Water weakening in dunite: Highlights from torsion experiments

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We have performed torsional deformation experiments on pre-hydrogenated fined-grain olivine aggregates using an innovative assembly to estimate water-weakening in mantle rocks at high shear strains. San Carlos olivine powder was cold-pressed, then 45 μL of water was added, and the sample was subsequently hot-pressed at 1523 K and 300 MPa for 3 h, producing aggregates with average grain sizes of 7 or 15 microns. Deformation experiments were performed in a high-resolution gas-medium apparatus equipped with a torsional actuator under a confining pressure of 300 MPa, a temperature of 1473 K, and constant shear strain rates of 1.4×10^{-4} to 8×10^{-5} s^{-1}.

Peak shear stresses ranged from 150 MPa to 195 MPa, values slightly weaker than determined in previous torsion experiments on dry fined-grain dunites with equivalent grain sizes, shear strain rates, and finite strains. Textures and microstructures of the starting material and deformed specimens were fully characterized by scanning electron microscopy and by electron backscatter diffraction. All deformed aggregates show a shape preferred orientation marking a foliation and lineation, grain size reduction, and a well-developed olivine crystal preferred orientation consistent with deformation by dislocation creep with dominant activation of the (010)[100] slip system. The hydrogen concentration in olivine aggregates was determined with unpolarized Fourier transform infrared spectroscopy. Analyses of the spectra indicate that the hydrogen concentration of the olivine might be limited and show a potential contamination by water-rich inclusion or intergranular material. These torsion experiments on hydrogenated fined-grain dunite provide new insights into the water weakening phenomenon observed in various nominally anhydrous minerals.

A missing process in the Eastern margin of Tibetan Plateau from multi-system thermochronology and its implication for late Cretaceous tectonic change from the Paleo-Tethyan to Neo-Tethyan regime

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Due to be lack of structural and sedimentary records to constrain the Jurassic-to-Cretaceous evolution, a missing process was here in Eastern margin of Tibetan Plateau. Given that all radioisotopic systems are subject to disturbance and resetting at different temperatures, we can restore the cooling process or emplacement of rock using different minerals or radioisotopic systems, which we call multi-system thermo-chronology. Based on the analysis of 125 thermochronology ages (e.g., U/Pb, Ar/Ar, Rb/Sr, FT, U-Th/He) of igneous rocks from the eastern margin of Tibet in the Yidun Arc, Yadjiang Deprssion and Songpan-Garze Fold Belt, we reconstruct the emplacement process of different granites using the multisystem thermochronology approach, to decipher the process.

At mid-to-late Indosinian, the initial emplacement age and depth of granites distinctly decrease from north to south, followed by a long slow cooling process in mid-to-upper crust during Yanshanian indicating a long period of thermal stability and tectonic quiescence. Those reflect the control of Paleotethyan tectonic setting. Whereas, between early and late Cretaceous, there was widespread granite emplacement and uplift-related cooling on the eastern margin of Tibetan again, with the declining tendency of magmatic activity and tectogenesis from south to north due to far-field effects of Lhasa-Qiangtang collision. In addition, the granites in north do not have an obvious emplacement process. Which reflect the control of Neotethyan tectonic setting. Correspondingly, as a sedimentary respose to the change of tectonic regime, there is an obvious change on depositional contact in adjoint basins from Late Cretaceous to Neogene. That is from a southward decreasing angularity of the unconformity in early to a northward decreasing angularity in later. Thus, the eastern margin of Tibet is thought to have experienced an important late Cretaceous (about 100Ma) tectonic change from the Paleo-Tethyan regime to Neo-Tethyan regime.