# Mercury cycling in the environment

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The potential consequences of mercury contamination of aquatic food webs were first recognized in the 1950s and 1960s in Minamata and Niigata, Japan, where human consumers of contaminated fish were severely poisoned. These and other tragic incidents prompted widespread reductions in direct releases of mercury into surface waters in many countries. Since about 1985, however, widespread mercury contamination of aquatic biota has become evident in systems remote from obvious anthropogenic mercury sources. Investigations at these sites have shown that in most cases, atmospheric transport and low rates of mercury deposition are largely responsible for the observed widespread mercury contamination of aquatic ecosystems across the globe. In some cases, concentrations in fishes from these remote sites have equalled or exceeded those in fishes from waters that have been heavily contaminated by direct industrial discharges. The key to understanding the apparent discordance between these despairing contamination levels, yet similar levels in fish is the methylation process. In brief, this process involves the conversion of inorganic mercury that is the dominant form in deposition to methylmercury, which is the dominant form in fish (>95%). Presently, researchers are engaged in unravelling the many complexities of the environmental mercury cycle, including source-receptor relationships, bioavailability of various mercury sources, speciation of the precise forms of mercury in various environmental media, bioaccumulation processes, and toxic effects to humans and wildlife. Although mercury contamination of the environment is an enormously complex area of research, significant advances in our understanding have been made over the past 15 years. Presently, however, one of the greatest challenges in integrating this improved understanding with policies that will lead to improved environmental conditions in the future.

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# Mercury in coal and its impact on utility mercury emissions

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## Mercury in Coal

U.S. coal-burning utility power stations emit 64% (1999) of input mercury (U.S. EPA, 2002), and remain the largest anthropogenic point source category of mercury emissions not regulated by the EPA. Efforts to reduce mercury output require knowledge of coal characteristics. Mercury contents differ by coal basin, by rank, and within individual coal beds, reflecting diagenetic differences at various scales. Mercury loading to combustion sources is a function of both the mercury and energy content of fuels.

We have investigated the modes of occurrence of mercury in various coal samples using selective chemical leaching and reconnaissance laser-ablation ICP-MS. In bituminous coals, pyrite is the primary host of mercury, whereas the proportion of organic-hosted mercury is generally greater in lignite and sub-bituminous coals. Coal preparation (to reduce sulfur) is effective in achieving modest reductions of mercury contents in bituminous coals by reducing pyrite contents. Higher (≥35%) mercury reductions likely require engineered approaches. The average mercury content of coals delivered to U.S. power plants in 1999 is 0.10 ppm (U.S. EPA, 2002).

## Impact of Coal Choice on Mercury Speciation

Knowledge of coal rank, chemistry, and mineral content is important in determining flue gas mercury speciation and capture efficiency of a given combustion system. Compared to bituminous coals, combustion of low rank coals evolves a greater proportion of elemental mercury ($Hg^0$), relative to oxidized (reactive) species ($Hg^{2+}$). For most emission control devices, capture of elemental mercury is less efficient than oxidized mercury (Pavlish and others, 2003). Chlorine present in coal also influences mercury speciation, by promoting oxidation of elemental mercury, leading to formation of $HgCl_2$ (Kilgroe and Senior, 2003). Detailed coal chemical and rank characterization, and knowledge of power station set-up are needed to predict mercury capture by emissions control devices and flue gas mercury speciation.

## References

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