Terrigenous input and microcharcoal changes in the Gulf of Papua during the last 60 kyrs

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The last glacial cycle is characterized by abrupt climate changes at high latitudes. Less documented at low latitudes, they seem to strongly impact the hydrological cycle, and therefore the amount of burnable vegetation. In Melanesia, though records of the aborigine's first migrations are scarce, it is established that human settlement occurred during the last glacial. To unravel the human impact on the fire regimes from the natural hydrological variability, we reconstruct microcharcoals and records of terrigenous inputs in a sediment core (MD97-2134) in the Gulf of Papua. We use MicroCharcoals Morphotypes (MCM) and BIT index, as respective indices of the types of burnt vegetation (woodland or grassland) and of terrigenous inputs. We assume that past terrigenous inputs in the Gulf of Papua respond to precipitations changes over the mainland which also control the frequency and intensity of fires.

The most striking feature of these records is the abrupt change in the MCM record at about 47 ka BP. Prior this change, from 60 ka BP to 47 ka BP, the BIT and MCM indexes are correlated, which suggests a direct forcing of droughts on the burnt vegetation. After 47 ka BP, each proxy shows a different dynamics: the elongation of microcharcoals decreases abruptly, whereas the BIT index still records high frequency oscillation until 31 ka BP. We interpret this abrupt decoupling of terrigenous and microcharcoal records as likely influenced by anthropogenic fires related to aboriginal practices consecutively of the first migration wave.

The MCM record further shows an increase during the early Holocene, indicating an increase in the proportion of bush/forest fires ratio. This increase might be due to the development of agriculture over Papua New Guinea, though the reduced frequency of El Niño Southern Oscillation events might have also contributed to this event.

Fungi accelerate mineral weathering via a synergy of mechanical and chemical attacks

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Rock weathering, through net transfer of atmospheric carbon into the Earth's crust, is the main climatic feedback over geological timescales. So far, the role of plant roots and, in particular, the ability of their symbiotic fungi (mycorrhiza) to accelerate mineral weathering remains debated. Mycorrhiza grow preferentially around, and on the surface of nutrient-rich minerals, making such mineral-fungi contact zones potential hot-spot of alteration in soils. However, because of their microscopic nature (only ~ 5 μm wide but up 1 mm long) and their tendency to strongly adhere to mineral substrates, an *in situ* quantification of the interfacial alteration rates by hypha on minerals has never been achieved.

Here, an ectomycorrhiza (*Paxillus involutus*) grown symbiotically with a pine tree (*Pinus sylvestris*) in the presence of freshly-cleaved biotite under humid, yet undersaturated, conditions typical of soils. A sequence of interfacial alteration cross-sections was sampled via FIB (Focussed Ion Beam) ion-milling along a single, surface-bound hypha. Elemental depth-profiles of Si, O, Fe, Al, Mg and K measured by high-resolution electron micro-spectroscopy (STEM-EDS) across these interfaces showed significant elemental transfer (for Fe, Mg, Al and K) from the mineral substrate into the hypha. A quantitative model based on solid-state diffusion was developed and hyphal interfacial alteration rates were derived from these profiles. When compared *consistently* with abiotic dissolution rates measured in batch and flow-through reactors (i.e., same substrate - biotite (001) basal plane-, pH and temperature), the results reveal that the surface bound-fungi were between 3.5 to 30 times faster to alter the basal plane of biotite. The remarkable capacity of surface-bound fungi to degrade biotite is not ascribed to hyphal acidification or organic acid exudation, but rather to the mechanical strain that these micro-organisms exert, simultaneously to chemical alteration, on the mineral substrate over which they grow [1].

[1] Bonneville *et al*. *Geology* (2009), **37**: 615-618.