Sources discrimination of heavy metals in soil and road dust using isotope fingerprints and multivariate analyses

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Apportioning sources of environmental pollutants is key to controlling pollution. In this study, the sources of heavy metals to 234 agricultural soils and 133 road dusts from China and were discriminated between using element analyses, Cd and Pb isotope compositions, and multivariate statistical analyses. The Cd isotope compositions ($\delta^{114/110}$Cd values −0.76‰ to −0.25‰) for the agriculture soils from Jianghan Plain (JHP) were similar to Cd isotope compositions found for smelter dust and incinerator fly ash, indicating Cd was supplied to the JHP soils by ore smelting and/or refining processes. The Pb isotope compositions for the JHP soils (^{206}Pb/^{207}Pb 1.182–1.195 and ^{208}Pb/^{206}Pb 2.078–2.124) were between the Pb isotope compositions found for Chinese coal and natural sources, which a binary isotope mixing model indicated contributed 52% and 48%, respectively, of the Pb in JHP soils. Cluster analysis and positive matrix factorization (PMF) indicated that the sources of heavy metals in JHP soils may consist of smelting and/or refining activities, coal combustion, agricultural activities, and natural sources (including Han River sediment and soil parent materials). Both ^{208}Pb/^{206}Pb and Sr concentrations were used to confirm the presence of pyrotechnic ash in road dusts. A binary model based on Pb isotopes indicates that pyrotechnic events contributed 34.3%–55.7% of the Pb in road dusts. Similarly, PMF model demonstrated that pyrotechnic events contributed 70.1%, 50.4%, 36.6% and 35.5% of the Sr, Cu, Cr and Pb contents, respectively, to these road dusts. These joined results demonstrated that combined use of istope composition and multivariate statistical analyses is effective and accurate in pollution source tracing.