3D electron diffraction in nano-geology: present and perspectives

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When working on advanced research topics in geosciences, one must often deal with small yields and cryptocrystalline polyphasic samples. Conventional optical and X-ray crystallographic tools may not be sufficient for the proper characterization of these samples. The development of efficient probes able to investigate the nanoworld becomes therefore crucial for pushing forward our understanding about the geochemical and mineralogical processes that regulate Earth and extraterrestrial environments.

In the last ten years, electron diffraction (ED) evolved from a qualitative method restricted to few dedicated TEM users, to a robust protocol for phase identification and ab-initio structure determination [1]. Such change has been mostly propelled by the development of routines for 3D data collection. This methodology is in principle equivalent to single-crystal X-ray diffraction, but allows sampling crystals of few tens on nanometers.

We will show here some examples of recent applications of ED in geosciences, namely how to achieve an easy and relatively fast characterization of minor and cryptocrystalline phases in natural and experimental samples. We were able identify and characterize modulated phases able to carry hydrogen at upper-mantle conditions, to follow aragonite growth from the first nucleation seeds [2] and to identify mineralogical phases and polytypes in non-equilibrated extraterrestrial samples and in impact rocks [3].

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