Deep crustal melting revealed by Pb isotopes and seismology in the western US

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In comparison to the uniform coverage of the western US (WUS) provided by the USArray, the NAVDAT database shows many poorly sampled regions. We therefore measured the Pb isotope compositions of crustal xenoliths from numerous volcanic and plutonic rocks across the Colorado Plateau (CP), and also sampled felsic plutonic rocks outcropping east of it, where data for the crust have been particularly scarce. When possible, we separated low-U/Pb K-feldspars to obtain the Pb isotope composition of the host magmas. We combined our new data with literature Pb isotope data from ores and felsic plutonic rocks, all of which we cast into the geologically informative variables of Pb model ages, U/Pb, and Th/U using a two-stage model. These parameters were then imaged on isotopic maps of the WUS using grid-cell averaging. Comparing the isotopic maps to seismic maps of tomographic anomalies [1] and Moho and LAB depths determined from receiver functions [2] leads to the following observations: (1) Pb model ages match geological ages only where the continental mantle is cold and the Moho is deep. Elsewhere, Pb model ages have been reset. (2) While U/Pb does not vary systematically with other geochemical or seismic data, Th/U, as inferred from measured $^{208}Pb/^{206}Pb$ systematics, is high in the Snake River plain, in Northern Utah, along the Uinta Mountains, along the western rim of the CP, along the Rio Grande Rift, and in the Laramide uplifts in Colorado, all places where Vp/Vs is high, and represent regions of either crustal thinning or basement exposure. We suggest two scenarios: (1) The Th/U systematics, which are not visibly controlled by heat flow, attest to thinning of the local continental crust above hot mantle. Lateral removal of the upper and middle crust, by extensional faulting or channel flow, allowed the uplift of deep high-Th/U crustal rocks and their melting. (2) Exhumation of basement rocks by either deep-seated Laramide style thrust faults or as metamorphic core complexes provides access to deeper levels of the crust, providing the observed high Th/U values.

[1] Schmandt and Humphreys, EPSL, 2010 [2] Levander and Miller, G-Cubed, 2012.

Large river floodplains: weathering without erosion?

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On their journey to the ocean, large river sediments undergo a series of sedimentation, temporary storage and reworking episodes in active floodplains, in which time is available for sediments to mature chemically. Weathering affecting material eroded from tectonically active mountain belts in these flat, non-erosive areas is a potential mode of coupling between erosion and weathering fluxes at the continental scale.

We quantified the chemical fluxes associated with weathering of sediments in the floodplains of the Amazon and Ganga river systems [1,2]. To this end, river sediments were sampled upstream and downstream four river reaches across these basins. Sampling along depth-profiles grants access to the whole grain size and chemical composition range of river sediment. Weathering intensities of major elements (i.e. losses of Na, K, Mg and Ca) associated with chemical weathering in floodplains were examined as a function of grain size and integrated over the entire grain size range. Finally, we computed weathering fluxes, using a steady-state mass balance model at the scale of the river reach.

Across the four river reaches (Marañon, Beni, Madeira, and Ganga rivers), two consistent features emerge: (1) significant carbonate dissolution and subsequent Ca and Mg release to the dissolved load; (2) retention of K and Mg in the silicate phase of the sediment. These observations are in agreement with what is predicted from mineral kinetics. In this respect, sediment transport time across the river reach is a controlling factor on the floodplain weathering flux. However, across the studied river reaches, the variable extent of Na and Ca release by plagioclase dissolution points at an additional control on the intensity, namely the potential exhaustion of weatherable minerals before the sedimentary material enters the floodplain (be it in modern soils of the erosive area, or during ancient weathering episodes).

Altogether, our results show that floodplains constitute the predominant locus of weathering in the Gangetic system but not in the Amazon Basin. However, CO_2 consumption fluxes associated with silicate weathering in floodplains in these two river basin floodplains is on the order of magnitude as those resulting from weathering in their erosive areas.

[1] Bouchez *et al*., 2012, *Chem. Geol.* **332-333**: 166-184 [2] Lupker *et al*., 2012, *Geochim. Cosmochim. Acta* **84**: 410-432

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