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ORIGINAL ARTICLE

Petrographic Analysis of Bentong-Raub Suture Rock Types in Batu Melintang, Kelantan

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ABSTRACT - The study focuses on the petrographic analysis of rock types in Batu Melintang area, which is part of the Bentong-Raub Suture Zone. The Bentong-Raub Suture Zone is genetically related to the sediment-hosted or orogenic gold deposits associated with the major lineaments of the Central Gold Belt of Peninsular Malaysia. Based on the conducted petrographic analysis, it showed the rock types of Bentong-Raub Suture identified in Batu Melintang, Kelantan; included schist, slate, phyllite, gneiss, hornfels, marble and granite. Most of the rocks showed a preferred orientation of rock minerals that indicated they undergo regional metamorphism. The petrographic analysis was conducted by analysing the thin section to measure the amount of mineral content in the rock sample. The thin section produced from the petrographic analysis gives information on the type of rocks in the study area as it gives confirmation of the rock types and also acts as supporting data to produce an updated geological map.

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Batu Melintang
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INTRODUCTION

The Bentong-Raub Suture rock as documented by the Geological Society of Malaysia [1] is comprised of Ordovician-Permian schist, phyllite, slate, argillite and mélang, also genetically related to the sediment-hosted or orogenic gold deposits associated with the major lineaments of the Central Gold Belt of Peninsular Malaysia. Batu Melintang, Kelantan is primarily made up of two major rock units: the Mangga Formation and the Telong Formation. In terms of lithostratigraphy, the Mangga Formation is the oldest rock unit in the study area which ranges in age from Carboniferous to Permian. While the Telong Formation, which ranges from the Late Permian to the Triassic, is the youngest rock unit in Batu Melintang [2].

Generally, the study area's lithologies were made up of gneiss, schist, and metasediment. Based on a research study by MT-JGSC [2], the Mangga Formation consists of metamorphic sequences of arenaceous, argillaceous, pyroclastic, calcareous, and schistose rocks; the Telong Formation mainly consisted of argillite, low-grade metasedimentary, and metavolcanic rocks. The granite intrusion in Batu Melintang was also documented which formed N-S trending parallel to the Bentong-Raub suture [2],[3].

In this study, petrographic analysis was used to determine the types of rock in Batu Melintang area that related to the lithologies of the Bentong-Raub Suture. The determination of rock types by using petrographic analysis was proven by several previous studies [4],[5]. Researchers from Adikusuma et al. [4] used assessment from petrographic analysis to identify three different types of igneous rocks in the Mount Endut region: andesite porphyry, diorite porphyry, and dacite porphyry. Research from Bilic and Garasic [5] also able to classify three rock types in the St. Barbara ore mine; sublithoarenite, quartz arenite and quartz greywacke by using petrographic analysis.

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MATERIALS AND METHODOLOGY

Study Area

Batu Melintang study area was located in the northern part of Jeli District, Kelantan. The study area was also found within the Bentong - Raub Suture Zone as shown in the map the of study area location in Figure 1.

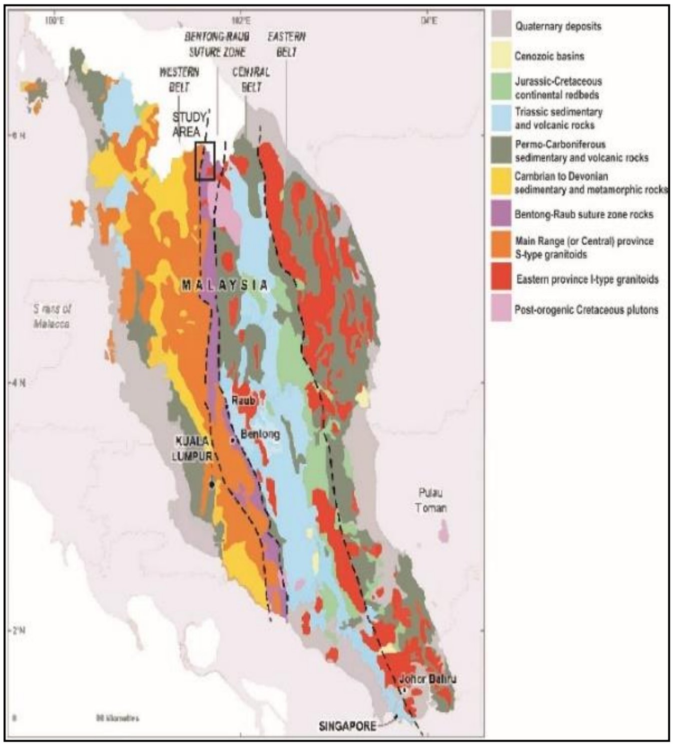

Figure 1. Map of study area location. Simplified version of geological map after[6].

Geological Mapping and Rock Sampling

Geological mapping was done by traversing the study area. The traversing method was used for this study as it was the most suitable and effective method for recording geological data and rock sampling. Representative rock samples were collected throughout the study area. The rock sampling of the fresh outcrop was chosen for petrographic analysis. Before being used for petrographic analysis, thin sections are prepared in the lab. The thin sections are then examined under a binocular polarised microscope.

Preparation of Thin Section

The preparation of a thin section was done by selecting a rock sample. A plane perpendicular to any planar fabric was used to cut the rock sample. The cut sample was polished with a 120-micron polisher before being washed to remove dust. The sample was then heated on a hot plate for 15 minutes to remove all of the water. After the rock chip had dried, Canada Balsam was applied to it and left for 30 minutes, or until a yellowish colour appeared on the rock surface. The rock was placed on a glass plate and covered with 3F powder to create a smooth and even surface. The rock had to be heated for another 30 minutes to remove water content that could interfere with the mounting process. The dried smooth surface of the rock was then coated with Laker Cement (lake cement) and secured with a mounting slide. The sample was then left unattended for 30 minutes to make sure the rock and slide were firmly attached. The thinned, glued rock chip was examined under a microscope after being thinned to a thickness of roughly 0.003mm. Following that, a cover slip was applied to protect the thin section from damage and to improve the clarity observed under the microscope.

Petrographic Analysis

Mineralogical content and percentage are determined after the thin section has been prepared. The thin section was observed under the microscope then, the mineral percentage comparison was made with a suitable rock naming chart to determine the type of rock, such as the Pettijohn classification of sedimentary rocks, the Gillen classification of metamorphic rocks, and the Streckeisen classification of igneous rocks. Mineral data obtained were also compared to existing references from previous studies related to the Mangga Formation and Telong Formation. An updated geological map of Batu Melintang was created after the correct lithologic boundaries have been established.

RESULTS AND DISCUSSION

Several types of rock were identified based on the exposed outcrop in the field such as schist, phyllite, slate, gneiss and marble that formed in a north-south trend. A representative rock sample was taken to the lab to prepare a thin section for petrographic analysis which resulted and confirmed that the rock found in the field was similar to the rock classification based on petrographic analysis.

In Batu Melintang's eastern and southern regions (Figure 8), schist was distributed widely. Schist characteristics were observed by its shiny-grey colour, fine-medium grained with flaky texture, and fissility that can split into thin sheets (Figure 2(a)). The clay minerals that displayed shiny colours were mica and muscovite. Schist is also composed of a highly foliated and schistosity texture. The photomicrograph of schist in Figure 2 consisted of approximately 61% of quartz in white to greyish black colour with anhedral crystal, 30% of biotite in orange to brown colour with subhedral crystal and 5% of silica clay mineral in blackish grey colour, anhedral shape with foliation texture.

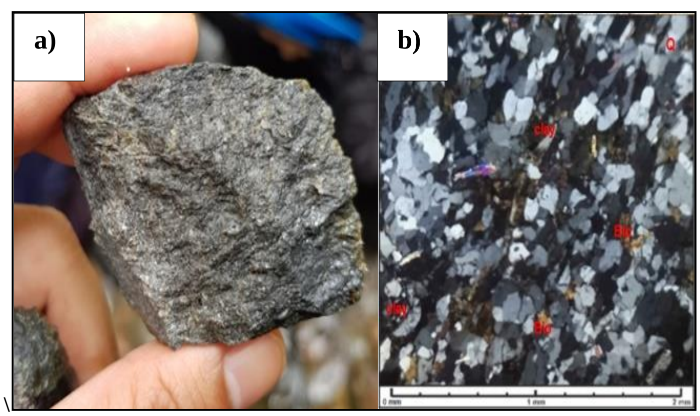

Figure 2. a) Schist sample, b) photomicrograph of schist (Q=Quartz, Bio=Biotite).

The widely distributed phyllite and slate rock in the study area were grouped as a rock unit, also found in interbedded form with a steep angle dipping east. As shown in Figure 3 (a), phyllite was distinguished by its greenish, greyish colour, fine to the medium-grained, wavy surface, and foliation texture with fissility to split into tiny sheets. While, slate (Figure 3(b)) was distinguished by its dark grey to black colour, very fine to fine grained, and also had foliated with smooth and flat surfaces known as slaty cleavage. Because of the parallel orientation of platy clay minerals, both phyllite and slate had foliation texture. Based on the photomicrograph, phyllite (Figure 3(c)) was primarily composed of clay minerals such as mica and chlorite, which is approximately 92% silica clay mineral in greyish black colour, anhedral shape with foliation texture; whereas slate (Figure 3(d)) was composed of 88% clay mineral in greyish black colour, anhedral shape and 8% oxidised silica clay in brownish grey colour with foliation texture. The grain size of phyllite was slightly larger than the slate rock.

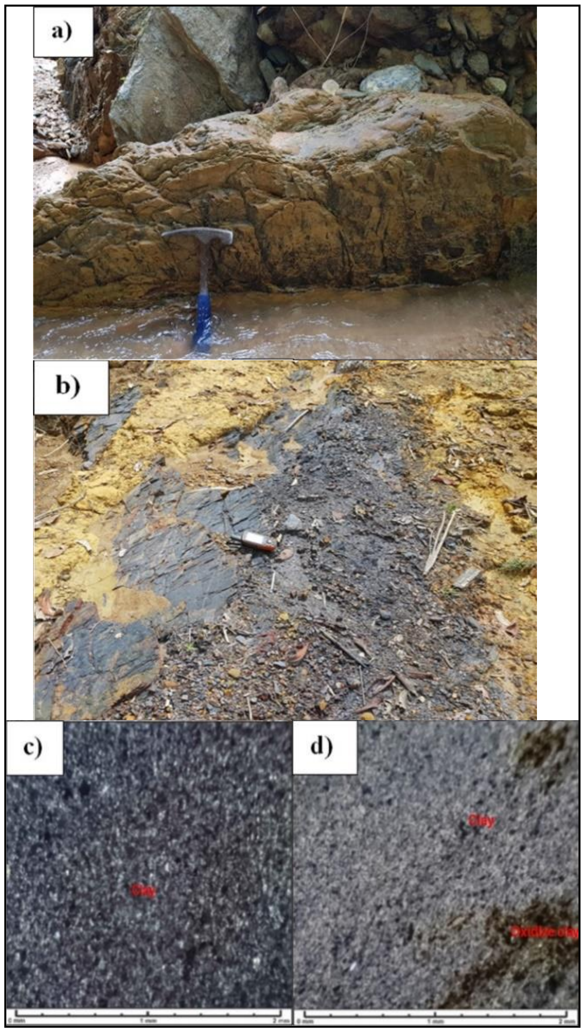

Figure 3. a) Outcrop of phyllite, b) slate, c) and d) photomicrograph of phyllite and slate respectively.

Hornfels exposures (Figure 4(a)) were also found in the south-east, near the granite intrusion in Gunung Reng. Hornfels was characterized as a compacted hard rock with a light grey colour, fine-grained texture, no foliation, and also recrystallized with quartz and calcite veinlets. Hornfels photomicrograph (Figure 4(b)) displayed approximately 40% sericite in brown-grey with anhedral crystal, 29% quartz in white-greyish with anhedral crystal, 20% clay mineral in greyish black with anhedral crystal, and 8% feldspar in light grey with subhedral to euhedral crystal.

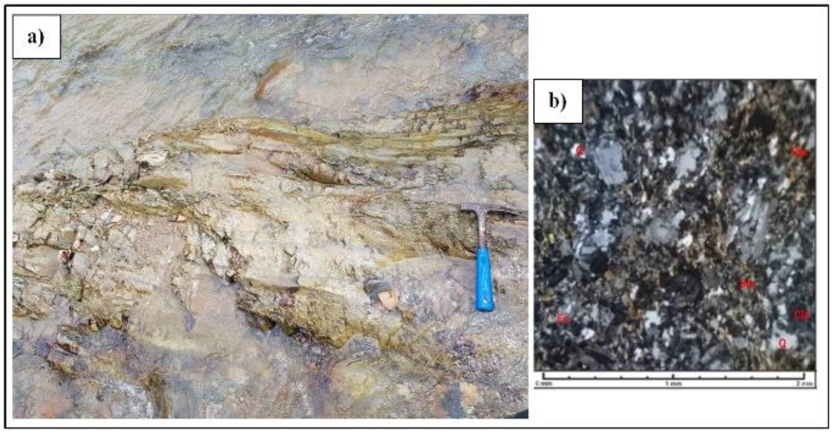

Figure 4. a) Hornfels outcrop and b) photomicrograph of hornfels (Q=Quartz, Ser=Sericite, Fs=Feldspar).

Gneiss rocks were found in the south-eastern and south-western regions of the study area. Gneiss rocks (Figure 5(a)) were characterized by their light grey, black colour, course-grained, and also had a gneissic banding texture and foliation structure. Petrographically, Figure 5(b) displayed the mineral composition of gneiss, which was composed of approximately 31% quartz in white to light grey colour with anhedral crystal, 30% plagioclase in light greyish colour with subhedral to euhedral crystal and exhibited albite twinning, and also 25% biotite in orange, brown colour with subhedral crystal.

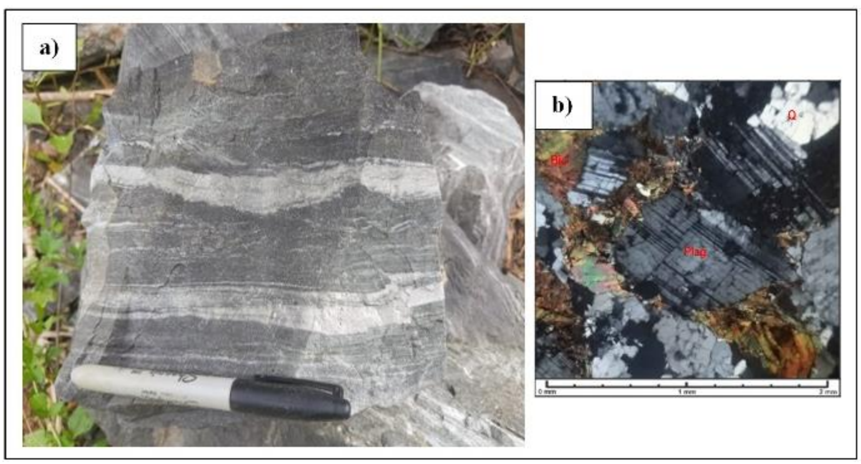

Figure 5. a) Gneiss outcrop in Batu Melintang and b) photomicrograph of gneiss (Q=Quartz, Bio=Biotite, Plag=Plagioclase).

The marble unit (Figure 6(a)) was exposed in the central part of the study area, located between Kalai and Gunung Reng. The marble was identified by its pure white colour with a medium-fine-grained texture. Petrographically, the marble (Figure 6(b)) displayed approximately 90% calcite in pinkish-green colour with anhedral crystal, 4% quartz in white to light grey colour with anhedral crystal, and 3% epidote in reddish-orange colour with irregular shape. This marble was classified as skarn because it contains minerals other than calcite, such as quartz, epidote, and the opaque mineral pyrite, which is related to the gold content of the igneous hydrothermal system.

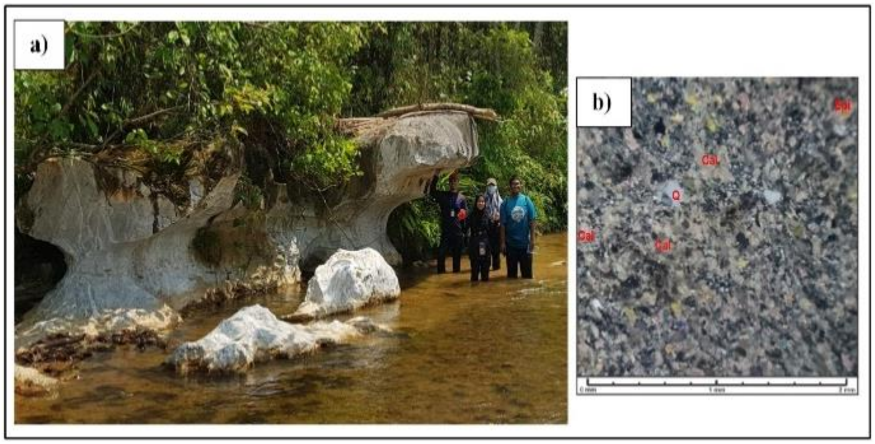

Figure 6. a) Marble outcrop in Batu Melintang and b) photomicrograph of skarn (Q=Quartz, Cal=Calcite, Epi=Epidote).

The intrusion of granite was found in the eastern and western regions of the study area. A small granite body also intruded a small middle part of the study area. The granite outcrop as shown in Figure 7(a) was composed of granite to granodiorite, with a predominance of grey, medium- to coarse-grained granite to granodiorite [6]. It was also rich in alkali feldspar minerals such as phenocryst. According to the petrographic analysis in Figure 7 (b), the granite was composed of 71% anorthoclase in greyish colour with subhedral to euhedral crystal and 25% quartz in white to light grey colour with anhedral crystal. According to the QAPF diagram, the granite was classified as alkali feldspar granite which consisted of a mineral percentage less than 10% plagioclase and between 20% to 60% quartz minerals with dominant alkali feldspar in rock composition.

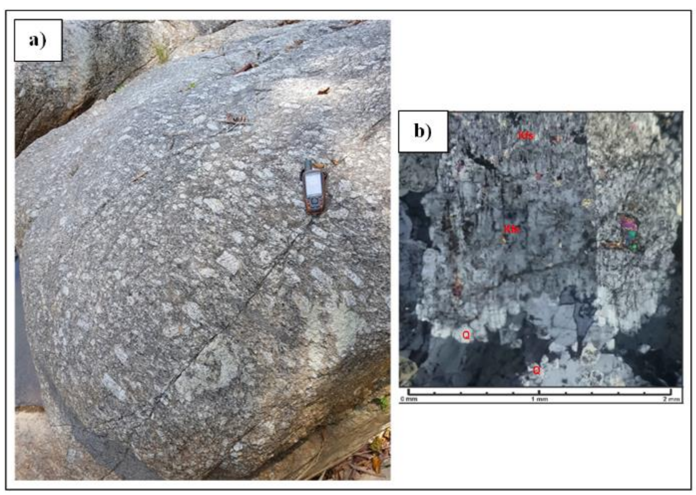

Figure 7. a) Granite outcrop and b) photomicrograph of alkali feldspar granite (Q=Quartz, Kfs=Alkali Feldspar).

An updated geological map of Batu Melintang, Kelantan was produced based on the results of petrographic analysis. The minerals in most of the rocks also showed a preferred orientation that indicated they undergo regional metamorphism [7]. Figure 8 showed the distribution of rock types found in the study area.

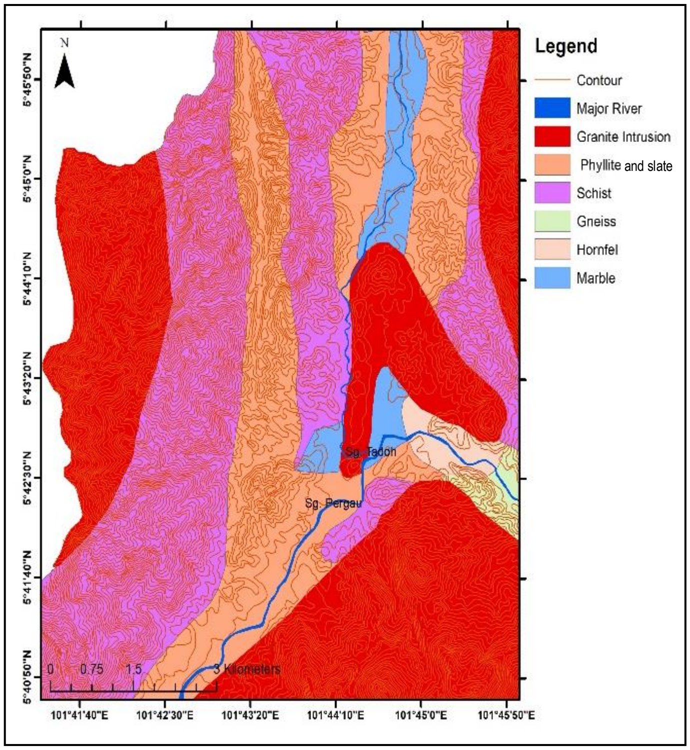

Figure 8. Geological map of Batu Melintang, Kelantan.

CONCLUSION

The results of the petrographic analysis showed the confirmation of the rock types of the Bentong-Raub Suture zone in Batu Melintang, Kelantan; including schist, slate, phyllite, gneiss, hornfels, marble and granite. The rock types in Batu Melintang revealed the petrotectonic assemblages of the Bentong-Raub zone were characterized by intensely deformed schist, phyllite, mylonite and slate occurred along the granite fault-scarpment. It is proven that the method used was able to validate the types of rock found in the field. The updated geological map of Batu Melintang was produced to improve the previous version of the Batu Melintang geological map and also can provide a lot of benefits for future researchers in the study area.

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