Deposition of rare earth elements and indium from the atmosphere to an ombrotrophic bog in the Northeastern United States

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The industrial production of the rare earth elements (REE) and indium is increasing dramatically due to new uses in rapidly growing electonics, clean energy, and defense applications. Little is known, however, about the natural or anthropogenic cycling of these elements or their environmental behavior, despite the fact that anthropogenic emissions to the environment appear to already exceed natural sources.

The history of metal deposition from the atmosphere is often reflected in the vertical profiles of the metals in ombrotrophic bogs, which by definition do not receive surface or subsurface runoff. Previous analysis of a peat core from Thoreau's Bog in Concord, Massachusetts, USA, shows that the rate of indium deposition to the bog increased beginning in the early 1900s, peaked in the early 1970s, and has since decreased dramatically to pre-1900 values. This profile is counter to the pattern of indium's industrial use, but coincides well with estimates of historic particulate emissions from smelting and from coal combustion in North America. Additional evidence suggests that indium is released to the atmosphere at relatively high concentrations by the smelting of primary metal sulfides, though the relative inputs of indium to Thoreau's Bog from coal combustion and smelting have not been distinguished. We hypothesize intermittant but relatively elevated concentrations contributed when wind blows from north to south, past a set of smelters, and a more constant influx of low level indium when wind blows from west to east, past a high density of coal-fired power plants.

Analysis of REE in the same peat core can shed light on the atmospheric cycling of REE, and may also help to track the sources of indium to Thoreau's Bog. REE profiles in the bog are similar to indium, suggesting a similar source of REE to the atmosphere in the northeastern US. However, because REE are typically not elevated in primary metal sulfide ores, the similarity of their profiles may suggest that the primary source of the rare earths and indium to Thoreau's Bog over the past century may in fact be dominated by coal combustion rather than primary metal smelting.