Geophysical Research Abstracts
Vol. 21, EGU2019-12236, 2019
EGU General Assembly 2019

Investigating the dynamic history of crustal flow in gneiss domes using the AMS of refractory mafic rocks: a case study from the Entia dome, Central Australia

Clémentine Hamelin (1), Andrea R. Biedermann (2,3), Christian Teyssier (1), and Donna L. Whitney (1)

(1) School of Earth Sciences, University of Minnesota – Twin Cities, Minneapolis, United States (hamel038@umn.edu), (2) Institute of Geological Sciences, University of Bern, Bern, Switzerland, (3) Institute of Geophysics, ETH Zürich, Zürich, Switzerland

Felsic material rheologically controls crustal flow that ultimately produces gneiss domes. This felsic material is easily re-equilibrated during the later stages of dome emplacement in the shallow crust, at low-pressure, where it crystallizes as gneiss/migmatite at high-temperature (LP-HT) conditions. The early part of dome history is typically obliterated in the felsic material; however, less volumetrically abundant refractory rocks have potential to preserve an early part of the metamorphic history from deeper crustal levels. In this study, we use anisotropy of magnetic susceptibility (AMS) of refractory mafic rocks associated with the dominant gneiss to investigate the record of processes by which rocks emplaced in gneiss domes deform during dome evolution. The Entia dome, central Australia, is an ideal field site to investigate these questions: it is a relatively equant dome with two well-defined sub-domes cored by granitic bodies and separated by a median high-strain zone defined by sub-vertical to vertical foliation trajectories and shallowly plunging lineation. The Entia dome contains exposed refractory lithologies ranging from mafic granulite pods or layers to amphibolite (± garnet, ± clinopyroxene) layers. Entia mafic rocks experienced varying degrees of strain and preserve a differential record of pressure history throughout the dome, evidenced in a range of P-sensitive mineral assemblages and reaction textures such as garnet-stable assemblages, garnet breakdown reaction textures, and the presence of Ti-bearing phases such as rutile, ilmenite, and titanite at different structural locations throughout the dome. We sampled mafic material across key structural sites and traverses, with comprehensive geographic coverage of the domal structure. The AMS of oriented cores was analyzed using both low- and high-field methods to measure the magnetic fabric preserved in representative samples throughout the dome. Principal susceptibility (K1 > K2 > K3) orientations and magnitudes, as well as anisotropy, were measured and used to calculate a shape parameter describing the AMS ellipsoid (oblate to prolate) for each core. In order to better understand the relationship between the orientation and strength of mineral alignment and the AMS ellipsoid, we performed modeling of expected total AMS based on the modal abundances, compositions, and crystallographic preferred orientation (CPO) of carrier phases measured by electron backscatter diffraction (EBSD).

Low-field AMS can be controlled by, and therefore informs, the preferred alignment of all magnetic carrier phases (paramagnetic amphiboles, pyroxenes or ferromagnetic iron oxides) in mafic rocks. High-field methods show that in most of our samples, the AMS is dominated by paramagnetic carriers. For a subset of samples, we determined 3-D grain shapes and orientations to characterize the shape preferred orientation (SPO) of carrier phases, and compared these measurements with AMS results to investigate potential correlations between measurable mineral characteristics and total magnetic anisotropy, and how the AMS ellipsoid may relate to strain (e.g. constriction vs. flattening). We compared the record of deformation and metamorphism preserved in rocks exposed at key structural sites (high-strain zone, dome margins) on a horizontal section through the dome, as they represent particles having experienced deformation through different P–T–t–d paths during crustal flow associated with dome evolution.