Geophysical Research Abstracts,
Vol. 11, EGU2009-4180-1, 2009
EGU General Assembly 2009

Using lanthanoid elements as tracers for anthropogenic contamination of atmospheric aerosols

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Lanthanoid elements are present in atmospheric particulate matter both within natural mineral particles and as anthropogenic aerosols emitted from industrial and traffic pollution sources. Whereas the total lanthanoid (Loid) content of atmospheric PM is controlled primarily by the amount of coarse crustal mineral material present, ratios between different lanthanoid elements (e.g. La/Ce and La/Sm) can be influenced by industrial processes such as the use of La-enriched fluid catalytic converters (FCC) in oil refineries, the combustion of refinery La-contaminated oils in power stations, or the abrasive loss of Ce-bearing PM from road vehicle catalytic converters. Use of lanthanoid ratios as tracers are especially useful in allowing the identification of specific La anomalies (La>Ce) when FCC refinery emissions are prominent. Increasing contamination of urban/industrial atmospheric PM samples away from crustal compositions may be tracked using a LaCeSm triangular plot, but this does not differentiate between FCC refinery and oil combustion emissions. Comparing lanthanoid and V concentrations does aid such differentiation, although given the likelihood of multiple PM sources in industrial locations, we recommend use of a LaCeV plot rather than simply La/V ratios. Lanthanoid geochemistry can be applied in this way to demonstrate for example how atmospheric PM in many urban areas is polluted more by V-bearing fuel oil combustion (e.g. Mexico City), whereas other cities are more influenced by different aerosol sources such as oil refineries (e.g. Houston) or coal burning (e.g. Beijing).

This work was funded by the Spanish Ministry of Science and Innovation
(GRACCIE-SCD2007-00067).