Erosion of organic matter in a tropical mountain catchment: Implications for carbon delivery from the Andes to the Amazon River

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Mountain rivers play a key role delivering carbon in particulate organic matter (POM) to large fluvial systems and the coastal ocean. In the case of the Amazon, one of Earth's most important biogeochemical systems, ~40% of the POM transported by the main river is thought to be derived from the Andes [1]. Nonetheless, we have poor constraint on POM sources delivered by tropical mountain rivers, particularly in sediment-laden flood waters. POM derived from vegetation and soil contains recently sequestered atmospheric CO_2 and exports nutrients downstream. In contrast, POM derived from bedrock may be a CO_2 source and supply nutrients downstream.

Here, we address these issues in the Peruvian Andes. We combine hydrometric measurements (water discharge) and frequent sampling of suspended sediments (every 3 hrs) during flood events in 2010, at two gauging stations (2250 masl and 1350 masl) on the Kosñipata River. We use elemental (%C_{org}, %N) and stable isotope composition and radiocarbon content of the organic carbon ($\delta^{13}C_{org}$, $\delta^{15}N$, $\Delta^{14}C_{org}$) to quantify POM sources [2]. $\delta^{13}C_{org}$ vs. N/C and $\Delta^{14}C_{org}$ demonstrate binary mixing of POM derived from fossil and non-fossil (soil and vegetation) sources. Mixing analysis allows us to quantify the proportion of fossil particulate organic carbon (POC_{fossil}) and bedrock-derived nitrogen ($PN_{bedrock}$), and allows us to identify the $\delta^{13}C_{org}$ and $\delta^{15}N$ of POM derived from the terrestrial biosphere.

We find that POC_{fossil} contributes ~40% of the total river POC. We also show, for the first time, that $PN_{bedrock}$ completely dominates the riverine particulate nitrogen load, comprising over 70%. Until now, the bedrock contribution to Andean river POM has been overlooked, and our findings provide impetus for further investigation. In addition, our measurements allow the contributions of POM from vegetation and soil to be isolated. They demonstrate that during the rising limb and peak discharge of floods, POM was mobilised predominately from upper (O_H) soil horizons, with important additional input from live vegetation. The results suggest an important climatic control on the erosion and export of carbon derived recently from atmospheric CO_2.

[1] Hedges et al. (2000) *Limnol Oceanogr* **45**, 1449-1466. [2] Hilton et al. (2010) *Geochim Cosmochim Ac* **74**, 3164–3181.

Igneous and metamorphic garnet-clinopyroxene assemblages in eclogite and granulite, Breaksea Orthogneiss, New Zealand: major and rare earth element characteristics

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Eclogite and omphacite granulite, interlayered on cm- to decameter-scale, form most of the Cretaceous Breaksea Orthogneiss, which experienced peak conditions of P≈1.8 GPa and T≈850°C. It is the highest grade part of the c. 125–115 Ma Western Fiordland Orthogneiss. A gneissic fabric in the host orthogneiss truncates igneous layering in coarsely layered, decametre-scale clinopyroxenite and garnetite inclusions. Field and microstructural relationships, together with rare earth element (REE) characteristics across a broad range of rock types permits the conclusion that most garnet is of igneous origin; geochemical data alone are ambiguous. Igneous diopside persists in coarse-grained, weakly deformed samples. Garnet cores in garnetite, and late-formed garnet rims in garnetite and clinopyroxenite have a range of REE contents interpreted to reflect cumulate processes involving continued grain growth isolated from the parent magma. Clear rims on inclusion- and Ca-Tschemakite-rich diopside in clinopyroxenite of composition distinct to grain cores are interpreted as recrystallization features. Garnet in granulite occurs in three textural settings, the most common Type 1 garnet having REE characteristics identical to garnet in eclogite, but depleted in heavy REE relative to garnet in garnetite. Type 2 garnet in granulite forming metamorphic coronae on omphacite has a pronounced positive Eu anomaly and is depleted in heavy REE compared with Type 1 garnet. Type 3 garnet in granulite migmatite is indistinguishable from Type 1 garnet, consistent with formation through magma injection.