Nutrient Dynamics in the Salton Basin--Implications from Calcium, Uranium, Molybdenum, and Selenium

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ABSTRACT: The Salton Sea has been accumulating chemical constituents delivered by its tributary streams for nearly 100 years because it has no outlet. The buildup of chemicals that are highly soluble and unreactive, such as chloride, has resulted in the development of a quasi-marine lake. In contrast, chemicals that react to form insoluble phases ultimately enter the sediment that accumulates on the floor of the Sea. Solubility properties are especially relevant for two important contaminants, selenium and nitrogen. The selenium is contained in Colorado River water used for irrigation, and nitrogen is derived mostly from chemical fertilizer in agricultural runoff. Both are delivered to the Salton Sea as highly soluble oxyanions by the Alamo and New Rivers, which are relatively high in dissolved oxygen at their outlets to the Salton Sea, but are removed as reduced species in anoxic sediment on the Sea's floor. Without this removal mechanism, selenium concentration would presently be about 400 micrograms per liter and nitrogen would be about 100 milligrams per liter in the Salton Sea's water, rather than the observed concentrations of only about 1 microgram per liter and 5 milligrams per liter, respectively. Ironically, anoxic conditions responsible for producing the noxious odors and low oxygen conditions that lead to periodic dieoffs of large numbers of fish in the Salton Sea have prevented aqueous selenium and nitrogen from reaching levels that could indeed pose an extreme environmental hazard.

Does all the selenium and nitrogen ever discharged to the Salton Sea still reside in its sediment, or has some been lost? It is well known that certain bacteria are capable of converting both elements into gases that can then be volatilized to the atmosphere. By comparing concentrations of selenium and nitrogen with those of molybdenum and uranium, elements with similar geochemical properties, this study concludes that there is now little, if any, selenium and nitrogen loss to the atmosphere. It is important that any engineering changes made to the Salton Sea that are intended to remediate for environmental effects do not result in reintroduction of these contaminants from sediment into the overlying water.

Dissolved nitrogen concentration in the Salton Sea is apparently several times higher today than it was in the mid-1950's; yet dissolved phosphorus concentration has changed little, if at all. Why have phosphorus levels not seen a similar increase? One possible explanation is that phosphate is efficiently removed from the water column by incorporation with calcium as apatite minerals--the material that composes bone. If so, attempts to slow or reverse excessive biological productivity (eutrophication) through large-scale harvesting of fish may not result in lowering the dissolved phosphorus concentration that would thereby improve the trophic status of the Salton Sea.

The selenium profile in a core from the Salton Sea was found to increase from about 9 at the sediment-water interface to as high as 15 micrograms per kilogram, before decreasing with increasing depth to the sub-microgram-per-gram level in material believed to predate the formation of the Salton Sea. The low concentrations in sediment that predates the lake are about the same as those for clay-rich soils in the Imperial Valley at the south end of the Sea. A possible explanation for the maximum at mid-depth is that the highest concentration corresponds to a period when agricultural development in the upper basin was resulting in greater input to the Colorado River from leaching of selenium-rich soluble salts than today.

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