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Trace elements in South America aerosol during 20th century inferred from a Nevado Illimani ice core, Eastern Bolivian Andes (6350 m asl)

A. Correia[1,2], R. Freydier[3], R. J. Delmas[2], J. C. Simões[4], J.-D. Taupin[5], B. Dupré[3], and P. Artaxo[1]

[1]Institute of Physics, University of São Paulo, São Paulo, Brazil
[2]LGGE, CNRS and Université Joseph Fourier, Grenoble, France
[3]UMR5563, LMTG, CNRS and Université Paul Sabatier, Toulouse, France
[4]Institute of Geosciences, Federal University of Rio Grande do Sul, Brazil
[5]LGGE, IRD, Grenoble, France

Abstract. A 137 m ice core drilled in 1999 from Eastern Bolivian Andes at the summit of Nevado Illimani (16º 37' S, 67º 46' W, 6350 m asl) was analyzed at high temporal resolution, allowing a characterization of trace elements in Andean aerosol trapped in the ice during the 20th century. The upper 50 m of the ice core were dated by multi-proxy analysis of stable isotopes ($\delta^{18}O$ and $\delta^{2}H$), ^{137}Cs and Ca^{+2} content, electrical conductivity, and insoluble microparticle content, together with reference historical horizons from atmospheric nuclear tests and known volcanic eruptions. This 50 m section corresponds to a record of environmental variations spanning about 80 years from 1919 to 1999. It was cut in 744 sub-samples under laminar flow in a clean bench, which were analyzed by Ion Chromatography for major ionic concentration, by a particle counter for insoluble aerosol content, and by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for the concentration of 45 chemical species from Li to U. This paper focuses on results of trace element concentrations measured by ICP-MS. The high temporal resolution used in the analyses allowed classifying samples as belonging to dry or wet seasons. During wet season elemental concentrations are low and samples show high crustal enrichment factors. During dry seasons the situation is opposite, with high elemental concentrations and low crustal enrichments. For example, with salt lakes as main sources in the region, average Li concentration during the 20th century is 0.035 and 0.90 ng g^{-1} for wet and dry seasons, respectively. Illimani average seasonal concentration ranges cover the spectrum of elemental concentration measurements at another Andean ice core site (Sajama) for most soil-related elements. Regional crustal dust load in the deposits was found to be overwhelming during dry season, obfuscating the contribution of biomass burning material. Marked temporal trends from the onset of 20th century to more recent years were identified for the concentrations of several trace species of anthropic origin, especially for Cu, As, Zn, Cd, Co, Ni and Cr. Among these elements, Cu shows average wet season crustal enrichment factors above 10^3, while the others range between 10^2 to about $5x10^2$. P and K show moderate average wet season enrichment factors, suggesting an impact of natural biogenic emissions from the Amazon Basin. Pb has multiple anthropic sources in the region, from mining activities in the beginning of 20th

century to automotive fuel after 1950s. From the large number of samples analyzed from Illimani, it was possible to derive an effective chemical characterization of the deposited background Andean soil dust aerosol during 20th century.

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