COMPONENTS:	EVALUATOR:
(1) Gold(III) hydroxide; $Au(OH)_3$; [1303-52-2] (2) Water; H_2O; [7732-18-5]	T. P. Dirkse Department of Chemistry Calvin College Grand Rapids, Michigan 49506, U.S.A. April 1984

CRITICAL EVALUATION:

Although gold has several oxidation states, the only oxide or hydroxide for which solubility data are reported is $Au(OH)_3$. There are only three papers reporting solubility data for this hydroxide. Two of these report data for 298 K, one in HNO_3 solutions (1), and the other in NaOH solutions (2). The third paper (3) reports solubility values in sulfuric acid solutions in the temperature range 291-303 K. A few solubility data for $Au(OH)_3$ in a dilute HNO_3 solution (4) are rejected because the average uncertainty in the values is about 2/3 of the value reported. Because no two papers report data for the same system all these data can only be classified as tentative.

One of these reports (2) gives solubility data for $Au(OH)_3$ in water at 298 K. The value is 3.1×10^{-6} mol kg^{-1}. The average uncertainty in the values reported to give this average is about 10%.

The solubility of $Au(OH)_3$ in aqueous NaOH passes through a maximum in a NaOH concentration of about 0.45 mol kg^{-1}, followed by a minimum in a NaOH concentration of about 1 mol kg^{-1}, Figure 1. The peak in solubility was a result of a change in the solid phase. This change in the solid phase was determined by chemical analysis as well as by microscopic examination. The originally brownish hydroxide changed to a needle-like green solid at the solubility peak. The composition of this new solid phase corresponded to Na_2HAuO_3. The solubility values up to NaOH concentrations of 0.5 mol kg^{-1} can be explained by the following equilibria:

$$Au(OH)_3 + OH^- = H_2AuO_3^- + H_2O \qquad (1)$$

$$Au(OH)_3 + 2OH^- = HAuO_3^{2-} + 2H_2O \qquad (2)$$

with equilibrium constant values of

$$K_1^\circ = (a_{H_2AuO_3^-}) \cdot (a_{H_2O^-})/(a_{OH^-}) = 5.25 \times 10^{-4} \qquad (3)$$

$$K_2^\circ = (a_{HAuO_3^{2-}}) \cdot (a_{H_2O})^2/(a_{OH^-})^2 = 23.0 \times 10^{-4}. \qquad (4)$$

To account for the decrease in solubility in NaOH concentrations of 0.5 to 1 mol kg^{-1} it is necessary to assume an additional equilibrium, perhaps equation (5).

$$Na_2HAuO_3 = 2Na^+ + HAuO_3^{2-} \qquad (5)$$

For NaOH concentrations larger than 1 mol kg^{-1} other equilibria are involved, perhaps resulting in the formation of AuO_3^{3-}.

Figure 2 combines data for acid and alkaline solutions (1, 2) at 298 K. The point of minimum solubility is difficult to determine. Johnston and Leland (2) suggest that this minimum is on the acid side of neutral, i.e., the water solubility does not represent the minimum solubility. From this it follows that a saturated solution of $Au(OH)_3$ in water contains $Au(OH)_3$(sln) plus another species, perhaps $H_2AuO_3^-$.

The solubility data reported for acid solutions do not agree well with each other, Figure 3. The solubilities are plotted as a function of the hydrogen ion concentration. The difference may be a result of the analytical method used in each case. Of the three papers reporting solubility data, the analytical method for determining the gold content was different for each investigation.

It is difficult to make a further evaluation because of the sparsity of data and the very small values of solubility.

REFERENCES

1. Bezzubenko, A. A.; Peshchevitskii, B. I. *Izvest. Sibir. Otdel. Akad. Nauk SSSR* 1961, 62
2. Johnston, H. L.; Leland, H. L. *J. Am. Chem. Soc.* 1938, *60*, 1439.
3. Jirsa, F.; Jelinek, H. *Z. Elektrochem.* 1924, *30*, 286.
4. Jirsa, F.; Jelinek, H. *Z. Elektrochem.* 1924, *30*, 534.

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

EVALUATOR:

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CRITICAL EVALUATION:

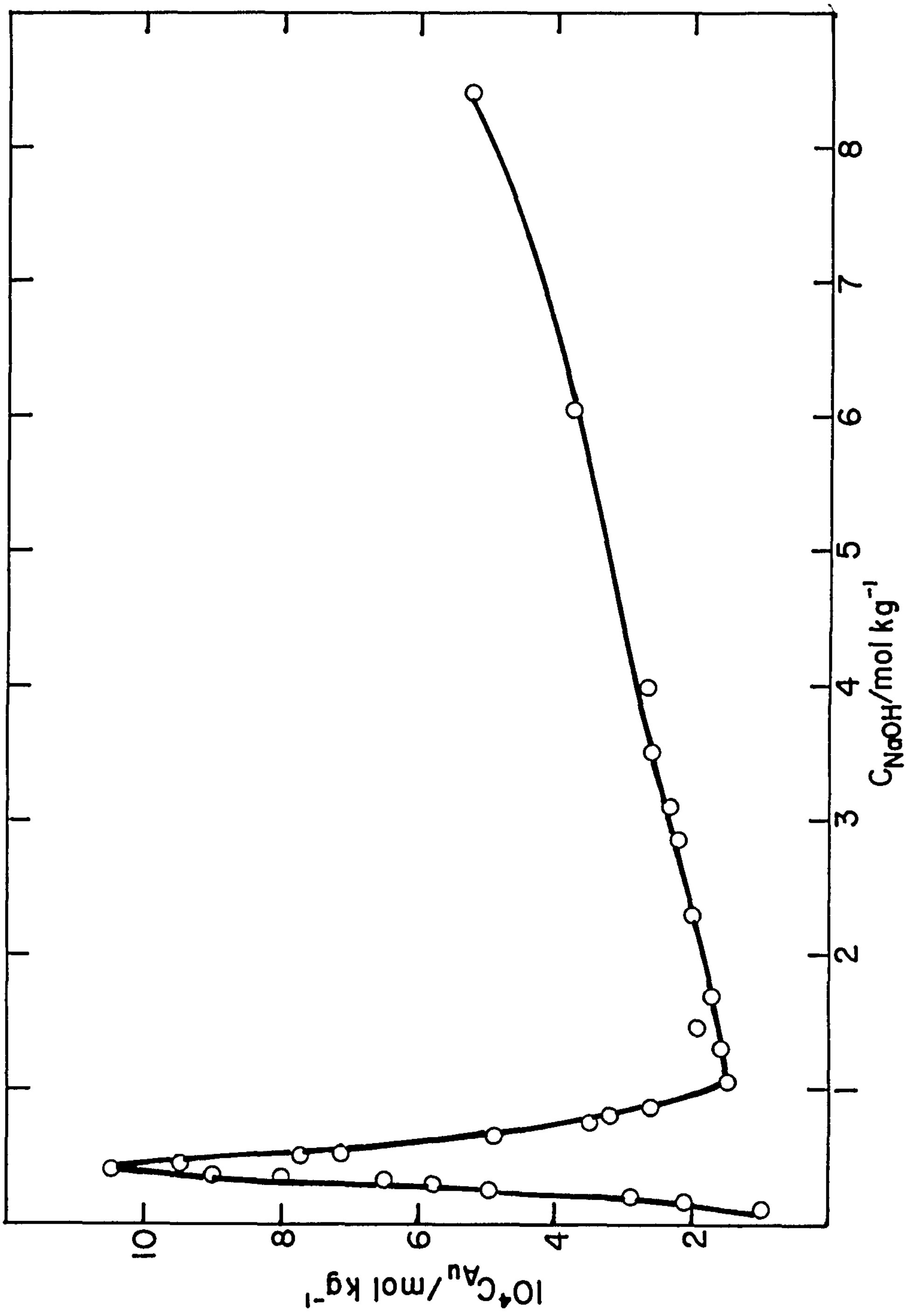

Figure 1. Solubility of $Au(OH)_3$ in aqueous NaOH at 298 K, ref. (2).

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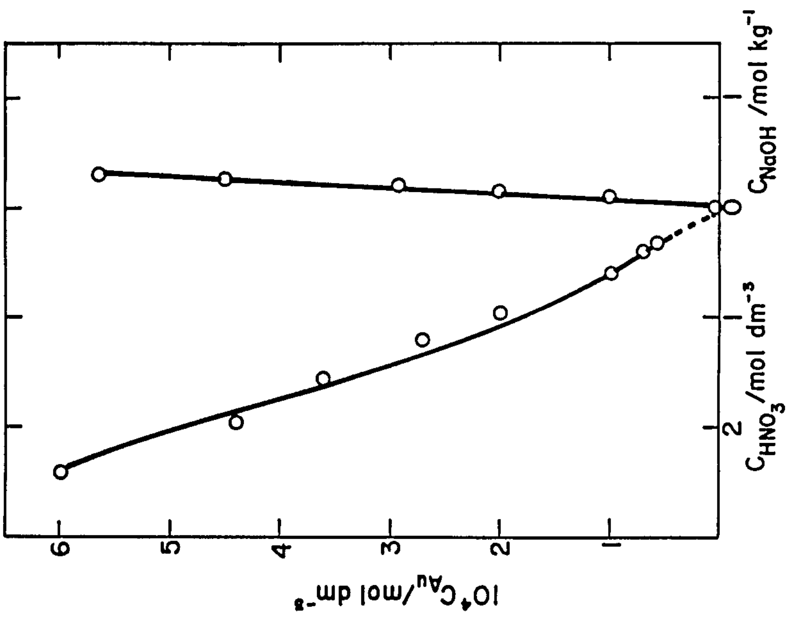

Figure 2. Solubility of $Au(OH)_3$ at 298 K in HNO_3 solutions (1) and in NaOH solutions (2).

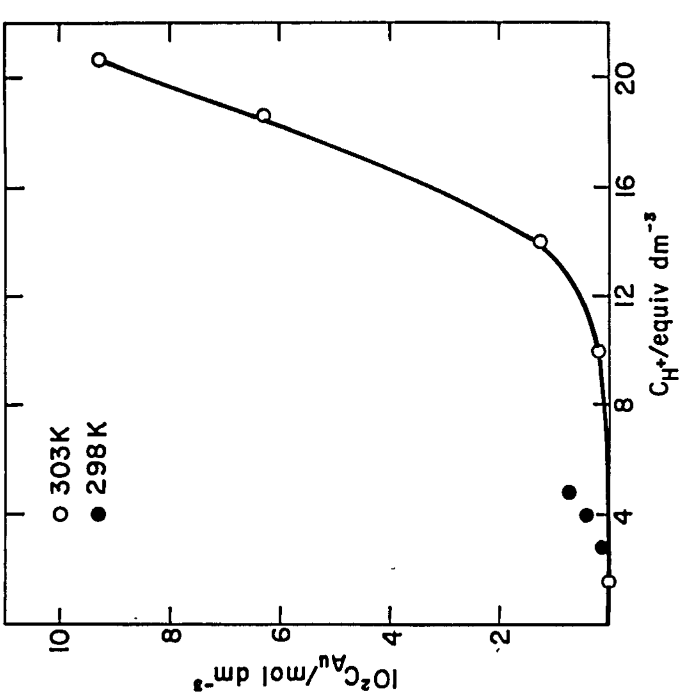

Figure 3. Solubility of $Au(OH)_3$ in nitric acid at 298 K (1) and in H_2SO_4 at 303 K (3).