and into many aspects of curricular organization and collegiate administration.

The pertinence of our findings to the current scientific manpower problem of the nation needs little elaboration. In brief, they indicate clearly the very large and rather unexpected contributions made by small liberal arts colleges to the training of American scientists, and suggest clearly that the future of the scientific profession would be adversely affected by any policy that neglected their well-being. Scientists, to be sure, can be trained in other types of institutions, but only at a greater cost for a smaller yield.

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Technical Papers

Observations on Radioactive Snows at Ann Arbor, Michigan

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Rigorous chemical separations performed on radioactivities found in snows around Ann Arbor, Michigan, after the Las Vegas atomic test explosions of January 27–February 6, have definitely established the presence of radioactive rare earth isotopes, barium and/or strontium isotopes, and have shown the possible presence of iodine isotopes.

Samples of snow for the experiments were taken from two sources several miles apart. The most definitive work was done on a snow pack one third to one half of which had fallen prior to January 31, and the remainder of which had fallen during January 31 and February 1. Samples included a complete cross section of the snow pack, as well as separate samples of the top and bottom halves. In all separations new glassware was used, and a "blank" run simultaneously to detect possible radioactive contaminants introduced by reagents, etc. The activities of the snow pack samples listed below are given as of midnight, February 4. Decay of the activities was followed from this date until February 21.

The snow samples were melted, and 10 mg of carriers of lanthanum, barium, and iodine added to 250-ml portions. Chemical separations were based on existing procedures for fission-product separations (*1*). Rare earths (including yttrium) were separated with the lanthanum by hydroxide precipitation followed by fluoride-hydroxide cycles and finally counted as the precipitated oxalate. Activities as high as 100 times background (30 cpm) were obtained in these rare earth fractions. The activity from samples of the cross section of the snow pack corresponded to about 9 dis/min/ml of melted snow, or about 60 dis/min/in.^{2} of snow sampled. These activities varied considerably with the locality of the sampling. From February 4 to February 21 the decay of the rare earth activity could be resolved into two components, one with a halflife of about 2 days, "tailing" into another with a halflife of about 12 days. Aluminum absorption curves of the longer-lived component indicated the presence of β particles of about 0.5 mev and 1.2 mev. Too little activity was available for further absorption data. These halflife and energy values are compatible with those of several of the more prominent rare earth fission products. The decay and absorption data of these rare earth fractions refute the possibility that this activity is due to naturally occurring radioactivities. Of the naturally occurring activities, only actinium would follow through the rare earth chemistry, and actinium isotopes would not show these observed characteristics.

The Ba-Sr fractions were separated by precipitation as the sulfate. These samples showed an activity about 5 times background at the time of separation. Within 4 days this activity increased by about 30%, due, undoubtedly, to the growth of the 40-hr La^{140} daughter of Ba^{140} and also to a small amount of the 65-hr Y^{90} daughter of Sr^{90}. After this initial increase in activity, the samples have decayed with a halflife of about 14 days.

Iodine in the −1 state was separated as the silver iodide. Samples of about half background were obtained, and these decayed with a halflife of about 8 days until accurate counts were no longer possible (about 6 days after separation). It is possible that this activity is due to the 8.0-day I^{131} remaining as a fission product in the −1 state.

The ratio of rare earth atoms to Ba-Sr atoms found in the snow pack corresponds roughly to what would be expected from a fission reaction. Although the distribution of fission products from an atomic explosion is undoubtedly somewhat different from that found in samples of uranium subjected to neutron irradiation in a nuclear reactor (*2*), this difference will probably not be significant (*3*). Hence, because of the chemical distribution of the activities found in the Ann Arbor snows, it can be stated that these activities undoubtedly originated in the Las Vegas atomic test explosions.

Experiments with samples taken from the bottom and the top of the snow pack indicated that the activity was concentrated in the top half of the snow—the portion that had fallen during January 31 and February 1. When portions of this top half were tested it was found that as much as 25 dis/min/ml of rare earth activity was present. Since atomic explosions were set off on the testing range near Las Vegas, Nev., on the mornings of January 27, 28, and

February 1, 2, and 6, it is evident that the activities in the snow must have come from the blasts of January 27 and/or January 28.

Subsequent snowfalls in Ann Arbor until February 11 were also checked for activity. Rare earth fractions from the snowfalls of February 6 showed very little activity, a maximum of about 1 dis/min/ml—approaching the limit of detection of our counting equipment. The activity of one other snowfall sample —that of February 4—was too near background to give evidence of isotopes in the rare earth region.

Many eastern localities have also reported the presence of radioactivity in their snows after the Las Vegas explosions. Although the activities reported in Ann Arbor in no way approach dangerous levels from a health standpoint, they could possibly become the source of contamination problems in such work as film packaging (*4*) or low-background radioactivity experiments.

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Electromigration in a Cation Exchange Resin[1]

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The exploration of the electrical conductance of ion exchange resins (*1-3*) and its dependence on the nature of the adsorbed ions suggest the study of electromigration in synthetic ion exchangers and the use of these resins for the separation of ions of different mobility. Electrical fields have been used to improve chromatographic separations (*4,5*) on cotton and siliceous materials and to effect separations on paper (*6,7*). Owing to the high capacity and great versatility of synthetic ion exchange resins, electromigration in these media is of special interest.

We followed the movement of ions in a resin column by use of the radiotracer technique. The experiments prove that the adsorbed cations carry the current. Thus, although solid in the physical sense, from the point of view of electrical conductivity the wet resins act similarly to solutions of electrolytes, confirming the hypothesis advanced to explain equilibrium experiments (*8*) that the resin phase is equivalent to an ionized salt solution.

An electric potential was applied to a resin column containing a layer of radioactive ions, and the movement of this layer along the column was observed. A Plexiglass electrolysis cell with perforated platinum electrodes was filled with Dowex-50[3] in the sodium form. A thin layer of active resin containing radiosodium was embedded in the resin column 3 cm from the anode. The activity at the beginning of the experiment and after passage of a constant current for a given time was measured by inserting the cell in a slide propelled by a screw under a Geiger-Mueller tube. This was mounted on a lead brick 9 cm high, covered with aluminum sheet to absorb most of the γ-radiation except for a narrow beam passing through the 3-mm slit cut in the brick under the tube. As different parts of the cell were exposed, the radiation emanating from each was recorded. The position of the tube could be read to an accuracy of 1/32 in. Voltage and current were measured at regular intervals, and a fast stream of deionized water (sp res, 10^6 ohm-cm) passed through the resin from anode to cathode in order to keep the resin temperature constant and to remove the sodium hydroxide formed at the cathode and the gases formed at both electrodes.

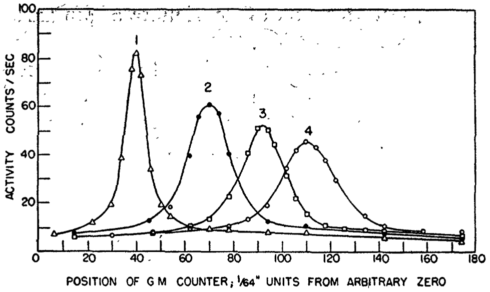

FIG. 1. Electrolysis of Dowex-50 in the sodium form traced with Na^{22}. Cell length, 9.8 cm; diam, 1.6 cm; resin mesh size, 80–100 (dry basis); current, 50 ma; tagged layer initially 3 cm from anode.

Curve 1, before applying the potential
" 2, after an electrolysis period of 3 hr
" 3, " " " " " 6 "
" 4, " " " " " 9 "

It had been verified that within a period equal to the length of the experiment only slight spreading of radioactive material occurs unless an electric potential is applied.

In different experiments, current and resin grain size were varied. The results of a typical experiment are given in Fig. 1, which shows a plot of the activity from a lamina of 2.6y Na^{22} tracer in the NaR, measured along the column at different times during the electrolysis.

The following electrode reactions were shown to occur:

Anode:

$$4R^- + 2H_2O = 4HR + O_2(g) + 4e^- \qquad (1)$$

Cathode:

$$4e^- + 4NaR + 4H_2O = 4Na^+ + 4R^- + 4OH^- + 2H_2(g) \qquad (2)$$

where R represents the resin radical.

As electrolysis proceeds, the hydrogen ions formed at the anode penetrate the whole sodium layer and

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[3] Furnished through the generosity of the Dow Chemical Company, Midland, Mich.