GEOLOGY OF EASTERN GHATS IN ANDHRA PRADESH

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ABSTRACT

The lithology, structure, metamorphism and stratigraphy of the granite gneisses, charnockite series, khondalite series and granites occurring in the Eastern Ghats of Andhra Pradesh are described. The granite gneisses consist of the garnetiferous granite gneiss, the grey granite gneiss and porphyritic granite gneiss. The charnockite series consists of granite, diorite, gabbro, norite, amphibolite and pyroxenite. The khondalite series comprises gneisses, schists, quartzites, and granulites, metamorphosed from argillaceous, arenaceous and calcareous sediments. The granites include the pink granites and pegmatites. The formations are highly folded with thrusts and strike slip faults. The granite gneisses, charnockite series and khondalite series are metamorphosed to the granulite facies, with a few members in the amphibolite facies and occasional members in the eclogite facies. Some granite gneisses are the oldest rocks present, and others contemporaneous with charnockite series, which are themselves older than or contemporaneous with the khondalite series. The pink granites and pegmatites are the youngest rocks of the region.

LOCATION

The Eastern Ghats in Andhra Pradesh are situated between Latitudes 16° and 19°, and Longitudes 80° and 85°, and stretch for about 350 miles from Srikakulam District in the north, through Visakhapatnam, Godavari and Krishna Districts, to Guntur District in the south. They include Kurupam, Madugula, Anantagiri, Gudem, Chodavaram, Papikonda, Kondapalli and Kondavidu hill ranges.

GEOLOGICAL FORMATIONS

Fermor (1936) included the Eastern Ghats in the garnetiferous type (manganese ore) marble province belonging to the charnockite region.
Sriramadas (1963) proposed that the south-eastern part of the Eastern Ghats, which are in Guntur, Krishna, West Godavari, East Godavari and South Visakhapatnam, be included in the Madras-Ongole iron ore province belonging to the charnockite region. The principal rock units of the Eastern Ghats are the granite gneisses, the charnockite series, the khondalite series and the granites. The charnockite series and the khondalite series are more in proportion in the hill ranges, whereas the granite gneisses are more in proportion in the plains between the hill ranges and the east coast (Sriramadas, 1960).

Lithology

The granite gneisses consist of granite gneiss, prophyritic granite gneiss, and garnetiferous granite gneiss and grey granite. The granite gneiss is made up of quartz, feldspar, biotite and iron ore. The porphyritic granite gneiss consists of phenocrysts of cuboidal twinned orthoclase in a groundmass of quartz, feldspar, garnet and biotite, with accessory hypersthene. The garnetiferous granite gneiss is composed of quartz, feldspar, garnet, biotite and iron ore. The constituents of the grey granite are quartz, perthite, oligoclase, whereas the pink granite consists of microcline perthite and quartz. The pegmatites contain perthite, quartz, biotite and muscovite. Quartz veins are related to pegmatite and silicified zones. They are made up of nearly 98% of quartz with a little garnet and iron ore.

The charnockite series comprises charnockite (hypersthene granite), diorite, gabbro, norite, amphibolite and pyroxenite. Charnockite contains blue quartz, blue orthoclase perthite, hypersthene and iron ores, with or without garnet. Diorite of the charnockite series consists of pyroxene, quartz, andesine and orthoclase, with a little hornblende. The gabbro of the charnockite series consists of pyroxene, labradorite and iron ores, with accessory hornblende and biotite. The amphibolite contains hornblende, andesine, hypersthene, and accessory augite and iron ores. The pyroxenite consists of augite, hypersthene, bytownite and accessory hornblende.

The khondalite series consists of metamorphosed argillaceous, siliceous and calcareous members. The metamorphosed argillaceous members comprise garnet gneiss, garnet-sillimanite gneiss, garnet-graphite schist, garnet-biotite gneiss, and garnet-sillimanite-cordierite gneiss. Quartz and orthoclase perthite form the main constituents of all these gneisses and schists. The siliceous members are quartzite, garnetiferous quartzite, magnetite quartzite, diopsidite quartzite, and graphite quartzite. The calcareous members consist of calc-granulite, diopsidite-garnet gneiss, phlogopite schist, and
crystalline limestone. These granulites, gneisses and schists, except crystalline limestone, contain quartz and labradorite.

Structure

Folding.—Due to intense metamorphism, the original bedding plane is difficult to trace. But the plane separating the quartzite from garnet gneiss or calc-granulite is taken to represent the original bedding plane. The trend of bedding is parallel to the trend of foliation except on the nose of the folds. The trend of bedding and foliation is N.E.–S.W. in the main Eastern Ghats hill ranges. The trend in isolated hills in between the main range and the coast is N.W.–S.E. and E.–W. (Sriramadas, 1963).

From the data on bedding and foliation, major folds are traced as at Mulanga Konda (amplitude of two miles) in Srikakulam District, and Kambala Konda (amplitude of four miles) in Visakhapatnam District. Both the folds plunge towards south-east. These are only a few examples among many other folds present but not revealed as very little work has been done in the main Eastern Ghat ranges in view of the impenetrable forests.

Faulting.—The Eastern Ghats are traversed by many faults. The western margin and possibly the eastern margin of the Eastern Ghats were supposed to be faulted (Fermor, 1936; Crookshank, 1938). The straight line course of the Sileru river for about 50 miles close to the western border of the Eastern Ghats also suggests a fault or thrust. The silicified zone half a mile long at Kolanga Konda, 8 miles west of Srikakulam, is considered to have filled a fault zone. The Nellimara manganese mine on the hill at Nellimara Railway Station N.E. of Vizianagaram is situated on a thrust (Sriramadas and Raju, 1964). The Nellimara river flows for some distance in the fault zone. The silicified zone west of Eradada hill near Visakhapatnam is also considered to be a fault zone.

Unconformity.—So far no unconformity has been recognised either between the granite gneiss and khondalite series or between charnockite series and khondalite series. King (1880) reported conglomerates in Nellore District but did not consider them as representing an unconformity. However, quartzites with a few quartz pebbles in a groundmass of quartz suggesting conglomerates are noticed in a few quartzites of the khondalite series of Visakhapatnam.

Field Relationship

The charnockite (granite), diorite, gabbro, amphibolite and pyroxenite of the charnockite series occur in bands parallel to each other. Each rock
type of the charnockite series grades into the other although when a granite and amphibolite of the charnockite series occur together the plane of the separation is sharp. Hence the mafic members are considered to belong to a separate series as distinct from felsic members.

The garnet gneiss, garnet-graphite schist, quartzite, garnetiferous quartzite, diopside quartzite, calc-granulite and crystalline limestone, occur as discrete members and with gradational contacts. Hence they are considered to be the metamorphosed, argillaceous, siliceous, and calcareous sediments.

The charnockite series in most places occurs topographically below the khondalite series. Banding is recognised in the various members of the charnockite series and so is the case with the different members of the khondalite series. Where the charnockite series with banding is overlain by the khondalite series the parallelism is seen in both. But the charnockite of the charnockite series shows intrusive relation with the khondalite series. The granite gneisses in some places contain hypersthene, and some charnockites contain very little hypersthene; this indicates a gradual transition between charnockite and granite gneiss. The pink granites and pegmatites, on the other hand, are distinctly intrusive into both the charnockite and khondalite series. Hence, the granite gneisses which are earlier than the pink granites and pegmatites are probably contemporaneous with the charnockite series.

Metamorphism

Practically all the rock formations in the area contain garnet as an essential constituent. The khondalite series with garnet, sillimanite and orthoclase, and the charnockite series with hypersthene, augite, orthoclase perthite, labradorite and garnet, are both in the granulite facies of metamorphism. In a few places like Tekuru in Papikonda range, the assemblage of garnet, omphacite and chromite places the rock in the eclogite facies. The amphibolite facies is observed in some members of the charnockite series. The amphiboles and biotites occurring in some of the rock types show conversion into augite and garnet. Hypersthene, orthoclase perthite and garnet are the most stable minerals.

Stratigraphy

Three main stratigraphic units have been recognised in this area. They are the granite gneisses, the charnockite series and the khondalite series. Each unit contains several sub-units. So far, in all these rock formations no key horizon has been established. Detailed mapping has not been possible in many parts of the Eastern Ghats because of the impenetrable forests.
In these circumstances, it is almost impossible to correlate the sub-unit. The discussion will, therefore, be confined to bringing out the relationship, among the three main units. The khondalite series consisting of metamorphosed argillaceous, siliceous and calcareous members is undoubtedly sedimentary. In the absence of conglomerates and age data the non-intrusive granite gneisses are taken to have formed the basement of the basin where the khondalite series were deposited. These granite gneisses are seen occupying the plains in between the hill ranges and the coast in Srikakulam District.

An important feature of the charnockite series is that it occurs intimately associated with the khondalite series, whether they are intrusive or conformable. The conformable members of the charnockite series can be considered either as syntectonic intrusives, or metamorphosed impure dolomitic shales of the khondalite series. Some members are probably of volcanic origin contemporaneous with the deposition of the khondalite series. The sedimentation of the khondalite series continued with the result that some of these members are younger than the charnockite series.

**Geological History**

In the Eastern Ghats area the geological history belongs to the early stages of the history of the earth's crust. Direct evidences are not available as to the nature of the geological formations that formed the basement on which the khondalite series of rocks were deposited. The basement was most probably made up of granite gneisses. In such a geosynclinal basin, were deposited argillaceous, arenaceous and calcareous sediments, which after metamorphism are known as khondalite series. Contemporaneous or a little earlier than the deposition of khondalite series, the dolomitic shales or basic syntectonic intrusives were formed, which after metamorphism and rheomorphism are now recognised as the charnockite series. The provenance for the khondalite series and part of the charnockite series could have been to the east or west.

Then followed a period of tectonism with the folding or thrusting of the sediments of the Eastern Ghats geosyncline. With this thrusting and probable faulting along N.W. and S.E. borders of Eastern Ghats the geosynclinal sediments have been compressed.

Contemporaneous with tectonism the formations got metamorphosed. The khondalite series are metamorphosed to granulite facies. At places like Tekuru where tectonism aided the metamorphism, the charnockite series
were metamorphosed to the eclogite facies. Basic members of the charnockite series were metamorphosed to amphibolite facies where water was available. The charnockite of the charnockite series intruded in the last stages of tectonism and metamorphism.

The pink granites were intruded into the khondalite series and the charnockite series as post-tectonic intrusives. The pegmatites were the last to get emplaced either by differentiation of the granite or by rheomorphism.

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