Webinars of geology

Department of Earth Sciences - Torino

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LINK WEBINAR

The mechanics of deep focus earthquakes: an experimental perspective

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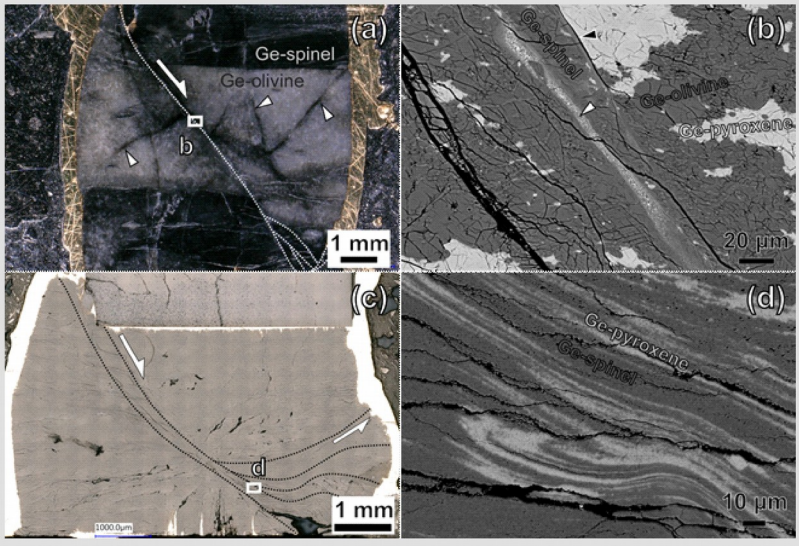
Deep focus earthquakes (DFEs) are those with hypocenters deeper than 300 km, depths where rocks flow in a viscous way. The hypocenters of DFEs match precisely the transition zone window at which olivine, the main constituent of the upper mantle, transforms to wadsleyite and ringwoodite. This has led to associating them to the transformation of metastable olivine. However, the way mineral reactions can modify the deformation regime of deep rocks, from ductile to brittle (embrittlement) is still poorly understood and remains one of the outstanding unsolved problems of geophysics and rock mechanics.

Here, we provide experimental evidence that, under differential stress at high pressure and temperature conditions (3-5GPa/800-1000°C), shear fractures nucleate and propagate at the onset of the olivine -> spinel transition in the Mg2GeO4 analogue system. The propagation of these fractures is sufficiently rapid to radiate energy in the form of intense acoustic emissions (AEs).

Transformational faulting can initiate within metastable olivine, and then continue to propagate via shear-enhanced melting within the transformed high-pressure phase. The mechanics of transformational faulting is controlled by ratio between strain rate and kinetics of the olivine-ringwoodite reaction, and we extrapolate this relationship to natural conditions at which DFEs may occur.

Put together, our observations provide strong experimental evidence of the role played by mineral reactions on earthquake triggering in the Earth mantle's transition zone.



The Speaker

After a doctorate from the Institut de Physique du Globe de Paris in 2003 and a post-doctorate at the University of Toronto (Canada), Alexandre Schubnel was recruited by CNRS in 2006 at the Laboratoire de Géologie of the École normale supérieure in Paris. There, he has strongly contributed to the establishment of a unique experimental set-up of rock mechanics making it possible to cover the ranges of pressures and temperatures prevailing in the Earth's lithosphere. This set up enabled him to reproduce and "listen", in the laboratory, to the processes involved during the propagation of earthquakes, and, in particular, made it possible to better understand the origin of deep earthquakes, which occur more than four hundred kilometers underground. In 2014, he was awarded the CNRS bronze medal and the Gouilloud-Schlumberger prize of the French Academy of Sciences. In 2015, he was laureate of an ERC consolidator grant on the topic of "laboratory earthquakes". Since 2019, he acts as the head of the Laboratoire de Géologie of the École normale supérieure de Paris.