# Nanogeology: A new approach to decoding the secrets of the Earth

## GUEST LECTURE

**BIOGRAPHY:**

Renelle Dubosq is a postdoctoral researcher in the Department of Microstructures and Alloy Design at the Max-Planck Institute for Iron Research in Dusseldorf, Germany. She recently completed her PhD program within the Department of Earth and Environmental Sciences at the University of Ottawa where she also obtained her BSc, and MSc degrees. Her work focusses on investigating the impact of nanoscale crystalline defect structures on mineral micro-rheology by applying and further developing new and innovative 2D and 3D microscopy techniques. She strives to establish bridges between Earth sciences and materials sciences and continue to study nanostructures in the hopes of investigating how they relate to the tectonic scale. In addition to research, Dubosq has also been engaged in community outreach to promote mineralogical studies and is committed to being a visible role model for other women in science.

## PRESENTER:


## Dr. Renelle Dubosq

Department of Microstructure Physics and Alloy Design, Max-Planck-Institut für Eisenforschung GmbH, Germany


Date: July 27, 2022
Time: 10:00 - 11:00 a.m.
Location: McMaster University, BSB 115


**ABSTRACT:**

Correlative analytical approaches involving high-spatial resolution microscopy techniques allow for the compositional measurements and spatial imaging of minerals at the near-atomic scale. By combining electron backscatter diffraction (EBSD) mapping, electron channeling contrast imaging (ECCI), scanning transmission electron microscopy (STEM) and atom probe tomography (APT) on various mineral systems, I have successfully documented element mobility regulated by structural defects. Although these techniques were initially developed in the materials sciences, they are now being applied to a broad range of applications within many subdisciplines of geosciences including geochemistry, geochronology, and economic geology. In one set of experiments, I applied a correlative approach on naturally deformed pyrite from an orogenic gold mine in northern Canada to assess the impact of crystal-plastic deformation on the remobilization of trace elements. This study has led to proposing a new paragenetic model for metallic ore deposits in which deformation creates nanostructures that act as traps for base- and precious-metals. Applying this approach on fluid inclusion-rich pyrite, I have also discovered new fluid hardening processes, whereby fluid inclusions and subsequent trace element mobility immobilize dislocations, which contrasts to the more commonly reported weakening effect of fluids on minerals. More recently, I have applied the same suite of analytical techniques to naturally deformed garnet porphyroclasts from an eclogite facies mylonite, central Australia, to investigate the mechanisms of brittle fracturing in the lower crust. The results demonstrate the enhanced diffusion of major elements along recrystallized grain boundaries, leading to the nucleation of element clusters that act as barriers for migrating dislocations and therefore to strain-hardening and mechanical failure. The interactions between elements and structural defects play a vital role in determining the mechanical properties of minerals. These sub-nanometer scale exchanges consequently control meso- to tectonic-scale geological processes. This innovative research not only highlights the latest advancements in analytical microscopy resolving long-standing geological problems but also brings us closer to bridging the gap between the fields of materials sciences and geosciences.


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