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Interphase misorientation as a tool to study metamorphic and magmatic processes

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Interphase boundaries are planar defects that separate two different minerals, which in rocks in general have different compositions and/or crystalline structures, and may play an important role as a pathway for fluids in rocks. Interphase boundaries can be classified coherent, semicoherent incoherent boundaries, depending on the degree of atomic structure matching between the two minerals. In coherent boundaries, the crystals match perfectly at the interface plane and the interfacial plane has the same atomic configuration in both phases. Small differences in lattice mismatch can be accommodated by elastic strain (coherency strain), which reduces the interface energy at the expense of increasing the energy on the adjacent phases. When the coherency strain energy becomes too large, semicoherent interfaces are then formed, where the elastic strain is replaced with localized strain due to dislocations. Incoherent interphase boundaries have a disordered structure between the two phases or large lattice mismatch at the interface. Although the determination of the degree of coherency of interphase boundaries and possible orientation relationships between the two adjacent phases is routinely performed by selected area electron diffraction in the transmission electron microscope, this method lacks of statistical representativeness. With the advent of techniques like EBSD, it is possible to calculate orientation relationships not only in single pairs of crystals, but in full thin sections, and not limited to single phases, but also between different minerals. The interphase misorientation is calculated from two orientations of two neighbour crystals of different phases. A set of single misorientations is then used to calculate the misorientation distribution function (MDF), from where we identify a maximum, and their crystallographic interpretation. If we then know the misorientation and the unit cell parameters of the individual phases, the crystallographic relationships
between them can be described with the pairs of parallel crystallographic planes and the pairs of crystallographic directions.

We present examples of the use of interphase misorientation analysis on the transformation of olivine-antigorite from serpentinites from Val Malenco, on the calcite-aragonite transition from experiments performed in a Griggs apparatus, from spinel lherzolites from the Horoman peridotite complex and from the Atlantis Bank mid-ocean ridges gabbros (ODP Hole 735).