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Sedimentology, Microfacies, and Depositional setting of Basal Clastic Sediments: A case study from Mumbai High

Abstract

Integrated sedimentological studies of cores and cuttings of Basal clastic succession of well X in the Mumbai high area have been carried out to understand vertical distribution of sedimentary facies, their depositional environment, diagenesis and reservoir characterization. In Mumbai High and adjacent structures of Mumbai Offshore Basin, a thin (~15m) Clastic succession, between 'Basement' and Cenozoic succession is referred as Basal Clastics. Lithological study of the 'Basement' in the study area suggests that it comprises dominantly of granite/granite gneiss, quartzite, chlorite schist, phyllite and migmatite. In well x Basement is chlorite Schist and 8.75m core is represented by Basal clastics. It is represented by two distinct sedimentary cycles. The "Conglomerates" represent the initial sedimentary succession deposited in a fluvial setup. The subsequent episode of deposition commenced with marine transgression wherein the existing conglomeratic sediments were reworked by the wave ravinement and redeposited in a marginal marine setup. These lag deposits represented by the pebbly sandstone are usually thin. The overlying transgressive clastics (Sandstone with interbedded siltstone/shale) of marginal marine to shallow marine affinity are homotaxial with the Panna sediments.

Introduction

In Mumbai High and adjacent structures of Mumbai Offshore Basin, a thin (~15m) clastic succession, between 'Basement' and Cenozoic succession is known as Basal Clastics. In the present work, Basal clastics in the study area is limited between the Pre Cambrian Basement complex at the base and the Oligocene Carbonates at the top. This clastic succession comprises of fining upward sequence of conglomerate, pebbly sandstone, sandstone, sand/silt alternations and carbonaceous silt at the top attaining a thickness of about 15 to 20m, the whole succession is preserved in this core (length 8.75m).

Methodology

Megascopy, lithomicrofacies and core gamma analysis of Cutting and Conventional Core sample is used to ascertain the sedimentological attributes and depositional setting.

Observations and depositional history

The Basal clastics in the present study is limited between the Precambrian Basement complex and the Oligocene Carbonates. This clastic succession comprises of conglomerate, pebbly sandstone, sandstone, sand/silt alternations attaining a thickness of about 15 to 20m. The generalized sedimentary succession of this unit is summarized in figure 1a and detailed description of each lithofacies is given in ascending stratigraphic order. Figure 1b illustrates the whole core photograph of the core CC-1, interval 1918-1927m with core recovery of 98.78%.

Core Gamma Ray Analysis:

Core Gamma log was recorded on CC-1 (int.1927.0-1918.0m) and spectral gamma ray components were analysed (Figs.2a-b).

Conglomerate is observed from the depth1926.71m to1925.20m followed by Pebbly Sandstone in the depth interval of 1925.20-1924.24m, overlain by sandstone up to 1919.66m depth. The overlying Sandstone and siltstone from 1919.66 are followed by Carbonaceous Siltstone at the top (Fig. 1a). All the major peaks are perfectly correlatable with the recorded open whole Gamma ray log. (Rec 96.78%)

Core gamma log shows a sharp change from high counts to low counts at the contact of conglomerate and overlying clastics implying different provenance for these two litho units.

Basement

The “Basement” in this area is dominantly granite/granite gneiss, Quartzite and chlorite schist. Granite gneiss is grey to dark grey, hard, compact, and crystalline with bands of light and dark coloured minerals. Granite gneiss comprises coarse to fine grained anhedral quartz embedded in dark green ground mass (Figs.3a-b).

Chlorite Schist is Greenish white, light green chlorite mineral is found imparting slight green hue. Schistose texture is visible. Flaky mica show preferred orientation and very thinly laminated. Chlorite schist fragments are also noticed with minor small folds and foliation (Figs.3c-d).

Free quartz grains and at some places granules containing cubic pyrite are seen. Quartz is white, coarse to very coarse grained and granular. Quartz grains are polycrystalline and highly fractured (Figs.3e-f).

Polymictic Conglomerate

White framework grains are embedded in grey ground mass of poorly sorted sandstone. It is hard, compact and polymictic in nature. Size of lithoclast ranges from granule to large pebble size, angular to rounded and spherical to ellipsoidal, at some places longitudinal in shape and hard to friable (Fig. 4g). These pebbles are mainly from quartzite, weathered granite, granite gneiss, set in fine to medium grained, greenish grey non-calcareous matrix. At some places carbonaceous matter also observed along with iron leaching.

Lithomicrofacies shows coarse to fine grained lithoclasts are set in arenecious to argillaceous matrix. Lithoclast of quartzite, Quartz mica schist, Granite and pyrite are noticed. Quartz grains are coarse to fine grained, bimodal, poly crystalline, tightly packed or interlocked by long, sutured to grain to grain contact and highly fractured (Figs. 4a-d).

Pebbly sandstone

It is whitish grey to buff, framework grains are embedded in argillaceous matrix, fine to coarse grained, friable to hard, angular to sub-rounded, poorly sorted, non-calcareous, ground mass is greyish green in colour with disseminated quartz at places. Pyrite also noticed at places. Floating sub-angular to sub-rounded clasts of quartzite, granite and weathered granite is observed at many places (Fig. 5e).

Litho Microfacies shows medium to fine grained, at places coarse pebbles of Quartzite dominating lithoclast are tightly bound together, bimodal, polycrystalline and fractured, very less Matrix pyritiferous with moderate intergranular porosity (Figs. 5a-d).

Sandstone

It is buff to brownish, hard, compact, massive, medium to fine grained, very feebly calcareous, moderately sorted, visual porosity is poor, medium to fine grained, and sub angular to sub rounded. Small pebble of disseminated quartz grains are dispersed in sandy ground mass. Small pebble of granite and quartzite are floating in ground mass. At many places sand is intercalated with dark argillaceous clay bands. Specks/streaks of carbonaceous matter are also seen (Fig 6e). Microfacies shows presence of Quartz wacke Bi-modular (medium to fine grained and fine to very fine grained), grains are showing point and long contact at places, sub-angular to sub-rounded, ill-sorted exhibiting poor inter-granular porosity, grains are floating in argillaceous matrix (Figs. 6a-b).

Siltstone

This is the uppermost unit of the basal clastics, unconfromably underlying the Oligocene carbonates. Greyish white, hard, compact and massive, fine grained, showing moderate to good sorting with sub angular to sub rounded grains, non-calcareous, patches of pyrite are abundant (Fig. 7e). Disseminated specks/streaks of carbonaceous matter are common. At top it is brownish black due to very high carbonaceous content. Microfacies shows medium to very fine grained grain size, bimodal distribution of grains, polycrystalline, occasionally coarse grained, poorly sorted, sub-rounded to sub-angular with moderate inter granular porosity. Grains are floating in the argillaceous matrix (Figs. 7a-d).

Conclusion:

The sedimentary succession overlying the Pre Cambrian Basement in the study area is represented by thin (2-3m thick) conglomerates deposited in a fluvial setup as indicated by polymictic, Floating sub-angular to sub-rounded pebbles and cobbles derived from the underlying Pre Cambrian Basement. These rudaceous, unfossiliferous, feebly metamorphosed sediments represent the initial sedimentary cover in the area, over the Pre Cambrian Basement.

The overlying sedimentary succession of Pebbly sandstone/Sandstone represents deposition during the first Paleocene marine transgression in the basin. The sedimentological evidences including poor sorting, floating granules and pebbles of sub-angular to rounded quartzite/Granite gneiss in the sandstone, which also illustrates provenance of this lithounit is from the underlying sedimentary succession.

The Conglomerates represent the initial sedimentary succession in the area in a fluvial setup. During the Paleocene transgression, these conglomeratic sediments were reworked by the wave ravinement and redeposited in a marginal marine setup. These lag deposits represented by the pebbly sandstone are usually thin (about 1 m thick). The overlying Sandstone with interbedded siltstone/shale was deposited as transgressive clastics in a marginal marine to shallow marine setup. The lag deposits can cumulatively be thicker if transgression is punctuated with repeated regressive phases. Next sedimentary cycle in Mumbai High is witnessed during the Oligocene with the deposition of carbonates in a shallow inner shelf setup. Thus, the Basal Clastics in the study area are represented by two distinct sedimentary cycles represented by Lower conglomerate and Upper pebbly sandstone / sandstone with intercalations of siltstone / shale.

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