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Tracing thallium contamination in soils using isotopes

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We report the thallium (Tl) isotope record in moderately contaminated soils, which have been historically affected by emissions from coal-fired power plants. Our findings clearly demonstrate that Tl of anthropogenic (high-temperature) origin with light isotope composition was deposited onto the studied soils, where heavier Tl (ε205Tl $\sim$-1) naturally occurs. The results show a positive linear relationship (R2 = 0.71) between 1/Tl and the isotope record, as determined for all the soils and bedrocks, also indicative of binary Tl mixing between two dominant reservoirs. We also identified significant Tl isotope variations within the products from coal combustion and thermo-desorption experiments with local Tl-rich coal pyrite. Bottom ash exhibited the heaviest Tl isotope composition (ε205Tl $\sim$0), followed by fly ash (ε205Tl between -2.5 and -2.8) and volatile Tl fractions (ε205Tl between -6.2 and -10.3), suggesting partial Tl isotope fractionations. Despite the evident role of soil processes in the isotope redistribution, we demonstrate that Tl contamination can be traced in soils, and propose that the isotope data represent a possible tool to aid our understanding of post-depositional Tl dynamics in surface environments for the future. This research was supported by the Czech Science Foundation (grant no. 14-01866S and 17-03211S).