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Initial results describing the scales of contemporary and geologic weathering on marine terraces, Santa Cruz, California, USA

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Chemical weathering at the Earth's surface can be addressed from two perspectives, either on a geologic time scale based on solid-state elemental, isotopic and mineralogical changes in soils and regoliths or else on a contemporary time scale based on present day solute compositions and fluxes. Long-term weathering reflects the integrated effects of intrinsic changes in mineral properties and abundances as well extrinsic effects such as climate, biology and topography, commonly occurring over tens of thousands to millions of years of soil development. In contrast, contemporary weathering reflects current fluid residence times and the influences of seasonal to decadal scale natural changes in precipitation, temperature and biota, in addition to anthropogenic influences. Chronosequences, comprising groups of soils that differ in age but have similar parent materials represent ideal environments to characterize chemical weathering over both time scales.

The present paper presents the initial characterization of the evolution of weathering on the Santa Cruz chronosequence of Northern California which is comprised of 5 marine terraces composed initially of reworked granitic sands, which based on recent cosmogenic isotopic data, range in age from 65 to 226 kyrs. Each terrace has been intensely instrumented in terms of vadose and ground water samplers, gas monitors, hydrologic and meteorological instrumentation, and vegetation plots. Chemical and x-ray analyses define the progressive development of argillic horizons at a depth of approximately 1 meter, comprised principally of kaolinite and Fe-oxyhydroxides, which over time become increasingly effective barriers to hydrochemical transport to greater depths (<16 m). Above these horizons, elemental contents, Sr and Ca isotopes and Ge/Si ratios in pore waters become progressively dominated by biogenic processes, which are defined in terms of annual vegetation fluxes. Lithogenic processes, i. e. weathering, below the argillic horizons produce strong concentration gradients in solid-state elements, minerals and isotopes as well as in pore water solute compositions. Such gradients are dependent on the pore water flux densities and rates of mineral weathering and are the ongoing focuses of the study.

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Iron isotope fractionation during soil formation – comparison of ligand and redox controlled processes

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Biogeochemical transformations of iron bearing minerals play an important role during weathering and soil formation and include both ligand and redox controlled reactions. In acidic, well-drained forest soils Fe can be translocated vertically under the influence of organic ligands, a process called podzolisation. In waterlogged soils Fe is mobilized under anoxic conditions by Fe-reducing bacteria and re-precipitated in oxic zones. In order to assess the patterns and magnitude of Fe isotope fractionation during pedogenesis, we have measured the Fe isotope distribution in two *Podzol* (acidic, well-drained) and one *Pseudogley* (seasonally anoxic) soil profiles at 12 different depths. Iron concentrations and isotope ratios in total digests were compared with values from a three-step sequential extraction procedure used to separate different Fe mineral phases in the soil. A 0.5M HCl extraction method was used to dissolve the poorly-crystalline Fe mineral pool, followed by a reductive hydroxylamine-hydrochloride leach to selectively dissolve well-crystalline Fe oxide minerals, before the residue containing Fe-bearing silicates was digested with HF. The extraction methods were tested for the absence of isotope fractionations during the procedure.

Iron isotope ratios were determined by MC-ICPMS coupled to a membrane desolvation system using a standard-bracketing approach (IRMM-014). Both low- and high-resolution instruments (Nu Plasma and Nu 1700) were used to measure the samples and a long term reproducibility of $\pm 0.15\%$ (2SD) for $\delta^{57}\text{Fe}$ was achieved.

Large variations in $\delta^{57}\text{Fe}$ exceeding the analytical precision by more than an order of magnitude were found in the soil samples. The HCl extracts of both *Podzol* profiles show very similar $\delta^{57}\text{Fe}$ distributions with -1.5% in the organic topsoil and -0.9% in the organic rich illuvial *Bh* horizon. This contrasts to positive $\delta^{57}\text{Fe}$ values in the HF digests of the eluvial *E* horizon. Iron-depleted reduced zones in the *Pseudogley* soil exhibit $\sim 0.5\%$ higher $\delta^{57}\text{Fe}$ values compared to Fe-enriched zones. These data imply that during both ligand and redox controlled reactions the lighter ^{54}Fe isotope is preferentially translocated. Iron mass and isotope balances describing transformation and redistribution reactions between different Fe mineral pools and within the three soil profiles will be presented.