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Sediment gravity flow deposit in Panna clastics: A unique case study from Ratnagiri area, Mumbai Offshore

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Abstract

Sedimentological and biostratigraphic studies of core of Panna Formation (Paleocene to Early Eocene Age) of well X in the Ratnagiri area, Mumbai Offshore have been carried out to understand vertical distribution of sedimentary facies and their depositional environment. A conventional core-1 (Depth Interval: 2615-2624m; Rec: 100%; Panna Formation) of well X has been studied for its sedimentological attributes and biostratigraphy. A depth shift of 1.4m for the core CC-1 (Drillers Interval 2615-2624m) has been observed from log using shale as a marker. The observed corrected depth interval of conventional core-1 is 2616.4-2625.4m. The core comprises of clastic sediments consisting of fissile, fractured (slickenslide) shale and sandstone intercalations. Sandstones is fine grained to medium-coarse grained quartz arenite exhibiting various sedimentary structures such as parallel laminations, cross laminations, climbing ripples, load cast structures, bioturabations and at places massive. Paleontological studies shows presence of Bryozoa, globular bodies, indeterminate smaller benthics and carbonized shell fragments. These carbonized fossils indicate rapid burial under anoxic conditions. The presence of unaltered feldspar grains in the sandstone also indicate deposition under rapid burial. The presence of sedimentary structures (load cast structures, climbing ripples, parallel laminations, high angle and low angle cross laminations) and carbonized fossils indicate deposition by gravity flow mechanism.

Introduction

Panna formation overlies Deccan Trap/ Basement and is overlain unconformably by Bassein/Belapur Formation. The formation is spread over the entire Bombay Offshore Basin except the paleo-highs and is composed of sandstone and claystone. In the Ratnagiri area Panna Formation is represented by a fairly thick trapwash sequence consisting of reddish brown claystone and siltstone. A fluvial to shallow marine depositional environment is deciphered for this formation.

Methodology

Foraminiferal biostratigraphic studies were carried out in the core interval 2616.4-2625.4m to determine environment of deposition and paleobathymetry. Sedimentological studies included detailed megascopic, microfacies analyses and X-Ray diffractometry (XRD) studies to bring out lithological variations, mineralogical composition, environmental interpretation and reservoir characterization of the studied succession.

Observations and depositional history

The Panna Formation in conventional core-1 (Depth Interval: 2615-2624m; Rec: 100%) of well X comprises of dominantly shale and sandstone intercalations. The generalized sedimentary succession of this unit and core shift is summarized in figure 1 where a depth shift of 1.4m has been observed from log using shale as a marker and the observed corrected depth interval of core CC-1 is 2616.4-2625.4m. The whole core photograph of the core CC-1, interval 2615-2624m with core recovery of 100% is illustrates figure 2. The corrected cored interval (2616.4-2625.4m) has been divided into 6 lithounits for the better understanding of lithofacies and depositional environment. The detailed description of each lithounit is given in ascending stratigraphic order.

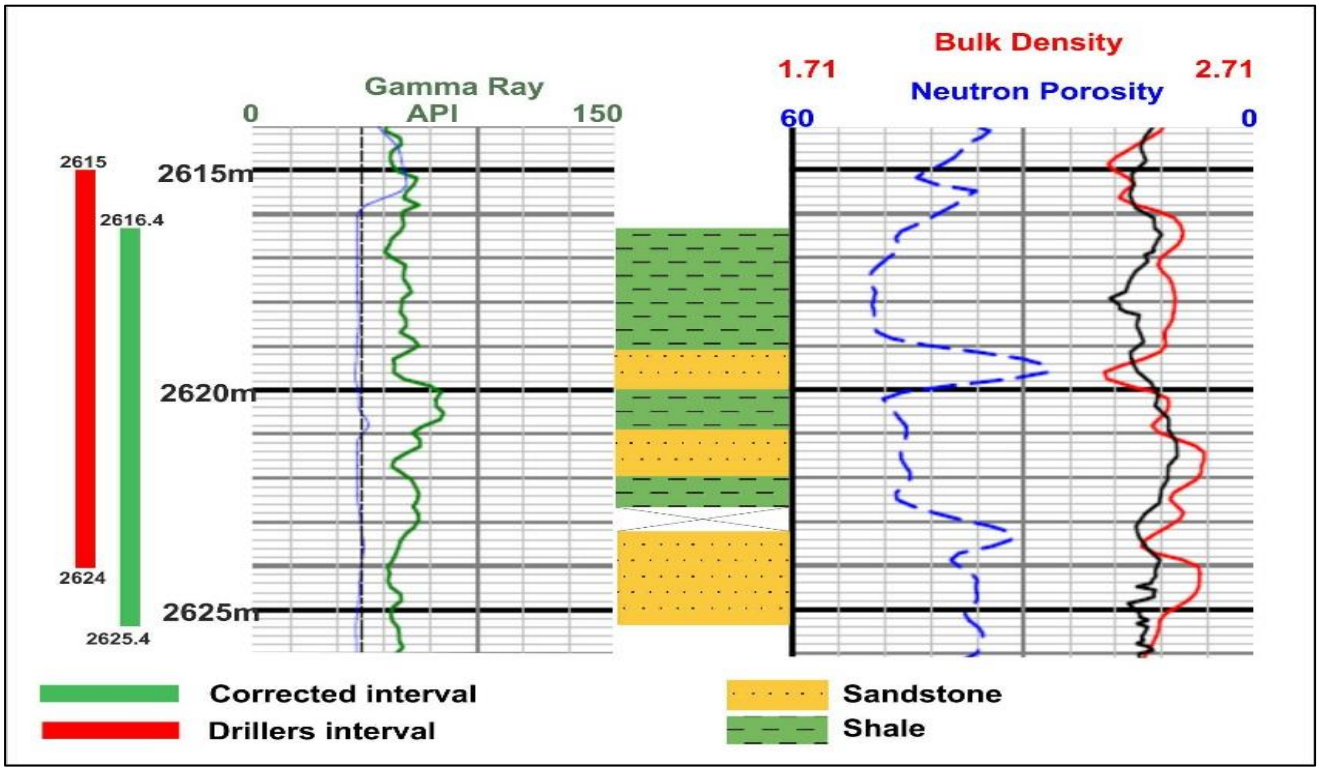
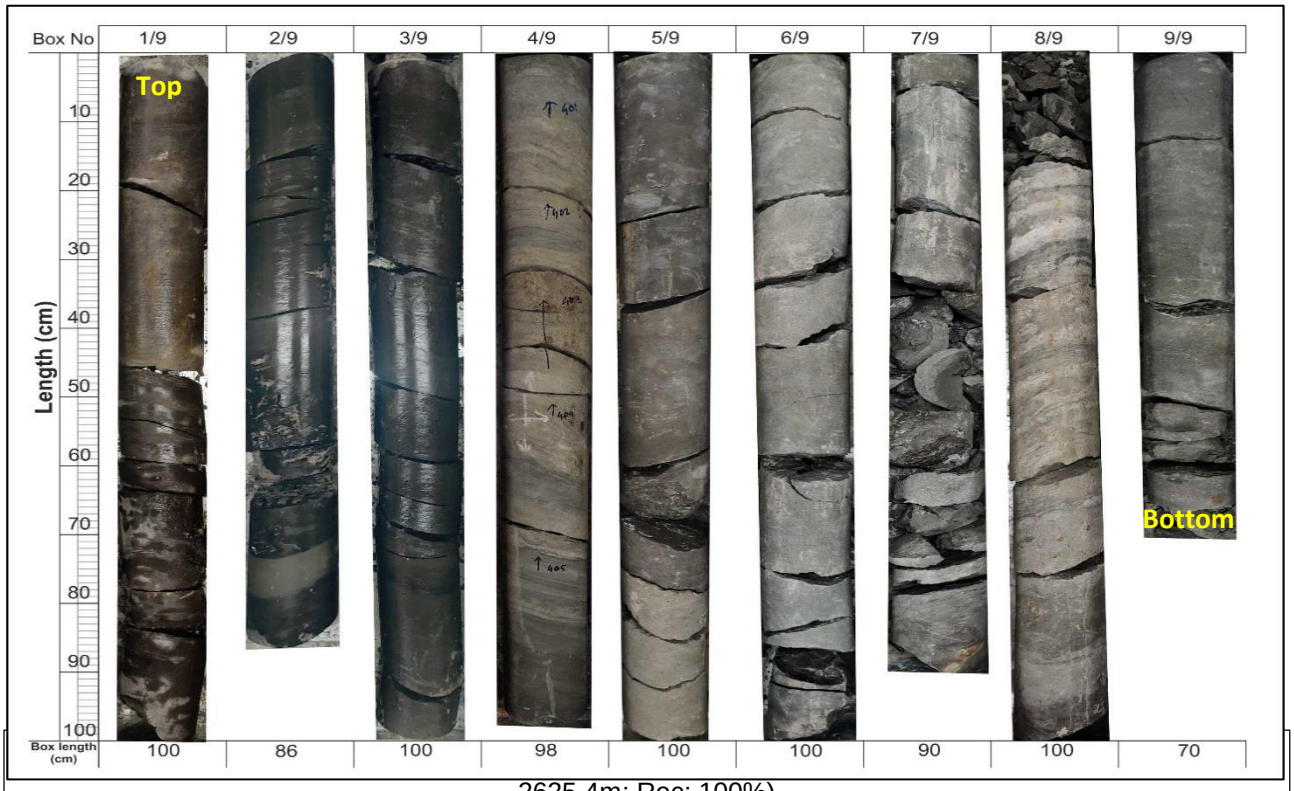


Fig.1: Core shift and Litho-column of of well X showing sedimentary succession



2625.4m; Rec: 100%)

Lithounit-I (2623.9m-2625.4m)

Lithounit 1 is the bottommost unit represented by the fining upward sandstone. Sandstone towards bottom part is light grey, hard, compact, non-calcareous and massive. Grain size is varies from fine to coarse grained, grains are mostly angular to sub-angular, at places rounded, and moderately sorted. Bivalve shell fragments which were later-on filled with carbonaceous matter are found in this zone (Fig. 3). Sandstone towards top part of the interval is buff-light grey, hard, compact, non-calcareous. Grain size is varies from very fine to medium grained, grains are mostly angular to sub-angular at places rounded and sorting is moderate. Sedimentary structures such as parallel bedding, low angle cross bedding, flaser bedding, lenticular bedding and climbing ripple structures are observed in this interval (Fig. 4&5). The lithomicrofacies indicate presence of quartz arenite facies, at places wacke facies (Fig. 6).

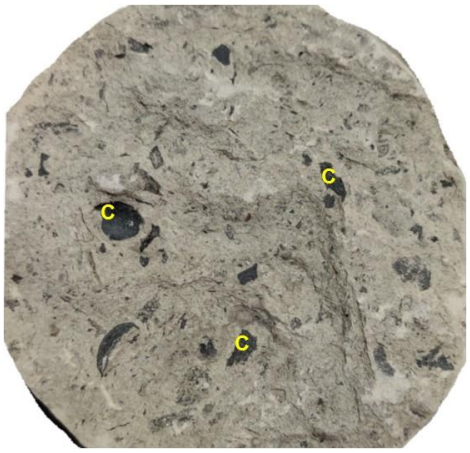


Fig. 3: Carbonized fossils (C) within sandstone. (Depth: 2624.7m)

Lithounit-II (2622.1m-2623.9m)

Lithounit 2 is represented by the shale. Shale is dark grey, poorly fissile and non-calcareous. There has been a core loss of 52cm reported in the interval of 2623.15 to 2623.67m.

Lithounit-III (2621m-2622.1m)

Lithounit 3 is represented by the sandstone. Sandstone is grey to light green, hard, compact, non-calcareous and massive. Grain size is varies from very fine to fine grained, grains are mostly angular to sub-angular at places rounded and are moderately well sorted.

Lithounit-IV (2620.25m-2621m)

Lithounit 4 is represented by the shale. Shale is dark grey, poorly fissile and non-calcareous. Towards bottom shale shows erosional contact with underlying sandstone (Fig. 7).

Lithounit-V (2619.3m-2620.25m)

Lithounit 5 is represented by the sandstone. Sandstone is buff-light grey, hard, compact, non-calcareous. Grain size varies from very fine to coarse grained, grains are mostly angular to sub-angular, at places rounded, and moderately sorted. Sedimentary structures such as parallel bedding, cross bedding, flaser bedding, lenticular bedding and climbing ripple structures are observed in this interval (Fig. 8&9). Litho Microfacies indicate presence of quartz arenite facies (Fig. 10). XRD analysis shows presence of quartz and feldspar along with kaolinite (Fig. 11).

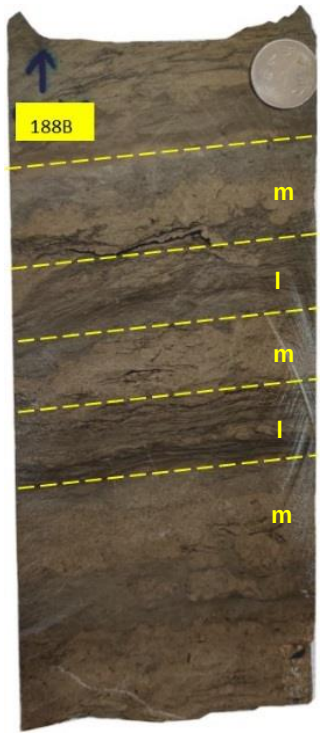


Fig. 5: Sandstone slab at depth of 2624.15m showing alternate medium grained massive sand (m) and fine grained laminated sand (l)

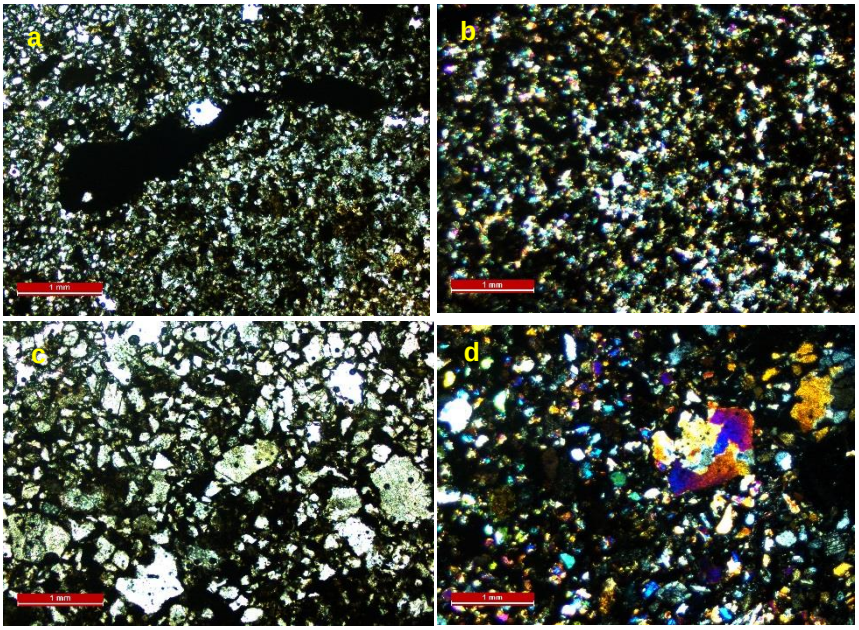


Fig. 6: a, b) Depth 2619.6m: Quartz arenite; Fine grained, angular to sub-angular, well sorted, dominantly quartz and feldspar grains, carbonaceous specks and streaks and kaolinite in the matrix, **c,d)** Depth 2624.4m: Quartz arenite at places showing wacke facies; Fine to coarse grained, angular to sub-angular and subrounded grains (coarse grained sand), poorly sorted, dominantly quartz, feldspar grains and few polycrystalline quartz grains floating in argillaceous matrix at places.

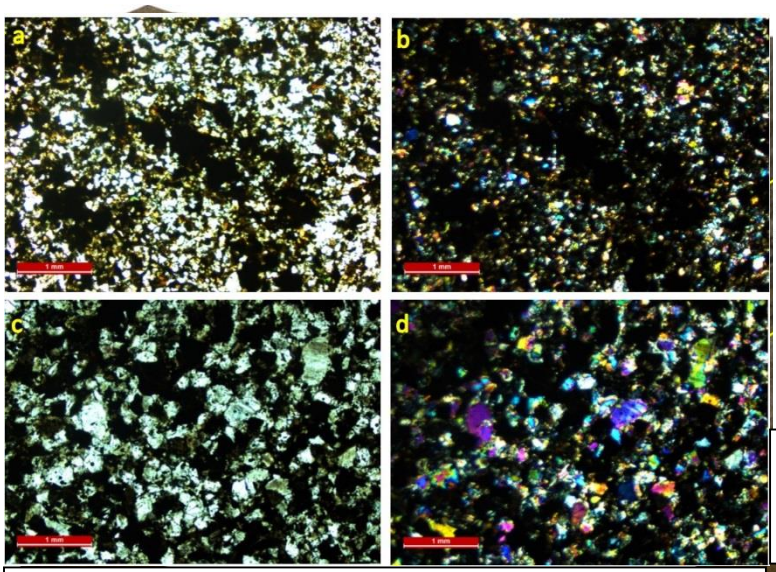


Fig. 10: a,b) Depth 2619.6m: Quartz arenite; Fine to medium grained, angular to sub-angular, moderately sorted, dominantly quartz and feldspar grains along with carbonaceous matter in matrix. **c,d)** Depth 2619.8m: Quartz arenite; Medium to coarse grained, angular to sub-angular (medium grained sand) as well as subrounded grains (coarse grained sand), moderately sorted, dominantly quartz, feldspar grains and few polycrystalline grains. Kaolinite and carbonaceous specks are observed in the matrix.

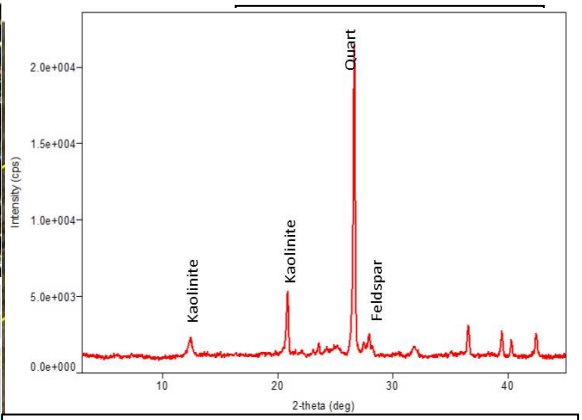


Fig. 11: XRD analysis of sandstone at depth of 2619.3m showing presence of quartz and feldspar along with kaolinite.

Fig. 9: Sandstone slab at a depth of 2619.28m

Lithounit-VI (2616.4m-2619.3m)

Lithounit 6 is represented by the shale. Shale is dark grey, fissile, non-calcareous with disseminated pyrite specks. Shale is fractured at places and shows presence of slickensides on the fractured surface.

Conclusions

The Panna Formation in well X is represented dominantly by shale and sandstone. The shale is fissile, fractured at places and shows presence of slickenside. Sandstone varies from fine grained to medium-coarse grained with sedimentary structures such as parallel laminations, cross laminations, climbing ripples, load cast structures and bioturbations. Paleontological studies shows presence of Bryozoa, globular bodies, indeterminate smaller benthics and carbonized shell fragments. Detailed analysis of litho-microfacies and biostratigraphy helped in determining depositional environments for the succession. Lithounit-I consists of fossiliferous quartz arenite exhibiting parallel bedding, low angle cross bedding, flaser bedding, lenticular bedding and climbing ripple along with carbonized fossils showing fining upward sequence. The presence of carbonized fossils such as bivalves within these sandstone indicate rapid burial under anoxic conditions, presence of unaltered feldspar grains in these sandstone also indicate rapid burial. Lithounit-II consists of massive, very fine to fine grained, angular to sub- rounded and moderately well sorted quartz arenite. Sandstone of Lithounit-V is consists of quartz arenite facies exhibiting sedimentary structures such as parallel bedding, cross bedding, flaser bedding, lenticular bedding and climbing ripples. The presence of sedimentary structures (load cast structures, ball and pillow, low and high angle cross beddings, climbing ripples and parallel laminations) and carbonized fossils in the lithounit-I and V indicate deposition by gravity flow mechanism, whereas massive sands of lithounit-III indicates deposition in deep water channels.

Acknowledgement

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