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Interaction of ^{90}Sr - ^{90}Y and some other
radionuclides with Na-alginate in sea
water and 0.55 M NaCl solutions

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The interaction of ^{90}Sr - ^{90}Y and some other radionuclides as ^{65}Zn , ^{109}Cd , and ^{210}Bi to a smaller extent with Na-alginate in sea water and sodium chloride solutions was investigated by high voltage paper electrophoresis. The concentration of Na-alginate was varied from 0.1 to 6.9 g/l. The electrolyte was 100%, 30%, and 10% sea water (previously filtered) of original salinity 38‰ and 0.55 M NaCl. The behaviour of radionuclides in sea water - Na-alginate systems was followed by measuring their electrophoretic mobilities depending on the concentration of Na-alginate and on aging of the systems from 0 to 8 days.

In sea water and NaCl systems without Na-alginate and at low concentration of Na-alginate in the systems ^{90}Sr , ^{90}Y , ^{65}Zn , and ^{109}Cd behave as cations, ^{210}Pb has two zones, one cationic and one at the starting point of the electrophoretic and chromatographic strips, while ^{210}Bi shows only tailing in the anionic direction.

Plotting the values of electrophoretic mobilities of investigated radionuclides against dilution of sea water (log scale) gives straight lines for all cations. In these diagrams all radionuclides have higher cationic electrophoretic mobilities in diluted sea water systems except ^{90}Y which has

smaller mobility in diluted systems. In diluted sea water (at lower Cl^- concentrations) ^{109}Cd gives very diffused zones. In these systems decomplexing of cadmium chloro-complexes probably occurs and Cd^{2+} and CdCl^+ are in equilibrium, but they can not be separated at the conditions of our experiments.

The interaction of Na-alginate and ^{90}Sr - ^{90}Y was studied more intensively than for other radionuclides. The results in later cases are only informative, because for each dilution of sea water only one system with high concentration of Na-alginate was prepared assuming that at those concentrations complexing should be observed if any.

By increasing the Na-alginate concentration the electrophoretic mobility of ^{90}Sr continuously changes but reaches anionic values only in 10% sea water. In the same time ^{90}Y has two reactions, one which continuously changes the electrophoretic mobility due to the increased Na-alginate concentration and another one with constant anionic electrophoretic mobility but which appears in older systems. For ^{65}Zn the change in electrophoretic mobility is more pronounced in diluted sea water systems, than in concentrated one. Although ^{65}Zn has very sharp and defined electrophoretic zones in 10% and 30% sea water - Na-alginate systems, the chromatograms show diffused zones with R_f values between 0.5 and 1. In 100% sea water - Na-alginate system the electrophoretic mobility of ^{109}Cd changes to small anionic value. In diluted sea water systems with Na-alginate chromatographic zones of ^{109}Cd are diffused having R_f values between 0.46 and 1, and 0.27 and 1 for 30% and 10% sea water respectively. As the electrophoretic zones are also diffused the calculation of electrophoretic mobilities do not have any sense. The cationic fraction of ^{210}Pb disappears by adding the Na-alginate to the sea water systems, and remains only a fraction at the starting point. While electropherograms show only zone of ^{210}Pb at the starting point, chromatograms show two zones, one with $R_f = 0$, and another one with R_f values 0.86, 0.89 and 0.90 for 100%, 30% and 10% sea water - Na-alginate systems, respectively. ^{210}Bi is in the radioactive equilibrium

with ^{210}Pb and its interaction with Na-alginate can be followed in the same run of experiments with ^{210}Pb . By adding the Na-alginate to the systems a well defined anionic zone of ^{210}Bi appears having high electrophoretic mobility.

All investigated radionuclides behave similarly in sea water and 0.55 M sodium chloride systems with or without addition of Na-alginate.

Aging of the systems was only significant in the case of ^{90}Y where the second fraction appears in older systems.

DISCUSSION

Question and comment:

1. Comment on solubility of Na-alginate. When looking at the adsorption of alginate, which behaves as surfactant we found that it is dissolved completely in sea water only at concentrations $< 40 \mu\text{g/l}$.
However, as you find increasing electrophoretic effects on the metal ions up to quantities of 10 g alginates, I suppose that the commercial product is a complex mixture of compounds of most different solubility, and that in your experiments you deal with soluble extracts of given quantities of alginates. (V. ŽUTIĆ, Yugoslavia).
- In diluted sea water - sodium alginate systems at higher Na-alginate concentrations gels are formed. In 100% sea water systems gelatinous precipitates and/or gels are formed, which are assumed to be calcium alginates and/or alginates of other cationic constituents of sea water.
According to our results that increasing sodium alginate concentration produces further change in electrophoretic mobility it is not probable that we work only with soluble extracts of alginates than that exchange reactions of in sea water formed Ca - (and/or Mg-) alginates with investigated radionuclides occurs. Sr and Y (and also Pb and Bi) have higher

affinities to alginates than calcium and exchange reactions are very probable. We suppose that gelatinous precipitates in 100% sea water and gels formed in 10% sea water - sodium alginate systems are due to Ca-alginate formation (and other cationic constituents of sea water alginates).

If you were right increase of sodium alginate concentrations in sea water systems would not produce change in electrophoretic mobility of investigated radionuclides than the electrophoretic mobility would reach constant value at certain sodium alginate concentration added (see for instance second zone of Y which appears at low sodium alginate concentration; electrophoretic mobility of this zone remained constant at very higher sodium alginate concentration).

In nature is not important if such a substance as sodium alginate is completely dissolved in sea water, than that a certain cation approaching in algae can enter such an organisms and remain there bound. That is probable mechanism of concentration of metals by marine algae. Locally they have higher concentration of such macromolecules than released in surrounding sea water and are able to bind certain metals.