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Fossil Fuels as a Source of Mercury Pollution

Abstract. *The upper limit of the quantity of mercury released by weathering processes is approximately 230 metric tons per year. The quantity of mercury released by burning of coal is estimated to be of the order of 3000 tons per year, a quantity comparable to that emitted as waste from industrial processes.*

Mercury is toxic to humans and animals and is therefore a very dangerous pollutant to our environment. Its presence in the tissues of wildlife has been studied in Sweden and found excessively high. The eggs of many wild birds do not hatch and numerous animals die because of mercury poisoning (*1*). Especially high mercury concentrations have been found in fish; older fish of larger size have relatively higher concentrations, which indicates that mercury accumulates in tissues (*2, 3*). This buildup of mercury in the biomass is a recent phenomenon (*2*).

One suspected source of pollution has been mercury-containing fungicides used in treatment of grain seeds. The treated seeds are highly poisonous to grain-eating birds and are available to them abundantly during the seeding seasons. However, the amounts used are much too small to explain high mercury contents in wildlife except in the grain-eating birds (2 to 3 mg per hectare of mercury every 4 to 5 years; 0.5 mg per metric ton of topsoil per year (*4*). A large part of the mercury found in the environment is apparently derived from industrially produced mercury, approximately 10,000 tons per year (*5*), most of which is eventually discarded in waste streams. However, another possible source of mercury could be fossil fuels and ores (other than mercury ores proper). Although the concentration of mercury in fuels is small (*6*), fuels are consumed at an enormous rate; consequently, they must be considered as a possibly significant source of mercury release into the environment.

The amount of mercury in coal is not well known. To obtain a preliminary value, 36 American coals were analyzed (Table 1) by means of a mercury vapor detector (*7*) that had been modified to eliminate organic vapors, which interfere in the detection process. In this procedure, the sample is burned in oxygen and the fumes are passed through hot (650° to 700°C) silver wire coils to complete the oxidation, after which a heated (150°C) gold amalgamator traps mercury while most of the other fumes pass through. To remove the remaining organics, mercury is released by heating and is re-amalgamated in a second trap; the mercury is again released by heating and is measured in the mercury vapor detector. Some organic fumes that pass through the first amalgamator are not completely oxidized and could cause some loss of mercury; also some mercury could be lost as oxide. Consequently, the values in Table 1 are biased on the low side.

Table 1. Mercury content of 36 American coals.

Locality (counties)	Hg ($\times 10^{-9}$ g/g)
Letcher (Ky.)	250
Knox (Ill.)	230
Saline (Ill.)	240
Northumberland (Pa.)	595
Northumberland (Pa.)	245
Northumberland (Pa.)	120
Richland (Mont.)	33,000
Pierce (Wash.)	510
Campbell (Wyo.)	18,600
Washington (Pa.)	240
Franklin (Pa.)	1,200
Franklin (Pa.)	10,500
Franklin (Pa.)	6,400
Franklin (Pa.)	4,900
Somerset (Pa.)	540
Somerset (Pa.)	340
Cambria (Pa.)	1,460
Nicholas (W. Va.)	6,540
Clay (W. Va.)	22,800
Clay (W. Va.)	3,700
Cambria (Pa.)	1,450
Cambria (Pa.)	460
Cambria (Pa.)	90
Cambria (Pa.)	630
Cambria (Pa.)	160
McDowell (W. Va.)	80
McDowell (W. Va.)	70
Jefferson (Ala.)	80
Jefferson (Ala.)	920
Harrison (Tex.)	380
LeFlore (Okla.)	110
Pitkin (Colo.)	220
Parke (Ind.)	310
Moultrie (Ill.)	210
Knox (Ill.)	90
Grundy (Ill.)	190

The analyses were performed on a relatively small number of samples that are not representative; even within one deposit, the mercury distribution is probably not uniform. The mercury content of the Illinois coal samples that were analyzed (average, 194×10^{-9} g/g) is in good agreement with analyses done at the Geological Survey of Illinois (average, 180×10^{-9} g/g) (*8*). The average of the results (3.3 parts per million) can be hardly applied to the total coal production. If we apply a more conservative estimate of 1 part per million to the yearly world production of coal [3×10^9 tons per year (*5*)], we may conclude that 3000 tons of mercury per year are released to the environment by the burning of coal.

The mercury content of oils is not known and remains to be evaluated. The mercury content of ores (excluding mercury ores proper) is most likely higher than in coals. The tonnage of ores mined annually is, however, much smaller than that of coal.

The upper limit for the natural release of mercury due to chemical weathering can be estimated by comparison with corresponding figures for sodium. The sodium leached by weathering is almost completely carried to the sea by rivers, 8×10^7 tons per year (runoff of rivers, 3.2×10^{13} tons per year; noncyclic sodium in river waters, 2.5 parts per million) (*9*). In the weathered rock masses, the ratio of mercury to sodium can be assumed to be the same as the ratio of their lithospheric abundances (2.8×10^{-6}) (*6, 10*), which yields an upper limit of 230 tons per year for leached mercury. The amount of mercury actually released is probably less than this estimate because proportionally more mercury than sodium is absorbed on clays, hydroxides, organics, and so forth.

The release of mercury into the environment during the combustion of coal is much larger than the amount released by weathering. Detailed studies of the distribution of mercury near power plants and other major users of coal would be useful to determine the level of mercury pollution in the vicinity of such installations.

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Obsidian Hydration Dating Applied to Dating of Basaltic Volcanic Activity

Abstract. *Basalt flows and bombs that contain remelted rhyolite glass can be dated by obsidian hydration dating.*

Recent rhyolitic volcanic eruptions have been dated (*1*) by the thickness of the hydration rind on obsidian associated with these events. The technique is now being applied to a study of the rhyolitic volcanism in the area of Newberry volcano, Oregon, approximately 20 miles (32 km) northeast of Bend, Oregon, and in special cases (as described below) may be used to date basaltic eruptions.

On the north shore of East Lake in the Newberry volcano area, there is a small fissure where fountaining basalt magma tore off pieces of solidified rhyolite from the fissure wall during the eruption. The rhyolite has been remelted and is very vesicular. Thin sections of the remelted rhyolite show that it has a hydration layer that allows us to date the time of the remelting. The hydration thickness in three of these samples is 3.0 μm (± 0.2 μm). A hydration rate of 3.1 μm^2 per 1000 years (*2*) yields an age for this event of 2900 ± 400 years. Rhyolite flows within 2 miles (3.2 km) of this fissure, as determined by the obsidian hydration method, date from about the same time; thus, a variety of volcanic activity at about this time is indicated.

During a recent collecting trip to Newberry crater, Peterson (*3*) mentioned the occurrence of cored bombs —that is, basaltic bombs that contain centers of other rocks, including rhyolite. These cored bombs occurred in some quantity at the Diamond craters, an area of recent volcanism near the center of Harney County in southeast Oregon. The area is in T. 28–29 N, R. 32 E, about 60 miles (96 km) south of Burns. Rhyolitic glass from four of the bombs was examined for occurrence of a hydration rind, and hydration rind was found on all the samples examined (see Fig. 1). All the samples displayed rinds that ranged in thickness from 7.0 to 7.3 μm. Using the hydration rate as mentioned above (3.1 μm^2 per 1000 years) gives an age for this explosive volcanicity at Diamond craters of 17,000 ± 2000 years.

Remelted obsidian-like material associated with basalts probably is not uncommon. The presence of such material makes it possible to date basaltic eruptions that remelt the rhyolite, provided that the eruptions occurred in the time interval from 200 to 250,000 years ago (*4*).

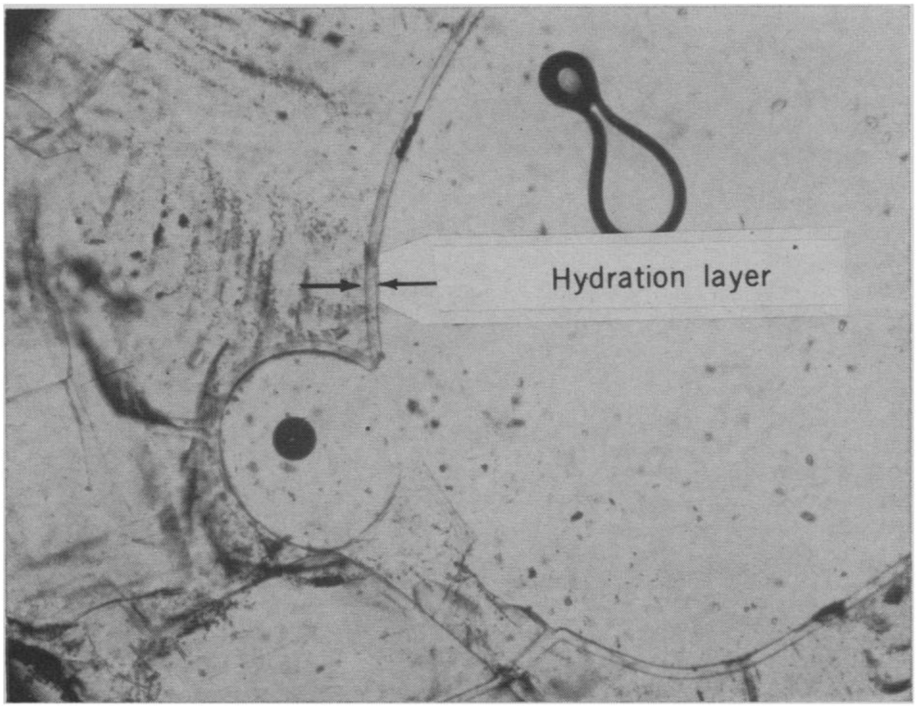

Fig. 1. Photomicrograph of a thin section of cored bomb from Diamond craters, Oregon; with the hydration layer (7 μm thick) indicated.

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