subjects carrying heterozygous and homozygous state of β^E-globin gene respectively.

A significant difference in Hb F level was also observed in subjects carrying homozygous state of Hb E ($t = 6.31$; $P = 0.000$) when compared with Hb F levels of subjects with normal haemoglobin pattern ($0.19 \pm 0.24\%$). The Hb F level was $0.81 \pm 0.73\%$ and $3.32 \pm 1.15\%$ in subjects with heterozygous and homozygous state of Hb E respectively.

A trend towards lower level of haemoglobin, mean corpuscular volume (MCV) and mean cell haemoglobin (MCH) was observed in subjects carrying β^E-globin gene (Table 1). However, with limited sample size of the present study, statistically significant difference could not be found.

The present study revealed that Hb E is prevalent among the Assamese Sikh community with a gene frequency of 0.209. Prevalence of Hb E has not been reported earlier among the Sikhs and it is considered to be a rare haemoglobin variant in this community[8,9]. However, a case of Hb E–thalassaemia was reported from Ludhina[9]. The gene frequency for Hb E among autochthonous population of Assam is as high as 0.6 (ref. 5). The present observation of Hb E among Assamese Sikhs may be due to the gene flow from autochthonous inhabitants of Assam because of the intermingling of migrant Sikh community with various ethnic groups since their initial settlement in Assam.

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ACKNOWLEDGEMENT. We thank Mr Raktim Dutta, Mr Sandhan Gogoi, Ms Lipika Chaliha and Mr Nilotpal Kaushik for providing technical support during the study.

Received 1 March 2013; accepted 11 March 2013

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Magnesite in the Palaeoproterozoic metasedimentary carbonate sequence of Aravalli Supergroup in Gujarat, western India

Carbonate rocks form a substantial part of the Palaeoproterozoic Aravalli Supergroup in western India. They are good repositories of stromatolitic rock phosphate at Jhamarkotra[1] and Sallopat areas (S. K. Trivedi, unpublished), Cu–Au–Fe mineralization in Banswara[2] and Zn–Pb–Ag in Zawar area[3] in southern Rajasthan. During large-scale mapping and sampling of a phosphate prospect in Champaner Group at Chalvad–Ranjitpura area in Panchmahals district, Gujarat[4], chemical analyses of a few samples yielded high MgO content beyond the compositional limit of pure dolomite (< 21.7 wt% MgO). In the absence of any significant amount of serpentine and talc, the high magnesia content was suspected to be periclase-brucite and/or magnesite. XRD analyses performed on high-MgO samples confirmed the presence of magnesite as a major carbonate phase. Here we report the discovery of magnesite in the Precambrian metasedimentary sequence of northern Gujarat.

The E–W trending metasedimentary sequence in Chalvad–Ranjitpura area forms a part of the Champaner Group of the Palaeoproterozoic Aravalli sequence that occupies about 1200 sq. km area in Vadodara and Panchmahals districts in Gujarat. The Champaner Group comprises mainly of an interbedded sequence of argillaceous, arenaceous and impure calcareous rocks that rest unconformably over the pre-Champaner Gneissic Complex. Gupta *et al*.[5] divided Champaner Group into six formations, viz. Lambia, Khandia, Narukot, Jaban, Mn-bearing Shivrajpur and Rajgarh. The Chalvad–Ranjitpura area exposes almost the entire section of the Champaner Group. The metasedimentary sequence is intruded by granitoids representing 955 ± 20 Ma-old Godhra magmatism[6] in the southern part of the Chalvad–Ranjitpura area (Figure 1).

Dolomite marble is an important member in the Khandia Formation that contains phosphorite-bearing stromatolites. The stromatolitic structures occur as discontinuous bands between Chalvad and Ranjitpura. The phosphatic stromatolite-bearing dolomite marble forms a large-scale antiformal fold that plunges moderately to WNW. Dwivedi (unpublished) carried out close-spaced grid sampling in stromatolitic carbonates in Ranjitpura area. The Directorate of Mining and Geology, Gujarat, followed up with a detailed exploration that involved 1600 m of drilling (N. V. Shah, unpublished). They reported sporadic low-grade phosphorite that analysed generally below 10% P_2O_5. Magnesite occurs at higher structural levels in the antiformal structure in the carbonate sequence.

In magnesite-poor samples, carbonates are represented by calcite and dolomite. There is size-bimodality in carbonate grains. Large idioblastic dolomite grains show features in support of late stage development in the milieu of fine-grained carbonates. The idioblastic dolomites contain smaller carbonate inclusions that together with the matrix define parallel *Si* and *Se* relationship. The other important minerals in carbonate rocks include calcite, talc, tremolite, serpentine and diopside. Apatite in non-phosphatic magnesite-bearing carbonates is always a minor phase that occurs as discrete micron-size particles in carbonates.

In the field, magnesite appears as a dark brown-coloured coarse-grained rock

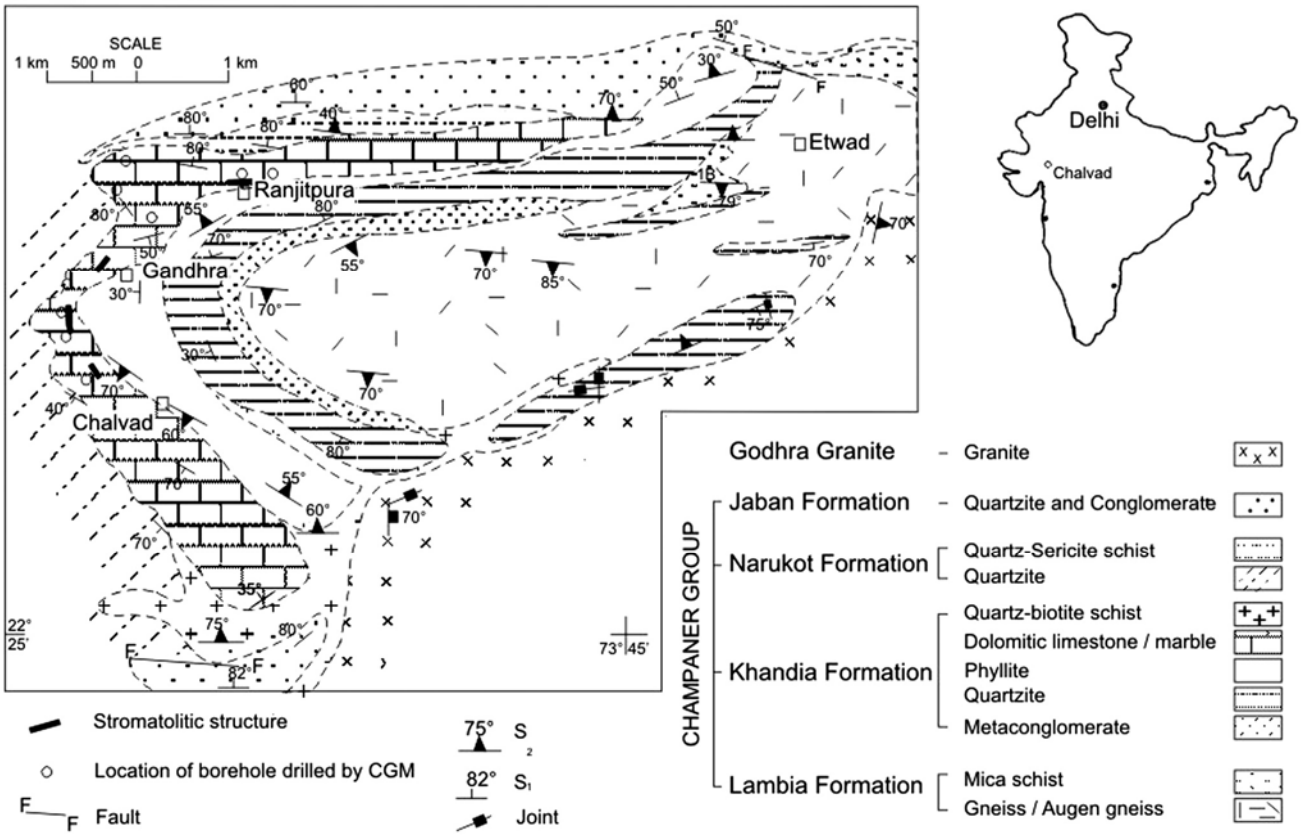

Figure 1. Geological map of Chalvad–Ranjitpura area, Panchmahals district, Gujarat.

Figure 2. Coarse-grained magnesite collected from outcrops near Gandhra road section.

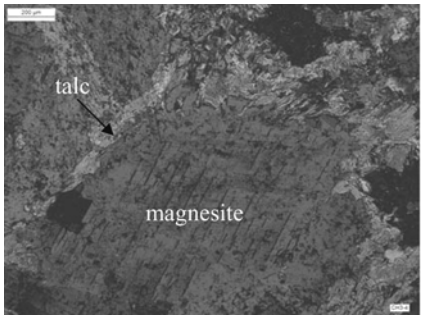

Figure 3. Photomicrograph showing magnesite crystal rimmed by talc.

(Figure 2) that does not produce effervescence with cold dilute HCl. It occurs as small discontinuous bands and patches within the dolomitic marble. It has perceptibly higher specific gravity than the dolomitic marble. Under the microscope magnesite grains are generally rimmed by talc (Figure 3). Size of the individual magnesite grains varies from 1 to 2 mm. It contains small inclusions of carbonates. The petrographic work on magnesite-bearing samples is supported by quantitative XRD analyses that indicate the presence of magnesite (~ 75%), dolomite (~ 12%), clinochlore (~ 5%), talc (~ 5%), quartz (~ 3%) and opaques (> 1%). In the non-magnesitic dolomite sample, the mineral phases are dolomite (~ 89%), calcite (~ 4%) and tremolite (6%), whereas clinochlore and talc occur in traces.

Chemical analyses of a few carbonate samples reveal that barring sample BR-47, phosphatic content in all other samples was found only in trace amounts. In all the phosphorite deposits in Rajasthan, CaO/MgO ratio is very high, generally above 15, as the main phosphatic mineral apatite requires CaO for its formation[7]. In the magnesite-bearing carbonates, this ratio is reversed indicating antithetic relationship between CaO and MgO. Another notable feature of chemical composition of magnesitic carbonate rocks is the high iron content (BR-47 and BR-49). In view of very low opaque mineral content and high LOI (= CO_2), it is believed that iron content may be due to the presence of ankerite in magnesitic carbonates. Despite the occurrence of workable manganese deposits in still higher stratigraphic levels, the MnO content in carbonates associated with magnesite is very low, ranging between 0.1% and 0.55%. Silica varies from 2.93% to 18.88%. Table 1 gives the chemical analyses of five carbonate samples. Samples BR-47 and BR-49 are magnesite bearing whereas the remaining three represent dolomite with minor calcite.

In contrast to vein-type magnesite in ultrabasic rocks, the sedimentary magnesite deposits are ascribed to various processes; from replacement of dolomite through hydrothermal fluids that emanated from extraneous sources[8], to algae-facilitated magnesite deposition[9] in tidal flat environment[10]. In the Chalvad–

Table 1. Chemical analysis of carbonate samples, Chalvad–Ranjitpura area, Panchmahals district, Gujarat

Oxide (wt%)	BR-33	BR-36	BR-47	BR-49	BR-51
Al_2O_3	0.89	0.67	0.74	1.50	4.31
Fe_2O_3	1.46	3.81	14.55	14.37	3.81
CaO	34.53	33.04	11.49	2.11	23.65
MgO	16.23	15.62	24.89	28.61	14.83
MnO	0.10	0.53	0.55	0.55	0.11
P_2O_5	0.01	0.04	8.85	0.19	0.10
SiO_2	2.93	5.27	3.65	8.89	18.88
LOI	43.89	41.08	36.25	43.68	33.59
Total	100.03	100.06	100.97	99.90	99.38

Ranjitpura area, there is petrographic evidence of dolomitization as revealed by larger dolomite porphyroblastic grains in the milieu of finer dolomitic marble. Preliminary evidence indicates that continued flux of magnesian fluids led to the formation of magnesite in an evaporitic setting that best approximates the present-day deposition of magnesian carbonates in a starved Coorong Lagoon in South Australia, which also supports algal stromatolitic growth[11]. The present discovery of magnesite opens a new line of work and the search may be extended to other parts of carbonate sequences in the Proterozoic Aravalli Supergroup.

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ACKNOWLEDGEMENTS. We thank Shri K. Parida, Deputy Director General and Head, Geological Survey of India, Western Region, Jaipur for support. We also thank the Petrology, Petrochemistry and Ore Dressing laboratory, Geological Survey of India, Bangalore for help with the magnesite samples and Deputy Director General, Training Institute of the Geological Survey of India for his encouragement.

Received 27 August 2012; revised accepted 5 March 2013

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