

Livingstone's statement that evidence of pole shift from paleomagnetic studies "is not pertinent unless it can be shown that the magnetic and mechanical poles shift together" ignores the basis of all modern theories of the origin of the earth's magnetic field (4).

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References and Notes

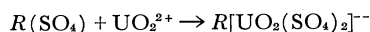
1. *Glacial Map of Canada* (Geological Association of Canada, Toronto, 1958).
2. R. F. Flint, *Glacial and Pleistocene Geology* (Wiley, New York, 1957), p. 315.
3. J. K. Charlesworth, *The Quaternary Era* (Arnold, London, 1957), vol. 2, p. 1321.
4. This report is Lamont Geological Observatory Contribution No. 331. *Erratum*: In part II of our theory [*Science* 127, 1159 (1958)], line 13 of the section "Pluvial Stages" (p. 1161) should have read: "... and the desert(s) of Central Asia and Australia, the (African) Kalahari, ..."

3 November 1958

Uranyl-Ion Exchange Resin Reaction and Demineralization

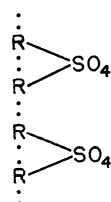
Abstract. Complex ion formation on an ion exchange resin with one ion of an electrolyte results in the release of exchange sites which are then available for the sorption of the remaining ion. The result is a demineralization with but one ion exchange resin. The exchange capacity of the resin is limited by the nature of the complex formed.

Complex ion formation directly at the exchange sites of an ion-exchange resin in a specific form is common (1). Thus, an anionic ion-exchange resin in the sulfate form will add on uranyl ions in the formation of a uranyl sulfate complex, $[\text{UO}_2(\text{SO}_4)_n]^{2-2n}$, a representative type being $[\text{UO}_2(\text{SO}_4)_2]^{2-}$ (2). If R represents an exchange site of an anionic ion-exchange resin—for example, IRA-400 or Nalcite SAR—this reaction may be formulated as



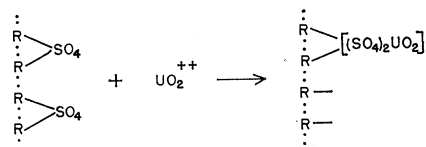
The uranyl sulfate complex, like the SO_4^{2-} , is doubly negatively charged and so remains sorbed by the anionic resin.

Such complex ion formation has implications in water demineralization. The sulfate form of an anionic ion exchange resin may be represented as follows:

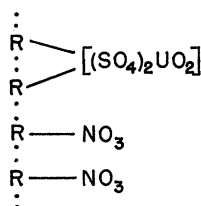


where $\cdot \cdot R \cdot \cdot R \cdot \cdot$ indicates a portion of the ion-exchange resin matrix and the sulfate radicals are shown attached to the active centers throughout the resin.

If this resin is treated with a solution of uranyl nitrate, for example, reaction of the uranyl ions to form the uranyl sulfate complex may proceed thus:



This results in the release of two exchange sites in the resin matrix. These are now available for the sorption of the nitrate ions of the uranyl nitrate, resulting in



Whatever the specific formula of the uranyl sulfate complex may be, two exchange sites will always be left after complexing to sorb the nitrate ion or other anion of the initial uranyl compound. Thus, a demineralization has been accomplished with only a single ion-exchange resin of the anionic type.

Five grams (dry weight) of IRA-400(SO_4), with a total exchange capacity of 15 milliequivalents (meq) were shaken with 30 ml of 1-percent uranyl nitrate solution, 10.0 g of $\text{UO}_2(\text{NO}_3)_2 \cdot 6 \text{H}_2\text{O}$ per liter. This solution is 0.040N in uranyl ion; 30 ml of it would contain 1.2 meq or approximately 8 percent of the total ion-exchange resin capacity. After shaking with the resin, the supernatant solution was filtered. Separate portions of the filtrate were tested for uranyl ion by the addition of 0.25M potassium ferrocyanide, and for nitrate ion, by the addition of FeSO_4 and concentrated H_2SO_4 (brown ring test). Both tests were negative, indicating that the sulfate form of the IRA-400 resin had sorbed both the positive uranyl ion and the negative sulfate ion.

Upon the assumption that the ion $[\text{UO}_2(\text{SO}_4)_2]^{2-}$ is formed, only half the total ion-exchange resin capacity is available for sorption of uranyl ions. The other half is used in sorbing the nitrate ions. If the uranyl ion were to form a complex ion $[\text{UO}_2(\text{SO}_4)_3]^{4-}$, only one-third the total resin exchange capacity would be available for the sorption of uranyl ions. For the formation of an ion $[\text{UO}_2(\text{SO}_4)_n]^{2-2n}$, the fraction of the resin exchange capacity available for uranyl ion sorption would be $1/n$.

With a complex ion of the type $[\text{M}_a(\text{X})_b]^{az_1-bz_2}$, where the valence of the metal M is z_1 and that of the non-metal X is z_2 , the fraction of the ion-exchange resin capacity available for the sorption of the metallic ion, in terms of equivalents, is az_1/bz_2 .

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References and Notes

1. W. E. Miller, *Anal. Chem.* 29, 1891 (1957).
2. T. V. Arden and G. A. Wood, *J. Chem. Soc.* 1956, 1596 (1956); R. Kunin and A. F. Preuss, *Ind. Eng. Chem.* 48, 30A (1956).

22 August 1958

Histology of Mammoth Bone

Abstract. Compact bone from a frozen Alaskan mammoth was examined histologically and chemically to determine whether there had been any detectable alterations since the death of the animal. Histological sections closely resembled similar specimens from modern elephants. Total nitrogen and acid-extractable carbonate were at levels to be expected in fresh bone.

For the chemical investigation of archeological bone, a control is usually provided in the form of a fresh animal, or human, bone. A possible substitute worth considering would be bone which is old but which, nevertheless, has not undergone appreciable alteration. For this purpose it is desirable to investigate the characteristics of "glacier-preserved" bone, since in this case there has, presumably, been little if any organic decomposition or interchange of substance between the bone and the surrounding environmental matrix.

The American Museum of Natural History in New York kindly supplied us with a fragment of compact bone from the mammoth skeleton discovered in 1907 at Elephant Point in Eschscholtz Bay, Alaska, by L. S. Quackenbush. Quackenbush made it very clear that the mammoth was embedded not in masses of pure ice, but in frozen silt distributed between ice layers in so-called "ice cliffs" (1). The explanation offered by Quackenbush for the fine preservation of hair, wool, tendons, and even some of the soft tissues is that a flood-plain sediment was frozen soon after burial of the mammoth and remained at a mean temperature below 28°F, thus causing the deposit to become progressively and permanently solidified. Quackenbush refers the remains of this particular mammoth to the Pleistocene period. A minimum of several thousand years since the bones were deposited must be conceded.

The fragment, roughly, 4 by 2 by 2