Stable Isotope Variations of Cu, and Zn and Pb in mineral dust samples: Controls and Implications for Biogeochemical Cycles

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Copper (Cu) and zinc (Zn) play an important role in many fundamental Earth System processes such as carbon fixation in the ocean and air pollution. Recent work has focussed on testing if the stable isotope systems of these elements can help us to better understand their past and present biogeochemical cycles in the atmospheric and aquatic environments. A major knowledge gap affecting the interpretation, however, has been the lack of isotopic characterisation of Cu and Zn in mineral dust.

To this end, we determined the range of isotopic composition of Cu and Zn of selected major mineral dust sources in Asia (i.e., Chinese Loess Plateau, Chinese deserts, Thar desert) and Africa (i.e., Sahel region) and constrained possible controls, i.e. mineralogy and particle size. We determined the isotopic composition of Pb in the mineral dust to compare to an isotope system that is not subjected to isotopic fractionation during low temperature processes. To test the implications of this novel data set to studies linking sources and sinks, we compared the isotopic ratios determined in the mineral dust with the signatures of aerosols and surface and deep ocean waters in areas close to the deserts and discuss the implications for atmospheric metal and marine biogeochemical cycles.

The ranges of isotope signatures observed were well in line with previously determined signatures of mineral dust but significantly different between the Thar deserts, the Chinese Loess Plateau and Chinese deserts and the Sahel. We find significant variations between size fractions (<4μm, 16-32 μm, >64 μm) for both isotope systems and a significant correlation between the isotopic composition of Zn and clay minerals. The isotopic signature of Cu and Zn found in aerosols (Beijing, Xian, North Atlantic Ocean) and ocean waters (eastern North Atlantic basin and western Pacific Ocean) are outside the range of those of the mineral dusts areas. Admixing of anthropogenic Zn and atmospheric processing are assessed and discussed as a possible role explaining the observed isotope ratios