AGU 100 FALL MEETING
Washington, D.C. | 10–14 Dec 2018

T31B-04: Comparing in-situ and ex-situ stress measurements in polymineralic rocks

Wednesday, 12 December 2018
08:45 - 09:00
Marriott Marquis - Liberty M

Constraints on the state of stress in the lithosphere are fundamental to understanding a breadth of geological phenomena. Paleo-stresses are generally estimated using microstructural elements for which there are experimentally calibrated relationships with applied stress, with an emphasis on recrystallised grain-size piezometers. However, it is often difficult to clearly distinguish newly recrystallised grains from the relict matrix. Furthermore, these grain-size piezometers are only applicable to rocks consisting of a single mineral.

An alternative proxy for paleo-stress in polymineralic rocks is the average subgrain size. Unfortunately, estimates of subgrain size differ significantly among different measurement methods, and therefore, piezometers must be individually calibrated for the method used. Existing subgrain-size piezometers are based on calibrations using optical or transmission electron microscopy. We use electron backscatter diffraction (EBSD), a common method of subgrain-boundary characterisation, to calibrate subgrain-size piezometers for both olivine and quartz.

To test the application of our olivine subgrain-size piezometer to polymineralic rocks, we deformed synthetic mixtures of olivine and orthopyroxene. Experiments were conducted using a Deformation-DIA apparatus at beamline 6BM-B Advanced Photon Source, Argonne National Laboratory. These experiments offer the unique possibility of simultaneously deforming the sample and measuring the average stresses within each phase using X-ray diffraction, before applying subgrain-size piezometry to the recovered samples. The results provide tests of (1) the manner in which stress is partitioned between phases, (2) whether the stresses measured in each phase by X-ray diffraction are comparable to those estimated by subgrain-size piezometry, and (3) whether stresses from subgrain piezometry can be used to estimate the macroscopic average applied stress. Stresses estimated from X-ray diffraction agree well with those made from subgrain-size piezometry in both monomineralic and polymineralic samples. In harzburgites, average stresses are similar in both phases and indicate that in this system, subgrain-size piezometric measurements from a single phase can be used to estimate the bulk stress.

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