ABSTRACT

Calc-granulites, khondalites, and leptynites occur in closely associated, parallel and alternating belts in the area around Garividi and Garbham, Andhra Pradesh. From carefully selected representative samples of each of these three rock types, in all 7 diopsides, 7 wollastonites, 7 scapolites, 5 calcites, 8 biotites, 20 garnets, 2 potash feldspars, and 4 ilmenites have been chemically analysed. Composition of magnetite has been determined from its unit cell edge. Rest of the minerals have been determined optically. In addition, 6 total rocks, two from each group, have been chemically analysed. Diopsides contain a considerable amount of hedenbergite (He 48-57%); scapolites are lime-rich (Me 65-72%); calcites are nearly pure ($CaCO_3 \sim 95\%$); biotites are almost midway between annite and phlogopite; garnets of the leptynites and the khondalites are rich in almandine and pyrope (total almandine + pyrope mol percent : 80-93); and garnets of the calc-granulites are rich in grossularite and andradite (total grossularite + andradite mol percent : 30-63). Hypersthenes are $Enstatite_{42-46}$ $Ferrosilite_{58-54}$ mol percent. Magnetite and ilmenite also are nearly pure. Plagioclase in the leptynite ranges from $An_{31} - An_{85}$ and potash feldspar of the same rock has a composition of $Or_{66-69} - Ab_{34-31}$.

Application of Gibbs' Phase Rule to these assemblages suggests that the variance was well within the geologically probable range. Disposition of the garnet-diopside tie lines on the AFM projection taken from the wollastonite/calcite point of the $CaO - Al_2O_3 - FeO - MgO$ tetrahedron indicates that chemical equilibrium was closely reached in the garnet-diopside-bearing assemblages. $Mg\text{-}Fe^{2+}$ distribution diagram for the same mineral-pair from the calc-granulites confirms this. However, garnet and quartz of the calc-granulites appear to be the products of late, retrograde reactions. At the highest P-T condition of metamorphism, the calc-granulites probably contained only wollastonite, calcite, scapolite, and diopside. Analysis of the tie-line patterns of the coexisting biotite-garnet, garnet-hypersthene, and biotite-hypersthene on the AFM projection of the leptynite phases (taken from the K-feldspar point of the $Al_2O_3 - K_2O - FeO - MgO$ tetrahedron) suggests that there is a facies transition within the leptynites : the hypersthene-bearing varieties having been equilibrated at a somewhat higher temperature than the hypersthene-free varieties. $Mg\text{-}Fe^{2+}$ distribution diagrams of coexisting garnet-biotite, biotite-hypersthene, and garnet-hypersthene from the leptynites point to the same conclusion.

The physical variables of the metamorphism have been determined from a consideration of the experimental data on analogous artificial systems. The approximate magnitudes of these variables are : T (leptynites)—— 790- 810°C; P (total, leptynites and khondalites)—— 3.0 - 5.6 kb; f_{H_2O} (leptynites)—— $\sim$ 31 bars; f_{O_2} (leptynites and khondalites)—— $10^{-17.3}$ atm; f_{O_2} (calc-granulites)- $10^{-8.5}$ atm; P_{CO_2} (calc-granulites)—— 442 bars. These variables along with the petrographic criteria indicate that the entire association belongs to the granulite facies of metamorphism. Part of the leptynites, however, may be transitional to the almandine-amphibolite facies. Wollastonite can remain stable in regionally metamorphosed lime-rich rocks of the granulite facies.