

Equilibrium and kinetics in metamorphism of pelites in the Nelson aureole, British Columbia

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This study examines the interplay between equilibrium and kinetics in the development of metapelitic mineral assemblages in the aureole of the Nelson Batholith, southeastern British Columbia. We focus on two main issues: (1) the relative unreactivity of porphyroblasts, in particular garnet and staurolite, when they are involved as reactants in prograde reactions; and (2) contrasts in the degree of overstepping of pelitic reactions as a function of reaction affinity and fluid presence. With respect to reaction overstepping, we contrast the formation of staurolite and andalusite from a reactive muscovite+chlorite precursor assemblage (large reaction affinity, non-porphyroblastic reactants, low overstepping of < 20 °C) with the formation of andalusite and sillimanite from a staurolite-bearing precursor assemblage (small reaction affinity, porphyroblastic reactants, large overstepping of up to 70 °C). Initial garnet formation appears to be an intermediate situation (overstepped by 20-30 °C). Once garnet has nucleated, it appears to grow broadly in accordance with phase equilibrium predictions, but does not dissolve as much as predicted, showing negligible consumption both during staurolite growth and upgrade of terminal staurolite consumption. Phase equilibrium modelling assuming purely fractional behaviour with no dissolution contradicts zoning evidence. An intermediate scenario in which garnet only partially dissolves may be closest to reality. Staurolite shows different behaviour, reacting out across a wide interval. In individual thin sections, staurolite may show substantial reaction to form andalusite in some domains but none in others, with no difference in composition, suggesting fluid control in locally lowering activation energy barriers. Major staurolite breakdown is delayed until sillimanite appears, resulting in formation of garnet in a domain in which phase equilibrium modelling predicts garnet to be consumed. Our study suggests that (1) thermally-activated reactions can be significantly overstepped even when the final mineral assemblage conforms closely to predictions from equilibrium thermodynamics, and (2) the actual reactions involved in the formation of a stable equilibrium assemblage can be considerably different from those predicted by equilibrium modelling.

Evolution of acapulcoites and lodranites revisited

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The Initial Study

In 2003, we examined 15 bulk samples of the acapulcoite/lodranite clan (ALs) for their major, minor, and trace element concentrations [1]. We concurred with previous workers [e.g., 2] that ALs were effected by various degrees of partial melting and melt migration. Based on our data, we proposed an extended classification scheme illustrating the thermal and chemical alteration of those meteorites. We found that K and Se were key elements in this scheme but also pointed out that additional petrologic information was important.

Recent Research

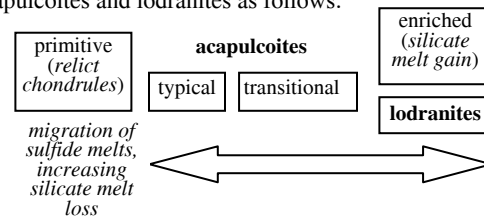
Recently, [3] delivered an in-depth description of a transitional sample that was subject to extensive metal/sulfide melt migration. They concluded that the AL parent body experienced a heterogenous thermal history including core formation and preservation of nebular components.

Similarly, [4] presented a detailed study of the Acapulco meteorite and, in contrast to previous investigations, argued that this meteorite did suffer silicate partial melting with subsequent closed-system crystallization.

Finally, [5] explained his view of AL petrogenesis in the light of shock-induced heating.

A Synthesis

In principle, recent research on ALs supports earlier findings and only disagrees as to the question of the absolute temperature experienced in individual cases. Considering the results of [3, 4, 5], we modify our classification scheme of acapulcoites and lodranites as follows:



- [1] Patzer *et al.* (2004) *MAPS* **39**, 61-85. [2] Floss (2000) *MAPS* **35**, 1073-1085. [3] McCoy *et al.* (2006) *GCA* **70**, 516-531. [4] El Goresy *et al.* (2005) *GCA* **69**, 4535-4556. [5] Rubin (2007) *GCA* **71**, 2383-2401.