How can stable isotope geochemistry help to better assess mineral nutrient dynamics in soils and export towards ecosystems?

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The United Nations Food and Agriculture Organization has designated 2015 the international year of soils, with good reasons. Soil is a geomembrane on the earth's surface across which water and solutes, as well as energy, gases, solids, and living organisms are actively exchanged among the lithosphere, hydrosphere, atmosphere, and biosphere. Soils play a crucial role in mineral nutrient production and export to terrestrial and aquatic ecosystems. In the face of human-induced rapid environmental change, it is essential to improve our knowledge of the sources and processes which govern these vital functions.

The advent of MC-ICP-MS some fifteen years ago paved the way for investigating complex biogeochemical interactions in soils which were hitherto inaccessible to the observation. For example, the use of Si stable isotopes has shed new light on Si recycling by plants, thereby allowing better quantification of the net abiotic continental rock weathering fluxes to the ocean and, relatedly, improved estimates of the long-term atmospheric CO_2-budget. Combined with other stable isotope systems such as Mg, Ca, Li, B, Fe and Mo, Si isotopic measurements can provide new insights into important soil reactions, such as silicate weathering, ion exchanges, redox reactions and organic matter-mineral interactions.

The next challenge ahead is to apply and relate stable isotope studies to the various soil-related disciplines. By doing so, there is great scope for developing a thorough understanding of how soil mineral nutrient production and export will be affected by environmental changes at the century timescale.