Zinc isotope fractionation in coal combustion systems

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Previous investigations suggested that lighter Zn isotopes enter the vapor phase during smelting and combustion, leaving the residual material enriched in the heavier isotopes [1] [2]. Zn ores and dust produced in a refinery show a strong isotope fractionation (from -0.66 to +0.22‰) while dust from the chimney displays a δ^{66}Zn value of -0.67‰ [2]. Borrok et al. observed a slight enrichment of the heavier Zn isotopes in the fly ash relative to the coals and tire-derived fuels but the isotopic changes of the bottom ashes are unconsistent [2]. More research is necessary to better constrain Zn isotope fractionation in combustion processes and develop a model that predicts the isotopic composition of the stack emissions and the fractionation through the air pollution control devices.

The aim of this work was to develop an accurate model accounting for Zn isotopic fractionation in coal and co-combustion systems. To achieve this, Zn isotopic variations in the feed materials and combustion residues from three different Spanish coal fired power plants were determined.

We find that the fractionation between the feed blends, bottom ashes and fly ashes show the same magnitude and direction, suggesting a similar controlling process in all the coal fired power plants. The bottom ashes are enriched in the lighter isotopes relative to the feed blend while heavier isotopes are observed in the fly ashes. We performed isotopic mass balances to constrain the isotopic signature of the flue gas and these calculations predict an isotopically light Zn emitted through the stack. We find that the observed fractionation can successfully be predicted using a Rayleigh distillation model.

The main implication of our work is that, although the operation of each coal-fired power plant differs on a great variety of parameters, the Zn isotope signature of the feed blend and evaporation and condensation within these plants control the isotopic fingerprint of the combustion by-products and the exhaust gas.

[1] Mattielli, N., et al., (2009) *Atmos. Environ.* **43** 1265-1272. [2] Borrok, D.M., et al., (2010) *Environ. Sci. Technol.*, **44** 9219-24.