CO_2-rich fluids in granulites: instrumental or incidental ?

M. SANTOSH

Centre for Earth Science Studies, P B 7250, Akkulam, Trivandrum 695 031, India

The anhydrous mineral asemblages which characterize granulite-facies rocks dictate that low water activities prevailed during their equilibration. Low water activities could result by the removal of a hydrous partial melt, baking by igneous intrusions or by the dilution of pore fluids through the influx of CO_2. From a generally fluid-free deep crust, episodic fluid bursts might be triggered by tectonic processes and accompanying regional thermal anomalies. This could manifest itself as high density fluid inclusions captured within minerals. The increase in CO_2 densities concomitant with increasing pressure across regional amphibiolite-granulite transitions, and the spectacular increase in the volume of CO_2 trapped within charnockite in the amphibolite gneiss-incipient charnockite reaction fronts suggest that CO_2 has been *instrumental* in granulite genesis. Conversely, CO_2-rich fluid inclusions can also be *incidental* to granulite formation in some instances. Several processes, such as the diffusion of H_2, strain-induced leakage of H_2O from pre-existing CO_2-H_2O inclusions, dehydration melting and the removal of H_2O, selective removal of H_2O to form retrograde mineral assemblages, among others, can produce pure CO_2 inclusions. Field structures, mineral phase equilibria, fluid inclusions and stable isotopic characteristics in many charnockite terrains, especially those in the East Gondwanian continental fragments, argue in favour of CO_2 being instrumental in granulite formation. It is also possible that the infiltration of CO_2 into the base of the crust has sometimes resulted in melting. Decompression melting, i.e., melting induced by the influx of CO_2, rather than dehydration melting assumes fundamental importance in evaluating the role of CO_2 granulites and melts.

Opinions are divided on the source of CO_2, and several internal and external CO_2 generating mechanisms have been proposed. Stable isotope data on fluid inclusions and graphite from the southern Indian terrain argue in favour of an external source, with fluid advection along faults and shears.

Channelised, copious influx of CO_2 can be traced, often at times-scales short of attaining isotopic equilibrium between the influxing fluid and the precipitating graphite. There are many examples where CO_2 influx has not caused charnockite formation due to the highly aluminous bulk chemical constraints of the precursor rocks (khondalites); however, evidence for fluid influx is preserved in such instances through stable isotope alteration. The tectonic setting of incipient charnockites, isotopic characteristics of the trapped fluids, and their Pan-African ages link the charnockitic alteration of gneisses with a fluid-rich igneous activity in the timespan of 750-550 Ma recognised in the various Gondwana continents. Igneous-derived fluids were channeled along pathways, resulting in structurally oriented zones of desiccation. The fluids were modified to varying degrees through exchange with crustal carbon.