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Geology, occurrence and gemmology of Khamti amber from Sagaing region, Myanmar

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Abstract

A large quantity of Burmite (or Myanmar amber) is produced at Tanai in the Hukaung valley in Kachin State and at Hti Lin (Tilin) in the Magway Region. Another occurrence of amber is found in Pat-tar bum (also called Pat-ta bum) which is located near the Nampilin stream, about 40 km southeast of Khamti (Hkamti), Khamti Township, Sagaing Region. The present mining sites in Pat-ta bum are Laychun (Lachun) Maw (most productive), Kyat Maw, Shan Maw, Gyar Maw, Kyauk Tan Maw and Nameindra Maw. Low grade metamorphic rocks, Kanpetlet schists and similar schists to the Naga Hills are exposed in the eastern part which include glaucophane schist, graphite schist, and epidote schist. Sedimentary units of Miocene age of the Upper Pegu Group are widely exposed in the western, middle and northeastern part. Amber is found in *Orbitolina* (mid-Cretaceous) bearing limestone which ranges from a few centimetres to up to two metres in thickness. This limestone is intercalated with sandstone and carbonaceous shaley limestone and sometimes together with carbonaceous materials. The bedding dips vary from 20˚ to 35˚ and amber production follows the bedding plane. Amber is also found in sandstone and carbonaceous shale. The primary amber mining is carried out by blasting the amber-bearing limestone, sandstone and carbonaceous shaley limestone along their bedding planes and aditing. The colour of Pat-tar bum (Khamti) amber varies from yellow, greenish-yellow, orangy-yellow, golden yellow, brownish-yellow and brown. Gemmologically, it is transparent to opaque and the refractive index ranges from 1.53 to 1.54 (spot reading), and the specific gravity ranges from 1.03 to 1.09. Ultraviolet radiation analyses show that very strong chalky yellowish-blue under long wave and weak chalky yellowish-blue or greenish weak chalky yellowish-blue or greenish under short wave. Some of the deep brownish material displays weak chalky blue or yellow under long wave ultraviolet light and inert under short wave ultraviolet light. Inclusions that identified in amber samples in the present study are flattened gas bubbles, flow marks, some brownish organic debris and various organic inclusions (spiders, flies, feather-like and plant-like inclusions and other organic materials). Eleven analysed specimens of Pat-tar bum amber were quite similar to one another and the IR features are dominated by a group of absorption bands at around 2800–3000 cm^{-1}, relatively narrow bands in the range of 950–1750 cm^{-1} overlaying a broad hump at 800–1400 cm^{-1}, and a weak broad band at around 3420 cm^{-1}. Pat-tar bum amber does not show the characteristic IR and Raman bands of young copal (which lie in the 1050–1250 cm^{-1} region and at 1764 cm^{-1}), which provides the confirmation for the older age of the amber i.e., mid--Cretaceous as confirmed by *Orbitolina* sp. in the host limestone.

Keywords: amber, FTIR and Raman spectra, Khamti, *Orbitolina* sp., Pat-tar bum

1. Introduction

Major production of Burmite (Myanmar amber) in Myanmar is from Tanai, Hukaung valley in Kachin State and Hti Lin (Tilin), Magway Region. Another occurrence of amber is found in Pat-tar bum (also called Pat-ta bum) which is located near the Nampilin stream, about 40 km southeast of Khamti (Hkamti), Khamti Township, Sagaing Region and about 112 km southwest of Tanai (Fig. 1). The present mining sites in Pat-tar bum are Laychun (also spelled Lachun or Lachon) Maw (most productive), Kyat Maw, Shan Maw, Gyar Maw, Kyauk Tan Maw and Nameindra Maw ("Maw" means "mine" in Myanmar) (Thet Tin Nyunt et al., 2019, 2020).

2. Geology

Paleocene to Eocene molasse-type sedimentary units of the Paunggyi Formation and the Cretaceous units are locally exposed including limestone in the study area (Fig. 2). Ultramafic and mafic intrusions of mostly Jurassic age also occurred (Soe Thura Tun et al., 2014). These intrusions include peridotite and serpentinite which are the important source for jadeitite near Nansibon (Cho Cho, 2016 ; Kyu Kyu Thin, 2016).

Low grade metamorphic rocks, Kanpetlet schists and similar schists to those of the Naga Hills are exposed in the eastern part which include glaucophane schist, graphite schist, and epidote schist. *Orbitolina* sp. bearing limestone (mid--Cretaceous, Albian?) intercalated with sandstone, shaley limestone and carbonaceous limestones are exposed in the Pat-tar bum area. Sedimentary units of Upper Pegu Group of Miocene age are widely exposed in the western, middle and northeastern part.

3. Occurrence of Amber

Amber from Pat-tar bum is found in *Orbitolina* sp. (mid-Cretaceous, Albian?) bearing limestone (Fig. 3). The fossils that present in the amber bearing limestone can only identify that these fossils ranges from Lower Aptian to Albian. So more thin sections are necessary for further identification of this important fossils (Tian Jiang, pers. comm.). The thickness of amber bearing limestone is ranges from a few centimetres to up to two metres. This limestone are intercalated with sandstone and carbonaceous shaley limestone and sometimes together with carbonaceous materials (Thet Tin Nyunt, et al., 2019, 2020).

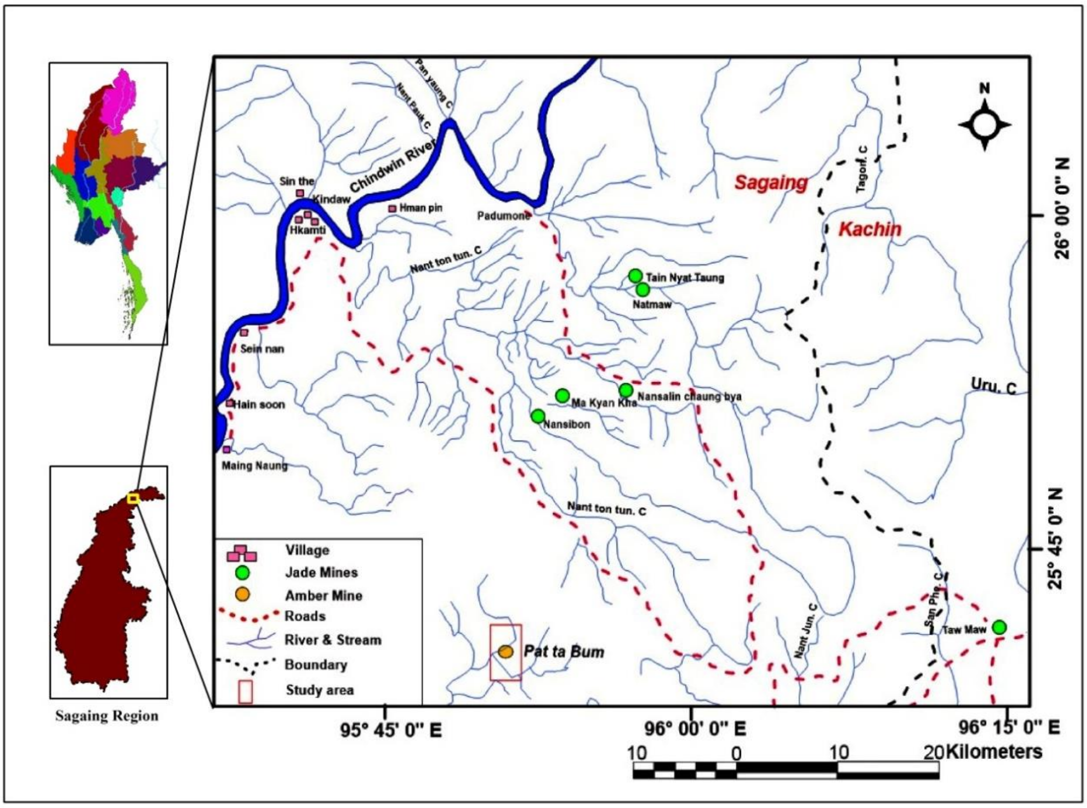

Fig 1: Location map of the Pat-tar bum amber mine in Sagaing Region.

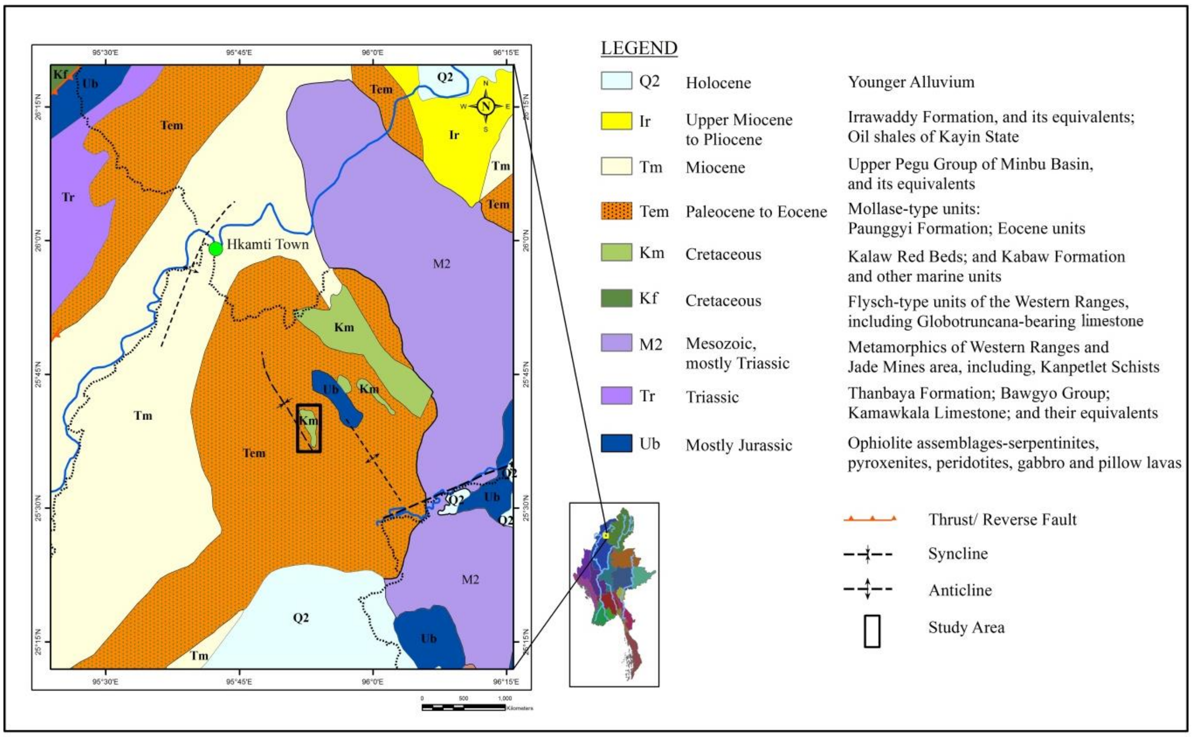

Fig 2: Regional geological map of the Pat-tar bum area (after Soe Thura Tun et al., 2014).

Fig 3: *Orbitolina* sp. in amber bearing mid-Cretaceous (Albian?) limestone (10×, cross-polarised transmitted light). (photos by Cho Cho)

4. Amber Production

Five major production sites including 13 blocks where the mining operation has been operated by Sea-Sun-Star Co. Ltd. are: Laychun (Lachun) Maw, Kyat Maw, Shan Maw, Gyar Maw and Kyauk Tan Maw (Fig. 4). Nameindra Maw is now under suspension. Among them, the Laychun Maw is currently the most productive. The dips of the bedding vary from 20˚ to 35˚ and amber production is carried out along the bedding plane by adits. The primary amber mining is carried out by blasting the amber-bearing limestone, sand-stone and carbonaceous shaley limestone along their bedding plane and aditing into the limestone. Excavated amber-bearing limestone were sorted by manpower outside of the adit (Figs. 5, 6 & 7).

5. Gemmology

The colour of Pat-tar bum (Khamti) amber varies from yellow, greenish-yellow, orangy--yellow, golden yellow, brownish-yellow, brown and reddish brown (Fig. 8). Clarity is from transparent to opaque, the refractive index ranges from 1.53 to 1.54 (spot reading), and specific gravity (SG) ranges from 1.03 to 1.09. These ranges are typical of amber (O'Donoghue, 2008) where the higher SG is due to the attachment of calcite matrix. Ultraviolet radiation analyses show that very strong chalky yellowish-blue under long wave and weak chalky yellowish-blue or greenish

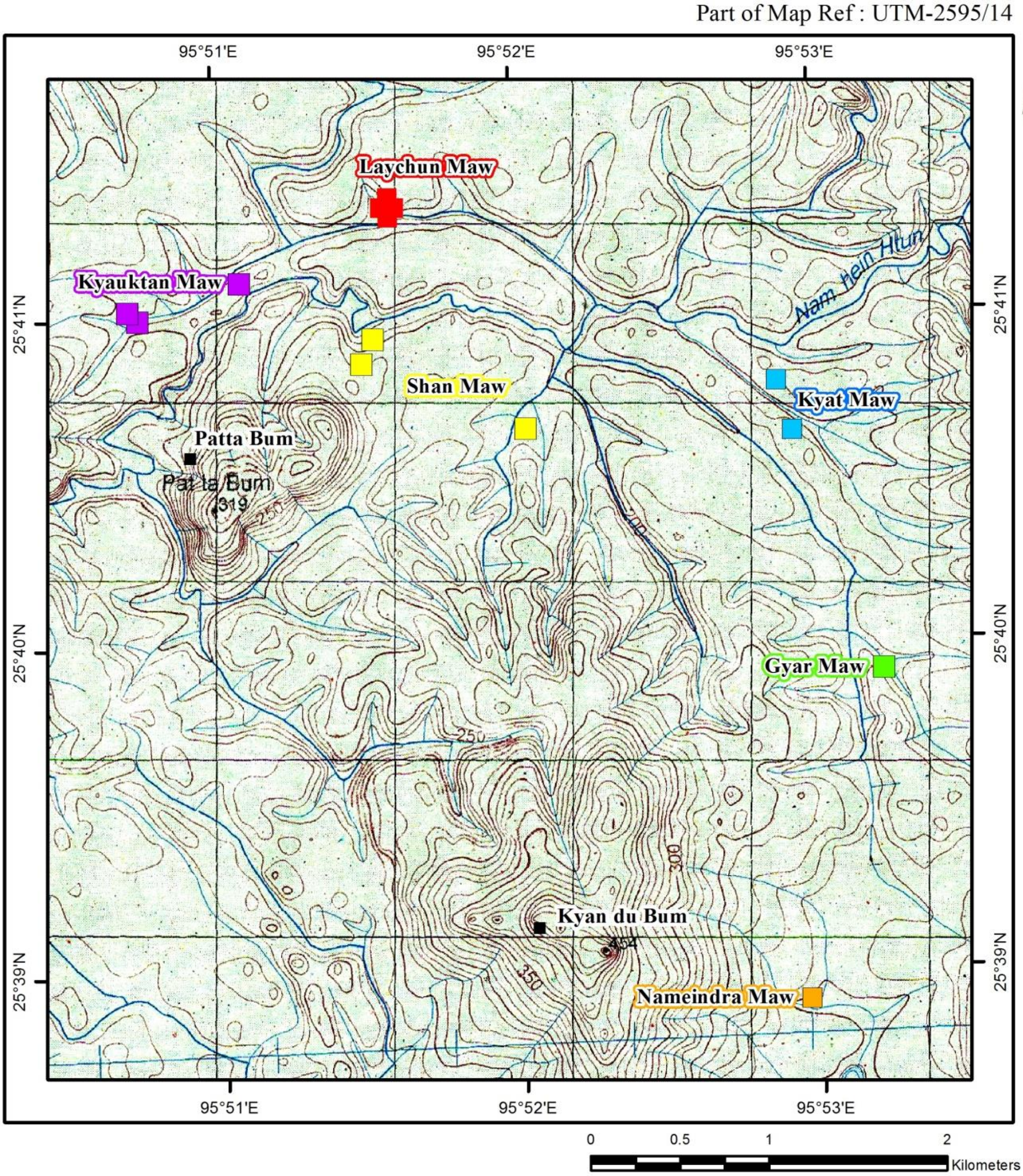

Fig 4: Location map of the Pat-tar bum amber mines.

Fig 5: Amber excavation at Laychun Maw: (a) Manual extraction of amber by manpower outside of the adit; (b) amber with carbonaceous materials in limestone; (c) extracted amber and (d) yellowish brown honey colour amber from Laychun Maw. (photos by Thet Tin Nyunt)

weak chalky yellowish-blue or greenish under short wave (Kocsis et al., 2020). Some of the deep brownish material displays weak chalky blue or yellow under long wave ultraviolet light and inert under short wave ultraviolet light.

6. Inclusions in Amber

Inclusions that are contained in amber samples collected the present study are flattened gas bubbles, flow marks, some brownish organic debris and various animal inclusions (spiders, flies, feathers-like and plant-like inclusions, and organic materials) (Figs. 9 & 10).

7. FTIR and Raman analyses

In the present study, eleven samples of Pat--tar bum amber were analyses by FTIR (Fourier--transform infrared) and Raman analyses. Fig. 11 presents a pair of infrared absorption [recorded in ATR (attenuated total reflection) mode] and Raman spectra obtained from amber sample KT21, which is representative of all samples analysed herein. The IR spectrum is dominated by a group of absorption bands at around 2800-3000 cm^{-1}, relatively narrow bands in the range 950-1750 cm^{-1} overlaying a broad hump at 800-1400 cm^{-1}, and a weak broad band at around 3420 cm^{-1} (Fig. 11, top; for details see Thet Tin Nyunt et al., 2020). The positions and relative intensities of bands in the IR spectrum of Khamti amber are similar to those seen in the IR spectra of Myanmar amber from Tanai and Hti Lin regions reported by various authors (e.g. Tay et al., 2015; Liu, 2018; Chen et al., 2019; Jiang et al., 2020; see Fig. 12), with the exception of a broad band at around ~3420 cm^{-1} (present study) or ~3500 cm^{-1} (Thet Tin Nyunt et. al., 2019), respectively, in the spectra of Khamti amber. The absence of bands at 3048, 1642 and 887 cm^{-1} in the Raman spectrum (Fig. 11, bottom) as well as in the IR spectrum confirms that the Khamti material is amber and

Fig. 6: Nature of amber bearing limestone and amber production at Laychun Maw: (a-b) Entrance for adit of the amber bearing limestone along the bedding plane where the amber is obtained; (c) The amber from amber bearing limestone is transported by a pulley system (yellow bucket with rope and pulley); (d) Intercalation of amber bearing limestone and carbonaceous materials, sometimes with sandstone. (photos by Thet Tin Nyunt)

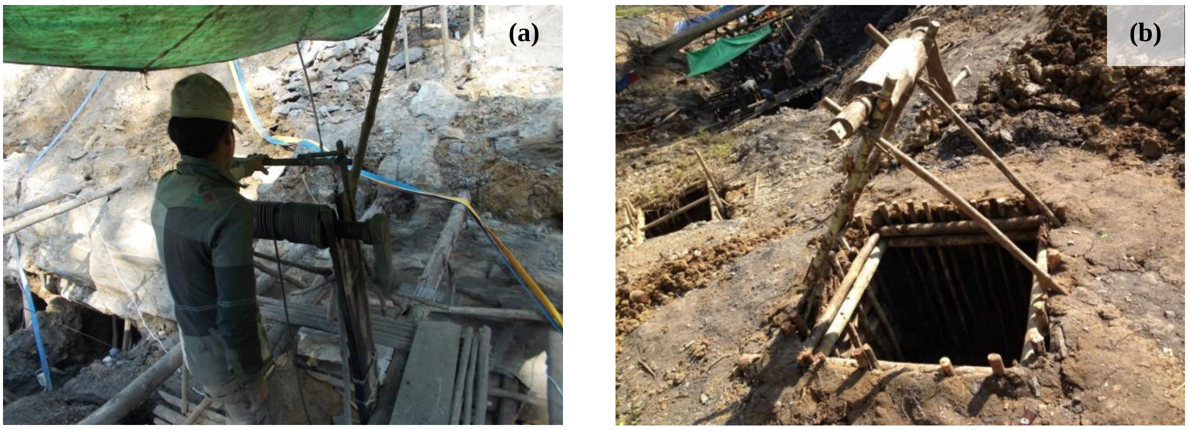

Fig. 7: (a-b) Vertical shafts (1.2 m across, locally called Laybin) are also used to reach the amber bearing limestone at Kyat Maw. (photos by Thet Tin Nyunt)

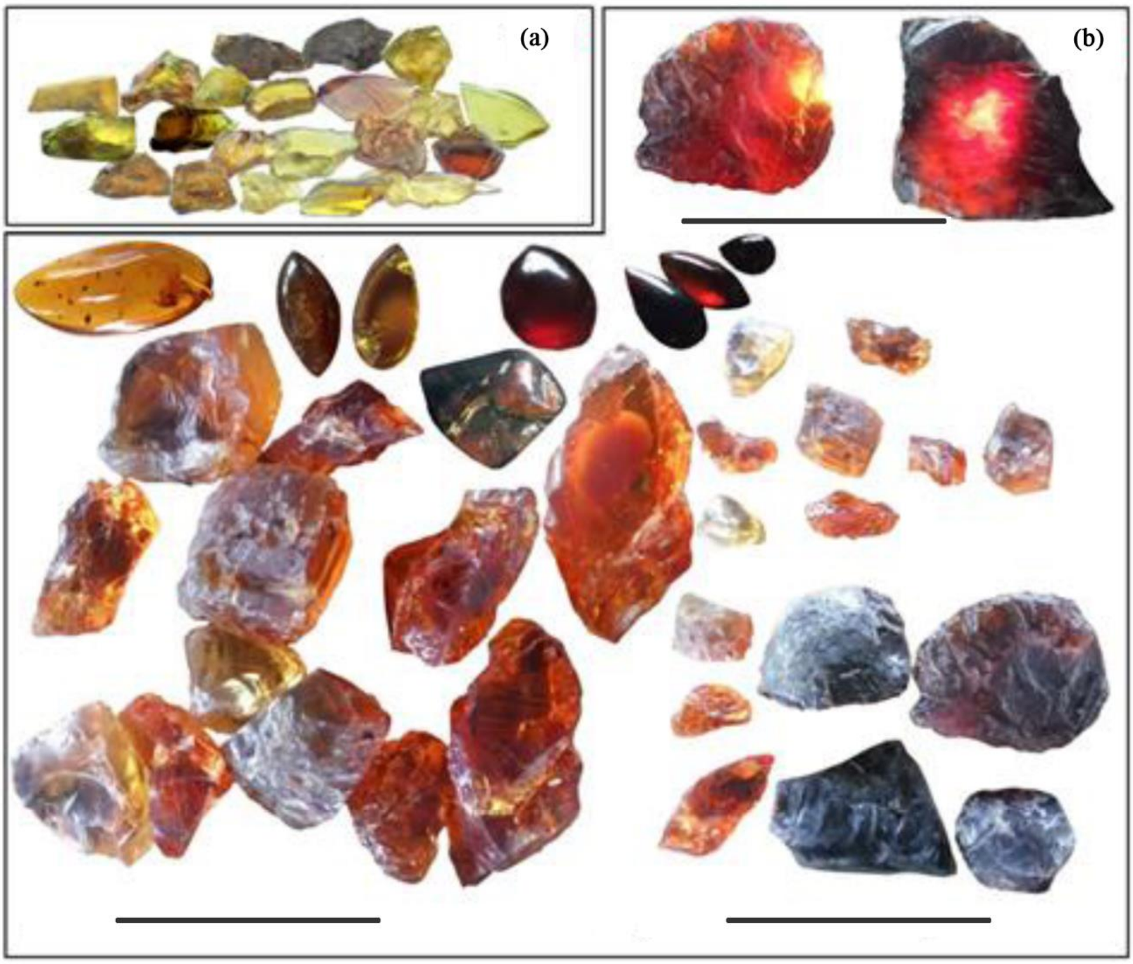

Fig. 8: (a) Twenty one analysed samples of amber for this research range from 0.45 ct (small brownish piece at the left) to 2.49 ct (yellow sample at the centre). (photo by Tay Thye Sun); (b) Khamti ambers with different colour varieties. (photos by Thet Tin Nyunt)(scale bars are 10 cm in length).

not copal (Brody et al., 2001; Wang et al., 2015; compare also Liu, 2018).

8. Discussion and Conclusion

Gemmological properties of Khamti amber, such as refractive index, specific gravity and bright luminescence under LWUV illumination, are quite similar to ambers from the Tanai and Hti Lin regions. A difference consists in the broad, O-H stretching related IR absorption band around 3500 cm^{-1} (3420 cm^{-1} in our samples) in the spectra of Khamti amber. This band is not found in amber from Tanai and Hti Lin, and it can be attributed to O-H stretching. In our previous study (Tay et al., 2015), the analysis of Tanai and Hti Lin amber was carried out with only five samples each and the IR work was focused at the range 3000 cm^{-1}.

Thus, following the discovery of 3500 cm^{-1} absorption in Khamti amber, a preliminary analysis of the Tanai and Hti Lin samples around 3500 cm^{-1} found that some samples appeared to have a peak at 3500 cm^{-1} which we need to do further analysis to confirm it. Therefore, considering the presence of carbonyl groups, this hydroxyl can be assigned to carboxylic acid, rather than molecular water in Khamti amber. The characteristic FTIR and Raman spectra of young copal have not been observed from the Khamti amber which provides confirmation for the older age of the amber i.e., mid-Cretaceous (Albian) or older age as confirmed by the *Orbitolina* sp. in the host limestone. Moreover, it appears likely that Khamti amber was captured and buried earlier or during the formation of the mid-Cretaceous (Albian) limestone.

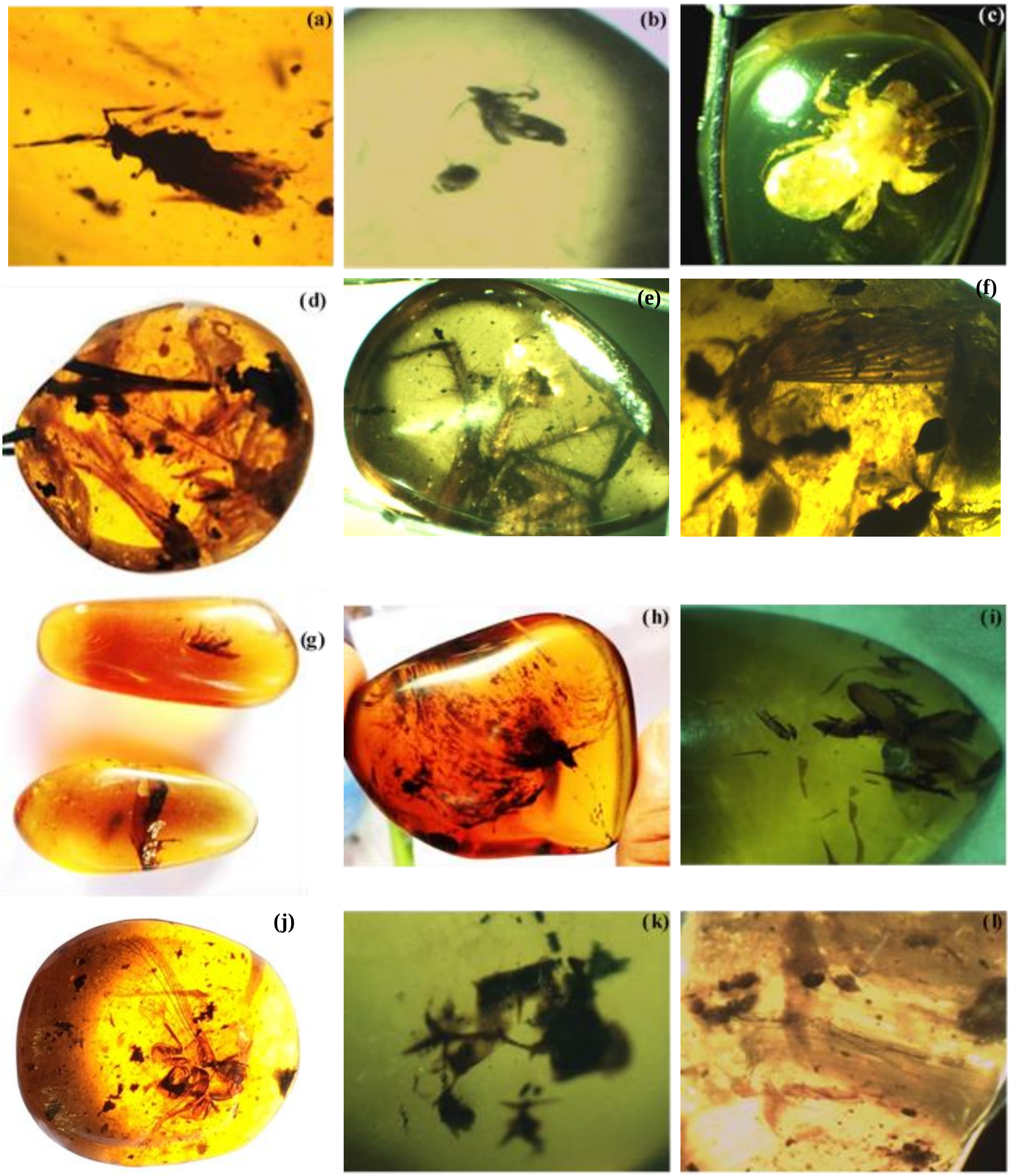

Fig. 9: Inclusions in Khamti amber: (a) Fly; (b) Mosquitoes?; (c) Spider; (d) Bird-Feather; (e) Spider; (f) Insect wings and organic debris; (g) Mosquito; (h) Organic debris; (i) Parts of insects (j) Dragon fly? (k) Some parts of insects and organic debris and (l) Ants and organic materials. (photomicrographs by Thet Tin Nyunt; dark field, 40×)

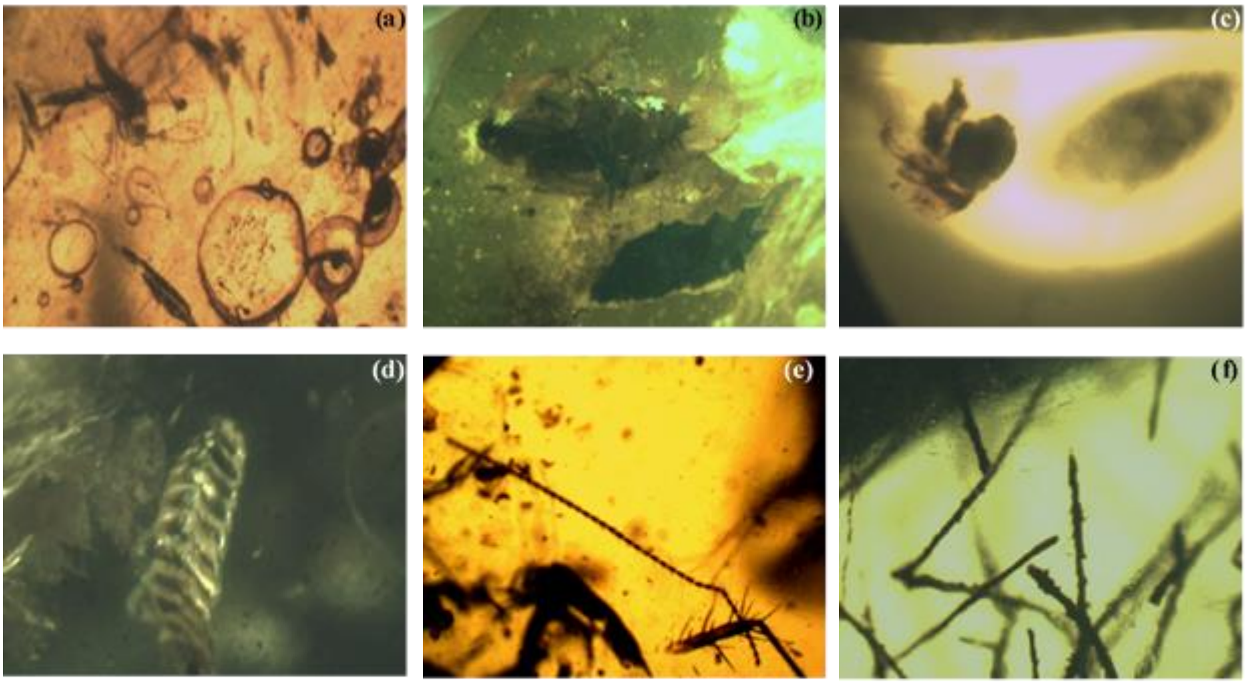

Fig. 10: (a) Organic debris and gas bubbles; (b) Insect inclusions; (c) Organic debris; (d) Insect inclusion; (e-f) Plants, other organic debris and gas bubbles in Khamti amber. (photomicrographs by Thet Tin Nyunt; dark field, 40×)

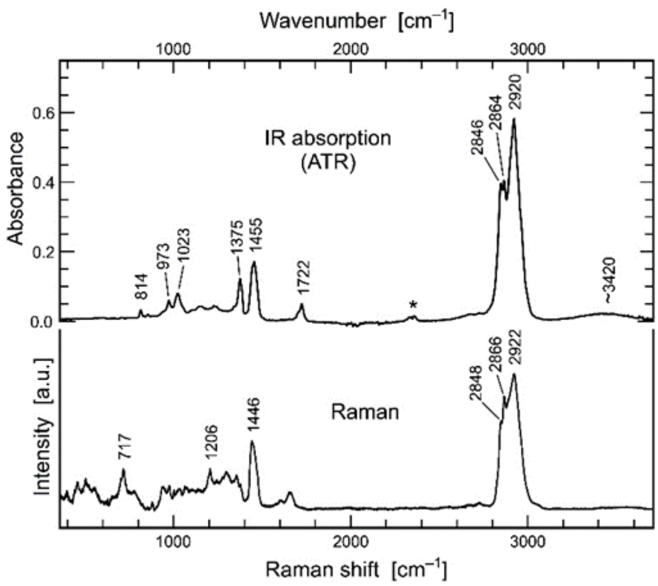

Fig. 11: Representative of IR absorption spectrum (top) and Raman spectrum (bottom) of Khamti amber (modified after Thet Tin Nyunt et al., 2020). The asterisk in the IR spectrum marks an analytical artefact (absorption by CO_2 in the air). The Raman spectrum has been corrected for strong broad-band background luminescence.

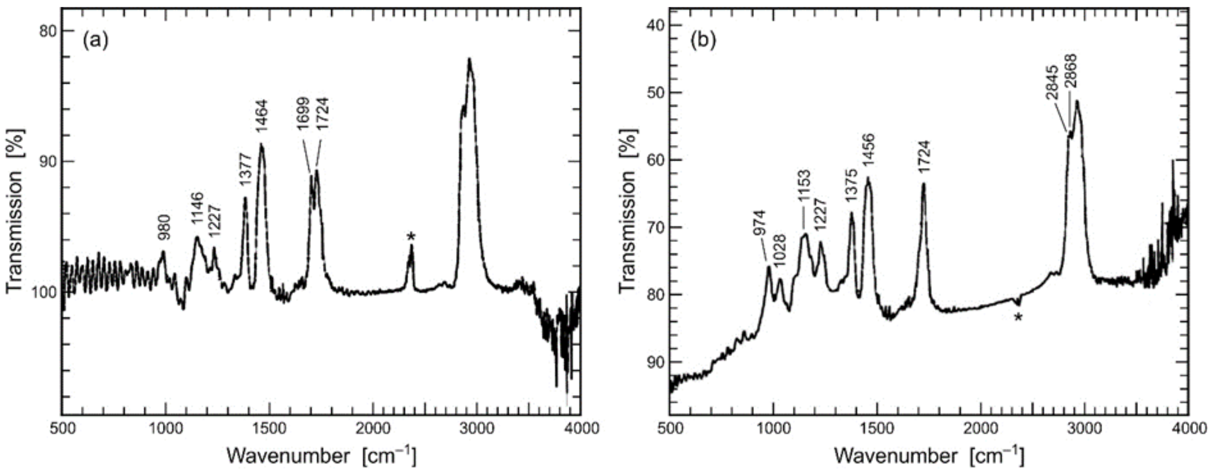

Fig. 12: (a) Infrared spectrum of Hti Lin amber with a double band at 1724 and 1699 cm^{-1}; (b) Infrared spectrum of amber from Tanai shows a single band at 1724 cm^{-1} (redrawn from Tay et al., 2015). Asterisk mark an analytical artefact (absorption by CO_2 in the air).

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