



## Interpreting metamorphic and metasomatic reactions from mineral textures

Håkon Austrheim (1) and Andrew Putnis (2)

(1) Physics of Geological Processes, University of Oslo, P.O. Box 1048 Blindern, N-0316 Oslo, Norway  
(h.o.astrheim@geo.uio.no), (2) University of Münster, Institut für Mineralogie, Münster, Germany (putnis@uni-muenster.de)

Metamorphism and metasomatism both involve the reequilibration of mineral assemblages due to changes in pressure, temperature and/or chemical environment. The distinction between metasomatism (which is a metamorphic reaction involving a significant change in chemical composition) and metamorphism (essentially isochemical) may appear to be well defined, but since no reaction can occur without transport these definitions require that we specify an arbitrary length scale to distinguish the two processes. It is generally accepted that material transport, even on a local scale, involves a fluid phase, and that dissolution and reprecipitation reactions are involved in converting one assemblage to another (Carmichael, 1969; Philpotts and Ague, 2009). Given that the fluid phase is not just pure water, a key question is the thermodynamic as well as the kinetic role of the fluid phase in the reaction.

In a metamorphic event P-T paths are inferred from sequences of discontinuous reactions assumed to take place as a rock crosses univariant reaction lines in P-T space and continuous reactions involving chemical reequilibration in coexisting minerals. Any fluid is assumed to merely play a catalytic role and not affect the thermodynamics of the reaction. The criteria for a 'metamorphic event' are primarily based on mineral textures in a rock, but this is subject to misinterpretation, as pointed out by Vernon et al. (2008). Microstructural criteria which have been considered reliable as indicating a sequence of metamorphic reactions in P,T space include corona structures and partial replacement textures, both suggesting arrested metamorphic reactions (Vernon and Clarke, 2008).

As a typical example of a corona structure we describe the textural and chemical characteristics of a reaction between kyanite and garnet to form sapphirine and plagioclase. Based on Na mobility, we argue that the availability and chemistry of the fluid is the primary driver for the reaction (Straume and Austrheim, 1999). This calls into question whether the reaction can simply be modelled in P,T space without considering the thermodynamic role of the fluid phase. Partial replacement textures are typical of fluid-mineral reactions (Putnis, 2009) and we present examples where it is clear that the composition of the fluid phase is the key to the reaction and that the parent and product phases may be 'co-existing' in a textural sense, but not in a thermodynamic sense. In a partial replacement the equilibrium, if any, may be between the fluid phase and the product phase of a mineral-fluid reaction. Both corona structures and partial replacement are equally indicative of a metasomatic reaction (driven by a fluid-induced compositional change) as they may be of a metamorphic reaction driven by a change in P and/or T. This re-opens the question of the interpretation of P,T-t paths based on inferred equilibrium reactions.

### References:

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