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Rare Mineral Evidence of Mahsuri Ring Meteorite Impact in Langkawi Island

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Abstract

The research area was conducted in Ulu Melaka Village, district of Langkawi, Kedah Province, Malaysia. Coordinate of research area around latitude 99°45'97" to 99°45'04" N and longitude 06°25'05" to 06°20'00"E, with coverage area around 7 x 5 km. This research area is a suspected meteorite impact crater. The analysis begins by taking 7 rock sediment samples spread around the research area. The aim of research to find evidence of meteorite impact has fallen around research area use geochemistry method refer to the content of Rare Minerals of rock samples in the study area. Rock samples were processed using an X-ray diffraction (XRD) machine and run by EVA Software. Rock samples which have been analyzed were S1, S2, S3, S4, S5, S10, S19. Result of the analysis found four types of minerals formed by a meteorite impact consist of Jagoite, Dickite, Rubidium and Germanium Silicate Zinc Sulfide Diaminopropane. Jagoite and Dickite found in sample S2, Rubidium Germanium Silicate in sample S4 and Zinc Sulfide Diaminopropane in samples S10 and S19, respectively .

Keywords: Rare Mineral, Geochemistry, X-ray Diffraction, Meteorite, Impact Crater

1. Introduction

The Research area is around southern of Langkawi Island, Kedah Darul Aman Province (Figure 1), around the area in Kampung Ulu Melaka. The latitude is 99°45'97" to 99°45'04"N and Longitude is 06°25'05" to 06°20'00", with scope area coverage 7 x 5km. Refer to Langkawi Island topographic maps, sheet 3069 L7030 series with a scale of 1: 50,000, published by the State Mapping Committee, Malaysia in 1990, the position of the research area in Ulu Melaka, adjacent to Mahsuri Buried and 14 km's from Kuah Town (Kamal Roslan, Ali, & Mohamed, 2018) .

2. Geology Regional

The rock formation of research area built from Peleozoic rock (Singa Formation), and there is a granite intrusive in the middle of the archipelago until the lift to four formations were formerly located under the surface, then experienced the rapture and exposed to the surface as seen at the present time. The division into stratigraphic formations shows in (Table 1) (Kamal Roslan et al., 2018) (Cahyaningsih, Crensonni, et al., 2019).

Singa Formation consists of a sequence of rocks are black mudstone, silty shale, siltstone, and quartz lithic sandstone. Black mudstone is calcareous and weathered on the surface. In general, sandstones consist of coarse quartz and calcareous. Igneous intrusive located in Gunung Raya and Dayang Bunting Island, Tuba Island, Kuah, extend to Apau Bay. Lithology of igneous intrusive is granite. Texture of granite is medium to coarse grain; the color is grey to smoke grey and porphyry. The igneous structure in these intrusives are banding tourmaline and quartz veins. Intrusion of granite was occur in Triassic, it is influenced the deformation of the rocks in this area. This intrusion was issue reverse faults, it is called Kisap Reverse Fault. Deduction from the intrusion also causes structure formed early rotated from original position to a new position. Alluvium found in this area closely related to processes by sea level changes. Sedimentation and sink of limestone of Setul Formation issued terrain unique seafront in the coastal karst features. Kilim Karst region dominated by half-submerged in the deep coves and tidal flow overgrown by mangroves. The last sea level rise in the past occurred about 5000 years ago (Roslan, 2016)(Unjah & Abdul Halim, 2018) (Catur Cahyaningsih; Puja Fransismik Crensonni., 2018) (Cahyaningsih, Choanji, et al., 2019) (Cahyaningsih, Ritonga, Aldila, & Zulhikmah, 2018).

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Meteorite impact is principal process in which a large object strikes in very high velocity, locally releasing a huge amount of energy (Krot, Keil, Scott, Goodrich, & Weisberg, 2013). In contrast to many endogenic geological processes, this basic simplicity makes impacts and the resulting impact craters amenable to physical modeling, and studies in impact geology have been long supported by extensive theoretical and laboratory investigations (Rubin, 2015a). Only petrographic and geochemical study of actual rocks from a potential impact structure will bring final confirmation of an impact origin. Meteorite fragments found to be associated with a crater are an exception, of course, but this is rare apart from classical cases, such as Meteor Crater; recent examples include Carancas in Peru and Kamil in Egypt (Reimold, 1982). The study of major and trace element compositions of the various rock types, as well as within mineral assemblages, at impact structures also allows investigation of alteration processes that are either part of the natural environment or due to impact-induced (e.g., hydrothermal) alterations see also isotopic studies (Rubin, 2015b) (Duczmal-Czernikiewicz & Michalska, 2018) (Krot et al., 2013) (Catur Cahyaningsih; Puja Fransismik Crensonni., 2018). The aim of this research to find evidence of meteorite impact has fallen around research area use geochemistry method refer to mineral content of rock around suspected area.

There are approximately 60 impact craters in Malaysia that have been recorded. The impact whether produced by a number of conditions such as valleys and domes, igneous intrusives, body subvolcanic or caldera. Fifteen impact craters are produced from the impact of space objects. Based on observations use thematic maps (1990) and geological maps of Malaysia (1985), recorded four impact crater in Langkawi include Mahsuri Ring (PM 37), Temin Ring (PM 38), Temoyong Ring (PM 39) and Tepor Ring (PM 40). Mahsuri Ring is located at coordinates 06°21'N and 99°46'E, with a crater diameter of 0.7 km and a depth of 150m. Temin Ring is located at coordinates 06°20'N and 99°46'E, with a circular structure, a diameter of 0.7km. Temoyong Rings located at coordinates 06°10'N and 99°43'E, shows double ring and the crater has a diameter of 0.8km. While Tepor Ring is located at coordinates 06°10'N and 99°42'E, with a diameter crater was 0.5km and 83m depth, revealing the shape of a half ring is open to the northern. Four structures contained in Langkawi impact of this is part of Singa Formation Carboniferous-Permian age (Samsudin & Ahmad, 2019) (Catur Cahyaningsih, Arrachim Maulana Putera, Gayuh Pramukti, 2018) (Mairizki & Cahyaningsih, 2016).

Evidence of meteorite impact in Mahsuri Ring is microscopic evidence Planar Deformation Feature (PDF) in quartz grain who have experienced shock metamorphism. Quartz is taken from one quarry not far from Sungai Batu Asah Bridge. This area is located 2 km from the center of Mahsuri Ring. Position in quarry with coordinates of 06°20'33"N and 99°48'37"E. Quartz veins are present as wide and 1m vein strike is northeast and almost vertical dip. Thin section of quartz, found there are 6 lines alternate of PDF. Lamela showed alternate black short lines. The lamellar direction of east-northeast, with gaps between the lamella spacing, is 500 microns. In the lamella filled by melted quartz. In addition to alternate lamellar metamorphism, there is other evidence of extinction "patchily" also. Macroscopic evidence of meteorite impact of Mahsuri Ring is presence gravity anomaly shows depression shape like cater use gravitymeter (Samsudin & Ahmad, 2019) (Abdul Rahim Samsudin, 2012) (Cahyaningsih, 2016) (Fatriadi, Asteriani, & Cahyaningsih, 2017)(Choanji, 2019).

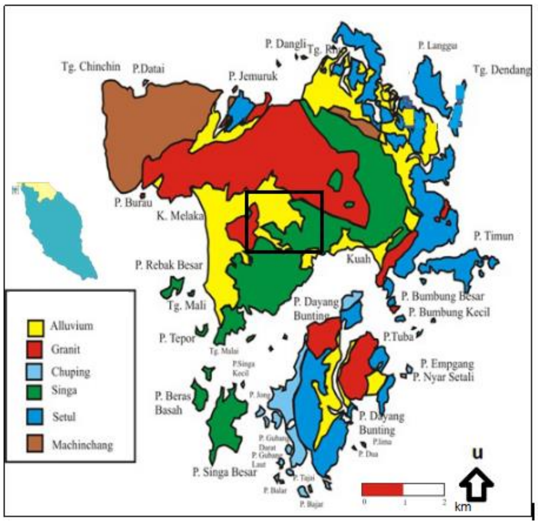

Figure 1: Map shows the research area in Ulu Melaka Village, Langkawi Islands, Kedah Province, Malaysia.

Age	Formation	Stratigraphic Symbol	Explanation
Quaternary	Alluvium		Mud, sand and loose gravel
Cretaceous Jurassic Triassic Permian	Granite Intrusion		Granite with texture medium to coarse grain, colour from gray to smoke gray
Carboniferous Late Devon	Singa Formation		Black mudstone, silty shale, siltstone and quartz lithic sandstone

Table 1: Stratigraphic sequence of research area shows Singa Formation, granite intrusion and alluvium

3. Methodology

X-Ray Diffraction (XRD) analysis was carried out a Bruker AXS machine D8 Advance Germany model, rate of 40 kV and 40 mA. It also uses a test tube type Cu Kα and scan range is 2θ = 10 ° - 60 ° and the scan interval at 0024 ° per second. The wavelength is 0.15406 nm, using fast 1D detector (Lynx-Eye), which is geometric optical Bragg-Brentano. XRD analysis requires a sample in the form of powder size less than 75μm. XRD is the basic principle of the nature of the X-ray can be refracted. Bragg equation should be met based on the wavelength of the X-ray direction, angle of incidence and d spacing material. Figure 2a shows an X-ray diffraction (XRD). Figure 2b shows the test tube type Cu Kᾱ the scan range is 2θ = 10 ° - 60 ° and the scan interval at 0024 ° per second.

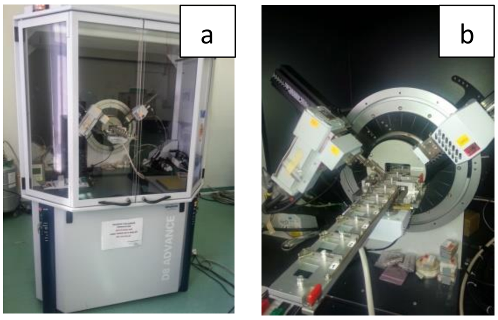

Figure 2: a) Machine XRD b) XRD test tube type Cu Kᾱ, the scanning range is 2θ = 10 ° - 60 °.

4. Result

Lithology in research area comprises several consists of silty shale rock, black mudstone, siltstone, sandstone, lithic quartz. Figure 3 shows the outcrop of silty shale, with characteristic yellowish grey color. The strike and dip of bedding are 330°E and 14°, successively. High and length of outcrop are 5m and 100m, respectively. Rock samples were also collected during the field work. Figure 4 shows a map of the rock sampling in the field. Some of the rocks that were collected during the field show in Figure 5. Figure 5a shows sample S1, type of frock is slate. This sample has a characteristic thick laminate, with yellowish grey color and fine grain. Figure 5b shows the sample S3, type of rock is siltstone. This sample has a characteristic light grey colour and medium to fine grain. Figure 5c shows a sample S5, type of rock is sandstone. This sample has a characteristic light yellow and coarse grain. Figure 5d shows a sample S10, type of rock is claystone. This sample has a characteristic dark grey and fine grain.

Seven samples were analyzed using a spectrometer analysis of X-ray diffraction (XRD) consist of S1, S2, S3, S4, S5, S10, and S19 sample. Data analysis and rock-forming mineral and secondary mineral has been summarized and shows in Table 2. Rock-forming mineral found in sample contains quartz, albite, muscovite, illite and microcline. Trace element found in some sample, it is called Rare Mineral. This mineral also indicated as a mineral formed after shock metamorphism by meteorite impact and iron bearing mineral and exist less than 1% I the sample. These minerals are Jagoite and Dickite that exist in S2 sample, Rubidium Germanium Silicate exist in S3 and S4, Zinc Sulfide Diaminopropane exist in S10 and S19 sample, respectively.

Jagoite is rare mineral that occurs in hematite ore, probably it is bearing from tiny small part after shock metamorphism of iron-manganese occur. Dickite is typically high temperature diagenetic clay, probably illite alterated after shock metamorphism hit the siltstone. Rubidium Germanium Silicate is rare mineral, possibly debris of giant star shock metamorphism left in the rock sample. Zinc Sulfide Diaminopropane is produced by igniting a mixture of Zinc and Sulfur after shock metamorphism.

Figure 3: Outcrop of slate with characteristic yellowish gray color with a thick laminated. Shows strike 330 ° E and dip 14 °.

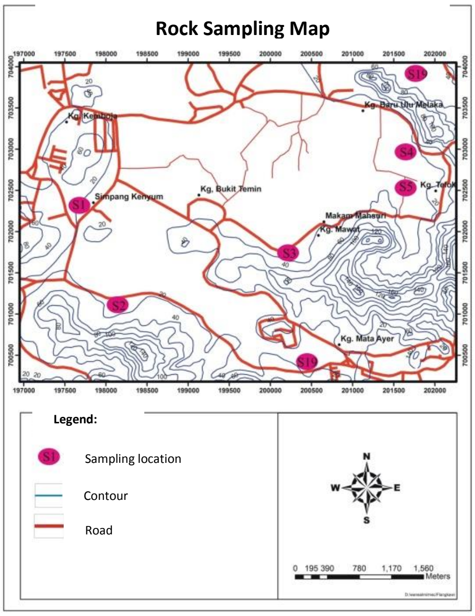

Figure 4: Map of rock sampling in the research area

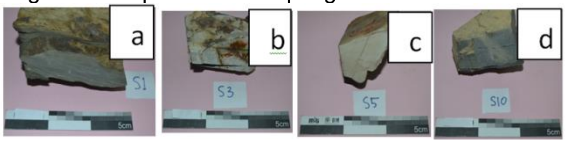

Figure 5: Some of rock samples collected during field a) Samples S1 is slate b) Sample S3 is siltstone c) Sample S5 is sandstone d) Sample S10 is claystone.

Table 2: Rock Forming Mineral and secondary mineral in sample found in research area use X-RD.

Sample No	Rock Forming Mineral	Secondary Mineral
S1	Quartz Albite Muscovite	*Clinochlore* *Vermiculite* *Faujasite* *Aerite* *Palladium*
S2	Quartz Muscovite Illite	*Flouroplogopite* *Dickite* *Nacrite* *Lizardite* *Jagoite*

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S3	Quartz Muscovite Illite	*Tainiolite* *Lepidolite*
S4	Quartz Microcline Orthoclase	*Clinochlore* *Yttrium Neodymium Silicate* *Rubidium Germanium Silicate*
S5	Quartz	*Antimony Gadolinium Nickel* *Graphite* *Copper iron Lithium Sulfide* *Cadmium Ammine Rhenium Oxide* *Alanine*
S10	Quartz Muscovite Illite	*Clinochlore* *Zinc Sulfide Diaminopropane*
S19	Quartz Muskovit	*Zinc Sulfide Diaminopropane*

5. Conclusion

XRD analysis found there are some secondary mineral is formed Rare Earth Mineral. These minerals are Jagoite, Dickite, Rubidium Germanium Silicate exist, Rubidium Germanium Silicate and Zinc Sulfide Diaminopropane. Those are minerals as a shred of geochemistry evidence to confirm meteorite impact in the research area.

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