Weathering rates from top to bottom in a carbonate environment

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It is generally thought that most of the weathering reactions take place near the surface of the Earth but the contribution from deeper water circulation is less well quantified. Yet, the groundwater fluxes needs to be assessed as a recent study has inferred that up to 20% of the weathering flux could be coming from the base flow. To address this issue, we have investigated weathering rate in a double-porosity carbonate environment by measuring U-series isotopes from the soil's surface down to a depth of ~70 m to determine the rates of dissolution. The samples we analyzed include soils, drill cores, fracture and matrix fluids. The samples were all analyzed by MC-ICPMS for U and Th isotopes. The solid samples were also analyzed for trace element concentrations by ICP-MS.

The results show quite clearly preferential mobility of U throughout the profile but with a much larger effect in the first meter below the surface. The surface samples show the greatest ^{230}Th excess together with moderate depletion in ^{234}U relative to ^{238}U. Accordingly, the ^{230}Th/^{232}Th ratios and the relative abundance of mobile trace elements are lower in the surface layers, which can be interpreted by faster disssolution of carbonates near the surface together with an enrichment in residual silicates. In this environment, the dissolution of carbonates can be easily distinguished from silicate dissolution and the dissolution rates results in a net removal of Th (and U). Redeposition of Th derived from the carbonate by adsorption or precipitation in secondary phases is not effective.

The combined ^{234}U-^{238}U and ^{230}Th-^{238}U systematics also allows to quantify the relative dissolution rates in the soil horizons compared with deeper horizons in the bedrock. In the surface horizons, the U-series signature can be thought of as being dissolution-dominated while in the deeper layers, it indicates slower dissolution and larger effects of recoil on ^{234}U-^{238}U systematics. Preliminary modelling suggests that dissolution rates can vary by a factor of 10 faster near the surface (with the slowest rate obtained for a clay-rich cap rock). At depth, there is generally slower dissolution and even reprecipitation of carbonates.

An isotope and PGE perspective on the mantle xenoliths from Marsabit Volcanic field (Kenya Rift)

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PGE and Os isotopes have been determined in 14 well-charaterized spinel peridotite xenoliths from the Marsabit volcanic field (Kenya Rift) pertaining to 3 different groups previously distinguished based on their textural characteristics (porphyroclastic (I) and recryztallized (II) spl-lherzolithe and porphyroclastic hazburgites (III) (Kaeser *et al*., 2006).

The overall total PGE contents of Marsabit xenoliths (Total PGE between 14 and 32 ppb) shows a rather restricted range.

Whether coarse-grained, recrystallized, deformed, virtually anhydrous or modally metasomatized, all peridotites have Pd-depleted PUM-normalized PGE patterns probably inherited from an old (archean?) partial melting event. This is confirmed by the crude correlation existing between the Ol or Cpx modal content of the rocks and their total PGE, Pd/Ir ratio or Al2O3 whole rock content. However the shape of PGE patterns can greatly vary between or within different peridotite groups and probably reflects differing recent magmatic history and/or ancient metasomatism.

Calculated Re depletion ages indicate 2 possible melting events around 2 Ga (Archean – for Group III) and around 650 Ma (Panafrican? for Group II and III). Group I consistently gives future ages and its Os isotope characteristics suggest some addition of radiogenic Os (either through metasomatism or mingling between peridotite and pyroxenite)

Preliminary Sr-Nd-Pb isotopic data show that the most refertilized lherzolithes (Group II and III) display unradiogenic signatures (cpx, or wholerock) incompatible with plume-type metasomatism enrichment.

References

Kaeser *et al*., (2006), *Journal of Petrology*, doi:10.1093/petrology/egl040