Spatial distribution of erosion rates in small Tahitian catchment ($10km^2$), from cosmogenic ^3He in olivine

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Understanding mechanisms that modify landscapes is essential for risk assessment in tropical islands. Such an understanding requires quantification of the rates at which landscapes respond to tectonic and climatic signals. Because measurements of long-term erosion rates are critical for understanding landform evolution, the use of cosmogenic isotopes in river sediments to estimate average erosion rates of drainage areas has grown rapidly in recent years.

In this study we present measurements of cosmogenic ^3He concentrations ([^3He_c]) in olivine grains from Tahitian river sediments (French Society Island) to predict the spatial pattern of erosion rates in the drainage area [1].

The olivine-rich sands come from 3 locations along the Matatia River, on the west part of Tahiti (catchment mouth, intermediate and upstream positions). He concentrations and isotopic ratios have been measured in 3 samples of olivine grains (1-2 mm) each weighing ~500 mg. The [^3He_c] has been calculated using: (i) the $^3He/^4He$ ratio measured by crushing and (ii) the ^3He and ^4He concentrations measured by melting the resulting powder.

Initial results indicate (i) an average erosion rate of 0.39±0.19 mm/yr upstream of the catchment mouth, and (ii) an average erosion rate of 0.0078±0.0007 mm/yr for the upstream sub-basin. The erosion rate at the intermediate position is too high to accumulate measurable amounts of ^3He_c.

The observed variation of erosion rates along the drainage area could be related to different erosional processes (landslides vs. soil creep), or can represent the erosion rates of different sub-basins (main stream vs. tributary). The measured erosion rates at the different locations allow us to invert for the spatial distribution of the erosion rates through nonlinear slope- and curvature-dependent erosion rates. This approach also enables us to constraint the form of parameterized erosion laws.

[1] Gayer, Mukhopadhyay and Meade (2008) *Earth Planet. Sci. Lett.* **266**, 303-315.

Melting conditions with PRIMELT: Examples and future work

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Determination of the magmatic melting conditions in the mantle is important for understanding the origin of intraplate magmas. The major element composition of primary magmas can provide such information, but there are important limitations. Of these, the best known is fractional crystallization. Other factors are source lithology variations and volatile content. PRIMELT2 [1] was introduced to calculate primary magma composition, but is restricted to primitive lavas that only crystallized olivine. It was calibrated from experiments on fertile mantle peridotite, and provides a mass balance primary magma. It calculates primary magma composition, melt fraction for accumulated fractional and batch melting, mantle potential temperature, olivine phenocryst composition, and warns the user of potentially compromising effects of source lithology variations and CO_2 content.

PRIMELT2 was used to evaluated variations in mantle potential temperature of OIB (ocean islands) [1] and to compare OIB to Large Igneous Provinces (LIPS) [2]. Results show that mantle plumes for LIPS were hotter and melted more extensively than plumes of modern OIB. Petrological solutions obtained from back-arc alkaline lavas from the Central American Volcanic Front yield T_p estimates within expected ambient mantle (1350-1400°C) [3]. These results indicate that PRIMELT2 is applicable for melting in a variety of tectonic environments. Work in progress will test the effects of alteration and simulate a decompression melting path.

[1] Herzberg & Asimow (2008) G3 **9**, Q09001. [2] Herzberg & Gazel, (2009) Nature **458,** 619-622. [3] Gazel *et al*., (2011) Lithos **121,** 117–134