Coupling deformation under high pressures, synchrotron X-rays and acoustic emissions monitoring for the study of deep earthquakes

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Abstract

The coupling of synchrotron radiation to the Deformation-Dia was a breakthrough for in studies of rheological properties under extreme conditions of pressure and temperature (up to 18-20 GPa and to 2000 K). Recent developments using acoustic emissions monitoring have significantly widened the range of problems that can be addressed with these experiments, including the study of phase transformations under high pressures and associated mechanical instabilities. Synchrotron X-ray diffraction and radiography allow measuring in-situ sample macroscopic strain, lattice preferred orientations, and lattice strains as proxy for stresses, from grain scale to sample scale. In addition, acoustic monitoring now allows studying crucial characteristics of 'brittle-like' events within the samples.
These developments bring for instance new clues on how deep earthquakes (> 50 km depth) could be triggered. At these confining pressures earthquakes cannot be explained by conventional rupture theories, and the causes for the seismicity occurring down to below 600 km depth in the earth are still unclear. We will present results from recent studies (e.g. Ferrand et al, 2017, Gasc et al, 2017, Incel et al, 2017) relevant for subduction zones intermediate-depth seismicity, that highlight how the interplay between mineralogy, elastic and plastic properties of minerals can produce micro-quakes in a laboratory. These methods open the door to a wide range of further studies in high pressure mineral physics.

T. P. Ferrand, N. Hilairet, S. Incel, D. Deldicque, L. Labrousse, J. Gasc, J. Renner, Y. Wang, H. W. Green ii, A. Schubnel, Dehydration-driven stress transfer triggers intermediate-depth earthquakes, Nature Communications 8 15247 (2017) [doi: 10.1038/ncomms15247]

J. Gasc, N. Hilairet, T. Yu, T. Ferrand, A. Schubnel, Y. Wang, Faulting of natural serpentinite: Implications for intermediate-depth seismicity, Earth and Planetary Science Letters 474 138-147 (2017) [doi: 10.1016/j.epsl.2017.06.016]

S. Incel, N. Hilairet, L. Labrousse, T. John, D. Deldicque, T. Ferrand, Y. Wang, J. Renner, L. Morales, A. Schubnel, Laboratory earthquakes triggered during eclogitization of

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lawsonite-bearing blueschist, Earth and Planetary Science Letters 459 320-331 (2017) [doi: 10.1016/j.epsl.2016.11.047]