DISCUSSION

PRECAMBRIAN COLLUVIAL IRON ORES IN THE SINGHBHUM CRATON: IMPLICATIONS FOR ORIGIN, AGE OF BIF-HOSTED HIGH GRADE IRON ORES AND STRATIGRAPHY OF THE IRON ORE GROUP by Joydip Mukhopadhyay, Gautam Ghosh, N.J. Beukes and Jens Guitzmer. Jour. Geol. Soc. India, v.70(1), 2007, pp.34-42.

Anupendu Gupta, Deputy Director General, Geological Survey of India, Kolkata, comments:

I went through the paper with much interest. The authors have elaborated the observations of Dunn (1941) regarding the presence of hard and massive hematitic iron ore pebbles in the Kolhan conglomerate and have offered their interpretations supported by maps and excellent field photographs and photomicrographs. They deserve compliments. However, the claim by the authors that this observation escaped the attention of later workers before them (vide last sentence under Introduction, p.34) is far from the fact. The stratigraphic implication of the iron ore, BIF and shale pebbles in the basal Kolhan conglomerate was considered by many workers (Saha, 1948, 1994; Banerji, 1977; Sarkar, S.C., 2000, 2002 and other references therein). The genetic possibilities of hematitic ore in the region, emerging from its occurrence in form of clasts in the Precambrian Kolhan sequence, was first pointed out by Sarkar, S.C. and Roy (1967). This was reiterated by Sarkar (2000) and was discussed later in more detail by Sarkar and Gupta (2005). The question addressed by them was whether the concentration of iron oxide (now represented by the iron ore pebbles in Kolhan conglomerate) was due to an ancient supergene process or by any of the possible primary processes. As it is difficult to consider tropical weathering, lateritisation and secondary supergene concentration of iron ores before Tertiary time, it appeared more plausible that primary ore concentration processes played an important role in many parts of iron ore deposits in India, particularly in the Jamda-Koira valley of Jharkhand and Orissa.

Besides the above mentioned evidence, Sarkar and Gupta (2005) enumerated and illustrated several other characteristics of iron ores from Eastern India, which are indicative of primary concentration of iron oxide by ascending fluids, much before the supergene processes triggered by descending fluids could have started. These are (1) pervasive tectonic structures and fabric (folds, faults and shears/cleavages) in massive ores, (2) instances of massive ores overlain by BIF (Gandamardan) or underlain by shales without BIF in the vicinity, (3) paleomagnetism retained in the massive ores, (4) very thick massive iron ore 'seams' ranging up to 30 m (Joda), (5) virtual absence of goethite in the massive ores, (6) petrographically, the massive ore dominated by hematite laths with sub-equigranular martite grains and small but variable proportion of pore space. Evidences of supergene ore concentration are of course there which include topographic influence on oxidation zones, development of lateritic and limonitic zones as well as goethite-bearing porous ores, preferred concentration of ore at the sites of interference of two sets of folds (reported from Malantoli by Chatterjee and Mukherjee, 1981).

The present authors have made a cursory mention of the publications by Sarkar, S.C. (op.cit.) and Sarkar and Gupta (op.cit.) but have largely misquoted their observations and opinion by portraying them as believers of (1) tropical weathering and supergene alteration as the main ore forming process and (2) "some tectonically controlled circulation process" responsible for ore concentration (vide Discussion, p.39).

Sarkar and Gupta (op. cit.) held that the origin of iron ores is no longer axiomatic. Based on their extensive studies on the iron ores from different parts of the country, they opined that there are iron ores wholly of hypogene (hydrothermal) or supergene origin and/or with the superposition of either on the other. However, pretectonic hypogene processes, spanning from diagenetic to later stages, have been by far the most important genetic process for the origin of the Precambrian BIF-related hematitic iron ores in the Eastern India.

Joydip Mukhopadhyay, Gautam Ghosh, N.J. Beukes and **Jens Gutzmer**; Email: joydip17@rediffmail.com replies:

We appreciate the comments and issues raised by Dr. Anupendu Gupta on our paper. However, we fail to agree with Dr. Gupta regarding issues raised in the discussion. We did not find any discussion on 'stratigraphic implications' of the iron ore pebbles in the Kolhan conglomerates in the publications (Saha, 1948, 1994, Sarkar and Roy, 1967, Banerjee, 1977, Sarkar, 2000, 2002, Sarkar and Gupta, 2005) as claimed by him Referring to Dunn (1941) on the occurrences of these ore pebbles in the Kolhan conglomerates, Sarkar (2000) and Sarkar and Gupta (2005) certainly raised the question of the possible significance of such pebbles, but did not elaborate or tried to resolve it through documentation In fact, Sarkar (2000) only refers to the iron ore pebbles in context of possible future scopes for studies of iron-formation and related iron ores in India to trace the rise of atmospheric oxygen Sarkar (2000, p 183, col 2, lines 33-35) raise the question and we quote " What is the significance of the presence of pebbles of iron ore in the Kolhan conglomerate? Were they derived from primary thick iron oxide layers, or supergene enrichment did take place even at the early stage?" Clearly the possibility that the pebbles may have been derived from earlier hydrothermal iron ore deposits, as we suggest in this paper, is not even mentioned In a subsequent paper by Sarkar and Gupta (2005) the only mention of the iron ore pebbles in the Kolhan conglomerate is in context of the genesis of the Eastern Indian iron ore stating " In Eastern India, Dunn (1941) reported pebbles of iron ore in Kolhan conglomerate Obviously, these could not be of recent origin and conjectured if they were of ancient supergene origin (S C Sarkar, 2000)" We thus have no hesitation to put our claim that we for the first time, after the original report by Dunn (1941), described these conglomerates in detail and discussed their implications for the stratigraphy and ore genesis based on our field and petrographic observations

We also fail to appreciate the 'characteristics' indicative of 'primary concentration of iron oxide by ascending fluid' as suggested by Dr Gupta and in Sarkar and Gupta (2005) Sarkar and Gupta (2005) did not provide any conclusive evidence from the Eastern Indian deposits in support of their proposed 'characteristics' We believe most of these criteria if not all can be produced by both 'ascending/descending fluid' However, most of the criteria will certainly fail to distinguish hydrothermal deposits from other types

Regarding the comment on the 'Discussion (p 39)' section of our paper, we clearly used the references of Sarkar (2000, 2002) and Sarkar and Gupta (2005) merely as reviews of earlier works and a long-standing view of supergene origin for these deposits In fact, Sarkar (2000, p 183, col 2, lines 6-7) also believed that iron ores of this region are 'mostly supergene alteration products of BIF' This was his view until we proposed the alternative 'hydrothermal' model based on petrographic evidences (Mukhopadhyay, 2002, Beukes, 2002, 2003) and he gives us full credit for that contribution by referring to it as follows " Dunn apparently did not study in detail the petrography of the massive ores, to distinguish them through petrography The issue apparently escaped the attention of most of the later workers, as may be concluded from a look at the literature record " Recently Mukhopadhyay et al (2002) and Beukes et al (2002) brought it forward According to these authors, the high grade ores involved two steps of development a first stage of hypogene (hydrothermal) episode, followed by late supergene modification The amount of massive equigranular martite mosaic, locally presented in hard ore they studied, exceeded the amount of diagenetic magnetite present in the BIF protoliths The excess magnetite now in the form of martite strongly suggests a hydrothermal addition of magnetite according to these authors Although the present author believes that there may be one or more alternative explanation to this observation, some high grade ores indeed formed much earlier than the present day supergene processes Their petrographic characters are that they are composed of hematite laths and sub-equidimensional martite with small but variable proportions and dispositions of pore spaces In the field they are blocky, the blocks produced by fracture systems, apparently of tectonic origin" (Sarkar, 2002, p 35, col 2, para 4) The subsequent paper by Sarkar and Gupta (2005) does not present a clear and conclusive model for the genesis of the Eastern Indian Ore Deposits and remains 'nonaxiomatic' In the last part of the discussion on the origin of these ores Sarkar and Gupta (2005) rather tentatively invoke 'structural control' as a relevant factor for ore formation as we could make out from sentences such as " if, however, the structural control suggested by Chatterjee and Mukherjee (op cit) are generally true, then the ore genesis in Malantoli area is better explained by the activity of descending solution than ascending" (Sarkar and Gupta, 2005, p 93, col 1, lines 26 30)

In the last paragraph of the discussion, Dr Gupta points out that the 'origin of iron ores is no longer axiomatic' It is true that there may be 'supergene or hydrothermal ores or a superposition of either on other', in fact all these options have been first proposed by Beukes and his co-workers (2002, 2003) We fully agree with Dr Gupta in this regard However, his claim that the idea was put forward by Sarkar and Gupta (2005) based on 'their extensive studies on iron ores from different parts of the country' is far from evident from this publication Neither does the paper describe any deposit outside Singhbhum craton, nor does it include any conclusive documentation with regard to field, petrography and geochemistry on iron ores from Eastern India in support of their model. It is essentially a review paper of earlier work and genetic models. In fact the models suggested for the genesis of high-grade BIF-hosted iron ore of the Singhbhum craton in this review paper by Sarkar and Gupta (2005) had already been proposed in Beukes et al. (2002, 2003).

References

BANERJI, A.K. (1977) On the Precambrian banded iron formations and the manganese ores of the Singhbhum region, eastern India. Econ. Geol., v.72, pp.90-98.

BEUKES, N.J., GUTZMER, J. and MUKHOPADHYAY, J. (2002) Geology and Genesis of high-grade hematite iron ore. In: Iron Ore 2005, Key Note Address, Conference Volume, Iron Ore Conference, AusIMM & CSIRO, Perth, WA, 9-11 September, pp.23-29.

BEUKES, N.J., GUTZMER, J. and MUKHOPADHYAY, J. (2003) Geology and Genesis of high-grade hematite iron ore. Applied Earth Science (Trans. Inst. Min. and Metall, B) UK, v.112, pp.B18-B25.

CHATERJEE, A.K. and MUKHERJEE, P. (1981) The structural set up of a part of the Malangtoloi iron ore deposits, Orissa. Jour. Geol. Soc. India, v.22, pp.121-130.

DUNN, J.A. (1941) The origin of the banded hematite ores in India. Econ. Geol., v.36, pp.355-370.

MUKHOPADHYAY, J., BEUKES, N.J. and GUTZMER, J. (2002) Petrographic evidence of Hydrothermal Origin of BIF-Hosted High-Grade Iron Ores from Eastern and Central India. 16th International Sedimentological Congress (Abstract Volume), Johannesburg, pp.271-272.

SAHA, A.K. (1948) Kolhan Series-Iron Ore Series boundary to the west and southwest of Chaibasa. Sci. & Cult., v.14, pp.77-79.

SAHA, A.K. (1994) Crustal evolution of Singhbhum-North Orissa, eastern India. Mem. Geol. Soc. India, No.27, 341p.

SARKAR, S.C. (2000) Crustal evolution and metallogeny in the eastern Indian craton. Geol. Surv. India Specl. Publ., No. 55, pp.169-194.

SARKAR, S. C. (2002) Crustal Evolution and metallogeny in South Singhbhum and the adjacent parts of Orissa: results of some recent studies and their possible significance. Indian Jour. Geol., v.74, pp.27-36.

SARKAR, S.C. and GUPTA, A. (2005) Nature and origin of the iron ores of eastern India: a subject of scientific interest and industrial concern. Proceedings of the Seminar on Mineral and Energy Resources of Eastern India, MGMI, Calcutta, pp.79-101.

SARKAR, S.C. and ROY, A.B. (1967) Progress and problems in the Precambrian geology of Singhbhum. *In:* S. Deb (Ed.), Contributions to the geology of Singhbhum. Jadavpur University, Calcutta, pp.1-4.

A MARCHANTIALEAN THALLUS FROM THE LOWER GONDWANA SEQUENCE OF GODAVARI BASIN, ANDHRA PRADESH by Omprakash S. Sarate and Navita Budhraja: Jour. Geol. Soc. India, v.70(1), 2007, pp.90-96.

H.K. Sabot, AMD Hyderabad – 500 016 comments:

The authors' work recording xerophytic bryophytes added to the database of Pranhita-Godavari Gondwanas. However, the following needs clarification.

In Fig.1 of the paper, the authors have given a geological map, which otherwise looks innocuous, by simply citing its source as "(after GSI)" without mentioning even the year (is it 1998!, if one goes by their references). The map of same area was shown differently in another paper by M. Burhanuddin (of GSI), published incidentally in the previous month (i.e. June, 2007 of JGSI). This map (cf. Fig.1, p.1336) by Burhanuddin (2007), who systematically mapped the same area on 1:50,000 scale for his doctoral thesis in 1991, is likely to be more authentic. His map showing Barakar Formation west of Mailaram differs from that of authors' above mentioned map in which the same area was shown as Kamthi Formation.

This is important, because Jha and Srivastava (1996) report decreasing order of Late Permian Palynoflora with consistent increase of typical Early Triassic elements and Permo-Triassic "palynofloral transition is largely gradual except in Mailaram area (borehole GAM-7) of Godavari Graben". Unfortunately, the location of GAM-7, in which Kamti horizon is reported from 166-453 m depth, in Mailaram area of Godavari Basin (Tripathi, 1996 quoting Srivastava and Jha, 1990) was not shown in the above maps prepared by Burhanuddin as well as the authors. In view of the assigned Early Triassic age to these transitional palynoflora in the litho-sequence of GAM-7 (Jha and