DISCUSSION

(1)

LATE QUATERNARY MOVEMENTS AND LANDSCAPE REJUVENATION IN SOUTHEASTERN KARNATAKA AND ADJOINING TAMIL NADU IN SOUTHERN INDIAN SHIELD by K.S. Valdiya, Jour. Geol. Soc. India, v.51(2), pp.139-166

K.S. Subramanian, 283, 17th East Street, Kamaraj Nagar, Thiruvanmiyur, Chennai-600 041, comments:

Prof. K.S. Valdiya's article is an interesting broad-brush picture of the geodynamic and geomorphic evolution of a part of the Indian Shield. As one who has some background on the subject, supported by field studies in Tamil Nadu and Kerala, I have the following comments to make.

1. The Precambrian terrain, as the author has said is marked by sets of faults. Several of these faults are characterised by igneous emplacements of granites, syenites, granophyres and carbonatites. Radio isotopic dating of some of these bodies suggests that their ages range from Late Proterozoic to Early Palaeozoic. The igneous emplacements are intact and are neither tectonically sheared nor metamorphosed, bearing out that the faults were not reactivated in post-emplacement times. Against this background, the age of the oldest planation surface at the highest elevation in the terrain needs to be considered.

The oldest planation surface in the Nilgiri and the Palni hills is traced at an altitude of about 8000' (2438m) and has been ascribed a Jurassic age. Let us consider the Nilgiri hills. Lateritic bauxite, traced on the plateau landform of the Nilgiris at an altitude of about 7500'-6500' (2286 m - 1996 m) was ostensibly formed under the influence of climate conducive for operation of lateritisation processes. The present-day temperate climate at the high altitude is not favourable for deep and sustained chemical weathering of rocks to give rise to laterites. If the Nilgiri massif had been uplifted in post-Jurassic times along the Bhavani fault skirting the southern and the southeastern boundaries and the Moyar fault along the northern boundary, the igneous emplacements predating the faults would have been sheared. The 475 m.y. old Punjaipuliyampatti granite in the Bhavani shear zone would have been affected by the reactivation of the fault. The granite remains as a plutonic igneous body. The limestone band in Madukkarai near Coimbatore in Tamil Nadu is traced continuously to Walayar in the Palghat Gap and no displacement, which is to be expected in case of faulting, is evident. Structural trends of Precambrian crystalline rocks along the stupendous topographic break from the Anamalai hills to the Palghat Gap are continuous without break. Thus, empirical evidences are not in favour of large-scale block uplift of the Nilgiri hills.

2. (a) The rifting and fragmentation of the Indian plate from the Gondwanaland are considered to have occurred at 140-120 m.y. ago (Late Jurassic - Early Cretaceous) on the basis of dating magnetic lineament patterns on the Indian Ocean floor. The stupendous tectonic forces involved did not affect the Late Proterozoic-Early Palaeozoic emplacements along the faults in the terrain. Apparently, the emplacements had effectively sealed the faults.

(b) It is recognised that the courses of some major rivers in the terrain have been controlled by faults and shears. For example, the Mettur dam is built across a roughly N-S trending shear zone, along which the Cauvery river flows south. The dam, one of the oldest in South India, has not been affected, pointing to lack of reactivation of the weak zone.

(c) A cross-section along the Western Ghat hill ranges from the southern tip of the Peninsula to Bababudan hills in the north is suggestive of a gentle upwarp of the continental crust along an

E-W axis passing through the Palghat Gap. The high-level planation surfaces with lateritic bauxite in the Nilgiri hills in the north and Palni hills in the south, separated by low level land-form of the Palghat Gap, are at the same level of elevation, suggesting that they are parts of a single surface. If the Nilgiri massif had been uplifted independently by block faulting the chances of the surface to be defined at the same level as that of the Palni hills would be understandably remote.

3. The high-level disposition of planation surfaces in the Nilgiri and the Palni hills and possibly elsewhere in the Peninsula may perhaps be attributed to epierogenic movements that take place to correct the isostatic imbalance arising out of the weathering, erosion and transport of crustal rock debris. Charnockites being more resistant to weathering than gneisses stand out prominently. Lithic sediments, totalling to more than 5000 metres in the Cauvery basin have a range extending from Late Jurassic to Recent. Such stupendous accumulation is an index of the inexorable weathering, erosion, transport and deposition of materials ever since the Bay of Bengal initially opened up at 140-120 m.y. ago.

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K.S. Valdiya, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur Campus, Jakkur P.O., Bangalore-560 064 replies:

I am grateful to K.S. Subramanian for providing very crucial information on the shear zones in southern south India. My paper which Subramanian describes as "a broad-brush picture" was based on extensive field work for 2½ years in the mountainous terrains, including where the notorious brigand roams.

Nowhere did I write that all faults (of Precambrian antiquity) have been reactivated. The maps show shear zones, some faults of which registering neotectonic movements. In quite many cases the main fault planes are inactive, while the subsidiary faults have registered perceptible to spectacular movements. The shear zones being characterised by mylonites and gouges, and a mesh pattern of fractures/faults, the neotectonism caused switching of the principal slip plane from one margin to the other of the main fault zones. The fact that igneous emplacements as old or young as 475 m.y. have remained intact — unsheared and unmetamorphosed – in the Bhavani Shear Zone (as emphatically pointed out by Subramanian) implies that the younger intrusive bodies served to block later movements on the main shear planes. This must have caused switching of the neotectonic movements from these planes to the subsidiary fault planes. Repeated movements on these subsidiary faults are responsible for uplift of the adjacent terranes.

Structural trends of the Nilgiri massif and the Palghat Gap (and presumably the Anamalai hills) exhibit parallelism, not unbroken continuity. I have not seen the Madukkarai-Walayar limestone. But then I did not study the region south of the Bhavani Shear Zone.

(2)

DEEP GEOELECTRIC STRUCTURE IN THE ROHTAK REGION USING THE MAGNETOTELLURIC STUDIES by Gautam Gupta, C.K. Rao and S.G. Gokarn, Jour. Geol. Soc. India, v.50(6), pp.697-708

H.S. Saini[1] and A.K. Gupta[2], Geological Survey of India, [1]Shillong, [2]Faridabad, comment:

The subsurface geological details of a large part of the Indogangetic plains are poorly understood due to huge thickness of alluvium and absence of exposures. Even then, with the help of borehole data, generated by Central Ground Water Board and Geological Survey of India, Quaternary lithostratigraphy and basinal structure (upto some extent) have been worked out for many sectors in Ganga basin (Kumar, 1994) and Haryana plains (Thussu, 1995; Saini and Anand, 1995). Where deep drilling data upto basement are absent geologists have to depend on geophysical data for an understanding of sub-surface geological setting.

Direct information of the alluvial plain of Rohtak is available upto 350 m depth through bore-hole logs of the Central Ground Water Board. We wish to confine our discussion to this depth.

(1) *Thickness of Alluvium:* The top layer of delineated structure, referred as Alluvium, has been interpreted to be only 25-60 m in thickness which is not even one fourth of the actual thickness.

(2) *Siwalik sequence:* The second and third layers interpreted as Upper and Middle Siwalik respectively are simply not present in the area upto 350 m depth. The entire explored thickness consists of clay, silt and sandy sediments of Varanasi Older Alluvium. The clays are, however, variously calcretised at several levels which has obliterated the original lithology, partially or fully. On the contrary, Upper and Middle Siwaliks are characterised by conglomerate, grits, sandstone, drab clays and brown sandstone, gravels respectively, which are not indicated in any of the lithologs.

(3) These conclusions of the authors are therefore not sustainable in the light of facts given above. It is suggested that interpretation of geophysical data need to be made with greater caution particularly in alluvial tracts. As geologists, we feel that variation in the resistivity values from 1.4 Ohm-m to 30 Ohm-m is not due to presence of Siwalik sequence but simply due to calcretised nature of the sediments of Varanasi Older Alluvium.

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S.G. Gokarn, Indian Institute of Geomagnetism, Colaba, Mumbai, replies:

We are grateful to H.S. Saini and A.K. Gupta for their interest and offer the following replies to their numbered comments.

1. *Thickness of Alluvium:* The magnetotelluric (MT) studies help in determining electrical resistivities of the crust and their variation with depth. The classification of the layers is our interpretation based on other factors like geology, stratigraphy or the outcrop/borehole studies in

the region of interest or in the absence of such information, on knowledge available in the neighbouring regions with similar geological settings. In this case, the Siwalik connection was based on the reports of Sastri et al. (1971), Wadia, (1983), Aditya et al. (1976) and Verma, (1991) in different parts of the Punjab plains, as quoted in the section on geology and tectonics p.698 of the paper. In view of the lithologs quoted by Saini and Gupta it seems that our evaluation is not correct. As suggested in the comments calcretisation process could also lead to decreased open porosity. Electrical resistivity due to mineralised fluids in open pores is thus governed by the degree of calcretisation. This seems to be the reason for the three sedimentary layers in the study region.

2. *"The thickness of the sediments is more than 350 m as against the value of 200 m reported in the paper"*: Some limitations of the magnetotelluric techniques havė been explained in the paper in the section "Possible limitations of the present interpretation". Some of our comments there are relevant in this case also and hence we will repeat them here with some modifications.

The MT technique is an interpretive technique based on electromagnetic principles, where in the response functions (apparent resistivities and phase) are used for determination of the crustal electrical structure. The strongly determined crustal parameters are the total depths to the bottom of the resistive layers and total conductance (thickness conductivity product) of the conductive layers. The individual conductivity and thickness of the conductive layers (for example in this case the depth of 200 m to the bottom of the 1.2 ohm-m layer) are weakly determined parameters and hence can be erroneous. However, the depths to the bottom of the 30 ohm-m (resistive) layer will be more realistic, as also the depth to the bottom of 100 and 1000 ohm-m layers (Fig.5b in the paper).

When the parameters of the conductive layers are the main purpose, some constraints are obtained (either the depth or the conductivity at one or more of the stations) and are used in obtaining the final model. However, in the present work, the main objective of the study was the seismicity of the region which could be reasonably explained on the basis of the upper crustal fault zone reported in the paper.

3. *"The upper crust is granitic below Kalanur":* This comment seems implicit in the statement "The hard rock basement (granite) is touched only at Kalanur". In the paper, the 100 ohm-m layer is interpreted as the metamorphosed basement, followed by an unconformity and then the granitic basement at depths of 3500-4500 m. This was based on the fact that a normal crystalline basement could not have a conductive layer at 3500 m. This conjecture is also based on the reports on possible existence of metamorphic rocks below sediments (Karunakaran and Ranga Rao, 1979, referred in the paper). Some support to the possible metamorphic basement also comes from the resistivity of this layer (100 ohm-m) which is rather unrealistic for granites. Further, Kalanur is about 300 km South of our EW profile which was analysed for the geo-electric structure reported here and in view of the strong variations in crustal characteristics along the NE-SW direction, it may not be appropriate to compare the basement settings in the two regions.

(3)

METAMORPHIC-METASOMATIC FLUIDS AND Al, Si ORDER/DISORDER OF K-RICH ALKALI FELDSPARS FROM SOUTHERN INDIAN HIGH GRADE TERRAIN by V. Swamy, G.V. Anantha Iyer and A.G. Menon, Jour. Geol. Soc. India, v.50, pp.681-690.

S. Viswanathan, 10, Bapuji Apts., R.P. Road, Dombivli (E) - 421 201 comments:

1. What are these K-rich alkali feldspars? The term suggests that they are K-rich soda feldspars. However, only potash feldspars are discussed.
2. Cross-hatching is reckoned as the sole indicator of microcline to differentiate it from orthoclase. Were 2V values determined to confirm this and the absence of untwinned microcline or Albitic plagioclase?
3. KKB feldspars are considered more albitic (p.687). Then, how are they all monoclinic (Table II)? Do the authors believe that a - b.c and b-c diagrams are significant in the absence of basic optical data of the alkali feldspars and their microprobe analyses of the studied samples?
4. How is it that thin section photomicrograph (Fig.2, B & C) of the feldspars from sillimanite gneiss from which the feldspars were not studied for X-ray diffraction, is presented?

V. Swamy, G.V. Anantha Iyer and **A.G. Menon,** Indian Institute of Science, Banglore - 560 012 replies:

1. The term "Potash feldspars" does indeed refer to "K-rich alkali feldspars" which are $KAlSi_3O_8$-rich alkali feldspars in the solid solution (K, Na)Al Si_3O_8.
2. We have used cross-hatching and powder X-ray diffraction characteristics to distinguish the various feldspars. The splitting of symmetry-sensitive peaks and the low-angle composition-sensitive peaks in the X-ray spectrum are sufficient to characterise alkali and plagioclase feldspars. The effects of strain, presence of domains of varying structural state, and effects of unmixing have to be borne in mind. We agree that 2V measurements would further corraborate the characterization.
3. The KKB feldspars are more albitic (higher $NaAlSi_3O_8$ component) than the southern Karnataka samples (presented side-by-side in Fig.4). This does not imply that the alkali feldspars are albites. On the second point, we would like to point out that feldspar mineralogists have been using the cell parameter plots (in particular the b-c plot) for characterising alkali feldspars. We have no reason to question that.
4. Our motivation in presenting the photomicrographs was to illustrate some interesting microstructural features in these feldspars which have relevance to the role of fluids. We recorded X-ray diffraction patterns of several alkali feldspars from the different rock types, and only the ones with reasonably low standard deviation for the refined unit cell parameters were used. It is well known that the near-equal abundance of unmixed K- and Na- components in mesoperthites complicates the unit cell refinements in these feldspars.