Geophysical Research Abstracts
Vol. 19, EGU2017-5773, 2017
EGU General Assembly 2017

Transformation of graphite by tectonic and hydrothermal processes in an active plate boundary fault zone, Alpine Fault, New Zealand

Matina Kirilova, Virginia Toy, Nicholas Timms, Angela Halfpenny, Catriona Menzies, Dave Craw, Jeremy Rooney, Carolina Giorgetti, and the DFDP Science Team
New Zealand (martina.a.kirilova@gmail.com)

Graphite is a material with one of the lowest frictional strengths, with coefficient of friction of ~ 0.1 and thus in natural fault zones it may act as a natural solid lubricant. Graphitization, or the transformation of organic matter (carbonaceous material, or CM) into crystalline graphite, is induced by compositional and structural changes during diagenesis and metamorphism. The supposed irreversible nature of this process has allowed the degree of graphite crystallinity to be calibrated as an indicator of the peak temperatures reached during progressive metamorphism.
We examine processes of graphite emplacement and deformation in the Alpine Fault Zone, New Zealand's active continental tectonic plate boundary. Raman spectrometry indicates that graphite in the distal, amphibolite-facies Alpine Schist, which experienced peak metamorphic temperatures up to 640 [U+25E6]C, is highly crystalline and occurs mainly along grain boundaries within quartzo-feldspathic domains. The subsequent mylonitisation in the Alpine Fault Zone resulted in progressive reworking of CM under lower temperature conditions (500[U+25E6]C-600[U+25E6]C) in a structurally controlled environment, resulting in spatial clustering in lower-strain protomylonites, and further foliation-alignment in higher-strain mylonites. Subsequent brittle deformation of the mylonitised schists resulted in cataclasites that contain over three-fold increase in the abundance of graphite than mylonites. Furthermore, cataclasites contain graphite with two different habits: highly-crystalline, foliated forms that are inherited mylonitic graphite; and lower-crystallinity, less mature patches of finer-grained graphite. The observed graphite enrichment and the occurrence of poorly-organised graphite in the Alpine Fault cataclasites could result from: i) hydrothermal precipitation from carbon-supersaturated fluids; and/or ii) mechanical degradation by structural disordering of mylonitic graphite combined with strain-induced graphite localisation.
The lack of published systematic studies of mechanical modification of the structure of graphite inhibits further conclusion to be drawn. Thus, we performed laboratory deformation experiments during which we sheared highly crystalline graphite powder at room temperature, normal stresses of 5 MPa and 25 MPa and sliding velocities of 1 μm/s, 10 μm/s and 100 μm/s. The degree of graphite crystallinity, both in the starting and resulting materials, was analysed by Raman microspectroscopy. Our results demonstrate consistent decrease of graphite crystallinity with increasing shear strain. We conclude that: i) graphite 'thermometers' are unreliable in brittely deformed rocks; ii) a shear strain calibration of graphite 'thermometers' is needed; iii) fault creep is very likely responsible for the observed structural and textural characteristics of graphite in the Alpine Fault cataclasites.
Finally, to investigate the possibility of hydrothermal origin for at least some of the graphite in the Alpine Fault cataclasites we will also present synchrotron FTIR and carbon isotope analysis of the Alpine fault rocks.