DISCUSSION

This section is intended to provide a forum for the discussion of papers published in our Journal by those working in similar fields of investigation and research. Such a discussion is expected to be of value not only to the actual workers in the concerned field, but also to a wider circle of readers interested in the progress of geological studies.—Editor.

Paper on 'SECTORAL GROWTH AND BIAXIALITY IN SOME APOPHYLLITE CRYSTALS FROM THE DECCAN TRAPS' by A. K. Saha and A. K. Roy, published in the Bulletin (Vol. 6, No. 1, January 1969).

Comments by A. V. Phadke (Geology Department, University of Poona)

A description of the optical characters and crystallography of apophyllite from the area around Poona appeared as early as 1964 in the published paper of Sowani and Phadke. Considerable work on apophyllite from Poona has also been done by Hsien Su Chen (1968) of the Dalhousie University, Canada.

Saha and Roy have tried to attribute the orthorhombic character of the lattice to an angular distortion of a tetragonal lattice, during growth, due to stress along (110) cleavage planes. It may be noted that in the mineral under investigation there is almost absence of such cleavage; and if at all it is seen it is extremely imperfect. Further no stress factor could be involved in a crystal growing freely in a cavity. The simultaneous growth of stilbite with apophyllite has nothing to do with any so-called distortion of lattice as is evident from the fact that single crystals, entirely free from stilbite also show orthorhombic symmetry and biaxiality.

Sowani and Phadke (1964) have calculated the axial ratios a : b : c from the measurements of interfacial angles of large crystals. These results are quite consistent with the work of Chen (1968) who calculated the unit cell dimensions from the X-ray data. Thus it is clear that the structure of apophyllite from Poona is orthorhombic and not tetragonal. Sahama Th.G. (1965) has also reported a biaxial apophyllite from Korsnas, Finland and has shown that it belongs to orthorhombic symmetry. Saha and Roy have stated their observation that the re-entrant angles are externally invisible; however it may be seen from the work of Sowani and Phadke (1964) and that of Chen (1968) that the re-entrant angles due to interpenetration twinning are clearly visible, and they have also shown this with diagrams giving plan and crystal drawing.

REFERENCES

HSIEN SU CHEN, (1968) 'Study on Apophyllite from Poona, India.' M. S. Thesis, Department of Geology, Dalhousie University, Halifax, Nova Scotia, Canada.

SAHAMA TH.G., (1965) Yellow Apophyllite from Korsnas, Finland. *Min. Mag.* Vol. 34, (Tilley Vol.) p. 406-415.

SOWANI P. V. and PHADKE A. V., (1964) A note on Apophyllite occurring around Poona. *Jour. Univ. Poona, Sci & Technol. Sec.* No. 28, p. 81-83.

Authors' reply

1. (a) Our work relates to apophyllite from Dehu Road area (18°41′ : 73°44′) which is about 20 miles from Poona (18°30′ : 73°50′), while Sowani and Phadke (1964) described apophyllite from four localities—all of them are situated within 5 miles of Poona city.

(b) While Sowani and Phadke (1964) did mention biaxiality and interpenetration twinning in the apophyllites of their areas, no twin plane was identified, nor did they trace the twinned sectors within individual crystals. On the other hand, in our note, the growth stages of the twinned sectors in two well developed crystals of apophyllite from Dehu Road area are traced out in detail by cutting a series of sections ⊥ to the c-axis of the crystals. The twin plane has been identified and a possible mechanism for the development of biaxiality and sectoral growth has been suggested.

(c) The external forms of two apophyllite crystals described by us are different from those sketched by Sowani and Phadke (1964). Further the $2V_Z$ values for our two crystals (19° to 22°) differ from those obtained by Sowani and Phadke (viz., 42° to 46°).

2. Our suggested mechanism to explain biaxiality and sectoral-growth in apophyllite is essentially a process of gliding along (110), and this has nothing to do with the degree of development of cleavage along that plane. It is well known that glide planes are not necessarily cleavage planes.

Phadke's contention that 'no stress factor would be involved in a crystal growing freely in a cavity' is untenable here, because the apophyllite crystals did not grow in the cavity in isolation within a fluid medium but were attached to the host rock through the already formed aggregates of stilbite and apophyllite which grew from the border inward. Under the circumstances, both (a) stresses affecting the host rock, as well as (b) stresses generated by the splitting stilbite would affect the growing crystals of apophyllite.

We concur with Phadke's observation from Poona area that single crystals of apophyllite, entirely free from stilbite, also show orthorhombic symmetry and biaxiality. But in our collection from Dehu Road area we noted absence of twinning (sectoral growth) in apophyllite where stilbite is absent. We do not, however, rule out the possibility that in Dehu Road area also, such twinning in apophyllite might locally occur in the absence of stilbite. Even then our suggestion that distortion of the tetragonal lattice of apophyllite is responsible for the development of biaxiality and sector twinning would not be disproved.

On the other hand, in our apophyllite collection from Dehu Road area, we find (a) that the $2V_Z$ is highly variable (18° to 38°) even within some single crystals, (b) that perfectly uniaxial apophyllite occurs in places associated with the biaxial ones, and (c) that there is high degree of small scale optical inhomogeneity within the crystals. These facts support our suggestion that gliding along (110) might have caused distortion of the tetragonal lattice to an orthorhombic symmetry and also development of the 'interpenetration' twinning. We are conscious of the fact that this suggestion needs verification by extensive single crystal X-ray work and experimental deformation studies.

3. We have not so far noticed any externally visible re-entrant angles in our apophyllite collection from Dehu Road area. It is not impossible that such externally visible re-entrant angles occur in Dehu Road area too.

4. We are thankful to Phadke for the information regarding the work of Chen (1968) on the apophyllites of Poona area at the Dalhousie University, Canada. But this unpublished work was not known to us at the time of preparation of our note. In any case, the purpose of our note was merely to draw attention to some interesting features of the apophyllites of Dehu Road, and not to make any regional generalisation.

Paper on 'DHARWAR CONGLOMERATES OF MYSORE—A RESTUDY' by B. L. Sreenivas and R. Srinivasan, published in the Journal (Vol. 9, No. 2, December 1968).

Comments by D. R. Gadekar (Geology Department, University of Baroda)

I would like to offer the following comments on the authors' scheme of classification:

While classifying the rocks, oligomictic conglomerates are divided into unicomponent and multicomponent types. I fail to find the criteria or the norms used for advocating such a subdivision.

The term 'oligomict' indicates that the coarse clastic sediment is composed of a single rock type occurring as phenoclasts, (Pettijohn 1957). It would therefore be highly interesting to learn the basis of the usage of the terms 'unicomponent and multicomponent oligomict conglomerates'.

On page 202, while describing conglomerates with graded bedding, the authors state '. . . These conglomerates are almost always multicomponent (polymictic) . . .'. Here it appears the above two terms are used as synonyms for one another. If this is so, how is it that in the proposed classification, the former term has been suggested as a subdivision of oligomictic conglomerate? To me this appears to be incongruous.

REFERENCE

PETTIJOHN, F. J., (1957) *Sedimentary Rocks*; Harper and Brothers, N. Y.; Chapter 6, page 255.

Authors' reply

The terms oligomictic and polymictic conglomerates are referred to in terms of maturity index of pebble beds. Both the unicomponent and multicomponent oligomictic conglomerates consist of highly resistant pebbles in terms of Goldich stability series. The multicomponent oligomictic conglomerates represented by 'conglomerates with quartzite pebbles' of Rama Rao (1935) are composed of orthoquartzite, vein quartz as well as flint and chert pebbles which are all highly resistant, whereas the unicomponent ones consist of vein quartz pebbles only, e.g.

Chikmagalur conglomerates. As opposed to this, the polymictic conglomerates which are always multicomponent are composed not only of resistant pebbles but also of metastable rocks such as granites, greenstones, schists etc. It is the presence of these latter which distinguishes geosynclinal polymictic conglomerates from those of unicomponent and multicomponent oligomictic conglomerates which are characteristic of stable zones of sedimentation, the latter owing their maturity to the repeated reworking characteristic of the stable zones. The multicomponent nature of the oligomictic conlgomerates has been detailed by Pettijohn (1957, p. 256) himself, and it is in this sense that we have classified the Dharwar conglomerates.

REFERENCES

PETTIJOHN, F. J., (1957) *Sedimentary rocks.* Harper and Brothers, N. Y; p. 256.

RAMA RAO, B., (1935) Note on some of the conglomerates of Mysore. *Rec. Mys. Geol. Dept.*, Vol. 34.

Paper on 'STROMATOLITES FROM THE LESSER HIMALAYAN CARBONATE FORMATIONS AND THE VINDHYANS' by K. S. Valdiya published in the Journal (Vol. 10, No. 1, June 1969).

Comments by N. Dasarathi (Geology Department, University of Jammu)

Valdiya's paper is yet another major attempt at the correlation of the unfossiliferous carbonate formations of Lower Himalaya (and the Vindhyans). Valdiya's recognition of many forms of stromatolites in these units and their possible employment in the correlation of these otherwise unfossiliferous sediments imparts to his classification a higher degree of certainty than that generally possessed by the earlier classifications of the Lower Himalayan formations extending from Kashmir to Nepal. To a certain extent, Valdiya's correlation of the Himalayan formations with the Vindhyan sediments had been anticipated by Boileau (Krishnan and Swaminath, 1959), who, however, based his correlation on the possible time-equivalence of Khaira quartzites (= Blaini, = ? Mandhali) with the Lower Kaimur basal members, all these units being tentatively assigned to Ordovician age. Valdiya, on the basis of stromatolites, relegates the Vindhyan, Shali and their equivalent units to a much inferior level (900 – 1300 my) in the chronologic scale.

In his inventory of stromatolite occurrences of Lower Himalaya, Valdiya has not included those of the Riasi Limestones (= Great Limestones) of Jammu area. These limestones, dolomitic and cherty in nature, along with their thin envelope of Eocenes, occur as isolated patches either thrust over the southerly-lying Neogenes (Riasi belt, Kotli 'inlier') or as second-order upright (Kalakor dome) or isoclinal (Sawalkot massif) folds of the parautochthon within the Murrees. The age of these limestones has long been a matter of controversy. Middlemiss had correlated them with the Sirban Limestones (Infra-Trias) of Hazara; and later, Wadia (1937) on the basis of certain slates (supposedly akin to the Agglomeratic Slates) which occur underneath the Limestones of Kotli 'inlier' assigned a Permian age to these bodies. There are indications that these slates occurring confined to faulted isoclinal-synclines within the Riasi Limestones are not possibly part of Agglomeratic Slate group, and hence of no utility in fixing the precise age of the limestones. Recent studies have, however, revealed the presence of similar carbonate formations (as Riasi limestones) in close association with the higher slate-units (Dogra slates) of the Outer Metamorphics belt, north of Panjal thrust. These slates themselves are overlain (with structural conformity) by fossiliferous Lower Paleozoics in different parts of Kashmir Himalaya. Consequently it is thought that the Riasi limestones with their basic intrusives are probably the marginal or shelf facies equivalents of the higher argillaceous members of the Outer Metamorphics belt, with their ophiolitic suite of rocks corresponding to pontic or basinal facies. As such, the stromatolites bearing Riasi Limestones may be referred to as Infra-Cambrian s.l.

No detailed work has been conducted on the stromatolites of Riasi area; all the same, there seems to be a broad corroboration to the suggested age of Riasi limestones from Valdiya's deduction of the age of Tundapathar Limestones (on the basis of stromatolites); and the close similarity in the structural-setting, lithologic characteristics and possible paleotectonic conditions between the two carbonate sequences.

References

Krishnan, M. S. and J. Swaminath., (1959) The Great Vindhyan Basin of Northern India, *Jour. Geol. Soc. Ind.*, Vol. 1.

Wadia, D. N., (1937) Permo-Carboniferous limestone inliers in the Sub-Himalayan Tertiary zone of Jammu, Kashmir. *Records Geol. Surv. Ind.*, Vol. 72, (2), pp. 162-173.

Author's reply

In my paper on the correlation of the unfossiliferous formations of the Lesser Himalaya (Valdiya, 1964a), I included the 'Great Limestone of Jammu, occurring in a 113 km long chain of large inliers between Punch and Riasi, and characterized by the mantles of Nummulitics and Dagshais' in the parautochthonous unit, which also embraces 'the Largi, Sutlej and Shali windows in the Sutlej Valley in Himachal Pradesh, revealing the Shali Series capped by Nummulitics and Dagshais; the Chakrata window in Garhwal, unveiling the Simla Slates and the Deoban Limestone'; and many tectonic windows between Solon and Subathu and Rishikesh and Dehra Dun 'disclosing the anticlinal folds of the Simla Slates mantled with Nummulitics and Dagshais'. In this unit I also included Toni Hagen's Pokhra Window in Nepal. Dicussing the mineralization, I pointed out the similarities of these various carbonate groups of the Lesser Himalaya.

It would be obvious that I believed, as I do now, that the Riasi limestone represents the equivalent, if not the northwesterly extension, of the Gangolihat-Deoban-Shali-Tundapatthar suite of carbonate rocks. I would go even further and include the carbonate part of the Buxa group of the Eastern Himalaya in this suite. As I stated in my paper on the tectonic history and the evolution of the Himalaya (Valdiya, 1964b), as a consequence of the Laramide (Karakoram) phase of orogeny (the harbinger of the emergence of the Himalaya) 'the Lesser Himalaya was flooded, probably for the first time after a long period, and the Simla Slates, Shali Series Great Limestone, etc., began to wear the mantles of Nummulitics, and subsequently Dagshais'. To my mind, the major part of the Lesser Himalaya (excepting possibly the Krol Belt between Solon and Nainital) remained a landmass from the end of the Upper Proterozoic times until the Himalayan orogenic revolution at the end of Cretaceous and beginning of Tertiary brought in the marine floods.

My paper on the stromatolites has regrettably excluded the Riasi and Buxa limestones. This is because I did not have the means and resources to reach those localities. I am sure, somebody will take up these studies.

REFERENCES

VALDIYA, K. S., (1964a) The unfossiliferous formations of the Lesser Himalaya and their correlation: *22nd Intern. Geol. Congr.*, Vol. 11.

——(1964b) A note on the tectonic history and the evolution of the Himalaya: *Ibid.*

Paper on 'AREAL VARIATION OF ANORTHITE CONTENT OF PLAGIOCLASE FELDSPARS FROM THE VAJRAT GABBRO, RATNAGIRI DISTRICT, MAHARASHTRA STATE' by N. W. Gokhale and V. C. Chavadi, published in the Journal (Vol. 10, No. 1, June 1969).

Comments by M. K. Bose (Geology Department, Presidency College, Calcutta).

1. It is found that the authors have completely ignored the study of structural states of the feldspar on which the research is based. Plagioclase may show variations in structural state and/or composition even in the scale of a standard thin section (Hunahasi et al, 1968). Studies on spatial variation of structural states within the body may help the authors in interpreting the mode of emplacement and crystallisation of the body. The structural state of plagioclase may be determined readily from X-ray powder diagram or from optical studies on U-stage (Bambauer et al, 1967, Slemmons, 1964).

Because of structural control on optics, any estimate on composition of plagioclase from optical data alone is prone to be incorrect. If, however, the authors intend to present average composition of feldspar in the samples, they may determine the refractive indices of plagioclase glasses (Foster, 1955).

2. In the paper there are no quantitative data on spatial variation of composition within the pluton. Isopleths for feldspars and mafic contents would have helped the readers in understanding the nature of modal variation within the body. The pattern of isopleths and anomalies (if any) may help the interpretation offered.

3. The authors have not paid adequate attention to the possible variation in physical conditions of crystallisation of the emplaced body. Evaluation of the magmatic history is prone to be incorrect particularly because the field of crystallisation of pyroxene is affected by variation in water pressure in the body.

Further, the form of the pluton must be correctly established to assess the true nature of the contacts.

REFERENCES

BAMBAUER, H. U., CORLET, M., EBERHARD, E. and VISWANATHAN, K., (1967) Diagram for the determination of plagioclase using X-ray powder methods (part III of laboratory investigations). *Scweiz. Miner. Mitt.* Vol. 47, pp. 333-49.

FOSTER, W. R., (1955) Samples for determination of the plagioclase feldspar. *Amer. Min.* Vol. 40, pp. 179-85.

HUNAHASI, M., KIM, C. W., OHTA, Y. and TSUCHIYA, T., (1968) Co-existence of plagioclase of different compositions in some plutonic and metamorphic rocks. *Lithos.* Vol. 1, No. 4, pp. 356-73.

SLEMMONS, D. B., (1962) Determination of volcanic and plutonic plagioclases using a three or four axis Universal stage. *Geol. Soc. Amer.* Sp. Paper. 69.

Authors' reply

Bose has rightly pointed out the various aspects for a fuller account of the Vajrat gabbro. In our paper on which comments are made, we have attempted on a quantitative data, especially the areal variation pattern of anorthite content of plagioclase feldspar, and have arrived at a tentative conclusion based on certain logic behind it. We are also aware of the latest techniques like X-ray investigation, X-ray fluorescence, microprobe analysis etc.; but as the plagioclase determination by 4-Axes Universal stage and the method of Reinhard is scientific and practised all over the world, we too likewise employed the same in our study. As our paper is a preliminary account on Vajrat gabbro, we refrain from giving any reply to the other points raised by Bose.

CORRECTION SLIP

In the paper on "The behaviour of some trace elements in the alkalic suite of Koraput, Orissa" by Mihir K. Bose, A. V. Sankaran and T. K. Bhattacharya, published in Vol. 10, No. 2 of the Journal, the following corrections may kindly be noted:

Table I: Read all values of Ta under Alk. Gabbro and Calc alkali syenite as < 500.

Table II: All values of Ta should read < 500; value of Ti marked < 10000 should read > 10000

Page 175: Consequent upon the corrections, the para under Niobium and Tantalum on p. 175 should read as follows:

"Some nepheline syenites particularly those in association with carbonatites and with agpaitic affinity are known to be rich in niobium and tantalum contents (Gerasimovskii, 1968) but the youngest derivative in Koraput suite is poor in both these elements. It may be emphasised that geochemical characters of nepheline syenites may vary within a wide range as they have diverse petrogenetic histories."