Brief geological field guide to the Kinta Limestone, Kinta Valley, Perak Malaysia

Organized by:

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I. Safety

Safety is priority number one during the field excursion. We all want to return safely, hence please follow the following advices among others.

- While on this field excursion you are expected to adhere to the safety standards.
- Please intervene whenever you observe anyone in unsafe situation or behavior.
- Everyone is responsible for compliance to safety standards by all members.
- If you require special medication, please inform field organizers before going into the field, or if you have physical condition preventing you from making long walks or steep climbs inform ahead of the field excursion.
- Use all means including your cell phone to inform anyone of the team members in case of emergency.
- Wear personal protective equipment (PPE) such as safety helmets and safety vests.
- Minimize the time spent at the base of cliff sections.
- When walking up a cliff, remember that there may be people below you.
- Beware of traffic, in particular when getting in and out of the bus.
- Avoid working on or near road bends.
- Avoid walking alone away from your teammates.
- Give attention to rock fall, slippery surface, dehydration, mosquito bites and others.

II. Time and venue (itinerary)

- Date: 8th October 2020
- 8:30 am Gather at Hotel
- 8:45 am Departure to UTP
- 9:45 am Arrival at UTP
- 10:15 am Laboratory visit at UTP
- 12:30 PM Lunch break and prayer
- 2:30 PM Departure to Kek Lok Tong Cave
- 4:30 pm Departure to Lost world of Tambun
- 6:30 PM Departure at Lost World of Tambun
- 7:15 pm Arrival at the hotel

III. Field excursion learning outcomes

During this field excursion you are going work on Paleozoic carbonate succession with the following objectives:

1. To observe and interpret the major post-depositional processes which may affect reservoir quality (karstification, cementation, fracturing …).
2. Look into analogue for slope to base of slope marine depositional environments.
3. Learn on the control of post-depositional deformations and related structural styles for fractured reservoir.
4. To examine the formation of dolomite and associated iron ore mineralization.
5. To observe speleothems (stalagmite, stalactite, flowstone, rimstone …) and infer the paleoflow directions in the caves (scallops, notch marks…)

Participants are expected to work in groups while the field organizers will provide a brief explanation about the geology of the areas. At the end of the fieldtrip the participants will be give simple exercise, which will be based on their active involvement in the field activities.

IV. Introduction

This field excursion guide contains an overview of the outcrops of the Kek Lok Tong Cave and the Lost World of Tambun, which are located in the Kinta Valley (Fig. 1 and 2). These two sections were selected for accessibility reasons. They contained some primary sedimentary features, which could help in understanding the depositional and post-depositional processes occurred on the Kinta Limestone.

V. Geological and Stratigraphic Setting

Peninsular Malaysia comprised from amalgamation of different types of terranes, which have unique characteristic of stratigraphy, magmatism, geological evolution and other geophysical properties (Lee, 2009, Foo, 1983, Metcalfe, 2013). The terranes have been accreted during the closure of Paleo-Tethys Ocean in the Permian (Metcalfe, 2013). Tectono-stratigraphic, paleobiogeographic and paleomagnetic data support the separation of the Sibumasu Terrane from Gondwana in the late Sakmarian (~294-284 Ma), and then drifted rapidly northwards during the Permian-Triassic (Metcalfe, 2000).

The tectonic evolution of the Peninsular Malaysia showed that it was made from three terranes juxtaposed to form a single terrane, but from two main different blocks, the Sibumasu and Indochina Blocks. The Western Belt is part of the Sibumasu Block. The Central and the Eastern terranes are part of the Indochina Block (Metcalfe, 2000). The stratigraphy of the Central and Eastern belts differs from the Western Belt as the stratigraphy is linked to their tectonic origins. The carbonates in the peninsular are distributed mainly in the Western Stratigraphic Belt. These are: the Kinta Limestone, Kuala Lumpur Limestone, Kaki Limestone, Chuping Limestone, and the Mempelam Limestone (Lee et al., 2004). These formations indicate that considerable portion of the Paleozoic time in the Peninsular was covered by deposition of huge carbonate sediments in the Paleo-Tethys Basin (Tsegab and Weng Sum, 2019). The global sea-level was rising since Devonian up to the Mississippian time, which may indicate the availability of accommodation space for deposition of thick sedimentary successions such as the Kinta Limestone (Gebretsadik et al., 2017).

The Palaeo-Tethys Ocean was subducted beneath the Indochina in the Permian and continued to develop with andesitic volcanism such as the Main Range and others in the area. By the Late Permian, the Sibumasu block detached from Gondwanaland collided with Indochina block and the collision continued until the Early Triassic to form the Bentong-Raub Suture. The suturing and S-type granite emplacement occurred as an integral part of the mountain building event known as Indosinian Orogeny. The Western Belt of Peninsula Malaysia, and western part of Thailand represent the remaining of Sibumasu block from the subduction process.

Kinta Valley is in the Western Belt, located in Perak state of Malaysia (Fig. 1). It hosts a major stratigraphic unit of Silurian to Permian age, the Kinta Limestone (Tsegab et al., 2017, Suntharalingam, 1968). The main lithology of the Kinta Valley is crystalline limestone represented by the Kinta Limestone. Minor lithologies such as schist, shale and quartzite had also been documented. Due to the tectono-thermal events mention above most of the Kinta Limestone is considered metamorphosed, hence most of the skeletal components are destroyed. Metamorphic and diagenetic alterations of the Kinta Limestone caused by the Triassic granitic intrusions and related fluids have made it one of the challenging successions for sedimentological studies. Therefore, it is only a few outcrops which have preserved sedimentary features for observation and description (Haylay et al., 2014, Tsegab et al., 2015). However, you are very much encouraged to find out some relict sedimentary features during this field excursion.

VI. Post-depositional processes

These processes include all changes which happened during and right after the deposition of the sediments until recent and still going on (Reineck and Singh, 2012). In the case of the Kinta Limestone, the post-depositional alternations could be categorized into two: diagenesis and metamorphism. the very obvious diagenetic alteration you will see is karstification. Karst is a topography formed from the dissolution of soluble rocks such as limestone, dolomite, and gypsum.

It is characterized by underground drainage systems with sinkholes and caves (Ford and Williams, 2007). It has also been documented for more weathering-resistant rocks, such as quartzite, given the right conditions (Jennings, 1985). Fracturing is also very common in the Kinta Limestone (Fig. 1). The following subsections will give you addition insight into the expected diagenetic features in the outcrops to be visited.

Figure 1. Heavily fractured Paleozoic outcrop in the Kinta Valley

A. Dolomite distribution

Dolomite bodies are widely distributed and observed at various places in the Kinta Valley. Mostly they are associated with fractures and mineralization of probably hydrothermal related fluids. The dolomite bodies may exhibit various phases, which could be distinguished on the basis of color contrast from the outcrop of hand specimen. Therefore, you will be looking into some outcrops which may provide insight to the post-depositional processes in the Kinta Limestone.

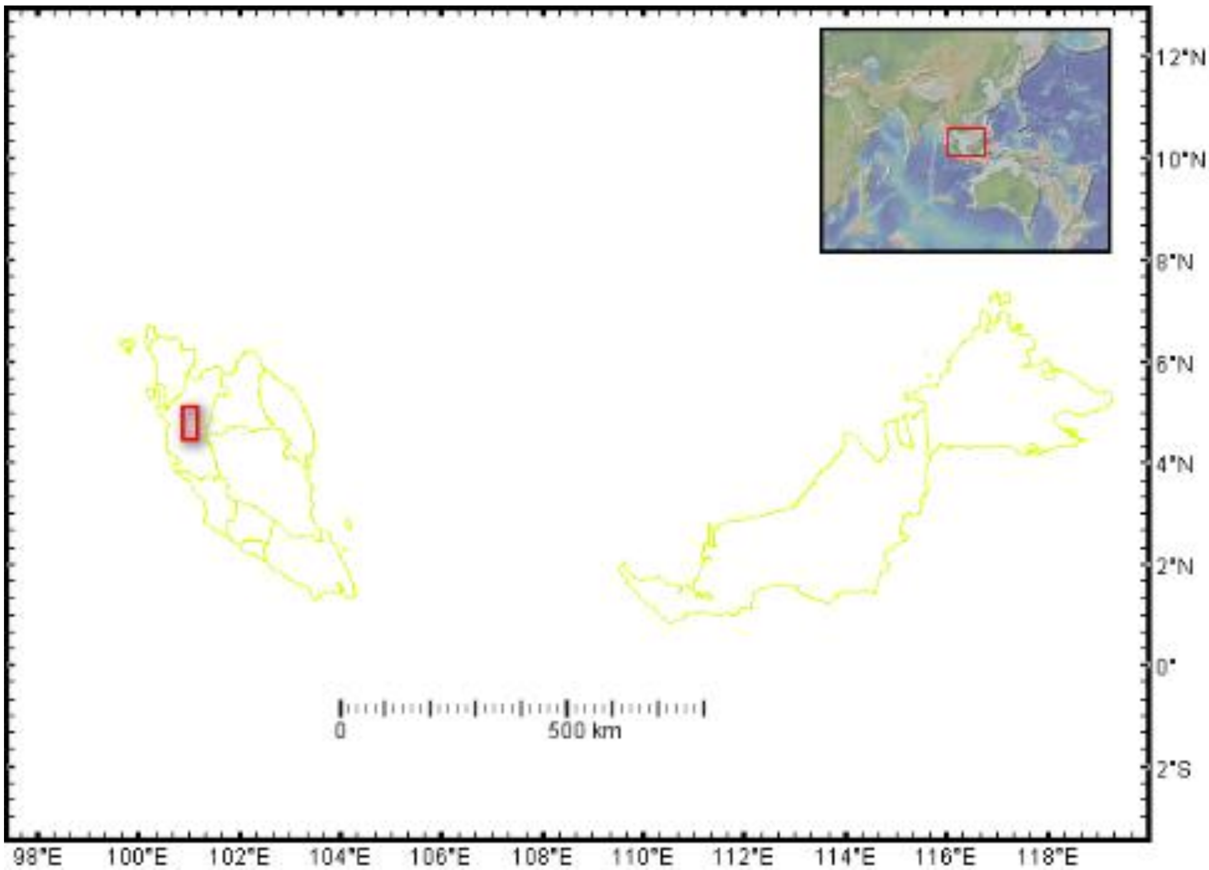

Figure 2. General location map of the Kinta Valley with respect to the entire Malaysia.

B. Karsification

As introduced in the above, karstification is a surficial phenomenon resulted from dissolution of soluble rock bodies, which produce ridges, towers, fissures, sinkholes and other characteristic landforms with well-developed subsurface drainage system (Waltham *et al.*, 2007). Extensive dissolution led to the development of the extant karst features. In Kinta valley, many rivers flow from the bounding Main Range and drain to the southwest through the Kinta River. Most of the limestone towers are also aligned in a preferred orientation near to the Main Range (Fig. 3, Fig. 4). During your field excursion, you will be observing relicts collapsed caves and probably modern caves on the making. According to Kassa *et al.* (2012), overall trend of cave passage orientation is from NNW-SSE. The orientation of cave passage most likely be controlled by regional structure of Peninsular Malaysia, which has NNW-SSE trend and this trend is superimposed by later N-S, NW-SE, NNE-SSW and E-W major faults. The limestone in the Kinta Valley have been severely eroded and karstified due to exposure in a humid, tropical to equatorial climate that most of the limestone hills of Kinta Valley have a similar, tower-like morphology with steep flanks and a rounded or flat tops referred to as tower karst (Kassa *et al*., 2011).

Figure 3. Needle Limestone in the Kinta Valley

C. Related mineralization

Kinta Valley is a well-known hotspot for geological studies besides being listed as the largest tin mine in the early of 20th century. The tin production was very successful in the early day until the British intervention in 1874. They increased the tin production by using high pressure water jet. Although a major portion of tin is extracted from the alluvial, the tin ores are also found in the form of lodes in between granite and pipes in the limestones. This leads to the involvement of the European mining companies with the support of Perak State Government. Menglembu Load Mining Company was the most successful tin mining company in Kinta Valley on 1889 and unfortunately it was shut down on 1891 due to the discovery of traces of arsenic in the tin. Although, tin is not prominent anymore in Kinta Valley, it still retains its status as the preferred geological site by geologist from around the globe.

Summary

The Paleozoic Kinta Limestone might be characterized as tight, recrystallized, and sparse in fossiliferous carbonate succession in the Kinta Valley. The limestone is highly fractures, tilted, and even folded. Most of the fractures were found sealed with calcite, dolomite or other iron-rich minerals. Thus, these processes can be taken as porosity destruction mechanisms, which filled the primary and secondary openings in the rock. However, especially in the Kek Lok Tong area and other parts of the Kinta Limestone you will notice large and small scale dissolution features, which had created porous media in contrary to the destructive processes.

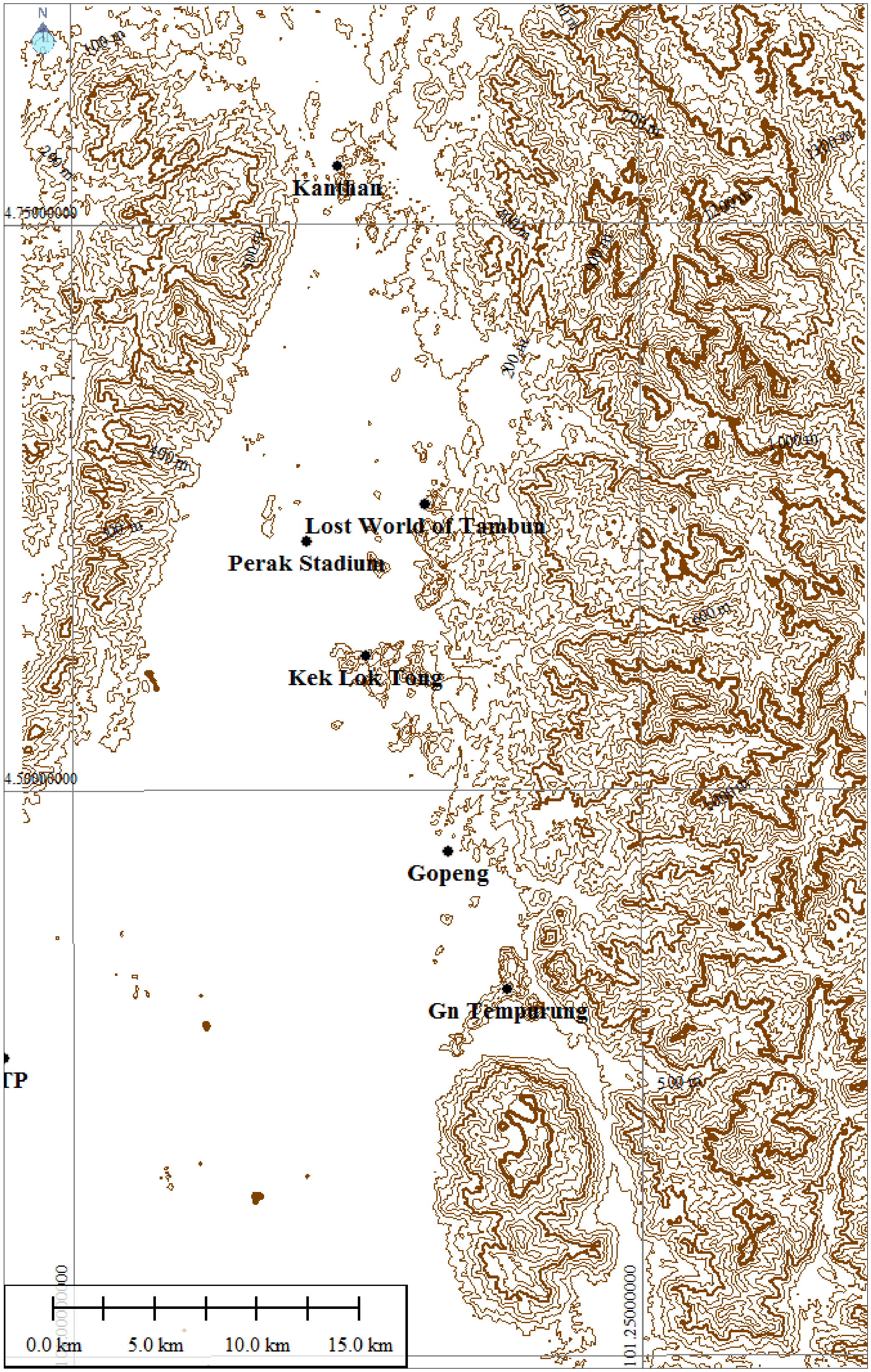

Figure 4. Location of map for the Kinta Limestone main sites with references of know localities

REFERENCES

FOO, K. Y. The Paleozoic Sedimentary Rocks of Peninsular Malaysia-Stratigraphy and Correlation. *In:* NUTALAYA, P., ed. Workshop on Stratigraphic Correlation of Thailand and Malaysia September 8-10 1983 Thailand. Thailand: Geological Society of Thailand, 1-19.

FORD, D. & WILLIAMS, P. D. 2007. *Karst Hydrogeology and Geomorphology,* Chichester, Wiley.

GEBRETSADIK, H. T., SUM, C. W., YURIY, G. A., HUNTER, A. W., AB TALIB, J. & KASSA, S. 2017. Higher-resolution biostratigraphy for the Kinta Limestone and an implication for continuous sedimentation in the Paleo-Tethys, Western Belt of Peninsular Malaysia. *TURKISH JOURNAL OF EARTH SCIENCES,* 26**,** 377-394.

HAYLAY, T. G., HUNTER, W. A. & CHOW, W. S. 2014. Depositional Environment of the Kinta Limestone, Western Peninsular Malaysia. AAPG International Conference & Exhibition 14-17 September 2014 Istanbul, Turkey. AAPG, 36.

JENNINGS, J. N. 1985. *Karst geomorphology*.

KASSA, S., PIERSON, B., CHOW, W. S. & TALIB, J. B. A. 2012. Identifying the link between lineament and cave passage trends to comprehend fractures continuity and influence on the Kinta Valley karst system. *International Journal of Speleology,* 41**,** 7.

KASSA, S., PIERSON, B. J., CHOW, W. & JASMI, B. History of Karst Development in the Kinta Valley: Emphasis on the Main Controlling Factors. First EAGE South-East Asia Regional Geology Workshop-Workshop on Palaeozoic Limestones of South-East Asia and South China, 2011.

LEE, C. P. 2009. Palaeozoic Stratigraphy. *In:* HUTCHISON, C. S. & TAN, D. N. K. (eds.) *Geology of Peninsular Malaysia.* 1st ed. Malaysia: Geological Society of Malaysia.

LEE, C. P., MOHAMED, S. L., KAMALUDIN, H., BAHARI, M. N. & RASHIDAH, K. 2004. *Stratigraphic Lexicon of Malaysia,* Malaysia, Geological Society of Malaysia.

METCALFE, I. 2000. The Bentong–Raub Suture Zone. *Journal of Asian Earth Sciences,* 18**,** 691-712.

METCALFE, I. 2013. Tectonic evolution of the Malay Peninsula. *Journal of Asian Earth Sciences,* 76**,** 195-213.

REINECK, H. E. & SINGH, I. B. 2012. *Depositional Sedimentary Environments: With Reference to Terrigenous Clastics*, Springer Berlin Heidelberg.

SUNTHARALINGAM, T. 1968. Upper Palaeozoic Stratigraphy of the area West of Kampar, Perak. *Geological Society of Malaysia,* 1**,** 1-15.

TSEGAB, H., SUM, C. W. & AARON, H. W. 2015. Preservation of Marine Chemical Signatures in Upper Devonian Carbonates of Kinta Valley, Peninsular Malaysia: Implications for Chemostratigraphy. *In:* AWANG, M., NEGASH, B. M., MD AKHIR, N. A. & LUBIS, L. A. (eds.) *ICIPEG 2014.* Springer Singapore.

TSEGAB, H., SUM, C. W., YURIY, G. A., HUNTER, A. W., AB TALIB, J. & KASSA, S. 2017. Higher-resolution biostratigraphy for the Kinta Limestone and an implication for 1 continuous sedimentation in the Paleo-Tethys, Western Belt of Peninsular Malaysia. . *Turkish Journal of Earth Sciences*.

TSEGAB, H. & WENG SUM, C. 2019. Chemostratigraphy of Paleozoic Carbonates in the Western Belt (Peninsular Malaysia): A Case Study on the Kinta Limestone. *New Insights into the Stratigraphic Setting of Paleozoic to Miocene Deposits - Case Studies from the Persian Gulf, Peninsular Malaysia and South-Eastern Pyrenees.* IntechOpen.

WALTHAM, T., BELL, F. G. & CULSHAW, M. 2007. *Sinkholes and Subsidence: Karst and Cavernous Rocks in Engineering and Construction*, Springer Berlin Heidelberg.