verted to the next conformational state, presumably of lower free energy. There is a plausible explanation for this transition. The chains in the double helix are not regular helices; therefore, alternate disaccharide repeats have different molecular environments. Thus, it may be argued that if a particular disaccharide is forming a maximum number of interchain linkages with the intertwining chain, it is unlikely that the adjacent dissaccharide (in its own chain) will also equally form an efficient interchain bonding arrangement. It is expected that in the structure as a whole, only about half the number of energetically favorable interchain linkages are utilized. Thus, on annealing the chains untwist to form single-strand regular helices capable of forming structures with lower free energy.

Hyaluronic acid is a good example of a material for which study of a variety of conformations, and their interrelation, is needed for better understanding of molecular behavior. Particular aspects of this behavior may then be related to the physical properties and biological functions of the substances.

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Strengite Dissolution in Flooded Soils and Sediments

Abstract. *Strengite ($FePO_4 \cdot 2H_2O$) undergoes partial dissolution under the reducing conditions existing in a flooded soil. The greatest release of phosphate and iron occurs under conditions of low oxidation-reduction potential in combination with low* pH.

A major source of phosphorus for lowland rice and swamp and marsh plants is phosphate compounds which are ordinarily insoluble but which are partially dissolved under the anaerobic conditions that exist as a result of oxygen depletion in flooded soils and sediments. The release of phosphorus from the sediments of freshwater lakes and streams is also enhanced by reducing conditions. Although the increased solubility and availability of phosphorus to plants under these conditions is well documented (*1, 2*), there is still lack of agreement about the cause. Among the major mechanisms proposed to account for the increase in phosphate solubility are: (i) the reduction of highly insoluble ferric phosphate to the more soluble noncrystalline ferrous form (*1, 3*); (ii) the displacement of phosphate from insoluble ferric phosphate and aluminum phosphate by organic anions produced in an anaerobic flooded soil (*4*); and (iii) the hydrolysis of ferric phosphate as a result of the almost invariable increase in soil *p*H which results when an acid soil is flooded (*5*).

The experiment reported here was designed to enable one to differentiate between the effects of reduction processes and *p*H changes in a waterlogged soil on the release of phosphorus from strengite ($FePO_4 \cdot 2H_2O$), a ferric phosphate mineral commonly occurring in soils. Suspensions (25 g of soil and 80 g of water) of a rice soil (Crowley silt loam from the coastal prairie of Louisiana) were incubated at oxidation-reduction (redox) potentials of +300, +100, −100, and −250 mv. These redox potentials were controlled to within ± 5 mv by means of an apparatus described previously (*6*). Microbial metabolism within the soil medium results in a release of electrons and hence in a lowering of the redox potential. The decrease in the redox potential can be controlled accurately by the automatic introduction of oxygen into the suspension. Native soil organic matter acts as an energy source for the microorganisms, although in this case we found it necessary to add glucose as an additional energy source to sustain redox potentials of −250 mv. At each redox potential the suspension was maintained at a *p*H of 5.0, 6.0, 7.0, or 8.0 ± 0.02 by the manual addition of either 0.5*N* HCl or 0.5*N* NaOH.

The strengite was synthesized according to the method of Cate *et al.* (*7*) and contained 31.2 percent iron and 17.4 percent phosphorus (by weight). The compound was uniformly labeled with ^{59}Fe to give an initial activity of 0.08 μc/mg. X-ray diffraction patterns of our compound and a sample of the preparation of Cate *et al.* showed the same crystalline structure (*8*).

After the soil suspensions had been maintained at the various redox potential–*p*H combinations for 3 days, 0.0478 g of finely powdered labeled strengite was added to each of the suspensions and incubation was continued for an additional 7 to 10 days. Samples of the suspensions were removed without contact with air, and iron (Fe^{2+} and Fe^{3+}) and orthophosphate ($H_2PO_4^-$ and HPO_4^{2-}) were extracted from the soil with 1*N* ammonium acetate solution adjusted to the same *p*H as that of the suspension. Extraction was carried out in a nitrogen-filled glove bag to prevent atmospheric oxidation. We analyzed the iron by means of the α,α'-dipyridyl method (*9*) and phosphate by means of the chlorostannous–reduced molybdophosphoric blue color method (*10*). We determined the activity of ^{59}Fe in the extract by using a deep-well gamma counter.

The results show that both *p*H and redox potential had marked effects on the dissolution of strengite in flooded soil. Using as independent solubility indicators either the amount of labeled iron released from the added strengite (Fig. 1A) or the total amount of extracted phosphate (Fig. 1B), we found that the amount of strengite dissolved ranged from no detectable amount at the highest *p*H in combination with the highest redox potential (*p*H 8 and +300 mv) to a marked amount at the lowest *p*H in combination with the lowest redox potential (*p*H 5 and −250 mv). At all *p*H levels decreases in the redox potential increased the amounts of iron and phosphate dissolved. The amounts dissolved were greater, however, at the lowest *p*H value.

More than one half (59 percent) of the ^{59}Fe in the added strengite was released under the most acid condition in combination with the most reduced condition (*p*H 5 and −250 mv). At *p*H 6, a more realistic value for a flooded soil, 21.5 percent of the total ^{59}Fe was extracted at a redox potential of −250 mv.

The effect of *p*H at constant redox

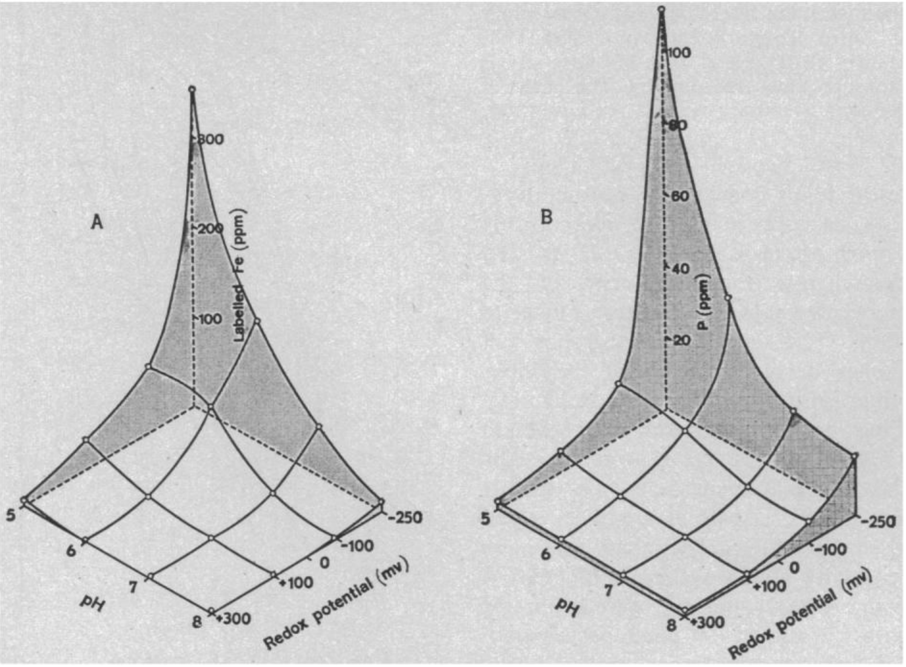

Fig. 1. (A) Release of labeled iron from strengite in flooded soil at various redox potential–pH combinations. The total amount of iron added as strengite was 598 parts per million (ppm). (B) Phosphate extracted from flooded soil at various redox potential–pH combinations; P represents both the phosphate added as strengite and the native soil phosphate. The total amount of phosphate added as strengite was 332 ppm. The original phosphate content of the soil was 182 ppm.

potential showed a similar trend: at the lowest redox potential (denoting highly reducing conditions), a decrease in pH resulted in a large increase in the amounts of iron and phosphate dissolved, whereas under more oxidizing conditions (higher redox potentials) pH had much less effect on the amounts of iron and phosphate dissolved. Tanaka *et al.* (*5*) attributed most of the increase in phosphate solubility after soil submergence to the increase in pH which usually occurs when acid soils are flooded. On the contrary, our results show that in reduced soils under conditions where pH was carefully regulated, increases in pH resulted in the release of smaller amounts of phosphate. The dissolution of strengite with the production of Fe^{2+} and $H_2PO_4^-$ which occurred as both pH and redox potential were decreased suggests that strengite dissolution in flooded soils may be described by the following equation:

$$FePO_4 \cdot 2H_2O + 2H^+ + e^- \rightleftharpoons Fe^{2+} + H_2PO_4^- + 2H_2O$$

$$E_{II} = E^\circ - 0.059 \log [Fe^{2+}] - 0.059 \log [H_2PO_4^-] - 0.118\, pH$$

where E_{II} represents the potential for the reversible reaction and E° is the potential when all substances are at unit activity. The ferrous phosphate produced probably remains in an amorphous form, since crystalline ferrous phosphate (vivianite) is extremely insoluble.

More intensive reducing conditions are apparently required to reduce strengite chemically than to bring about its microbial reduction. In a study of strengite dissolution in a chemical system, Williams and Patrick (*11*) found that in cases where nascent hydrogen was used as a reducing agent a redox potential of −290 mv was required at pH 5 to reduce and solubilize strengite. At higher pH values no more than a trace of strengite was reduced even at more negative redox potentials. Microbial enzyme systems that function in a flooded soil are apparently effective in lowering the activation energy required for strengite reduction with the result that there is a shift in the critical redox potential to a higher value.

The results of this study show that strengite partially dissolves under reducing conditions such as those that exist in flooded soils deprived of oxygen. A close relationship existed between the amount of strengite dissolved and both the redox potential and the pH of the soil suspension. There is a marked interaction between acidity and redox potential, with strengite reduction and solubilization being more pronounced under conditions of low pH combined with low redox potential.

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Comet Bennett 1970 II

Abstract. *The model for dust comets, formulated by Finson and Probstein, which had previously been tested only on Comet Arend-Roland 1957 III, has been successfully applied to three calibrated photographic plates of Comet Bennett. The size distribution, emission rate, and initial velocities of dust particles emitted from the comet's nucleus are given.*

Comet 1970 II, discovered at Riviera, South Africa, by J. C. Bennett on 28 December 1969, became a spectacular object visible to the naked eye in the spring of 1970 when it displayed a straight narrow plasma tail and a huge moderately curved dust tail. With the use of photographic plates sensitive only in certain parts of the spectrum (particularly in the red region) and with