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CORRESPONDENCE

Carbon Isotope Composition of Raialo Carbonates and Its Equivalents, Mesoproterozoic Delhi Supergroup, India: Implications for Stratigraphic Correlation

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Carbon isotopic studies are useful not only for reconstruction of palaeoenvironment, but have also been used successfully for chronostratigraphic purposes. The marine limestones and even dolostones faithfully record the carbon isotopic composition of the ocean water in which they formed (Schole and Arthur, 1980; Gao and Land, 1991; Wang et al., 1996). Saltzman et al. (1998) investigated the carbon isotope stratigraphy of the well-dated carbonates of the Phanerozoic part of geological record and confirmed that large perturbations in the carbon isotope ratios of common carbonate rocks may be used as a precise measure of time.

The Mesoproterozoic Delhi Supergroup of Aravalli Mountain Range, Rajasthan, India (Fig. 1) is mainly comprised of quartz arenite, conglomerate, felds arenite, phyllite, limestone, marble and calc-gneiss. These rocks have undergone polyphase deformation and suffered greenschist to amphibolite facies metamorphism. A marginal marine depositional environment has been envisaged for the sedimentary sequences of the Delhi Supergroup (Deb, 1980; Singh, 1982a). The Raialo Group (type area is Raynahalla town) of Delhi Supergroup, is exposed on the northern extremity of the fold belt and is characterized by the frequent presence of dolomitic carbonates. Carbonates have also been reported on the western limits of the Delhi Supergroup but are significantly calcitic in composition (Heron, 1953).

The stratigraphic status of calcitic carbonates occurring on the western margin of the Delhi Fold Belt and its correlation with carbonates from the Raialo Group is a matter of debate. Heron (1953) correlated the carbonates on the western margin of the Delhi Supergroup with the Raialo carbonates. Sen (1983), on the other hand, suggests that these should belong to a younger sequence. Roy and Sharma (1999) advocated for the correlation of these carbonates with the younger Sirohi Group sediments. To resolve the issue we have carried out sampling of carbonates from the Raialo Group and its equivalents occurring on the western margin of the Delhi Supergroup for analysis of carbon and oxygen isotope composition. The whole-rock carbonate samples were collected at close intervals along a stratigraphic profile in the Raialo Group around the Rayanhalla town. Representative samples were however, collected from the different carbonate occurrences occurring on the western margin of Delhi Supergroup and included in the ambit of the Raialo Group. The preliminary isotope results are provided in table 1.

Isotopic Data and Discussion

Thirty-one carbonate samples (Fig. 1 shows sampling locations) were analysed for their carbon isotopic composition. The perusal of results summarised in table 1 shows that carbonates from western limits of the Delhi Supergroup are characterised by high C values (up to 4.3‰ PDB) compared to carbonates from the Raialo Group, with $\delta^{13}C$ values around zero, typical of Mesoproterozoic marine

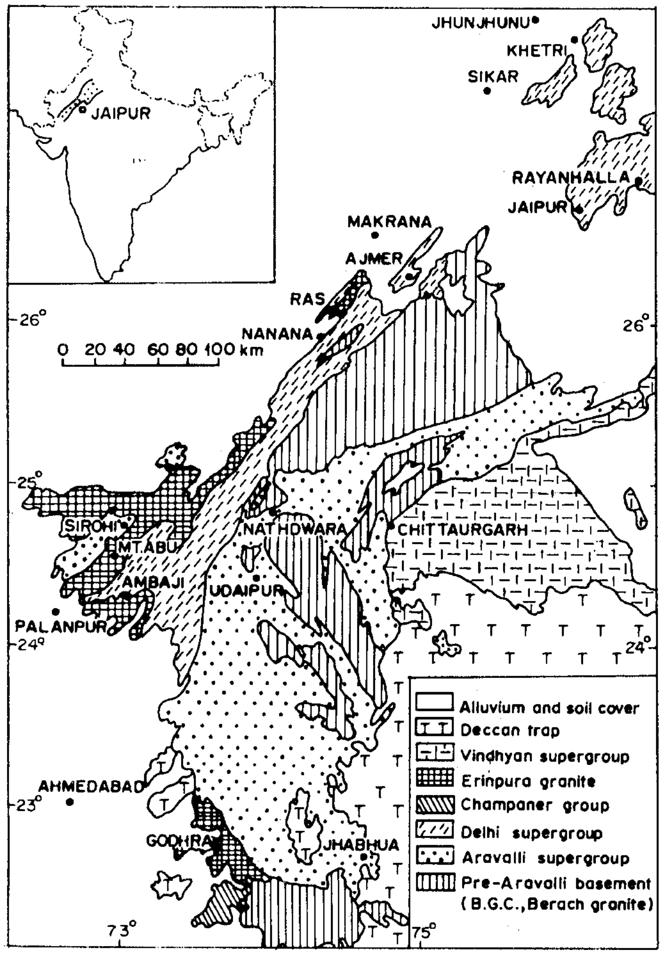

Fig. 1. Location and regional geology of the area investigated.

Table 1. Stable isotope data for Raialo carbonates and its equivalents, Delhi Supergroup, Northwestern India.

Sl. No.	Sample No.	Locality	$\delta^{13}C$	$\delta^{18}O$
1	RLO 1	Rayanhalla	0.19	–9.49
2	RLO 2	Rayanhalla	0.64	–8.48
3	RLO 3	Rayanhalla	0.39	–8.17
4	RLO 4	Rayanhalla	0.07	–8.24
5	RLO 5	Rayanhalla	0.11	–7.61
6	RLO 6	Rayanhalla	0.65	–9.07
7	RLO 7	Rayanhalla	0.63	–8.27
8	RLO 8	Rayanhalla	0.49	–9.79
9	RLO 12	Rayanhalla	0.94	–9.13
10	RLO 17	Rayanhalla	0.17	–8.96
11	RLO 18	Rayanhalla	0.14	–8.66
12	RLO 21	Rayanhalla	0.26	–9.51
13	RLO 22	Rayanhalla	0.15	–9.25
14	RLO 24	Rayanhalla	0.24	–9.47
15	RLO 26	Rayanhalla	0.71	–8.41
16	RLO 27	Rayanhalla	0.25	–10.19
17	RLO 29	Rayanhalla	0.55	–10.89
18	RLO 30	Rayanhalla	0.55	–10.77
19	RLO 33	Rayanhalla	0.89	–10.31
20	RLO 35	Rayanhalla	0	–14.81
21	RLO 36	Rayanhalla	–0.26	–10.03
22	RLO 37	Rayanhalla	0.56	–13.25
23	RLO 39	Rayanhalla	0.64	–11.34
24	RLO 40	Rayanhalla	0.64	–9.4
25	S 3	Jhunjhunu	4.3	–14.89
26	S 2	Sikar	2.1	–12.13
27	21	Makrana	3.3	–13.5
28	RM	Ras	3.8	–13.01
29	NM	Nannana	2	–12.23
30	24	Ambaji	4.3	–20.21
31	23	Palanpur	3.9	–8.02

Sl. No. 1 to 24 – Raialo carbonates, 25 to 31 – Equivalent carbonates.

carbonates. A preliminary $\delta^{13}C$- $\delta^{18}O$ plot of study carbonates provide distinct cluster of carbonates. The carbonates from the western limits of the Delhi Supergroup and the Raialo carbonates occupy their own distinct positions in this plot. Besides the distinct $\delta^{13}C$ values of these two groups of carbonates, differences in their composition and field disposition is also noted. The Raialo carbonates are essentially dolomitic while carbonates around Makarana, Ras, Ambaji, etc., are calcite rich. Furthermore, the carbonates occurring on the western limits of the Delhi Supergroup are formed mainly on older gneisses while the Raialo carbonates represent the lowermost unit of the Delhi Supergroup.

The positive $\delta^{13}C$ values in the metamorphosed carbonates are interpreted to represent carbon isotope composition of pre-metamorphic carbonate, because there is no known process to enrich carbonate in $\delta^{13}C$ during regional metamorphism (Zheng, 1997; Zheng et al., 1998). $\delta^{13}C$ is much more difficult to change than $\delta^{18}O$ in a rock system as the relative masses of C in rock vs. diagenetic fluids is typically such that $\delta^{13}C$ compositions will be buffered towards rock values (Banner and Hanson, 1990). As such, oxygen isotopic compositions of the carbonate will be altered upon diagenesis at a much quicker rate than carbon isotopic compositions.

The $\delta^{13}C$ and its variation during the Proterozoic period is globally recognized (Karhu, 1993; Schidlowski et al., 1975). The Mesoproterozoic carbonates are characterized by typical marine $\delta^{13}C$ values (Buick et al., 1995), while the carbonates deposited during Neoproterozoic period are characterized by high $\delta^{13}C$ values. The Delhi Supergroup carbonates are characterized by low $\delta^{13}C$ values around zero as is typical for the Mesoproterozoic carbonates. The high $\delta^{13}C$ carbonates along the western limits of the Delhi Supergroup may, however, point to their deposition during a period other than Mesoproterozoic and are more typical of the Neoproterozoic period, a period characterized by such high positive $\delta^{13}C$ values.

The perusal of this preliminary data set therefore points to the fact that the correlation of high $\delta^{13}C$ calcitic carbonates with dolomitic Raialo carbonates as has hitherto been believed, needs revision. Further detailed studies are required to resolve the issue of carbonate correlation in the Delhi Supergroup. The detailed isotope study of carbonates from the Delhi Supergroup is however, in progress and more results will be available in the near future.

References

Banner, J.L. and Hanson, G.N. (1990) Calculation of simultaneous isotopic and trace element variations during water-rock interaction with applications to carbonate diagenesis. Geochim. Cosmochim. Acta, v. 54, pp. 3123-3137.

Buick, R., Marais, D.J.D. and Knoll, A.H. (1995) Stable isotope compositions of carbonates from the Mesoproterozoic Bangemall Group, northwestern Australia. Chem. Geol., v. 123, pp. 153-171.

Deb, M. (1980) Genesis and metamorphism of two stratiform massive sulphide deposits at Ambaji and Deri in the Precambrian of western India. Econ. Geol., v. 75, pp. 572-591.

Gao, G. and Land, L.S. (1991) Geochemistry of Cambrian-Ordovician Arbuckle I Oklahoma: implications for diagenetic $\delta^{18}O$ alteration and secular $\delta^{13}C$ and $^{87}Sr/^{86}Sr$ variation: Geochim. Cosmochim. Acta, v. 55, pp. 2911-2920.

Heron, A.M. (1953) The geology of Central Rajputana. Geol. Surv. India, Mem., v. 79, 389p.

Karhu, J.A. (1993) Palaeoproterozoic evolution of the carbon isotope ratios of sedimentary carbonates in the Fennoscandian Shield. Geol. Surv. Finland, Bull., v. 71, pp. 1-87.

Roy, A.B. and Sharma, K.K. (1999) Geology of the region around Sirohi town, western Rajasthan- a story of Neoproterozoic evolution of the Aravalli crust. In: Paliwal, B.S. (Ed.), Evolution of northwestern India, Scientific Publishers, Jodhpur, pp. 19-23

Saltzman, M.R., Runnegar, B. and Lohmann, K.C. (1998) Carbon isotope stratigraphy of Upper Cambrian (Steptoean Stage) sequences of the eastern Great Basins: record of a global oceanographic event. Geol. Soc. of Amer. Bull., v. 110, pp. 285-297.

Schidlowski, M., Eichmann, R. and Junge, C.E. (1975) Precambrian sedimentary carbonates: carbon and oxygen isotope geochemistry and implications for the terrestrial oxygen budget. Precamb. Res., v. 2, pp. 1-69.

Schole, P.A. and Arthur, M.A. (1980) Carbon isotope fluctuations in Cretaceous pelagic limestones: potential stratigraphic and petroleum exploration tool. Amer. Assoc. Petrol. Geol. Bull., v. 64, pp. 67-87.

Sen, S. (1983) Stratigraphy of crystalline Precambrian of central and northern Rajasthan: a review. In: Sinha-Roy, S. (Ed.), Structure and tectonics of Precambrian rocks. Recent researches in geology, 10, Hindustan Publishing Corp. New Delhi, pp. 26-39.

Singh, S.P. (1982a) Palaeotectonics and sedimentation trend of the Delhi Supergroup around Rajgarh, northeastern Rajasthan, J. Ind. Assoc. Sediment., v. 3, pp. 29-44.

Wang, K., Geldsetzer, H.H.J., Goodfellow, W.D. and Krouse, H.R. (1996) Carbon and sulphur isotope anomalies across the Frasnian-Famennian extinction boundary, Alberta, Canada. Geology, v. 24, pp. 187-191.

Zheng, Y.F. (1997) Oxygen and carbon isotope anomalies in the ultrahigh pressure metamorphic rocks of the Dabie-Sulu terranes: implications for geodynamics. Episodes, v. 20, pp. 104-108.

Zheng, Y.F., Fu Bin, Gong, B. and Wang, Z.R. (1998) Carbon isotope anomaly in marbles associated with eclogites from the Dabie mountains in China. J. Geol., v. 106, pp. 97-104.