Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Geology

Paper Code: GEC – 1O8

Paper Title: Sedimentary Petrology

Unit: III

Module Name: Organic Limestones

Module No: 17

Name of the Presenter: Dr. Ankeeta Amonkar

Notes

Organic Limestone

Limestone are sedimentary rocks precipitated (non-clastic, chemical or inorganic limestone), secreted by marine organisms such as algae and coral (biochemical limestone), or can form from the shells of dead sea creatures (bioclastic limestone).

- Limestones are Polygenetic.

They could be fragmental, detrital, and mechanically transported and deposited or they could be chemical or bio-chemically precipitated.

Organic Limestone deposits may originate in different ways

A) They may be built up directly, from the beginning, as quite solid material, e.g., coral rocks, algal limestone

B) The deposition may be biochemical, i.e., organic activity promotes chemical conditions favoring precipitation, e.g., bacterial iron ore

C) The deposition may be biomechanical, when the rock is due to the detrital accumulation of organic materials, e.g., in crinoidal and shelly limestones, and some coals.

Organic Limestones are Bioclastic sedimentary rocks in which the carbonate fraction exceeds the non-carbonate percentage in the rock. Their origin is due, directly or indirectly, to the vital activities of animals and plants.

For example: Shells can get broken up and cemented back together to form organic limestone (also called coquina).

Composition

Organic limestones are essentially made up of Carbonate skeletons which marks the major portion of these rocks. They are chiefly composed of calcite ($CaCO3$) or aragonite. The calcite in limestone often contains Magnesium and based on this, the calcite in limestone is divided into low-magnesium and high-magnesium calcite, with a base line of 4%.

Low-magnesium calcite skeletal grains are typical of articulate brachiopods, planktonic (free-floating) foraminifera, and coccoliths. High-magnesium calcite skeletal grains are typical of benthic (bottom-dwelling) foraminifera, echinoderms and coralline algae. Aragonite skeletal grains are typical of molluscs calcareous green algae, stromatoporoids, corals, and tube worms.

The skeletal grains also reflect specific geological periods and environments. For example, coral grains are more common in high-energy environments (characterized by strong currents and turbulence) while

bryozoan grains are more common in low-energy environments (characterized by quiet water).

Other carbonate grains composing limestones are ooids, Oncoliths, Pisoliths, Peloids, and limeclasts (intraclasts and extraclasts) and Skeletal grains which are also referred to as Allochem.

Allochem is a term introduced by Folk to describe the recognizable "grains" in carbonate rocks. Any fragment from around 0.5 mm upwards in size may be considered an allochem.

Hard parts in an Organic limestone = ALLOCHEMS

1) **Ooids**

Ooids (sometimes called ooliths) are sand-sized grains (less than 2mm in diameter) consisting of one or more layers of calcite or aragonite around a central quartz grain or carbonate mineral fragment. These likely form by direct precipitation of calcium carbonate onto the ooid.

2) **Oncoliths**

Oncoliths resemble ooids but show a radial rather than layered internal structure, indicating that they were formed by algae in a normal marine environment.

3) **Pisoliths**

Pisoliths are similar to ooids, but they are larger than 2mm in diameter and tend to be more irregular in shape. Limestone composed mostly of ooids is called an oolite or sometimes an oolitic limestone. Ooids form in high-energy environments and typically show crossbedding and other features associated with deposition in strong currents.

4) **Peloids**

Peloids are spherical, ovoid, or rod-shaped, mainly silt-sized carbonate grains that commonly lack definite internal structure. They are composed of microcrystalline calcite of coarse silt to fine sand size. Most appear to be fecal pellets from burrowing benthic organisms.

As these organism's burrow through the muddy carbonate-rich sediment, they ingest material in search of nutritional organic compounds resulting in waste products containing microcrystalline calcite. The peloids are much easier seen in thin section than in hand specimen because of their small size.

5) **Limeclasts**

Limeclasts are fragments of earlier formed limestone or partially lithified carbonate sediment. Most are intraclasts, originating within the basin of deposition. They may be pieces of partially cemented carbonate mud that were ripped from the seafloor by storms. Some appear to be fragments of partially cemented carbonate mud that originated in intertidal mudflats. Some may also be pieces of limestone carried into the basin from nearby carbonate outcrops.

6) **Skeletal grains**

Skeletal grains are among the most abundant and important kinds of grains in Organic Limestone. Skeletal grains may consist of whole fossil organisms, angular fragments of fossils, or fragments rounded to various degrees by abrasion. These skeletal remains are mostly cemented together with a small amount of micrite or sparry calcite cement. Most skeletal grains are composed of aragonite, calcite, or magnesian calcite.

Vertebrate remains, fish scales, conodonts, and the remains of a few invertebrate organisms such as inarticulate brachiopods are composed of calcium phosphate. Diatoms and radiolarians, are composed of silica. Aragonite in skeletal grains transforms to calcite with time and, as indicated, high-magnesian calcite may either lose Mg and alter to low-magnesian calcite or gain Mg to form dolomite.

Matrix and Cement

- The matrix of carbonate rocks consists of either fine grained carbonate mud, called **micrite**.
- Or coarser grained calcite crystals formed during diagenesis, called **sparite.**
- The micrite results from recrystallization of carbonate mud during diagenesis or from direct precipitation of calcite, and causes lithification of the sediment.
- The micrite gives the dull opaque appearance of most limestones as seen in hand specimen. If the rock consists entirely of fine-grained mud matrix, it implies deposition in a low energy environment just like in siliclastic mudstones.
- Some of the mud may start as aragonite needles 5 to 10 mm in length produced by calcareous algae. But again, this becomes recrystallized to a microspar 5 to 15 mm in diameter during diagenesis.
- Larger sparry calcite matrix results from diagenesis in the same way that calcite cement originates in sandstones.

Structures

- Structures like cross-bedding, ripple marks, dunes, graded bedding, and imbricate bedding are common in carbonate rocks but it will be dependent on depositional environment for Organic limestones.
- Since many shells of organisms have curved outlines in cross-section (brachiopods, pelecypods, ostracods, and trilobites, especially), when the organism dies, it may settle to the bottom with the outline being concave downward, and later become filled with carbonate mud. When such features occur, they can be used as top/bottom indicators.
- lamination in organic limestone is produced by blue-green algae that grow in the tidal environment. These organisms grow as filaments and produce mats by trapping and binding microcrystalline carbonates, as incoming tides sweep over the sand.
- This leads to the formation of laminated layers that consist of layers of organic tissue interbedded with mud.

Occurrence and Distribution

Organic limestone are found in five different settings

- **Shallow water Marine deposit** are largely calcareous sand and has both skeletal and oolitic, with a lesser volume of fine carbonate mud and reef rocks.

  Shallow water environments include: Reef, tidal, Flat, Open Bank, mud accumulates in the tidal flats, continental shelf and platforms

- **Deep-water marine deposit** mainly includes the turbidite or basinal deposit and pelagic deep-sea deposit
- They are absent in rainless deserts and in the frozen polar lands