Ichnofossil significance on paleogeographic reconstruction and deep water turbidite reservoir

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Abstract. Petro-physical properties are the most important factor that controls the quality of the reservoir. Porosity, permeability, and the grain size are the main parameters to measure the quality of the reservoir. Thin section analysis was used to identify the arrangement of the grains within the rock. The existence of trace fossil can change the condition of the parameters of the reservoir. Bioturbation trace in a rock which made by organism activity, Planolites, changes the quality of reservoir significantly. The porosity value in a bioturbated zone was around 80 % and in the non-bioturbated zone was 5 %. It increased the permeability too. This was identified from the interconnected pores in the bioturbated section, it has 90 % of quartz mineral with the same grain size relatively in bioturbated section and non-bioturbated section. The existence of Planolites trace implied that the outcrop was deposited in the deep-marine environment.

Keywords: Planolites, bioturbation, quality of reservoir

1. Introduction
Study the traces formed by organism activity in the substrate and its relation to Sedimentology, Paleontology, Biology and Ecology was well-known as Ichnology [1]. In recent times, many studies have been conducted on this topic such as the influence of ichnofossil on the quality of a reservoir. Physical properties such as porosity and permeability are important factors in controlling the quality of the reservoir itself. With additional features such as bioturbation, ichnofossils in a reservoir rock allowed for changes in the physical properties of the reservoir. Previous studies have explained that bioturbation can have a positive or negative impact on petrophysical properties depending on the nature of the sedimentary facies. Porosity might increase as the grained burrow was coarser than the surrounding rock grains as well as permeability might increase in relation to several factors such as the level of interconnection between the burrow and the contrast between the burrow and the matrix [2]. Burrows mechanism could make the secondary or primary pathway of the fluid such as hydrocarbon that means increasing of the permeability value of the reservoir rock [3]. This study aimed to understand the effect of ichnofossil on the quality of the reservoir.
2. Data and method

2.1. Field observation
Fieldwork was conducted to obtain hand specimens taken directly from outcrops of Jatiluhur Formation, Bogor Regency, West Java. The rock samples contained high intensity of the trace fossil. The average size of rock samples was 0.15 m wide by 0.10 m and 0.08 m thick.

2.2. Laboratory method
Megascopic descriptions aimed to identify the pattern of trace fossil which then it can be determined the type of organism involved there. These hand specimens were then prepared for a thin section.

Grains observation of thin section was done under a microscope with 25 times magnification. Thin section was made specifically perpendicular to bioturbated part. Blue dye was used in a thin section to better differentiate the pores and the grains.

The observations comprised of comparing the porosity of bioturbated section and non-bioturbated section. Mineral content in both parts, pore size, permeability, and sorting were also observed during this study. These parameters were then used to assess the quality of the reservoir. The quality of the reservoir was determined only by qualitative approaches.

3. Results and discussion
The results of the megascopic observations demonstrated rock samples were composed by silt-size carbonate detritus both in bioturbated part and non-bioturbated. Bioturbation patterns are the result of Planolites burrowing mechanism that could be seen from the similarity of these patterns to previous studies (figure 1) [3, 4].

Based on thin section observations, porosity value, permeability value, and grain size distributions from the bioturbated area and non-bioturbated area were observed respectively. The porosity calculation was done by image-based calculation. Different porosity values were observed in both areas. Porosity in the bioturbated area has a value of around 80 % and non-bioturbated area 5 % (figure 2) This finding emanated that bioturbation had a strong impact on porosity value.

While permeability in the bioturbated section is relatively better compared to the non-bioturbated part (figure 2). It can be identified from the interconnected pores in the bioturbated section. It could be concluded that bioturbation had an impact on permeability value.

![Figure 1](image1.jpg)

**Figure 1.** Planolites trace fossil in rock samples, (a) found in studies area, and (b) found in the previous study modified from Marenco et al. [4]
Figure 2. porosity, permeability, and grain size distribution observation based on thin section of bioturbated and non-bioturbated area contain quartz minerals (Qz) and Opaque (Op), (a) found in bioturbated area, and (b) non-bioturbated area.

The mineral contained in rock samples is dominated by 90% of quartz with the size of 0.2–0.5 mm, the content of cement is a carbonate. The size of the grain between those bioturbated sections and non-bioturbated section are similar. While the sortation is quite well in non-bioturbated part contrasts the sortation became poor in the bioturbated part (figure 2).

Based on the results of the observation, it is found that the trace pattern of the fossil is caused by organism activity, i.e. Planolites, based on the previous study [4]. These organisms commonly live in deep-sea environments, this reinforces the notion that this outcrop was formed in a deep-marine depositional environment [5].

This study indicated that the occurrence of burrowing can be seen on a thin section arrangement of grains on the fossil trace tends to be more irregular compared with the non-bioturbated part. The arrangement of these grains also resulted in different degrees of cementation between the two parts. In non-bioturbated part, grains were highly cemented and well-sorted. In contrast, in the bioturbated part, the degree of cementation was very low with poorly sorted grain distribution.

Bioturbation had also an impact on the petrophysical properties. The bioturbated part has a higher porosity value than in the non-bioturbated section. Therefore, obviously bioturbation can increase the porosity value of the rock. It could be seen from the thin section of bioturbation had rearranged the grain distribution to create more pores between the grains. Thus, porosity became effective because it was interconnected with each other so that permeability became better. Given the fact that porosity and permeability are getting better in value with trace fossils, the impacts that will affect the reservoir will greatly benefit where the ability of the reservoir to store fluids will increase. If there are fossil traces in a very large amount of a reservoir rock, then it will significantly improve the quality of the reservoir. However, the more comprehensive study should be done in order to support these findings.
4. Conclusion
Based on the study that had been done, it could be concluded that Planolites trace fossil supported the previous finding. Planolites could only be found in the distal part of the submarine fan where this outcrop was originally deposited. While the appearance of bioturbation should increase the porosity and permeability value, the more comprehensive study on this relationship should be done in the near future.

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References
[1] Knaust D 2017 Atlas of Trace Fossils in Well Core Appearance, Taxonomy and Interpretation (Switzerland: Springer Nature)
[2] Croix A D L, MacEachern J A, Ayranci K, Hsieh A and Dashtgard S E 2017 Mar. Petroleum Geol. 86 636-54
[3] Baniak G M, Gingras M k and Pemberton S G 2013 Mar. Pet. Geol. 48 275-92
[4] Marenco K N and Bottjer D J 2008 Palaeogeogr. Palaeoclimatol. Palaeoecol. 258 189-99
[5] Abdurrokhim and Ito M 2013 J. Asian Earth Sci. 73 68-86