Sheldrick Prize

Crystals under stress: from mineral inclusions to diamond anvil cells (and back)

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Pressure and temperature are key variables to explore the physical properties of matter, allowing to access new reactivity paths, tuning properties, and modifying both length and angles and thus crystal structures. The effects of these variables can be studied directly using specific devices, such as diamond anvil cells (DACs), or more indirectly exploiting natural samples, like mineral inclusions.

In combination with laser heating, DACs allow to reach very high pressure and temperature and to unravel new reactivity paths. The synthesis of new nitrides, namely AsN and Sb3N5 [1-2], starting from nitrogen, typically unreactive due to its triple bond, is an interesting example of compounds only accessible at extreme conditions.

Mineral inclusions, where a mineral trapped inside another mineral, can be a treasure trove of information on the geological history of a sample. From the identification of mineral phases, it is possible to derive the environment in which the host-inclusion system grew. The mutual orientations of the host and the inclusions, can bear insight on the timing of the formation of the system, in particular if the inclusion formed before or together with the host. Last but not least, from the stress state of the inclusion we can back-calculate the conditions of entrapment. In principle, using X-ray diffraction we can characterize all of these aspects in just one measurement, but the practical application is not straightforward and requires to be properly checked against controlled experiments, such as the ones performed in diamond anvil cells [3], and often benefits of a combination of experimental and computational techniques [4-5].

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