

## Quadrant II – Notes

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### **GEOLOGY OF GOA**

Millions of years ago, there was no Goa, no India, no Arabian Sea. This article attempts to trace the geological history of the region, beginning from the formation of the oldest rocks such as a trondhjemite gneiss to more recent deposits such as laterite.

The advent of man and therefore human history, is only a tiny fraction of the colossal dimension of geological time. The age of the earth (4.5 billion years) and of most geological events are several orders of magnitude (often millions of times) older than historical or archaeological dates. Apes and the ancestors of man have been around for only the last few million years. Human history has been recorded for a mere ten thousand years and most of the great ancient civilizations are much younger.

Goa has a rich and long human history but its geological record of the past is far more daunting. In the Anmod ghat to the east of the state, the oldest rock in India has been dated at 3.4 billion (or 3400 million) years (Dhoundial, 1987). The rock is a trondhjemite gneiss. Trondhjemite gneisses are generally very old rocks, over 3

billion years in age and these rocks are also found in Canacona besides the western ghats.

Geologically, the state of Goa, which occupies an area of about 3700 sq. km. on the West coast of India, forms a part of the Indian Precambrian shield (Figure 5). In this region, there are greenschist supracrustal rocks which overlie a basement consisting of trondhjemitic (Peninsular) gneiss and are intruded by mafics, ultra-mafics and granites. The late Cretaceous Deccan Traps are found only at the northeastern periphery of the state. Laterite (of variable thickness on residual hills) (Figure 6) and alluvium and sand (on the coastal-estuarine plains) cover most of the geological formations, as one would expect in the wet tropical climate.

The sequence (oldest to youngest) as described by the Geological Survey of India (1996), consists of the Peninsular Gneissic complex (Archaean), the Goa Group of meta-volcanic and meta-sedimentary assemblage (Archaean to lower Proterozoic), mafic-ultramafic complexes and intrusive granites (lower Proterozoic), Deccan trap (Upper Cretaceous to Eocene), laterite (Cenozoic) and beach sands and estuarine alluvium (Quaternary).

The oldest known rock found in Goa is the Anmod Ghat Trondhjemitic Gneiss (>3.4 billion years, Dhondial et al., 1987). This gneiss which forms the basement for the Goa Group of rocks can be correlated with the older parts of the Peninsular Gneiss of South India. It is over this basement that the Goa group of rocks (which is part of the Dharwar Supergroup) eventually formed.

The Goa Group consists of low grade (greenschist facies) metamorphic rocks and is

divided into the Barcem, Sanvordem, Bicholim-Rivona and Vageri Formations in the ascending order of superposition .

**The Barcem formation**, dominant in south Goa, comprises of ortho-quartzite, a thick pile of meta-basalt, metagabbro, meta-acid volcanics (quartz-porphyry, meta rhyodacite and tuffs) and quartz-chlorite-amphibole schist with bands of agglomerate (G.S.I., 1996).

**The Sanvordem formation** consists mainly of turbidite deposits comprising polymictic meta-conglomerate / breccia, metagreywacke, quartz-chlorite schist and thick lenses of quartzite. The thickness of the formation is variable reportedly upto 400m. The meta-conglomerate / breccia contains rounded to angular, pebble to boulder size clasts of quartzite, gneissic granite, granodiorite, and mica schist. The conglomerate is widely but irregularly distributed at various stratigraphic levels and is also reported to show transitional contact with the overlying quartz-chlorite-biotite schist of the Bicholim formation (G.S.I., 1996).

**The Bicholim-Rivona formation** is represented by quartz-chlorite-biotite/amphibole schist with thin lenses of metabasalt, sills of metagabbro, carbonaceous and manganiferous chert, quartzite, banded iron formation (BIF), quartz-sericite schist and magnesian limestone. This formation occupies a large part of Goa, the midlands in particular and its thickness is reported as 250 to 500 m. In south Goa the lower units of the Bicholim formation are manganiferous. The Banded Iron Formations with associated iron ore deposits occur in a belt 95 km long and 1 to 14 km wide. The BIF is intercalated with quartz-chlorite-biotite / amphibole schist, chert, quartzite, limestone and meta-volcanic associations and exhibits pinching and swelling of the units. Two types of oxide facies are discernable: the lower one is reportedly

haematitic (BHQ) and the upper one dominantly magnetitic (BMQ). The BIF shows

extensive supergene enrichment yielding iron ore deposits. The limestone, interbedded with chert is relatively rich in Mg (G.S.I., 1996).

**The Vageri formation** consists of carbonate-quartz-chlorite schist and metagreywacke with thin lenses of metabasalt and quartzite. (G.S.I., 1996).

Some

metagreywacke units to the north are garnet bearing.

Laterite is a residual weathered layer of rock, often several tens of meters thick, which

is typical of wet tropical climates. It forms due to the concentration of the oxides and

hydroxides of Iron and Aluminum after the other elements are leached away during

decomposition of silicate minerals. Laterite has a unique characteristic of being hard

on top and soft below. A typical laterite profile consists of 8 to 12 metres thick massive (hard) laterite exposed on the top of hills that are often plateaus.

This

massive duricrust is followed downward by, or grades into, a layer of gravelly laterite

of varying thickness. The original igneous and metamorphic rocks lie further below

and are sometimes covered by lithomarge (a layer of clay which can vary in thickness). The original unweathered (fresh) igneous and metamorphic rocks are exposed only in

coastal headlands or along steep slopes of high hill ranges or in man made cuttings like quarries, road cuts and railway tunnels.