

Wollastonite-scapolite in granulite facies calc-silicates: reaction models and implications for P-T-fluid histories

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Tectonic models for the formation and evolution of granulite-facies terrains depend critically upon the pressure (P)-temperature (T) information provided by high-grade mineral assemblages. To date, this P-T data has mostly been obtained from mafic, felsic, and pelitic rock types for which either reaction grids or quantitative geothermobarometers have been developed and in which many disequilibrium textures are now understood in terms of mineral reactions. In contrast, high-grade calc-silicates have been little used in the definition of P-T histories, and the relationships between disequilibrium textures and mineral reactions in these lithologies remain obscure.

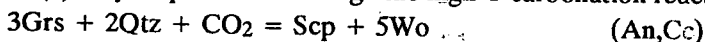
Granulite facies calc-silicates from the Rauer Group, East Antarctica, contain grossular + wollastonite + scapolite + clinopyroxene assemblages, with either quartz or calcite, which preserve spectacular symplectite and corona textures often involving the growth of secondary wollastonite:

1. wollastonite-scapolite-clinopyroxene symplectites replacing grossular;
2. wollastonite-plagioclase symplectites replacing grossular or the earlier symplectites;
3. wollastonite-plagioclase rims and intergrowths between quartz and scapolite; and
4. wollastonite rims between quartz and calcite.

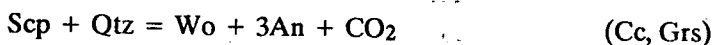
Only in rocks or domains lacking wollastonite and quartz is the breakdown of scapolite to plagioclase-calcite symplectites seen.

Calculated mineral reactions between the phases garnet (Grs), scapolite (Scp), wollastonite (Wo), calcite (Cc), quartz (Qtz), plagioclase (An) and vapour (V) in the CASHCO₂ system show that **these textures are indicative of near-isothermal decompression (ITD) at 800 to 850°C**. This implies a decrease in P from 8 to 6 kbar, consistent with P-T path determinations based on other rock types.

The reaction topologies have been calculated and adjusted using activity-composition relations for Ca-end members in calc-silicate garnets and scapolites. The resulting P-T (vapour-absent), T- a_{CO_2} and P- a_{CO_2} grids show that important reactions limiting the stability of scapolite + wollastonite involve carbonation with increasing T, rather than decarbonation. For example, texture (1) may be produced through the high-T carbonation reaction:

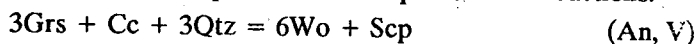


with increasing T, or decompression, at 8 to 7 kbar, 820 to 850°C, and a_{CO_2} of 0.40 to 0.48. Texture (3) is consistent with progress of the decarbonation reaction:



from left to right with increasing T, or decompression, at similar T- a_{CO_2} conditions but slightly lower pressures (6.5 kbar).

Localisation of the reaction textures, systematic variations in modal proportions of product phases (e.g., wollastonite:clinopyroxene) in relation to initial grossular composition, and a clear relation between reaction progress and mineral composition, preclude open-system behaviour or the involvement of an external fluid phase in the generation of these reaction textures during decompression. The vapour-absent reactions:



and



are inferred to have produced the textures (1) and (2), respectively, at *ca.* 7.5 kbar, 850°C and under low a_{CO_2} conditions (0.4 to 0.5). The occurrence of orthopyroxene + Kfeldspar + plagioclase assemblages adjacent to these calc-silicates is consistent with this vapour-absent P-T evolution.

Wollastonite-scapolite calc-silicates from many other Proterozoic granulite terrains including the Northern Prince Charles Mountains, Antarctica, and the Arunta Complex, Australia, do not preserve garnet-breakdown textures like those recorded from the Rauer Group. Instead, secondary garnet is often developed in rims and coronas between primary Wo + Scp, accompanied by Qtz ± Cc. These garnet-forming textures are considered to have been produced through the progress of reactions such as (An, V) and

(An, Cc) from right to left in response to **near-isobaric cooling** at 6 to 8 kbars in these terrains. In contrast to previous interpretations, our calculations indicate that an influx of H₂O and consequent decrease in aCO₂ are not required for these textures to develop.

The broader implications of the occurrence of carbonation with increasing temperature, and liberation of CO₂ on cooling, in such calc-silicate granulites are discussed.