# CHARACTERISTICS OF DOLOMITIZED LIMESTONE OF PRUPUH FORMATION BASED ON PETROGRAPHY ANALYSIS IN SENDANG AGUNG, EAST JAVA

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***ABSTRACT***

*The East Java Basin is a large hydrocarbon producing basin in Java. From the drilling wells in this region it is known that the reservoir comes from carbonate rocks. The Prupuh Formation acts as a reservoir because of its high porosity value, not only primary porosity but also secondary porosity. The study of limestone characteristics of Prupuh Formation in Sendang Agung Village, Paciran District, Lamongan Regency, East Java Province is a combination of field and laboratory activities. Field activities include collecting data through detailed measurements, making measured stratigraphic cross sections with systematic rocks sampling. Laboratory activities are petrographic analysis through thin sections. The purpose of this study is to increase the knowledge about Prupuh limestone which acts as a reservoir in the East Java Basin oil and gas system. Based on the results of the field activity, a measured stratigraphic section with a thickness of 32.5 meters was made, the lower and middle sections were composed of dolomite, then at the top there were bioclastic limestones as reported by Pringgoprawiro, 1983. A total of 6 (six) rock samples were chosen for petrographic analysis of thin sections. Results of the analysis obtained 32 meters is a crystalline dolomite with a very bad porosity system. Dolomite which is found is the result of dolomitization of the wackestone bioclastics limestone. So it was concluded that the carbonate rocks the Prupuh Formation in research area had very bad potential to become reservoir rocks.*

***Keywords****: Prupuh Formation, Measured Section, Petrography, Microfacies, Reservoir.*

**ABSTRAK**

Cekungan Jawa Timur merupakan cekungan penghasil hidrokarbon yang besar di Jawa. Dari sumur pemboran di wilayah ini diketahui bahwa reservoirnya berasal banyak dari batuan karbonat. Formasi Prupuh berperan sebagai reservoir karena nilai porositas yang tinggi, tidak hanya porositas primer namun juga porositas sekunder. Studi mengenai karakteristik batugamping Formasi Prupuh di Desa Sendang Agung, Kecamatan Paciran, Kabupaten Lamongan, Propinsi Jawa Timur merupakan gabungan antara kegiatan lapangan dan laboratorium. Kegiatan lapangan mencakup pengumpulan data melalui pengukuran detil, pembuatan penampang stratigrafi terukur disertai pengambilan contoh batuan secara bersistem. Kegiatan laboratorium adalah pengujian petrografi melalui sayatan tipis. Tujuan dari studi ini adalah untuk menambah pengetahuan tentang batugamping Formasi Prupuh yang berperan sebagai reservoir dalam sistem minyak dan gas bumi Cekungan Jawa Timur. Berdasarkan hasil kegiatan lapangan dibuat penampang stratigrafi terukur dengan tebal mencapai 32,5 meter yang bagian bawah dan tengah disusun oleh dolomit berwarna abu-abu kecoklatan hingga coklat kemerahan, kemudian pada bagian atas dijumpai batugamping bioklastik seperti yang dilaporkan oleh Pringgoprawiro, 1983. Sejumlah 6 (enam) contoh batuan dipilih untuk analisa petrografi sayatan tipis. Berdasarkan hasil analisa tersebut diperoleh sekitar 32 meter merupakan dolomit kristalin dengan sistem keporian sangat buruk. Dolomit yang dijumpai merupakan hasil dolomitisasi dari batugamping bioklastika wackestone. Sehingga disimpulkan bahwa batuan karbonat Formasi Prupuh di memiliki potensi yang sangat buruk untuk menjadi batuan reservoir.

**Kata Kunci**: Formasi Prupuh, Penampang Terukur, Petrografi, Mikrofasies, Reservoir.



E-ISSN : 2579 – 3136

## INTRODUCTION

The East Java Basin is a large hydrocarbon producing basin in Java. From the drilling wells in this region it is known that the reservoir comes from carbonate rocks. In oil and gas exploration, carbonate rocks can act as reservoirs because of their high porosity values, not only primary porosity but also secondary porosity. The relatively high heterogeneity of carbonate reservoirs is characterized by varying porosity values which will affect the interconnection and fluid flow mechanism in it. The value of porosity in carbonate rocks cannot be separated from the deposition and diagenesis process. The study of limestone characteristics of Prupuh Formation as one of reservoirs in the East Java Basin is interesting because it related to the volumetric of reservoir. This research was conducted in Sendang Agung Village, Paciran District, Lamongan Regency, East Java Province (Figure 1).

## RESEARCH METHODS

The object in this study is the data of surface outcrops and rock samples for laboratory analysis. The research method is a combination of field and laboratory activities. Field activities include collecting data through detailed measurements, making measured stratigraphic cross sections with systematic sampling of rocks. Rocks samples that have been collected then analyzed petrographically through thin sections. The aim of this study is to increase knowledge about limestone from the Prupuh Formation which acts as a reservoir in the East Java Basin oil and gas system.

## STRATIGRAPHY OF THE PRUPUH FORMATION

Pringgoprawiro (1983) establishes this rock unit as the Prupuh Formation. The type location is located along the Prupuh Village road, 5 Km northwest of Panceng, Paciran District, East Java Province. The Prupuh Formation stratigraphy has been studied and reported by previous authors, among others, by Harsono Pringgoprawiro (1983) (Figure 2). The stacking rocks unit are dominated by bioclastic limestones, thick, hard, rich in Orbitoid fossils, on the edge of a 300-meter long road between the villages of Prupuh and Pundut. Besides that, there were also intercalations of dirty white chalky limestone with light gray white bioclastic limestone exposed. Fine to very fine-grained chalky limestone, sometimes loose grained, but often compact and brittle. Bioclastic limestone in the form of plates as thick as 6-50 cm, gray white, medium to coarse grained, well to medium sorting, poor porosity, closed fabric, rich in orbitoids and algae. The age of the whole Prupuh Formation is Upper Oligocene to Lower Miocene or N 3 to N 4 zone (Blow, 1969), with a depositional environment in the Outer Neritic zone. This formation overlying the Kujung Formation on the lower part to then overlaid directly by the Tuban Formation above it.

## RESULTS AND DISCUSSION

The results of field observations are the measured stratigraphic cross section on the Sendangagung Village, along this track there are continuous sedimentary rock outcrop with the following characteristics (Figure 3):

The lower part consists of dolomite, brownish to reddish-brown, bedded, partially hard to powdery, in some places dolomite still contains calcite. This dolomite layer shows the bedding plane with slope direction N 335° - 350° E and dip angle 31°. The middle part consists of dolomite and limestone intercalations. The slope direction and dip of the bedding plane between N 330° E/ 33° to N 347° E/ 42°. The upper part is a fine-grained limestone, brownish-brown, with parallel and cross lamination sedimentary structures. The thickness of the formation exposed at this location is 32.5 meters. From the measured stratigraphic section, 6 (six) rock samples have been selected.

Based on petrographic analysis of stratigraphic cross sections samples from Sendang Agung, it can be categorized into 2 (two) microfacies, which are crystalline dolomite and bioclastics limestone.

Crystalline dolomite microfacies were identified in SA 18A, SA 19, SA 21B, SA 23G and SA 26C thin sections (Microfoto 1-5). The crystalline dolomite is a non-iron component dolomite. Very rare traces of grains, fine grains are still present which are characterized by clustered of micrite mud, but there are also those of an undetermined type with sizes reaching 0.80 mm, and only characterized by grouping of dolomite crystals. Crystals of fine unimodal dolomite (subidiotopic) with granular mosaic structure, some nuclei in the center of a rhombohedral crystal, in average size of 0.35 mm to various forms of unimodal rhombohedral (idiotopic - xenotopic) measuring 0.25 mm, which forms a granular anhedral granular texture with the intersection of the triple junction crystal plane. Very rarely dolomite crystals are calcified. Micrite mud or dedolomitization is present randomly inside and outside the calcite crystals. Iron oxide is present as filler in most inter-crystalline cavities in an irregular pattern, and is sometimes associated with brownish muddy autigenic clays.



E-ISSN : 2579 – 3136

Bioclastic limestone microfacies were identified in SA 27C thin sections (Microfoto 6). Bioclastic limestones is fine bioclastic rocks which are poorly sorted and supported by alternated carbonate mud matrix. The fossil component is diverse, but is still dominated by fossils of small planktonic foraminifera. Some fossils appear to be replaced, with fossil cavities filled with carbonate mud and silica. Very fine grained pellets present very rarely and unevenly. The carbonate mud matrix is quite much between granules and partially replaced by microsparite. Orthosparite is present limited between and inside the granules, iron oxide is randomly distributed to replace granules, and anhedral quartz silica appears to fill the cavity in granules (Microfoto 6).

The diagenetic characteristics of crystalline dolomite are intensive dolomitization so that the texture and structure of the origin become lost, desiccation and calcification, filling of the inter crystalline cavity by iron oxide and autigenic clay. Poor phantom system, in the form of very fine cavities (reaching 0.60 mm) mainly from the type of inter crystalline which is spread fairly even and some have been filled with iron oxide and autigenic clay and very rarely space resulting from very fine size dissolution locally and unevenly. Diagenesis characteristics of bioclastic limestone are substitution, cementation or cavities fill in and silicification, very rarely dissolution and final fill out. The porosity system is very poor, from the remain of particles and spaces type due to dissolution with very fine size locally and unevenly.

Crystalline dolomite microfacies were initially thought to be deposited in a limited shelf environment - evaporite while the microfacies of bioclastic limestones were deposited in shallow water with open water circulation under waves influence in open shelf.

## CONCLUSION

Based on the field observations, the composition of Prupuh Formation in the research area composed of Dolomite at the bottom which was overlaid by dolomite and limestone intercalations in the middle. The uppermost part is fine-grained bioclastic limestone. The thickness of the formation revealed at this location is 32.5 meters. From the measured stratigraphic cross section, 6 (six) rock samples have been selected.

Based on petrographic analysis of the dolomitic limestone of the Prupuh Formation, almost entire section composed of crystalline dolomite with a very poor porosity system, in the form of fine-sized inter crystalline cavities (reaching 0.60 mm) distributed fairly even, some part has been filled by iron oxide and authigenic clay and very rarely space originated from dissolution. The fossil component is diverse, but is still dominated by foraminifera fossils. This dolomite is a result of dolomitization in wackestonebioclastics limestone that significantly has changed and formed new porosity system.

Based on microfacies analysis, crystalline dolomite microfacies were initially thought to be deposited in a limited shelf environment, most likely in shallow water-evaporate. Dolomitization process was triggered by hot weather or climate that causes high evaporation process so dolomite crystals are formed in Prupuh limestones.

## THANKS TO

The author would like to thank Mrs. Emma Yan Patriani, Mr. Alexander Limbong and Mr. Sigit Maryanto who have helped during the research activities conducted.

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E-ISSN : 2579 – 3136

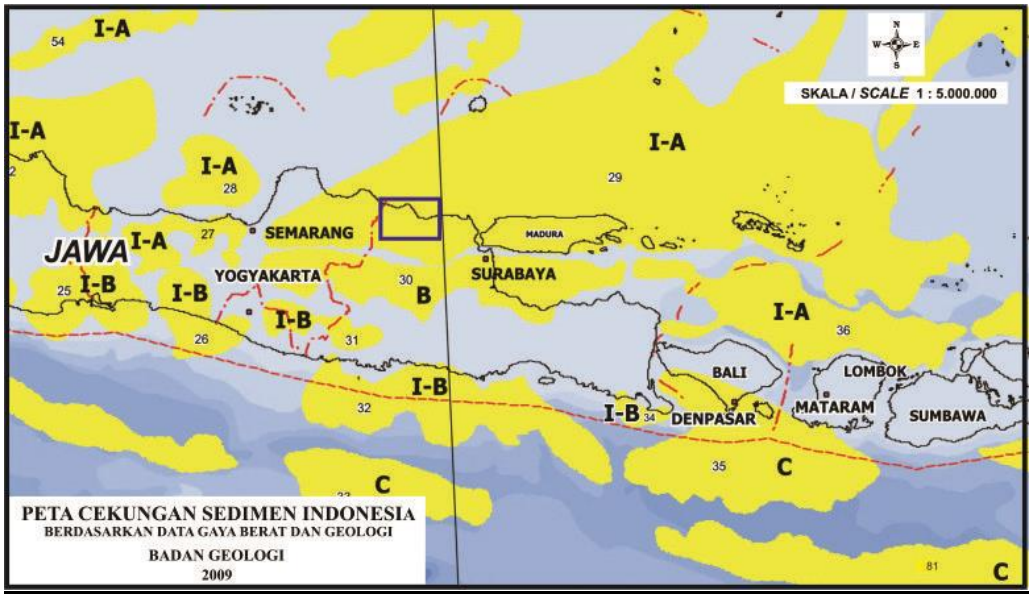



Figure 1. Map of research area in Sendangagung Village, East Java (Peta cekungan sedimen berdasarkan Gaya Berat dan Geologi, Badan Geologi, 2009).

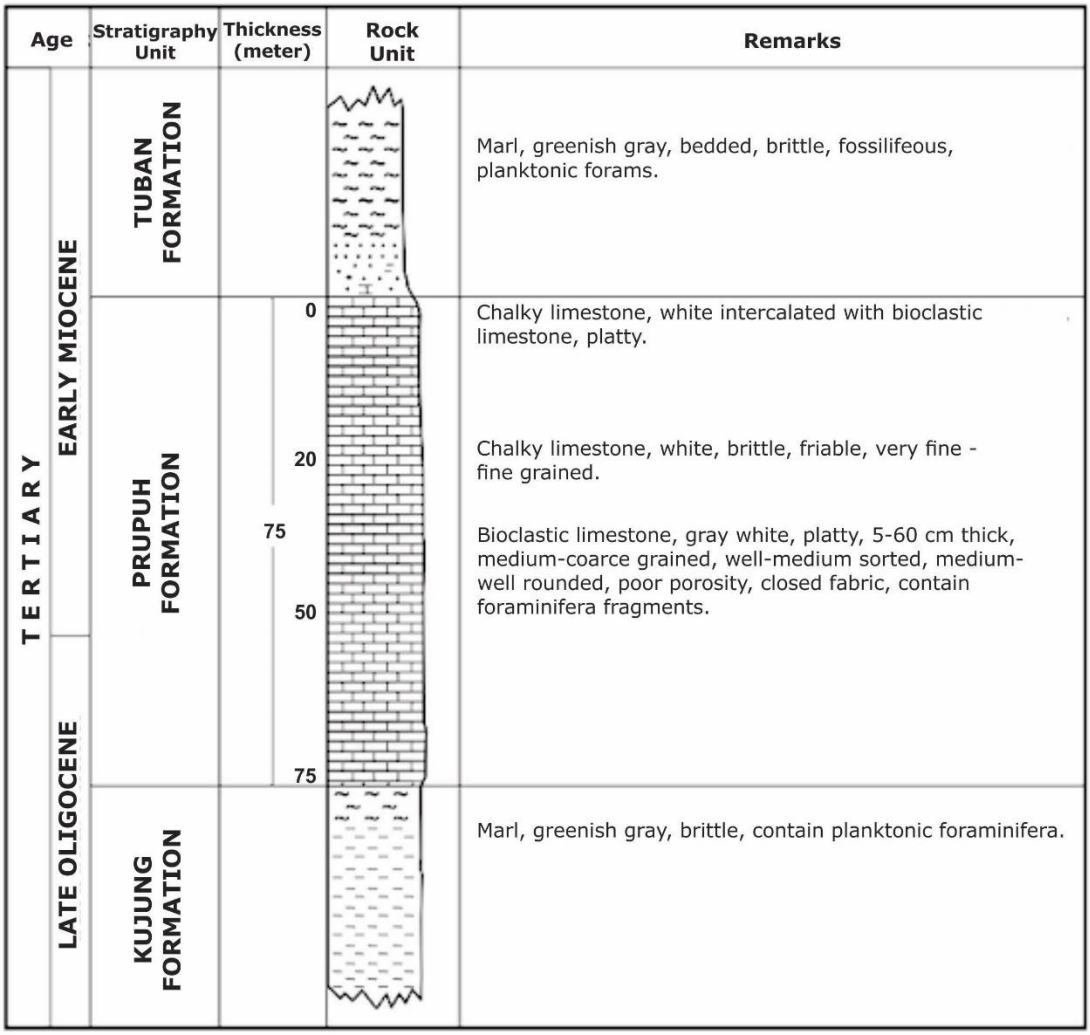



Figure 2. Stratigraphic column of Prupuh Formation (Pringgoprawiro, 1983).



E-ISSN : 2579 – 3136

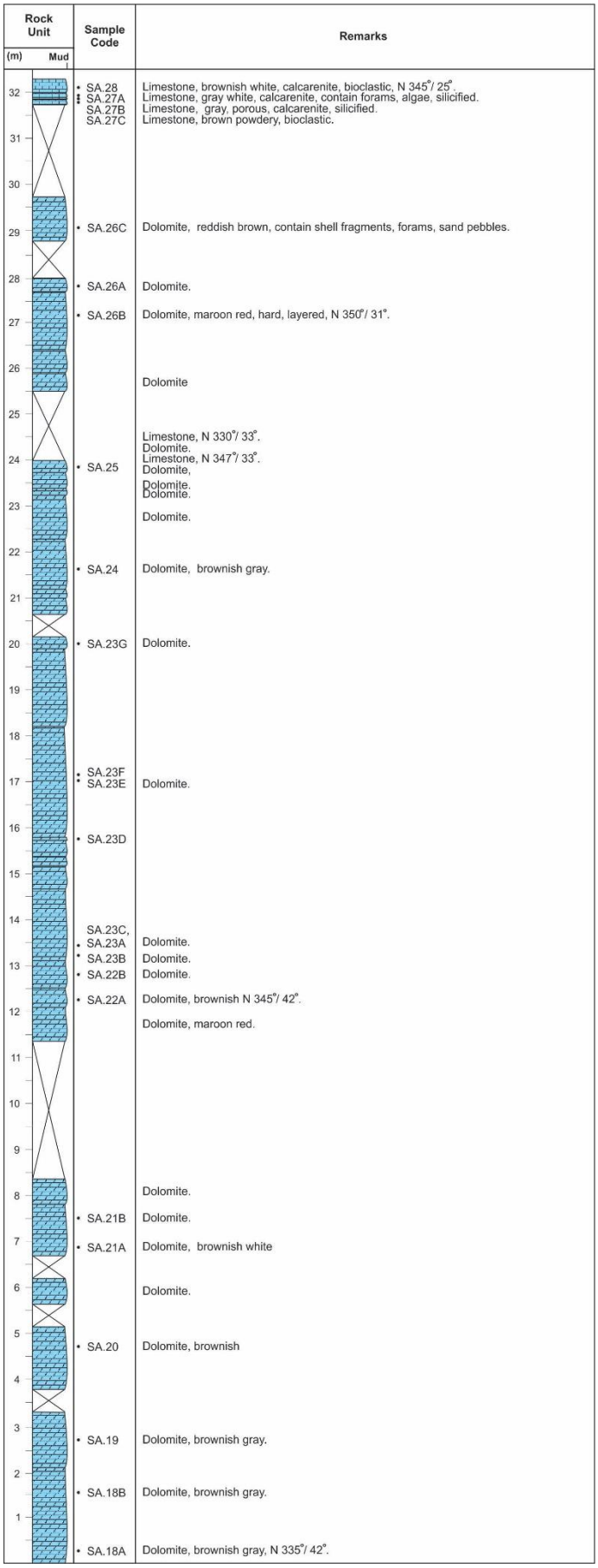
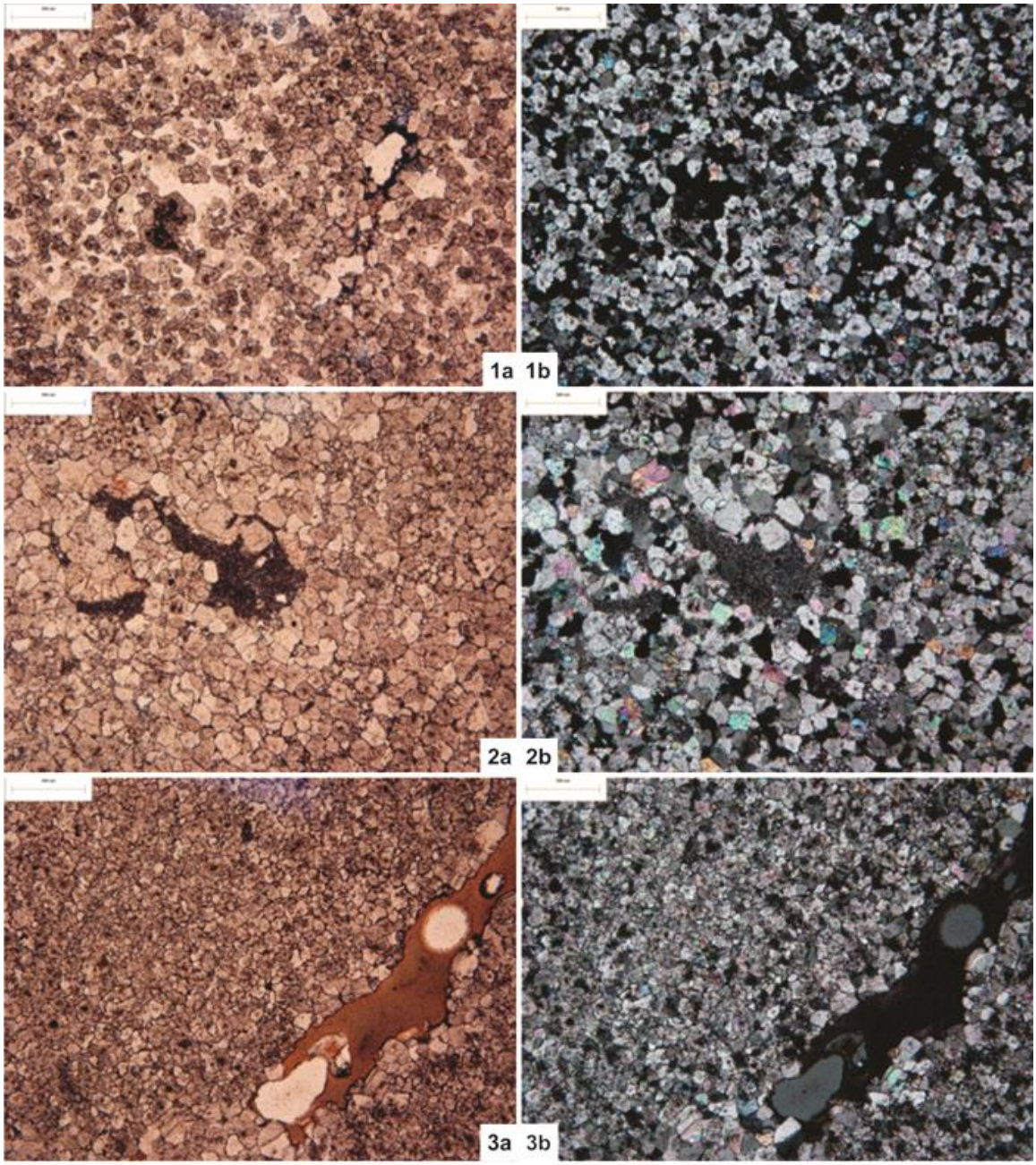



Figure 3. Stratigraphic cross section of dolomitized limestone of Prupuh Formation in Sendangagung Village, East Java.



E-ISSN : 2579 – 3136




Microfoto 1. Thin section of SA 18A sample is crystalline dolomite which is supported by very fine non-iron unimodal rombohedral dolomite crystals.
Microfoto 2. Thin section of SA SA 19 sample is a crystalline dolomite which is supported by a coarser-sized unimodal rombohedral dolomite crystal. The contents of autigenic clay are mixed with iron oxide.
Microfoto 3. Thin section of SA 21B sample is crystalline dolomite which is supported by very fine non-iron unimodal rombohedral dolomite crystals. The cavity appears to be partially filled with autigenic clay and iron oxide.

a) Without cross nichol.
b) With cross Nichol.



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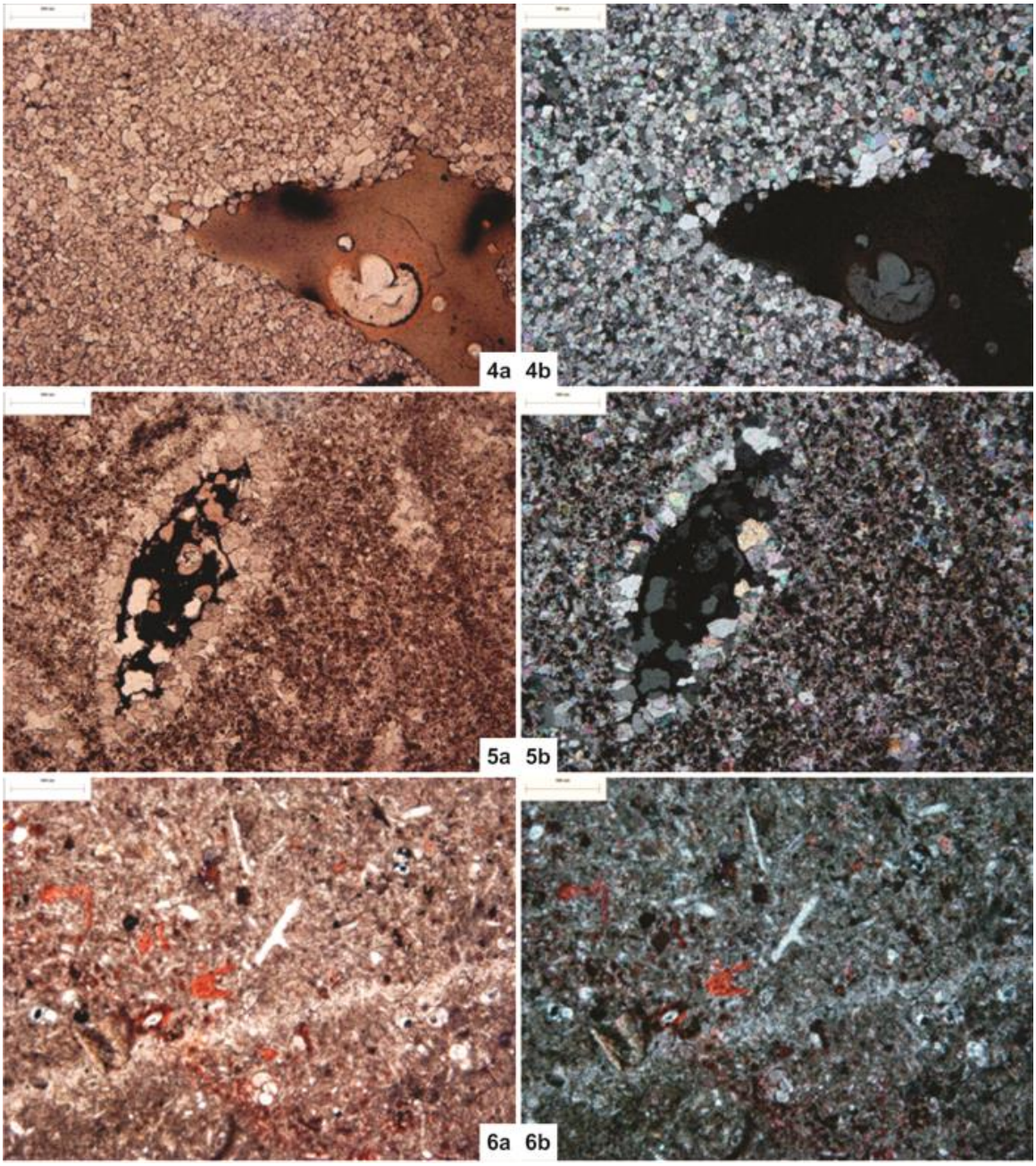


Microfoto 4. Thin section of SA 23G sample is crystalline dolomite which is supported by very fine non-iron unimodal rombohedral dolomite crystals. The cavity appears to be partially filled with autigenic clay and iron oxide.
Microfoto 5. Thin section of SA 26C sample is crystalline dolomite which is supported by very fine and medium sized non-iron polymodal rombohedral dolomite crystals. Traces of grains are characterized by coarser cluster of crystals.
Microfoto 6. Thin section of SA 27 is a poorly sorted wackestone bioclastic rock supported by a slightly alternated carbonate mud matrix. Carbonate grain components are still dominated by plangtonic foraminifera.

a) Without cross nichol.
b) With cross Nichol.



E-ISSN : 2579 – 3136