Environmental Studies of Mineral Deposits in Alaska

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Short articles summarize environmental geochemical studies of metallic mineral deposits in Alaska, including massive sulfide, gold, mercury, chromium, and uranium mines and deposits. The studies report metal and acid concentrations in samples collected around such mines and deposits, and evaluate environmental effects of the deposits. The articles are written in a style intended to reach a general audience

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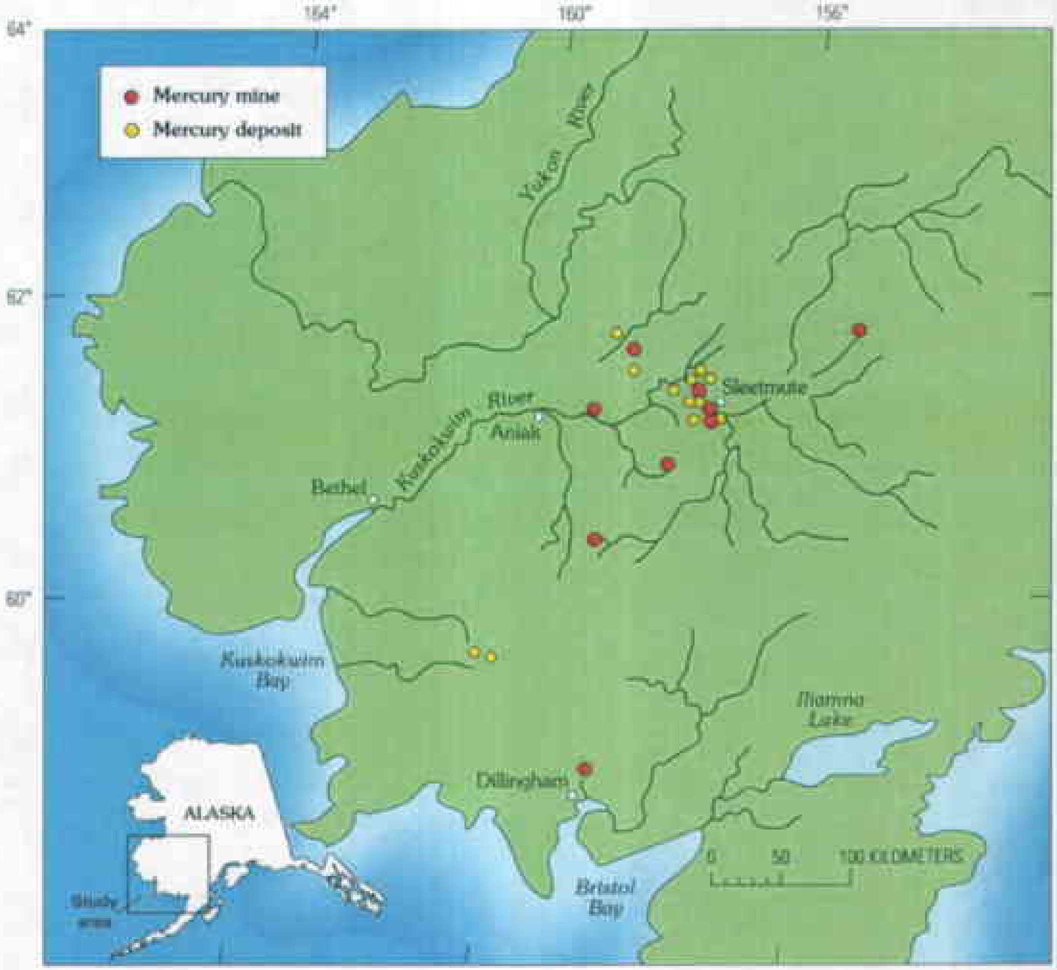


Figure 10. Location of mercury mines and deposits in southwestern Alaska.

ENVIRONMENTAL GEOCHEMISTRY OF MERCURY MINES IN SOUTHWESTERN ALASKA

Mercury-rich mineral deposits in Alaska are another type of deposit under investigation for natural and mining-related heavy-metal concentrations in the environment. Mercury deposits are scattered over a wide region in southwestern Alaska covering several tens of thousands of square kilometers (fig. 10). The mercury sulfide mineral *cinnabar* is the most common mercury ore mineral in the deposits (fig. 11), but liquid mercury also occurs naturally at some localities. Several of the mercury deposits have been mined, but most of the deposits are small and undisturbed. None of the mercury mines in Alaska are currently operating, due to economic factors. Mercury is used in the manufacturing of electrical instruments, fungicides, pharmaceuticals, and munitions, in the production of paper, and in the extraction of gold (*amalgamation of gold*) in mining.

Should we be concerned about mercury mineral deposits in southwestern Alaska?—Mercury is a heavy metal that has no known metabolic function and is toxic to living organisms. In humans, mercury adversely affects the central nervous system and internal organs such as the kidneys. In streams and lakes, bacterial activity converts mercury in sediments from inorganic compounds (such as cinnabar) to organic forms (such as methylmercury). Organic mercury compounds are easily absorbed by organisms and are more hazardous than inorganic forms.

The primary sources of mercury are naturally occurring mineral deposits, rocks, soils, and volcanic eruptions, as well as man-made industrial sources such as factory effluents and airborne incinerations. Southwestern Alaska has no major sources of industrial mercury; however, mercury is highly concentrated around mineral deposits in the region. Thus, the presence of mercury deposits in southwestern Alaska is a potential hazard to residents and wildlife because drainage from the deposits enters streams and rivers that are part of local ecosystems (fig. 12). To evaluate the environmental concerns of these mercury deposits, the concentration of mercury was measured in sediment, water, soil, vegetation, and fish collected around some of the mercury deposits. These data were then compared with those from streams in unmineralized (background) areas.

Figure 11. Rock sample containing the mercury ore mineral cinnabar (red mineral). Pencil point for scale.

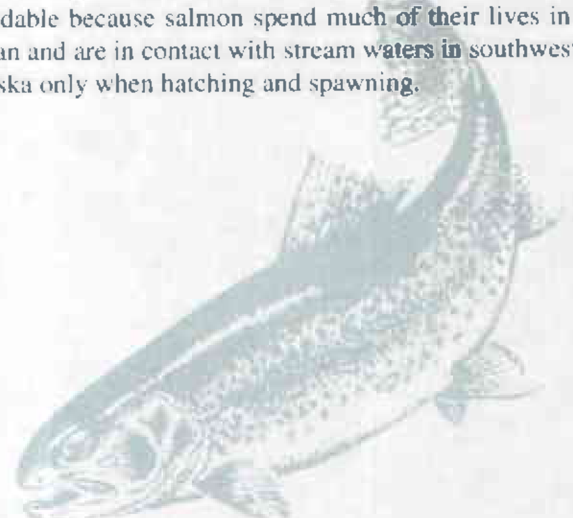
Measuring mercury levels in stream sediments, stream water, and fish.—Stream-sediment samples collected near some mines contain total mercury concentrations in excess of 5,000 ppm (Gray, 1994). Stream-sediment samples collected from streams in local unmineralized areas typically contain less than 1 ppm mercury, indicating that the samples collected near the mines are highly enriched in mercury. These high mercury concentrations in stream sediments near the mines are the result of erosion of cinnabar into the streams. Cinnabar is resistant to weathering, and thus, it remains in streams for long periods of time (fig. 13).

Stream waters below the mercury mines generally are neutral to slightly alkaline with pH values of about 7 to 8. The formation of acid drainage below some mineral deposits containing sulfide minerals can be of concern; however, cinnabar is highly insoluble in water and does not easily form acid drainage during weathering. Thus, acid formation in streams below the mercury mines and deposits in southwestern Alaska is probably insignificant.

Samples of stream water collected below mercury mines contained as much as 0.75 ppb mercury, whereas background stream and river waters in the region typically contain less than 0.10 ppb. These mercury concentrations are below the 2.0 ppb drinking water standard recommended by the State of Alaska and the 2.4 ppb instream EPA-CMC standard (table 1).

Although cinnabar is highly insoluble in water, the water data indicate that minor amounts of mercury are converted to forms that are soluble in water, probably organic forms of mercury, that are easily absorbed by organisms, such as fish, living in the stream environment. For this reason, fish were collected throughout southwestern Alaska and analyzed for mercury to evaluate the potential for mercury to enter local food sources and the food chain. Mercury concentrations were measured in fish muscle samples (edible fillets) and livers. Maximum mercury concentrations in the muscle samples of freshwater fish collected downstream from mercury mines were about 0.6 ppm (wet weight) and about 1.3 ppm in the liver samples (fig. 14) (Gray and others, 1994, 1996). These concentrations are considered elevated because similar fish collected from background streams in southwestern Alaska contained only about 0.2 ppm mercury. Most of the mercury in the fish (> 90 percent) was the highly toxic organic form of mercury, methylmercury. Although the fish collected downstream from the mines contain mercury concentrations higher than background levels, mercury contents in the edible portions of the fish were below the 1.0 ppm limit established by the Food and Drug Administration (FDA).

Mercury concentrations were also measured in salmon collected from large rivers in the region because these fish are foods of local residents and sportsmen. Mercury concentrations in salmon muscle samples were low, less than 0.1 ppm (Gray and others, 1996), well below the recommended FDA limit. These low mercury concentrations are understandable because salmon spend much of their lives in the ocean and are in contact with stream waters in southwestern Alaska only when hatching and spawning.



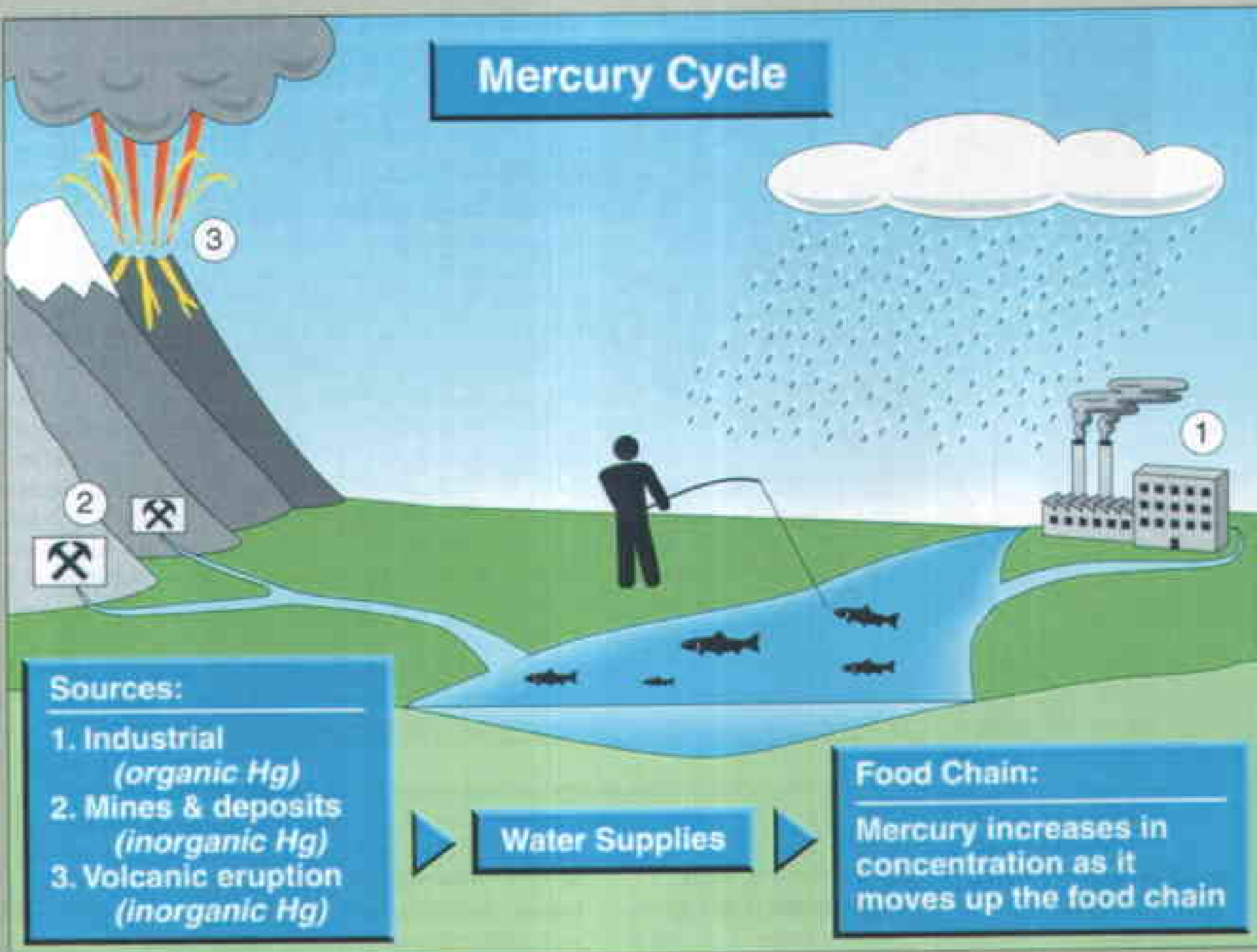


Figure 12. Schematic diagram of mercury cycle showing the most important sources of mercury—industrial, volcanoes, and mineral deposits such as those in southwestern Alaska. When mercury from mineral deposits erodes into streams, toxic mercury compounds can be absorbed by fish and eventually consumed by humans.

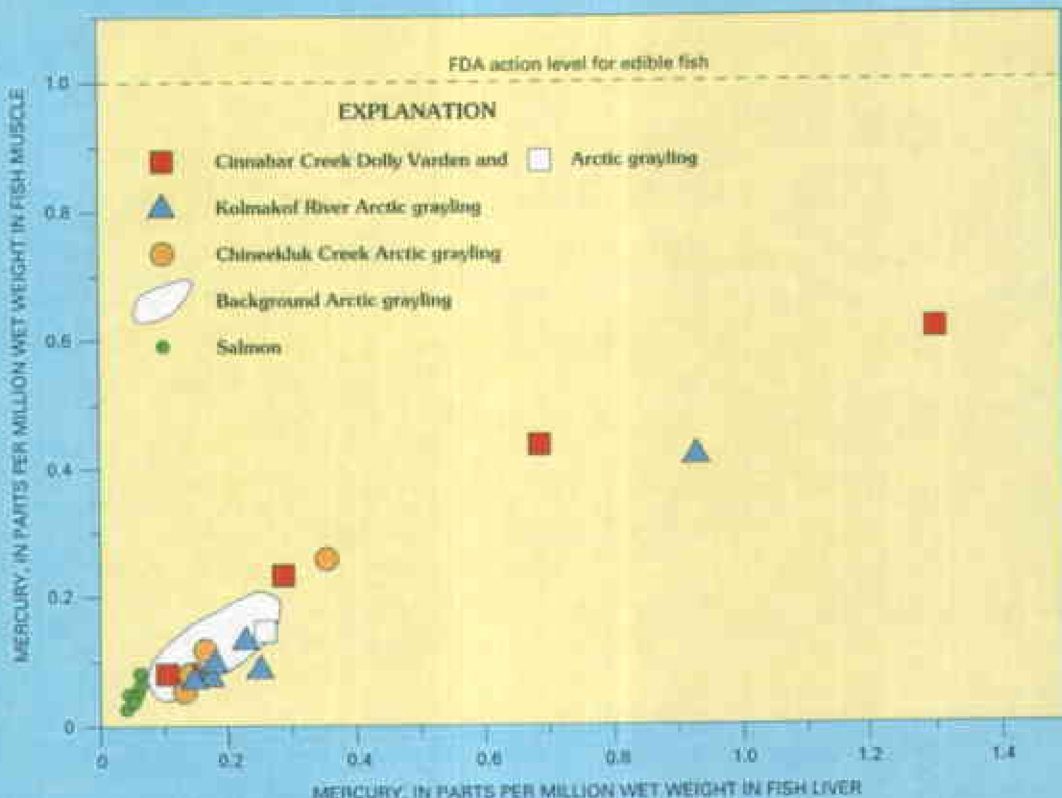


Figure 14. Plot of mercury in fish muscle versus mercury in fish liver for fish collected throughout southwestern Alaska.