IVAN JURKOVIĆ and BOŽIDAR ZALOKAR

THE ORE OCCURENCES OF THE SHANGALON AREA, SOUTH-WEST OF KAWLIN, UPPER BURMA

(With 3 geological maps, 1 topographical map and 4 plates.)

Introduction

The Shangalon area in the Katha District, Upper Burma (latitude 23°30′ N. and longitude 95°30′ E.-map No 1) is nearly 16 miles distant from the town of Kawlin in south-western direction. The main railway line connects Kawlin with Mandalay and Myitkyina.

The village of Shangalon is situated in a valley in the middle of this area amidst paddy fields watered by the Zalok, Mine, Shawdon and Shangyiang Creeks. All these creeks unite at Shangalon, forming the Kalon Creek. In addition to Shangalon, this area also holds two smaller villages: Kyangalon-Pudaw and Gwedauktaw.

The area in question is a hilly one, with rather low hills rising to a maximum elevation of a few hundred metres.

The climate is semi-arid, with monsoon rains occurring from May to October.

At the request of the Mineral Resources Development Corporation, Ministry of Mining, Government of Burma, and within the framework of an agreement with the Yugoslav enterprise »Geoistraživanja«, Zagreb, both authors visited this area in March, 1955, performing geological explorations. During these explorations the hills south and west of Shangalon, the Pagoda, Kyaunggon Taung, Taung Byu and Chigyindaung Taung ranges east of Shangalon, as well as the area between the Zalok and Shangyiaung Creeks east of the village of Pudaw and that north of these two villages were mapped. In addition to these detailed explorations, we prospected the area around the village of Gwegyo, several miles north-west of Pudaw, as well as the area around the village of Kydaw, several miles north of Pudaw. We likewise made passing observations on our way to and from Kawlin, paying attention to the petrographic characteristics of the country rocks present.

During our field work a considerable number of rock and ore specimens were collected. The majority of these specimens were determined immediately on the spot, along with the mapping. Chosen specimens as well as specimens of rocks that were strongly metamorphosed or doubtful in the macroscopical determination were examined microscopically by *Prof. Dr. Luka Marić* and *Dr. Eng. Vladimir Majer.* The results of their examination were utilized by us for correcting the field geological map. On this occasion we are expressing to them our indebtedness for the help proffered in the making of the geological map.

Explanations of the geological map of the Shangalon area

Before our explorations, the wider Shangalon area had not been surveyed geologically, and consequently it still represents a »white spot« on the regional maps of Burma. These constitute the first data about the geology and petrography of this area.

A considerable number of rocks participate in the geological structure of this area. They are basic extrusive rocks, basic intrusive rocks, acid extrusive rocks, acid intrusive rocks, furthermore tuffs, hornstones, arkose sandstones, actinolithic schists, aplites and pegmatites of granitic magma (map No. 2, plate V). The magmatic rocks are of Tertiary age.

Basic extrusive rocks

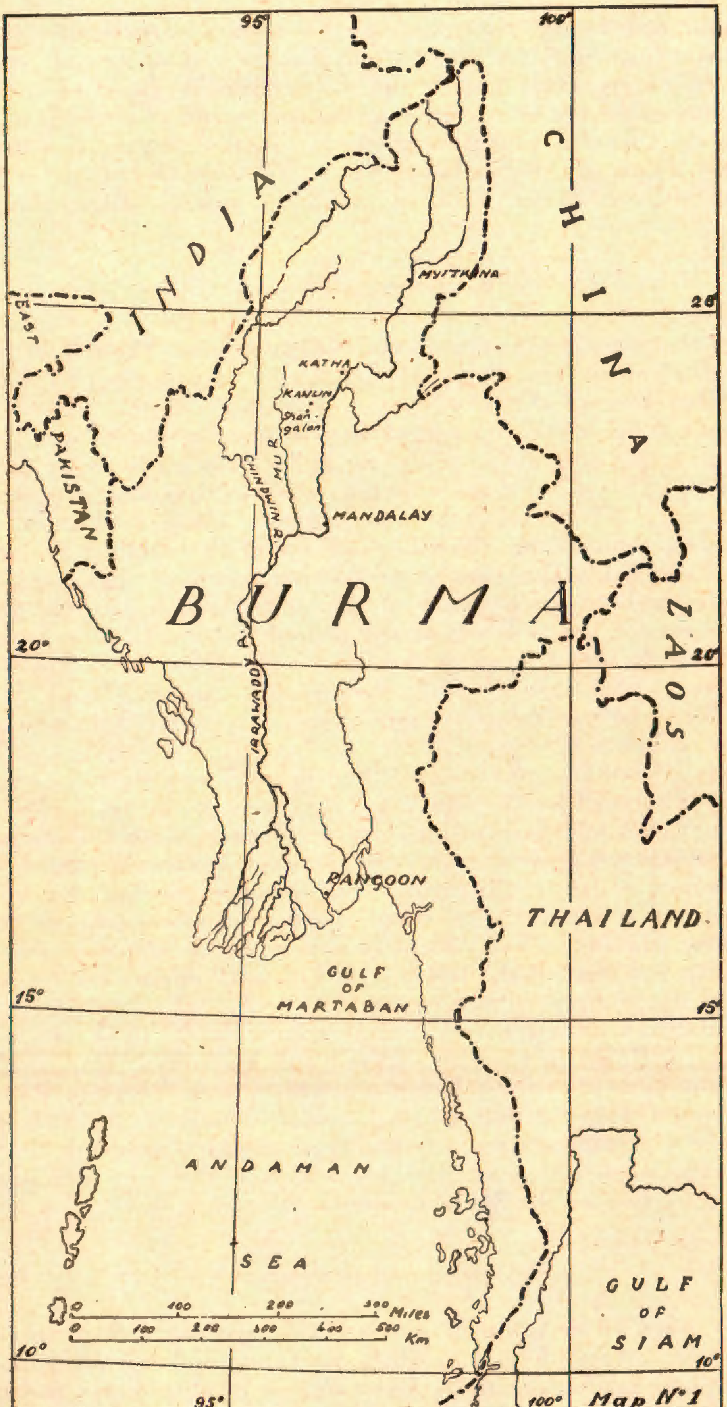
In the mapped area the dikes and sills of the basic extrusive rocks are frequent. A bigger extension of these rocks could be noted in the eastern part of the narrow Taung Byu range. There are porphyric diabase, spilite-diabase and melaphyre. In the main, they are rocks dark in colour; some of them are dense, others are fine- or coarse-grained and crossed by veinlets of epidote. As minor intersections these rocks are present in the Kyaunggon Taung range, furthermore around ore occurrence No. 2 (melaphyre and diabase), and near ore occurrence in the Kyee gully (gabbro-diabase). There is diabase also in the range west of Shangalon. The dikes and sills are very often hydrotermally altered, as for instance in the adit in the Kyee gully near a monastery in the Kyaunggon Taung range, and in the same range south-east of an old shaft, and finally in many places around old mining works in the Taung Byu range.

Basic intrusive rocks

These rocks are commonest in the hills south and west of Shangalon. There are amphibole-ophitic gabbroes, actinolite-hornblende gabbroes and amphibole microgabbroes. On the eastern slopes of the Taung Byu range, on the southern slopes of the Kyaunggon Taung range, as well as in the area near the ore occurrence of the Kyee Creek there appears gabbro-diabase.

Acid extrusive rocks

Dikes and sills of andesite, dacite, dacite-andesite with more or less sericitized and kaolinized plagioclases and chloritized ferromagnesium minerals appear around the ore occurrence in the Kyee Creek. Nearly fresh dacite as well as silicified and kaolinized andesite (?) were observed in the Kyaunggon Taung range. In the range of ore occurrence No. 1 there is a sill of fresh dacite stretching in NW-SE direction as far as the monastery. There are also kaolinized dikes. Minor exposures of dacite and andesite were noted in the stream valley between the Kyang-


95°
100°
INDIA
CHINA
MYITKYINA
25
EAST
KATHA
KANLIN
Shan-
galon
PAKISTAN
CHINDWIN
MU R.
MANDALAY
BURMA
20°
20
LAOS
IRRAWADDY R.
RANGOON
THAILAND
GULF
OF
MARTABAN
15°
15
ANDAMAN
SEA
0 100 200 300 Miles
0 100 200 300 400 500 Km
GULF
OF
SIAM
10°
10
95°
100°
Map N°1

gon Taung and Taung Byu ranges. In the eastern portion of the Taung Byu range epidotized and chloritized andesite was observed. North of Pudaw there are many dacite and dacite-andesite exposures, particularly between the ore occurrences in the Hnambat and Shawdon Creeks. East of the Hnambat Creek there occurs silicified dacite. The area between the Zalok and Shangyiaung Creeks contains numerous exposures of trachiandesite, dacite, silicified dacite and strongly altered trachiandesite.

Acid intrusive rocks

These rocks are commonest in the Shangalon area. They have the largest extension in the Chigyindaung Taung, Kyaunggon Taung and Taung Byu ranges, but they extend beyond the Zalok Creek in the north and as far as the village of Gwedauktaw in the south. Further, they occupy the area north of Pudaw as far as a height of 945 ft. and the Hnambat Creek with the adjoining hillocks. Granite, plagiogranite, granodiorite and quartzdiorite were noticed. These rocks are in the main coarse-grained, the dimensions of the grains ranging from 0,5 to 5 mm. When fresh, they are greyish-white in colour. In some places, especially smal-grained portions of the rocks, exhibit tabular jointing; the thickness of the tables does not exceed 2–3 cm. In the vicinity of the ore occurrences and along the dikes and sills of the effusive-rocks the intrusive rocks are altered – kaolinized, sericizized and silicified. In the field, and particularly in mining works, weathered and kaolinized types of rocks are commonly observed. The largest extension of hydrothermally altered granodiorites is found in the Taung Byu range around mining workings of locality No 1 & 2, but remarkable are exposures in the Mine Creek and than around ore occurrences near the monastery. Kaolinization and sericitization are the most common forms of the hydrothermal activity. Silification is of lesser extension. An intensive occurrence of silification is observed in the stream between the Kyaunggon Taung and Taung Byu ranges as well as on the slope of the Taung Byu range and west of the monastery. Limonite originated trough oxidation of the primary sulphide minerals.

The observed intrusive rocks rarely appear fresh; they are more or less altered. Plagioclase are sericitized and kaolinized, and the ferromagnesium minerals are leached out or chloritized. Sometimes they are desintegrated, forming the so-called »grus«. The rocks in the western portion of the mapped area are usually more coarse-grained, the grains being less rounded than is the case with the intrusive rocks of the southern portion of the Shangalon area.

Aplites and pegmatites

Occurrences of an aplite of quartzdioritic composition were encountered on the slopes of the Chigyindaung Taung and Kyaunggon Taung ranges. These are leucocratic rocks, composed of plagioklase and quartz.

In the Taung Byu range there are granites of micropegmatitic texture – aplitic nature. Tourmaline-quartz pegmatite composed of euhedral columnar and needle-shaped black tourmaline and indentedly ingrown quartz mass was found in the Kyaunggon Taung range. Between the Zalok and Shangyiaung Creeks a leuco-differentiated variety of acid intrusive rocks, aplite, was observed.

Tuffs

In the mapped area tuffs have a widespread extension and they are represented by a considerable number of varieties differing in colour and habit. Predominant is the fluidal texture with kaolinized phenocrysts of feldspars. There are also tuffs without feldspars. Silicified tuffs are common, too. They are more compact and firmer than the unsilicified ones, which are porous and very light. Most frequently the tuffs are violet, dark-red and brown in colour, rarely are they greenish-grey. In connection with the silicified tuffs near the ore occurrence in the lower course of the Hnambat Creek mineralization of chalcopyrite had taken place.

The summits of the two hills south of Shangalon are capped by dacite tuffs with transitions to arkose. In the Chigyindaung Taung range there are fine-grained sandstones, very dense and completely sericitized; they are probably metamorphosed tuffs, then transitions from tuffs to arkose with coarse-grained chips of quartz and quartzose sandstones. In the Kyaunggon Taung range there are localy silicified tuffs. Transitions to sandstones and arkose and fine-grained silicified tuffs were observed in the Taung Byu range and on its western slopes. Acid and strongly silicified tuffs were observed in the northern portion of the mapped area. A remarkable extension of the tuffs is discovered in Sagyindaung Taung range.

Hornstones

Hornstones, along with the tuffs and arkose, participate in the structure of the hill tract of the Sagyindaung Taung range. They are composed of dense quartz tinted with red coloured hematite powder and contain microfauna of radiolaria and diatomacea. There are minor extensions of hornstones in the Taung Byu range. This hornstone is composed of fine-grained quartz tinted with limonite; it is remarkably porous. Rocks similar to hornstones (probably completely silicified tuffs) were observed on the northern slopes of the Kyaunggon Taung range. These are very dense rocks composed of fibrous, radialbanded, columnar and fine-grained quartz masses with sericite and kaolin, all impregnated with colloidal limonite. Similar rocks were observed also in the northern region between the ore occurrences of the area of the Shawdon Creek, in the lower course of the Hnambat Creek, as well as in the area north-east of the village of Pudaw.

Arkose-sandstones

In the hillocks south of Shangalon along with tuffs, psephitic quartzose sandstones can be observed sporadically. Some tuffs in the Chigyindaung Taung range resemble sandstone-arkose. Those of pelitic nature and without quartz chips and of no relict texture may be considered sericitic-quartzite, but others, with coarse-grained splinters of quartz or quartzose-sandstones were classified as proper arkose-sandstones. The arkose of Pagoda Hill contains especially coarse-grained chips of quartz. In a certain portion of the Sagyindaung Taung range there are arkose-sandstones composed of polygonal grains of quartz, dense hornstones and scanty feldspars cemented with finegrained quartz. Minor occurrences of sandstones were observed in the eastern part of the Kyaunggon Taung range. South of the Hnambat Creek in the northern part of the mapped area there are transition members between tuffs, hornstones and sandstones.

Actinolitic schists

Metamorphosis of diabases gave origin in a higher temperature phase to occurrences of actinolite schist west and south of the village of Shangalon.

Characteristics of the petrographical structure of the Shangalon area

Microscopical study of a certain number of rock specimens was performed by Professor Dr. Luka Marić, Technological Faculty, University of Zagreb, and the following is his opinion on the petrographical structure of this area:

»West and south of the village of Shangalon there are intrusive and extrusive differentiates of gabbro-dioritic magma, as for instance: macro- and micro-gabbro, diabase, diorite, quartz-diorite, quartz-gabbro as well as dacite-andesite and andesite. The more acid extrusives are accompanied by corresponding tuffs. Along with diabase there occur actinolitic shists. The actinolitic shists are probably a product of the metamorphoses of diabases in a higher hydrothermal facies, but, on the other hand, it may also be a product of the metamorphoses of dacite-andesites rich in amphiboles and pyroxenes. The magmatic rocks are capped by tuffs. Sporadically there are carbonatized arkose with fragments of feldspars and angular quartz. The tuffs are highly sericitized and silicified. Silicon metasomatism was widely spread, and there remain very scanty relicts of unaltered tuff.

The plane of Shangalon extending in NW-SE direction represents probably a tectonic boundary between the already mentioned magmatic rocks, tuffs and arkose on the one hand, and the granitic plutonic mass in the east-north-eastern portion of the Shangalon area on the other. It is obvious that erosion and denudation cut deeply into the plutonic mass, while only small masses of tuffs and arkose remained on the south-western side of the tectonic boundary.

East-north-east of the exposed part of the granitic mass there are granodiorites, plagiogranites, gabbroes, diabases and layers of sedimentary hornstones, arkose and tuffs, and finally protrusions of silico-metasomatic altered dacite-andesites. This is a somewhat better preserved mantle of the granitic mass from the north-eastern side. In the cupolas of the plutonic mass there are numerous protrusions of the volcanic rocks of the dacite-andesitic and andesitic groups and their more basic derivates, which are according to their mineral constituents and texture similar to diabase or maybe to altered lamprophyres(?). In addition to a strong silicon-metasomatism there are in the cupolas of the granitic mass occurrences of heavy kaolinization, sericitization, tourmalinization. actinolitization, epidotization, perthitization (pegmatite occurrences), i. e. a high-temperature pneumatholitic-hydrothermal metamorphic (probably also pyrometasomatic) paragenesis. There are also hydrothermal occurrences of pyrite and chalcopyrite.«

THE ORE OCCURRENCES

(Map No. 3 & 4)

In the vicinity of the village of Shangalon numerous ore occurrences of uniform paragenetical and genetical characteristics were observed. The main ore minerals are pyrite and chalcopyrite, but the chief gangue mineral is quartz. The works on these ore occurrences are in the phase of mining prospecting but new occurrences of the same characteristics are still being discovered. A great number of these occurrences are situated east of Shangalon, in the Chigyindaung Taung, Kyaunggon Taung and Taung Byu ranges, while only a few are located north of the village of Pudaw in the area of the Hnambat and Shawdon Creeks. The mineralized area of Shangalon was examined by detailed field work, and all the specimens collected were examined and tested in laboratories.

In the village of Gwegyo and in the Kydaw region a few miles north-west or north of the village of Pudaw there are deposits of a special hematite ore. These two localities were only prospected, but the collected rocks and ore specimens underwent a detailed petrographic and mineragraphic study.

A. THE COPPER OCCURENCES OF THE NARROWER SHANGALON AREA

(Map No. 3)

1. *The Area east of Shangalon*

I. THE CHIGYINDAUNG TAUNG RANGE

The Chigyindaung Taung Range extends east of the village of Shangalon in the direction of the village of Gwedauktaw. The north-western and central portions of the range are composed of magmatic intrusive rocks: plagiogranites and quartz-diorites respectively. These rocks are heavily, in some places entirely decomposed and altered – kaolinized, sericitized and partly silicified. In the area of the Kyee Creek, which flows from the northern slopes of the range into the Mine Creek, on the cart-road Shangalon-Gweďauktaw the intrusive rocks are protruded by dikes and sills of volcanic rocks. The effusive rocks belong to the type of rhyolite-dacite, andesite and rarely diabase. The effusive rocks are also hydrothermally altered. The southernmost and at the same time highest part of the range (Pagoda Taung) is capped by tuffs, hornstones and conglomeratic sandstones.

On the northern slopes of the Chigyinďaung Taung range, in the gully of the Kyee Creek, five ore occurrences have been observed so far.

Position No. 1. – Kyee Creek

Ore occurrences were observed in the upper course of the gully of the Kyee Creek about 200 m. south of the cart-road Shangalon-Gwedauktaw. Mineralization had taken place in weathereď and altered quartzdiorite with almost entirely kaolinized and sericitized feldspars. The mineralization is controlled by a tectonic zone of NW-SE direction. Along this zone quartzdiorite is noticeably silicified. A system of vertical cracks and fissure veins ranging from a few cm. to a few decimetres in thickness is mineralized. Thus there occurs a system of veins, veinlets and lenses, and sporadically there occur even networks of mutually connected veins anď lenses.

The first prospecting was performed in 1921/22. An adit from the level of the Kyee Creek, about 35 m. long, was dug. The end of the adit was connected by a shaft about 11 m. deep. The shaft followed the gradient of the ore zone. These works were resumed in March, 1955. The adit ran along the ore zone up to 27 m., where the ore zone disappeared, again to appear at the bottom of the shaft. About 3 m. before its disappearance the ore zone was cut by a sill of completely altered aphanitic rock circa 20 cm. thick.

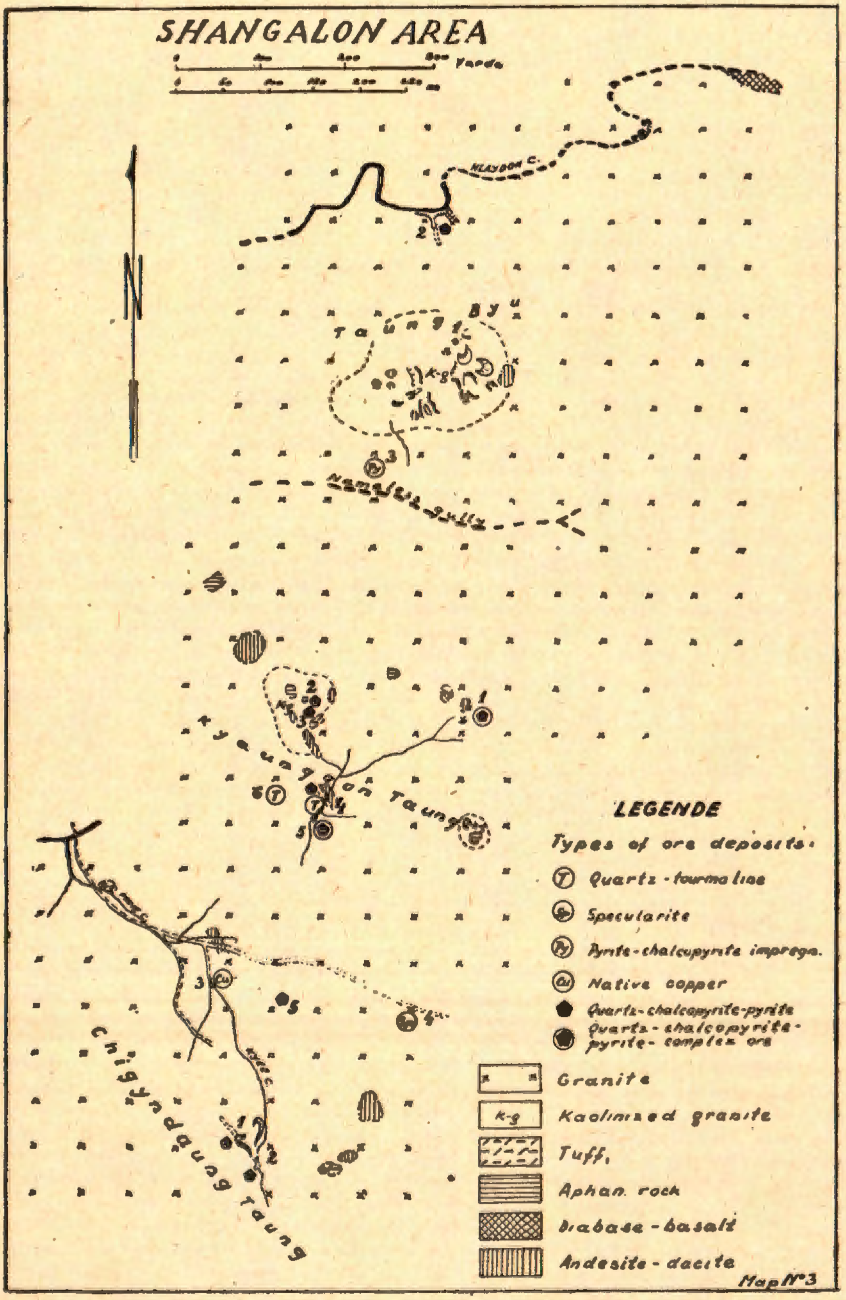
The ore deposit was opened up by mining work in the zone of oxidation and cementation, i. e. in the zone of supergene minerals. The supergene minerals prevail over the relicts of primary minerals. Megascopically, primary pyrite and chalcopyrite as well as quartz gangue were observed. Among the supergene minerals incrustation of limonite and malachite are the most abundant. In places, where the ore veins were swollen, steel-blue chalcocite accompanied by malachite, cuprite and a little tenorite was observed. The largest amounts of compact chalcocite appeared at 13 m., and of cuprite between 15 and 17 m. of the adit. With a magnifiying glass native copper could be seen in cuprite.

By mineragraphic studies the following paragenesis were proveď:

a) primary minerals: *molybdenite, pyrite, quartz, chalcopyrite, chalcedony,*

b) supergene minerals: *chalcocite, cuprite, tenorite, native copper, malachite, azurite, goethite* and *lepidocrocite.*

Molybdenite is very scanty. It was observed in chalcocite as individuals leaves of very strong reflection pleochroism and anisotropism. In quartz and very rarely in


SHANGALON AREA
Yards
N
LEGENDE
Types of ore deposits:
Quartz - tourmaline
Specularite
Pyrite-chalcopyrite impregn.
Native copper
Quartz-chalcopyrite-pyrite
Quartz - chalcopyrite - pyrite - complex ore
Granite
Kaolinized granite
Tuff.
Aphan. rock
Diabase - basalt
Andesite - dacite
Map N°3

supergene minerals, corroded grains of very high relief, bright greyish colour, anisotropism, with twinning lamellae and internal reflection were noticed. *Pyrite* is coarse-grained, rarely euhedral, and it abounds in relicts of primary minerals. It is much cataclased – the sharpe-edged or subrounded fragments are cemented predominantly with chalcedony *(Phot. 1)*. Pyrite is often replaced by chalcopyrite, or chalcopyrite fills the cracks in pyrite. In the masses of supergene minerals there are corroded and rounded grains of pyrite. The main mass of pyrite is oxidized in goethite and lepidocrocite. *Chalcopyrite* is the main primary ore mineral. In polished sections only various irregular forms of oxidation remnants of chalcopyrite could be observed. Weathering is noticeable in all formation phases. Most resistant to weathering are very small masses of chalcopyrite in the micropores of quartz. Larger masses of chalcopyrite are irregularly cracked and consequently filled with chalcedony. *Quartz* is the most common gangue mineral. It is coarse-grained and cataclased, the cracks being filled with supergene minerals. In addition, it is partially corroded by primary sulphides. *Chalcedony* is the youngest member of the paragenesis. Its occurrence follows a strong tectonic phase, which caused crushing of the primary minerals, the cracks being filled up with chalcedony. *Chalcocite* is the main mineral of the supergene zone of the deposit. It had originated through the action of descendant solutions of copper sulphates on chalcopyrite. The so-called cementation advances from the rim of the anhedral grains of the chalcopyrite masses towards their centre *(Phot. 2)*. In cataclased chalcopyrite grains the cementation folows the net of cracks. All phases of cementation up to a complete replacement of chalcopyrite were observed. Sporadically are found pseudomorphosis of chalcocite on chalcopyrite*(Phot. 3)*. Chalcocite is developed in the form of lamellae *(Phot. 4)*. In some grains there are only a few wider or thinner lamellae, others displaying a nearly polysintetic lamellar texture. In several places isotropic blue chalcocite with rare lamellae of orthorhombic chalcocite is to be found. Chalcocite is generally oxidized into cuprite, tenorite and malachite, rarely into azurite. Oxidation commences at the rims of the polygonal grains of chalcocite and advances concentrically towards the centre of the grains, in places combined with weathering in the form of dendrites. In those places where the oxidation was very intensive only irregular fragments (patches) of chalcopyrite embedded in the mass of cuprite, or cuprite with malachite could be seen *(Phot. 5)*. *Cuprite* builds microporous masses filled with malachite, native copper *(Phot. 6)* or some silicates from the group of chrisocolle. The sizes of the pores vary from submicroscopical to microscopical dimensions, from a few microns to tens of microns. Sporadically there are vugs rimmed with terminal planes of cuprite crystals or with skeleton of the same mineral *(Phot. 7)* filled with malachite. The porous masses of cuprite pass in portions into distinctly crystallized cuprite of cubic, octahedral and similar cross-sections up to 0,4 mm. in size. Not infrequently between such bigger crystals malachite, native copper or skeletons of cuprite of very interesting forms are to be found. In cuprite nearly regularly tinsels of copper could be observed. Besides compact cuprite, which in places is developed to such dimensions as to be easily seen with the naked eyes thanks to its typical red colour, there are also smaller clusters of crystals, skeletons and fibrous clusters of *chalcotrichite (Phot. 8)*, and submicroscopic grainy aggregates. Such forms of cuprite could be found in the masses of malachite. Ofteutimes malachite is littered with »clouds« of cuprite or cuprite combined with tenorite. Besides chalcocite, malachite is also replaced by cuprite. Cuprite is bright greyish in colour with a bluish tint. This bluish tint is more obvious when cuprite occurs with chalcocite. The relief of cuprite is higher than that of tenorite, chalcocite and native copper. Characteristic are its deep blood-red internal reflections especially under crossed nicols or in an oil immersion. *Tenorite* is far less common than cuprite. It occurs together with cuprite, malachite and native copper around masses of chalcocite when they are caught by weathering. It is exeptionally fine-grained. The size of the crystals range on an average from 5–20 microns. As a rule tenorite appears in the form of »clouds« of anhedral grains and radial aggregates in malachite, or in the form of dendritic crystals replacing chalcocite. In places, the »clouds« of tenorite and cuprite are in contact or interwoven. The size of these »clouds« does not exceed 0,5 mm. Tenorite is characterized by a strong reflection pleochroism and a strong anisotropism. It is grey, with a brownish tint. *Native copper* is exclusively bound to masses of cuprite.

In some masses of cuprite native copper is finely dispersed so as to be observed only under strong magnification under the microscope, forming denser or thinner tinsels of copper. In other specimens the tinsels of copper are of larger dimensions, even exceeding 10 microns. They are irregular in form and fill up the micropores in cuprite or the interstices of the skeleton crystals of cuprite. Sometimes they replace cuprite along the rims of the crystals. The largest observed masses of copper measured 130 microns. The size of the masses of copper is functionally dependent on the size of the micropores or on the size of the cuprite crystals. Native copper is either simultaneous with or younger than cuprite. When fresh, native copper possesses its characteristic red colour and a very bright metallic lustre. It is soft. Along with cuprite and chalcocite, *malachite* is a very widespread mineral in the zone of supergene minerals. Its origin is linked most frequently with the oxidation of the minerals of the cementation zone. Malachite cements and envelops clusters of quartz grains, cracks in quartz, remnants of weathered chalcocite as well as other gangue minerals. It possesses predominantly anhedral grains and is fine-grained. In some places there are radial aggregates of malachite. An intimate intergrowth of malachite with the minerals of the chrisocolle group was observed. In malachite there are smaller and bigger »clouds« of cuprite and tenorite. *Azurite* is very scanty and usually occurs with malachite. It forms submicroscopically fine-grained aggregates. It is to be found most frequently in cracks of quartz. *Goethite* and *lepidocrocite* are impure with admixtures of mechanical and colloidal supstance, and they occur in the form of powdery and earthy masses.

Mineralization had commenced in the pneumatholitic phase, which is represented by microscopic amounts of molybdenite and a thus far undetermined mineral (maybe wolframite). The main phase of ore formation is hydrothermal, and during this phase the crystallization of pyrite, chalcopyrite and quartz take place. Later, intensive tectonic processes cause crushing of the primary minerals, while along open crevices colloidal SiO_2 ascends and chalcedony is formed. The supergene processes are very intensive. In the surface portions of the deposit pyrite and chalcopyrite are completely oxidized into sulphates. Iron sulphate hydrolyzes, giving birth to limonite, while copper sulphate is leached out and acts in the form of descending solutions upon primary copper sulphides forming chalcocite, which, by a lowering of the water level, oxidizes into cuprite, tenorite, malachite and azurite.

Position No. 2, – Kyee Creek

This position is situated about 20 m. in south-eastern direction from position No. 1 on the oposite bank of the Kyee Creek. Most probably it is a continuation of the ore zone No. 1.

Also here the mineralization occurs in strongly altered quartzdiorite, in whose vicinity there are occurrences of silicified tuffs actually metasomatic quartz-metamorphite with a rarely preserved relict structure of the tuffs.

Two ore veins of an average thickness of 5 cm. each, about 30 cm. apart from each other extending in the direction NW-SE and possessing a dip of 70^0 toward the NE were opened by an adit about 8 m long and of a general direction 150^0 N. In fact, the ore veins are a discontinous series of lenses. The prevalent mineral constituents are pyrite and quartz with sporadical nests of chalcopyrite. Pyrite and chalcopyrite are rather weathered with frequent incrustations, crusts and nests of limonite and minor quantities of malachite and tenorite. In the aphanitic rock there are malachite staining and some cuprite, while along diaclases is to be found also tenorite.

Microscopic examinations revealed the following paragenesis:

a) primary minerals: *molybdenite, the mineral »X«, pyrite, chalcopyrite, Co-Ni-mineral, quartz, sericite* and *chalcedony*,

b) supergene minerals: *chalcocite, covellite, malachite, tenorite, cuprite, native copper, native silver, goethite, lepidocrocite.*

Quartz and pyrite are the main minerals of this ore occurrence. Chalcopyrite is scantier, but still in noticeable quantities. Molybdenite, the mineral »X« and the Co-Ni-mineral were discovered only under the microscope. Chalcedony occurs as plexus of fine veinlets in chalopyrite. Sericite is an auxiliary constituent. Of secondary minerals the most frequent are malachite, chalcocite and covellite, cuprite is scantier, while tenorite and the native metals (copper and silver) are extremely rare. Goethite and lepidocrocite are frequent, but they always occur in small quantities.

Molybdenite occurs in chalcopyrite or in its weathering products, developed as rosette-shaped aggregates of more or less curved foliae about 50–100 microns long. The basis of the foliae are parallel with the walls of the veins. The foliae of molybdenite show undulatory extinction and often parallel displacement, producing a twinning-like texture. *The mineral »X«* is very scanty. It usually occurs in minute corroded grains (enbedded in quartz) of very high relief, grey in colour with internal reflections and distinct anisotropism. *Pyrite* is coarse-grained. It fills the micropores and vugs of quartz, or it appears in the form of corroded masses in chalcopyrite. Not infrequently it is considerably cataclased, even crushed and cemented with chalcedony and chalcopyrite. *Chalcopyrite* was noted in the micropores or larger vugs in quartz, or as bigger masses in the central part of the veins. Pyrite and partially quartz were replaced by chalcopyrite. Chalcopyrite is coarse-grained and often exhibits twinning lamellae. The lamellae are usually wide. The cataclases in chalcopyrite are filled with chalcedony. In the studied polished sections chalcopyrite is already weathered in considerable measure. In some polished sections the prevalent products of alteration are covellite, chalcocite, goethite and tenorite; in others, malachite cuprite and goethite. *The Co-Ni-mineral* was observed in chalcopyrite in the form of minute corroded and yellow grains of a higher relief than in chalcopyrite. It is isotropic. *Quartz* is older than the sulphides. and it usually occurs in the gouges of the ore veins. It is coarse-grained and optically anomalous. *Sericite* is rare. It occurs in the form of clusters of minute laminar crystals. *Chalcedony* was found as cement in cataclastic grains of pyrite and chalcopyrite. *Chalcocite* and *covellite* are the products of supergene processes. They replace chalcopyrite. By alteration they produce cuprite, tenorite or malachite, but in some places they are leached out. *Cuprite* occurs with malachite; as a rule it is scanty, being more frequent only in places. *Tenorite* is intimately mixed with colloidal iron hydroxides. *Malachite* is along with lepidocrocite and goethite the most frequent secondary mineral caused by alteration of chalcopyrite. It is fine-grained or radially-tabular. Sporadically, quartz is tinted by dispersed malachite. *Native silver* is very rare. It was observed in the form of tiny masses up to 0,5 mm. in diameter in the cracks and micropores of quartz along with masses of chalcopyrite and the Co-Ni-mineral. It exhibits a very high metal lustre white in colour, with a cream tint. *Native copper* is extremelly rare. It occurs in the form of tiny masses in cuprite.

The ore occurrence at position No. 2 is a natural continuation of the ore occurrence at position No. 1. They possess common genetic and paragenetic characteristics.

Position No. 3, lower course of Kyee Creek

By trenching in the Kyee Creek, about 60 m. far from the cart-road Shangalon-Gwedauktaw in contact with plagiogranite and diabase, a small ore occurence was discovered. The ore vein dips almost vertically in NW-SE direction. The ore minerals are tectonically completely crushed. With the naked eye only *pyrite* coated with some *sulphide* of lead-greyish colour could be observed. In diabase there are impregnations of *native copper.*

Position No. 4 near the Shangalon-Gwedauktaw watershed

This vein-like ore occurrence is connected with altered quartz-diorite The prevalent mineral is quartz, while specularite was observed in the form of minor nests and aggregates.

Microscopical examinations established the following paragenesis: *quartz, specularite (hematite), pyrite* and *chalcopyrite.*

Quartz is fine-grained, the dimensions of the grains range from 50–100 microns. The grains are polygonal in shape. A part of them exhibits undulatory extinction, the others are optically normal. Sporadically can be observed beginnings of a recrystallization of the quartz grains. *Specularite* is needleshaped and tabular in cross-section. The lengths of the needles vary from a few tens of microns to 300 microns. Single folia of hematite are very scanty. Plexuses of hematite crystals with subparallel, radial or sometimes bended crystals are more common. Some plexuses are very dense. *Pyrite* and *chalcopyrite* are developed as microscopically fine grains and masses. Pyrite is more frequent.

The fine granularity of quartz as well as the occurrence of specularite prove that the ore deposition occurred under epithermal conditions.

Position No. 5, Kyee Creek

At this position only fragments of ore not »in situ« were found. The site is circa 70 m. east of position No. 3.

Under the microscope the following paragenesis was established:

a) primary minerals: *pyrite, chalcopyrite* and *quartz*

b) supergene minerals: *malachite, azurite, cuprite, tenorite, native copper* and *chalcocite.*

Pyrite and *chalcopyrite* have, in the main, succumbed to a process of weathering and alteration; only tiny grains and masses of microscopical dimensions have remained. *Quartz* is the main gangue mineral. It is coarse-grained and cataclased, the cracks being filled with secondary minerals. *Chalcocite* is nearly completely oxidized into cuprite and tenorite, which replace chalcocite net-like. *Cuprite* is along with malachite an abundant secondary mineral. It is rarely developed in individual crystals of hexahedral, octahedral or similar cross-sections embedded in malachite. More frequently it is developed in crystal aggregates or in the form of »clouds«. It can be observed most frequently in the form of microporous masses filled with larger or smaller patches of native copper. As a rarity we should also mention the beautiful skeleton crystals of cuprite or cuprite in the form of chalcotrichite. Cuprite from this position displays very beautiful anisotropism of violet and green. *Tenorite* is much less frequent than cuprite. It replaces net-like chalcocite or builds oval aggregates. *Native copper* appears exclusively in the company of cuprite in the form of tiny patches in micropores. *Malachite* is abundant. It builds radially-fibrous aggregates or anhedral granular aggregates. In places it appears in an earthy form mixed with other colloidal minerals. It replaces chalcocite, cuprite and tenorite. *Azurite* is very rare. It occurs in the form of submicroscopic, granular and dense aggregates.

These ore specimens are very similar to those from position No. 1 both as to the paragenesis and the sequence of the mineralization.

Characteristics of the ore occurrences of the Chigyindaung Taung range

The ore occurrences are to be found in weathered plagiogranite and quartzdiorite. Some deposits are in contact with diabase, others are close to aphanitic dikes or tuffs.

The ore deposition is of the vein type. Mineralized is either the system of cracks or individual lenticular fissures. The direction of the zones of fissures and the mineral deposits is NW-SE, dipping almost vertically. By the present mining works the described ore occurrences are opened at the levels of oxidized zones and zone of supergene enrichment with relicts of hypogene minerals. The principal minerals of the primary paragenesis are coarse-granular, optically anomalous quartz as well as coarse-granular pyrite and chalcopyrite. The accessory constituents are molybdenite, the mineral »X« as well as one undetermined Co-Ni mineral. An exception is the ore occurrence at position No. 4, where fine granular quartz with specularite and minute amounts of pyrite and chalcopyrite occurs.

Thus two paragenetical types of ore deposits are proved in the Chigyindaung Taung range. The first is a high temperature type. Here the mineralization begins with a faintly expressed pneumatholitic phase represented by microscopical quantities of molybdenite and mineral »X«. The hydrothermal phase is the principal phase of the mineralization, and it is characterized by coarse granular quartz, pyrite and chalcopyrite. These minerals as well as the unknown Co-Ni mineral occurring in microscopical quantities had originated in the kata-mesothermal stage. Subsequently a strong tectonic activity caused crushing and sporadic brecciating of the ore mass, the cataclases and splinters being cemented with an ascedent generation of chalcedony. An extensive oxidation resulted in the formation of secondary minerals.

The second genetic type is represented by low temperature fine granular quartz and specularite.

All the hitherto discovered ore deposits of the Chigyindaung Taung range are of small extent.

II. THE KYAUNGGON TAUNG RANGE

The Kyaunggon Taung range is built of intrusive magmatic rocks of the granodioritic group protruded by dikes and sills of volcanic acid and basic rocks. Some hillocks of the same range are capped by tuffs. Intrusive as well as volcanic rocks and tuffs have undergone intensive hydrothermal alterations. Especially characteristic is kaolinization of the extrusive rocks. Up to 1955 six ore occurrences were known.

Position No. 1, Old Shaft

A shaft about 10 m. deep was sunk into strongly kaolinized quartz-diorite and plagiogranite. Individual hills of the range harbour thin-bedded tuffs. They are strongly kaolinized and hydrothermally altered. Ore specimens were collected from the ore dump close to the shaft. According to the specimens, the ore vein is about 15 cm. in width, its boundaries being very sharp and distinct. The feldspars and ferromagnesium minerals of the adjoing rock are metamorphosed into sericite, calcite, kaolin, chlorite; only primary quartz is unaltered.

Microscopic examinations established the following paragenesis:

a) primary minerals: *molybdenite, the mineral »X«, pyrite, chalcopyrite, enargite, quartz, calcite* and *chalcedony*

b) supergene minerals: *chalcocite, covellite, goethite, lepidocrocite.*

Chalcopyrite is the principal ore mineral, while pyrite could be observed by the naked eye only sporadically. Molybdenite, the mineral »X« and enargite are present only in microscopical quantities. The main gangue mineral is quartz, which is followed by calcite, while sericite and chalcedony are very scanty. The supergene minerals are very rare and likewise occur in small quantities.

Molybdenite occurs in the form of thin folia, their sizes ranging from 10 to 200 microns (average 50–100 microns). They appears as single crystals or form rosette-shaped aggregates. Molybdenite occurs most frequently in calcite, then in the micropores of quartz. It is very rare in chalcopyrite. Molybdenite crystals are usually bent and exhibit sometimes a twinning-like texture. *The mineral »X«* is finely dispersed in quartz, calcite and chalcopyrite in the form of grains or corroded aggregates of grains. According to its optical properties, it is similar to wolframite: a low reflectivity similar to sphalerite, a light greyish colour, which when immersed in cedar oil assumes a pinkish-brown tint, furthermore weak reflection pleochroism, distinct anisotropism, oblique extinction, twinnig, brownish and dark-red internal reflection. It is replaced by chalcopyrite. *Pyrite* fills up the micropores and interstices of the quartz masses alone or together with chalcopyrite. The larger masses are crushed. Pyrite is replaced by chalcopyrite. *Chalcopyrite* fills the vugs of quartz or replaces calcite, thus forming larger masses. It is most abundant in calcite gangue. In some masses of chalcopyrite younger veinlets of enargite were observed. Chalcopyrite changes to chalcocite, covellite and goethite. The veinlets of these secundary minerals are crossed by still younger veinlets of calcite and chalcedony of descedant origine. *Enargite* is extremely rare; it is noticeable under the microscope using strong magnification. It constitutes the youngest ore mineral. *Quartz* is mainly protoquartz from plagiogranite. Only a minor part of it had originated in the phase of silification, which preceded the mineralization, and it manifest itself in the immediate gouges of the ore veins. Calcite, as a younger member, replaces quarts, including irregular corroded remnants of quartz. *Sericite* is scanty and is observed in the form of foliated plexuses. *Calcite* is anhedrally granular. The dimensions of the polygonal grains are amount to 0,5 mm. A particular lamellar structure and sporadical texture as well as rhombohedral cleavage were disclosed by etching with cloric acid. Patch-like and irregular remnants of quartz were also seen. Calcite is replaced by chalcopyrite.

Secondary minerals replace net-like primary sulphides.

Mineralization commenced with a slightly expressed pneumatholitic phase in which molybdenite and the mineral »X« were crystallized. All other minerals were crystallized in the hydrothermal phase and this is the principal phase of the mineralization. From high temperature solutions pyrite was crystallized, folowed by mesothermal solutions, from which chalcopyrite and calcite were precipitated. Subsequent to a syngenetic tectonic phase thermae ascended, which carried besides Cu ions ions of arsenic, thus forming minimal but characteristic quantities of enargite.

Position No. 2, near the monastery

A few metres east of the monastery there is a completely weathered limonite vein with secondary copper minerals.

The microscope established the following paragenesis: *malachite, cuprite, tenorite, goethite, lepidocrocite, minerals of the chrisocolle group* in *quartz*-gangue. There are no primary minerals, but according to the paragenesis of the secondary minerals it is possible to conclude that we are concerned with a pyritic and chalcopyritic ore occurrence.

Position No. 3, cca 45 m south of the monastery

At this position lumps of an undetermined ore vein were found. By the naked eye a brecciated texture was noticeable, the fragments of pyrite being cemented with quartz (chalcedony). Many fragments of pyrite were lost through mechanical action, or they were leached out, thus making the ore porous.

Under the microscope the following paragenesis was discovered:

a) primary minerals: *pyrite* and *chalcedony;* b) hypergene minerals: *goethite* and *lepidocrocite.*

Pyrite is completely crushed in sharpe-edged and subrounded fragments, which are cemented with chalcedony. In the veinlets of *chalcedony* microscopically fine fragments of pyrite were noticeable. Pyrite was only partly oxidized to *goethite* and *lepidocrocite.*

Position No. 4, – upper part of the »Galena gully«

In the kaolinized granodiorite of the »Galena gully« there is a *quartz-vein* containing secondary copper minerals such as: *malachite, cuprite, tenorite, chalcocite, azurite, native copper* and *goethite.* In the granodiorite around this ore occurrence veinlets of *tourmaline* were observed. The thickness of this tourmaline veinlets did not exceed 4 mm. Tourmaline was intergrown with finely granular *quartz.*

Position No. 5 – upper part of the »Galena gully«

The ore occurrence in the »Galena gully« is about 150 m. from the Shangalon-Gwedauktaw cart-road. The vein is about 12 cm. thick, of NW-SE direction, and dipping towards the SW. The adjoint country rock is weathered and altered granodiorite. Ore-breccias are noticeable with even the naked eye. Fragments of quartz and sulphidic minerals are cemented by chalcedony. Chalcedony is dark-grey in colour. Among the sulphides galena, pyrite, some chalcopyrite and scanty sphalerite are to be seen. On the bottom as well as in the hanging wall there are thin pyrite veins; they are mainly limonitized with sporadical stainings of copper.

The paragenesis of this ore occurrence is as follows:

a) primary minerals: *pyrite, quartz, sphalerite, chalcopyrite, bornite, tetrahedrite, freibergite, enargite, galena, »sulphosalts«, calcite* and *chalcedony.*

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

Most abundant among the primary minerals are galena and chalcedony. Sphalerite and chalcopyrite are hardly noticeable with the naked eye. All the other minerals are only noticeable under the microscope. Most frequent among the supergene minerals are anglesite and cerussite.

Pyrite is along with galena the main sulphidic mineral. It is extremely strongly cataclased, frequently quite cruscned into angular and subangular fragments of various dimensions up to microscopic sizes. The fragments are cemented with chalcedony. Sporadically are to be seen fluidal texture; caused by flowage and linear arrangements of fragments of pyrite. This proves that chalcedony was deposited from very viscous solutions of silicon and of highly ascedent properties. Practically there was no corrosion of pyrite in the process. Pyrite is sporadically replaced by younger sulphides and sulphosalts. *Quartz* occurs only in the form of relicts in chalcedony, which cements quartz masses. Quartz is partly protoquartz of plagiogranite and partly it is a product of silification of the rocks along the mineralized tectonic fissures. In the micropores of quartz there are younger sulphidic minerals, and also calcite, which replaces quartz. *Sphalerite* is actually marmatite because of the dark internal reflections. It is cataclased and crushed in the same way as pyrite, the fragments being cemented with chalcedony *(Phot. 9).* Contrary to pyrite, the fragments of sphalerite are not angular but rounded, even sporadically corroded by chalcedony. Sphalerite is replaced by other younger sulphides and sulphosalts, especially by galena *(Phot. 10),* but such replacement is rarely distinct owing to the general phenomenon of crushing of all minerals. *Chalcopyrite* is almost completely crushed, in places it is even pulverized. The masses of chalcopyrite are sometimes intergrown with sphalerite, more frequently with tetrahedrite. Chalcopyrite is noticeable replaced by galena. In some masses of chalcopyrite there are orientated strings of pyrite grains. In our opinion they are the products of alteration of lamellar pyrrhotite or cubanite in chalcopyrite. At the same time this points to the high temperature of origin of this chalcopyrite. *Tetrahedrite* exhibits a greenish colour in reflected light, which is characteristic of *tennantite.* It is in the company of chalcopyrite, with which it is frequently intergrown. Tennantite occurs in small masses of usually microscopic dimensions, frequently crushed into subrounded and angular fragments. Tennantite replaces sphalerite, the latter being replaced by galena. Fragments of tennantite are cemented and simultaneously corroded by chalcedony. Tennantite is a frequent mineral, but its total quantity is relatively small. *Galena* is most abundant in the ore occurrence. It is anhedrally granular, the dimensions of the grains ranging from 20–50 microns. This fine granularity of galena is probably due to a tectonic action, and in this case we are concerned with a recrystallization texture. The texture of galena becomes evident only in the process of alteration into anglesite or covellite. Cataclastic textures of galena are rare owing to its latent plasticity. Only sporadically regular cubic cleavages of galena cemented with chalcedony could be observed. Galena is replaced noticeably by chalcedony in such a way that only sporadically wormlike and threadlike forms and flakes of galena remain. Galena itself replaces the older sulphides, especially sphalerite. Owing to stress galena is as a plastic mineral pressed also into cracks of the friable minerals. A particularity is exsolution of *freibergite* in galena in the form of drops and rounded masses or rarely euhedral crystals *(Phot. 11)*. The dimensions of freibergite are average 1–5 microns, rarely 10–20 microns, but the largest masses reach 50 microns in diameter. In some places the exsolutions of freibergite are very dense, suggesting replacement instead of exsolution. Freibergite is green in colour. *Enargite* with intergrowths of some »*sulphosalt*« in the form of minute masses was observed in galena. *Bornite* is very rare and of microscopic dimensions. It is intergrown with chalcopyrite. *Calcite* is coarse granular. It replaces quartz, being replaced itself by chalcedony. *Chalcedony* is the most prominent gangue mineral, and it is the youngest. It was deposited from very viscous solutions following a strong tectonic phase causing almost total crushing of the ore mass. The fragments of the ore were subsequently cemented with chalcedony, producing a brecciated texture *(Phot. 9)*.

By supergene processes galena was oxidized to *anglesite*, or it was replaced by *covellite*. *Goethite* is very rare.

The ore occurrence is of hydrothermal origin. The thermal solutions were of relatively high temperature because in the paragenesis of the minerals there are sphalerite rich in iron, chalcopyrite with cubanite or pyrrhotite lamellae (subsequently altered to pyrite), and galena rich in silver. During the first phase of the mineralization the crystallization of pyrite, marmatite, and chalcopyrite with cubanite lamellae took place. Later, owing to a decrease of the temperature there followed crystallization of chalcopyrite, bornite, tennantite and galena with freibergite and enargite. At the end of the crystallization a strong tectonic action, causing crushing of the already deposited ore mass, took place. Through a subsequent ascension of viscous silicon acid there developed chalcedony, cementing or partially replacing the older minerals. The sulphides and sulphosalts react to the tectonics in various ways. While some of them (pyrite and sphalerite) only become cataclastic, others being more plastic (galena and tennantite) recrystallize partially or completely.

Position No. 6, southern slopes of the Kyaunggon Taung range

In kaolinized granodiorite there could be observed quartz-tourmaline veinlets with needle-shaped euhedral tourmaline embedded in an indented quartz mass.

Characteristics of the ore occurrences in the Kyaunggon Taung range

All the enumerated ore occurrences of this range occur in strongly kaolinized and altered plagiogranites. In the vicinity of the ore occurrences there are dikes and sills of volcanic rocks. The ore bodies are in the form of veins. The hitherto discovered veins are of small thickness, at the most up to 20 cm. Owing to the very small extent of the hitherto performed mining works it was not possible to ascertain the elements of the extension and dip of the ore occurrences. Being close to the surface, the ore occurrences are very oxidized and in places also the zone of cementation is developed.

According to the paragenesis we can distinguish three types of ore occurrences, of which the second and third have common characteristics and belong to the same genetic type.

To the first type belong the occurrences of quartz-tourmaline veins, representing the pneumatholitic-pegmatitic type of the mineralization.

The second paragenetic type is the same as in the Chigyindaung Taung range, i. e. a pyritic-chalcopyritic deposit with quartz, chalcedony, and in some places with calcite gangue. These ore occurrences have a more or less expressed brecciated texture with chalcedony serving as cement for the older crushed minerals. The specimens of some ore occurrences belong to the secondary enriched zone without relics of primary minerals, but the paragenesis of the secondary minerals and their texture would point to primary paragenesis.

The third type differs from the second general paragenetic type by the presence of an addition phase of mineralization before or simultaneously with the tectonic phase which enabled conveying considerable quantities of lead and some quantities of arsenic, silver and probably some antimony, so that in this phase there crystallize galena, tennantite and freibergite – a complex paragenesis.

Similarly to the ore occurrences in the Chigyindaung Taung range, the ore occurrences of the second and third types were subjected to intensive stresses causing a cataclastic, even brecciated texture of the ore mass, the fragments being cemented with chalcedony of viscous ascedent solutions. Silification also caused precipitation of mineral content owing to the replacing activity of chalcedony. This is especially expressed by galena.

III. THE TAUNG BYU RANGE

The western slopes of this range are built of granodiorite protruded by basic volcanic rocks. Basic igneous rocks have a larger extension in the eastern portion of the range. Granodiorite is intensively kaolinized, especially around the mining workings at positions Nos 1 and 2. Silification was noticed in a nameless creek between the Taung Byu and Kyaunggon Taung ranges as well as on the southern slopes of the Taung Byu range in the direction of position No. 3.

Position No. 1 – Old Shaft

The mining workings consist of a collapsed shaft of unknown depth sunk in strongly kaolinized igneous rock and of an adit about 80 m. south of the shaft. The adit is about 13 m. long, ending in a raise of about 4 m. The adit was excavated in kaolinized and sericitized coarse granular granodiorite. In the side walls a staining of malachite as well as system of fissures of N 117^0–175^0 direction, filled with limonite and malachite, were observed. Under the microscope the following minerals were proved: *malachite, goethite* and *lepidocrocite*, i. e. no primary mineral. The texture of the secondary minerals points to a pyrite-chalcopyrite ore occurrence.

Position No. 2 – Hlaydon Creek

This position is situated about 200 m. north of position No. 1 in the bed of the Hlaydon Creek. In 1921/22 an adit was excavated from the level of creek in SSE direction. Only 17 m. of the adit were passable. The country rock is decomposed and kaolinized granodiorite. At the entrance of the adit a rather thin limonitized ore vein is noticeable. The rock-walls are tinted and stained by malachite. At the end of the adit a quartz vein containing only limonite was discovered.

Under the microscope the following minerals were proved: *malachite*, *goethite* and *lepidocrocite*. According to the texture of the mentioned secondary minerals we can draw the inference that pyrite and chalcopyrite were the primary minerals.

Position No. 3 in the Taung Byu range

Impregnations of *pyrite* and *chalcopyrite* were observed in kaolinized granodiorite.

Characteristics of the ore occurrences in the Taung Byu range

In spite of the fact that by the above mining workings no zone of primary minerals was reached, mineragraphic studies of the secondary minerals and their textures point to the ore occurrences of the Taung Byu range belonging to the paragenetical type of the chalcopyrite veins already described in the Chigyindaung Taung and Kyaunggon Taung ranges. Besides, there are also impregnations of the kaolinized zones of smaller extensions.

2. The Pudaw Area

I. THE HNAMBAT CREEK

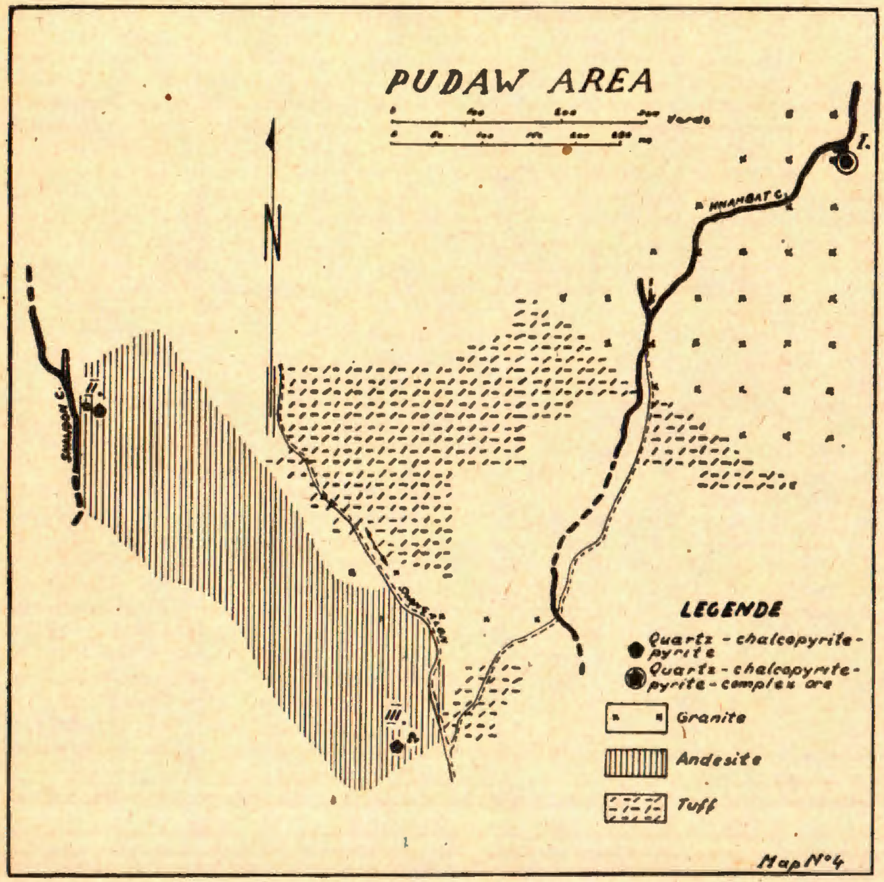
The country rock of the lower and middle courses of the Hnambat Creek is kaolinized, sericitized and sporadically silicified plagiogranite.

The ore occurrence is located about 850 m. from the junction of the Shangalon-Gwedauktaw cart-road. The adjoint country rock is a corse granular variety of plagiogranite. The ferromagnesium minerals (especially biotite) are chloritized; the plagioclases have undergone intensive sericitization and kaolinization. Farther away from the ore vein the country rock is noticeable more fresh. There are two thinner ore veins of NW-SE direction, dipping almost vertically. The thicker vein is on an average 5 cm. wide. It was exposed along a length 10 m. In this veinlet the main ore mineral is chalcopyrite, with quartz and calcite as gangue minerals. It the other veinlet the main ore mineral is pyrite; quartz is the only gangue mineral.

Under the microscope the following paragenesis was proved:

a) primary minerals: *molybdenite, pyrite, quartz, sericite, sphalerite, chalcopyrite, krennerite (?), bornite, tennantite, enargite, galena, calcite* and *chalcedony.*

b) supergene minerals: *goethite, lepidocrocite, covellite, chalcocite* and *chalcedony.*



The principal ore minerals are pyrite and chalcopyrite. Tennantite and enargite are frequent minerals, but they occur in small quantities. Sphalerite, bornite and galena are far scantier; molybdenite and krennerite are present only in microscopical quantities. Among the gangue minerals quartz is the most abundant, followed by calcite and sericite. Chalcedony is very rare.

The ore occurrence is situated in the bed of the creek, and therefore it is almost fresh, with very small quantities of secondary minerals.

Molybdenite was observed only in one polished section. Jt occurs in the form of minute single folia or aggregates of foliae (dimensions ranging from 50 to 150 microns) in quartz. The largest aggregate was 0,3 mm. in diameter. The folia of molybdenite are bent, frequently with a »twinning-like texture«. *Pyrite* is of coarse granular crystallization. It is cataclased, the cataclases being sporadically filled with chalcedony and tennantite. *Quartz* is partly protoquartz, cataclased and optically anomalous. The micropores and interstices are filled with other minerals, especially chalcopyrite. A part of quartz was formed by a process of silification. *Sericite* was observed in the form of larger or smaller aggregates. *Sphalerite* is older than chalcopyrite and the other sulphides and sulphosalts except pyrite. It forms smaller masses whose »bays« are filled with youuger minerals, most frequently with bornite and enargite. Sphalerite is found also in the micropores of pyrite, sometimes even in the cracks of pyrite, or it is grown in protoquartz. It is rare in chalcopyrite. In a vug of pyrite sphalerite of various skeleton forms was observed in calcite. Honey-yellow and red-brownish internal reflections point to a moderate content of iron. *Chalcopyrite* is concentrated in certain parts of the ore veins, particularly in the rim zones. It occurs also in fine veinlets or lenses in the company of small quantities of pyrite and calcite as a gangue mineral. In the bigger masses of pyrite chalcopyrite is scanty, filling up the micropores. Pyrite and chalcopyrite belong to various generations. Pyrite is the older, being replaced by chalcopyrite. Sphalerite, sericitized and kaolinized plagioclases as well as chloritized biotite are replaced by chalcopyrite. Characteristic of this ore occurrence are cataclases of chalcopyrite serving as channels for ascedent hydrothermal solutions carrying ions of lead, arsenic and copper. In the cracks there occurred crystallization of galena, enargite and tennantite as well as replacement of chalcopyrite *(Phot. 12)*. Thus there occurred rarer and denser systems of veinlets of the younger sulphides and sulphosalts crossing chalcopyrite *(Phot. 13)*. Sporadically they formed small masses of younger sulphides containing flakes of chalcopyrite. The average width of the veinlets is 5–10 microns. In some polished sections the veinlets are parallel with the walls of the ore vein. Chalcopyrite is coarse granular, some grains being lamellated. *Bornite* was crystallized simultaneously with chalcopyrite, forming a myrmekitic structure. Sometimes it contains exsolutions of chalcopyrite in the form of discs or lamellae. There is also a younger bornite, which replaces chalcopyrite at the rims of the grains or along cracks in the form of microscopically fine veinlets. These veinlets are a little older than similar veinlets of tennantite and enargite. There are bornite in the »bays« of sphalerite masses. *Tennantite* is a very common mineral in this ore occurrence, but it is hardly noticeable with the naked eye. A minor portion of tennantite fills up the micropores of pyrite, a larger one is accompanied inside the masses of chalcopyrite by enargite, more rarely by bornite, and exceptionally rarely by galena or krennerite. A very intimate intergrowth with enargite points to a simultaneous crystallization. There are tennantite in the »bays« of sphalerite. Tennantite is greenish in colour, with a bluish tint. *Enargite* occurs exclusively in the company of tennantite, but in smaller quantities than the latter. Galena is very rare, far rarer than bornite and enargite. *Galena* occurs along with sphalerite. As a matter of fact sphalerite is replaced by galena. But most abundant is galena in chalcopyrite, forming small masses. These masses are composed of galena alone or of galena and younger minerals. Galena occurs, although rarely, with enargite and tennantite. It is characterized by a certain colour, and it is called »purple galena«. It is isotropic. *Krennerite* (?) was observed in the form of small masses in but one section of chalcopyrite. It is intimately intergrown with tennantite. The dimensions of the masses range from 100 to 150 microns. The reflectivity is higher than in chalcopyrite. It is light yellow in colour, rather soft, with numerous scratches on the surface. It exhibits a faint reflection pleochroism and weak anisotropism. *Calcite* is developed in two generations. The older generation of calcite is coarse granular (crystals up to 0,2 mm.) and partly replaced by chalcopyrite. The younger one is very fine granular, with crystals up to 50 microns in diameter. This generation is simultaneous with the development of the younger sulphides and sulphosalts. This kind of calcite occurs in minute cracks of chalcopyrite. *Chalcedony* appears exclusively in cracks of chalcopyrite. Part of this chalcedony is most probably of descendent origin.

Goethite, *lepidocrocite*, *chalcocite* and *covellite* are very scanty and of microscopical quantities, which is due to the freshness of the exposed ore.

Characteristics of the ore occurrence

Mineralization commenced with a weakly expressed pneumatholitic phase, in which there crystallized very small quantities of molybdenite. The hydrothermal phase commenced with crystallization of coarse granular high-temperature pyrite, and later also with crystallization of small quantities of sphalerite rich in iron. After crystallization of pyrite and sphalerite there ascended copper bearing thermal solutions, from which chalcopyrite and some bornite crystallized. Then there followed a tectonic phase, which caused cataclases of the already crystallized minerals. There occurred a new ascension of the thermal solutions, which carried ions of copper, arsenic, zinc, silver, gold and tellurium. Thus a fine plexus of veinlets filled with enargite, tennantite and krennerite was formed. Subsequently there occurred an ascension and crystallization of galena. The oldest generation of the gangue minerals is represented by crystallization of coarse granular quartz. The mesothermal phase of the crystallization, i. e. of the crystallization of chalcopyrite and bornite, was accompanied by coarse granular calcite. Fine granular calcite and chalcedony crystallized simultaneously with the complex minerals of copper, arsenic and lead. In spite of the fact that this ore occurrence has no economic value, it is nevertheless very important from the genetical and geochemical point of view.

II. THE SHAWDON CREEK

The ore occurrence is situated about 600 m. from the just described ore occurrence in the Hnambat Creek in WNW direction, in the plain between the Shangalon-Kydaw cart-road and the Shawdon Creek.

In a heavily altered volcanic country rock, along the joint planes, there are some tabular ore veins. The thickness of the ore veins varies greatly, the thickest one amounting to 20 cm. The extension of the veins and veinlets is NW-SE dipping 60^0 towards the SE. The occurrence was explored by an excavation. Nearly all the primary minerals are already altered. Only in the greatest thickenings of the veins can the primary minerals still be observed.

Under the microscope the following paragenesis was proved:

a) primary minerals: *quartz, pyrite, chalcopyrite, tetrahedrite, chalcedony,*

b) supergene minerals: *covellite, chalcocite, malachite, goethite, lepidocrocite, chalcedony.*

Quartz is the most abundant mineral. Among the primary minerals the most common is chalcopyrite, to be followed by pyrite, while tetrahedrite is very scanty. The secondary minerals predominate.

Quartz is the oldest mineral, and the sulphides occur in its vugs and interstices as well as in its micropores. The crystallization of quartz occurred in the process of silification, which preceded the mineralization. *Pyrite* is older than chalcopyrite, because the former is embedded in the latter. Pyrite is also replaced by chalcopyrite. The replacement is sometimes very intensive, so that only minute grains of pyrite remain in chalcopyrite. Pyrite is coarse granular, sometimes even euhedral. It is full of microcracks. *Chalcopyrite* is rarely fresh. By oxidation there occur sulphates; they are subsequently hydrolized, partly leached out, or deposited as limonite. Secondary chalcocite and covellite are widely spread in chalcopyrite. *Tetrahedrite* occurs in the form of small masses together with chalcopyrite.

Among the secondary minerals *goethite* and *lepidocrocite* predominate over *chalcocite, covellite, malachite* and *chalcedony*.

III. THE LOWER COURSE OF THE HNAMBAT CREEK

The ore occurrence is not »in situ«. Big boulders of silicified and mineralized tuffs were discovered near the Shangalon-Kydaw cart-road about 0.5 km. south of the ore occurrence near the Shawdon Creek. Smaller boulders of silicified but barren tuffs were observed in the area between these two occurrences.

Under the microscope the following paragenesis was proved:

a) primary minerals: *arsenopyrite, pyrite, loellingite (?), chalcopyrite, quartz* and *chalcedony*,

b) supergene minerals: *goethite, lepidocrocite, chalcocite* and *covellite*.

Among the ore minerals chalcopyrite is the most abundant; pyrite is hardly noticeable; arsenopyrite and loellingite are present in microscopical quantities; while covellite and chalcocite are the most common secondary minerals. Quartz occurs in considerably greather quantities than chalcedony.

Arsenopyrite is far less common than pyrite. It is developed in euhedral rhombic cross-sections, but the crystals are regularly cataclased and fragmented. *Loellingite (?)* is to be found in the masses of pyrite or sometimes in the masses of arsenopyrite. The relief of loellingite is a little lower than that of arsenopyrite. The anisotropism of loellingite is also stronger than that of arsenopyrite. Loellingite is bluish in colour *Pyrite* is extremely strongly cataclased, even broken into coarser or finer angular fragments cemented with chalcedony. Sporadically the minute, microscopical stringers of pyrite exhibit a fluidal texture. This points to the high viscosity of the colloidal solutions producing chalcedony. *Chalcopyrite* is also entirely crushed, forming finer and coarser fragments ranging from such as are hardly visible under the microscope to such as are 1 mm. in size. Its fragments are cemenetd with chalcedony *(Phot. 14)*. It is rarely fresh; it is replaced by chalcocite and covellite. In places the replacement is in its first stage, in others nearly the whole chalcopyrite is replaced by secondary minerals. Not infrequently the secondary minerals are leached out and ore mass is porous. *Quartz* is the main matrix of the ore minerals. It is completely crushed and cemented with chalcedony. In places the quartz matrix is leached out, causing a boxwerk structure. *Chalcedony* is the cement of the completely crushed ore mass. It was deposited after a very strong tectonic phase from highly viscous solutions of silicon acid. *Covellite* is more abundant than chalcocite. It occurs in the form of minute plates which, orientated along the crystallographical planes, replace chalcopyrite. *Chalcocite* is of submicroscopical dimensions, while *goethite* and *lepidocrocite* are very scanty.

The texture of the ore is microbrecciated. After a strong silification of tuffs there crystallized from high-temperature solutions pyrite, arsenopyrite, loellingite and chalcopyrite. After a strong tectonic phase that caused complete brecciating of the ore, there occurred a younger phase of silification with deposition of chalcedony.

IV. THE RANGE SOUTH OF THE HNAMBAT CREEK

On a hillock south of the Hnambat Creek a thin quartz-pyrite vein of microbrecciated texture was discovered.

Under the microscope the following paragenesis was proved:
a) primary minerals: *quartz, pyrite* and *chalcedony*, b) secondary minerals: *goethite* and *lepidocrocite*

Pyrite and *quartz* are completely cataclased, forming angular fragments of various dimensions. The fragments are cemented with *chalcedony*. Pyrite is partially oxidized, generating *goethite* and *lepidocrocite.*

The genesis of the ore occurrences of the Shangalon-Pudaw Area

East and north-east of the villages of Shangalon Pudaw a cupola of granodiorite plutonic intrusion was revealed. In the rim zones of this batholite remnants of an earlier sedimentary cover are still preserved. There are sandstones, arkose, hornstones and tuffs. In the western region the plutonic mass is in contact with gabbro, diorite and diabase.

In the cupola of this granodiorite plutonic mass there are numerous protrusions of volcanic rocks such as dacite, andesite and diabase, as well as veins of pegmatites, aplites and leucogranites.

The plutonic mass is heavily altered by hydrothermal processes as sericitization, kaolinization, chloritization, epidotization and silification. These processes are especially intensive in the vicinity of the protrusions of the volcanic roks. The process of kaolinization, sericitization and partial silification preceded the mineralization in some zones of the granodiorite mass. Such altered zones are noticeable in the Taung Byu and Kyaunggon Taung ranges as well as in the area of the Mine Creek. The largest kaolinized zone is to be found in the Taung Byu range (map No. 3). All these zones are characterized by numerous hypoabissal protrusions of extrusive rocks. Between these protrusions, the hydrothermal activity and mineralization there exists a close genetic relation.

The ore occurrences of the Shangalon-Pudaw area are situated almost exclusively in the cupolas of the granodiorite plutonic mass, especially in places where there are protrusions of volcanic rocks. The ore occurrences are close to the protrusions or in immediate contact with the volcanic and plutonic rocks, rarely inside of volcanic rocks or tuffs. It is noteworthy that the ore occurrences are controlled by tectonic zones of NW–SE direction. Along these same zones there occurred protrusions of volcanic rocks. The same tectonic channels were used by ascending thermal solutions which caused the mineralization.

In the Shangalon-Pudaw area, up to 1955, 18 ore occurrences were observed, viz. five in the Chigyindaung Taung range, six in the Kyaunggon Taung range, four in the Taung Byu range, and four in the Hnambat and Shawdon Creeks. In three places only fragments of ore were found, while no deposit »in situ« was discovered.

Microscopic examinations of all these 18 ore occurrences proved the presence of the folowing six paragenetic types:

1. *the quartz-tourmaline type of veins*
2. *the quartz-pyrite-chalcopyrite type*
3. *the quartz-chalcopyrite type with complex paragenesis*
4. *the specularite (hematite) type*
5. *pyrite-chalcopyrite impregnations*
6. *impregnations of native copper*

Type One: The quartz-tourmaline veins were discovered on the southern slopes of the Kyaunggon Taung range (thin veins). So far no other mineral except tourmaline and quartz was proved. Tourmaline is crystallized in columnar and needle-shaped forms, grown in aggregates of indentedly intergrown quartz grains. These occurrences are related to the pegmatite-pneumatholitic phase of the ore development.

Type Two: The quartz-chalcopyrite veins are the most common, and they are typical of this metallogenetic region. Twelve out of the 18 ore occurrences of the whole explored area belong to this type. All these ore occurrences are in the form of veins. The veins are rather thin, their average thickness not surpassing 20–30 cm. They are irregular as to their strike and dip, but generally their strike is NW–SE, and they possess a very steep, almost vertical dip. Besides individuals veins also systems of parallel veinlets and lenticles we observed. At the time of our explorations the mining workings were still being developed and were being carried out mainly in the oxidation zones. Nowhere was the primary zone touched upon, and consequently the primary paragenesis (except relics) is still non-existent. Mineralization of this ore type commenced with a weakly expressed pneumatolitic phase depositing minute quantities of molybdenite and a mineral of similar optical properties as wolframite. In the katathermal (hypothermal) stage of the hydrothermal phase coarse granular pyrite was deposited, but in one of the ore occurrences (lower course of the Hnambat Creek) small amounts of arsenopyrite and loellingite and in another occurrence (Kyee Creek) microscopical quantities of an undetermined Ni-Co mineral were observed. The mesothermal stage commenced with crystallization of chalcopyrite. In some ore occurrences chalcopyrite is more abundant than pyrite in others less so. In the Shawdon Creek there is some tetrahedrite together with chalcopyrite. Among the gangue minerals quartz (part of it is protoquartz) is characteristic of the hypothermal stage, and coarse granular calcite of the mesothermal stage of the crystallization. Very characteristic of this type of ore deposits is the brecciated and microbrecciated texture caused by a strong tectonic action following deposition of chalcopyrite. Pyrite, quartz and chalcopyrite are more or less cataclased, in some places even in angular fragments of various sizes. The cracks and cataclases are cemented with chalcedony. The secondary processes were very widely spread, yielding a number of minerals such as chalcocite, cuprite, tenorite, malachite, azurite, native copper, native silver, goethite, lepidocrocite and chrysocolle. In some ore occurrences only secondary minerals were found, but mineragraphic studies of the specimens collected revealed the same texture and identical paragenesis, so we can state with certainty that they belong to the same paragenetic type.

Type three: The quartz-chalcopyrite veins with complex paragénesis are very similar to the preceding type. The minerals of the pneumatolitic, kathathermal and mesothermal stages are nearly the same. The difference is that in this third type crystallization of chalcopyrite is preceded by a certain quantity of sphalerite (marmatite), and that there also commenced crystallization of bornite in very small quantities. The main peculiarity of the third type is ascension of polymetallic thermal solutions simultaneously with the tectonic activity, carrying enargite, tennantite, freibergite, bornite, krennerite and galena. The mentioned minerals crystallize in the form of the fine veinlets or small masses, replacing the older minerals, especially chalcopyrite. Considerable quantities of these minerals are noticeable at the position »Galena gully« in the Kyaunggon Taung range, but they are very scanty in the Hnambat Creek. At position near the monastery in the Kyaunggon Taung range in this stage only microscopical quantities of enargite crystallized, and consequently it represents a transition between the second and third types. Connected with the polymetallic stage is crystallization of a younger generation of fine granular calcite. The hydrothermal activity ended with the ascension of small quantities of chalcedony. The three ore occurrences discovered so far are very small.

Type Four: The specularite ore occurrence is a low-temperature occurrence of hematite in fine granular quartz. This type of ore deposits characterizes the end of the hydrothermal activity related to granodioritic (granitic) magma, but it is not impossible that it is in genetic relation to the diabases. This deposit was observed in the Chigyindaung Taung range, it is of no economic value.

Type Five: The pyrite-chalcopyrite impregnations in granodiorite were observed in the Taung Byu range. They are also of small extent and consequently of mineralogical importance. There exists, however, a theoretical possibility that inside the large kaolinized zones of granodiorite there are larger impregnated copper bearing pyritic bodies.

Type Six: The impregnations of native copper in diabase in the Mine Creek are a topomineralogical ore occurrence. The basic character of diabase conditioned reduction of copper ions from the thermal solutions as well as deposition of native copper in dispersed form. The occurrence is of mineralogical interest.

A predominant number of ore occurrences exhibit a typical paragenesis of plutonic-hydrothermal ore deposits. Present are tourmaline. molybdenite, coarse granular pyrite and quartz, arsenopyrite, loellingite and finally coarse granular chalcopyrite. In addition these paragenesis are very simple, and they are scattered over large areas. The very presence of molybdenum and boron in the ore minerals points to a relation with granite (granodiorite). Also the other occurrences with the exception of specularite and impregnations of native copper are most closely connected paragenetically with the mentioned plutonic-hydrothermal type, for they differ from it only by the existence of another polymetallic generation, while the earlier phases of the ore deposition are identical.

All ore occurrences thus far discovered are characterized by very small dimensions. Cracks and thin fissures were used by the hydrothermal solutions for the reason that in the Shangalon-Pudaw area there are no bigger tectonic fault lines. The existing cracks and fissures posesss a general NW–SE direction of strike. It cannot be excluded that at least a certain number of them represent contraction cracks in the grano-diorite cupola. The occurrence of brecciating of the ore mass in almost all ore occurrences indicates that the tectonic activity, which caused the brecciating, was of regional character, because it manifested itself at the southernmost point of the ore region in the Chigyindaung Taung range as well as in the extreme north in the ore occurrences of the Hnambat and Shawdon Creeks. We presume that this paroxism was simultaneous with the protrusions of some hypabyssal volcanic rocks. During this phase, which lasted for a considerable time (for the volcanic rocks were of various petrological characteristics, i. e. very differentiated), grano-diorite was protruded in many places like a sieve by acid or basic dikes. These protrusions, especially acid ones, opened ways to new thermal solutions, this time to polymetallic ones, which ascended through cracks formed by the brecciating of the ore substance of earlier generations, and they deposited a complex generation of sulphides and sulphosalts on some ore occurrences, i. e. mostly chalcedony. Between the phase of the mineralization of the older generations and the phase of the brec-ciating a period of time must have elapsed. During that time there oc-curred partial erosion of the sedimentary blanket, the plutonic mass came nearer to the surface, and the younger thermal solutions acted at a subvolcanic level. This would be an explanation of the complexity and mutual intergrowth of the minerals of the younger generation, as well as of the occurrence of chalcedony.

B. THE OCCURRENCES OF HEMATITE NORTH AND NORTH-WEST OF PUDAW

I. THE GWEGYO AREA

The Gwegyo area is several miles north-west of the village of Pudaw. No data about the geological structure or the ore occurrences of this area are available in the existing literature.

Petrographic studies of a considerable number of thin-sections revea-led that this particular area consits of different types of gabbroid rocks, such as quartz-gabbro, amphibolic-gabbro, piroxene gabbro, an-orthosite as well as transitional types of rocks from subvolcanic diabase to hypabyssal gabbrodiabase. Sporadically there are also protrusions of dacite, andesite as well as granite-pegmatite dikes. Further, there are also metamorphic rocks as amphibolic schists, typical amphibolite, acti-nolite-epidote schists and biotite-amphibole gneiss-granite. Sedimentary quartz-sandstones were likewise observed.

Lumps and boulders of hematite were found in creek beds flowing in gabbro-anorthosite.

Under the microscope the following paragenesis was proved: *magnetite, martite, hematite, quartz* and *native silver.*

Magnetite is visible with the naked eye as small masses up to 1 mm. in diameter, but usually it is of microscopical dimensions. Most frequently it is embedded in hematite in the form of small masses or flakes. It occurs very rarely in euhedral forms. *Martitization* commenced along crystallographic planes. *Hematite* is principal ore mineral, while magnetite is very rare. Hematite occurs predominantly in tabular, columnar and needle-shaped forms *(Phot. 15).* The plates are of rhombic, isometric cross-sections up to 1 mm. in size The columnar crystals reach up to 3 mm. in size, while the needles are from 50–100 microns long. Commonest are the columnar crystals, rarest the needle-shaped ones. The larger and smaller crystals of hematite touch and intersect each other, while the interstices are with quartz containing individual needles of hematite. Hematite envelops remnants of magnetite. A certain number of hematite crystals – especially columnar ones – are lamellated. Usually individual lamellae could be seen, more rarely dense strings of narrow lamellae. Some broader lamellae are transversely lamellated. Bends and translations of lamellae were also observed. The hematite from Gwegyo is characterized by appearance of the exsolutions of the minute discs, visible under very strong magnification. This phenomenon is first discovered by P. Ramdohr, 1955; Cavan and Edwards hold it for micro-scale twinning. This exsolution was observed in a larger number of hematite crystals from Gwegyo, and it was especially clearly visible when the nicols were not completely crossed. The density of the discs is unevenly distributed in the crystals of hematite. In some lamellated crystals the lamellae do not contain discs, but they are inclined 60° towards the lamellae. There are crystals where the discs are bent, translated or disturbed. *Quartz* is the only gangue mineral, and it is less abundant than hematite. It fills up interstices of hematite. *Native silver* is scanty and of microscopical dimensions.

Hematite is relatively coarse granular, and in places it is crystallized in the form of isometric plates and short columns. These circumstances as well as the presence of magnetite indicate that the paragenesis originated at higher temperature, and that the ore occurrence is linked up with basic gabbro magma.

2. THE KYDAW AREA

The Kydaw area is a few miles north of the village of Pudaw. There are no data about the geology or the ore occurrences of this area. Small occurrences of specularite are genetically connected with diabase.

Under the microscope the following paragenesis was proved: *hematite, quartz, chalcopyrite, siderite, pyrite, goethite, lepidocrocite* and *chalcocite.*

The principal ore mineral is specularite; it appears in diabase in the form of nests, impregnations and interlayers. Interlayers of hematite 1–2 mm. wide alternate with quartz bands containing needle-shaped hematite, or with bands of coarse granular siderite (ankerite) containing needles of hematite as aggregates, or sometimes with bands of fine granular pyrite. Chalcopyrite is noticeable only under the microscope.

Hematite occurs in the form of fine foliae, forming bunches. Usually the bunches are built of subparallel or radially foliated aggregates, but there are bunches with divergently arranged foliae *(Phot. 16).* There are also needle-shaped aggregates of hematite, sporadically even single needles. The foliae of hematite are very thin; their thickness does not exceed 30 microns. The bunches of hematite foliae are usually paralel with the schistosity of diabase. The interlayers of hematite in diabase are of various thickness (some tens of microns up to 2 mm), and are lense-shaped. *Chalcopyrite* is very rare and occurs in the form of microscopically fine masses or foliae as pseudomorphoses on specularite. By weathering it produces a plexus of chalcocite and goethite. *Ankerite (siderite)* is coarse granular, the grains measuring as much as 3 mm. The form of the grains is anhedral. It occurs in the form of bands and envelops needles and masses of hematite. *Pyrite* is prevalently oxidized in goethite and lepidocrocite, forming pseudomorphosis on pyrite. Pyrite occurs in the form of coarse crystals or as fine granular masses in bands. In places the needles and bunches of hematite are cemented with pyrite.

The specularite occurrences of the Kydaw area are of epithermal origin, and they are connected with diabase.

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Authors:

Dr. Ivan Jurković,
Institute of Mineralogy, Petrology and Ore Deposits, Technological Faculty, University of Zagreb, Yugoslavia

Božidar Zalokar, M. E.
Enterprise »Geoistraživanja« Zagreb, Yugoslavia

Resumé

IVAN JURKOVIĆ, BOŽIDAR ZALOKAR

RUDNE POJAVE PODRUČJA SHANGALON, JUGOISTOČNO OD GRADA KAWLINA, GORNJA BURMA

Područje Shangalon se nalazi u Gornjoj Burmi u Katha Districtu (prilog 1). Najbliže veće mjesto je gradić Kawlin, 16 milja udaljen od Shangalona, a leži na željezničkoj pruzi Myitkyina-Mandalay.

Oba autora izvršila su u martu mjesecu 1955. god. terenska geološko-rudarska istraživanja područja Shangalon. Istraživanjem je obuhvaćeno područje kose, koja se pruža južno i zapadno od sela Shangalon, zatim područje Chigyindaung Taung, Kyaunggon Taung i Taung Byu kosâ, koje se nalaze istočno od istog sela, kao i područja između potoka Zalok i Shangyiaung istočno od sela Pudaw, te slivno područje potoka Hnambat i Shawdon sjeverno i sjeveroistočno od sela Pudaw. Osim tih detaljnijih istraživanja autori su prospektirali područja Gwegyo i Kydaw, nekoliko milja sjeverozapadno, odnosno sjeverno od sela Pudaw.

Šire područje Shangalona nije dosad geološki istraženo, na geološkoj karti Burme nalazi se na odgovarajućem mjestu »bijela mrlja«. Naši podaci su prvi podaci o geologiji, petrografiji i rudnim pojavama tog područja.

Naša terenska i laboratorijska istraživanja su pokazala, da u geološkoj građi područja Shangalon učestvuje veći broj petrografskih članova: porfiroidni dijabaz, spilit-dijabaz i melafir od bazičnih efuzivnih stijena; amfibolski ofitski gabro, aktinolitski hornblende gabro, amfibolski mikrogabro te gabro-dijabaz od bazičnih intruzivnih i hipoabisalnih stijena; andezit, dacit, dacitoandezit, trahiandezit od kiselih

efuzivnih stijena; granit, plagiogranit, kvarcdiorit od kiselih intruzivnih stijena, te apliti i pegmatiti granitske magme. Magmatske stijene prate svježi ili silificirani tufovi. Od sedimentnih stijena utvrđene su arkoze, pješčenjaci, rožnaci, a od metamorfnih aktinolitski škriljavac (prilog 2).

Središnji dio istraženog terena izgrađen je od granitskog plutona, čije je tjeme otkriveno erozijom u akrobatolitskom nivou. Pluton je probijen brojnim dajkovima i silovima kiselih i bazičnih efuzivnih stijena. Po rubovima otkrivenog plutona nalaze se ostaci sedimentnog pokrivača tufova, pješčenjaka, arkoza i rožnaca. Osim jake siliko-metasomatoze u tjemenu plutona zapažene su i pojave kaolinizacije, sericitizacije, turmalinizacije, aktinolitizacije i epidotizacije, kao i brojne hidrotermalne rudne pojave (prilozi 2 i 3).

Mikroskopskim studijem uzoraka svih 18 dosad otkrivenih rudnih pojava u području Shangalon utvrđeno je šest paragenetskih tipova:

1. kvarcno-turmalinski tip,
2. kvarcno-piritsko-halkopiritski tip s najmlađom kompleksnom generacijom mi-minerala,
4. spekularitski tip,
5. piritsko-halkopiritske impregnacije,
6. impregnacije elementarnog bakra.

Najrašireniji i ekonomski najvredniji je tip kvarcno-piritsko-halkopiritskih žica, svi su ostali tipovi ili mnogo rjeđi ili su samo mineraloškog i geokemijskog značaja.

U području Gwegyo nađene su pojave visokotemperaturnog hematita s nešto magnetita u gabro-anortozitu.

U području Kydaw zapažene su manje pojave niskotemperaturnog spekularita u dijabazima.

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Institut za mineralogiju, petrologiju i rudna ležišta, Tehnološki fakultet, Sveučilište Zagreb

»Geoistraživanja«, Zagreb

Explanations of the microphotographs

(Tumač mikrofotografija)

Plate I. – Tabla I.

Phot. 1. – Sl. 1. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 130×
Fragments of crushed pyrite cemented with chalcedony. – Fragmenti pirita cementirani kalcedonom.

Phot. 2. – Sl. 2. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 130×
Chalcopyrite(ch) enriched by supergene chalcocite(cc). In chalcopyrite a network of chalcedony(cd). – Halkozin(cc) potiskuje halkopirit(ch). Halkopirit prožet mrežom žilica kalcedona(cd).

Phot. 3. – Sl. 3. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 130×
Masses of chalcocite(cc) formed by weathering of chalcopyrite with the cracks filled with malachite and azurite (black). – Mase halkozina(cc), koje su nastale trošenjem halkopirita, s prslinama ispunjenim malahitom i azuritom(crno).

Phot. 4. – Sl. 4. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 325×
Lamellated chalcocite(cc), the mineral »X«(x), malachite(black) and cuprite(cp). – Lamelarni halkozin(cc), mineral »X«(x), malahit(crno) i kuprit(cp).

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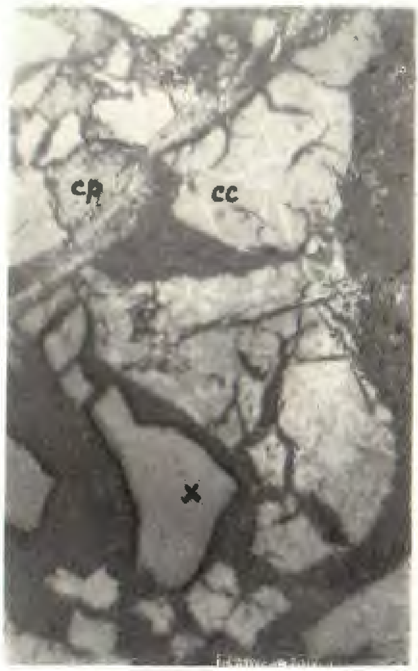

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Plate II. – Tabla II.

Phot. 5. – Sl. 5. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 130× Fragments of chalcocite(cc), the pseudomorphoses on chalcopyrite in the mass of malachite(black), cuprite(cp) and tenorite(tr). Fragmenti halkozina(cc) kao pseudomorfoze po halkopiritu u masi malahita(crno), kuprita(cp) i tenorita (tr).

Phot. 6. – Sl. 6. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 130× Porous cuprite(cp) with the masses of native copper(cu). – Porozan kuprit(cp) s masicama elementarnog bakra(cu).

Phot. 7. – Sl. 7. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 325× Euhedral and skeleton crystals of cuprite. – Idiomorfno razvijeni i skeletni oblici kuprita.

Phot. 8. – Sl. 8. Chigyindaung Taung Range, Kyee Creek, Position 1, magnified 325× Chalcotrichite(cpf), a fibrous variety of cuprite(cp.) m = malachite. – Halkotrihit(cpf), vlaknati varijetet kuprita izrasta iz poroznog kuprita(cp). m = malahit.

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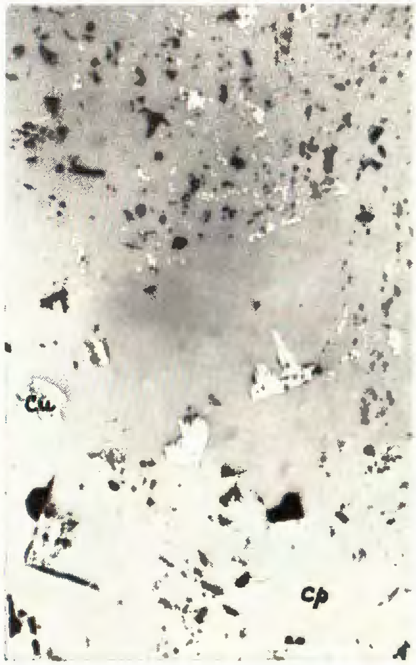

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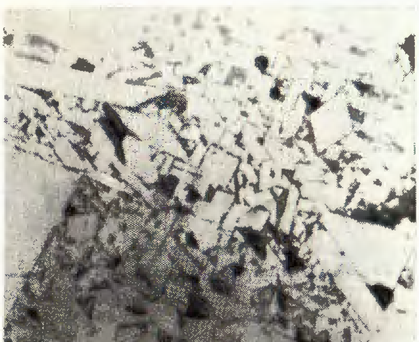

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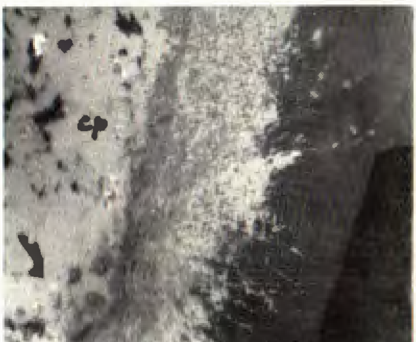

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Plate III. – Tabla III.

Phot. 9. – Sl. 9. Kyaunggon Taung Range, Galena Gully, Position 2, magnified 130× Cataclased and crushed chalcopyrite(ch), sphalerite(sp) and galena(g) cemented with chalcedony(black). – Kalcedon(crno) cementira kataklazirani halkopirit(ch), sfalerit(sp) i galenit(g).

Phot. 10. – Sl. 10. Kyaunggon Taung Range, Galena Gully, Position 2, magnified 250× Sphalerite(sp) replaced by galena(g) along cracks. – Galenit potiskuje sfalerit(sp) duž prslina.

Phot. 11. – Sl. 11. Kyaunggon Taung Range, Galena Gully, Position 2, magnified 250× Galena(g) with exsolutions of freibergite(f). Krennerite(white) replaces galena along rims of the grains. – Galenit(g) s izdvajanjima fraibergita(f). Krenerit potiskuje galenit.

Phot. 12. – Sl. 12. Hnambat Creek, Pudaw Area, magnified 130× Chalcopyrite breccia (ch) with tennantite(t) and calcite(black) as cement. – Halkopiritna breča s cementom tenantita(t) i kalcita(crno).

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Plate IV. – Tabla IV.

Phot. 13. – Sl. 13. Hnambat Creek, Pudaw Area, magnified 130× The veinlets of enargite(e) in chalcopyrite(ch). – Žilice enargita(e) u halkopiritu(ch).

Phot. 14. – Sl. 14. The lower course of the Hnambat Creek, Pudaw Area, magnified 70× Completely crushed chalcopyrite(ch), fragments being cemented with chalcedony(black). Chalcopyrite alterates to covellite(grey) and chalcocite(cc) on the rims of fragments or along craks. – Potpuno zdrobljeni halkopirit, čiji su fragmenti cementirani kalcedonom(crno). Halkopirit se troši u kovelin(sivo) i halkozin(cc) po obodima fragmenata ili po njihovim prslinama.

Phot. 15. – Sl. 15. Gwegyo, nort-west from Pudaw, magnified 139× Columnar crystals of hematite(h) with the remnants of magnetite(m) Stubasti kristali hematita(h) s ostacima magnetita(m).

Phot. 16. – Sl. 16. Kydaw, north from Pudaw, magnified 130× Foliated specularite (ematite) in quartz(black) – Lisnat spekularit(hematit) u kvarcnoj jalovini(crno).

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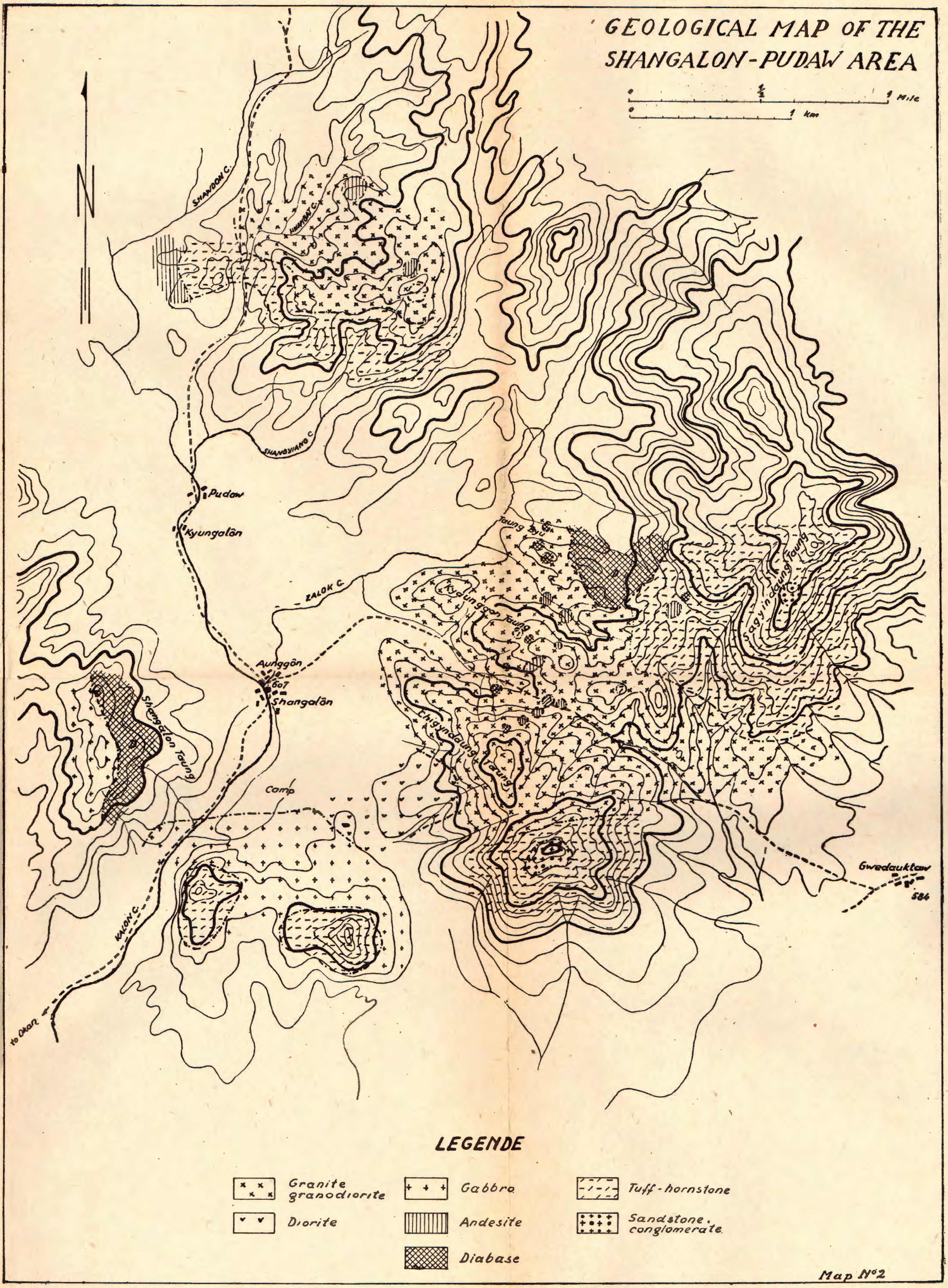
GEOLOGICAL MAP OF THE SHANGALON - PUDAW AREA
1 Mile
1 km
N
SHANDON C.
SHANGYIANG C.
Pudaw
Kyungalôn
ZALOK C.
Aunggôn
607
Shangalôn
Shangalon Taung
Camp
KALON C.
to Okan
Taung Byu
Kudunggan Taung
Lhigyndaung Taung
Sagyindaung Taung
Gwedauktaw
584
LEGENDE
Granite granodiorite
Gabbro
Tuff - hornstone
Diorite
Andesite
Sandstone, conglomerate
Diabase
Map N°2