Geophysical Research Abstracts
Vol. 20, EGU2018-10803, 2018
EGU General Assembly 2018

Lu-Hf garnet chronology on (ultra-)high pressure rocks; Western Gneiss Complex, Norway, shows geodynamic changes during continental collision

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The burial of continental lithosphere during collisional orogenesis is a first-order process in global geochemical cycles and tectonics. Current models for continental subduction are based on decades of inter-disciplinary geoscience research; still, few empirical constraints exist on the processes and rates of burial. To address these knowledge gaps, we performed Lu-Hf garnet chronology and Zr-in-rutile thermometry on meta-mafic rocks in the Western Gneiss Complex (WGC) in Norway – the world's largest and best-preserved continental ultrahigh pressure (UHP) terrane – along a 100-km vector oriented parallel to the paleo-subduction direction. Our Lu-Hf ages, which range from 420-400 Ma (± 0.3-1 %RSD), do not mimic pressure and temperature trends, which decrease up-slab. However, Zr-in-rutile data for the same samples demonstrate that our youngest ages (404-400 Ma) represent the cessation of recrystallization at peak pressures and the onset of exhumation, whereas the older ages (420-410 Ma) represent garnet relics that grew during burial. The differences in pressure, temperature, and age of garnet (re-)crystallization are used to calculate a vertical burial rate of ∼5 mm/yr. This rate is much slower than that of subducting, mature oceanic crust. These results demonstrate that the chemical and chronological records of garnet may represent prograde- to peak-conditions, the latter of which provides an earliest constraint for the switch of orogenic systems towards exhumation. Furthermore, the consistency of our data to observations from Earth's main active collisional orogen, the India-Asia collision zone suggests that burial rates for continental crust during orogenesis are uniform and independent of pre-collisional convergence rate and slab angle. These results provide a new quantitative framework for evaluating and predicting changes in the geodynamics at active margins and establishes continental collision as a prime mechanism for the reorganization of regional plate motions.