Fluid-absent and fluid-dominated domains in granulites and eclogites

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Prograde reactions and partial melting in high-grade metamorphic rocks occur mainly in a fluid-absent regime: all volatiles participating to the reaction are, either bound in mineral structures, or dissolved in melts. But fluid-absent reaction does not mean that the existence of a free volatile phase is impossible. It can be present, either as remnants of earlier fluids not participating to the reaction, or as 'neutral' fluids produced by the reaction itself (e.g. CO_2 extracted from a mixed aqueous-gazeous fluid by preferential H_2O dissolution in silicate melts) or introduced in the system from an external source (fluid-dominated systems).

These 'external' fluids can only be identified if remnants have been preserved in inclusions. The knowledge of the composition and molar volume of the enclosed fluids, combined with the precise timing of the inclusion formation in respect to the host mineral, allows the unambiguous characterization of inclusions formed at each stage of the metamorphic evolution (pre-, syn- or post peak metamorphic conditions). Some granulites appear to be very well suited for this type of study, both from the variety and surprising amount of inclusions that they contain: pre- (e.g. Vry and Brown, 1991), syn- (e.g. Srikantappa *et al.*, 1992) and post-metamorphic inclusions (not unsurprisingly, by far the most abundant, Lamb *et al.*, 1987) have thus been documented in a number of occurrences (India, Baltic Shield, Adirondacks, etc.), with always the same fluid types: high-density, almost pure CO_2 (eventually mixed with minor amounts of N_2 or CH_4), typical for peak- and post-metamorphic conditions, and high-salinity brines which (with few exceptions) are remnants from pre-metamorphic fluids (sedimentary pore water) (e.g. Touret, 1992a).

Fluid-absent and fluid-dominated domains in granulites

The coexistence at various scale (decimetric to metric) of fluid-absent and fluid- dominated domains is obvious in the well-known incipient charnockites from Southern India and Sri-lanka. Several mechanisms are probably involved (Raith *et al.*, 1989), with the distinct possibility for CO_2 to be internally generated (Raith and Srikantappa, 1993). However, in some cases at least it seems now clear, both from direct observation and isotopic analysis (Santosh *et al.*, 1992), that the charnockite formation is related to CO_2 streaming from a not too distant source, probably underlying 'massive' charnockite or enderbite which may contain huge amounts of juvenile CO_2 (T. Dunai, this volume).

Another less popularized, but very interesting region where fluid- dominated and fluid-absent domains coexist at a regional scale occurs in Southern Finland. The West-Uusimaa granulite complex (Schreurs, 1985) is clearly CO_2-dominated, whereas the contemporaneous (about 1.8 Ga) Turku granulite area, occurring about 100 km westwards, shows only very scarce CO_2 inclusions and can only be interpreted by fluid-absent reactions (Van Duin, 1992). It is interesting to note that both regimes correspond to striking, immediately noticeable field differences: well-defined Opx-isograd intersecting regional layering in the West-Uusimaa Complex, diffuse, compositionally related granulite 'patches' in the Turku area. Very different also is the relative abundance of opx- or gt-bearing quartz segregations, incidentally the places which concentrate most CO_2-rich inclusions; these are very abundant in West-Uusimaa, occurring in any rock-type (metasediments or metavolcanics), almost absent in the Turku area. The source of the CO_2 remains problematic. From comparison with other regions (e.g. Touret, 1992a), it could be supposed that it could derive from the crystallisation of deep-seated, synmetamorphic intrusives, but no possible candidate occurs in West-Uusimaa. Conversely, the Turku area is characterized by the occurrence of several synmetamorphic igneous suites, notably charnockites, but these are CO_2-free (Van Duin, 1992). The question whether both regions correspond to a different level of a single, large scale vertical system (from a depth of about 10 to 30 km) or to independent regions remains open.

Eclogites: strikingly different fluids, but also possible fluid-dominated and fluid-absent systems.

Early undisturbed inclusions are not possible in eclogites (e.g. Touret, 1992b). Therefore, their study is much more difficult than granulites, but recent studies (see Symposium lUS-3, Section C, EUG7, *Chem. Geol.* **108-1/4**, 1993) have shown that fluids are present during eclogitisation, either internally controlled (hence comparable to fluid-absent systems in granulites) or externally derived (fluid-dominated systems). But the nature of the fluids is strikingly different: eclogitisation is triggered by the influx of aqueous fluids, ther origin of which remains problematic. CO_2 is conspicuously absent, but various quantities of N_2 are almost always present. This unexpected volatile is possibly released from the crystal structure during feldspar breakdown, but other sources are also possible. In the present state of our knowledge, it is not possible at this moment to integrate fluid inclusion data in a coherent model comparable to those which have been developed for the granulites.

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