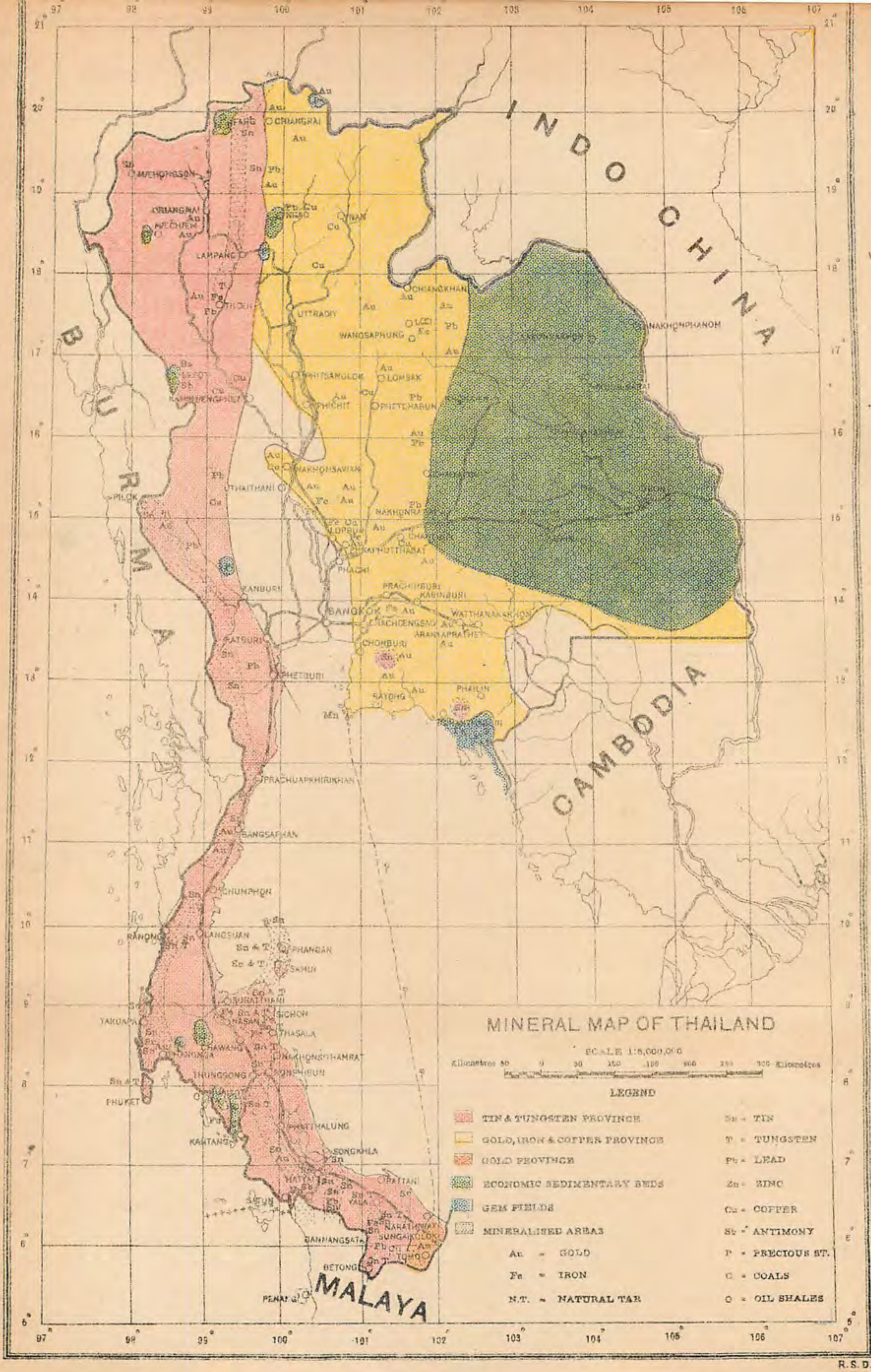
MINERAL MAP OF THAILAND
SCALE 1:6,000,000
LEGEND
TIN & TUNGSTEN PROVINCE
GOLD, IRON & COPPER PROVINCE
GOLD PROVINCE
ECONOMIC SEDIMENTARY BEDS
GEM FIELDS
MINERALISED AREAS
Au = GOLD
Fe = IRON
N.T. = NATURAL TAR
Sn = TIN
T = TUNGSTEN
Pb = LEAD
Zn = ZINC
Cu = COPPER
Sb = ANTIMONY
P = PRECIOUS ST.
C = COALS
O = OIL SHALES
INDO CHINA
BURMA
CAMBODIA
MALAYA
BANGKOK
CHIANGRAI
LAMPANG
UTTRADIT
PHITSANULOK
NAKHONSAWAN
LOPBURI
KANBURI
RATBURI
PHETBURI
CHONBURI
RAYONG
PHAILIN
PRACHUAPKHIRIKHAN
BANGSAPHAN
CHUMPHON
RANONG
LANGSUAN
PHANGAN
SAMUI
SURATTHANI
THASALA
NAKHONSITHAMRAT
RONPHIBUN
PHUKET
PHATTHALUNG
SONGKHLA
HATYAI
PATTANI
YALA
SATUN
NARATHIWAT
SUNGAIKOLOK
BETONG
CHIANGKHAN
NAKHONPHANOM
WATTHANANAKHON
ARANYAPRATHET

R.S.D.

## MINERAL RESOURCES OF THAILAND.*

SMAK BURAVAS, B. SC. (HONS), A. R. S. M.
MINISTRY OF DEFENCE.

The mineral industry of Thailand ranks second in importance only to her rice industry. The value of tin concentrates exported from 1936 onwards exceeds forty million ticals per year, while wolfram concentrates usually fetch a yearly revenue of some 300,000 ticals. Now, with the outbreak of war and the shifting of world's ore-buying centres, the revenue from tin industry is much higher than previously.

There is a marked activity recently in tungsten (wolfram) mining and at the end of the year this will cause a wealth of not less than two million ticals to the country. Quiet as it is, gold mining has been more important than tungsten mining. The revenue from one mine only, in Toh Moh, is as much as 800,000 ticals yearly. Primitive mining for gold has been actively going on in many parts of the country, and, although there is as yet no record of the production, the writer, who has visited many of the workings, believes that the output is considerable.

Of all non-metallic minerals naturally precipitated chalk, known locally as Din So Pong, has been the most important as it is used in cement making. Gypsum and kaolin come next, but at present the requirement of home industry for these minerals seems to be small. There are gem workings in Ganburi, Chanthaburi and Krat, but, as gems from neighbouring countries have been also sent through Thailand to be exported at Bangkok and Chanthaburi, the writer thinks it is advisable not to give any figure of production.

In writing this short article, the writer wishes only to point out in what parts of the country would a certain economic mineral be found. It is the desire of the writer to show the world that as a mining country Thailand will, for some more hundred years, be successful. She has also been endowed with nearly all other natural resources required in modern civilisation. The writer wishes to stress the fact that Thailand is not only rich in the fauna and flora, which so far have interested this society, but also minerals and rocks—the

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* Illustrated Lecture, accompanied by an exhibit of specimens, delivered before the Natural History Section of the Society, December 1940.

study of which, for some reasons or other, has been regrettably neglected.

A "mineralised area" (sometimes called "mineralised belt or mineralised zone") connotes a particular part of the earth's crust in which economic minerals occur. This would mean that outside the area no economic minerals could be found. The mineralised area is, then, an area enclosing all mineral deposits of similar origin, structure and mineralogical constitution. In a certain part of the country, there would be many similar mineralised areas lying close together. Therefore they are grouped together to form a "metallogenetic province". A metallogenetic province, then, includes a certain part of the country which has been subjected to the same earth movement causing mineralisation. The writer has found it necessary to introduce a new term in economic geology : namely "economic sedimentary bed," to signify an area of sedimentary rocks, which contain sedimentary mineral beds and deposits of natural fuels such as coals, petroleum and oil shales.

Reference to the mineral map will show that the writer has divided the country into many mineralised areas and economic sedimentary beds. Seperate areas are then grouped together into three metallogenetic provinces.

This map will help one to find out in what part of the country a certain mineral might likely occur. The writer should stress the purpose of this short article, that it is only of scientific value. He will not assure the readers that all the deposits talked of are workable. For detailed informations on ore deposits, the readers are advised to consult the Department of Mines or the writer himself. The writer can put them in the right mineralised areas and then leave them to apply their own geological knowledge to find the deposits. Sometimes, it is very helpful, once one is in the right mineral fields, to ask local people where the deposits are, because usually these people who live close to or even on top of minerals know well where to find them.

The writer has divided the country up into three metallogenetic provinces. He has to admit that with more extensive prospecting more metallogenetic provinces may be split off from the three. Out of seventy four provinces fourteen are situated on the plain of Chao Phya river and are therefore devoid of economic minerals. The remaining sixty provinces enclose hilly areas where economic minerals might occur.

The three metallogenetic provinces are :—

I. The Tin and Tungsten province occupying the western belt of the country.

II. The Gold, Iron and Copper province forming a region which surrounds the Korat plateau.

III. The Gold province occupying the Southern part of Narathivat and joining Malayan gold belt.

I. The Tin and Tungsten metallogenetic province. This province contains all the tin fields of Lower Burma, Southern Thailand, Malaya and Dutch East Indies. Tin and tungsten minerals are the most important. There are some iron deposits but they have not been prospected as yet. Lead, zinc, copper and gold are present in small amounts, but in many places they occur in workable quantities. Antimony, bismuth and molybdenum are very rare. Up to the present, only tin and tungsten minerals are mined in this province.

The mineralised areas enclose all the mountain ranges of the North and South. In these ranges the highest peaks are of granites. It is somewhat reasonable to assume that the cores of the mountain are also of granites. Therefore, if any mountains are seen in the south, granite will be there with its associative tin and tungsten minerals. The only exception is seen in the Singora mineralised area, where granite outcrops acquire comparatively low altitudes.

The mountain ranges of Thailand within the tin and tungsten metallogenetic province are arranged approximately along the North-South line. These have been formed by intense earth folding which caused the intrusion of granite. There are many folds parallel to one another but only the large ones have been intruded by granites. The igneous rocks have been injected from the sial crust below under intense pressure. In Southern Thailand the coverings of sedimentary beds exceed 45,000 feet. Therefore all the deposits of tin and tungsten minerals are of high temperature and pressure varieties. The sedimentary rocks in contact with the granites are Paleozoic slates, quartzites and schists but rarely limestones. It may be that the igneous rocks have not intruded far enough to reach the limestones.

The association of granite with tin and tungsten minerals is well known to students of geology and practical mining engineers. Therefore, to prospect for tin and tungsten, one should approach granite outcrops. It has been found that tin and tungsten deposits are in granite or in sedimentary rocks within two miles from the contacts with granites. It is one hundred percent right, in Thailand, to say that where-ever tin and tungsten minerals are found, granite will be present nearby. The reverse, however, is not always true. There are many outcrops of granite where neither tin nor tungsten minerals have been found.

### Mineralised Areas.

As a result, the mineralised areas are also granite areas. In the tin and tungsten metallogenetic province there are seven mineralised areas as follow:

A. The Chiangrai–Tak area: here there is a long granite outcrop from the extreme north of Thailand down south as far as Tark. The outcrop of granite is cut by the railway line at Khoon Tarn tunnel. Diorites and gabbros are associated with the intrusions of granites. Cassiterite, the mineral of tin, has been found in Umpur Vieng Pa Pao, Umpur Chare Hom and Umpur Muang Lampang. In many places gold has been worked by primitive mining.

B. The Ganburi–Prachuapkirikhan area: this area may be a collection of three or more areas which so far have not been much known to geologists. The outcrops of granite are present as a long range of mountains bordering Burma and Thailand. The area is as yet inaccessible and prohibited for mining. Gold and lead are the other minerals found in this area.

C. The Ranong–Phuket area: in this area the colour of cassiterite is mainly black; wolframite occurs to a smaller extent in Ranong and Phuket.

D. The Nakhon–Satun area: this is a well defined area which extends from Koh Tao, Koh Phangnga as far as Penang island.

E. The Singora area: in this province granite outcrops acquire comparatively low altitudes among Triassic sediments. There are outcrops here and there which seem to be scattered well away from the main range of granite. Cassiterite has yellowish and honey-brown tints. Wolframite is rare in this area. It seems to be confined to regions of high altitudes only.

F. The Lumphya–Betong area: the characteristic phenomenon in this area is that at Umpur Bannang Star granite comes into contact with limestone, giving rise to contact metamorphic tin deposits.

G. The Yala–Saiburi area:

There is another mineralised area of tin and tungsten outside the metallogenetic province. It is in the region surrounding Kao Sabab in Chanthaburi and Kao Keo in Chonburi.

ORES OF TIN.

Only one mineral of tin, Cassiterite, has been found in Thailand. Stannite, the sulphide of tin, has been suspected at many places, but at present there is no serious search for the mineral. Cassiterite is tin dioxide, which, if one hundred percent pure, would contain 78.6% of tin metal. The mineral would also be colourless and transparent. In nature, however, cassiterite has all sorts of colour, due to various impurities. A certain colour is characteristic of the particular area, as has been mentioned.

Cassiterite has been found in both alluvial and lode deposits. At present there are very few lode mines, all others working alluvial deposits. Yet there are evidences that lode mining will be popular in the next ten years and that, by then, Thailand will lead the world in tin production.

An alluvial deposit of tin consists generally of a bed of coarse material such as quartz-pebbles, stone pebbles, cassiterite, ilmenite, monazite, zircon, tourmaline and sometimes clay from decaying rocks. This coarse bed rests immediately above bed-rock and is overlain by beds of sands, clays and sandy clays.

In lode deposits cassiterite is associated mainly with quartz. The lode is tabular or lens-like but sometimes the ore body assumes the shape of a pipe.

In primary deposits cassiterite is associated with ordinary vein minerals, namely felspar, quartz, micas, tourmaline, topaz, galena, pyrite, sphalerite, chalcopyrite, arsenopyrite and molybdanite. The writer has found it necessary to divide primary deposits of cassiterite into six types as follow:—

PRIMARY DEPOSITS OF CASSITERITE.

I. Rock deposits:—Occurrence of cassiterite in rock is uncommon. It has been found in some aplites. In Ranong the primary deposits of cassiterite are pipes in granite near a granite-schist contact. The pipes contain felspar, quartz, cassiterite and wolframite in a granitic texture. Owing to the soft nature of the rock and ore the property has been worked as a gravel-pump mine.

II. Pegmatite deposits:—Several pegmatite veins contain cassiterite. The associative minerals are quartz, muscovite, tourmaline and sometimes arsenopyrite. The association of cassiterite and tourmaline has been observed by local people who call tourmaline "friend of tin." Sometimes, felspar is kaolinised with the result that the veins become soft white stuffs known locally as "Kla." "Kla" mining is much practised in the western tin belt, where the granite is so decomposed that the veins may be worked by ground sluicing or gravel pumping.

III. Pegmato-pneumatolytic deposits: In this type of deposits felspar of pegmatites has been attacked by boron and water vapours to form tourmaline and muscovite respectively. The walls, if they are of granite, are greisenised with the development of tourmaline and muscovite in place of original felspar crystals. Cassiterite is present in the veins and also in the greisenised walls (greisen), pyrrhotite, pyrite and arsenopyrite may accompany cassiterite in these veins. Fluorspar is rare. Primary quartz, tourmaline and muscovite are generally present. These deposits are, indeed, pegmatites which on cooling have been attacked by vapours, carried along with them.

IV. Pegmatitic Quartz veins: These veins have been differentiated from pegmatites and, if followed, will show a transition from purely quartz veins through pegmato—pneumatolytic veins to pegmatites. The ore then consists principally of quartz with minor amounts of tourmaline and muscovite. Cassiterite, arsenopyrite, pyrite, chalcopyrite, pyrrhotite and molybdanite are the metallic minerals present.

In veins of pegmatitic origin wolframite often accompanies cassiterite. Mining of these veins results in mixed concentrates which have to be treated by magnetic separators.

V. Contact Metamorphic deposits: when granite comes into actual contact with limestones, the contact zones are metamorphosed with the development of green minerals such as olivine, hedenbergite, andradite, epidote and idocrase. Admixed with these so-called "skarn minerals" are many sulphides such as galena, sphalerite, pyrrhotite, arsenopyrite, bismuthinite, pyrite and chalcopyrite. Magnetite, specularite and oxides of manganese are invariably present. Cassiterite has been found as extremely fine crystals in the skarn minerals. Sometimes it is present as pockets in the skarn minerals in coarse crystals. Wolframite is absolutely absent.

VI. Hypothermal quartz—sulphides veins: these veins are much sought after, due to their regularity in values and persistence in widths. They are found mostly in sedimentary rocks adjacent to the granite. The associative minerals are arsenopyrite, galena, sphalerite, pyrite and chalcopyrite. The gangue consists wholly of crypto-crystalline quartz.

On top of primary deposits of cassiterite and near them are soils containing cassiterite. These are called detrital deposits. They are richer than alluvial deposits, but owing to their low yardage they are only worked by poor people possessing small capital.

### ORES OF TUNGSTEN.

There are two tungsten minerals, scheelite and wolframite. Scheelite is calcium tungstate, while wolframite is an isomorphous mixture of iron tungstate and manganese tungstate.

Scheelite is white but is the densest of all white minerals. The only mineral which may be mistaken for it is baryte, the sulphate of barium.

Wolframite is dark brown and has metallic lustre. It breaks into metallic-looking thin plates and so can be easily distinguished from cassiterite.

Owing to its weakness wolframite never survives to be present in true alluvial desposits. It is however found in detrital deposits near to wolfram veins and may be worked by hydraulic mining.

It has been said that wolframite accompanies cassiterite in deposits of pegmatitic origin and is totally absent in contact metamorphic deposits. Therefore to study its occurrence one should turn back to descriptions of cassiterite primary deposits.

In hypothermal quartz-sulphides veins (i. e. formed under high temperature and pressure) wolframite occurs alone without cassiterite. Hypothermal wolfram veins have only been found in granite. The gangue is wholly quartz again and the associative minerals are sphalerite, galena, pyrite, and chalcopyrite.

It has been noted that wolfram occurs mainly in regions of high altitudes. The mineral seems to be associated with intense earth folding.

The writer has not seen any scheelite deposits, but he has been informed that it is found in limestones adjacent to granite outcrops. Therefore he thinks that the character of the deposits would be the same as of those in Malaya.

### GOLD.

Gold has been found with cassiterite in alluvial deposits at Ranong and Phangna. Attempts to find gold-bearing veins have failed. Even in alluvial deposits it is present in extremely small quantity.

There are two promising gold fields. One ore field is in Ganburi and another at Bangspan in Prachuapkirikhan. The gold is probably derived from some quartz veins in sedimentary rocks far away from the granite.

In Lamphun and Tern there are several alluvial gold deposits, probably associated with quartz-diorite.

### SILVER.

Native silver has been found in a tin mine at Chana in Singora. It is derived from the decomposition of argentiferous galena, admixed with tin ore. The quantity present is again too small.

### LEAD.

Lead, in the form of galena, is found associated with cassiterite and wolframite in hypothermal quartz—sulphides veins in nearly all mineralised areas. It is always argentiferous. Promising deposits are in Bannang Star, Yala, where galena occurs as veins in limestones adjacent to the granite or in contact-metamorphic deposits.

In regions far away from granite outcrops, galena has been found with quartz in slates and limestones. Promising deposits of this type are in Umpur Sri Swasdi, At Doi Chiang Dao galena occurs among calcite gangue with sphalerite, pyrite and chalcopyrite. The ore body is in limestone. The deposit is, probably, of meteoric origin.

### ZINC.

Zinc occurs as sphalerite which is zinc sulphide. Zinc sulphide should be colourless and transparent, but—owing to iron and cadmium impurities—it acquires yellow to honey brown colour.

In hypothermal veins sphalerite is frequently present in small quantity, but workable deposits may be found in Bannang Star.

In dark limestones there are specks of sphalerite scattered here and there. The only likely deposit of sphalerite is at Doi Chiang Dao, where the mineral occurs in association with galena and chalcopyrite.

### COPPER

It is as yet impossible to say whether copper pyrite found in the tin metallo-genetic province is present in workable quantity. In contact metamorphic deposits at Bannang Star, chalcopyrite occurs in pyritic bodies or in association with galena and zinc blende. Perhaps veins of galena and chalcopyrite in limestones near the contact with granite may be promising.

### ARSENIC

Arsenic is found in arsenopyrite which is associated with cassiterite and wolframite. Arsenopyrite, the silvery white mineral, contains iron, arsenic and sulphur. The mineral is then a by-product of tin and tungsten (wolfram) mining. Arsenious oxide is driven off in roasting tin and wolfram concentrates and may be collected.

Veins high in arsenic are found in Koh Smui and Na Sarn.

### PYRITE

Pyrite is a brass-yellow mineral. It is a disulphide of iron. In view of the fact that Thailand needs sulphur for her rubber and sulphuric acid industries, pyrite may become an important mineral soon.

Pyrite is present in small amounts with other minerals in nearly all types of deposits. However, the most likely place to look for pyrite is Bannang Star where the mineral occurs as massive bodies and veins in "skarn rocks" of contact metamorphic deposits.

Some veins of wolfram in Ta Sa la are filled with solid pyrite in certain portions of the ore bodies.

### IRON.

The tin metallogenetic province is in the region of high rainfall and hence laterite beds have been developed in all iron-bearing rocks.

Therefore many iron deposits, talked of in this regions, are laterite deposits. The writer admits that good iron ore may be developed in laterite beds but the most that he has visited is just ordinary laterite with not more than twenty per cent. of iron.

At Koh Lek in Krabi, the iron ore, which is partly limonite and partly hematite, fills fault hollows in shale and sandstone beds. The quantity present is too small.

In Ganburi iron ores of good grade have been found on top of the limestones. The deposits have been formed by the dissolving of calcium carbonate by meteoric water, leaving behind iron oxides.

Promising deposits of specularite and hematite have been discovered at Koh Smui, Sichol, Ta Sa La, Na Sarn and Lumphya. The minerals are found with quartz in veins traversing slates and sandstones. The ore carries over 65% iron with very little sulphur and phosphorus.

II. The Gold, Iron and Copper metallogenetic province.

This province extends from Chiang San southward as far as Chanthaburi. It encircles the Korat plateau.

The earth movement which was responsible for the formation of the Korat plateau is not as intense as that in the west. In the process of folding the Upper Triassic strata seem to slide freely on the older rocks and thus are not much affected by the folding action, but are simply lifted up to form a highland.

The folding was accompanied by contemporaneous faultings which are characteristic of this metallogenetic province. Therefore, although the movement was not intense enough for granite to come up, other hypabyssal rocks such as quartz diorites, greenstones, porphyrys and andesites intruded the sedimentary rocks.

Where movement is intense, which is shown by the presence of mountains, there are granite outcrops.

The igneous rocks and emanations from magma below come into contact with limestones and give rise to contact zones which are characterised by skarn minerals, mostly of green garnet.

This period of mineralisation is noted for the association of three important minerals, namely native gold, magnetite-specularite and chalcopyrite. Pyrite occurs as large masses in some contact zones. Other mineral, such as galena, is rare. There are many gold occurrences in this metallogenetic province, and it may as well be called gold province.

### IRON.

In this province iron ores have been formed by contact metamorphism and by decomposition of iron-rich rocks.

At Khao Tong and Hua Ngio good hematite ores, carrying over 65 % metallic, have been formed by laterisation. The parent rock is rich in iron and low in free silica. This would explain the good quality of the ore.

On limestone highlands, where terra rossa is developed, nodules of good iron ore are seen in the red soil.

Iron ores from these two sources are of small tonnage and could only be worked by ancient people, who had very little need for iron.

The writer has just finished joining the Thai Cement Company in prospecting two contact metamorphic iron deposits in Lopburi and Nakorn Swan. The deposits consist of solid magnetite-specularite lenses in green garnet rock. The outcrop at Hua Wai is of very pure magnetite and it shows strong magnetism. In some of these deposits chalcopyrite is admixed with the specularite and magnetite. The Kao Tub Kwai magnetite-hematite deposit in Lopburi, suggested by the writer, has been found by prospecting to be rich enough for an iron industry on a small scale.

### COPPER

Copper occurs as chalcopyrite and its oxidised products, azurite, malachite, atacamite, chrysocolla and brochantite. The primary mineral chalcopyrite is found disseminated in green garnet rock at Kok Katiem. At Hua Wai chalcopyrite occurs in hypothermal quartz veins in limestones, the walls of which have been garnetised. The mineral is found also with magnetite and specularite in contact metamorphic deposits.

In Nan and Lampang chalcopyrite occurs in quartz veins.

### GOLD.

In this province gold is found in two types of deposits.

In the high temperature and pressure deposits the main gangue is quartz. There is very little pyrite, and gold is found native embedded in quartz. At Nong Sung station the gold vein is in limestone. At the contact green garnet is developed.

Quartz veins in andesite porphyry carry native gold and much pyrite. The quartz is cryptocrystalline and very tough. Much of the gold is within pyrite crystals. In limestones near porphyry intrusions mesothermal veins of gold occur. The ore consits of calcite, quartz, chalcedony, pyrite, bismuthinite, chalcopyrite and native gold.

At Ban Bo Tong in Nakorn Swan province such mesothermal gold-bearing veins have been intruded by quartz-diorite and high temperature quartz. The veins were broken and garnet was developed. The ores are of two types, white mesothermal ore and green garnet ore.

III. The Gold metallogenetic province. This gold province begins at Sungei Padi station, where there is an outcrop of granite among argillaceous rocks. This gold belt extends into Malayan gold fields where rocks of "Pahang Volcanic series" predominate. The outcrop of granite has its length along a North-South line. It passes into Malaya at Toh Moh where gold is mined.

This granite carries no tin and tungsten minerals and it is much altered. There are numerous quartz veins in both granite and schist in contact with the granite. Close observation has shown that quartz has been there long before the period of mineralisation. By certain earth movements the veins of quartz have been cracked and into these cracks hydrothermal solutions were injected. As a result, the cracks have been filled with veinlets of gold ore carrying sericite, talc, calcite, arsenopyrite, pyrite, galena, zinc blende, native gold and chalcopyrite. Much of the gold is present in the sulphide minerals. These hydrothermal solutions also penetrate granite and schist walls and mineralise them. Later veins of biotitite and diorite cut across the veins of quartz and the writer believes that this diorite has come at the same period as that of mineralisation.

### LEAD.

In many of these gold bearing veins, galena is predominant. Promising deposits of galena have been reported from Sungei Padi.

### ECONOMIC SEDIMENTARY BEDS.

Thailand has rocks of two ages which may contain economic sedimentary beds. They are Triassic and Tertiary rocks.

Permo-Carboniferous rocks are predominant in this country but unfortunately they do not contain any coal beds. No reports of petroleum or oil shale have come from a country of old rocks.

Triassic rocks, where they are much folded, contain igneous rocks and are mineralised. In the Korat plateau they are least affected by earth movements; therefore the whole plateau is devoid of metallic minerals. However in the strata there are beds of rock salt deep down below the surface of the ground. Natural brine springs, which pass through the beds, come to the surface and leave the salt on the ground. This salt is a godsend for Thai people living on the plateau.

Tertiary rocks in Thailand carry natural tar, oil shales and bituminous coals.

At Fang natural tar occurs in sandy beds among clay strata. Boring to strike petroleum failed as the tar seeps are shallow and there is no sign of any petroleum below the tar deposits.

Oil Shales occur at Mae Sod in many thick parallel beds. The reserve is considerable and the percentage of extractable crude oil is considered high. Unfortunately the district is inaccessible.

Bituminous coals or black lignites have been found in Tertiary beds at Kantang, Krabi, Betong, Me Moh, Chang Kerng and Pra Sang. They carry high volatile contents and fair calorific values. Therefore the writer hopes that in the future these coals will be very useful to Thailand.

### GEMS.

Thailand has become world famous because of her splendid sapphires and zircons. Unfortunately the zircons have come from Cambodia through Thailand and are not produced in this country.

Thai sapphires are of many colours, colourless, yellow, green, violet and the most priced cornflower colour. Rubies have also been produced, but the majority of them are dull red and incomparable with Burma rubies of fine pigeon blood colour.

Amethyst, prase and citrine have been collected from quartz veins in the Gold-Iron-Copper metallogenetic province.

Rubies and sapphires have their origin in the mass of basalts. They are associated with black spinel or hercynite. Up to the present, the writer has failed to detect the presence of corundum (rubies and sapphires) in these basalts. This may be due to rarity of the mineral.

There are outcrops of gem-bearing basalt areas in Chanthaburi, Trat, Ganburi, Phrae and Chiang Kong.

## ORNAMENTAL STONES.

In the Iron-Copper-Gold province good marbles have been found at Pra Bat. Of course, marbles may be found in all parts of Thailand except in the Korat plateau.

Pyrophyllite soapstone occurs at Phramani in Nakhon Nayok. It is soft and can be carved into any ornamental figures.

Serpentine of fine green colour may be had at Umpur Lap Lare in Uttradit.

## NON-METALLIC MINERALS

Asbestos of poor quality occurs at Uttradit in pyroxenite. It is hoped that beyond the water table the grade is better. Barytes have been found at Mae Sod in a workable quantity. Kaolin occurs in many localities and by simple washing good clean kaolin may be obtained. Gypsum from Me Moh finds ready use in the cement factory. Diatomite at Muang Lampang has not yet received any attention. The only non-metallic mineral, much required for the cement factory, is the inexhaustible natural precipitated chalk at Saraburi.

In conclusion the writer wishes to offer his help to the Thailand Research Society at all times in the further study and development of Mineral Resources in this country.