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Role of Cementing Material in the Diagenetic History of Bhander Limestone of Simariya Area in Panna District, Madhya Pradesh

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Abstract*: Petrological studies of Bhander Limestone of Simariya area in Panna District indicate that the limestone has sparry calcite cement. On the basis of fabric characteristics of spars, four types of sparry calcite cements are noticeable (1) Fibrous non-ferroan calcite cement (2) dog tooth fringe cement (3) syntaxial rim cement, and (4) Drusy mosaic cement. Microfacies indicates that the Bhander Limestone was first chemically precipitated as lime mud, which was disintegrated by wave action, carried and laid down as oomicrite and intramicrite. Fibrous cement, forming coating of allochemical grains, must have undergone syngenetic precompaction. Percolating waters dissolved the fibrous aragonite, and calcium carbonate so liberated formed the low-magnesian, non-ferroan dog tooth fringe cement into which the fibrous cement grades. These cements were formed due to the effect of circulating water in the pore filling under near surface intermittently emergent marine environment. After early diagenetic cementation and partial lithification, the Bhander limestone has undergone a shallow submergence, where pore water chemistry favoured precipitation of ferroan calcite as drusy mosaic cement in the moldic porosity created during dissolution. It is a second generation ferroan calcite cement, which precipitated in the reducing environment, which is also late diagenetic. Ferroan nature of micrite calcite also point out its formation in a reducing environment. Other diagenetic changes in the limestone include neomorphism, silicification and dolomitisation and compaction and pressure solution.

***Keywords*: Limestone.**

1. Introduction

Study of diagenetic history of Bhander Limestone is likely to provide insight into various physical, geochemical and biological processes which influenced its diagenesis. In view of growing interest of the various cement industries present study of carbonate rocks assume significance. Present paper examines the diagenetic evolution of Bhander Limestone of the Simariya area in Panna District. Limestone of this area has undergone both early and late diagenetic modifications.

2. Cementing Material and Diagenetic History

As per Bathurst (1975), "Cement" include all passively precipitated space filling carbonate crystals which grow attached to the free surface. Folk (1965) called it "precipitated calcite". Cement occurs in the form of Micrite calcite (which has a very less evidences therefore the description of the same has not been given) and sparry calcite in the Bhander Limestone of Simariya area.

A. Sparry calcite cement

The sparite, which is a clear calcite comprises cement as grains of more than 10-micron size (Folk, 1959), occurs in granular, fibrous and drusy forms. Most commonly it is a pore filling cement and pores are often lined first by fibrous calcite. A hybrid fabric invoving both micritic and sparry calcite is also seen in a few thin sections. On the basis of fabric characteristics of the spar four types of sparite cements have been recognized in the limestone of the study area.

1) *Dog tooth fringe cement:* It is an important cement in all microfacies of the dark grey limestone excepting the micritic one. Dog tooth crystals are non-ferroan calcite. There is noticeable size difference between the crystals of the fringing dog tooth and the central mosaic of the crystals filling the cavity (Fig.1). The fringe generally shows undulose extinction indicating some strain effect during its formation, but the crystals maintain their crystallographic identity. In many cases the dog tooth fringe observed on oolites and intraclasts, occurs directly over the grain boundaries or over the fibrous calcite cement with transitional boundary. Width of fringe and size of individual crystals are variable from grain to grain and even in a single grain.
2) *Fibrous non-ferroan calcite cement:* This forms only a partial cement in the microfacies of the dark grey variety. It is observed as crusts over oolites and peloids and is best developed in the oosparite and intrasparite microfacies. The fibrous are oriented at right angles to the grain surfaces. Generally, this cement terminates into dog tooth shaped crystals which are in optical continuity with the fibres (Fig. 1) and are mainly non-ferroan. It is associated with immediate contact with allochem grains that's why it is of first generation. Non-ferroan nature further

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supports its origin from surface waters in an oxidizing environment.

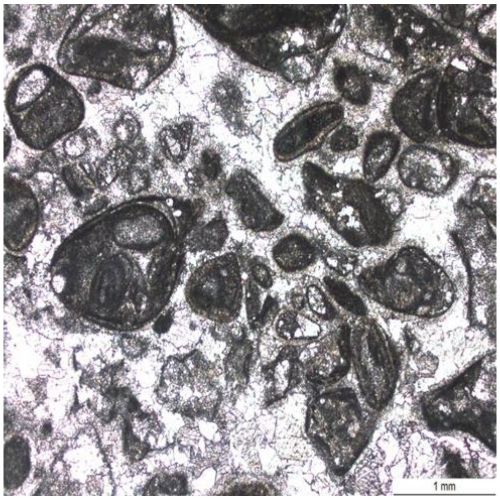

Fig. 1. Composite ooids. More than one ooids within a layer. Most of the ooids are micritic, setup in matrix of Sparry calcite. Fibres and dog tooth calcite crystals are seen at the top of photo. (Pol. Light)

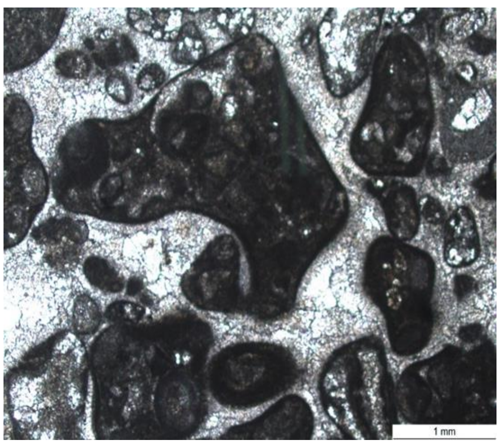

Fig. 2. Lumpstone, ooids enclosed within an envelop. Lumps are of various shapes and size. Sparry calcite cementing these lumps. The cement displays drusy texture The small calcite crystals around the margins of lumps are oriented with their long dimensions perpendicular to lump surfaces. These small oriented crystals grade towards the centre of the pores to larger randomly oriented calcite crystals. (Pol. Light)

3) *Drusy mosaic cement:* There are many isolated spaces filled with sparite exhibiting all the characteristics of drusy mosaic outlined by Bathrust (1958, 1964 & 1975). The dog tooth spar of earlier generation, in which the crystals are commonly scalenohedral in habit, is covered by the larger crystals of the second generation. The size of these mosaic of equant anhedral calcite crystals increases away from the walls of the empty space into which the crystals grew (Fig. 2). It is found generally in association with the dog tooth fringe, the scalenohedral faces of which are preserved under the later overgrowth of the mosaic cement. The differences in the grain size and chemical composition of the two cements indicate a time gap and environmental change between the two phases of cementation (Bathrust,1975). Lack of any collapse feature around the margins of drusy calcite filled cavaties indicates that most of the drusy mosaic was formed after consolidation of these limestones. Friedman and Sanders (1978) have demonstrated that drusy mosaic, which is so common in carbonates, may form due to precipitation of calcite from fresh water at late diagenetic stage.
4) *Syntaxial rim cement:* This type of cement has a very little occurrence and is seen only in a few microfacies with micrite allochems and occurs as overgrown crust on them. This secondary over growth is of clear ferroan calcite and the host and rim are syntaxial, i.e. in optical continuity. The crystalline mosaic produced by this overgrowth is characterized by planar intergranular boundaries.

Fig. 3. Elongated lithoclasts enclosed within a single layer, initially micritic but showing different phases of Neomorphism. A few fragments are completely Neomorphosed.Development of Neomorphic spars from an original Dog Tooth and Drusy Mosaic Cements. (Pol. Light)

3. Other Diagenetic Changes in the Limestone of Study Area

Compaction and pressure solution: Some ruptured allochems and spalled oolitic envelop present in the limestone indicates some amount of compaction prior to early lithification (Zankel, 1969). The effect of pressure solution manifested in the formation of stylolites, which are shown mostly in dark grey limestone. These are in various size from micro to 4 cm amplitude. Most stylolites are conformable type suggesting pressure solution along parallel lines. The general trend of stylolites are parallel to bedding planes on which the allochems were physically oriented by currents at the time of deposition. The stylolites are of post- cementation in origin, because they transect the intergranular cement in the cavities. Allochems grains are commonly dissolved along the stylolites even opposite to the matrix which suggest that stylolisation took place after lithification.

Silicification: The manifestation of silisification is seen in the form of development of nodular and bedded cherts of light to dark grey in colours. Nodular cherts are usually seen along or parallel to bedding plane. Mostly they are less than the 15cm of diameter. At places the outer parts of certain nodules is porous and shows chalky appearance. Though the chert possibly represents a single period of late diagenetic replacement, which is known to be the end product of silicification process (Pettijohn,1975), reports are also available for early diagenetic mobilization of Silica (Matheney and Knauth, 1993). Chert formation can also take place due to precipitation of primary silica from the circulating ground water (Mason, 1966; Thayer,1983).

Neomorphism: Limestone of the area shows aggradational (cf. Folk, 1965) type of Neomorphism by the recrystallization of the originally precipitated lime mud to a mosaic of coarse crystals of calcite (Fig. 3) through various stages of grain enlargement. Fine crystal mosaic has been replaced by coarse one without change in mineralogy as well as without passing through intermediate stages porosity development. Sparry mosaic show curved and irregular boundaries and their contacts with allochems are gradational (Fig.2). Micrite relicts and inclusions are also observed. Neomorphism is more pronounced in the micron size crystals. Since the growth of neomorphic spar is known to begin in the partly consolidated sediment (Bathrust, 1975), the neomorphism in the Bhander Limestone seem to have taken place before early diagenetic phase of cementation.

Dolomitisation: Dolomitisation is either sporadic or ubiquitous and is very common in the stromatolitic microfacies where the alternating lighter laminae are always composed of tiny rhombohedra of Dolomite. Dolomitisation is more prevalent in the matrix than in pellets and oolites. According to Gabelein and Hoffman (1973), Dolomitised layers represent the original algal layers. The preferential development of Dolomite indicates its post – depositional and late diagenetic origin.

4. Conclusion

On the basis of above illustrations, it may be inferred that first the Bhander Limestone was chemically precipitated in calm water as aragonite lime mud, which was later transformed into low Mg- Calcite. Such lime mud got disintegrated due to wave action and carried as oomicrite and intramicrite to the neighbouring parts of the depositional site, below the zone of wave action where lime mud precipitation continued (evidenced by mud-supported fabric; Okhravi and Lahijani, 1994). Along with the deposition of the lime clastics, fibrous aragonite cement developed as crust over some of the allochems. Due to the intermittent subarial exposure of these sediments, the Aragonite micrite was recrystalised which caused the formation of non-ferroan neomorphic spar. The conversion of syngenetic fibrous aragonite cement into low Mg- calcite cement was without any change in the habit. The aragonite grains were partially dissolved by percolating water. Calcium carbonate available from such dissolutions resulted into precipitation of dog tooth fringe non-ferroan calcite. This marked the early diagenetic phase of cementation. After partial lithification in the emergent marine environment, the sedimentary pile was apparently submerged, where reducing conditions prevailed. Moldic pores created by dissolution in the intermittently emergent marine settings were filled up by a drusy mosaic of ferroan calcite, marking the late diagenetic phase of cementation. Syntaxial rim of ferroan calcite and chert also formed in this reducing environment. Pressure solution and further compaction and final reduction of porosity apparently took place during this period.

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