Dolomitisation in the northern part of the Chhattisgarh Basin, Bilaspur District, Madhya Pradesh

P. G. ADYALKAR AND V. N. DUBE

Abstract

Dolomite, occurring in the shale-limestone sequence of the Raipur Stage of the *Precambrian sedimentaries of the Raipur Series in the northern part of the Chhattisgarh* basin, was formed by dolomitisation of the calcium carbonate sediments in two phases. The dolomitised sediments were deposited in a linear, shallow, near-shore, uneven basin, which was divided into (i) closed or partly connected, shallow, sub-basin and (ii) isolated, comparatively deeper and 'starved' sub-basin. Higher values of pH, PCO_2, Mg/Ca ratio and CO_3 ion concentration prevailing in the closed, shallow sub-basin gave rise to an early replacement forming extensive dolomite bodies. The second phase, responsible *for veins and smaller irregular dolomite bodies was effected by the Mg-ions released* during the recrystallisation of calcite and labile material of the limestones and their subsequent diffusion by the squeezed out connate waters.

Solution features developed during dolomitisation and subsequently by surface and groundwaters have induced secondary porosity in the dolomite. These are therefore significant for groundwater exploration in the area.

Introduction

Dolomite occurs at a number of places in the northern part of the Chhattisgarh basin in Bilaspur and Raipur districts of Madhya Pradesh. These are significant as they throw considerable light on their depositional environment, mode of origin and the configuration of the basin, in which the sediments were deposited.

Geological Setting

The Chhattisgarh basin is occupied by rocks belonging to the Precambrian sedimentaries of the Raipur Series (Adyalkar *et al.* 1975).

The northern and western margin of the Chhattisgarh basin is occupied by the formations trending in a NE-SW direction with low or sub-horizontal dips in the northwest and southeast directions. The lenticular limestone, shale and sandstone formations of the Raipur Stage frequently show off and onlap relationship, and directly rest over the basement along the periphery of the basin. Small isolated exposures of these formations also occur amidst the Archaean metamorphics as outliers.

Occurrence of Dolomite

The dolomite occurs as lenses or as irregular bodies of varying shapes and dimensions ranging from a few metres to tens of kilometres associated with the shale-limestone sequence of the Raipur Stage. At a few places it occurs as thin veins along joints and fractures of the enclosing rocks.

The dolomite occurring within the shaly horizon forms extensive bands traceable as a distinct formation. The Hirri (21°58' : 82°03') dolomite band is 80 m thick and extends over 15 km in a NE-SW direction. It continues further in either direction and shows conformable contact with both the overlying and the underlying shales. In Chilhati (21°47' : 82°18') area, a 40 m thick dolomite band extends for about 20 km in both NE-SW and E-W directions showing discordant relation with the adjoining shales and the dolomitic limestones.

The dolomite associated with the limestones occurs as irregular bodies and lenticular masses, usually small extending for a few metres only. The largest lens, about a kilometre long, trends roughly in a N-S direction and is exposed near Dhaneli (21°48′ : 82°06′). Smaller irregular discordant dolomite bodies showing many tongues and protuberances are exposed at Amaldiha (22°51′ : 82°09′), Chhedolia (22°54′ : 82°23′), and Heraspur (22°53′ : 82°53′).

Description of the Dolomite

The dolomite is a grey, fine to coarse grained, massive rock showing circular or elliptical rings (10-40 cm in diameter) on weathered surfaces. The coarse grains are aligned oblique to the bedding planes of the adjoining rocks and often penetrate into them. The fine and coarse grains form 1 to 2 m thick alternating layers showing sharp contact with enclosing rocks. Faint to well developed algal structures are generally present. Sometimes voids ranging from 0.1 to 0.5 mm in diameter are aligned parallel to the stromatolitic laminae. Bedding planes are usually faint or entirely missing. Faint bedding planes show continuity from the dolomite body to the adjoining rocks. Sometimes, unsupported patches of limestones and shales are present within the dolomite. Stylolites, drusy quartz, calcite and quartz veins are found in the dolomite bodies. In Hirri area, slickensides, brecciation and carbonaceous encrustations around dolomite grains are noticed at a few places.

Solution Features in the Dolomite

Number of solution features are present in the dolomite. Clints, karrens and grikes ranging from a few cm to over a metre wide are generally present. Giant potholes (3.7 m × 1.7 m), large caves (up to 10m long) are located in the Hirri area. Cavities measuriug a few cm to over 1.6 m wide are encountered at 5.6, 10, 15, 18, 23 and 29 m below ground level in the Hirri and Chilhati areas, and are generally filled with gypsiferous clays.

Alignment of these solution features conforms to the joint pattern of the area and more particularly to the NNE-SSW and ESE-WNW trending planes, suggesting thereby a well-knit structural control.

Biohermal Structures in the Dolomite

In Hirri area, two biohermal structures, aligned in a NE-SW direction show well preserved core, quaquaversally dipping flanking strata and flat distal beds in the dolomite (Fig. 1). They show elliptical outline with larger axis 280 m and shorter axis 240 m long. The central part, consisting of grey, dense, horizontally bedded dolomite with well preserved stromatolites, forms the core of the bioherm. The core also has an elliptical shape with long and short axes of 178 m and 120 m respectively. Grikes, cavities and giant potholes are frequently present in this part of the bioherm. The core area is flanked by steeply dipping fine-grained limestone and sandy carbonate beds. In the latter, coarse sandy calcareous grains are loosely held in a poor matrix. The flanking beds are usually devoid of algal structures, but at a few places, poorly preserved stromatolites are present. The zone of flanking strata varies from 20 m to 80 m in width, and is marked by the presence of voids, strong silicification and brecciation. The southern bioherm shows angular to subrounded fragments of quartz, dolomite and limestone ranging from 1 to 20 cm in diameter embedded in a fine-grained limestone. The zone of flanking strata is further surrounded by fine grained, light grey, non-stromatolitic, horizontally bedded dolomite. Thin veinlets of quartz and up to 10 cm thick veins of calcite are, however, present in these beds, particularly in the vicinity of the northern bioherm.

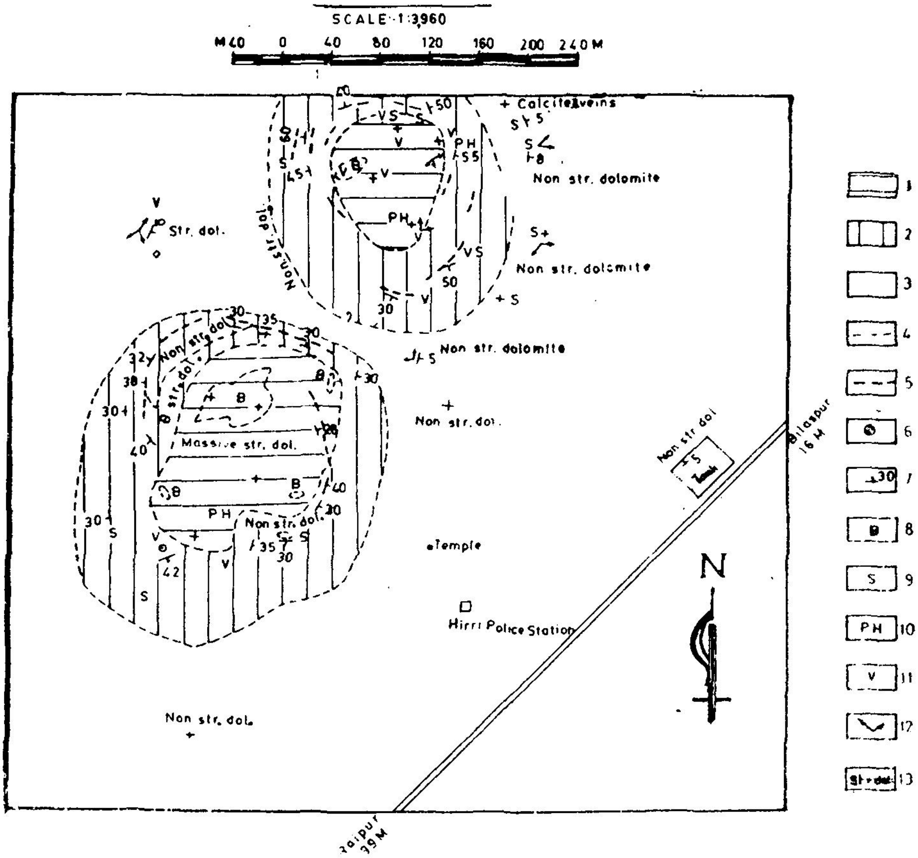

Figure 1. Map showing bioherms in dolomite formation, Hirri area, Bilaspur District, M.P.

Expl. 1. Core of the bioherm, 2. Flanking strata zone of the bioherm, 3. Distal beds of the bioherm, 4. Zonal boundary, 5. Trace of the bedding plane, 6. Horizontal bed 7. Strike and dip of the beds, 8. Brecciation, 9. Silicification, 10. Giant potholes, 11. Voids in the rock, 12. Trend of grikes, 13. Stromatolitic dolomite.

Discussion

From the available observations relating to changes in the rock fabric, obliteration of algal structures, sharp contact of dolomitic layers and oblique alignment of recrystallised grains of dolomite along the bedding planes of the enclosing rocks, it is clear that dolomitisation has taken place in the area. Shukla *et al* (op. cit) have also arrived at similar conclusions after detailed investigation of the Chilhati dolomite deposits. Indeed it is the environment and the mode and stages of dolomitisation that require critical examination from the evidences afforded in the area vis-a-vis established theories describing dolomitisation of ancient carbonate sediments.

The geological setting and lithological association indicates uneven topography along the northern and western margins of the Chhattisgarh basin. Association of red, siliceous and calcareous shales with the stromatolitic limestones suggests condition of evaporite formation. Massive bioherms and algal reefs occurring in the limestones are suggestive of their growth in intertidal zone (Pettijohn, 1957, p. 626; Logan, 1961). Frequent lenticular intercalations of dark, carbonaceous, thinly laminated, pyritous, cherty shales with nonstromatolitic limestone lenses show deposition under isolated 'starved basins' (Pettijohn, 1957, p. 625). Thus, the overall depositional picture appears to be a near-shore, shallow, uneven basin, which was divided into many partly or completely isolated smaller sub-basins. Depositional environments under such conditions would show large variations. The isolated 'starved' sub-basins would be marked by low pH, Eh and slow rate of sedimentation. On the other hand, higher values of pH, Eh and CO_3 ionic concentration would prevail in the shallow, partly connected or closed sub-basins. Cloud (1962), after working in Bahamas concluded that under higher values of pH, Pco_2 and CO_3 ionic concentration in the depositional milieu, the Mg/Ca ratio in the sea water increases to a degree which is sufficient to cause early dolomitisation. Investigations by Shinn *et al.* (1965) on lime mud flats of the Caribbean Sea have shown that the evaporation of sea water increases the Mg/Ca ratio in the intertidal waters to a value that permits replacement of calcium carbonate sediments by dolomite. The reflex theory of Adams and Rhodes (1960) explains dolomitisation by downdip migration of highly saline dense waters from lagoons through the underlying carbonate sediments. The Hirri dolomite and other similar massive bodies are marked by invariable association with algal and biohermal carbonate beds showing well to poorly preserved primary sedimentary and organo-sedimentary structures, considerable thickness (up to 80 m) and extensive areal distribution, particularly in the peripheral regions of the main Chhattisgarh basin. Hence it appears that these dolomitic bodies, showing bedding plane continuity with the host rocks, were dolomitised prior to lithification of the sediments.

The dolomite veins and smaller irregular discordant bodies, however, show evidences that suggest their formation later, after the formation of the sediments. Frequent association of stylolites, drusy and vein quartz and calcite veins with these bodies suggests changes in the limestones caused by recrystallisation of calcite and dolomite and segregation of silica from the matrix. Cloud (1962) has shown that the process of dolomitisation is effected by the magnesium, derived from the solid solution of calcite by an upward and updip migration of the squeezed out connate waters.

Conclusions

Based on the above discussion, the following tentative conclusions have been drawn:

1. The shale-limestone sequence of the Raipur Stage was deposited in a linear, uneven, near-shore, shallow basin, which was divided into many partly connected or isolated sub-basins located in the vicinity of each other.

2. The original calcium carbonate sediments have undergone dolomitisation in two phases; the earlier phase was caused by the higher Mg/Ca ratio in sea waters, while during the second phase dolomitisation was effected by the Mg ions derived from the recrystallisation of calcite and the labile material (i.e. matrix) of the limestones.

3. The various changes culminating in the dolomitisation of limestones have created a large number of voids, cavities, ponors and embuts in the dolomite bodies. Solution features like giant potholes, grikes, clints, and karrens, were developed subsequently by surface waters and groundwaters in the dolomite in preference to limestone as magnesium is more soluble than calcium. These solution features have

induced secondary porosity in the dolomite which would act as effective conduits for groundwater movement. The dolomite deposits are therefore, promising aquifers for groundwater development in the area.

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Address of the authors

P. G. ADYALKAR and V. N. DUBE, Central Groundwater Board, Nagpur.

A note on the occurrence of *Eurydesma* and *Deltopecten* assemblage from the Kuling Formation (Permian) Baralacha Ban Area, Lahaul Valley, Himachal Himalaya

S. V. SRIKANTIA, O. N. BHARGAVA, AND H. M. KAPOOR

Abstract

This note records the occurrence of *Eurydesma* and *Deltopecten* assemblage from the Kuling Formation (Permian) of Lahaul and discusses its significance.

Introduction

During a Himalayan geodynamics expedition to Lahaul and Rupshu, two of us (SVS and ONB) mapped the area between the Rohtang Pass in Lahaul and Upshi in Ladakh which also includes certain hitherto uncovered areas. In the course of mapping, besides several other Permian fossils, a shell of *Eurydesma cordatam* Morris and impressions of *Deltopecten cf. mitchelli* (Etheridge and Dun) were recovered (Srikantia, 1974) from the Kuling Formation (Permian) exposed near Baralacha Ban area about 7 km, southeast of Baralacha Pass, in the Lahaul Valley, Himachal Pradesh, (Fig. 1). The present note records the description and significance of these fossils.

Geological Set-up

In earlier maps published by the Geological Survey of India, the area is shown to contain only Precambrian Formations. However, the present survey has established the existence of a complete sequence ranging from Precambrian to Triassic.