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NOTES ON THE MINERALS IN THE WUNTHO REGION, BURMA

(With 1 Figure)

The mineralized area of Shangalon was explored by the authors in 1955, and about the copper, lead and zinc deposits a separate report was submitted (I. Jurković and B. Zalokar, 1958).

During their sojourn at Kawlin, the authors received from the Town Officer an appreciable number of mineral specimens that had been collected in the Wuntho region, especially at Myelin, a village south-east of Pinlebu, as well as at Mawkwin and Kaydwin, villages situated between Pinlebu and Banmauk. As the Wuntho region is mineralogically very interesting, although but poorly explored, we found it advisable to examine at least the mineral specimens. Petrographic and mineragraphic studies of the specimens collected were performed by Dr. I. Jurković. Here is a brief report on these studies.

The Wuntho region forms part of the Katha district. Its boundaries are marked roughly by the Irrawaddy on the east, and the Mu River on the north and west. Passing Kawlin, in the south, the volcanic cones disappear in the big plain of the Irrawaddy. The railway line Mandalay -Myitkyina crosses the region in its eastern part. In this region there are several larger villages and towns. Nearly all of them are situated on the borders of this region; they are Banmauk, Naba and Indaw in the north, Kawlin in the south, and Pinlebu in the west (map 1).

The central portion of the area is composed of granite (granodiorite) -Wuntho granite-, but the outer rims of the region consist of effusive rocks, volcanic breccias, agglomerates, tuffs, volcano ashes and flows of basalt. There is quite a number of conspicuous dead volcano cones, cupolas and craters.

According to H. L. Chibber (1934a), the magmatic activity of this region is of Posteocene age, but prior to Miocene. The igneous activity commenced with deposition of fine-grained tuffs and volcanic ashes under submarine conditions, followed by explosive volcanic actions and abundant development of volcanic breccias. Simultaneously, there oc-

curred effusions of basalt lava, forming flows and sheets. The magmatic action closed with intrusion of a huge Wuntho granite batholith. In the Kawlin area, andesite, dacite and diabase protruded the mass of granite (granodiorite) in the form of dikes and veins.

About the ore occurrences in this region data can be found in H. L. Chibber (1934 b). He states as follows: »Noetling (8) found veins of cerussite traversing a band of apphanitic rock at Kaydwin« (24°15′, 95°40′) on the Nammaw river. The average thickness of the band is

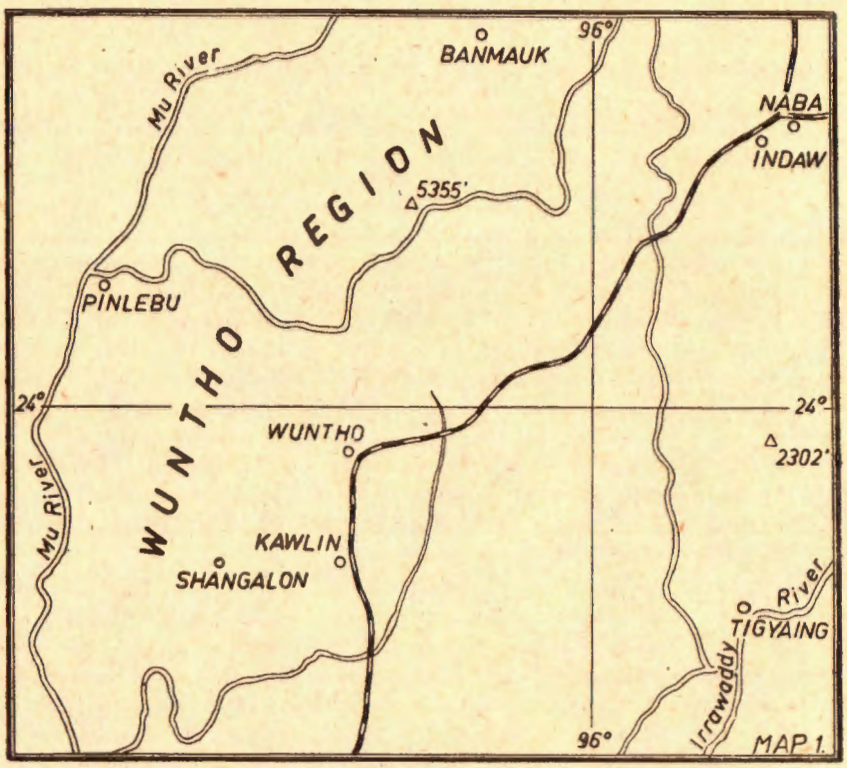

Fig. 1. Map of the Wuntho region

Sl. 1. Karta predjela Wuntho

about 4 feet, and cerussite occurs in thin layers along the cracks in the rock. Samples of the ore yielded on assay 69,1 per cent of lead and 33 ozs. 16 dwt. 4 grains of silver per ton of lead. Another similar occurrence exists at Mawkwin (24°10′, 95°37′), six miles south-west of Kaydwin«.

Later, E. L. G. Clleg (1944) stated the same in a shorter version in his pamphlet.

DESCRIPTION OF THE MINERAGRAPHIC STUDIES

I. *Specimens from Kawlin area*

1. *Hematite (specularite) from the village of Gydbin*

In these specimens hematite is developed in thin-tabular, laminated fibrous and radiated aggregates of needle-shaped crystals. The length of the crystals varies from 10 microns to 3–4 mm, the thickness from several to 100 microns. A certain number of crystals display lamellar twinning. The internal reflections are a deep red, especially in oil. Sporadically, goethite replaces hematite. The specimens contain fine-grained *quartz*, with inclusions of needle-shaped *hematite* crystals. Actually, a part of this quartz is partly recrystallized *chalcedony*. The paragenesis is typical of lowtemperatured iron-ore deposits.

2. *Pyrite from Na-Maw Chaung, 8 miles north-west of Kawlin*

The specimens consist of *pyrite* fragments 0,5–1 cm. in size. Under the microscope they display coarse-grained aggregates and cataclased fragments of pyrite.

II. *Specimens from the Myelin area*

1. *Quartz crystals from Khaung-Pwa*

The specimens represent idiomorphically developed translucent *quartz* crystals 0,1–2 cm. in size.

2. *Specimens of a quartz vein from Khaung-Pwa*

The specimens represent a crushed quartz mass coated with a yellowish, brown or black film.

Microscopically, they are cataclased, coarse-grained, optically anomalous *quartz* (a chemical analysis showed 99.14% of SiO_2) cemented with extraordinarily fine-grained or submicroscopical *chalcedony*. Along the fine cracks, or within crushed zones dark-green and slightly pleochroitic *chlorite* could be seen, as well as some impregnations of fine-grained *pyrite*.

The specimens represent a high-temperature hydrothermal quartz vein.

3. *Tourmaline from Khaung-Pwa*

The specimens consist of columnar black crystals ranging from several millimetres to 2–3 cm. in length. The larger crystals are idiomorphically developed, the smaller ones are either xenomorphically or allotriomorphically developed. The vugs among these crystals are filled with needle-shaped tourmaline crystals. A slight limonitisation of tourmaline was noted.

Microscopically, dark-green and brownish granular aggregates of very strong pleochroitic properties could be noted. Sometimes they display a zoning with the innermost zone, which is much darker brownish than the outer one. The index of refraction is very high (n = 1,6). Birefraction is moderate (0,025, measured by prof. M a r i ć L.). Absorption O = dark-brown to dark-green; E = light-pinkish, yellowish. Such type

of tourmaline is rich in iron (»Schörl« in German language). *Tourmaline* is accompanied by an opaque black and granular mineral. Mineragraphic studies revealed *magnetite.*

The coarser crystals of tourmaline are characteristic of pegmatitic veins or of pneumatolytically tourmalinized granite.

4. *Specimens of pyritized granite from Khaung-Pwa*

The specimens represent dense impregnations of small-grained (1–2 mm) *pyrite* in granite.

5. *Specimens of the pyritized quartz-vein from Khaung-Pwa*

The specimens from completely cataclased and crushed, optically anomalous, coarse-grained *quartz* cemented or replaced by *chalcedony* and *pyrite.* The texture is breccia-like.

The specimens represent a high-temperatured hydrothermal and tectonically crushed quartz-vein.

III. *Specimens from the Pinlebu-Banmauk area*

1. *Cerussite from Mawkwin*

The specimens represent an earthy mass of *cerussite* with remnants of *galena.* Cerussite is cryptocrystalline and mixed with other undetermined minerals.

2. *Chalcopyrite- and molybdenite-bearing quartz-vein from Mawkwin*

The following paragenesis was noted: *quartz, calcite, chalcopyrite, pyrite, molybdenite, chalcedony.*

Microphysiography of the minerals:

Quartz is coarse-grained and partly replaced and corroded by calcite. Its interstices are filled with chalcopyrite. *Calcite* is allotriomorphic, granular and fine-grained. Calcite cements the fragments of chalcopyrite and envelops molybdenite. *Pyrite* is coarse-grained. It occurs rarely, mostly in the form of corroded grains in chalcopyrite. *Chalcopyrite* is coarse-grained, but very strongly cataclased, its fragments being cemented with calcite. *Molybdenite* forms minute inclusions (50-300 microns) in calcite and to a lesser degree in chalcopyrite. Common forms are rosette-shaped aggregates or curved plates with undulatory extinction. Anisotropism is very strong. Reflection pleochroism is extremely high. *Chalcedony* fills only the microscopic veinlets in chalcopyrite and quartz, and it is of secondary origin.

Sequence of the ore minerals:

quartz → pyrite → molybdenite → chalcopyrite → tectonic phase → calcite → hypergene minerals → chalcedony.

The specimens represent a high-temperature pneumatolytic-hydrothermal ore deposit connected with granitic magma, with a significant quantity of molybdenite (more than 0,2%).

3. *Goethite and psilomelane from the village of Kongyi*

The ore section displays botryoidal and globular masses of *goethite* and *psilomelane,* intimately intergrown ore, forming alternative bands. The texture is microporous or microcellular. The cells are built of goe-

thite, psilomelane, or of both minerals. The size of the cell-walls varies from 5–30 microns, and the size of the irregular pores from 100–200 microns. The reflectivity of goethite is distinctly lower than that of psilomelane. The anisotropism of goethite is distinct, but that of psilomelane is stronger. Goethite displays a yellow-brownish internal reflection. The microscopically fine system of veinlets is filled with very fine -grained goethite and psilomelane of the second generation, originated in lateral secretion.

4. *Disseminated pyrite ore from the village of Kyaw-Ywa-gyi, west of Dan Din Taung*

The specimens represent fine-grained *pyrite* impregnations in a completely altered rock.

5. *Disseminated pyrite ore from the Kame village Tract*

The specimens represent fine grains of *pyrite* irregularly disseminated in the rock.

6. *Disseminated pyrite ore from the village of Taung Dun*

The specimens represent impregnations of *pyrite* in the rock.

7. *Copper-bearing pyritic quartz-vein from a location 8 miles west of Nankan*

This compact and brecciated pyrite is cemented with veined quartz. Microscopically, the following paragenesis was established: *pyrite, quartz, chalcopyrite, Cu-sulphosalt, sericite.*

Pyrite is the oldest mineral. It occurs in the form of very large hexaedral crystals. The cataclastic texture is very common. Rounded and angular fragments of pyrite are cemented with quartz. Sometimes pyrite is corroded by quartz, but it is also replaced by chalcopyrite or the sulphosalts. The replacement follows the cracks, fissures and grain boundaries. Sometimes sieve-like forms of pyrite filled with chalcopyrite and Cu-sulphosalts could be seen. Therefore pyrite is the copper-bearing mineral of the deposit.

Quartz is allotriomorphically grained, the grains are isometric or elongated. The size of the grains varies from 10 microns to 1 mm. It is a typically veined quartz. Quartz cements and corrodes the cataclased pyrite and envelopes the Cu-minerals. Usually it is transparent and optically normal, very rarely opaque, owing to some mineral powder. *Sericite* is associated with quartz as laminated aggregates or foliae, sometimes as coating on hexaedral crystals of pyrite. *Chalcopyrite* is very fine-grained; it occurs as small masses filling up the interstices in quartz, or replacing or impregnating pyrite. *Cu-sulphosalt* replaces or impregnates pyrite, and sometimes it is associated with chalcopyrite. It is grey -white in colour and distinctly anisotropic.

The paragenesis is typical of mesothermal hydrothermal ore deposits. After crystallization of coarse-grained pyrite, there followed a strong tectonic phase. Cataclased pyrite is cemented and replaced by the younger generation of minerals: quartz and the sulphosalts.

8. *Specimens of galena ore-locality 11 miles west of Nankan*

In these specimens, according to mineragraphic studies, the following paragenesis was established:

a) primary minerals: *pyrite, sphalerite, chalcopyrite, tetrahedrite, galena, freibergite, »two silver-bearing minerals«, chalcedony.*

b) secondary minerals: *cerussite, anglesite, covellite, chalcocite, goethite* and *lepidocrocite.*

The main constituents of this ore are galena and chalcedony, to be followed by sphalerite; chalcopyrite and tetrahedrite are the accessory constituents.

Pyrite is the oldest mineral and occurs in minute corroded and cataclased grains in other minerals. *Sphalerite* shows an extraordinarily strong cataclastic texture. The fragments of sphalerite are cemented with chalcedony and sporadically with galena. The white, light yellow and yellowish internal reflection points to Fe-poor sphalerite. In some places sphalerite is replaced by galena. *Chalcopyrite* occurs in the form of smaller or larger rounded masses in galena, and also as crystal splinters cemented with chalcedony. Intergrowths with tetrahedrite could likewise be seen. Alterations to covellite and chalcocite follow the cracks and rims of the chalcopyrite grains. *Tetrahedrite* occurs in two forms: as crystal -splinters or angular fragments cemented with chalcedony, then as minute, densely packed, more or less rounded grains or lamellae, crystallographically orientated in galena. The size of these inclusions varies from several to 100 microns. This tetrahedrite is silver-bearing, consequently it is *freibergite.* Owing to this fact galena holds a high content of silver. *Galena* is the most abundant mineral. It belongs together with chalcedony to the younger generation of mineralization, and it is rich in inclusions of silver-bearing minerals: freibergite and *»two other silver minerals«* of unknown identity. One of these forms myrmekitic intergrowths with *freibergite.* Galena and chalcedony are intimately intergrown. Galena fills the vugs in chalcedony and the cracks in sphalerite. The alteration of galena to cerussite and anglesite reveals the fine-grained structure of galena. Further, the oxidation follows the cleavage planes and rims of galena grains. Also supergene chalcocite and covellite coatings of the galena grains could be seen. Along some cleavage planes galena was replaced by a younger generation of chalcedony. *Chalcedony* is a gangue mineral, and it serves as cement for other, older and strongly cataclased minerals. It is either submicroscopical to small-grained, or it forms fibrous and radially-fibrous agregates. Within the small-grained chalcedony there are angular fragments of an older generation of chalcedony. Many vugs and interstices in granular chalcedony are filled with a fibrous variety. *Cerussite* and *anglesite* are the products of the alteration of galena. The analysed samples contained more anglesite than cerussite. Cerussite is to be distinguished from anglesite by its high reflection pleochroism and very strong anisotropism. *Covellite* and *chalcocite* are the products of the alteration of chalcopyrite and tetrahedrite in the zone of cementation. They fill up the cracks or coat grains, of both chalcopyrite and tetrahedrite. Sporadically, both minerals are intimately intergrown with cerussite and anglesite.

The texture of the ore is microbrecciated; as already mentioned, chalcedony is cement to the other minerals.

Pyrite, sphalerite, chalcopyrite and tetrahedrite were developed during the first phase of the mineralization. Deposition of these minerals was interrupted by a strong tectonic phase – causing the cataclastic texture of the ore – and was followed by a younger generation of the mineralization. The second phase of the mineralization is represented by galena, silver-bearing freibergite, sulphosalts and chalcedony cementing and partly replacing the older minerals. The ore deposit belongs to the middle and to low-temperature hydrothermal deposits. Most probably it is connected with volcanic rocks.

9. *Specimens of a pyritic quartz vein, from the villages of Kani and Da-Yu, Mun Taung*

The vein is about 10 cm. thick and composed of milk-white or translucent bluish-white massive quartz containing smaller or larger masses of coarse-grained brecciated pyrite.

Microscopically, the following paragenesis can be noted: *pyrite, quartz, chalcopyrite, chlorite* and *calcite* as primary minerals, and *goethite* with *lepidocrocite* as secondary minerals.

Pyrite is the oldest mineral. It is coarse-grained and cataclased, its fragments being cemented with quartz. Sporadically, hexaedral cross sections of pyrite could be noted. Pyrite shows minute inclusions (smaller than 20 microns in diameter) of *chalcopyrite* and therefore this is a copper-bearing ore. Also *quartz* is coarse-grained. Optically it is anomalous, with irregular and undulatory extinction. Quartz was exposed to a very strong stress, causing recrystallization of quartz, thus forming small-grained aggregates of younger quartz along the cracks and rims of the grains. In some places even entire grains of quartz are recrystallized. The younger veinlets in quartz are filled with fine-grained quartz of the second phase, with *chlorite*. Chlorite envelops also the pyrite grains. It is green, slightly pleochroitic with anomalous anisotropism. *Calcite* is an accessory constituent. It occurs along the cracks, but only in quartz. Calcite is fine-grained. *Goethite* and *lepidocrocite* are the products of the oxidation of pyrite. They occur as coatings or veinlets.

The ore has a brecciated texture. The specimens represent a high-temperature hydrothermal pyritic quartz vein with a small content of copper.

10. *Specimens of galena with cerussite from the village of Peinlebin, Khe Taung*

The earthy specimens vary in colour from a dirty white to grey. Under the ore microscope patches of unaltered *galena*, embedded in a dark-grey isotropic mass, could be noted. In permeated light, the pale-grey and opaque ore mass consists of submicroscopically fine particles, a mixture of *cerussite* and other secondary minerals. The mass is isotropic. A quantitative analysis (performed by I. Lovreček, Ch. Eng.) gave the following values: 54% of PbS, 28% of $PbCO_3$, 0,3% of ZnS, 17,7% undetermined.

The specimens represent a low-temperature hydrothermal galena deposit.

11. *Lead-zinc ore deposit on the Khwe-Mogo Taung Pula Legin road*

The paragenesis is as follows: *sphalerite, galena, quartz.*

Sphalerite and *galena* are most intimately intergrown, and we presume that they originated from colloidal solutions and that they formerly had a colloform texture which later recrystallized. *Quartz* is the only gangue. It is fine-grained and intergrown with sulphides. The ore specimens represent a rich, high-grade ore.

12. *Tourmalinized quartz-vein from Pantha, about 40 miles west of Kawlin*

The specimens represent coarse-grained *quartz* with black *iron-tourmaline*, the so called »*Schörl*«.

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Resummé

IVAN JURKOVIĆ i BOŽIDAR ZALOKAR

PRILOG POZNAVANJU MINERALA WUNTHO PODRUČJA U BURMI

UVOD

Autori su u proljeće god. 1955. istraživali rudne pojave u području Shangalon, koje se nalazi na krajnjem južnom dijelu velike magmatske i metalogene oblasti Wuntho (skica 1). Rezultati tog istraživanja nalaze se u štampi (I. Jurković – B. Zalokar, 1958).

Prilikom boravka u gradiću Kawlinu sakupljena je posredstvom gradonačelnika značajna kolekcija rudnih uzoraka iz oblasti Wuntho, naročito iz područja Myelin jugoistočno od grada Pinlebu i iz područja Mawkin i Kaydwin istočno i sjeveroistočno od Pinlebua.

Metalogena oblast Wunto je geološki vrlo slabo istražena i osim vrlo oskudnih podataka o magmatizmu i nekoliko rudnih pojava, koje daju H. L. Chibber (1934) i E. L. Clegg (1940) nema u literaturi drugih vijesti.

Po Chibberu središnji dio Wuntho područja izgrađen je od velikog batolita granit -granodiorita, koji je okružen efuzivnim stijenama, vulkanskim brečama, aglomera-

tima, vulkanskim tufovima i bazaltnim lavama. Područje obiluje ugašenim vulkanima i kraterima. Magmatska aktivnost odigrala se između eocena i miocena. Započela je sedimentacijom submarinskih finih tufova i vulkanskog pepela. Dolazi eksplozivna faza vulkanske djelatnosti i stvaranje brojnih kratera izgrađenih od vulkanskih breča i aglomerata. Simultano došlo je i do efuzija bazaltnih lava kao tokova i ploča. Magmatska aktivnost uglavnom se završava intruzijom golemog Wuntho batolita i sporadičnim probojima dajkova andezita, dacita i dijabaza kroz taj batolit.

Rezultati mineragrafskog istraživanja

1. *Gydbin village*, pločast, lisnat i vlaknat *spekularit* sa sitnozrnatim *kvarcom* i *kalcedonom*. Rudna pojava je epitermalna, vezana za proboje dijabaza.

2. *Na-Maw Chaung*, krupnozrnati, kataklazirani fragmenti katatermalnog *pirita*.

3. *Khaung-Pwa*, a) idiomorfno razvijeni providni kristalići *kvarca*, b) krupnozrnati, kataklazirani i zdrobljeni optički anomalni *kvarc* s *kalcedonom* kao cementom pršlina i fragmenata. Lokalno, naročito po pršlinama tamnozeleni *klorit*, te impregnacije sitnih zrnaca *pirita*. Uzorak pripada katatermalnoj kvarcnoj žici, c) krupni kristali crnog *turmalina (šerla)* do 2–3 cm veličine kao idiomorfno razvijeni individuumi ili ksenomorfne i alotriomorfne mase, kojih su međuprostori ispunjeni igličastim turmalinom. Lokalno u masi turmalina zrnca *magnetita*. Uzorci su pneumatolitskog porijekla, d) uzorci rjeđe ili gušće impregniranog granita sitnim zrncima *pirita*, e) potpuno zdrobljene mase krupnozrnatog i optički anomalnog *kvarca* cementiranog i potiskivanog *kalcedonom* i *piritom*. Uzorak je od katatermalne piritno-kvarcne žice.

4. *Mawkin*, a) zemljasti *ceruzit* s ostacima neoksidiranog *galenita*, b) krupnozrnati *kvarc* djelomično potiskivan sitnozrnatim *kalcitom*. Međuprostore kvarca ispunjava *halkopirit*, koji je pretežno zdrobljen i cementiran *kalcitom*. U kalcitu i halkopiritu inkluzije mikroskopski sitnih listića *molibdenita*. *Kalcedon* je hipergenog porijekla i ispunjava sitne žilice u halkopiritu. Uzorci potječu od pneumatolitsko-hidrotermalnog ležišta.

5. *Kongyi village*, *Yeshin village Tract*, bubrežaste i grozdaste mase intimno proraslih ili vrlo fino alternirajućih radijalno-koncentričnih zona *getita* i *psilomelana*, ispresijecanih mikroskopski finim spletom istih minerala druge generacije.

6. *Kyaw-Ywa-gyi village*, *western Dan Din Taung*, impregnacije finozrnatog *pirita* u izmijenjenoj stijeni.

7. *Kame village Tract*, nepravilno razasute impregnacije *pirita* u stijeni.

8. *West of Nankan*, krupnozrnati *pirit* kataklaziran ili zdrobljen u angularne i subangularne fragmente, cementiran i korodiran sitnozrnatim masama izometrijskih i izduženih zrnaca *kvarca*, sitnozrnatim *halkopiritom* i mjestimice vrlo malim masicama anizotropne *Cu-sulfosoli*. U kvarcu se vide lokalno agregati listića *sericita*. Uzorci pripadaju mezotermalnom rudnom ležištu.

9. *West of Nankan*, glavni minerali su *galenit* i *kalcedon*, *sfalerita* ima znatno manje, a *pirit*, *halkopirit* i *tetraedrit* su sporedne sastavine. Prvoj generaciji orudnjenja pripadaju pirit, sfalerit, halkopirit i tetraedrit. Nakon vrlo jake tektonske faze i drobljenja kristaliziraju mlađi minerali, galenit s brojnim mikroskopski sitnim inkluzijama *frajbergita* i izdvajanjima dvaju neodređenih *Ag-sulfosoli*, te *kalcedon*. Ti minerali dijelom cementiraju, a dijelom potiskuju fragmente starijih minerala. Zbog toga je struktura rude mikrobrečasta. U hipergenoj fazi nastali su *ceruzit*, *anglezit*, *kovelin*, *getit* i *lepidokrokit*. Rudna pojava je mezo-epitermalnog karaktera.

10. *Kani village*, *Da Yu village*, *Muin Tract*, kvarcno-piritna žica izgrađena od krupnozrnatog, kataklaziranog i optički anomalnog *kvarca* s početnim stadijem rekristalizacije u sitnozrnati kvarc. U kvarcu manje i veće mase i gnijezda krupnozrnatog, brečiiranog *pirita* s mikroskopski sitnim inkluzijama *halkopirita* obavijenog katkad *sericitom*. Pršline kvarca ispunjene su listićavim *kloritom* i sitnozrnatim *kalcitom*. *Getit* i *lepidokrokit* su kao prevlaka i žilice u rudi. Struktura rude je brečasta. Rudna pojava je katatermalnog porijekla.

11. *Pein Ne'pin village*, *Khe Taung*, zemljasta masa *ceruzita* s masicama neizmijenjenog *galenita*. Rudna pojava je epitermalnog porijekla.

12. *Khwe-Mogo Taung, Pula Legin road*, vrlo intimno prorasle mase sitnozrnatih *galenita* i *sfalerita* u sitnozrnatoj *kvarcnoj* jalovini. Strukture su prvobitno bile koloidnih formа. Pojava je epitermalnog porijekla.

13. *Pantha, 40 milja zapadno od Kawlina*, krupnozrnati *kvarc* s kristalima crnog *turmalina (šerla)*. Pojava je pneumatolitskog karaktera.

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