ABSTRACT

The investigation is based on detailed geological mapping of the western part of the Bolangir anorthosite massif of Orissa, India and its granulite borders, detailed petrography, whole rock chemistry, mineralogy and an equilibrium thermodynamic analysis of the mineral phase relations. Structural analysis of the foliations of the granulites and the primary flow layers and the joint system of the anorthositic rocks strongly indicates that the pluton was forcefully intruded into the granulitic cover with considerable stretching and extension and approached the form and structure of a schlieren dome. The anorthositic suite of rocks includes anorthositic norites (median plagioclase composition An_{75}), noritic anorthosites (median plagioclase composition An_{70}) and anorthosites (median plagioclase composition An_{52}), while the bordering granulites include leptynites (K-feldspar + plagioclase + quartz + orthopyroxene + biotite + garnet + ilmenite), khondalites (K-feldspar + quartz + sillimanite + graphite + ilmenite ± biotite), basic granulites (plagioclase + diopsidic clinopyroxene + orthopyroxene + garnet + hornblende + ilmenite ± K-feldspar ± quartz ± magnetite) and calcgranulites (diopside + scapolite + calcite + garnet + microcline + quartz + sphene ± magnetite ± apatite). The anorthositic rocks are calc-alkaline with a relatively high K_2O/SiO_2 ratio and the MgO/FeO ratio mainly between 1 and 2. The MgO/FeO vs. plagioclase/mafics relations of the anorthositic suite indicate a fractionation trend : anorthositic norite → noritic anorthosite → anorthosite.

For the determination of equilibration pressure and temperature of the anorthosites and the granulites, 8 reactions defining the (1) orthopyroxene-clinopyroxene (2) orthopyroxene-garnet (3) orthopyroxene-plagioclase-garnet-quartz (4) plagioclase-clinopyroxene-quartz (5) garnet-biotite (6) biotite-quartz-K-feldspar-orthopyroxene-vapour (7) hornblende-clinopyroxene-quartz-vapour and (8) alkali feldspar-plagioclase equilibria have been used. For the two-pyroxene, orthopyroxene-garnet, garnet-biotite and alkali-feldspar-plagioclase equilibria, the calibrated thermometers after Wood and Banno (1973), Wood (1974), Ferry and Spear (1978) and Powell and Powell (1977) respectively were used. The orthopyroxene-plagioclase-garnet-quartz, plagioclase-clinopyroxene-quartz, biotite-quartz-K-feldspar-orthopyroxene-vapour and hornblende-clinopyroxene-quartz-vapour equilibria were directly calculated from the available standard state thermodynamic data. The end member activities were calculated from 33 analysed minerals on the basis of ideal and random on-site-mixing activity-composition relations. Variable P_{H_2O}/P_{total} ratios were used, wherever necessary, in the equilibrium calculations.

The calculated equilibrium curves of the anorthosites and the granulites converge to two separate clusters in the PT-field, located approximately at 2.5 - 7.5 Kbar/850 - 925°C and 2.5 - 4.5 Kbar/ 500 - 675°C. The gentle pressure-temperature gradient between the two convergences may represent the PT-path of cooling of the pluton under an estimated sialic cover between 10 and 26 km. The deduced pressure-temperature gradient can be fitted with the model of a parent, hydrous anorthositic norite magma generated at moderate depths of the Archaean crust between 20 and 30 km and at pressures and temperatures around 6 - 8 Kbar and 1100 - 1200°C.