Direct measurement of mantle exhumation rates using Cr-Al diffusion in spinel

J.H. CIPAR,[1] A.J. SMYE[1]

[1]Department of Geosciences, Penn State University, University Park PA 16802 (jhc5220@psu.edu)

Rates of mantle exhumation during rifting of continental lithosphere control important geodynamic processes such as the volume and rate of syn-rift melt generation. However, these rates are only loosely constrained by indirect observations (e.g. syn-rift sedimentation). Exhumed tracts of lithospheric mantle in ancient rift zones provide a direct window into the thermal evolution of the mantle lithosphere during continental break-up. Here, we apply bulk phase equilibrium modelling coupled with forward diffusion modelling of Al-Cr re-equilibration in spinel from the Lanzo Peridotite, Italy to directly determine mantle exhumation rates during Tethyan extension.

Well-developed Al-Cr zoning in spinel is ubiquitious in spinel-plagioclase peridotites from the Lanzo massif [1]. Phase equilibria modelling of perioditites similar in composition to Lanzo rocks indicate that Al-Cr partitioning is strongly pressure-dependent within the plagioclase stability field [2]. Observed rimward increases in Cr content of Lanzo spinel are consistent with decreasing pressure. We infer that decreasing pressure results from mantle upwelling during lithospheric extension, and that this zoning directly records shallow mantle exhumation rates during opening of the Jurassic Ligurian Tethys oceanic basin.

To quantify mantle exhumation rates, we invert observed Al-Cr profiles using a forward modeling approach that accounts for sample-specific bulk composition and the compositional dependence of Al-Cr diffusion in spinel [3]. Our study shows that this approach has potential to be applied to plagioclase-spinel peridotites exposed along other hyper-extended margins to directly constrain mantle exhumation rates immediately prior to continental breakup.

[1] Kaczmarek & Muntener (2008) *Journal of Petrology* **12,** 869-892. [2] Jennings & Holland (2015) *Journal of Petrology* **5,** 2187-2220. [3] Suzuki *et al*. (2008) *Physics of Chemistry & Minerals* **8,** 433-445.