Fe cycling and isotope fractionation in paddy soils of Suzhou, China

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Paddy soils undergo regular flooding and drying during rice-growing period, which dominates redox conditions, and therefore elemental transportation, and mineral dissolution and precipitation in soils. Fe isotope ratios can be used to investigate anthropogenic effects on paddy soils because Fe mobility and Fe isotope fractionation are sensitive to redox conditions. Generally, ferric (III) species are immobile and ferrous (II) species are mobile in solution [1-2]. During reduction, light Fe isotopes prefer to partition into the solution as mobile Fe (II), leaving the residue enriched with heavy Fe isotopes [3].

Soil samples chosen in this study were collected from a 2.6m vertical profile of paddy soil from Suzhou, located in the lower reaches of the Yangtze River of China. It includes an anthrostagnic epipedon (0-28cm), a hydragric horizon (28-205cm), and a gley horizon (205-260cm). Samples were collected every 3-5 cm through the profile to closely monitor Fe concentration and isotopic variations along the profile. The $Fe_2O_3^T$ of most samples in this profile are close to 5 wt.% with slight variation, while samples from two layers (110-160 and 220-230 cm) have higher $Fe_2O_3^T$ (11-14% and 8%, respectively). δ^{56}Fe changes with depth, showing a strong negative correlation with $Fe_2O_3^T$. For instance, ^{56}Fe values of the two Fe-rich layers have δ^{56}Fe lower than other samples by more than 0.2‰.

Fe concentration and isotopic variations are clearly related to anthropogenic activity. During the flooding season, the Eh in the top layer of soil decreases due to quick consumption of oxidative materials, including the reduction of Fe (III) to Fe (II). While solutions with light Fe isotopes moved to the unsaturated layer (110-160 cm) with relatively higher Eh, Fe-rich minerals (Fe nodules) with low δ^{56}Fe precipitate there. Below this layer, the Eh of soils is so low that Fe (II) and light isotopes can be transported in groundwater due to water movement.

[1] Millero *et al* (1995) *Mar. Chem.* **50**, 21-39. [2] Millero (1998) *EPSL* **154**, 323-329. [3] Johnson *et al* (2002) *EPSL* **195**, 141-153.