ally, the data obtained with O^{18} are consistent with an ionic mechanism ($—COO^- R^+$) and suggest the possibility that PAH transport may involve an ion-exchange mechanism such as has been postulated in the tubular excretion of hydrogen (*12*) and potassium ions (*13*).

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Method of Preparing Radioactive Cations for Tracing Ground Water

In recent years there has been considerable interest in the use of radioisotopes as ground-water tracers. The properties and use of several types of chemical and radioactive tracers have been described (*1*).

Because of adsorption in the soil by cation exchange, the use of radioactive tracers has been limited almost entirely to the two anions iodine (I^{131}) and bromine (Br^{82}); the other radioactive anions are unsuitable for other reasons. The fact that there are only two suitable radionuclides limits the experimenter in his choice of half-life, type of radiation, and energy. It is a further unfortunate circumstance that iodine has one of the lowest permissible concentrations in water (4.8×10^{-4} $\mu c/cm^3$ for an 8-hour period) of any of the radioisotopes (*2*); radioactive bromine presumably has a similarly low permissible concentration.

However, it is possible to reduce greatly the adsorption by the soil of certain of the normally cationic radioisotopes by chelation—that is, by binding them into a un-ionic form. This has been done with Versene (*3*), the tetrasodium salt of ethylenediamine tetraacetic acid. With this simple procedure, consisting of adding Versene to a solution of the radioisotope, it is possible to use a number of radioisotopes with widely different half-life and radiation energy as ground-water tracers. Virtually all of these isotopes are much less hazardous than I^{131} or Br^{82}.

Laboratory tests using Co^{60}, Sb^{124}, and Cr^{51} have been made. Versene is nonspecific in its action on metal ions; it inactivates the normal ionic properties of almost all polyvalent cations by forming with them water-soluble chelates that are extremely stable, except when they enter a solution containing metallic ions capable of forming more strongly chelated compounds. Such ions would displace the metals from the more weakly chelated compounds, exposing them to the possibility of adsorption on particles of earth material. Therefore, metals chosen for use as tracers should be capable of forming more strongly chelated compounds than can the common cations in the ground water, of which calcium is the strongest. In practice this means that they should be above calcium on the "chelation scale" at *p*H values characteristic of natural water—about 7. The order of chelation of some of the common metals at *p*H 8.65 is as follows:

$$\mathrm{Ni} > \mathrm{Co} > \mathrm{Cu} > \mathrm{Zn} \text{ or } \mathrm{Cd} > \mathrm{Ca} > \mathrm{Mg} > \mathrm{Sr} > \mathrm{Ba}.$$

Processed Co^{60} of high specific activity (5.3-year half-life), Sb^{124} (60-day half-life), and Cr^{51} (26.5-day half-life) were used as the radioactive tracers. They were obtained as chlorides in less than 1*N* HCl. Five microcuries of each tracer was divided into two equal portions. To one portion, about 10 mg of reagent-grade Versene was added to chelate the radiocationic tracer, and then each portion was diluted to 250 ml using Oak Ridge tap water.

The solution containing the tracer was allowed to percolate slowly (4 ml/min) through an 18-mm column containing 10 g of a fine-grained, somewhat weathered calcareous shale, which has an ion-exchange capacity, as determined by using ammonium acetate, of about 30 milliequivalent/100 g.

Samples of the chelated and unchelated influents and effluents were prepared for nuclear counting. The relative concentrations of radioactivity in the effluents from the column (Fig. 1) show the extent to which chelation inhibited the adsorption of the radioisotopes by the shale. The shale used is believed typical of earth materials having a relatively high adsorption capacity for radiocations (*4*), but the scale of the experiment makes it unwise to predict that all chelated cations will be sufficiently free from adsorption to be satisfactory under all conditions. However, it is hoped that more laboratory work and some field tests can be reported later.

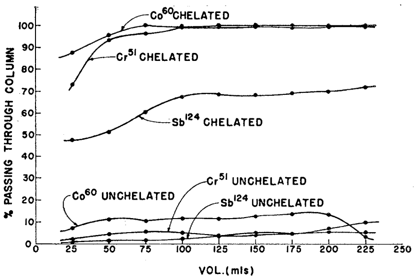

Fig. 1. Test results showing percentage adsorption of chelated and unchelated radioisotopes.

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Inhibition of Yeast Hexokinase by Fluoride Ion

It has been repeatedly demonstrated that various hexokinases require magnesium ion for optimal activity (*1, 2*). It has also been reported that magnesium-activated yeast hexokinase is not affected by fluoride ion in concentrations exceeding 0.1*M* (*1*), and fluoride is, in fact, often added to tissue extracts to inhibit adenosine triphosphatase (ATPase) during measurements of hexokinase activity (*3*). Since the solubility of MgF_2 is very