THE EPARCHAEAN UNCONFORMITY AT TIRUMALAI—A STUDY

K. V. SURYANARAYANA

Reader in Geology, Sri Venkateswara University, Tirupati, Andhra Pradesh, India

ABSTRACT

The Tirumalai Hill Range, with the scarp topography and with the two ghat roads dissecting it, presents several interesting geological features, one of which is the unconformable contact between the granite basement over which lies the Cuddapah quartzite. The bedded quartzite, with very low dips, forms escarpments, whereas the granite beneath has flaring slopes. As the quartzite is deposited over the granite domes and dolerite ridges, the latter appear to project themselves into the former. It is stressed here that the contact between the granite and quartzite is depositional and not intrusive. The presence of granite pebbles in basal conglomerate is of great significance, as such occurrences are rare. The basement granite has diversely oriented joints and is also traversed by dykes. The igneous activity and the stresses that promoted the formation of fracture system in the granite had ceased before the epeirogenic movement responsible for the deposition of Cuddapah sediments and its uplift intervened.

INTRODUCTION

THE steep scarp of the Tirumalai Hill Range, rising to a height of over 3,000 ft. from the plains of an average height of 500 ft. at the Tirupati township (India), presents a remarkable evidence of an unconformity in its topographic, structural, and denudational features. This unconformity is the Eparchaean unconformity—a universal phenomenon—not the least well-represented in the Cuddapah basin, of which the Tirumalai sediments form a part. This statigraphic break occurs between the crystalline schists, gneisses, and the granites of the Archaean and the subsequent group, called the Puranas (Proterozoic or late Precambrian). In his admirable portrayal of this gap in the geological record, Pascoe (1939) pictures a prolonged period of denudation to which the Archaeans were exposed, and thus to the enormous time interval prior to the deposition on their denuded surface of the later sediments.

THE TIRUMALAI UNCONFORMITY

Topographic Expression

Dealing with the topographic features first, one can see, looking north from the Tirupati side, a flat, or gently northerly dipping quartzite exposed in the vertical cliffs forming ascarpment to the south. The quartzite is yellowish brown and is barren of vegetation. Beneath the quartzite lies the granite covered by a thin layer of residual soil that supports a sparse vegetation. The sudden appearance of vegetation from the unconformable junction downwards is very striking. The granite massif from its unconformable contact with the quartzite, has a flaring slope in bells and disappears in the plains of Tirupati under a thick cover of gravelly soil to rise again farther south as domes and tors. Along its flaring slopes could be seen, here and there, dome-like projections of bare granite with exfoliated surface. This topographic discordance between the granite and the underlying quartzite is a result of structural and mineralogical differences between the two rocks which cause differential erosion to take place. The granite is a coarse-grained porphyritic granite. The phenocrysts of potash feldspars, have random orientation. Neither foliation nor lineation is present, despite the fact that biotite is the mineral present as a mafic constituent. The porphyritic granite has thus a mesoscopic isotropic fabric. These features together with the fact that the granite is coarse-grained promote more rapid disintegration (Lahee, 1961, p. 26). This, together with concentric weathering and exfoliation, produces sphericity in the granite to form dome-shaped masses. The granites are traversed by joints which have diverse orientation. These diversely oriented joints promote removal of exfoliated sheets during the process of weathering to produce domical surfaces. The overlying quartzites have dip of 10° to 13° and, at places, are almost horizontal. They are characterised by bedding joints and the master joints which stand vertical. The weathering of quartzite takes place, perforce, by the mechanical process of dislodgement of blocks by separation along joint planes. Thus, are produced the steep, vertical scarps in quartzite. The quartzite is fine-grained, homogeneous and, hence, produces sharp edges and corners. There is a pointed reference to this type of weathering by Lahee (1961, p. 388).

The erosion surface on which the Tirumalai quartzite is deposited is not a flat surface; it is a highly irregular undulating surface. Along the south-facing, east-west trending scarp of Tirumalai, the granite has a number of rises and falls. The rises between two depressions appear to protrude into the flat, horizontally bedded quartzite to give an erroneous impression of the granite to be an intrusive body. This impression is much more misleading in the case of dolerites which occur as long ridges and stand out in bold relief above the granite outcrops and meet the quartzites in protuberances. Vaidyanadhan (1957) refers to a dolerite dyke at 9/4 miles along the old ghat road, as having cut through not only the granite but also the overlying quartzite, and says, that this intrusive is obviously younger than the quartzose sandstone. On close examination, this dolerite was found to have a domical contact with the quartzite and is never found cutting across the quartzite. The ghat road has exposed the quartzite in a vertical cliff. The quartzite is horizontal, thickly bedded, and overlies the eroded domical surface of the dolerite as a thick cover.

The Depositional versus *Intrusive Contact*

The important point to bear in mind in all such occurrences is the distinction between the intrusive and the depositional contact. The contact between the quartzite and the granite domes and dolerite ridges, which looks like an intrusive contact, is in reality a depositional contact. When the sedimentation starts on the denuded surface of an old terrane consisting of granite and dykes, the deposition first takes place in the hollows on either side of the ridge, and, when the hollows are completely filled up, it would then proceed on the domes and ridges. The bedding has been essentially horizontal both in the hollows and the ridges. This is the reason why the quartzite at Tirumalai is thinly bedded on the ridges and domes and thick in hollows. Further, if the dolerite is intrusive into the quartzite, it should have chilled margins against the quartzite. It has chilled margins at the contact with granite, but not with quartzite.

The dolerites intrusive into the granite have sent in tongues of its material into the massive granite at Tirumalai. Such off shoots should have been much more in evidence in the quartzites, if the dolerite had intruded the latter, for the quartzites are more jointed to provide passage ways for the dolerite magma. Such off shoots are conspicuous by their absence on the margins of dolerites in contact with the quartzite. As a matter of fact, there are intrusive sills in the Cheyair series of Cuddapahs which are connected with each other by dykes that break across the intervening beds. Such sill-like bodies are not found at Tirumalai.

Nowhere are dykes reported to have intruded right across both granite and Cuddapah sediments in any part of the Cuddapah basin. The lone dyke earlier reported as intruding into the quartzite at Tirumalai is no exception to this general observation.

The Basal Conglomerate

An unequivocal evidence of the existence of an unconformity is the occurrence of basal conglomerate at the base of the quartzite that overlies the granite and dolerite. The conglomerate occurs as a thin band of 6″ to 18″ in thickness. It is absent where the granite presents a domical surface below the quartzite, thicker where the eroded surface of the granite is flat, and thickest in the hollows. These features are clearly seen where the surface of unconformity is exposed on the slopes of hills. Away from the fringe slopes there are inliers of conglomerate in the quartzite and shale, having fragments of vein quartz, unaltered pegmatite, and leucocratic granite of variable size, some attaining diameter one foot. These fragments actually constitute a breccia. One such exposure is seen about 800 yards north of the Venkateswara shrine. The conglomerate is represented by both oligomict and petromict types; but often it is a mixture of both. The fragments are weathered granite, pegmatite, quartzite, vein quartz, and rarely jasper. Of these, only granite and quartzite pebbles are more or less spherical in shape. The conglomerate, occurring between the quartzite and the underlying dolerite has fragments of highly weathered dolerite.

The occurrence of granite pebbles, though weathered, is of significance, as reports of such occurrences are rare. Granite usually does not survive the rigours of weathering. Pascoe (1950, p. 358) refers to the total absence of granite pebbles in the Gulcheru quartzite, at the base of the Cuddapahs, and, points at the unsuitability of the granite to survive as pebbles under the weathering conditions and in sedimentary environment. Another significant feature is that the matrix binding the pebbles is partly arkose and partly detrital quartz. The massive granite over which the conglomerate lies is also weathered. As it is impossible for granite pebbles to survive as spherical masses in a sedimentary basin after kaolinisation, the only explanation that could be offered for their existence is that such fragments as were still fresh got incorporated in the overlying quartzite during sedimentation.

Conclusions

Topographic features, differences in lithology, the presence of basal conglomerate, and the irregular domical nature of the granite that underlies the almost horizontal beds are unique in their delineation of the nature of the great Eparchaean unconformity at the Tirumalai Hill Range. Caution in differentiating the depositional and intrusive contacts is stressed. The discovery of granite pebbles in the conglomerate is of significance as such occurrences are rare, and calls for the examination of the Cuddapah basin, not only at its fringes but also in the interior of the basin (as at the Venkateswara shrine) to reveal whether any variation in the type of pebbles occurs from place to place. The Cuddapah sediments were originally horizontally bedded but were tilted to attain a dip of 10° to 13° due to epirogenic uplift.

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NODULATION PATTERN IN GROUNDNUT (*ARACHIS HYPOGAEA* LINN.) AS INFLUENCED BY VARYING LEVELS OF PLANT DENSITY NITROGEN AND PHOSPHORUS*

K. R. PAWAR

Associate Dean (Instruction), Marathwada Agricultural University, Parbhani

AND

V. S. KHUSPE

Dean, Faculty of Agriculture, Marathwada Agricultural University, Parbhani

ABSTRACT

Nodulation in groundnut was initiated at flowering, profuse at pod formation and continued upto 85 days. Nodules started degenerating after 85 days. Highest plant density treatment (2,00,000 plants/ha) was found to produce significantly less number and small sized nodules per plant, only at latter stages of nodulation in both the seasons. The medium (1,50,000 plants/ha) and low (1,00,000 plants/ha) densities were found at par. The retarding effect of nitrogen, on nodulation applied either at 20 or 40 kg. N/ha over the control was observed at active growth phase in both the seasons. However, in the initial stage of nodulation, and at 85 days, the effect of nitrogen was not significant. The positive effect of phosphorus in increasing the volume of nodules was evident in the initial stage of nodulation. The dose of 60 kg P_2O_5/ha was found effective over 20 and 40 kg P_2O_5/ha, especially under low population. The lower doses of phosphorus were not effective.

1. INTRODUCTION

It is essential to know the pattern of nodulation in order to harness biological nitrogen fixation effectively for increased groundnut production through root nodule bacteria (*Rhizobum leguminosarum*) by symbiosis especially under present day fertilizer constraint. Many internal and external factors influence the extent of nodulation. Supply of nutrients and density of plant population are important factors controlling nodulation under average farming conditions. In this communication we describe the results of field experiments on the pattern of nodulation in groundnut crop grown under varying levels of plant density, nitrogen and phosphorus.

2. METHODS AND MATERIAL

A field experiment was conducted on groundnut crop, variety AK 12–24 at the Agricultural College Farm, Akola in *Kharif* seasons of 1971 and 1972. The three factor experiment was conducted in split plot design. Nine treatment combinations formed by combining 3 rates of planting one lakh S_1, one and half lakhs S_2, and two lakhs S_3, of plants per ha with 3 levels of nitrogen 0 (N_0), 20 (N_1) and 40 (N_2) kg N/ha were tried as the main plot treatments. The four levels of phosphorus, 0 (P_0), 20 (P_1), 40 (P_2) and 60 (P_3) Kg P_2O_5/ha were superimposed as subplot treatments. The set of 36 treatment combinations, was replicated three times. Each experimental unit was 9 m × 7·2 m, and 7·2 m × 5·4 m in gross and net plot sizes respectively. The site and randomization were changed in second season. Five plants at each stage were selected at random from each net plot and uprooted carefully for studies on number and volume (cc) of nodules per plant. Nodulation studies were taken up in second and third months. Nodules started degenerating in fourth month, hence data for fourth month are not recorded.

3. EXPERIMENTAL FINDINGS AND DISCUSSION

Data on mean number of nodules and their volume in cc per plant collected at various stages in both the seasons are presented in Table I.

* Contribution from the Department of Agronomy, Punjabrao Krishi Vidyapeeth, Akola.