PETROGRAPHY AND SEDIMENTOLOGY OF THE GHUNDAI SAR REEF COMPLEX, JAMRUD: KHYBER AGENCY: PAKISTAN.

By

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ABSTRACT

A belt of Siluro-Devonian Coralline limestone of pink, yellowish-pink, and grayish-white colour is exposed in the hills of Ghundai Sar, near Jamrud; Khyber Agency.

The entire formation represents deposition on a stable shelf. The environments were conductive for the development of coral reef. The ortho-quartzites associated with dolomite and limestone supports this observation.

In this paper, petrography and sedimentology of the reef limestone is discussed in detail. 101 specimens were collected and 30 sections were cut to describe the petrography.

The limestone and dolomite show variations in their mineralogical composition. All variations from arenaceous limestone to calcareous ortho-quartzite occur.

INTRODUCTION

A sequence of pink, yellowish-pink, and grayish-white limestone, called the Nowshera Formation, is exposed in the hills of Ghundai Sar. This limestone is dominantly or entirely a coralline limestone. However, metamorphism and dolomitization has almost completely obliterated its original characters. Later dolomitization and limonitization has further modified its lithological characters.

Thin sections were cut from various samples from this limestone and were described. In order to classify the various samples and evolve a general classification for this limestone three end members were selected, namely Calcite, dolomite, and others (limonite, quartz, iron ore, and feldspar). Organic remains present as crystals of calcite were not treated as organic allochems, but

considered with calcite components. The limestone ranges from pure limeston to all the various types such as dolomitic limestone, sandy limestone, limonitized limestone and calcitic dolomite.

PETROGRAPHY AND SEDIMENTOLOGY

Thin Section No. 1 & 2.

Dolomitic limestone brown to greyish-white in colour with calcarenit texture. Minerals are sub-hedral to anhedral. Grains are subrounded t bladed, give crystalline to fragmental sedimentary texture. The grains are witl much corroded boundaries specially limonite, Clastic material brought by lon shore currents in much more rounded and less corroded than non-clastic Limonite of brownish colour is the weathered product. Compactibility i 80-90% and porosity 10-20%. The rock is well cemented by carbonate an limonite. Fossils are indistinctive and recrystallized due to the metamorphis and dolomitization. Environment of deposition is the stable shelf area of clea shallow and warm marine water with abundant oxygenation.

Thin Section No. 3—6.

Dolomitic limestone grey to brownish-white in colour, characterized b calcarenite to calcisiltite texture. Minerals are subhedral to anhedral. Grain are subrounded with much corroded boundaries. Clastic material of san particles are less corroded but much rounded than non-clastic. Metamorphi texture is by the induced medium grade regional metamorphism. Compactibilit is 60—80% and porosity 15—40%. Cementing material is carbonate an limonite.

Limonite replaces calcite. Abundant fragments of crystallized fossils ar present. Due to the metamorphism and dolomitization its difficult to identif the fossils even at generic level. Thin sections suggest conditions of clear, warm and shallow water with abundant oxygenation and free circulation.

Thin Section No. 7 & 8.

Sandy limestone dirty white grey with calcarenite to calcisiltite texture. Grains are subrounded with significant corroded boundaries. Due to low

metamorphism the texture is sedimentary fragmental to crystalline. Minerals are anhedral to subhedral. Intergrowth of clastic material is dominent. Inclusions are present in the carbonates. Replacement of carbonate by clastic sand grains such as by quartz occur. Sand grains are more rounded but less corroded than carbonate. Compactibility 50-60% and porosity 30-40%. Cementing material is carbonate and quartz. Due to the low metamorphism and poor dolomitization rock can be seen clearly full of *Favosites* colonies, stromatoporoids and some other fossils. Association is in the free circulation zone of shallow warm water. Abundant clastic sand grains are deposited with it by the long shore currents.

Thin Section No. 9 & 10.

Limonitized limestone brownish black to brown spoty white with calcarenite to calcisiltite texture. Minerals are anhedral. Grains are subrounded. Due to the medium metamorphism the rock texture is metamorphic (granoblastic). Grains are with much corroded boundaries and are interlocked with each other. Replacement by clastic material such as by quartz is seen. Compactibility is 70-75% and porosity 25%. Cementing material is carbonate and limonite. *Favosites*, *Cladopora*, *Thamnopora*, and crinoids are recrystallized due to metamorphism and dolomitization. Environment of deposition is the stable shelf area of clear warm shallow marine water with abundant oxygenation or areation.

Thin Section No, 11 & 12.

Limonitized limestone of brown colour with dirty white spots and characterized by calcarenite to calcisiltite texture. Fragmental sedimentary texture is present. Grains are subhedral and with much corroded boundaries specially limonite. Islands of clacite in limonite field are seen. Quartz is replacing calcite and limonite. Grains are well interlocked. Metamorphism is low and the rock is characterized by sedimentary texture. Compactibility is 70—80% and porosity 20—30%. Cementing material is carbonate and limonite. Fossils are recrystallized and indistinctive. Association is the shallow and clear freely circulated sea water.

Thin Section No. 13.

Sandy limestone of greyish colour with calcarenite to calcisiltite texture. Rock texture is metamorphic (granoblastic) due to medium to high metamor-

phism. Minerals are anhedral. Grains are much corroded and well inte locked. Compactibility is 75% and porosity 20%. Sand particles are muc rounded than non-clastic. Cementing material is carbonate and quart Fragments of *Favosites*, *Cladopora*, and coiumnals of crinoid are presen Association is the shallow, clear, freely circulated sea water. Sand particle seems to have been brought and deposited by long shore currents.

Thin Section No. 14.

Dolomitic limestone of dirty white colour with brown corroded spots characterized by calcilutite texture. Grains are much corroded and wil interlocked. Metamorphism is medium and rock is with metamorphi (granoblastic) texture. Compactibility is 70% and porosity 30%. Cementin material is carbonate. Coiumnals of crinoids, *Cladopora*, and *Favosites* ar in the fragmental form. Environment of deposition is clear, warm, shallov and freely circulated water in the stable shelf area.

Thin Section No. 15—17.

Limonitizcd limestone, grey, brownish-white to brown, greyish-white, characterized by calcilutite texture. Veins of limonite are seen running accross the slide, orientation of crystals of calcite induced due to metamorphism. Grains arc subrounded and the rock texture is metamorphic (granoblastic) as a result of high grade of metamorphism. Clastic material such as quartz is with less corroded boundaries, while non-clastic material is highly corroded specially limonite. Grains are interlocked occasionally. Compactibility is 70—80% and porosity 20—25%. Cementing material is carbonate and limonite. *Favosites*, *Cladopora*, *Thamnopora*, and crinoids are recrystallized due to metamorphism primarily and dolomitization secoudarily. Environment of deposition is the stable shelf area of shallow, clear, free circulated warm sea water. Clastic particles may be due to the influx of detrital material from land. which is reworked by the long shore currents. The influx of detritus might be due to hurricanes or seasonal influx from land, which is reworked by the long shore currents.

Thin Section No. 18.

Calcitic dolomite, grey, dirty white, with calcisiltite texture. Minerals are anhedral to euhedral. Grains are subrounded, interlocked and corroded.

Fragmental texture is present. Due to the low to medium metamorphism, typical metamorphic texture can be seen. Compactibility 65% and porosity is 30%. Cementing material is carbonate and limonite. Fossils are indistinctive and completely recrystallized due to the dolomitization mainly, and metamorphism secondarily. This section suggests conditions of shallow, warm, clear and free circulated water in the stable shelf area with abundant oxygenation.

Thim Section No. 19.

Dolomitic limestone of brownish-white grey colour, characterized by calcarenite to calcilutite texture. Minerals are anhedral. Grains are subrounded in shape and interlocked with highly corroded boundaries specially limonite. Metamorphism is high and the rock is with metamorphic (granoblastic) texture. Compactibility is 75—80 and porosity 20%. Cementing material is carbonate and limonite. Rock with abundant recrystallized fossils. Cementing material is carbonate and limonite. Depositional environment is the stable shelf area of free circulated and well oxygenated clear, warm, shallow marine water, and low energy currents.

Thln Section No. 20.

Limonitized limestone of brownish colour with calcarenite to calcilutite texture. Minerals are anhedral in shape. Metamorphism is highy and rock is characterized by metamorphic texture. Grains are with less corroded boundaries except limonite which is highly corroded, and the rock is extensively limonitized. Clastic grains such as quartz and feldspar are less corroded and rounded than non-clastic. Carbonate and limonite are the cementing materials. Fossils are indistinctive. Association is the stable shelf area of clear warm shallow marine water with abundant oxygenation or areation. Sand particles brought and deposited by long shore currents or by seasonal influx of detritus from adjoining land are abundant.

Thin Section No. 21.

Sandy limestone brown dirty greyish-white characterized by calcilutite texture. Minerals are subhedral to anhedral in shape. Rock texture is metamorphic (granoblastic) due to high metamorphism. Grains are less corroded except limonite which is highly corroded. A clear vein of medium size grain texture, chiefly composed of quartz and feldspar (plagioclase) is seen. The vein

might to the result of contact of the limestone with the dolorite intrusion in the area. Few other veins, composed of the same minerals, can be seen. Compactibility 80% and porosity is 20-25%. Cementing materials are carbonate. limonite, and quartz. Fossils are highly recrystallized and indistinctive. Non-clastic material deposited from the shallow, clear, and free circulated warm marine water while igneous material in the particular slide is present due to the intrusion.

Thin Section No. 22.

Dolomitic limestone, greyish-brown, dirty white, calcilutite texture Grains are subrounded with highly corroded boundaries. Minerals are subhedral to anhedral. Metamorphism is high and the rock texture is metamorphic. Due to high metamorphism and dolomitization fossils are recrystallized and indistinctive. Compactibility is 75-80%, porosity is 20%. Cementing material is carbonate and limonite. It indicates shallow, well oxygenated water of comparatively vigorous current activities. It is inferred from the abundance of sand particles.

Thin Section No. 23.

Sandy limestone, dirty greyish-white characterized by calcarenite to calcisiltite texture. Minerals are anhedral. Grains are with much corroded boundaries. Intergrowth and replacement by detrital grains such as quartz occur. Due to medium to high metamorphism rock texture is granoblastic. Compactibility 80% and porosity 15—20%. Carbonate and silica are the cementing materials Fossils are recrystallized and indistinctive. Thin section suggests conditions of deposition to be shallow, warm and clear freely circulating marine water.

Thin Section No. 24.

Calcitie dolomite, dirty greyish-white, with corroded spots characterized by calcarenite to calcisiltite texture. Minerals are anhedral. Clastic material is with less corroded boundaries while non-clastic is highly corroded. Rock texture is metamorphic due to high metamorphism. Intergrowth occurs. Replacement by clastie grains is seen. Porosity 15% i. e. very low due to high compactibility that is 85% and less sphericity. Carbonate and limonite are the cementing materials. Fragments of *Cladopara*, stromatoporoids, and crinoids are present. *Favosites* is absent here. Environment of deposition is the stable shelf area of clear, warm, shallow, and freely circulated marine water.

Thin Section No. 26.

Dolomitic limestone, dirty greyish-white with clacilutite texture. Minerals are anhedral. Clastic grains are less rounded and corroded than others. Non-clastic grains are with much corroded boundaries. Limonite is highly corroded. Inclusions of limonite in carbonate are seen. Intergrowth of detritus material is clearly seen. Due to the medium to high metamorphism the rock texture is metamorphic (granoblastic). Compactibility 70%. Porosity 25%. Fragments of crystallized crinoids and micro fossils are present. Deposition occured in the shallow clear, warm and freely circulated marine water. Sand grains were brought and deposited by long shore currents during storms or by seasonal changes.

Thin Section No. 27 & 28.

Limonitized limestone of dark brownish colour with white patches to dirty-greyish wifh brown corroded spots, characterized by calcarenite to calcilutite texture. Grains are subrounded with medium to high corroded boundaries. Inrergrowth of clastic and non-clastic grain occur. Inclusions of iron ore and quartz in very fine grains are seen. Metamorphic texture indicates that metamorphism is medium to high. Cementing material is carbonate and limonite. Micro-fossils and crinoids are in recrystallized form. Association is the stable shelf area of freely circulated marine water with abundant oxygenation.

Thin Section No. 29.

Dolomitic limestone, brownish, with grey corroded spots, characterized by calcarenite to calcilutite texture. Rock texture is metamorphic. Metamorphism is medium to high. Minerals are anhedral. Grains are with medium corroded boundaries, only limonite is highly corroded. Inclusions are present in carbonate. Porosity 30—35%. Compactibility is 60%. Cementing material is carbonate and limonite. Rock is full of recrystallized corals, crinoids, and stromatoporoids. Origin is the shallow well oxygenated marine water.

CONCLUSION

The carbonates of the Ghundai Sar Reef Complex show wide variations. They range from pure bioclastic limestone to calcitic dolomites and from arenaceous dolomitic limestones to calcareous and dolomitic arenites. Intermediate textural and mineralogical variations also occur.

The low grade regional metamorphism has caused extensive obliteration of fossils, recrystallization, and dolomitizatian. However, all the dolomite is not secondary but primary as well.

The grade of metamorphism increases in intensity towards north. This has caused marmorization of the limestone. Late Cretaceous and Early Tertiary doleritic intrusions have introduced crystalline silica and feldspar.

The porous nature of the limestones nnd dolomites and their association with extensive reefs might be of great economic significance as oil and gas reserves are associated with such deposits.

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