SEDIMENTARY FACIES OF THE UPPER PART OF TAPAK FORMATION IN BANYUMAS AREA, CENTRAL JAVA

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ABSTRACT

The upper part of Tapak Formation in Kali Cimande of Banyumas area shows a good example of tidal flat succession. The interval consists of alternating sandstones, siltstone and mudstone that show a fining and thinning upward bedding pattern and includes sand flat, mixed flat and mud flat sedimentary facies. The sand flat facies is characterized by medium-grained sandstone, moderately sorted, with cross-lamination sedimentary structures and bioturbation trace fossils (Skolithos) found mostly on the top of sandstone layer. The mixed flat facies is characterized by an alternation of thin layered sandstones with mudstone and siltstone, with lenticular, wavy, and flaser sedimentary structures. This facies contains many forms of bioturbations, such as Planolites, Thallasinoides, Lockeia, and Ophiomorpha. The mud flat facies is characterized by repeated claystone and thin sandstone intercalation, where the ratio of clay content being more than 95 % of the total layers, and contains abundant Lockeia trace fossil. The Upper Tapak Formation in Banyumas basin has moderate reservoir potential.

Keywords: *Tapak Formation, Tidal Flat, Banyumas*

INTRODUCTION

Kali Cimande (Cimande River) is located in the synclinal part of Banyumas Basin (Figure 1). The outcrop along Kali Cimande shows good example of tidal flat succession that was deposited during a Pliocene regressive event, where the depositional environment changed from deep water during Middle Miocene to shallow water following the inversion (uplift) event in the Middle Miocene to Plio-Pleistocene.

The study area is covered by Majenang Geological sheet of GRDC, mapped by Kastowo and Suwarna (1996). This area is showing a complicated structure as deformation was very intense in this area (Figure 2). Some alteration and gold mineralization were found along with this structure in the area.

Several hydrocarbon seepages were found along the NW–SE-oriented Cipari anticline. Mulhadiyono (2006) reported that one of the potential reservoirs where oil seepage was found occurs within Tapak Formation. The oil seepage that penetrated through Tapak Formation was observed in Bumiayu Area. KRG-1 well was drilled in 1992 by Pertamina with the target to test Tapak Formation. However, the drilling was discontinued after 1851m and without hydrocarbon shows. This well penetrated only three meters of Tapak Formation carbonate and 1800m of Halang Formation (Figure 3). The failure to discover hydrocarbon caused this area to be considered as un-prospective.

Kastowo and Suwarna (1996) subdivided the stratigraphy of South Serayu Mountain into seven formations. Tapak Formation was deposited in the Early Pliocene and was subdivided into two members, namely Lower Tapak and Upper Tapak Members (Djuri et al., 1996).
The Lower Tapak Member is characterized by interbedded coarse sandstone and marl, greenish sand, conglomerate and breccia in many spots. The Upper Tapak Member contains calcareous sandstone, limestone, and marl with mollusk fragments. Locally, reefal limestones can also be found (Marks, 1957). The thickness of the Tapak formation is about 500 m and it was deposited in shallow marine environments (Kertanegara et al., 1987).

DATA AND METHODS

This study is basically based on a field-work observation that took place at Cimande River, Banyumas Area. The location was preferred out of many other candidates because it is believed that the stratigraphy represent the vertical succession of the Upper Tapak Formation and furthermore, thick and continuous sedimentary rock are exposed along this river. Ninety meters of continuous outcrop was measured and described in details. Some rock samples were taken and used for petrography and biostratigraphy analyses.

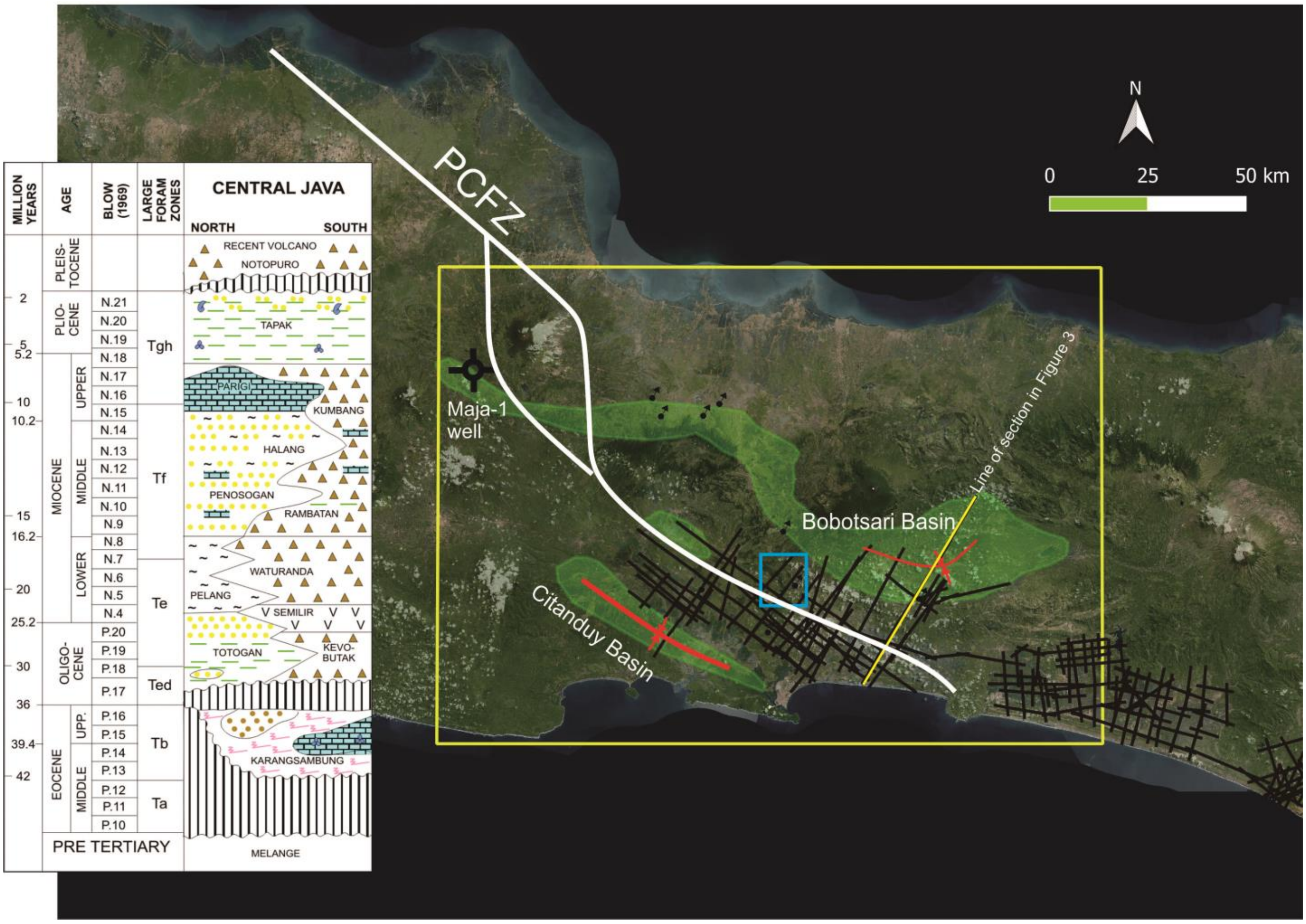

Figure 1: The location of study area is located in blue rectangle. The PCFZ fault of Armandita et al. (2010) is shown by regional NE-SW trending along with Pliocene Basin of Lunt (2008) shown by green shaded area in the map. There are many oil seeps found in this area. The Maja-1 is the first exploration well in Indonesia. The stratigraphy column is adapted from Satyana (2007).

REGIONAL GEOLOGY

The study area is located in the blue rectangle on Figure 1, which is part of the Cipari Anticline trend, where many oil seeps have been found. The area is also where a regional, NW-SE-oriented fault zone namely Pamanukan-Cilacap Fault Zone (PCFZ) developed (Armandita et al., 2010). This fault zone contains Miocene-Pliocene volcaniclastic turbidites. However, on geological map, the faults are mostly showing NE-SW trend, which probably belong to antithetic faults of the PCFZ. The Pliocene basins, which include Citanduy and Bobotsari Basins of Lunt (2008), are shown in green shaded area with NE-SW trend, which some are already covered by recent volcanoes. The Tapak Formation is grouped into Pliocene sediment that well developed along the Pliocene basin.

OUTCROP OBSERVATION, RESULTS AND INTERPRETATION

The Tapak Formation of the study area shows similarity to those described by Kastowo and Suwarna (1996). It is characterized by a light grey, calcareous sandstones, fine to medium grain size, moderate to poorly sorted, fair porosity, with abundant bioturbations and some skeletal grains. The compositions are dominated by fossil fragments, plagioclase and quartz, cemented by carbonate material.

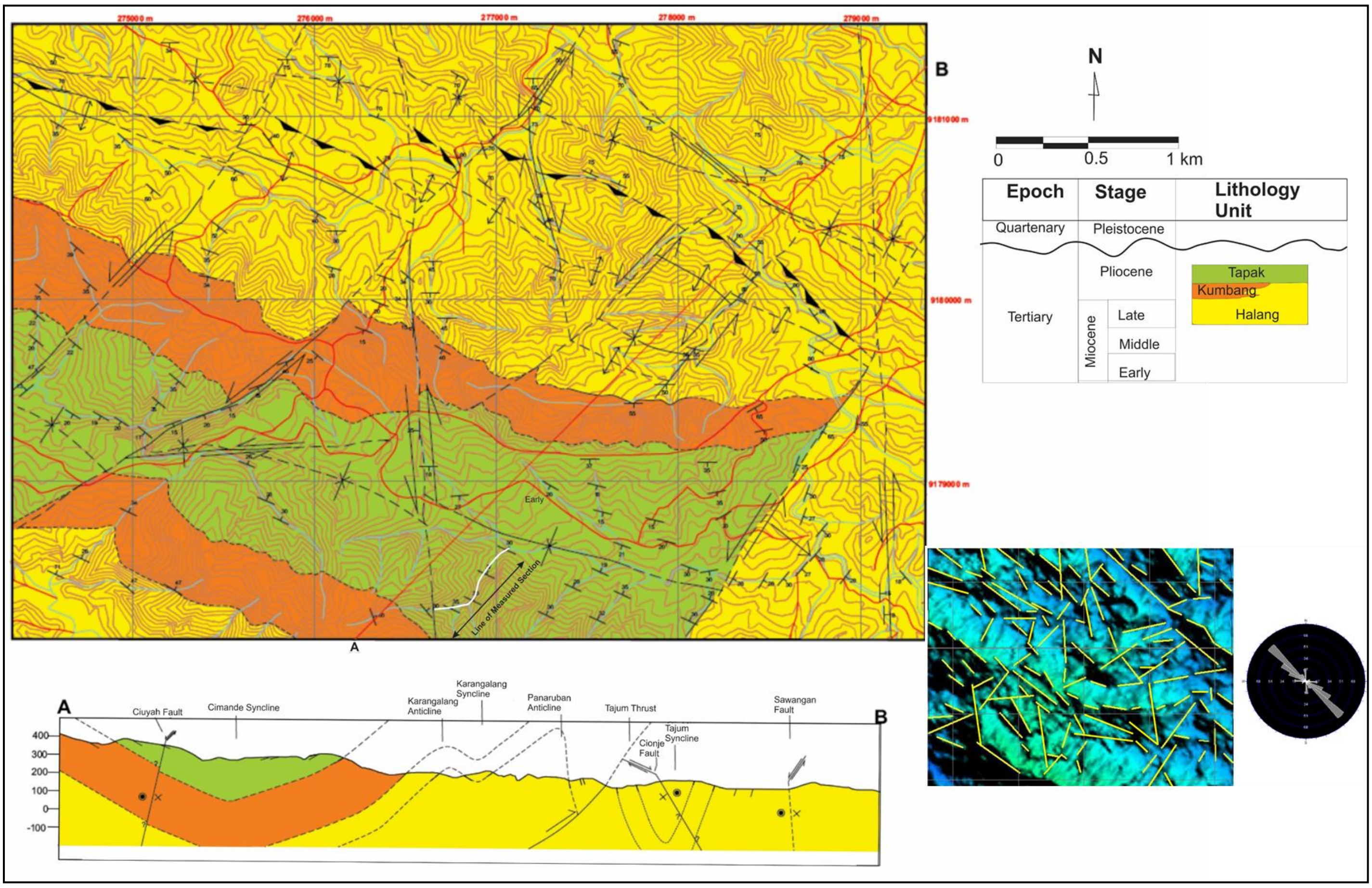

Figure 2: *Geological map of the study area and the location of measured sections for Tapak Formation.*

The thickness of the sandstone layers varies from 10cm to 120cm. The mudstone is grey to greenish grey, calcareous, contains foraminifera and shell fragments. The calcarenite limestone is yellowish grey, fine grain size, well sorted, compact and hard, generally present as thin bedding. The sandstone interbeds show fining and thinning upwards succession with lenticular, wavy, and flaser sedimentary structures. The planktonic forams show a N19-N20 (Early Pliocene) of Blow Zonation and the observed benthonic foraminifera include *Dentalina* sp., *Nonion* sp., *Quinqueloculina* sp., and *Lagena* sp., which all show a tidal to inner neritic depositional environment.

The abundance of tidal flat trace fossils indicates that the Upper Tapak Formation in the study area was deposited in the tidal flats, which are part of the intertidal zone. Based on lithological characteristics and patterns of succession and trace fossil content, the depositional environment of the intertidal zone can be subdivided into sand flat facies, mixed flat facies, and mud flat facies (Desjardins, 2012).

Sand Flat Facies Association

This facies association is composed of sandstone with mudstone intercalation. Sandstone has medium grain size, moderately sorted, cross-lamination and *Skolithos* trace fossils at the upper part. Based on microscopic analysis the sandstone is feldspathic wacke, moderately to poorly sorted, open package (point / concavo / sutured contact), grains (50%) consist of plagioclase, quartz, mafic minerals, opaque minerals, rock fragments and foraminifera fossil fragments of benthic and planktonic, rounded - angular shape, matrix (20 - 30%), cement (10 - 15%), porosity (10-15%) in the form of moldic, intergranular, intergranular (Figure 4).

The thickness of this facies succession is around 10m. The vertical succession of this facies can be seen on Figure 4.

Mixed Flat Facies Association

This facies association is characterized by interbedded of thin layered of fine sandstone and mudstone. The thickness of sandstone varies from 1cm to 10cm, is rich with lenticular, wavy, and flaser sedimentary structures. The sand and mudstone alternation contain bioturbations, including *Planolites, Thallasinoides, Lockeia, and Ophiomorpha* (Figure 5).

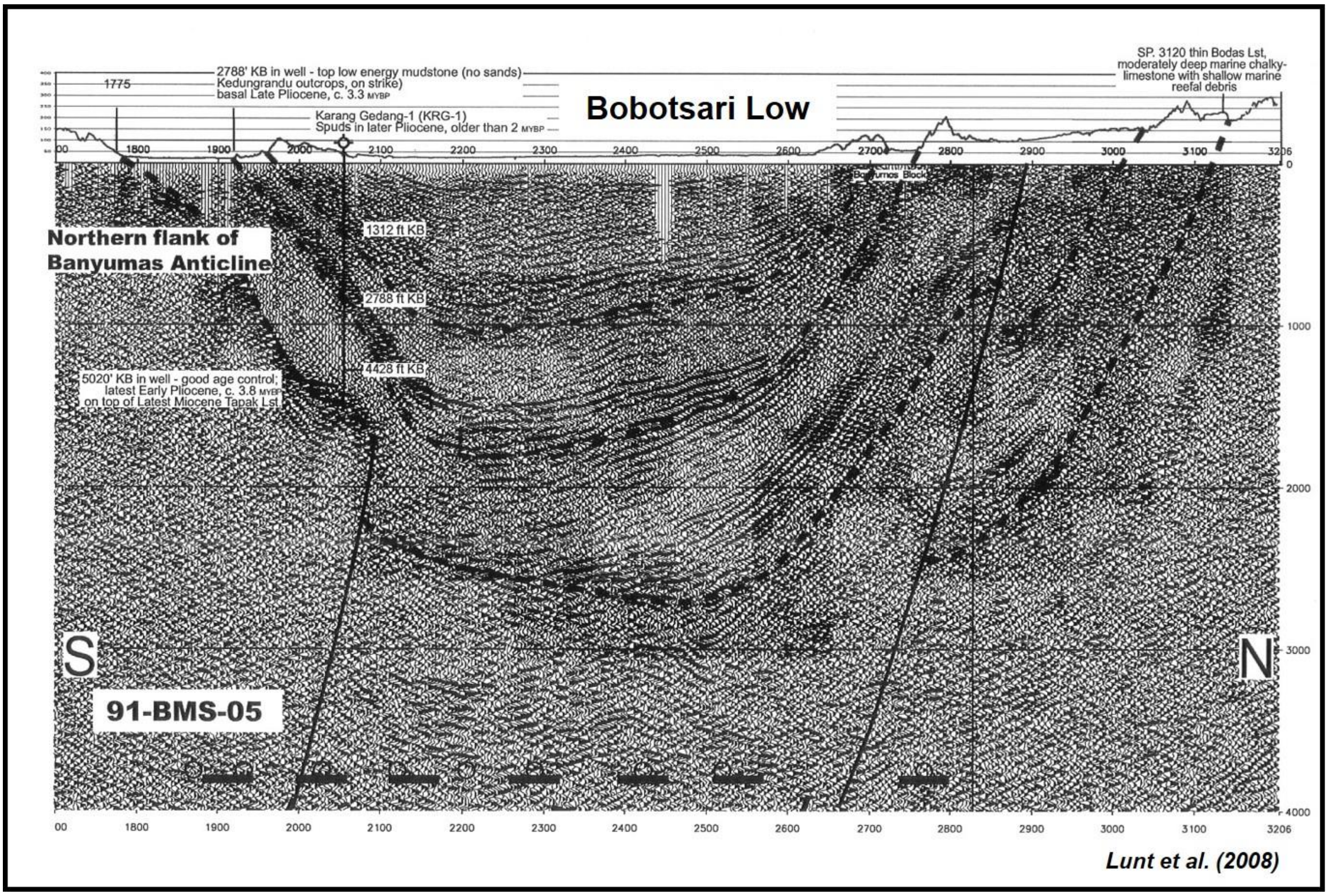

Figure 3: *Seismic line through KRG-1 well that penetrated Tapak Formation (Lunt et al., 2008).*

Mud Flat Facies Association

This facies association is characterized by alternation of thin layered mudstone, siltstone and sandstone with sandstone intercalation, which is characterized by mudstone content of >95% of the total layer (Figure 4). The alternation contains abundant *Lockeia* trace fossil.

Reservoir Potential

Based on visual porosity estimation during petrography analysis, the sandstone of sandflat facies has approx. 10% -15% of porosity and this can be categorized as having moderate porosity (Ehrenberg and Nadeau, 2005). Therefore, the Upper Tapak Formation may have moderate reservoir potential. Thick sandstone in the sand flat facies, with moderately to poorly sorted and moderate porosity are necessary to provide hydrocarbon flows in the Banyumas Basin. This fact is proven by oil seepages that penetrated through the Upper Tapak Formation along Cipari Anticline

However, the sand-shale ratio along the measured section in Cimande area shows a good percentage of sand (50-60%) in sand flat to mixed flat area which can be a good reservoir potential.

The thick claystone of mud flat facies can be the top seal to prevent hydrocarbon flowing from the sand flat facies and keep the hydrocarbon preserved along the anticlines in the Banyumas Basin, such as the Cipari and Banyumas Anticlines.

Another well-preserved Tapak Formation outcrop that also have reservoir potential can be seen in Wanasuta area, where the Tapak Formation show 60-70% sand-shale ratio (Figure 6). It is also showing a similar fining and thinning upward with abundant bioturbations.

However, the abundance of bioturbations can either destruct or enhance the porosity. More routine and special core analysis is needed to get a better evaluation of the reservoir quality.

There is no question of the source rock presence since many oil seepages have been found in this area.

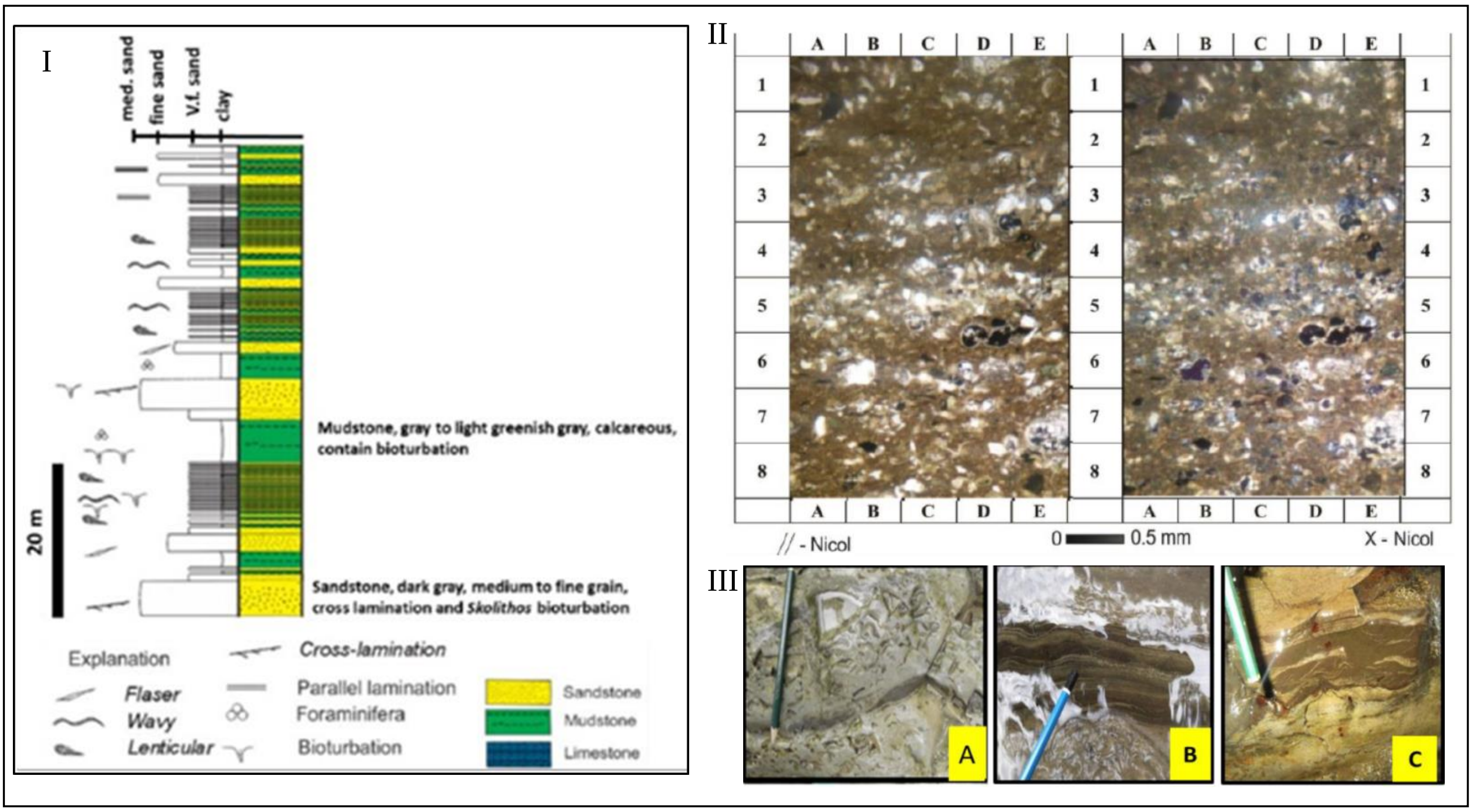

Figure 4: *(I) The profile of Tapak Formation in Cimande area, (II) The petrography of sand flat facies association, and (III), (a) lenticular, (b) wavy lamination, and (c) flaser sedimentary structure.*

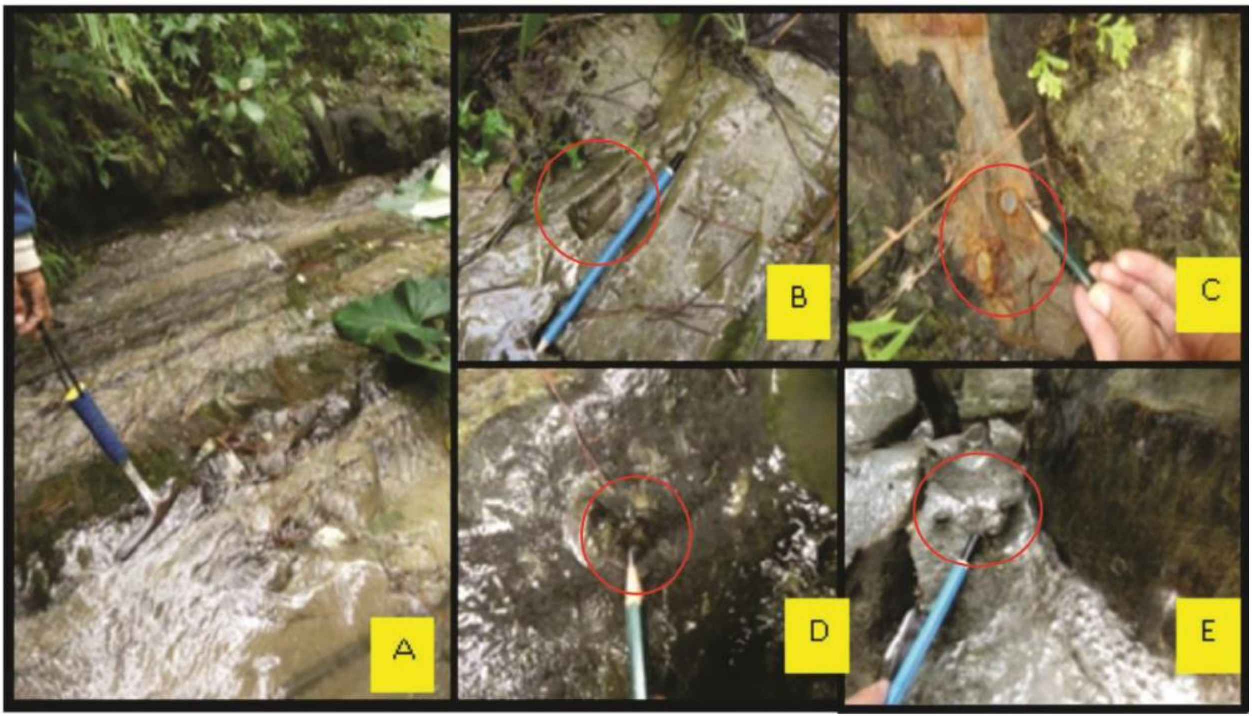

Figure 5: *(A) Outcrops of sandstones and mudstone alternation (mixed flat facies associations) with bioturbation (B) Planolites, (C) Ophiomorpha, (D) Zoophycos, and (E) Lockeia.*

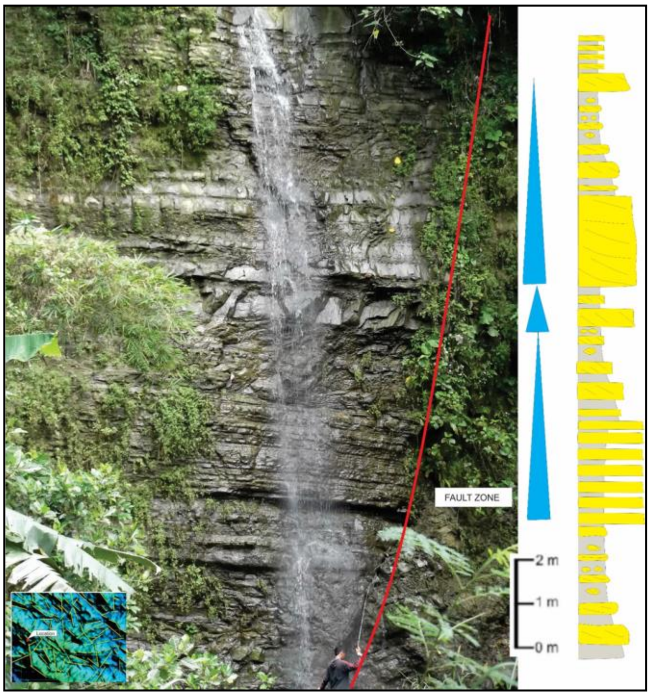

Figure 6: *Profile of Tapak Formation showing a variety from sand flat, mixed flat, and mud flat in Wanasuta area.*

CONCLUSION

The Upper Tapak Formation at Kali Cimande area consists of a repeating succession of sandstone with siltstone and mudstone with layering pattern of fining and thinning upward. Its facies associations consist of sand flat, mixed flat, and mud flat facies associations. There is a reservoir potential for this formation based on its visual petrography and high sand-shale ratio. However, it needs to be confirmed by routine and special core analysis.

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