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The Presence of Iron in Surface Waters

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THE PRESENCE OF IRON IN SURFACE WATERS

James Phelan

A

Report

for

Dr. Joe Nix

Special Studies 491

May 10, 1967

Honors Paper # 47

THE PRESENCE OF IRON IN SURFACE WATERS

Iron is found in most natural surface waters, although in widely varying amounts, depending on several factors relating to the water and its environment. This report is designed primarily to gain an understanding of these factors contributing to the stability and solubility of iron in these natural waters.

It has been found that iron is present in rather large amounts in aquatic vegetation and that this same vegetation is important in adding iron to surface water and in removing dissolved or suspended iron from the water. When iron is combined with organic ions or molecules, it may form complexes that are both stable and soluble. When larger water plants are present, they may produce rather drastic changes in iron content of natural waters. When dense growths of aquatic plants cover all or nearly all the open water surface, the exchange of air and water is either completely stopped or greatly reduced. Too, aquatic plants such as algae, fungi, and bacteria greatly reduce the oxygen supply already present.¹

One may ask, "Why does a change in oxygen supply affect the stability and solubility of iron?" This question may

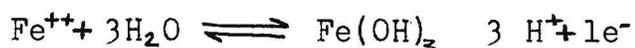
¹Hem, John D., and Oborn, Eugene T., 1961, Microbiologic Factors in the Solution and Transport of Iron: U.S. Geological Survey Water-Supply Paper 1459-H.

perhaps be best answered by the following discussion concerning the relation of redox potential, pH, and iron content: The measurement of redox potentials in ground water is very difficult, for the concentrations of the ions in solution that produce such a potential are usually very small. The reserve ions that have the ability to stabilize the redox potential is similar to the solute supply which stabilizes the pH. When related to redox potential, this effect is called poisoning, and when related to pH, it is called buffering. A laboratory determination of pH is possible, for the pH of a ground sample may not closely show the hydrogen-ion activity of the water in the aquifer.

Upon reaching the atmosphere, ground water is generally only weakly poise. When the water reaches the zone near or above the water table where oxygen is found, some oxygen immediately diffuses into the solution, the result being a water-oxygen couple which stabilizes the redox potential as long as a contact with air is available. This occurs because the large available supply of oxygen found in the atmosphere gives a poisoning effect.

If the ground water has only a few parts per million of iron, it will have a low redox potential in the aquifer, but when oxygenation takes place the redox potential rises. At saturation, there is a possibility of the water containing oxygen in a molarity 10 to 100 times greater than that of iron. The subsequent adjustment of iron to this new and stable redox potential ultimately results in the oxidation of

nearly all the iron to the ferric state.



The above oxidation and hydrolysis to ferric hydroxide explains the precipitation of iron from the water and the subsequent incorrect laboratory determinations of iron in water. Thus, the iron content should be determined in the field.²

The following data taken from the Caddo River and DeGray Creek provides excellent examples for the above discussion.

LOCATION	SAMPLING PERIOD	pH	IRON
Caddo River (Station 5)	6 (10/22/66)	7.2	0.19
DeGray Creek	6 (10/22/66)	6.8	1.90

Carbon dioxide-bicarbonate-carbonate equilibria occurs in most natural waters. Thus, the type of rock (such as those rich in calcite) over which the water runs may be very important to the iron content, for it is this equilibrium that determines the limits for solubility of iron under reducing conditions. This occurs because of its effect on pH, which in turn affects the solubility of iron.

²Hem, John D., 1960, Restraints on Dissolved Ferrous Iron Imposed by Bicarbonate Redox Potential, and pH: U.S. Geological Survey Water-Supply Paper 1459-B.