Geophysical Research Abstracts
Vol. 21, EGU2019-4596, 2019
EGU General Assembly 2019

Evolution of microporosity and permeability of quartzofeldspathic rocks during changes in crustal conditions and tectonite fabric.

Virginia Toy (1), Ludmila Adam (2), Christopher Gerbi (3), Roland Hellman (4), Scott Johnson (3), Martina Kirilova (1), Emma Kluge (1), David Lockner (5), Oliver Plümper (6), Katrina Sauer (1), Won Joon Song (3), and Richard Wirth (7)

(1) Department of Geology, University of Otago, Dunedin, New Zealand. (virginia.toy@otago.ac.nz), (2) School of Environment, University of Auckland, Auckland, New Zealand. (l.adam@auckland.ac.nz), (3) School of Earth and Climate Sciences, University of Maine, Orono, ME 04469, USA. (johnsons@maine.edu), (4) ISTerre, CNRS, Université Grenoble-Alpes, Grenoble, France. (roland.hellmann@univ-grenoble-alpes.fr), (5) Rock Physics Laboratory, USGS, Menlo Park, CA 94025, USA. (dlockner@usgs.gov), (6) Geosciences, Universiteit Utrecht, The Netherlands. (o.plumper@uu.nl), (7) Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Potsdam, Germany. (wirth@gfz-potsdam.de)

Most crustal rocks contain some microporosity that can host fluids and allow them to permeate, which in turn impacts their physical properties and rheology. Using electron microscopic methods we have examined the nature of microporosity in quartzofeldspathic rocks recovered from surface outcrops and boreholes that are representative of those actively deforming at up to 35km depth beneath New Zealand's Southern Alps. In these exhumed samples the main types of microporosity are: (i) dilatant grain boundaries, (ii) grain boundary dislocation etch pits, (iii) intragranular fluid inclusions of various types, (iv) dilatant sites on phyllosilicate basal planes. We observe changes in the distribution and nature of porosity with proximity to the mylonitic shear zone down-dip of the active Alpine Fault, and these may be related to changes in the nature of the tectonite fabric.

Our measurements of anisotropy of experimentally measured electrical conductivity and elastic wave propagation, and its change with increasing confining pressure (P_{conf}), provide insights into the relationship of microfracture porosity and mineral orientation. For example, electrical and elastic wave anisotropy ($\rho_{\|}/\rho_{\perp}$ and $v_{p\|}/v_{p\perp}$) is high but decreases rapidly with increasing P_{conf} in samples with the strongest foliations, comprising foliation domains of quartz+feldspar with planar and through going phyllosilicate microlithons. Conversely, most weakly foliated samples where the same phases are well-mixed are less anisotropic and display less change in electrical and elastic wave anisotropy with increasing P_{conf}. This suggests linked type (iv) pore spaces parallel to foliation, which can host saline fluids, are preferentially closed with increasing P_{conf}.

These types of changes are likely to only be significant at low P_{conf}, i.e., brittle conditions. At greater depth, in the creeping part of the shear zone, changes in the geometric arrangement of microporosity are more likely to result from differential thermal expansion and/or fluid-rock interactions. The TESA toolbox (https://umaine.edu/mecheng/vel/software/tesa_toolbox/) allows us to predict how thermal contraction may yield anisotropic grain boundary porosity for real microstructures. We can then validate these predictions by relating evidence of limited fluid-rock reactions to equilibrium phase diagrams for real bulk compositions.