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Volume 52

ALKALINE EARTH HYDROXIDES IN WATER AND AQUEOUS SOLUTIONS

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ALKALINE EARTH HYDROXIDES IN WATER AND AQUEOUS SOLUTIONS

Volume Editors

IRMA LAMBERT
Commissariat à l'Energie
Atomique D'Etudes
Fontenay-aux-Roses, France

H. LAWRENCE CLEVER
Emory University
Atlanta, GA, USA

Contributors

HISAHIKO EINAGA
Nagoya Institute of Technology
Nagoya, Japan

YU KOMATSU
National Institute for Research
in Inorganic Materials
Tsukuba, Ibaraki, Japan

JIRI HALA
J. E. Purkyne University
Brno, Czechoslovakia

JOHN W. LORIMER
University of Western Ontario
London, Ontario, Canada

A. F. VOROB'EV and D. I. MUSTAFIN
Mendeleev Institute of Chemical Technology
Moscow, Russia

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FOREWORD

> *If the knowledge is*
> *undigested or simply wrong,*
> *more is not better*

The Solubility Data Series is a project of Commission V.8 (Solubility Data) of the International Union of Pure and Applied Chemistry (IUPAC). The project had its origins in 1973, when the Analytical Chemistry Division of IUPAC set up a Subcommission on Solubility Data under the chairmanship of the late Prof. A. S. Kertes. When publication of the *Solubility Data Series* began in 1979, the Committee became a full commission of IUPAC, again under the chairmanship of Prof. Kertes, who also became Editor-in-Chief of the Series. The Series has as its goal the preparation of a comprehensive and critical compilation of data on solubilities in all physical systems, including gases, liquids and solids.

The motivation for the Series arose from the realization that, while solubility data are of importance in a wide range of fields in science and technology, the existing data had not been summarized in a form that was at the same time comprehensive and complete. Existing compilations of solubility data indeed existed, but they contained many errors, were in general uncritical, and were seriously out-of-date.

It was also realized that a new series of compilations of data gave educational opportunities, in that careful compilations of existing data could be used to demonstrate what constitutes data of high and lasting quality. As well, if the data were summarized in a sufficiently complete form, any individual could prepare his or her own evaluation, independently of the published evaluation. Thus, a special format was established for each volume, consisting of individual data sheets for each separate publication, and critical evaluations for each separate system, provided sufficient data from different sources were available for comparison. The compilations and, especially, the evaluation were to be prepared by active scientists who were either involved in producing new data, or were interested in using data of high quality. With minor modifications in format, this strategy has continued throughout the Series.

In the standard arrangement of each volume, the Critical Evaluation gives the following information

(i) A text which discusses the numerical solubility information which has been abstracted from the primary sources in the form of compilation sheets. The text concerns primarily the quality of the data, after consideration of the purity of the materials and their characterization, the experimental method used, the uncertainties in the experimental values, the reproducibility, the agreement with accepted test values, and finally, the fitting of the data to suitable functions, along with statistical tests of the fitted data.

(ii) A set of recommended data, whenever possible, including weighted averages and estimated standard deviations. If applicable, one or more smoothing equations which have been computed or verified by the evaluator are also given.

(iii) A graphical plot of the recommended data, in the form of phase diagrams where appropriate

The Compilation part consists of data sheets which summarize the experimental data from the primary literature. Here much effort is put into obtaining complete coverage, many good data have appeared in publications from the late nineteenth and early twentieth centuries, or in obscure journals. Data of demonstrably low precision are not compiled, but are mentioned in the Critical Evaluation. Similarly, graphical data, given the uncertainty of accurate conversion to numerical values, are compiled only where no better data are available The documentation of data of low precision can serve to alert researchers to areas where more work is needed.

A typical data sheet contains the following information:

(i) list of components: names, formulas, Chemical Abstracts Registry Numbers;
(ii) primary source of the data;
(iii) experimental variables;
(iv) compiler's name;
(v) experimental values as they appear in the primary source, in modern units with explanations if appropriate;
(vi) experimental methods used;
(vii) apparatus and procedure used;
(viii) source and purity of materials used;
(ix) estimated error, either from the primary source or estimated by the compiler;
(x) references relevant to the generation of the data cited in the primary source.

Each volume also contains a general introduction to the particular type of system, such as solubility of gases, of solids in liquids, etc., which contains a discussion of the nomenclature used, the principle of accurate determination of solubilities, and related thermodynamic principles. This general introduction is followed by a specific introduction to the subject matter of the volume itself.

The Series embodies a new approach to the presentation of numerical data, and the details continue to be influenced strongly by the perceived needs of prospective users. The approach used will, it is hoped, encourage attention to the quality of new published work, as authors become more aware that their work will attain permanence only if it meets the standards set out in these volumes. If the Series succeeds in this respect, even partially, the Solubility Data Commission will have justified the labour expended by many scientists throughout the world in its production.

January, 1989

J. W. Lorimer,
London, Canada

PREFACE

This volume presents solubility data for the hydroxides of the alkaline earth metals Be, Mg, Ca, Sr and Ba in water and aqueous solutions. No data were found for radium hydroxide. The literature has been covered up to 1990. The primary literature sources were *Chemical Abstracts*, and the reference books by Seidell and Linke (1), Gmelin (2), Pascal (3) and Mellor (4).

The calcium, strontium and barium hydroxides were used in sugar refining in the last century. Thus, it is not surprising that the first publications of solubility data for these hydroxides are to be found in the older literature connected with this industrial process. However, few quantitative data are available from these older publications and only published reports of quantitative data have been compiled. Many of these older papers are cited at the end of the evaluation reference lists. A partial listing of papers that report solubility studies of alkaline earth hydroxide containing systems, but contain no data on the alkaline earth hydroxide component, have also been appended to the evaluation reference lists.

The alkaline earth metal hydroxides can be divided into two groups depending on the hydration of the solid. One group consists of the sparingly soluble anhydrous hydroxides of beryllium, magnesium and calcium. The solubility of the magnesium and calcium hydroxides decreases with increasing temperature. Beryllium hydroxide probably has the same temperature coefficient of solubility, but the experimental solubility data are ambiguous. The more soluble strontium and barium hydroxides are octahydrates at room temperature and above. Their solubility increases with increasing temperature.

The alkaline earth hydroxides are strong bases which ionize in aqueous solution according to the solubility equilibrium

$$\mathrm{M(OH)_2 \cdot \mathit{r}H_2O(\mathit{s})} \rightleftharpoons \mathrm{M^{2+}(aq) + 2OH^-(aq) + \mathit{r}H_2O(\ell)}$$

The solubility depends strongly on p*H*. The thermodynamic solubility product is

$$K^{\circ}_{s0} = a(\mathrm{M}^{2+})a(\mathrm{OH}^-)^2 a(\mathrm{H_2O})^r \qquad [1]$$

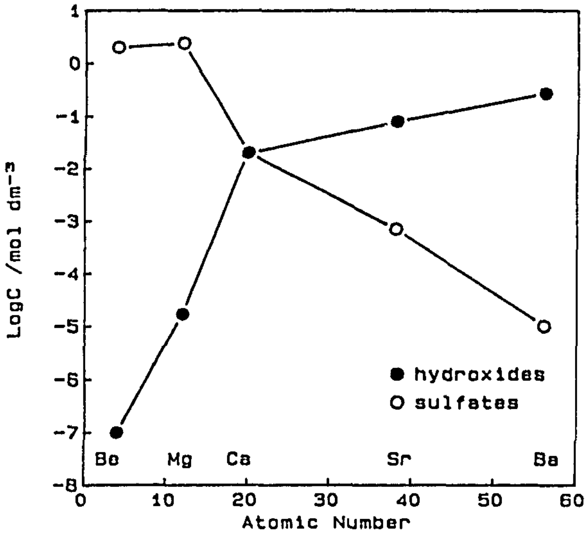
Because formation of ion pairs (and of higher complexes in the case of beryllium hydroxide) is important in solutions of these hydroxides, expressing the solubility product in pure water in terms of the molality, m, of the saturated solution, the mean activity coefficient, $\gamma_\pm$, and the osmotic coefficient, ϕ, requires as well the degree of association, α, thus

$$K^{0}_{s0} = 4\gamma_\pm^3(1 - \alpha)^3 m^3 \exp(-3r(1 - \alpha)\phi) \qquad [2]$$

It should be noted that the averaged evaluated solubility data alone are not of sufficient accuracy to derive values of the association constants from the fit of a model to the solubility data. The association constants must be determined by other methods such as spectrophotometry.

The solubility also depends on the crystalline state of the hydroxide. The freshly precipitated hydroxide is generally a poorly crystallized product. On aging the crystallinity improves and the substance is less soluble. This is especially true of the beryllium, magnesium and calcium hydroxides which form non-hydrated solids. The solid strontium and barium hydroxides which are hydrated do not show differences in solubility with aging.

The alkaline earth metal cations form salts with a wide range of solubilities with two common anions, the hydroxide and the sulfate. The accompanying figure shows solubilities at 298 K of the stable solid phase of these two series of substances as a function of cation atomic number. It is clear that the solubilities of the solid increase with increasing cation atomic number, while those of the sulfates decrease. Quantitative discussion of these differences must take account of the complications arising from the occurrence of hydrates $\mathrm{BeSO_4 \cdot 4H_2O}$, $\mathrm{MgSO_4 \cdot 6H_2O}$, $\mathrm{CaSO_4 \cdot 2H_2O}$, $\mathrm{Sr(OH)_2 \cdot 8H_2O}$ and $\mathrm{Ba(OH)_2 \cdot 8H_2O}$, as well as the variety of crystal structures for the various solid phases. However, the general trends are clear when the Gibbs energy and enthalpy for the solubility equilibria are considered as the resultant of decomposition of the crystal lattice plus hydration and complexation of the separated ions.



The solubility of the alkaline earth hydroxides and sulfates as a function of cation atomic number, 298 K.

First of all, the decrease of solubility with temperature of $Mg(OH)_2$ and $Ca(OH)_2$ indicates that the magnitude of the enthalpy of solvation is greater than the magnitude of the lattice enthalpy. For the octahydrates, the ions are already largely solvated in the crystal lattice, so the lattice enthalpy predominates. For the sulfates, the solubility generally increases with increasing temperature (except for a reversal of sign for $SrSO_4$ above room temperature), indicating the predominance of the lattice enthalpy in determining solubility.

Secondly, the magnitude of the thermodynamic solubility product is determined by the Gibbs energy, which can be split into contributions from entropy and enthalpy of lattice decomposition and solvation. We can postulate that the entropy of solvation is much larger for the hydroxide ion than for the sulfate ion: the hydroxide tends to lose its identity when solvated. Thus the entropy and enthalpy terms are determined mainly by the hydroxide ions, and have roughly the same magnitude for the Be, Mg and Ca hydroxides, so that the solubilities are low. For the Sr and Ba hydroxide octahydrates the hydroxide ions are already hydrated in the crystal, so the solubilities are greater, and not too different. For the sulfates, solvation is restricted to the cations, and decreases with decreasing charge density, *i.e.* as the atomic number increases. Thus, with increasing atomic number, the enthalpy and entropy contributions to the Gibbs energy become smaller and more equal, and the solubility decreases.

These general conclusions are supported by those thermodynamic values for standard state solvation enthalpies which can be calculated from tabulated data (6). More precise conclusions depend on knowledge of the detailed structure of the crystalline phases and of the saturated solutions.

General procedures for Evaluation

(a) Beryllium hydroxide. No reliable data for the temperature coefficient of solubility are available. The critical evaluation makes use of ancillary data relating to the structure and composition of dilute solutions of beryllium hydroxide.

(b) Other hydroxides. General equations for the activity coefficients under all conditions of temperature and composition were examined, but the number of unknown, but necessary parameters, was sufficiently large that a simpler approach was adopted for fitting the solubility data as a function of temperature. Under the assumptions that the factors containing activity and osmotic coefficients and the degree of association in eqn [1] follow the same temperature dependence along the solubility curve as does the solubility itself, and that the enthalpy of solution can be expressed by a general equation which is discussed in the *Introduction to the Series on Solubility of Solids in Liquids* in this volume, two fitting equations were used. For anhydrous solid phases in contact with pure water,

$$Y_m = \ln(m/m^0) = B_1 + B_2K/T + B_3\ln(T/K) \qquad [3]$$

where m is the molality, m^0 the standard molality of 1 mol kg^{-1}, T the thermodynamic temperature, and B_i $i = 1,2,3$ are constants found by least square fits to the experimental data.

For the hydrated solid phases,

$$Y_m = \ln(m/m^*) - (m/m^* - 1) = A_1 + A_2K/T + A_3\ln(T/K) \qquad [4]$$

where $m^* = 1/rM_W$ is the molality at the metastable congruent melting point of the salt hydrate, with M_W the molar mass of water, and A_i, $i = 1,2,3$ constants, again found by a least square fit to the experimental data. Once the coefficients of this equation are found, an estimation of the congruent melting point can be made by setting $Y_m = 0$. When this equation has been applied to data with a known saturating solid phase over a particular range of temperature, then data at higher temperatures can be tested for consistency with the given solid phase.

For ternary and higher systems, and for non-aqueous systems, sufficient data for reliable evaluation are rarely available. Those data that do exist are summarized in the critical evaluations.

The editors gratefully acknowledge the advice and comments from members of the IUPAC Commission V.8 on Solubility Data, in particular Dr. Mark Salomon, Chairman, IUPAC Commission V.8, and Professor J. W. Lorimer, Editor-in-Chief, for their constructive criticisms and suggestions. Professor Lorimer suggested and contributed to the comparison of the hydroxide and sulfate solubilities above. We also thank Ms. Marian Iwamoto for her help in typing parts of the manuscript.

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Irma Lambert
Fontenay-aux-Roses
FRANCE

H. Lawrence Clever
Atlanta, Georgia, USA

December, 1991

INTRODUCTION TO THE SOLUBILITY OF SOLIDS IN LIQUIDS

Nature of the Project

The Solubility Data Project (SDP) has as its aim a comprehensive search of the literature for solubilities of gases, liquids, and solids in liquids or solids. Data of suitable precision are compiled on data sheets in a uniform format. The data for each system are evaluated, and where data from different sources agree sufficiently, recommended values are proposed. The evaluation sheets, recommended values, and compiled data sheets are published on consecutive pages.

Definitions

A *mixture* (1, 2) describes a gaseous, liquid, or solid phase containing more than one substance, when the substances are all treated in the same way.

A *solution* (1, 2) describes a liquid or solid phase containing more than one substance, when for convenience one of the substances, which is called the *solvent*, and may itself be a mixture, is treated differently than the other substances, which are called *solutes*. If the sum of the mole fractions of the solutes is small compared to unity, the solution is called a *dilute solution*.

The *solubility* of a substance B is the relative proportion of B (or a substance related chemically to B) in a mixture which is saturated with respect to solid B at a specified temperature and pressure. *Saturated* implies the existence of equilibrium with respect to the processes of dissolution and precipitation; the equilibrium may be stable or metastable. The solubility of a substance in metastable equilibrium is usually greater than that of the corresponding substance in stable equilibrium. (Strictly speaking, it is the activity of the substance in metastable equilibrium that is greater.) Care must be taken to distinguish true metastability from supersaturation, where equilibrium does not exist.

Either point of view, mixture or solution, may be taken in describing solubility. The two points of view find their expression in the quantities used as measures of solubility and in the reference states used for definition of activities, activity coefficients and osmotic coefficients.

The qualifying phrase "substance related chemically to B" requires comment. The composition of the saturated mixture (or solution) can be described in terms of any suitable set of thermodynamic components. Thus, the solubility of a salt hydrate in water is usually given as the relative proportion of anhydrous salt in solution, rather than the relative proportions of hydrated salt and water.

Quantities Used as Measures of Solubility

1. *Mole fraction of substance B*, x_B:

$$x_B = n_B/\sum_{s=1}^{c} n_s \qquad [1]$$

where n_s is the amount of substance of s, and c is the number of distinct substances present (often the number of thermodynamic components in the system). *Mole per cent* of B is $100\ x_B$.

2. *Mass fraction of substance B*, w_B:

$$w_B = m_B'/\sum_{s=1}^{c} m_s' \qquad [2]$$

where m_s' is the mass of substance s. *Mass per cent* is $100\ w_B$. The equivalent terms *weight fraction* and *weight per cent* are not used.

3. *Solute mole (mass) fraction of solute B* (3, 4):

$$x_{s,B} = m_B/\sum_{s=1}^{c'} m_s = x_B/\sum_{s=1}^{c'} x_s \qquad [3]$$

$$w_{s,B} = m_B'/\sum_{s=1}^{c'} m_s' = w_B/\sum_{s=1}^{c'} w_s \qquad [3a]$$

where the summation is over the solutes only. For the solvent A, $x_{S,A} = x_A/(1 - x_A)$, $w_{S,A} = w_A/(1 - w_A)$. These quantities are called *Jänecke mole (mass) fractions* in many papers.

4. *Molality* of solute *B* (1, 2) in a solvent A:

$$m_B = n_B/n_A M_A \qquad \text{SI base units: mol kg}^{-1} \qquad [4]$$

where M_A is the molar mass of the solvent.

5. *Concentration* of solute *B* (1, 2) in a solution of volume V:

$$c_B = [B] = n_B/V \qquad \text{SI base units: mol m}^{-3} \qquad [5]$$

The symbol c_B is preferred to [B], but both are used. The terms *molarity* and *molar* are not used.

Mole and mass fractions are appropriate to either the mixture or the solution point of view. The other quantities are appropriate to the solution point of view only. Conversions among these quantities can be carried out using the equations given in Table 1-1 following this Introduction. Other useful quantities will be defined in the prefaces to individual volumes or on specific data sheets.

In addition to the quantities defined above, the following are useful in conversions between concentrations and other quantities.

6. *Density*: $\rho = m/V$ SI base units: kg m^{-3} [6]

7. *Relative density*: d; the ratio of the density of a mixture to the density of a reference substance under conditions which must be specified for both (1). The symbol $d_{t'}^{t}$ will be used for the density of a mixture at t°C, 1 bar divided by the density of water at t'°C, 1 bar. (In some cases 1 atm = 101.325 kPa is used instead of 1 bar = 100 kPa.)

8. *A note on nomenclature*. The above definitions use the nomenclature of the IUPAC *Green Book* (1), in which a solute is called *B* and a solvent *A* In compilations and evaluations, the first-named component (component 1) is the solute, and the second (component 2 for a two-component system) is the solvent. The reader should bear these distinctions in nomenclature in mind when comparing nomenclature and theoretical equations given in this Introduction with equations and nomenclature used on the evaluation and compilation sheets.

Thermodynamics of Solubility

The principal aims of the Solubility Data Project are the tabulation and evaluation of: (a) solubilities as defined above; (b) the nature of the saturating phase. Thermodynamic analysis of solubility phenomena has two aims: (a) to provide a rational basis for the construction of functions to represent solubility data; (b) to enable thermodynamic quantities to be extracted from solubility data. Both these are difficult to achieve in many cases because of a lack of experimental or theoretical information concerning activity coefficients. Where thermodynamic quantities can be found, they are not evaluated critically, since this task would involve critical evaluation of a large body of data that is not directly relevant to solubility. The following is an outline of the principal thermodynamic relations encountered in discussions of solubility. For more extensive discussions and references, see books on thermodynamics, e.g., (5-12).

Activity Coefficients (*1*)

(a) *Mixtures*. The activity coefficient f_B of a substance *B* is given by

$$RT \ln (f_B x_B) = \mu_B - \mu_B^* \qquad [7]$$

where μ_B^* is the chemical potential of pure *B* at the same temperature and pressure. For any substance *B* in the mixture,

$$\lim_{x_B \to 1} f_B = 1 \qquad [8]$$

(b) *Solutions*.

(i) *Solute B*. The molal activity coefficient γ_B is given by

$$RT \ln(\gamma_B m_B) = \mu_B - (\mu_B - RT \ln m_B)^{\infty} \qquad [9]$$

where the superscript $^{\infty}$ indicates an infinitely dilute solution. For any solute *B*,

$$\gamma_B^{\infty} = 1 \qquad [10]$$

Activity coefficients y_B connected with concentrations c_B, and $f_{x,B}$ (called the *rational activity coefficient*) connected with mole fractions x_B are defined in analogous ways. The relations among them are (1, 9), where ρ^* is the density of the pure solvent:

$$f_B = (1 + M_A\sum_s m_s)\gamma_B = [\rho + \sum_s(M_A - M_s)c_s]y_B/\rho^* \qquad [11]$$

$$\gamma_B = (1 - \sum_s x_s)f_{x,B} = (\rho - \sum_s M_s c_s)y_B/\rho^* \qquad [12]$$

$$y_B = \rho^* f_{x,B}[1 + \sum_s(M_s/M_A - 1)x_B]/\rho = \rho^*(1 + \sum_s M_s m_s)\gamma_B/\rho \qquad [13]$$

For an electrolyte solute $B \equiv C_{\nu+}A_{\nu-}$, the activity on the molality scale is replaced by (9)

$$\gamma_B m_B = \gamma_\pm{}^\nu m_B{}^\nu Q^\nu \qquad [14]$$

where $\nu = \nu_+ + \nu_-$, $Q = (\nu_+{}^{\nu_+}\nu_-{}^{\nu_-})^{1/\nu}$, and $\gamma_\pm$ is the mean ionic activity coefficient on the molality scale. A similar relation holds for the concentration activity, $y_B c_B$. For the mole fractional activity,

$$f_{x,B}x_B = Q^{\,\nu} f_\pm{}^\nu x_\pm{}^\nu \qquad [15]$$

where $x_\pm = (x_+x_-)^{1/\nu}$. The quantities x_+ and x_- are the ionic mole fractions (9), which are

$$x_+ = \nu_+x_B/[1 + \sum_s(\nu_s - 1)x_s]; \quad x_- = \nu_-x_B[1 + \sum_s(\nu_s - 1)x_s] \qquad [16]$$

where ν_s is the sum of the stoichiometric coefficients for the ions in a salt with mole fraction x_s. Note that the mole fraction of solvent is now

$$x_A{}' = (1 - \sum_s \nu_s x_s)/[1 + \sum_s(\nu_s - 1)x_s] \qquad [17]$$

so that

$$x_A{}' + \sum_s \nu_s x_s = 1 \qquad [18]$$

The relations among the various mean ionic activity coefficients are:

$$f_\pm = (1 + M_A\sum_s \nu_s ms)\gamma_\pm = [\rho + \sum_s(\nu_s M_A - M_s)c_s]y_\pm/\rho^* \qquad [19]$$

$$\gamma_\pm = \frac{(1 - \sum_s x_s)f_\pm}{1 + \sum_s(\nu_s - 1)x_s} = (\rho - \sum_s M_s c_s)y_\pm/\rho^* \qquad [20]$$

$$y_\pm = \frac{\rho^*[1 + \sum_s(M_s/M_A - 1)xs]f_\pm}{\rho[1 + \sum_s(\nu_s - 1)x_s]} = \rho^*(1 + \sum_s M_s m_s)\gamma_\pm/\rho \qquad [21]$$

(ii) *Solvent, A*:

The *osmotic coefficient*, ϕ, of a solvent A is defined as (1):

$$\phi = (\mu_A{}^* - \mu_A)/RT\,M_A\sum_s m_s \qquad [22]$$

where $\mu_A{}^*$ is the chemical potential of the pure solvent.

The *rational osmotic coefficient*, ϕ_x, is defined as (1):

$$\phi_x = (\mu_A - \mu_A{}^*)/RT\ln x_A = \phi M_A\sum_s m_s/\ln(1 + M_A\sum_s m_s) \qquad [23]$$

The activity, a_A, or the activity coefficient, f_A, is sometimes used for the solvent rather than the osmotic coefficient. The activity coefficient is defined relative to pure A, just as for a mixture.

For a mixed solvent, the molar mass in the above equations is replaced by the average molar mass; i.e., for a two-component solvent with components J, K, M_A becomes

$$M_A = M_J + (M_K - M_J)x_{v,K} \qquad [24]$$

where $x_{v,K}$ is the *solvent* mole fraction of component K.

The osmotic coefficient is related directly to the vapor pressure, p, of a solution in equilibrium with vapor containing A only by (12, p.306):

$$\phi M_A\sum_s \nu_s m_s = -\ln(p/p_A{}^*) + (V^*_{m,A} - B_{AA})(p - p_A{}^*)/RT \qquad [25]$$

where $p_A{}^*$, $V^*_{m,A}$ are the vapor pressure and molar volume of pure solvent A, and B_{AA} is the second virial coefficient of the vapor.

The Liquid Phase

A general thermodynamic differential equation which gives solubility as a function of temperature, pressure and composition can be derived. The approach is similar to that of Kirkwood and Oppenheim (7); see also (11, 12). Consider a solid mixture containing c thermodynamic components i. The Gibbs-Duhem equation for this mixture is:

$$\sum_{i=1}^{c} x_i'(S_i'dT - V_i'dp + d\mu_i') = 0 \qquad [26]$$

A liquid mixture in equilibrium with this solid phase contains c' thermodynamic components i, where $c' > c$. The Gibbs-Duhem equation for the liquid mixture is:

$$\sum_{i=1}^{c} x_i(S_i dT - V_i dp + d\mu_i') + \sum_{i=c+1}^{c'} x_i(S_i dT - V_i dp + d\mu_i) = 0 \qquad [27]$$

Subtract [26] from [27] and use the equation

$$d\mu_i = (d\mu_i)_{T,p} - S_i dT + V_i dp \qquad [28]$$

and the Gibbs-Duhem equation at constant temperature and pressure:

$$\sum_{i=1}^{c} x_i(d\mu_i')_{T,p} + \sum_{i=c+1}^{c'} x_i(d\mu_i)_{T,p} = 0 \qquad [29]$$

The resulting equation is:

$$RT\sum_{i=1}^{c} x_i'(d\ln a_i)_{T,p} = \sum_{i=1}^{c} x_i'(H_i - H_i')dT/T - \sum_{i=1}^{c} x_i'(V_i - V_i')dp \qquad [30]$$

where

$$H_i - H_i' = T(S_i - S_i') \qquad [31]$$

is the enthalpy of transfer of component i from the solid to the liquid phase at a given temperature, pressure and composition, with H_i and S_i the partial molar enthalpy and entropy of component i.

Use of the equations

$$H_i - H_i^0 = -RT^2(\partial\ln a_i/\partial T)_{x,p} \qquad [32]$$

and

$$V_i - V_i^0 = RT(\partial\ln a_i/\partial p)_{x,T} \qquad [33]$$

where superscript ^{0} indicates an arbitrary reference state gives:

$$RT\sum_{i=1}^{c} x_i' d\ln a_i = \sum_{i=1}^{c} x_i'(H_i^0 - H_i')dT/T - \sum_{i=1}^{c} x_i'(V_i^0 - V_i')dp \qquad [34]$$

where

$$d\ln a_i = (d\ln a_i)_{T,p} + (\partial\ln a_i/\partial T)_{x,p} + (\partial\ln a_i/\partial p)_{x,T} \qquad [35]$$

The terms involving enthalpies and volumes in the solid phase can be written as:

$$\sum_{i=1}^{c} x_i'H_i' = H_s^* \qquad \sum_{i=1}^{c} x_i'V_i' = V_s^* \qquad [36]$$

With eqn [36], the final general solubility equation may then be written:

$$R\sum_{i=1}^{c} x_i' d\ln a_i = (H_s^* - \sum_{i=1}^{c} x_i'H_i^0)d(1/T) - (V_s^* - \sum_{i=1}^{c} x_i'V_i^0)dp/T \qquad [37]$$

Note that those components which are not present in both phases do not appear in the solubility equation. However, they do affect the solubility through their effect on the activities of the solutes.

Several applications of eqn [37] (all with pressure held constant) will be discussed below. Other cases will be discussed in individual evaluations.

(a) *Solubility as a function of temperature.*

Consider a binary solid compound A_nB in a single solvent A. There is no fundamental thermodynamic distinction between a binary compound of A and B which dissociates completely or partially on melting and a solid mixture of A and B; the binary compound can be regarded as a solid mixture of constant composition. Thus, with $c = 2$, $x_A' = n/(n + 1)$, $x_B' = 1/(n + 1)$, eqn [37] becomes:

$$d\ln(a_A{}^n a_B) = -\Delta H_{AB}{}^0 d(1/RT) \qquad [38]$$

where

$$\Delta H_{AB}{}^0 = nH_A + H_B - (n + 1)H_s{}^* \qquad [39]$$

is the molar enthalpy of melting and dissociation of pure solid A_nB to form A and B in their reference states. Integration between T and T_0, the melting point of the pure binary compound A_nB, gives:

$$\ln(a_A{}^n a_B) = \ln(a_A{}^n a_B)_{T=T_0} - \int_{T_0}^{T} \Delta H_{AB}{}^0 d(1/RT) \qquad [40]$$

(i) Non-electrolytes

In eqn [32], introduce the pure liquids as reference states. Then, using a simple first-order dependence of $\Delta H_{AB}{}^*$ on temperature, and assuming that the activitity coefficients conform to those for a simple mixture (6):

$$RT \ln f_A = wx_B{}^2 \qquad RT \ln f_B = wx_A{}^2 \qquad [41]$$

then, if w is independent of temperature, eqn [32] and [33] give:

$$\ln\{x_B(1-x_B)^n\} + \ln\left\{\frac{n^n}{(1 + n)^{n+1}}\right\} = G(T) \qquad [42]$$

where

$$G(T) = -\left\{\frac{\Delta H_{AB}{}^* - T^*\Delta C_p{}^*}{R}\right\}\left\{\frac{1}{T} - \frac{1}{T^*}\right\} + \frac{\Delta C_p{}^*}{R}\ln(T/T^*) - \frac{w}{R}\left\{\frac{x_A{}^2 + nx_B{}^2}{T} - \frac{n}{(n + 1)T^*}\right\} \qquad [43]$$

where $\Delta C_p{}^*$ is the change in molar heat capacity accompanying fusion plus decomposition of the pure compound to pure liquid A and B at temperature T^*, (assumed here to be independent of temperature and composition), and $\Delta H_{AB}{}^*$ is the corresponding change in enthalpy at $T = T^*$. Equation [42] has the general form:

$$\ln\{x_B(1-x_B)^n\} = A_1 + A_2/(T/K) + A_3\ln(T/K) + A_4(x_A{}^2 + nx_B{}^2)/(T/K) \qquad [44]$$

If the solid contains only component B, then $n = 0$ in eqn [42] to [44].

If the infinite dilution reference state is used, then:

$$RT \ln f_{x,B} = w(x_A{}^2 - 1) \qquad [45]$$

and [39] becomes

$$\Delta H_{AB}{}^\infty = nH_A{}^* + H_B{}^\infty - (n + 1)H_s{}^* \qquad [46]$$

where $\Delta H_{AB}{}^\infty$ is the enthalpy of melting and dissociation of solid compound A_nB to the infinitely dilute reference state of solute B in solvent A; $H_A{}^*$ and $H_B{}^\infty$ are the partial molar enthalpies of the solute and solvent at infinite dilution. Clearly, the integral of eqn [32] will have the same form as eqn [35], with $\Delta H_{AB}{}^\infty$ replacing $\Delta H_{AB}{}^*$, $\Delta C_p{}^\infty$ replacing ΔCp^*, and $x_A{}^2 - 1$ replacing $x_A{}^2$ in the last term.

See (5) and (11) for applications of these equations to experimental data.

(ii) Electrolytes

(a) Mole fraction scale

If the liquid phase is an aqueous electrolyte solution, and the solid is a salt hydrate, the above treatment needs slight modification. Using rational mean activity coefficients, eqn [34] becomes:

$$\ln\left\{\frac{x_B{}^{\nu}(1 - x_B)^n}{[1 + (\nu - 1)x_B]^{n+\nu}}\right\} - \ln\left\{\frac{n^n}{(n + \nu)^{n+\nu}}\right\} + \ln\left\{\left[\frac{f_B}{f_B{}^*}\right]^{\nu}\left[\frac{f_A}{f_A{}^*}\right]^{n}\right\}$$

$$= -\left\{\frac{\Delta H_{AB}{}^* - T^*\Delta C_p{}^*}{R}\right\}\left\{\frac{1}{T} - \frac{1}{T^*}\right\} + \frac{\Delta Cp^*}{R} \ln(T/T^*) \qquad [47]$$

where superscript * indicates the pure salt hydrate. If it is assumed that the activity coefficients follow the same temperature dependence as the right-hand side of eqn [47] (13-16), the thermochemical quantities on the right-hand side of eqn [47] are not rigorous thermodynamic enthalpies and heat capacities, but are apparent quantities only. Data on activity coefficients (9) in concentrated solutions indicate that the terms involving these quantities are not negligible, and their dependence on temperature and composition along the solubility-temperature curve is a subject of current research.

A similar equation (with $\nu = 2$ and without the heat capacity terms or activity coefficients) has been used to fit solubility data for some MOH-H_2O systems, where M is an alkali metal (13); enthalpy values obtained agreed well with known values. The full equation has been deduced by another method in (14) and applied to MCl_2-H_2O systems in (14) and (15). For a summary of the use of equation [47] and similar equations, see (14).

(2) Molality scale

Substitution of the mean activities on the molality scale in eqn [40] gives:

$$\nu\ln\left[\frac{\gamma_{\pm}m_B}{\gamma_{\pm}{}^*m_B{}^*}\right] - \nu(m_B/m_B{}^* - 1) - \nu(m_B(\phi - 1)/m_B{}^* - \phi^* + 1)$$

$$= G(T) \qquad [48]$$

where $G(T)$ is the same as in eqn [47], $m_B{}^* = 1/nM_A$ is the molality of the anhydrous salt in the pure salt hydrate and $\gamma_{\pm}$ and ϕ are the mean activity coefficient and the osmotic coefficient, respectively. Use of the osmotic coefficient for the activity of the solvent leads, therefore, to an equation that has a different appearance to [47]; the content is identical. However, while eqn [47] can be used over the whole range of composition ($0 < x_B < 1$), the molality in eqn [48] becomes infinite at $x_B = 1$; use of eqn [48] is therefore confined to solutions sufficiently dilute that the molality is a useful measure of composition. The essentials of eqn [48] were deduced by Williamson (17); however, the form used here appears first in the *Solubility Data Series*. For typical applications (where activity and osmotic coefficients are not considered explicitly, so that the enthalpies and heat capacities are apparent values, as explained above), see (18).

The above analysis shows clearly that a rational thermodynamic basis exists for functional representation of solubility-temperature curves in two-component systems, but may be difficult to apply because of lack of experimental or theoretical knowledge of activity coefficients and partial molar enthalpies. Other phenomena which are related ultimately to the stoichiometric activity coefficients and which complicate interpretation include ion pairing, formation of complex ions, and hydrolysis. Similar considerations hold for the variation of solubility with pressure, except that the effects are relatively smaller at the pressures used in many investigations of solubility (5).

(b) *Solubility as a function of composition.*

At constant temperature and pressure, the chemical potential of a saturating solid phase is constant:

$$\mu_{A_nB}{}^* = \mu_{A_nB}(\mathrm{sln}) = n\mu_A + \mu_B \qquad [49]$$

$$= (n\mu_A{}^* + \nu_+\mu_+{}^\infty + \nu_-\mu_-{}^\infty) + nRT \ln f_Ax_A$$

$$+ \nu RT \ln(\gamma_{\pm}m_{\pm}Q)$$

for a salt hydrate A_nB which dissociates to water (A), and a salt (B), one mole of which ionizes to give ν_+ cations and ν_- anions in a solution in which other substances (ionized or not) may be present. If the saturated solution is sufficiently dilute, $f_A = x_A = 1$, and the quantity K_s in

$$\Delta G^\infty = (\nu_+\mu_+{}^\infty + \nu_-\mu_-{}^\infty + n\mu_A{}^* - \mu_{AB}{}^*)$$

$$= -RT \ln K_s$$

$$= -\nu RT \ln(Q\gamma_{\pm}m_B) \qquad [50]$$

is called the *solubility product* of the salt. (It should be noted that it is not customary to extend this definition to hydrated salts, but there is no reason why they should be excluded.) Values of the solubility product are often given on mole fraction or concentration scales. In dilute solutions, the theoretical behaviour of the activity coefficients as a function of ionic strength is often sufficiently well known that reliable extrapolations to infinite dilution can be made, and values of K_S can be determined. In more concentrated solutions, the same problems with activity coefficients that were outlined in the section on variation of solubility with temperature still occur. If these complications do not arise, the solubility of a hydrate salt $C_{\nu}A_{\nu}\cdot nH_2O$ in the presence of other solutes is given by eqn [50] as

$$\nu \ln\{m_B/m_B(0)\} = -\nu\ln\{\gamma_{\pm}/\gamma_{\pm}(0)\} - n \ln\{a_A/a_A(0)\} \qquad [51]$$

where a_A is the activity of water in the saturated solution, m_B is the molality of the salt in the saturated solution, and (0) indicates absence of other solutes. Similar considerations hold for non-electrolytes.

Consideration of *complex mixed ligand equilibria* in the solution phase are also frequently of importance in the interpretation of solubility equilibria. For nomenclature connected with these equilibria (and solubility equilibria as well), see (19, 20).

The Solid Phase

The definition of solubility permits the occurrence of a single solid phase which may be a pure anhydrous compound, a salt hydrate, a non-stoichiometric compound, or a solid mixture (or solid solution, or "mixed crystals"), and may be stable or metastable. As well, any number of solid phases consistent with the requirements of the phase rule may be present. Metastable solid phases are of widespread occurrence, and may appear as polymorphic (or allotropic) forms or crystal solvates whose rate of transition to more stable forms is very slow. Surface heterogeneity may also give rise to metastability, either when one solid precipitates on the surface of another, or if the size of the solid particles is sufficiently small that surface effects become important. In either case, the solid is not in stable equilibrium with the solution. See (21) for the modern formulation of the effect of particle size on solubility. The stability of a solid may also be affected by the atmosphere in which the system is equilibrated.

Many of these phenomena require very careful, and often prolonged, equilibration for their investigation and elimination. A very general analytical method, the "wet residues" method of Schreinemakers (22), is often used to investigate the composition of solid phases in equilibrium with salt solutions. This method has been reviewed in (23), where [see also (24)] least-squares methods for evaluating the composition of the solid phase from wet residue data (or initial composition data) and solubilities are described. In principle, the same method can be used with systems of other types. Many other techniques for examination of solids, in particular X-ray, optical, and thermal analysis methods, are used in conjunction with chemical analyses (including the wet residues method).

COMPILATIONS AND EVALUATIONS

The formats for the compilations and critical evaluations have been standardized for all volumes. A brief description of the data sheets has been given in the FOREWORD; additional explanation is given below.

Guide to the Compilations

The format used for the compilations is, for the most part, self-explanatory. The details presented below are those which are not found in the FOREWORD or which are not self-evident.

Components. Each component is listed according to IUPAC name, formula, and Chemical Abstracts (CA) Registry Number. The formula is given either in terms of the IUPAC or Hill (25) system and the choice of formula is governed by what is usual for most current users: i.e., IUPAC for inorganic compounds, and Hill system for organic compounds. Components are ordered according to:

(a) saturating components;
(b) non-saturating components in alphanumerical order;
(c) solvents in alphanumerical order.

The saturating components are arranged in order according to a 18-column periodic table with two additional rows:

Columns 1 and 2: H, alkali elements, ammonium, alkaline earth elements
3 to 12: transition elements
13 to 17: boron, carbon, nitrogen groups; chalcogenides, halogens
18: noble gases
Row 1: Ce to Lu
Row 2: Th to the end of the known elements, in order of atomic number.

Salt hydrates are generally not considered to be saturating components since most solubilities are expressed in terms of the anhydrous salt. The existence of hydrates or solvates is carefully noted in the text, and CA Registry Numbers are given where available, usually in the critical evaluation. Mineralogical names are also quoted, along with their CA Registry Numbers, again usually in the critical evaluation.

Original Measurements. References are abbreviated in the forms given by *Chemical Abstracts Service Source Index* (CASSI). Names originally in other than Roman alphabets are given as transliterated by *Chemical Abstracts*.

Experimental Values. Data are reported in the units used in the original publication, with the exception that modern *names* for units and quantities are used; e.g., mass per cent for weight per cent; mol dm^{-3} for molar; etc. Both mass and molar values are given. Usually, only one type of value (e.g., mass per cent) is found in the original paper, and the compiler has added the other type of value (e.g., mole per cent) from computer calculations based on 1983 atomic weights (26).

Errors in calculations and fitting equations in original papers have been noted and corrected, by computer calculations where necessary.

Method. Source and Purity of Materials. Abbreviations used in *Chemical Abstracts* are often used here to save space.

Estimated Error. If these data were omitted by the original authors, and if relevant information is available, the compilers have attempted to estimate errors from the internal consistency of data and type of apparatus used. Methods used by the compilers for estimating and and reporting errors are based on the papers by Ku and Eisenhart (27).

Comments and/or Additional Data. Many compilations include this section which provides short comments relevant to the general nature of the work or additional experimental and thermodynamic data which are judged by the compiler to be of value to the reader.

References. See the above description for Original Measurements.

Guide to the Evaluations

The evaluator's task is to check whether the compiled data are correct, to assess the reliability and quality of the data, to estimate errors where necessary, and to recommend "best" values. The evaluation takes the form of a summary in which all the data supplied by the compiler have been critically reviewed. A brief description of the evaluation sheets is given below.

Components. See the description for the Compilations.

Evaluator. Name and date up to which the literature was checked.

Critical Evaluation

(a) Critical text. The evaluator produces text evaluating *all* the published data for each given system. Thus, in this section the evaluator reviews the merits or shortcomings of the various data. Only published data are considered; even published data can be considered only if the experimental data permit an assessment of reliability.

(b) Fitting equations. If the use of a smoothing equation is justifiable the evaluator may provide an equation representing the solubility as a function of the variables reported on all the compilation sheets.

(c) Graphical summary. In addition to (b) above, graphical summaries are often given.

(d) Recommended values. Data are *recommended* if the results of at least two independent groups are available and they are in good agreement, and if the evaluator has no doubt as to the adequacy and reliability of the applied experimental and computational procedures. Data are considered as tentative if only one set of measurements is available, or if the evaluator considers some aspect of the computational or experimental method as mildly undesirable but estimates that it should cause only minor errors. Data are considered as *doubtful* if the evaluator considers some aspect of the computational or experimental method as undesirable but still considers the data to have some value in those instances where the order of magnitude of the solubility is needed. Data determined by an inadequate method or under ill-defined conditions are *rejected*. However references to these data are included in the evaluation together with a comment by the evaluator as to the reason for their rejection.

(e) References. All pertinent references are given here. References to those data which, by virtue of their poor precision, have been rejected and not compiled are also listed in this section.

(f) Units. While the original data may be reported in the units used by the investigators, the final recommended values are reported in S.I. units (1, 28) when the data can be accurately converted.

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September, 1986

R. Cohen-Adad,
Villeurbanne, France

J. W. Lorimer,
London, Ontario, Canada

M. Salomon,
Fair Haven, New Jersey, U.S.A.

Table I-1

Quantities Used as Measures of Solubility of Solute *B*
Conversion Table for Multicomponent Systems
Containing Solvent *A* and Solutes *s*

	mole fraction $x_B =$	mass fraction $w_B =$	molality $m_B =$	concentration $c_B =$
x_B	x_B	$\dfrac{M_B x_B}{M_A + \sum_s (M_s - M_A) x_s}$	$\dfrac{x_B}{M_A(1 - \sum_s x_s)}$	$\dfrac{\rho x_B}{M_A + \sum_s (M_s - M_A) x_s}$
w_B	$\dfrac{w_B/M_B}{1/M_A + \sum_s (1/M_s - 1/M_A) w_s}$	w_B	$\dfrac{w_B}{M_B(1 - \sum_s w_s)}$	$\rho w_B/M_B$
m_B	$\dfrac{M_A m_B}{1 + M_A \sum_s m_s}$	$\dfrac{M_B m_B}{1 + \sum_s m_s M_s}$	m_B	$\dfrac{\rho m_B}{1 + \sum_s M_s m_s}$
c_B	$\dfrac{M_A c_B}{\rho + \sum_s (M_A - M_s) c_s}$	$M_B c_B/\rho$	$\dfrac{c_B}{\rho - \sum_s M_s c_s}$	c_B

ρ = density of solution
M_A, M_B, M_s = molar masses of solvent, solute *B*, other solutes *s*
Formulas are given in forms suitable for rapid computation; all calculations should be made using SI base units.

ACKNOWLEDGEMENTS

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1. The solubility of beryllium hydroxide in aqueous systems.

Systems	Pages
$Be(OH)_2 + H_2O$	2-11(E) 12-15
$BeO + HF + H_2O$	6(E), 16-17
——— + ——— + $HNO_3 + H_2O$	6(E), 18
$Be(OH)_2 + HCl + H_2O$	2(E), 19
$BeO + HClO_4 + H_2O$	6(E), 20
$Be(OH)_2 + HClO_4 + H_2O$	2(E), 21
——— + $HNO_3 + H_2O$	- , 22
——— + $BeCl_2 + NaOH + H_2O$	6(E), 23-24
——— + $BeBr_2 + (HBr) + NaOH + H_2O$	6(E), 25-26
——— + $BeI_2 + (HI) + NaOH + H_2O$	6(E), 27-28
——— + $BeSO_4 + H_2O$	6(E), 29
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——— + ——— + $KOH + H_2O$	6(E), 32
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——— + ——— + $NaHCO_3 + H_2O$	5-6(E), 45
——— + ——— + $Na_2CO_3 + H_2O$	5-6(E), 46
——— + ——— + $CH_2COOHC(OH)(COOH)CH_2COOH + H_2O$	6(E), 47
——— + $NaNO_3 + H_2O$	6(E), 48

(E) for evaluation pages.

COMPONENTS:	EVALUATOR:	
(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

An evaluation of the solubility of beryllium hydroxide in water and in various aqueous solutions.

The solubility of beryllium hydroxide depends on the crystaline form of the hydroxide. Solubility data are reported for three forms of the solid: an amorphous hydroxide, a metastable α-$Be(OH)_2$ and the stable β-$Be(OH)_2$. At temperatures above 673 K the anhydrous oxide, BeO, is the stable form (1). The amorphous hydroxide forms on precipitation from a salt solution. In water it transforms to the less soluble metastable α-$Be(OH)_2$ (2, 6). In concentrated basic solution α-$Be(OH)_2$ spontaneously transforms to the thermodynamically stable β-$Be(OH)_2$ (6).

The solubility of beryllium hydroxide has been determined either by direct analysis of the saturated solution or by a potentiometric method. The direct analysis of the saturated solution is used for the stable forms and the potentiometric method is used during precipitation of the amorphous form. Results from references (5, 11, 12, 14) were rejected because the temperature or the nature of the solid phase were ill-defined, or when the experimental details were insufficient to allow evaluation of the precision of the measurements.

1. Solubility of $Be(OH)_2$ in water and in dilute solutions of acids and bases near room temperature.

Direct solubility measurements in dilute acid and base solutions have been reported around room temperature (1-3, 5, 9-13, 15). Because of the very low solubility in pure water, few direct solubility measurements were performed in this medium, and solubility values in pure water must be evaluated by extrapolation.

A. <u>α-$Be(OH)_2$</u>

Gilbert and Garrett (10) performed an extensive study at 298.15 K of the solubility of α-$Be(OH)_2$ in dilute solutions of acids (HCl, $HClO_4$) and base (NaOH). The nature of the solid phase was confirmed by X-ray analysis. The solubility increases with increase in either acid or base concentration as shown on Figs. 1 and 2. Schindler and Garrett (13) interpreted the data by the equilibria:

$$\alpha\text{-Be(OH)}_2(s) + 2H^+(aq) = Be^{2+}(aq) + 2H_2O(\ell) \qquad [1]$$

$$3\alpha\text{-Be(OH)}_2(s) + 3H^+(aq) = (BeOH)_3^{3+}(aq) + 3H_2O(\ell) \qquad [2]$$

$$\alpha\text{-Be(OH)}_2(s) + OH^-(aq) = HBeO_2^-(aq) + H_2O(\ell) \qquad [3]$$

$$\alpha\text{-Be(OH)}_2(s) + 2OH^-(aq) = BeO_2^{2-}(aq) + 2H_2O(\ell) \qquad [4]$$

No significant differences in solubility were found for the two acidic media (HCl and $HClO_4$) which showed the absence of any complexation by the Cl^- ion.

The constants of the different equilibria were calculated by least squares anaysis at 298.15 K and $I = 0$. The values obtained (13) were:

$$\log K_1 = 6.86 \pm 0.05$$

$$\log K_2 = 11.67 \pm 0.05$$

$$\log K_3 = -2.49 \pm 0.1$$

$$\log K_4 = -2.70 \pm 0.3$$

Equilibria 3 and 4 account for about 20% of the calculated solubility.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Water; H_2O; [7732-18-5], and various aqueous solutions

EVALUATOR:

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CEA/SCECF/SECA
B. P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE
November, 1991

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

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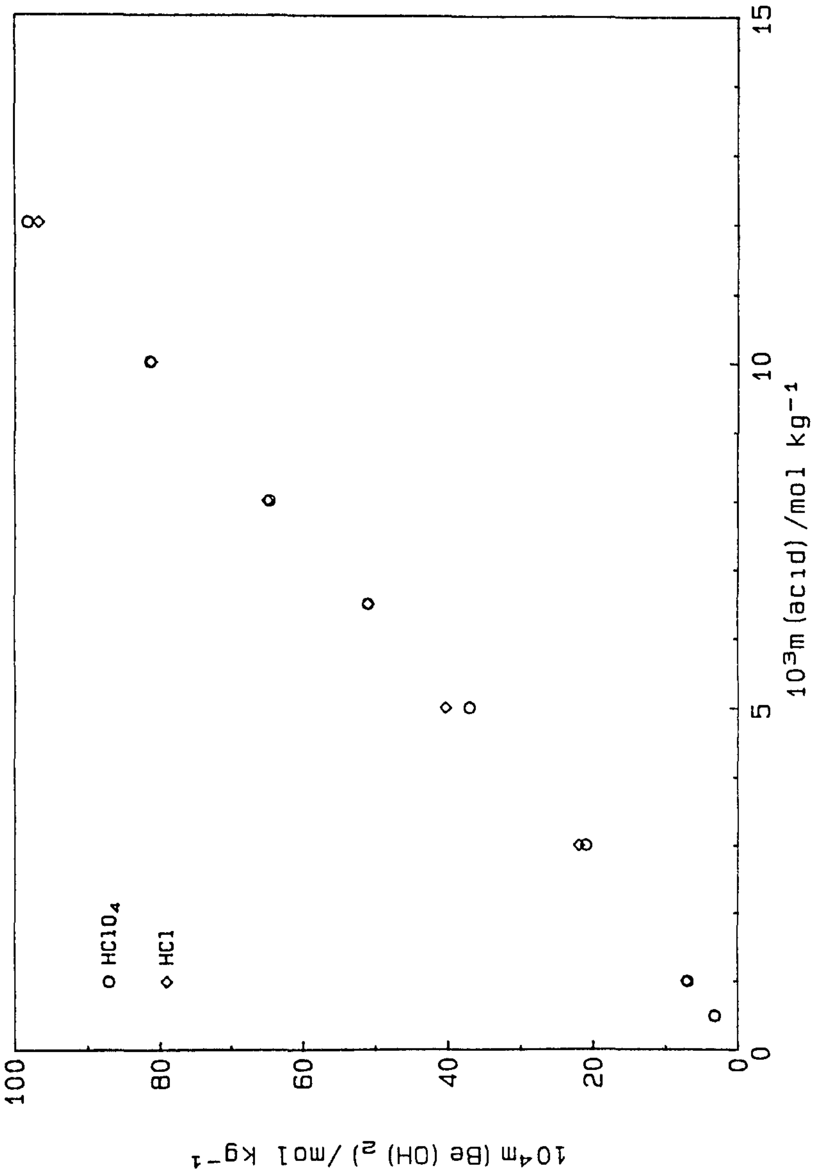

Figure 1. Solubility of α - $Be(OH)_2$ in acidic solution (10)

COMPONENTS:	EVALUATOR:
(1) Beryllium hydroxide; Be(OH)$_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

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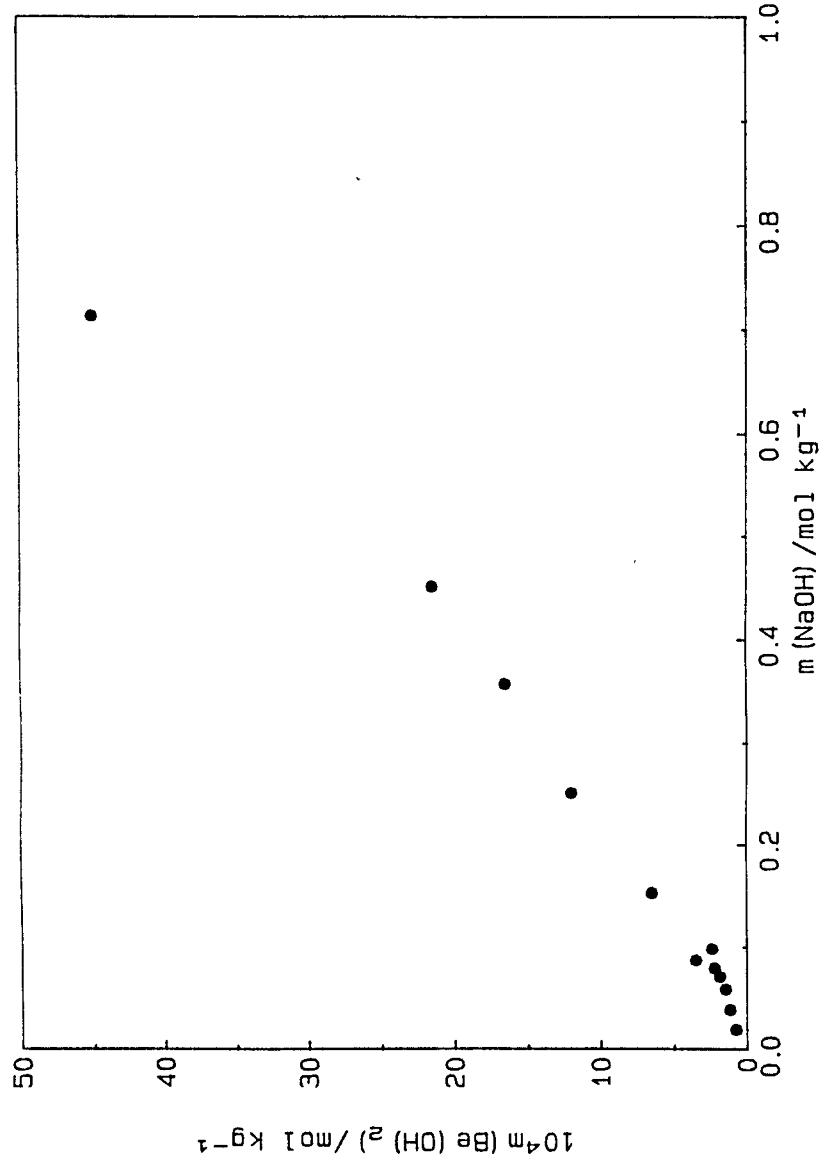

Figure 2. Solubility of α - Be(OH)$_2$ in NaOH solutions (10)

COMPONENTS:	EVALUATOR:	
(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

The K_1 and K_2 values allow calculation of the equilibrium constant of the overall equilibrium:

$$3Be^{2+}(aq) + 3H_2O(\ell) = (BeOH)_3^{3+}(aq) + 3H^+(aq) \qquad K_{33} = 1.26 \times 10^{-9}$$

which is in good agreement with the value deduced by Lanza and Carpeni (21) of $K_{33} = 1.2 \times 10^{-9}$ from potentiometric measurements.

Baes and Mesmer (22) have reviewed the hydrolysis reactions of Be^{2+} in acidic solutions. In addition to the species considered by Garrett and Schindler (13) there is evidence of the species $Be_3OH^{3+}(aq)$, $BeOH^+(aq)$ and $Be(OH)_2(aq)$. When the equilibria:

$$Be^{2+}(aq) + H_2O(\ell) = BeOH^+(aq) + H^+(aq) \qquad \log K_{11} = -5.4$$

and

$$Be^{2+}(aq) + 2H_2O(\ell) = Be(OH)_2(aq) + 2H^+(aq) \qquad \log K_{12} = -13.65,$$

are taken into account, the results of Gilbert and Garrett (10) lead to the solubility product:

$$K_{s0} = m(Be^{2+})(m(OH^-))^2/m^{\circ 3} \qquad \log K_{s0} = -21.3.$$

The difference between activity and molality is ignored because of the low molalities involved. The solubility of α-$Be(OH)_2$ in pure water, assuming the presence of the aqueous species Be^{2+}, $BeOH^+$ and $Be(OH)_2$ should be about

$$m(Be) = 5 \times 10^{-7} \text{ mol kg}^{-1}.$$

The value is doubtful because the hydrolysis constants are not precise. Bertin and Thomas (14) calculate $\log K_{12} = -11$ from their hydrolysis measurements. The value of $\log K_{11} = -5.4$ is only a rough extimate, because the data treatment ignored polynuclear species.

Solubility in the presence of sodium salts

The solubility measurements in the presence of chlorides, fluorides, nitrates, perchlorates and carbonates show a strong complexation by fluoride and carbonate (14, 17-20).

B. <u>β-$Be(OH)_2$</u>

Fricke and Hume (6) measured the solubility of β-$Be(OH)_2$ in aqueous NaOH solutions at 303 K. The β-$Be(OH)_2$ was formed *in situ* by aging α-$Be(OH)_2$. From the variation of the solubility with time, it is possible to estimate the difference of Gibbs energy of formation of the two forms at 303 K:

$$\Delta_f G(\beta\text{-}Be(OH)_2) - \Delta_f G(\alpha\text{-}Be(OH)_2) \simeq -2 \text{ kJ mol}^{-1}$$

This difference would lead to an approximate $\log K^{\circ}_{s0} = -21.6_5$ for the β-$Be(OH)_2$.

Fricke and Hume (6) pointed out the existence of the solid phase $BeO\cdot NaOH\cdot H_2O$ above 36.3 mass % NaOH. The data of Kolenkova *et al.* (15) are in qualitative agreement with Fricke and Hume's results.

C. Freshly precipitated Beryllium Hydroxide.

Solubility in water.

Oka (9) found a solubility of 1.4×10^{-7} mol kg^{-1} for the freshly precipitated hydroxide, but no details of the method are given. The value should be larger than the value for the more stable α-$Be(OH)_2$. This is evidence that the calculated value of 5×10^{-7} is probably too large. The value of $c_{Be} = 8 \times 10^{-6}$ mol dm^{-3} found by the conductivity

COMPONENTS:	EVALUATOR:	
(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

measurements of Remy and Kuhlman (5) is an order of magnitude higher than Oka's value and was rejected.

Solubility of amorphous beryllium hydroxide in acidic solutions.

Prytz (7, 8) studied the precipitation of $Be(OH)_2$ by NaOH solutions at different beryllium salt concentrations. He interpreted his results assuming a solution species, $Be_2O^{2+}(aq)$, and the equilibrium solid, $Be_2O(OH)_2$, the hypotheses which best fitted his data. The mean value of the solubility product calculated from his results is:

$$K_{s0} = c(\mathrm{Be}^{2+})(c(\mathrm{OH}^-))^2/c^{\circ 3} \qquad \log K_{s0} = -20 \pm 1.$$

This is a tentative value because the results for the different beryllium salts differ, and the values depends on the hydrolysis equilibria used.

Solubility of amorphous beryllium hydroxide in basic solutions.

The solubility of freshly precipitated beryllium hydroxide in NaOH solution has been reported (1 - 3). The results are shown in Fig. 4 where they are compared with the solubility of α-$Be(OH)_2$ (10). Haber and Van Oordt (2) pointed out the importance of the decrease of solubility as the precipitate aged in NaOH solutions. Similar experiments were reported on KOH solutions by Bleyer and Kaufman (4) and are shown on Fig. 3. These two figures illustrate the difficulty of assessing the solubility values when starting with ill-defined materials.

Solubility of beryllium hydroxide in four- and five-component systems.

The solubility of amorphous $Be(OH)_2$ was studied in aqueous $NaClO_4$ solutions with the addition of sodium bicarbonate (17), sodium carbonate (18), sodium bicarbonate and sodium fluoride (20) and citric acid (19). Quantitative comparison among the results is difficult as the crystalline form of the $Be(OH)_2$ is not always the same. Nevertheless a strong complexation by both F^- and HCO_3^- is observed.

SOLUBILITY AT HIGH TEMPERATURE.

Solubilities of freshly precipitated and of "inactive" (probably α) forms were measured in dilute NaOH solutions up to 373 K (2). Solubilities of α-$Be(OH)_2$ in dilute NaOH and in dilute HNO_3 have been reported up to 573 K (16). The precision is poor and even the sign of the temperature coefficient is not clear. The solubility values at the high temperatures are judged doubtful.

Soboleva *et al.* (26) studied the solubility of α-beryllium oxide (bromellite [13598-21-5]) in NaOH + NaF + H_2O at 423, 473 and 523 K. The authors treated the data to obtain equilibrium constants for the reaction

$$\mathrm{BeO(s)} + \mathrm{H_2O}(\ell) + \mathrm{F^-(aq)} = \mathrm{Be(OH)_2F^-(aq)}$$

of 0.018±0.011, 0.022±0.003 and 0.012±0.003, respectively, at the three temperatures.

The solubility of BeO (bromellite) has also been studied at 573 K in aqueous $HClO_4$ and aqueous HF by Koz'menko *et al.* (27). The authors proposed a model, and derived equilibrium constant values from a weighted least squares method. See the data sheets for details.

Comparison of these results with other evaluations.

Both the *NBS Thermodynamic Tables* (23) and the *Critical Stability Constant* collection (24) contain evaluated data on the $Be(OH)_2(s) + H_2O$ system. Some of these data are presented here for comparison. Without

COMPONENTS:	EVALUATOR:
(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

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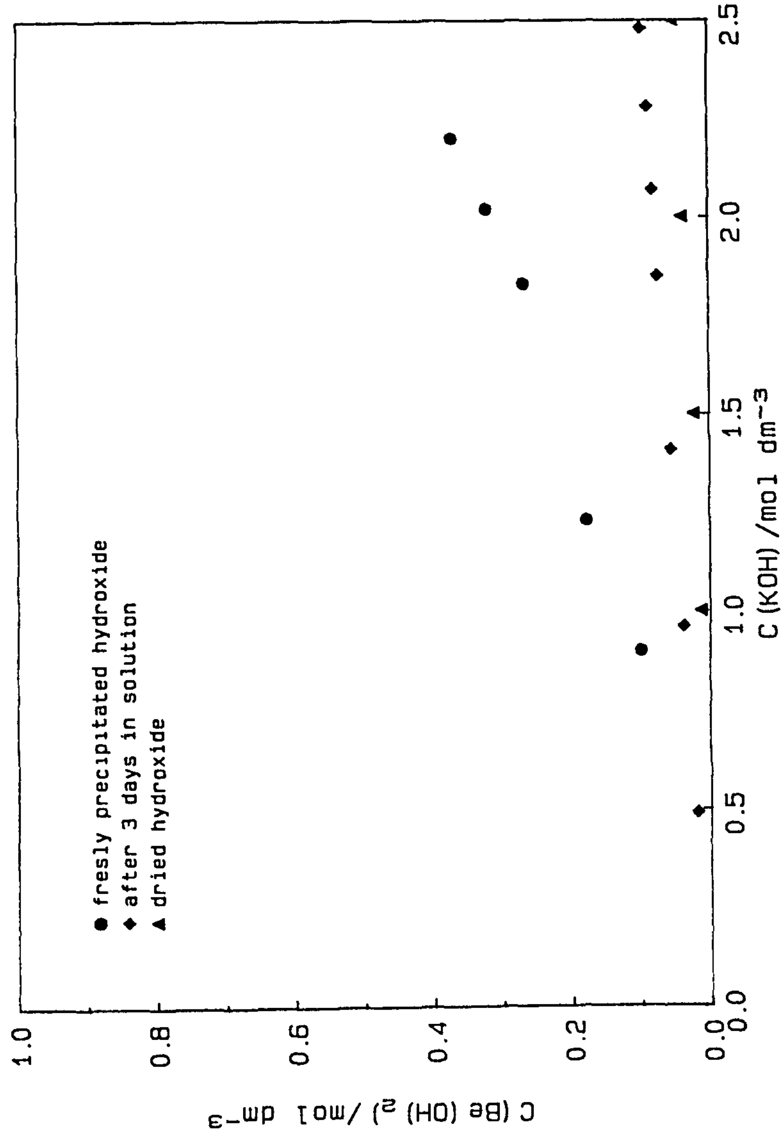

Figure 3. Solubility of $Be(OH)_2$ in KOH solutions. Room temperature. Influence of aging (4).

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Water; H_2O; [7732-18-5], and various aqueous solutions

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Irma Lambert
CEA/SCECF/SECA
B. P. 6
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H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

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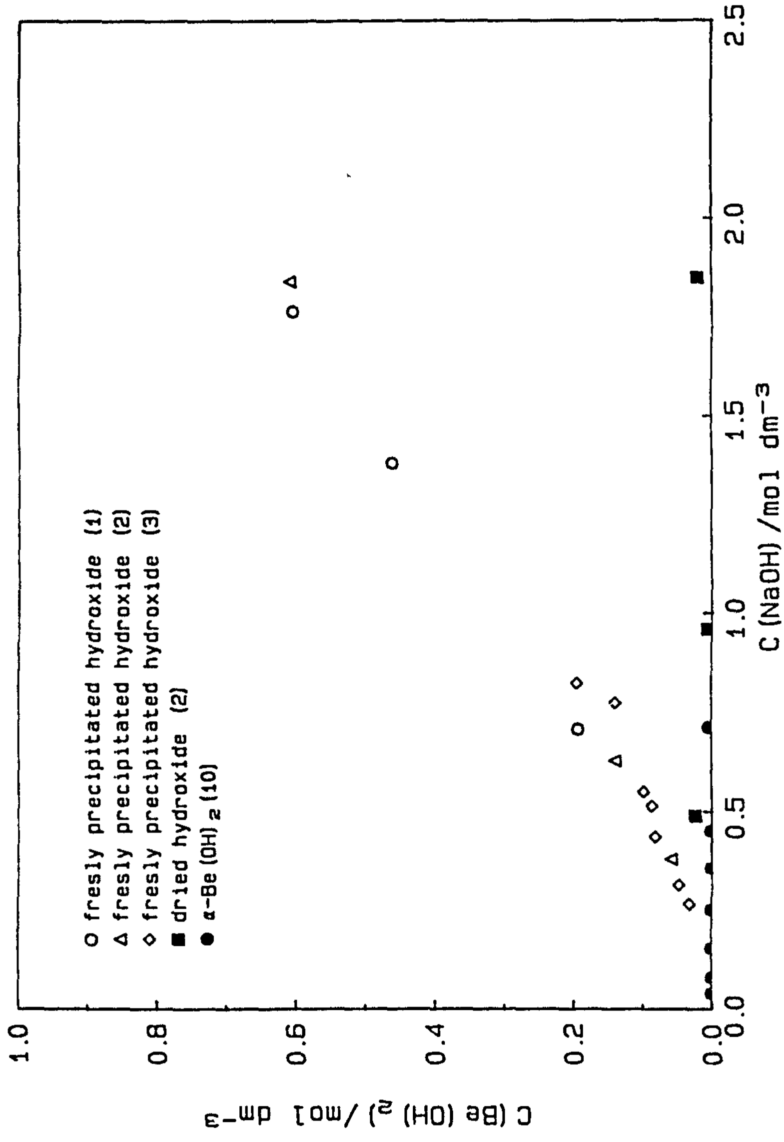

Figure 4. Solubility of $Be(OH)_2$ in NaOH solutions. Room temperature. Influence of aging (4).

COMPONENTS:	EVALUATOR:	
(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

references and information about methods of evaluation no further comparison is warrented.

Smith and Martell (24) report log K_{s0} values at 298.15 K and zero ionic strength of -21.0, -21.31 and -21.7 for $Be(OH)_2$(s, amorphous), α-$Be(OH)_2$(s) and β-$Be(OH)_2$(s), respectively. The values for α- and β-forms agree well with the values presented here.

Smith and Martell (24) report the following association constants:

Equilibrium	log *K* at 298 K and Ionic Strengths (mol dm^{-3}):				
	0	0.1	0.5	2.0	3.0
$Be^{2+} + OH^- = BeOH^+$	8.6	8.3 ^{a}			
$Be^{2+} + 2OH^- = Be(OH)_2$	(14.4)	(16.5) (16.7) ^{a}			(17.5)
$Be^{2+} + 3OH^- = Be(OH)_3^-$	18.8				
$Be^{2+} + 4OH^- = Be(OH)_4^{2-}$	18.6				
$2Be^{2+} + OH^- = Be_2(OH)^{3+}$	(10)	10.54		10.68	10.95
$3Be^{2+} + 3OH^- = (BeOH)_3^{3+}$	33.1		32.41	32.98	33.88
$6Be^{2+} + 8OH^- = Be_6(OH)_8^{4+}$	(85)				

^{a} values at 293 K. Values of questionable validity are given in ( ).

All species are in aqueous solution.

The *NBS Thermodynamic Tables* (23) contain a number of Gibbs energy of formation values from which we have calculated the following log *K* values at 298.15 K.

Equilibrium	log *K*
α-$Be(OH)_2(s) = Be^{2+}(aq) + 2OH^-(aq)$	-21.16
β-$Be(OH)_2(s) = Be^{2+}(aq) + 2OH^-(aq)$	-21.60
α-$Be(OH)_2(s) + 2H^+(aq) = Be^{2+}(aq) + H_2O$	6.66
3α-$Be(OH)_2(s) + 3H^+(aq) = (BeOH)_3^{3+}(aq) + 3H_2O$	11.91
$3Be^{2+}(aq) + 3H_2O = (BeOH)_3^{3+}(aq) + 3H^+(aq)$	-8.58
α-$Be(OH)_2(s) + 2OH^-(aq) = BeO_2^{2-}(aq) + 2H_2O$	-2.65

The Gibbs energy difference for:
α-$Be(OH)_2$(s) = β-$Be(OH)_2$(s) -2.5 kJ mol^{-1}

Crystal structures of beryllium oxide and hydroxide solids.

Characterization of the solid state in equilibrium with the saturated solution is an important part of any modern solubility study. The following information, mostly from the *Crystal Data Determinative Tables*, is neither complete nor evaluated, but is presented as a reminder of this important point.

Crystal Formula	Type	Density, ρ/Mg m^{-3}
[13598-21-5]; α-BeO (bromellite)	Hexagonal	3.008
[1304-56-9]; β-BeO (beryllia)	Tetragonal	2.69
[13327-32-7]; α-$Be(OH)_2$	Tetragonal	-
[13327-32-7]; β-$Be(OH)_2$	Orthorhombic	1.94

COMPONENTS:	EVALUATOR:	
(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA
(2) Water; H_2O; [7732-18-5] and various aqueous solutions		

CRITICAL EVALUATION:

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COMPONENTS:	EVALUATOR:
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CRITICAL EVALUATION:

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23. Wagman, D. D.; Evans, W. H.; Parker, V. B.; Schumm, H.; Halow, I.; Bailey, S. M.; Churney, K. L.; Nuttall, R. L. *J. Phys. Chem. Ref. Data* 1982, *11*, Supplement No. 2, *THE NBS TABLE OF THERMODYNAMIC PROPERTIES*.

24. Smith, R. M.; Martell, A. E. *CRITICAL STABILITY CONSTANTS*, vOL. 4, *INORGANIC COMPLEXES*, Plenum Press, New York, 1976, PP. 1-2.

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26. Soboleva, G.I.; Tugarinov, I.A.; Golitsina, N.S.; Khodakovskii, I.L.
Geokhimiya 1984, (NO. 6), 812-22;
Geochem. Int. (Engl. Transl.) 1984, *21*(7), 20-30.

27. Koz'menko, O.A.; Peshchevitskii, B.I.; Belevantsev, V. I.
Geokhimiya 1985 (No. 11), 1614-20;
Geochem. Int. (Engl. Transl.) 1986, *23*(4), 162-69.

The references below were not used because either they contained no experimental data, no reliable data, data from other published sources, or $Be(OH)_2$ solubility values were not among those determined for the system.

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[$BeO + CO_2(aq) + H_2O$]

29. Renz, C. *Ber.* 1903, *36*, 2751-55.
[$Be(OH)_2 + NH_3$ or amines $+ H_2O$]

30. Britton, H. T. S. *J. Chem. Soc.* 1925, *127*, 2120-41.

31. Sidgwick, N. V.; Lewis, N. B. *J. Chem. Soc.* 1926, 1287-1302.
[$BeO + BeSO_4$ or $BeC_2O_4 + H_2O$ at 25°C]

32. Vol'nov, I. I. *Izv. Sektora Fiz.-Khim. Anal., Inst. Obshch. Neorg. Khim., Akad. Nauk SSSR* 1955, *26*, 211-14.
[$Be(OH)_2 + H_2O_2 + H_2O$ at 0°C]

33. Novoselova, A. V.; Reshetnikova, L. P.; Semenenko, K. N.; Pham van Thuong *Vestn. Mosk. Univ., Ser. II* 1967, *22* (1), 32-35.
[$Be(OH)_2 + Be(NO_3)_2 + H_2O$ at 25°C]

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Remy, H.; Kuhlmann, A.

Z. Anal. Chem., 1924, *65*, 161-81.

VARIABLES:

$T/K = 291$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Specific conductivity measured on conductivity water saturated with α-BeO at 20.0 - 20.2°C was 1.795×10^{-6} $(\Omega\ cm)^{-1}$, which was converted to the value at 18°C of 1.729×10^{-6} $(\Omega\ cm)^{-1}$ by applying a temperature coefficient of 0.0190. After the correction for dissolved CO_2 (ref 1), solubility of $Be(OH)_2$ was calculated from the specific conductivity by using the intrinsic specific conductivity of saturated $Be(OH)_2$ solution of 3.29×10^{-6} $(\Omega\ cm)^{-1}$ to give 0.00020 g BeO per liter of solution. Solubility and solubility product of $Be(OH)_2$ were calculated by the authors to be 8.1×10^{-6} mol L^{-1} and 2×10^{-20} $(mol\ L^{-1})^3$ respectively, under the assumption that $Be(OH)_2$ dissociates completely in water.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Conductivity water was saturated with BeO (specific conductivity, 1.258×10^{-6} $(\Omega\ cm)^{-1}$) in a conductivity cell by shaking at 20.0 - 20.2°C for 1.5 to 2.5 hours. Specific conductivity of the resulting saturated solution was measured.

NOTE: The specific conductivity unit, $(\Omega\ cm)^{-1}$, has been replaced by electrolytic conductivity, S cm^{-1}.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide. $Be(NO_3)_2$ of high purity was dissolved in conductivity water followed by addition of freshly distilled NH_3 to precipitate $Be(OH)_2$. After being washed with water, the precipitate was dissolved in acetic acid, the resultant beryllium(II) acetate was distilled at 330 - 331°C. It was dissolved in water to get a dilute aqueous solution from which $Be(OH)_2$ was again precipitated by the addition of NH_3. The precipitate was heated at about 440°C to obtain BeO.

(2) Water. Conductivity water of specific conductance 1.258×10^{-6} $(\Omega\ cm)^{-1}$ was used.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Remy, H.
Z. Elektrochem. Angew. Phys. Chem. 1925, *31*, 88.

COMPONENTS: (1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Oka, Y. *Nippon Kagaku Kaishi (1921-47)* 1940, *61*, 311-20.
VARIABLES: T/K = Room temperature	PREPARED BY: H. Einaga Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in water was determined by potentiometry to be

$$1.4 \times 10^{-7} \text{ mol L}^{-1}$$

at room temperature (not specified).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: Aqueous $Be(NO_3)_2$ solution was titrated at room temperature with a standard aqueous NaOH solution potentiometrically by using glass and hydrogen electrodes to record pH *vs* alkali content relation from which solubility was calculated. There was no description of titration or calculation procedures.	SOURCE AND PURITY OF MATERIALS: (1) Beryllium hydroxide. (2) Water. Nothing specified. ESTIMATED ERROR: No estimates possible. REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5]	Schindler, P.; Garrett, A. B. *Helv. Chim. Acta* 1960, *43*, 2176-8.

EXPERIMENTAL VALUES:

$Be(OH)_2 + H^+ + H_2O$ at 25°C

$10^3 Z$	$10^3 B$	$-\log h$	$-\log b$	$\log K'_{s0}$	$-\log s$		$-\log K_{snn}$	
					n = 2	n = 3	n = 2	n = 3
0.495	0.322	5.32_1	3.75_9	6.88_3	4.12_8	4.30_4	6.51_4	11.65_9
0.944	0.702	5.21_0	3.53_5	6.88_5	3.68_8	3.86_4	6.73_2	11.76_6
2.99	2.15	5.00_8	3.07_6	6.94_0	3.18_4	3.36_0	6.83_2	11.66_4
4.99	3.88	4.88_0	2.95_5	6.80_5	2.85_9	3.03_5	6.90_1	11.60_5
6.48	5.10	4.85_1	2.86_0	6.84_2	2.73_0	2.90_6	6.97_2	11.64_7
7.98	6.48	4.81_0	2.82_4	6.79_6	2.60_4	2.78_0	7.01_6	11.65_0
9.98	8.13	4.79_0	2.73_3	6.84_7	2.50_3	2.67_9	7.07_7	11.69_1
11.98	9.74	4.77_0	2.65_0	6.89_0	2.42_6	2.60_2	7.11_4	11.70_8
			Mean value	6.86 ± 0.05		Mean value		11.67 ± 0.05

$h = [H^+]$

$b = [Be^{2+}]$

$K'_{s0} = [Be^{2+}]/[H^+]^2$

$s = [(BeOH)_n^{n+}]$

$K_{snn} = [(BeOH)_n^{n+}]/[H^+]^n$

The results of Gilbert and Garrett (ref 1) in acidic medium were reinterpreted by taking into account the reactions:

$Be(OH)_2 + 2H^+ = Be^{2+} + 2H_2O$ K'_{s0}

$nBe(OH)_2 + nH^+ = (BeOH)_n^{n+} + nH_2O$ K_{snn}

with the values n = 2 and n = 3.

Quantities used in the calculations are shown in the table above with:

H = total concentration of the acid (HCl, $HClO_4$), see ref 1.

h = concentration of H^+ in the saturated solution.

B = total Be concentration = $[Be^{2+}] + n[(BeOH)_n^{n+}]$

$Z = H - h = 2[Be^{2+}] + n[(BeOH)_n^{n+}]$

$b = Z - B = [Be^{2+}]$

$s = [(BeOH)_n^{n+}] = (2B - Z)/n$

The calculations show that K_{s33} is a constant and that $(BeOH)_3^{3+}$ is the main polymeric species present.

$$K_{s0} = [Be^{2+}][OH^-]^2 = K'_{s0}K_w^2;\ K'_{s0} = [Be^{2+}]/[H^+]^2$$

K_{s0} was calculated by the compilers using $-\log K_w = 13.996$ to be

$$-\log K_{s0} = 21.13 \pm 0.05$$

(continued on next page)

COMPONENTS: (1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7] (2) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Schindler, P.; Garrett, A. B. *Helv. Chim. Acta* 1960, *43*, 2176-8.
VARIABLES: $T/K = 298$	PREPARED BY: H. Einaga Y. Komatsu I. Lambert

EXPERIMENTAL VALUES:

(sign of log K'_{s0} by the authors appears to be in error). The value of

$$K_{s33} = [(BeOH)_3^{3+}]/[H^+]^3$$

for the solution reaction

$$3Be(OH)_2\ (s) + 3H^+ = (BeOH)_3^{3+} + 3H_2O$$

is given by the authors to be $-\log K_{s33} = 11.67 \pm 0.05$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Experimental data on solution equilibria of α-$Be(OH)_2$, a metastable crystalline modification of $Be(OH)_2$ in dilute acid (HCl, $HClO_4$) solution, were taken from ref 1. The data were reanalyzed by taking presence of polynuclear hydrolyzed species of $(BeOH)_3^{3+}$ (ref 2) into consideration.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide.

(2) Water.

See data sheets of (ref 1). No new data measured for this work.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Gilbert, R. A.; Garrett, A. B. *J. Am. Chem. Soc.* 1956, *78*, 5501.
2. Kakihana, H.; Sillen, L. G. *Acta Chem. Scand.* 1956, *10*, 985.

COMPONENTS:

(1) Berylium oxide (bromellite); α-BeO; [13598-21-5]

(2) Hydrogen fluoride; HF; [7604-39-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Koz'menko, O.A.; Peshchevitskii, B.I.
Belevantsev, V.I.

Geokhimiya <u>1985</u>, (no. 11), 1614-20.

**Geochem. Int. (Engl. Transl.)* <u>1986</u> *23*(4), 162-69.

EXPERIMENTAL VALUES:

Solubility of α-BeO in HF(aq) at 300°C
and Saturation Vapor Pressure.

Hydrogen Fluoride $10^3 c_2$/mol L^{-1}	Number of Independent Measurements	Bromellite Solubility $10^4 c_1$/mol L^{-1}
0.0	1	0.051±0.008
0.27±0.01	3	0.070±0.004
0.80±0.05	3	0.25 ±0.01
1.6 ±0.1	3	0.66 ±0.02
3.2 ±0.1	3	1.4 ±0.1
4.2 ±0.2	3	1.9 ±0.1
8.0 ±0.2	3	6.9 ±0.2
13. ±1.	3	12. ±1.
16. ±1.	3	20. ±1.

The authors analyzed the data on the basis of the following equilibria:

$$\alpha\text{-BeO(s)} + H_2O = \text{Be(OH)}_2\text{(aq)} \qquad K'_0 = (5.2\pm0.6)\times10^{-6}$$

$$\alpha\text{-BeO(s)} + H^+\text{(aq)} = \text{Be(OH)}^+\text{(aq)} \qquad K'_1 = 0.029\pm0.009$$

$$\alpha\text{-BeO(s)} + 2H^+\text{(aq)} = \text{Be}^{2+}\text{(aq)} + H_2O \qquad K'_2 = 10.4\pm1.8$$

$$H_2O = H^+\text{(aq)} + OH^-\text{(aq)} \qquad K_w = 3.2\times10^{-12}$$

$$\alpha\text{-BeO(s)} + \text{HF(aq)} = \text{Be(OH)F} \qquad K_1 = 0.02\pm0.01$$

$$\alpha\text{-BeO(s)} + 2\text{HF(aq)} = \text{BeF}_2\text{(aq)} + H_2O \qquad K_2 = 10.9\pm3.4$$

$$\text{HF(aq)} = H^+\text{(aq)} + OH^-\text{(aq)} \qquad K_D = 6.3\times10^{-7}$$

$$\text{HF(aq)} + F^-\text{(aq)} = \text{HF}_2^-\text{(aq)} \qquad K = \text{room temp. value}$$

The data were treated by a weighted least squares method. Additional details in the original paper. Calculated concentrations of Be(OH)^+(aq) and Be^{2+}(aq) were smaller than the measured beryllium concentration, and thus, they were neglected. The HF_2^-(aq) concentration was also negligably small.

The dilute concentrations could be used as molalities with negligable error.

COMPONENTS:

(1) Berylium oxide (bromellite); α-BeO; [13598-21-5]

(2) Hydrogen fluoride; HF; [7604-39-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Koz'menko, O.A.; Peshchevitskii, B.I. Belevantsev, V.I.

Geokhimiya 1985, (no. 11), 1614-20.

**Geochem. Int. (Engl. Transl.)* 1986 *23*(4), 162-69.

VARIABLES:

T/K = 573
p_1/kPa = solution vapor pressure

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The equilibrium constants for the reactions at 300°C, saturation vapor pressure, and ionic strength, I = 0 on the molality scale were given as:

Reaction	log K
$\alpha\text{-BeO(s)} + H_2O = Be(OH)_2(aq)$	-5.28±0.05
$\alpha\text{-BeO(s)} + 2H^+(aq) = Be^{2+}(aq) + H_2O$	1.02±0.7
$\alpha\text{-BeO(s)} + H^+(aq) = Be(OH)^+(aq)$	-1.7 ±0.2
$\alpha\text{-BeO(s)} + HF(aq) = BeOHF(aq)$	-1.7 ±0.2
$\alpha\text{-BeO(s)} + 2HF(aq) = BeF_2(aq) + H_2O$	1.0 ±0.2
$HF(aq) = H^+(aq) + F^-(aq)$	-6.2 ±0.2
$H_2O = H^+(aq) + OH^-(aq)$	-11.5 ±0.2

Stability constants for Be^{2+} complexes were derived from the equilibrium constants above for 300°C, 88 atm, and ionic strength, I = 0.

$Be^{2+}(aq) + OH^-(aq) = Be(OH)^+(aq)$	8.8±0.2
$Be^{2+}(aq) + 2OH^-(aq) = Be(OH)_2(aq)$	16.7±0.3
$Be^{2+}(aq) + 2F^-(aq) = BeF_2(aq)$	12.4±0.3
$Be^{2+}(aq) + OH^-(aq) + F^-(aq) = Be(OH)F(aq)$	15.0±0.4
$BeF_2(aq) + OH^-(aq) = Be(OH)F(aq) + F^-(aq)$	2.6±0.4
$BeF_2(aq) + 2OH^-(aq) = Be(OH)_2(aq) + 2F^-(aq)$	4.3±0.6

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The autoclave method was used under isothermal conditions. The α-BeO crytals and the acid solutions were sealed by welding in gold capsules of 5 or 10 mm diameter of 1 to 3.5 mL volume. The contents were adjusted so there was no more than 2 % vapor volume at 300°C. From 5 to 10 of these capsules were placed in a stainless steel autoclave, sealed and placed in a preheated oven for seven days. Preliminary studies showed equilibrium was established within 5 days. The autoclave was removed and cooled rapidly in cool water. The capsule contents were analyzed immediately for Be by an atomic absorption spectrometer. Either a flame or flame free method was used depending in part on the sample size. Results were checked in some cases by the weight loss of α-BeO.

SOURCE AND PURITY OF MATERIALS:

(1) Bromellite (α-BeO). Crystals of 10-40 mg were washed with boiling aqua regia to eliminate inclusions contaning V or Pb. After each experiment the crystals were washed with 5 % HF and inspected for cracks and inclusions.
(2) Hydrogen fluoride. Prepared from special reagent. Conc. checked by pot. titrn. with F^- electrode.
(3) Water. Nothing specified.

ESTIMATED ERROR:

Temp.: Precision ±0.5 K.
Soly.: See std. error of mean in table above.

REFERENCES:

COMPONENTS:

(1) Beryllium oxide, BeO; [13598-21-5]
(2) Hydrogen fluoride; HF; [7604-39-3]
(3) Nitric acid; HNO_3; [7697-37-2]
(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Soboleva, G. I.; Tugarinov, I. A.; Golitsina, N.S.; Khodakovskii, I.L.

Geokhimiya 1984, (No. 6), 812-22.

**Geochem. Int. (Engl. Transl.)* 1984, *21*(7), 20-30.

VARIABLES:

$T/K = 423, 473$ and 523

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Hydrogen Fluoride	Nitric Acid	Total Beryllium
$t/°C$	T/K	m_2/mol kg^{-1}	m_3/mol kg^{-1}	m_{Be} /mol kg^{-1}
150	423	0.00010	-	3.9×10^{-5}
		0.0010	-	4.8×10^{-4}
		0.0025	-	2.9×10^{-4}
		0.010	-	1.2×10^{-3}
200	473	0.00010	-	$(6.5\pm1.0)\times10^{-5}$
		0.00025	-	1.2×10^{-4}
		0.0010	-	$(3.5\pm0.3)\times10^{-4}$
		0.0025	-	$(9.7\pm2.0)\times10^{-4}$
		0.010	-	$(2.2\pm0.5)\times10^{-3}$
		0.10	-	$(6.5\pm0.3)\times10^{-3}$
		0.0025	0.0011	4.4×10^{-4}
		0.025	0.011	5.9×10^{-3}
		0.25	0.11	8.4×10^{-2}
250	523	0.00010	-	4.2×10^{-5}
		0.0010	-	4.9×10^{-4}
		0.0025	-	5.9×10^{-4}
		0.010	-	2.8×10^{-3}

The authors treated these data to obtain equilibrium constants for the reaction $BeO(s) + HF(aq) = Be(OH)F(aq)$ of 0.50±0.30, 0.50±0.30 and 0.56±0.20 at 150, 200 and 250°C, respectively.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Same method as used by the authors in a study of the solubility of BeO in aqueous NaOH and aqueous HNO_3 (ref 1).

Aqueous solutions were saturated with α-BeO in an autoclave at a specified temperature within ± 5 degrees for 7 - 25 days. After equilibration, the aqueous phase was sampled, and the dissolved Be^{2+} was determined fluorometrically by use of Morin [480-16-0] as a complexing reagent.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium oxide (bromellite). Artificial crytals. Hexagonal crystals prepared by a hydrothermal method.

(2) Hydrogen fluoride. Chemically pure.

(3) Nitric acid. Chemically pure.

(3) Water. Twice distilled CO_2 free water.

ESTIMATED ERROR:

Temp.: Precision ± 5 K.
Soly.: See average deviations in table above.

REFERENCES:

1. Soboleva, G.I.; Tugarinov, I.A. Kalinina,V.F.; Khodakovskii, I.L. *Geokhimiya* 1977, (No. 7), 1013.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Hydrochloric acid; HCl; [7647-01-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Gilbert, R. A.; Garrett, A. B.

J. Am. Chem. Soc. <u>1956</u>, *78*, 5501-5.

VARIABLES:

$T/K = 298.15$

$m_2/\text{mol kg}^{-1} = 0.0010 - 0.0120$

PREPARED BY:

H. Einaga

Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of α-$Be(OH)_2$ in HCl solution at 25°C

Molality HCl $m_2/\text{mol kg}^{-1}$	Molality α-$Be(OH)_2$ $10^4 m_1/\text{mol kg}^{-1}$
0.0010	7.08
0.0030	22.0
0.0050	40.4
0.0065	51.0
0.0080	65.0
0.0100	81.3
0.0120	96.7

The results were interpreted by the three reactions:

$$Be(OH)_2(s) \rightleftharpoons Be^{2+} + 2OH^- \qquad (1)$$

$$Be(OH)_2(s) + 2H^+ \rightleftharpoons Be^{2+} + 2H_2O \qquad (2)$$

$$Be^{2+} + Be(OH)_2 \rightleftharpoons Be_2O^{2+} + H_2O \text{ (ref 1)} \qquad (3)$$

which give

$$K_2 = (a_{Be^{2+}})/(a_{H^+})^2 = 7.3 \times 10^6$$

and

$$K_1 = (a_{Be^{2+}}) \times (a_{OH^-})^2 = K_2 \times K_W^2 = 7.3 \times 10^{-22}$$

$$(K_W = a_{H^+}\, a_{OH^-} = 1 \times 10^{-14})$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

α-$Be(OH)_2$ was equilibrated with acid solution in glass flask either from supersaturation (preliminary equilibration at 35°C followed by cooling to 25°C) or from undersaturation (dissolution at 25°C) at 25.00 ± 0.02°C for seven days. After the sedimentation of solid $Be(OH)_2$ for further standing of seven days, pH was measured on the solution using a glass electrode pH meter and dissolved Be^{2+} was determined spectrophotometrically.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium hydroxide. The metastable form was prepared by dissolving fused Be (99.5 %) in aqueous HCl followed by precipitation with chemically pure NaOH.

(2) Hydrochloric acid. C.p. reagent grade.

(3) Water. Triply distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.

Soly.: reproducibility ± 1.5 %, (Av. 3 determinations).

REFERENCES:

1. Mattock, G. *J. Am. Chem. Soc.* <u>1954</u>, *76*, 4835.

COMPONENTS:

(1) Beryllium oxide (bromellite); α-BeO; [13598-21-5]

(2) Perchloric acid; $HClO_4$; [7601-90-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Koz'menko, O.A.; Peshchevitskii, B.I. Belevantsev, V.I.

Geokhimiya 1985, (no. 11), 1614-20.

**Geochem. Int. (Engl. Transl.)* 1986 *23*(4), 162-69.

VARIABLES:

$T/K = 573$

p_1/kPa = solution vapor pressure

PREPARED BY·

H. L. Clever

EXPERIMENTAL VALUES:

Solubility of α-BeO in $HClO_4$(aq) at 300°C and Saturation Vapor Pressure.

Perchloric Acid 10^3c_2/mol L^{-1}	Number of Independent Measurements	Bromellite Solubility 10^4c_1/mol L^{-1}
0.0	1	0.051±0.008
0.507	3	0.15 ±0.02
1.02	3	0.84 ±0.10
5.07	3	3.7 ±0.5
10.2	3	13. ±2.
25.8	2	55. ±5.

The authors analyzed the data on the basis of the following equilibria:

$$\alpha\text{-BeO(s)} + H_2O = Be(OH)_2(aq) \qquad K_0' = (5.2\pm0.6)\times10^{-6}$$

$$\alpha\text{-BeO(s)} + H^+(aq) = Be(OH)^+(aq) \qquad K_1' = 0.029\pm0.009$$

$$\alpha\text{-BeO(s)} + 2H^+(aq) = Be^{2+}(aq) + H_2O \qquad K_2' = 10.4\pm1.8$$

$$H_2O = H^+(aq) + OH^-(aq) \qquad K_w = \text{300°C Handbook value.}$$

The data were treated by a weighted least squares method. Additional details in the original paper.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The autoclave method was used under isothermal conditions. The α-BeO crytals and the acid solutions were sealed by welding in gold capsules of 5 or 10 mm diameter of 1 to 3.5 mL volume. The contents were adjusted so there was no more than 2 % vapor volume at 300°C. From 5 to 10 of these capsules were placed in a stainless steel autoclave, sealed and placed in a preheated oven for seven days. Preliminary studies showed equilibrium was established within 5 days. The autoclave was removed and cooled rapidly in cool water. The capsule contents were analyzed immediately for Be by an atomic absorption spectrometer. Either a flame or flame free method was used depending in part on the sample size. Results were checked in some cases by the weight loss of α-BeO.

SOURCE AND PURITY OF MATERIALS:

(1) Bromellite (α-BeO). Crystals of 10-40 mg were washed with boiling aqua regia to eliminate inclusions containg V or Pb. After each experiment the crystals were washed with 5 % HF and inspected for cracks and inclusions.

(2) Perchloric acid. Prepared from chemically pure concentrated acid. Conc. checked by titration.

(3) Water. Nothing specified.

ESTIMATED ERROR:

Temp.: Precision ±0.5 K.

Soly.: See std. error of mean in table above.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Perchloric acid; $HClO_4$; [7601-90-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Gilbert, R. A.; Garrett, A. B.

J. Am. Chem. Soc. 1956, *78*, 5501-5.

VARIABLES:

$T/K = 298.15$
$m_2/\text{mol kg}^{-1} = 0.0005 - 0.0120$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of α-$Be(OH)_2$ in $HClO_4$ solution at 25°C

Molality $HClO_4$ $m_2/\text{mol kg}^{-1}$	Molality α-$Be(OH)_2$ $10^4 m_1/\text{mol kg}^{-1}$
0.0005	3.22
0.0010	6.95
0.0030	21.0
0.0050	37.1
0.0065	51.0
0.0080	64.7
0.0100	81.4
0.0120	98.2

The results were interpreted by the three reactions:

$$Be(OH)_2(s) \rightleftharpoons Be^{2+} + 2OH^- \qquad (1)$$

$$Be(OH)_2(s) + 2H^+ \rightleftharpoons Be^{2+} + 2H_2O \qquad (2)$$

$$Be^{2+} + Be(OH)_2 \rightleftharpoons Be_2O^{2+} + H_2O \text{ (ref 1)} \qquad (3)$$

which give

$$K_2 = (a_{Be^{2+}})/(a_{H^+})^2 = 7.3 \times 10^6$$

and

$$K_1 = (a_{Be^{2+}}) \times (a_{OH^-})^2 = K_2 \times K_w^2 = 7.3 \times 10^{-22}$$

$$(K_w = a_{H^+}\, a_{OH^-} = 1 \times 10^{-14})$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

α-$Be(OH)_2$ was equilibrated with acid solution in glass flask either from supersaturation (preliminary equilibration at 35°C followed by cooling to 25°C) or from undersaturation (dissolution at 25°C) at 25.00 ± 0.02°C for seven days. After the sedimentation of solid $Be(OH)_2$ for further standing of seven days, pH was measured on the solution using a glass electrode pH meter and dissolved Be^{2+} was determined spectrophotometrically.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium hydroxide. The metastable form was prepared by dissolving fused Be (99.5 %) in aqueous HCl followed by precipitation with chemically pure NaOH.

(2) Perchloric acid. C. p. reagent grade.

(3) Water. Triply distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: reproducibility ± 1.5 %, (av. 3 determinations).

REFERENCES:

1. Mattock, G. *J. Am. Chem. Soc* 1954, *76*, 4835.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Nitric acid; HNO_3; [7697-37-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Soboleva, G. I.; Tugarinov, I. A.; Kalinina, V. F.; Khodakovsky, I. L.

**Geokhimiya* <u>1977</u>, *(7)*, 1013-24.

[No translation in *Geochem. Int.*]

VARIABLES:

$T/K = 423 - 523$
$m_2/\text{mol kg}^{-1} = 0 - 0.11$

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous nitric acid

$t/°C$	Concentration of HNO_3 $m_2/\text{mol kg}^{-1}$	Concentration of $Be(OH)_2$ $10^4 m_1/\text{mol kg}^{-1}$
150	0.0011	0.942 ± 0.20
	0.011	13.4 ± 1
200	0	0.035 ± 0.025
	0.00011	0.43 ± 0.30
	0.000275	0.46 ± 0.10
	0.0011	2.2
	0.00275	8.6 ± 1.1
	0.011	29 ± 2
	0.0275	66 ± 18
	0.11	230 ± 60
250	0	0.052 ± 0.040
	0.0011	0.81 ± 0.06
	0.011	28 ± 2

The total pressure, p = saturating vapor pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

α-BeO was saturated with aqueous HNO_3 solution in an autoclave at a specified temperature within ±5°C for 7 - 25 days. After equilibration, the aqueous phase was taken out, and dissolved Be^{2+} was determined fluorometrically by using Morin [480-16-0] as a complexing reagent.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium hydroxide. α-BeO (hexagonal crystal) was prepared by a hydrothermal method.

(2) Nitric acid. Chemically pure.

(3) Water. Twice distilled CO_2 free water.

ESTIMATED ERROR·

Temp.: precision ± 5 K.
Soly.: see error reported by authors with molality values above.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium chloride; $BeCl_2$; [7787-47-5]

(3) Sodium hydroxide; NaOH; [1310-73-2]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. 1929, *180*, 355-69.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$BeCl_2$ c_2/mol L^{-1}	pH at N=0.5	a_{H^+}/f_{H^+} = $[H^+]$	$10^7 K_0$	pH at N=1.5	a_{H^+}/f_{H^+} = $[H^+]$	$10^{-9} S_0$
0.1	3.79	0.000224	(2.7)	5.76	0.00000250	(3.5)
0.05	3.98	0.000139	2.2	5.83	0.00000196	3.0
0.02	4.24	0.0000713	1.7	5.93	0.00000145	2.4
0.01	4.42	0.0000452	1.5	6.03	0.00000111	2.0
0.008	4.49	0.0000382	1.7	6.06	0.00000103	2.0
0.005	4.61	0.0000283	1.3	6.07	0.00000098	1.3
			$\bar{K}_0$ = 1.7			$\bar{S}_0$ = 2.1

$K_{s0} = 2.9 \times 10^{-19}$

Results were interpreted through the hydrolysis equation

$$2Be^{2+} + 2H_2O = (BeOH)_2^{2+} + 2H^+ \qquad (1)$$

or

$$2Be^{2+} + H_2O = Be_2O^{2+} + 2H^+$$

followed by the precipitation reaction

$$(BeOH)_2^{2+} + H_2O = Be_2O(OH)_2\ (s) + 2H^+ \qquad (2)$$

or

$$Be_2O^{2+} + 2H_2O = Be_2O(OH)_2\ (s) + 2H^+.$$

The hydrolysis constant was defined by

$$K_0 = a_{H^+}^2[(BeOH)_2^{2+}]/[Be^{2+}]^2 = a_{H^+}^2[Be_2O^{2+}]/[Be^{2+}]^2$$

and the solubility product by

$$K_{s0} = L = [Be^{2+}][OH^-]^2 = [Be_2O^{2+}]K_W^2/[H^+]^2 = S_0 K_W^2.$$

Calculations were performed through the relations

(Be) = Total Be concentration

N = NaOH added, expressed in equivalents

$K_W = 1.4 \times 10^{-14}$

$[(BeOH)_2^{2+}] = (1/2)[N(Be) + [H^+]].$

(continued on next page)

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium chloride; $BeCl_2$; [7787-47-5]

(3) Sodium hydroxide; NaOH; [1310-73-2]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. 1929, *180*, 355-69.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0.005 - 0.1$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Beryllium salt solutions were titrated potentiometrically by 1 mol L^{-1} NaOH in a thermostated apparatus. The potential was measured by a platinum electrode which was freshly platinized before every experiment. A calomel electrode (KCl 3.5 M) was used as the reference electrode.

The first inflection point in the titration curve corresponded to the hydrolysis reaction and the second one to the hydroxide precipitation.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide.

(2) Beryllium chloride. Prepared by the reaction $BeSO_4 + BaCl_2 \rightarrow BeCl_2 + BaSO_4$ (s).

(3) Sodium hydroxide.

(4) Water.

ESTIMATED ERROR:

$K_0 = (1.7 \pm 0.35) \times 10^{-7}$
$S_0 = (2.1 \pm 0.6) \times 10^{9}$
$K_{s0} = (2.9 \pm 0.8) \times 10^{-19}$

REFERENCES:

1. Randall, M.; Breckenridge, G. F. *J. Am. Chem. Soc.* 1927, *49*, 1435.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium bromide; $BeBr_2$; [7787-86-4]

(3) Hydrobromic acid; HBr; [10035-10-6]

(4) Sodium hydroxide; NaOH; [1310-73-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. 1931, *197*, 103-12.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$BeBr_2$ c_2/mol L^{-1}	HBr c_3/mol L^{-1}	pH at N=0.5	$a_{H^+}/f_{H^+} = [H^+]$	$10^7 K_0$
0.1	0.0562	3.51	0.000394	(9.8)
0.05	0.0281	3.72	0.000240	7.5
0.02	0.0112	3.97	0.000128	6.1
0.01	0.00562	4.14	0.0000833	5.5
0.008	0.00449	4.20	0.0000716	5.3
0.005	0.00281	4.32	0.0000532	5.0
				$\overline{K_0}$ = 5.9

$BeBr_2$ c_2/mol L^{-1}	HBr c_3/mol L^{-1}	pH at N=1.5	$a_{H^+}/f_{H^+} = [H^+]$	$10^{-9} S_0$
0.1	0.0562	5.63	0.00000298	(2.3)
0.05	0.0281	5.71	0.00000245	1.9
0.02	0.0112	5.82	0.00000180	1.5
0.01	0.00562	5.93	0.00000135	1.4
0.008	0.00449	5.90	0.00000141	1.1
0.005	0.00281	5.99	0.00000113	1.0
				$\overline{S_0}$ = 1.4
				$K_{s0} = 2.7 \times 10^{-19}$

Results were interpreted through the hydrolysis equation

$$2Be^{2+} + 2H_2O = (BeOH)_2^{2+} + 2H^+ \quad (1)$$

or

$$2Be^{2+} + H_2O = Be_2O^{2+} + 2H^+$$

followed by the precipitation reaction

$$(BeOH)_2^{2+} + H_2O = Be_2O(OH)_2\ (s) + 2H^+ \quad (2)$$

or

$$Be_2O^{2+} + 2H_2O = Be_2O(OH)_2\ (s) + 2H^+.$$

The hydrolysis constant was defined by

$$K_0 = a_{H^+}^2[(BeOH)_2^{2+}]/[Be^{2+}]^2 = a_{H^+}^2[Be_2O^{2+}]/[Be^{2+}]^2$$

and the solubility product by

$$K_{s0} = L = [Be^{2+}][OH^-]^2 = [Be_2O^{2+}]K_W^2/[H^+]^2 = S_0 K_W^2.$$

(continued on next page)

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium bromide; $BeBr_2$; [7787-86-4]

(3) Hydrobromic acid; HBr; [10035-10-6]

(4) Sodium hydroxide; NaOH; [1310-73-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. 1931, *197*, 103-12.

VARIABLES:

$T/K = 298$
$c_2/mol\ L^{-1} = 0.005 - 0.1$
$c_3/mol\ L^{-1} = 0.00281 - 0.0562$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Calculations were performed through the relations

(Be) = Total Be concentration

N = NaOH added, expressed in equivalents

$K_W = 1.4 \times 10^{-14}$

$[(BeOH)_2^{2+}] = (1/2)[N(Be) + [H^+]]$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Beryllium salt solutions were titrated potentiometrically by 1 mol L^{-1} NaOH in a thermostated apparatus. The potential was measured by a platinum electrode which was freshly platinized before every experiment. A calomel electrode (KCl 3.5 M) was used as the reference electrode.

The first inflection point in the titration curve corresponded to the hydrolysis reaction and the second one to the hydroxide precipitation.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide.

(2) Beryllium bromide. Prepared by adding $BeSO_4$ in a solution of $Ba(OH)_2$ and excess HBr then precipitating $BaSO_4$ and filtering the $BeBr_2$ solution. The absence of barium in the solution was tested. Be and acidity were titrated in the resulting solution.

(3) Hydrobromic acid.

(4) Sodium hydroxide.

(5) Water.

ESTIMATED ERROR:

$K_0 = (5.9 \pm 1) \times 10^{-7}$
$S_0 = (1.4 \pm 0.4) \times 10^{9}$
$K_{s0} = (2.7 \pm 0.8) \times 10^{-19}$

REFERENCES:

1. Livingston, R. S.
J Am Chem. Soc. 1926, *48*, 53.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium iodide; BeI_2; [7787-53-3]

(3) Hydriodic acid; HI; [10034-85-2]

(4) Sodium hydroxide; NaOH; [1310-73-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. 1931, *197*, 103-12.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

BeI_2 c_2/mol L^{-1}	HI c_3/mol L^{-1}	pH at N=0.5	$a_{H^+}/f_{H^+} = [H^+]$	10^7K_0
0.1	0.00453	3.53	0.000358	(8.9)
0.05	0.00227	3.79	0.000193	5.4
0.02	0.000906	4.04	0.000106	4.7
0.01	0.000453	4.22	0.0000689	3.8
0.008	0.000343	4.25	0.0000638	4.2
0.005	0.000227	4.35	0.0000502	4.1

$\bar{K}_0 = 4.4$

BeI_2 c_2/mol L^{-1}	HI c_3/mol L^{-1}	pH at N=1.5	$a_{H^+}/f_{H^+} = [H^+]$	$10^{-9}S_0$
0.1	0.00453	5.67	0.00000260	(3.2)
0.05	0.00227	5.78	0.00000200	2.9
0.02	0.000906	5.86	0.00000160	1.9
0.01	0.000453	5.93	0.00000134	1.4
0.008	0.000343	5.96	0.00000125	1.3
0.005	0.000227	6.02	0.00000107	1.1

$\bar{S}_0 = 1.7$

$K_{s0} = 3.3 \times 10^{-19}$

Results were interpreted through the hydrolysis equation

$$2Be^{2+} + 2H_2O = (BeOH)_2^{2+} + 2H^+ \quad (1)$$

or

$$2Be^{2+} + H_2O = Be_2O^{2+} + 2H^+$$

followed by the precipitation reaction

$$(BeOH)_2^{2+} + H_2O = Be_2O(OH)_2\ (s) + 2H^+ \quad (2)$$

or

$$Be_2O^{2+} + 2H_2O = Be_2O(OH)_2\ (s) + 2H^+.$$

The hydrolysis constant was defined by

$$K_0 = a_{H^+}^2[(BeOH)_2^{2+}]/[Be^{2+}]^2 = a_{H^+}^2[Be_2O^{2+}]/[Be^{2+}]^2$$

and the solubility product by

$$K_{s0} = L = [Be^{2+}][OH^-]^2 = [Be_2O^{2+}]K_W^2/[H^+]^2 = S_0K_W^2.$$

(continued on next page)

COMPONENTS.

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium iodide; BeI_2; [7787-53-3]

(3) Hydriodic acid; HI; [10034-85-2]

(4) Sodium hydroxide; NaOH; [1310-73-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. 1931, *197*, 103-12.

VARIABLES:

$T/K = 298$
$c_2/mol\ L^{-1} = 0.005 - 0.1$
$c_3/mol\ L^{-1} = 0.000227 - 0.00453$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Calculations were performed through the relations

(Be) = Total Be concentration

N = NaOH added, expressed in equivalents

$K_w = 1.4 \times 10^{-14}$

$$[(BeOH)_2^{2+}] = (1/2)[N(Be) + [H^+]].$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Beryllium salt solutions were titrated potentiometrically by 1 mol L^{-1} NaOH in a thermostated apparatus. The potential was measured by a platinum electrode which was freshly platinized before every experiment. A calomel electrode (KCl 3.5 M) was used as the reference electrode.

The first inflection point in the titration curve corresponded to the hydrolysis reaction and the second one to the hydroxide precipitation.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide.

(2) Beryllium iodide. Prepared by adding $BeSO_4$ in a solution of $Ba(OH)_2$ and excess HI then precipitating $BaSO_4$ and filtering the BeI_2 solution. The absence of barium in the solution was tested. Be and acidity were titrated in the resulting solution.

(3) Hydriodic acid.

(4) Sodium hydroxide.

(5) Water.

ESTIMATED ERROR:

$K_0 = (4.4 \pm 0.6) \times 10^{-7}$
$S_0 = (1.7 \pm 0.7) \times 10^{9}$

REFERENCES:

1. Pearce, J. N.; Fortsch, A. R. *J. Am. Chem. Soc.* 1923, *45*, 2852.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium sulfate; $BeSO_4$; [13510-49-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kovalenko, P. N.; Geiderovich, O. I.

**Zh. Neorg. Khim.* <u>1959</u>, *4*, 1974-8.

Russ. J. Inorg. Chem. (Engl. Transl.) <u>1959</u>, *4*, 895-8.

VARIABLES:

T/K = 292

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

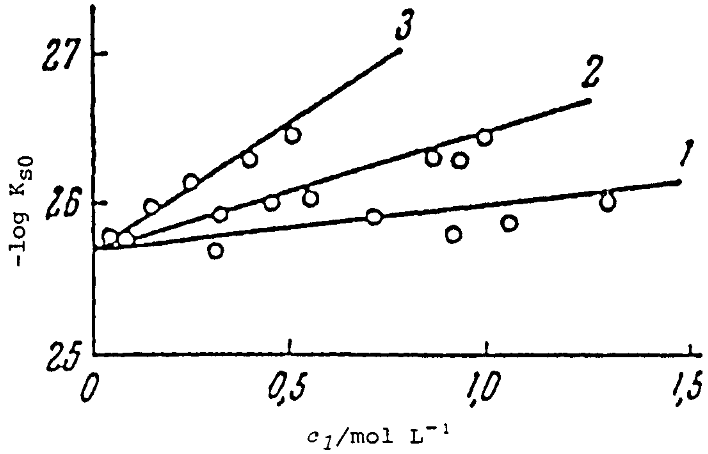


Figure 1

The solubility product of $Be(OH)_2$,

$$K_{s0} = ([Be^{2+}][OH^-]^2),$$

was calculated from experimental data of the concentration of $Be(OH)_2$ and pH by the relation,

$$K_{s0} = c_1 \times K_w^2 \times 10^{2pH},$$

where K_w is the ion product of water (the value was not given in the text). Relation between K_{s0} and c_1 given in Figure 1 was analyzed by the relation,

$$-\log K_{s0} = -\log K_{s0}^0 + bc_1,$$

where b is a constant. K_{s0}^0 was estimated to be

$$-\log K_{s0}^0 = 25.7.$$

Solubility of $Be(OH)_2$ in water at 19°C was calculated from K_{s0}^0 to be 1.71×10^{-9} mol L^{-1}. In Figure 1, curves 1, 2, and 3 corresponds to initial concentration of beryllium(II) of 2×10^{-3}, 1×10^{-3}, and 0.5×10^{-3} mol L^{-1}. Note that c_1 is assumed to be equal to concentration of Be^{2+} in the solution.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An aqueous solution containing $(0.5 - 2) \times 10^{-3}$ mol L^{-1} $BeSO_4$ was hydrolyzed at 19°C under a constant pH value for 60 minutes (no description of the hydrolysis procedure). Be^{2+} in the solution was determined polarographically at -1.84 V (*vs* SCE) using 0.1 mol L^{-1} tetraethylammonium iodide as the supporting electrolyte, and pH was determined by a glass electrode pH meter.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide. Chemically pure.

(2) Beryllium sulfate.

(3) Water.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium sulfate; $BeSO_4$; [13510-49-1]

(3) Sodium hydroxide; NaOH; [1310-73-2]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. <u>1929</u>, *180*, 355-69.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$BeSO_4$ c_2/mol L^{-1}	pH at N=0.5	$a_{H^+}/f_{H^+} = [H^+]$	10^7K_0	pH at N=1.5	$a_{H^+}/f_{H^+} = [H^+]$	$10^{-9}S_0$
0.1	3.92	0.00036	1.5	5.87	0.00000406	1.1
0.07	4.00	0.00026	1.5	5.73	0.00000532	0.5
0.06	4.02	0.000239	1.6	5.86	0.00000345	1.0
0.05	4.05	0.000210	1.6	5.84	0.00000340	0.9
0.04	4.02	0.000207	2.4	5.83	0.00000321	0.8
0.02	4.28	0.0000945	1.4	5.94	0.00000207	0.7
0.0175	4.34	0.0000799	1.3	5.98	0.00000184	1.0
0.0117	4.42	0.0000600	1.3	5.98	0.00000166	0.8
0.01	4.44	0.0000558	1.3	6.02	0.00000147	0.8
0.00875	4.51	0.0000457	1.1	6.04	0.00000135	1.0
0.007	4.54	0.0000403	1.2	6.01	0.00000137	0.7
0.00583	4.58	0.0000355	1.2	6.06	0.00000118	0.8
0.005	4.63	0.0000304	1.1	6.06	0.00000113	0.7
			$\overline{K_0} = 1.4$			$\overline{S_0} = 0.84$

$K_{s0} = 1.1 \times 10^{-19}$

Results were interpreted through the hydrolysis equation

$$2Be^{2+} + 2H_2O = (BeOH)_2^{2+} + 2H^+ \qquad (1)$$

or

$$2Be^{2+} + H_2O =, Be_2O^{2+} + 2H^+$$

followed by the precipitation reaction

$$(BeOH)_2^{2+} + H_2O = Be_2O(OH)_2\ (s) + 2H^+ \qquad (2)$$

or

$$Be_2O^{2+} + 2H_2O = Be_2O(OH)_2\ (s) + 2H^+.$$

The hydrolysis constant was defined by

$$K_0 = a_{H^+}^2[(BeOH)_2^{2+}]/[Be^{2+}]^2 = a_{H^+}^2[Be_2O^{2+}]/[Be^{2+}]^2$$

and the solubility product by

$$K_{s0} = L = [Be^{2+}][OH^-]^2 = [Be_2O^{2+}]K_W{}^2/[H^+]^2 = S_0K_W{}^2.$$

Calculations were performed through the relations

(Be) = Total Be concentration

N = NaOH added, expressed in equivalents

$K_W = 1.4 \times 10^{-14}$

$[(BeOH)_2^{2+}] = (1/2)[N(Be) + [H^+]].$

(continued on next page)

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium sulfate; $BeSO_4$; [13327-32-7]

(3) Sodium hydroxide; NaOH; [1310-73-2]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Prytz, M.

Z. Anorg. Allg. Chem. 1929, *180*, 355-69.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0.005 - 0.1$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Beryllium salt solutions were titrated potentiometrically by 1 mol L^{-1} NaOH in a thermostated apparatus. The potential was measured by a platinum electrode which was freshly platinized before every experiment. A calomel electrode (KCl 3.5 M) was used as the reference electrode.

The first inflection point in the titration curve corresponded to the hydrolysis reaction and the second one to the hydroxide precipitation.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide.

(2) Beryllium sulfate. Pure $BeSO_4 \cdot 4H_2O$ was analyzed for Be and SO_4 before use.

(3) Sodium hydroxide.

(4) Water.

ESTIMATED ERROR:

$K_0 = (1.4 \pm 0.35) \times 10^{-7}$
$S_0 = (0.84 \pm 0.6) \times 10^{9}$ (S_0 is supposed to be too low because of sulfate occlusion in precipitated $Be_2O(OH)_2$); $K_{s0} = (1.1 \pm 0.8) \times 10^{-19}$.

REFERENCES:

1. Randall, M.; Breckenridge, G. F. *J Am. Chem. Soc.* 1927, *49*, 1435.

2. Akerlof, G. *J Am. Chem. Soc.* 1926, *48*, 1160.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium sulfate; $BeSO_4$; [13510-49-1]

(3) Potassium hydroxide; KOH; [1310-58-3]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bleyer, B.; Kaufman, S. W.

Z. Anorg. Chem. 1913, *82*, 71-91.

VARIABLES:

T/K not specified room temperature
c_3/mol L^{-1} = 0.49 - 3.5

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Be(OH)_2$ in aqueous KOH at room temperature.

Procedure	KOH	Be	
	c_3/mol L^{-1}	c/mol L^{-1}	c/mol L^{-1}
Hydroxide A	2.9	0.5140	
	2.58	0.4256	
	2.20	0.3713	
	2.02	0.3212	
	1.83	0.2688	
	1.54	0.2280	
	1.23	0.1780	
	0.9	0.100	
Hydroxide B	2.69	0.1071	
	2.48	0.0975	
	2.28	0.0876	
	2.07	0.0809	
	1.85	0.0741	
	1.41	0.0566	
	0.96	0.0385	
	0.49	0.0196	
Hydroxide C_1	3.5	0.0948	0.0904
(left column)	3.0	0.0689	0.0705
Hydroxide C_2	2.5	0.0518	0.0498
(right column)	2.0	0.0386	0.0330
	1.5	0.0227	0.0191
	1.0	0.0139	0.0139

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A.: A one mol L^{-1} solution of $BeSO_4$ is poured, drop by drop, into different KOH solutions until precipitation of $Be(OH)_2$. The OH^- and Be concentrations are measured at the beginning of precipitation.

B.: After precipitation of A, the precipitate stays 3 days in contact with the solution, and transforms itself into the form B.

C.: C_1. Hydroxide B is filtered and dried. The solubility is measured after three days in contact with the KOH solution.
C_2. A commercial product (Merck) treated the same way as C_1.

Be is analyzed gravimetrically as BeO after precipitation by NH_4OH. No other details given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Beryllium nitrate; $Be(NO_3)_2$; [13597-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Korenman, I. M.; Frum, F. S.; Tsygankova, S. A.

**Zh. Obshch. Khim. USSR* 1956, *26*, 1558-60.

J. Gen. Chem. USSR (Engl. Transl.) 1956, *26*, 1745-7.

VARIABLES:

T/K = Room temperature

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Composition of the saturated solution at room temperature

Series[a]	Be^{2+} 10^2c/mol L^{-1}	pH
I	21.7	5.74
	20	5.68
	20	5.68
	18.8	5.52
	18.2	5.61
	17.8	5.56
	17.0	5.64
	16.8	5.80
	14.9	5.62
	14.5	5.66
	14	5.69
	9.9	5.70
	9.8	5.73
	9.2	5.74
	8.1	5.79
	7.2	5.76
	3	6.00
	2.2	6.20
II	0.199	6.45
	0.18	6.48
	0.15	6.50
	0.13	6.52
	0.10	6.68

[a] Series I, Be^{2+} determined gravimetrically, $c_{Be^{2+}}$ = 0.022 - 0.217, Series II, Be^{2+} determined colorimetrically, $c_{Be^{2+}}$ = 0.001 - 0.002.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The method of Akselrud and Fialkov (ref 1) was used. The $Be(OH)_2$ was dissolved in an aqueous $Be(NO_3)_2$ solution. The Be^{2+} concentration (series I, gravimetric method, series II colorimetric method) and H^+ concentration (electrometric method) were measured.

Series I resulted in a $Be(OH)_2$ solubility product of (3.5 ± 1.4) x 10^{-18} and series II a value of (1.7 ± 0.3) x 10^{-18}. The difference was attributed to the effect of ionic strength. A water ion product of 1 x 10^{-14} was used to convert the measured data into the solubility product value:

$$\log K_{s0} = \log[Be^{2+}] - 28 + 2pH.$$

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide.

(2) Beryllium nitrate.

(3) Water.

Nothing specified on components.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Akselrud, N. V.; Fialkov, Ya. A. *Ukr. Khim. Zh. (Russ. Ed.)* 1950, *16*, 294, 299.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Rubenbauer, J.

Z. Anorg. Chem. 1902, *30*, 331-7.

VARIABLES:

T/K = Room temperature
$c_2/\text{mol L}^{-1}$ = 0.7303 - 3.7725

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous NaOH at room temperature

Na g/0.020 L^{-1} sln	Concentration of NaOH[a] $c_2/\text{mol L}^{-1}$	Be g/0.020 L^{-1} sln	Concentration of $Be(OH)_2$[a] $c_1/\text{mol L}^{-1}$
0.3358	0.7303	0.0358	0.199
0.6716	1.461	0.0882	0.489
0.8725	1.898	0.1175	0.6519
1.7346	3.7725	0.2847	1.580

[a] Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Freshly prepared $Be(OH)_2$ was shaken with aqueous NaOH solution at room temperature (no specification in the original paper) for 5 hours. An aliquot of the resulting saturated solution was taken out, and Be^{2+} in the solution was determined gravimetrically.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide. Precipitated from acidic aqueous solution containing Be^{2+} with NH_3, washed with H_2O, and pressed to remove excess H_2O to obtain $Be(OH)_2$ gel.

(2) Sodium hydroxide. CO_2 free solution, prepared from metallic Na.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Haber, F.; van Oordt, G.

Z. Anorg. Chem. 1904, *38*, 377-98.

VARIABLES:

$T/K = 293 - 373$
$c_2/\text{mol L}^{-1} = 0.39 - 2.0$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous NaOH

$t/°C$	Concentration NaOH $c_2/\text{mol L}^{-1}$	Concentration $Be(OH)_2$ $c_1/\text{mol L}^{-1}$	Remarks
20 - 23	0.39	0.06	(a)
	0.65	0.144	"
	1.99	0.66	"
20 - 23	0.50	0.0024	(b)
	1.0	0.0068	"
	2.0	0.0227	"
50 - 53	0.50	0.0032	(b)
	1.0	0.0091	"
	2.0	0.0360	"
100	0.50	0.0032	(b)
	1.0	0.0108	"
	2.0	0.0408	"

(a) Freshly precipitated $Be(OH)_2$.
(b) Dried and aged precipitate of $Be(OH)_2$. Drying of the freshly precipitated $Be(OH)_2$ at room temperature or heating in the presence of NaOH at 100°C for 2 h brought it into less soluble, inactive modification.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Be(OH)_2$ in the form of active or inactive modification was equilibrated with aqueous NaOH solution at room temperature (20 - 23°C) or at 50 - 53°C for 24 hours or at 100°C for 2 hours, the remaining solid $Be(OH)_2$ was filtered off, and Be^{2+} in the filtrate was determined gravimetrically.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide. $BeCO_3$ as a starting material was purified from Fe, S, etc. $Be(OH)_2$ was prepared from the purified $BeCO_3$ by dissolving it in aqueous HCl followed by precipitating it with NH_3. The precipitate was thoroughly washed with H_2O and, when necessary, dried over H_2SO_4.

(2) Sodium hydroxide. Highest purity and CO_2 free.

(3) Water.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Wood, J. K.

J. Chem. Soc. 1910, *97*, 878.

VARIABLES:

$T/K = 298$

$c_2/\text{mol L}^{-1} = 0.268 - 0.854$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous NaOH at 25°C

Concentration NaOH $c_2/\text{mol L}^{-1}$	Concentration $Be(OH)_2$ $c_1/\text{mol L}^{-1}$
0.268	0.0330
0.318	0.0492
0.446	0.0841
0.526	0.089
0.563	0.101
0.801	0.143
0.854	0.202

The author interprets the results by the hydrolysis equation:

$$Be(ONa)_2 + 2H_2O = Be(OH)_2 + 2NaOH \qquad (1)\ (\text{ref } 1)$$

$$K = 1.21 \times 10^{-3}$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The hydroxide and NaOH solutions were mixed in a glass bottle and left in a thermostat at 25°C until the solution reached a constant composition as tested by repeated analysis.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide. A solution of the chloride was prepared by dissolving beryllium carbonate in hydrochloric acid; from this, the hydroxide was obtained by precipitation with ammonia, the product being repeatedly washed with warm distilled water.

(2) Sodium hydroxide.

(3) Water.

ESTIMATED ERROR:

No estimation. Discrepancies with equation (1) were attributed to differences in the physical character of precipitate.

REFERENCES:

1. Haber, F.; van Oordt, G. *Z. Anorg. Chem.* 1904, *38*, 377.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Fricke, R.; Humme, H.

Z. Anorg. Allg. Chem. 1929, *178*, 400-10.

VARIABLES:

T/K = 303
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 30°C

NaOH/mass %	BeO/mass %	Solid phase
14.10	0.159	$Be(OH)_2$
16.20	0.197	"
19.52	0.352	"
24.16	0.780	"
28.27	1.66	"
31.00	2.95	"
34.10	4.66	"
36.32	3.22	$BeO\cdot NaOH\cdot H_2O$
39.00	3.04	"
40.04	3.06	"
43.38	3.35	"
43.89	3.40	"
46.47	3.78	"

Temperature coefficient of the solubility of the stable β-$Be(OH)_2$ in aqueous NaOH solution was reported by the authors to be positive.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Inactive modification of $Be(OH)_2$ was equilibrated with aqueous NaOH solution at 30 ± 1°C by shaking for 3 - 7 days, the equilibrated suspension was subjected to filtration, and dissolved Be^{2+} in the filtrate was determined gravimetrically.

SOURCE AND PURITY OF MATERIALS:

(1) β-Beryllium hydroxide. Prepared by precipitating the hydroxide from aqueous $BeSO_4$ solution with NH_3, washing it thoroughly with H_2O, refluxing it in aqueous 10 % NH_3 solution for 24 h on a sand bath, again washing it with H_2O, and finally drying it over $CaCl_2$.

(2) Sodium hydroxide. Prepared to its highest concentration to precipitate dissolved CO_2.

(3) Water.

ESTIMATED ERROR:

Temp.: precision ± 1 K.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Gilbert, R. A.; Garrett, A. B.

J. Am. Chem. Soc. 1956, *78*, 5501-5.

VARIABLES

$T/K = 298.15$
$m_2/\text{mol kg}^{-1} = 0.0197 - 0.7130$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of α-$Be(OH)_2$ in aqueous NaOH at 25°C

Molality NaOH $m_2/\text{mol kg}^{-1}$	Molality α-$Be(OH)_2$ $10^4 m_1/\text{mol kg}^{-1}$
0.0197	0.75
0.0391	1.16
0.0589	1.46
0.0709	1.86
0.0790	2.22
0.0871	3.51
0.0981	2.40
0.1531	6.48
0.2506	12.0
0.3565	16.5
0.4512	21.5
0.7130	45.0

The results were interpreted by the two reactions:

$$Be(OH)_2(s) + OH^- = HBeO_2^- + H_2O \qquad (1)$$

$$Be(OH)_2(s) + 2OH^- = BeO_2^{2-} + 2H_2O \qquad (2)$$

From a least squares treatment of the data, with activity coefficients taken from ref 1, K_1 and K_2 were found to be

$$K_1 = 3.2 \times 10^{-3} \qquad K_2 = 2.0 \times 10^{-3}.$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

α-$Be(OH)_2$ was equilibrated with aqueous NaOH solution in a glass flask coated inside with paraffin, either from supersaturation (preliminary equilibration at 35°C followed by cooling to 25°C) or from undersaturation (dissolution at 25°C) at 25.00 ± 0.02°C for seven days. After the sedimentation of solid $Be(OH)_2$ for further standing of seven days, pH was measured on the solution using a glass electrode pH meter and dissolved Be^{2+} was determined spectrophotometrically.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium hydroxide. The metastable form was prepared by dissolving fused Be (99.5 %) in aqueous HCl followed by precipitation with NaOH.

(2) Sodium hydroxide. Baker and Adamson reagent grade. Carbonate free solution prepared.

(3) Water. Triply distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: reproducibility ± 1.5 %, (av. 3 determinations).

REFERENCES:

1. Harned, H. S.; Owen, B. B <u>The Physical Chemistry of Electrolyte Solutions</u>. New York: Rheinhold Publishing, 1950.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

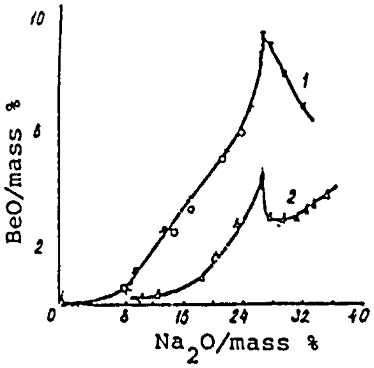
ORIGINAL MEASUREMENTS:

Kolenkova, M. A.; Blistanova, T. D.; Zakirova, A. V.; Bakashova, R. P.; Popov, A. I.

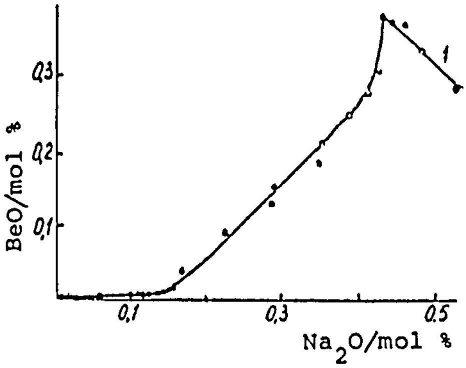
**Izv. Vyssh. Uchebn. Zaved., Tsvetn. Metall.* <u>1974</u>, *17*(4), 118-22.
Sov. Non-Ferrous Met. Res. (Engl. Transl.) <u>1974</u>, *2*, Not found.

EXPERIMENTAL VALUES:

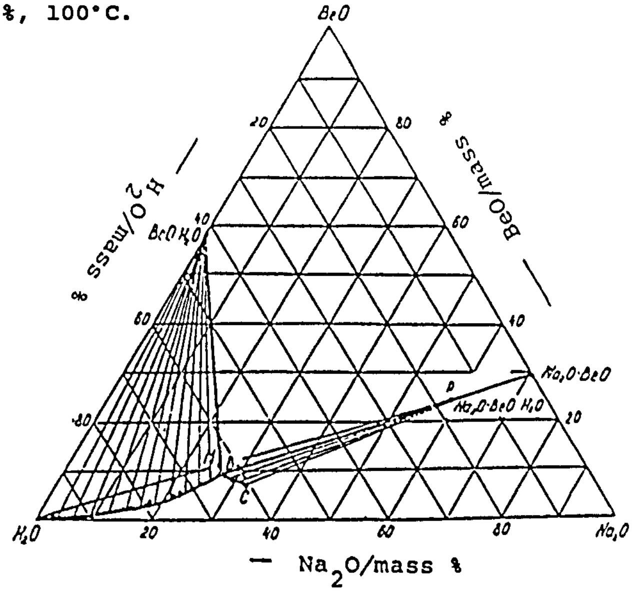
No numerical data on solubility were given in the original paper. Change of amorphous to crystalline state on prolonged treatment of $Be(OH)_2$ was pointed out.



(1) Solubility Curve.
1 - BeO/mass % *vs* Na_2O/mass %, 100°C.
2 - BeO/mass % *vs* Na_2O/mass %, 30°C.



(2) Solubility Curve.
1 - BeO/mol % *vs* Na_2O/mol %, 100°C.



(3) Phase Diagram.
System Na_2O + BeO + H_2O at 100°C.

(continued on next page)

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kolenkova, M. A.; Blistanova, T.D.; Zakirova, A. V.; Bakashova, R. P.; Popov, A. I.

**Izv. Vyssh. Uchebn. Zaved., Tsvetn. Metall.* 1974, *17*(4), 118-22.
Sov. Non-Ferrous Met. Res. (Engl. Transl.) 1974, *2*, Not found.

VARIABLES:

T/K = 303, 373
Composition

PREPARED BY:

E. Einaga
I. Lambert

EXPERIMENTAL VALUES.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Be(OH)_2$ and aqueous NaOH solution (Na_2O: 1.3 - 36 wt %) were equilibrated in a vessel made of Mo glass at the specified temperature by shaking for 6 - 12 h. The temperature was regulated within ±0.1°C during the equilibration. The saturated solution was taken out , and after filtration it was analyzed for Na_2O by titration with a standard HCl solution, and for BeO by the photoneutron method (no methodology description).

The authors (ref 1) described other physicochemical properties of $Be(OH)_2$ in an earlier paper.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide. Prepared as a precipitate by neutralization of aqueous $BeCl_2$ solution with NH_3 to pH 7.5.

(2) Sodium hydroxide. Concentrated NaOH solution (50 wt % NaOh) containing 0.04 wt % Na_2CO_3 was used as prepared.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Kolenkova,M.A.; Blistanova,T.D. Bakashova, R.P.; Zakirova, A.V. *Izv. Vyssh. Uchebn. Zaved., Tsvetn. Metall.* 1973, *16*(4), 825.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Soboleva, G. I.; Tugarinov, I. A.; Kalinina, V. F.; Khodakovsky, I. L.

**Geokhimiya* <u>1977</u>, *(7)*, 1013-24.

[No translation in *Geochem. Int.*]

VARIABLES:

T/K = 423 - 523
m_2/mol kg^{-1} = 0 - 1.0

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous sodium hydroxide

t/°C	Concentration of NaOH m_2/mol kg^{-1}	Concentration of $Be(OH)_2$ $10^4 m_1$/mol kg^{-1}
150	0.0001	0.0213 ± 0.002
	0.01	0.134 ± 0.01
200	0	0.035 ± 0.025
	0.00001	0.014
	0.0001	0.022 ± 0.008
	0.0005	0.016 ± 0.009
	0.001	0.029 ± 0.005
	0.005	0.083 ± 0.028
	0.01	0.30 ± 0.09
	0.1	2.0 ± 0.6
	0.25	8.6
	0.5	9.8 ± 0.4
	1.0	21 ± 1
250	0	0.052 ± 0.040
	0.0001	0.028 ± 0.008
	0.01	0.46 ± 0.01
	0.1	7.0 ± 1.0

The total pressure, p = saturating vapor pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

α-BeO was saturated with aqueous NaOH solution in an autoclave at a specified temperature within ±5°C for 7 - 25 days. After equilibration, the aqueous phase was taken out and acidified with HCl; and dissolved Be^{2+} was determined fluorometrically by using Morin [480-16-0] as a complexing reagent.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium hydroxide. α-BeO (hexagonal crystal) was prepared by a hydrothermal method.

(2) Sodium hydroxide. Chemically pure.

(3) Water. Twice distilled CO_2 free water.

ESTIMATED ERROR:

Temp.: precision ± 5 K.
Soly.: see error reported by authors with molality values above.

REFERENCES:

COMPONENTS:

(1) Beryllium oxide, BeO; [13598-27-5]
(2) Sodium fluoride; NaF; [7681-49-4]
(3) Sodium hydroxide; NaOH; [1310-73-2]
(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Soboleva, G. I.; Tugarinov, I. A.; Golitsina, N.S.; Khodakovskii, I.L.

Geokhimiya 1984, (No. 6), 812-22.

**Geochem. Int. (Engl. Transl.)* 1984, *21*(7), 20-30.

VARIABLES:

T/K = 423, 473 and 523

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Sodium Fluoride	Sodium Hydroxide	Total Beryllium
t/°C	T/K	m_2/mol kg^{-1}	m_3/mol kg^{-1}	m_{Be}/mol kg^{-1}
150	423	0.0025	-	8.7×10^{-5}
		0.010	-	2.7×10^{-4}
		0.025	-	2.0×10^{-4}
		0.10	-	9.6×10^{-4}
		0.25	-	2.4×10^{-3}
200	473	0.0010	-	$(2.6\pm0.1)\times10^{-5}$
		0.0025	-	$(6.7\pm0.6)\times10^{-5}$
		0.010	-	3.1×10^{-4}
		0.025	-	$(4.0\pm1.5)\times10^{-4}$
		0.10	-	$(1.7\pm0.4)\times10^{-3}$
		0.50	-	$(7.7\pm1.0)\times10^{-3}$
		0.10	0.010	2.4×10^{-5}
		0.25	0.010	3.6×10^{-4}
		0.50	0.010	2.6×10^{-3}
		0.25	0.10	4.2×10^{-5}
		0.50	0.10	1.9×10^{-4}
250	523	0.0025	-	3.9×10^{-5}(?)
		0.010	-	1.4×10^{-4}
		0.025	-	3.0×10^{-4}
		0.10	-	1.1×10^{-3}
		0.25	-	3.8×10^{-3}

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Same method as used by the authors in a study of the solubility of BeO in aqueous NaOH and aqueous HNO_3 (ref 1).

Aqueous solutions were saturated with α-BeO in an autoclave at a specified temperature within ± 5 degrees for 7 - 25 days. After equilibration, the aqueous phase was sampled, and the dissolved Be^{2+} was determined fluorometrically by use of Morin [480-16-0] as a complexing reagent.

The authors treated these data to obtain equilibrium constants for the reaction:

$$BeO(s) + H_2O(\ell) + F^-(aq) = Be(OH)_2F^-(aq)$$

of 0.018±0.011, 0.022±0.003 and 0.012±0.003 at 150, 200 and 250°C, repectively.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium oxide (bromellite). Artificial crytals. Hexagonal crystals prepared by a hydrothermal method.

(2) Sodium fluoride.
(3) Sodium hydroxide.
Reagents specified chemically pure.

(3) Water. Twice distilled CO_2 free water.

ESTIMATED ERROR:

Temp.: Precision ± 5 K.
Soly.: See average deviations in table above.

REFERENCES:

1. Soboleva, G.I.; Tugarinov, I.A. Kalinina,V.F.; Khodakovskii, I.L. *Geokhimiya* 1977, (No. 7), 1013.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium fluoride; NaF; [7681-49-4]

(3) Sodium bicarbonate; $NaHCO_3$; [144-55-8]

(4) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Samchuk, A. I.; Kokot, T. K.

**Ukr. Khim. Zh. (Russ. Ed.)* 1981, *47*, 1107-9.

Sov. Prog. Chem. (Engl. Transl.) 1981, *47(10)*, 103-5.

VARIABLES:

T/K = 298
c_2/mol L^{-1} = 0.0002 - 0.10

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in NaF + $NaHCO_3$ aqueous solution at ionic strength $I(NaClO_4)$ = 0.1 mol L^{-1} and 25°C

Concentration of NaF c_2/mol L^{-1}	Concentration of $NaHCO_3$ 10^4c_3/mol L^{-1}	Concentration of $Be(OH)_2$ 10^4c_1/mol L^{-1}
0.0002	1	0.9
0.0004	1	1.2
0.0007	1	2.0
0.0025	1	5.2
0.0050	1	7.0
0.0070	1	10
0.010	1	16
0.10	1	110

Additional experiments on the dependence of $Be(OH)_2$ solubility on the fraction, $\alpha = [F^-]/([F^-] + [HCO_3^-])$, gave a maximum at $\alpha = 0.5$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

β-$Be(OH)_2$ was equilibrated with aqueous NaF solution of different concentrations containing $NaHCO_3$ in a closed teflon vessel by shaking for 70 hours. The ionic strength of the aqueous solution was adjusted to 0.1 with $NaClO_4$ before the equilibration. After 24 hours of standing, a supernatant portion of the saturated solution was taken out, and dissolved Be^{2+} was determined fluorometrically by using Morin [480-16-0] or spectrophotometrically by using beryllon as complexometric reagents.

SOURCE AND PURITY OF MATERIALS:

(1) β-Beryllium hydroxide. Prepared from analytical grade $BeSO_4$ and NaOH in aqueous solution.

(2) Sodium fluoride. Chemically pure.

(3) Sodium bicarbonate. Chemically pure.

(4) Sodium perchlorate.

(5) Water. Distilled CO_2 free water.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bertin, F.; Thomas, G.; Merlin, J.-C.

C. R. Hebd. Seances Acad. Sci. 1965, *260*, 1670-3.

VARIABLES:

T/K room temperature (not specified)

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility product of $Be(OH)_2$ in aqueous 0.5 mol L^{-1} $NaClO_4$ at room temperature

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The solubility product in the form $K_s' = [Be(OH)_2][H^+]^2/[Be^{2+}] = 1.0 \times 10^{-11}$.

The compiler calculated a tentative value of $K_{s0} = [Be^{2+}][OH^-]^2$ from K_s' and $K_w = 1.0 \times 10^{-14}$. The value is $K_{s0}/[Be(OH)_2] = K_w^2/K_s' = 1.0 \times 10^{-17}$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An aqueous 0.5 mol L^{-1} $NaClO_4$ solution containing (1 - 80) x 10^{-3} mol L^{-1} Be^{2+} was titrated potentiometrically with a standard NaOH solution using a glass electrode. The potentiometric data were analyzed in terms of surface potentiometry (ref 1).

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Lefebvre, J.
J. Chim. Phys. 1957, *54*, 553; 1958, *55*, 227.

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium bicarbonate; $NaHCO_3$; [144-55-8]

(3) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mitskevich, B. F.; Samchuk, A. I.

Geokhimiya 1978, *(9)*, 1419-24.

[No translation in *Geochem. Int.*]

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0.00005 - 1.0$

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous $NaHCO_3$ at ionic strength $I(NaClO_4) = 0.01$ mol L^{-1} and 25°C

Concentration of $NaHCO_3$ $c_2/\text{mol L}^{-1}$	Concentration of $Be(OH)_2$ $10^4 c_1/\text{mol L}^{-1}$
0.00005	0.8
0.0001	1.0
0.0005	1.5
0.001	2.4
0.005	8.1
0.01	19
0.06	50
0.1	100
0.5	1400
1.0	3300

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Be(OH)_2$ was equilibrated with aqueous $NaHCO_3$ solution in a closed teflon vessel by shaking for 40 hours. The ionic strength of the aqueous solution was adjusted to 0.01 with $NaClO_4$ before the equilibration. After 20 hours of standing, the supernatant portion of the saturated solution was taken out, and dissolved Be^{2+} was determined fluorometrically by using Morin [480-16-0] or spectrophotometrically by using beryllon as complexometric reagents.

SOURCE AND PURITY OF MATERIALS:

(1) Beryllium hydroxide. Chemically pure or analytical grade reagent.

(2) Sodium bicarbonate.

(3) Sodium perchlorate. Apparently formed in solution from analytical grade $HClO_4$ and NaOH.

(4) Water. Twice distilled CO_2 free water.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium carbonate; Na_2CO_3; [497-19-8]

(3) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Samchuk, A. I.; Mitskevich, B. F.

Geokhimiya 1980, *(9)*, 1371-6.

Geochem. Int. (Engl. Transl.) 1980, *17(5)*, 62-6.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0.0005 - 0.5$

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous Na_2CO_3 at ionic strength $I(NaClO_4) = 1.0\ \text{mol L}^{-1}$ and 25°C

Concentration of Na_2CO_3 $c_2/\text{mol L}^{-1}$	Concentration of $Be(OH)_2$ $10^4 c_1/\text{mol L}^{-1}$
0.0005	0.6
0.0010	0.8
0.0050	1.1
0.010	3.3
0.025	7.7
0.050	11
0.10	44
0.5	500

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

α-$Be(OH)_2$ was equilibrated at 25 ± 1°C with aqueous Na_2CO_3 solution in a closed teflon vessel by shaking for 80 hours. The ionic strength of the aqueous solution was adjusted to 1.0 with $NaClO_4$ before the equilibration. After 40 hours of standing, the supernatant portion of the saturated solution was taken out, and dissolved Be^{2+} was determined fluorometrically by using Morin [480-16-0] as a complexing reagent.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium hydroxide. Prepared from analytical grade $BeSO_4$ and NaOH in aqueous solution.

(2) Sodium carbonate. Chemically pure.

(3) Sodium perchlorate.

(4) Water. Twice distilled CO_2 free water.

ESTIMATED ERROR:

Temp.: precision ± 1 K.
Soly.:analytical error ± 5 %.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Citric acid; $C_6H_8O_7$; [77-92-9]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Samchuk, A. I.; Kokot, T. K.

**Ukr. Khim. Zh. (Russ. Ed.)* <u>1980</u>, *46*, 432-3.

Sov. Prog. Chem. (Engl. Transl.) <u>1980</u>, *46(4)*, 92-3.

VARIABLES:

T/K = Room temperature
c_3/mol L^{-1} = 0.0005 - 0.1
c_2/mol L^{-1} = 0.1 (constant I)

PREPARED BY:

H. Einaga
I. Lambert
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in citric acid solution at ionic strength, $I(NaClO_4)$ = 0.1 mol L^{-1} and room temperature.

Concentration of $C_6H_8O_7$ c_3/mol L^{-1}	Concentration of $Be(OH)_2$ 10^4c_1/mol L^{-1}
0.0005	2
0.001	2
0.005	3
0.01	4
0.025	6
0.05	9
0.1	17

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

β-$Be(OH)_2$ was equilibrated with aqueous citric acid solution of different concentrations in a closed teflon vessel by shaking for 60 hours. After 24 hours of standing, a supernatant portion of the saturated solution was taken out, and dissolved Be^{2+} was determined fluorometrically by using Morin [480-16-0] or spectrophotometrically by using beryllon as complexometric reagents.

SOURCE AND PURITY OF MATERIALS:

(1) β-Beryllium hydroxide. Prepared from analytical grade $BeSO_4$ and NaOH in aqueous solution.

(2) Sodium perchlorate. Origin not specified.

(3) Citric acid. Chemically pure.

(4) Water. Distilled CO_2-free water was used.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Beryllium hydroxide; $Be(OH)_2$; [13327-32-7]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Soboleva, G. I.; Tugarinov, I. A.; Kalinina, V. F.; Khodakovsky, I. L.

**Geokhimiya* 1977, *(7)*, 1013-24.

[No translation in *Geochem. Int.*]

VARIABLES:

T/K = 473
m_2/mol kg^{-1} = 0 - 0.1

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Be(OH)_2$ in aqueous sodium nitrate

t/°C	Concentration of $NaNO_3$ m_2/mol kg^{-1}	Concentration of $Be(OH)_2$ $10^4 m_1$/mol kg^{-1}
200	0	0.035 ± 0.025
	0.0001	0.045
	0.001	0.050
	0.01	0.017 ± 0.005
	0.1	0.022 ± 0.010

The total pressure, p = saturating vapor pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

α-BeO was saturated with aqueous $NaNO_3$ solution in an autoclave at a specified temperature within ±5°C for 7 - 25 days. After equilibration, the aqueous phase was taken out and acidified with HCl; and dissolved Be^{2+} was determined fluorometrically by using Morin [480-16-0] as a complexing reagent.

SOURCE AND PURITY OF MATERIALS:

(1) α-Beryllium hydroxide. α-BeO (hexagonal crystal) was prepared by a hydrothermal method.

(2) Sodium nitrate. Chemically pure.

(3) Water. Twice distilled CO_2 free water.

ESTIMATED ERROR:

Temp.: precision ± 5 K.
Soly.: see error reported by authors with molality values above.

REFERENCES:

2. The solubility of magnesium hydroxide in aqueous systems.

Systems	Pages
$Mg(OH)_2 + H_2O$	50-64(E) 65-73
——— $+ H_2O_2 + H_2O$	58(E), 74-75
——— $+ NH_4Cl + H_2O$	52(E), 76
——— + ——— $+ NH_3 + H_2O$	52(E), 77
——— $+ NH_4NO_3 + H_2O$	52(E), 76
——— $+ H_3BO_3 + H_2O$	60(E), 78
——— $+ MgO + CrO_3 + H_2O$	60(E), 79-80
——— $+ MgCl_2 + H_2O$	52-53(E), 81-85
——— + ——— $+ NH_3 + NH_4Cl + H_2O$	52(E), 86-87
——— + ——— $+ Ca(OH)_2 + CaCl_2 + H_2O$	52-53(E), 88-89
——— + ——— $+ Ba(OH)_2 + H_2O$	52-53(E), 90-91
——— $+ MgSO_4 + H_2O$	59(E), 92
——— + ——— $+ NH_3 + (NH_4)_2SO_4 + H_2O$	52(E), 93
——— $+ Mg(SCN)_2 + NH_3 + NH_4SCH + H_2O$	52(E), 94
——— $+ Mg(NO_3)_2 + NH_3 + NH_4NO_3 + H_2O$	52(E), 95
——— + ————— $+ NaNO_3 + H_2O$	53-54(E), 96-97
——— $+ MgCO_3 + CO_2 + H_2O$	52(E), 98-99
——— $+ Mg(C_2H_3O_2)_2 + NH_3 + NH_4C_2H_3O_2 + H_2O$	52(E), 100
——— $+ CaCO_3 + H_2O$	51(E)T, 101
——— + (HCl, NaCl or $NaNO_3$) $+ H_2O$	56-58(E), 102-103
——— + (LiCl, NaCl, KCl, KBr or KI) $+ H_2O$	51(E)T, 53-54(E) 104-105
——— + (Na_2SO_4 or K_2SO_4) $+ H_2O$	
——— $+ KOH + H_2O$	
——— $+ NaOH + NaCl + H_2O$	54(E), 106-107
——— $+ NaClO_4 + H_2O$	56(E)T, 108
——— $+ Na_2SO_4 + H_2O$	50-51(E), 56-58(E) 109
——— $+ CH_3OH + H_2O$	60(E), 110
——— $+ C_2H_5OH + H_2O$	60(E), 111
——— $+ C_6H_{12}O_6 + H_2O$	60(E)

(E) is for evaluation pages.
T refers to a table value.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE
November, 1991

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

CRITICAL EVALUATION:

An evaluation of the solubility of magnesium hydroxide in water and in various aqueous solutions.

The solubility of magnesium hydroxide in water and in aqueous solutions is reported in 35 publications. Some of them are very old and do not contain quantitative data, precise data, or enough experimental detail to evaluate. Such papers are only referenced and their data were not compiled.

In aqueous solution the main equilibria which take place are:

$$Mg(OH)_2(s) = Mg^{2+}(aq) + 2OH^-(aq) \qquad K^{\circ}_{s0} = [Mg^{2+}][OH^-]\gamma^3_\pm \qquad [1]$$

and

$$Mg^{2+}(aq) + OH^-(aq) = MgOH^+(aq) \qquad [2]$$

The solubility is therefore a pronounced function of pH.

The solubility of magnesium hydroxide is also dependent on its physical state. Both the precipitation of the hydroxide from salt solution and the hydration of MgO lead to the formation of an amorphous magnesium hydroxide designated in the literature as "labile" or "active". Aging the amorphous form changes it to the thermodynamically stable, well crystallized form, which is less soluble, called the "stable" or "inactive" form. The evolution toward the stable form may be slow, depending on temperature and chemical conditions. Thus, the solubility data may refer, in some cases, to some intermediate ill-defined state. The difference in solubility of these different forms may be perceptible in precise measurements.

The crystalline magnesium hydroxide [1309-42-8] and the mineral brucite [1317-43-7] have the same structure (39). They are hexagonal with an a/c ratio of 1.5206 and a calculated density of 2.40×10^3 kg m^{-3}.

1. The solubility of magnesium hydroxide in water.

Direct measurements of the solubility, obtained by saturating pure water with MgO or $Mg(OH)_2$ and analyzing the supernatant liquid at equilibrium, are reported in a number of papers (1-3, 5, 7, 9-12, 14, 17, 23, 32). The $Mg(OH)_2$ is determined by titration with an acid or by conductivity measurements. These measurements require total exclusion of CO_2 because of the strong influence of pH on the solubility. The papers of Fyfe (1) and Fresenius (2) are mostly of historical interest. Fyfe (1) did recognize that magnesium hydroxide solubility decreases with increasing temperature. See (45) for a summary of early solubility work.

The starting material may be either the "active" hydroxide (2, 7, 10, 12, 14, 32) or the "inactive" hydroxide (17, 29). Several papers (5, 11, 23) give no indication of the form used. The "active" hydroxide results when MgO is used or when *in situ* precipitation from a salt solution is used. The "inactive" hydroxide results when the crystalline material is used. Bush (14) observed a decrease in solubility with time from 2.14×10^{-4} to 2.06×10^{-4} mol dm^{-3} at 302 K which he attributed to aging. The change is small compared to the scatter observed in other results which range from 1 to 4.5×10^{-4} mol dm^{-3} between 291 and 297 K (table 1). Nikolaev and Chelishcheva's result (23) is much larger and was rejected. No systematic trend with temperature or with starting material ("active" or "inactive") was observed in the values in table 1. The average of these results, excluding the two highest, gives an approximate value of the solubility around room temperature of:

$$c_1 = (1.97 \pm 0.7) \times 10^{-4} \text{ mol dm}^{-3}$$

Travers and Nouvel (9) measured the magnesium hydroxide solubility over the 291 to 473 K temperature interval. They observed a linear decrease in solubility with increasing temperature up to 373 K.

COMPONENTS:	EVALUATOR:	
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Their results will be discussed later.

Table 1. Solubility of $Mg(OH)_2$ in water; direct measurements.

T/K	Physical State	Solubility $10^4 c_1$/mol dm^{-3}	Reference
room	active	4.5[a]	2
291	undefined	1	5
291	active	1.44	7
291	undefined	2	11
291-297	active	3.6	12
302	active	2.14	14
302	inactive	2.06	14
291	inactive	1.9	17
293	active	1.8	10
291	active	4.6[a]	32
295	undefined	1.8	29
		Av. 1.97, $s(m)$ = 0.7	

[a] Values not included in the average.

2. The magnesium hydroxide solubility product; measurements in ternary systems.

Since the solubility of $Mg(OH)_2$ is very small and difficult to measure with precision, many studies are devoted to solubility measurements in solutions of different pH and ionic strengths. The experimental data can be analyzed to obtain the solubility product, K°_{s0}, which in turn leads to an indirect value of the solubility in water. This kind of measurement is reported in a number of publications (6, 8, 9, 13, 16, 21, 22, 24, 29-31). All of the papers except the last one report data in the region of room temperature.

The available experimental data are total magnesium concentration, hydroxide ion concentration by titration or hydroxide ion activity by pH measurement. When the experimental precision permits, the Mg^{2+}(aq) concentration is obtained from the total magnesium concentration by taking into account the $MgOH^+$(aq) formation.

The thermodynamic solubility product, K°_{s0}, is calculated by evaluation of the activity coefficients or by fitting the data and extrapolation to zero ionic strength. Different authors have used different methods to estimate the activity coefficients. Hostetler's evaluation (30) was based on a Debye-Hückel treatment fitted to the experimental data of $\gamma_{\pm(\mathrm{MgCl_2})}$ and $\gamma_{\pm(\mathrm{KCl})}$ (36) for the activity coefficients. They were used to calculate K°_{s0} from different sources and compare the results.

An improved treatment would require the estimation of the activity coefficients by full Pitzer equations fitted to each set of binary and ternary results. This is beyond the scope of this work, and it is not justified by the precision of most of the data.

COMPONENTS:	EVALUATOR:	
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

A. $Mg(OH)_2 + NH_3 + NH_4X + H_2O$ $X = Cl^-, SCN^-, NO_3^-, CH_3CO_2^-, SO_4^{2-}$

Four publications (6, 8, 22, 29) report data on these systems. The $Mg(OH)_2$ is equilibrated with the ammonia-ammonium salt solution. The saturated solutions are analyzed for Mg^{2+}, NH_3 and NH_4^+ and the OH^- concentration is calculated from the base ionization constant for NH_3(aq). Activity coefficients are neglected in these works, and the solubility product is calculated from $K_{s0}^{\circ} = [Mg^{2+}][OH^-]^2$ and the solubility from $c_1 = (K_{s0}/4)^{1/3}$.

Loven (6) measured the magnesium hydroxide solubility as a function of ionic strength for five anions at 283 and 289 K. Since he did not find a systematic variation in the values with ionic strength, a more refined treatment, with estimation of activity coefficients, is not necessary. Loven calculated the solubility of $Mg(OH)_2$ in water. The evaluator repeated the calculation using more recent (38) values of the aqueous ammonia ionization constant. The results are:

With $K_b = 1.6 \times 10^{-5}$; $c_1 = 2.7 \times 10^{-4}$ mol dm^{-3} at 283 K, and
with $K_b = 1.7 \times 10^{-5}$; $c_1 = 2.8 \times 10^{-4}$ mol dm^{-3} at 289 K.

The data in (8, 22, and 29) were also recalculated by the evaluator using recent (38) K_b values. The results are summarized in table 2.

B. $Mg(OH)_2 + H_2CO_3 + H_2O$

Kline (16) studied this system at 298 K as a function of CO_2 partial pressure (10.8 to 98.123 Pa). The $Mg(OH)_2$ was precipitated from $MgCO_3$ solution. The saturated solution was analyzed for Mg^{2+} and HCO_3^- and the OH^- calculated from the dissociation constant of H_2CO_3. The thermodynamic solubility product was calculated by two methods: values of the concentration solubility product were calculated for each ionic strength and then extrapolated to zero ionic strength, or activity coefficients were estimated and combined with the solubility product of $MgCO_3$ and the ionization constants of H_2CO_3.

The evaluator prefers the first more direct method. By this method Kline reports $\log K_{s0}^{\circ} = -11.57$. The evaluator repeated the calculation with a modern first ionization constant of H_2CO_3 ($pK_{a1} = 6.35$ at 298 K (38)) and obtained a value of $\log K_{s0}^{\circ} = -11.77$ which leads to a solubility value of $c_1 \approx 8 \times 10^{-5}$ mol dm^{-3}. Neither calculation corrected for the activity coefficient of the ions in pure water.

C. $Mg(OH)_2 + MgCl_2 + H_2O$

Six papers (13, 15, 18, 19, 27, 30) report studies of this system, however, three of them (15, 18, 27) only report qualitative observations of the increase in $Mg(OH)_2$ solubility with increasing $MgCl_2$ concentration.

The complete phase diagram at 298 K is reported by Bury and Davies (19). They showed the existence of the three solid phases $Mg(OH)_2$, $3MgO \cdot MgCl_2 \cdot 6H_2O$ and $MgCl_2 \cdot 6H_2O$. They also studied (20) the five-component system $MgO + CaO + MgCl_2 + CaCl_2 + H_2O$. In the region of the five-component system in which Mg^{2+} can be detected in solution only $Mg(OH)_2$ and/or $MgCl_2 \cdot 3MgO \cdot 11H_2O$ are solid species. No solid Ca containing species is present.

Hostetler (30) made the most careful studies of this system. He studied the solubility of magnesium hydroxide at 298 K as a function of ionic strength, aging and grain size.

COMPONENTS:	EVALUATOR:	
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Hostetler followed the solubility during aging and correlated it to the grain size of the solid (see Figure 1). At a grain radius of about 50 nm the solid is in its stable state.

Hostetler (30) also measured pH and total magnesium concentration. He assumed two forms for the magnesium in solution

$$[Mg]_{total} = [Mg^{2+}] + [MgOH^+]$$

He evaluated the $MgOH^+$ contribution by a fitting his data to the equilibrium equations, and obtained the formation constant:

$$K_{11} = [MgOH^+]/[Mg^{2+}][OH^-] = 10^{2.6} = 4 \times 10^2 \text{ dm}^3 \text{ mol}^{-1}$$

He treated his data to obtain values of the thermodynamic solubility product and the solubility, both corrected for the $MgOH^+$ contribution, for both the stable and the active hydroxide. The results are:

Stable magnesium hydroxide: $\log K^\circ_{s0} = -11.15$, $c_1 = 1.34 \times 10^{-4}$ mol dm^{-3};

Active magnesium hydroxide: $\log K^\circ_{s0} = -10.38$, $c_1 = 2.55 \times 10^{-4}$ mol dm^{-3}.

Gjaldbaek (13) carried out a similar set of experiments, but with a shorter time allowed for aging. The evaluator has recalculated the results using the same activity coefficients as Hostetler (30). The results are:

Stable magnesium hydroxide: $\log K^\circ_{s0} = - 10.8$, $c_1 = 1.7 \times 10^{-4}$ mol dm^{-3};

Active magnesium hydroxide: $\log K^\circ_{s0} = - 9.2$, $c_1 = 6 \times 10^{-4}$ mol dm^{-3}.

The Hostetler results are preferred because of the longer time used to establish equilibrium.

D. $Mg(OH)_2$ + Alkali Metal Salts + H_2O

Whitby (21) measured the solubility of magnesium hydroxide in seven aqueous alkali metal salt solutions at 298 K up to concentrations of 2 mol dm^{-3}. The results do not show a systematic correlation (figure 2).

Näsänen (24) measured the solubility of magnesium hydroxide as a function of ionic strength in aqueous NaCl and KCl solutions at 298 K. He measured the pH on precipitation of magnesium hydroxide from $MgCl_2$ solution, and took great care to avoid CO_2, but did not take into account $MgOH^+$. He extrapolated his results to zero ionic strength and obtained $\log K^\circ_{s0} = -10.734$. The evaluator recalculated the constant using Hostetler's activity coefficients and $MgOH^+$ formation constant. The result was little changed, being:

$$\log K^\circ_{s0} = -10.84 \text{ and solubility } c_1 = 1.6 \times 10^{-4} \text{ mol dm}^{-3}.$$

Horn (32) determined the solubility product at $I = 3$ mol dm^{-3} $NaClO_4$ at 298 K by an emf method. The physical state of the solid was not defined, although he did wait 3 to 7 days for his cells to come to equilibrium. He calculated $\log K_{s0} = -11.14$ from his data. The compiler and evaluator recalculated and obtained $\log K_{s0} = -11.86$. A thermodynamic constant cannot be calculated because the activity coefficients in this medium are not known.

Einaga (33) studied freshly precipitated $Mg(OH)_2$ at $I = 1$ mol dm^{-3} $NaNO_3$ at 298 K. He found evidence of polynuclear species $Mg_2(OH)_2^{2+}(aq)$ and $Mg_3(OH)_4^{2+}(aq)$. Re-analysis of Hostetler's data taking into account the polynuclear species and their constants evaluated by Einaga did not change his thermodynamic solubility product at zero ionic strength.

COMPONENTS:	EVALUATOR:
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

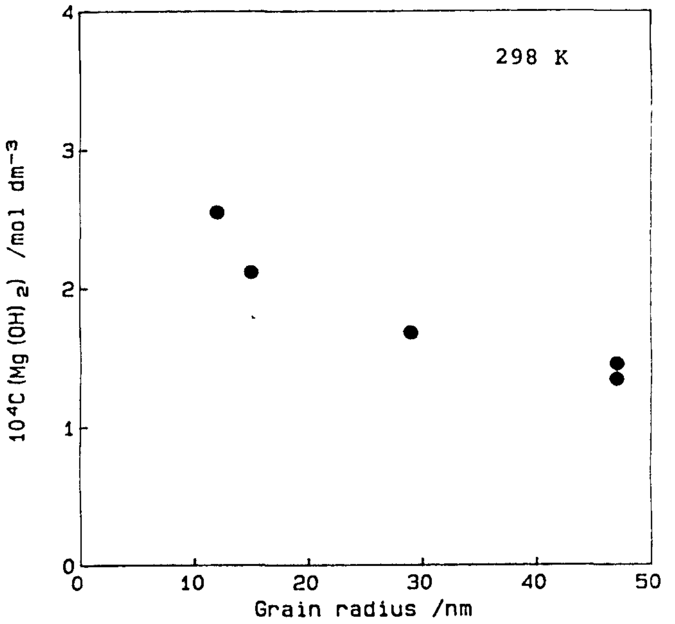

Figure 1. The solubility of $Mg(OH)_2$ (brucite) as a function of grain size, Hostetler (30).

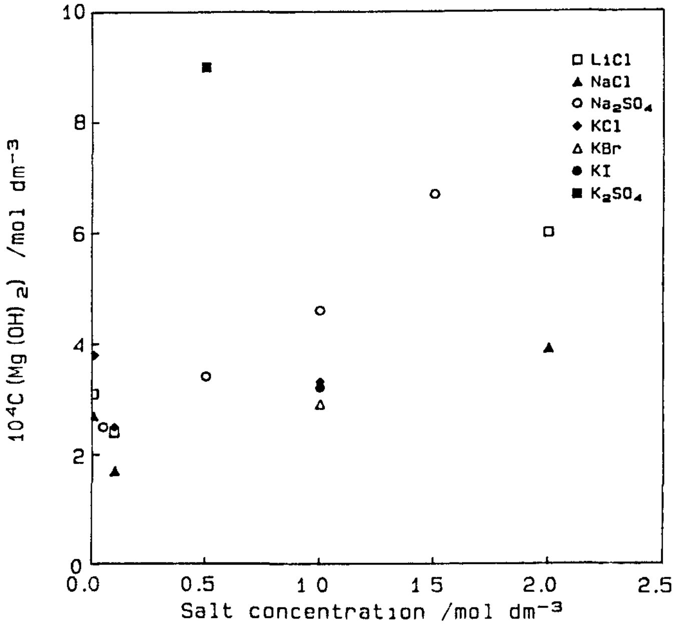

Figure 2. The solubility of $Mg(OH)_2$ in various alkali metal salts solutions, 298 K, Whitby (21).

COMPONENTS:	EVALUATOR:
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Einaga's value in the I = 1 mol dm^{-3} medium is:

$$\log K_{s0} = -9.38$$

It is not possible to calculate a value of K°_{s0} from Einaga's experiment because of lack of knowledge of activity coefficients in the medium. However, using the same activity coefficients as Hostetler leads to:

$$\log K^\circ_{s0} \approx -9.8$$

and the solubility in pure water of $c_1 \approx 3.4 \times 10^{-4}$ mol dm^{-3}.

Maigret (9) and Boryachek *et al.* (31) both studied the system $Mg(OH)_2 + NaCl + NaOH + H_2O$. The results in (9) are suprisingly high for a basic solution and are rejected. Boryachek *et al.* (31) observed the expected decrease in solubility with increasing NaOH concentration. The solubility of magnesium hydroxide in 310 g dm^{-3} NaCl is 3.7×10^{-4} mol dm^{-3} (31), not very different from the solubility in pure water shown in Tables 1 and 2.

The solubilities in pure water near room temperature estimated in this section from thermodynamic solubility product values are summarized in Table 2. Although the calculation from K°_{s0} values is questionable, the results show less scatter and there is an identifiable difference in the solubility of active and inactive magnesium hydroxide when compared with the values from direct solubility measurements in Table 1.

Hostetler's lower value, $c_1 = 1.34 \times 10^{-4}$ mol dm^{-3} at 298 K, obtained under rigorous conditions is considered the best value of the solubility of inactive magnesium hydroxide in pure water. However, it is classed as a tentative value as it is an indirect result.

Because of the rapid change of the active state from freshly precipitated magnesium hydroxide toward the inactive state the active state is not well defined. It is only possible to say that the active magnesium hydroxide has a solubility 2 to 3 times larger than the inactive.

Table 2. Magnesium hydroxide solubility in water estimated from solubility products measured in ternary systems.

T/K	Added Salt	Physical State $Mg(OH)_2$	Solubility $10^4 c_1$/mol dm^{-3}	Reference
283	NH_4^+ salts	undefined	2.7	6
289		undefined	2.8	6
302		undefined	1.8	8
291		active	1.84	22
291		inactive	1.73	22
291		undefined	2.1	29
298	H_2CO_3	active (?)	0.8	16
298	$MgCl_2$	inactive	1.34 [a]	30
298	$MgCl_2$	active	2.55	30
298	KCl, NaCl	inactive	1.6	24
298	$NaNO_3$	active	~3.4	33

[a] Tentative value of magnesium hydroxide solubility in water at 298 K.

COMPONENTS:	EVALUATOR:	
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Table 3 summarizes values of the solubility product and formation constant of $MgOH^+$ to use at 298 K under several conditions. The K°_{s0} and K_{11} values are tentative.

Table 3. Magnesium hydroxide solubility product values.

T/K	Ionic Strength (I/mol dm^{-3})/Salt	log K_{s0}	log K°_{s0}	Reference
298	0		−11.15	30
	1.0/$NaNO_3$	−9.38		33
	3.0/$NaClO_4$	−11.86		32 [a]
	0	log K_{11} = 2.6	($MgOH^+$)	30
	1.0/$NaNO_3$	log β_{22} = −21.07	($Mg_2(OH)_2^{2+}$)	33 [b]
	1.0/$NaNO_3$	log β_{34} = −39.16	($Mg_3(OH)_4^{2+}$)	33 [b]

[a] As recalculated by the evaluator.

[b] Cumulative formation constant, β_{nm}.

3. Solubility measurements above room temperature.

Lambert, Lefevre and Montel (34) studied the solubility of $Mg(OH)_2$ at two ionic strengths from 293 to 573 K. The ionic strengths were I/mol kg^{-1} = 0.01 (HCl) and 0.50 (NaCl or $NaNO_3$). The measurements were carried out in a titanium autoclave on a well-defined inactive $Mg(OH)_2$ sample prepared by conditioning eight days at 573 K before the start of the measurements. The Mg^{2+} concentration was measured as a function of temperature. The pH was measured at room temperature and estimated at the other temperatures from the know variation of K_w with temperature. Side reactions of the solution with the walls of the autoclave induce some uncertainty in the pH calculations so no effort was made to evaluate the $MgOH^+$ formation constant. Comparison of the results in NaCl and $NaNO_3$ solutions showed evidence of $MgCl^+$ complex ion formation.

The authors (34) applied the Debye-Hückel treatment to obtain values of K°_{s0}. Although this type of calculation is uncertain at the highest temperatures of the experiment, these were the only data available to use to estimate the solubility of $Mg(OH)_2$ in water for comparison with the direct measurements of Travers and Nouvel (17) over the 281 to 473 K interval. Only the results at low ionic strength were used after correction for $MgCl^+$ formation. K°_{s0} was recalculated using activity coefficients evaluated from the electrostatic term of Pitzer's equation as the virial terms were unknown:

$$\ln \gamma_\pm = -|z_M z_X|\ A^\Phi\ (I^{1/2}/(1 + bI^{1/2}) + (2/b)\ \ln\ (1 + bI^{1/2})) \qquad [3]$$

with A^Φ values at the different temperatures from (37).

The solubility in water was evaluated from

$$m_1/\text{mol kg}^{-1} = (K^\circ_{s0}/4)^{1/3} \qquad [4]$$

as the precision of the results was too poor to justify calculation of activity coefficients in pure water containing only the dissolved magnesium hydroxide.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE
November, 1991

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

CRITICAL EVALUATION:

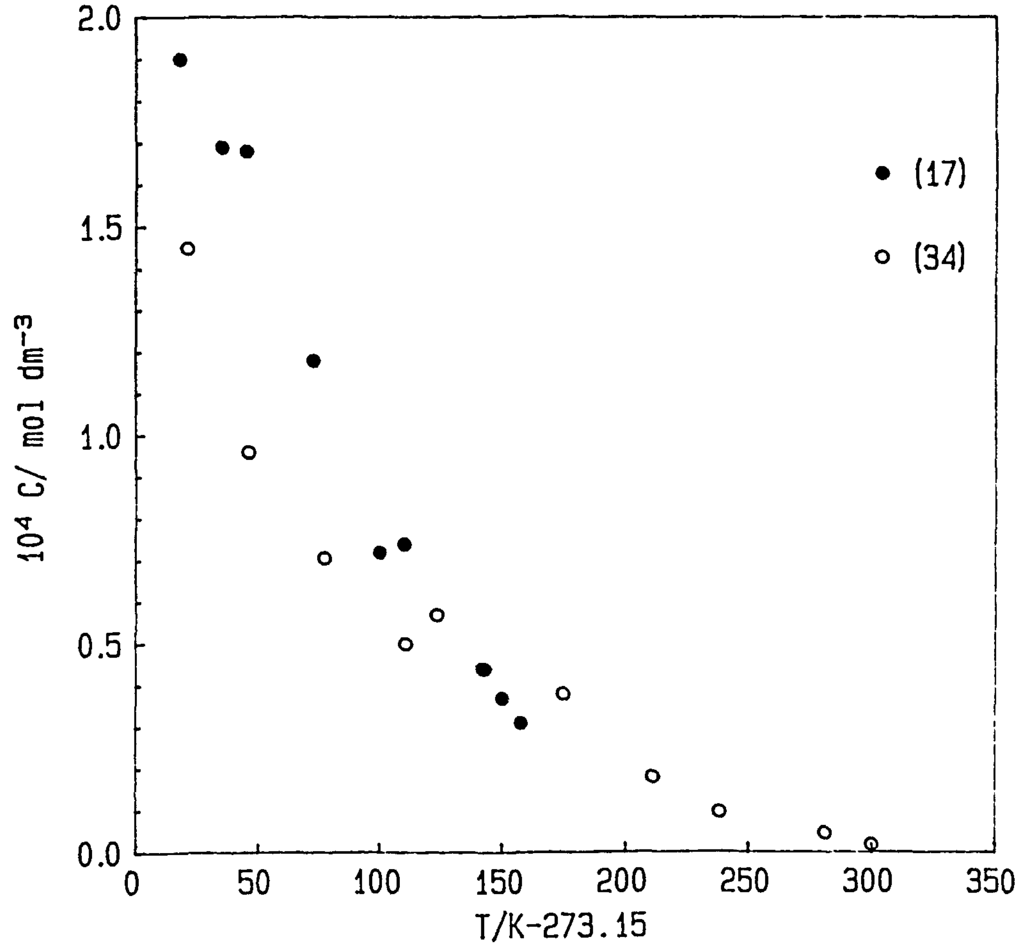

Figure 3. The solubility of $Mg(OH)_2$ as a function of temperature, ● Travers and Nouvel (17), ○ Lambert, Lefevre and Montel (34).

COMPONENTS:	EVALUATOR:	
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

The solubility results obtained from the data (34) at room temperature by the above procedure and by using Hostetler's activity coefficients differ by about 10 % which is less than the experimental precision.

The solubility values calculated as described above (34) and those of Travers and Nouvel (17) are compared in figure 3 and table 4. The results of (17) are up to 50 % larger at the lower temperatures than the values of (34). The difference may be due to insufficient aging of the solid $Mg(OH)_2$ by Travers and Nouvel. The results were fitted to a three constant equation. At 291.15 K the average of five data points with a weight of 1 from (17) were used to avoid undue influence of the low temperature results from that work. The result is:

$$\ln (m_1/\text{mol kg}^{-1}) = 81.965 - 3432.07/(T/\text{K}) - 13.893 \ln (T/\text{K}) \qquad [5]$$

$$s(m_1) = 1.83 \times 10^{-5} \text{ mol kg}^{-1}$$

No attempt was made to improve the fitting of the data by excluding values that were more than two standard deviations from the regression line as this would have excluded all of the high temperature data. The 298 K value is in reasonable agreement with the *tentative* value given earlier (about 24 % higher), assuming equality of concentration and molality in the dilute aqueous solution. Smoothed values from equation [5] are classed as *tentative* and are given in Table 5.

Table 4. Solubility of magnesium hydroxide in water as a function of temperature (17, 34) used in fitting equation [5].

T/K	Solubility of $Mg(OH)_2$ $10^5 m_1$/mol kg^{-1}	Reference
291.15	18.9(mean value)	17
308.15	16.9	17
318.15	15.0	17
343-348	11.8	17
373.15	7.2	17
383.15	7.4	17
415.15	4.4	17
423.15	3.7	17
431.15	3.1	17
294.15	14.5	34
319.15	9.6	34
350.15	7.1	34
383.65	5.0	34
396.15	5.7	34
416.15	4.4	34
448.15	1.8	34
511.15	0.96	34
554.15	0.46	34
573.15	0.18	34

4. Solubility measurements in supercritical water.

Walther (42) measured the solubility of brucite in supercritical water between 573 and 873 K and from 1 to 3 kbar total pressure. The concentration of Mg^{2+} decreases monotonically from 623 to 823 K at 1 kbar, but shows a sigmoidal behavior at 2 kbar. The solubility reaction

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

November, 1991

CRITICAL EVALUATION:

Table 5. Tentative values of the solubility of $Mg(OH)_2$ in water from Eqn [5].

t/°C	T/K	Solubility $10^5 m_1$/mol kg^{-1}
0	273.15	19.5
25	298.15	16.6
50	323.15	13.2
75	348.15	10.0
100	373.15	7.44
125	398.15	5.39
150	423.15	3.85
175	448.15	2.72
200	473.15	1.92
225	498.15	1.35
250	523.15	0.95
275	548.15	0.67
300	573.15	0.47

is proposed to be:

$$H^+(aq,\ s.c.) + Mg(OH)_2(s) = Mg(OH)^+(aq,\ s.c.) + H_2O(s.c.).$$

where s.c. = supercritical.

Available thermodynamic data for Mg^{2+} support $Mg(OH)^+$ as the dominant magnesium species in solution. The equilibrium constant for

$$H_2O(s.c.) + Mg^{2+}(aq,\ s.c.) = Mg(OH)^+(aq,\ s.c.) + H^+(aq,\ s.c.)$$

was estimated from literature data. Values of pK at 1 kbar range from 5.38 at 623 K to 0.77 at 823 K, and at 2 kbar from 5.69 to 3.43 at the same temperatures. The calculations indicate $Mg(OH)^+$ becomes the dominant magnesium species at neutral pH at temperatures above 633 K at 1 kbar and above 723 at 2 kbar. Walther's data are classed as tentative.

The early measurements of Poty *et al.* (44) at 773 K and 1 kbar were questioned by Walther because of the quenching procedure used. No data sheet was prepared for them.

5. Other ternary inorganic systems

A. $Mg(OH)_2 + MgSO_4 + H_2O$

Kiessewetter (25) found that the influence of $MgSO_4$ on $Mg(OH)_2$ solubility depends on the physical state of the hydroxide. The author gives no explanation of the data and no evaluation of its reliability can be made.

Danilov and co-workers (43) studied the system at 298 and 323 K. They show $Mg(OH)_2$ to be the equilibrium solid phase up to 21.3 mass % $MgSO_4$ at 298 K and up to about 24.5 mass % $MgSO_4$ at 323 K. They show partial phase diagrams with regions of stability for the solids $3MgO\cdot MgSO_4\cdot 11H_2O$ at 298 K and $5MgO\cdot MgSO_4\cdot 8H_2O$ at 323 K. The solubility of $MgSO_4\cdot 7H_2O$ was 27.60 mass % $MgSO_4$ at 298 K and the solubility of $MgSO_4\cdot 6H_2O$ was 33.30 mass % at 323 K. The authors did not determine the $Mg(OH)_2$ composition of the liquid phase and, thus, no data sheets were prepared.

COMPONENTS:	EVALUATOR:
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CRITICAL EVALUATION:

B. $MgO + CrO_3 + H_2O$

Revzin *et al.* (35) studied the system and showed the existence of $MgCrO_4 \cdot 5H_2O$.

C. $MgO + B_2O_3 + H_2O$

Nikolaev and Chelishcheva (23) studied the system and found that the successive equilibrium solids as mass % B_2O_3 increased were $Mg(OH)_2$, $2MgO \cdot 3B_2O_3 \cdot 15H_2O$, $MgO \cdot 2B_2O_3 \cdot 9H_2O$ and $MgO \cdot 3B_2O_3 \cdot 7.5H_2O$.

D. $MgO + H_2O_2 + H_2O$

Makarov and Volnov (26) studied the system at 273 and 283 K. They found MgO to be the equilibrium solid only at 273 K and <0.43 mass % H_2O_2. The other solids appearing in the system are $MgO_2 \cdot H_2O$, $MgO_2 \cdot 0.5H_2O$ and MgO_2.

6. Ternary systems with an organic component

A. $Mg(OH)_2 + CH_4O + H_2O$
$Mg(OH)_2 + C_2H_6O + H_2O$

Janković (28) studied the solubility of $Mg(OH)_2$ in methanol + water mixed solvent up to 35.3 mass % methanol and in ethanol + water mixed solvent up to 21.6 mass % ethanol. The solubility of $Mg(OH)_2$ decreased with increasing alcohol concentration with the ethanol showing a greater effect than the methanol. The solid phase was claimed to be $Mg(OH)_2$.

B. $Mg(OH)_2 + C_6H_{12}O_6$(glucose) $+ H_2O$

Fleury (4) observed that glucose increases the solubility of $Mg(OH)_2$ in water.

7. Comparison of the present results with other evaluations.

These values are presented for comparison; no effort has been made to judge one set of data against another.

Smith and Martell (40) give log K^{o}_{s0} = -11.15±0.2 at 298.15 K. They also give formation constants at 298.15 K and ionic strength of 0 and 3 for:

Reaction	log K at 298.15 K and ionic strength: 0	3.0 mol dm^{-3}
$Mg^{2+}(aq) + OH^-(aq) = Mg(OH)^+(aq)$	2.58±0.0	1.85 " "
$4Mg^{2+}(aq) + 4OH^-(aq) = (Mg_4(OH)_4)^{4+}(aq)$	16.3	16.93 " "

The *NBS Thermodynamic Tables* (39) give Gibbs energy of formation data from which we calculate log K^{o}_{s0} = -11.25 for $Mg(OH)_2$(s) and log K = 2.58 for the formation of $Mg(OH)^+$(aq)

8. Crystal structure of magnesium hydroxide.

Characterization of the solid state in equilibrium with the saturated solution is an important part of any modern solubility study. The following information, mostly from the *Crystal Data Determinative Tables* (41), is neither complete or evaluated, but it serves as a reminder of this important point.

Crystal Formula	Type	Density, ρ/Mg m^{-3}
MgO; (periclase [1317-74-4])	cubic	3.61
$Mg(OH)_2$; (formed in boiling H_2O)	orthorhombic	-
$Mg(OH)_2$; (normal form [1309-42-8]) $Mg(OH)_2$; (brucite [1317-43-7])	hexagonal	2.40

COMPONENTS:	EVALUATOR:
(1) Magnesium hydroxide; $Mg(OH)_2$ [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

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Kirwan, J. *Elements of Mineralogy*, London, 1784, p. 6.
126.5 mg per liter of cold water.
Dalton, J. *New System of Chemical Philosophy*, Manchester, 1808.
62.5 mg per liter of cold water.
Henry, O. *J. Pharm.* [1] 1827, *13*, 1.
172.4 mg per liter of water at 15°C (288 K).
Fyfe, A., see reference 1 above.
194.5 mg per liter of water at ordinary temperatures,
27.8 mg per liter of water at 100°C (373 K).
Fresenius, R. see reference 2 above and data sheet.
27.8 mg per liter of either cold or boiling water.
Bineau, M. A., see reference 3 above.
5-10 mg per liter of cold water.
Warington, R. *J. Chem. Soc.* 1865, *18*, 27-29.
Magnesium hydroxide solubility in water enhanced by ammonia.
Precht, H. *Z. Anal. Chem.* 1879, *18*, 438-39.
16.13 mg per liter of 2 mol per liter KOH.

These early studies were flawed because of the presence of carbon dioxide or the presence of bases from the glassware used, because of impurities in the magnesium hydroxide samples, and because sufficient time to attain equilibrium was not always used. They are rejected.

The papers listed below contain information on magnesium hydroxide containing aqueous solutions, but they were not used because they either contained no experimental data, no reliable data, data from other published sources, or they were preliminary accounts published in more detail later.

46. Robinson, W. O.; Waggaman, W. H. *J. Phys. Chem.* 1909, *13*, 673-78. [$MgO + MgCl_2 + H_2O$ at 25°C.]

COMPONENTS:	EVALUATOR:
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

REFERENCES (continued)

47. Gjaldbaek, J. K.
Z. Anorg. Allg. Chem. 1925, *144*, 145-68.
[Preliminary data on $Mg(OH)_2$ + H_2O used in (13)]

48. Britton, H. T. S.
J. Chem. Soc. 1925, *127*, 2110-20.
[Electrometric titration]

49. Maeda, T.; Yamane, S.
Sci. Papers Inst. Phys. Chem. Res. (Tokyo) 1926, *4*, 85-101.
[MgO + $MgCl_2$ + H_2O at 50°C (graph)]

50. Näsänen, R.
Z. Phys. Chem., Stoechiom. Verwandschafsl. 1941, *188A*, 2172-83.
[$Mg(OH)_2$ + alkali salts + H_2O, error in accounting for CO_2, corrected in a later paper (24)]

51. Quataroli, A.; Belfiori, O.
Ann. Chim. Appl. 1941, *31*, 56-61.
[Compare solubility of precipitated $Mg(OH)_2$ and brucite]

52. Stock, D. I.; Davies, C. W.
Trans. Faraday Soc. 1948, *44*, 856-59.
[Titration of $MgCl_2$ + $Ba(OH)_2$, formation of $MgOH^+$]

53. Roy, D. M.; Roy, R.
Am. J. Sci. 1957, *265*, 574-83.
[Coexistence curve of brucite ($Mg(OH)_2$) and periclease (MgO) in water]

54. Feitknecht, W.; Schindler, P.
Pure Appl. Chem. 1963, *6*, 130-99.
[Review and evaluation of solubility of metal hydroxides, see pp. 158-61 for alkaline earth hydroxides]

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Fresenius, R.

J. Liebigs Ann. Chem. Pharm. 1846, *59*, 117-28.

VARIABLES:

$T/K = ca.$ 293 and 373

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Mg(OH)_2$ in water at room temperature and at the boiling point of the aqueous saturated solution.

Temperature	Sample Mass	Magnesium Oxide	
	mass/g	mass/g	m_1/mol kg^{-1}
Room	84.82	0.0015 ± 0.00005	4.5×10^{-4}
Boiling	84.82	0.0016	4.7×10^{-4}

The compiler calculated the molal values.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Equilibration for 24 hours, followed by filtration. No other experimental details given.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Basic magnesium hydroxide was precipitated from magnesium sulfate by carbonic acid and ammonia. The precipitate was dissolved in nitric acid and reprecipitated the same way in order to obtain a pure product. It was then decomposed to MgO by heating to constant weight in a platinum crucible.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS: (1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Kohlrausch, F.; Rose, F. *Z. Phys. Chem. Stoechiom. Verwandtschaftsl.* 1893, *12*, 235-43.
VARIABLES: T/K = 283, 291	PREPARED BY: I. Lambert

EXPERIMENTAL VALUES:

The authors measured the conductivity of saturated $Mg(OH)_2$ solutions at 10 and 18°C. From their results they estimated the solubility of $Mg(OH)_2$ in water to be 9 mg L^{-1} or 1 x 10^{-4} mol L^{-1} at 18°C. The solubility ratio, c_{10}/c_{18} = 0.85 (the same as the conductivity ratio).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: The conductivity of water was subtracted from the total conductivity of the saturated solution. The calculation of the solubility seems to have been performed through empirical coefficients. No details are given.	SOURCE AND PURITY OF MATERIALS: Nothing specified.
	ESTIMATED ERROR: No estimates possible.
	REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Dupre, F. T. B.; Bialas, J.

Angew. Chem. 1903, *16*, 54-5.

VARIABLES:

T/K = 291

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Based on conductivity at 18°C:

Conductance of saturated solution	$\kappa_{\mathrm{sln}} = 77.82 \times 10^{-6}\ \mathrm{S\ cm^{-1}}$
Conductance of distilled water	$\kappa_{\mathrm{W}} = 15.23 \times 10^{-6}\ \mathrm{S\ cm^{-1}}$
Conductance due to $Mg(OH)_2$	$\kappa = 62.59 \times 10^{-6}\ \mathrm{S\ cm^{-1}}$

The solubility was calculated from

$$c_1 = 1000\kappa/\Lambda\mathrm{o}(Mg(OH)_2)$$

based on the data of Kohlrausch, which gives

$$\Lambda\mathrm{o}(1/2\ Mg(OH)_2) = 217.4\ \mathrm{S\ cm^2\ mol^{-1}}.$$

Using

$$\Lambda\mathrm{o}(Mg(OH)_2) = 434.8\ \mathrm{S\ cm^2\ mol^{-1}}$$

from the above equation,

$$\mathrm{Soly} = 1.44 \times 10^{-4}\ \mathrm{mol\ L^{-1}}.$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The conductivity of the solution was measured between two platinum electrodes by means of a Kohlrausch bridge. The conductivity cell was maintained in a thermostated bath.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. MgO was purified from carbonate by heating in a platinum crucible.

(2) Water. Distilled several times, free of air.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Kohlrausch, L.; Holborn Leitvermogen von Electrolyten. Leipzig: 1898.

COMPONENTS: (1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Tamm, O. *Z. Phys. Chem. Stoechiom. Verwandtschaftsl.* 1910, *74*, 496-502.
VARIABLES: $T/K = 291$	PREPARED BY: H. L. Clever

EXPERIMENTAL VALUES:

The paper reports an investigation of equilibrium between $Mn(OH)_2$ and the oxy acids citric, glycolic, lactic malic and tartaric. Measurements were made on the solubility of both $Mn(OH)_2$ and $Mg(OH)_2$ in water at 18°C by conductivity. The saturated $Mg(OH)_2$ solution was reported to have a conductivity of 8.9×10^{-5} from which it was calculated the solubility of $Mg(OH)_2$ is 0.012 g L^{-1} or 2×10^{-4} mol L^{-1} at 18°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: Nothing specified.	SOURCE AND PURITY OF MATERIALS: Nothing specified.
	ESTIMATED ERROR: No estimates possible
	REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Remy, H.; Kuhlmann, A.

Z. Anal. Chem. 1924, *65*, 1-24.

Z. Elektrochem. Angew. Phys. Chem. 1925, *31*, 93.

VARIABLES:

$T/K \approx 291 - 297$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

Solubility of $Mg(OH)_2$ in water at 18 - 24°C

$Mg(OH)_2$ $10^4 c_1$/mol L^{-1}	Method	Remarks
3.97	Gravimetry	Inactive form of $Mg(OH)_2$
3.48	Conductivity measurement	"
3.92	Conductimetric titration	"

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

MgO was equilibrated with conductivity water for 3.75 - 48 hours. Solubility of $Mg(OH)_2$ was determined for the saturated filtrate by a gravimetric method with evaporation of the solvent, by conductivity measurements, or by conductimetric neutralization titration with HCl and KOH solutions. Contamination by CO_2 was avoided ultimately by the gravimetric method and the method of conductimetric titration. Influence of CO_2 was corrected for in the calculation of solubility of $Mg(OH)_2$ from the conductivity data in the method of conductivity measurements by taking equilibrium

$$CO_2 + 2OH^- \rightleftharpoons CO_3^{2-} + H_2O,$$

into consideration.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. MgO was calcined before use.

(2) Water. Conductivity water of approximately 1×10^{-6} S cm^{-1} was used for the preparation of the saturated solution.

ESTIMATED ERROR:

Temp.: precision ± 3 K (compiler).
Soly.: precision ± 2 % (compiler).

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Busch, W.

Z. Anorg. Allg. Chem. 1927, *161*, 161-79.

VARIABLES:

T/K = 298

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

Solubility of Mg(OH)2 in water at 25°C

$Mg(OH)_2$ 10^4c_1/mol L^{-1}	Equilibration time t/hours
2.14	8
2.13	8
2.08	14
2.06	20

Decrease in solubility with prolonged equilibration was explained by the original author to be due to change of $Mg(OH)_2$ from active (or labile) to stable form as suggested by Gjaldbaek (ref 1).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Purified MgO was mixed with freshly distilled conductivity water at 29.0 ± 0.1°C for 8 to 20 hours. The resulting saturated solution was filtered, H_2SO_4 was added to the filtrate, and the solution was titrated potentiometrically with KOH solution to determine dissolved $Mg(OH)_2$. Contamination of atmospheric CO_2 was avoided by using stoppered flasks and liquid paraffin. Care was taken during filtration not to carry away any residual $Mg(OH)_2$ from the saturated solution.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. MgO of Merck was dissolved in HNO_3; the resulting $Mg(NO_3)_2$ was recrystallized and ignited to MgO at 850°C.

(2) Water.

ESTIMATED ERROR:

Temp.: precision ± 0.1 K.
Precision in the titration procedure was about 1.2 %.

REFERENCES:

1. Gjaldbaek, J. K. *Z. Anorg. Allg. Chem.* 1925, *144*, 269.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Travers, A.; Nouvel

C. R. Hebd. Seances Acad. Sci. **1929**, *188*, 499-501.

VARIABLES:

$T/K = 291 - 473$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

Solubility of $Mg(OH)_2$ in water

$t/°C$	$Mg(OH)_2$ $10^4c_1/mol\ L^{-1}$
18	2.45
18	1.72
18	1.68
18	1.85
18	1.75
35	1.69
45	1.5
70 - 75	1.18
100	0.72
110	0.74
142	0.44
150	0.37
158	0.31
178	0
200	0

Solubility of $Mg(OH)_2$ in water decreased linearly with increasing temperature in the range 35 - 100°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Mg(OH)_2$ and water were equilibrated in a Cu flask or autoclave for 1 to 2 days. The dissolved $Mg(OH)_2$ was determined by titration with standard acid solution either potentiometrically using a hydrogen electrode or with phenol red as an indicator. A CO_2 free atmosphere was maintained during the titration.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Crystalline form used.

(2) Water. Freshly distilled water (pH 6.8) was used for the preparation of the saturated solution of $Mg(OH)_2$ to avoid contamination by atmospheric CO_2.

ESTIMATED ERROR:

Soly.: precision ± 9 % (18°C).

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Magnesium hydroxide (brucite); $Mg(OH)_2$; [1317-43-7] (2) Water; H_2O; [7732-18-5]	Walther, J. V. *Geochim. Cosmochim. Acta* 1986, *50*, 733-39.

EXPERIMENTAL VALUES:

The solubility of brucite in super-critical water as a function of temperature and pressure.

Temperature		Pressure	Duration	Approach	log (m_{Mg}/mol kg^{-1})
t/°C	T/K	p_{tot}/bar	t/days		
351	624	1010	3	S	-4.315
		1015	3	-	-4.319
400	673	1000	2	-	-4.508
		1040	7	U	-4.492
401	374	1015	2	-	-4.487
451	724	985	2	U	-4.694
		1005	2	-	-4.727
452	725	1015	2	U	-4.789
499	772	995	2	S	-5.127
500	773	1000	3	U	-5.087
503	776	1060	2	U	-5.012
547	820	1000	2	S	-5.433
		1010	2	U	-5.281
549	822	1010	2	S	-5.354
545	818	1495	2	S	-4.529
595	868	1605	2	S	-4.871
598	871	1540	1	S	-5.005
601	874	1520	2	S	-5.102
350	623	1995	3	-	-3.986
351	624	1995	4	U	-4.006
		2000	4	-	-4.013
399	672	1995	4	U	-4.144
400	673	1885	4	S	-4.225
		1950	3	U	-4.212
		1995	4	U	-4.123
451	724	1990	4	S	-4.261
		2005	4	-	-4.309
		2200	4	S	-4.108
460	733	2010	5	U	-4.258
500	773	2005	3	U	-4.193
501	774	2000	10	U	-4.026
548	821	1930	2	U	-4.157
549	822	1995	2	-	-4.145
550	823	1810	2	-	-4.275
		1990	2	-	-4.130
608	881	2010	1	S	-4.834
609	882	1995	3	U	-4.698
610	883	1950	2	U	-4.579
629	902	3000	2	-	lost
630	903	2890	2	U	-4.192

Approach: S from supersaturation, U from undersaturation, and
- from near same concentration (within 10%).

The author's data in the paper were arranged in the order the experiments were done on the 1.7 g sample of $Mg(OH)_2$. The compiler arranged the data above in the order of increasing temperature at the pressures of 1, 1.5, 2 and 3 kbar.

continued on the next page . . .

COMPONENTS:

(1) Magnesium hydroxide (brucite); $Mg(OH)_2$; [1317-43-7]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Walther, J. V.

Geochim. Cosmochim. Acta 1986, *50*, 733-39.

VARIABLES:

$T/K = 623 - 903$
$p/MPa = 98.5 - 300.0$

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The author proposes the solubility reaction

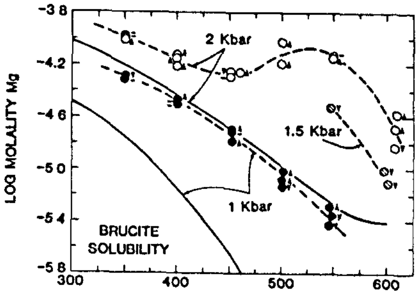
$$H^+(aq)+Mg(OH)_2(s) = Mg(OH)^+(aq)+H_2O$$

with the reaction

$$H_2O + Mg^{2+}(aq) = Mg(OH)^+(aq)+ H^+(aq)$$

being important. Calculations based on this model show $Mg(OH)^+(aq)$ becomes the dominant species at temperatures above 450°C (723 K) at 2 kbar and above 360°C (633 K) at 1 kbar and neutral pH.

The smaller increase of brucite solubility with increasing pressure at 450°C than at 550°C causes a cross-over near 1.6 kbar below which the 450°C isotherm gives the greater solubility and above which the 550°C isotherm shows the greater solubility.



Experimental determination of brucite solubility in pure H_2O as a function of temperature at 1, 1.5 and 2 kbar Direction of approach to equilibrium (▲) undersaturation, (▼) supersaturation, and (—) same The dashed lines connect values at constant pressure The solid lines are computed assuming Mg^{++} is the dominant species in solution

Figure 1

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility measurements were performed with an extraction quench hydrothermal apparatus (ref 1, 2). A 1.7 g sample of $Mg(OH)_2$ was deflocculated and the fines removed by settling. X-ray and optical microscope examination indicated a completely crystalline material.

The sample was brought to its first sampling temperature and pressure and allowed to equilibrate for seven days. Successive measurements followed at 1 to 10 (usually 2 to 4) day intervals. After sampling the sampling apparatus was flushed with 0.01 mol L^{-1} HCl. The magnesium concentration was determined using a DCP plasma spectrometer.

SOURCE AND PURITY OF MATERIALS:

(1) Brucite. Sargent Welch reagent grade. Treated as described in the method.

(2) Water. Distilled, deionized, and decarbonated.

ESTIMATED ERROR:

Author estimated analytical method for Mg as ±2 %, Over all with uncertanties in *p* and *T* as ±5 %.

REFERENCES:

1. Walther, J. V.; Orville, P. M. *Amer. Mineral.* 1983, *68*, 731-41

2. Ragnarcdottir,K.V.; Walther,J.V. *Geochim. Cosmochim. Acta* 1985, *49*, 2109-16.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Hydrogen peroxide; H_2O_2; [7722-84-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Makarov, S. Z.; Volnov, I. I.

Izv. Akad. Nauk SSSR, Otdel. Khim. Nauk 1954, 765-9.
**Bull. Acad. Sci. USSR, Div. Chem. Sci. (Engl. Transl.)* 1954, 657-60.

EXPERIMENTAL VALUES:

The $Mg(OH)_2 + H_2O_2 + H_2O$ system at 0 and 20°C

t/°C	$(1/2)O_2$ mass %	MgO mass %	Solid Phase
0	0	0.002	A
	0.43	0.05	A + B
	0.62	0.02	B
	6.02	-	B
	6.37	0.01	B
	9.04	0.02	B
	15.47	0.03	B
	16.02	0.10	B
	27.83	0.14	B
	28.45	0.13	B
	33.61	0.10	C
	38.99	0.04	C
	43.35	-	C
	44.45	-	C
	45.06	-	C
	45.25	-	C
20	0.55	-	A
	0.80	-	C
	1.20	-	C
	2.41	-	C
	3.27	-	C
	4.65	-	C
	8.37	-	C
	8.37	-	C
	10.30	-	C
	13.84	-	D
	22.30	-	D
	29.14	-	D
	40.43	-	D

Solid Phases: A $Mg(OH)_2$ B $MgO_2 \cdot H_2O$
C $MgO_2 \cdot 0.5H_2O$ D MgO_2

The authors state that $Mg(OH)_2$ is the stable solid phase between 0 and 1.5 mass % H_2O_2 at 0°C, and between 0 and 2 mass % H_2O_2 at 20°C.

The system was analyzed as MgO, $(1/2)O_2$ and H_2O. The $(1/2)O_2$ is 0.47 of H_2O_2. H_2O_2/mass % can be calculated from $(1/2)O_2$/mass % by multiplying by 2.127.

(Continued on next page)

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$ [1309-42-8]

(2) Hydrogen peroxide; H_2O_2; [7722-84-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Makarov, S. Z.; Volnov, I. I.

Izv. Akad. Nauk SSSR, Otdel. Khim. Nauk 1954, 765-9.
**Bull. Acad. Sci. USSR, Div. Chem. Sci. (Engl. Transl.)* 1954, 657-60.

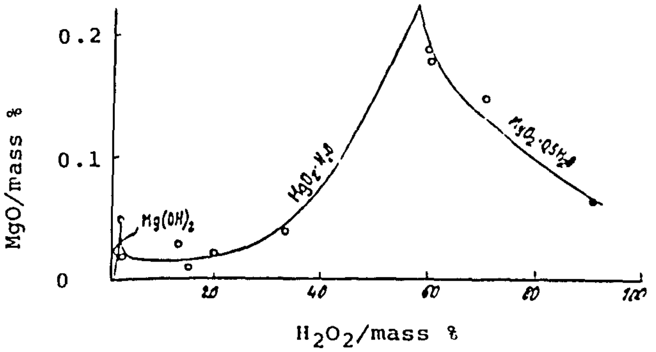
VARIABLES:

T/K = 273, 293
Composition

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:



The $Mg(OH)_2 + H_2O_2 + H_2O$ system at 0°C. Solubility curve from isotherm in triangular coordinates.

ADDITIONAL INFORMATION: The authors also studied the $Ca(OH)_2 + H_2O_2 + H_2O$ system at -21, -10, and 0°C (ref 1). Because of ice formation at the lower temperatures they did not study the dilute H_2O_2 region. In the regions studied $Ca(OH)_2$ was not a stable solid phase. The stable solids found were $CaO_2 \cdot 8H_2O$, $CaO_2 \cdot 2H_2O$ and $CaO_2 \cdot 2H_2O_2$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A suspension of $Mg(OH)_2$ (80 % water) was cooled in an ice filled cryostat. Definite volumes of H_2O_2 were successively added for each experimental point. The excess H_2O_2 ranged from 1.5 to 150 of the stoichiometric amount. Equilibrium was attained within 3 hours.

Both the saturated solution and the wet resdue were analyzed. The active oxygen was determined by titration with standard $KMnO_4$. The wet solid was analyzed for magnesium ion by precipitation as $Mg_2P_2O_7$, and the saturated solution was analyzed for magnesium ion by a colorimetric method after complete decomposition of the peroxide.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Merck Chemically pure MgO was calcined at 800°C to eliminate CO_2, and slaked for 48 h with a 100-fold excess of freshly boiled distilled water.

(2) Hydrogen peroxide. Stated to be chemically pure and without inhibitor.

(3) Water.Freshly boiled distilled.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Makarov, S.Z.; Grigoryeva, N. K. *Izv. Akad. Nauk SSSR, Otedel. Khim Nauk* 1954, 385-91.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Ammonium chloride; NH_4Cl; [12125-02-9] *or*
Ammonium nitrate; NH_4NO_3; [6684-52-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Herz, W.; Muhs, G.

Z. anorg. Chem. <u>1904</u>, *38*, 138-42.

VARIABLES

T/K = 302
Concentration

PREPARED BY.

H. L. Clever

EXPERIMENTAL VALUES:

The solubility Product of $Mg(OH)_2$ in aqueous NH_4Cl or NH_4NO_3 at 29°C

NH_4^+ c/mol L^{-1}	Mg^{2+} c/mol L^{-1}	$[Mg^{2+}]^{1\ 5}/[NH_4^+]$ = K	K_{s0}
Ammonium chloride solution			
0.388	0.156	0.159	
0.250	0.108	0.142	
0.172	0.089	0.154	
0.106	0.0638	0.152	
0.0771	0.0490	0.141	
		Av. 0.149 ± 0.008	2.6×10^{-11}
Ammonium nitrate solution			
0.1834	0.0833	0.131	
0.076	0.0495	0.145	
		Av. 0.138	2.2×10^{-11}

The compiler calculated the K_{s0} values using the ammonia K_b value of 1.7×10^{-5}, and the author's relationship

$$K_{s0} = 4K_b^2[Mg^{2+}]^3/[NH_4^+]^2.$$

The relationship took no account of $MgOH^+$ formation. Only the solubility of $Mg(OH)_2$ as simple ions and the dissociation of NH_3 were considered.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE.

Pure $Mg(OH)_2$ was prepared and an excess shaken with aqueous solutions of NH_4Cl and of NH_4NO_3 of known initial concentrations. The saturated solutions were titrated with acid to a nitrophenol end point.

The ammonia concentration was obtained from the titration. The ammonium ion concentration was obtained by difference from the initial ammonium salt concentration, and the magnesium ion concentration was taken as 1/2 the ammonia concentration.

$$Mg(OH)_2 + 2NH_4Cl = MgCl_2 + 2NH_4OH$$

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Prepared by addition of ammonia to a solution of $MgSO_4$.

Nothing further specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES·

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Ammonia; NH_3; [7664-41-7]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shirasaki, T.

Denki Kagaku oyobi Kogyo Butsuri Kagaku 1962, *30*, 43-5.

VARIABLES:

$T/K = 291, 295$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Mg(OH)_2$ in aqueous $NH_3 + NH_4Cl$ at 18 and 22°C

$t/°C$	$Mg(OH)_2$ $10^4c_1/mol\ L^{-1}$	Remarks
22	1.8	A. $Mg(OH)_2$ precipitated in the absence of organic acids.
	5.6	B. $Mg(OH)_2$ precipitated in the presence of citric acid.
	5.3	C. $Mg(OH)_2$ precipitated in the presence of sodium tartrate.
18	2.1	A. As A. above.
	6.5	B. As B. above.
	6.1	C. As C. above.

The solutions at 18°C contained NH_3, $c_2/mol\ L^{-1} = 0.0136$ and NH_4Cl, $c_3/mol\ L^{-1} = 0.0125$.

The solubility product of $Mg(OH)_2$ at 18°C was calculated from the relations:

$K = [NH_4^+]^2/([Mg^{2+}][NH_4OH]^2)$, $K_b = [NH_4^+][OH^-]/[NH_4OH] = 1.75 \times 10^{-5}$ (18°C),

and $K_{s0} = [Mg^{2+}][OH^-]^2 = K_b^2/K$. The analytical results for $[NH_3]$ ($=[NH_4OH]$), $[NH_4^+]$ and $[Mg^{2+}]$ were used to obtain values for K_{s0} of 3.71×10^{-11} (cf. A.), 1.11×10^{-9} (cf. B.), and 9.00×10^{-10} (cf. C.).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Procedure I. $Mg(OH)_2$ was equilibrated at 22°C with CO_2-free water for 8 h. The Mg^{2+} in the supernatant portion was determined by titration with standard HCl solution.

Procedure II. $Mg(OH)_2$ was equilibrated with an aqueous solution containing 0.0125 mol L^{-1} NH_4Cl and 0.0136 mol L^{-1} NH_3 by shaking 8 h at 18°C. The supernatant saturated solution was analyzed for NH_3 by titration with standard HCl solution and for Cl^- by Mohr's method. The $[Mg^{2+}]$ and $[NH_4^+]$ were calculated by difference by the materials balance requirement.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. The $Mg(OH)_2$ was precipitated from an aqueous solution containing 0.5 mol L^{-1} $MgCl_2$, 0.25 mol L^{-1} NH_4Cl, 1.24 mol L^{-1} NH_3, and $(0-3) \times 10^{-3}$ mol L^{-1} of either citric acid or sodium tartrate. The solution and precipitate were protected against CO_2 and allowed to stand 2-3 days at room temperature. The precipitate was washed with water and used without any drying procedure.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Boric acid; H_3BO_3; [10043-35-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Nikolaev, A. V.; Chelishcheva, A.G.

C. R. Acad. Sci. URSS 1940, *28*, 127-30.

VARIABLES:

$T/K = 298$
Composition

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The $MgO + B_2O_3 + H_2O$ system at 25°C

B_2O_3 mass %	MgO mass %	Solid Phase
0	0.004	A
0.215	0.100	A + B
0.573	0.060	B
1.47	0.119	B + C
2.72	0.206	C
2.87	0.210	C + D
2.98	0.211	D
4.76	0.271	D + E
3.17	0	E

Solid Phases: A. $Mg(OH)_2$ B. $2MgO\cdot 3B_2O_3\cdot 15H_2O$

C. $MgO\cdot 2B_2O_3\cdot 9H_2O$ D. $MgO\cdot 3B_2O_3\cdot 7.5H_2O$ E. H_3BO_3

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The MgO, H_3BO_3 and H_2O are mixed and allowed to stand in a stirred thermostated vessel at 25°C for 40 to 125 days.

Samples are taken by pipet through a cotton wool filter. The $Mg(OH)_2$ is titrated in the presence of the boric acid by a strong acid with methyl orange as the indicator. The boric acid is titrated in the presence of mannitol, glycerin, or invert sugar with a strong base with phenolphthalein as the indicator (ref 1).

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium oxide. Freshly ignited MgO used.

(2) Boric acid. Recrystallized boric acid used.

(3) Water. Distilled. Boiled before use to eliminate CO_2.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Nikolaev, A. V. *Izv. Akad. Nauk. SSSR* 1938, 415-32.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Magnesium oxide; MgO; [1309-48-4] (2) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (3) Chromium (VI) oxide; CrO_3; [1333-82-0] (4) Water; H_2O; [7732-18-5]	Revzin, G. E.; Volkova, L. V. Dmitrienko, T. I.; Sennikov, S. G. *Zh. Neorg. Khim.* 1983, *28*, 495-8. **Russ. J. Inorg. Chem. (Engl. Transl.)* 1983, 28, 275-7.

EXPERIMENTAL VALUES:

The CrO_3 + MgO + H_2O system at 25°C

Series I. Pure solid MgO was used.

MgO mass %	CrO_3 mass %	Solid Phase
2.86	6.34	A
5.33	12.22	A
7.45	16.73	A
8.39	18.77	A
9.90	22.56	A
10.82	25.71	A + B
9.45	28.45	B
8.51	30.53	B
8.36	34.01	B
8.51	36.46	B
9.03	42.81	B
9.89	49.02	B
10.05	50.02	B
10.29	51.09	B + C
9.43	52.21	C
9.15	56.12	C
8.69	57.68	C
8.51	61.66	C + D
7.29	60.39	D
5.15	60.01	D
2.92	62.01	D

The $Mg(OH)_2$ + CrO_3 + H_2O system at 25°C

Series II. Pure $Mg(OH)_2$ was used to prepare samples.

MgO mass %	CrO_3 mass %	Solid Phase
2.96	7.21	$Mg(OH)_2$
4.95	12.68	$Mg(OH)_2$
6.63	16.77	$Mg(OH)_2$
7.99	19.97	$Mg(OH)_2$

The original paper also gives the compositions of the "wet residues".

The authors claim that the MgO, used in Series I above, in not transformed to $Mg(OH)_2$ by water under their conditions. The Schreinemaker "wet residue" method shows MgO the equilibrium solid for the first five points.

Solid Phases: A. MgO B. $MgCrO_4 \cdot 5H_2O$

C. $MgCr_2O_7 \cdot 6H_2O$ D. CrO_3

continued on the next page.

COMPONENTS:

(1) Magnesium oxide; MgO; [1309-48-4]

(2) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(3) Chromium (VI) oxide; CrO_3; [1333-82-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Revzin, G. E.; Volkova, L. V. Dmitrienko, T. I.; Sennikov, S. G.

Zh. Neorg. Khim. 1983, *28*, 495-8.

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1983, 28, 275-7.

VARIABLES:

$T/K = 298$

PREPARED BY:

I. Lambert
H. L. Clever

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA:

The authors used two samples of MgO. They were (1) "analytical reagent" grade, sulfur-free MgO (to specification GOST 4526-67), and (2) "pure" grade superlight MgO (to specification TU 6-09-2213-72). The authors state "since neither of the varieties of MgO used reacts with water, magnesium hydroxide cannot be formed under our experimental conditions." The Schreinemakers' method of residues confirms this by showing MgO to be the phase in equilibrium with the saturated solution in Series I.

Series II experiments used both reagent grade and freshly precipitated $Mg(OH)_2$. The equilibrium solid is $Mg(OH)_2$. The solubility curves from Series I and II show good agreement.

Neither series showed the presence of magnesium oxide chromates or basic chromates. The solid phases present were identified by X-ray diffraction.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility was studied by isothermal treatment in a thermostat at (25 ± 0.1)°C until equilibrium was attained between the liquid and solid phases (0.5 to 3 h). The solutions were sampled after filtration or centrifugation. The saturated solutions were analyzed for both magnesium and chromium (VI). The magnesium was determined by titration with Trilon B [disodium salt of EDTA], and the chromium by reaction with ammonium iron (II) sulfate.

The "wet residues" were also analyzed. Water was determined by either drying to constant weight or as the difference between the total weight and the weight of MgO and CrO_3. Agreement between the two procedures was good.

The solid phases were determined graphically by Schreinemaker's method of residues. The solid phases were identified by X-ray diffraction.

The paper also reports the solubility of pure $MgCrO_4 \cdot 5H_2O$ and $MgCr_2O_7 \cdot 6H_2O$ and 25°C.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium oxide. See additional comments above.

(2) Magnesium hydroxide. Either analytical reagent grade (to specification MRTU 6-09-5084-68) $MgO \cdot 0.97H_2O$ by analysis of freshly precipitated material.

ESTIMATED ERROR:

Sold. No estimates possible.
Temp. % 0.1 K (precision).

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Magnesium chloride; $MgCl_2$; [7786-30-3] (3) Water; H_2O; [7732-18-5]	Gjaldbaek, J. K. *Z. Anorg. Allgem. Chem.* 1925, *144*, 145-68, 269-88.

EXPERIMENTAL VALUES:

The solubility product of inactive $Mg(OH)_2$ in aqueous $MgCl_2$ at 25°C[a]

$MgCl_2$ c_2/mol L^{-1}	$Mg(OH)_2$ $10^4 c_1$/mol L^{-1}	pH	$-\log \gamma_{Mg^{2+}}$	$-\log S_o$
0.5	3.5	9.219	1.005	11.33
0.1	1.6	9.551	0.592	10.95
0.02	1.3	9.822	0.370	10.88
0.004	1.7	10.115	0.296	10.91
0.0008	2.45	10.336	0.206	10.98
0	3.25	10.653	0.268	10.92
			Av.	10.99 ± 0.17

[a] $S_o = c_{Mg^{2+}} \cdot \gamma_{Mg^{2+}} \cdot a^2_{OH^-}$

$-\log \gamma_{Mg^{2+}} = k\, n\, (c)^{1/3}$

where c = total ion concentration,

n = ionic charge of Mg^{2+}, and

k = a fitted constant.

The total magnesium ion concentration is calculated

$c_{Mg^{2+}} = c_{MgCl2} + c_{Mg(OH)2} - c_{MgOH^+}$

The hydroxide ion activity is calculated from $a_{H^+} \cdot a_{OH^-} = 10^{-14.23}$ at 18°C.

d log $(K^\circ_{s0})/d\,T$ was determined to be 0.006 in the 0-35°C range for the inactive form of $Mg(OH)_2$.

The solubility product of labile $Mg(OH)_2$ in aqueous $MgCl_2$ at 18°C

$MgCl_2$ c_2/mol L^{-1}	pH	$-\log S_{s0}$
0.1	10.34	9.37
0.02	10.59	9.32
0.0049	10.90	9.18

$c_{Mg^{2+}} = c_{MgCl2}$; pH is taken as the beginning of precipitation, and the remaining calculation is as in the former case.

NOTE: The compilers were unable to recalculate the values of $-\log \gamma$ in the tables from the data given.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Magnesium chloride; $MgCl_2$; [7786-30-3] (3) Water; H_2O; [7732-18-5]	Gjaldbaek, J. K. Z. Anorg. Allgem. Chem. 1925, 144, 145-68, 269-88.
VARIABLES:	PREPARED BY:
$T/K = 273 - 308$ $c_2/\text{mol L}^{-1} = 0 - 0.5$	H. Einaga I. Lambert

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

I. Inactive modification of $Mg(OH)_2$. 300 mg of $Mg(OH)_2$ are mixed with 100 mL of $MgCl_2$ solution and the pH of the solution is measured continously with a hydrogen electrode until a constant emf is reached (2 m to 2 h). The Mg^{2+} in the filtered saturated solution is determined by titration with 0.01 mol L^{-1} HCl, and 0.01 mol L^{-1} NaOH using the hydrogen electrode as indicator. In order to evaluate c_{MgOH^+}, the hydrolysis constant, $a_{MgOH^+}/(a_{Mg^{2+}} \cdot a_{OH^-})$, was estimated so as to obtain agreement between the pH and the calculated hydroxide ion activity, $a_{OH^-} = \gamma_{OH^-} c_{OH^-}$. The hydroxide ion concentration was deduced from the titration, and the activity coefficient calculated from $-\log \gamma_{OH^-} = 0.2(c_{ion})^{1/3}$.

II. Active (labile) modification of $Mg(OH)_2$. Either metallic Mg was introduced into the $MgCl_2$ solutions, or NaOH was added to the $MgCl_2$ solution until precipitation. The pH is measured continuously and the highest value used in the solubility product calculation which is carried out in the same manner as for the inactive modification.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Inactive form. Prepared by precipitation from $MgCl_2$ solution using an under-stoichiometric amount of NaOH in a CO_2 free environment. After three days the $Mg(OH)_2$ was washed with distilled water until free of chloride ion. The final product contained only traces of carbonate.

(2) Magnesium chloride. Solutions were prepared in distilled water taking care to avoid CO_2 contamination.

(3) Water. Distilled, CO_2 free.

ESTIMATED ERROR:

Emf measurements: Accuracy better than 0.5 mV.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium chloride; $MgCl_2$; [7786-30-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Maeda, T.; Yamane, S.

Rikagaku Kenkyusho Iho (Bull. Inst. Phys. Chem. Res., Tokyo) 1928, *7*, 339-56.

VARIABLES:

$T/K = 323$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

The solubility of $Mg(OH)_2$ in aqueous solution increases with increasing concentration of $MgCl_2$ in the aqueous phase at both 25 and 50°C. At 50°C 0.0372 mass% (as MgO) of $Mg(OH)_2$ was dissolved in the aqueous solution of 36.73 mass% $MgCl_2$ solution. No other numerical data on the solubility of $Mg(OH)_2$ in relation to concentration of $MgCl_2$ at 25 and 50°C were given in the original paper.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Known amounts of MgO were equilibrated with aqueous $MgCl_2$ solutions of different concentrations at 25 and 50°C in a specially designed solubility measurement apparatus (ref 1) having stirring and temperature regulating devices. The solid phase was separated and dissolved in aqueous HCl solution followed by back titration with standard NaOH solution. The dissolved $Mg(OH)_2$ was obtained as a difference from the initial amount.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. MgO was obtained from Merck. It was washed with H_2O and then calcined at 800 - 900°C to expel the small amount of accompanying CO_2.

(2) Magnesium chloride. Merck & Co. Used after filtration of its aqueous solution to separate insoluble residues.

(3) Water. Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Maeda, T.; Yamane, S. *Rikagaku Kenkyusho Iho* 1924, *3*, 679.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium chloride; $MgCl_2$; [7786-30-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lukens, H. S.

J. Am. Chem. Soc. 1932, *54*, 2372-80.

VARIABLES:

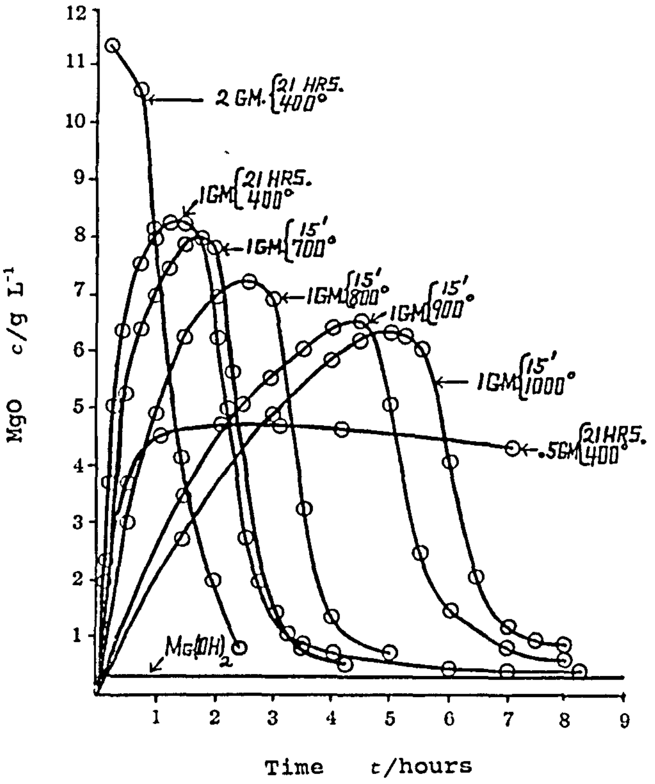
$T/K = 303$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

$MgCl_2$ solutions ($d = 1.179$ g cm^{-3}) were saturated with MgO at 25°C. The results were reported in graphical form.



AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

MgO was equilibrated with aqueous $MgCl_2$ solution ($d = 1.179$ g cm^{-3}). The resulting solutions were digested at 30°C for 0 to 8 hours with periodical stirring. The dissolved MgO was determined by titration with standard HCl solution using phenolphthalein as an indicator.

ESTIMATED ERROR:

No estimates possible.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. The MgO used had the following impurities: sulfates, 0.7500%; chlorides, 0.250%; carbonates, 0.100%; nitrates, 0.0064%; Ba, 0.0200%; Ca, 0.0200%; Fe, 0.025%; other heavy metals, 0.000%.

(2) Magnesium chloride.

(3) Water.

Nothing specified about $MgCl_2$ and H_2O.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium chloride; $MgCl_2$; [7786-30-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bury, C. R.; Davies, E. R. H.

J. Chem. Soc. 1932, 2008-15.

VARIABLES:

T/K = 298
Composition

PREPARED BY:

I. Lambert
H. Einaga

EXPERIMENTAL VALUES:

The $MgO + MgCl_2 + H_2O$ system at 25°C

$MgCl_2$ mass %	Solid Phase	$MgCl_2$ mass %	Solid Phase
2.12	A	10.98	B
2.65	A	14.41	B
6.44	A	16.43	B
8.61	A	17.36	B
9.45	A	21.12	B
10.36	A	21.38	B
10.52	A	24.21	B
		26.59	B
		26.86	B
10.62	B*	31.14	B
		33.69	B
10.88	A + B	34.77	B
10.90	A + B		
		35.70	B + C
12.08	A*	35.72	B + C
15.32	A*	35.72	C

* Metastable equilibrium.
Solid Phases: A. $Mg(OH)_2$ B. $MgCl_2 \cdot 3MgO \cdot 11H_2O$
C. $MgCl_2 \cdot 6H_2O$

The concentration of $Mg(OH)_2$ in the saturated solutions was below the limit of detection of their method.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A mixture of $MgCl_2$, MgO, and H_2O was shaken in a thermostat at 25°C for 2 months until equilibrium had been established. After the equilibration the solid phase was filtered off through a fine sintered glass plate and the filtrate analyzed for Cl^- by the Volhard method. The wet solid was analyzed (results are in the paper but not given here) for Mg^{2+} by the gravimetric method as $Mg_2P_2O_7$ and for Cl^- by the Volhard method.

The values above are the mean of two concordant measurements.

The authors cite earlier papers (ref 1, 2) that were not successful in establishing the phase rule line of this system.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium oxide. Prepared by heating $MgCO_3$ to 850°C. It contained about 0.3 mass % CaO.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Robinson, W. O.; Waggaman, W. H. *J. Phys. Chem.* 1908, *13*, 673.

2. Maeda, T.; Yamane, S. *Bull. Inst. Phys. Chem. Res.* (Tokyo) 1926, *4* (No. 50), 85; 1928, *7*, 340.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium chloride; $MgCl_2$; [7786-30-3]

(3) Ammonia; NH_3; [7664-41-7]

(4) Ammonium chloride; NH_4Cl; [12125-02-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Loven, J. M.

Z. Anorg. Chem. <u>1896</u>, *11*, 404-15.

VARIABLES:

$T/K = 283$
c_2, $c_3/\text{mol L}^{-1}$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

An estimation of the solubility of $Mg(OH)_2$ in pure water from the composition of aqueous solutions of $MgCl_2 + NH_3$ at 10°C

Mg^{2+} $c/\text{mol L}^{-1}$	NH_3 $c_3/\text{mol L}^{-1}$	NH_4^+ $c/\text{mol L}^{-1}$	$Mg(OH)_2$ $10^4c_1/\text{mol L}^{-1}$
0.03762	0.0189	0.00655	3.46
0.03746	0.0193	0.00615	3.65
0.02336	0.0414	0.0095	3.89
0.0219	0.0394	0.0115	3.26
0.01865	0.2209	0.0479	3.74
0.00849	0.0662	0.0101	3.64
0.008415	0.0658	0.0105	3.52

The solubility of $Mg(OH)_2$ was calculated from the expressions for the ionization of ammonia and the solubility product of $Mg(OH)_2$.

$K_b = [NH_4^+][OH^-]/[NH_3]$, and $[Mg^{2+}][OH^-]^2 = K_{s0}^\circ = 4c^3$, where the

last term applies to $Mg(OH)_2$ in pure water as an ideal, completely ionized substance without association or hydrolysis. The author eliminated $[OH^-]$ from the two expressions, and solved for c. An ammonia ionization constant of 2.3×10^{-5} (ref 1) was used in the calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of magnesium chloride and ammonia were equilibrated for several days in stoppered bottles at ambient temperature. After filtering, the saturated solutions were evaporated, and the dry solid decomposed to MgO by heating in a platinum vessel which was weighed.

The NH_3 is titrated with *o*-nitrophenol as the indicator. The NH_4^+ ion concentration is calculated as the difference between the initial NH_3 concentration and the final NH_3 concentration found by titration.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Bredig, G.
Z. Phys. Chem., Stoichiom. Verwandtschaftsl. <u>1894</u>, *13*, 289.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium chloride; $MgCl_2$; [7786-30-3]

(3) Ammonia; NH_3; [7664-41-7]

(4) Ammonium chloride; NH_4Cl; [12125-02-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Fredholm, H.

Z. Anorg. Allg. Chem. 1934, *218*, 235-40.

VARIABLES:

$T/K = 291$
$c_2, c_3, c_4/\text{mol L}^{-1}$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

The solubility of $Mg(OH)_2$ in aqueous solutions containing $MgCl_2$, NH_3 and NH_4Cl at 18°C

NH_3 $c/\text{mol L}^{-1}$	NH_4^+ $c/\text{mol L}^{-1}$	Mg^{2+} $c/\text{mol L}^{-1}$	$Mg(OH)_2$ $10^4c_1/\text{mol L}^{-1}$	Method
0.0637	0.0409	0.0317	1.8	I
0.0369	0.0228	0.0338	1.9	I
0.0308	0.0220	0.0410	1.8	I
0.0760	0.0285	0.0120	1.9	I
0.0357	0.0167	0.0175	1.8	I
0.1024	0.0952	0.0512	1.7	II
0.0577	0.0411	0.0289	1.7	II
0.0391	0.0201	0.0196	1.8	II

The author calculated the solubility from the relations:

$$c_{Mg(OH)2} = (c_{Mg^{2+}}[(1/2)K_2(c_{NH3})(c_{NH4^+})]^2)^{1/3}, \text{ and}$$

$K_2 = c_{NH4^+}\cdot c_{OH^-}/c_{NH3} = 1.77 \times 10^{-2}$ (ref 1). The K_2 value is used to calculate $Mg(OH)_2$ concentration values from ref 2 and 3 as 2.9×10^{-4} at 10°C and 2×10^{-4} at 29°C mol L^{-1}, respectively.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility of $Mg(OH)_2$ in aqueous NH_3-NH_4Cl-$MgCl_2$ solutions was determined by two methods. Method I. NH_3 and NH_4Cl were added to aqueous $MgCl_2$ solution. Method II. Solid $Mg(OH)_2$ was shaken with aqueous NH_4Cl solution. The mixtures were shaken 2 - 7 days at 18.00 ± 0.02°C. Aliquots of the saturated supernatant aqueous phase were withdrawn by pipet to which filter paper had been attached. The saturated solutions were analyzed for Mg^{2+} by titrimetry. Contamination with CO_2 was carefully avoided. Paraffined flasks were used for the equilibration vessels.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Precipitated from aqueous $MgCl_2$ solution with NaOH, filtered in CO_2 free atm and dried at room temperature.

(2) Magnesium chloride
(4) Ammonium chloride. Both analytical grade, stated they were purified, but no details given.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Lunden, H. *Ahrens chem. chem. tech. Vortrage* 1909.
2. Loven, J. M. *Z. Anorg. Allg. Chem.* 1896, *11*, 404.
3. Herz, W.; Muhs, G. *Z. Anorg. Allg. Chem.* 1904, *38*, 138.

COMPONENTS.

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(3) Magnesium chloride; $MgCl_2$; [7786-30-3]

(4) Calcium chloride; $CaCl_2$; [10043-52-4]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bury, C. R.; Davies, E. R. H.

J. Chem. Soc. 1933, 701-5.

EXPERIMENTAL VALUES:

The CaO + $MgCl_2$ + H_2O system at 25°C

$MgCl_2$ mass %	$CaCl_2$ mass %	CaO mass %	Solid Phase
Series I. Solutions in which $MgCl_2$ was detected. All of these solutions also contain about 0.002 mass % MgO.			
8.46	1.864		A
5.02	12.99		A
2.562	15.91		A
4.313	10.96		A
3.186	20.02		A
7.29	7.95		A
0.532	22.87		A
1.481	22.88		A
0.546	26.21		A
10.36	2.483		A + B
9.89	2.537		A + B
9.33	6.105		A + B
8.11	8.59		A + B
7.99	8.60		A + B
6.40	11.10		A + B
4.62	14.64		A + B
3.82	18.17		A + B
2.415	20.78		A + B
1.680	22.89		A + B
0.754	26.20		A + B
0.498	27.30		A + B
0.366	31.58		A + B
0.330	36.09		A + B
0.230	41.68		A + B
14.69	4.160		B
21.84	5.981		B
12.07	3.353		B
18.00	5.753		B
6.96	22.43		B
5.144	15.62		B
2.850	22.51		B
19.44	21.41		B
11.63	12.30		B
9.38	9.44		B
1.808	23.27		B
0.741	27.41		B
0.597	34.97		B
0.368	40.52		B
0.477	32.08		B
Series II. Solutions in which no magnesium was detected in the saturated solutions.			
	14.85	0.141	A + C
	18.06	0.150	A + C + D

Continued on next page.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(3) Magnesium chloride; $MgCl_2$; [7786-30-3]

(4) Calcium chloride; $CaCl_2$; [10043-52-4]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bury, C. R.; Davies, E. R. H.

J. Chem. Soc. 1933, 701-5.

VARIABLES:

T/K = 298
Composition

PREPARED BY:

I. Lambert
H. Einaga

EXPERIMENTAL VALUES:

The $CaO + MgCl_2 + H_2O$ system at 25°C

$MgCl_2$ mass %	$CaCl_2$ mass %	CaO mass %	Solid Phase
Series II.	(continued)		
	20.08	0.145	A + E
	23.56	0.145	A + E
	29.05	0.168	A + E
	29.22	0.170	A + E
	32.98	0.235	A + D + F
	36.44	0.098	A + F
	36.82	0.083	A + F
	37.10	0.091	A + F
	40.85	0.051	A + F
	44.92	0.034	A + F + G

Solid Phases:
A. $Mg(OH)_2$
B. $MgCl_2 \cdot 3MgO \cdot 11H_2O$
C. $Ca(OH)_2$
D. $CaCl_2 \cdot 3CaO \cdot 16H_2O$
E. $CaCl_2 \cdot 3CaO \cdot 11H_2O$
F. $CaCl_2 \cdot CaO \cdot 2H_2O$
G. $CaCl_2 \cdot 6H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of $CaCl_2$ and of $MgCl_2$ of accurately known, but very different composition were mixed in various proportions. Then 0.2 g of either MgO or sometimes CaO was added to each mixture. The solutions were equilibrated for 2 months at 25°C. The saturated solutions were analyzed for Cl^- by the Volhard method, for Ca^{2+} by the gravimetric method as $CaCO_3$, and for Mg^{2+} by the gravimetric method as $Mg_2P_2O_7$. The wet solid analysis is also given in the original paper.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium chloride; $MgCl_2$; [7786-30-3]

(3) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Hostetler, P. B.

Am. J. Sci. 1963, *261*, 238-58.

EXPERIMENTAL VALUES:

The solubility product of $Mg(OH)_2$ in aqueous solution at 25°C

Series	pH	Ionic Strength I/mol kg^{-1}	Magnesium Ion m/mol kg^{-1}	γ/-	-log K°_{s0}
A	9.82	0.0096	0.00275	0.685	11.09
	9.68	0.0256	0.00815	0.575	10.97
	9.37	0.102	0.0332	0.412	11.12
	9.14	0.384	0.1250	0.303	11.14
	8.90	1.62	0.520	0.337	10.95
	9.40	0.102	0.0331	0.412	11.06
B	10.28	0.00187	0.000509	0.828	10.81
	10.09	0.00553	0.001765	0.742	10.70
	9.87	0.0138	0.00450	0.647	10.80
	9.90	0.0139	0.00454	0.646	10.73
	9.73	0.0393	0.0126	0.521	10.72
	9.55	0.128	0.0423	0.389	10.68
				Av.	10.74 ± 0.07
C	10.14	0.0326	0.000639	0.545	11.18
	9.90	0.0154	0.00178	0.635	11.15
	9.71	0.0139	0.00458	0.647	11.11
	9.50	0.0397	0.0130	0.519	11.17
	9.31	0.129	0.0427	0.388	11.16
	9.11	0.400	0.133	0.301	11.18
				Av.	11.16 ± 0.02
D	9.355	0.116	0.0348	0.398	11.15
	9.335	0.127	0.0394	0.389	11.15
	9.62	0.0388*	0.00773	0.523	11.15
	9.85	0.0503**	0.00302	0.490	11.13
				Av.	11.15 ± 0.01***

---

* NaOH used instead of $Ba(OH)_2$.

** KCl added to increase the ionic strength.

*** Value recommended by the author, but as 11.15 ± 0.03.

Series A. Brucite. Author stated insufficient aging time was used, and possibly CO_2 contamination took place.

Series B. Brucite. Solutions possibly supersaturated because of insufficient stirring after proper aging.

Series C. Brucite. Carried out with continous stirring in a CO_2 free atmosphere. pH *vs.* time confirmed aging time.

Series D. Used $Mg(OH)_2$ precipitated in solution from $Ba(OH)_2$ and $MgCl_2$ rather than Brucite. Conditions as in Series C.

$K^\circ_{s0} = a_{Mg^{2+}} \cdot a^2_{OH^-}$ where a = activity.

The magnesium ion activity coefficient, $\gamma_{Mg^{2+}}$, was calculated from the mean activity coefficients of $MgCl_2$ and KCl (ref 1).

Correction for $MgOH^+$ formation was carried out.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium chloride; $MgCl_2$; [7786-30-3]

(3) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Hostetler, P. B.

Am. J. Sci. 1963, *261*, 238-58.

VARIABLES:

$T/K = 298$
m_2, $m_3/\text{mol kg}^{-1}$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

Influence of grain size of solid $Mg(OH)_2$ on solubility and solubility product at 25°C

Grain Size radius/A	$Mg(OH)_2$ $10^4c_1/\text{mol L}^{-1}$	$-\log K^\circ_{s0}$
120	2.55	10.38
150	2.12	10.60
290	1.68	10.88
470	1.45	11.06
-	1.34	11.15

The solubility values are the sum of the calculated Mg^{2+} and $MgOH^+$ molalities. The author gave the table value as a concentration because there is negligible difference between molal and molar in water at these concentrations.

The last value in the table is one of the runs in series D on the previous page. The next to last value is from series A.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Emf measurements were used to determine the pH of the cell: Ag,AgCl/KCl//sample sln/glass elec. The symbol // represents the palladium junction of the commercial electrode which suppresses leakage of KCl during the long period of the experiment. The dissolved Mg^{2+} was determined gravimetrically with 8-quinolinol as the precipitating agent. The activity of the magnesium ion was calculated from its molality using activity coefficients either from published data (ref 1) or by calculation from Debye-Huckel equation. Nitrogen gas was bubbled through the suspension to keep the system CO_2 free.

Aging (particle size), stirring, and CO_2 contamination problems were solved for series C and D.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Reagent grade $Mg(OH)_2$ in the form of well crystallized brucite was used as received.

(2) Magnesium chloride. Reagent grade purified by recrystallization.

ESTIMATED ERROR:

Accuracy of emf measurements:
± 0.02 pH units.

REFERENCES:

1. Harned, H. S.; Owen, B. B. *Physical Chemistry of Electrolyte Solutions*, 3rd. ed. 1958, Reinhold Pub. Corp., New York.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium sulfate; $MgSO_4$; [7487-88-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kiessewetter, F.

Radex. Rundsch. 1953, 117-25.

VARIABLES:

$T/K = 293$
$c_2/\text{mol L}^{-1} = 0.5 - 2$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

The solubility of $Mg(OH)_2$ in aqueous $MgSO_4$ at 20°C

$MgSO_4$ $c_2/\text{mol L}^{-1}$	$Mg(OH)_2$ $c_1/\text{mol L}^{-1}$	Mole Ratio n_1/n_2	Remarks
1	0.0416	0.0416	A
1.5	0.0649	0.0433	A
2	0.0908	0.0454	A
1	0.400	0.400	B
0.5	0.0375	0.075	C
0.5	0.0376	0.076	C
1	0.133	0.133	C
1	0.163	0.163	C
1.5	0.519	0.346	C
1.5	0.370	0.247	C

Remarks: A inactive modification (ignited at 950°C),

B active modification (ignited at 500°C),

C active modification (ignited at 550°C).

The mole ratio was independent of the $MgSO_4$ concentration for the inactive, but not for the active modification.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Aqueous $MgSO_4$ solutions were shaken with MgO at 20 ± 0.1°C for 5 to 330 minutes. The solid phase was filtered and the resulting saturated solution analyzed for Mg^{2+} either gravimetrically as the sulfate or by acid-base titration with standard HCl solution with methyl orange indicator.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium oxide. Powdered natural magnesite (composition, mass %: SiO_2, 2.19; Fe_2O_3, 0.77; Al_2O_3, 0.53; CaO, 0.60; MgO, 45.79; and loss on ignition, 50.12) was ignited at a temperature between 500 and 950°C for 14 h, and cooled over P_2O_5.
(2) Magnesium sulfate. Analytical reagent grade.
(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.1 K.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium sulfate; $MgSO_4$; [7487-88-9]

(3) Ammonia; NH_3; [7664-41-7]

(4) Ammonium sulfate; $(NH_4)_2SO_4$; [7783-20-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Loven, J. M.

Z. Anorg. Chem. 1896, *11*, 404-15.

VARIABLES:

$T/K = 289\text{-}290$
c_2, $c_3/\text{mol L}^{-1}$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

An estimation of the solubility of $Mg(OH)_2$ in pure water from the composition of aqueous solutions of $MgSO_4$ + NH_3 at 16-17°C

Mg^{2+} $c/\text{mol L}^{-1}$	NH_3 $c_3/\text{mol L}^{-1}$	NH_4^+ $c/\text{mol L}^{-1}$	$Mg(OH)_2$ $10^4c_1/\text{mol L}^{-1}$
0.2352	0.0325	0.0198	[4.38]
0.1084	0.0499	0.0284	3.52
0.0802	0.0546	0.02915	3.34
0.0699	0.0612	0.02602	3.71
0.0203	0.0421	0.01022	3.57
0.0054	0.0747	0.00905	3.86

The solubility of $Mg(OH)_2$ was calculated from the expressions for the ionization of ammonia and the solubility product of $Mg(OH)_2$.

$K_b = [NH_4^+][OH^-]/[NH_3]$, and $[Mg^{2+}][OH^-]^2 = K_{s0}^{\circ} = 4c^3$, where the

last term applies to $Mg(OH)_2$ in pure water as an ideal, completely ionized substance without association or hydrolysis. The author eliminated $[OH^-]$ from the two expressions, and solved for c. An ammonia ionization constant of 2.3×10^{-5} (ref 1) was used in the calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of magnesium sulfate and ammonia were equilibrated for several days in stoppered bottles at ambient temperature. After filtering, the saturated solutions were evaporated, and the dry solid decomposed to MgO by heating in a platinum vessel which was weighed.

The NH_3 is titrated with *o*-nitrophenol as the indicator. The NH_4^+ ion concentration is calculated as the difference between the initial NH_3 concentration and the final NH_3 concentration found by titration.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Bredig, G.
Z. Phys. Chem., Stoichiom. Verwandtschaftsl. 1894, *13*, 289.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium thiocyanate; $Mg(SCN)_2$; [306-61-6]

(3) Ammonia; NH_3; [7664-41-7]

(4) Ammonium thiocyanate, NH_4SCN; [1762-95-4]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Loven, J. M.

Z. Anorg. Chem. 1896, *11*, 404-15.

VARIABLES:

$T/K = 289-290$
c_2, $c_3/mol\ L^{-1}$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

An estimation of the solubility of $Mg(OH)_2$ in pure water from the composition of aqueous solutions of $Mg(SCN)_2 + NH_3$ at 16-17°C

Mg^{2+} $c/mol\ L^{-1}$	NH_3 $c_3/mol\ L^{-1}$	NH_4^+ $c/mol\ L^{-1}$	$Mg(OH)_2$ $10^4c_1/mol\ L^{-1}$
0.0281	0.02027	0.0059	3.53
0.0162	0.04123	0.01111	3.09
0.00594	0.06713	0.01188	3.01
0.00409	0.07375	0.01001	3.01
0.00305	0.07850	0.00873	3.19

The solubility of $Mg(OH)_2$ was calculated from the expressions for the ionization of ammonia and the solubility product of $Mg(OH)_2$.

$K_b = [NH_4^+][OH^-]/[NH_3]$, and $[Mg^{2+}][OH^-]^2 = K_{s0}^\circ = 4c^3$, where the

last term applies to $Mg(OH)_2$ in pure water as an ideal, completely ionized substance without association or hydrolysis. The author eliminated $[OH^-]$ from the two expressions, and solved for c. An ammonia ionization constant of 2.3×10^{-5} (ref 1) was used in the calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of magnesium thiocyanate and ammonia were equilibrated for several days in stoppered bottles at ambient temperature. After filtering, the saturated solutions were evaporated, and the dry solid decomposed to MgO by heating in a platinum vessel which was weighed.

The NH_3 is titrated with *o*-nitrophenol as the indicator. The NH_4^+ ion concentration is calculated as the difference between the initial NH_3 concentration and the final NH_3 concentration found by titration.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Bredig, G.
Z. Phys. Chem., Stoichiom. Verwandtschaftsl. 1894, *13*, 289.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium nitrate; $Mg(NO_3)_2$; [10377-60-3]

(3) Ammonia; NH_3; [7664-41-7]

(4) Ammonium nitrate; NH_4NO_3; [6484-52-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Loven, J. M.

Z. Anorg. Chem. 1896, *11*, 404-15.

VARIABLES:

$T/K = 283$
c_2, $c_3/\text{mol L}^{-1}$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

An estimation of the solubility of $Mg(OH)_2$ in pure water from the composition of aqueous solutions of $Mg(NO_3)_2 + NH_3$ at 10°C

Mg^{2+} $c/\text{mol L}^{-1}$	NH_3 $c_3/\text{mol L}^{-1}$	NH_4^+ $c/\text{mol L}^{-1}$	$Mg(OH)_2$ $10^4c_1/\text{mol L}^{-1}$
0.0811	0.0181	0.00736	[4.02]
0.0698	0.0167	0.0088	3.21
0.0427	0.03736	0.01354	3.50
0.0421	0.0357	0.0152	3.16
0.0383	0.0194	0.00604	3.85
0.0224	0.04125	0.00965	3.78
0.0167	0.0626	0.001876	3.58
0.0159	0.0610	0.0154	3.21

The solubility of $Mg(OH)_2$ was calculated from the expressions for the ionization of ammonia and the solubility product of $Mg(OH)_2$.

$K_b = [NH_4^+][OH^-]/[NH_3]$, and $[Mg^{2+}][OH^-]^2 = K_{s0}^\circ = 4c^3$, where the last term applies to $Mg(OH)_2$ in pure water as an ideal, completely ionized substance without association or hydrolysis. The author eliminated $[OH^-]$ from the two expressions, and solved for c. An ammonia ionization constant of 2.3×10^{-5} (ref 1) was used in the calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of magnesium nitrate and ammonia were equilibrated for several days in stoppered bottles at ambient temperature. After filtering, the saturated solutions were evaporated, and the dry solid decomposed to MgO by heating in a platinum vessel which was weighed.

The NH_3 is titrated with *o*-nitrophenol as the indicator. The NH_4^+ ion concentration is calculated as the difference between initial NH_3 concentration and the final NH_3 concentration found by titration.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Bredig, G.
Z. Phys. Chem., Stoichiom. Verwandtschaftsl. 1894, *13*, 289.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (2) Magnesium nitrate; $Mg(NO_3)_2$; [10377-60-3] (3) Sodium nitrate; $NaNO_3$; [7631-99-4] (4) Water; H_2O; [7732-18-5]	Einaga, H. *J. Inorg. Nucl. Chem.* <u>1981</u>, *43*, 229-33.

EXPERIMENTAL VALUES:

Solubility product of $Mg(OH)_2$, K_{s0}, where

$$K_{s0} = [Mg^{2+}][OH^-]^2 = [Mg^{2+}]\cdot h^{-2}\cdot K_w^{\,2},$$

was determined under the condition of the coexistence of the freshly precipitated amorphous $Mg(OH)_2$ in 1.0 mol L^{-1} aqueous $NaNO_3$ solution from emf measurement for h, where h = $[H^+]$, with K_w of 1 x $10^{-13.80}$ and from saturated concentration of Mg(II) from the data depicted in Figure 1. The graphical analyses carried out according to the relations are as follows:

$$\log G = \log 2(1 + \beta_{22}K_{s0}K_w^{-2} + \beta_{34}K_{s0}^2K_w^{-4})K_{s0}K_w^{-2} + 2\log h$$

$$G = 2C_{Mg,sol} - (C_{OH} - [OH^-])$$

$$\beta_{22} = [Mg_2(OH)_2^{2+}]\cdot h^2/[Mg^{2+}]^2 = 10^{-21.07 \pm 0.10} \qquad \text{(ref 1)}$$

$$\beta_{34} = [Mg_3(OH)_4^{2+}]\cdot h^4/[Mg^{2+}]^4 = 10^{-39.16 \pm 0.10} \qquad \text{(ref 1)}$$

The result is

$$\log K_{s0} = -9.38 \pm 0.10$$

at 25°C in 1.0 mol L^{-1} $NaNO_3$ solution.

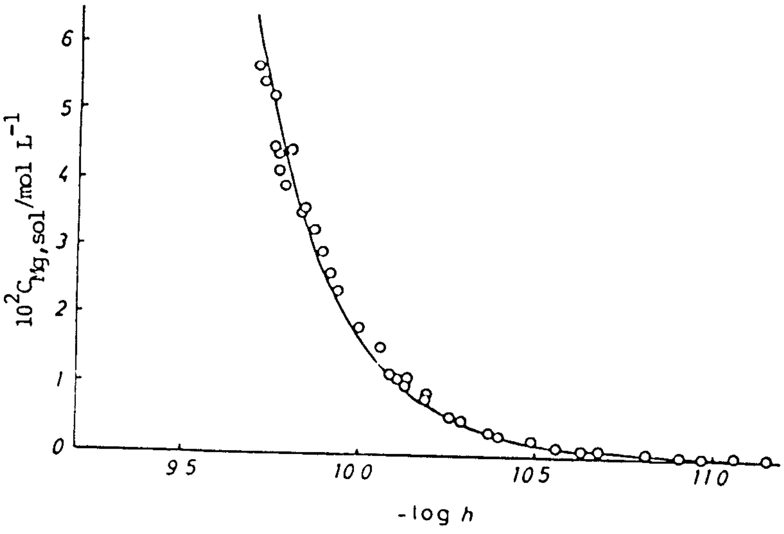


Figure 1. Relation between $C_{Mg,sol}$ and -log h

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium nitrate; $Mg(NO_3)_2$; [10377-60-3]

(3) Sodium nitrate; $NaNO_3$; [7631-99-4]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Einaga, H.

J. Inorg. Nucl. Chem. 1981, *43*, 229-33.

VARIABLES:

$T/K = 298$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$[H^+]$ was determined from emf measurements on the cell

Hg, $Hg_2Cl_2|3.33$ mol L^{-1} KCl$||$1.0 mol L^{-1} KCl$||$1.0 mol L^{-1} $NaNO_3||S|$glass electrode.

For the experimental solution S,

$[Mg(II)]_{tot}$ = B mol L^{-1},

$[H^+]_{init}$ = H mol L^{-1},

$[Na^+]$ = (1.0 - 2B - H) mol L^{-1}, and

$[NO_3^-]$ = 1.0 mol L^{-1}.

After equilibration for 6 hours, the following relation was used in the calculations:

$$E/mV = E° + 59.15 \log h + E_j(h)$$

where $E_j(h)$ is the liquid junction potential. Concentration of Mg(II) in saturated solution was determined by complexometric titration.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Analytical grade.

(2) Magnesium nitrate. Recrystallized from aqueous solution of $Ba(OH)_2$ and then added to NaOH solution in order to precipitate any dissolved CO_2 as insoluble $BaCO_3$.

(3) Sodium nitrate. Analytical grade.

(4) Water.

ESTIMATED ERROR:

Accuracy of the emf measurements was better than 0.2 mV.

REFERENCES:

1. Einaga, H. *J. Chem. Soc., Dalton Trans.* 1977, 912.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium carbonate; $MgCO_3$; [546-93-0]

(3) Carbon dioxide; CO_2; [124-38-9]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kline, W. D.

J. Am. Chem. Soc. 1929, *51*, 2093-7.

EXPERIMENTAL VALUES:

The $Mg(OH)_2 + MgCO_3 + CO_2 + H_2O$ system at 25°C as a function of CO_2 partial pressure.

CO_2 $10^3 p_3$/atm	Ionic Strength	Mg^{2+} $10^3 m$/ mol kg^{-1}	HCO_3^- $10^3 m$/ mol kg^{-1}	CO_3^{2-} $10^3 m$/ mol kg^{-1}	OH^- $10^5 m$/ mol kg^{-1}	Solid Phase
0.107	0.0149	4.33	4.88	1.89	3.84	A
0.113	0.0153	4.45	5.01	1.95	3.73	A
0.170	0.0194	5.77	7.45	2.05	3.69	A
0.179	0.0199	5.93	7.63	2.12	3.59	A
0.197	0.0224	6.58	7.95	2.61	3.40	A
0.210	0.0243	7.08	8.06	3.05	3.23	A
0.233	0.0270	7.80	8.37	3.61	3.03	A
0.251	0.0280	8.07	8.55	3.80	2.87	A
0.310	0.0346	10.13	11.84	4.21	3.22	A
0.376	0.0448	12.96	14.04	5.94	3.14	A
0.380	0.0470	13.55	14.32	6.39	-	A
0.510	0.0489	14.37	17.10	5.82	-	B
0.680	0.0511	15.12	18.72	5.76	-	B
0.845	0.0527	15.66	19.90	5.71	-	B
0.887	0.0535	15.93	20.46	5.70	-	B
0.930	0.0544	16.24	21.19	5.65	-	B
1.600	0.0609	18.59	26.98	5.10	-	B
3.34	0.0707	22.10	35.48	4.36	-	B
6.90	0.0779	25.07	44.68	2.73	-	B
15.0	0.0950	31.27	60.22	1.16	-	B
43.2	0.1390	46.01	89.98	1.02	-	B
111.6	0.1889	62.66	123.6	0.85	-	B
968.4	0.6405	213.5	426.9	-	-	B

Solid Phases: A $Mg(OH)_2$

B $MgCO_3 \cdot 3H_2O$

NOTE: The Mg^{2+} and the HCO_3^- were determined directly. The CO_3^{2-} was calculated by $m_{CO3^{2-}} = m_{Mg^{2+}} - (1/2) m_{HCO3^-}$. The total ionic strength is from the molalities of Mg^{2+}, HCO_3^- and CO_3^{2-}. The hydroxyl ion molality was found from the bicarbonate molality, the carbon dioxide partial pressure, the value of Henry's constant for CO_2, and the ionization constants of H_2CO_3.

The transition pressure between $Mg(OH)_2$ and $MgCO_3 \cdot 3H_2O$ at 25°C is 0.0004 atm. carbon dioxide.

The solubility product of $Mg(OH)_2$ was obtained from the data by by two approaches. Approach I. Values of $m_{Mg^{2+}} \cdot m_{OH^-}^2$ calculated from the table above were extrapolated to zero ionic strength to give a value of $K_{s0}^{\circ} = 2.7 \times 10^{-12}$.

(continued on the next page)

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium carbonate; $MgCO_3$; [546-93-0]

(3) Carbon dioxide; CO_2; [124-38-9]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kline, W. D.

J. Am. Chem. Soc. <u>1929</u>, *51*, 2093-7.

VARIABLES:

$T/K = 298$
$p_3/Pa = 10.8 - 98{,}123.$
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA:

Solubility product of $Mg(OH)_2$. <u>Approach</u> <u>II</u>. Calculated to be

5.5×10^{-12} from the relation

$K^\circ_{s0} = K_w/(\gamma\lambda m_{CO2}K_{a1}K_{a2})(K_{MgCO3}/K_{tr})$, where:

K_w = the ion product of water,
γ = the activity coefficient of CO_2,
λ = the activity coefficient of water,
m_{CO2} = the molality of CO_2 at a partial pressure of one atm.,
K_{a1} and K_{a2} = the ionization constants of H_2CO_3,
K_{MgCO3} = the solubility product of $MgCO_3$, and
K_{tr} = the transition pressure between $Mg(OH)_2$ and $MgCO_3 \cdot 3H_2O$.

The author recommended the value from Procedure II.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$MgCO_3 \cdot 3H_2O$ was suspended for 3 to 5 days in water saturated with CO_2 at the partial pressure of the experiment. The saturated solutions were analyzed for Mg^{2+} and HCO_3^-.

SOURCE AND PURITY OF MATERIALS:

(2) Magnesium carbonate. A commercial sample was used as received.

No other information given.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Johnston, J. *J. Am. Chem. Soc.* <u>1915</u>, *37*, 2001.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Magnesium acetate; $Mg(CH_3COO)_2$ [142-72-3]

(3) Ammonia; NH_3; [7664-41-7]

(4) Ammonium acetate; NH_4CH_3COO; [631-61-8]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Loven, J. M.

Z. Anorg. Chem. 1896, *11*, 404-15.

VARIABLES:

$T/K = 289\text{-}290$
$c_2,\ c_3/\text{mol L}^{-1}$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

An estimation of the solubility of $Mg(OH)_2$ in pure water from the composition of aqueous solutions of $Mg(CH_3COO)_2 + NH_3$ at 16-17°C

Mg^{2+} $c/\text{mol L}^{-1}$	NH_3 $c_3/\text{mol L}^{-1}$	NH_4^+ $c/\text{mol L}^{-1}$	$Mg(OH)_2$ $10^4 c_1/\text{mol L}^{-1}$
0.04498	0.02087	0.0058	[4.52]
0.0246	0.04158	0.01076	3.65
0.00901	0.06655	0.01196	3.33
0.00495	0.07716	0.01009	3.37

The solubility of $Mg(OH)_2$ was calculated from the expressions for the ionization of ammonia and the solubility product of $Mg(OH)_2$.

$K_b = [NH_4^+][OH^-]/[NH_3]$, and $[Mg^{2+}][OH^-]^2 = K_{s0}^{\circ} = 4c^3$, where the last term applies to $Mg(OH)_2$ in pure water as an ideal, completely ionized substance without association or hydrolysis. The author eliminated $[OH^-]$ from the two expressions, and solved for c. An ammonia ionization constant of 2.3×10^{-5} (ref 1) was used in the calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of magnesium acetate and ammonia were equilibrated for several days in stoppered bottles at ambient temperature. After filtering, the saturated solutions were evaporated, and the dry solid decomposed to MgO by heating in a platinum vessel which was weighed.

The NH_3 is titrated with *o*-nitrophenol as the indicator. The NH_4^+ ion concentration is calculated as the difference between the initial NH_3 concentration and the final NH_3 concentration found by titration.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Bredig, G.
Z. Phys. Chem., Stoichiom. Verwandtschaftsl. 1894, *13*, 289.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Calcium carbonate; $CaCO_3$; [471-34-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Whipple, G. C; Mayer, A. Jr.

J. Infec. Dis. [Suppl. 2] 1906, *2*, 151.

VARIABLES:

T/K = 293, 308, and 310

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Mg(OH)_2$ in aqueous saturated $CaCO_3$

$t/°C$	$Mg(OH)_2$[a]	$Mg(OH)_2$ $10^4 m_1/mol\ kg^{-1}$
20	17	1.8
35	20	2.1
37	15	1.6

[a] expressed as mg kg^{-1} $CaCO_3$.

The compiler calculated the molal $Mg(OH)_2$ solubility.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of calcium bicarbonate and magnesium bicarbonate are precipitated by $Ca(OH)_2$ solutions. Concentrations are not specified. After precipitation the $Mg(OH)_2$ and $CaCO_3$ in the supernatant liquid are titrated with H_2SO_4 (0.02 mol L^{-1}). Samples are taken at different times until equilibrium is reached. The $Mg(OH)_2$ concentration is found by subtracting the base concentration obtained in a similar experiment with $CaCO_3$ alone.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible. The colloidal nature of the precipitate may give too large results.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Hydrochloric acid; HCl; [7647-01-0]
or
Sodium chloride; NaCl; [7647-14-5]
or
Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lambert, I.; Lefevre, A.; Montel, J.

Presented at the Eighth International CODATA Conference: Data for Science and Technology Jachranka, Poland 1982.

Water chemistry and corrosion problems in nuclear power plants. IAEA-SM-264 Vienne, 1983.

EXPERIMENTAL VALUES:

The solubility of $Mg(OH)_2$ in aqueous HCl, or $NaNO_3$, or NaCl between 20 and 300°C

t/°C	$Mg(OH)_2$ $10^3 m_1$/mol kg^{-1}	pH
Table I. Ionic strength, I = 0.01 (HCl 0.01 mol kg^{-1}), pH measured at 21°C.		
300	0.08	5.3
281	0.66	5.48
238	1.66	6.33
211	4.52	8.43
175	3.78	9.10
143	3.86	9.18
123	5.76	9.25
110.5	4.16	9.23
77	6.25	9.36
46	6.	9.56
21	5.18	9.85
Table II. Ionic strength, I = 0.5 ($NaNO_3$ 0.5 mol kg^{-1}), pH measured at 22°C.		
300	0.884	5.33
270	1.15	6.35
241.5	1.18	7.07
180	1.69	9.20
146	1.72	9.41
114	1.72	9.33
86	1.74	9.83
46	1.69	10.07
22	1.93	10.18
Table III. Ionic strength, I = 0.5 (NaCl 0.5 mol kg^{-1}), pH measured at (19-24°C). See (°C) below.		
300	0.062	9.74 (23)
280	0.079	9.73 (24)
254	0.0847	9.96 (23)
221	0.127	10.24 (22)
183	0.165	10.25 (23)
146	0.222	10.47 (22)
107.5	0.234	10.61 (21)
88	0.253	10.78 (20)
39	0.296	10.63 (19)
21.5	0.265	10.65 (20)
21	0.284	10.60 (20)

The data in tables 2 and 3 allows calculation of the complexation constant, $K_{Cl} = [MgCl^+]/([Mg^{2+}][Cl^-])$. The data from tables 1 and 2 (table 1 corrected for complexation by Cl^-) are used to calculate the $Mg(OH)_2$ solubility product, $K^\circ_{s0} = a_{Mg^{2+}} \cdot a^2_{OH^-}$ at each temperature.

(continued on next page)

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Hydrochloric acid; HCl; [7647-01-0]
or
Sodium chloride; $NaCl$; [7647-14-5]
or
Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lambert, I.; Lefevre, A.; Montel,J.

Presented at the Eighth International CODATA Conference: Data for Science and Technology, Jachranka, Poland <u>1982</u>.

Water chemistry and corrosion problems in nuclear power plants. IAEA -SM-264 Vienne, <u>1983</u>.

VARIABLES:

$T/K = 293 - 573$
Concentration

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA (continued):

Activity coefficients evaluated from Debye-Huckel treatment (1). The results were fitted to the equation:

$$\log K^{\circ}_{s0} = 73.9 - 29.8 \log (T/K) - 605.7/(T/K) + 4.428 \times 10^{-2} (T/K).$$

The discrepancy at low temperatures with reported results (2) is assumed to be related to a different crystalline form.

The precision of the results does not allow consideration of $MgOH^+$ formation in the calculation. The imprecision is mainly due to high temperature reactions of solutions with the walls of the autoclave.

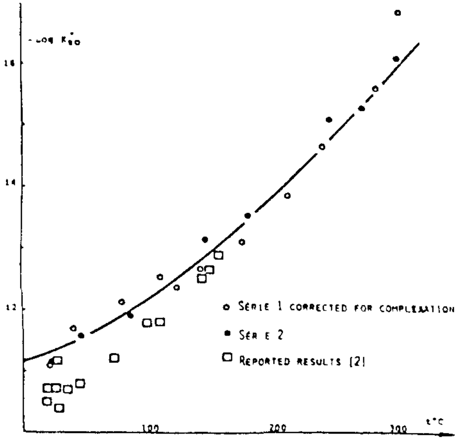


FIG 4 SOLUBILITY PRODUCT
$K^{\circ}_{so} = a_{Mg^{++}} a^2_{OH^-}$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Mg(OH)_2$ and the desired solution are placed in a titanium autoclave and stirred for 16 hours to attain equilibrium. Prior to the equilibration procedure, the $Mg(OH)_2$ is heated for 8 days at 300°C to convert the labile form into the stable inactive form. After equilibration the liquid phase is sampled through a titanium filter and condenser. The magnesium is analyzed by colorimetry of the complex formed with xylidyl blue. The pH is measured at room temperature with a glass electrode. The pH at the temperature of the experiment was calculated from K_w values at each temperature assuming complete dissociation of $Mg(OH)_2$ and any products from wall reactions.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Prepared *in situ* by hydration of MgO.

All reagents are analytical grade.

ESTIMATED ERROR:

$\log K^{\circ}_{s0}$ precision = ± 0.3 log units.

REFERENCES:

1. Hostetler, P. B. Am. J. Sci. <u>1963</u>, 261, 238.
2. Linke, W. F. Solubilities of inorganic and metal organic compounds, Van Nostrand Co., New York, <u>1958</u>.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Sodium chloride; NaCl; [7647-14-5]

or

Potassium chloride; KCl; [7447-40-7]

(3) Water; H_2O; [7731-18-5]

ORIGINAL MEASUREMENTS:

Näsänen, R.

Z. Phys. Chem., Abt. A 1942, *190*, 183-94.

VARIABLES:

$T/K = 298$

$c_2/\text{mol L}^{-1} = 0.0119\text{-}2.62$

PREPARED BY:

H. Einaga

I. Lambert

EXPERIMENTAL VALUES:

The solubility product of $Mg(OH)_2$ in aqueous NaCl and in aqueous KCl at 25°C

Sodium Chloride Solutions		Potassium Chloride Solutions	
$I^{1/2}$	$-\log K_{s0}$	$I^{1/2}$	$-\log K_{s0}$
0.109	10.450	0.108	10.497
0.268	10.215	0.266	10.220
0.473	10.005	0.484	10.079
0.970	9.906	0.961	10.056
1.47	10.064	1.34	10.250
1.62	10.190	1.63	10.409

I is ionic strength. Solubility products are av. of two measurements.

The thermodynamic value of the solubility product, K°_{s0}, was found by fitting the data to the Debye-Hückel equation in the form:

$-\log K_{s0} = -\log K^{\circ}_{s0} + 3.04\, I^{1/2}/(1 + a\, I^{1/2}) - B\, I$. The result is

$-\log K^{\circ}_{s0} = 10.734$ or $K^{\circ}_{s0} = 1.84 \times 10^{-11}$

NOTE: Earlier data (1) were regarded as erroneous by the author because he did not consider the effects of dissolved CO_2. Additional experiments at known CO_2 partial pressures are reported.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Aqueous solutions of $MgCl_2$ containing either NaCl or KCl were titrated with either aqueous NaOH or KOH, and the pH change was followed during the titration by emf measurements (1). The potentiometric titration curves were analyzed to obtain the $Mg(OH)_2$ solubility product, K_{s0}. Results were obtained in the absence of CO_2. Controlled additions of CO_2 were made, and the influence of CO_2 interpreted by taking $MgHCO_3^+$ formation into account.

SOURCE AND PURITY OF MATERIALS:

Alkali hydroxide solutions were stored over barium hydroxide, and handled at low temperature in order to avoid CO_2.

ESTIMATED ERROR:

No description, but precision in log K_{s0} may be estimated to be less than ± 0.02 log units.

REFERENCES:

1. Näsänen, R. *Z. Phys. Chem. Abt. A* 1941, *188*, 272.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Alkali metal halides, hydroxides and sulfates, see table below.

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Whitby, L.

Trans. Faraday Soc. 1933, *29*, 1318-31.

Trans. Faraday Soc. 1935, *31*, 638-48.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0 - 4$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

Solubility of $Mg(OH)_2$ in aqueous alkali metal salt solutions at 25°C

Alkali Metal Salt	Salt $c_2/\text{mol L}^{-1}$	Magnesium Hydroxide $10^4 c_1/\text{mol L}^{-1}$
Lithium chloride; LiCl; [7447-41-8]	0	4.6
	0.01	3.1
	0.1	2.4
	2	6.0
Sodium chloride; NaCl; [7647-14-5]	0	4.6
	0.01	2.7
	0.1	1.7
	2	3.9
	3	2.5
	4	3.0
Sodium sulfate; Na_2SO_4; [7681-38-1]	0	4.6
	0.05	2.5
	0.5	3.4
	1	4.6
	1.5	6.7
Potassium hydroxide; KOH; [1310-58-3]	0	4.6
	0.001	2.2
Potassium chloride; KCl; [7447-40-7]	0	4.6
	0.01	3.8
	0.1	2.5
	1	3.3
	2	5.0
Potassium bromide; KBr; [7758-02-3]	0	4.6
	1	2.9
Potassium iodide; KI; [7681-11-0]	0	4.6
	1	3.2
Potassium sulfate; K_2SO_4; [7778-80-5]	0	4.6
	0.5	9.0

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The freshly prepared labile form (ref 1) of $Mg(OH)_2$ was mixed with each of the alkali metal salt solutions in the above table. The mixtures were equilibrated for three weeks. The saturated solutions were filtered, and the $Mg(OH)_2$ determined gravimetrically with 8-quinolinol.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Prepared by method of (ref 1).

(2) Alkali metal salts. Analytical grade chemicals.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Gjaldbaek, J. K. *Z. Anorg. Allg. Chem.* 1925, *144*, 269.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Sodium hydroxide; NaOH; [1310-73-2]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Maigret, E.

Bull. Soc. Chim. Fr. 1905, 631-4.

VARIABLES:

c_2/g L^{-1} = 125 - 160
c_3/g L^{-1} = 0.8 - 4.0
T/K = Room temperature

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

Composition of the saturated solution at room temperature

NaCl		NaOH		MgO	$Mg(OH)_2$
c_2/g L^{-1}	c_2/mol L^{-1a}	c_3/g L^{-1}	c_3/mol L^{-1a}	c/g L^{-1}	10^4c_1/mol L^{-1a}
125	2.14	0.8	0.02	0.07	17
140	2.40	0.8	0.02	0.045	11
160	2.74	0.8	0.02	0	0
125	2.14	4.0	0.10	0.03	7
140	2.40	4.0	0.10	0	0
160	2.74	4.0	0.10	0	0

[a] Calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Mixtures of MgO, NaCl and NaOH were agitated until equilibration was attained. The resulting salt solution was filtered, and $Mg(OH)_2$ was determined by titration with HCl using phenolphthalein indicator.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide.

(2) Sodium chloride.

(3) Sodium hydroxide. The NaOH solution was decarbonated by addition of $BaCl_2$.

No other information given.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Sodium chloride; NaCl; [7647-14-5]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Boryachek, A. F.; Gromova, E. T.; Kulagina, O. N.

Zh. Prikl. Khim. (Leningrad) 1968, *41*, 1606-8.

J. Appl. Chem. USSR (Engl. Transl.) 1968, *41*, 1524-6.

VARIABLES:

$T/K = 298 - 348$

$10^3c_2/\text{mol L}^{-1} = 0 - 2.5$

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Mg(OH)_2$ in brine containing 310 g L^{-1} NaCl, 0.005-0.010 g L^{-1} Ca, and NaOH

$t/°C$	NaOH $10^3c_1/\text{mol L}^{-1}$	Mg^{2+} $10^3c_1/\text{g L}^{-1}$	$Mg(OH)_2$ $10^4c_1/\text{mol L}^{-1a}$
25	0	9.0	3.7
	1.25	1.5	0.62
	2.5	1.4	0.58
50	0	10.7	4.40
	1.25	2.5	1.0
	2.5	0	0
75	0	11.0	4.53
	1.25	3.5	1.4
	2.5	0	0

[a] Calculated by compilers.

Solubility of $Mg(OH)_2$ in brine increases with increasing temperature and decreases with increasing NaOH concentration.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Freshly precipitated $Mg(OH)_2$ was equilibrated with brine containing different concentrations of NaOH in round-bottomed glass flasks at 25°C for 7 days, at 50°C for 6 days, and at 75°C for 5 days within ±0.2°C under continuous shaking. At the end of the shaking, the solutions stood for an additional 24 hours. Aliquots of the clear portions were analyzed for Mg^{2+} by spectrophotometry and for OH^- by titration with standard HCl solution using cresol red and thymol blue as indicators.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Freshly precipitated, prepared from aqueous $MgCl_2$ solution by the addition of NaOH.

(2) Sodium hydroxide.

(3) Sodium chloride.

(4) Water. Doubly distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Horn, G.

Radex Rundsch. 1969, 439-59.

VARIABLES.

T/K = 298

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

The solubility product of $Mg(OH)_2$ in aqueous $NaClO_4$ (3 mol L^{-1}) at 25°C

H 10^3c/mol L^{-1}	B 10^3c/mol L^{-1}	b 10^3c/mol L^{-1}	log K'_{s0} (from b)	log K'_{s0} (from B)
200.00	97.90	102.10	16.52	16.50
200.00	99.20	100.80	16.57	16.57
200.00	100.01	99.99	16.56	16.56
80.00	42.90	37.11	16.57	16.63
80.00	43.07	36.93	16.58	16.64
80.00	43.06	36.94	16.56	16.66
22.86	13.00	9.86	16.60	16.72
22.86	13.29	9.57	16.61	16.75
28.86	13.20	9.66	16.61	16.84
10.01	6.23	3.78	16.57	16.79
10.01	6.23	3.78	16.58	16.80
10.01	6.23	3.78	16.58	16.80
4.00	2.80	1.20	16.58	16.94
4.00	2.62	1.38	16.59	16.86
4.00	2.63	1.37	16.56	16.86
			Av. 16.58 ± 0.06	

H = $[H^+]_{init}$, h = $[H^+]_{eq}$, B = $[Mg_{tot}]_{eq}$, b = $[Mg^{2+}]_{eq}$,

$K'_{s0} = [Mg^{2+}][H^+]^{-2}$, $K_{11} = [Mg^{2+}][OH^-]$, $K_{s0} = [Mg^{2+}][OH^-]^2$, and

$K_w = [H^+][OH^-] = 10^{-14\,22}$. $[Mg^{2+}]$ was evaluated by b = H - B.

Lack of constancy of K'_{s0} from B is attributed to $MgOH^+$ formation. The formation constant is evaluated by log K_{11} = log (B-b) + log (b·OH^-). Values of the solubility product and association constant in 3 mol L^{-1} aqueous $NaClO_4$ were calculated to be log K_{s0} = -11.14 ± 0.07 and log K_{11} = 4.88 ± 0.07.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Emf measurements were made on the cell, Ag,AgCl//2.99 mol L^{-1} $NaClO_4$, 0.010 mol L^{-1} NaCl//3.00 mol L^{-1} $NaClO_4$//sample at 3.00 mol L^{-1} $NaClO_4$//AgCl, Ag. The emf of the cell is $E - E^\circ + 59.16 \log h - 16.7h$ (ref 1).Standing 3 to 7 days were required to attain equilibrium. The dissolved Mg^{2+} was determined complexometrically. The solubility product was calculated from the values of h and $[Mg^{2+}]$ in the 3 mol L^{-1} $NaClO_4$ solution.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Prepared by precipitation from aqueous solution containing Mg^{2+} and an alkali hydroxide. Analytical grade reagents were used as received.

ESTIMATED ERROR:

Emf: Accuracy ± 0.2 mV.

REFERENCES:

1. Bidermann, G.; Sillen, L. G
Ark. Kemi 1953, 5, 425.

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Sodium sulfate; Na_2SO_4; [7757-82-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Travers, A.; Nouvel

C. R. Hebd. Seances Acad. Sci. 1929, *188*, 499-501.

VARIABLES:

$T/K = 383, 433$

PREPARED BY:

H. Einaga

EXPERIMENTAL VALUES:

Solubility of $Mg(OH)_2$ in aqueous Na_2SO_4

$t/°C$	Na_2SO_4 mass %	$Mg(OH)_2$ $10^4c_1/\text{mol L}^{-1}$
110	1	2.38
160	1	1.42

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Mg(OH)_2$ and aqueous Na_2SO_4 were equilibrated in a Cu flask or autoclave for 1 to 2 days. The dissolved $Mg(OH)_2$ was determined by titration with standard acid solution either potentiometrically using a hydrogen electrode or with phenol red as an indicator. A CO_2 free atmosphere was maintained during the titration.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Crystalline form used.

(2) Sodium sulfate.

(3) Water. Freshly distilled water (pH 6.8) was used for the preparation of the saturated solution of $Mg(OH)_2$ to avoid contamination by atmospheric CO_2.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Methanol; CH_4O; [67-56-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Janković, S. *Rastvorljivost Nekih Soli i Hidroksida Zemnoalkalnih Metala u Sistemima Voda-Etil Alkohol i Voda-Metil Alkohol, i Struktura Takvih Zasicenih Rastvora.* Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

VARIABLES:

T/K = 298

CH_4O mass % = 8.23 - 35.3

PREPARED BY:

J. W. Lorimer

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

Water	Methanol		Magnesium hydroxide	
mol %	mol %[a]	mass %[a]	mass %	m_1/mmol kg^{-1}[a]
95.2	4.8	8.23	0.0021	0.36
90.0	10.0	16.5	0.0014	0.24
83.3	16.7	26.3	0.0007	0.12
76.5	23.5	35.3	0.0003	0.05

[a] Calculated by compiler.

Properties of the saturated solution at 25°C

Water mol %	Relative Density d_{25}^{25}	Conductivity $10^6\kappa$/S cm^{-1}	Viscosity η/mPa s
95.2	0.9877	5.5	1.10
90.0	0.9751	3.5	1.31
83.3	0.9596	1.35	1.50
76.5	0.9415	1.1	1.61

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Salt and solution were stirred for 8 days in a thermostat. After equilibration, samples were removed for analysis through a pipet fitted with a glass wool filter. Density was measured using a pycnometer; the pycnometer contents were evaporated to dryness in a platinum dish. Viscosity was measured using a Vogel-Ossag viscometer and conductivity with a Philips bridge (CM 4249; average reading error 2 %) and dip cell.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Merck, pro analysi.

(2) Methanol. Chemapol (Prague), pro analysi, absolute.

(3) Water. Redistilled.

ESTIMATED ERROR:

Temp.: precision within ± 0.05 K.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8]

(2) Ethanol; C_2H_6O; [64-17-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Janković, S. *Rastvorljivost Nekih Soli i Hidroksida Zemnoalkalnih Metala u Sistemima Voda-Etil Alkohol i Voda-Metil Alkohol, i Struktura Takvih Zasicenih Rastvora.* Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

VARIABLES:

T/K = 298
C_2H_6O mass % = 0.585 - 21.6

PREPARED BY:

J. W. Lorimer

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

Water	Ethanol		Magnesium hydroxide	
mol %	mol %^{a}	mass %^{a}	mass %	m_1/mmol kg^{-1a}
96.8	3.2	0.585	0.0015	0.26
91.6	8.4	14.0	0.0006	0.10
86.6	13.4	21.6	0.0002	0.03

^{a}Calculated by compiler.

Properties of the saturated solution at 25°C

Water	Relative Density	Conductivity	Viscosity
mol %	d_{25}^{25}	$10^6\kappa$/S cm^{-1}	$10^3\eta$/mPa s
96.8	0.9905	4.5	1.23
91.6	0.9709	1.95	1.77
86.6	0.9573	1.3	2.14

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Salt and solution were stirred for 8 days in a thermostat. After equilibration, samples were removed for analysis through a pipet fitted with a glass wool filter. Density was measured using a pycnometer. Solubility was measured from analysis for Mg by complexometric titration. Viscosity was measured using a Vogel-Ossag viscometer and conductivity with a Philips bridge (CM 4249; average reading error 2 %) and dip cell.

SOURCE AND PURITY OF MATERIALS:

(1) Magnesium hydroxide. Merck, pro analysis.

(2) Ethanol. C. Erba, anhydrous, 99.9 - 100 % pure, density 0.795.

(3) Water. Redistilled.

ESTIMATED ERROR:

Temp.: precision within ± 0.05 K.
Soly.: no estimates possible.

REFERENCES:

3. The solubility of calcium hydroxide in aqueous systems.

(E) refers to evaluation page(s).

COMPONENTS:	EVALUATOR:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

An evaluation of the solubility of calcium hydroxide in water and in various aqueous solutions.

Calcium hydroxide solubility measurements in water and aqueous solutions have been reported in 61 publications. Calcium hydroxide is a sparingly soluble strong base. The solubility equation, relative to complete ionization, is

$$Ca(OH)_2(s) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq). \qquad [1]$$

The solubility equilibrium refers to the completely ionized state and clearly depends on pH.

The solubility also depends strongly on the physical state of the solid: aging of the amorphous hydroxide obtained either by precipitation or by CaO hydration leads to a thermodynamically well defined compound, which is crystalline and less soluble than the amorphous form. The crystalline form is hexagonal with an a/c ratio of 1.3660 and a calculated density of 2.244 Mg m^{-3} (64). It is therefore necessary to take into account the physical state of $Ca(OH)_2(s)$ in the comparison of experimental results.

1. The solubility of calcium hydroxide in water.

Twenty publications (1-4, 7, 11, 12, 17, 23, 28, 29, 31, 36-38, 44, 45, 48, 49, 51, 53, 54) are devoted to the the study of the solubility of calcium hydroxide in water. Another 17 papers (5, 6, 8, 9, 14, 15, 18, 20, 24, 32, 33, 35, 42, 52, 58, 60) are concerned with a study of ternary systems, but also report solubility values in water. A critical review of the literature solubility data up to 1960 was carried out by Greenberg and Copeland (51). A review of work prior to 1920 is to be found in Mellor (71).

Results from three papers (4, 28, 54) were rejected. Shipley and McHaffie (28) found solubilities lower by a factor of 2 than the mean value from other publications. Koudelka's values (54) were for systems that did not reach equilibrium, and Shenstone and Cundall (4) were the only workers to report an increase in calcium hydroxide solubility with temperature.

The method generally used is equilibration of $Ca(OH)_2(s)$ with water, and analysis of the supernatant solution for calcium by gravimetry or complexometry, or acidimetry of the $Ca(OH)_2(aq)$. The results were classified, as much as possible, according to the state of the solid hydroxide: aged (33, 36, 44, 48, 49, 52); fresh, obtained by *in situ* hydration of CaO (2, 7, 12, 17, 31, 38); and undefined. When it was not possible to define the initial state of the hydroxide, the results were rejected.

At 298.15 K, the mean solubility values are:

"aged" calcium hydroxide $m\,[Ca(OH)_2] = 2.02 \times 10^{-2}$ mol kg^{-1}
$s(m) = 2.5 \times 10^{-4}$ mol kg^{-1}, and

"fresh" calcium hydroxide $m\,[Ca(OH)_2] = 2.09 \times 10^{-2}$ mol kg^{-1}
$s(m) = 1 \times 10^{-3}$ mol kg^{-1}.

The greater standard deviation for the "fresh" state is probably related to a poor definition of that state, which is unstable by nature. The difference in solubility is not significant.

The difference between the solubility of the "fresh" and "aged" calcium hydroxide decreases as the temperature increases. This is probably due to a faster rate of aging of the amorphous form at the higher temperatures.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

November, 1991

CRITICAL EVALUATION:

Table 1. Experimental solubility values of "aged" calcium hydroxide used for the fitting equation.

T/K	Calcium Hydroxide $10^2 m_1$/mol kg^{-1}	Reference
273.03	2.32	36
273.15	2.32	36
273.65	2.29	52
278.15	2.28	36
283.15	2.23	36
288.15	2.18	36
293.15	2.10	44
293.15	2.11	49
297.15	2.07	48
298.15	2.04	56
298.15	2.03	49
298.15	2.02	16
298.15	2.02	52
298.15	1.98 ^{a}	33
298.65	2.05	48
303.15	1.95	36
303.15	1.96	49
303.65	1.96	48
310.15	1.86	48
313.05	1.81	48
313.15	1.80	44
313.15	1.78	36
315.15	1.78	48
317.15	1.74	48
318.15	1.72	36
321.35	1.67	48
323.15	1.67	52
323.15	1.64	36
324.75	1.62	48
328.15	1.54 ^{a}	36
328.55	1.56	48
330.45	1.53	48
333.95	1.46 ^{a}	36
354.85	1.17	36
363.15	1.05 ^{a}	36
368.15	1.	36
372.15	0.93	36
373.15	0.999	52
398.15	0.737	52
423.15	0.547	52
448.15	0.401	52
473.15	0.292	52
498.15	0.209	52
523.15	0.144	52
548.15	0.0909	52
573.15	0.062	52
598.15	0.0317	52
623.15	0.0195	52

^{a} values not used in the final fitting.

COMPONENTS:	EVALUATOR:	
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

The solubility data at 303 K and higher temperatures were fitted to an equation of the type:

$$\ln (m_1/\text{mol kg}^{-1}) = A_1 + A_2/(T/\text{K}) + A_3 \ln (T/\text{K}) + A_4 (T/\text{K})$$

The fourth term was not required for this system. During the fitting procedure, if the residual error between the observed and calculated molality, Δm, was larger than twice the standard deviation ($s(m)$) about the regression line for all m, the value was rejected, and the fitting procedure was started again.

As the difference between the solubility of "fresh" and "aged" calcium hydroxide was small and decreased as the temperature increased, the first fitting trial used all of the data at temperatures of 303 K and higher. Applying the procedure described above it was found that all of the rejected data were for "fresh" calcium hydroxide. Therefore it was decided to apply the fitting to only the "aged" calcium hydroxide data given in Table 1. The best fitting was obtained with the three-parameter equation:

$$\ln (m_1/\text{mol kg}^{-1}) = 86.1534 - 3492.14/T/\text{K}) - 13.7494 \ln (T/\text{K}) \qquad [2]$$

which has a standard error of estimate over the range 273.15 to 623.15 K of

$$s(m) = 1.7 \times 10^{-4} \text{ mol kg}^{-1}.$$

Solubilities calculated by means of the equation are given in Table 2. Solubility values between 273 and 573 K are *recommended*. Values above 573 K, where the solubility values become the order of magnitude of the standard error, are *tentative*.

Table 2. Smoothed (recommended) values of the solubility of "aged" calcium hydroxide as a function of temperature.

T/K	Calcium Hydroxide Solubility $10^3 m_1$/mol kg^{-1}
273.15	23.1
293.15	21.0
298.15	20.3
313.15	18.1
333.15	15.1
353.15	12.3
373.15	9.8
393.15	7.7
413.15	6.0
433.15	4.6
453.15	3.5
473.15	2.7
493.15	2.1
513.15	1.6
533.15	1.2
553.15	0.9
573.15	0.7
593.15	0.5 [a]
613.15	0.4 [a]

[a] tentative values.

COMPONENTS:	EVALUATOR:	
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

2. The solubility of calcium hydroxide in supercritical water.

Walther (67) measured the solubility of portlandite, $Ca(OH)_2$, [12177-68-3] in supercritical water between 573 and 873 K at pressures between 1 and 3 kbar. He found that at constant pressure the solubility decreases as temperature increases. Thus at 2 kbar he states the log molality of calcium is -2.34, -2.71, -3.18 and -4.18 at temperatures of 573, 673, 773 and 873 K, respectively. The solubility at constant temperature increases with increasing pressure. Thus, at 773 K the log molality of calcium is -4.40, -3.18 and -2.65 at pressures of 1, 2 and 3 kbar, respectively. (Note that the trends are mis-stated in the abstract of the paper).

The author assumed $Ca^{2+}(aq)$ to be the dominant calcium species and used literature thermodynamic data to calculate the distribution of species. The solutions apparently contain no significant concentrations of either $Ca(OH)^+(aq)$ or $Ca(OH)_2(aq)$. The calculated pH is 2 units greater than neutral and the solubility reaction is thought to be

$$2H^+(aq) + Ca(OH)_2(s) = Ca^{2+}(aq) + 2H_2O(s.c.)$$

where S.C. stands for supercritical. There are no other data on the system and the results are classed as tentative.

3. Ternary Inorganic Systems.

A. $Ca(OH)_2 + MOH + H_2O$ $M = NH_4$, Li, Na, K

Five publications report solubility measurements in basic medium: NH_3 (37), LiOH (53, 55), NaOH (11, 44), KOH (44).

Results obtained at 293 K in NaOH solutions by d'Anselme (11) and by Fratini (44) are in fair agreement up to 0.1 mol dm^{-3} NaOH. The NaOH results do not differ from the results in KOH solutions (44) in the same concentration range. The solubility decreases with increasing hydroxide ion concentration as expected from the equilibrium equation [1]. The calcium hydroxide solubility at 293 K in the 0 to 0.1 mol dm^{-3} NaOH or KOH range is fitted to the quadratic equation:

$$c_1/\text{mol dm}^{-3} = 0.02056 - 0.2993\ c_2/\text{mol dm}^{-3} + 1.4457\ c_2^2/\text{mol dm}^{-3} \qquad [3]$$

with a standard deviation in concentration of $s(c_1) = 1.4 \times 10^{-3}$ mol dm^{-3}.

The decrease of solubility with increasing base concentration is much less for LiOH and NH_4OH than for the NaOH and KOH. A quantitative comparison is not possible because of the differences in experimental conditions.

Measurements up to 373 K in aqueous NaOH and up to 423 K in aqueous LiOH show a negative temperature coefficient of solubility. Again no quantitative comparison or evaluation can be made because of the differences in experimental conditions.

B. $Ca(OH)_2 + MX + H_2O$ (where M = alkali metal cation, and X = singly-charged anion).

Several studies (8-9, 14, 18, 33, 42, 52, 56, 58) are concerned with ionic strength effects on the solubility of "aged" calcium hydroxide in which an alkali metal salt is used to adjust the ionic strength. Cabot (8) observed a solubility increase in the presence of alkali metal salts which was of greater magnitude with Na^+ than with K^+ salts. Johnston and Grove (33) compared the effect of a number of salts on the solubility at 298.15 K relative to the solubility in pure water. They observed the solubility increase for cations is in the order $Cs^+ < K^+ < Na^+ < Li^+$ and for anions the order of increase is $ClO_4^- < I^- < ClO_3^- < BO_2^- < Cl^- < NO_3^- = NO_2^- < CH_3CO_2^-$. These comparisons are shown in figures 1 and 2.

COMPONENTS:	EVALUATOR:	
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

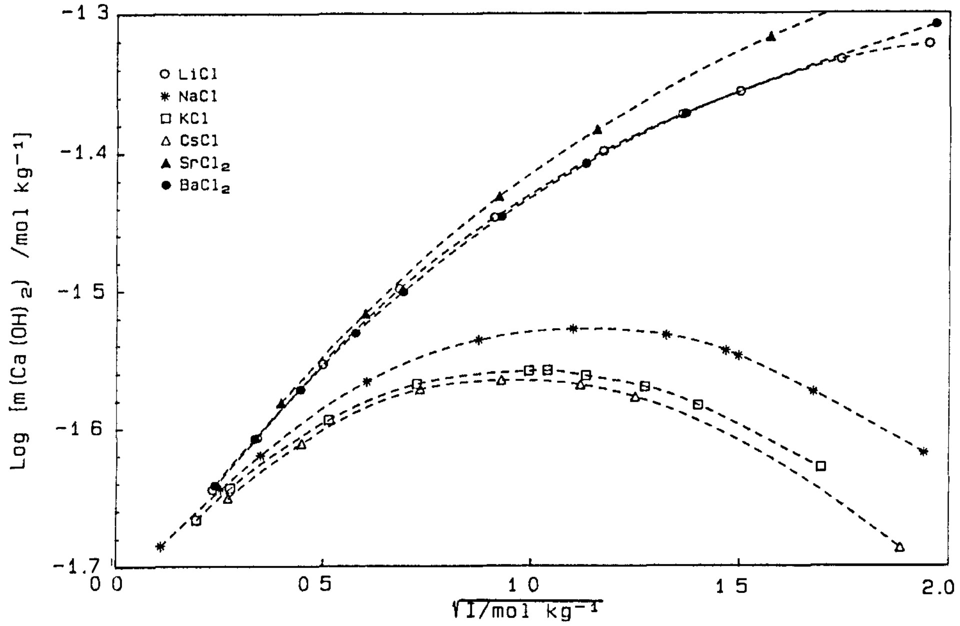


Figure 1. Effect of added electrolyte on the solubility of $Ca(OH)_2$ at 298.15 K. Alkali and alkaline earth chlorides. Johnston and Grove (33).

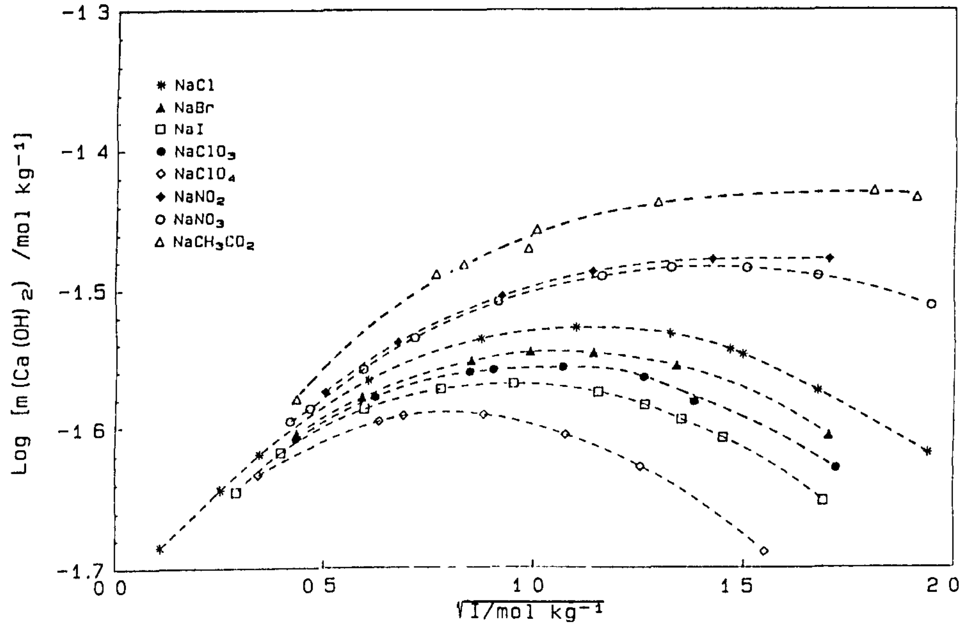


Figure 2. Effect of added electrolyte on the solubility of $Ca(OH)_2$ at 298.15 K. Sodium salts. Johnston and Grove (33).

COMPONENTS:	EVALUATOR:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA November, 1991

CRITICAL EVALUATION:

Table 3. Tentative values of the solubility of calcium hydroxide at 293 K in either NaOH or KOH solutions (Eqn 3).

Base (NaOH or KOH) c_2/mol dm^{-3}	Calcium Hydroxide 10^3c_1/mol dm^{-3}
0.00	20.6
0.01	17.7
0.02	15.2
0.03	12.9
0.04	10.9
0.05	9.2
0.06	7.8
0.07	6.7
0.08	5.9
0.09	5.3
0.10	5.1

Yeatts and Marshall (52) carried out a detailed study of the influence of $NaNO_3$ on the solubility of calcium hydroxide over the 273 - 623 K temperature range. They evaluated the thermodynamic solubility product constant ($K^\circ_{s0} = (4m_1\gamma_\pm/m_0)^3$) at each temperature from their results. The mean ionic activity coefficients were evaluated from an extended Debye-Hückel equation fitted to their data at each temperature. The solubility product was fitted to the equation:

$$\log (K^\circ_{s0}) = -25.7085 - 530.49/(T/\mathrm{K}) + 12.9722 \log (T/\mathrm{K}) - 0.032331 (T/\mathrm{K}) \qquad [4]$$

Standard thermodynamic relations were used to derive the thermodynamic functions reported in table 4 below.

$$\Delta G^\circ = -RT \ln K^\circ_{s0}$$

$$\Delta H^\circ = RT^2(\partial \ln K^\circ_{s0}/\partial T)_p$$

$$\Delta S^\circ = (\Delta H^\circ - \Delta G^\circ)/T$$

$$\Delta C^\circ_p = (\partial \Delta H^\circ/\partial T)_p$$

The results depend on the choice of equation for the activity coefficients. As Yeatts and Marshall evaluated their activity coefficients by a Debye Hückel extended equation fitted to their own data at each temperature their results are considered reliable.

Only Yeatts and Marshall report solubility measurements above 373 K. Between 273 and 373 K there are a number of reliable solubility values of "aged" calcium hydroxide. While these could be analyzed to obtain more reliable values of the thermodynamic solubility product and thermodynamic function at the lower temperatures, this would require a careful evaluation of the activity coefficients by, for example, the Pitzer equations fitted to each set of results for the binary and ternary systems, a treatment that is beyond the scope of this work.

The measurements of Komar and Vovk (56, 58) in aqueous KCl and NaCl are in good agreement with the results of Johnston and Grove (33) up to a chloride concentration of 1 mol dm^{-3} and are slightly lower at the higher ionic strengths. Dschorbenadse *et al.'s* results (42) in aqueous NaCl are much higher. No explanation for the higher results could be found by study of their method and the results are rejected.

COMPONENTS:	EVALUATOR:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Table 4. Thermodynamic functions of calcium hydroxide solution in water calculated from equation [4] (52).

Temperature		$\Delta G^{\circ}/$	$-\Delta H^{\circ}/$	$-\Delta S^{\circ}/$	$-\Delta C_p^{\circ}/$
$t/^{\circ}C$	T/K	$kJ\ mol^{-1}$	$kJ\ mol^{-1}$	$J\ K^{-1}\ mol^{-1}$	$J\ K^{-1}\ mol^{-1}$
0	273.15	25.00	6.55	118.	230.
25	298.15	28.70	12.75	139.	261.
50	323.15	32.50	19.65	161.	292.
75	348.15	36.80	27.35	184.	323.
100	373.15	41.70	35.80	208.	354.
150	423.15	53.15	55.25	256.	416.
200	473.15	67.40	77.45	306.	477.
250	523.15	83.75	103.0	357.	540.
300	573.15	103.0	131.5	409.	603.
350	623.15	124.8	163.3	461.	666.

Additions of ammonium chloride, as measured by Noyes and Chapin (9), causes a larger increase in calcium hydroxide solubility than the other 1-1 electrolytes. (The solubility at 0.04 mol dm^{-3} NH_4Cl is about twice the value in pure water). It is not possible to evaluate this single observation. The effect is probably related to the acid nature of the aqueous ammonium ion.

C. $Ca(OH)_2 + CaCl_2 + H_2O$

Calcium hydroxide solubility data in this system have been reported in nine papers (5, 6, 19, 25, 26, 30, 46, 60, 70) in the 273-373 K temperature range. The whole temperature and concentration range was not covered in all papers so that only partial comparisons can be performed. All authors started with $Ca(OH)_2$, $CaCl_2$ and H_2O as the initial components except Milikan (26) who started with $Ca(OH)_2$, HCl and H_2O. The results of Lunge (5) and of Zahorsky (6) were rejected because their solubility values in pure water were not reliable, and because composition of the solid phase was not given. The other results are in qualitative agreement.

The solid phases present in the system as the $CaCl_2$ concentration increases are $Ca(OH)_2$, $3CaO\cdot CaCl_2\cdot 16H_2O$ [or 15 H_2O (43)], $CaO\cdot CaCl_2\cdot H_2O$, and $CaCl_2\cdot 2H_2O$ up to a temperature of 313 K. At temperatures above 308-313 K the phase of highest hydration disappears.

The solubility of $Ca(OH)_2$ in aqueous $CaCl_2$ solutions decreases with increasing temperature at $CaCl_2$ molalities <0.5 mol kg^{-1} (as it does in pure water), and increases with increasing temperatures at $CaCl_2$ >1 mol kg^{-1}. Between $CaCl_2$ molalities of 0.5 and 1 mol kg^{-1} there is no agreement on the temperature coefficient of solubility among the various workers. The results of O'Connor (30) are much higher than the others and are rejected.

Data for the four-component system $Ca(OH)_2 + CaCl_2 + NaCl + H_2O$ have been given (60). The equilibrium solid phases are similar to those for the three-component system. They are $Ca(OH)_2$, $3Ca(OH)_2\cdot CaCl_2\cdot 12H_2O$ (or $3CaO\cdot CaCl_2\cdot 15H_2O$), $Ca(OH)_2\cdot CaCl_2$, and NaCl.

D. $Ca(OH)_2 + CaX_2 + H_2O$ X = Br or I

These systems were studied at 298 K by Milikan (25), and are analogous to the $Ca(OH)_2 + CaCl_2 + H_2O$ system. The bromide-containing

COMPONENTS:	EVALUATOR:	
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

systems were also reported on earlier by Schreinemakers and Milikan (70). Besides $Ca(OH)_2$, Milikan identified $3CaO \cdot CaBr_2 \cdot 16H_2O$, $4CaO \cdot 3CaBr_2 \cdot 16H_2O$ and $CaBr_2 \cdot 6H_2O$ as equilibrium solids in the bromide-containing system. The iodide-containing system showed regions for the three solids $Ca(OH)_2$, $3CaO \cdot CaI_2 \cdot 16H_2O$ and $CaI_2 \cdot 6H_2O$.

E. $Ca(OH)_2 + Ca(ClO)_2 + H_2O$

O'Connor (30) studied this system at 273 K. He used the wet residue method to identify the solids $Ca(OH)_2$, $3CaO \cdot Ca(ClO)_2 \cdot 3H_2O$, $2CaO \cdot Ca(ClO)_2 \cdot 2H_2O$ and $Ca(ClO)_2 \cdot 3H_2O$.

F. $Ca(OH)_2 + CaSO_4 + H_2O$

The system was investigated by Cameron and Bell (15) at 298 K. They claimed the only solid phases are $Ca(OH)_2$ and $CaSO_4 \cdot 2H_2O$.

G. $Ca(OH)_2 + Ca(NO_3)_2 + H_2O$

The system was first investigated at 298 K by Cameron and Robinson (16) who claimed the existence of solid solutions $CaO \cdot xN_2O_5 \cdot yH_2O$, a basic nitrate $2CaO \cdot N_2O_5 \cdot 1.5H_2O$ and $Ca(NO_3)_2 \cdot 4H_2O$. A careful study of the same system was made by Bassett and Taylor (24) at 298 and 373 K. They found the same basic nitrate, but found no undefined solid solutions, a result which seems in better agreement with the strongly basic behavior of $Ca(OH)_2$. The part of the isotherms corresponding to the equilibrium solid $Ca(OH)_2$ is shown in figure 3.

H. $Ca(OH)_2 + Mg(OH)_2 + H_2O$

Bury and Davies (35) found that the presence of $Mg(OH)_2$ does not influence the solubility of $Ca(OH)_2$ in water, which is expected because of the low solubility of $Mg(OH)_2$.

I. $Ca(OH)_2 + B_2O_3 + H_2O$

Both Sborgi (22) and Nikolaev and Chelisheva (39) report data on this system. The equilibrium solids reported in the two papers differ in the hydrate number. The results of Nikolaev and Chelisheva were obtained after a much longer equilibration time, and they are considered to be the more reliable results. They reported equilibrium solids $Ca(OH)_2$, $CaO \cdot B_2O_3 \cdot 6H_2O$, $2CaO \cdot 3B_2O_3 \cdot 13H_2O$, $CaO \cdot 3B_2O_3 \cdot H_2O$ and H_3BO_3 [or $CaO \cdot xB_2O_3 \cdot yH_2O = Ca_3(BO_3)_2 \cdot 2(3x-1)H_3BO_3 \cdot 3(1-3x+y)H_2O$].

J. $Ca(OH)_2 + D_2O + H_2O$

Kingerley and LaMer (40) measured the solubility of calcium hydroxide in mixtures of D_2O and H_2O and found by extrapolation the solubility of $Ca(OD)_2$ in heavy water at 298.15 K:

$$m_1 = 0.0112 \text{ mol kg}^{-1}$$

Five-Component Systems

Hansen and Pressler (43) measured the solubility of a mixture of $Ca(OH)_2$ and $CaSO_4$ in solutions of mixed NaOH and KOH. They do not give enough details to permit an evaluation.

4. Ternary aqueous system containing an organic component

A. $Ca(OH)_2 + C_{12}H_{22}O_{11}$ (sucrose) + H_2O

Data for the system $Ca(OH)_2$ + sucrose + H_2O are reported in nine publications (10, 20, 21, 32, 34, 47, 59, 61, 62) at temperatures between 288 and 353 K.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE
November, 1991

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

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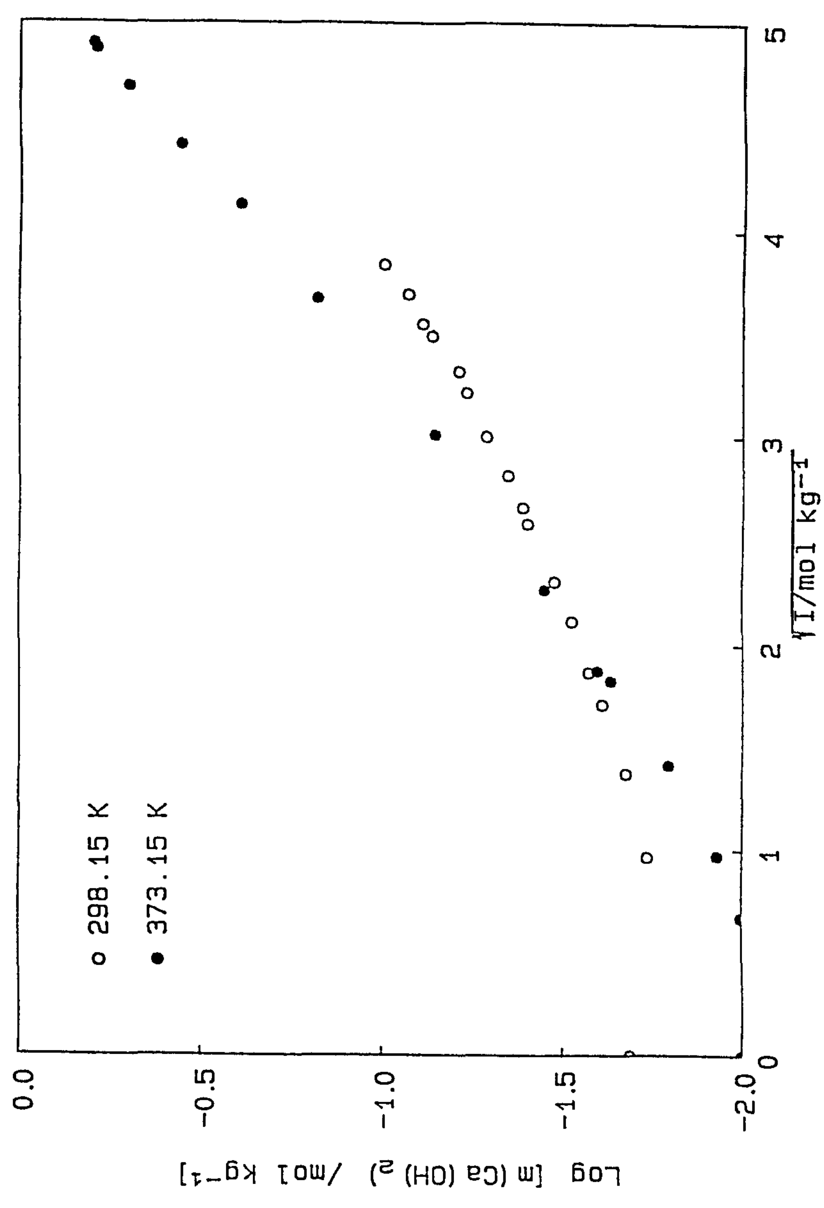

Figure 3. Solubility of $Ca(OH)_2$ in aqueous $Ca(NO_3)_2$ at 298 and 373 K, Bassett and Taylor (24). Note inversion of solubility magnitude at ionic strength 2.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

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Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
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CRITICAL EVALUATION:

Data from a number of these papers are rejected. Weisberg's results (10) depend on the excess of solid which indicates that equilibrium was not reached. The data are rejected. Cameron and Patten (21) and Fuchs (32) report values for the solubility of $Ca(OH)_2$ in water which are too high, thus their results in the presence of sucrose were not considered. Bugaenko *et al.*'s results (59) were rejected because the sucrose concentrations were not indicated. Sapronov *et al.*'s paper (61) was rejected because it does not contain quantitative data.

Data from the papers of Reinders and Van Gelder (34) and Koneczny *et al.* (62) show qualitative agreement. The $Ca(OH)_2$ solubility increases with increasing sucrose concentration up to the formation of a sucrate compound of an undefined composition. The temperature coefficient of solubility is not apparent because of a large scatter in the experimental results. However, comparison with the data of Van Ginnekin (20) at 353 K indicates a negative temperature coefficient of solubility. Koneczny's assumption of CaO in the solid phase appears to be implausible for the aqueous solutions.

Yokoyama (47) studied the five-component system $Ca(OH)_2$ + NaCl + $CaCl_2$ + sucrose + H_2O. He found an increase of calcium hydroxide solubility with increasing concentration of any other solute and a decrease with increasing temperature.

B. $Ca(OH)_2$ + $C_3H_8O_3$(glycerol) + H_2O

The data for this and the other ternary systems containing organic components listed below are reported in only one or two publications for each system. Thus, there is too little information to allow evaluations.

Cameron and Patten (21) and Herz and Knoch (13) studied the glycerol-containing system at 298 K. Both observed an increase in calcium hydroxide solubility with increasing glycerol concentration up to 7 mol dm^{-3} glycerol with $Ca(OH)_2$ assumed to be the equilibrium solid. The two studies are in fair agreement up to 3 mol dm^{-3} glycerol as shown in figure 4.

C. $Ca(OH)_2$ + C_6H_6O(phenol) + H_2O

Van Meurs (27) studied this system at 298 K. He interpreted his wet residue analysis to indicate the equilibrium solids $Ca(OH)_2$, $Ca(C_6H_5O)_2 \cdot 3H_2O$ and C_6H_6O.

D. $Ca(OH)_2$ + CH_4O(methanol) + H_2O
$Ca(OH)_2$ + C_2H_6O(ethanol) + H_2O

These two systems were studied by Janković (50). The methanol-containing system was studied from 6.9 to 69.1 mass % methanol at 298 K and from 4.7 to 81.8 mass % methanol at 308 K. The ethanol-containing system was studied from 10.1 to 89.1 mass % ethanol at 298 K. In both systems the calcium hydroxide solubility decreased as the alcohol concentration increased. The solid was assumed to be $Ca(OH)_2$

E. $Ca(OH)_2$ + NaOH + $Ca(HCOO)_2$ + HCHO(formaldehyde) + H_2O

Belkin and Belkina (57) studied the solubility of $Ca(OH)_2$ in solutions containing sodium hydroxide, calcium formate and formaldehyde. They showed that the presence of formaldehyde increases the solubility of $Ca(OH)_2$ in NaOH solutions, which they attributed to the slightly acidic properties of the aldehyde in this medium.

5. Nonaqueous binary system

A. $Ca(OH)_2$ + $C_5H_4O_2$(furfural)

COMPONENTS:	EVALUATOR:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

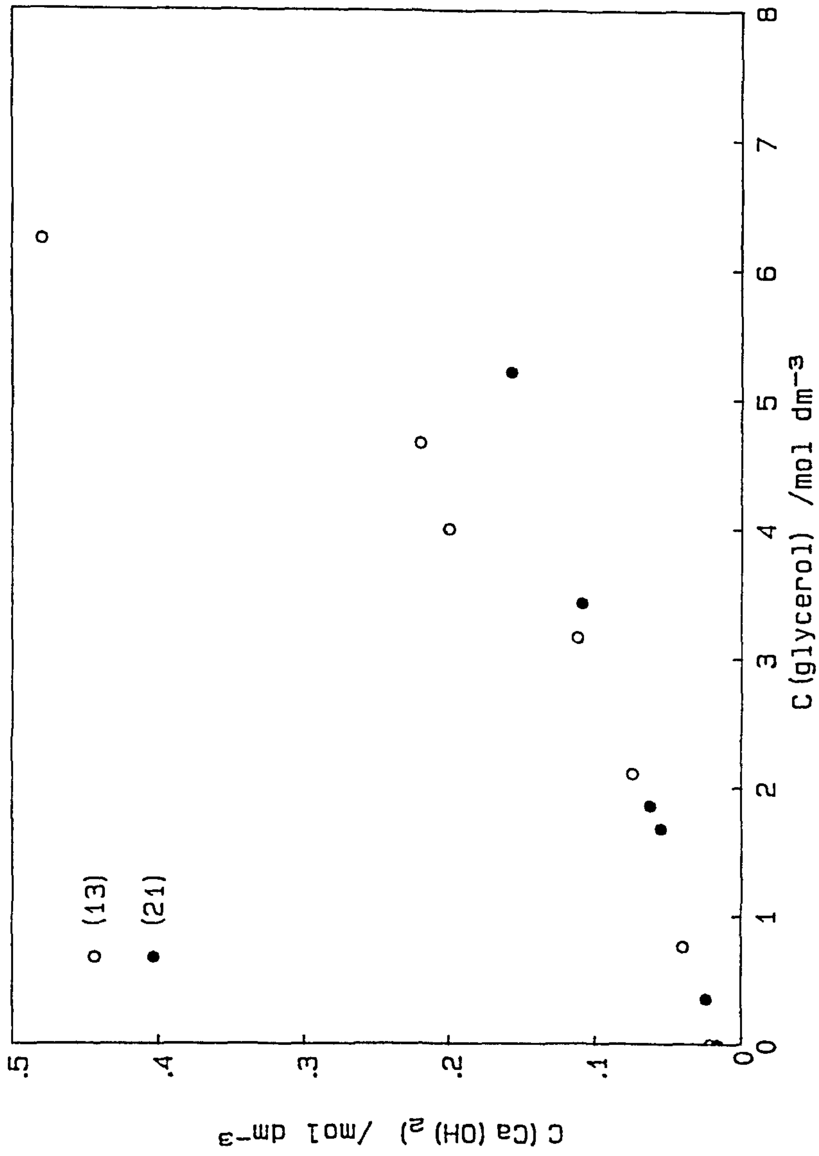

Figure 4. Solubility of $Ca(OH)_2$ in aqueous glycerol at 298 K. Comparison of results of Herz and Knoch (13) and Cameron and Pattern (21).

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

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Trimble (41) measured the solubility of $Ca(OH)_2$ in anhydrous furfural at 298 K and found a solubility of about the same magnitude as that in water:

$$m_1 = 1.8 \times 10^{-2} \text{ mol kg}^{-1}.$$

6. Comparison of the present results with other evaluations.

These results are presented for comparison, and no effort has been made to judge one set of data against the other. Data were taken from three sources: Smith and Martell (64), the NBS Thermodynamic Tables (65) and the CODATA Thermodynamic Tables (69) of recommended values for some compounds of calcium.

$$Ca^{2+}(aq) + OH^-(aq) = Ca(OH)^+(aq)$$

Smith and Martell (64) give formation constant values at 298.15 K and two ionic strengths. At $I = 0$ mol dm^{-3}, log $K = 1.3 \pm 0.1$ ($K = 20$), and at $I = 3.0$ mol dm^{-3}, log $K = 0.64$ ($K = 4.4$).

CODATA (69) gives Gibbs energy of formation values from which one calculates the zero ionic strength value of log $K = 1.217$ ($K = 16._5$) at 298.15 K.

$$Ca(OH)_2(s) = Ca^{2+}(aq) + 2OH^-(aq)$$

The 298.15 K zero ionic strength solubility product constant can be obtained from all three publications. The values are:

log K^o_{s0}	K^o_{s0}	Reference
-5.19 ± 0.2	6.5×10^{-6}	(64)
-5.330	4.68×10^{-6}	(65)
-5.291	5.11×10^{-6}	(69)

The CODATA table (69) does not give a Gibbs energy of formation value for the aqueous hydroxide ion so the value from the NBS tables (65) was used.

7. Crystal structures of calcium oxide and hydroxide.

Characterization of the solid state in equilibrium with the saturated solution is an important part of any modern solubility study. The following information, mostly from the *Crystal Data Determinative Tables*, is neither complete nor evaluated, but it serves as a reminder of this important point.

It is normaly stated that calcium hydroxide does not form a hydrate. However, Mellor (71) describes the work of Selivanoff who claimed to have identified a hemi-hydrate ($Ca(OH)_2 \cdot 0.5H_2O$) which transformed to an amorphous form on heating The amorphous form did not transform to the crytalline form on standing or heating in water. We are not aware that the observation was confirmed.

Crystal Formula	Type	Density, ρ/Mg m^{-3}
CaO; [1305-78-8]	cubic	3.342
$Ca(OH)_2$ (normal form); [1305-62-5]	hexagonal	2.244
$Ca(OH)_2$ (portlandite); [12177-68-3]	hexagonal	2.23

The normal chemically pure calcium hydroxide [1305-62-8] and the mineral, portlandite [12177-68-3], differ by natural impurities.

COMPONENTS:	EVALUATOR:	
(1) Calcium hydroxide; $Ca(OH)_2$; [1308-62-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

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COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1308-62-8]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

November, 1991

CRITICAL EVALUATION:

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COMPONENTS:	EVALUATOR:	
(1) Calcium hydroxide; $Ca(OH)_2$; [1308-62-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

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COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1308-62-8]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

November, 1991

CRITICAL EVALUATION:

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Mellor lists a number of early references on the solubility of $Ca(OH)_2$ in aqueous systems not included in this volume. We were unable to check all of these references, or even locate some of them. The evaluator feels these can be rejected because of impure components, failure to exclude atmospheric carbon dioxide, and use of insufficient time to attain equilibrium.

Some of the papers below contain only comments about trends in solubility, others contain data on ternary inorganic systems in addition to the $Ca(OH)_2$ + H_2O system.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1308-62-8]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B.P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE
November, 1991

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

CRITICAL EVALUATION:

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Graham, T. *Phil. Mag. [2]* 1827, *2*, 20.
Bineau, A. *Ann. Chim. Phys. [3]* 1857, *51*, 290.
Tichborne, R.C. *Bull. Soc. Chim. Fr.* 1871, *17*, 24.
Pavesi, A.; Rotondi, E. *Ber. Dtsch. Chem. Ges.* 1874, *7*, 817.
de la Croix, F. *Arch. Pharm. [3]* 1879, *14*, 145.
Goldammer, A. *Pharm. Centrh.* 1886, *26*, 442, 455.
Selivanoff, F.F. *Bull. Soc. Chim., Fr. [3]* 1902, *28*, 824; *J. Russ. Phys. Chem. Soc.* 1902, *34*, 14.

The papers below were cited by Mellor as containing studies on ternary systems.

$Ca(OH)_2$ + alkali + H_2O
Pelouze, T.J. *Compt. Rend.* 1851, *33*, 353.

$Ca(OH)_2 + NH_4Cl + H_2O$
Berthelot, M. *Bull. Soc. Chim. Fr. [2]* 1875, *24*, 102.

$Ca(OH)_2$ + NaCl, $CaCl_2 + H_2O$
Karsten, C.J.B. *Philosophie der Chemie*, Berlin 1843, p. 175.

$Ca(OH)_2 + Na_2CO_3 + H_2O$
Bodlander, G.; Lucas, R. *Z. Angew. Chem.* 1905, *18*, 1137.

$Ca(OH)_2$ + Sucrose + H_2O
Peligot, E.M. *Ann. Chim. Phys. [3]* 1858, *54*, 383.
Pelouze, T.J. *Ann. Chim. Phys. [4]* 1865, *6*, 203
Boivin, E.; Loiseau, D. *Ann. Chim. Phys. [4]* 1865, *6*, 216.
Deon, P.H. *Bull. Soc. Chim. Fr. [2]* 1872, *17*, 155.
Claasen, H. *Z. Ver. Zuckerind.* 1911, 489.

The papers below contain information on calcium hydroxide or calcium hydroxide containing systems. The papers were rejected for various reasons including no new experimental data, not enough experimental detail to judge reliability of the data, or no solubility data when the calcium hydroxide was the stable solid phase (a number of the papers contain valid solubility data on compounds formed in the systems, but no solubility data on $Ca(OH)_2$).

72. Dubourg, J.
Bull. Assoc. Chim. Suc. Dist. 1931, *48*, 297-306.
[compounds of sugar with lime (CaO)]

73. Saalman, E.
Z. Ver. deut. Zucherind 1933, *83*, 963-1041.
[Soly studies of $Ca(OH)_2$ in 0 to 60 % aqueous sucrose, (p. 1003)]

74. Balezin, S. A.
Bull. Acad. Sci. URSS, Classe Sci. Chim. 1946, 355-61.
[CaO + glucose + water, etc.]

75. Davies, C. W.; Hoyle, B. E.
J. Chem. Soc. 1951, 233-34.
[Dissociation constant, $CaOH^+(aq) \rightleftharpoons Ca^{2+}(aq) + OH^-(aq)$]

COMPONENTS:	EVALUATOR:
(1) Calcium hydroxide; $Ca(OH)_2$; [1308-62-8] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B.P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

REFERENCES (continued)

76. Greenberg, S. A.; Chang, T. N.; Anderson, E.
J. Phys. Chem. 1960, *64*, 1151-57.
[Soly $Ca(OH)_2$ from solid solutions of $Ca(OH)_2$ + silica]

77. Karibyan, A. N.;Burnazyan, A. S.; Sinanyan, I. M.; Babayan, G. G.
Arm. Khim. Zh. 1969, *22*, 303-07.
[$Ca(OH)_2$ + H_3BO_3 + H_2O at 30°C (Formation of Ca borates)]

78. Gregory, T. M.; Moreno, E. C.; Brown, W. E.
J. Res. Natl. Bur. Stds. 1970, *74A*, 461-75.
[$Ca(OH)_2$ + H_3PO_4 + H_2O at 5, 15, 25 and 37.5°C.(Soly $CaHPO_4 \cdot 2H_2O$)]

79. Mtschedlow-Petrossian, O. P.; Sawenkow, W. W.; Tschernjawski, W. L.
Silikattechnik 1973, *24*, 348-50.
[$Ca(OH)_2$ + K_2SiO_3 + H_2O (Soly potassium hydrosilicates)]

80. Zharov, E. F.; Grineva, I. R.; Osenkova, N. N.
Izv. Uchebn. Zaved., Khim. Khim. Tekhnol. 1979, *22*, 597-600.
[$Ca(OH)_2$ + $Al_2(SO_4)_3$ + $CaCl_2$ + H_2O (Soly $Ca_3[(Al(OH)_6]_2$]

81. Verbeeck, R. M. H.; Steyaer, H.; Thun, H. P.; Verbeeck, F.
J. Chem. Soc., Faraday Trans. I. 1980, *76* 209-19.
[$Ca(OH)_2$ + H_3PO_4 + H_2O at 25°C (Soly Ca hydroxy apatite)]

82. Verbeeck, R. M. H.; Driessens, F. C. M.; Thun, H. P.; Verbeeck, F.
Bull. Soc. Chim. Belg. 1981, *90*, 409-17.
[$Ca(OH)_2$ + $Sr(OH)_2$ + H_3PO_4 + H_2O at 25°C (Soly Ca and Sr hydroxy apatite)]

83. Ivanov-Emin, B. N.; Kaziev, G. Z.; Gerasimova, T. Yu.
Izv. Vyssh. Uchebn. Zaved., Khim. Khim. Tekhnol. 1982, *25*, 915-17.
[$Ca(OH)_2$ + $GaO(OH)$ + H_2O at 25°C (Soly $Ca_3[Ga(OH)_6]_2$]

84. Alekseev, A. I.
Zh. Prikl. Khim. (Leningrad) 1982, *55*, 2502-06.
[CaO + Al_2O_3 + Na_2O + H_2O at 25 - 95°C (Soly $Ca_3[Al(OH)_6]_2$]

85. Alpysbaeva, E. T.; Petropavlovskii, I. A.; Yakhontova, E. L.; Portnova, N. L.
Zh. Vses. Khim. O-va im D. I. Mendeleeva 1986, *31*, 232-3.
[CaO + P_2O_5 + HCl + H_2O at 25°C (Soly $Ca(H_2PO_4)_2 \cdot H_2O$ and $Ca(H_2PO_4 \cdot CaCl_2 \cdot H_2O]$

86. Eraizer, L. N.; Kaganski, I. M.; Zaventyaeva, T. I.
Izv. Akad. Nauk SSSR Neorg. Mater. 1986, *22*, 1359-63.
[CaO + P_2O_5 + H_2O at ≤ 250°C Soly $CaHPO_4$, $Ca(H_2PO_4)_2$, $Ca(H_2PO_4)_2 \cdot H_2O$ and $CaH_2P_2O_7$]

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Guthrie, F.

Philos. Mag. [5] 1878, *6*, 35-44.

VARIABLES:

T/K = 273

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The $Ca(OH)_2 + H_2O$ system at -0.15°C

CaO mass %	Solid Phase Composition
0.26	
0.29	
Av. $0.27_5 \pm 0.02$	$CaO + 1116\ H_2O$

In modern terms the experiment reported here was a determination of the eutectic composition and temperature of the system.

A solution of this composition will freeze to a solid of the same composition.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A solution saturated with $Ca(OH)_2$ at room temperature is cooled until the temperature of formation of cryohdrate [*eutectic composition*] is reached and cryohydrate is solidified.

Analysis not specified, but it is probably carbonate precipitation and weighing of $CaCO_3$ (method used by author for Ba determination).

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR·

Std. Dev. about 8 %.

REFERENCES

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lamy, A.

Ann. Chim. Phys. 1878, *14*, 145-90.

VARIABLES:

$T/K = 273 - 373$

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water at 0 to 100°C

	Calcium Oxide			Calcium Hydroxide		
t/°C	CaO/g (kg soln.)$^{-1}$			$10^2 m_1$/mol kg^{-1}		
	(a)	(b)	(c)	(a)	(b)	(c)
0	1.362	1.381	1.430	2.432	2.446	2.554
10	1.311	1.342	1.384	2.341	2.396	2.471
15	1.277	1.299	1.348	2.280	2.319	2.407
30	1.142	1.162	1.195	2.039	2.074	2.133
45	0.986	1.005	1.033	1.760	1.794	1.844
	0.996(ref 1)					
60	0.844	0.868	0.885	1.506	1.549	1.579
100	0.562	0.576	0.584	1.003	1.028	1.042

(a) - (c); See Source and Purity of Materials.
Results for the two highest temperatures were corrected for the dissolution of container glass.
NOTE: The unit g (kg soln.)$^{-1}$, used by the author.

The $Ca(OH)_2$ molality values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ (or CaO) was equilibrated with water at the specified temperature. The resulting saturated solution was filtered, acidified with H_2SO_4 to convert the Ca^{2+} in the solution to $CaSO_4$, ignited for gravimetric determination.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. (a) White marble was dissolved in HNO_3, and treated with $(NH_4)_2CO_3$ which precipitated $CaCO_3$. The $CaCO_3$ was calcined to CaO, which was hydrated to $Ca(OH)_2$. (b)The marble was directly calcined to CaO, which was hydrated to $Ca(OH)_2$. (c) Red burned CaO was also used.

(2) Water.

ESTIMATED ERROR:

Reproducibility better than 1 %.

REFERENCES:

1. Lamy, A.
C. R Hebd. Seances Acad. Sci. 1878, *86*, 333.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Maben, T.

Pharm. J. Trans. [3] 1883, *14*, 505.

VARIABLES:

$T/K = 273 - 372$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water from 0 to 99°C

	Calcium Oxide	Calcium Hydroxide
$t/°C$	$CaO/g\ (100\ g\ H_2O)^{-1}$	$10^2 m_1/mol\ kg^{-1}$
0	0.131	2.34
5	0.130	2.32
10	0.129	2.30
15	0.128	2.29
20	0.126	2.25
25	0.120	2.14
30	0.116	2.07
35	0.109	1.95
40	0.107	1.91
45	0.101	1.80
50	0.098	1.75
55	0.090	1.61
60	0.088	1.57
65	0.082	1.46
70	0.080	1.43
75	0.076	1.36
80	0.073	1.30
85	0.072	1.29
90	0.063	1.13
95	0.060	1.07
99	0.060	1.07

The molal solubilities were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A glass beaker containing $Ca(OH)_2$ and distilled water was placed in a water bath. The water bath was heated or cooled to bring to the desired temperature as indicated by a thermometer in the bath. The beaker contents were filtered as soon as the desired temperature was reached. The $Ca(OH)_2$ in solution was titrated by acidimetry.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. The material was considered as "perfectly free from impurities" by the author.

(2) Water. Distilled.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shenstone, W. A.; Cundall, J. T.

J. Chem. Soc. 1888, *53*, 544-50.

VARIABLES:

$T/K = 292, 423$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water

$t/°C$	Parts Soln. per Part $Ca(OH)_2$	CaO /g kg^{-1}
19	640	1.18
150	3081	0.246

The compiler calculated the CaO solubility values.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The vessel used in the measurement was a platinum tube. Care was taken to avoid CO_2. No other details given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Herzfeld, A.

Z. Ver. Rubenzuck.-Ind. 1897, 818-20.

**Chem. Zentralbl.* 1897 II, 932.

VARIABLES:

T/K = 288 - 353

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water, 15-80 °C

t/°C	Parts H_2O for 1 part CaO	Calcium Hydroxide $10^2 m_1$/mol kg^{-1}
15	776	2.30
20	813	2.20
25	848	2.10
30	885	2.02
35	924	1.93
40	962	1.86
45	1004	1.78
50	1044	1.71
55	1108	1.61
60	1158	1.54
65	1244	1.44
70	1330	1.34
75	1410	1.27
80	1482	1.20

The molal solubility of $Ca(OH)_2$ was calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Equilibrium was reached both from undersaturation (by cooling of a saturated boiling solution) and from supersaturation (by heating a solution saturated at room temperature). Calcium hydroxide was analyzed by acidimetry of the filtered solution. No other experimental details are given.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Prepared from calcium oxalate by thermal decomposition. Hydrated and heated to obtain CaO free of CO_2.

(2) Water. Not specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Herold, I.

Z. Elektrochem. Angew. Phys. Chem. 1905, *11*, 417-30.

VARIABLES:

$T/K = 393 - 463$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water, 120-190 °C

	Calcium Oxide	Calcium Hydroxide
$t/°C$	$/g\ L^{-1}$	$c_1/mol\ L^{-1}$
120	0.314	0.00560
	0.309	0.00551
	0.301	0.00537
150	0.167	0.00298
	0.171	0.00305
	0.169	0.00301
190	0.088	0.0016
	0.083	0.0015
	0.080	0.0014

The solid phase in equilibrium with the saturated solution was $Ca(OH)_2$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Aqueous solutions saturated with $Ca(OH)_2$ at room temperature were equilibrated in a steel autoclave at the specified temperature for 6-8 h. The equilibrated solution was filtered under pressure through a platinum filter. The pressure was reduced to atmospheric, and the filtrate removed. The $Ca(OH)_2$ in the filtrate was determined by titration with standard HCl solution using phenolphthalein as an indicator.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Merck, Inc. From marble containing traces of Fe. Used as received.

(2) Water. Doubly distilled.

ESTIMATED ERROR:

Relative error: about ± 2 % or better (compiler).

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Moody, G. T.; Leyson, L. T.

J. Chem. Soc., Trans. 1908, *93*, 1767-72.

VARIABLES:

$T/K = 275 - 353$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water at 2 to 80°C

t/°C	Calcium Oxide g H_2O required to dissolve 1 g of CaO	Calcium Hydroxide c_1/mol L^{-1}
2	768.5	0.02320
10	786.8	0.02266
15	804.3	0.02216
20	826.4	0.02158
25	868.7	0.02052
30	908.2	0.01963
40	988.1	0.01805
50	1083.0	0.01647
60	1179.0	0.01512
70	1274.8	0.01399
80	1368.1	0.01303

The $Ca(OH)_2$ concentrations were calculated by the compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Water was saturated with CaO by stirring for 10 days at a specified temperature. The saturated solution was analyzed for Ca^{2+} by a neutralization titration.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. The purest calcite obtainable was calcined to CaO.

(2) Water. Recently boiled distilled water.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Tschugaeff, L.; Chlopin, W.

Z. anorg. Chem. 1914, 86, 154-62.

Zh. Russ. Fiz.-Khim. O-va., Chast Khim. 1914, *46*, 1659-68.

VARIABLES.

$T/K = 348, 368$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES.

The solubility of $Ca(OH)_2$ in H_2O at 75 and 95°C

	Calcium Oxide	Calcium Hydroxide
$t/°C$	$/g\ (100\ g)^{-1}$	$m_1/mol\ kg^{-1}$
75	0.0705	0.0126
95	0.0580	0.0103

The molalities were calculated by the compiler.

Editor's Note: The authors names are listed as L. A. Chugaev and V. G. Khlopin in *Chem. Abstr* 1914, *8*, 1897 and 1915, *9*, 2176.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The temperature is controlled by the pressure over the boiling solution. Water and excess $Ca(OH)_2$ are placed in a glass container maintained at a fixed pressure by the combined use of a water pump and a constant air ingress. The solution is boiled at this pressure by placing the apparatus in a water bath at a temperature 5 to 10 degrees higher than the boiling point of the solution at the controlled pressure. After 1/2 hour of boiling, the solution is filtered by aspiration into a calibrated container located in the main vessel. Analysis is performed by drying and weighing.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Herzfeld, A. *Z. Ver. Rubenzuck.-Ind.* 1897, 818.

COMPONENTS: (1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Shipley, J. W.; McHaffie, I. R. *J. Soc. Chem. Ind., London, Trans. Commun.* 1923, *42*, 319T-26T.
VARIABLES: T/K = 293	PREPARED BY: I. Lambert

EXPERIMENTAL VALUES:

The solubility product of $Ca(OH)_2$ in water at 20°C

The solubility product was calculated from the pH of a saturated solution and the value of the ion product of water assuming an ideal solution with no hydrolysis or complex formation.

$Ca(OH)_2$ saturated solution, pH = 12.37

$[H^+][OH^-] = 1 \times 10^{-14}$, $[OH^-] = 0.0235$ mol L^{-1}

$[Ca^{2+}] = (1/2)[OH^-] = 0.0117$ mol L^{-1}

Solubility product, $K_{s0} = [Ca^{2+}][OH^-]^2$
$= 6.46 \times 10^{-6}$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility and solubility product determined from pH measurements in saturated solutions. No other details given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Haslam, R. T.; Calingaert, G.; Taylor, C. M.

J. Am. Chem. Soc. 1924, *46*, 308-11.

VARIABLES:

$T/K = 283 - 353$

PREPARED BY:

H. Einaga
Y. Komatsu
I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in water, 10-80 °C

$t/°C$	Calcium Oxide $/g\ kg^{-1}$ soln.	Calcium Hydroxide $m_1/mol\ kg^{-1}$
10	1.310	0.0234
42	1.018	0.0182
48	0.957	0.0171
56	0.884	0.0158
60	0.855	0.0153
61	0.842	0.0150
66	0.802	0.0143
70	0.762	0.0136
80	0.673	0.0120

The solubility of water decreased linearly with increasing solution temperature.

NOTE: The unit, g $(kg\ soln.)^{-1}$, was used by the authors.

The $Ca(OH)_2$ molalities were calculated by the compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Equilibration of $Ca(OH)_2$ in water was approached from both supersaturation and undersaturation sides. No definite procedures are given in the original paper. The dissolved $Ca(OH)_2$ was determined by titration with standard HCl solution using phenolphthalein as an indicator.

SOURCE AND PURITY OF MATERIALS:

Nothing specified

ESTIMATED ERROR:

No estimates possible

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Miller, L. B.; Witt, J. C.

J. Phys. Chem. 1929, *33*, 285-9.

VARIABLES:

$T/K = 303$

PREPARED BY:

H. Einaga
I. Lambert
H. L. Clever

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water at 30°C

Calcium Oxide /g L^{-1}	Calcium Hydroxide c_1/mol L^{-1}	Equilibration Method	Preparation Method
1.195	0.02131	A	a
1.200	0.02140	B	a
1.198	0.02136	A	a
1.202	0.02143	B	a
1.196	0.02133	A	a
1.194	0.02129	A	a
1.201	0.02142	B	b
1.196	0.02133	B	b
mean	0.02136 ± 0.00005		

No meaningful difference in the solubility was noticed from the origin of the starting material.

The compiler calculated the $Ca(OH)_2$ concentration values.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A. CaO was slaked with a small amount of conductivity water and allowed to stand 24 h. It was then added to conductivity water at 30°C in 1 L Pyrex bottles and shaken until equilibrium reached as indicated by conductivity measurements. B. The CaO was placed directly into 1 L Pyrex bottles nearly filled with conductivity water, allowed to slake and likewise was shaken until equilibrium was reached.

The Ca^{2+} in the saturated solution was determined gravimetrically after precipitation as the oxalate and ignition to CaO.

The crystals in B. are more finely divided when conductivity measurements begin. They may initially show a higher solubility. However, time-conductivity studies show both methods come to the same solubility value in 32-36 h.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. (a) Iceland spar was calcined to CaO, and hydrated to $Ca(OH)_2$. (b) A chemically pure sample of $CaCO_3$ was dissolved in HNO_3 followed by precipitation with $(NH_4)_2CO_3$. The precipitated $CaCO_3$ was ignited to CaO, and hydrated to $Ca(OH)_2$.

(2) Water. Conductivity water.

ESTIMATED ERROR:

Temp.: precision ± 0.005 K.
Soly.: reproducibility better than ± 0.34 %.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5]	Bassett, H. *J. Chem. Soc.* <u>1934</u>, 1270-5.

EXPERIMENTAL VALUES:

Solubility of coarse grain $Ca(OH)_2$ in water

t/°C	CaO g/100 g solution	$Ca(OH)_2$ m_1/mol kg^{-1}[a]
-0.116	0.130	0.0232
0	0.130	0.0232
5	0.128	0.0228
10	0.125	0.0223
15	0.122	0.0218
25	0.113	0.0202
30	0.109	0.0195
40	0.100	0.0178
45	0.0962	0.0172
50	0.0917	0.0164
55	0.0861	0.0154
60.8	0.0818	0.0146
81.7	0.0657	0.0117
90	0.0591	0.0105
95.3	0.0561	0.0100
99	0.0523	0.0093

Solubility of fine grain $Ca(OH)_2$ in water

t/°C	CaO g/100 g solution	$Ca(OH)_2$ m_1/mol kg^{-1}[a]
-0.123	0.144	0.0257
-0.123	0.140	0.0250
0	0.151	0.0270
0	0.143	0.0255
5	0.142	0.0254
10	0.138	0.0246
15	0.133	0.0237
25	0.129	0.0230
30	0.121	0.0216
40	0.107	0.0191
50	0.0968	0.0173
60	0.0917	0.0164
70	0.0800	0.0143

[a] Calculated by compilers.

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bassett, H.

J. Chem. Soc. 1934, 1270-5.

VARIABLES:

T/K = 273 - 372

PREPARED BY:

H. Einaga
Y. Komatsu
I. Lambert

EXPERIMENTAL VALUES:

Solid phase in equilibrium with the saturated solution was $Ca(OH)_2$. Influence of grain size of the starting material on the solubility was stressed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Water was saturated with $Ca(OH)_2$ by mechanically shaking the mixtures at the specified temperatures. The mixtures were agitated in Ag or Pt bottles for six hours a month. The supernatant portion of the saturated solutions were analyzed for Ca^{2+} by precipitation as oxalate followed by titration with standard $KMnO_4$ solution.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Obtained by slaking CaO which was obtained by ignition of pure precipitated $CaCO_3$. Both coarse and fine grains were used.

(2) Water.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Larocque, G. L.; Maass, O.

Can. J. Res., Sec. B 1935, *13*, 276-9.

VARIABLES:

$T/K = 273 - 303$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in water at 0 to 30°C

	Calcium Oxide	Calcium Hydroxide
$t/°C$	$CaO/g\ L^{-1}$	$10^2c_1/mol\ L^{-1}$
0	1.456	2.60
5	1.430	2.55
10	1.404	2.50
15	1.370	2.45
20	1.333	2.38
25	1.284	2.29
30	1.230	2.20

The $Ca(OH)_2$ concentrations were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Electrical conductivities in lime solutions of known concentration and in saturated solutions were measured with a stirring glass system under CO_2 free air in a constant temperature bath. The system was kept one hour at each temperature with periodic conductivity readings. Equilibrium was established from both increasing and decreasing temperature, and the average result was reported. The solubility was calculated by plotting the isothermal conductivity versus concentration and taking the intercept with the level corresponding to saturation.

Grieve, Gurd and Maas (ref 1) used the same method to obtain solubility values of 1.55, 1.45, 1.34 and 1.28 g L^{-1} at temperatures of 0, 10, 18, and 25°C, respectively. The results are considered less accurate than the present work.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Prepared by heating Iceland spar crystals at 100°C for several days. The absence of CO_2 was tested.

(2) Water. Distilled. Freed from gases by repeated cycles of freezing, evacuating, and melting.

ESTIMATED ERROR:

Temp.:not stated, but given to 0.01 K in paper; Soly.: precision ± 0.008 g L^{-1} CaO (authors).

REFERENCES:

1. Grieve, A. D.; Gurd, G. W.; Maass, O.
Can. J. Res. 1933, *8*, 577.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Peppler, R. B.; Wells, L. S.

J. Res. Natl. Bur. Stand. (U.S.) <u>1954</u>, *52*, 75-92.

VARIABLES:

$T/K = 303-523$

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water at 30 to 250°C

$t/°C$	Calcium Oxide $/g\ L^{-1}$	Calcium Hydroxide $c_1/mol\ L^{-1}$
30	1.03	0.0184
125	0.380	0.00678
150	0.270	0.00481[a]
150	0.247	0.00440
200	0.05	0.0009
250	0.037	0.00066

[a] The solid in equilibrium with the saturated solution was very fine crystals. The solid used in the other runs was large crystals of $Ca(OH)_2$. In all cases the solid in equilibrium with the saturated solutions was well crystallized $Ca(OH)_2$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An aqueous solution saturated with $Ca(OH)_2$ at room temperature was heated in a pressure bomb at specified temperatures (125-250°C) for 5 to 10 days. After the equilibration the saturated solution was removed, and analyzed for Ca^{2+} by a gravimetric method by precipitation as the oxalate and calcination to CaO.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. The $Ca(OH)_2$ solutions were prepared by dissolving CaO in distilled water. The CaO was prepared by heating reagent grade $CaCO_3$ at 950°C.

(2) Water. Distilled.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Hedin, R.

Handl. Sven. Forskningsinst. Cem. Betong. K. Tek. Hoegsk. Stockholm 1955, No. 27, 14 pp (in English).

Chem. Abstr. 1956, *50*, 6147c.

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water as a function of particle size at several temperatures

Temperature $t/°C$	Log c_{CaO} c in g L^{-1}	1/Diameter $1/(D/\mu m)$	$Ca(OH)_2$ Method of Synthesis*	Quadratic mean deviation on D μm
24	0.064	0.00	K	-
25.5	0.058	0.00	K	-
30.5	0.040	0.00	K	-
	0.043	0.31	K	0.19
	0.044	0.31	K	0.22
	0.046	0.65	S	0.20
	0.063	1.72	K	0.23
	0.064	1.80	K	0.18
32.0	0.033	0.00	K	-
	0.042	0.65	S	0.21
33.0	0.030	0.00	K	-
	0.047	1.40	S	0.22
	0.055	1.76	S	0.25
	0.067	2.51	S	0.19
	0.066	2.61	S	0.23
37.0	0.014	0.00	K	-
	0.033	1.33	S	0.24
	0.033	1.42	S	0.21
	0.035	1.44	S	0.21
	0.035	1.48	S	0.20
	0.038	1.52	S	0.24
	0.039	1.56	S	0.19
	0.035	1.58	S	0.23
	0.038	1.68	S	0.18
	0.037	1.79	S	0.24
	0.040	1.90	S	0.18
	0.040	1.93	S	0.21
	0.042	1.94	S	0.16
39.9	0.003	0.00	K	-
42.0	-0.006	0.00	K	-
44.0	-0.015	0.00	K	-
45.6	-0.017	0.31	K	0.21
	-0.018	0.31	K	0.26
	0.006	1.90	S	0.24
	0.007	2.21	S	0.21
48.2	-0.033	0.00	K	-
	-0.022	0.66	S	0.21
	-0.024	0.66	S	0.22
	-0.002	2.21	S	0.20
51.6	-0.048	0.00	K	-
	-0.032	1.35	S	0.20
	-0.028	1.65	S	0.17
	-0.021	1.68	S	0.24
	-0.028	1.69	S	0.22

Continued on the next page.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5]	Hedin, R. *Handl. Sven. Forskningsinst. Cem. Betong. K. Tek. Hoegsk. Stockholm* 1955, No. 27, 14 pp (in English). *Chem. Abstr.* 1956, *50*, 6147c.

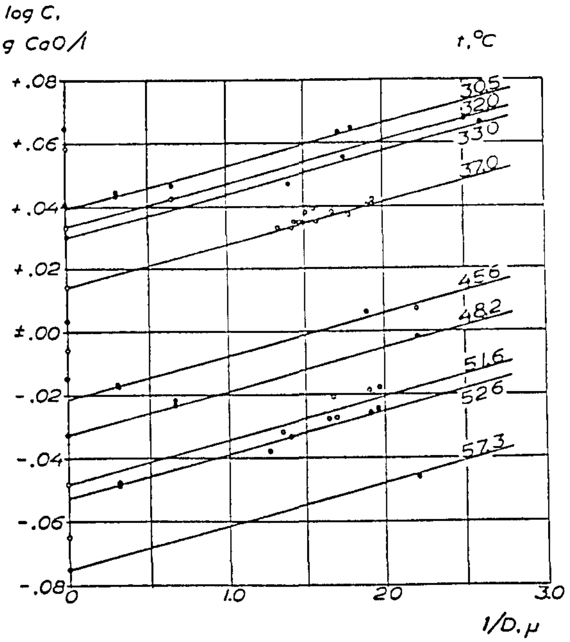
EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water as a function of particle size at several temperatures (continued)

Temperature t/°C	Log c_{CaO} c in g L^{-1}	1/Diameter 1/(D/μm)	$Ca(OH)_2$ Method of Synthesis*	Quadratic mean deviation on D μm
51.6	-0.019	1.91	S	0.24
	-0.018	1.97	S	0.24
52.6	-0.049	0.31	K	0.21
	-0.048	0.31	K	0.19
	-0.038	1.26	K	0.23
	-0.034	1.40	S	0.21
	-0.026	1.92	S	0.17
	-0.025	1.96	S	0.20
55.4	-0.065	0.00	K	-
57.3	-0.075	0.00	K	-
	-0.046	2.21	S	0.20

* K = Prepared by grinding crystalline product; S = prepared by slaking CaO.

ADDITIONAL DATA AND/OR COMMENTS;



Equilibrium concentrations of $Ca(OH)_2$ solutions as a function of the temperature and the particle size in the solid phase.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Hedin, R.

Handl. Sven. Forskningsinst. Cem. Betong. K. Tek. Hoegsk. Stockholm 1955, No. 27, 14 pp (in English).

Chem. Abstr. 1956, *50*, 6147c.

VARIABLES:

T/K = 297 - 330

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

About 100 mg of $Ca(OH)_2$ suspended in a few mL of water was poured into 100-150 mL of nearly saturated $Ca(OH)_2$ solution. The flask, equipped with a conductivity cell, was thermostated with shaking for 10 - 20 hours. The $Ca(OH)_2$ concentration was calculated from the equilibrium conductivity value. The relation between conductivity and concentration was taken from (ref 1). The particle size distribution of $Ca(OH)_2$ was determined by microscopic examination of suspended samples. The arithmetic mean value was used to characteristic of particle size in each sample.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Prepared by two methods. 1) Meth. K. Large $Ca(OH)_2$ crystals were formed by slow diffusion of NaOH and $CaCl_2$ solutions into a common vessel containing water. After washing and drying under protection from the atmosphere they were ground to powder in a mortar. 2) Meth. S. CaO, prepared by calcining commercial grade $Ca(OH)_2$, was slaked with CO_2 free water to produce a thin milky suspension.

ESTIMATED ERROR:

Temp.: ± 0.3 K (precision)
Soly.: ± 0.004 g L^{-1} $Ca(OH)_2$

REFERENCES:

1. Ringqvist, G. *Handl. Sven. Forskningsinst. Cem. Betong K. Tek. Hoegsk. Stockholm* 1952, No. 19, 55 pp.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bates, R. G.; Bower, V. E.; Smith, E. R.

J. Res. Natl. Bur. Stand. (U.S.) 1956, *56*, 305-12.

VARIABLES:

$T/K = 293 - 303$

PREPARED BY:

H. Einaga
I. Lambert
H. L. Clever

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in water

$t/°C$	$Ca(OH)_2$ $m_1/mol\ kg^{-1}$
20	0.0211
25	0.02037 ± 0.00011(5)(initial detn) 0.02032 ± 0.00006(4)(1 month) 0.02022 (2)(6 months) 0.0203 Av.
30	0.0196

These values are the averages determined at time 0, 1 month, and 6 months after the preparation of $Ca(OH)_2$. No evolution with time was found. Detailed values given only at 25°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ was equilibrated with water at a specified temperature by agitation. The resulting saturated solutions were analyzed for Ca^{2+} by titration with standard HCl solution using phenol red as an indicator.

Equilibration was repeated at different times after the preparation of $Ca(OH)_2$ in order to test its aging effect.

The authors state the results do not preclude a solubility lower by perhaps 1 to 3 percent for large well-defined crystals of $Ca(OH)_2$.

Concentrations (mol L^{-1}) and molality (mol kg^{-1}) differ by about 0.3 %.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Chemically pure $CaCO_3$ containing low alkali was calcined at 1000°C for 45 minutes to CaO. The product was then hydrated to give $Ca(OH)_2$. The precipitated $Ca(OH)_2$ was dried at 110°C. Classed by authors as finely granular.

(2) Water.

ESTIMATED ERROR:

Soly.: reproducibility is ± 0.5 % or better (authors).

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Water; H_2O; [7732-18-5]	Greenberg, S. A.; Copeland, L. E. *J. Phys. Chem.* 1960, *64*, 1057-9.

EXPERIMENTAL VALUES:

An evaluation of the solubility product of $Ca(OH)_2$ in water.

Solubility product values between 20 and 40 °C
by several methods

t/°C	$-\log K^{\circ}_{s0}$			
	Meth a	Meth b	Meth c	Av.
20	4.83	5.12	4.99	4.98
25	5.10	-	5.04	5.07
40	-	5.30	5.18	5.24

An evaluation was made of the solubility product of $Ca(OH)_2$ from published data (ref 1 - 7). Three methods were used:

Method a. Solubility as a function of the concentration of sodium chloride solutions (ref 1 and 2). Solubility data at 20 °C (ref 1) and 25 °C (ref 2) as a function of sodium chloride concentration were analyzed by the relation

$$\log m - 2A\mu^{0.5} = (1/3)\log (K^{\circ}_{s0}/4) - B\mu,$$

which had been derived from

$$K^{\circ}_{s0} = m_{Ca^{2+}} \cdot m_{OH^-}^{2} \cdot f_{\pm}^{3} \qquad \text{Eqn. I}$$

where

$$m_{Ca(OH)_2} - m_{Ca^{2+}} - (1/2)m_{OH^-}, \text{ and } \log f_{\pm} = 2A\mu^{0.5} - B\mu \qquad \text{Eqn. II}$$

(ref 8). Here, the authors allowed m to represent either concentration or molality since the solutions were dilute, $f_{\pm}$ is the mean activity coefficient, and μ is the ionic strength. Solubility product values at zero ionic strength are obtained.

Method b. Solubility data as a function of hydroxyl ion concentration. Solubility data at 20 and 40 °C (ref 3) as a function of KOH or NaOH concentration were analyzed graphically by the relation

$\log K_{s0} - 6A\mu^{0.5} = \log K^{\circ}_{s0} - 3B\mu$, which had been derived from

$K_{s0} = m_{Ca^{2+}} \cdot m_{OH^-}^{2}$ and Eqn. II.

Method c. Solubility as a function of temperature. All the reported solubility data (ref 1 - 7) in the range of 20 to 100 °C were plotted against temperature. The good agreement among the values indicated that the equilibrium solid was always one form of crystalline $Ca(OH)_2$. The values of Bates, Bower, and Smith (ref 4) were heavily weighted, and a line was put through the data. Values from this "best" line are in the following table. The Debye-Huckel equation was used to evaluate the mean activity coefficient at each temperature. It was combined with the solubility value to obtain values of the thermodynamic solubility product at five degree intervals between 20 and 100 °C.

The solubility product values were treated by a non-linear regression to obtain the equation:

$$\ln K^{\circ}_{s0} = 17.67 \ln (T/K) - 0.078(T/K) - 89.0$$

It was pointed out by the authors that the coexistence of $CaOH^+$, the purity of the starting $Ca(OH)_2$ samples, and the crystallinity of $Ca(OH)_2$ did not influence the solubility data, and that only one form of crystalline $Ca(OH)_2$ was present in equilibrium with its saturated solutions.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Greenburg, S.; Copeland, L. E.

J. Phys. Chem. 1960, *64*, 1507-9.

VARIABLES:

T/K = 293 - 373

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The solubility and solubility product of $Ca(OH)_2$ in water between 20 and 100 °C

t/°C	Calcium Hydroxide	
	c_1/mol L^{-1}	$10^6 K^{\circ}_{s0}$
20	0.0211	10.2
25	0.0203	9.04
30	0.0195	8.00
35	0.0189	7.28
40	0.0183	6.64
45	0.0176	6.00
50	0.0169	5.52
55	0.0163	4.84
60	0.0155	4.24
65	0.0150	3.84
70	0.0142	3.24
75	0.0136	2.88
80	0.0128	2.44
85	0.0121	2.08
90	0.0114	1.76
95	0.0107	1.48
100	0.0100	1.24

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No original experimental data reported. The authors critically evaluated selected literature solubility data at various temperatures.

REFERENCES:

1. Dschorbenadse, D.; Mosebach, R.; Nacken, R. *Zement* 1942, *31*, 513.
2. Johnstone, J.; Grove, C. *J. Am. Chem. Soc.* 1931, *53*, 3976.
3. Fratini, S. *Ann. Chem. Appl.* 1949, *39*, 616.

REFERENCES (Continued):

4. Bates, R. G.; Bower, V. E.; Smith, E. R. *J. Res. NBS* 1956, *56*, 305.
5. Bassett, H. *J. Chem. Soc.* 1934, 1270.
6. Haslam, R. T.; Calingaert, G.; Taylor, C. M. *J. Am. Chem. Soc.* 1924, *46*, 308.
7. Mellor, J. *"A Comprehensive Treatise on Inorganic and Theoretical Chemistry"*, Vol. III, Longmans, 1923, 623.
8. Hitchcock, D. I. *J. Am. Chem. Soc.* 1928, *50*, 2076.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Koudelka, L.

Chem. Prum. 1976, *26*, 580-3.

VARIABLES:

$T/K = 273$

PREPARED BY:

J. Hala

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water at 0°C

Equilibration time after preparation t/min	$Ca(OH)_2$ Initial Mixture /mass %	Ca^{2+} [a] c/mg cm^{-3}	$Ca(OH)_2$ [b] c_1/mg cm^{-3}	$Ca(OH)_2$ [c] c_1/mg cm^{-3}
0	1.5	0.89	1.65	1.67
	3.0	0.90	1.66	1.76
7	1.5	0.90	1.66	1.67
	3.0	0.92	1.70	1.67
15	1.5	0.92	1.70	1.70
	3.0	0.92	1.70	1.67
30	1.5	0.95	1.76	1.76
	3.0	0.93	1.72	1.67

[a] determined by complexometric titration.

[b] calculated from (a).

[c] determined from titration with 0.1 mol L^{-1} HCl.

For the 30 min experiment the average solubility is (1.73 ± 0.04) mg cm^{-3} or (0.0234 ± 0.0006) mol L^{-1} (compiler).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal Method. Slaked lime containing about 20 mass % $Ca(OH)_2$ was prepared from CaO and distilled water. Mixtures containing initially either 1.5 or 3.0 mass % $Ca(OH)_2$ were equilibrated by mixing at 0°C for 30 minutes. Samples of the suspension were taken for analysis immediately after preparing the mixture, and then at 7, 15 and 30 minute intervals. The samples were filtered at 0°C through a sintered glass crucible (S2). The filtration took approximately 1 minute. Two aliquots of the filtrate were analyzed, one for Ca^{2+} by complexometric titration, and the other for $Ca(OH)_2$ by titration with standard 0.1 mol L^{-1} HCl.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Lachema, Brno, Czechoslovakia. Analyzed titrimetrically and contained 96.3 mass % CaO.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Edmiston, M. D.; Suter, R. W.

J. Chem. Ed. 1988, *65*, 279-80.

VARIABLES:

T/K = 293

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in water was measured using a labelling technique at 20°C to be:

0.17 g $(100\ cm^3)^{-1}$.

The compiler calculated values of

1.7 g dm^{-3} and

0.023 mol dm^{-3} from the reported value.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A 1.00 cm^{-3} solution of 0.100 mol dm^{-3} $CaCl_2$ containing about 3 ppb of ^{45}Ca (0.2 μCi, low β energy) is reacted with NaOH solution to precipitate $Ca(OH)_2$. The precipitate is washed three times with pure water, and, each time separated from the water by centrifugation. The $Ca(OH)_2$ is stirred twice with water, allowed to stand one minute after each stirring, and then centrifugated. The supernatant solution (1) is separated. The solid $Ca(OH)_2$ is dissolved in HCl and combined with rinsing solutions from the preparation so all non-dissolved base is in solution (2). The two solutions are evaporated and the residue counted for ^{45}Ca. The quantity dissolved is calculated from N(1)/[N(1) + N(2)], N(1) and N(2) being the number of counts for solutions (1) and (2), respectively.

SOURCE AND PURITY OF MATERIALS:

(1) $Ca(OH)_2$. Precipitated from $CaCl_2$ solution by NaQH. See method.

(2) Water. Not specified.

ESTIMATED ERROR:

Temp.: Not specified.
Soly.: Not specified, compilers estimate 5 - 10 %.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide (portlandite); $Ca(OH)_2$; [12177-68-3]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Walther, J. V.

Geochim. Cosmochim. Acta 1986, *50*, 733-39.

EXPERIMENTAL VALUES:

The solubility of portlandite in super-critical water as a function of temperature and pressure.

Temperature		Pressure	Duration	Approach	log (m_{Ca}/mol kg^{-1})
t/°C	T/K	p_{tot}/bar	t/days		
300	573	990	3	S	-2.648
350	623	1000	24		lost
		1000	10	U	-2.952
		1000	5	S	-3.074
352	625	1000	3	-	-3.083
		1010	5	S	-3.006
399	672	1000	3		lost
400	673	1125	2	S	-3.149
401	374	1000	10	S	-3.381
426	699	990	4	S	-3.597
		1000	3	-	-3.635
		1080	4	S	-3.581
427	700	1000	4	-	-3.602
428	701	1000	6		lost
449	722	1000	3	-	-3.834
450	723	1000	2	S	-3.907
		1070	4	S	-3.798
476	749	1000	4	S	-4.200
477	750	1000	5	S	-4.130
500	773	1000	6	S	-4.375
502	775	1000	2	S	-4.441
302	575	1300	3	S	-2.497
		1600	3	S	-2.414
351	624	1700	3	S	-2.678
352	625	1305	1	S	-2.831
		1440	6	S	-2.709
551	824	1520	4	S	-4.236
		1655	2	S	-3.881
552	825	1420	2	S	-4.583
302	575	2000	2	U	-2.340
350	623	2000	3	U	-2.529
400	673	2000	3	S	-2.696
		2000	4	-	-2.693
		2000	3	-	-2.696
401	674	2200	3	S	-2.597
424	697	1995	4	S	-2.822
449	722	2010	3	U	-3.002
474	747	2000	3	S	-3.070
499	772	1995	2	S	-3.146
		2020	2	-	-3.178
500	773	2000	2	-	-3.190
525	798	2020	2	S	-3.341
550	823	1810	2	S	-3.604
553	826	2040	2	S	-3.456
598	871	2010	1	-	-4.207
599	872	2000	2	U	-4.021
601	874	2000	2	S	-4.172
610	883	1950	2	U	-4.579
402	675	2475	5	U	-2.542
399	672	3000	2	-	-2.353
400	673	3010	2	U	-2.392

continued on the next page . . .

COMPONENTS:

(1) Calcium hydroxide (portlandite); $Ca(OH)_2$; [12177-68-3]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Walther, J. V.

Geochim. Cosmochim. Acta 1986, *50*, 733-39.

VARIABLES:

T/K = 573 - 877
p/MPa = 99.0 - 302.0

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The solubility of portlandite in super-critical water as a function of temperature and pressure.

Temperature		Pressure	Duration	Approach	log (m_{Ca}/mol kg^{-1})
t/°C	T/K	p_{tot}/bar	t/days		
503	776	3000	3	U	-2.657
		3000	2	-	-2.627
600	873	3000	1	U	-3.998
603	876	3020	1	S	-3.099
604	877	3020	2	U	-3.090

Approach: S from supersaturation, U from undersaturation, and
- from near same concentration (within 10%).

The author's data in the paper were arranged in the order the experiments were done on the 2 g sample of $Ca(OH)_2$. The compiler arranged the data above in the order of increasing temperature at the pressures of 1, 1.5, 2, 2.5 and 3 kbar.

The author proposes the solubility reaction

$$2H^+(aq) + Ca(OH)_2(s) = Ca^{2+}(aq) + 2H_2O$$

Neither $Ca(OH)^+(aq)$ or $Ca(OH)_2(aq)$ appear to be important species, although the solution pH is about 2 units above neutral. The solubility increases with increasing pressure at constant temperature, decreases with increasing temperature at constant pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility measurements were performed with an extraction quench hydrothermal apparatus (ref 1). A 2 g sample of $Ca(OH)_2$ was deflocculated and the fines removed by settling. X-ray and optical microscope examination indicated a completely crystalline material.

The sample was brought to its first sampling temperature and pressure and allowed to equilibrate for seven days. Successive measurements followed at 1 to 10 (usually 2 to 4) day intervals. After sampling the sampling apparatus was flushed with an NaOH soln. The calcium concentration was determined using a DCP plasma spectrometer.

SOURCE AND PURITY OF MATERIALS:

(1) Portlandite. Sargent Welch reagent grade. Treated as described in the method.

(2) Water. Distilled, deionized, and decarbonated.

ESTIMATED ERROR:

Author estimated analytical method for Ca as ±2 %, over-all with uncertanties in p and T as ±5 %.

REFERENCES:

1. Walther, J. V.; Orville, P. M. *Amer. Mineral.* 1983, *68*, 731-41

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Water-d_2; D_2O; [7789-20-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kingerley, R. W.; La Mer, V. K.

J. Am. Chem. Soc. 1941, *63*, 3256-62.

VARIABLES:

$T/K = 298$

Mol fraction, $x_2 = 0 - 1$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in water + heavy water mixtures, 25°C

$t/°C$	Mol Fraction D_2O x_2	Solubility $10^2c_1/mol\ L^{-1}$	Solid Phase
25	0	2.15	$Ca(OH)_2$
	0.868	1.26	
	0.925	1.20	
	1.00	1.12 [a]	$Ca(OD)_2$

[a] extrapolated value.

The author's also report the solubility of thallium chloride; TlCl; [7791-12-0] in the same solvent mixtures.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Ammonia; NH_3; [7664-41-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kolthoff, I. M.; Stenger, V. A.

J. Phys. Chem. 1934, *38*, 639-43.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0 - 1.955$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous NH_3 at 25°C

Ammonia $c_2/\text{mol L}^{-1}$	Calcium Hydroxide $c_1/\text{mol L}^{-1}$
0	0.02128
0.496	0.01933
0.981	0.01850
1.475	0.01700
1.955	0.01571

The solubility of $Ca(OH)_2$ decreased linearly with increasing NH_3 concentration.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

CaO was equilibrated with aqueous NH_3 solutions in either a container coated with paraffin or a pyrex bottle at 25.00 ± 0.02°C by shaking for 14-20 h. The clear portion of the saturated solution was analyzed for calcium ion either by precipitation as oxalate followed by titration with a standard $KMnO_4$ solution, or by evaporation to dryness and addition of HCl followed by back titration with standard NaOH solution using methyl orange indicator.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Chemically pure $CaCl_2$ was reacted with ammonium oxalate in hot water to precipitate calcium oxalate, which was ignited to give pure CaO.

(2) Ammonia. Prepared CO_2 free by distillation of 20% aqueous NH_3 in the presence of $Ba(OH)_2$.

(3) Water.

ESTIMATED ERROR:

Accuracy in the titration procedure was better than 0.5%.
Temp.: See Method.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Ammonium chloride; NH_4Cl; [12125-02-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Noyes, A. A.; Chapin, E. S.

J. Am. Chem. Soc. 1899, *21*, 511-6.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1899, *28*, 518-22.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0 - 0.08703$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous NH_4Cl at 25°C

Ammonium Chloride $c_2/\text{mol L}^{-1}$	Calcium Hydroxide $c_1/\text{mol L}^{-1}$
0	0.02022
0.02176	0.02908
0.04352	0.03923
0.08703	0.05968

Each solubility value is the mean of five measurements.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Aqueous NH_4Cl solutions were saturated with $Ca(OH)_2$ in a CO_2 free atmosphere (ref 1). The resulting saturated solution was filtered, and the filtrate was titrated with standard HCl solution using methyl orange indicator.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Prepared by dissolving reputed pure $Ca(OH)_2$ in aqueous HCl solution, treating with NH_3 to remove other metallic impurities, Precipitating Ca^{2+} with ammonium carbonate, and igniting the precipitate to CaO just before use.

(2) Ammonium chloride. Commercial material recrytallized three times.

ESTIMATED ERROR:

Soly.: ± 0.24 - ± 0.43 % as a relative error.

REFERENCES:

1. Noyes, A. A. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1892, *9*, 602.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Boric acid; H_3BO_3; [10043-35-3] (3) Water; H_2O; [7732-18-5]	Sborgi, U. *Atti. Accad. Naz. Lincei., Cl. Sci. Fis., Mat. Nat., Rend.* 1913, *84*, 636-42, 715-19, 798-801.

EXPERIMENTAL VALUES:

The $CaO + B_2O_3 + H_2O$ system at 30°C

B_2O_3 mass %	CaO mass %	Solid Phase
0.0140	0.1263	A
0.0321	0.1398	A
0.127	0.2174	A + B
0.1293	0.2079	A + B
0.1335	0.22	B
0.1379	0.1177	B
0.1395	0.1085	B
0.140	0.110	B
0.1663	0.1073	B + C
0.1687	0.1086	B + C
0.1690	0.1150	B + C
0.171	0.1091	B + C
0.2897	0.0516	C
0.6117	0.0471	C
0.8691	0.0666	C
1.025	0.0772	C
1.116	0.0759	C
1.339	0.0928	C + D
1.3784	0.09435	C + D
1.64	0.1436	C + D
2.0588	0.0928	D
2.434	0.2232	D
2.509	0.0991	D
2.55	0.1095	D
2.798	0.1085	D
3.128	0.1384	D
3.3133	0.1433	D
3.841	0.152	D
4.250	0.155	D + E
4.1795	0.1368	E

Solid Phases:
A. $Ca(OH)_2$
B. $CaO\cdot B_2O_3\cdot 6H_2O$
C. $2CaO\cdot 3B_2O_3\cdot 9H_2O$
D. $CaO\cdot 3B_2O_3\cdot 12H_2O$
E. H_3BO_3

Continued on next page.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Boric acid; H_3BO_3; [10043-35-3] (3) Water; H_2O; [7732-18-5]	Sborgi, U. *Atti. Accad. Naz. Lincei., Cl. Sci. Fis., Mat. Nat., Rend.* 1913, *84*, 636-42, 715-19, 798-801.
VARIABLES:	PREPARED BY:
$T/K = 303$ Composition	I. Lambert

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The CaO, H_3BO_3 and H_2O are mixed and allowed to reach equilibrium in a stirred thermostat. Equilibrium is reached faster if some $CaO\cdot B_2O_3\cdot 6H_2O$ is added to the mixture. The $Ca(OH)_2$ and H_3BO_3 are analyzed in both the solution and the residue. $Ca(OH)_2$ is titrated by HCl with methylorange as indicator. H_3BO_3 is titrated with NaOH in the presence of mannitol with phenolphthalein as indicator. Equilibrium time is 3 to 14 days.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. CaO is calcinated to eliminate last traces of CO_2.

(2) Boric acid. Recrystallized before use.

(3) Water. Boiled before use to eliminate CO_2.

$CaO\cdot B_2O_3\cdot 6H_2O$ is prepared by double decomposition between calcium salt and alkaline borate (ref 1).

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Meyerhoffer, W.; Van't Hoff, J.H. *Ann. Chem.* 1907, *351*, 100.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Boric acid; H_3BO_3; [10043-35-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Nikolaev, A. V.; Chelishcheva, A.G.

C. R. Acad. Sci. URSS <u>1940</u>, *28*, 127-30.

VARIABLES:

T/K = 298
Composition

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The CaO + B_2O_3 + H_2O system at 25°C

B_2O_3 mass %	CaO mass %	Solid Phase
0	0.119	A
0.102	0.190	A + B
0.104	0.175	B
0.126	0.090	B + C
0.380	0.034	C
0.955	0.053	C + D
1.34	0.044	D
3.30	0.058	D + E
3.17	0	E

Solid Phases: A. $Ca(OH)_2$ B. $CaO\cdot B_2O_3\cdot 6H_2O$

C. $2CaO\cdot 3B_2O_3\cdot 13H_2O$ (Invoite) D. $CaO\cdot 3B_2O_3\cdot 4H_2O$ E. H_3BO_3

The difference in results between this work and that of Sborgi (ref 1) is attributed to Sborgi's not reaching equilibrium.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The CaO, H_3BO_3 and H_2O are mixed and allowed to stand in a stirred thermostated vessel at 25°C for 21 to 153 days.

Samples are taken by pipet through a cotton wool filter. The $Ca(OH)_2$ is titrated in the presence of the boric acid by a strong acid with methyl orange as the indicator. The boric acid is titrated in the presence of mannitol, glycerin, or invert sugar with a strong base with phenolphthalein as the indicator (ref 2).

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Freshly ignited CaO used.

(2) Boric acid. Recrystallized boric acid used.

(3) Water. Distilled. Boiled before use to eliminate CO_2.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Sborgi, U. *Atti. Accad. Naz. Lincei. Rend.* <u>1913</u>, *84*, 715-19.

2. Nikolaev, A. V. *Izv. Akad. Nauk. SSSR* <u>1938</u>, 415-32.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Magnesium hydroxide; $Mg(OH)_2$; [1309-42-8] (3) Water; H_2O; [7732-18-5]	Bury, C. R.; Davies, E. R. H. *J. Chem. Soc.* 1933, 701-5.
VARIABLES:	PREPARED BY:
T/K = 298 Composition	I. Lambert H. Einaga

EXPERIMENTAL VALUES:

The $MgO + CaO + H_2O$ system at 25°C

Ratio, R^a	CaO mass %	$Ca(OH)_2$ m_1/mol L^{-1}
1.00	0.117	0.0209
0.77	0.116	0.0207
0.53	0.115	0.0205
0.33	0.115	0.0205
0.125	0.116	0.0207
0.037	0.115	0.0205

[a] Ratio = undissolved CaO/(undissolved CaO + MgO)

The experiment above showed that no compound of the form $CaO \cdot MgO \cdot xH_2O$ existed in the system. The $Ca(OH)_2$ solubility remained constant at the value it would have over pure solid $Ca(OH)_2$.

The compiler calculated the $Ca(OH)_2$ molality.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Known weights of CaO, MgO and H_2O were shaken in a thermostat at 25°C for 3 months. The solution was filtered, and the CaO in the filtrate was determined by titration with standard acid solution. From the initial weights of CaO and MgO and the measured solubility of CaO, the ratio, R, was calculated.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lunge, G.

J. Soc. Chem. Ind., London 1892, *11*, 882.

VARIABLES:

$T/K = 293 - 373$
$CaCl_2/g\ (100\ mL)^{-1} = 0 - 30$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous $CaCl_2$ at 20 to 100°C

$t/°C$	Calcium Chloride $/g\ (100\ mL)^{-1}$	Calcium Oxide $/g\ (100\ mL)^{-1}$	Calcium Hydroxide $10^2c_1/mol\ L^{-1}$
20	0	0.1374	2.45
	5	0.1370	2.45
	10	0.1661	2.97
	15	0.1993	3.56
	20	0.1875*	3.35
	25	0.1661*	2.97
	30	0.1630*	2.91
40	0	0.1162	2.08
	5	0.1160	2.07
	10	0.1419	2.53
	15	0.1781	3.18
	20	0.2249	4.02
	25	0.3020*	5.39
	30	0.3084*	5.51
60	0	0.1026	1.83
	5	0.1020	1.82
	10	0.1313	2.34
	15	0.1706	3.05
	20	0.2204	3.94
	25	0.2989	5.34
	30	0.3644	6.51
80	0	0.0845	1.51
	5	0.0936	1.67
	10	0.1328	2.37
	15	0.1736	3.10
	20	0.2295	4.10
	25	0.3261	5.82
	30	0.4112	7.34
100	0	0.0664	1.19
	5	0.0906	1.62
	10	0.1389	2.48
	15	0.1842	3.29
	20	0.2325	4.15
	25	0.3714	6.63
	30	0.4922	8.79

* Calcium oxychloride is present in the solid phase.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No description.

The $Ca(OH)_2$ concentrations were calculated by the compiler.

The identical data are given by B. Zahorsky *Z. anorg. Chem.* 1893, 34 - 43.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium chloride; $CaCl_2$; [10043-52-4] (3) Water; H_2O; [7732-18-5]	Zahorsky, B. *Z. anorg. Chem.* 1893, *3*, 34-43.
VARIABLES:	**PREPARED BY:**
T/K = 293 - 373 Concentration	H. L. Clever

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous $CaCl_2$ at 20 - 100°C

t/°C	$CaCl_2$ mass %	CaO g/100 mL	$Ca(OH)_2$ c_1/mol L^{-1}
20	0	0.1374	0.0245
	5	0.1370	0.0244
	10	0.1661	0.0296
	15	0.1993	0.0355
	20	0.1857*	0.0331
	25	0.1661*	0.0287
	30	0.1630*	0.0291
40	0	0.1162	0.0207
	5	0.1160	0.0207
	10	0.1419	0.0253
	15	0.1781	0.0318
	20	0.2249	0.0401
	25	0.3020*	0.0539
	30	0.3684*	0.0657
60	0	0.1026	0.0183
	5	0.1020	0.0182
	10	0.1313	0.0234
	15	0.1706	0.0304
	20	0.2204	0.0393
	25	0.2989	0.0533
	30	0.3664	0.0653
80	0	0.0845	0.0151
	5	0.0936	0.0167
	10	0.1328	0.0237
	15	0.1736	0.0310
	20	0.2295	0.0409
	25	0.3261	0.0581
	30	0.4122	0.0735
100	0	0.0664	0.0118
	5	0.0906	0.0162
	10	0.1389	0.0248
	15	0.1842	0.0328
	20	0.2325	0.0415
	25	0.3710	0.0662
	30	0.4922	0.0878

* Solid contained some calcium oxychloride.

The compiler calculated the $Ca(OH)_2$ concentrations. At 20°C the $CaCl_2$ concentrations are 0, 0.468, 0.976, 1.53, 2.12, 2.77 and 3.46 mol L^{-1}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
The paper is concerned mostly with the properties and composition of calcium oxychloride. Only limited details about the solubility measurement. The $Ca(OH)_2$ soly values in pure water appear high.	Nothing specified. ESTIMATED ERROR: No estimates possible.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Schreinemakers, F.A.H.; Figee, Th.

Chem. Weekbl. 1911, *36*, 683-88.

VARIABLES:

T/K = 298
Composition

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The $CaO + CaCl_2 + H_2O$ system at 25°C

$CaCl_2$ mass %	CaO mass %	Solid Phase
5.02	0.101	A
10.00	0.113	A
12.94	0.128	A
15.14	0.140	A
17.20	0.143	A
18.15	0.148	A + B
18.01	0.152	B
21.02	0.147	B
23.80	0.146	B
24.33	0.147	B
28.37	0.170	B
29.54	0.180	B
32.67	0.225	B
33.21	0.245	B
33.72	0.254	B + C
34.36	0.173	C
38.61	0.060	C
41.32	0.048	C
44.30	0.030	C
44.51	0.022	C + D
44.69	0.036	C + D
44.77	-	D

Solid Phases: A. $Ca(OH)_2$ B. $CaCl_2 \cdot 4CaO \cdot 14H_2O$

C. $CaCl_2 \cdot CaO \cdot 2H_2O$ D. $CaCl_2 \cdot 6H_2O$

In the author's notation D^4_{14}, D^1_2, and Ca_6 are B, C and D, respectively.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The saturated solutions are analyzed for $CaCl_2$ by titration with 0.1 mol L^{-1} $AgNO_3$, and for CaO by titration with 0.1 mol L^{-1} HCl. The wet residue is dissolved in a sucrose solution and analyzed as above. The solid phase composition is calculated by the "method of residues".

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Schreinemakers, F.A.H; Milikan, J.

Proc. K. Ned. Acad. Wet. 1912, *15*, 52-54.

VARIABLES:

T//K = 283 - 323

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The following solids were identified by the residue method in ternary systems $MO + MX_2 + H_2O$ where M = Ca or Ba and X = Cl, Br or I.

$CaO + CaCl_2 + H_2O$	$CaCl_2 \cdot 6H_2O$ at 10 and 25°C, $CaCl_2 \cdot 2H_2O$ at 50°C, $CaCl_2 \cdot 3CaO \cdot 16H_2O$ at 10 and 25°C, $CaCl_2 \cdot CaO \cdot 2H_2O$ at 10, 25 and 50°C, $CaCl_2 \cdot CaO \cdot 3H_2O$ at 50°C, and $Ca(OH)_2$ at 10, 25 and 50°C.
$CaO + CaBr_2 + H_2O$	$CaBr_2 \cdot 6H_2O$, $CaBr_2 \cdot 3CaO \cdot 16H_2O$, $3CaBr_2 \cdot 4CaO \cdot 16H_2O$, and $Ca(OH)_2$ all at 25°C.
$BaO + BaCl_2 + H_2O$	$BaCl_2 \cdot 2H_2O$, $BaCl_2 \cdot BaO \cdot 5H_2O$, and $Ba(OH)_2 \cdot 8H_2O$ all at 30°C.
$BaO + BaBr_2 + H_2O$	$BaBr_2 \cdot 2H_2O$, $BaBr_2 \cdot BaO \cdot 5H_2O$, and $Ba(OH)_2 \cdot 8H_2O$ all at 25°C.
$BaO + BaI_2 + H_2O$	$BaI_2 \cdot 7H_2O$, $BaI_2 \cdot 2H_2O$, $BaI_2 \cdot BaO \cdot 9H_2O$, and $Ba(OH)_2 \cdot 8H_2O$ all at 25°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Analyzed by the residue method.

See data sheets in this volume from the papers of J. Milikan for more details on these systems.

SOURCE AND PURITY OF MATERIALS:

Not specified.

ESTIMATED ERROR:

Not specified.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

EXPERIMENTAL VALUES:

Composition of the saturated solution

t/°C	$CaCl_2$ mass %	CaO mass %	Solid phase
10	15.46	0.102	$Ca(OH)_2 + CaCl_2 \cdot 3CaO \cdot 16H_2O$
	15.21	0.102	"
	26.30	0.110	$CaCl_2 \cdot 3CaO \cdot 16H_2O$
	32.38	0.115	"
	34.60	0.140	"
	35.94	0.151	$CaCl_2 \cdot 3CaO \cdot 16H_2O + CaCl_2 \cdot CaO \cdot 2H_2O$
	35.93	0.151	"
	38.23	0.106	$CaCl_2 \cdot CaO \cdot 2H_2O$
	38.45	0.126	"
40	29.38	0.455	$Ca(OH)_2$
	31.93	0.609	$Ca(OH)_2 + CaCl_2 \cdot CaO \cdot 2H_2O$
	31.90	0.571	"
	31.86	0.580	"
	49.97	0.055	$CaCl_2 \cdot CaO \cdot 2H_2O + CaCl_2 \cdot 4H_2O$
45	31.72	0.621	$Ca(OH)_2 + CaCl_2 \cdot CaO \cdot 2H_2O$
	31.95	0.634	"
	35.87	0.442	$CaCl_2 \cdot CaO \cdot 2H_2O$
	38.12	0.069	"
	43.31	0.074	"
	52.10	0.047	"
	56.96	0.121	$CaCl_2 \cdot CaO \cdot 2H_2O + CaCl_2 \cdot 2H_2O$
	57.19	0	$CaCl_2 \cdot 2H_2O$
48	31.80	0.434	$Ca(OH)_2 + CaCl_2 \cdot CaO \cdot 5(4)H_2O$
	31.73	-	"
	32.86	0.320	$CaCl_2 \cdot CaO \cdot 5(4)H_2O + CaCl_2 \cdot CaO \cdot 2H_2O$
50	4.08	0.112	$Ca(OH)_2$
	9.03	0.114	"
	15.02	0.142	"
	19.97	0.182	"
	29.41	0.538	"
	29.57	0.436	"
	29.66	0.362	$Ca(OH)_2 + CaCl_2 \cdot CaO \cdot 5(4)H_2O$
	29.60	0.517	$CaCl_2 \cdot CaO \cdot 5(4)H_2O$ (?)
	31.70	0.470	"
	35.20	0.106	"
	36.95	0.113	$CaCl_2 \cdot CaO \cdot 5(4)H_2O + CaCl_2 \cdot CaO \cdot 2H_2O$
	36.82	0.146	"
	36.93	0.124	$CaCl_2 \cdot CaO \cdot 2H_2O$
	39.43	0.069	"
	45.57	0.051	"
	46.42	0.046	"
	47.19	0.034	"
	48.75	0.046	"
	54.03	0.048	$CaCl_2 \cdot CaO \cdot 2H_2O + CaCl_2 \cdot 2H_2O$
	54.07	0.068	"
	56.95	0	$CaCl_2 \cdot 2H_2O$

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

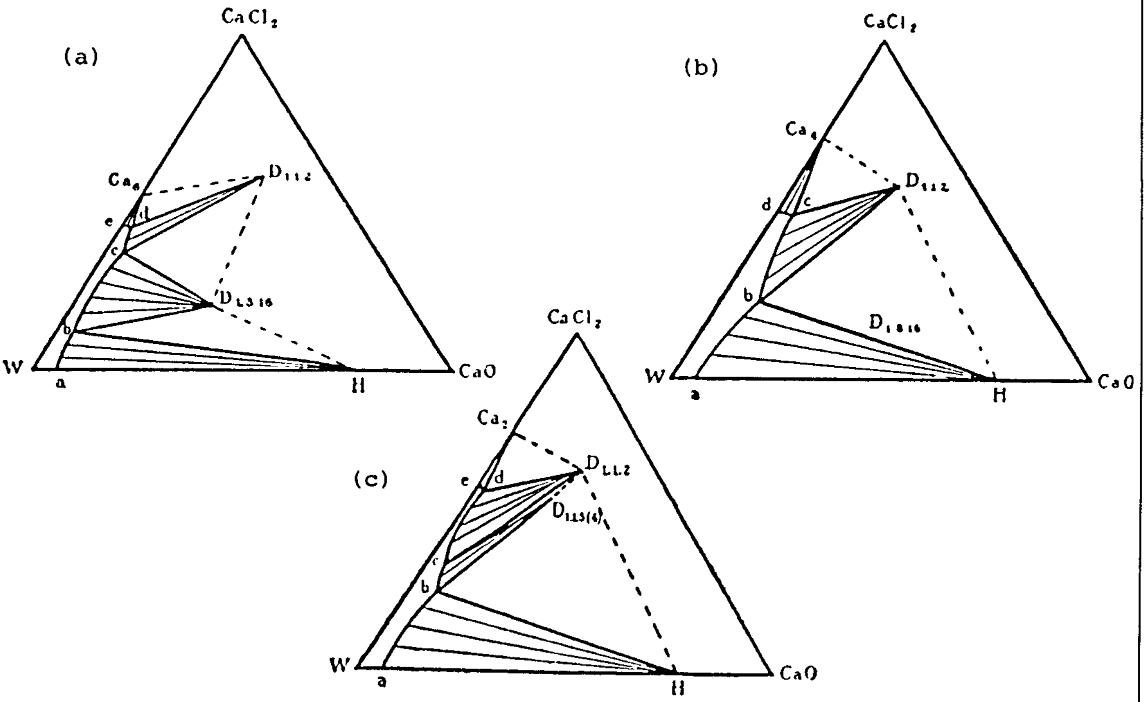
VARIABLES:

T/K = 283 - 323
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:



$CaO + CaCl_2 + H_2O$ system at
(a) 10°C, (b) 40°C, and (c) 50°C.

Ca_2: $CaCl_2 \cdot 2H_2O$
Ca_4: $CaCl_2 \cdot 4H_2O$
Ca_6: $CaCl_2 \cdot 6H_2O$
$D_{1.1.2}$: $CaCl_2 \cdot CaO \cdot 2H_2O$
$D_{1.1.5(4)}$: $CaCl_2 \cdot CaO \cdot 5(4)H_2O$
$D_{1.3.16}$: $CaCl_2 \cdot 3CaO \cdot 16H_2O$
H: $Ca(OH)_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases determined by Schreinemaker's method of wet residues.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide.

(2) Calcium chloride.

(3) Water.
Nothing specified about materials.

ESTIMATED ERROR;

No estimates possible.

REFERENCES:

1. Schreinemakers, F. A. H.; Figee, T.
Chem. Weekbl. 1911, *8*, 683.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

O'Connor, E. R.

J. Chem. Soc. 1927, *130*, 2700-10.

VARIABLES:

$T/K = 273$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The $Ca(OH)_2 + CaCl_2 + H_2O$ system at 0°C

Calcium Chloride mass %	Calcium Oxide mass %	Calcium Hydroxide mass %	Density d_4^0	Solid Phase
2.7	0.214	0.283	1.025	A
5.5	0.226	0.299	1.048	A
6.8	0.216	0.285	1.056	A + B
7.6	0.212	0.280	1.067	B
10.2	0.186	0.246	1.089	B
12.5	0.172	0.227	1.111	B
15.2	0.164	0.217	1.133	B
17.4	0.152	0.201	1.155	B
20.0	0.148	0.196	1.186	B
22.8	0.145	0.192	1.213	B
25.6	0.142	0.188	1.240	B
28.0	0.138	0.182	1.265	B
29.7	0.152	0.201	1.280	B
34.9	0.190	0.251	1.338	B
37.6	0	0	1.370	C

Solid Phases: A $Ca(OH)_2$; B $CaCl_2 \cdot 3CaO \cdot 16H_2O$; C $CaCl_2 \cdot 6H_2O$

The $Ca(OH)_2$ mass percents were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ and $CaCl_2$ were equilibrated with water at 0°C for 24 h. Samples of the saturated solution were analyzed for $Ca(OH)_2$ by neutralization titration, and for $CaCl_2$ by titration of the chloride ion by the Volhard method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Freshly calcined CaO was slaked.

Nothing further specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Makarov, S. Z.; Vol'nov, I. I.

Izv. Sekt. Fiz.-Khim. Anal., Inst. Obshch. Neorg. Khim., Akad. Nauk SSSR 1954, 320-33.

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + $CaCl_2$ + H_2O systems from 5 to 75°C

t/°C	$CaCl_2$ mass %	$Ca(OH)_2$ mass %	Solid Phase
5	-	0.18	A
	6.53	0.15	A
	7.57	0.15	A + B
	11.06	0.13	B
	13.62	0.11	B
	19.25	0.10	B
	29.03	0.11	B
	34.75	0.16	B
	36.58	0.19	B + C
	37.04	0.10	C
	37.90	0.09	C + D
	38.29	-	D
10	-	0.18	A
	7.33	0.14	A
	8.87	0.14	A
	10.26	0.15	A + B
	12.12	0.14	B
	18.27	0.12	B
	25.04	0.12	B
	30.90	0.15	B
	36.09	0.23	B + C
	36.58	0.16	C
	37.90	0.10	C
	39.00	0.08	C + D
	39.4	-	D
30	-	0.15	A
	12.80	0.16	A
	19.61	0.21	A
	20.63	0.23	A + B
	23.50	0.24	B
	26.58	0.26	B
	32.05	0.37	B
	32.76	0.39	B
	32.90	0.43	B + C
	33.86	0.22	B + C
	35.96	0.15	B + C
	38.74	0.08	B + C
	41.88	0.07	B + C
	46.60	0.06	C + E
	49.25	-	E

Continued

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Makarov, S. Z.; Vol'nov, I. I.

Izv. Sekt. Fiz.-Khim. Anal., Inst. Obshch. Neorg. Khim., Akad. Nauk SSSR 1954, *25*, 320-33.

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + $CaCl_2$ + H_2O systems from 5 to 75°C

t/°C	$CaCl_2$ mass %	$Ca(OH)_2$ mass %	Solid Phase
40	-	0.14	A
	13.02	0.18	A
	19.44	0.23	A
	26.08	0.37	A
	30.00	0.58	A
	31.00	0.67	A
	32.00	0.74	A + C
	32.38	0.56	C
	34.47	0.21	C
	38.72	0.10	C
	44.29	0.05	C
	48.25	0.06	C
	49.44	0.06	C + E
	49.32	0.06	C + E
	52.95	-	E
45	-	0.12	A
	5.45	0.13	A
	21.55	0.27	A
	28.15	0.41	A
	31.18	0.71	A
	31.28	0.76	A + C
	32.24	0.32	C
	36.05	0.13	C
	39.59	0.09	C
	43.69	0.06	C
	50.63	0.07	C
	53.48	0.08	C + F
	56.5	-	F
50	-	0.12	A
	16.89	0.20	A
	19.64	0.23	A
	24.31	0.32	A
	30.75	0.62	A
	31.64	0.74	A + C
	31.78	0.72	A + C
	32.40	0.60	C
	33.20	0.44	C
	36.32	0.16	C
	39.13	0.10	C
	40.42	0.09	C
	49.61	0.08	C
	53.81	0.09	C + F
	56.90	-	F

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COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Makarov, S. Z.; Vol'nov, I. I.

Izv. Sekt. Fiz.-Khim. Anal., Inst. Obshch. Neorg. Khim., Akad. Nauk SSSR 1954, 320-33.

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + $CaCl_2$ + H_2O systems from 5 to 75°C

t/°C	$CaCl_2$ mass %	$Ca(OH)_2$ mass %	Solid Phase
55	-	0.12	A
	6.75	0.13	A
	13.35	0.18	A
	19.25	0.25	A
	28.10	0.55	A
	30.09	0.67	A
	31.76	0.76	A + C
	32.23	0.53	C
	33.27	0.37	C
	35.13	0.20	C
	36.77	0.12	C
	43.34	0.07	C
	45.48	0.07	C
	49.75	0.07	C
	52.65	0.06	C
	54.92	0.08	C + F
	57.27	-	F
75	-	0.10	A
	6.30	0.12	A
	19.33	0.30	A
	26.03	0.55	A
	30.58	0.72	A + C
	32.99	0.30	A + C
	46.45	0.10	A + C
	56.98	0.12	C + F
	58.85	-	F

Solid Phases:

A. $Ca(OH)_2$

B. $CaCl_2 \cdot 3Ca(OH)_2 \cdot 12H_2O$

C. $CaCl_2 \cdot Ca(OH)_2 \cdot H_2O$

D. $CaCl_2 \cdot 6H_2O$

E. $CaCl_2 \cdot 4H_2O$

F. $CaCl_2 \cdot 2H_2O$

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Makarov, S. Z.; Vol'nov, I. I.

Izv. Sekt. Fiz.-Khim. Anal., Inst. Obshch. Neorg. Khim., Akad. Nauk SSSR 1954, *25*, 320-33.

VARIABLES:

T/K = 278 - 348

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ and water are equilibrated in a glass vessel in a thermostat regulated at ± 0.1°C to obtain the $Ca(OH)_2$ solubility in water. Then $CaCl_2$ is added in increasing amounts, either as solution or anhydrous salt for the subsequent solubility measurements. Equilibrium is reached in 2 to 5 days.

Samples for analysis are pipetted through a filter at the temperature of the experiment. Analysis: Total alkalinity by titration with 0.1 M HCl, chloride ion by Volhard's method, and calcium ion by precipitation of the oxalate and subsequent titration by 0.1 M $KMnO_4$.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Carbonate free $Ca(OH)_2$. $CaCl_2 \cdot 3Ca(OH)_2 \cdot 12H_2O$ prepared by heating 1 L 24 % $CaCl_2$ with 10 g CaO (temperature not given), filtering at same temperature, quenching at 5°C, and filtering in a CO_2 atm. The product is decomposed by boiling distilled water and washed until free of Cl^-.

(2) Calcium chloride. Analytical grade $CaCl_2 \cdot 6H_2O$.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]]

(3) Water; H_2O; [7732-18-51

ORIGINAL MEASUREMENTS:

Mozharova, T. V.; Zozulya, A. F. Markel, S. A.; Tsurko, N. G.

**Zh. Neorg. Khim.* 1983, *28*, 2389-93.

Russ. J. Inorg. Chem. (Engl. Transl.) 1983, *28*, 1355-8.

VARIABLES:

T/K = 303, 323, and 373
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + $CaCl_2$ + H_2O System at 30 to 100°C

t/°C	Calcium Chloride mass %	Water mass %	Calcium Hydroxide mass %	Solid Phase
30	0	99.85	0.148	A
	2.56	97.30	0.137	A
	5.02	94.84	0.133	A
	7.62	92.24	0.141	A
	10.04	89.81	0.148	A
	14.93	84.88	0.189	A
	20.82	78.94	0.244	B
50	0	99.87	0.127	A
	2.44	97.44	0.119	A
	4.88	94.99	0.126	A
	9.36	90.48	0.159	A
	14.42	85.37	0.207	A
	20.28	79.45	0.268	A
100	0	99.93	0.072	A
	5.44	94.45	0.111	A
	9.93	89.89	0.176	A
	14.10	85.64	0.256	A
	19.74	79.87	0.391	A

Solid Phases: A $Ca(OH)_2$

B $CaCl_2 \cdot 3Ca(OH)_2 \cdot 12H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$, and $CaCl_2$, were equilibrated with water at a specified temperature by stirring for 3 h. Aliquots of the saturated aqueous phases were analyzed for Cl^- by titration with standard Hg^{2+} solution using sodium nitroprusside indicator, for Ca^{2+} by titration with standard EDTA solution using a mixed indicator (not specified in the text), and for OH^- by titration with standard HCl solution using methyl red indicator. No other experimental details are given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium chloride; $CaCl_2$; [10043-52-4] (3) Hydrogen chloride; HCl; [7647-01-0] (4) Water; H_2O; [7732-18-5]	Milikan, J. *Z. Phys. Chem. Stoechiom. Verwandtschaftsl.* <u>1917</u>, *92*, 496-510.

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + HCl + H_2O system at 25°C

HCl mass %	CaO mass %	Solid Phase
3.30	2.64	A
6.57	5.17	A
8.50	6.66	A
9.95	7.79	A
11.30	8.83	A
11.93	9.32	A + B
11.84	9.25	A + B
13.81	10.77	B
15.64	12.17	B
15.99	12.44	B
18.64	14.50	B
19.41	15.10	B
21.47	16.73	B
21.82	17.02	B + C
22.16	17.29	B + C
22.58	17.53	C
25.37	19.56	C
27.15	20.92	C
29.11	22.41	C
29.25	22.51	C + D
29.37	22.61	C + D
29.42	22.62	D
30.57	22.02	D
31.68	22.08	D
32.57	22.48	D + E
33.35	21.77	E
34.46	19.44	E
34.87	18.52	E
35.38	17.39	E
35.52	17.36	E
38.84	14.11	E
40.07	14.43	E + F
40.06	14.30	E + F
40.12	14.43	E + F
40.10	14.05	F

Solid Phases: A. $Ca(OH)_2$; B. $CaCl_2 \cdot 3CaO \cdot 16H_2O$;
C. $CaCl_2 \cdot CaO \cdot 2H_2O$; D. $CaCl_2 \cdot 6H_2O$;
E. $CaCl_2 \cdot 4H_2O$; F. $CaCl_2 \cdot 2H_2O$.

The author did not measure the solubility of $Ca(OH)_2$ in pure water.

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COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium chloride; $CaCl_2$; [10043-52-4]

(3) Hydrogen chloride; HCl; [7647-01-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1917, *92*, 496-510.

VARIABLES:

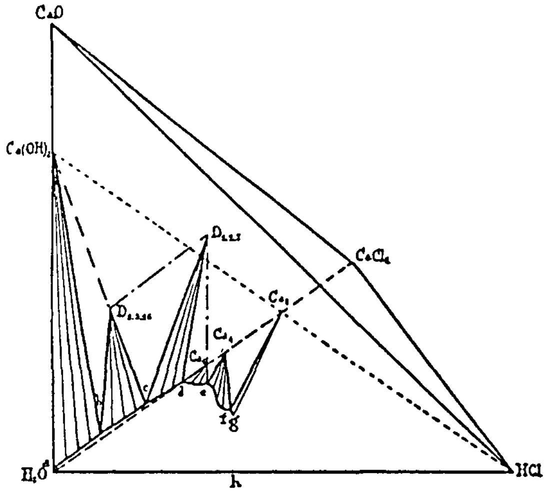
$T/K = 298$
HCl/mass % = 3.30 - 40.12

PREPARED BY:

I. Lambert
H. Einaga

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA: The CaO + HCl + H_2O phase diagram at 25°C



$D_{13\ 16}$ = B (previous page)
D_{112} = C (" ")
Ca_6 = D (" ")
Ca_4 = E (" ")
Ca_2 = F (" ")

Figure. CaO + HCl + H_2O System at 25°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Calcium chloride; $CaCl_2$; [10043-52-4]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T. V.; Zozulya, A. F.
Markel, S. A.; Tsurko, N. G.

**Zh. Neorg. Khim.* 1983, *28*, 2389-93.

Russ. J. Inorg. Chem. (Engl. Transl.) 1983, *28*, 1355-8.

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + NaCl + $CaCl_2$ + H_2O System at 30 to 100°C

t/°C	Calcium Chloride mass %	Sodium Chloride mass %	Calcium Hydroxide mass %	Solid Phase
30	0	6.27	0.215	A
	2.72	6.01	0.104	A
	4.84	6.18	0.092	A
	7.39	6.12	0.085	A
	9.98	6.08	0.085	A
	12.74	5.78	0.115	A
	13.55	6.15	0.122	A
	14.57	6.25	0.126	A
	15.67	5.81	0.141	A
	17.53	5.91	0.168	A + B
	17.48	5.75	0.168	A + B
	18.33	5.87	0.181	B
	21.34	5.92	0.185	B
	23.62	5.73	0.207	B
	24.77	5.89	0.230	B
	26.13	5.16	0.256	B + C
30	0	12.03	0.179	A
	2.45	12.08	0.081	A
	4.73	12.02	0.070	A
	7.26	12.25	0.067	A
	10.64	12.01	0.090	A
	11.99	11.84	0.100	A
	13.49	11.73	0.115	A + B
	13.83	11.87	0.119	B
	14.87	12.88	0.133	B
	17.82	10.42	0.163	B + C
50	0	6.0	0.172	A
	4.87	6.37	0.115	A
	10.16	5.78	0.119	A
	14.65	6.23	0.178	A
	19.15	6.41	0.282	A
	21.07	6.11	0.330	A
	24.24	5.87	0.444	A + D
50	0	11.93	0.167	A
	2.93	12.02	0.081	A
	4.82	12.03	0.081	A
	7.56	12.00	0.085	A
	9.67	12.12	0.115	A
	12.41	11.69	0.118	A
	14.14	11.66	0.156	A
	15.06	12.41	0.171	A
	16.75	12.04	0.248	A

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Calcium chloride; $CaCl_2$; [10043-52-4]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T. V.; Zozulya, A. F. Markel, S. A.; Tsurko, N. G.

***Zh. Neorg. Khim.* 1983, *28*, 2389-93.

Russ. J. Inorg. Chem. (Engl. Transl.) 1983, *28*, 1355-8.

VARIABLES:

T/K = 303, 323, and 373
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + NaCl + $CaCl_2$ + H_2O System at 30 to 100°C

t/°C	Calcium Chloride mass %	Sodium Chloride mass %	Calcium Hydroxide mass %	Solid Phase
100	0	7.23	0.131	A
	5.54	7.12	0.096	A
	7.54	7.35	0.120	A
	10.00	7.30	0.144	A
	14.51	7.18	0.222	A
	14.71	7.30	0.226	A
	19.88	7.17	0.363	A
100	0	10.21	0.126	A
	2.62	9.99	0.076	A
	5.53	9.81	0.093	A
	9.92	10.05	0.139	A
	14.55	9.95	0.241	A
	20.11	10.11	0.507	A

Solid Phases:

A	$Ca(OH)_2$
B	$CaCl_2 \cdot 3Ca(OH)_2 \cdot 12H_2O$
C	NaCl
D	$CaCl_2 \cdot Ca(OH)_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$, $CaCl_2$, and NaCl were equilibrated with water at a specified temperature by stirring for 3 h. Aliquots of the saturated aqueous phases were analyzed for Cl^- by titration with standard Hg^{2+} solution using sodium nitroprusside indicator, for Ca^{2+} by titration with standard EDTA solution using a mixed indicator (not specified in the text), for OH^- by titration with standard HCl solution using methyl red indicator, and for Na^+ by flame photometry. No other experimental details are given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium hypochlorite; $Ca(ClO)_2$; [7778-54-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

O'Connor, E. R.

J. Chem. Soc. 1927, *130*, 2700-10.

VARIABLES:

$T/K = 273$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The $Ca(OH)_2 + Ca(ClO)_2 + H_2O$ system at 0°C

Calcium Hypochlorite	Calcium Oxide	Calcium Hydroxide	Density	Solid Phase
mass %	mass %	mass %	d_4^0	
3.0	0.106	0.140	1.030	A
5.7	0.105	0.139	1.053	A
8.2	0.110	0.145	1.077	A
9.9	0.091	0.120	1.093	B
11.1	0.093	0.123	1.104	B
13.0	0.0093	0.123	1.123	B
15.1	0.077	0.102	1.142	B
16.9	-	-	1.161	B
17.8	-	-	1.168	B
18.0	-	-	1.171	B + C
18.2	-	-	1.172	C
19.2	0.113	0.149	1.189	C
19.8	0.106	0.140	1.188	C
21.2	0.106	0.140	1.203	C
21.8	-	-	1.213	D

Solid Phases: A $Ca(OH)_2$; B $Ca(ClO)_2 \cdot 3CaO \cdot 3H_2O$; C $Ca(ClO)_2 \cdot 2CaO \cdot 2H_2O$; D $Ca(ClO)_2 \cdot 3H_2O$

The $Ca(OH)_2$ mass percents were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ and $Ca(ClO)_2$ were equilibrated with water at 0°C for 1-5 days. Samples of the saturated solution were analyzed for $Ca(OH)_2$ by neutralization titration after decomposition of the ClO^- by hydrogen peroxide, and for $Ca(ClO)_2$ by an iodometric titration.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Freshly calcined CaO was slaked.

(2) Calcium hypochlorite. Prepared by the reaction of aqueous $Ca(OH)_2$ with Cl_2 gas, and recrystallization from water. The purified salt contained no Cl_2 or $Ca(ClO_3)_2$, but contained 0.5 wt % $Ca(OH)_2$.

Nothing further specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium hypochlorite; $Ca(ClO)_2$; [7778-54-3] or Calcium chloride; $CaCl_2$; [10043-52-4] (3) Water; H_2O; [7732-18-5]	O'Connor, E. R. *J. Chem. Soc.* 1927, *130*, 2700-10.

EXPERIMENTAL VALUES:

COMMENTS AND/OR ADDITIONAL DATA: PHASE DIAGRAMS.

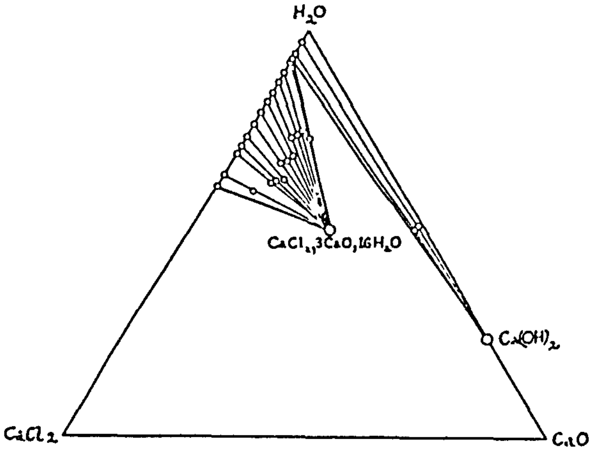


Figure 1. System $CaO + CaCl_2 + H_2O$ at 0°C

$CaO \cdot H_2O = Ca(OH)_2$

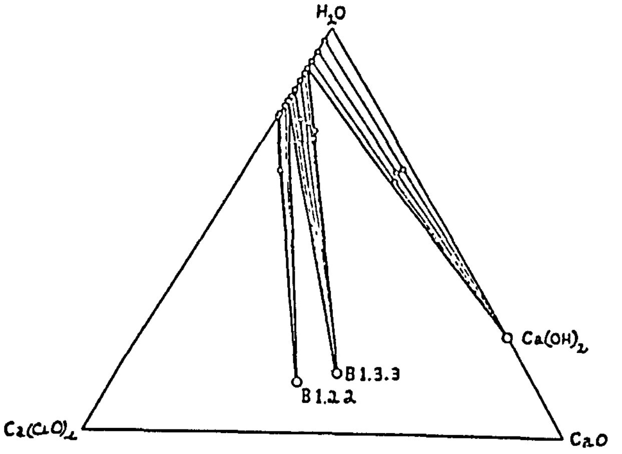


Figure 2. System $CaO + Ca(ClO)_2 + H_2O$ at 0°C.

$B_{1.2.2} = Ca(ClO)_2 \cdot 2CaO \cdot 2H_2O$

$B_{1.3.3} = Ca(ClO)_2 \cdot 3CaO \cdot 3H_2O$

$CaO \cdot H_2O = Ca(OH)_2$

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium bromide; $CaBr_2$; [7789-41-5] (3) Water; H_2O; [7732-18-5]	Milikan, J. *Z. Phys. Chem. Stoechiom. Verwandtschaftsl.* <u>1916</u>, *92*, 59-80.

EXPERIMENTAL VALUES:

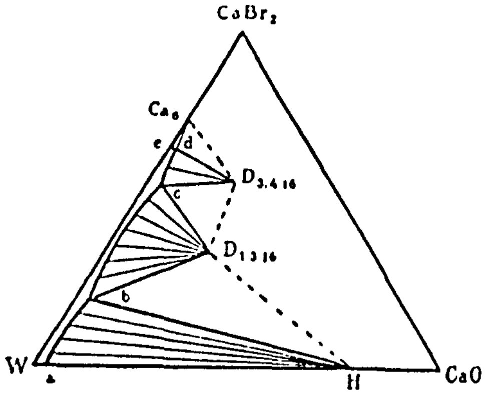
Composition of the saturated solution at 25°C

$CaBr_2$ mass %	CaO mass %	Solid phase
9.28	0.119	$Ca(OH)_2$
13.75	0.101	"
19.18	0.115	"
20.72	0.092	$Ca(OH)_2 + CaBr_2 \cdot 3CaO \cdot 16H_2O$
20.78	0.102	"
21.80	0.103	$CaBr_2 \cdot 3CaO \cdot 16H_2O$
22.39	0.092	"
25.15	0.089	"
28.21	0.089	"
32.50	0.080	"
32.92	0.080	"
41.36	0.077	"
44.21	0.098	"
50.04	0.132	"
53.39	0.247	"
54.30	0.383	$CaBr_2 \cdot 3CaO \cdot 16H_2O + 3CaBr_2 \cdot 4CaO \cdot 16H_2O$
54.15	0.334	"
55.29	0.271	$3CaBr_2 \cdot 4CaO \cdot 16H_2O$
56.94	0.235	"
58.90	0.199	"
59.48	0.192	"
60.09	0.209	$3CaBr_2 \cdot 4CaO \cdot 16H_2O + CaBr_2 \cdot 6H_2O$
60.07	0	$CaBr_2 \cdot 6H_2O$

(continued on next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium bromide; $CaBr_2$; [7789-41-5] (3) Water; H_2O; [7732-18-5]	Milikan, J. *Z. Phys. Chem. Stoechiom. Verwandtschaftsl.* 1916, *92*, 59-80.
VARIABLES:	PREPARED BY:
$T/K = 298$ Composition	H. Einaga Y. Komatsu

EXPERIMENTAL VALUES:



$CaO + CaBr_2 + H_2O$ system at $t/°C = 25$

Ca_6:	$CaBr_2 \cdot 6H_2O$
$D_{3.4.16}$:	$3CaBr_2 \cdot 4CaO \cdot 16H_2O$
$D_{1.3.16}$:	$CaBr_2 \cdot 3CaO \cdot 16H_2O$
H:	$Ca(OH)_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases determined by Schreinemaker's method of wet residues.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide.

(2) Calcium bromide.

(3) Water.

Nothing specified about materials.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium bromide; $CaBr_2$; [7789-41-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Orazkulieva, G.L.; Nuryev, A.; Kuliev, Ch.A.; Khodzhamamedov, A.M.; Ksenzenko, V.I.; Umarova, N.S.

Izv. Akad. Nauk Turkm. SSR, Ser. Fiz.-Tekh., Khim. Geol. Nauk 1989, (No. 4), 79-82.

VARIABLES:

$CaBr_2$ Concentration
T/K = 288.15

PREPARED BY:

I. Lambert
H. L. Clever

EXPERIMENTAL VALUES:

Composition of the saturated solution at 15°C.

$CaBr_2$ mass %	CaO mass %	Solid Phase
0.000	0.14	$Ca(OH)_2$
5.05	0.13	"
13.99	0.15	"
14.32	0.16	$Ca(OH)_2 + CaBr_2 \cdot 3CaO \cdot 16H_2O$
14.34	0.15	$CaBr_2 \cdot 3CaO \cdot 16H_2O$
24.98	0.11	"
30.50	0.09	"
34.55	0.06	"
41.76	0.09	"
45.80	0.15	"
49.24	0.22	"
51.82	0.28	"
52.93	0.36	" + $3CaBr_2 \cdot 4CaO \cdot 16H_2O$
53.69	0.29	$3CaBr_2 \cdot 4CaO \cdot 16H_2O$
55.26	0.13	"
56.10	0.15	"
56.26	0.30	" + $CaBr_2 \cdot 6H_2O$
57.10	-	$CaBr_2 \cdot 6H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The components were placed in a glass vessel, thermostated at 15°C, and stirred 48 to 72 hours to establish equilibrium.

The liquid and solid residues were analyzed for bromide by iodometry, and for calcium by complexometric titration with Trilon B.

The solid phase composition was determined by Schreinemakers' method of residues. The crystals were examined by microscopy.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide, CaO. A 96 % base was obtained by heating commercial oxide.

(2) Calcium bromide. Pure chemical grade, recrystallized twice.

(3) Water. Distilled.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium iodide; CaI_2; [10102-68-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

VARIABLES:

$T/K = 298$
Composition

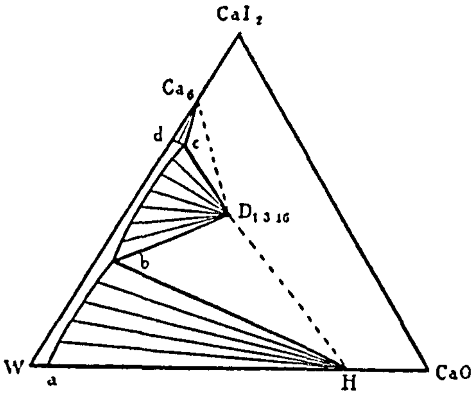
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

CaI_2 mass %	CaO mass %	Solid phase
9.14	0.076	$Ca(OH)_2$
17.42	0.089	"
25.80	0.087	"
28.44	0.097	$Ca(OH)_2 + CaI_2 \cdot 3CaO \cdot 16H_2O$
31.33	0.089	$CaI_2 \cdot 3CaO \cdot 16H_2O$
33.00	0.075	"
40.30	0.064	"
46.37	0.054	"
47.09	0.055	"
49.70	0.047	"
59.34	0.139	"
66.72	0.587	$CaI_2 \cdot 3CaO \cdot 16H_2O + CaI_2 \cdot 6H_2O$
66.65	0.553	"
66.80	0	$CaI_2 \cdot 6H_2O$



$CaO + CaI_2 + H_2O$ system at $t/°C = 25$

Ca_6: $CaI_2 \cdot 6H_2O$

$D_{1.3.16}$: $CaI_2 \cdot 3CaO \cdot 16H_2O$

H: $Ca(OH)_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases determined by Schreinemaker's method of wet residues.

No error estimates possible.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide.

(2) Calcium iodide.

(3) Water.
Nothing specified about materials.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium sulfate; $CaSO_4$; [7778-18-9] (3) Water; H_2O; [7732-18-5]	Cameron, F. K.; Bell, J. M. *J. Am. Chem. Soc.* 1906, *28*, 1220-2.
VARIABLES:	PREPARED BY:
$T/K = 298$ Composition	H. Einaga Y. Komatsu

EXPERIMENTAL VALUES:

The $Ca(OH)_2 + CaSO_4 + H_2O$ system at 25°C

Calcium Sulfate /g L^{-1}	Calcium Oxide /g L^{-1}	Calcium Hydroxide c_1/mol L^{-1}	Solid Phases
0	1.166	0.02079	A
0.391	1.141	0.02035	A
0.666	1.150	0.02051	A
0.955	1.215	0.02167	A
1.214	1.242	0.02215	A
1.588	1.222	0.02180	B
1.634	0.939	0.01674	C
1.722	0.611	0.01090	C
1.853	0.349	0.00622	C
1.918	0.176	0.00314	C
2.030	0.062	0.0011	C
2.126	0	0	C

Solid Phases:

A $Ca(OH)_2$

B $Ca(OH)_2 + CaSO_4 \cdot 2H_2O$

C $CaSO_4 \cdot 2H_2O$

The compilers calculated the calcium hydroxide concentrations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Solid CaO was added to aqueous $CaSO_4$ solutions and equilibrated in a thermostated bath at 25°C for two weeks. An aliquot of the saturated solution was analyzed for calcium and sulfate ions (procedures were not stated in the original paper).	Nothing specified.
	ESTIMATED ERROR·
	No estimate possible.
	REFERENCES.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium sulfate; $CaSO_4$; [7778-18-9]

(3) Sodium hydroxide; NaOH; [1310-73-2]

(4) Potassium hydroxide; KOH; [1310-58-3]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Hansen, W. C.; Pressler, E. E.

Ind. Eng. Chem. 1947, *39*, 1280-82.

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ and $CaSO_4 \cdot 2H_2O$ in aqueous mixtures of NaOH and KOH at 25 and 30°C

	Original Solution		Saturated Solution		
	K_2O	Na_2O	CaO	SO_3	OH^-
t/°C	c/mol L^{-1}	c/mol L^{-1}	c/mol L^{-1}	c/mol L^{-1}	c/mol L^{-1}
25	-	-	0.0331	0.0123	0.0414
	0.0100	-	0.0292	0.0151	0.0488
	0.0200	-	0.0240	0.0190	0.0502
	0.0401	-	0.0211	0.0289	0.0649
	0.0601	-	0.0183	0.0426	0.0726
	0.1002	-	0.0161	0.0722	0.0888
	0.2005	-	0.0165	0.1562	0.1164[a]
30	-	-	0.0319	0.0125	0.0387
	0.0050	-	0.0298	0.0141	0.0419
	0.0025	0.0025	0.0294	0.0141	0.0393
	0.0150	0.0050	0.0256	0.0191	0.0529
	0.0100	0.0101	0.0236	0.0196	0.0477
	0.0251	-	0.0228	0.0223	0.0523
	0.0125	0.0125	0.0226	0.0219	0.0514
	0.0150	0.0151	0.0226	0.0236	0.0585
	0.0251	0.0050	0.0231	0.0241	0.0587
	0.0150	0.0151	0.0216	0.0252	0.0536
	0.0301	-	0.0214	0.0253	0.0524
	0.0401	-	0.0211	0.0299	0.0626
	0.0200	0.0202	0.0198	0.0303	0.0602
	0.0150	0.0252	0.0195	0.0303	0.0589
	0.0501	-	0.0185	0.0373	0.0618
	0.0251	0.0252	0.0188	0.0376	0.0633
	0.0251	0.0252	0.0194	0.0363	0.0672
	0.0050	0.0500	0.0184	0.0395	0.0698
	0.0500	0.0050	0.0190	0.0398	0.0689
	0.0601	-	0.0187	0.0430	0.0710
	0.0301	0.0302	0.0180	0.0425	0.0711
	0.0150	0.0504	0.0175	0.0468	0.0734
	0.0501	0.0252	0.0174	0.0544	0.0771
	0.1002	-	0.0162	0.0710	0.0806
	0.1002	0.0050	0.0167	0.0783	0.0884
	0.1002	0.0252	0.0164	0.0951	0.0940
	0.1504	-	0.0162	0.1167	0.0972
	-	0.1448	0.0150	0.1151	0.1024
	0.1504	0.0050	0.0162	0.1211	0.1011
	0.1504	0.0252	0.0162	0.1382	0.1048
	0.2005	-	0.0164	0.1626	0.1062
	-	0.1930	0.0149	0.1586	0.1146
	0.2506	-	0.0161	0.2055	0.1136[a]
	0.1253	0.1250	0.0169	0.2040	0.1188[a]
	0.3750	-	0.0094	0.2121	0.1455[a]
	-	0.3750	0.0051	0.2629	0.2279
	0.5012	-	0.0093	0.2083	0.1386[a]
	1.0023	-	0.0034	0.3662	0.2752[a]

Continued on the next page.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium sulfate; $CaSO_4$; [7778-18-9]

(3) Sodium hydroxide; NaOH; [1310-73-2]

(4) Potassium hydroxide; KOH; [1310-58-3]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Hansen, W. C.; Pressler, E. E.

Ind. Eng. Chem. <u>1947</u>, *39*, 1280-82.

VARIABLES:

$T/K = 298, 303$
Concentration

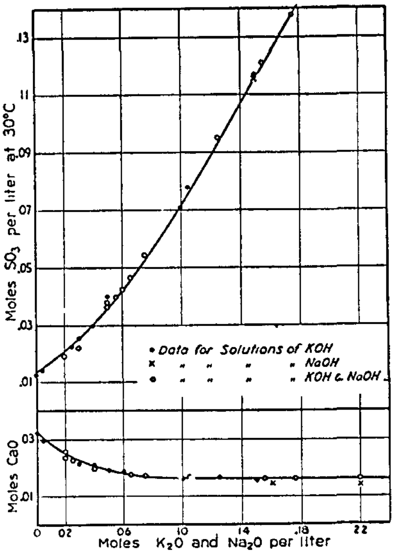
PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solid phase is always $Ca(OH)_2 + CaSO_4 \cdot 2H_2O$ except for the rows marked "*" where probably $CaSO_4 \cdot K_2SO_4 \cdot H_2O$ formed.

Many of the data are shown in the figure to the right. The solubilities of $Ca(OH)_2$ and $CaSO_4$ are about the same in $K_2O + Na_2O$ as in K_2O alone. They differ slightly in Na_2O from the values in the two alkalis or K_2O alone. From two to four values were obtained at one concentration of $K_2O + Na_2O$, but when they differed so little that it did not show on the scale of the figure only the average value was plotted.



Concentrations of CaO and SO_3 vs Concentrations of K_2O and Na_2O

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An excess of finely powdered CaO and gypsum were added to standardized solutions of alkali hydroxides. The reaction mixtures were agitated in Erlenmeyer flasks in a thermostated water bath for 48 hours. The saturated solutions were filtered with care to protect from air. Samples were taken from the filtrate. The total alkalinity was determined by acidimetry. The CaO was determined by precipitation of the oxalate and titration with standard $KMnO_4$. The SO_3 was precipitated and weighed as $BaSO_4$. The Na_2O was precipitated and weighed as sodium uranyl zinc acetate.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Temp.: ± 0.1°C (precision)
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium nitrite; $Ca(NO_2)_2$; [13780-06-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Popova, T. B.; Berdyukova, V. A.

Term. Anal. Fazouye Ravnovesiya 1985, 92-96.Edited by Verzhbitskii, F. R., Permsk.Gos. Univ., Perm, USSR

VARIABLES:

$T/K = 298$

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Isotherms at 25°C were determined for solubility, density, electrical conductivity, viscosity and refractive index of $M(OH)_2 + M(NO_2)_2 + H_2O$ ternary systems with M = Ca, Sr and Ba.

Results are given in small scale graphs which are too small to be read reliably.

The following solids were identified in the solubility study.

$Ca(OH)_2 + Ca(NO_2)_2 + H_2O$

$Ca(OH)_2 \cdot H_2O$
$Ca(OH)_2 \cdot Ca(NO_2)_2 \cdot 2H_2O$; [Incongruently melting compound (1)]
$Ca(NO_2)_2 \cdot 4H_2O$; [15136-63-7]

$Sr(OH)_2 + Sr(NO_2)_2 + H_2O$

$Sr(OH)_2 \cdot 8H_2O$; [1311-10-0]
$Sr(OH)_2 \cdot 4Sr(NO_2)_2 \cdot 8H_2O$
$Sr(NO_2)_2 \cdot H_2O$; [13450-96-9]

$Ba(OH)_2 + Ba(NO_2)_2 + H_2O$

$Ba(OH)_2 \cdot 8H_2O$; [12230-71-6]
$Ba(NO_2)_2 \cdot H_2O$; [7787-38-4]

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Not specified.

SOURCE AND PURITY OF MATERIALS:

Not specified.

ESTIMATED ERROR:

Not specified

REFERENCES:

1. Popova, T. B.; Berdyukova, V. A. *Zh. Prikl. Khim. (Leningrad)* 1986, *59*(1), 8-12.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium nitrate; $Ca(NO_3)_2$; [10124-37-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cameron, F. K.; Robinson, W. O.

J. Phys. Chem. 1907, *11*, 273-8.

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ + $Ca(NO_3)_2$ + H_2O system at 25°C

Calcium Nitrate g/100 cm^3 sln	Calcium Nitrate mass %	Calcium Hydroxide g/100 cm^3 sln	Calcium Oxide mass %	Density d^{25}_{25}	Solid Phase
0					A
3.35	3.27	0.095	0.092	1.0249	A
8.18	7.78	0.105	0.100	1.0484	A
12.91	11.80	0.120	0.110	1.0940	A
19.43	17.07	0.170	0.149	1.1383	A + B
26.49	22.37	0.171	0.144	1.1840	B
29.82	24.64	0.180	0.149	1.2101	B
32.97	26.83	0.190	0.155	1.2287	B
33.27	27.07	0.191	0.156	1.2290	B
35.87	28.60	0.200	0.160	1.2541	B
37.04	29.44	0.203	0.161	1.2581	B
40.88	31.87	0.226	0.176	1.2826	B
41.08	31.83	0.229	0.177	1.2905	B
48.99	36.73	0.277	0.207	1.3337	B
50.88	37.04	0.346	0.252	1.3735	B
63.93	45.04	0.440	0.310	1.4195	B + C
73.58	49.58	0.331	0.223	1.4840	C
81.91	53.43	0.263	0.172	1.5330	C
90.38	57.17	0.203	0.128	1.5809	C + D
91.84	57.74	0	0	1.5842	D

Solid Phases:

A $Ca(OH)_2$

B $CaO \cdot xN_2O_5 \cdot yH_2O$ (solid solution)

C $CaO \cdot Ca(NO_3)_2 \cdot 3.5H_2O$ (hydrated basic calcium nitrate)

D $Ca(NO_3)_2 \cdot 4H_2O$

The authors also tabulate g/100 g water of both calcium nitrate and calcium oxide as calcium hydroxide.

The numbers in columns two and four above were calculated by the compilers.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium nitrate; $Ca(NO_3)_2$; [10124-37-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cameron, F. K.; Robinson, W. O.

J. Phys. Chem. 1907, *11*, 273-8.

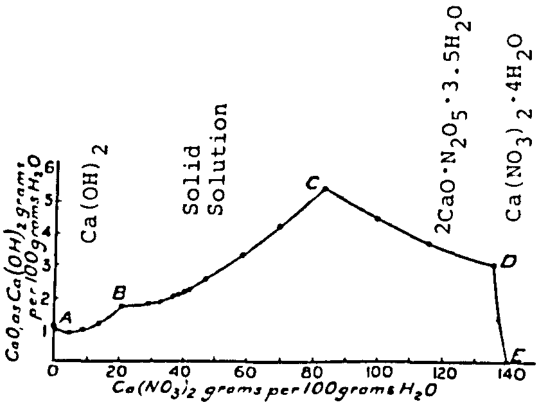
VARIABLES:

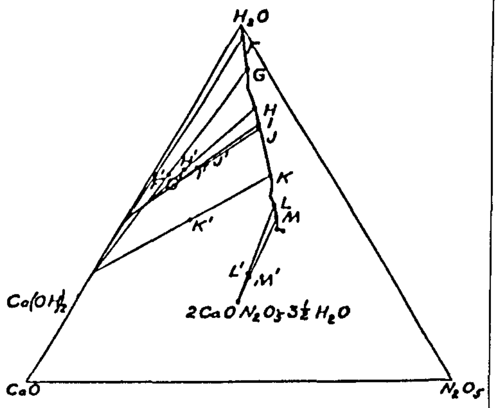
$T/K = 298$
$Ca(NO_3)_2$/mass % = 3.27 - 57.74

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:





The authors carried out a wet residue analysis from which they constructed the figures above. The right figure shows regions of stability for pure calcium hydroxide, a solid solution, and a hydrated basic calcium nitrate. The region for pure $Ca(NO_3)\cdot 4H_2O$ is not shown. The solubility curve to the left shows all regions with the equilibrium solid identfied above each branch.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Freshly prepared CaO was added in excess to aqueous $Ca(NO_3)_2$ solutions of known concentration. The mixtures were equilibrated at 25°C by mixing for more than six weeks. An aliquot of saturated solution was titrated with standard HNO_3 solution with phenolphthalein indicator to determine the dissolved $Ca(NO_3)_2$.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Freshly prepared lime.

(2) Calcium nitrate. Calcium carbonate impurity converted to the nitrate by treatment with nitric acid.

(3) Water. Freshly boiled distilled water.

ESTIMATED ERROR:

No estimate possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium nitrate; $Ca(NO_3)_2$; [10124-37-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bassett, H., Jr.; Taylor, H. S.

J. Chem. Soc. 1914, *105*, 1926-41.

EXPERIMENTAL VALUES:

The $Ca(OH)_2 + Ca(NO_3)_2 + H_2O$ system at 25 and 100°C

t/°C	$Ca(NO_3)_2$ mass %	CaO mass%	Solid phase
25	0	0.115	$Ca(OH)_2$
	4.836	0.0978	"
	9.36	0.1074	"
	13.77	0.1193	"
	15.98	0.1265	"
	19.65	0.1342	"
	22.46	0.1444	"
	26.63	0.1624	"
	27.83	0.1650	"
	30.16	0.1755	"
	32.94	0.1931	"
	35.95	0.2093	"
	37.46	0.2150	"
	39.86	0.2460	"
	40.66	0.2579	"
	42.59	0.2722	"
	44.44	0.3060	"
	45.28	0.2802	$Ca_2N_2O_7 \cdot 3H_2O$
	46.80	0.2536	"
	47.79	0.2314	"
	49.03	0.2158	"
	51.07	0.1894	"
	51.62	0.1798	"
	53.20	0.1659	"
	53.58	0.1647	"
	53.79	0.1635	"
	54.93	0.1526	"
	55.25	0.1486	"
	57.72	0.0836	$Ca(NO_3)_2 \cdot 4H_2O$
	57.98	0	"

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Calcium nitrate; $Ca(NO_3)_2$; [10124-37-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bassett, H., Jr.; Taylor, H. S.

J. Chem. Soc. 1914, *105*, 1926-41.

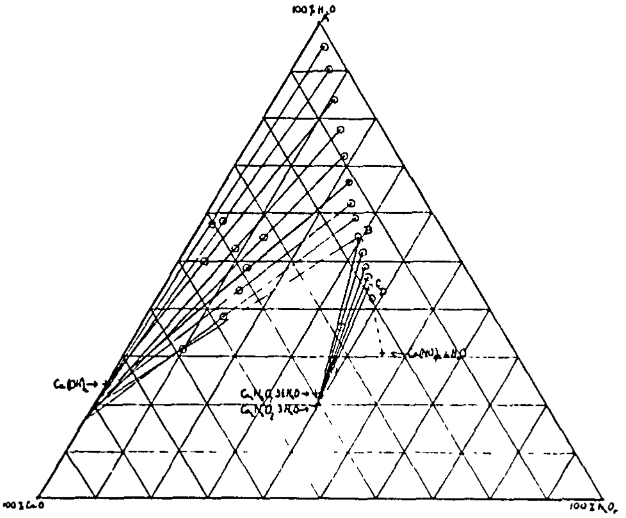
EXPERIMENTAL VALUES:

t/°C	$Ca(NO_3)_2$ mass %	CaO mass%	Solid phase
100	0	0.0561	$Ca(OH)_2$
	2.42	0.055	"
	4.91	0.0624	"
	9.90	0.081	"
	15.39	0.111	"
	16.10	0.120	"
	21.86	0.155	"
	33.03	0.269	"
	42.26	0.480	"
	47.76	0.713	"
	50.94	0.973	"
	53.75	1.261	"
	55.40	1.477	"
	55.43	1.476	"
	55.65	1.491	"
	56.89	1.635	$Ca(OH)_2 + Ca_2N_2O_7\cdot 2H_2O$
	57.03	1.686	"
	57.91	1.596	$Ca_2N_2O_7\cdot 2H_2O$
	58.16	1.534	"
	58.67	1.576	"
	59.32	1.419	"
	59.56	1.420	"
	59.58	1.423	"
	60.34	1.362	"
	60.44	1.348	"
	61.06	1.323	"
	61.29	1.320	"
	62.82	1.167	"
	64.35	1.088	"
	66.44	1.077	"
	67.10	1.084	"
	68.05	1.120	"
	68.57	1.135	"
	69.08	1.174	"
	69.12	1.141	"
	70.60	1.252	$Ca_2N_2O_7\cdot 2H_2O + Ca_2N_2O_7\cdot {}^1/_2H_2O$
	70.40	1.203	$Ca_2N_2O_7\cdot {}^1/_2H_2O$
	71.35	1.140	"
	71.44	1.103	"
	71.70	1.071	"
	72.70	1.044	"
	72.77	0.995	"
	73.85	0.937	"
	74.57	0.920	"
	74.94	0.886	"
	75.74	0.849	"
	76.64	0.814	"
	76.94	0.815	"
	77.62	0.804	$Ca(NO_3)_2$
	77.74	0.412	"
	78.43	0	"

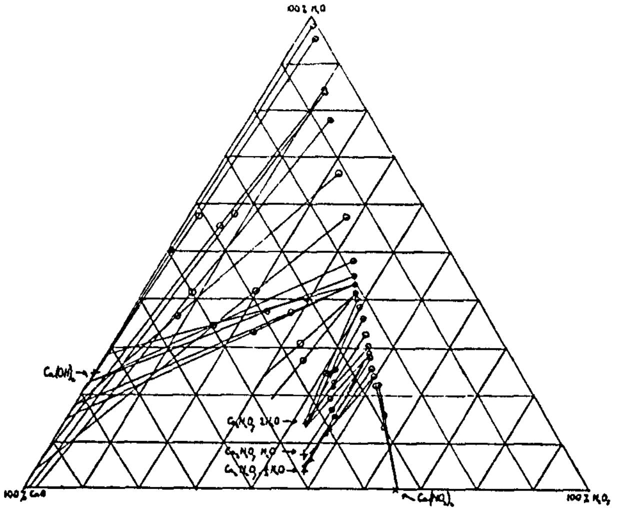
(continued on next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium nitrate; $Ca(NO_3)_2$; [10124-37-5] (3) Water; H_2O; [7732-18-5]	Bassett, H., Jr.; Taylor, H. S. *J. Chem. Soc.* <u>1914</u>, *105*, 1926-41.

EXPERIMENTAL VALUES:



$CaO + N_2O_5 + H_2O$ system at t/°C = 25



$CaO + N_2O_5 + H_2O$ system at t/°C = 100

(continued on next page)

COMPONENTS: (1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Calcium nitrate; $Ca(NO_3)_2$; [10124-37-5] (3) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Bassett, H., Jr.; Taylor, H. S. *J. Chem. Soc.* 1914, *105*, 1926-41.
VARIABLES: T/K = 298, 373 Composition	PREPARED BY: H. Einaga Y. Komatsu

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ was rotated in a thermostat with aqueous $Ca(NO_3)_2$ solutions in ceresin wax bottles at 25 ± 0.2 or 100 ± 0.2°C for 4 days to 6 months. The supernatant was analyzed for $Ca(OH)_2$ by titration with standard HNO_3 solution using methyl orange indicator. Total Ca in the titrated solution was determined gravimetrically as the oxalate. $Ca(NO_3)_2$ present was calculated from the difference.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. CaO was prepared by the ignition of precipitated $CaCO_3$.

(2) Calcium nitrate. Obtained from Merck; contained 0.017 % MgO.

ESTIMATED ERROR:

Temp.: precision ± 0.2 K.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Strontium chloride; $SrCl_2$; [10476-85-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.053 - 3.18$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous $SrCl_2$ at 25°C

$SrCl_2$ $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.053	0.02624
0.120	0.03043
0.283	0.03702
0.445	0.04135
0.823	0.04819
1.33	0.05336
2.19	0.05622
2.23	0.05623
3.18	0.05537

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous strontium chloride solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and $SrCl_2$ was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Strontium chloride. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.019 - 1.59$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous $BaCl_2$ at 25°C

$BaCl_2$ $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.019	0.02283
0.037	0.02470
0.066	0.02683
0.111	0.02945
0.159	0.03157
0.287	0.03578
0.425	0.03910
0.624	0.04246
1.29	0.04916
1.44	0.04991
1.59	0.05022

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous barium chloride solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and $BaCl_2$ was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Barium chloride. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Lithium hydroxide; LiOH; [1310-65-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Itkina, L. S.; Chaplygina, N. M.; Portnova, S. M.

***Zh. Neorg. Khim.* <u>1975</u>, *20*, 3396-7.

Russ. J. Inorg. Chem. (Engl. Transl.) <u>1975</u>, *20*, 1880-1.

VARIABLES:

$T/K = 423$
LiOH/mass % = 0 - 0.99

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous LiOH at 150°C

Lithium Hydroxide mass %	Calcium Hydroxide mass %
0	0.031
0.14	0.0034
0.31	0.0015
0.32	0.0020
0.32	0.0015
0.36	0.0017
0.45	0.0023
0.52	0.00185
0.70	0.00098
0.96	0.00063
0.99	0.00098

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Finely powdered CaO was equilibrated with aqueous LiOH solution at 150°C according to a literature procedure (ref 1). The resulting saturated solutions were analyzed for hydroxide ion by titration with standard HCl solution using methyl orange indicator, and for calcium ion by flame photometry.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Special high purity powder (particle diameter < 0.003 mm) containing < 1% $CaCO_3$.

(2) Lithium hydroxide. High purity $LiOH \cdot H_2O$. The aqueous LiOH stood 4 days before use to precipitate contaminated $Ca(OH)_2$. After separation and dilution to *ca* 1% LiOH solution it contained less than 2 mg Ca^{2+} per liter of solution.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Kotsupalo, N.P.; Pushnyakova, V.A.; Berger, A. S. *Zh. Neorg. Khim.* <u>1976</u>, *21*, 1365.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Lithium hydroxide; LiOH; [1310-65-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kotsupalo, N. P.; Pushnyakova, V.A. Berger, A. s.

Zh. Neorg. Khim. 1976, *21*, 1365-8.

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1976, *21*, 746-8.

VARIABLES:

T/K = 298, 323, and 373
Li_2O/mass % = 0.011 - 7.18

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous LiOH at 25, 50, and 100°C

Temperature t/°C	Lithium Oxide Li_2O/mass %	Calcium Oxide CaO/mass %
25	0.011	0.080
	0.025	0.069
	0.090	0.036
	0.525	0.0065
	1.07	0.0049
	2.50	0.0037
	4.75	0.0029
	7.18	0.0015
50	0.025	0.062
	0.090	0.022
	0.510	0.0033
	1.05	0.0020
	2.50	0.0015
	4.75	0.0006
	7.18	trace
100	0.030	0.038
	0.090	0.010
	0.510	0.0020
	1.05	0.0010
	2.42	0.0009
	4.92	trace
	7.18	trace

The solid phase in equilibrium with the saturated solution was $Ca(OH)_2$.
The solubility of $Ca(OH)_2$ in aqueous LiOH solution had a negative temperature coefficient between 25 and 100°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

CaO was equilibrated with aqueous LiOH in a Fluoroplast vessel with a hydraulic seal at specified temperature within ± 0.1 °C. The samples were stirred 10 h at 100°C and 48 h at 25°C. After saturation, Li^+ in the solution was determined by flame photometry, and Ca^{2+} by complexometry with EDTA using fluorexone as an indicator and by flame photometry.

The complexometric titration could not be used for samples high in Li_2O.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Prepared by heating high purity $CaCO_3$.

(2) Lithium hydroxide. Chemically pure $LiOH \cdot H_2O$ was used.

(3) Water.

ESTIMATED ERROR:

Relative error for the determination of Ca^{2+} was 5.5 % at 0.005 mass %, 10 % at 0.002 mass %, 30 % at 0.001 mass % and +24 to -42 % at < 0.001 mass %.
Temp.: accuracy ± 0.1 K (authors).

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Lithium chloride; LiCl; [7447-41-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.054 - 10.37$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous LiCl at 25°C

LiCl $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.054	0.02266
0.115	0.02473
0.249	0.02799
0.465	0.03172
0.830	0.03573
1.37	0.03990
1.85	0.04239
2.25	0.04405
3.03	0.04643
3.81	0.04762
5.36	0.04845
10.37	0.04472

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous lithium chloride solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and LiCl was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Lithium chloride. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

d'Anselme, A.

Bull. Soc. Chim. Fr. 1903, *29*, 936-9.

VARIABLES:

T/K = 293 - 373

c_2/mol L^{-1} = 0 - 0.5

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of calcium hydroxide in aqueous sodium hydroxide

t/°C	Sodium hydroxide c_2/mol L^{-1}	Calcium oxide g L^{-1}	Calcium hydroxide c_1/mol L^{-1} [a]
20	0	1.170	0.02086
	0.01	0.940	0.0168
	0.04	0.570	0.0102
	0.0667	0.390	0.00695
	0.125	0.180	0.00321
	0.2	0.110	0.00196
	0.5	0.020	0.00036
50	0	0.880	0.0157
	0.01	0.650	0.0116
	0.04	0.350	0.00624
	0.0667	0.200	0.00357
	0.125	0.060	0.0011
	0.2	0.020	0.00036
	0.5	trace	trace
70	0	0.750	0.0134
	0.01	0.530	0.00945
	0.04	0.225	0.00401
	0.0667	0.110	0.00196
	0.125	0.040	0.00071
	0.2	0.010	0.00018
	0.5	0.000	0.00000
100	0	0.540	0.00963
	0.01	0.350	0.00624
	0.04	0.140	0.00250
	0.0667	0.050	0.00089
	0.125	0.010	0.00018
	0.2	trace	trace
	0.5	0.000	0.00000

---

[a] Calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Calcium hydroxide was equilibrated with aqueous NaOH solution at a specified temperature by mechanical stirring for four hours. The calcium ion in the saturated solution was precipitated as calcium carbonate by the addition of ammonium carbonate. The calcium carbonate was converted to calcium sulfate with sulfuric acid.

NOTE: Bodlander, G.; Lucas, R. *Z. Angew. Chem.* 1905, *18*, 1137 quote the 50°C data above. They also present data on the reversibility of CO_3^{2-}(aq) + $Ca(OH)_2$(s) = $CaCO_3$(s)+$2OH^-$(aq).

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Fratini, N.

Ann. Chim. Appl. 1949, *39*, 616-20.

VARIABLES:

$T/K = 293, 313$

$c_2/\text{mol L}^{-1} = 0 - 0.209$

PREPARED BY:

H. Einaga

I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous NaOH at 20 and 40°C

	Sodium Hydroxide	Calcium Hydroxide
$t/°C$	$c_2/\text{mol L}^{-1}$	$c_1/\text{mol L}^{-1}$
20	0	0.0210
	0.0252	0.0139
	0.0525	0.0092
	0.1035	0.0050
	0.1535	0.0035
	0.2090	0.0026
40	0	0.0180
	0.050	0.0071
	0.1495	0.0025

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Calcium oxide was equilibrated with aqueous NaOH solution at a specified temperature by agitation. The resulting saturated solutions were filtered, and the filtrate was analyzed for hydroxide ion by titration with standard HCl solution, and for calcium ion by titration with a standard permanganate solution after its separation as the oxalate. The filtration and analytical procedures were carried out in the absence of atmospheric carbon dioxide.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Analytical grade CaO was digested four days in boiling distilled water in order to obtain large crystals [ref 1].

(2) Sodium hydroxide. Nothing specified.

(3) Water. Distilled.

ESTIMATED ERROR:

No estimate possible.

REFERENCES.

(1) Bassett, H.
J. Chem. Soc. 1934, 1270.

COMPONENTS:

(1) Calcium Hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Sodium Chloride; NaCl; [7647-14-5]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Maigret, E.

Bull. Soc. Chim. Fr. <u>1905</u>, 631-4.

VARIABLES:

Room Temperature
Concentrations of NaOH and NaCl

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous NaOH + NaCl at room temperature

Sodium Hydroxide /g L^{-1}	Sodium Chloride /g L^{-1}	Calcium Oxide /g L^{-1}	Calcium Hydroxide c_1/mol L^{-1}
0.8	0	0.8	0.014
0.8	5	0.9	0.016
0.8	10	1.0	0.018
0.8	25	1.1	0.020
0.8	50	1.25	0.0223
0.8	75	1.4	0.025
0.8	100	1.4	0.025
0.8	125	1.3	0.023
0.8	150	1.25	0.0223
0.8	175	1.2	0.021
0.8	182	1.2	0.021
0.8	200	1.1	0.020
0.8	225	1.0	0.018
0.8	250	0.9	0.016
0.8	275	0.7	0.013
0.8	300	0.7	0.013
0.8	314	0.7	0.013
4.0	0	0.22	0.0039
4.0	75	0.55	0.0098
4.0	150	0.44	0.0079
4.0	300	0.22	0.0039

The concentrations of $Ca(OH)_2$ were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ was equilibrated with aqueous solutions containing NaOH and NaCl. The resulting saturated solutions were filtered, and the dissolved $Ca(OH)_2$ in the filtrate determined by titration with standard HCl solution using phenolphthalein as indicator.

SOURCE AND PURITY OF MATERIALS:

(2) Sodium hydroxide. Decarbonated by addition of $Ba(OH)_2$.

Nothing else specified.

ESTIMATED ERROR:

Measurements are given by the author as approximate.

REFERENCES:

COMPONENTS:

(1) Calcium Hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium Chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Maigret, E.

Bull. Soc. Chim. Fr. 1905, 631-4.

VARIABLES:

Room Temperature
Concentrations of NaOH and NaCl

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous NaCl at room temperature

Sodium Chloride /g L^{-1}	Calcium Oxide /g L^{-1}	Calcium Hydroxide c_1/mol L^{-1}
0	1.3	0.023
5	1.4	0.025
10	1.6	0.029
25	1.7	0.030
50	1.8	0.032
75	1.9	0.034
100	1.85	0.0330
125	1.7	0.030
150	1.65	0.0294
175	1.6	0.029
182	1.6	0.029
200	1.55	0.0276
225	1.4	0.025
250	1.3	0.023
275	1.2	0.021
300	1.1	0.020
314	1.0	0.018

The concentrations of $Ca(OH)_2$ were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ was equilibrated with aqueous solutions containing NaCl. The resulting saturated solutions were filtered, and the dissolved $Ca(OH)_2$ in the filtrate determined by titration with standard HCl solution using phenolphthalein as indicator.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Measurements are given by the author as approximate.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0 - 3.76$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous NaCl at 25°C

NaCl $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.012	0.02065
0.064	0.02268
0.121	0.02402
0.366	0.02718
0.763	0.02911
1.21	0.02966
1.75	0.02933
2.15	0.02857
2.24	0.02833
2.81	0.02669
3.76	0.02410

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium chloride solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and NaCl was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2 (ref 1). Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium chloride. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

1. Johnston, J.
J. Am. Chem. Soc. 1914, *36*, 6.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kilde, G.

Z. Anorg. Allg. Chem. 1934, *218*, 113-28.

VARIABLES:

$T/K = 298$

$c_2/\text{mol L}^{-1} = 0 - 0.121$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility product of $Ca(OH)_2$ in aqueous NaCl at 25°C

NaCl	$Ca(OH)_2$	Ca^{2+}	$CaOH^+$	OH^-	Solubility Product
$c_2/\text{mol L}^{-1}$	$c_1/\text{mol L}^{-1}$	$c/\text{mol L}^{-1}$	$c/\text{mol L}^{-1}$	$c/\text{mol L}^{-1}$	$10^6 K_{s0}/(\text{mol L}^{-1})^3$
0	0.01976	0.0146	0.0052	0.0343	18.1
0.012	0.02065	0.0154	0.0052	0.0360	19.9
0.064	0.02268	0.0176	0.0051	0.0402	28.5
0.121	0.02402	0.0188	0.0052	0.0428	34.4

The experimental data in columns 1 and 2 are from (ref 1).

The author calculated the concentrations of Ca^{2+}, $CaOH^+$, and OH^- ions from his study of the dissociation of $Ca(OH)_2$. He measured the solubility of $Ca(IO_3)_2$ in solutions of NaOH and $Ca(OH)_2$. By assuming that the small amount of IO_3^- dissolved is entirely ionized the dissociation of $Ca(OH)_2$ can be computed. See *Solubility Series* 1983, *14*, 99 and 102.

The thermodynamic solubility product, $K^\circ_{s0} = 5.47 \times 10^{-6}$, was calculated from K_{s0} values using activity coefficients of $Ca(OH)_2$, Ca^{2+}, $CaOH^+$, and OH^- (ref 2). The activity coefficient relations used were:

$\log f_{Ca2+} - 3 \log f_{Ca(OH)2} - 2 \log f_{OH-}$,

$\log f_{CaOH+} = -0.50\ I^{0\ 5} + 0.1\ I$, and

$\log f_{Ca(OH)2} = -1.008\ I^{0.5} + 0.90\ I$, where I is ionic strength.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The author's experiment was the determination of the solubility of $Ca(IO_3)_2$ in the presence of NaCl and NaOH or NaCl and $Ca(OH)_2$. From his experiment he calculated the dissociation of $Ca(OH)_2$ which he then applied to the solubility data of Johnston and Grove (ref 1) to obtain the $Ca(OH)_2$ solubility product as described above.

SOURCE AND PURITY OF MATERIALS:

See paper (ref 1) and data sheet in this volume of Johnston and Grove.

ESTIMATED ERROR:

REFERENCES:

1. Johnston, J.; Grove, C. *J. Am. Chem. Soc.* 1931, *53*, 3976.
2. Bejurrum, N.; Unmack, A. *Mat.-Fys. Medd.-K. Dan. Vidensk. Selesk.* 1929, *9*, 1.

COMPONENTS.

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Dschorbenadse, D.; Mosebach, R.; Nacken, R.

Zement 1942, *31*, 513-8.

VARIABLES:

$T/K = 293$
$m_2/\text{mol kg}^{-1} = 0 - 0.200$

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The solubility of calcium hydroxide in aqueous sodium chloride at 25 °C

Sodium chloride $m_2/\text{mol kg}^{-1}$	Calcium oxide $/\text{g kg}^{-1}$	Calcium hydroxide $m_1/\text{mol kg}^{-1}$
0	1.2408	0.022126
0.005	1.2896	0.022996
0.010	1.3136	0.023424
0.020	1.3432	0.023951
0.030	1.3704	0.024437
0.040	1.3788	0.024586
0.050	1.4216	0.025350
0.100	1.4664	0.026148
0.200	1.5552	0.027732

Increase in solubility of $Ca(OH)_2$ with increasing NaCl molality was explained by the contribution of the equilibrium $Ca(OH)_2 + 2NaCl = CaCl_2 + 2NaOH$.

The compiler calculated the $Ca(OH)_2$ molality values.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Komar, N. P.; Vovk, S. I.
Sinyuta, T. I.

Zh. Fiz. Khim. 1976, 50, 2403-4.

Russ. J. Phys. Chem. (Engl. Transl.) 1976, *50*, 1439.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0 - 3.0$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous NaCl at 25°C

Sodium Chloride $c_2/\text{mol L}^{-1}$	Calcium Hydroxide $c_1/\text{mol L}^{-1}$	Sodium Chloride $c_2/\text{mol L}^{-1}$	Calcium Hydroxide $c_1/\text{mol L}^{-1}$
0	0.0203	1.20	0.0291
0.05	0.0222	1.50	0.0287
0.10	0.0235	1.70	0.0284
0.15	0.0245	2.00	0.0275
0.25	0.0260	2.20	0.0272
0.40	0.0272	2.50	0.0263
0.50	0.0278	2.70	0.0256
0.70	0.0286	3.00	0.0245
1.00	0.0290	-	-

The solubility product of $Ca(OH)_2$, $K_{s0}^{\circ} = a_{Ca^{2+}} \cdot a_{OH^-}^{2}$, was calculated from the measured concentration of $Ca(OH)_2$ and the hydrogen ion activity, a_{H^+}, by considering the following equilibria:

$2H_2O = H_3O^+ + OH^-$; $Ca^{2+} + H_2O = CaOH^+ + H_3O^+$; $Ca(OH)_2(s) = Ca^{2+} + 2OH^-$.

From the relations, $[Ca(OH)_2] = [Ca^{2+}] + [CaOH^+]$ and $2[Ca^{2+}] + [CaOH^+] = [OH^-]$, and using the activity coefficients of Ca^{2+} and OH^- calculated from the Debye-Huckel equation, $\log K_{s0}^{\circ} = -5.22 \pm 0.02$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ was equilibrated with aqueous NaCl solution at 25.0 ± 0.1°C by shaking for 2 h. The saturated aqueous phase was filtered, and the dissolved $Ca(OH)_2$ was determined by titration with standard HCl solution using phenolphthalein indicator. All procedures were carried out under a nitrogen atmosphere. The pH of the saturated solution was determined potentiometrically using a hydrogen electrode.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Prepared from reagent grade CaO. The CaO was calcinated 1 h at 1000-1100°C, and the product slaked in a Soxhlet apparatus. The $Ca(OH)_2$ formed was dried in a N_2 atmosphere.

(2) Sodium chloride. Reagent grade.

(3) Water. CO_2 free conductivity water ($<2 \times 10^{-6}\ \Omega^{-1}$).

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5] *or* Potassium chloride; KCl; [7447-40-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cabot, G. L.

J. Soc. Chem. Ind. London 1897, *16*, 417-9.

VARIABLES:

T/K = 273, 288, 372
Concentration

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous NaCl or KCl at 0, 15 and 99°C

t/°C	Alkali Chloride		CaO	$Ca(OH)_2$
	/g L^{-1}	c_2/mol L^{-1}	/g L^{-1}	c_1/mol L^{-1}
	Sodium chloride			
0	0	0	1.36	0.0243
	30	0.51	1.813	0.0323
	60	1.03	1.909	0.0340
	120	2.05	1.86	0.0332
	240	4.11	1.37	0.0244
	320	5.48	1.054	0.0188
5	60	1.03	1.872	0.0334
7	60	1.03	1.861	0.0332
10	120	2.05	1.756	0.0313
15	0	0	1.31	0.0234
	30	0.51	1.703	0.0304
	60	1.03	1.824	0.0325
	120	2.05	1.722	0.0307
	240	4.11	1.274	0.0227
	320	5.48	0.929	0.0166
17	120	2.05	1.712	0.0305
99	0	0	0.635	0.0113
	30	0.51	0.969	0.0173
	60	1.03	1.004	0.0179
	120	2.05	1.015	0.0181
	240	4.11	0.771	0.0137
	320	5.48	0.583	0.0104
	Potassium chloride			
0	0	0	1.36	0.0243
	30	0.40	1.701	0.0303
	60	0.80	1.725	0.0308
	120	1.61	1.718	0.0306
	240	3.22	1.248	0.0223
	sat	-	1.21	0.0216
15	0	0	1.31	0.0234
	30	0.40	1.658	0.0296
	60	0.80	1.674	0.0299
	120	1.61	1.606	0.0286
	240	3.22	1.199	0.0214
99	0	0	0.635	0.0113
	30	0.40	0.7883	0.0141
	60	0.80	0.8764	0.0156
	120	1.61	0.8938	0.0159
	240	3.22	0.6172	0.0110
	sat	-	0.5614	0.0100

The c/mol L^{-1} values were calculated by the compiler.

There was nothing specified about method, apparatus or procedure or about source and purity of materials. No error estimates were possible.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chlorate; $NaClO_3$; [7775-09-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. <u>1931</u>, *53*, 3976-91.

VARIABLES:

$T/K = 298$

$m_2/\text{mol kg}^{-1} = 0.189 - 4.56$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous $NaClO_3$ at 25°C

$NaClO_3$ $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.189	0.02466
0.386	0.02643
0.716	0.02755
0.814	0.02765
1.14	0.02776
1.59	0.02731
1.97	0.02618
2.96	0.02352
4.56	0.01899

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium chlorate solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and $NaClO_3$ was determined gravimetrically for the dried residue as sulfate.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium chlorate. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.118 - 3.57$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous $NaClO_4$ at 25°C

$NaClO_4$ $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.118	0.02325
0.399	0.02538
0.476	0.02562
0.776	0.02566
1.16	0.02479
1.58	0.02353
2.40	0.02046
3.57	0.01624

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium perchlorate solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and $NaClO_4$ was determined gravimetrically for the dried residue.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium perchlorate. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Sodium bromide; NaBr; [7647-15-6] (3) Water; H_2O; [7732-18-5]	Johnston, J.; Grove, C. *J. Am. Chem. Soc.* 1931, *53*, 3976-91.
VARIABLES:	PREPARED BY:
$T/K = 298$ $m_2/\text{mol kg}^{-1} = 0.189 - 2.90$	H. Einaga Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous NaBr at 25°C

NaBr $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.189	0.02485
0.348	0.02641
0.721	0.02805
0.979	0.02847
1.30	0.02841
1.77	0.02780
2.90	0.02478

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium bromide solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and NaBr was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium bromide. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium iodide; NaI; [7681-82-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.085 - 4.21$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous NaI at 25°C

NaI $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.085	0.02261
0.159	0.02410
0.356	0.02590
0.605	0.02678
0.904	0.02702
1.33	0.02662
1.60	0.02605
1.83	0.02541
2.11	0.02466
2.86	0.02228
4.21	0.01871

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium iodide solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and NaI was determined titrimetrically by the Volhard method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium iodide. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium nitrite; $NaNO_2$; [7632-00-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.252 - 5.82$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous $NaNO_2$ at 25°C

$NaNO_2$ $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.252	0.02665
0.455	0.02894
0.854	0.03127
1.30	0.03255
2.03	0.03321
2.90	0.03322
4.12	0.03204
5.82	0.02964

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium nitrite solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and $NaNO_2$ was determined gravimetrically for the dried residue as sulfate.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium nitrite. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.176 - 4.72$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous $NaNO_3$ at 25°C

$NaNO_3$ $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.176	0.02538
0.217	0.02592
0.351	0.02767
0.510	0.02915
0.838	0.03098
1.35	0.03230
1.76	0.03275
2.27	0.03274
2.81	0.03231
3.78	0.03079
4.72	0.02931

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium nitrate solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and $NaNO_3$ was determined gravimetrically for the dried residue as sulfate.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium nitrate. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Yeatts, L. B.; Marshall, W. L.

J. Phys. Chem. 1967, *71*, 2641-50.

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous $NaNO_3$

t/°C	$NaNO_3$ m_2/mol kg^{-1}	$Ca(OH)_2$ m_1/mol kg^{-1}
0.5	0	0.0229
	0	0.0228
	0	0.0226
	0.0487	0.0252
	0.219	0.0300
	0.412	0.0327
	0.882	0.0369
	1.24	0.0377
	2.73	0.0390
	4.87	0.0363
	4.87	0.0379
	4.87	0.0380
	4.87	0.0379
25	0	0.0202
	0.0527	0.0224
	0.229	0.0264
	0.437	0.0286
	0.888	0.0307
	1.33	0.0320
	2.80	0.0320
	4.72	0.0289
50	0	0.0167
	0.0195	0.0181
	0.102	0.0201
	0.207	0.0220
	0.390	0.0241
	0.842	0.0260
	2.31	0.0268
	4.79	0.0233
100	0	0.00999
	0	0.0103
	0.0231	0.0109
	0.0549	0.0119
	0.104	0.0129
	0.116	0.0129
	0.212	0.0139
	0.286	0.0147
	0.416	0.0156
	0.542	0.0164
	0.834	0.0174
	1.35	0.0183
	2.33	0.0187
	2.79	0.0181
	4.71	0.0177
	5.97	0.0170
125	0	0.00737
150	0	0.00543
	0	0.00552
	0.0257	0.00619
	0.106	0.00756

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Yeatts, L. B.; Marshall, W. L.

J. Phys. Chem. 1967, *71*, 2641-50.

EXPERIMENTAL VALUES:

t/°C	$NaNO_3$ m_2/mol kg^{-1}	$Ca(OH)_2$ m_1/mol kg^{-1}
150	0.205	0.00856
	0.415	0.00979
	0.840	0.0114
	2.243	0.0133
	4.71	0.0139
175	0	0.00401
200	0	0.00287
	0	0.00297
	0.0232	0.00348
	0.105	0.00456
	0.210	0.00518
	0.417	0.00633
	0.837	0.00779
	2.38	0.0104
	4.68	0.0124
225	0	0.00209
250	0	0.00146
	0	0.00142
	0.0225	0.00181
	0.103	0.00257
	0.106	0.00265
	0.216	0.00327
	0.256	0.00345
	0.416	0.00412
	0.513	0.00440
	0.846	0.00556
	1.30	0.00660
	2.25	0.00852
	2.70	0.00929
	4.62	0.0118
	6.29	0.0139
275	0	0.000909
300	0	0.000604
	0	0.000641
	0.0218	0.000946
	0.0545	0.00129
	0.107	0.00155
	0.122	0.00172
	0.207	0.00220
	0.308	0.00271
	0.425	0.00288
	0.542	0.00333
	0.838	0.00449
	1.41	0.00565
	2.17	0.00765
	2.77	0.00900
	4.65	0.0144
325	0	0.000317

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Yeatts, L. B.; Marshall, W. L.

J. Phys. Chem. 1967, *71*, 2641-50.

EXPERIMENTAL VALUES:

$t/°C$	$NaNO_3$ $m_2/mol\ kg^{-1}$	$Ca(OH)_2$ $m_1/mol\ kg^{-1}$
350	0	0.000197
	0	0.000192
	0.0250	0.000445
	0.116	0.000923
	0.232	0.00128
	0.235	0.00142
	0.461	0.00178
	0.549	0.00235
	0.875	0.00331
	0.878	0.00314
	2.27	0.00661
	2.34	0.00733
	4.81	0.0129
	4.91	0.0125

Solubility product as a function of temperature

$t/°C$	K°_{s0}
0	1.32×10^{-5}
25	9.37×10^{-6}
50	5.68×10^{-6}
75	3.05×10^{-6}
100	1.47×10^{-6}
150	2.68×10^{-7}
200	3.74×10^{-8}
250	4.27×10^{-9}
300	4.13×10^{-10}
350	1.08×10^{-11}[a]
350	3.51×10^{-11}[b]

[a] Calculated by equation I.
[b] Calculated by equation II.

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Yeatts, L. B.; Marshall, W. L.

J. Phys. Chem. <u>1967</u>, *71*, 2641-50.

VARIABLES:

T/K = 273 - 623
m_2/mol kg^{-1} = 0 - 6.29

PREPARED BY:

H. Einaga
Y. Komatsu
I. Lambert

EXPERIMENTAL VALUES:

The solubility product, K°_{s0}, was calculated from experimental data according to the following relation (equation I):

$$K^\circ_{s0} = \log K_{s0} + 3\log \gamma_{\pm}.$$

$$\log \gamma_{\pm} = -2S\mu^{1/2}/(1 + A\mu^{1/2}) - B\mu - C\mu^2$$

is the extended Debye-Huckel equation. K_{s0} is the stoichiometric solubility product at the ionic strength μ (in molal units), $\gamma_{\pm}$ signifies a mean activity coefficient of Ca^{2+} and OH^-, S is the limiting Debye-Huckel slope for a 1:1 electrolyte, and A, B, and C are empirically derived constants.

The following relation (equation II) was deduced experimentally,

$$\log K^\circ_{s0} = -25.7085 + 12.9722 \log(T/K) - 530.49/(T/K) - 0.0323310(T/K).$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

For the two lower temperatures solid $Ca(OH)_2$ was equilibrated with aqueous $NaNO_3$ solution in Kel F 800 coated pyrex bottles at the desired temperature for 2 to 5 hours. At the higher temperatures special high pressure vessels were used (ref 1) and equilibration time was 22-64 hours.The resulting solutions were analyzed for Ca^{2+} by complexometry and for $NaNO_3 + Ca(OH)_2$ by gravimetry after neutralization with HNO_3 and evaporation to dryness.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Reagent grade; in the 0.5 and 25°C experiments, the $Ca(OH)_2$ used was predigested at 250° for four hours.

(2) Sodium nitrate. Reagent grade.

(3) Water.

ESTIMATED ERROR:

The estimated error in the solubility data was calculated by the compilers to be less that 2% below 150°C; above this, it increased with temperature to 6% at 350°.

REFERENCES:

1. Marshall, W. L.; Jones, E. V. *J. Phys. Chem.* <u>1966</u>, *70*, 4028.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium acetate; CH_3COONa; [127-09-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.188 - 4.88$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous CH_3COONa at 25°C

CH_3COONa $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.188	0.02633
0.588	0.03243
0.692	0.03295
0.972	0.03383
1.01	0.03492
1.67	0.03648
3.26	0.03718
3.64	0.03679
4.88	0.03497

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous sodium acetate solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein as indicator, and CH_3COONa was determined gravimetrically for the dried residue.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Sodium acetate. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Potassium hydroxide; KOH; [1310-58-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Fratini, N.

Ann. Chim. Appl. 1949, *39*, 616-20.

VARIABLES:

$T/K = 293, 313$

$c_2/\text{mol L}^{-1} = 0 - 0.212$

PREPARED BY:

H. Einaga

I. Lambert

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous KOH at 20 and 40°C

	Potassium Hydroxide	Calcium Hydroxide
$t/°C$	$c_2/\text{mol L}^{-1}$	$c_1/\text{mol L}^{-1}$
20	0	0.0210
	0.0206	0.0152
	0.0412	0.0109
	0.0746	0.0068
	0.1048	0.0049
	0.1537	0.0033
	0.2120	0.0027
40	0	0.0180
	0.0200	0.0123
	0.0737	0.0050
	0.1012	0.0036
	0.1977	0.0019

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Calcium oxide was equilibrated with aqueous KOH solution at a specified temperature by agitation. The resulting saturated solutions were filtered, and the filtrate was analyzed for hydroxide ion by titration with standard HCl solution, and for calcium ion by titration with standard permanganate solution after its separation as the oxalate. The filtration and analytical procedures were carried out in the absence of atmospheric carbon dioxide.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Analytical grade CaO was digested four days in boiling distilled water in order to obtain large crystals (ref 1).

(2) Potassium hydroxide. Nothing specified.

(3) Water. Distilled.

ESTIMATED ERROR:

No estimate possible.

REFERENCES:

1. Bassett, H.
J. Chem. Soc. 1934, 1270.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Potassium chloride; KCl; [7447-40-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kernot, G.; d'Agostino, E.; Pellegrino, M.

Gazz. Chim. Ital. 1908, *39* [I], 532-4.

VARIABLES:

$T/K = 323$
KCl/(mol/100 g) = 0 - 0.575

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous KCl at 50°C

Potassium Chloride mol/100 g	Calcium Hydroxide mol/100 g
0	0.0029
0.0236	0.0042
0.0947	0.0045
0.1894	0.0042
0.2368	0.0038
0.2841	0.0036
0.3315	0.0033
0.3552	0.0017
0.5750	-

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Excess $Ca(OH)_2$ was equilibrated with the KCl solution in a thermostat at 50°C for 72 hours with periodic aggitation. The solution was filtered and the $Ca(OH)_2$ analyzed by neutralizing a weighed sample with excess 0.1 mol L^{-1} HCl and back-titrating with 0.1 mol L^{-1} NaOH.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydoxide. Prepared by calcination of $CaCO_3$.

(2) Potassium chloride. Prepared by neutralization of KOH by HCl. Purified by repeated recrystallizations.

(3) Water. Distilled. The fraction with minimum conductivity was used.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Potassium chloride; KCl; [7447-40-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.038 - 2.87$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous KCl at 25°C

KCl $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.038	0.02157
0.076	0.02273
0.264	0.02550
0.527	0.02708
0.989	0.02766
1.08	0.02768
1.28	0.02744
1.62	0.02696
1.96	0.02610
2.87	0.02351

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous potassium chloride solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and KCl was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2 (ref 1). Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Potassium chloride. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

1. Johnston, J.
J. Am. Chem. Soc. 1914, *36*, 6.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Potassium chloride; KCl; [7447-40-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Komar, N. P.; Vovk, S. I.

**Zh. Fiz. Khim.* 1977, *51*, 2037-40.

Russ. J. Phys. Chem. (Engl. Transl.) 1977, *51*, 1189-91.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0 - 3.50$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous KCl at 25°C

Potassium Chloride $c_2/\text{mol L}^{-1}$	Calcium Hydroxide $c_1/\text{mol L}^{-1}$	Potassium Chloride $c_2/\text{mol L}^{-1}$	Calcium Hydroxide $c_1/\text{mol L}^{-1}$
0	0.0202	1.20	0.0268
0.05	0.0223	1.50	0.0256
0.10	0.0235	1.70	0.0256
0.15	0.0242	2.00	0.0243
0.25	0.0225	2.20	0.0234
0.40	0.0263	2.50	0.0225
0.50	0.0269	2.70	0.0208
0.70	0.0271	3.00	0.0198
1.00	0.0269	3.50	0.0180

The solubility product of $Ca(OH)_2$, $K^\circ_{s0} = a_{Ca^{2+}} \cdot a_{OH^-}{}^2$, was calculated from the measured concentration of $Ca(OH)_2$ and the hydrogen ion activity, a_{H^+}, by considering the following equilibria: $2H_2O \rightleftharpoons H_3O^+ + OH^-$; $Ca^{2+} + H_2O \rightleftharpoons CaOH^+ + H_3O^+$; $Ca(OH)_2(s) \rightleftharpoons Ca^{2+} = 2OH^-$. From the relations, $[Ca(OH)_2] = [Ca^{2+}] + [CaOH^+]$ and $2[Ca^{2+}] + [CaOH^+] = [OH^-]$, and using the activity coefficients of Ca^{2+} and OH^- calculated from the Debye-Huckel equation, $\log K^\circ_{s0} = -5.35 \pm 0.01$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ was equilibrated with aqueous KCl solution at 25.0 ± 0.1°C by shaking for 2 h. The saturated aqueous phase was filtered, and the dissolved $Ca(OH)_2$ was determined by titration with standard HCl solution using phenolphthalein indicator. All procedures were carried out under a nitrogen atmosphere. The pH of the saturated solution was determined potentiometrically using a hydrogen electrode.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Prepared from reagent grade CaO. The CaO was calcinated 1 h at 1000-1100°C, and the product slaked in a Soxhlet apparatus. The $Ca(OH)_2$ formed was dried in a N_2 atmosphere.

(2) Potassium chloride. Reagent grade.

(3) Water. CO_2 free conductivity water ($<2 \times 10^{-6}\ \Omega^{-1}$).

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Potassium bromide; KBr; [7758-02-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.162 - 3.24$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous KBr at 25°C

KBr $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.162	0.02404
0.270	0.02509
0.453	0.02608
0.759	0.02669
0.930	0.02670
1.27	0.02636
1.55	0.02596
2.09	0.02441
3.24	0.02058

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous potassium bromide solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and KBr was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Potassium bromide. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Cesium chloride; CsCl; [7647-17-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Johnston, J.; Grove, C.

J. Am. Chem. Soc. 1931, *53*, 3976-91.

VARIABLES:

$T/K = 298$
$m_2/\text{mol kg}^{-1} = 0.073 - 3.55$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in aqueous CsCl at 25°C

CsCl $m_2/\text{mol kg}^{-1}$	$Ca(OH)_2$ $m_1/\text{mol kg}^{-1}$
0	0.01976
0.073	0.02236
0.199	0.02451
0.537	0.02684
0.862	0.02724
1.25	0.02703
1.56	0.02647
3.55	0.02056

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Well-defined crystals of $Ca(OH)_2$ were equilibrated at 25 ± 0.02°C for 24 hours with aqueous cesium chloride solutions and protected from atmospheric CO_2. $Ca(OH)_2$ in the saturated solutions was determined by titration with standard HCl solution using phenolphthalein and/or methyl red as indicators, and CsCl was determined titrimetrically by the Mohr method.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Crystalline form (hexagonal pyramids) of highest purity was prepared by the mutual diffusion process of $CaCl_2$ and NaOH in aqueous solution free of CO_2. Its purity was 99.92% but contained 0.075% (as NaCl) or 0.071% (as $CaCl_2$) impurity.

(2) Cesium chloride. Chemically pure grade used after several recrystallizations from distilled water.

(3) Water. Distilled.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: precision ± 0.4 % (compiler)

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Methanol; CH_4O; [67-56-1] (3) Water; H_2O; [7732-18-5]	Janković, S. *Rastvorljivost Nekih Soli Hidrokisida Zemnoalkalnih Metala u Sistemima Voda-Etil Alkohol i Voda-Metil Alkohol, i Struktura Takvih Zasicenih Rastvora.* Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

EXPERIMENTAL VALUES:

Composition of the saturated solution

t/°C	Water	Methanol		Calcium hydroxide	
	mol %	mol %[a]	mass %	$10^5 w_1$	m_1/mmol kg^{-1}[a]
25	96.0	4.0	6.9	129.0	17.4
	90.9	9.1	15.1	109.8	14.8
	86.1	13.9	22.3	95.0	12.8
	82.3	17.7	27.7	81.8	11.0
	78.0	22.0	33.4	70.8	9.56
	73.5	26.5	39.1	59.8	8.08
	68.0	32.0	45.6	47.8	6.45
	62.4	37.6	51.7	39.5	5.33
	59.3	40.7	55.0	34.7	4.69
	56.7	43.3	57.6	31.0	4.19
	50.0	50.0	64.0	24.7	3.33
	44.3	55.7	69.1	19.8	2.67
35	97.3	2.7	4.7	122.0	16.5
	93.8	6.2	10.5	107.0	14.5
	87.9	12.1	19.7	87.5	11.8
	81.7	18.3	28.5	68.5	9.25
	79.0	21.0	32.1	58.9	7.95
	77.6	22.4	33.9	56.1	7.58
	71.9	28.1	41.0	46.6	6.29
	66.0	34.0	47.8	38.0	5.13
	62.6	37.4	51.5	34.5	4.66
	57.4	42.6	56.9	30.2	4.08
	47.8	52.2	66.0	21.6	2.92
	33.8	66.2	77.7	13.5	1.82
	28.3	71.7	81.8	10.5	1.42

[a] Calculated by compiler.

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Methanol; CH_4O; [67-56-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Janković, S.

Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

EXPERIMENTAL VALUES:

Properties of the saturated solution

t/°C	Water mol %	Relative Density d^{25}_{25}	Conductivity $10^5\kappa$/S cm^{-1}	Viscosity η/mPa s
25	96.0	0.9910	570	1.14
	90.9	0.9752	345	1.35
	86.1	0.9629	220	1.49
	82.3	0.9537	150	1.60
	78.0	0.9436	100	1.67
	73.5	0.9342	60	1.72
	68.0	0.9219	37	1.66
	62.4	0.9101	17.5	1.58
	59.3	0.9017	14	1.54
	56.7	0.8971	11.8	1.50
	50.0	0.8820	6.7	1.41
	44.3	0.8795	4.6	1.30
35	97.3	0.9915	630	0.91
	93.8	0.9805	478	0.99
	87.9	0.9628	300	1.16
	81.7	0.9502	205	1.25
	79.0	0.9437	170	1.30
	77.6	0.9410	161	1.32
	71.9	0.9290	125	1.35
	66.0	0.9162	96	1.33
	62.6	0.9093	83.9	1.30
	57.4	0.8990	71	1.24
	47.8	0.8732	40	1.13
	33.8	0.8429	22	0.99
	28.3	0.8300	19	0.93

(continued on next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Methanol; CH_4O; [67-56-1] (3) Water; H_2O; [7732-18-5]	Janković, S. Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.
VARIABLES:	PREPARED BY:
T/K = 298 - 308 CH_4O mass % = 4.7 - 81.8	J. W. Lorimer

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Salt and solution were stirred for 8 days in a thermostat. After equilibration, samples were removed for analysis through a pipet fitted with a glass wool filter. Density was measured using a pycnometer; the contents of which were then used for analysis of sulfate by volumetric or colorimetric methods. Viscosity was measured using a Vogel-Ossag viscometer and conductivity with a Philips bridge (CM 4249; average reading error 2 %) and dip cell.	(1) Calcium hydroxide. C. Erba, pro analysi. (2) Methanol. Chemapol (Prague), pro analysi. (3) Water. Redistilled.
	ESTIMATED ERROR:
	Temp.: precision within ± 0.05 K. Soly.: no estimates possible.
	REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Ethanol; C_2H_6O; [64-17-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Janković, S. *Rastvorljivost Nekih Soli i Hidrokisida Zemnoalkalnih Metala u Sistemima Voda-Etil Alkohol i Voda-Metil Alkohol, i Struktura Takvih Zasicenih Rastvora.* Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

Water	Ethanol		Calcium hydroxide	
mol %	mol %[a]	mass %	$10^5 w_1$	m_1/mmol kg^{-1}[a]
95.8	4.2	10.1	73.5	9.93
91.9	8.1	18.4	47.0	6.35
86.7	13.3	28.2	26.7	3.60
82.4	17.6	35.3	17.9	2.42
76.2	23.8	44.4	11.0	1.48
70.1	29.9	52.2	6.1	0.82
64.9	35.1	58.0	4.1	0.55
57.2	42.8	65.7	2.0	0.27
47.9	52.1	73.6	1.1	0.15
23.8	76.2	89.1	0.1	0.01

[a] Calculated by compiler.

Properties of the saturated solution at 25°C

Water mol %	Relative Density d_{25}^{25}	Conductivity $10^5\kappa$/S cm^{-1}	Viscosity η/mPa s
95.8	0.9891	335	1.52
91.9	0.9721	172	1.82
86.7	0.9564	68.9	2.26
82.4	0.9460	36.9	2.43
76.2	0.9249	15.5	2.44
70.1	0.9101	6.6	2.42
64.9	0.898	3.0	2.38
57.2	0.8801	1.2	2.27
47.9	0.8585	0.43	2.03
23.8	0.8212	0.13	1.54

(continued on next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (2) Ethanol; C_2H_6O; [64-17-5] (3) Water; H_2O; [7732-18-5]	Jankovič, S. Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.
VARIABLES:	PREPARED BY:
$T/K = 298$ C_2H_6O mass % = 10.1 - 89.1	J. W. Lorimer

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Salt and solution were stirred for 8 days in a thermostat. After equilibration, samples were removed for analysis through a pipet fitted with a glass wool filter. Density was measured using a pycnometer; the contents of which were then used for analysis of sulfate by volumetric or colorimetric methods. Viscosity was measured using a Vogel-Ossag viscometer and conductivity with a Philips bridge (CM 4249; average reading error 2 %) and dip cell.	(1) Calcium hydroxide. C. Erba, pro analysi. (2) Ethanol. C. Erba, anhydrous, 99.9 - 100 % pure, density 0.795. (3) Water. Redistilled.
	ESTIMATED ERROR:
	Temp.: precision within ± 0.05 K. Soly.: no estimates possible.
	REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) 1,2,3-Propanetriol (glycerol); $C_3H_8O_3$; [56-81-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Herz, W.; Knoch, M.

Z. Anorg. Chem. 1905, *46*, 193-6.

VARIABLES:

T/K = 298
Glycerol/mass % = 0 - 69.2

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous glycerol at 25°C

1,2,3-Propanetriol mass %	$(1/2)Ca(OH)_2$ c_1/mmol (100 mL sln)$^{-1}$	$Ca(OH)_2$ c_1/mol L^{-1}
0	4.3	0.021_5
7.15	8.13	0.0402
20.44	14.9	0.0745
31.55	22.5	0.112_5
40.95	40.1	0.200_5
48.7	44.0	0.220
69.2	95.8	0.479

The compiler calculated the $Ca(OH)_2$ concentrations in the last column.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The water + glycerol mixed solvent was saturated with $Ca(OH)_2$ at 25°C. The dissolved $Ca(OH)_2$ was determined by titration with a strong acid.

Solution specific gravities, Sp Gr_4^{25}, were given. They are 1.003, 1.0244, 1.0537, 1.0842, 1.1137, 1.1356 and 1.2072 as the glycerol increases from 0 to 69.2 mass %.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) 1,2,3-Propanetriol or glycerol; $C_3H_8O_3$; [56-81-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cameron, F. K.; Pattern, H. E.

J. Phys. Chem. 1911, *15*, 67-72.

VARIABLES:

$T/K = 298$

$C_3H_8O_3$/mass % = 0 - 55.04

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous glycerol at 25°C

$C_3H_8O_3$ mass %	$Ca(OH)_2$ mass %	Solution Density ρ/g cm^{-3}
0	0.117	0.983
3.30	0.178	1.008
15.59	0.413	-
17.84	0.48	1.042
34.32	0.88	1.088
55.04	1.34	1.149

Solid phase assumed to be $Ca(OH)_2$

The solubility of $Ca(OH)_2$ in water is from Cameron and Bell (ref 1).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details are given. Method must be the same as in the case of the $Ca(OH)_2$ + sucrose + H_2O system. See that data sheet from this paper.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Cameron, F. K.; Bell, J. M. *Bull. No. 49*, 1907, Bureau of Soils, US Department of Agriculture.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Calcium formate; $Ca(HCOO)_2$; [544-17-2]

(4) Formaldehyde; CH_2O; [50-00-0]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Belkin, D. J.; Belkina, N. V.

Zh. Prikl. Khim. (Leningrad) 1977, *49*, 1875-7.

J. Appl Chem. USSR (Engl. Transl.) 1977, *49*, 1882-4.

VARIABLES:

T/K = 298

c_2, c_3, and c_4

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of calcium hydroxide in an aqueous mixture of sodium hydroxide, calcium formate, and formaldehyde at 25°C

Formaldehyde c_4/mol L^{-1}	Calcium formate c_3/mol L^{-1}	Sodium hydroxide c_2/mol L^{-1}	Calcium hydroxide c_1/mol L^{-1}
1.0	0.1	0	0.06
1.0	0.2	0	0.05
6.1	0.3	0	0.08
1.4	0	0.54	0.01
2.4	0	0.08	0.17
4.8	0	0.92	0.05
3.6	0	0.5	0.08
3.6	0	0	0.23
2.4	0.1	0.5	trace
2.4	0.1	0	0.11
1.8	0.35	0.5	trace
1.8	0.35	0	0.08

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An aqueous solution of calcium formate, formaldehyde, and sodium hydroxide was equilibrated with excess calcium hydroxide for 10-15 minutes at 25 ± 0.5°C. Samples of the resulting saturated solution were analyzed for calcium ion by a gravimetric method, for calcium hydroxide by a neutralization titration method, and for the formaldehyde by using hydroxylamine. The pH of the solution was measured with a glass electrode.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Analytical grade.

(2) Sodium hydroxide. Chemically pure.

(3) Calcium formate. Chemically pure.

(4) Formaldehyde. Freshly distilled, free of methanol.

ESTIMATED ERROR:

Temp.: precision ± 0.5 K.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Phenol; C_6H_6O; [108-95-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

van Meurs, G. J.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

EXPERIMENTAL VALUES:

The system $Ca(OH)_2 + C_6H_6O + H_2O$ at 25°C

Phenol mol %	Calcium Hydroxide $(1/2)Ca(OH)_2$ mol %	Solid Phase
0.40	0.46	A
1.25	1.35	A
2.11	2.19	A
2.63	2.63	A + B
4.82	4.20	B
7.65	5.16	B
11.03	6.12	B
12.41	6.47	B
16.72	6.95	B
25.19	7.79	B
30.26	8.67	B
35.56	8.30	B
38.38	8.21	B
53.19	7.56	B
68.25	4.08	B
75.25	3.60	B + C
74.06	1.38	C
74.27	0	C

Solid Phases:

A $Ca(OH)_2$

B $Ca(C_6H_5O)_2 \cdot 3H_2O$

C C_6H_6O

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Phenol; C_6H_6O; [108-95-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

van Meurs, G. J.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

VARIABLES:

T/K = 298
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

COMMENTS AND/OR ADDITIONAL DATA: Phase Diagram.

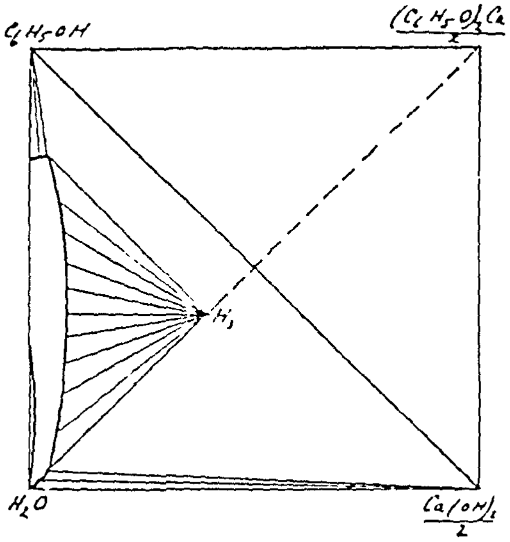


Figure. The $Ca(OH)_2 + C_6H_6O + H_2O$ system at 25°C

$H_3 = Ca(C_6H_5O)_2 \cdot 3H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ and phenol were equilibrated with water at 25°C by shaking. The resulting saturated solutions were analyzed for $Ca(OH)_2$ by titration with standard HCl or H_2SO_4 solution, and for phenol by the titration method of Koppeshaar (ref 1).

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Koppeschaar, W. F. *Z. Anal. Chem.* 1876, *15*, 233.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5

ORIGINAL MEASUREMENTS:

Weisberg, J.

Bull. Soc. Chim. Fr. 1899, *21*, 773-6.

VARIABLES:

T/K = 288-290
Sucrose/g (100 mL sln.)$^{-1}$ = 0.625-16.41

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous sucrose at 15 to 17°C

t/°C	Sucrose /g (100 mL sln)$^{-1}$	Calcium Oxide /g (100 g sucrose)$^{-1}$	Calcium Hydroxide c_1/mol L^{-1}
16 - 17	0.7814	37.9	0.0529
	0.912	32.3	0.0529
	1.400	30.5	0.0763
	1.693	28.9	0.0874
	4.754	27.7	0.235
	5.73	27.1	0.278
	10.159	27.5	0.499
	11.2	27.2	0.544
	12.5	27.3	0.609
	13.93	27.9	0.694
	14.487	27.5	0.711
	16.41	28	0.820
15	0.625	71.6	0.0799
	0.964	53.4	0.0919
	2.084	36	0.134
	3.028	32.3	0.175
	3.451	31.7	0.195
	4.168	30.2	0.225
	4.880	28.7	0.250
	5.73	28.3	0.290
	6.12	27.4	0.299
	6.25	27.7	0.309
	6.51	27.5	0.320
	7.55	27.9	0.376
	8.20	27.3	0.400

In the second series of measurements (15°C) the excess of CaO was greater than in the first series (16-17°C).

The $Ca(OH)_2$ concentrations were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Stoppered flasks containing the mixture stayed for a "long" (not specified) time at ambient temperature, and were shaken from time to time. Analytical methods were not described.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

No estimate possible.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cameron, F. K.; Pattern, H. E.

J. Phys. Chem. 1911, *15*, 67-72.

VARIABLES:

$T/K = 298$
Sucrose/mass % = 0 - 19.86

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous sucrose at 25°C

$C_{12}H_{22}O_{11}$ mass %	$Ca(OH)_2$ mass %	Solution Density $\rho/g\ cm^{-3}$
0	0.117	0.983
0.62	0.188	1.008
4.82	0.73	1.021
7.50	1.355	1.037
9.87	2.31	1.051
11.90	3.21	1.067
15.1	4.57	1.092
17.42	5.38	1.109
19.86	6.07	1.123

Attempts to determine the nature of the solid by the wet residue method failed due to the high solution viscosity which prevented satisfactory separation of mother liquid and solid. The authors state the solid is either $Ca(OH)_2$ or a series of solid solutions containing $Ca(OH)_2$.

The solubility of $Ca(OH)_2$ in water is from Cameron and Bell (ref 1).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Cane sugar solutions varying from 0.5 to 40 mass % were prepared, and slaked lime added to each in slight excess. These were brought to equilibrium at about 0°C, the supernatant liquid poured off, and the saturated liquid thermostated at 25°C where the solubility is less. A finely divided solid forms which shows no tendency to aggregate.

The sucrose in the saturated solution was determined by weighing the CO_2 formed by dry combustion of the solution. The $Ca(OH)_2$ was determined by evaporation of the solution, burning off the sucrose, and igniting to CaO.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Cameron, F. K.; Bell, J. M. *Bull. No. 49*, 1907, Bureau of Soils, US Department of Agriculture.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Von Ginnekin, P. J. M.

Versl. Gewone Vergad. Wis.-Natuurk., Afd. K. Akad. Wet. Amsterdam 1911, *20*, 442-61.

VARIABLES:

$T/K = 353$
Sucrose/mass % = 4.9 - 29.70

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$ in aqueous sucrose at 80°C

$C_{12}H_{22}O_{11}$ mass %	CaO mass %	Solid Phase
4.9	0.117	$Ca(OH)_2$
9.9	0.189	$Ca(OH)_2$
14.75	0.230	$Ca(OH)_2$
19.50	0.358	$Ca(OH)_2$
24.60	0.548	$Ca(OH)_2$
29.70	1.017	$Ca(OH)_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A solution of 5 g of $Ca(OH)_2$ in 10 g of water, and a solution of sucrose of the desired concentration are heated separately at 80°C in a thermostat. When temperature equilibrium is established the solutions are mixed with care to see that no cooling occurs. The resulting solution was shaken several hours in the thermostat. The time necessary for equilibrium was checked by performing experiments of 4, 8, and 24 hours shaking time. After 8 hours no change in composition occured.

Samples were filtered through a cotton wool plug, and analyzed for $Ca(OH)_2$ by acidimetry with phenolphthalein as indicator, and for sucrose by polarimetry.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Temp.: ± 0.2°C (precision)
Soly.: ± 0.01 (compiler estimate)

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) *α*-*D*-Glucopyranoside, *β*-*D*-fructofuranosyl (sucrose); $C_{12}H_{22}H_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Fuchs, P.

Ber. Dtsch. Chem. Ges. B 1929, *62*, 1535-8.

VARIABLES:

T/K = 290
Sucrose concentration

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

Solubility of freshly precipitated $Ca(OH)_2$ in aqueous sucrose at 17.0-17.5 °C

Sucrose	Calcium Hydroxide	
g/100 cm^3 sln.	g/100 cm^3 sln.	c_1/mol L^{-1}
0	0.304	0.0410
0.10	0.452	0.0610
0.20	0.545	0.0736
0.30	0.671	0.0906
0.40	0.785	0.106
0.50	0.871	0.118
0.60	0.915	0.124
0.70	0.943	0.127
0.90	0.926	0.125
1.20	0.911	0.123
1.40	0.893	0.121
1.50	0.882	0.119
1.60	0.900	0.122
1.70	0.904	0.122
2.10	1.193	0.1610
2.50	1.559	0.2104

The calcium hydroxide concentrations were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Aqueous sucrose solutions of known concentration were mixed with stoichiometric amounts of NaOH and $CaCl_2$ solutions. The freshly precipitated $Ca(OH)_2$ was equilibrated with the solution at 17.0-17.5 °C with frequent five minute periods of shaking. The excess solid $Ca(OH)_2$ was filtered off, and the filtrate titrated with standard HCl solution using methyl orange indicator to determine the dissolved $Ca(OH)_2$. The concentration of NaCl in the solutions is unknown.

SOURCE AND PURITY OF MATERIALS:

No description, but analytical reagent grade $CaCl_2$ and NaOH were probably used.

ESTIMATED ERROR:

Temp: range given as 17.0 to 17.5 °C.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sucrose; $C_{11}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Reinders, W.; Van Gelder, D. W.

Recl;. Trav. Chim. Pays-Bas 1932, *51*, 253-9.

VARIABLES:

T/K = 285, 298, and 318
Composition

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The CaO + $C_{12}H_{22}O_{11}$ + H_2O system between 12 and 45°C

t/°C	Sucrose mass %	Calcium Oxide mass %	Solid Phase
12	0	0.137	A
	9.8	1.99	A
	18.7	4.75	A
	29.2	8.50	A
	32.4	8.08	B
	38.6	8.01	B
	40.6	7.50	B
	45.1	7.1	B
25	0	0.122	A
	2.1	0.242	A
	4.2	0.461	A
	6.6	0.750	A
	8.6	1.11	A
	11.8	1.86	A
	15.4	2.76	A
	21.1	4.53	A
	27.2	6.72	A
	31.4	8.39	A
	35	10.10	B
	36.2	9.80	B
	43.7	8.84	B
	53.2	7.87	B
	68.3	4.08	C
45	0	0.102	A
	9.93	1.02	A
	20.0	3.19	A
	30.6	6.10	A
	40.8	9.50	A
	45.3	9.54	B
	58.3	8.0	B

Solid Phases: A $Ca(OH)_2$; B Calcium saccharate of unknown composition; C Sucrose.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ca(OH)_2$ was shaken with the sucrose solution for several days. No details are given about the temperature control. After decantation, samples were removed by aspiration, and $Ca(OH)_2$ was titrated with standard acid. Sucrose was analyzed by polarimetry.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. Prepared by hydration of CaO by excess water.

Nothing further specified.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) *α-D*-Glucopyranoside, *β-D*-fructofuranosyl (sucrose); $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bugaenko, I. F.; Samoilova, T. H.

Sakh. Prom-st. 1981, *(1)*, 27-8.

VARIABLES:

T/K = 293, 343

PREPARED BY:

A. F. Vorob'ev
D. I. Mustafin

EXPERIMENTAL VALUES:

Solubility of calcium oxide in aqueous sucrose

t/°C	Content of dry remainder in solution mass %	Calcium oxide solubility CaO g/100 ml	CaO *c*/mol L^{-1}
20	41	1.794	0.3199
	45	1.718	0.3064
	49	1.446	0.2578
	56	1.128	0.2011
70	35	2.630	0.4690
	41	2.513	0.4481
	45	2.445	0.4360
	49	1.854	0.3306
	56	1.469	0.2620

Editor's Note: Sucrose content of dry remainder in solution may be intended as second column heading.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An excess of $Ca(OH)_2$ was added to an aqueous sucrose solution (30 - 60 mass % sucrose). The mixture was stirred for six hours at the desired temperature. The solid phase was separated by centrifugation. The calcium concentration in the solution was determined complexometrically. The dry remainder (sucrose ?) content was determined by refractometry.

Editor's Note: The abstract states the solubility increases with increasing sucrose concentration up to 32-6 mass % and then decreases.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide. "Chemical pure" grade, USSR standard. The quantity of impurities was not indicated.

(2) Sucrose. Refined sugar.

(3) Water. Distilled.

ESTIMATED ERROR:

Not specified.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Sapronov, A. R.; Ozerov, D. V. Karaulov, N. E.; Fishchenko, V.N. Yan'shin, V. P.

Sakh. Prom-st. <u>1983</u>, (5), 37-9.

VARIABLES:

T/K = 298, 323

PREPARED BY:

A. F. Vorob'ev
D. I. Mustafin

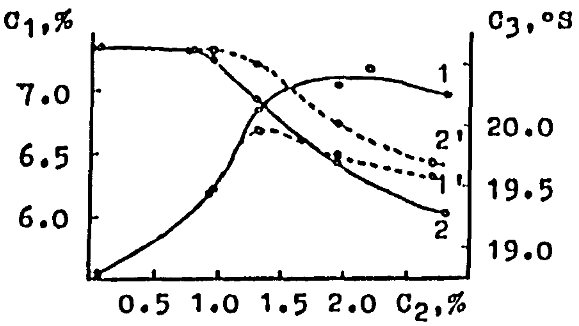
EXPERIMENTAL VALUES:

The total solid content (curves 1, 1') and polarization (curves 2, 2') of sucrose solutions as a function of added CaO at 25°C (curves 1, 2) and 50°C (curves 1' 2').

C_1 - sum of total solids in solution, mass %,

C_2 - added CaO, mass %, and

C_3 - sucrose concentration in solution, S° (each S° unit corresponds to 0.26026 g of sucrose per 100 g of solution).



AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An aqueous extract of sugar beet was treated with 0.1 g of CaO per 100 g of the extract, and the sediment was separated. CaO was added to the aqueous solutions in various amounts (0.95, 1.30, 1.95, and 2.75 g CaO per 100 g of solution), and the systems carefully mixed for five minutes. Aliquots of the saturated solutions were filtered, and the sucrose concentration determined by polarimetry. The total solids were measured by refractometry. *Editor's Note:* The difference between total solids and sucrose is a measure of the $Ca(OH)_2$ in the saturated solution (?).

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium oxide; CaO; [1305-78-8]	Koneczny, H.; Mielczarek, M.
(2) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]	*Chem. Stosow.* <u>1983</u>, *27*, 129-36.
(3) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]	
(4) Water; H_2O; [7732-18-5]	

EXPERIMENTAL VALUES:

The $Ca(OH)_2$ (CaO) + Sucrose + H_2O system at 20, 40 and 60°C

t/°C	Density	Solution Composition		Solid Composition, 10^2x			
		$Ca(OH)_2$	Sucrose	Assuming CaO in the solid		Assuming $Ca(OH)_2$ in the solid	
	ρ/g cm^{-1}	m_2/mol kg^{-1}	m_3/mol kg^{-1}	CaO	Sucrose	$Ca(OH)_2$	Sucrose
20	1.006	0.02	0.00				
	1.0121	0.08	0.10				
	1.0339	0.18	0.20				
	1.0653	0.35	0.33	100	0	100	0
	1.1278	1.20	0.67	100	0	99.02	0.98
	1.1753	1.58	1.16				
	1.2240	2.30	1.46	94.06	5.94	90.77	9.23
	1.2349	2.55	1.54	91.60	8.40	85.99	14.01
	1.2533	3.09	1.80				
	1.3157	3.26	2.81	79.43	20.57	74.42	25.57
40	0.9933	0.02	0.00				
	1.0037	0.09	0.10				
	1.0303	0.17	0.20				
	1.0446	0.28	0.29	100	0	99.56	0.44
	1.0817	0.56	0.57				
	1.1329	1.14	0.87				
	1.1878	1.85	1.27	100	0	98.02	1.98
	1.2843	3.36	2.25				
	1.2955	3.24	2.59	93.71	6.29	87.48	12.52
	1.3549	3.49	4.21	83.74	16.26	76.83	23.17
60	0.9871	0.02	0.00				
	1.0037	0.08	0.11				
	1.0168	0.10	0.20	99.97	0.03	99.59	0.41
	1.0590	0.37	0.42	97.80	2.20	99.01	0.99
	1.1004	0.74	0.72				
	1.1371	0.99	1.07	97.62	2.38	88.00	12.00
	1.2683	2.48	1.95				
	1.2760	2.91	2.29				
	1.3454	3.15	4.69				
	1.3542	2.98	5.09	97.41	2.50	84.47	15.53

Calcium is assumed to be present in both CaO and $Ca(OH)_2$.

The isotherms are represented successively by the two fitting equations (corresponding to the two parts of the curve):

y = Ax + 0.02B and y = ax + b.

The parameter values are:

t/°C	A	B	a	b
20	1.45	1.3	0.006	3.13
40	1.38	1.3	0.07	3.0
60	1.12	1.3	0.18	2.29

(continued on next page).

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Calcium oxide; CaO; [1305-78-8] (2) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] (3) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1] (4) Water; H_2O; [7732-18-5]	Koneczny, H.; Mielczarek, M. *Chem. Stosow.* 1983, *27*, 129-36.
VARIABLES:	PREPARED BY:
T/K = 293, 313, and 333	I. Lambert

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

CaO is slowly introduced into the stirred sucrose solution. After equilibration (12 hours) a sample of clear solution is taken off in an Ostwald pycnometer for density measurement and then for chemical analysis. The $Ca(OH)_2$ was analyzed by acidimetry with HCl using methyl orange as the indicator, and the sucrose was determined by polarimetry.

The composition of the solid was determined by the method of residues.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium oxide. Prepared by ignition of $Ca(OH)_2$ at 950 - 1000 °C.

(2) Calcium hydroxide. Commercial product.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Calcium chloride; $CaCl_2$; [10043-52-4]

(4) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Yokoyama, T.

Kogyo Kagaku Zasshi <u>1954</u>, *57*, 417-9.

EXPERIMENTAL VALUES:

Solubility of $Ca(OH)_2$ in $NaCl$-$CaCl_2$-sucrose solution

t/°C	NaCl c_2/mol L^{-1}	$CaCl_2$ g_3/100 g_5	Sucrose g_4/100 g_5	$Ca(OH)_2$ g_1/100 g_5
20	0.05	5	2	0.48
		10	2	0.46
		15	2	0.54
		20	2	0.59
		5	4	0.95
		10	4	0.82
		15	4	0.94
		20	4	1.02
		5	6	1.57
		10	6	1.44
		15	6	1.37
		20	6	1.40
	0.1	5	8	2.60
		10	8	2.08
		15	8	1.92
		20	8	2.09
30	0.05	5	2	0.41
		10	2	0.39
		15	2	0.43
		20	2	0.51
		5	4	0.66
		10	4	0.62
		15	4	0.73
		20	4	0.88
		5	6	1.49
		10	6	1.22
		15	6	1.17
		20	6	1.30
	0.1	5	8	2.33
		10	8	1.84
		15	8	1.73
		20	8	1.85
40	0.05	5	2	0.33
		10	2	0.32
		15	2	0.46
		20	2	0.62
		5	4	0.57
		10	4	0.56
		15	4	0.68
		20	4	0.79
		5	6	1.33
		10	6	0.94
		15	6	1.00
		20	6	1.11
	0.1	5	8	1.89
		10	8	1.33
		15	8	1.44
		20	8	1.62

(continued on next page)

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Calcium chloride; $CaCl_2$; [10043-52-4]

(4) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Yokoyama, T.

Kogyo Kagaku Zasshi 1954, *57*, 417-9.

VARIABLES:

$T/K = 293 - 313$
$c_2/\text{mol L}^{-1} = 0.05 - 0.1$
$g_3/100\ g_5 = 5 - 20$
$g_4/100\ g_5 = 2 - 8$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The $CaCl_2$, sucrose, and $Ca(OH)_2$ concentrations are given as g per 100 g of water. The NaCl is given as mol L^{-1}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Aqueous NaOH and $CaCl_2$ were mixed stoichiometrically with dissolved sucrose to form NaCl and $Ca(OH)_2$ in saturation. The resulting solutions were equilibrated for 2 days at a definite temperature within ±0.1°C. Aliquots of saturated solution were analyzed for $Ca(OH)_2$ by titration with standard HCl solution using methyl orange as an indicator.

SOURCE AND PURITY OF MATERIALS:

(1) Calcium hydroxide.

(2) Sodium chloride.

(3) Calcium chloride. Analytical reagent grade.

(4) Sucrose. Purified by treating the aqueous solution with activated charcoal followed by recrystallization from the aqueous solution by addition of ethanol.

(5) Water.

ESTIMATED ERROR:

Temp.: precision ± 0.1 K.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Calcium hydroxide; $Ca(OH)_2$; [1305-62-0] *or*
Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) 2-Furancarboxaldehyde or furfural; $C_5H_4O_2$; [98-01-1]

ORIGINAL MEASUREMENTS:

Trimble, F.

Ind. Eng. Chem. 1941, *33*, 660-2.

VARIABLES:

T/K = 298

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The solubility of $Ca(OH)_2$, $Ba(OH)_2$ and $Ba(OH)_2 \cdot 8H_2O$ in furfural at 25°C

/mass %	m_1/mol kg^{-1}
Calcium hydroxide; $Ca(OH)_2$	
0.13	1.8×10^{-2}
Barium hydroxide; $Ba(OH)_2$	
<0.01	$<6 \times 10^{-4}$
Barium hydroxide octahydrate; $Ba(OH)_2 \cdot 8H_2O$	
9.0	0.31_3

The molal values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Furfural and an excess of solute were agitated for 24 hours (a time shown to be sufficient for establishment of equilibrium) in a constant temperature bath. The solution was filtered at the same temperature as the saturation.

About 40 g of saturated solution was accurately weighed, 100 mL of water added and the solution evaporated to about 10 mL. The solution was transferred to a weighed crucible and evaporated to dryness, treated with conc. sulfuric acid, ignited at 700°C and weighed as the sulfate.

SOURCE AND PURITY OF MATERIALS:

(1) Hydroxides. Stated to be chemically pure grade.

(2) Furfural. Commercial grade distilled three times at a reduced pressure of 12 mmHg. About 15 % discarded at the end of each fractionation. B.p. range at 12 mmHg 54-55°C; Sp. Gr. d^{25}_{25} 1.1585; moisture 0.0 %; Acidity (as acetic acid) 0.002-0.003 %.

ESTIMATED ERROR:

Temp.: Nothing specified.
Soly.: Duplicates checked within 25 % (generally).

REFERENCES:

4. The solubility of Strontium hydroxide in aqueous systems.

Systems	Pages
$Sr(OH)_2 + H_2O$	248-255(E), 256-260
———— $+ SrCl_2 + H_2O$	253(E), 261-262
———— + ——— $+ HCl + H_2O$	253(E), 263
———— $+ SrBr_2 + H_2O$	253(E), 264
———— $+ SrI_2 + H_2O$	253(E), 265
———— $+ Sr(SH)_2 + H_2O$	253(E), 266-267
———— $+ Sr(NO_2)_2 + H_2O$	- , 188, 268
———— $+ Sr(NO_3)_2 + H_2O$	253(E), 269
———— $+ C_2H_5OH + H_2O$	254(E), 270-271
———— + (alcohols, ketones, ethers or amines) $+ H_2O$	254(E), 272
———— $+ C_6H_5OH + H_2O$	254(E), 273-274
———— $+ C_{12}H_{22}O_{11} + H_2O$	253(E), 275-283

(E) refers to evaluation page(s).

COMPONENTS:	EVALUATOR:	
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

An evaluation of the solubility of strontium hydroxide in water and various aqueous solutions.

Quantitative measurements of the solubility of strontium hydroxide, $Sr(OH)_2$, in aqueous solutions have been reported in 13 rather old papers. Many of these papers are related to the use of strontium hydroxide in refining sugar from sugar beets. The solubility of strontium hydroxide in pure water is reported in six papers (1, 2, 9-12). The SrO + sucrose + water system is described (9-12). Phase diagrams of the systems SrO + strontium salts ($SrCl_2$, $SrBr_2$, SrI_2, $Sr(NO_3)_2$ and $Sr(SH)_2$) + H_2O were also determined (3, 5, 6, 8). A review of early solubility work in Mellor (18) contains some references not covered here.

1. The solubility of strontium hydroxide in water.

Different investigators all measured the solubility of strontium hydroxide in water by a similar method, involving isothermal equilibration of $Sr(OH)_2$ or SrO with water, filtration and acidimetric titration. The source and purity of the $Sr(OH)_2$ or SrO were not given. In spite of the probable different origin of the strontium compounds, the reported results (1, 2, 9-12) are in good agreement up to a temperature of 343 K, but diverge at higher temperatures. All the solubility values are shown in Figure 1. The solubility increases with temperature. Above 358 K only Reinders and Klinkenberg (11) found a decrease of solubility with increasing temperature.

All of the authors identify the solid phase in equilibrium with the saturated solution as $Sr(OH)_2 \cdot 8H_2O$ at the lower temperatures. Reinders and Klinkenberg (11) claim that the stable phase above 358 K is $Sr(OH)_2 \cdot H_2O$, which should have a different solubility and temperature coefficient of solubility, as they observed. The observed increase in solubility above 358 K (2, 9, 10; Fig. 1) may be related to the existence of a metastable octahydrate.

The data were fitted by the method of least squares to a type of equation recommended in the "Introduction to the Solubility of Solids in Liquids", eqn [48], with activity and osmotic coefficient terms included in the Y_m function. This equation is based on a thermodynamic treatment of saturated solutions and their equilibrated solid phases and has the form

$$Y_m = A_1 + A_2/(T/K) + A_3 \ln (T/K).$$

where $Y_m = \ln (m/m_0) - (m/m_0 - 1)$ with $1/m_0 = 0.144$ kg mol^{-1} at the congruent fusion temperature, T_c. When the usual procedure of discarding points which deviate by more than two standard deviations and repeating the fit was applied, the points noted in Table 1 were discarded.

The resulting fitting equation is:

$$Y_m = - 231.074 + 7392.013/(T/K) + 35.5946 \ln (T/K) \qquad [1]$$

with $\sigma(Y_m) = 0.033$. The standard deviation in molality and the congruent octahydrate melting point are $\sigma(m) = 0.027$ and $T_m = 384.3$ K with $\sigma(T_m) = 0.4$ K.

The equation was used to calculate the recommended solubility values at 5 degree intervals from 273.15 to 373.15 K in Table 2 and the fitted curve in Figure 1.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Water; H_2O; [7732-18-5], and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B. P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

November, 1991

CRITICAL EVALUATION:

Table 1. Experimental values of the solubility of strontium hydroxide (solid phase $Sr(OH)_2 \cdot 8H_2O$) in water between 273.05 and 373.35 K

T/K	Strontium Hydroxide m_1/mol kg^{-1}	Reference
273.05	0.0388 [a]	1
273.05	0.0370	1
273.15	0.034	2
273.15	0.034	9
273.15	0.034	10
278.15	0.04	2
283.15	0.04 [a]	2
284.15	0.046	9
286.15	0.05	9
288.15	0.055	2
293.15	0.067	9
293.15	0.066	2
294.15	0.068	9
297.15	0.075	9
297.34	0.079	11
298.15	0.086 [a]	10
298.15	0.081	2
298.15	0.083	2
303.15	0.098	2
308.15	0.126 [a]	10
308.15	0.121	2
308.15	0.12	11
313.15	0.14	9
313.15	0.148	2
314.15	0.15	9
316.15	0.16	9
317.15	0.17	9
318.15	0.178	11
318.15	0.178	2
321.15	0.19	9
323.15	0.215	2
323.15	0.210	9
323.15	0.212	10
328.15	0.259	2
328.15	0.266	11
329.04	0.326 [a]	11
330.15	0.278	9
332.15	0.292 [a]	9
333.15	0.311	2
338.15	0.375	9
338.15	0.376	2
340.15	0.405	9
341.15	0.419	9
342.15	0.423 [a]	9
343.15	0.46	2
343.18	0.509	11

Table continued on next page . . .

COMPONENTS:	EVALUATOR:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Table 1. (Cont.) Experimental values of the solubility of strontium hydroxide (solid phase $Sr(OH)_2 \cdot 8H_2O$) in water between 273.05 and 373.35 K

T/K	Strontium Hydroxide m_1/mol kg^{-1}	Reference
348.15	0.572	2
348.15	0.539 [a]	9
348.15	0.547 [a]	10
348.15	0.590	
352.15	0.642 [a]	9
353.15	0.729	2
354.15	0.716 [a]	9
358.15	1.059 [a]	2
358.15	0.964	9
361.15	1.16	9
363.15	1.524 [a]	2
363.15	1.31	9
363.15	1.314	10
368.15	2.098 [a]	2
368.15	1.721	10
371.15	2.027	10
373.15	2.855 [a]	2
373.15	2.201	10
374.35	3.059 [a]	2
374.35	2.31	9

[a] Values not used in the final fitting.

Table 2. Recommended values of the solubility of strontium hydroxide (solid phase $Sr(OH)_2 \cdot 8H_2O$) in water between 273.15 and 373.15 K.

Temperature t/°C	Temperature T/K	Solubility of Strontium Hydroxide m_1/mol kg^{-1}
0	273.15	0.034
5	278.15	0.040
10	283.15	0.047
15	288.15	0.056
20	293.15	0.067
25	298.15	0.079
30	303.15	0.096
35	308.15	0.116
40	313.15	0.141
45	318.15	0.172
50	323.15	0.210
55	328.15	0.258
60	333.15	0.317
65	338.15	0.393
70	343.15	0.488
75	348.15	0.610
80	353.15	0.768
85	358.15	0.974
90	363.15	1.25
95	368.15	1.63
100	373.15	2.18

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Water; H_2O; [7732-18-5], and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B. P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE
November, 1991

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

CRITICAL EVALUATION:

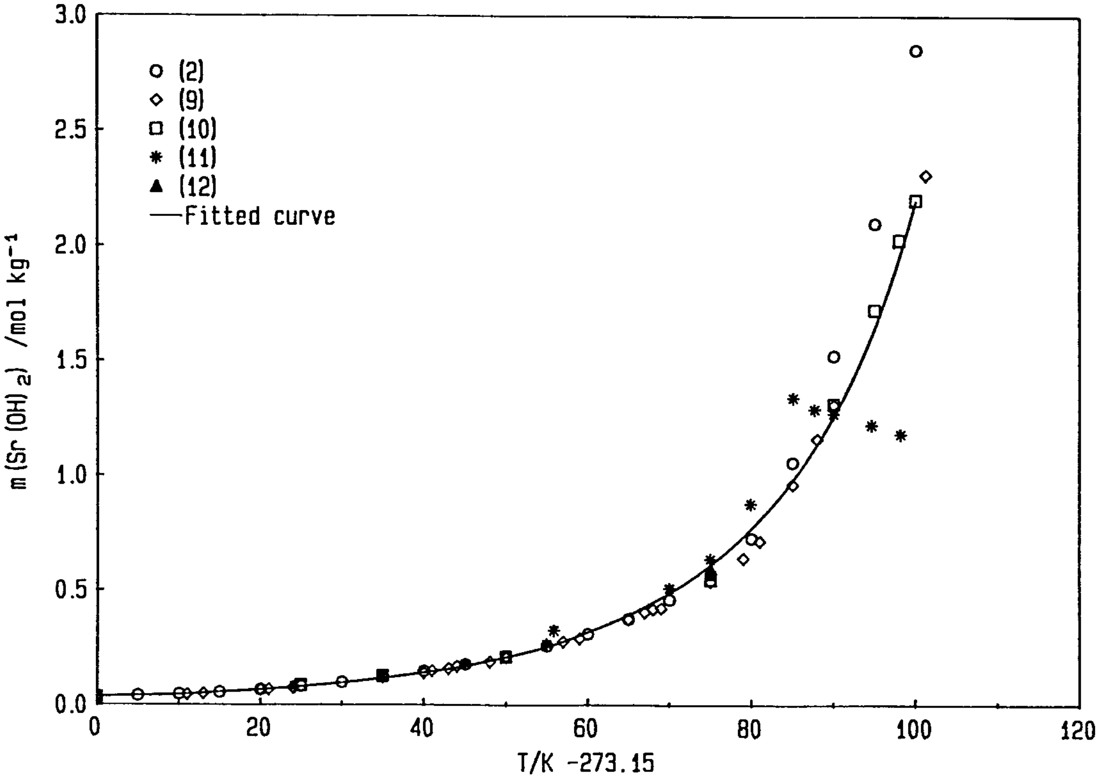


Figure 1. The solubility of strontium hydroxide as a function of temperature. Experimental points from Table 1 with fitted equation calculated from Eqn [1] assuming metastable octahydrate, $Sr(OH)_2 \cdot 8H_2O(s)$.

COMPONENTS:	EVALUATOR:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

The recommended values come from the treatment of data up to 374 K corresponding to a metastable octahydrate.

2. Ternary systems $SrO + SrX_2 + H_2O$.

Milikan (5, 6) studied the ternary systems $SrO + SrX_2 + H_2O$ with X = Cl^-, Br^- and I^- at temperatures near 298 K. He showed the formation of hydrated compounds in all three cases. They were $SrCl_2\cdot Sr(OH)_2\cdot 8H_2O$ (or $SrCl_2\cdot SrO\cdot 9H_2O$), $SrBr_2\cdot Sr(OH)_2\cdot 8H_2O$ (or $SrBr_2\cdot SrO\cdot 9H_2O$), and $SrI_2\cdot Sr(OH)_2\cdot 7H_2O$ (or $SrI_2\cdot SrO\cdot 8H_2O$), respectively. The first system was studied over the 273 to 313 K temperature range, and the solid $SrCl_2\cdot Sr(OH)_2\cdot 8H_2O$ appeared only at temperatures equal to or higher than 298 K.

The $SrO + Sr(NO_3)_2 + H_2O$ system was studied by Parson and Perkins (3), and the $SrO + Sr(SH)_2 + H_2O$ system was studied by Terres and Brückner (8). Mixed compound formation was not observed in either of these systems. It was observed in the $Sr(OH)_2 + Sr(NO_2)_2 + H_2O$ system (14).

3. Strontium oxide + sucrose + water systems.

Data for the sucrose-containing ternary systems are reported in four publications (9-12). Qualitative agreement exists concerning the solid phases possibly in equilibrium with the solution. They are $SrO\cdot 9H_2O$ (or $Sr(OH)_2\cdot 8H_2O$), $C_{12}H_{22}O_{11}\cdot 2SrO$ and $C_{12}H_{22}O_{11}\cdot SrO$. The later two substances result from reaction of $Sr(OH)_2$ with the two $-CH_2OH$ groups in sucrose:

$$C_{10}H_{16}O_9(CH_2OH)_2 + xSr(OH)_2 = C_{10}H_{16}O_9(CH_2OH)_{2-x}(CH_2OSrOH)_x + xH_2O$$

with x = 1, 2.

Solubility isotherms obtained by different authors were compared when a common range of temperature and sucrose concentration was available. We compared results from (10) and (11) at 298.15 and 363.15 K, and from (10) and (12) at 348.15 K. No agreement, even as to the shape of the isotherms, exists between the pairs of data sets compared. The results reported by Reinders and Klinkenberg (11) at 343.15 K were compared to the data of Nischizawa and Hachihama (12) at 348.15 K and they were found to be compatible.

Reinders and Kinkenberg observed that equilibrium was very difficult to reach, especially at high sucrose concentration, when the viscosity of the solution increases. A gel may be obtained when the sucrose concentration reaches 20 mass %. Metastable equilibria were also observed. The time necessary to reach equilibrium was not recorded for each set of data, but the authors mention times of 3 to 9 days at 298.15 K. Grube and Nussbaum (10) do not mention a time of equilibration for their experiments. Siderski (9) took samples after some hours. The data of these two publications (9, 10) were rejected because of insufficient time of equilibration.

As indicated above, data from (11) and (12) are in qualitative agreement at the relatively close temperatures of 343.15 and 348.15 K in the common sucrose concentration range (mass fraction < 0.3) as to both solubility values and solid phases, which are $Sr(OH)_2\cdot 8H_2O$ and $C_{12}H_{22}O_{11}\cdot 2SrO$. Their data may be considered as "tentative". Reinders and Klinkenberg (11) determined the range of stability of the different solids at other temperatures. They found the solid $C_{12}H_{22}O_{11}\cdot SrO$ (monosucchrate) was stable at temperatures lower than 343 K. At higher temperatures the stable solid is the disucchrate.

4. The solubility of strontium hydroxide in mixed solvents.

Rothmund (4) compared the effect of the addition of different organic substances at a concentration of 0.5 mol dm^{-3} on the solubility of

COMPONENTS:	EVALUATOR:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

$Sr(OH)_2$ in water. Some alcohols (mannitol, propanetriol and ethanediol) enhance the solubility. Van Meurs (7) observed an enhancement of the solubility in the SrO + phenol + water system, and he showed the existence of the solid compound $Sr(C_6H_5O)_2 \cdot 4H_2O$.

The SrO + ethanol + water system was studied at 298 K by Janković (13). He claimed that the only solid phase is $Sr(OH)_2 \cdot 8H_2O$.

As there are no confirmatory data for these systems, these data are classed as tentative.

5. Results from other evaluations.

Smith and Martell (15) give the association constant at 298.15 K and ionic strengths of 0 and 3.0 mol dm^{-3} for $Sr^{2+}(aq) + OH^-(aq) = (SrOH)^+(aq)$ as:

Ionic Strength mol dm^{-3}	log K	K
0	0.8 ± 0.1	6.3
3.0	0.23	1.7

The *NBS Thermodynamic Tables* (16) do not have values of the Gibbs energy of formation for any solid forms of strontium hydroxide, and no calculations can be made regarding the solid. There are data to calculate the association constant above. At 298.15 K and zero ionic strength the value is $K = 1.0$.

6. Crystal structure of strontium hydroxide.

Characterization of the solid state in equilibrium with the saturated solution is an important part of any modern solubility study. The following information, mostly from the *Crystal Determinative Tables* (17), is neither complete nor evaluated, but it serves as a reminder of this important point.

Crystal Formula	Type	Density, ρ/Mg m^{-3}
SrO; [1314-11-0]	Cubic	5.235
$Sr(OH)_2$; [18480-07-4]	Orthorhombic	3.407
$Sr(OH)_2 \cdot H_2O$; [21800-33-9]	Orthorhombic	3.07
$Sr(OH)_2 \cdot 8H_2O$; [1311-10-0]	Tetragonal	1.88

REFERENCES

1. Guthrie, F.
Philos. Mag. [5] 1878, *6*, 35-44.

2. Scheibler, C.
J. Pharm. Chim. [5] 1883, *8*, 540.

3. Parsons, C.L.; Perkins, C.L.
J. Am. Chem. Soc. 1910, *32*, 1387-89.

4. Rothmund, V.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1910, *69*, 523-46.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Water; H_2O; [7732-18-5] and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B. P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

November, 1991

CRITICAL EVALUATION:

REFERENCES (Continued)

5. Milikan, J.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

6. Milikan, J.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *92*, 496-510.

7. Van Meurs, G.J.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

8. Terres, E.; Brückner, K.
Z. Electrochem. Angew. Phys. Chem. 1920, *26*, 25-32.

9. Sidersky, M.D.
Bull. Assoc. Chim. Sucr. Distill. Ind. Agri. Fr. Colon. 1921, *39*, 167-77.

10. Grube, G.; Nussbaum, M.
Z. Electrochem. Angew. Phys. Chem. 1928, *34*, 91-98.

11. Reinders, W.; Klinkenberg, A.
Recl. Trav. Chim. Pays-Bas 1929, *48*, 1227-64.

12. Nishizawa, K.; Hachihama, Y.
Z. Electrochem. Angew. Phys. Chem. 1929, *35*, 385-92.

13. Janković, S.
Rastvorljvost Nekih Soli i Hidroksida Zemoalkalnih Metala u Sistemima Voda-Etil Alkohol i Voda-Metil Alkohol, i Struktura Takvih Zasicenih Rastvora. Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

14. Popova, T.B.; Berdyukova, V.A.; Khutsistova, F. M.
Zh. Neorg. Khim. 1990, *35*, 507-11; *Russ. J. Inorg. Chem. (Engl. Transl.)* 1990, *35*, 288-90.

15. Smith, R.M.; Martell, A.E. *CRITICAL STABILITY CONSTANTS*, Vol. 4, *Inorganic Complexes*, Plenum Press, New York, 1976, pp. 1-2.

16. Wagman, D.D.; Evans, W.H.; Parker, V.B.; Schumm, R.H.; Harlow, I.; Bailey, S.M.; Churney, K.L.; Nuttall, R.L. *J. Phys. Chem. Ref. Data* 1982, *11*, Supplement No. 2, *THE NBS TABLES OF THERMODYNAMIC PROPERTIES*.

17. Donnay, J.D.H.; Ondik, H.M., Editors, *CRYSTAL DATA DETERMINATIVE TABLES*, Published jointly by the National Bureau of Standards and the Joint Committee on Powder Diffraction Standards, 1973, Volume 2.

18. Mellor, J. W. *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*, Longmans, Green and Co., London, 1923, pp. 673-87.

Mellor lists and discusses several papers on the solubility of strontium hydroxide not included in this volume. We believe the papers listed below can be rejected because of one or more of the following reasons, impure materials, presence of atmospheric carbon dioxide, and insufficient time allowed to reach equilibrium.

Bucholz, C. F. *Gehlen's J.* 1807, 4, 128.
Bineau, A. *C. R. Hebd. Seances Acad. Sci.* 1855, *41*, 509.

The following paper listed by Mellor contains a discusion of the relative order of solubility among the alkaline earth hydroxides.

Tilden, W. A. *Proc. Roy. Soc.* 1886, *38*, 401.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Water; H_2O; [7732-18-5]	Guthrie, F. *Philos. Mag. [5]* 1878, *6*, 35-44.
VARIABLES:	PREPARED BY:
$T/K = 273$	I. Lambert

EXPERIMENTAL VALUES:

The $Sr(OH)_2 + H_2O$ system at -0.1°C

SrO mass %	Solid Phase Composition
0.3838	
0.4020	
Av. 0.3929 ± 0.012	$SrO + 1463\ H_2O$

In modern terms the experiment reported here was a determination of the eutectic composition and temperature of the system.

A solution of this composition will freeze to a solid of the same composition.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A solution saturated with $Sr(OH)_2$ at room temperature is cooled until the temperature of formation of cryohdrate [*eutectic composition*] is reached and cryohydrate is solidified.

Analysis not specified, but it is probably carbonate precipitation and weighing of $SrCO_3$ (method used by author for Ba determination).

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Std. Dev. about 3 %.

REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Scheibler, C.

J. Pharm. Chim. 1883, [5], *8*, 540.

VARIABLES:

$T/K = 273 - 374$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Composition of the saturated solution

$t/°C$	SrO g/1000 g solution	 $10^1m/\text{mol kg}^{-1}$ [a]
0	3.5	0.34
5	4.1	0.40
10	4.8	0.46
15	5.7	0.55
20	6.8	0.66
25	8.3	0.81
30	10.1	0.98
35	12.4	1.21
40	15.1	1.48
45	18.1	1.78
50	21.8	2.15
55	26.1	2.59
60	31.2	3.11
65	37.5	3.76
70	45.5	4.60
75	56.0	5.72
80	70.2	7.29
85	98.9	10.59
90	136.4	15.24
95	178.6	20.98
100	228.5	28.55
101.2	240.7	30.59

[a] Calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified. See (ref 1).

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. Nothing specified.

(2) Water. Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Scheibler C.
Neue Z. Ruebenzucker-Ind. 1881, *7*, 258.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Sidersky, M. D.

Bull. Assoc. Chim. Sucr. Distill. Ind. Agri. Fr. Colon. 1921, *39*, 167.

VARIABLES:

$T/K = 273 - 374$

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Composition of the saturated solution

$t/°C$	SrO	
	g/100 g solution	$10^1 m/mol\ kg^{-1}$[a]
0	0.35	0.34
11	0.47	0.46
13	0.52	0.50
20	0.69	0.67
21	0.70	0.68
24	0.77	0.75
40	1.48	1.4
41	1.54	1.5
43	1.66	1.6
44	1.69	1.7
48	1.91	1.9
50	2.13	2.1
57	2.80	2.78
59	2.94	2.92
65	3.74	3.75
67	4.03	4.05
68	4.10	4.19
69	4.20	4.23
75	5.29	5.39
79	6.24	6.42
81	6.91	7.16
85	9.08	9.64
88	10.74	11.6
90	11.95	13.1
101.2	19.34	23.1

[a] Calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Sr(OH)_2$ and water are placed in a stoppered flask fitted with two tubes passing through the cork, one of them with a felt plug at the end. After some hours at the desired temperature, samples are withdrawn by forcing the solution through the felt plug and then the $Sr(OH)_2$ concentration is analyzed by acidimetry. Temperatures are controlled by an ice bath (0°C), by flowing water (11 - 13°C), by a thermostated bath (40 - 90°C), and by boiling (101°C). 20 - 24°C are the ambient temperatures. Each experiment is repeated two or three times.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. Prepared from "Strontionite" ($SrCO_3$ ore) ignited, dissolved in hot water, filtered, and recrystallized three times.

(2) Water. Nothing specified.

ESTIMATED ERROR:

Temp.: Nothing specified.

Soly.: precison < 6 ± $Sr(OH)_2$ (author).

REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Grube, G.; Nussbaum, M.

Z. Elektrochem. Angew. Phys. Chem. 1928, *34*, 91-8.

VARIABLES:

$T/K = 273 - 373$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution

$t/°C$	SrO g/100g$_2$	Molality of $Sr(OH)_2$[a] m_1/mol kg^{-1}
0	0.35	0.034
25	0.89	0.086
35	1.31	0.126
50	2.20	0.212
75	5.67	0.547
90	13.62	1.314
95	17.83	1.721
98	21.00	2.027
100	22.81	2.201

[a] Calculated by compilers.

Solid phase in equilibrium with the saturated solution was strontium hydroxide octahydrate, $Sr(OH)_2 \cdot 8H_2O$ [1311-10-0].

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

SrO was equilibrated with pure CO_2 free water at a definite temperature with continuous stirring. Aliquots of saturated solution were titrated with standard HCl solution for determination of dissolved $Sr(OH)_2$.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. SrO of high purity was used.

(2) Water.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Water; H_2O; [7732-18-5]	Reinders, W.; Klinkenberg, A. *Recl. Trav. Chim. Pays-Bas* 1929, *48*, 1227-45.
VARIABLES:	PREPARED BY:
$T/K = 297 - 371$	I. Lambert

EXPERIMENTAL VALUES:

Composition of the saturated solution

$t/°C$	SrO		Solid phase
	g/100 g solution	$10^1 m/mol\ kg^{-1}$ [a]	
24.2	0.822	0.799	$Sr(OH)_2 \cdot 8H_2O$
35	1.227	1.20	"
45	1.81	1.78	"
55	2.68	2.66	"
55.89	3.27	3.26	"
70.03	5.01	5.09	"
74.98	6.37	6.56	"
79.93	8.34	8.78	"
85.10	12.19	13.4	"
87.70	11.83	12.9	$Sr(OH)_2 \cdot H_2O$
90.00	11.66	12.7	"
90.24	11.59	12.6	"
94.65	11.20	12.2	"
98.2	10.92	11.8	"

[a] Calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Stoppered flasks containing weighed amounts of $Sr(OH)_2$ and water were agitated in a thermostat for an undefined amount of time. The saturated solution was filtered through a cotton plug or centrifugated when the precipitate grain size was too small to allow filtration. $Sr(OH)_2$ was titrated with standard acid. The composition of the hydrate stable above 85°C was determined by a study of the $Sr(OH)_2 + NaBr + H_2O$ system at 100°C. Analysis of both $Sr(OH)_2$ saturated solution and wet precipitate confirmed the monohydrate, $Sr(OH)_2 \cdot H_2O$.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. Commercial product from Merck, "free from barite." Used without further purification.

(2) Water. Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium chloride; $SrCl_2$; [10476-85-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

EXPERIMENTAL VALUES:

Composition of the saturated solution

t/°C	$SrCl_2$ mass %	SrO mass %	Solid phase
0	23.74	0.29	$Sr(OH)_2 \cdot 8H_2O$
	29.03	0.30	"
	30.58	0.31	$Sr(OH)_2 \cdot 8H_2O + SrCl_2 \cdot 6H_2O$
	30.52	0.31	"
	30.68	0	$SrCl_2 \cdot 6H_2O$
25	12.52	0.86	$SrCl_2 \cdot 8H_2O$
	22.09	0.75	"
	33.41	1.09	$Sr(OH)_2 \cdot 8H_2O + SrCl_2 \cdot Sr(OH)_2 \cdot 8H_2O$
	33.61	1.09	"
	33.33	1.09	"
	35.65	0.85	$SrCl_2 \cdot Sr(OH)_2 \cdot 8H_2O + SrCl_2 \cdot 6H_2O$
	35.39	0.83	"
	35.60	0	$SrCl_2 \cdot 6H_2O$
40	18.48	1.42	$Sr(OH)_2 \cdot 8H_2O$
	28.84	1.90	"
	29.01	1.91	"
	32.07	2.49	$Sr(OH)_2 \cdot 8H_2O + SrCl_2 \cdot Sr(OH)_2 \cdot 8H_2O$
	32.09	2.50	"
	32.97	2.10	$SrCl_2 \cdot Sr(OH)_2 \cdot 8H_2O$
	34.13	2.03	"
	36.08	1.76	"
	36.62	1.73	"
	39.25	1.36	$SrCl_2 \cdot Sr(OH)_2 \cdot 8H_2O + SrCl_2 \cdot 6H_2O$
	39.28	1.36	"
	39.62	0	$SrCl_2 \cdot 6H_2O$

(continued on next page)

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium chloride; $SrCl_2$; [10476-85-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

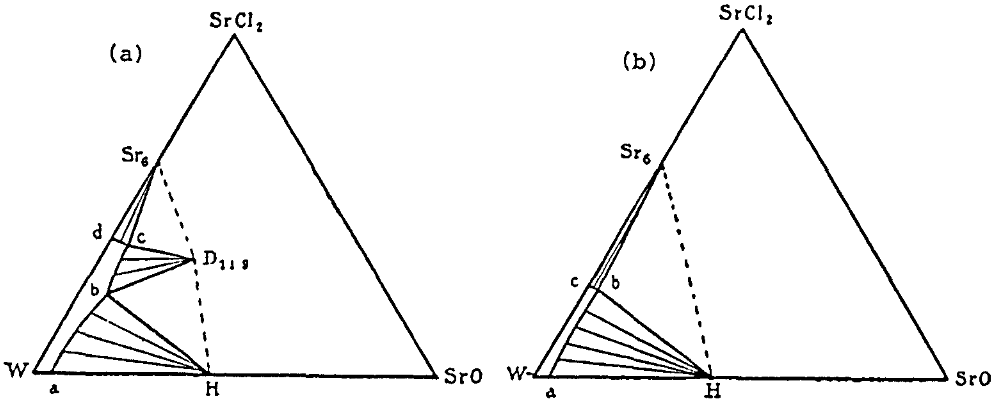
VARIABLES:

$T/K = 273 - 313$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:



SrO + $SrCl_2$ + H_2O system at (a) $t/°C = 40$ and (b) $t/°C = 0$

Sr_6: $SrCl_2 \cdot 6H_2O$

$D_{1.1.9}$: $SrCl_2 \cdot Sr(OH)_2 \cdot 8H_2O$ or $SrCl_2 \cdot SrO \cdot 9H_2O$

H: $Sr(OH)_2 \cdot 8H_2O$ or $SrO \cdot 9H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases determined by Schreinemakers' method of wet residues.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium chloride; $SrCl_2$; [10476-85-4]

(3) Hydrogen chloride; HCl; [7647-01-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. <u>1917</u>, *92*, 496-510.

VARIABLES:

$T/K = 298$
HCl/mass % = 0 - 37.72

PREPARED BY:

I. Lambert
H. Einaga

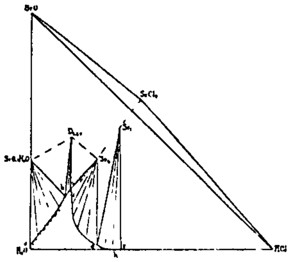
EXPERIMENTAL VALUES:

The SrO + HCl + H_2O system at 25°C

HCl mass %	SrO mass %	Solid Phase
0	0.85	A
5.76	9.04	A
10.16	15.19	A
15.37	22.94	A + B
15.46	23.06	A + B
15.33	22.88	A + B
16.40	24.15	B + C
16.19	23.83	B + C
16.38	23.27	C
16.29	22.20	C
17.24	18.01	C
20.66	6.44	C
21.96	4.37	C
28.10	1.46	C
28.16	1.38	C + D
28.82	0.84	D
36.59	0.10	D
37.72	0.08	D

Solid Phases: A. $Sr(OH)_2 \cdot 8H_2O$; B. $SrCl_2 \cdot Sr(OH)_2 \cdot 8H_2O$

C. $SrCl_2 \cdot 6H_2O$ D. $SrCl_2 \cdot 2H_2O$



$D_{119} = B$

$Sr_6 = C$

$Sr_2 = D$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium bromide; $SrBr_2$; [10476-81-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

VARIABLES:

$T/K = 298$
Composition

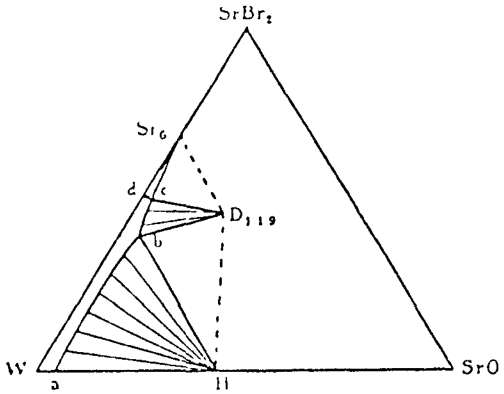
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$SrBr_2$ mass %	SrO mass %	Solid phase
16.27	0.66	$Sr(OH)_2 \cdot 8H_2O$
21.46	0.65	"
27.33	0.66	"
35.83	0.73	"
38.68	0.79	"
40.66	0.84	$Sr(OH)_2 \cdot 8H_2O + SrBr_2 \cdot Sr(OH)_2 \cdot 8H_2O$
41.78	0.64	$SrBr_2 \cdot Sr(OH)_2 \cdot 8H_2O$
42.76	0.61	"
44.24	0.47	"
47.65	0.28	"
48.06	0.25	"
49.78	0.21	$SrBr_2 \cdot Sr(OH)_2 \cdot 8H_2O + SrBr_2 \cdot 6H_2O$
49.79	0	$SrBr_2 \cdot 6H_2O$



$SrO + SrBr_2 + H_2O$ system at $t/°C = 25$

Sr_6: $SrBr_2 \cdot 6H_2O$

$D_{1.1.9}$: $SrBr_2 \cdot Sr(OH)_2 \cdot 8H_2O$ or $SrBr_2 \cdot SrO \cdot 9H_2O$

H: $Sr(OH)_2 \cdot 8H_2O$ or $SrO \cdot 9H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases detd. by Schreinemakers' method of wet residues.

No error estimates possible.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide.

(2) Strontium bromide.

(3) Water.
Nothing specified about materials.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium iodide; SrI_2; [10476-86-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

VARIABLES:

$T/K = 298$
Composition

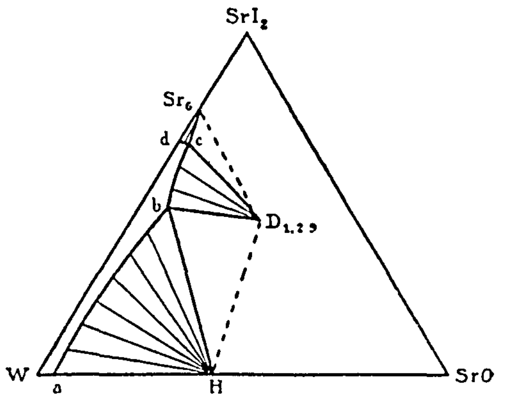
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

SrI_2 mass %	SrO mass %	Solid phase
22.36	0.57	$Sr(OH)_2 \cdot 8H_2O$
29.98	0.53	"
39.50	0.55	"
49.37	0.74	$Sr(OH)_2 \cdot 8H_2O + SrI_2 \cdot 2Sr(OH)_2 \cdot 7H_2O$
53.04	0.72	$SrI_2 \cdot 2Sr(OH)_2 \cdot 7H_2O$
54.16	0.60	"
55.09	0.51	"
55.58	0.46	"
60.32	0.19	"
60.77	0.18	"
64.04	0.16	$SrI_2 \cdot 2Sr(OH)_2 \cdot 7H_2O + SrI_2 \cdot 6H_2O$
64.70	0	$SrI_2 \cdot 6H_2O$



$SrO + SrI_2 + H_2O$ system at $t/°C = 25$

Sr_6: $SrI_2 \cdot 6H_2O$

$D_{1.2.9}$: $SrI_2 \cdot 2Sr(OH)_2 \cdot 8H_2O$ or $SrI_2 \cdot 2SrO \cdot 10H_2O$

H: $Sr(OH)_2 \cdot 8H_2O$ or $SrO \cdot 9H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases detd. by Schreinemakers' method of wet residues.

No error estimate possible.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide.

(2) Strontium iodide.

(3) Water.
Nothing specified about materials.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Strontium hydrosulfide; $Sr(SH)_2$; [12135-37-4] (3) Water; H_2O; [7732-18-5]	Terres, E.; Brückner, K. *Z. Elektrochem. Angew. Phys. Chem.* 1920, *26*, 25-32.

EXPERIMENTAL VALUES:

The $Sr(OH)_2$ + $Sr(SH)_2$ + H_2O system at 0 to 100°C

t/°C	$Sr(SH)_2$ /g (100 g sln)$^{-1}$	$Sr(OH)_2$ /g (100 g sln)$^{-1}$	Solid Phase
0	1.56	0.30	A
	6.68	0.25	A
	12.65	0.22	A
	14.80	0.20	A
	18.20	0.16	A
	19.05	0.15	A
	23.4	0.10	B
	24.8	0.10	B
	27.5	0.20	B
20	5.9	0.72	A
	11.4	0.70	A
	15.8	0.62	A
	18.3	0.60	A
	20.3	0.55	A
	24.	1.	B
	26.	0.25	B
	26.8	0.20	B
	27.5	0.15	B
	29.7	0.1	B
40	1.40	1.65	A
	4.87	1.60	A
	10.83	1.60	A
	15.93	1.55	A
	20.00	1.50	A
	24.10	1.10	B
	26.20	0.80	B
	28.30	0.42	B
	29.25	0.30	B
	31.60	0.10	B
60	1.6	3.15	A
	6.08	3.04	A
	11.85	3.16	A
	16.72	3.15	A
	25.0	1.75	B
	26.6	1.75	B
	30.8	0.6	B
	33.6	0.1	B
80	5.6	5.60	A
	9.5	5.00	A
	15.50	4.88	A
	19.60	4.10	A
	27.50	2.70	B
	28.00	2.10	B
	30.40	1.40	B
	35.60	0.05	B
100	7.40	14.00	A
	37.80	0.15	B

Solid Phases: A. $Sr(OH)_2 \cdot 8H_2O$

B. $Sr(SH)_2 \cdot 4H_2O$

(continued on next page)

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium hydrosulfide; $Sr(SH)_2$; [12135-37-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Terres, E.; Brückner, K.

Z. Elektrochem. Angew. Phys. Chem. 1920, *26*, 25-32.

VARIABLES:

$T/K = 273 - 373$
Composition

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solid phase was identified by inspection of Fig 8 in the original paper.

The paper also gives the solubility of $Sr(SH)_2 \cdot 4H_2O$ in pure water.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of $Sr(OH)_2$ and $Sr(SH)_2$ are mixed and allowed to stand overnight after the precipitation takes place. Freshly prepared $Sr(SH)_2$ is used in each experiment, and solubilities are obtained both by increasing and decreasing temperature.

Analysis of solution: Sulfide is oxidized into sulfate by H_2O_2 which precipitates as $SrSO_4$. $SrSO_4$ is precipitated from the remaining solution by addition of either $SrCl_2$ or H_2SO_4 depending on which species in excess. The $SrSO_4$ is determined gravimetrically.

Analysis of solid: The solid is dissolved in water an titrated with standard HCl solution using phenolphthalein (titration of OH^-) and methyl orange (titration of SH^-) as indicators.
Methods essentially the same as in (ref 1).

SOURCE AND PURITY OF MATERIALS:

(2) Strontium hydrosulfide. Prepared by reaction of sulfuric acid on a solution of strontium hydroxide at 65-70°C.

ESTIMATED ERROR:

No estimates possible

REFERENCES:

1. Terres, E.; Brückner, K. *Z. Elektrochem.* 1920, *26*, 1.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium nitrite; $Sr(NO_2)_2$; [13470-06-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Popova, T. B.; Berdyukova, V. A.; Khutsistova, F. M.

**Zh. Neorg. Khim.* 1990, *35*, 507-11.

Russ. J. Inorg. Chem. (Engl. Transl.) 1990, *35*, 288-90.

VARIABLES:

T/K = 298
Composition

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The $Sr(OH)_2 + Sr(NO_2)_2 + H_2O$ system at 25°C.

Liquid phase composition		Solid phase composition		Solid Phase
$Sr(NO_2)_2$ mass %	$Sr(OH)_2$ mass %	$Sr(NO_2)_2$ mass %	$Sr(OH)_2$ mass %	
41.58	-	-	-	A
41.50	0.26	68.94	5.76	A + B
41.50	0.26	81.26	2.15	A + B
41.50	0.26	69.95	11.32	A + B
36.78	0.51	65.12	10.52	B
35.90	0.50	56.80	7.00	B
30.81	0.59	53.24	7.32	B + C
30.81	0.59	43.85	12.08	B + C
29.04	0.85	24.05	25.22	C
23.99	0.90	6.78	31.20	C
12.96	0.90	3.73	52.63	C
7.27	0.97	1.70	38.38	C
-	0.97	-	-	C

A = $Sr(NO_2)_2 \cdot H_2O$ [13450-96-9]
B = $4Sr(NO_2)_2 \cdot Sr(OH)_2 \cdot 8H_2O$ [126604-73-7]
C = $Sr(OH)_2 \cdot 8H_2O$ [1311-10-0]

The paper also reports density, refractive index, electrical conductivity and viscosity of the above solutions.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility in the $Sr(OH)_2 + Sr(NO_2)_2 + H_2O$ system was studied isothermally at (25.0±0.1)°C in a water thermostat. It was confirmed that samples reached equilibrium after 34-36 h of continual stirring by analysis of liquid phase specimems. The equilibrium phases were analyzed for nitrite ion permanganatometrically, for hydroxide ion acidimetrically and for strontium ion complexometrically. References to the methods are in the paper. The composition of the solid phases was found by Schreinemakers' graphical method of residues and confirmed by chemical analysis.

The solubility in water was $Sr(OH)_2$ 0.97 mass % and $Ca(NO_2)_2$ 41.58 mass %. The values agreed satisfactorily with published data (1, 2).

SOURCE AND PURITY OF MATERIALS:

(1) $Sr(OH)_2$. Chemically pure grade used without recrytallization. The CO_3^{2-} ion content did not exceed 0.05 mass %.

(2) $Sr(NO_2)_2$. Prepared by double decomposition between $Ba(NO_2)_2$ and $SrSO_4$. Recrytallized material analyzed 99.60 mass % anhydrous salt.

(3) water. Nothing specified.

ESTIMATED ERROR:

Temp.: Precision ± 0.1 K.
Soly.: Nothing specified.

REFERENCES:

1. Protsenko, P.I.; Razumovskaya, O.N.; Brykov, N.A. *Spravochnik po Rastvorimosti Solevykh Sistem*, Izd. Khimiya, Leningrad, 1971, 272 pp.
2. Milikan, J. *Z. Phys. Chem.* 1918, *92*, 72.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Strontium nitrate; $Sr(NO_3)_2$; [10042-76-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Parsons, C. L.; Perkins, C. L.

J. Am. Chem. Soc. 1910, *32*, 1387-9.

VARIABLES:

$T/K = 298$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu
I. Lambert

EXPERIMENTAL VALUES:

The $Sr(OH)_2 + Sr(NO_3)_2 + H_2O$ system at 25°C

Strontium Nitrate $/g\ (100\ g\ H_2O)^{-1}$	Strontium Hydroxide $/g\ (100\ g\ H_2O)^{-1}$	Strontium Hydroxide $m_1/mol\ kg^{-1}$	Specific Gravity	Solid Phase
4.45	0.78	0.0641	1.033	A
6.29	0.79	0.0650	1.059	A
8.96	0.81	0.0663	1.079	A
12.78	0.84	0.0691	1.108	A
16.21	0.87	0.0715	1.126	A
17.96	0.91	0.0748	1.148	A
23.83	0.95	0.0780	1.178	A
26.58	0.96	0.0789	1.206	A
28.80	1.01	0.0830	1.217	A
32.41	1.03	0.0847	1.239	A
37.81	1.11	0.0913	1.267	A
40.83	1.14	0.0938	1.291	A
44.03	1.20	0.0986	1.317	A
46.97	1.27	0.104	1.327	A
52.90	1.34	0.110	1.359	A
56.30	1.41	0.116	1.381	A
60.37	1.47	0.121	1.403	A
63.71	1.51	0.124	1.419	A
66.88	1.55	0.127	1.450	A
74.27	1.71	0.141	1.490	A
81.06	1.76	0.145	1.506	A + B
80.83	0.78	0.0645	1.494	B
79.47	0.38	0.0312	1.492	B
79.27	0	0	1.481	B

Solid Phases: A $Sr(OH)_2 \cdot 8H_2O$; B $Sr(NO_3)_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solid $Sr(OH)_2$ was added to aqueous $Sr(NO_3)_2$ solution in tightly stoppered bottles and rotated for four months at 25°C to attain equilibrium. Aliquots of saturated solution were removed and the $Sr(OH)_2$ determined by titration with standard HNO_3 solution using phenolphthalein as indicator. The $Sr(NO_3)_2$ was determined by acidification of an aliquot with HNO_3, evaporation to dryness, weighing the residue, and subtraction of the amount corresponding to $Sr(OH)_2$.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. Prepared from pure SrO.

(2) Strontium nitrate. Commercial sample specially purified by separation of barium salt impurity.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Ethanol; C_2H_6O; [64-17-5] (3) Water; H_2O; [7732-18-5]	Janković, S. *Rastvorljivost Nekih Soli i Hidrokisida Zemnoalkalnih Metala u Sistemima Voda-Etil Alkohol i Voda-Metil Alkohol, i Struktura Takvih Zasicenih Rastvora.* Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

Water	Ethanol		Strontium hydroxide	
mol %	mol %[a]	mass %	10^5w_1	m_1/mmol kg^{-1}[a]
98.2	1.8	4.5	735.5	60.9
95.7	4.3	10.3	554.4	45.8
92.0	8.0	18.2	383.6	31.7
88.78	11.2	24.4	280.7	23.1
80.4	19.6	38.4	141.0	11.6
74.6	25.4	46.5	81.5	6.71
70.2	29.8	52.1	60.1	4.94
64.5	35.5	58.5	40.5	3.33
59.0	41.0	64.0	27.8	2.29
47.3	52.7	74.0	9.7	0.80
34.3	65.7	83.0	6.1	0.50
25.5	74.5	88.2	4.4	0.36
12.1	87.9	94.9	0.2	0.02

[a] Calculated by compiler.

Properties of the saturated solution at 25°C

Water mol %	Relative Density d^{25}_{25}	Conductivity $10^5\kappa$/S cm^{-1}	Viscosity η/mPa s
98.2	1.0006	2070	1.16
95.7	0.9892	1200	1.43
92.0	0.9760	720	1.81
88.78	0.9604	483	2.18
80.4	0.9394	176	2.48
74.6	0.9214	95	2.48
70.2	0.9087	57.8	2.48
64.5	0.8936	35.5	2.35
59.0	0.8790	21.6	2.26
47.3	0.8566	5.2	1.96
34.3	0.8359	1.3	1.72
25.5	0.8230	0.57	1.53
12.1	0.8043	0.247	1.33

(continued on next page)

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Ethanol; C_2H_6O; [64-17-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Janković, S.

Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

VARIABLES:

$T/K = 298$
C_2H_6O mass % = 4.5 - 94.9

PREPARED BY:

J. W. Lorimer

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Salt and solution were stirred for 8 days in a thermostat. After equilibration, samples were removed for analysis through a pipet fitted with a glass wool filter. Density was measured using a pycnometer; the contents of which were then used for analysis of sulfate by volumetric or colorimetric methods. Viscosity was measured using a Vogel-Ossag viscometer and conductivity with a Philips bridge (CM 4249; average reading error 2 %) and dip cell. The author claims that there is no phase change in the equilibrium solid, which is $Sr(OH)_2 \cdot 8H_2O$.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. Hopkins-Williams.

(2) Ethanol. C. Erba, anhydrous, 99.9 - 100 % pure, density 0.795.

(3) Water. Redistilled.

ESTIMATED ERROR:

Temp.: precision within ± 0.05 K.
Soly.: no estimates possible.

REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Organic solvents; See table of experimental values.

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Rothmund, V.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1910, *69*, 523-46.

VARIABLES:

T/K = 298
Nature of second component.

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Sr(OH)_2$ various aqueous-organic mixed solvents at 25°C

Component (2) c_2/mol L^{-1} - 0.5	Strontium Hydroxide c_1/mol L^{-1}
Reference: Solubility in water	0.0835
Pyridine; C_5H_5N; [110-86-1]	0.0694
N-Ethylethanamine; $C_4H_{11}N$; [109-89-7]	0.0586
Ammonia; NH_3; [7664-41-7]	0.0785
Urea; CH_4N_2O; [57-13-6]	0.0820
D-Mannitol; $C_6H_{14}O_6$; [69-65-8]	0.1996
1,2,3-Propanetriol; $C_3H_8O_3$; [56-81-5]	0.1094
1,2-Ethanediol; $C_2H_6O_2$; [107-21-1]	0.0922
1,1'-Oxybisethane; $C_4H_{10}O$; [60-29-7]	0.0645
2-Propanone; C_3H_6O; [67-64-1]	0.0692
2-Methyl-2-butanol; $C_5H_{12}O$; [75-85-4]	0.0630
1-Propanol; C_3H_8O; [71-23-8]	0.0708
Ethanol; C_2H_6O; [64-17-5]	0.0744
Methanol; CH_4O; [67-56-1]	0.0820

In all cases the solid phase is $Sr(OH)_2 \cdot 8H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Sr(OH)_2 \cdot 8H_2O$ and aqueous solution containing 0.5 mol L^{-1} of the organic component were equilibrated with mechanical stirring at 25°C. Aliquots of the saturated solution were titrated with standard HCl solution using methyl orange and Na indigosulfonate as indicators with protection against atmospheric CO_2. Coexisting volatile bases were removed by evaporation before the titration procedure.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. $Sr(OH)_2 \cdot 8H_2O$ free of $Ba(OH)_2$ and $Ca(OH)_2$ was recrystallized from water with protection against atmospheric CO_2.

Nothing further specified.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Phenol; C_6H_6O; [108-95-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

van Meurs, G. J.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

EXPERIMENTAL VALUES:

Composition of the $Sr(OH)_2 + C_6H_5OH + H_2O$ system at 25°C

Phenol mol %	(1/2)$Sr(OH)_2$ mol %	Solid phase
0.49	0.72	$Sr(OH)_2 \cdot 8H_2O$
1.28	1.48	"
3.74	3.83	"
4.80	4.86	"
5.52	5.58	"
6.04	6.12	$Sr(OH)_2 \cdot 8H_2O + Sr(C_6H_5O)_2 \cdot 4H_2O$
9.67	6.82	"
20.24	8.87	"
24.84	9.38	"
47.30	11.16	"
63.77	9.62	$Sr(C_6H_5O)_2 \cdot 4H_2O + C_6H_6O$
65.46	6.17	C_6H_6O
69.91	3.54	"
74.27	0	"

(Continued on the next page)

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Phenol; C_6H_6O; [108-95-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

van Meurs, G. J.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

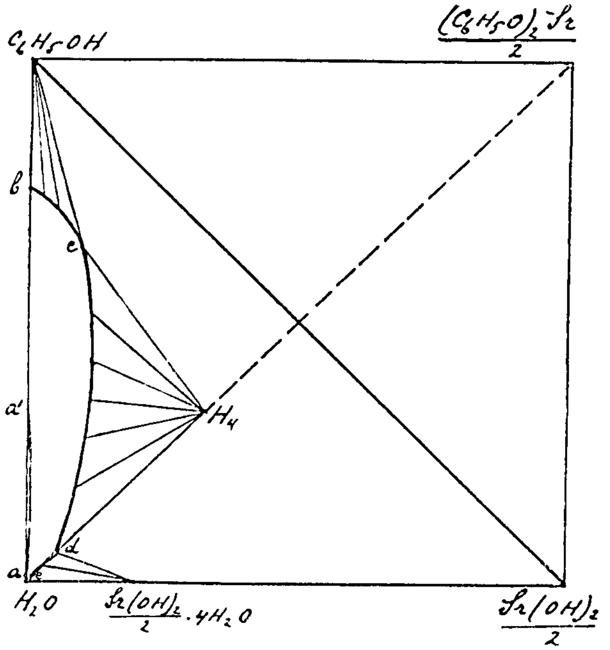
VARIABLES:

$T/K = 298$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:



$Sr(OH)_2/2 + C_6H_5OH + (C_6H_5O)_2Sr/2 + H_2O$ system at 25°C.
H_4: $Sr(C_6H_5O)_2 \cdot 4H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Sr(OH)_2$ and phenol were equilibrated with water at 25°C by shaking. The resulting saturated solutions were analyzed for $Sr(OH)_2$ by titration with a standard HCl or H_2SO_4 solution and for phenol by the titrimetric method (ref 1).

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide.

(2) Phenol.

(3) Water.

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Koppescharr, W. F.
Z. Anal. Chem. 1876, *15*, 233.

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Sidersky, M. D.

Bull. Assoc. Chim. Sucr. Distill. Ind. Agri. Fr. Colon. 1921, *39*, 167-77.

VARIABLES:

T/K = 276 - 313
Composition

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

Composition of the saturated solution

t/°C	Sucrose	SrO	
	g_2/100 g solution	g/100 g solution	m/mol kg^{-1a}
3	1.59	0.52	0.051
	4.49	0.75	0.076
	9.01	1.14	0.122
	12.29	1.42	0.159
	17.71	1.87	0.224
	21.57	2.21	0.280
15	1.82	0.72	0.071
	4.66	0.98	0.100
	9.35	1.43	0.155
	13.49	1.83	0.209
	17.97	2.19	0.265
	22.09	2.68	0.343
24	1.87	0.98	0.097
	4.76	1.37	0.141
	9.35	1.94	0.211
	13.76	2.52	0.290
	18.44	3.10	0.381
	22.69	3.63	0.475
40	1.50	1.77	0.176
	4.55	2.37	0.246
	8.21	3.19	0.347
	13.26	4.21	0.492

[a] Calculated by compiler. Solid phase not analyzed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Sr(OH)_2$ and water are placed in a stoppered flask fitted with two tubes passing through the cork, one of them with a felt plug at the end. After some hours at the desired temperature, samples are withdrawn by forcing the solution through the felt plug. $Sr(OH)_2$ is analyzed by acidimetry and the sucrose concentration measured by polarimetry. Temperatures are controlled by an ice bath (0°C), by flowing water (11 - 13°C), by a thermostated bath (40 - 90°C), and by boiling (101°C). 20 - 24°C are the ambient temperatures. Each experiment is repeated two or three times.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. Prepared from "Strontionite" ($SrCO_3$ ore) ignited, dissolved in hot water, filtered, and recrystallized three times.

(2) Sucrose. Nothing specified.

(3) Water. Nothing specified.

ESTIMATED ERROR:

Temp.: Nothing specified.
Soly.: reproducibility < ± 6 % $Sr(OH)_2$ (author).

REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Grube, G.; Nussbaum, M.

Z. Elektrochem. Angew. Phys. Chem. 1928, *34*, 91-8.

EXPERIMENTAL VALUES:

Composition of the saturated solution

t/°C	Sucrose $g_2/100g_3$	SrO $g/100g_3$	Solid phase
0	0	0.35	$Sr(OH)_2 \cdot 8H_2O^a$
	10.0	0.30	"
	15.1	0.26	$C_{12}H_{22}O_{11} \cdot SrO$
	29.2	0.20	"
	75.4	0.05	"
	120.0	0.04	"
	150.0	0.02	$C_{12}H_{22}O_{11}$
	179.4	0	"
25	0	0.89	$Sr(OH)_2 \cdot 8H_2O^a$
	9.0	0.80	"
	11.5	0.79	"
	12.5	0.75	$C_{12}H_{22}O_{11} \cdot SrO$
	17.2	0.67	"
	30.0	0.50	"
	58.9	0.34	"
	78.6	0.21	"
	120.4	0.14	"
	152.6	0.10	$C_{12}H_{22}O_{11}$
	182.2	0.07	"
	212.3	0	"
35	0	1.31	$Sr(OH)_2 \cdot 8H_2O^a$
	7.4	1.15	"
	12.7	1.10	$C_{12}H_{22}O_{11} \cdot SrO$
	16.5	1.02	"
	22.4	0.92	"
	33.3	0.81	"
	74.0	0.50	"
	101.2	0.43	"
	136.6	0.31	"
	151.4	0.25	$C_{12}H_{22}O_{11}$
	188.9	0.09	"
	227.9	0	"
50	0	2.20	$Sr(OH)_2 \cdot 8H_2O^a$
	6.8	2.06	"
	11.5	1.95	"
	16.2	1.82	$C_{12}H_{22}O_{11} \cdot SrO$
	23.1	1.64	"
	30.0	1.59	"
	43.6	1.28	"
	60.1	1.00	"
	90.7	0.69	"
	107.6	0.56	"
	134.1	0.50	"
	150.0	0.42	$C_{12}H_{22}O_{11}$
	168.3	0.29	"
	178.9	0.22	"
	198.1	0.15	"
	260.2	0	"

(continued on next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1] (3) Water; H_2O; [7732-18-5]	Grube, G.; Nussbaum, M. *Z. Elektrochem. Angew. Phys. Chem.* <u>1928</u>, *34*, 91-8.

EXPERIMENTAL VALUES:

t/°C	Sucrose $g_2/100g_3$	SrO $g/100g_3$	Solid phase
75	0	5.67	$Sr(OH)_2\cdot 8H_2O^a$
	7.0	5.25	"
	12.5	5.08	"
	13.7	5.02	"
	18.0	4.75	$C_{12}H_{22}O_{11}\cdot SrO$
	22.8	4.50	"
	37.0	3.94	"
	62.4	3.15	"
	100.0	2.40	"
	140.0	1.60	$C_{12}H_{22}O_{11}$
	180.0	0.77	"
	240.0	0.22	"
	339.2	0	"
90	0	13.60	$Sr(OH)_2\cdot 8H_2O^a$
	5.2	13.20	"
	15.4	12.70	"
	23.7	12.50	$C_{12}H_{22}O_{11}\cdot SrO$
	27.0	11.95	"
	30.5	11.65	"
	33.9	11.50	"
	50.0	10.35	"
	70.1	9.29	"
	110.1	5.78	$C_{12}H_{22}O_{11}$
	150.0	3.58	"
	200.0	2.08	"
	300.0	0.61	"
	415.7	0	"
95	0	17.83	$Sr(OH)_2\cdot 8H_2O^a$
	20.0	16.38	"
	27.5	15.93	"
	34.9	15.50	$C_{12}H_{22}O_{11}\cdot SrO$
	36.5	15.21	"
	41.5	14.82	"
	45.7	14.30	"
	47.8	14.27	"
	70.1	12.50	"
	100.1	7.91	$C_{12}H_{22}O_{11}$
	140.1	5.03	"
	195.2	2.98	"
	294.6	1.01	"
	448.2	0	"
96	0	18.72	$Sr(OH)_2\cdot 8H_2O^a$
	21.3	17.00	"
	28.4	16.62	"
	39.0	16.00	$C_{12}H_{22}O_{11}\cdot SrO$
	43.1	15.52	"
	45.0	15.28	"
	54.2	14.51	"
97	0	19.20	$Sr(OH)_2\cdot 8H_2O^a$

(continued on next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1] (3) Water; H_2O; [7732-18-5]	Grube, G.; Nussbaum, M. *Z. Elektrochem. Angew. Phys. Chem.* <u>1928</u>, *34*, 91-8.

EXPERIMENTAL VALUES:

t/°C	Sucrose $g_2/100g_3$	SrO $g/100g_3$	Solid phase
97	21.5	17.61	$Sr(OH)_2 \cdot 8H_2O^a$
	30.0	16.89	$C_{12}H_{22}O_{11} \cdot 2SrO$
	37.5	16.50	"
	44.0	15.97	$C_{12}H_{22}O_{11} \cdot SrO$
	45.8	15.91	"
	50.2	15.30	"
98	0	21.00	$Sr(OH)_2 \cdot 8H_2O^a$
	9.8	19.70	"
	13.1	19.55	"
	16.0	19.34	$C_{12}H_{22}O_{11} \cdot 2SrO$
	20.2	18.75	"
	24.0	18.38	"
	44.1	17.15	"
	47.6	17.08	"
	56.0	16.71	"
	63.5	16.62	"
	65.0	16.40	"
	66.9	15.92	$C_{12}H_{22}O_{11} \cdot SrO$
	70.2	15.85	"
	82.1	14.98	"
	87.0	13.01	$C_{12}H_{22}O_{11}$
	110.0	9.04	"
	190.0	4.14	"
	300.0	1.16	"
	470.5	0	"
100	0	22.81	$Sr(OH)_2 \cdot 8H_2O^a$
	5.9	21.62	"
	9.5	21.00	"
	22.9	19.23	$C_{12}H_{22}O_{11} \cdot 2SrO$
	28.0	18.75	"
	37.2	18.15	"
	40.0	18.04	"
	68.0	17.01	"
	70.5	16.80	"
	80.0	16.03	$C_{12}H_{22}O_{11} \cdot SrO$
	83.2	15.65	"
	140.0	7.06	$C_{12}H_{22}O_{11}$
	200.0	4.11	"
	300.0	1.32	"
	487.0	0	"

$^a Sr(OH)_2 \cdot 8H_2O$ Strontium hydroxide octahydrate [1311-10-0]

(continued on next page)

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Grube, G.; Nussbaum, M.

Z. Elektrochem. Angew. Phys. Chem. 1928, *34*, 91-8.

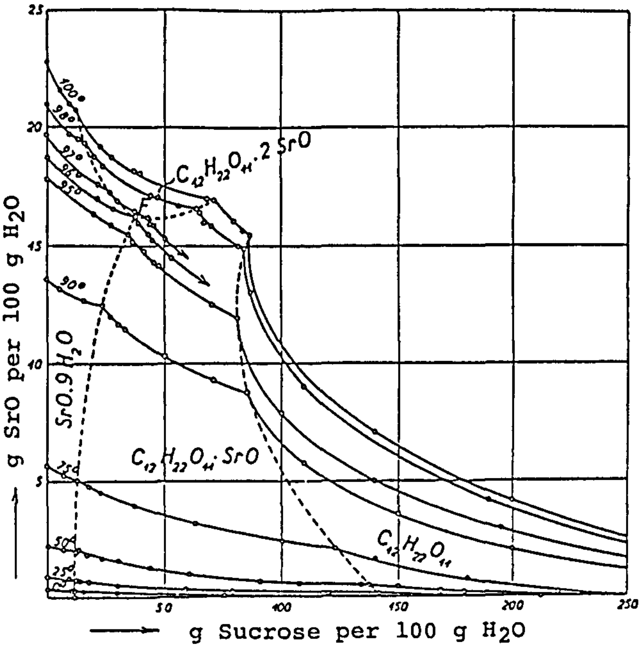
VARIABLES:

T/K = 273 - 373
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:



AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

SrO and sucrose were equilibrated with CO_2 free water at a definite temperature with continuous stirring. Aliquots of saturated solution were analyzed for $Sr(OH)_2$ by titration with a standard HCl solution and for sucrose by polarimetry.

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. SrO of high purity was used.

(2) Sucrose. Commercial sucrose of highest purity was used as received.

(3) Water.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Reinders, W.; Klinkenberg, A.

Recl. Trav. Chim. Pays-Bas 1929, *48*, 1227-45.

Recl. Trav. Chim. Pays-Bas 1929, *48*, 1246-64.

EXPERIMENTAL VALUES:

Composition of the saturated solution

t/°C	Sucrose	SrO		Solid phase
	g_2/100 g solution	g/100 g solution	10^1m/mol kg^{-1} [a]	
25	0	0.86	0.84	A
	4.1	1.58	1.62	B
	3.63	1.45	1.47	C
35	0	1.23	1.20	A
	1.9	1.6	1.60	B (I)
	4.2	2.11	2.17	C
45	0	1.81	1.78	A
	0.6	1.95	1.93	B (I)
	14	2.35	2.71	D (I)
	2.5	1.51	1.52	E (I)
55	0	2.68	2.66	A
	0.32	2.75	2.74	B
	27.5	3.5	4.89	D
	2.5	1.51	1.52	E
70	0	5	5.08	A
	0.06	5.03	5.11	F
	0.27	3.03	3.02	E
	0.93	1.73	1.71	E
	1.77	1.52	1.52	E
	6.24	1.59	1.66	E
	8	1.69	1.81	E
	11.53	1.91	2.13	E
	17.95	2.37	2.87	E
	23.8	2.83	3.72	E
	30.9	3.42	5.02	E
90	0	11.66	12.73	G
	0.01	11.66	12.74	H
	0.19	2.83	2.82	E
	0.57	1.94	1.92	E
	2.07	1.5	1.5	E
	2.49	1.42	1.43	E
	8.18	1.58	1.52	E
	12.6	1.86	1.69	E
	15.7	2.06	2.42	E
	19.3	2.27	2.79	E
	26.6	2.73	3.73	E

[a] Calculated by compiler.

(continued on next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4] (2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1] (3) Water; H_2O; [7732-18-5]	Reinders, W.; Klinkenberg, A. *Recl. Trav. Chim. Pays-Bas* 1929, *48*, 1227-45. *Recl. Trav. Chim. Pays-Bas* 1929, *48*, 1246-64.
VARIABLES:	PREPARED BY:
T/K = 298 - 363 Composition	I. Lambert

EXPERIMENTAL VALUES:

Note:

A = $Sr(OH)_2 \cdot 8H_2O$

B = $Sr(OH)_2 \cdot 8H_2O$ + strontium disucrate

C = $Sr(OH)_2 \cdot 8H_2O$ + strontium monosucrate $\cdot 6H_2O$

D = Strontium disucrate + strontium monosucrate $\cdot 6H_2O$

E = Strontium disucrate

F = $Sr(OH)_2$ + strontium disucrate

G = $Sr(OH)_2 \cdot H_2O$

H = $Sr(OH)_2 \cdot H_2O$ + strontium disucrate

I = Interpolated from constructed phase diagram

Only experimental points corresponding to equilibrium (as tested by the authors) were reported. Metastable equilibria were excluded.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Stoppered flasks containing weighed amounts of $Sr(OH)_2$ and water were agitated in a thermostat for an undefined amount of time. The saturated solution was filtered through a cotton plug or centrifugated when the precipitate grain size was too small to allow filtration. $Sr(OH)_2$ was titrated with standard acid. Sucrose was analyzed by polarimetry.	(1) Strontium hydroxide. Commercial product from Merck, "free from barite." Used without further purification. (2) Sucrose. Pure commercial sugar. (3) Water. Nothing specified.
	ESTIMATED ERROR:
	No estimates possible.
	REFERENCES:

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Nishizawa, K.; Hachihama, Y.

Z. Elektrochem. Angew. Phys. Chem. 1929, *35*, 385-92.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 75°C

Sucrose mass %	SrO mass %	H_2O mass %	Solid phase
0	5.78	94.22	$Sr(OH)_2 \cdot 8H_2O$
0.20	5.99	93.81	$Sr(OH)_2 \cdot 8H_2O + C_{12}H_{22}O_{11} \cdot 2SrO$
0.14	5.09	94.77	$C_{12}H_{22}O_{11} \cdot 2SrO$
0.13	4.16	95.71	"
0.55	2.27	97.18	"
1.98	1.68	96.34	"
3.74	1.63	94.63	"
5.45	1.64	92.91	"
7.72	1.88	90.49	"
14.92	2.38	82.70	"
18.62	2.77	78.61	"
23.65	3.25	73.10	"
26.90	3.18	69.92	"
29.98	3.63	66.29	"
33.35	4.25	62.40	"
38.84	4.62	56.54	"
45.32	5.51	49.17	"
46.80	5.60	47.60	"
31.31	4.15	64.54	$C_{12}H_{22}O_{11} \cdot 2SrO + C_{12}H_{22}O_{11} \cdot SrO$
31.78	3.92	64.30	"
32.38	3.92	63.70	"
32.75	4.20	63.05	"
33.69	3.76	62.55	"
32.22	3.68	64.10	$C_{12}H_{22}O_{11} \cdot SrO$
37.30	4.22	58.48	"
40.02	4.17	55.81	"
43.75	3.64	52.61	"
44.56	3.95	51.49	"
45.65	3.76	50.59	"
49.40	3.58	47.02	"
53.69	3.41	42.90	"
59.79	3.26	36.95	"
63.81	3.14	33.05	"
65.43	2.94	31.63	"
72.64	2.50	24.86	"
75.50	2.33	22.17	"
77.95	2.29	19.76	"
78.63	2.26	19.11	"
79.25	1.06	19.69	$C_{12}H_{22}O_{11}$
78.58	0	21.42	"

(continued on next page)

COMPONENTS:

(1) Strontium hydroxide; $Sr(OH)_2$; [18480-07-4]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Nishizawa, K.; Hachihama, Y.

Z. Elektrochem. Angew. Phys. Chem. 1929, *35*, 385-92.

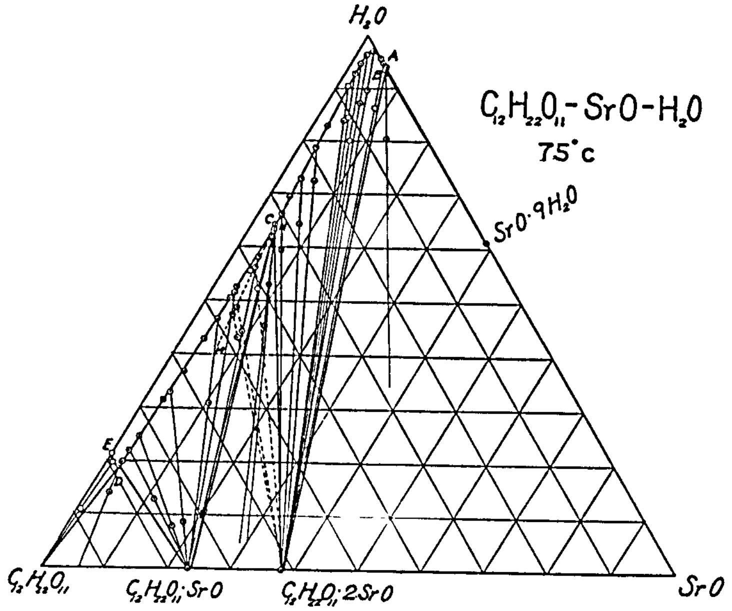
VARIABLES:

T/K = 348
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:



SrO + $C_{12}H_{22}O_{11}$ + H_2O system at t/°C = 75

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Sucrose, $Sr(OH)_2$, and water mixtures were equilibrated with agitation at 75 ± 0.05°C for 24 - 48 hours. Aliquots of saturated solution were analyzed for $Sr(OH)_2$ by titration with standard HCl solution using methyl orange indicator. Aliquots of saturated solution were additionally analyzed for sucrose by the method of Quinsumbing and Thomas (ref 1) after neutralization with HCl followed by inversion with the Soxhlet method (ref 2).

SOURCE AND PURITY OF MATERIALS:

(1) Strontium hydroxide. Analytical grade, purified by recrystallization from water.

(2) Sucrose. Purified by recrystallization from aqueous methanol.

(3) Water. Distilled CO_2 free water.

ESTIMATED ERROR:

Temp.: precision ± 0.05 K.
Soly.: Nothing specified.

REFERENCES:

1. Quinsumbing, F. A.; Thomas, A. W. *J. Am. Chem. Soc.* 1921, *43*, 1503.

2. Tollens, B. Handbuch der Kohlenhydrate, p. 333.

5. The solubility of barium hydroxide in aqueous systems.

Systems	Pages
$Ba(OH)_2$ + H_2O	284-294(E), 295-299
——— + $BaCl_2$ + H_2O	288(E), 166, 300-308
——— + ——— + HCl + H_2O	288(E), 309-310
——— + ——— + NaOH + NaCl + H_2O	287-289(E), 311-316
——— + $Ba(ClO_3)_2$ + H_2O	290(E), 317
——— + $BaBr_2$ + H_2O	288(E), 166, 318
——— + BaI_2 + H_2O	288(E), 166, 319
——— + $Ba(SH)_2$ + H_2O	288(E), 290(E), 320-321
——— + $Ba(NO_2)_2$	- , 188
——— + $Ba(NO_3)_2$ + H_2O	290(E), 322
——— + $Ba(C_2H_3O_2)_2$ + H_2O	290(E), 323
——— + $Ba(SCN)_2$ + H_2O	290(E), 324
——— + $Ba(AlO_2)_2$ + Al_2O_3 + H_2O	290(E), 325
——— + (LiCl, NaCl, KCl or RbCl) + H_2O	290(E), 326
——— + NaOH + H_2O	287-289(E), 308, 327-332
——— + KOH + H_2O	287-288(E), 333
——— + C_2H_5OH + H_2O	290(E), 334-335
——— + CH_3COCH_3 + H_2O	290(E), 336
——— + C_6H_5OH + H_2O	290(E), 337, 339
——— + 1,3-$C_6H_4(OH)_2$ + H_2O	290(E), 338-339
——— + $C_{12}H_{22}O_{11}$ + H_2O	290(E), 340-341
——— + C_4H_3OCHO	290-291(E), 242

(E) refers to evaluation page(s).

COMPONENTS:	EVALUATOR:
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5], and various aqueous solutions.	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

An evaluation of the solubility of barium hydroxide in water and in various aqueous solutions.

The solubility of barium hydroxide in water and aqueous solutions is reported in 22 publications. The starting material, when its nature is described, is the well-crystallized hydrate, $Ba(OH)_2 \cdot 8H_2O$.

1. The solubility of barium hydroxide in water.

Data for the solubility of $Ba(OH)_2$ in water have been reported in 19 publications (1-5, 7, 8, 11, 13-17, 20-25). The solid phase in equilibrium with the saturated solution up to 353 K is $Ba(OH)_2 \cdot 8H_2O$; at higher temperatures (25) it is $Ba(OH)_2 \cdot H_2O$. Reynolds' (23) measurements, which are the result of student experiments, are of poor reproducibility, and may be rejected. Rosenthiel and Ruhlman's (1) results at the lower temperatures agree well with the presently recommended values, their values are low at intermediate temperatures and high at high temperatures. Other rejected early data are given in Mellor (32).

The solubility data at temperatures below 353 K, for which $Ba(OH)_2 \cdot 8H_2O$ is the equilibrium solid, have been converted to molalities and are given in Table 1. Some of the data near room temperature (4, 7, 15 and 16) were given in concentration units which required knowledge of the density of the solution for conversion to molalities. There are few reliable data for the density of $Ba(OH)_2$ solutions. We used the relative density value estimated by linear interpolation of the two d^{20}_{20} values reported in the *International Critical Tables* (26), ignoring the variation with temperature. The maximum error is estimated to be $\Delta d = \pm 0.01$ which would lead to an error in molality of:

$$\Delta m = 3.3 \times 10^{-3} \text{ mol kg}^{-1}.$$

The data were fitted by the method of least squares to a type of equation recommended in the "Introduction to the Solubility of Solids in Liquids", eqn [48], (see also (27)), with activity and osmotic coefficient terms included in the Y_m function. This equation is based on a thermodynamic treatment of saturated solutions and their equilibrated solid phases and has the form

$$Y_m = A_1 + A_2/(T/K) + A_3 \ln (T/K).$$

where $Y_m = \ln (m/m_o) - (m/m_o - 1)$ with $1/m_o = 0.144$ kg mol^{-1} at the congruent fusion temperature. When the usual procedure of discarding points which deviate by more than two standard deviations and repeating the fit was applied, the four points marked in table 1 were discarded.

The resulting fitting equation is:

$$Y_m = -225.404 + 6019.08/(T/K) + 35.0861 \ln (T/K) \qquad [1]$$

with $s(Y_m) = 0.026$. The equation was used to calculate *recommended* solubility values at 5 degree intervals [$s(m) = 0.015$] from 273.15 to 348.15 K; see Table 2 and Fig. 1. The temperature calculated for the congruent melting point is 352.4 K with $s(T_m) = 0.6$ K.

The solubility at 298 K is known with better precision than the 298 K value from the fitting equation. The experimental solubility is:

$$m[Ba(OH)_2] = 0.265 \text{ mol kg}^{-1} \text{ at } 298.15 \text{ K}$$
$$s(m) = 0.009 \text{ mol kg}^{-1}$$

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Water; H_2O; [7732-18-5], and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B. P. 6
92265 Fontenay-aux-Roses Cedex
FRANCE
November, 1991

H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

CRITICAL EVALUATION:

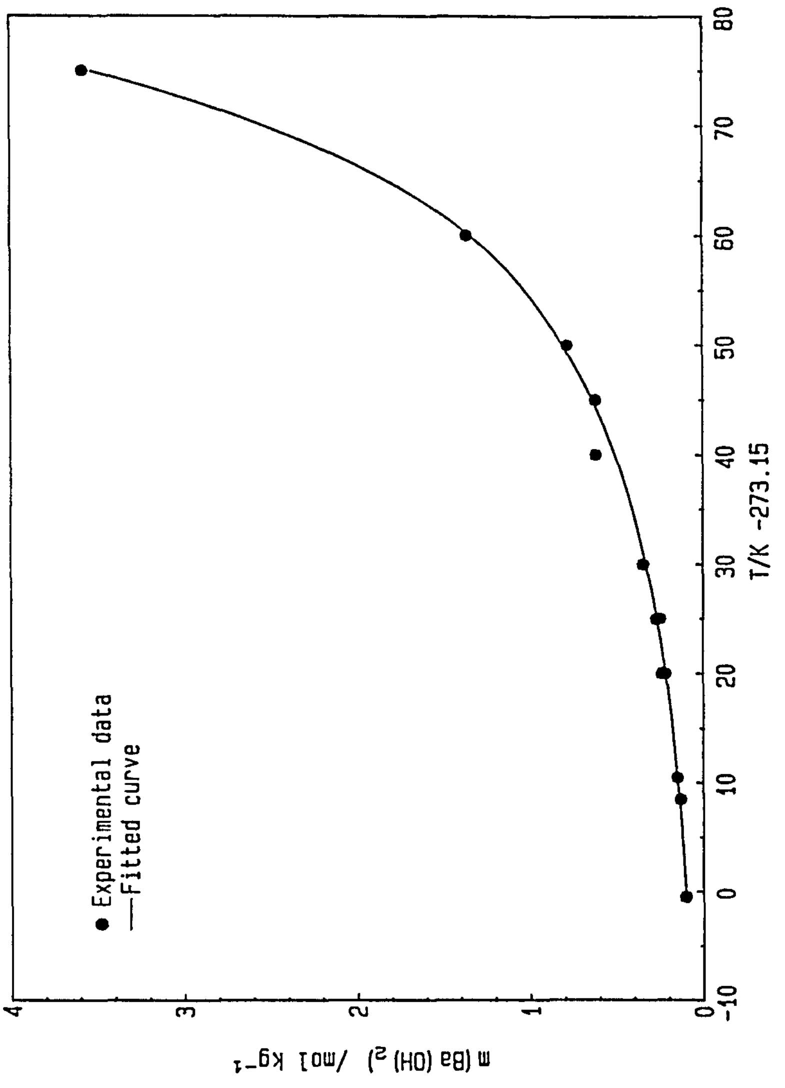


Figure 1. The recommended solubility of barium hydroxide octahydrate as a function of temperature. Equation [1] and Table 2.

COMPONENTS:	EVALUATOR:	
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5], and various aqueous solutions.	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Table 1. Experimental values of the solubility of $Ba(OH)_2 \cdot 8H_2O$ in water between 272.65 and 348.15 K.

T/K	Relative Density d_{20}^{20}	Solubility m_1/mol kg^{-1}	Average Solubility m_1/mol kg^{-1}	Reference
272.65		0.09945		2
272.65		0.09938		2
272.65		0.1019		2
272.65			0.1002 ± 0.0014	
281.65		0.133		3
283.65		0.148		22
293.15		0.225		13
293.15		0.236^{b}		22
293.15		0.238^{b}		3
293.15	1.039^{a}	0.218		16
293.15			0.229 ± 0.009	
298.15	1.047^{a}	0.263		15
298.15	1.047^{a}	0.262		15
298.15	1.046^{a}	0.258		15
298.15		0.272		14
298.15		0.25^{b}		6
298.15		0.2743		17
298.15		0.2756		8
298.15		0.2756		8
298.15	1.047^{a}	0.262		4
298.15	1.047^{a}	0.265		7
298.15			0.265 ± 0.009	
303.15		0.345		5
303.15		0.345		11
303.15			0.345	
313.15		0.62^{b}		21
318.15		0.626		14
323.15		0.785		21
333.15		1.364		24
348.15		3.58		14

[a] Relative density from *ICT* (26) as described on previous page was used to convert concentration to molality.

[b] Values not used in the final fitting.

2. Barium hydroxide + electrolyte + water: ternary systems.

A. $Ba(OH)_2 + NaOH + H_2O$ and $Ba(OH)_2 + KOH + H_2O$

Studies of these systems were reported in seven papers (5, 15, 16, 20, 22, 24, 25). Insufficient data were obtained under the same conditions of temperature and concentration to recommend any set of values. Only qualitative observations can be made. Results given only as concentrations (15) were rejected because they could not be compared with the work of others. The 293 K isotherm was studied by both Scholder and Pätsch (16) and by Mozharova and Kuznetsova (22). Their results are

COMPONENTS:	EVALUATOR:	
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5], and various aqueous solutions.	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

Table 2. Recommended values of the solubility of $Ba(OH)_2 \cdot 8H_2O$ in water between 273.15 and 348.15 K.

Temperature		Barium Hydroxide Solubility
$t/°C$	T/K	$m_1/mol\ kg^{-1}$
0	273.15	0.10
5	278.15	0.12
10	283.15	0.15
15	288.15	0.18
20	293.15	0.22
25	298.15	0.27
30	303.15	0.33
35	308.15	0.41
40	313.15	0.51
45	318.15	0.64
50	323.15	0.81
55	328.15	1.04
60	333.15	1.35
65	338.15	1.78
70	343.15	2.42
75	348.15	3.53

compared in Fig. 2 and agree well up to 13 mol kg^{-1} NaOH.

All workers, except Scholder and Pätsch (16), identified successively the three hydrates: $Ba(OH)_2 \cdot 8H_2O$, $Ba(OH)_2 \cdot 3H_2O$ and $Ba(OH)_2 \cdot H_2O$ as the NaOH concentration increases. At high temperatures only the monohydrate is stable. The same behavior is observed in KOH solution (24). Comparison of the results at different temperatures shows that the solubility of $Ba(OH)_2 \cdot 8H_2O(s)$ increases with temperature in the 283 to 333 K range. The behavior of the lower two hydrates is not as clearly defined as shown in Fig. 1.

B. $Ba(OH)_2 + BaCl_2 + H_2O$

Studies of this system were reported in six publications (5, 10, 17, 22, 24, 25, 31) of which three are from the same laboratory. Each paper reports data at a different temperature, thus no direct comparison of the results can be made. The phase diagrams at the different temperatures are consistent. The equilibrium solid phases observed as the $BaCl_2$ concentration increases are successively $Ba(OH)_2 \cdot 8H_2O$ (or $Ba(OH)_2 \cdot H_2O$ at 353 K), $BaClOH \cdot H_2O$ and $BaCl_2 \cdot 2H_2O$.

The same equilibrium solids are obtained when HCl is a starting component in place of $BaCl_2$ (11). The system $Ba(OH)_2 + BaCl_2 + NaOH + NaCl + H_2O$ exhibits the same compounds plus NaCl(s).

C. $Ba(OH)_2$ + Barium salt + H_2O

The systems $Ba(OH)_2 + BaBr_2 + H_2O$ and $Ba(OH)_2 + BaI_2 + H_2O$ were studied by Schreinemakers and Milikan (31) and by Milikan (10). They behave qualitatively in the same manner as the $Ba(OH)_2 + BaCl_2 + H_2O$ system. The absence of experimental details does not allow an evaluation of the data.

Only one source of data is available for each of the following four systems, and thus no evaluations are possible.

The system $Ba(OH)_2 + Ba(SH)_2 + H_2O$ was studied by Terres and Brückner (12) over the temperature interval 273 - 373 K. Its behavior is

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Water; H_2O; [7732-18-5], and various aqueous solutions

EVALUATOR:

Irma Lambert
CEA/SCECF/SECA
B. P. 6
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H. L. Clever
Department of Chemistry
Emory University
Atlanta, GA 30322
USA

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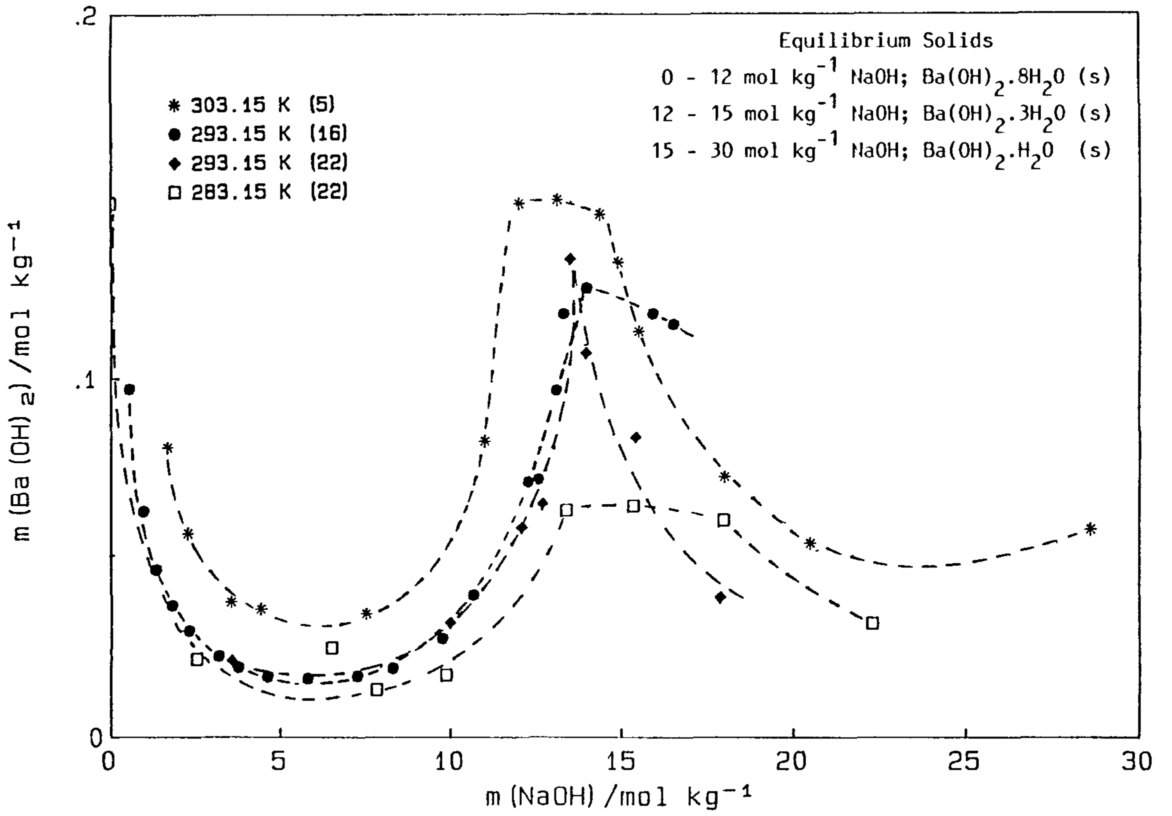

Figure 2. The solubility of barium hydroxide in aqueous sodium hydroxide solutions at several temperatures. References 5, 16 and 22.

COMPONENTS:	EVALUATOR:
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5], and various aqueous solutions.	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

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analogous to the previous systems in that there are three equilibrium solids: $Ba(OH)_2 \cdot 8H_2O$ (the authors do not mention lower hydrates at the higher temperatures), $Ba(OH)_2 \cdot Ba(SH)_2 \cdot 6H_2O$ and $Ba(SH)_2 \cdot 6H_2O$. Unlike the systems containing barium halide, $Ba(OH)_2 \cdot 8H_2O$ is claimed to remain the stable solid phase over a larger range of $Ba(SH)_2$ concentration when the temperature increases.

Foote and Hickey (17) studied the systems $Ba(OH)_2 + Ba(SCN)_2 + H_2O$, $Ba(OH)_2 + Ba(CH_3COO)_2 + H_2O$ and $Ba(OH)_2 + Ba(ClO_3)_2 + H_2O$ at 298 K. Parsons and Corson (6) studied the $Ba(OH)_2 + Ba(NO_3)_2 + H_2O$ system at 298 K. In the systems containing thiocyanate and acetate ion a double salt exists as in the hydrosulfide case. In the systems containing chlorate and nitrate ion only barium hydroxide octahydrate and the anhydrous chlorate or nitrate salt exist as equilibrium solids.

D. $Ba(OH)_2 + MCl + H_2O$ (M = Li, Na, K, Rb)

Herz (7) showed that the solubility of $Ba(OH)_2$ increased on addition of alkali halides, with the effect decreasing from Li to Rb.

E. $Ba(OH)_2 + Al_2O_3 + H_2O$

Malquori (13) studied the system at 293 K. The following solid phases were identified: $BaO \cdot 2H_2O$ (or $Ba(OH)_2 \cdot H_2O$), $Al_2O_3 \cdot 2BaO \cdot 5H_2O$ (or $2Al(OH)_3 \cdot 2Ba(OH)_2$), $Al_2O_3 \cdot BaO \cdot 6H_2O$ (or $2Al(OH)_3 \cdot Ba(OH)_2 \cdot 2H_2O$) and $Al_2O_3 \cdot xH_2O$ (or $Al(OH)_3 \cdot xH_2O$).

3. Barium hydroxide + organic component + water ternary systems.

A. $Ba(OH)_2 + C_{12}H_{22}O_{11}$ (Sucrose) + H_2O

Nishizawa and Hachihama (14) studied the system over the 298 to 348 K temperature range. Three solid phases were reported at 298 and 318 K, depending on the sucrose concentration: $Ba(OH)_2 \cdot 8H_2O$, $C_{12}H_{22}O_{11} \cdot BaO$ (or $C_{12}H_{21}O_{11} \cdot BaOH$) and $C_{12}H_{22}O_{11}$. At 348 K $C_{12}H_{22}O_{11} \cdot 3BaO$ was also reported. Rendelman (33) reviewed all metal oxide carbohydrate interactions and says they are either alcoholates or carbohydrate metal oxide (or hydroxide) adducts with reports of up to four BaO per saccharide unit.

B. $Ba(OH)_2 + C_6H_6O$ (Phenol) + H_2O and
$Ba(OH)_2 + C_6H_6O_2$ (1,3-Benzenediol) + H_2O

Van Meurs (9) studied these systems and showed the formation of $Ba(C_6H_5O)_2 \cdot 4H_2O$ in the first case and $Ba(C_6H_5O_2)_2 \cdot 2H_2O$ in the second.

C. $Ba(OH)_2 + C_2H_6O$ (Ethanol) + H_2O

Jankovic (19) studied the system up to 87.7 mol percent ethanol at 298 K. He claimed that barium hydroxide was the solid phase.

D. $Ba(OH)_2 + C_3H_6O$ (2-Propanone) + H_2O

Herz and Knock (4) studied the system up to 70 volume % 2-propanone (acetone) at 298 K. The solubility decreased with increasing 2-propanone concentration. No mention is made of the composition of the solid. The authors' solubility value in water was rejected and the solubility values in the mixed solvent are considered doubtful.

4. Non-aqueous systems

A. $Ba(OH)_2 + C_5H_5O$ (furfural)

Trimble (18) measured the solubility of both the anhydrous and the octahydrate barium hydroxide in dry furfural. The octahydrate was more soluble. It is thought this is because the water of hydration makes the

COMPONENTS:	EVALUATOR:	
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5], and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

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system a mixed furfural + water solvent. The data are tentative.

5. Comparison of these results with other evaluations.

The present work evaluated the stoichiometric solubility of barium hydroxide. Two standard evaluations present information on the barium hydroxide solubility product and the barium ion and hydroxide ion association constant.

The authors of *Critical Stability Constants* (30) evaluated data from six sources. They give values of log K_{assn} of $Ba(OH)^+(aq)$ at three ionic strengths at 298.15 K which we summarize below:

$I/\text{mol dm}^{-3}$	0.0	0.1	3.0
$K_{assn}/\text{mol dm}^{-3}$	4.0	2.5	1.0

The authors also gave a value of log $K_{s0} = -3.6$ or $K_{s0} = 2.5 \times 10^{-4}$ at zero ionic strength and 298.15 K for the $Ba(OH)_2 \cdot 8H_2O$ hydrate. Their enthalpy of solution is 57.3 kJ mol^{-1}.

Gibbs energy data given in the *Thermodynamic Tables* (29) also allows calculation of the $Ba(OH)^+(aq)$ formation constant at zero ionic strength and 298.15 K. The value is 155, substantially larger than the value in *Critical Stability Constants*.

We have a slight preferance for the larger value which is based on thermodynamic information available to the authors of both works cited above.

The *Thermodynamic Tables* (29) do not have Gibbs energies of formation for $Ba(OH)_2(s)$ or its mono-, tri- or octahydrates. Thus no calculation of the solubility product is possible from that source.

6. Crystal structures of the barium hydroxide solids.

Characterization of the solid state in equilibrium with the saturated solution is an important part of any modern solubility study. The following information, mostly from the *Crystal Data Determinative Tables*, and Buchmeier and Lutz (34), is neither complete nor evaluated, but it serves as a reminder of this important point.

Crystal Formula	Type	Density/Mg m^{-3}
BaO; [1304-28-5]	Cubic	5.982
$Ba(OH)_2$; [17194-00-2]	Amorphous	4.495
$Ba(OH)_2 \cdot H_2O$; [22326-55-2]	Orthorhombic Monoclinic	3.648 3.618
$Ba(OH)_2 \cdot 3H_2O$; [66905-77-9]	Orthorhombic	2.881
$Ba(OH)_2 \cdot 8H_2O$; [12230-71-6]	Monoclinic	2.061-2.188

The Kirk-Othmer *Encyclopedia of Chemical Technology*, J. Wiley, New York, 1978, Vol. 3, states $Ba(OH)_2 \cdot 8H_2O$ melts in its own water of crytallization, *i. e.* peritechtic temperature = 351.1 K (77.9°C) (vapor pressure 30.3 kPa). When further boiled under exclusion of atmospheric carbon dioxide the solution boils dry at a composition of $Ba(OH)_2 \cdot H_2O$. Upon continous heating a solid-phase transition to anhydrous $Ba(OH)_2$, m. p. 678 K, occurs. On heating to red heat at about 1073 K water is split off and BaO is formed. It is further stated that the trihydrate may be a mixture of the mono- and octahydrates.

COMPONENTS:	EVALUATOR:	
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991	H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

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COMPONENTS:	EVALUATOR:
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

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Mellor lists a number of early references on the solubility of $Ba(OH)_2$ in aqueous systems not included in this volume. We were unable to locate and check all of these references. The evaluator believes these references can be rejected because of impure components, failure to exclude carbon dioxide, and not using sufficient time to attain eqilibrium.

The references are:

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COMPONENTS: (1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5] and various aqueous solutions	EVALUATOR: Irma Lambert CEA/SCECF/SECA B. P. 6 92265 Fontenay-aux-Roses Cedex FRANCE November, 1991 H. L. Clever Department of Chemistry Emory University Atlanta, GA 30322 USA

CRITICAL EVALUATION:

REFERENCES (continued)

Mellor also lists books which contains pre-1900 data on the solubility of barium hydroxide in non-aqueous solvents.

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There are a number of studies of ternary systems containing $Ba(OH)_2$, water and a third component which report no solubility data of the $Ba(OH)_2$ and its hydrates as the equilibrium solid. These papers are not included.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Rosenstiehl, A.; Ruhlmann, (?)

Bull. Soc. Ind. Mulhouse <u>1870</u>, *40*, 127-53 [Soly study pp. 152-3 and a Figure].

VARIABLES:

T/K = 273.2 - 351.7

PREPARED BY:

Irma Lambert
H. L. Clever

EXPERIMENTAL VALUES:

The solubility of BaO ($Ba(OH)_2$) in water from 0 to 78.5°C

Temperature		g BaO per	$Ba(OH)_2$	$Ba(OH)_2$
t/°C	T/K	100 g H_2O	mass %	m_1/mol kg^{-1}
0	273.2	1.5	1.65	0.098
6	279.2	5.8 [*sic*]	6.13	0.38
6.5	279.7	1.9	2.1	0.12
12	285.2	2.4	2.6	0.16
15.5	288.7	2.9	3.15	0.19
16	289.2	3.	3.25	0.195
21	294.2	3.6	3.9	0.235
22	295.2	3.7	4.0	0.24
30	303.2	5.	5.3	0.33
36	309.2	6.4	6.7	0.42
41	314.2	7.6	7.9	0.50
46	319.2	9.5	9.7	0.625
54	327.2	14.	13.7	0.93
58.5	331.7	17.2	16.4	1.165
59	332.2	17.5	16.6	1.165
64	337.2	23.8	21.5	1.60
68.5	341.7	27.7	24.2	1.865
69	342.2	31.6	26.8	2.14
70	343.2	31.9	27.0	2.16
73	346.2	44.9	34.6	3.09
77.2	350.4	70.	46.0	4.97
78.5	351.7	85.	51.3	6.16

Equilibrium solid $BaO\cdot9H_2O$ [$Ba(OH)_2\cdot8H_2O$].

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The compilers calculated the $Ba(OH)_2$ mass % and molality values.

Water and excess crystals of barium hydroxide were placed in a vessel which was maintained in a large water bath of known temperature (not thermostated) for 2 to 10 hours. The solution was decanted, a sample taken, weighed and titrated with oxalic acid.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Prepared by the reaction of ZnO on BaS in boiling water for 1.5 hours. The insoluble ZnS precipitates, is separated by decantation, and the barium hydroxide is crytallized from the solution by cooling.

(2) Water. Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS: (1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Guthrie, F. *Philos. Mag. [5]* 1878, *6*, 35-44.
VARIABLES: $T/K = 273$	PREPARED BY: I. Lambert

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + H_2O$ system at -0.5°C

BaO mass %	Solid Phase Composition
1.4995	
1.4984	
1.5352	
Av. 1.511 ± 0.02	$BaO + 565\ H_2O$

In modern terms the experiment reported here was a determination of the eutectic composition and temperature of the system.

A solution of this composition will freeze to a solid of the same composition.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A solution saturated with $Ba(OH)_2$ at room temperature is cooled until the temperature of formation of cryohydrate [*eutectic composition*] is reached and cryohydrate is solidified.

Barium is analyzed by addition of ammonium carbonate to precipitate $BaCO_3$, igniting and weighing.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Std. Dev. about 1.5 %.

REFERENCES:

COMPONENTS: (1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Bauer, O. *Z. Angew. Chem.* <u>1903</u>, *15*, 341-50. *Z. Anorg. Chem* <u>1906</u>, *47*, 401-20.
VARIABLES: T/K = 282, 293	PREPARED BY: I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ba(OH)_2 \cdot 3H_2O$ in water at 8.5 and 20°C

t/°C	BaO mass %	Solid Phase
8.5	2	$Ba(OH)_2 \cdot 3H_2O$
20	3.5	$Ba(OH)_2 \cdot 3H_2O$

The author compared his results with those of Rosenstiehl and Ruhlman (ref 1) for $Ba(OH)_2 \cdot 8H_2O$ at 10 and 20°C. They reported values of 2.2 and 3.48 mass % BaO, respectively for the two temperatures. The comparison led the author to conclude both hydrates have the same solubility.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The $Ba(OH)_2 \cdot 3H_2O$ is added to CO_2 free water. No other details are specified.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. The $Ba(OH)_2 \cdot 3H_2O$ is prepared by slow cooling from boiling $Ba(OH)_2 \cdot 8H_2O$. The starting material was the hydroxide, controlled by chemical analysis by the author and found to be 99.5 % purity. The octahydrate melts at 78°C, boils at 103 with an increase in temperature to 109 at which the trihydrate separate out.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Rosensthiel, A.; Ruhlman, *Bull. Soc. Mulhouse* <u>1870</u>, *40*, 153; *Forshritte Chem.* <u>1870</u>, 314.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Sill, H. F.

J. Am. Chem. Soc. 1916, *38*, 2632-43.

VARIABLES:

$T/K = 298$
$p/MPa = 0.1 - 49$

PREPARED BY:

H. Einaga
Y. Komatsu
H. L. Clever

EXPERIMENTAL VALUES:

The solubility of $Ba(OH)_2$ in water as a function of pressure at 25°C

Pressure	Barium Hydroxide			Comments
p/bar	$Ba(OH)_2 \cdot 8H_2O$ mass %	$Ba(OH)_2$ mass %	m_1/mol kg^{-1}	
1	8.304	4.510	0.2754	a
1	8.295	4.505	0.2756	b
245	8.779	4.768	0.2924	a
245	8.802	4.780	0.2932	b
490	9.366	5.087	0.3130	c

Comments:
a. Solution first saturated at 30, then cooled to 25°C (approach from over sat.).
b. Solution first saturated at 20, then warmed to 25°C (approach from under sat.).
c. no information.

Solid phase in equilibrium with saturated solution was $Ba(OH)_2 \cdot 8H_2O$.

The molal solubility of $Ba(OH)_2$ was calculated by the compiler assuming the mass % referred to $Ba(OH)_2 \cdot 8H_2O$. He also calculated mass % $Ba(OH)_2$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Mixtures of $Ba(OH)_2$ and H_2O were equilibrated at either 20 or 30°C for 0.5 hour then 2-3 hours at 25°C in a U-tube type pressure bomb which permitted solution sample withdrawing without pressure relief. The $Ba(OH)_2$ content of the saturated solution was determined by titration with standard HCl solution.

NOTE: The author labeled the pressure unit as megabar and used definition
Megabar = 10^6 dynes = 1.02 kg cm^{-2}

The compilers used
1 bar = 1.02 kg cm^{-2} and labeled pressure column bar.

p/bar	p/kg cm^{-2}	p/MPa	p/atm
1	1.02	0.100	0.987
245	250	24.5	242
490	500	49.0	484

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Chemically pure $Ba(OH)_2 \cdot 8H_2O$ was used.

(2) Water. Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Reynolds, J. P.

J. Chem. Ed. 1975, *52*, 521-2.

VARIABLES:

$T/K = 295 - 305$

PREPARED BY:

Y. Komatsu
H. Einaga

EXPERIMENTAL VALUES:

Concentration solubility product of $Ba(OH)_2$

$t/°C$	K_{s0}	Method (See below)
room	2.00×10^{-2}	A
room	1.02×10^{-2}	A
room	2.14×10^{-2}	A
room	4.28×10^{-2}	B
room	1.25×10^{-2}	B
room	3.00×10^{-2}	B
22	4.03×10^{-2}	C
28	1.08×10^{-1}	C
32	2.56×10^{-1}	C

Solid phase recovered on drying at room temperature was $Ba(OH)_2 \cdot H_2O$ (Method A).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method A. Distilled water was saturated with $Ba(OH)_2 \cdot 8H_2O$ by shaking. After equilibration, the residual solid phase was filtered (the filtrate was reserved for Method B); it was dried for two days and then weighed. The solubility, c_1, and the solubility product, $K_{s0} = 4c_1^3$, were calculated. All procedures were carried out at a not specified room temperature.

Method B. The filtrate reserved in Method A was titrated with standard HNO_3 to determine the $[OH^-]$, from which the solubility product was calculated from $K_{s0} = (1/2)[OH^-]^3$.

Method C. Methods A and B were carried out at an elevated temperature using a water bath for preparation of the saturated solution.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Specified to be the hydrate $Ba(OH)_2 \cdot 8H_2O$.

(2) Water. Distilled.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Schreinemakers, F. A. H.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1909, *68*, 83-103.

VARIABLES:

$T/K = 303$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 30°C

$BaCl_2$ mass %	BaO mass %	Solid phase
0	4.99	$Ba(OH)_2 \cdot 8H_2O$
10.77	4.45	"
12.81	4.58	"
17.08	4.60	"
18.04	4.62	"
18.10	4.65	$Ba(OH)_2 \cdot 8H_2O + BaClOH \cdot 2H_2O$
18.77	4.64	"
18.83	4.29	"
18.97	4.86	"
19.18	4.67	$BaClOH \cdot 2H_2O$
21.46	3.27	"
24.20	2.50	"
24.98	2.33	"
27.41	1.75	$BaClOH \cdot 2H_2O + BaCl_2 \cdot 2H_2O$
27.31	1.79	"
27.42	1.78	$BaCl_2 \cdot 2H_2O$
27.6	0	"

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide.

(2) Barium chloride.

(3) Water.

Nothing specified about materials.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Foote, H. W.; Hickey, F. C.

J. Am. Chem. Soc. 1937, *59*, 648-50.

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + BaCl_2 + H_2O$ system at 25°C

$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid phase
0	4.489	$Ba(OH)_2 \cdot 8H_2O$
3.649	4.224	"
6.788	4.100	"
10.10	4.04	"
12.62	4.03	"
15.33	4.05	"
17.05	4.06	"
19.31	4.11	$Ba(OH)_2 \cdot 8H_2O + BaOHCl \cdot 2H_2O$
19.32	4.13	"
20.79	3.38	$BaOHCl \cdot 2H_2O$
22.05	3.13	"
23.57	2.65	"
26.69	1.94	$BaOHCl \cdot 2H_2O + BaCl_2 \cdot 2H_2O$
26.71	1.95	"
26.72	1.77	$BaCl_2 \cdot 2H_2O$
26.83	1.39	"
26.94	0.89	"
27.16	0	"

(continued on next page)

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Foote, H. W.; Hickey, F. C.

J. Am. Chem. Soc. 1937, *59*, 648-50.

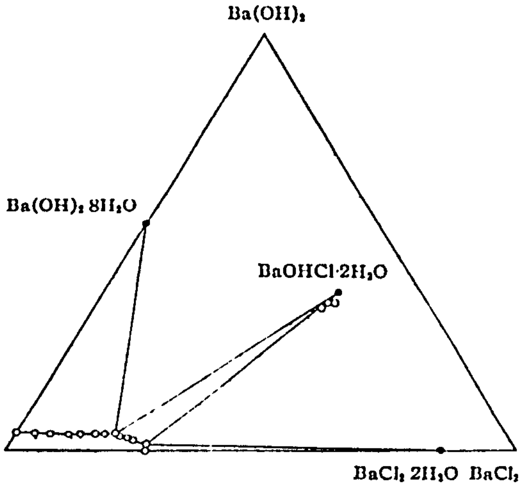
VARIABLES:

$T/K = 298$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:



$Ba(OH)_2 + BaCl_2 + H_2O$ system at $t/°C = 25$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and $BaCl_2$ were equilibrated with water at 25.00 ± 0.03°C by stirring for several days. Aliquots of saturated solution were analyzed for $Ba(OH)_2$ by titration with standard HCl solution using nitrazine yellow as an indicator. Total Ba^{2+} in solution was determined by evaporating with HCl and weighing as $BaCl_2$.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Recrystallized before use.

(2) Barium chloride. Recrystallized before use.

(3) Water.

ESTIMATED ERROR:

Temp.: precision ± 0.03 K.
Soly.: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Akhmetov, T. G.; Polyakova, G. I.

**Zh. Neorg. Khim.* <u>1972</u>, *17*, 1770-1.

Russ. J. Inorg. Chem. (Engl. Transl.) <u>1972</u>, *17*, 918-9.

EXPERIMENTAL VALUES:

Solubility of $Ba(OH)_2$ in aqueous $BaCl_2$

t/°C	$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid phase
40	0	9.60	$Ba(OH)_2 \cdot 8H_2O$
	2.7	8.48	"
	5.92	7.54	"
	9.68	8.06	"
	12.85	7.83	"
	15.3	8.00	"
	16.13	7.74	$Ba(OH)_2 \cdot 8H_2O + BaClOH \cdot 2H_2O$
	17.30	6.7	$BaClOH \cdot 2H_2O$
	17.82	6.43	"
	20.60	4.77	"
	21.70	4.18	"
	23.5	3.6	"
	26.08	2.76	"
	27.2	2.46	$BaCl_2 \cdot 2H_2O$
	28.26	1.04	"
	28.9	0	"
50	0	11.85	$Ba(OH)_2 \cdot 8H_2O$
	2.75	11.87	"
	4.05	11.93	"
	13.8	11.7	$Ba(OH)_2 \cdot 8H_2O + BaClOH \cdot 2H_2O$
	17.55	7.76	"
	18.61	7.15	$BaClOH \cdot 2H_2O$
	23.6	5.25	"
	24.3	4.15	"
	26.6	3.45	"
	27.1	2.96	"
	28.0	2.7	"
	31.32	2.54	$BaCl_2 \cdot 2H_2O$
	30.8	1.3	"
	31.02	0	"

(continued on next page)

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-23]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Akhmetov, T. G.; Polyakova, G. I.

**Zh. Neorg. Khim.* 1972, *17*, 1770-1.

Russ. J. Inorg. Chem. (Engl. Transl.) 1972, *17*, 918-9.

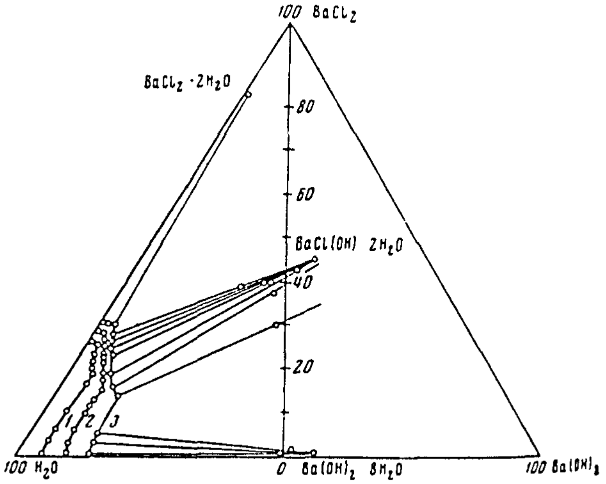
VARIABLES:

$T/K = 313 - 323$
$BaCl_2$ mass % = 0 - 31.32

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:



Solubility isotherms for the $BaCl_2$-$Ba(OH)_2$-H_2O system at different temperatures (°C): 1) 25; 2) 40; 3) 50.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and $BaCl_2$ were equilibrated with water at 40 or 50°C for 7 to 10 hours. $Ba(OH)_2$ and $BaCl_2$ in the saturated solutions were determined volumetrically (ref 1).

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Purified by recrystallization.

(2) Barium chloride. Purified by recrystallization.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Schwarzenbach, G.; Flaschka, H. Complexometric Titration (Russ. Transl.). Moscow: Izd. Khimiya, 1970.

COMPONENTS:

(1) Barium chloride; $BaCl_2$; [10361-37-2]

(2) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T. V.; Kuznetsova, O. M.

*Zh. Neorg. Khim. 1974, 19, 1940-7.

Russ. J. Inorg. Chem. (Engl. Transl.) 1974, 19, 1060-5.

VARIABLES:

$T/K = 283, 293$
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The $BaCl_2 + Ba(OH)_2 + H_2O$ system at 10 and 20°C

t/°C	$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid Phase
10	0	2.48	A
	13.52	1.53	A
	22.60	1.87	A + B
	23.79	1.75	B
	24.56	1.65	B + C
	25.04	0	C
20	0	3.89	A
	9.50	3.04	A
	20.87	3.20	A + B
	23.37	2.63	B
	26.13	1.88	B + C
	26.42	0	C

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $BaClOH \cdot 2H_2O$; C $BaCl_2 \cdot 2H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and $BaCl_2$ were equilibrated with water at 10.0 ± 0.1 and 20.0 ± 0.1°C by stirring for two days. The Ba^{2+}, Cl^-, and OH^- ions in the saturated solutions were determined (no procedures are given in the original paper).

The phase diagram at 10°C is given on another page.

SOURCE AND PURITY OF MATERIALS:

(1) Barium chloride. Chemically pure.

(2) Barium hydroxide. Analytical grade, recrystallized from water before use.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium chloride; $BaCl_2$; [10361-37-2]

(2) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T.V.; Pavlyuchenko, E.N.

Zh. Neorg. Khim. 1979, *24*, 2522-8.

Russ. J. Inorg. Chem. (Engl. Transl.) 1979, *24*, 1401-5.

VARIABLES:

$T/K = 333$
Composition

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The $BaCl_2 + Ba(OH)_2 + H_2O$ system at 60°C

t/°C	$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid Phase
60	0	18.94	A
	5.53	18.64	A
	10.70	18.99	A + B
	13.53	13.36	B
	17.71	8.98	B
	22.86	5.02	B
	25.27	4.32	B
	27.73	3.15	B
	31.14	2.55	B + C
	31.60	0	C

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $BaClOH \cdot 2H_2O$; C $BaCl_2 \cdot 2H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Experimental procedures the same as in (ref 1). See compilation of (ref 1) for details.

The phase diagram at 60°C is given in the original paper.

SOURCE AND PURITY OF MATERIALS:

Nothing specified, probably the same as (ref 1).

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Mozharova, T.V.; Kuznetsova, O.M. *Zh. Neorg. Khim.* 1974, *19*, 1940.

COMPONENTS:

(1) Barium chloride; $BaCl_2$; [10361-37-2]

(2) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T.V.; Pavlyuchenko, E.N.

Zh. Neorg. Khim. 1980, *25*, 1638-44

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1980, *25*, 909-14.

VARIABLES:

$T/K = 353$
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The $BaCl_2 + Ba(OH)_2 + H_2O$ system at 80°C

t/°C	$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid Phase
80	0	57.60	A
	2.91	49.97	A
	7.15	42.80	A + B
	7.82	40.09	B
	8.08	36.56	B
	9.76	31.40	B
	12.80	22.09	B
	19.00	11.31	B
	22.93	8.01	B
	33.37	3.37	B + C
	34.30	0	C

Solid Phases: A $Ba(OH)_2 \cdot H_2O$; B $BaClOH \cdot 2H_2O$; C $BaCl_2 \cdot 2H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Experimental procedures the same as in (ref 1). See compilation of (ref 1) for details.

The phase diagram at 80°C is given on another page.

SOURCE AND PURITY OF MATERIALS:

Nothing specified, probably the same as (ref 1).

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Mozharova, T.V.;Kuznetsova,O.M. *Zh. Neorg. Khim.* 1974, *19*, 1940.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Barium chloride; $BaCl_2$; [10361-37-2] or Sodium hydroxide; NaOH; [1310-73-2]	Mozharova, T. V.; Kuznetsova, O. M. **Zh. Neorg. Khim.* 1974, *19*, 1940-7.
(2) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]	Mozharova, T.V.; Pavlyuchenko, E.N. *Zh. Neorg. Khim.* 1980, *25*, 1638-44.
(3) Water; H_2O; [7732-18-5]	

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA: Ternary Phase Diagrams at 283, 293 and 353 K.

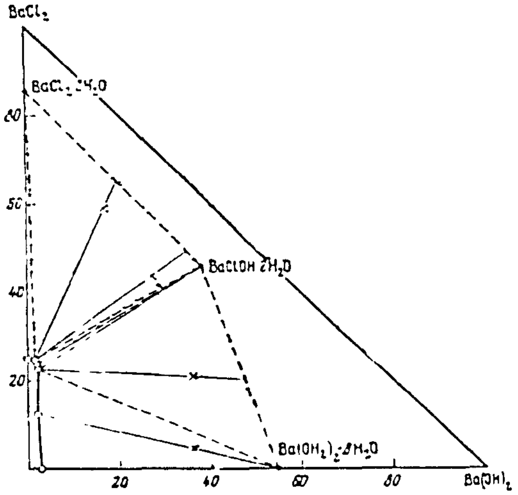


Figure 1 Solubility isotherm of the $BaCl_2 - Ba(OH)_2 - H_2O$ system at 10°C

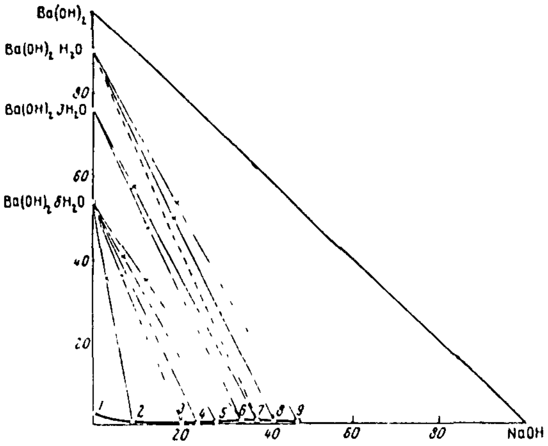


Figure 2 Solubility isotherm of the $Ba(OH)_2 - NaOH - H_2O$ system at 20°C.

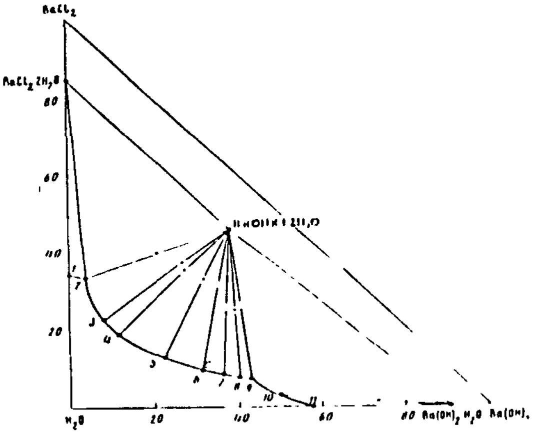


Figure 3 80 °C solubility isotherm of the $BaCl_2 - Ba(OH)_2 - H_2O$ system

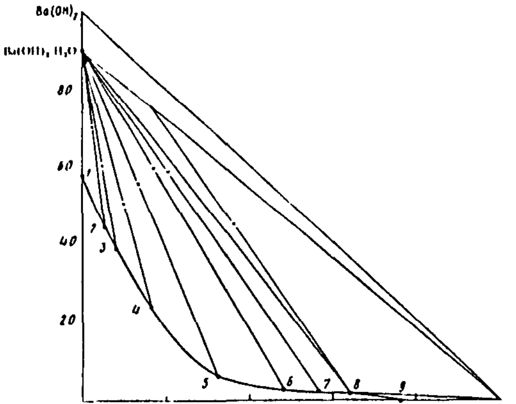


Figure 4 80 °C solubility isotherm of the $Ba(OH)_2 - NaOH - H_2O$ system

ACKNOWLEDGEMENT:

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COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Hydrogen chloride; HCl; [7647-01-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1917, *92*, 496-510.

EXPERIMENTAL VALUES:

The $Ba(OH)_2$ + HCl + H_2O system at 30°C

HCl mass %	BaO mass %	Solid Phase
0	4.99	A
3.77	12.38	A
4.49	14.01	A
5.98	17.18	A
6.32	17.90	A
6.34	17.98	A + B
6.57	18.46	A + B
6.59	18.15	A + B
6.64	18.83	A + B
6.72	18.79	B
7.51	19.07	B
8.47	20.32	B
8.75	20.72	B
9.60	21.93	B + C
9.56	21.90	B + C
9.60	21.97	C
9.66	20.32	C
9.66	18.21	C
10.48	9.55	C
12.90	2.83	C
18.27	0.16	C
32.35	0	C
37.34	0	C + D
38.63	0	D

Solid Phases:
A. $Ba(OH)_2 \cdot 8H_2O$
B. $BaCl_2 \cdot Ba(OH)_2 \cdot 4H_2O$
C. $BaCl_2 \cdot 2H_2O$
D. $BaCl_2 \cdot H_2O$

Another table gives the data in mol percent.

(continued on the next page)

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Hydrogen chloride; HCl; [7647-01-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1917, 92, 496-510.

VARIABLES:

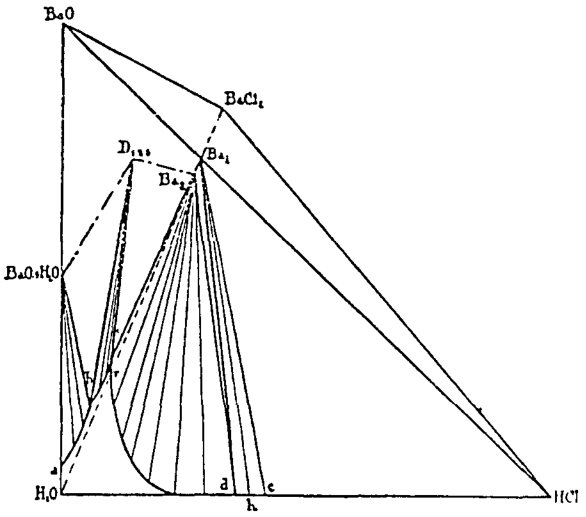
$T/K = 303$
Composition

PREPARED BY:

I. Lambert
H. Einaga

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA:



D_{115} = B (previous page)

Ba_2 = C (previous page)

Ba_1 = D (previous page)

Figure. The $Ba(OH)_2 + HCl + H_2O$ system at 30°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Barium chloride; $BaCl_2$; [10361-37-2]

(4) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T. V.; Kuznetsova, O. M.

***Zh. Neorg. Khim.* <u>1974</u>, *19*, 1940-7.

Russ. J. Inorg. Chem. (Engl. Transl.) <u>1974</u>, *19*, 1060-5.

EXPERIMENTAL VALUES:

The $[BaCl_2 + 2NaOH \rightleftharpoons Ba(OH)_2 + 2NaCl] + H_2O$ system at 10 and 20°C

t/°C	NaCl mass %	NaOH mass %	$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid Phase
10	-	-	24.56	1.65	A + B
	5.44	-	18.21	1.60	A + B
	15.69	-	7.25	1.63	A + B
	24.80	-	2.50	-	A + C
	24.55	-	0.76	1.81	A + B + C
	-	-	22.60	1.87	B + D
	5.37	-	15.58	2.19	B + D
	10.51	-	8.89	2.44	B + D
	16.71	-	2.31	3.03	B + D
	20.59	0.93	-	2.42	B + D
	21.64	2.13	-	1.44	B + D
	24.17	1.32	-	1.36	B + C
	23.45	2.29	-	1.05	B + C
	23.14	3.18	-	0.93	B + C + D
	19.68	7.61	-	0.27	C + D
	14.46	13.85	-	0.13	C + D
	3.89	30.50	-	0.41	C + D + E
	-	34.65	-	0.69	D + E
20	-	-	26.13	1.88	A + B
	5.56	-	19.12	1.77	A + B
	9.91	-	14.58	1.63	A + B
	16.32	-	7.52	1.77	A + B
	24.50	-	3.00	-	A + C
	24.62	-	1.38	1.93	A + B + C
	-	-	20.87	3.20	B + D
	4.27	-	14.30	3.36	B + D
	7.30	-	10.59	3.34	B + D
	11.18	-	6.07	3.96	B + D
	17.65	0.98	-	3.83	B + D
	19.22	2.15	-	2.44	B + D
	20.26	3.19	-	1.63	B + D
	24.05	1.79	-	1.45	B + C
	23.61	2.13	-	1.31	B + C
	22.86	3.47	-	1.11	B + C
	31.31	5.71	-	0.91	B + C + D
	19.49	7.60	-	0.62	C + D
	19.12	7.97	-	0.45	C + D
	14.02	14.83	-	2.14	C + D
	8.65	21.96	-	0.19	C + D
	4.97	28.20	-	0.57	C + D
	4.42	29.22	-	0.52	C + D + E
	2.22	30.35	-	0.67	D + E
	-	34.58	-	1.46	D + E
	0.91	50.01	-	0.16	C + F + G
	-	49.61	-	0.43	F + G

Solid Phases: A $BaCl_2 \cdot 2H_2O$; B $BaClOH \cdot 2H_2O$; C NaCl;

D $Ba(OH)_2 \cdot 8H_2O$; E $Ba(OH)_2 \cdot 3H_2O$;

F $Ba(OH)_2 \cdot H_2O$; G $NaOH \cdot H_2O$

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Barium chloride; $BaCl_2$; [10361-37-2]

(4) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T. V.; Kuznetsova, O. M.

**Zh. Neorg. Khim.* 1974, *19*, 1940-7.

Russ. J. Inorg. Chem. (Engl. Transl.) 1974, *19*, 1060-5.

VARIABLES:

T/K = 283, 293
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA: Phase Diagrams.

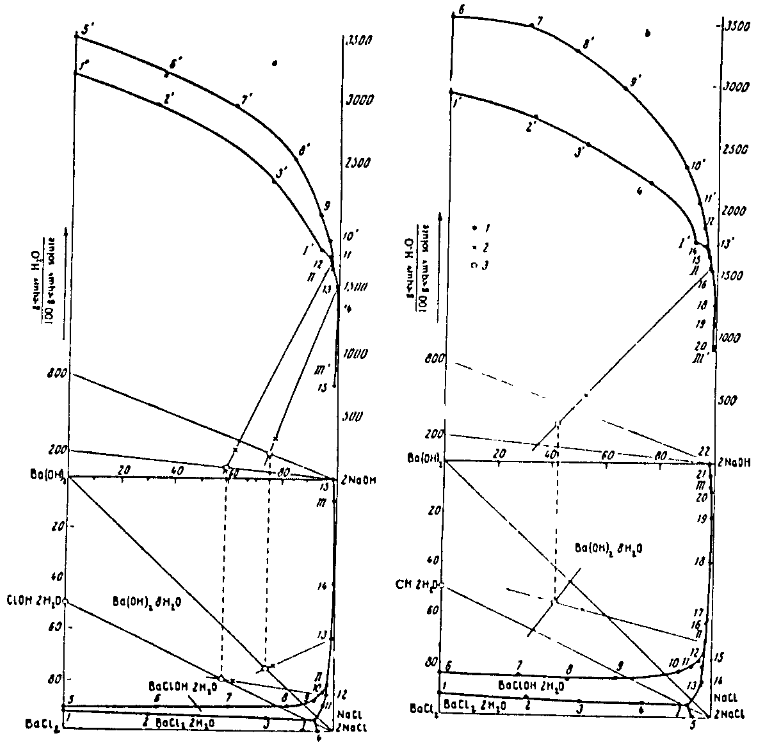


Figure The 2Na$^+$, Ba^{2+} ‖ 2Cl$^-$, 2OH$^-$–H_2O system at 10° (a) and 20°C (b) 1) Solution, 2) residue, 3) precipitate.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$, $BaCl_2$, NaOH and NaCl were equilibrated with water at 10.0 ± 0.1 and 20.0 ± 0.1°C by stirring the mixture for two days. The Ba^{2+}, Cl^- and OH^- in the saturated solution were determined (no procedures are given in the original paper), and the Na^+ ion was calculated by difference from the material balance.

ACKNOWLEDGMENT: The figures are reprinted from *Zh. Neorg. Khim.* by permission of the copyright owners, VAAP, The Copyright Agency of the USSR

SOURCE AND PURITY OF MATERIALS:

(1) Sodium chloride. Stated to be chemically pure.

(2) Sodium hydroxide. Stated to be specially pure.

(3) Barium chloride. Stated to be chemically pure.

(4) Barium hydroxide. Analytical reagent grade, recrystallized from water before use.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chloride; $BaCl_2$; [10361-37-2]

(3) Sodium hydroxide; NaCl; [1310-73-2]

(4) Sodium chloride; NaCl; [7647-14-5]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T.V.; Pavlyuchenko, E.N.

Zh. Neorg. Khim. 1979, *24*, 2522-8

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1979, *24*, 1401-5.

EXPERIMENTAL VALUES:

The [$BaCl_2$ + 2NaOH ≈ $Ba(OH)_2$ + 2NaCl] + H_2O system at 60°C

t/°C	NaCl mass %	NaOH mass %	$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid Phase
60	-	-	31.14	2.55	A + B
	6.69	-	21.97	2.26	A + B
	13.07	-	15.33	2.11	A + B
	23.40	-	6.70	-	B + C
	23.23	-	5.87	5.87	A + B + C
	24.41	-	2.64	2.77	B + C
	22.12	1.36	-	3.03	B + C
	23.42	3.01	-	2.38	B + C
	22.88	3.99	-	2.30	B + C
	21.71	6.61	-	2.26	B + C
	18.30	9.25	-	2.38	B + C
	16.30	11.60	-	2.74	B + C
	15.77	12.39	-	2.97	B + C
	13.74	14.74	-	3.49	B + C
	11.98	16.84	-	4.24	B + C
	9.64	19.51	-	5.83	B + C
	7.37	21.83	-	8.83	B + C + D
	-	-	10.70	18.99	B + E
	6.21	-	1.09	20.12	B + E
	7.40	2.99	-	16.20	B + E
	7.70	6.73	-	12.68	B + E
	7.16	11.71	-	11.33	B + E
	6.02	15.42	-	13.39	B + E
	5.03	16.25	-	16.09	B + D + E
	-	20.25	-	12.55	D + E
	2.15	19.16	-	13.52	D + E
	3.73	17.75	-	14.67	D + E
	5.37	17.41	-	14.49	B + D
	6.49	20.42	-	10.65	B + D
	-	27.88	-	7.76	D + F
	1.67	26.35	-	8.33	D + F
	4.40	24.22	-	8.29	D + F
	6.83	22.59	-	9.22	C + D + F
	6.08	25.76	-	6.24	C + F
	4.38	30.87	-	3.72	C + F
	3.95	33.28	-	2.18	C + F
	3.06	37.32	-	2.18	C + F
	1.96	46.29	-	0.51	C + F
	1.90	61.36	-	0.15	C + F + G

Continued on the next page. (Solid phases defined on next page).

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Barium hydroxide; $BaCl_2$; [17194-00-2] (2) Barium chloride; $BaCl_2$; [10361-37-2] (3) Sodium hydroxide; NaOH; [1310-73-2] (4) Sodium chloride; NaCl; [7647-14-5]] (5) Water; H_2O; [7732-18-5]	Mozharova, T.V.; Pavlyuchenko, E.N. *Zh. Neorg. Khim.* 1979, *24*, 2522-8. **Russ. J. Inorg. Chem. (Engl. Transl.)* 1979, *24*, 1401-5.
VARIABLES:	PREPARED BY:
T/K = 333 Composition	H. L. Clever

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA:

Solid Phases: A $BaCl_2 \cdot 2H_2O$; B $BaClOH \cdot 2H_2O$; C NaCl;
D $Ba(OH)_2 \cdot 3H_2O$; E $Ba(OH)_2 \cdot 8H_2O$;
F $Ba(OH)_2 \cdot H_2O$; G $NaOH \cdot H_2O$.

The 60°C isotherm of the Ba, 2Na‖2Cl, 2OH-H_2O system is shown in a large scale figure in the paper.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
$Ba(OH)_2$, $BaCl_2$, NaOH and NaCl were equilibrated with water at the specified temperature by stirring the mixture for two days. The Ba^{2+}, Cl^- and OH^- in the saturated solution were determined (no procedures are given in the original paper), and the Na^+ ion was calculated by difference from the material balance (ref 1).	No description, but probably the same as (ref 1), which is also tabulated in this volume.
	ESTIMATED ERROR:
	No estimates possible.
	REFERENCES:
	1. Mozharova, T.V.; Kuznetsova, O.M. *Zh. Neorg. Khim.* 1974, *19*, 1940.

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Barium chloride; $BaCl_2$; [10361-37-2]

(4) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T.V.; Pavlyuchenko, E.N.

Zh. Neorg. Khim. 1980, *25*, 1638-44

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1980, *25*, 909-14.

EXPERIMENTAL VALUES:

The [$BaCl_2$ + 2NaOH = $Ba(OH)_2$ + 2NaCl] + H_2O system at 80°C

t/°C	NaCl mass %	NaOH mass %	$BaCl_2$ mass %	$Ba(OH)_2$ mass %	Solid Phase
80	-	-	33.37	3.37	A + B
	9.22	-	22.13	2.42	A + B
	15.44	-	13.44	2.60	A + B
	22.80	-	9.40	-	B + C
	22.17	-	8.39	2.19	A + B + C
	24.56	-	3.38	3.48	B + C
	24.39	1.76	-	3.83	B + C
	21.95	4.14	-	3.54	B + C
	20.85	6.26	-	3.49	B + C
	18.62	8.98	-	4.07	B + C
	15.40	12.38	-	5.38	B + C
	13.26	14.38	-	6.44	B + C
	11.38	16.30	-	9.01	B + C
	10.35	16.72	-	11.43	B + C
	-	-	7.15	42.80	B + D
	4.16	1.30	-	44.64	B + D
	4.32	3.41	-	43.08	B + D
	4.65	6.40	-	39.16	B + D
	5.29	9.51	-	32.90	B + D
	6.33	12.29	-	28.77	B + D
	8.04	16.18	-	20.20	B + C + D
	8.30	17.35	-	18.12	C + D
	7.70	20.45	-	13.73	C + D
	5.79	28.59	-	6.27	C + D
	4.25	34.64	-	3.54	C + D
	2.48	63.45	-	1.50	C + D + E
	-	63.98	-	1.48	D + E
	2.95	72.16	-	-	C + E

Solid Phases: A $BaCl_2 \cdot 2H_2O$; B $BaClOH \cdot H_2O$; C NaCl;
D $Ba(OH)_2 \cdot H_2O$; E NaOH.

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Barium chloride; $BaCl_2$; [10361-37-2]

(4) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T.V.; Pavlyuchenko, E.N.

Zh. Neorg. Khim. 1980, *25*, 1638-44

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1980, *25*, 909-14.

VARIABLES:

T/K = 353
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

ADDITIONAL COMMENTS AND/OR DATA: Phase Diagram.

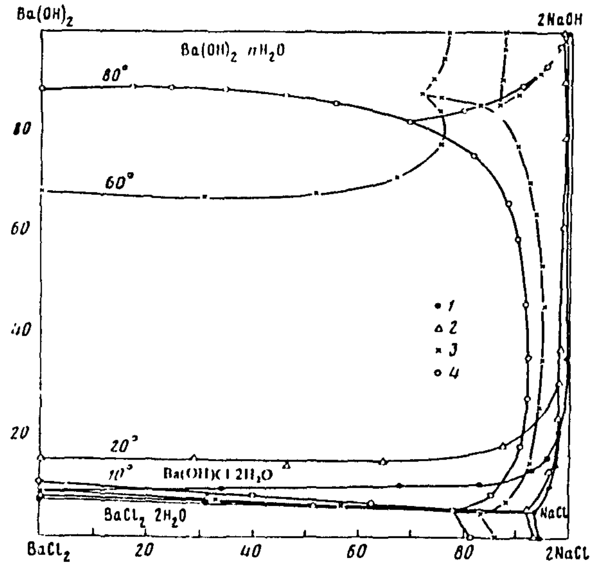


Figure Polythermal solubility diagram of the Ba,2Na‖2Cl,2OH–H_2O quaternary reciprocal system. Temperature, °C 1) 10, 2) 20, 3) 60, 4) 80.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$, $BaCl_2$, NaOH and NaCl were equilibrated with water at the specified temperature by stirring the mixture for two days. The Ba^{2+}, Cl^- and OH^- in the saturated solution were determined (no procedures are given in the original paper), and the Na^+ ion was calculated by difference from the material balance (ref 1).
ACKNOWLEDGMENT: The figure is reprinted from *Zh. Neorg. Khim.* by permission of the copyright owners, VAAP, The Copyright Agency of the USSR

SOURCE AND PURITY OF MATERIALS:

No description, but probably the same as (ref 1), which is also tabulated in this volume.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Mozharova, T.V.;Kuznetsova, O.M. *Zh. Neorg. Khim.* 1974, *19*, 1940.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium chlorate; $Ba(ClO_3)_2$; [13477-00-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Foote, H. W.; Hickey, F. C.

J. Am. Chem. Soc. 1937, *59*, 648-50.

VARIABLES:

$T/K = 298$
Composition

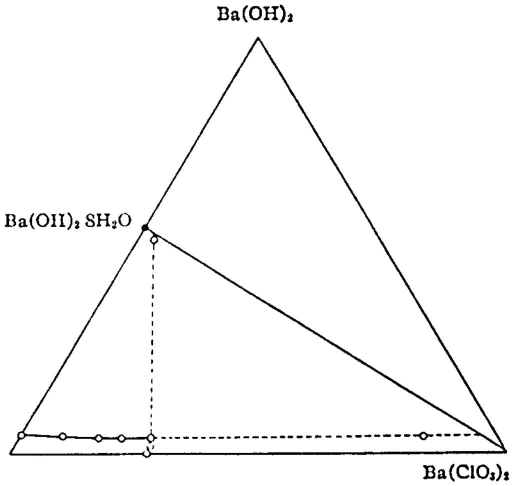
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$Ba(ClO_3)_2$ mass %	$Ba(OH)_2$ mass %	Solid phase
0	4.489	$Ba(OH)_2\cdot 8H_2O$
8.79	4.02	"
15.98	3.85	"
21.85	3.77	"
26.55	3.72	$Ba(OH)_2\cdot 8H_2O + Ba(ClO_3)_2$
26.62	3.71	"
27.17	1.87	$Ba(ClO_3)_2$
27.58	0	"



$Ba(OH)_2 + Ba(ClO_3)_2 + H_2O$ system at 25°C

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and $Ba(ClO_3)_2$ were equilibrated with water at 25.00 ± 0.03°C by stirring for several days. Aliquots of saturated solution were analyzed for $Ba(OH)_2$ by titration with standard HCl solution using nitrazine yellow as an indicator. Total Ba^{2+} in solution was determined by evaporating with HCl and weighing as $BaCl_2$.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Recrystallized before use.

(2) Barium chlorate. Recrystallized before use.

(3) Water.

ESTIMATED ERROR:

Temp.: precision ± 0.03 K.
Soly.: No estimates possible.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium bromide; $BaBr_2$; [10553-31-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

VARIABLES:

$T/K = 298$
Composition

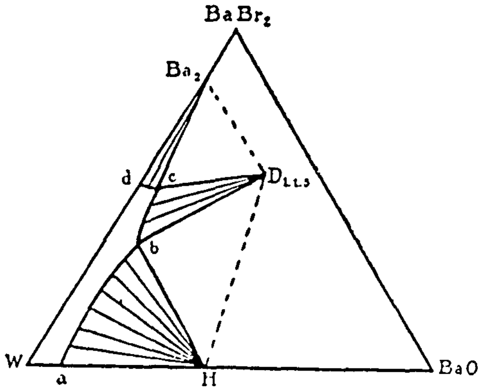
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$BaBr_2$ mass %	BaO mass %	Solid phase
13.45	3.53	$Ba(OH)_2 \cdot 8H_2O$
18.42	3.41	"
25.03	3.48	"
27.91	3.46	"
36.41	3.71	$Ba(OH)_2 \cdot 8H_2O + BaBr_2 \cdot Ba(OH)_2 \cdot 4H_2O$
40.47	2.42	$BaBr_2 \cdot Ba(OH)_2 \cdot 4H_2O$
41.71	2.15	"
49.30	0.91	"
50.65	0.79	$BaBr_2 \cdot Ba(OH)_2 \cdot 4H_2O + BaBr_2 \cdot 2H_2O$
50.67	0.78	"
51.10	0	$BaBr_2 \cdot 2H_2O$



$BaO + BaBr_2 + H_2O$ system at $t/°C = 25$

Ba_2: $BaBr_2 \cdot 2H_2O$

$D_{1.1.5}$: $BaBr_2 \cdot Ba(OH)_2 \cdot 4H_2O$ or $BaBr_2 \cdot BaO \cdot 5H_2O$

H: $Ba(OH)_2 \cdot 8H_2O$ or $BaO \cdot 9H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases detd. by Schreinemaker's method of wet residues.

No error estimates possible.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide.

(2) Barium bromide.

(3) Water.
Nothing about materials specified.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium iodide; BaI_2; [13718-50-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Milikan, J.

Z. Phys. Chem. Stoechiom. Verwandtschaftsl. 1916, *92*, 59-80.

VARIABLES:

T/K = 298
Composition

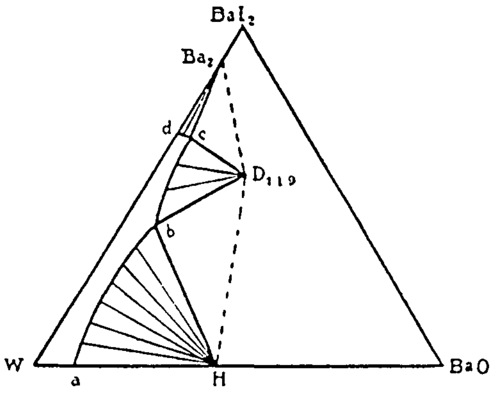
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

BaI_2 mass %	BaO mass %	Solid phase
18.38	3.25	$Ba(OH)_2 \cdot 8H_2O$
28.43	3.01	"
32.92	3.00	"
42.28	3.08	"
44.91	3.11	$Ba(OH)_2 \cdot 8H_2O + BaI_2 \cdot Ba(OH)_2 \cdot 8H_2O$
45.07	3.18	"
49.85	1.67	$BaI_2 \cdot Ba(OH)_2 \cdot 8H_2O$
52.39	1.25	"
53.68	1.04	"
56.77	0.64	"
60.33	0.40	"
62.76	0.36	"
68.51	0.21	$BaI_2 \cdot Ba(OH)_2 \cdot 8H_2O + BaI_2 \cdot 2H_2O$
68.53	0.27	"
68.59	0	$BaI_2 \cdot 6H_2O$



$BaO + BaI_2 + H_2O$ system at t/°C = 25

Ba_2: $BaI_2 \cdot 2H_2O$

$D_{1.1.9}$: $BaI_2 \cdot Ba(OH)_2 \cdot 8H_2O$ or $BaI_2 \cdot BaO \cdot 9H_2O$

H: $Ba(OH)_2 \cdot 8H_2O$ or $BaO \cdot 9H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method probably used. Solid phases detd. by Schreinemaker's method of wet residues.

No error estimates possible.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide.

(2) Barium iodide.

(3) Water.
Nothing specified about materials.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium hydrosulfide; $Ba(SH)_2$; [25417-81-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Terres, E.; Brückner, K.

Z. Elektrochem. Angew. Phys. Chem. 1920, *26*, 25-32.

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + Ba(SH)_2 + H_2O$ system at 0 to 100°C

t/°C	$Ba(SH)_2$ /g (100 g sln)$^{-1}$	$Ba(OH)_2$ /g (100 g sln)$^{-1}$	Solid Phase
0	0.92	1.49	A
	5.45	0.88	A
	13.6	0.6	B
	19.6	0.6	B
	26.3	0.65	B
	22.5	0.69	B
	27.8	0.65	B
	28.6	0.70	B
	29.0	0.60	C
	32.6	0.96	C
20	4.87	3.0	A
	6.20	2.85	A
	15.60	1.03	B
	17.90	1.08	B
	29.0	1.0	B
	17.1	1.95	B
	26.2	1.1	B
	29.0	1.0	B
	30.0	0.9	C (?)
	32.8	1.18	C
40	4.5	4.65	A
	9.55	3.8	B
	15.3	1.9	B
	20.4	1.5	B
	27.5	1.5	B
	17.6	1.65	B
	20.7	1.44	B
	25.1	1.39	B
	30.6	1.32	B
	35.2	1.29	C
60	1.15	12.9	A
	7.82	11.0	A
	10.03	8.0	B
	12.25	5.38	B
	19.9	3.0	B
	27.0	2.56	B
	28.8	2.52	B
	33.0	2.13	B
	33.5	2.10	B (?)
	37.2	2.07	C
80	1.81	22.3	A
	5.5	19.0	A
	9.6	18.5	A
	12.4	9.0	B
	21.0	6.0	B
	25.0	4.6	B
	30.0	4.0	B
	31.4	4.2	B
	34.95	3.7	B
	39.0	2.05	C

(continued on next page)

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium hydrosulfide; $Ba(SH)_2$; [25417-81-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Terres, E.; Bruckner, K.

Z. Elektrochem. Angew. Phys. Chem. 1920, *26*, 25-32.

VARIABLES:

$T/K = 273 - 373$
Composition

PREPARED BY:

I. Lambert
H. L. Clever

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + Ba(SH)_2 + H_2O$ system at 0 to 100°C

t/°C	$Ba(SH)_2$ /g (100 g sln)$^{-1}$	$Ba(OH)_2$ /g (100 g sln)$^{-1}$	Solid Phase
100	1.32	41.9	A
	7.1	30.5	A
	7.6	29.5	A
	11.9	27.3	A
	13.0	24.4	B
	35.2	5.8	B
	41.8	5.0	C
	43.7	1.96	C

Solid Phases: A. $Ba(OH)_2 \cdot 8H_2O$

B. $Ba(OH)_2 \cdot Ba(SH)_2 \cdot 10H_2O$ or $Ba(OH)(SH) \cdot 5H_2O$

C. $Ba(SH)_2 \cdot 4H_2O$

The solid phase was identified by inspection of Fig. 4 in the original paper. There is uncertainty in identifying the exact solution composition at which the solid changes composition.

The paper also gives the solubility of $Ba(SH)_2 \cdot 4H_2O$ in pure water from -15 to 100°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solutions of $Ba(OH)_2$ and $Ba(SH)_2$ are mixed and allowed to stand overnight after the precipitation takes place.

Analysis of solution: Sulfide is oxidized into sulfate by H_2O_2 which precipitates as $BaSO_4$. $BaSO_4$ is precipitated from the remaining solution by addition of either $BaCl_2$ or H_2SO_4 depending on which species in excess. The $BaSO_4$ is determined gravimetrically.

Analysis of solid: The solid is dissolved in water and titrated with standard HCl solution using phenolphthalein (titration of OH^-) and methyl orange (titration of SH^-) as indicators.

SOURCE AND PURITY OF MATERIALS:

Technical commercial products are used. The $Ba(SH)_2$ is obtained by hydrolysis of BaS.

ESTIMATED ERROR:

No estimates possible

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium nitrate; $Ba(NO_3)_2$; [10022-31-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Parsons, C. L.; Corson, H. P.

J. Am. Chem. Soc. 1910, *32*, 1383-7.

VARIABLES:

$T/K = 298$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu
I. Lambert

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + Ba(NO_3)_2 + H_2O$ system at 25°C

Barium Nitrate	Barium Hydroxide		Specific Gravity	Solid Phase
$/g\ (100\ g\ H_2O)^{-1}$	$/g\ (100\ g\ H_2O)^{-1}$	$m_1/mol\ kg^{-1}$		
0	4.29	0.250	1.0512	A
0.43	4.29	0.250	1.0538	A
1.45	4.35	0.254	1.0640	A
1.88	4.35	0.254	1.0651	A
2.53	4.42	0.258	1.0711	A
2.79	4.40	0.257	1.0731	A
3.14	4.46	0.260	1.0774	A
3.47	4.48	0.262	1.0790	A
4.04	4.52	0.264	1.0840	A
4.41	4.53	0.264	1.0864	A
4.44	4.52	0.264	1.0885	A
5.32	4.54	0.265	1.0937	A
5.46	4.55	0.266	1.0949	A
5.66	4.60	0.269	1.0975	A
6.08	4.64	0.271	1.1010	A
6.55	4.61	0.269	1.1044	A
6.82	4.65	0.271	1.1062	A
7.01	4.72	0.276	1.1133	A
7.55	4.72	0.276	1.1220	A
8.66	4.83	0.282	1.1288	A
10.21	4.93	0.288	1.1371	A
11.48	5.02	0.293	1.1448	A + B
11.04	3.22	0.188	1.1210	B
10.66	1.55	0.090	1.1002	B
10.30	0	0	1.0797	B

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $Ba(NO_3)_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solid $Ba(OH)_2$ was added to aqueous $Ba(NO_3)_2$ solution in tightly stoppered bottles and rotated for four months at 25°C to attain equilibrium. Aliquots of saturated solution were removed and the $Ba(OH)_2$ determined by titration with standard HNO_3 solution using phenolphthalein as indicator. The $Ba(NO_3)_2$ was determined by acidification of an aliquot with HNO_3, evaporation to dryness, weighing the residue, and subtraction of the amount corresponding to $Ba(OH)_2$.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide.

(2) Barium nitrate.

Specially pure samples of each component were used.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium acetate; $Ba(C_2H_3O_2)_2$; [543-80-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Foote, H. W.; Hickey, F. C.

J. Am. Chem. Soc. 1937, *59*, 648-50.

VARIABLES:

T/K = 298
Composition

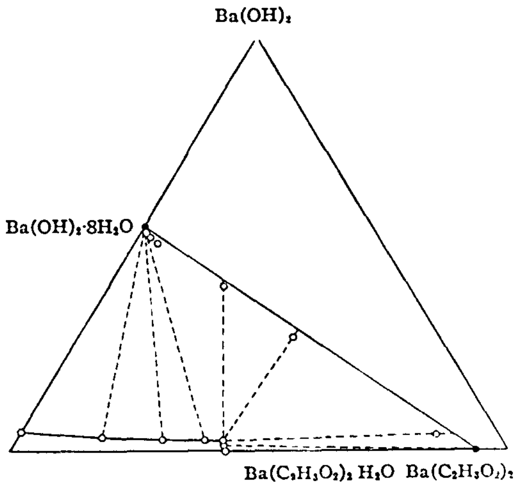
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$Ba(C_2H_3O_2)_2$ mass %	$Ba(OH)_2$ mass %	Solid phase
0	4.489	$Ba(OH)_2\cdot 8H_2O$
16.91	3.22	"
29.32	2.85	"
37.97	2.64	"
41.71	2.56	$Ba(OH)_2\cdot 8H_2O + Ba(C_2H_3O_2)_2\cdot H_2O$
41.80	2.60	"
42.40	1.35	$Ba(C_2H_3O_2)_2\cdot H_2O$
43.20	0	"



$Ba(OH)_2 + Ba(C_2H_3O_2)_2 + H_2O$ system at 25°C

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and $Ba(C_2H_3O_2)_2$ were equilibrated with water at 25.00 ± 0.03°C by stirring for several days. Aliquots of saturated solution were analyzed for $Ba(OH)_2$ by titration with standard HCl solution using phenolphthalein as an indicator. Total Ba^{2+} in solution was determined by evaporating with HCl and weighing as $BaCl_2$.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Recrystallized before use.

(2) Barium acetate. Recrystallized before use.

(3) Water.

ESTIMATED ERROR:

Temp.: precision ± 0.03 K.
Soly.: No estimates possible.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Barium thiocyanate; $Ba(SCN)_2$; [2092-17-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Foote, H. W.; Hickey, F. C.

J. Am. Chem. Soc. 1937, *59*, 648-50.

VARIABLES:

$T/K = 298$
Composition

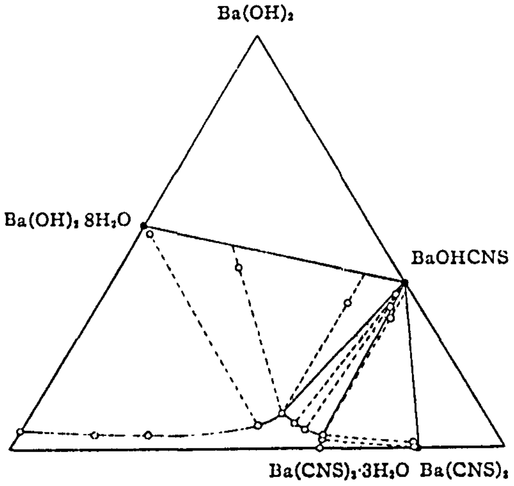
PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

$Ba(SCN)_2$ mass %	$Ba(OH)_2$ mass %	Solid phase
0	4.489	$Ba(OH)_2 \cdot 8H_2O$
15.83	3.58	"
26.54	3.44	"
47.51	5.89	"
50.88	8.45	$Ba(OH)_2 \cdot 8H_2O$ + BaOHSCN
51.00	8.49	"
54.49	6.16	BaOHSCN
57.34	4.75	"
61.61	3.18	BaOHSCN + $Ba(SCN)_2 \cdot 3H_2O$
61.73	3.16	"
61.97	2.05	$Ba(SCN)_2 \cdot 3H_2O$
62.63	0	"



$Ba(OH)_2 + Ba(SCN)_2 + H_2O$ system at 25°C

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and $Ba(SCN)_2$ were equilibrated with water at 25.00 ± 0.03°C by stirring for several days. Aliquots of saturated solution were analyzed for $Ba(OH)_2$ by titration with standard HCl solution using nitrazine yellow as an indicator. SCN^- in solution was determined by titration with a standard Ag^+ solution by using ferric alum as an indicator.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Recrystallized before use.

(2) Barium thiocyanate. Recrystallized before use.

(3) Water.

ESTIMATED ERROR:

Temp.: precision ± 0.03 K.
Soly.: No estimates possible.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Barium aluminate; $Al_2O_3 \cdot 2BaO \cdot 5H_2O$; [12349-65-4] (3) Aluminum oxide; Al_2O_3; [1344-28-1] (4) Water; H_2O; [7732-18-5]	Malquori, C. *Gazz. Chim. Ital.* 1926, *56*, 51-5.
VARIABLES:	**PREPARED BY:**
T/K = 293 Composition	I. Lambert

EXPERIMENTAL VALUES: The $BaO + Al_2O_3 + H_2O$ system at 20°C

BaO mass %	Al_2O_3 mass %	Solid Phase
3.3200	-	A
3.3200	0.0012	A
3.3900	0.0020	A
3.4500	0.4300	A
3.5000	0.6800	A + B
3.5100	0.6730	A + B
3.5410	0.6590	A + B
3.5230	0.6610	A + B
2.2110	0.6410	B
2.1310	0.6280	B + C
2.0913	0.6180	B + C
2.1540	0.6370	B + C
2.1170	0.6250	B + C
1.8730	0.4560	C
1.7320	0.3780	C
1.6540	0.3454	C
1.3300	0.2790	C
1.2100	0.2080	C + D
1.1940	0.2130	C + D
1.2060	0.2040	C + D
1.2090	0.2170	C + D
0.9016	0.1179	D
0.5187	0.0373	D
0.0100	0.0020	D

Solid Phases:
A. $Ba(OH)_2 \cdot 8H_2O$
B. $Al_2O_3 \cdot 2BaO \cdot 5H_2O$
C. $Al_2O_3 \cdot BaO \cdot 6H_2O$
D. $Al_2O_3 \cdot xH_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Mixtures of $Al_2O_3 \cdot 2BaO \cdot 5H_2O$ and $Ba(OH)_2$ or γ-Al_2O_3 in water are allowed to equilibrate in a thermostated bath at 20°C. The equilibration time is about one month. The solid phase was separated by filtration, and the solution analyzed for aluminum as Al_2O_3 and for barium as $BaSO_4$.

If mixtures of Al_2O_3 and $Ba(OH)_2$ in water are used, the equilibration time is much longer (about five months).

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Nothing specified.
(2) Barium aluminate. Prepared by reaction of Al_2O_3 on a sat. soln. of $Ba(OH)_2$ at the boiling point. The solution is conc. by distillation and the product crystallizes from solution.
(3) Aluminum oxide. Three methods. α: reaction of NH_4OH with $AlCl_3$ or $Al(NO_3)_3$. β: reaction of CO_2 on Na or K aluminate. γ: hydrolysis of barium aluminate. In all three cases the product was dried at 150°C.

ESTIMATED ERROR:

No estimates possible

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Alkali halides; see table below.

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Herz, W.

Angew. Chem. 1910, *67*, 365-8.

VARIABLES:

$T/K = 298$
Concentration of LiCl, NaCl, KCl, and RbCl.

PREPARED BY:

I. Lambert

EXPERIMENTAL VALUES:

The solubility of $Ba(OH)_2$ in aqueous alkali halide solutions at 25°C

Alkali Halide	Cl^- c/mol L^{-1}	OH^- c/mol L^{-1}	$Ba(OH)_2$ c_1/mol L^{-1}
Lithium chloride; LiCl	0	0.555	0.278
[7447-41-8]	0.75	0.745	0.373
	1.42	0.937	0.468
	2.3	1.336	0.668
Sodium chloride; NaCl;	0	0.555	0.278
[7647-14-5]	0.73	0.630	0.315
	1.43	0.699	0.350
	2.82	0.806	0.403
Potassium chloride; KCl;	0	0.555	0.278
[7447-40-7]	0.86	0.645	0.323
	1.75	0.660	0.330
	8.4	0.676	0.338
Rubidium chloride; RbCl;	0	0.555	0.278
[7791-11-9]	1.25	0.648	0.324

The compiler calculated the solubility of $Ba(OH)_2$ from the relation: $c_{Ba(OH)2} = (1/2)c_{OH-}$.

The greater increase of $Ba(OH)_2$ solubility in LiCl solutions compared to NaCl, KCl, and RbCl solutions was attributed by the author to the lower dissociation of LiOH compared with other alkali hydroxides.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Excess $Ba(OH)_2 \cdot 8H_2O$ was stirred with the salt solution until saturation was attained. After decantation, an aliquot of saturated solution was removed by aspiration. The hydroxide ion was determined by titration with standard sulfuric acid solution using phenolphthalein indicator, and the chloride ion was determined by titration with standard silver nitrate solution using potassium chromate indicator.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Error on OH^- and Cl^- determinations is estimated by the author to be less than 1 %.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Schreinemakers, F. A. H.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1909, *68*, 83-103.

VARIABLES:

T/K = 303
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

Composition of the saturated solution at 30°C

NaOH mass %	BaO mass %	Solid phase
0	4.99	$Ba(OH)_2 \cdot 8H_2O$
4.78	1.29	"
6.43	0.89	"
9.63	0.57	"
11.62	0.53	"
17.87	0.47	"
23.28	1.06	"
24.63	1.87	$Ba(OH)_2 \cdot 8H_2O + Ba(OH)_2 \cdot 3H_2O$
26.14	1.84	$Ba(OH)_2 \cdot 3H_2O$
27.72	1.75	"
28.43	1.58	"
29.24	1.34	$Ba(OH)_2 \cdot 3H_2O + Ba(OH)_2 \cdot H_2O$
32.12	0.82	$Ba(OH)_2 \cdot H_2O$
34.72	0.59	"
41.09	0.57	$Ba(OH)_2 \cdot H_2O$, $NaOH \cdot H_2O$
+42	0	$NaOH \cdot H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Nothing specified.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide.

(2) Sodium hydroxide.

(3) Water.

Nothing specified about materials.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Neale, S. M.; Stringfellow, W. A.

Trans. Faraday Soc. 1932, *28*, 765-6.

VARIABLES:

$T/K = 298$
$c_2/\text{mol L}^{-1} = 0 - 1.837$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ba(OH)_2$ in aqueous NaOH at 25°C

NaOH $c_2/\text{mol L}^{-1}$	$(1/2)Ba(OH)_2$ $c/\text{mol L}^{-1}$	$Ba(OH)_2$ $c_1/\text{mol L}^{-1}$
0	0.54	0.27
0	0.546	0.273
0	0.548	0.274
0.4417	0.3052	0.1526
0.6135	0.2440	0.1220
0.6135	0.2450	0.1225
0.9177	0.1729	0.0864_5
0.9177	0.1725	0.0862_5
1.230	0.1215	0.0607_5
1.230	0.1207	0.0603_5
1.837	0.083	0.041_5
1.837	0.086	0.043
1.837	0.082	0.041

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solid $Ba(OH)_2$ was shaken with CO_2 free aqueous NaOH solution at 25°C overnight. The resulting saturated solutions were allowed to stand at 25.00 ± 0.05°C for several hours. An aliquot of the clear solution was titrated with standard HCl solution.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Merck, Inc. Recrystallized before use.

(2) Sodium hydroxide. Specified to be pure and carbonate free.

Nothing else specified.

ESTIMATED ERROR:

Relative error: less than 1.5 % in solutions where the NaOH concentration was < 1.23 mol L^{-1}.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Sodium hydroxide; NaOH; [1310-73-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Scholder, R.; Pätsch, R.

Z. Anorg. Allg. Chem. 1935, *222*, 135-44.

VARIABLES:

$T/K = 293$
$c_2/\text{mol L}^{-1} = 0 - 19.4$

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ba(OH)_2$ in aqueous NaOH at 20°C

NaOH $c_2/\text{mol L}^{-1}$	BaO $/\text{g (100 mL)}^{-1}$	$Ba(OH)_2$ $c_1/\text{mol L}^{-1}$	Solid Phase
0	3.470	0.2263	A
0.56	1.473	0.09607	A
0.97	0.942	0.0614	A
1.34	0.706	0.0460	A
1.80	0.549	0.0358	A
2.31	0.443	0.0289	A
3.19	0.328	0.0214	A
3.75	0.292	0.0190	A
4.57	0.247	0.0161	A
5.70	0.241	0.0157	A
7.0	0.244	0.0159	A
7.92	0.274	0.0179	A
9.17	0.386	0.0252	A
9.9	0.553	0.0361	A
11.07	0.966	0.0630	A
11.28	1.064	0.06399	A
11.64	1.317	0.08589	A
11.78	1.598	0.1042	A
12.25	1.687	0.1100	B
13.6	1.543	0.1006	B
14.0	1.494	0.09744	C
14.8	1.102	0.07187	C
14.9	1.081	0.07050	C
16.5	0.714	0.0466	C
17.0	0.675	0.0440	C
18.9	0.641	0.0418	D
19.2	0.638	0.0416	D
19.4	0.645	0.0421	D

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $Ba(OH)_2 \cdot 4H_2O$;
C $Ba(OH)_2 \cdot 1.5H_2O$; D $Ba(OH)_2 \cdot H_2O$.

The authors noted $Ba(OH)_2$ was weakly amphoteric.

The compiler calculated the $Ba(OH)_2$ concentrations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Aqueous solutions of $Ba(OH)_2$ and NaOH were mixed and equilibrated in a closed Ni coated Cu vessel at 20.0 ± 0.02°C for 7-14 days with stirring. The solid phase was filtered off under a N_2 atm, and an excess of standard HCl added. The OH^- was detd. by backtitration with standard NaOH solution. The Ba^{2+} in the filtrate was determined as sulfate by gravimetry. The NaOH concentration detd by difference.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. $Ba(OH)_2 \cdot 8H_2O$ was used.

(2) Sodium hydroxide. Pure NaOH was dissolved in water to >50 mass % and filtered to remove insoluble carbonate before use.

ESTIMATED ERROR:

Temp.: precision ± 0.02 K.
Soly.: No estimates possible.

COMPONENTS:

(1) Sodium hydroxide; NaOH; [1310-73-2]

(2) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T. V.; Kuznetsova, O. M.

**Zh. Neorg. Khim.* 1974, *19*, 1940-7.

Russ. J. Inorg. Chem. (Engl. Transl.) 1974, *19*, 1060-5.

VARIABLES:

T/K = 283, 293
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The NaOH + $Ba(OH)_2$ + H_2O system at 10 and 20°C

t/°C	NaOH mass %	$Ba(OH)_2$ mass %	Solid Phase
10	0	2.48	A
	9.27	0.33	A
	20.68	0.08	A
	23.82	0.17	A
	28.26	0.21	A
	34.65	0.69	A
	-	-	A + B
	37.79	0.67	B + C
	41.59	0.59	C
	47.03	0.28	C + D
20	0	3.89	A
	12.52	0.31	A
	28.50	0.38	A
	32.41	0.66	A
	33.64	0.72	A
	34.58	1.46	A + B
	35.40	1.16	B
	37.80	0.87	B + C
	41.53	0.38	B + C
	49.61	0.47	B + C
	44.13	0.43	B + C
	-	-	C + E

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $Ba(OH)_2 \cdot 3H_2O$
C $Ba(OH)_2 \cdot H_2O$ D $NaOH \cdot 2H_2O$ E $NaOH \cdot H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and NaOH were equilibrated with water at 10.0 ± 0.1 and 20.0 ± 0.1°C by stirring for two days. The Ba^{2+} and OH^- ions in the saturated solution were determined (no procedures are given in the original paper), and the Na^+ ion was calculated from the material balance.

The phase diagram at 20°C is given on another page.

SOURCE AND PURITY OF MATERIALS:

(1) Sodium hydroxide. A specially pure grade was used.

(2) Barium hydroxide. Analytical grade, recrystallized from water before use.

ESTIMATED ERROR:

No estimates possible.

COMPONENTS:

(1) Sodium hydroxide; NaOH; [1310-73-2]

(2) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T.V.; Pavlyuchenko, E.N.

Zh. Neorg. Khim. 1979, *24*, 2522-8.

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1979, *24*, 1401-5.

VARIABLES:

$T/K = 333$
Composition

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The $NaOH + Ba(OH)_2 + H_2O$ system at 60°C

$t/°C$	NaOH mass %	$Ba(OH)_2$ mass %	Solid Phase
60	0	18.94	A
	3.58	12.71	A
	8.63	8.79	A
	9.74	7.48	A
	12.24	7.08	A
	15.76	6.06	A
	16.38	6.89	A
	18.39	8.70	A
	20.28	11.10	A
	20.25	12.55	A + B
	23.81	9.44	B
	24.91	8.79	B
	27.88	7.76	B + C
	29.82	5.20	C
	32.01	4.33	C
	35.86	2.57	C
	36.64	2.03	C
	39.95	2.13	C
	43.21	1.94	C
	47.84	1.35	C
	48.94	1.31	C
	53.37	1.23	C
	56.86	0.71	C
	60.18	0.70	C + D
	63.9	0	D

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $Ba(OH)_2 \cdot 3H_2O$;
C $Ba(OH)_2 \cdot H_2O$; D $NaOH \cdot H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Experimental procedures are the same as in (ref 1). See the compilation of (ref 1) for details.

The phase diagram at 60°C is shown in the original paper.

SOURCE AND PURITY OF MATERIALS:

No description, but probably the same as in (ref 1).

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Mozharova, T.V.; Kuznetsova, O.M. *Zh. Neorg. Khim.* 1974, *19*, 1940.

COMPONENTS:

(1) Sodium hydroxide; NaOH; [1310-73-2]

(2) Barium hydroxide; $Ba(OH)_2$ [17194-00-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Mozharova, T.V.; Pavlyuchenko, E.N.

Zh. Neorg. Khim. 1980, *25*, 1638-44

**Russ. J. Inorg. Chem. (Engl. Transl.)* 1980, *25*, 909-14.

VARIABLES:

$T/K = 353$
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The NaOH + $Ba(OH)_2$ + H_2O system at 80°C

t/°C	NaOH mass %	$Ba(OH)_2$ mass %	Solid Phase
80	0	57.60	A
	4.64	43.75	A
	7.99	37.91	A
	16.07	24.80	A
	33.04	4.64	A
	48.19	2.60	A
	56.66	2.23	A
	63.98	1.48	A + B
	75.8	0	B

Solid Phases: A $Ba(OH)_2 \cdot H_2O$ B NaOH

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Experimental procedures are the same as in (ref 1). See the compilation of (ref 1) for details.

The phase diagram at 80°C is shown on another page.

SOURCE AND PURITY OF MATERIALS:

No description, but probably the same as in (ref 1).

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Mozharova, T.V.;Kuznetsova, O.M. *Zh. Neorg. Khim.* 1974, *19*, 1940.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Potassium hydroxide; KOH; [1310-58-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Movsesyan, M. S.; Grigoryan, G. O. Khachatryan, A. A.

Arm. Khim. Zh. 1969, *22*, 211-4.

VARIABLES:

$T/K = 368$
Composition

PREPARED BY:

H. Einaga
I. Lambert

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + KOH + H_2O$ system at 95°C

Potassium Hydroxide mass %	Barium Hydroxide mass %	Solid Phase
0	61.20	A
2.51	47.21	A
8.47	30.52	A
13.74	22.82	A
23.88	17.94	A
29.57	13.76	A
32.56	13.20	A
34.70	11.50	A
37.36	9.50	A
55.74	7.41	A
59.52	6.84	A + B
62.12	0.68	B
64.10	0	B

Solid Phases: A $Ba(OH)_2 \cdot H_2O$

B $KOH \cdot H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and KOH were equilibrated with water at 95°C by stirring for 7.5 h. The saturated solution was analyzed for $Ba(OH)_2$ by gravimetry (ref 1), and for KOH by flame photometry and by gravimetry as the chloroplatinate.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Analytical grade.

(2) Potassium hydroxide. Chemically pure.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Alekseevskii, E. V.; Gol'its, R. K.; Musakin, A.P. *'Gravimetric Analysis,'* GONTI, Leningrad, 1955, p. 145.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Ethanol; C_2H_6O; [64-17-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Janković, S. *Rastvorljivost Nekih Soli i Hidrokisida Zemnoalkalnih Metala u Sistemima Voda-Etil Alkohol i Voda-Metil Alkohol, i Struktura Takvih Zasicenih Rastvora.* Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.

EXPERIMENTAL VALUES:

Composition of the saturated solution at 25°C

Water	Ethanol		Barium hydroxide	
mol %	mol %[a]	mass %	$10^5 w_1$	m_1/mmol kg^{-1}[a]
94.6	5.4	12.7	139.04	8.13
93.8	6.2	14.5	134.41	7.86
92.7	7.3	16.8	129.06	7.54
91.4	8.6	19.4	122.08	7.13
86.0	14.0	29.4	87.96	5.14
80.7	19.3	38.0	65.85	3.85
73.5	26.5	48.0	39.56	2.31
62.6	37.4	60.4	16.25	0.949
40.3	59.7	79.1	5.20	0.304
34.2	65.8	83.1	3.25	0.190
12.3	87.7	94.8	1.20	0.0700

[a] Calculated by compiler.

Properties of the saturated solution at 25°C

Water mol %	Relative Density d^{25}_{25}	Conductivity $10^5\kappa$/S cm^{-1}	Viscosity η/mPa s
94.6	0.9918	1690	1.61
93.8	0.9867	1460	1.71
92.7	0.9823	1190	1.86
91.4	0.9760	1020	1.93
86.0	0.9602	600	2.29
80.7	0.9431	400	2.50
73.5	0.9207	204	2.72
62.6	0.8901	84	2.53
40.3	0.8458	17.3	1.95
34.2	0.8324	11.0	1.83
12.3	0.8045	2.55	1.36

(continued on next page)

COMPONENTS: (1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Ethanol; C_2H_6O; [64-17-5] (3) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Janković, S. Doctoral Dissertation, Faculty of Pharmacy, Zagreb, 1958.
VARIABLES: T/K = 298 C_2H_6O mass % = 12.7 - 94.8	PREPARED BY: J. W. Lorimer

EXPERIMENTAL VALUES:

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Salt and solution were stirred for 8 days in a thermostat. After equilibration, samples were removed for analysis through a pipet fitted with a glass wool filter. Density was measured using a pycnometer; the contents of which were then used for analysis of sulfate by volumetric or colorimetric methods. Viscosity was measured using a Vogel-Ossag viscometer and conductivity with a Philips bridge (CM 4249; average reading error 2 %) and dip cell.

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. $Ba(OH)_2 \cdot H_2O$, Mallinckrodt, pro analysi.

(2) Ethanol. C. Erba, anhydrous, 99.9 - 100 % pure, density 0.795.

(3) Water. Redistilled.

ESTIMATED ERROR:

Temp.: precision within ± 0.05 K.
Soly: No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) 2-Propanone (acetone); C_3H_6O; [67-64-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Herz, W.; Knoch, M.

Z. Anorg. Chem. 1904, *41*, 315-24.

VARIABLES:

T/K = 298

Acetone/vol % = 0 - 70

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The solubility of $Ba(OH)_2$ in aqueous acetone at 25°C

2-Propanone Vol %	Water Vol %	$(1/2)Ba(OH)_2$ /mmol (100 mL sln.)$^{-1}$	$Ba(OH)_2$ c_1/mol L^{-1}
0	100	55.08	0.2754
10	90	31.84	0.1592
20	80	17.79	0.0890
30	70	9.1	0.045_5
40	60	4.75	0.0238
50	50	1.54	0.0770
60	40	0.48	0.0024
70	30	0.08	0.0004

In solutions with more than 70 vol % acetone, no dissolution of $Ba(OH)_2$ could be detected

The compiler calculated the concentrations of $Ba(OH)_2$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The water + acetone mixed solvent was saturated with $Ba(OH)_2$ at 25°C. The dissolved $Ba(OH)_2$ was determined by titration with standard acid (not specified) using phenolphthalein indicator.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Phenol; C_6H_6O; [108-95-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

van Meurs, G. J.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

VARIABLES:

$T/K = 298$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + C_6H_6O + H_2O$ system at 25°C

Phenol mol %	Barium Hydroxide (1/2)$Ba(OH)_2$ mol %	Solid Phase
0.76	1.54	A
1.48	2.19	A
2.51	3.09	A
3.07	3.62	A + B
3.06	3.63	A + B
3.17	3.29	B
3.59	3.30	B
4.78	3.67	B
12.03	5.44	B
14.44	5.89	B
19.25	6.70	B
33.57	7.53	B
50.25	7.06	B
69.61	4.98	B
70.74	5.04	B + C
70.36	4.94	C
73.48	3.28	C
74.27	0	C

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $Ba(C_6H_5O)_2 \cdot 4H_2O$; C C_6H_6O

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and phenol were equilibrated with water at 25°C by shaking. The resulting saturated solutions were analyzed for $Ba(OH)_2$ by titration with standard HCl or H_2SO_4 solution, and for phenol by the titration method of Koppeschaar (ref 1).

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Koppeschaar, W. F.
Z. Anal. Chem. 1876, *15*, 233.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) 1,3-Benzenediol; $C_6H_6O_2$; [108-46-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

van Meurs, G. J.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

VARIABLES:

$T/K = 303$
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

The $Ba(OH)_2 + C_6H_6O_2 + H_2O$ system at 30°C

1,3-Benzenediol mol %	Barium Hydroxide $(1/2)Ba(OH)_2$ mol %	Solid Phase
2.45	3.42	A
4.37	5.29	A
5.77	6.62	A
9.40	10.38	A
13.96	14.56	A + B
18.00	14.45	B
20.44	14.21	B
47.75	10.42	C
43.63	6.86	C
40.71	3.30	C
38.81	0	C

Solid Phases:

A $Ba(OH)_2 \cdot 8H_2O$

B $Ba(C_6H_4O_2) \cdot 2H_2O$

C $C_6H_6O_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

$Ba(OH)_2$ and 1,3-benzenediol were equilibrated with water at 30°C by shaking. The resulting saturated solutions were analyzed for $Ba(OH)_2$ by titration with standard HCl or H_2SO_4 solution, and for 1,3-benzenediol by the titration method of Degener (ref 1), with slight modifications.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Degener, P. *J. Prakt. Chem.* [2] 1879, *20*, 322.

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) 1,3-Benzenediol; $C_6H_6O_2$; [108-46-3]
or
Phenol; C_6H_6O; [108-95-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

van Meurs, G. J.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1916, *91*, 313-46.

EXPERIMENTAL VALUES:

COMMENTS AND/OR ADDITIONAL DATA; Phase Diagrams.

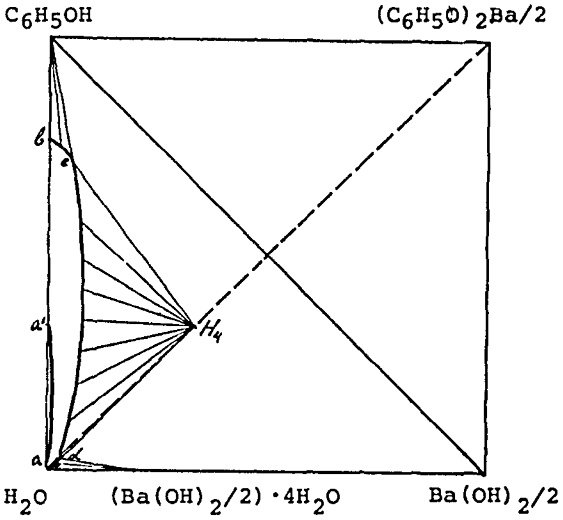


Figure 1. The $Ba(OH)_2 + C_6H_6O + H_2O$ system at 25°C

$H_4 = Ba(C_6H_5O)_2\cdot 4H_2O$

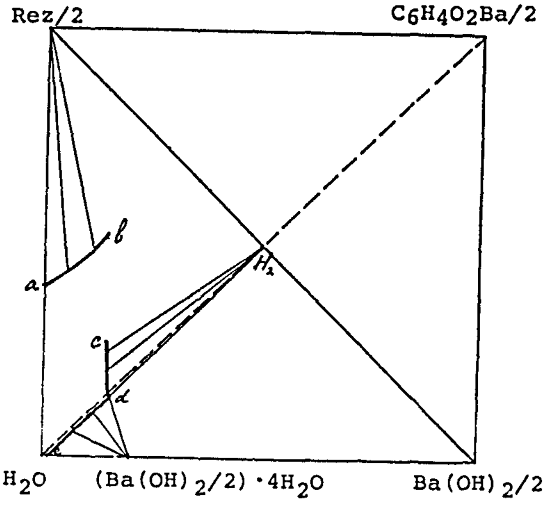


Figure 2. The $Ba(OH)_2 + C_6H_6O_2 + H_2O$ system at 30°C

$H_2 = Ba(C_6H_4O_2)\cdot 2H_2O$ (?)

The (?) was added by the original author.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2] (2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1] (3) Water; H_2O; [7732-18-5]	Nishizawa, K.; Hachihama, Y. *Z. Elektrochem. Angew. Phys. Chem.* 1929, *35*, 385-92.

EXPERIMENTAL VALUES:

The $Ba(OH)_2$ (BaO) + $C_{12}H_{22}O_{11}$ + H_2O system at 25, 45 and 75°C

t/°C	Sucrose mass %	Barium Oxide mass %	Water mass %	Solid Phase
25	0	3.99	96.01	A
	3.70	5.52	90.78	A*
	5.47	6.33	88.20	A*
	9.58	8.12	82.30	A*
	16.58	11.11	72.21	A*
	20.09	12.55	67.36	A*
	0.16	3.99	95.85	A + B
	0.16	4.01	95.83	A + B
	0.71	0.95	98.34	B
	1.40	0.70	97.90	B
	1.88	0.66	97.46	B
	9.95	0.74	89.31	B
	12.61	0.86	86.53	B
	12.76	0.93	81.81	B
	21.93	1.04	77.03	B
	27.61	1.22	71.17	B
	31.44	1.29	62.27	B
	39.68	1.52	58.50	B
	45.58	1.83	52.59	B
	50.01	1.75	48.24	B
	61.76	1.75	36.49	B
	67.86	1.50	30.64	B + C
	66.96	1.46	31.58	B + C
	68.23	0.33	31.44	C
	67.32	0	32.68	C
45	0	8.67	91.33	A
	0.13	8.99	90.88	A + B
	0.14	7.32	92.54	B
	0.18	3.60	96.22	B
	0.19	3.20	96.61	B
	0.31	1.54	98.15	B
	0.39	1.32	98.29	B
	1.76	0.64	97.60	B
	5.13	0.61	94.26	B
	7.83	0.66	91.51	B
	12.25	0.72	87.03	B
	13.44	0.74	85.82	B
	20.22	0.85	78.93	B
	22.22	0.88	76.90	B
	27.22	0.91	71.87	B
	31.76	0.99	67.25	B
	41.12	1.11	57.77	B
	46.35	1.09	52.56	B
	51.29	1.10	47.61	B
	51.50	1.12	47.38	B
	63.56	1.08	35.36	B
	72.52	1.25	26.23	B + C
	71.05	0	28.95	C

(continued on the next page)

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Nishizawa, K.; Hachihama, Y.

Z. Elektrochem. Angew. Phys. Chem. 1929, *35*, 385-92.

EXPERIMENTAL VALUES:

The $Ba(OH)_2$ (BaO) + $C_{12}H_{22}O_{11}$ + H_2O system at 25, 45 and 75°C

t/°C	Sucrose mass %	Barium Oxide mass %	Water mass %	Solid Phase
75	0	34.00	66.00	A
	0.67	34.82	64.51	A + D
	0.83	33.34	65.83	D
	0.73	32.24	67.03	D
	0.67	29.62	69.71	D
	0.78	28.79	70.43	D
	0.67	27.82	71.51	D
	0.48	26.76	72.76	D
	0.99	25.08	73.93	B + D
	1.00	25.09	73.91	B + D
	1.09	24.81	74.10	B
	0.97	23.92	75.11	B
	0.79	23.07	76.14	B
	0.68	20.79	78.53	B
	0.40	19.11	80.49	B
	0.15	9.36	90.49	B
	0.17	3.62	96.21	B
	1.59	0.70	97.71	B
	2.27	0.61	97.12	B
	7.08	0.58	92.34	B
	12.69	0.68	86.63	B
	19.05	0.66	80.29	B
	25.12	0.72	74.16	B
	27.27	0.72	72.01	B
	34.11	0.72	65.17	B
	41.13	0.89	57.98	B
	51.95	1.03	47.02	B
	58.90	0.78	40.32	B
	62.94	0.73	36.33	B
	72.31	0.56	27.13	B
	79.06	0.48	20.46	B + C
	79.81	0.46	19.73	B + C
	78.58	0	21.42	C

* Supersaturated

Solid Phases: A $Ba(OH)_2 \cdot 8H_2O$; B $C_{12}H_{22}O_{11} \cdot BaO$;

C $C_{12}H_{22}O_{11}$; D $C_{12}H_{22}O_{11} \cdot 3BaO$.

The authors published these data in an earlier set of papers, see:

J. Soc. Chem. Ind. Jpn. 1925, *28*, 272,
J. Soc. Chem. Ind. Jpn. 1927, *30*, 435-8, and
J. Soc. Chem. Ind. Jpn. 1928, *31*, 1253.

(continued on next page)

COMPONENTS:

(1) Barium hydroxide; $Ba(OH)_2$; [17194-00-2]

(2) Sucrose; $C_{12}H_{22}O_{11}$; [57-50-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Nishizawa, K.; Hachihama, Y.

Z. Elektrochem. Angew. Phys. Chem. 1929, *35*, 385-92.

VARIABLES:

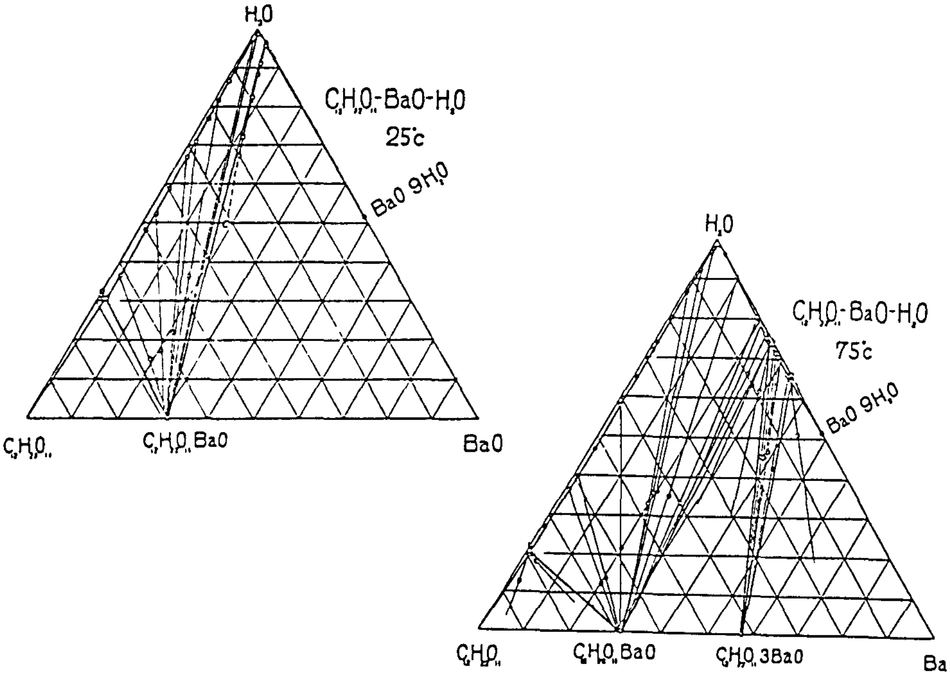
T/K = 298, 318, and 348
Composition

PREPARED BY:

H. Einaga
Y. Komatsu

EXPERIMENTAL VALUES:

ADDITIONAL DATA AND/OR COMMENTS: Phase Diagrams at 25 and 75°C.



AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Sucrose and $Ba(OH)_2$ aqueous mixtures were equilibrated within ± 0.05°C at a specified temperature for 2 - 4 days at 25 and 45°C and for 8 - 12 hours at 75°C. Aliquots of saturated solution were analyzed for $Ba(OH)_2$ gravimetrically as $BaSO_4$, and for sucrose by the method of Quinsumbing and Thomas (ref 1) after neutralization with HCl followed by inversion by the Soxhlet method (ref 2).

SOURCE AND PURITY OF MATERIALS:

(1) Barium hydroxide. Analytical grade, purified by recrystallization from water.

(2) Sucrose. Purified by recrystallization from aqueous ethanol.

(3) Water. Distilled CO_2 free water.

ESTIMATED ERROR:

No estimates possible.

REFERENCES:

1. Quinsumbing, F.A.; Thomas, A.W. *J. Am. Chem. Soc.* 1921, *43*, 1503.

2. Tollens, B. *"Handbuch der Kohlenhydrate"*, p. 333.

SYSTEM INDEX

Page numbers preceded by E refer to evaluation texts whereas those not preceded by E refer to compiled tables. Substances are index as in Chemical Abstracts, for example ammonium acetate is indexed under acetic acid, ammonium salt.

REGISTRY NUMBER INDEX

Pages preceded by E refer to evaluation texts whereas those not preceded by E refer to compiled tables.

AUTHOR INDEX

Pages preceded by E refer to evaluation texts whereas those not preceded by E refer to compiled tables.

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