P-T EVOLUTION OF THE SAUSAR GROUP, INDIA

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Metamorphic rocks largely preserve the mineral assemblage formed at the metamorphic peak. The actual prograde P-T path followed by an individual rock sample or segment of a metamorphic complex may be difficult or impossible to determine, unless the tectonic history of the region is known, or unless evidence of lower grade conditions is preserved in the form of residual minerals or compositional zoning. In contrast, the typical incompleteness of retrograde reactions allows the change in P-T conditions during exhumation to be assessed from a direct comparison of metamorphic peak and retrograde assemblages, preferably occurring in a single rock sample. It is likely that the rates of many retrograde reactions are controlled by the availability of water to form lower grade hydrous assemblages. Thus, it is valid to treat retrograde reactions as taking place close to equilibrium and hence to use the methods of equilibrium thermodyanmics to calculate P-T-X_{H_2O} conditions during retrograde metamorphism. In this paper, mineral inclusions in garnet, retrograde phase relations, mineral chemistry and geothermobarometry of a suite of samples of pelitic gneiss from a small area of Suasar metasediments are used to estaiishb the P-T path followed by the Sausar Group in Chindwara District, Madhya Pradesh.

Metasediments of the Proterozoic Sausar Group and associated granitic rocks, which include diatexites, are well exposed in the area around Ramakona. To the east, the Tirodi Gneiss gives a Rb/Sr isochron age of 1525 $\pm$ 70 Ma, while mineral 'ages' cluster around 900 Ma. The metasediments include a variety of pelitic, psammitic and calcareous types metamorphosed in the upper amphibolite facies. The pelites are characterized by the almost ubiquitous presence of quartz, biotite and sillimanite; garnet and/or cordierite commonly occur as additional phases together with plagioclase, magnetite and accessory phases. The suite of samples analyzed herin contain interpretable textures and mineral chemistries developed during the latter part of the prograde path and the exhumation path in P-T space.

Migmatitic garnet-cordierite gneisses are composed of two contrasting domains at the thin section scale: garnet-bearing domains; and, garnet-absent domains. In the garnet-absent domains, brown biotite (average Mg/(Mg+Fe) of 0.54), of slightly low TiO_2 contents (Ti around 0.27 per 22 Oxygens) for the grade of metamorphism, and sillimanite are replaced by cordierite (average Mg/(Mg+Fe) of 0.72). Brown biotite and cordierite are concentrated against occasional migmatitic veins, the veins being composed of quartz, plagioclase and microcline with cordierite and sillimanite and occasional biotite-rich aggregates and seams. In one vein, one small relict kyanite occurs with prismatic sillimanite in plagioclase. In the garnet-bearing domains, green biotite (with a wide range of Mg/(Mg+Fe) of 0.72 + 0.47), with extremely low TiO_2 contents (Ti of 0.08 — 0.04 per 22 Oxygens), and, in the case of green biotite which replaces garnet, occasional CaO and MnO, occurs both as inclusions in garnet (with Mg/(Mg+Fe) of 0.72 — 0.66) and intergrown with plagioclase replacing garnet. Garnet exhibits two stages of growth. Relatively inclusion-free broad rims have homogeneous middles (which have Mg/(Mg+Fe) of up to 0.32) and surround inclusion-riddled trails in growth-zoned cores, while the margins at the outside of the rims show retrograde zoning (down to Mg/(Mg+Fe) of 0.16, with Mn increasing towards the edge) developed by discontinuous reaction eithet o cordierite or to biotite + plagioclase. Inclusions do occur within the rims and the minerals present help to constrain the latter part of their prograde P-T path. Quartz, biotite and magnetite inclusions are ubiquitous, small embayed staurolite inclusions are common and occur towards the outer edge of the rim, sometimes with prismatic sillimanite included mearby, and in one case, kyanite has been observed, also towards the outer part of the rim. Using the equilibria kyanite = sillimanite and Fe-staurolite + quartz = almandine + Al_2SiO_2+ water, it is suggested that peak metamorphism occurred around 690°C and 7.2 kbar. Garnet-biotite Fe-Mg exchange thermometry on inclusions and garnet-plagioclase-Al_2SiO_5-quartz barometry give P-T estimates around 710 $\pm$ 50°C and 8$\pm$2 kbar, although Fe-Mg exchange thermometry involving biotite may not be reliable at these temperatures. P-T conditions at two points on the exhumation P-T path are: cordierite stage, P = 5.5 $\pm$ 1.0 kbar and T = 700 — 660°C; and, biotite + plagioclase stage, P= 4 $\pm$ 2 kbar and T = 525 $\pm$ 50°C, except that conditions of sillimanite stability must apply and assuming contemporaneity of closure to diffusion of Mg, Fe and Ca.

These date define a clockwise loop in P-T space. During the Phanerozoic such loops in P-T space are generated during collision processes at convergent plate margins; such a tectonic setting may be appropriate for the Sausar Group during the Proterozoic.