Reversible sorption of phosphate anions by sediments of Lake Baikal

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Results of experimental studies of the adsorption of phosphate by sediments of Lake Baikal are described. It was believed earlier that inorganic phosphate is buried in the sediments of Lake Baikal as hydroxyl apatite (Mizandrontsev, 1990). A similar mechanism was proposed for Lake Michigan (Brooks and Edginton, 1994). Our studies showed that in case of Lake Baikal this is not true. Modern sediments from the Southern Basin of Lake Baikal were sterilized by gamma-irradiation. Samples of wet sediments (~0.1 g dry mass) were stirred with Baikal water (~100 mL; pH 7.8). Portions of carrier-free [^{32}P]-orthophosphate were added, radioactivities of the supernatant and the sediment found, and distribution coefficient K_D calculated (Fig. 1).

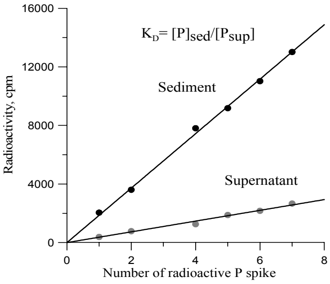

Figure 1. Adsorption of [^{32}P]-phosphate by Baikal sediment.

Addition of alkali liberated part of radioactive phosphate, whereas addition of acid resulted in its stronger binding.

Similar experiments were performed with carrier-free [^{35}S]-sulfate; this anion was not bound by sediments at all After Baikal sediment was stripped of iron-hydroxous film by treatment with 1% oxalic acid, K_D for phosphate dropped from 6000 to 600.

Discussion of results: It is clear that hydroxyl apatite $Ca_{10}(PO_4)_6OH_4$ cannot be the phase of the sediments of Lake Baikal which binds phosphate, because this mineral does not dissolve in alkali, but does dissolve in acid. Data obtained with stripped sediment support the suggestion that the binding agent is Fe (III) hydroxide (Moore. and Reddy, 1994). The fact that intact sediment does not bind sulfate suggests that binding of phosphate is a specific process, rather than mere anion exchange.

Conclusion: The results obtained are significant for environmental protection of Lake Baikal – they will help to estimate the permissible discharge of P.

References

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Examining water-rock interaction at the Idaho National Engineering and Environmental Laboratory using uranium and strontium isotopes as natural environmental tracers

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^{87}Sr/^{86}Sr, δ^{234}U, and U and Sr concentrations of perched water and core leachates have been measured to examine water-rock interation at the Vadose Zone Research Park (VZRP) at the Idaho National Engineering and Environmental Laboratory. U and Sr are used as proxies at the uncontaminated VZRP for water-rock interaction of radiochemical waste contamination on other laboratory property. The VZRP consists of active percolation ponds surrounded by monitoring wells, which are open at geologic contacts in the subsurface to sample perched water. Preliminary analyses of five outflow and twenty perched water samples show isotopic compositions that range between those of the outflow water and another end member(s) at depth. Uranium concentrations range from 2.01 ± 0.01 ppb at the outflow to 6.41 ± 0.02 ppb at 120 feet, and corresponding isotopic compositions decrease from 1063.2 ± 15.6 ‰ δ^{234}U to 866.8 ± 4.9 ‰ δ^{234}U. Sr concentrations and ^{87}Sr/^{86}Sr isotopic ratios of most perched samples lie within the variable compositions of the outflow water, except two wells, in which the ^{87}Sr/^{86}Sr isotopic composition decreases and Sr concentration increases. Water samples taken from one depth over a period of two months during a Br^- tracer test show decreasing δ^{234}U that corresponds with Br^- breakthrough. The Br^- tracer test coincided with a change in the location of the outflow discharge; thus the decreasing δ^{234}U is a result of interaction with newly wetted vadose zone materials. Interestingly, these samples also show essentially no change in uranium concentration. This type of natural attenuation would be undetectable without isotopic analyses. ^{87}Sr/^{86}Sr vs. δ^{234}U for all samples gives a reaction path mixing model between two end members, the outflow water and another member. The nature of the other endmenber(s) will be determined by isotopic analysis of leachate from sequential extractions of core material from the site.