HEART OF BORNEO SERIES 5

PROCEEDINGS OF HEART OF BORNEO SEMINAR

TAMU ABU

Heat of Borneo Series 5

PROCEEDINGS OF SEMINAR

TAMA ABU

FOREST DEPARTMENT SARAWAK

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PREFACE

This Proceedings gives us a glimpse on the findings of the Scientific Expedition to Tama Abu PF made in 2017 which was organized by the Forest Department of Sarawak.

This book is the fifth in a Heart of Borneo Series publication under the Heart of Borneo Project Initiative for Sarawak. It highlights part of the findings of the 2017 expedition that presented during the Heart of Borneo Seminar 2018.

A total of twenty-one papers, that includes flora (11), fauna (9) and one paper each on microbial and geological that part of the findings of the expedition were presenting in this Seminar Proceedings book. While others findings will be include in the pictorial coffee-table book (Heart of Borneo Series 7).

EDITORS

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GEOLOGY AND GEOHERITAGE SIGNIFICANT OF TAMA ABU AREA

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Abstract

The geology of Tama Abu area comprises of sedimentary rocks of Oligocene Kelabit Formation, Miocene Meligan Formation and recent sediments. All of the rock formations contributed to the geodiversities, subsequently to enrich the geoheritage significant in this area. Kelabit Formation, the oldest rock in Tama Abu area is dominant and conformably overlain by the Meligan Formation. Lithologically the Kelabit Formation comprised of mudstone or mudstone interbedded with sandstones and siltstones meanwhile Meligan Formation is composed of massive interbedded sandstones with present of minor mudstone layers. Meligan Formation crop-out and formed the hills and plateau at the higher elevation meanwhile Kelabit Formation mostly formed the lower level of the Tama Abu range. The younger deposits are composed of semi consolidated terrace, gravel, colluviums and alluvium deposited by river systems along the river, valley and lower slope within the area. Kelabit Formation had been tilted, folded and extremely faulted in few places. However, though obviously tilted but there are no indication of folding and faulting in the massive Meligan Formation sequence. Further analysis of 23 stream sediment samples indicated very low existing of economic mineral resources in this area. Meanwhile, micro-fossil analysis from 6 samples does not reveal any existing of foraminifera or benthonic fossil. Beside the important of geological evolution, the geodiversity of landforms, geological landscape, sedimentary structure and tectonic have been identified as the main characters that could contribute to the enrichment of the geoheritage significant for conservation and protection of Tama Abu area.

Keywords: *Geology, geoheritage significant, Tama Abu*

INTRODUCTION

Tama Abu Range located at Southern Kelabit Highland, Ulu Baram, the most eastern part of Miri Division, Sarawak (Figure 1). It is prominent range where the highest mountain, Mount Murud situated. As the main range of Sarawak and elongated NE - SW, the Tama Abu Range covered a large area near the international boundary between Malaysia (Northern Sarawak) and Indonesia (Northen Kalimantan). The expedition coverage concentrating on southern part of Tama Abu Range within the combination of four topography map published by Department of Survey and Mapping Malaysia (*Jabatan Ukur dan Pemetaan Malaysia* - JUPEM) in 2006 Series T738 comprising Map Sheet 7119 (Long Salt), 7219 (Bukit Kelit), 7118 (Long Banga) and 7218 (Ulu Sungai Banga). Upper Batang Baram or Ulu Baram river with its main tributeries Sungai Baleh and few others sub-tributaries such as Sungai Peluan and Sungai Banga forming natural drainage system in this area. The accessibility to this area is by road from Miri which proper tar seal road up to Long Lapok and followed by logging track/road from Long Lapok to Bario, the largest settlement in the Kelabit Highland which is located further up from study area. Existing Long Lapok-Bario logging track/road was contructed and previously maintained by Samling Sdn. Bhd. There are three nearby residential comprises of Long Banga, Long Paluan and Long Beruang at the southern part outsite expedition area; meanwhile Pa Dalih and Ramudu of Bario at the northern part outside expedition area. Long Paluan, Pa dalih and Ramudu accupied by mostly Kelabit communities; Long Banga by Kenyah and Penan communities; meanwhile Long Beruang is a special resettlement for Penan community.

The morphology of both Tama Abu Range with extension to Kelabit Highland to the North East are significant indicating the backbone highland of Sarawak. Detail geological information of this area is limited, hence the inventory on its geology and geological interpretation are still much needed. No detail geological description been done though there at least two rock formations similar to Meligan Formation and Kelabit Formation in Kelabit Highland probably existing in this area base on general previous geological report by Thomson (2015) and Haile (1962).

Figure 1: Locality of Tama Abu area. (source: Google earth map)

OBJECTIVE

There are three main objectives of the study comprising; to identify and characterize significant geological and geomorphological resources for geotourism (geo-ecotourism) and geoconservation; to integrate geological resources with biodiversity of highland area as important elements for conservation; to update geological map of Sarawak, its interpretation as well as to clarify the existing of economic mineral for clearance. The existing geological map of Sarawak not much indicated the geological information in study area (Figure 2). showing Base on accumulative geology and geodiversities information, a preliminary geodiversity and geoheritage report could be establish for future planning and development particularly on conservation efforts.

Methodology and research approach are involving literature review, fieldwork, laboratory test, data analyses and finally report writing. Literature review are inclusive collecting and preliminary analyzing geological and geomorphological information of Tama Abu area from published and non-published report, article, journal and also website. As for desktop study, literature review mainly to collect secondary data from previous study regarding geological and geomorphological information in this area. However, primary data collection throught fieldwork only commence during the scientific expedition. The approach is base on basic geological and geomorphological mapping prosedur such as identification of the site location, observation of lithology boundary and its primary structure, measurement of geological structure and documentation as well as scatching and photos taken.

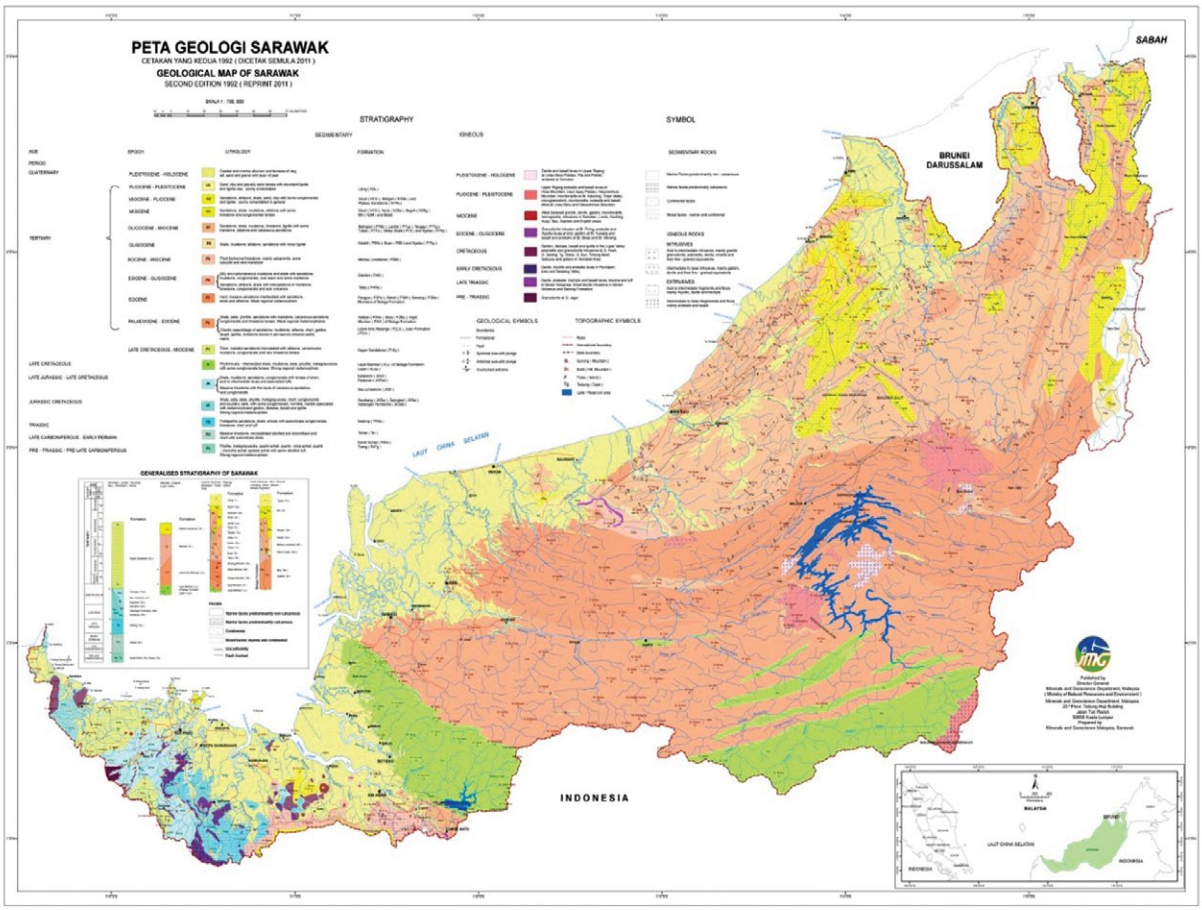

Figure 2: Geological map of Sarawak and Tama Abu area
(source: Dept. of Mineral and Geoscience Malaysia Sarawak, 2012).

Among geological tools and equipment used are geological hammer, measuring tape, compas, GPS, fieldnote, camera and citric acid. Confirmation of geological formation including rock types and mineral, geological processes, fossil identification, structure and landscape are also taking part during fieldwork. Some of the rock and residuel soil are also collected for sampling for further analysis. Identification and characterisation of geodiversity for significant geoheritage also conducted during fieldwork. Most of fieldwork was done throught traversing along the rivers, old logging track, road, and also along the existing transect established by the Forest Department Sarawak.

METHODOLOGI AND RESEARCH APPROACH

Rock samples are being selected for thin section in order to classify the rock types in detail through mineralogy and petrology analysis. A total of 12 rock samples have been selected for thin section preparation in lapidary laboratory, followed by rock classification which is being classified using microscope. All of rock samples are sedimentary rock (sandstone, shale, siltstone) and their classification is base on ratio of three main mineral comprising quartz, feldsfar and lithick by Pettijohn (1975) classification.

A total of 23 stream sediment samples was collected from various existing river within study area for analysis of possibility economic mineral contains. The samples were sent to the Geochemical Laboratory, at Department of Minerals and Geoscience Malaysia, Sarawak in Kuching. Inductively coupled plasma (ICP) analysis were conducted for 32 elements namely Ag, As, B, Ba, Be, Bi, Ca, Co, Cr, Cu, Fe, K, La, Li, Mn, Mo, Na, Nb, Ni, Pb, Sb, Sc, Sn, Sr, Ta, Th, Ti, U, W, Y, Zn and Zr. Meanwhile, 6 loose soil from soft sedimentary rock such as shale and siltstone are being crush and sieved for foraminifera analysis (micro ancient marine life).

RESULT AND DISCUSSION

Based on field observation of lithology sequence and geological structure, there are two different rock formations in this area, they are Kelabit Formation and Meligan Formation respectively (Figure 3). The clear boundary between the rock formations was not found but it might be a conformable relationship where the underlying Kelabit Formation passes up to the Meligan Formation (Figure 4).

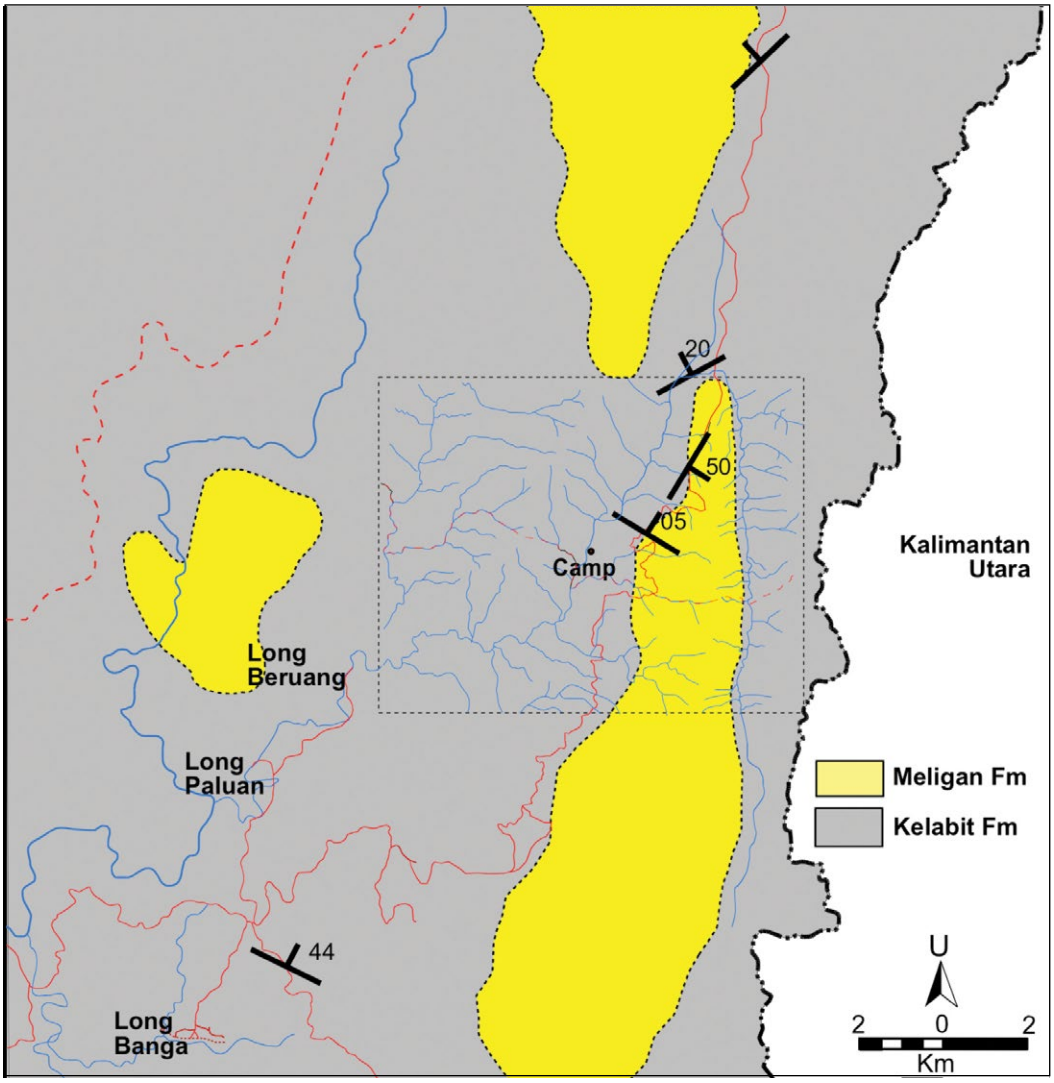

Figure 3: Geological map of Tama Abu Range and expedition area.

Kelabit Formation

Kelabit Formation is most dominant and its distribution covered large parts of the low-lying area including bottom of hills within Tama Abu range. Previously there were no type section was assigned for the Kelabit Formation but only the reference section. The reference section is the Kelapang River in Bario area which is located at the further North of Tama Abu range (Haile et al. 1962).

Lithology of Kelabit Formation comprised of predominantly mudstone interbedded with beds of siltstones and sandstone of various thickness (Figure 5 to Figure 8). The orientation of bedding plain dominant in two directions, to the Northwest and Northeast with dipping to the Northeast and Southeast respectively. Most of sandstone layer forms high ridges and small hills due to more resistant to natural weathering and surface erosion. The sandstone layer is thickening upward trend which is relatively thin layer at the bottom sequence but getting thicker at upper sequence. However, the base of the Kelabit Formation composed of grey or brownish mudstone passing up gradually to more arenaceous successions, indicated coarsening upward trend.

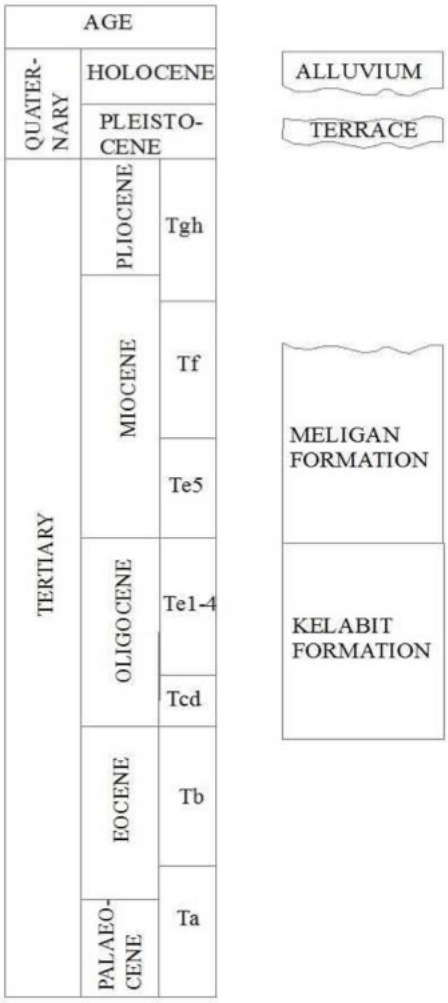

Figure 4: Stratigraphy showing the conformable relationship between Kelabit Formation and Meligan Formation (Thomson, 2015).

Figure 5: A sequence of interbedded thick sandstone and mudstone of Kelabit Formation being quaried manually for the road construction.

Figure 6: Ripple mark, an abundance sedimentary structures in Kelabit Formation.

Figure 7: Thinly bedded red mudstone bed in Kelabit Formation.

Figure 8: Rounded pable of red mudclast embeded in the light grey mudstone bed Kelabit Formation.

Meligan Formation

The type section of the Meligan Formation was defined by Liechti et al. (1960) as outcrops occurring between Long Layat and Long Kaya in Lawas. The type section was also assigned between Long Slobang and Ulu Sepetar. Not much outcrop of Meligan Formation was observed in study area and most of them forms the hills and plateau at the higher elevation. Lithology of Meligan Formation dominated by sandstone with thick to massive layer (Figure 9 to Figure 12). The bedding orientations are various but the general strike is East-West with the dipping directions to the North. Some sandstones beds show parallel laminations. The sandstone is medium grained size and well-sorted, subangular to subrounded and sometimes contain mudclasts of approximately 5cm in diameter. Average grains size 0.2mm to 0.5mm, composed of predominantly quartz, with some feldspar, minor opaque, heavy minerals present are zircons and tourmaline. This particular sandstone fining upwards bedding, which showing courser materials at the bottom sequence layer and fine grain size materials toward upper sequence. Most of the sandstone types is classified as subarkose similar lithology with the nearby Bario area.

The age indicated from the fossils found within the sandstone of Meligan Formation, Miocene (Te) (Liechti et al. 1960; Thomson, 2015). Environmental deposition of Meligan Formation probably represents the delta front of a prograding delta system. Its indicated that, during the Miocene there is an increase in input of sand into the marine environment represented by the older and more argillaceous Kelabit Formation.

Figure 9: Thick to massive sandstone Meligan Formation. The sandstone bed was tilted almost vertically.

Figure 10: Massive and hard sandstone of Meligan Formation more resistant to the surface erosion and usually formed the cascade and waterfalls.

Figure 11: Sandstone of Meligan Formation occured mostly at the higher elavation and formed the cliff and cascades.

RECENT SEDIMENT

Recent sediment comprising all young deposit composed of semi consolidated terrace, gravel, colluviums and alluvium deposited by river systems obviously along the river, valley and lower slope within the study area. The size of material that forms recent sediment are various ranging from few cm up to 6-7 meter. Most of recent sediments are originated and formed by sandstone boulders from Meligan Formation (Figure 12 and Figure 13).

Figure 12: Various size of boulders deposited along several rivers within Tama Abu area.

Figure 13: Recent and un-consolidated sedimen along the rivers due to the debris flow.

ECONOMIC MINERAL EXISTING

The existing of economic mineral also highlighted and recorded based on result analysis of the 23 stream sediment samples. The stream sediment sampling relatively only covered a small area for regional geochemical sampling analysis. Most of the stream sediment samples was collected within Long Beruang and Long Paluan at the Southern area and upper tributeris of Sg. Baleh toward Bario to the North. However, the result indicated very low of economic mineral resources (Table 1). This result also supported by none existing of any igneous intrusion that might could contribute to mineralisation of older rock formations (Kelabit Formation and Meligan Formation). Less existing of economic mineral also probably due to very low grad of metamorphism or regional methamorphism by regional tectonic. A total of 23 stream sediment samples are very much lesser and insufficient to plot an anomaly map of mineral existing in this area. Appropriate and accepted anomaly map could be nicely produced from at laest few hundred to thousand of stream sediment samples. Further discussion of the result only based on average of each element from respective rivers locations as below;

Argentum (Ag): The argentum (Ag) content is mostly <0.1 ppm only TAS 19 6.49 ppm. The median value is 0.38 ppm.

Arsenic (As): The arsenic (As) content is <0.5 ppm. The median value is <0.5 ppm. The arsenic contents only show background value.

Boron (B): The boron (B) content ranges from <0.5 ppm to 6.718 ppm. The median value is 3.79 ppm.

Barium (Ba): The barium (Ba) content ranges from <0.5 ppm to 48.29 ppm. The median value is 15.14 ppm.

Berilium (Be): The berilium (Be) content ranges from <0.1 ppm to 0.805 ppm. The median value is 0.23 ppm.

Bismuth (Bi): The bismuth (Bi) content ranges from <0.1 ppm. The median value is 0.1 ppm. The bismuth contents only show background value.

Calcium (Ca): The calcium (Ca) content ranges from <0.5 ppm to 892.10 ppm. The median value is 182.99 ppm.

Cobalt (Co): The cobalt (Co) content ranges from 1.191 ppm to 9.996 ppm. The median value is 3.13 ppm.

Chromium (Cr): The chromium (Cr) content ranges from <0.5 ppm to 50.66 ppm. The median value is 7.20 ppm.

Copper (Cu): The copper (Cu) content ranges from <0.5 ppm to 9.977 ppm. The median value is 3.57 ppm.

Iron (Fe): The iron (Fe) content ranges from 0.00% to 3.04%. The median value is 0.58%.

Lantanum (La): The lantanum (La) content ranges from <0.5 ppm to 6.976 ppm. The median value is 2.49 ppm.

Lithium (Li): The lithium (Li) content ranges from <0.5 ppm to 59.91 ppm. The median value is 12.65 ppm.

Manganese (Mn): The manganese (Mn) content ranges from <0.5 ppm to 483.8 ppm. The median value is 113.67 ppm.

Molybdenum (Mo): The molybdenum (Mb) content ranges from <0.1 ppm to 0.234 ppm. The median value is 0.11 ppm.

Neobymium (Nb): The neobymium (Nb) content ranges from <0.5 ppm to 12.51 ppm. The median value is 5.32 ppm.

Nickel (Ni): The nickel (Ni) content ranges from <0.5 ppm to 29.38 ppm. The median value is 6.25 ppm.

Lead (Pb): The lead (Pb) content ranges from 2.362 ppm to 12.14 ppm. The median value is 8.79 ppm.

Stibnium (Sb): The stibnium (Sb) content ranges from <0.5 ppm to 1.986 ppm. The median value is 0.70 ppm.

Scandium (Sc): The scandium (Sc) content ranges from <0.5 ppm to 4.135 ppm. The median value is 1.10 ppm.

Stanum (Sn): The stanum (Sn) content ranges from <0.5 ppm to 3.157 ppm. The median value is 1.53 ppm.

Strontium (Sr): The strontium (Sr) content ranges from <0.5 ppm to 7.449 ppm. The median value is 2.67 ppm.

Thalium (Ta): The thalium (Ta) content is <0.5 ppm. The median value is <0.5 ppm. The thalium contents only show background value.

Thorium (Th): The thorium (Th) content ranges from <0.1 ppm to 1.297 ppm. The median value is 0.42 ppm.

Titanium (Ti): The titanium (Ti) content ranges from <0.5 ppm to 16.73 ppm. The median value is 4.41 ppm.

Uranium (U): The uranium (Us) content ranges from <0.1 ppm to 1.410 ppm. The median value is 0.22 ppm.

Tungsten (W): The tungsten (W) content ranges from <0.5 ppm to 3.489 ppm. The median value is 0.84 ppm.

Yttrium(Y): The yttrium(Y) content ranges from <0.5 ppm to 5.023 ppm. The median value is 1.56 ppm.

Zinc (Zn): The zinc (Zn) content ranges from <0.5 ppm to 49.34 ppm. The median value is 10.82 ppm.

Zirconium (Zr): The arsenic (As) content ranges from <0.5 ppm to 1.220 ppm. The median value is 0.53 ppm.

Gold (Au): The gold/aurum (Au) content ranges from <0.01 ppm to 0.25 ppm. The median value is 0.05 ppm.

Mercury (Hg): The mercury (Hg) content ranges from 2.6 ppm to 15.3 ppm. The median value is 6.73 ppm.

GEODIVERSITY AND GEOHERITAGE

Geodiversity is 'the natural range (diversity) of geological rocks (rocks, minerals, fossils), geomorphological (landform, processes) and soil features, including their assemblage of features, relationships, properties, interpretations and systems (Gray, 2004). Several geodiversities have been identified during expedition, they are consisting of rock formations, rock and mineral types, sedimentary structure, fossil, geological structure, geological landscape and geological processes (Table 2; Figure 14 to Figure 21). Most of these geodiversities scattered within the area particulally along river banks.

Geoheritage is component of geodiversity that is important to human beings (and communities) for the purposes other than resource exploitation, i.e. things we would wish to retain for present and future generations (Sullivan 1997; Eberhard 1997). Geoheritage site is derived from significance geodiversities in which the geological aspect is the fundamental.

Table 2: Geodiversity and potential of geoheritage significance value.

GEODIVERSITIES	FEATURES	SIGNIFICANCE GEOHERITAGE VALUE
Rock formations	Kelabit Formation, Meligan Formation	Scientific
Rock types	Sandstone, Mudstone, Siltstone, Red mudstone, Shale.	Scientific
Mineral types	Quartz, Feldspar	Scientific
Sedimentary structure	Bedding, Slumps Sole markings; Flute cast, Load cast, Ripple mark.	Scientific
Fossil	Types, Activities.	Scientific
Geological structure	Faults, Folds, Joint.	Scientific
Geological landscape	Mountain, Valley, Rivers, Ridges, Waterfalls.	Scientific, Aesthetic, Recreational
Geological processes	Erosion, Deposition, Rock falls, Landslide.	Scientific, Culture

Figure 14: Ripple marks.

Figure 15: Flute casts sole markings.

Figure 16: Thinly bedded sequence of sandstone and mudstone.

Figure 17: Mega size load cast.

Figure 18: Single burrow trace fossil.

Figure 19: Trace fossil.

Figure 20:

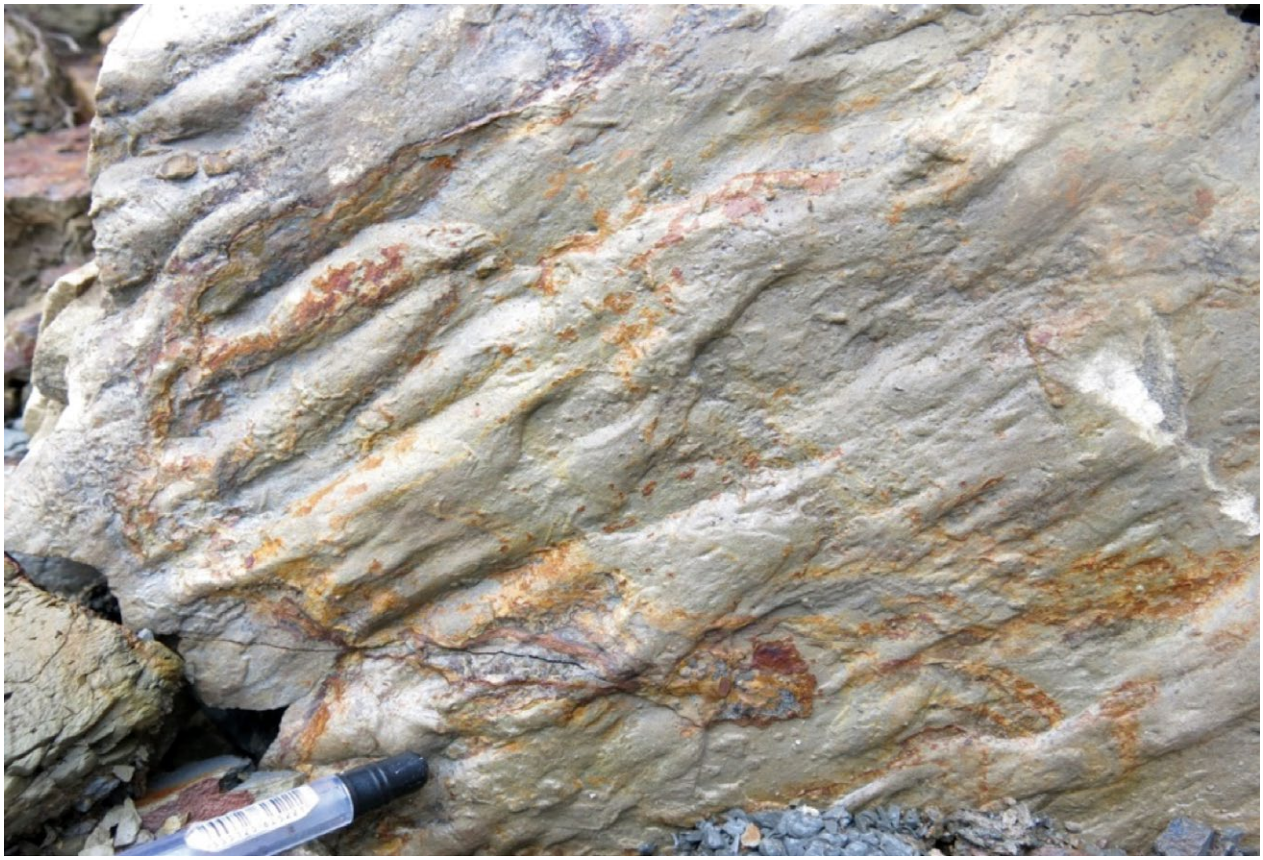

Figure 21: Flute casts as sole markings of sandstone in Kelabit Formation.

CONCLUSION

A fundamental for the existing of geodiversity and biodiversity within Tama Abu area are depending on only two sedimentary rock formation, Kelabit Formation and Meligan Formation. The richness of most geodiversity directly influences by various rock types in Kelabit and Meligan Formation. Meanwhile, diversity for geological landform are mostly influence by major geological structure within both Kelabit and Meligan Formation. However, landscape diversity and biodiversity are relying on soil types from respective parents' material of rock types. Based on the preliminary finding from this expedition, the study area is considered free from economic mineral existing. As such there is no conflict between economic minerals and conservation efforts to become a protected area. The geology and its geological evolution are fundamental elements for the integrated conservation of the nature (geodiversity and biodiversity) and cultural heritage.

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