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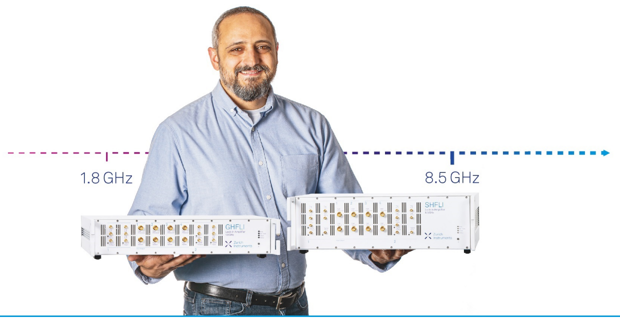

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Sulphide Minerals in Limestone: Trap Rock of Buton Asphalt on Block Kabungka Mine C PT Wijaya Karya Bitumen, Buton Regency, South East Sulawesi

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Abstract. This article presents data analysis of presence of the sulphide mineral from three samples including two samples of limestone trap rocks with low grade asphalt and one sample of Buton asphalt rock. These samples were observed with petrographic analysis at the Laboratory of Sample Preparation, Faculty of Engineering, Hasanuddin University. The samples were prepared using the thin section method. Observation of the sample using a Polarized Microscope Nikon Eclipse LV 100ND POL/DS. The results show that sulphide minerals found on all three samples as pyrite (FeS_2), chalcopyrite ($CuFeS_2$), bornite (Cu_3FeS_4), and covellite (CuS). There were no traces of hydrothermal solution such as altered rock or quartz veins, but the composition of the analyzed sulphide minerals had similarities to the sulphide mineral composition in andesite rocks of Central Lombok. The presence of sulphide minerals in Buton asphalt trap rocks has the potential to produce pollution in the form of acid mine drainage (AMD). Therefore, it needs a proper treatment technique to countermeasure of water pollution occurrence.

INTRODUCTION

The sulphide minerals are the major source of world supplies of a very wide range of metals and are the most important group of ore minerals. In addition to their concentrated occurrence in ore deposits and areas of mineralization, a limited number of sulphide minerals are found as accessory minerals in rocks. Pyrite (FeS_2) is by far the most abundant sulphide mineral. The very fine particle iron sulphides found in reducing environments beneath the surfaces of recent sediments and soils, although transient species, are also volumetrically important [1].

In mining, it is important to know the presence of sulfide minerals in rock, especially in open mine area. It is important to know the trace of mineralization. In addition, the existence of sulphide minerals, especially pyrite in open mine area, potential to produces water pollution known as the acid mine drainage (AMD) [2].

In this paper, it was conducted on the Buton asphalt (asbuton) mining area of PT Wijaya Karya Bitumen which located in Block Kabungka Mine C, Pasarwajo District, Buton Regency, South East Sulawesi Province. This study is to know the presence of sulphide minerals so that can be a reference for preventing contamination of acid mine drainage.

GEOLOGICAL SETTING

The research location lies in the Sampolakosa Formation (Fig. 1). The Sampolakosa Formation is composed of marl, thick bedded-massive, intercalated by calcarenite in the middle and upper part of the formation. It contains Globorotalia plesiotumida, Globorotalia acostaensis, Globorotalia multicamerata, Globigerina venezuelana,

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Globigerinoides ruber, Globigerinoides extremus, Hastigerina siphonifera, Globoquadrina altispira, Sphaeroidinesllopsis subdehiscens, Sphaeroidinellopsis seminulina. Oil and asphalt seepages are found in this formation in the Kabungka, Pasarwajo and Lasalimu villages, Buton. In this area, the formation is known as local type of Sampolakosa River [3]. The formation is Late Miocene to Early Pliocene in age, deposited in neritic-bathyal environment. Some typical mollusc fossil indicate deep sea environment [4].

The Sampolakosa Formation shows a more marlous unit, rarely contains sandstone inserts, and is located in harmony above the Tondo Formation. In this unit, many fossils of foraminifera plankton of the globigerinae species were found. In addition, many mollusc fossils are found that are unique to the deep-sea environment [4]. Generally, Buton Island is covered widely by rock units from the Sampolakosa Formation.

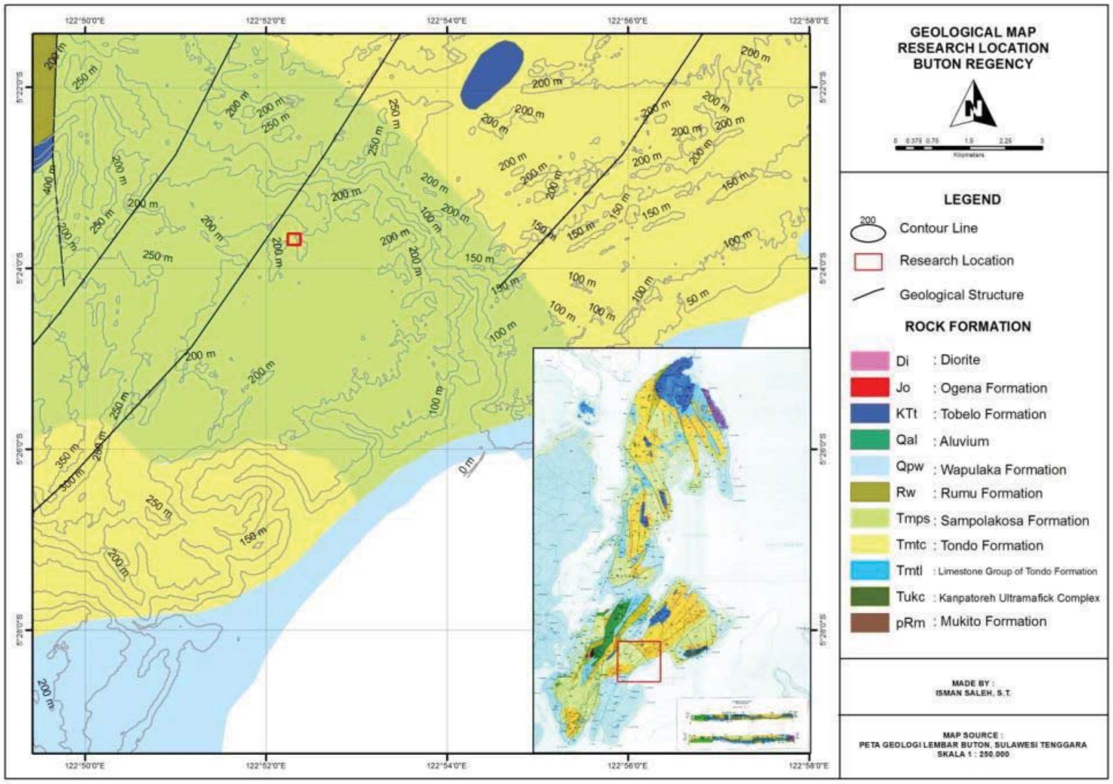


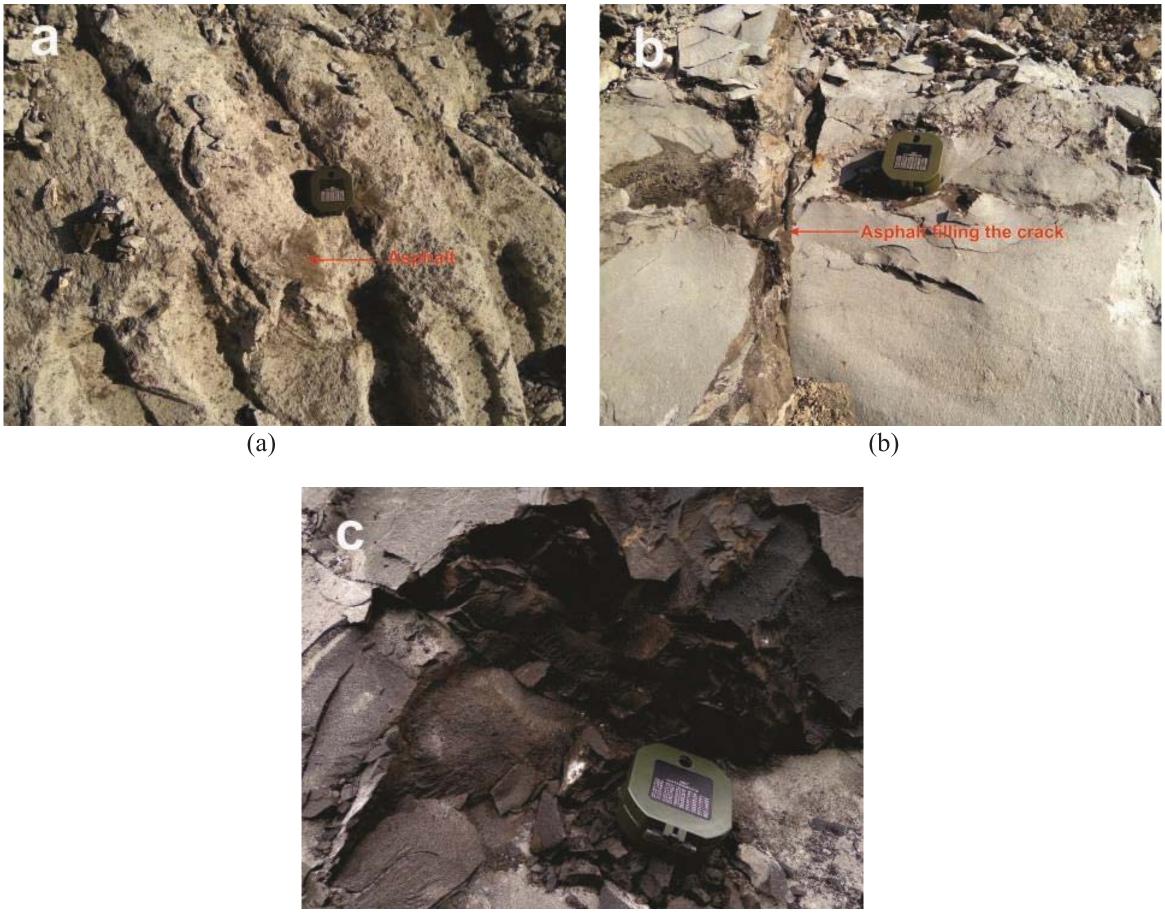
FIGURE 1. Regional geological map of research location

Structural patterns of tectonic conditions of the Buton Island cannot be separated from the tectonic patterns that have developed in the eastern region of Sulawesi. The impact of the tectonic process results in folds and containment faults that are formed. The folds are often the asymmetry which is steeper on the west side. There are differences in the structural pattern of Buton Island as a whole, where in general there are three different parts, namely the southern, central and western parts. The folds and fractures formed as a result of the tectonic process produce an asymmetrical anticlinorium. The structural pattern in the south of the island shows the northwest-northeast direction, the center of the island is north-south, while the northern part of the island shows the main northwest-southeast direction. A number of faults that have developed in this island area are of great importance to the presence of the asphalt formed. The phenomenon of this affirmation includes forming a graben that runs southwest-northeast across the southern part of the island, which is known as the Lawele Graben [4].

SAMPLE DESCRIPTION AND ANALYTICAL METHOD

The samples were analyzed consisted of two trap rocks with low asphalt content and one Buton asphalt sample (Fig. 2). Figure 2 shows the scattered asphalt content on the limestone body which is marked with a darker color than the white limestone. Figure 2b shows the liquid asphalt filling the brown limestone crack. Figure 2c shows a high asphalt content characterized by black rock throughout the rock body.

All samples were petrographically to determine mineral assemblages. The method used is the polish section of the three rock sample (TR1C-002, TR2C-001, and ATC-002). Analysis of polish section sample was carried out using microscope polarized Nikon Eclipse LV 100ND POL/DS in Sample Preparation Laboratory Faculty of Engineering, Hasanuddin University.



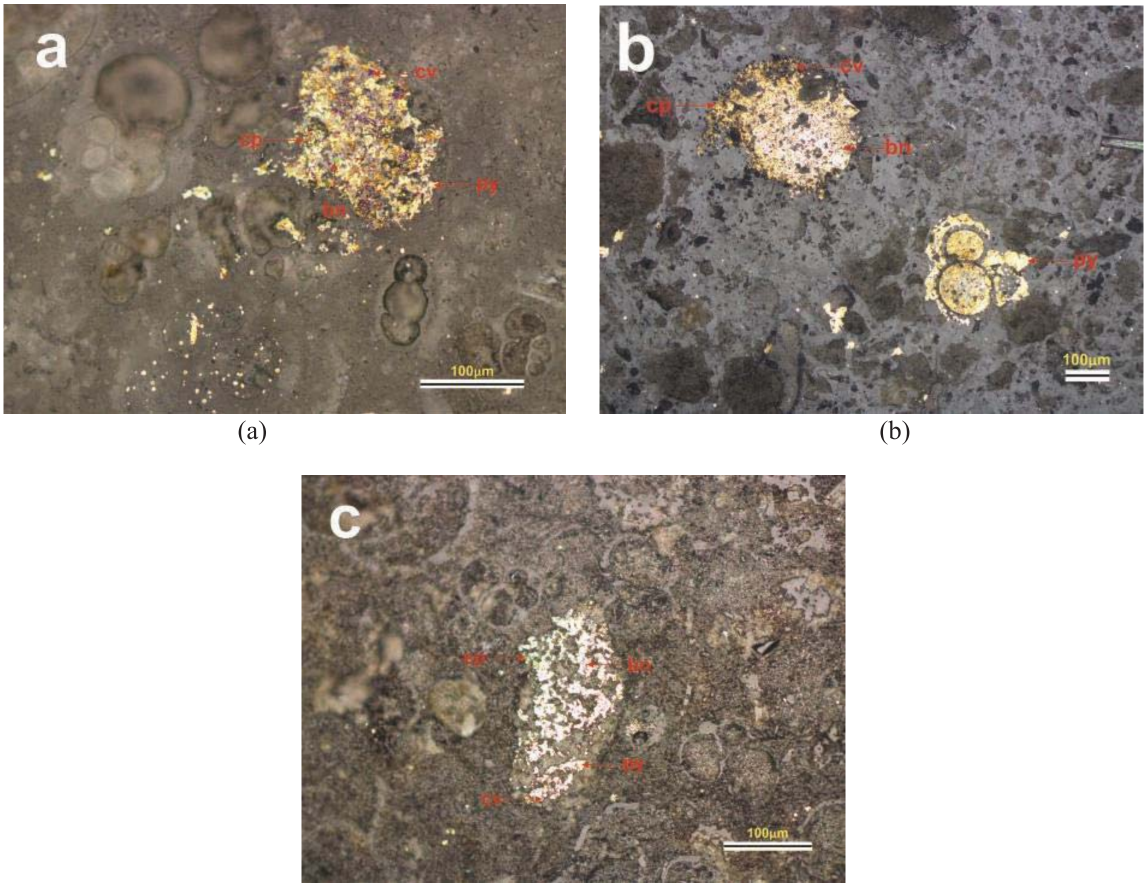
(a) (b)

(c)

FIGURE 2. (a) Limestone outcrop with low grade asphalt (sample TR1C-002), (b) Asphalt filling the crack of limestone (sample TR2C-001), (c) Buton rock asphalt (sample ATC-002)

RESULT AND DISCUSSION

The result of field observations found no veins or hydrothermal alteration in the rock as a characteristic of contamination from hydrothermal sulphide solution. However, the result of observations of the polish section sample showed the presence of sulphide minerals, that is pyrite (FeS_2), chalcopyrite ($CuFeS_2$), bornite (Cu_3FeS_4), and covellite (CuS). The result of analysis using microscope polarized shown in Fig. 3. Mineral sulphides composition and description are shown in Table 1.



(a) (b)

(c)

FIGURE 3. (a) TR1C-002 polish section, (b) TR2C-001 polish section, (c) ATC-002 polish section

TABLE 1. Sulphide mineral compositions of analysis result

No.	Sulphide mineral composition	Symbol	Color
1.	Pyrite (FeS_2)	py	Yellowish white
2.	Chalcopyrite ($CuFeS_2$)	cp	Copper yellow
3.	Bornite (Cu_3FeS_4)	bn	Pink, green
4.	Covellite (CuS)	cv	Blue

Pyrite (FeS_2) commonly occurs and widespread of sulphide minerals and is almost found in gold deposit (Au), Volcanic Massive Sulphide (VMS), and porphyry. It forms at low and high temperatures in hydrothermal vein, sedimentary rock, igneous rock, and metamorphic rock and it is a source of sulphur [5]. Chalcopyrite ($CuFeS_2$) occur with pyrite and almost altered to covellite along crack and grain boundaries and almost founded to replace pyrite [5]. Figure 3 shows that chalcopyrite replaces pyrite crystals.

Bornite (Cu_3FeS_4) has a characteristic pink color and usually shows an altered texture with chalcopyrite, chalcocite, covellite, digenite, enargite, and tetrahedite-tenantite [5]. Figure 3 shows the presence of bornite as a result of the replacement of the mineral chalcopyrite. Covellite (CuS) characterized by indigo blue color and is commonly associated and altered by pyrite, chalcopyrite, chalcocite, digenite, and bornite [5]. Figure 3 shows the presence of pyrite as a result of the replacement of chalcopyrite.

The sulphide mineral composition obtained is similar to the sulphide mineral composition in porphyry type andesite rocks from Central Lombok, Nusa Tenggara Barat (Fig. 4). This indicates that the limestone has contamination of a hydrothermal solution.

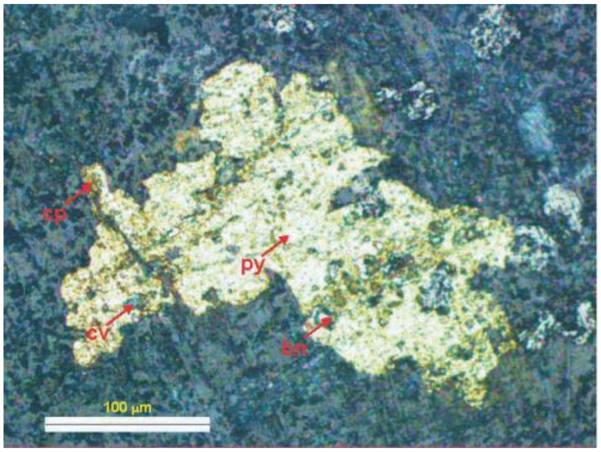


FIGURE 4. Polish section sample of porphyry type andesite rock Central Lombok, NTB

In general, from the analysis of the three samples, it is known that the most common sulfide mineral is pyrite. Pyrite is the dominant solid-phase form of sulfur in organic-matter-bearing marine sediments [6]. Framboids (from the French framboise raspberry) consist of densely packed generally spheroidal aggregates of discrete equigranular submicron-sized pyrite crystals. The individual microcrysts are usually cubes or pyritohedra. Framboidal pyrite forms during the early stages of diagenesis, and retains a size distribution characteristic of its depositional environment during later stages of diagenesis [6].

As the overwhelmingly dominant sulphide in most natural systems, there have been numerous studies of the oxidation of pyrite in air and aqueous media. The literature almost universally acknowledges that any oxidation reaction mechanism is surface-reaction controlled. It is suggested that, in aqueous solution, pyrite oxidizes by a combination of the half-reactions [1].

$$FeS_2 + 8H_2O = Fe^{3+} + 2SO_4^{2-} + 16H^+ + 15e^- \tag{1}$$

and

$$FeS_2 = Fe^{3+} + 2S + 3e^- \tag{2}$$

For which the activity of electrons (Eh) and hydrogen ions (pH) determine the dominant pathway: the sulphate route dominates under ambient conditions. At low pH, pyrite may be oxidized by O_2 and Fe_{aq}^{3+} [1]:

$$FeS_2 + 7/2O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+ \tag{3}$$

and

$$FeS_2 + 14Fe^{3+} + 8H_2O = 15Fe^{2+} + 2SO_4^{2-} + 16H^+ \tag{4}$$

The abundance of sulphide minerals on rocks, especially pyrite is potentially polluting the environment. In particular, the release of sulphur through the weathering of sulphides in natural rocks or in mine wastes generates sulphuric acid, resulting in acid rock drainage or acid mine drainage (AMD). In addition, the heating process of asbuton has the potential to produce toxic gas because it produce gas that mix with sulfur and on a large scale it can cause acid rain. Therefore, right treatment is needed to reduce the potential for contamination by the mineral sulphide content in asbuton.

CONCLUSION

Based on the result of the analysis, it can be concluded that asbuton trap rocks contain sulphide mineral, including pyrite (FeS_2), chalcopyrite ($CuFeS_2$), bornite (Cu_3FeS_4), and covellite (CuS). Field observation found no trace of hydrothermal alteration or quartz vein as an indication of hydrothermal solution contamination. However, the sulphide mineral content in the asbuton trap rock has the same composition as the sulphide minerals found in the andesite rocks porphyry type in Central Lombok. This condition indicates the existence of contamination of a hydrothermal solution in the asbuton trap rock. Therefore, a good treatment is required to reduce the impact of environmental pollution due to the minerals of sulphide on the asbuton trap rock.

REFERENCES

1. D.J. Vaughan, in *Encycl. Geol.*, edited by D. Alderton and S.A. Elias, 2nd ed. (Academic Press, 2021), pp. 395–412.
2. A. Akcil and S. Koldas, J. Clean. Prod. **14**, 1139–1145 (2006).
3. N. Sikumbang, P. Sanyoto, R.J.B. Supandjono, and S. Gafoer, *Geological Map of Buton Sheet, Southeast Sulawesi* (Center for Geological Research and Development, Bandung, 1995). [in Bahasa]
4. S. Hadiwisastra, *Overview of Natural Asphalt Conditions in the Buton Basin* (Journal of Geological and Mining Research, 2009).
5. D. Marshall, C.D. Anglin, and M. Hamid, *Ore Mineral Atlas* (Geological Association of Canada, Canada, 2004).
6. M.B. Goldhaber, Treatise on Geochemistry **7**, 257–288 (2003).