

## Mineralogical and microtextural properties of soils by erosion during the rainy season in the Andong area, southeastern part of Korea

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Along with geochemical information on weathering properties, properties of mineralogy and microtexture of soils are helpful to better understand the causes and patterns of soil erosion and landslide[1]. A total of annual soil loss in the Andong area, the southeastern part of the republic of Korea, amounts to one million tons due to heavy rainfall. We analyzed soils on natural slopes using XRD and SEM.

The most common minerals in soil on natural slopes are quartz, feldspars, illite, kaolinite, vermiculite, and iron oxides. Based on XRD data, the content of quartz in sandstone areas varies from 53.3 to 80.2 wt% while it ranges from 13.6 to 23.2 wt% in gneiss areas. According to SEM observation, fine particles comprising soil vary in size and shape with different geology. They are generally subrounded or elongated with rough surfaces, moderately compacted with some voids. Quartz and feldspars in soils are relatively coarser and frequently densely coated with illite with submicron in size and amorphous iron oxides. Most feldspars show rough surface with dissolution cavities or etch pits. In the same site, the content of quartz and feldspars increases with increasing the rate of soil erosion. The differences in mineralogy and soil texture are attributed to different slope angles and lithology, together with erosion rates. The mineralogical and microtextural properties of soil on natural slopes are important for determining soil erosion by rainfall because fine particles such as clays have great specific surface area and expandability.

[1] Jeong *et al.* (2011) *Nat Hazards* **59**, 347-365.

## Anomalous isotope fractionation of sulfur (AIF-S) during thermochemical sulfate reduction by solid organic matter

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Watanabe *et al.* [1] found distinct AIF-S signatures in the products of Na<sub>2</sub>SO<sub>4</sub> reduction by glycine at 150-200°C:  $\Delta^{33}\text{S}$  values up to +0.92 ‰ for H<sub>2</sub>S and up to +2.06‰ for Cr-reducible S. Here we report the results of new series of experiments using various mixtures of alanine, glycine, Na<sub>2</sub>SO<sub>4</sub>, and H<sub>2</sub>SO<sub>4</sub> at 200-300°C.

We have found that the  $\Delta^{34}\text{S}$  ( $= \delta^{34}\text{S}_{\text{prod}} - \delta^{34}\text{S}_{\text{mit,SO}_4}$ ) and  $\Delta^{33}\text{S}$  ( $= \delta^{33}\text{S} - 0.515 \delta^{34}\text{S}$ ) values greatly vary depending on the starting materials, presence of various reaction products (H<sub>2</sub>S, S<sup>0</sup>, Cr-reducible S, HCl-soluble S, and organic S), temperature, pH, and reaction time. For example, mixtures of the two amino acids and Na<sub>2</sub>SO<sub>4</sub> generated H<sub>2</sub>S with much larger ranges in  $\Delta^{34}\text{S}$  (-10.6 to +15.5 ‰) and  $\Delta^{33}\text{S}$  (+0.5 to +2.3 ‰) and more consistent  $\Delta^{36}\text{S}$  fractionation (+.4 to +1.4‰) compared to the experiments using a single type of amino acid and/or H<sub>2</sub>SO<sub>4</sub>. Under some experimental conditions we also observe changes from positive to negative  $\Delta^{33}\text{S}$  fractionation (+.21 to -.22) in H<sub>2</sub>S with time when reduction rates were high. In the experiments where large fractions of the initial SO<sub>4</sub><sup>2-</sup> were reduced, the residual SO<sub>4</sub><sup>2-</sup> possessed  $\Delta^{34}\text{S} = -.27$  to 7.85‰ and  $\Delta^{33}\text{S} = -.15$  to .01‰. These data suggest the AIF-S signatures resulting from TSR are dependent on the degree of polymerization/dehydration of the organic matter, which affect its surface characteristics.

Our experimental data on sulfides and sulfates are similar to those in more than 60 percent of the AIF-S signatures in pre-2.4 Ga sedimentary rocks. If we consider the additional isotope effects due to Rayleigh distillation and recycling, our data can explain all the data reported on natural rocks.

Our experimental data, therefore, provide strong supportive evidence for the hypothesis that most (if not all) AIF-S signatures in geologic materials were created during thermochemical sulfate reduction, rather than by atmospheric UV reactions of volcanic SO<sub>2</sub>. This suggestion is also supported by the fact that large Archean AIF-S signatures are typically found in kerogen rich pyritic black shales and the recent discoveries of large AIF-S in post-2.2 Ga materials that have undergone high-temperature reactions between organic matter and sulfate.

[1] Watanabe *et al.* (2009) *Science* 324, 370-373