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Archives of environmental contamination

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Geologists have an old saying: "the present is the key to the past". By studying geological processes as they occur today, it is possible to understand the processes which must have taken place through geological time, and which may be only partly preserved in the rock record. For scientists with an abiding interest in the sources, transport, and fate of contaminants in the environment, we could say that "the past is the key to the present." To understand the true extent of human impacts on the geochemical cycles of individual naturally-occurring radionuclides, elements, or molecular species, it is sometimes helpful to have a window on the past to understand how things worked prior to significant intervention by Man. This is precisely where "archives" can be useful: they provide us with quantitative insight into physical and chemical processes as they operated naturally, in historic or pre-historic times.

What is an archive? An archive is a geological, biological, or chemical medium that grows or accumulates over time, possibly preserving a record of some environmental change. Lacustrine and marine sediments are examples of geological archives because they accumulate sedimentary material (both organic and inorganic) *via* erosion and aquatic transport, in addition to dissolved species and atmospheric particles. Tree rings and peat bogs are kinds of biological archives that are alive and growing at one surface, but dead and accumulating below that surface. Alpine and polar ice, as well as carbonate formations (marine corals, stalagmites, stalactites) and manganese nodules can be viewed as chemical archives with especially simple matrices. All of these have preserved some important records of environmental change, and each has its own inherent advantages and disadvantages.

Peat bogs and ice caps are unique archives because they are directly linked to the atmosphere. Alpine and polar snow and ice cores, in particular, have provided the scientific community with valuable records of the concentrations and isotopic composition of gases, soil dust, volcanic ash particles, marine aerosols, and trace metals extending back through several glacial cycles. Ice cores have also provided direct evidence of links between greenhouse gas concentrations and climate, providing many new insights into the Earth's climate system and playing a central role in the debate about human impacts and global change. Studies of ice cores have also created exemplary levels of international collaboration with all aspects of the work and led to the creation of a true scientific community.

The use of lake sediment records as archives of recent environmental changes is well established in the journal literature. Here, too, there has been an increasing effort to establish international collaborations. However, separating atmospheric from non-atmospheric signals can be challenging. Moreover, for many chemical elements of interest, physical or chemical transformations caused by variable pH and redox conditions during diagenesis confuse the interpretation of data.

Peat bogs, on the other hand, have been less intensively exploited as paleoclimate and paleoenvironmental archives. While changes in the botanical composition of peat reflected in the relative abundance of plant macrofossils, have been known for centuries to reflect changes in paleoclimate, the inorganic fraction of peat – derived from soil dust particles, volcanic ashes, cosmogenic dust, marine aerosols, and atmospheric contaminants – has barely been investigated. Here, there is great potential to undertake innovative, basic research about the inorganic fraction in peat bogs by injecting major new knowledge from other fields (geochemistry, analytical chemistry, radiometric age dating, isotope geology, paleobotany, environmental physics, and glaciology). Ombrotrophic peats are clearly the best continental archives of atmospheric Pb deposition. We now have an opportunity to quantify temporal changes in atmospheric Pb contamination worldwide. In the coming years, this will undoubtedly provide new insight into the early history of mining and metallurgy. Using Pb isotope analyses of pre-anthropogenic peat, we can also use peat cores to reconstruct the rates and sources of atmospheric soil dust deposition, and identify the predominant source areas. But which other elements are so well preserved? For elements that are quantitatively retained in the peat column, we now have an opportunity to study natural and anthropogenic geochemical cycles on an element-by-element basis. Using state-of-the-art analytical methods of element and isotopic analyses combined with high resolution core slicing and accurate age-depth modelling, we are now able to follow the sources, transport, and fate of environmental contaminants in much more detail than ever before.

This Special Issue contains papers on peat bogs and lake, saltmarsh and overbank sediments presented during the "Archives of Environmental Contamination" Sessions at the Sixth International Symposium on Environmental Geochemistry, Edinburgh, Scotland, 7–11 September 2003, chaired by John Farmer, University of Edinburgh.

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