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Anthropogenic heavy metals in polar and alpine snow and ice: from the antiquity to present (Alfred Wegener Medal Lecture)

Claude F. Boutron

Laboratoire de Glaciologie et Géophysique de l' Environnement (UMR 5183 CNRS / Université Joseph Fourier de Grenoble), 54 rue Molière, Domaine Universitaire, B.P. 96, 38402 Saint Martin d' Hères cedex, France (boutron@lgge.obs.ujf-grenoble.fr)

During the last decade, a wealth of new fascinating data have been obtained on man-induced changes in heavy metals in dated snow and ice deposited in Greenland, Antarctica, the Alps and the Andes during Roman times and after the Industrial Revolution.

Amongst the most interesting data are those which were obtained through the analysis of snow/ice cores drilled at Summit in central Greenland as part of the Eurocore and GRIP european programmes. They showed clear evidence of an early large scale pollution of the atmosphere of the Northern Hemisphere for Pb and Cu by Greek and Roman civilizations from about 500 B.C. to 300 A.D., linked with emissions from mining and smelting activities. They also allowed to document the history of the huge pollution of the atmosphere of the Northern Hemisphere for Pb after the 1940s caused by the widespread use of Pb additives in gasoline. Another interesting result is the discovery of a pronounced increase in Pt, Pd and Rh concentrations during the last few decades, which shows evidence of a recent large scale pollution of the atmosphere of the Northern Hemisphere for platinum group elements especially because of the ever increasing use of automobile catalytic converters.

In Antarctica, recent studies have shown that the remote Antarctic continent was already contaminated for Pb as early as the end of the 19th century, before the conquest of the geographic South Pole by Amundsen and Scott. Pollution for heavy metals can now be detected in Antartic snow for various other metals such as Cr, Cu, Zn, Ag, Bi and U. It shows that atmospheric pollution for heavy metals is now really global.

Man induced changes in heavy metals have also been documented in the Alps and the Andes, thanks to the analysis of snow/ice cores drilled at high altitude sites, such as Colle Gnifetti (a high altitude (4450 m) saddle near the summit of Monte Rosa at the Swiss/Italian border) and Sajama (a small high altitude tropical ice cap covering the top of the highest mountain in Bolivia (altitude of 6540 m)). The Colle Gnifetti data show highly enhanced concentrations for many metals in snow/ice dated from recent decades, compared with concentrations in ancient ice dated from the 17th and 18th centuries, and allow to reconstruct past changes in metal emission to the atmosphere from Western Europe during the last few centuries.

Highly interesting data have also been obtained on past natural changes in the occurrence of various heavy metals and trace elements in Antarctic and Greenland ice dated from the last climatic cycles.