STATE OF CALIFORNIA
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AGENCY

SALTON SEA ECOSYSTEM RESTORATION PLAN

SELENIUM AND ITS IMPORTANCE TO THE SALTON SEA

What is Selenium?

Selenium is a semi-metallic, naturally occurring trace element. It is commonly found in rocks and soils derived from certain types of marine sedimentary rocks in the western United States and also is found in combination with other minerals such as sulfides, silver, copper, lead, and nickel.

Selenium Cycling

Selenium has a complex environmental chemistry. In natural systems, it occurs in four different chemical (oxidation or valence) forms: selenide (Se^{2-}); elemental selenium (Se^{0}); selenite (Se^{4+}), and selenate (Se^{6+}). The form selenium takes in nature depends on a variety of environmental conditions, and the chemical form is very important in understanding how it affects animals and how it cycles in the Salton Sea.

Selenate and **Selenite –** In alkaline (high pH) surface waters and oxidizing soil conditions that are commonly found in arid areas, selenium occurs mainly as soluble selenate salts that are highly mobile because they are soluble in water and they don't adhere well to soils. Selenates can be reduced to selenites, which are more readily accumulated by fish and other aquatic organisms.

Elemental Selenium – If further chemical reduction occurs, selenites may be converted to elemental selenium, which is not very soluble in water and is not readily taken up by plants or animals. In sediment, most of the selenium may occur in the elemental form. If the sediments become oxidized (exposed to air), most of the selenium can be converted to selenates and selenites.

Selenide – Metal and organic selenides also are common in bottom sediments (such as those in the Salton Sea). Like elemental selenium, selenides can become oxidized to forms that are more available to plants and wildlife. Organic forms of selenium also occur in or are produced by plants and animals. While the organic forms of selenium are typically less abundant than inorganic selenium (selenate and selenite), the organic forms are important from a biological toxicity standpoint.

Selenium in the Salton Sea Environment

Selenium occurs in dissolved and suspended forms in the irrigation water brought in from the Lower Colorado River. The reported selenium concentration in the Colorado River water ranges from 2 to 3 microgram per liter (one microgram per liter equals one part per billion). Selenium has also been shown to exist naturally in soils within the Salton Sea watershed.

Selenium enters the Salton Sea primarily in water from the various rivers (Alamo River, New River, and Whitewater River) that drain agricultural areas within the watershed. Despite the relatively higher selenium concentrations in these inflows (ranging from undetectable to 10 microgram per liter), Salton Sea water has relatively low (1 to 2.1 microgram per liter) dissolved or suspended selenium concentrations, and it is believed that most of the selenium is deposited into deep, oxygen-deficient sediments, which act as a selenium “sink” (where selenium is sequestered or adsorbed on the sediment particles) and as a “reservoir” (from which the selenium can be remobilized). A much smaller proportion of selenium in the Salton Sea is associated with the tissues of plants and animals.

Why is Selenium Important for the Management of the Salton Sea?

Selenium is important because it can bioaccumulate (be taken up) in aquatic and terrestrial food chains. Ingestion is the main uptake pathway for bioaccumulation and the greatest ‘step’ occurs from water to aquatic plants or invertebrates (which may contain 1,000 times the waterborne concentration). Selenium occurs in both plant and animal tissues, but the bioavailability is higher from plant tissues than from animal tissues. Selenate is the preferred form for uptake by plants, especially in alkaline conditions. As previously mentioned, oxidation of deep Salton Sea sediments can make the “sequestered” selenium become more water-soluble and bioavailable.

When it is present at elevated levels in the diets of animals, selenium can replace sulfur in some important metabolic pathways and cause short- or long-term toxic responses. Toxicity can occur when dietary selenium concentrations are about 5 micrograms per gram (one microgram per gram equals one part per million; about 2 to 3 times background levels). Early life stages of aquatic animals (such as fish and amphibians) and terrestrial animals (such as birds) are especially susceptible to selenium in water or dietary sources. Long-term selenium contamination causes reproductive problems such as embryo mortality and birth defects.

Decisions about safe selenium levels in water, sediments, soils, and the food chain for humans and wildlife will be based upon the existing regulatory criteria and a review of the scientific literature.

Fish Consumption Advisory for the Salton Sea

An advisory for the consumption of fish caught in the Salton Sea was issued in 1986 by the California Environmental Protection Agency. The advisory was based on elevated concentrations of selenium detected in fish caught in the Salton Sea.

The advisory was updated in September 2004 as follows: *“Because of elevated selenium levels, no one should eat more than four ounces [114 grams] of croaker, orangemouth corvina, sargo, or tilapia taken from the Salton Sea in any two-week period.”*

The fish advisory remains in effect until additional information is provided to the California Environmental Protection Agency that would provide a basis for revising it.