DISCUSSION

GEOLOGICAL CHARACTERISTICS OF THE IRON-URANIUM MINERALIZATION IN THE LESSER HIMALAYAN REGION OF ARUNACHAL PRADESH by B S. Bisht, M.A. Ali, A.K. Pande and R. Pavanagaru, Jour. Geol. Soc. India, v.66(2), 2005, pp.185-202.

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Authors report Iron-Uranium mineralization in a volcani-sedimentary sequence within the Siang Group, which is correlated to the Daling Group of Darjeeling Himalaya It is worth noting that the stratiform nature of these 'banded iron' units consisting of magnetite-hematite quartzite, garnetiferous schist/amphibolite, green phyllite/schist/ amphibolite are closely similar to the exhalative polymetallic-sulphide bearing iron-formation within the Daling Group from Gorubathan area, which is the type area of the Daling 'series' (Daling Fort) The other comments stated below are not on the main topic of the paper but on the regional geology of the Arunachal Pradesh, and particularly on the distribution and age of the Miri Formation and the Abor Volcanics

The Geological Map of Arunachal Himalaya shown in Fig 1 in the paper is not based on the published map by GSI (1998) It shows extensive spread of the Miri Formation, which is assigned Silurian-Devonian age The Abor Volcanics exposed in the Siang gorge is assigned Permian age This information is not factually correct and discussed below for the general interest of the readers

The Miri Quartzite was recognized by B Laskar (*In* Krishnan, 1958) named after the local tribes of the area It is a quartzite-conglomerate sequence that is exposed at the confluence of the Kamala river and Pipiajuli stream in the Subansiri valley, and it often has *Skolithos* burrows Laskar considered it to be younger than the Buxa 'series' but older to the Late Palaeozoic Gondwana rocks The age and correlation of this unit outside its type area is still uncertain

Western parts of Fig 1 show two belts of the Miri Formation, one north of the Gondwana and the other along an ENE-WSW trending belt passing south of Bomdila. Major parts of these rocks actually correspond to low-grade Proterozoic formations and contain equivalents of the Buxa dolostone (GSI, 1998)

A narrow band of quartzite overriding the Gondwana diamictite may be correlated to the Miri/Thungsing Quartzite, which is better developed in the eastern Bhutan Himalaya (Srinivasan, 2001) The Miri Formation is thus very minor component, if at all, of the exposed rocks within western part of Arunachal Pradesh, and it cannot be shown in the scale of Fig 1

The presence of the Miri Formation in the Siang gorge, in the eastern part of Fig 1 is also uncertain These rocks closely resemble the Miri, but calcareous beds in them have yielded larger foraminifera indicating late Palaeocene to early Eocene age (Acharyya, 1994, Sengupta et al 1996) The Miri-like quartzite unit conformably underlies the Abor Volcanics In the GSI (1998) map these rocks are shown as Yinkiong Formation of Eocene age

However, in its type area and other sections, outside the Siang gorge, the Miri Quartzite is tentatively dated early Palaeozoic in age based on its stratigraphic relation with the Gondwana diamictite The age of the Miri Quartzite is thus open to debate

The Abor Volcanics exposed in the Siang valley are conformably sandwiched between two sedimentary sequences that are dated Late Palaeocene-Early Eocene, and Mid Eocene respectively, based on rich larger foraminifera assemblage (Acharyya, 1994, Sengupta et al 1999) Tripathi and Roychoudhury (1983) reported the presence of early Permian miospores of Gondwana affinity from some intertrappeans in the Abor Volcanics exposed in the Siang gorge They recognized Abor Volcanics of two ages an older section of the Permian and a younger section of Eocene ages Kumar (1997), on the other hand, assigns early Permian age to the Abor Volcanics based on the presence of miospores However, the presence of reworked Permian spores of Gondwana affinity is well known from the Tertiary rocks from the NE India The entire exposed belt of the Abor Volcanics in the Siang valley type area is regarded to be Eocene in age (GSI, 1998)

The presence of Early Permian basaltic volcanics is, however, recorded from Lichi area, Ranga Valley and Tatamuri-Daring area, Subasiri district These are closely intercalated with fossiliferous Gondwana sediments (Acharyya at al 1975) The presence of basic volcanics of both Permian and Eocene ages is shown in the Geological map of North East India (GSI, 1998).

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Dr. S.K. Acharyya is profusely thanked for his constructive comments and for providing an update on the regional geology of the Arunachal Himalaya with regard to the field disposition and ages of the Miri Quartzite and Abor Volcanics. The new information provided in the GSI (1998) map could be vital for researchers in the Himalayan domain.

As has been noted by Dr. Acharyya, the Iron-Uranium (+sulphides, REEs) association of Siang Group in Arunachal Pradesh is similar to the polymetallic sulphide mineralisation of Gorubathan area. Such comparison of the study area with Gorubathan area in Darjeeling Himalaya (Ray, 1976; Sen and Pattnaik, 1989) and Bhotang area, Rangpo in Sikkim Himalaya (Ghose, 1968) were made in the earlier works (Bisht, 1998 and Bisht et al. 1991). However, Uranium and REE mineralisation is not known from Darjeeling and Sikkim Himalayas.

In the paper, aspects on regional geology were briefly dealt due to the main emphasis on the understanding of the Fe-U mineralisation in the volcano-sedimentary sequence of Proterozoic Siang Group. The views on the younger Miri Quartzite and Abor Volcanics were thus mainly derived from the references cited in the paper. In the following section brief account of some of the published work (other than those suggested by Dr. Acharyya), which were consulted while preparing the text but could not be included because of space limitations, and which in the authors opinion are important in understanding the complexities, and evolution of thoughts, particularly with regard to the ages of Miri Formation and Abor Volcanics of the Arunachal Himalaya are presented along with reply.

Figure 1 on the Regional Geological Map of Arunachal Himalaya has been referred from the published literature (Singh and Chowdhary, 1990), and this source has been indicated in title of the figure. In their paper, the authors have used Dedza-Menga Belt for the lithotectonic unit (Miri Formation in the paper) with occurrences in two different tectonic positions (i) as a persistent belt succeeding the Gondwana belt in the south and (ii) in the tectonic window further north, extending NE-SW from Menga in the east to Dedza Rupa in the west. The Dedza-Menga belt is composed of quartzite-limestone-dolomite-phyllite sequence, to which various nomenclatures have been assigned by researchers at different times, such as Tenga Group (Das et al. 1975), Buxa-Miri Group (Nandi et al. 1975), Miri Group (Jain et al. 1974), Yazali Zone (Bakliwal et al. 1979) etc.

As has also been indicated by Dr Acharyya, opinions vary on the age of Miri Formation. Laskar (*In* Krishnan, 1958) considered 'Miri quartzite' younger to Buxa 'Series' but older to Gondwana beds. It was assigned Silurian to Devonian age by *Anon* (1974). In the Eastern Himalayas, based on conformable Buxa-Gondwana and Miri-Gondwana relations, the Miri and Buxa Formations were broadly considered Carboniferous-Devonian in age (Acharyya, 1974). The basal diamictite of the Gondwana Group exposed between Garu and Igo on Likabali-Along road section in Arunachal Pradesh, essentially consists of pebbly and gritty slate, carbonaceous argillites, feldspathic quartzite, volcanoclastics and Abor Volcanics. Lithological gradations from older Miri Formation to the Rangit Pebble-Slate with volcani-clastic intercalations have also been postulated in Igo-Basar section of Arunachal Pradesh and in Dewathunt-Norphong section of Bhutan (Jangpangi, 1974; Acharyya et al. 1975). It was therefore thought that the pre-Gondwana rocks were subjected to erosion and reworking during Gondwana sedimentation, but in several places the sedimentation was continuous with unfossiliferous Buxa and Miri Formations (Acharayya, 1978).

The Miri Formation has not yielded diagnostic fossils except for trace fossils of Skolithos and Planolites (Tandon et al. 1979; Singh and De, 1989) both having long range from Precambrian/Cambrian to Recent. This point has also been mentioned by Dr. Acharyya in his comments. Singh and De (1989) and Singh (1993) have shown an unconformable relationship of the Miri Formation (their Nikte Formation) with the underlying Khetabari and Tenga Formation (their Ragidoke Formation) and conformable with the overlying Lower Permian Bichom Formation. Singh (1993) assigned Lower to Middle Paleozoic age to Nikte Quartzite.

In view of the observation that the Miri Formation has conformable contacts with the overlying Bichom Formation of Gondwanas (yielding Lower Permian fauna) and that identical diamectite beds occur in both Miri and Bichom formations, Kumar (1997) compared the Miri Formation with the Lower Gondwana Group.

Abor Volcanics

Abor Volcanics were first described by Coggin Brown (1912) from the Siang Valley section in the East Siang district of Arunachal Pradesh. These consist essentially of amygdaloidal basaltic-andesitic flows, rhyolitic-andesitic tuffs, volcanic conglomerates and lava breccia. The type section, measuring more than 1000 m in thickness, is represented near Dosing on Along-Yinkiong road section In the Siang Valley, the intertrappeans associated with the Abor Volcanics yielded Lower Permian microflora (Roychowdhury, 1984, Prasad et al 1989)

In Arunachal Pradesh, Abor Volcanics occur closely associated with the Buxa Group and are intercalated with the Gondwana rocks, particularly the basal diamictites and to a lesser extent with the overlying Damuda Group (Acharyya et al 1983) The Abor Volcanic Formation is considered coeval with the Lower Permian Panjal Volcanic Formation of the northwest Himalaya (Acharyya, 1978, Kumar, 1997) Contrary to the earlier view that these volcanics are solely of Palaeozoic age, Tripathi et al (1981) considered them partly Palaeozoic and partly Tertiary in age based on their relationships with the Tertiary Geku Formation of the Yinkiong Group which yielded Paleocene-Lower Eocene plant fossils Geochronological data on Abor Volcanics from the type area in Siang Valley indicated 93±3 to 98±3 Ma (Anon *in* Singh and Chowdhary, 1990) and 94-66Ma (Shanker et al 1989) making some researchers believe that the Abor Volcanics represent Late Mesozoic (Cretaceous) rifting in the region

Present understanding of Miri and Abor Volcanic formations, based on lithological associations, structures, palaeontological and limited isotopic ages, thus have resulted in divergent views on their stratigraphic correlation More systematic sedimentalogical, mineralogical, geochemical, isotopic and geochronological studies are necessary to arrive at a commonly acceptable view

References

ACHARYYA, S K (1974) Stratigraphy and sedimentation of the Buxa Group, Eastern Himalaya Him Geol, v 4, pp 102-116

ACHARYYA, S K (1978) Stratigraphy and Tectonic Features of the Eastern Himalaya In P S Saklani (Ed), Tectonic Geology of the Himalaya, pp 243-268

ACHARYYA, S K (1994) The Cenozoic foreland basin and tectonics of the Eastern Sub-Himalaya problems and prospects Him Geol, v 15, pp 3-21

ACHARYYA, S K, GHOSE, S C, GHOSE, R N and SHAH, S C (1975) The continental Gondwana Group and associated marine sequences of Arunachal Pradesh (NEFA), Eastern Himalaya Him Geol, v 5, pp 60-82

ACHARYYA, S K, GHOSE, S C and GHOSE, R N (1983) Geological framework of the eastern Himalayas in parts of Kameng, Subansiri, Siang district, Arunachal Pradesh Geol Surv India Misc Publ no 43, pp 145-152

ANON (1974) Geology and Mineral Resources of the States of India-Assam and adjoining states Geol Surv India, Misc Publ, no 30, pp 1-24

BAKLIWAL, P C, SANGMA, L and DAS, A K (1979) Geology of Ranga valley, Subansiri district, Arunachal Pradesh Him Geol, v 9, pp 42-51

BISHT, B S (1998) Iron-Uranium association in the Proterozoic Daling Group rocks in Arunachal Pradesh Mineralogical and Geochemical studies and controls Unpublished PhD Thesis, Osmania University, 212 p

BISHT, B S, SHARMA, Y C, VIRNAVE, S N and KAUL, R (1991) The Proterozoic iron- formations and associated rocks of the Daling Group at Maro and Gamkak, Arunachal Pradesh, India - Some aspects of geology, geochemistry and uranium mineralization Exploration and Research for Atomic Minerals, v 3, pp 69-81

COGGIN BROWN, J (1912) A geological reconnaissance through the Dihang Valley, being the geological result of the Abor Expedition, 1911-1912 Rec Geol Surv India, v 42(4), pp 231-264

DAS, A K, BAKLIWAL, P S and DHOUNDIYAL, D P (1975) A brief outline of geology of parts of Kameng district, NEFA Geol Surv India Misc Publ no 24, pp 115-127

GEOLOGICAL SURVEY OF INDIA (1998) Geological and Mineral map of North East India, (1 2M)

GHOSE, A K (1968) Quantitative analysis of polymetallic orebody zoning at Rangpo, Sikkim Econ Geol, v 63, pp 682 687

JAIN, A K, THAKUR, V C and TANDON, S K (1974) Stratigraphy and structure of the Siang district, Arunachal (NEFA) Himalaya Him Geol, v 4, pp 28-63

JANGPANGI, B S (1974) Stratigraphy and Tectonics of parts of Eastern Bhutan Him Geol, v 4, pp 117-136

KRISHNAN, M S (1958) General report of the Geological Survey of India for the year 1954 Rec Geol Surv India, v 88(1), pp 10-12

KUMAR, G (1997) Geology of Arunachal Pradesh Geological Society of India, Bangalore, 217p

NANDY, D R, MULLICK, B B BASUCHODHURY and MURTHY, M V N (1975) Geology of NEFA Himalaya Geol Surv India Misc Publ no 24, pp 91-114

PRASAD, B, DEY, A K, GAGOI, P K and MAITHANI, A K (1989) Early Permian plant microfossils from the intertrappean beds of Abor Volcanics, Arunachal Pradesh, India Jour Geol Soc India, v 34(1), pp 83-88

RAY, K K (1976) Some problems of stratigraphy and tectonics of Darjeeling and Sikkim Himalaya Geol Surv India, Misc Publ no 24(2), pp 371-394

ROYCHOWDHURY, J (1984) The Abor Group of rocks in Arunachal Pradesh Rec Geol Surv India, v 113(4), pp 48 57

SEN, P and PATTNAIK, S C (1989) Biogeochemical prospecting as a guide to mineralisation in parts of Eastern Himalayas Geol Surv India, Spl Publ no 22, pp 85-96

SENGUPTA, S , ACHARYYA, S K and DE SMITH, J B (1996) Geochemical characteristics of the Abor volcanic rocks, N E Himalaya, India nature and Early Eocene magmatism Jour Geol Soc London, v 153, pp 695-704

SINGH, S (1993) Geology and tectonics of the Eastern Syntaxial Bend, Arunachal Himalaya Jour Him Geol , v 4(2), pp 149-163

SINGH, S and CHOWDHARY, P K (1990) An Outline of the Geological Framework of the Arunachal Himalaya Jour Him Geol , v 1(2), pp 189-197

SINGH, S and DE, A K (1989) Geology and structure of the Siyom Valley, Arunachal Himalaya *In* PS Saklani, (Ed), Current Trends in Geology Metamorphism, Ophiolites and Orogenic Belts, Today and Tommonow's Printers and Publishers, New Delhi, pp 291-206

SHANKER, R , KUMAR, G and SAXENA, S P (1989) Stratigraphy and sedimentation in Himalaya A Reappraisal *In* Geology and Tectonics of the Himalaya, Geol Surv India Spl Publ no 26, pp 1-60

SRINIVASAN, V (2001) Stratigraphy and structure of low-grade metasedimentaries in eastern Bhutan and western Arunachal Pradesh Him Geol , v 22, pp 83-98

TANDON, S K , NANDA, A C and SINGH, T (1979) The Miri rocks of the Eastern Himalaya- Stratigraphic and ichnological considerations *In* P K Verma, (Ed), Metamorphic rock sequences of the Eastern Himalaya K P Bagchi & Co , Calcutta, pp 85-99

TRIPATHI, C and ROYCHOWDHURY, J (1983) Gondwanas of Arunachal Himalaya Him Geol , v 11, pp 73-90

TRIPATHI, C , ROYCHOWDHURY, J and DAS, D P (1981) Discovery of Tertiary plant fossils from Geku Formation of Dihang Valley, Siang district, Arunachal Pradesh *In* A K Sinha, (Ed), Contemporary Geoscientific Researches in Himalaya, v 1, pp 225-230

EFFICACY OF PERCOLATION PONDS AS ARTIFICIAL RECHARGE STRUCTURES AND THE CONTROLLING FACTORS by B.S. Sukhija, D.V. Reddy, P. Nagabhushanam and M.V. Nandakumar. Jour Geol. Soc. India, 2005, v.66(1), pp.95-104.

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I have read with interest the above article which gives a good account of water balance in percolation ponds The percolation tank near Kalwakurthi referred by authors is in Thimmarapalli village (they could have mentioned the name of the village instead of saying as near Kalwakurthi and possibly shown it on a location map too), The State Ground Water Department had established a hydro-meteorological station just upstream of the tank-bed Officers of the Department had inventoried, all the wells and monitored water levels in the wells around the tank for 8 or 9 years This programme was given up due to resource constraints I was part of the team of the officers from State Department involved in these studies for sometime I would appreciate if the authors can clarify/further elaborate the following points

1 The authors state that "the water in two open wells close to the dam rose close to the ground surface which never happened prior to the construction of percolation tank" I would like to state that the percolation tank referred is not a new tank but just a conversion of old minor irrigation tank The sluice of the old tank was permanently closed, breach plugged, and that the bund was strengthened somewhat to convert it from an irrigation tank to percolation pond The wells close to the dam, especially on the right bank (of the small streamlet across which the bund was made many many years ago) always had the water to the brim whenever the tank had some water The other well did not react as fast I do not know if the authors have noticed a dolerite dyke that may be influencing the flow direction of groundwater or at least affecting the rate of flow There is no mention of this dyke in their paper
2 They state that soil characteristics of the tank-bed as well as the ayacut are equally important, but why? They have not elaborated on the reasons as to how the soils in ayacut influence the efficacy of percolation tanks
3 The percolation from tank is calculated as -20,000 m^3, which is hardly equal to groundwater draft from two wells This is a rather negligible quantum This volume can irrigate less than 2 hectares of paddy Does it not suggest that percolation tanks are not effective?
4 In fact I was convinced after this tank was converted to percolation pond that there is no need for such an exercise Simple irrigation tanks serve the purpose of recharge and do so not only from the tank bed but also from irrigated area In case of paddy cultivation, about