A STUDY OF OOLITES FROM THE GANGOLIHA T
DOLOMITE, KATHPURIA CHHINA AREA,
ALMORA DISTRICT, U.P. WITH SPECIAL REFERENCE
TO DIAGENETIC CHANGES

S. KUMAR and V. C. TEWARI*
Geology Department, Lucknow University, Lucknow

ABSTRACT

A well developed oolitic horizon is recorded from the lower part of the
Gangolihat Dolomite. The oolitic horizon is interbedded with stromatolitic
dolomites and intraformational conglomerate. On the basis of the internal
structure and composition five different types of oolites are recognised: con-
centric, concentric cum radial, composite, siliceous and pseudo oolites. These
oolites have been subjected to diagenetic changes in 3 stages, namely (1) recry-
 stalization (2) dolomitization and (3) silicification. On the basis of the presence
of the oolites, the environment of deposition of these dolomites is discussed.

INTRODUCTION

The oolites are recorded from the rocks ranging in age from Precambrian
to Recent from all over the world. Most of them are considered to be of marine
origin though primary fluvial and lacustrine oolites have also been recorded
(Bradley, 1964; Eardley, 1966; Mc Gannon, 1975). Contemporary oolites have
been extensively studied in the Carrebbean Sea, the Mediterranean Sea, the
Persian Gulf and the Gulf of Mexico and other areas. These studies helped in
better evaluation of oolites in deciphering both physical parameters and chemical
milieu in ancient rocks.

In India, not much work has been done on oolites. Bassi and Vatsa (1971)
recorded the oolites from the Upper Tal Member of the Tal Formation of Rishi-
kesh area and studied the shape, size and depositional environment of oolites.
Sarkar (1973) has studied the deformation of oolites in the Precambrian Bhandar
Limestone (Upper Vindhyan) from Maihar area, M.P. Kharakwal and Bagati
(1974) have recorded the siliceous oolites and pisolites from the carbonate rocks
of the Krol Formation, Simla Himalaya. Mukherjee and Chaudhari (1975) have
studied the oolitic rock of Naya Bazar, Sikkim Himalaya. There is a casual
mention of the occurrence of oolites from the Calc Zone of Pithoragarh (Valdiya,

*Present Address : Wadia Institute of Himalayan Geology, Dehra Dun.
In the present paper a thin oolitic horizon in the Gangolihat Dolomite exposed on the mule track between Kathpuria Chhina and Dhuraphat, Almora District, U.P., is studied with special reference to the environment of deposition and diagenetic changes.

For the study of oolites, the thin sections were prepared and stained with Alizarine Red S solution as suggested by Friedman (1959), for the identification of calcite and dolomite. The size measurement of 300 oolites has been done under the microscope with the help of eye piece micrometer.

**GEOLOGICAL SETTING**

A great thickness of sedimentaries between the Central Crystallines and the Crystalline Zone of Almora has been designated as the Zone of Badolisera by Heim and Gansser (1939). These sedimentaries have been litho-stratigraphically subdivided into two groups by Valdiya (1962); the younger is the Berinag Quartzite and the older is the Calc Zone of Pithoragarh. The Calc Zone of

**TABLE 1**

LITHOSTRATIGRAPHIC SUCCESSION OF THE CALC ZONE OF PITHORAGARH; BY KUMAR AND KUMAR, (1977 MODIFIED AFTER VALDIYA, 1968)
Pithorāgarh has been further subdivided into different lithostratigraphic formations (Valdiya, 1968) (Table 1).

There are two views regarding the tectonic position of these sedimentaries. Misra and Valdiya (1961), Valdiya (1962), Misra and Kumar (1968) and Misra and Banerjee (1968) considered that the different formations of the Calc Zone of Pithorāgarh are regionally overturned. Heim and Gansser (1939), Gansser (1964), Banerjee (1975), Ahmed (1975), Ramji (1976) Kumar and Tewari (1977) have regarded them to be normal. In the present area the sedimentaries are considered as normal (Fig. 1).

![Geological map of Kathpuria Chhina area, district Almora, Uttar Pradesh.](image)

Fig. 1. Geological map of Kathpuria Chhina area, district Almora, Uttar Pradesh.

1. Crystalline Zone of Almora,
2. Sor Slate,
3. Gangolihat Dolomite,
4. Berinag Quartzite.
Stromatolitic dolomite with *Stratifera* and *Conophyton misrai* associated with crystalline magnesite

Stromatolitic dolomite with *Conophyton garganicus* and *Colonella columnaris*

Oolitic dolomite

Stromatolitic dolomite with *Conophyton garganicus* and *Colonella–columnaris*

Fig. 2. Litholog of the lower part of Gangolihat Dolomite, Kathpuria Chhina area, district Almora, U.P.
Study of Oolites from the Gangolihat Dolomite

Fig. 3. Detailed litholog of oolitic horizon showing vertical succession of sedimentary structures, Gangolihat Dolomite, Kathpuria Chhina area, district Almora, U.P.

- Thinly laminated dolomite with oolitic bands
- Thinly laminated dolomite with intraformational conglomerate and oolitic band
- Thinly laminated dolomite together with intraformational conglomerate
- Thinly laminated dolomite with oolites
- Thinly laminated dolomite together with oolitic band and intraformational conglomerate
- Thinly laminated dolomite together with intraformational conglomerate
- Oolitic band with bands of lenticular dolomite thinly laminated dolomite alternating with oolitic bands
- Thinly laminated dolomite interbedded with penecontemporaneous deformation structure and ripple lamination
- Thinly laminated bluishgray dolomite, parallel bedding with low angle discordances and oolitic dolomite with ripple lamination
Gangolihat Dolomite

The Gangolihat Dolomite occupies a vast region in the Almora-Pithoragarh district, U.P. It is represented by dolomite, dolomitic limestone, stromatolitic dolomite, limestone, intraformational conglomerate, slates, bedded magnesite and talcose phyllites. The varied lithologies are intimately interbedded. The Gangolihat Dolomite is characterized by extensive development of columnar stromatolites in association with crystalline magnesite.

Recently, Kumar and Tewari (1977) have recorded the association of *Conophyton garganicus* and *Colonella columnaris* from the lower horizon of Gangolihat Dolomite from Kathpuria Chhina area, Almora district, U.P., with which is associated a metre thick oolitic dolomite horizon (Fig. 2, 3). The litholog showing oolitic horizon is shown in Fig. 2. The sedimentary structures associated with this horizon are thinly laminated dolomite with low angle discordances, ripple laminations, small scale current bedding, penecontemporaneous deformation structures and intraformational conglomerate (Fig. 3).

OOLITES

The oolite has been defined as a spherical or sub-spherical body, 0.25 to 2 mm in diameter of any composition usually displaying a nucleus around which at least one concentric layer has been deposited by an accretion process (Carozzi, 1960). In the present study the oolites are made up of dolomite. The rock showing presence of oolites is made up of intraclasts which are embedded in a sparry dolomite cement. The rock may be termed as oosparite (Folk, 1959).

DESCRIPTION OF OOLITES

The oolites have been classified into five major types on the basis of their internal structure and composition. Their relative size distribution is shown in Fig. 4.

1. Concentric oolites 34%
2. Concentric cum radial oolites 41%
3. Composite oolites 6%
4. Siliceous oolites 12%
5. Pseudo-oolites 7%

1. Concentric oolites

The concentric oolites are mostly circular, oblate and elliptical in shape showing concentric rings with or without a nucleus (Plate II—3). Oolites show successive as much as 26 concentric rings as a result of accretionary growth. Most of the oolites have a nucleus which is circular, rhombohedral or polygonal in shape and is made up of microcrystalline dolomite. The concentric oolites
range in diameter from 0.3 to 0.9 mm. The average equatorial diameter is 0.65 mm.

2. **Concentric cum radial oolites**

The oolites showing both concentric as well as radial features are termed as concentric cum radial oolites (Plate I—1, II—4, 5). The radial texture superimposed over concentric pattern shows alternating 6 to 22 spokes of microcrystalline dolomite. Mostly the oolites are elliptical in shape but oblate and circular are also recorded. Concentric cum radial oolites have nucleus of variable size and shape composed of dolomicrite. The concentric cum radial oolites are
larger than concentric oolites. They range in diameter from 0.52 to 0.9 mm. The average equatorial diameter is 0.78 mm.

3. Composite oolites

Surrounded by a common envelope the composite oolites are mostly concentric cum radial oolites which are joined to each other through the extension of one of them (Plate I—3, II—1). Composite oolites with two and even three centers have been seen. The rest of the features are similar to concentric oolites. They range in diameter from 0.23 to 0.53 mm. The average equatorial diameter is 0.34 mm.
4. **Siliceous oolites**

Siliceous oolites show no distinct features. They are made up of microcrystalline to crypto-crystalline silica (Plate I–4). Sometimes a central nucleus of variable size is seen. Presence of ghosts of dolomicrite observed in the nucleus as well as in outer layers indicate that these bodies have originated in situ, by selective silica replacement of the original carbonate oolites. Silicification of carbonate oolites varies in degree from partial replacement of nucleus or concentric layers to complete replacement of both. Microtexture and structure in siliceous oolites are rarely preserved. They range in diameter from 0.42 to 0.8 mm. The average equatorial diameter is 0.6 mm.

5. **Pseudo-oolites**

Rounded to elliptical bodies made up of microcrystalline dolomite and less than 2 mm in diameter showing no internal structure have been termed pseudo-oolites (Plate I–2). Pseudo-oolites are larger in size than the associated oolites. They range in diameter from 0.30 to 2 mm. The average equatorial diameter of pseudo-oolite is 0.83 mm.

**DIAGENESIS**

The oolitic horizon of the Gangolihat Dolomite of the present area clearly demonstrates diagenetic processes of dolomijization, recrystallization and silicification. The oolites have affected the pattern of diagenesis and the oolitic texture is quite helpful in deciphering the diagenetic process. The study of ancient and modern oolites suggests that the original oolites are made up of either aragonite or calcite (Friedman, 1964; Swett, 1965; Kahle, 1974; Mc Gannon, 1975). In the present work also it is assumed that the original oolites were aragonitic or calcitic. Replacement of calcitic oolites by dolomite and silica, accompanied by loss of structural details of the oolites supports the validity of this assumption.

**DOLomitization**

The original oolites were made up of aragonite or calcite with concentric structure in calcareous matrix. The original rock was completely altered by dolomitization as there is no trace of the original composition. It seems that dolomitization started in the groundmass by the development of rhombs and irregular grains of dolomite. Later on, dolomitization affected the oolites which resulted in the obliteration of the concentric texture of the oolites due to the development of dolomite rhombs. However, at this stage the original outline of the oolites was still preserved. In the final stage oolites were completely transformed into microgranular globules which differ from the surrounding dolomite cement in having smaller size of the dolomite granule.
SILICIFICATION

The shape, size and texture of the siliceous oolites is similar to that of carbonate oolites. The siliceous oolites are made up of wholly or partially of cryptocrystalline and microcrystalline silica. They consist of a central nucleus surrounded by faint concentric rings. Dolomicrite observed in the core and the microcrystalline silica in the outer layers indicate that these siliceous oolites are formed by silica replacement of the original carbonate oolites (Plate II—3, 4). Silicification varied in degree from partial replacement of core and concentric layers to complete replacement of dolomite by silica. In the final stage the oolites are entirely made up of silica. The oolitic texture of completely silicified oolites is retained where the silicification was rapid and the silica was microcrystalline. The internal structure has been lost where the replacement was slow and the silica was fine to medium textured chert. Silicification has also produced pseudomorphs of microcrystalline quartz by the preservation of rhombic outlines of replaced dolomite.

DIAGENETIC SEQUENCE

The diagenetic trend observed in oolitic dolomite of Kathpuria Chhina area can be summarized in the following sequence:

1. Recrystallization
2. Dolomitization
3. Early Silicification
4. Late Silicification.

To explain the diagenetic sequence and the inter-relationship of the various authigenic replacements it is assumed that the oolites were originally made up of aragonite or calcite with or without clacareous matrix. These oolites show radial structure superimposed over concentric rings which of diagenetic secondary origin as exhibited by certain radial fibers which extend out side the envelope, encroaching on the matrix.

The radial pattern is diagenetic and is formed by the recrystallization of aragonite to calcite or recrystallization of aragonite to aragonite (Eardly, 1938, in Carozzi 1962; Kahle, 1974). In the present case, in the absence of any evidence of the original composition of the rock it is difficult to decide this point. However, the radial pattern in these oolites can be said to be due to recrystallization.

Textural evidences show that these oolites were subjected to dolomitization and silicification. Dolomitization shows disappearance of concentric texture of the oolites and development of microcrystalline dolomite. This has been followed by replacement of dolomite by silica. The siliceous oolites are made up of partially or wholly of microcrystalline silica. Some of the veins of microcrystalline quartz have cut across the silicified oolites indicating a late silicification stage.
They also show pseudomorphs of microcrystalline quartz after dolomite rhombs with relict structure.

**Depositional Environment**

The sedimentary structures and associated stromatolites *Colonella columnaris* and *Conophyton garganicus* suggest that the depositional environment of the lower part of Gangolihat Dolomites is an intertidal of a carbonate tidal flat (Kumar and Tewari, 1977).

The occurrence of oolites in association with pseudo-oolites and intraclasts in the lower part of Gangolihat Dolomite overlying the stromatolite bearing horizon must have been formed in a shallow warm and agitating marine environment in a similar way as has been explained by Carozzi (1960).

**Acknowledgement**

The authors are grateful to Prof. S. N. Singh for laboratory facility and encouragement. Financial assistance from the Wadia Institute of Himalayan Geology, Dehra Dun is thankfully acknowledged.

**References**


