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Osmiridium—a discovery in Cheroh, Pahang, Peninsular Malaysia—and its significance

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Abstract: Significant traces of osmiridium, a platinum-group metal, were found in a tin placer deposit along the Sungai Semantan near Cheroh 16.1 km (10 miles) north of Raub, Pahang, Peninsular Malaysia. The likely source of this metal is a large serpentinite body situated 6.4 km (4 miles) to the west which is drained by some tributaries of the Sungai Semantan. The presence of osmiridium further supports the view that the serpentinite bodies of the Foothills group of rocks represent an ophiolite belt of Lower Palaeozoic age.

INTRODUCTION

In late 1980, a tin miner gave the author a small sample bag containing many grains of a platy mineral with a strong metallic lustre. This sample weighs only approximately 5 grams. The mineral was then known to be hard and had an extremely high melting temperature. It was found together with some gold associated with the heavy mineral discard or "amang" after the cassiterite had been separated from the tin "ore".

This tin mine, the Kundang Patah Mine No. 9, is situated on the alluvial flats of the Sungai Semantan in the Cheroh area, 16.1 km (10 miles) north of Raub, in the state of Pahang (Figs. 1 & 2). It is an open-cast mine, working by ground sluicing and gravel-pump method on a shallow placer deposit of recent river alluvium. The bedrock consists of weathered shale interbedded with tuffaceous sandstone of probable Triassic age.

MINERAL IDENTIFICATION

On close examination, the mineral is noted to be opaque and tin white in colour. It commonly occurs as irregular flattened grains of up to 3 mm in dimension with a well developed basal cleavage like mica (Plate 1). The more crystalline grains appear to be hexagonal in outline. It has a hardness of 6.0–7.0 (Moh's scale) and specific gravity of about 22. The mineral is resistant to acid attack and has a melting temperature of over 2,000 °C.

The elements detected by a qualitative X-ray fluorescence spectrometry (XRF) scan are listed in Table 1 below.

TABLE 1.
ELEMENTS DETECTED BY XRF

Osmium	—	very intense peak
Iridium	—	intense peak
Ruthenium	—	intense peak
Copper	—	weak peak
Iron	—	weak peak

Presented at GSM Regional Geology Seminar, April 1981.

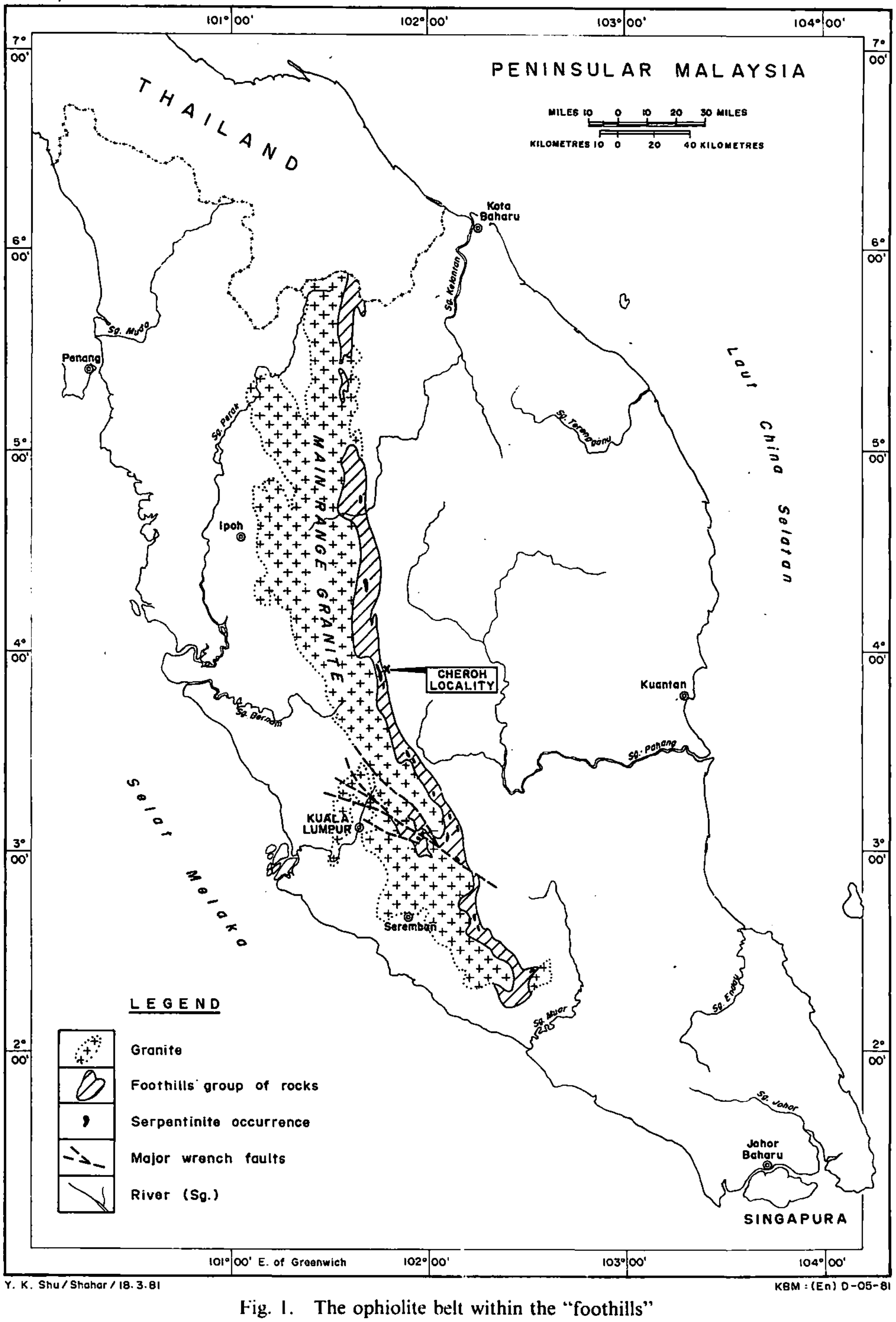

Fig. 1. The ophiolite belt within the "foothills"

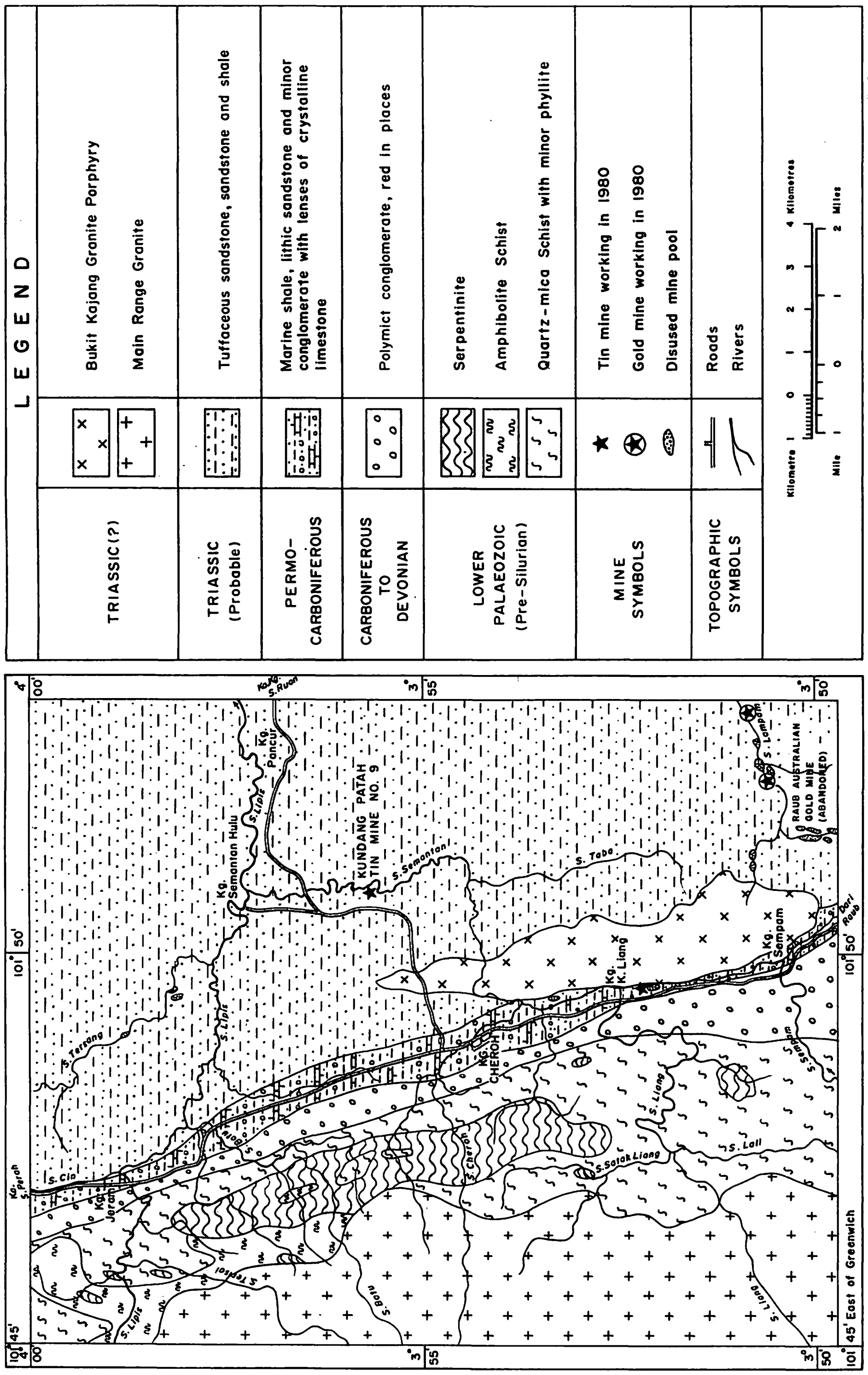

Fig. 2. General Geology of the Cheroh area

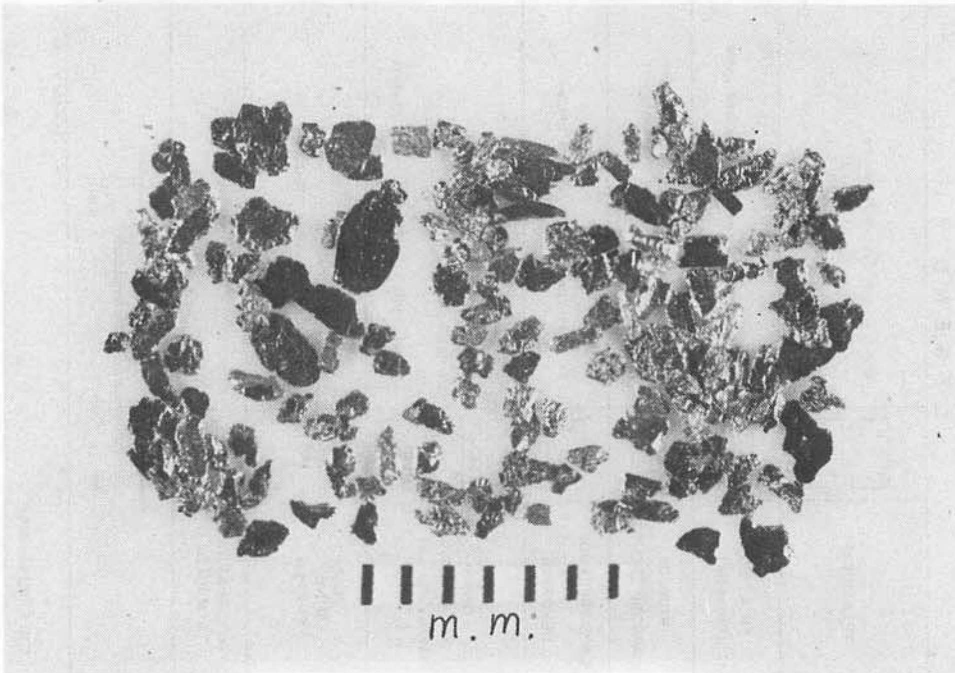

Plate 1. Platy crystals of osmiridium.

In the X-ray diffraction (XRD) determination using the preferred orientation photograph of the grains, sufficient lines were obtained to identify the mineral as osmiridium, a platinum-group metal. Due to the lack of time, the exact composition of the osmiridium has yet to be determined. This aspect of the investigation will be undertaken by the Geochemistry Division of the Geological Survey.

THE PLATINUM-GROUP METALS

The platinum-group of metals comprises platinum, iridium, osmium, ruthenium, rhodium and palladium. Platinum, iridium and osmium have the greatest density and iridium is now recognized as the heaviest element that occurs in nature. These six elements are divided by their densities into two sets, which are analogous to gold and silver. Thus all six of these elements are invariably present as native alloys of the platinum metals (Table 2).

The native platinum metals, found mainly in placer deposits, consist generally or intergrown with one another. These alloys are designated commercially and generically as "platinum" and "osmiridium". Platinum consists dominantly of that metal, but includes invariably the other five metals in variable amounts. Osmiridium consists dominantly of iridium and osmium but includes also the metals ruthenium, rhodium, and platinum.

TABLE 2.

PHYSICAL PROPERTIES OF THE PLATINUM METALS, GOLD AND SILVER (AFTER MERTIE, 1969)

Precious Metals	Atomic Number	Atomic Weight	Density at 20 C	Hardness (Moh's scale)	Melting Point (°C)	Workability
Platinum	78	195.2	21.45	4.0 4.5	1,769	Malleable and ductile
Iridium	77	193.1	22.65	6.0–7.0	2,443	Brittle
Osmium	76	190.2	22.61	7.0	3,045	do
Ruthenium	44	101.7	12.45	6.5	2,310	Brittle, cold. Malleable, red heat.
Rhodium	45	102.9	12.41	6.0	1,960	do-
Palladium	46	106.7	12.02	4.5–5.0	1,552	Malleable and ductile but less so than platinum
Gold	79	197.2	19.27	2.5–3.0	1,063	Very malleable and ductile
Silver	47	107.9	10.50	2.5 3.0	961	Malleable and ductile

Since they readily form native alloys, both osmium and iridium combine in widely divergent compositions. In this respect the terms "osmiridium" and "iridosmine" are employed to denote iridium-rich and osmium-rich alloys respectively. The name nevyanskite has also been used for alloys with over 40% iridium and siserskite for those that contain much less iridium and more osmium. However, for this paper, the name osmiridium, which is a more widely accepted term, is used to denote the osmidium-iridium native alloys.

OSMIRIDIUM OCCURENCES

Osmiridium is well represented in most of the platinum placer deposits around the world, in particular the Russian Urals, the lithified placers of South Africa, and Western Tasmania (Mertie, 1969). It is also found associated with a number of placer gold deposits where no other platinum-group alloys are present. This characteristic is due to the fact that platinum, and to a lesser extent platinum, rhodium, and ruthenium, are solubilized during the placer formation. Thus in most mature placers the predominant alloy of platinum-group metals is osmiridium, composed of the remaining elements, osmium and iridium.

The world's principal source of osmiridium is the lithified placers of the Witwatersrand in the Republic of South Africa. In the 1920's and 30's, the famous osmiridium fields, known as the Heazelwood district and Adamsfield district of Western Tasmania were rather rapidly mined to exhaustion (Lennon, 1927 McDonald, 1960 and Nye, 1929). Presently, apart from the Witwatersrand, this platinum-group alloy is produced as a by-product of a number of small platinum placer fields around the world. The distribution of known platinum-group metals occurrences in Southeast Asia and Australia are listed in Table 3 below (Mertie, 1969).

POSSIBLE SOURCE ROCK

Placers of the platinum metals are commonly derived from dunite or serpentinite, less commonly perknite, in which these metals are sparsely and irregularly distributed. It may be inferred that the original lodes could be discovered by tracing the alluvial deposits upstream, but workable lodes can rarely be located. The possible explanation is the original source rocks may have been of extremely low grade, and the placers may have been concentrated from such sources over a very long period of time.

In the case of the Cheroh deposit, a 9.7 km (6 miles) long by 1.2 km (3/4 mile) wide serpentinite body (Richardson, 1939), situated 6.4 km (4 miles) to the west among the foothills of the Main Range, is the most likely source of the osmiridium. This platinum-group metal could have been brought down by fast flowing mountain streams, as tributaries of the Sungai Semantan, which empty into the rolling plain east of the foothills. With the sudden change in river gradient, large alluvial flats with the associated placer deposits are formed. Likewise, the source of the placer tin deposits is the Main Range granite situated further to the west which is drained by even larger mountain streams.

Since no follow-up work has been undertaken to prospect for platinum-group metals in the Cheroh area, the possibility of finding economical deposits in the form of

TABLE 3.

KNOWN DISTRIBUTION OF PLATINUM-GROUP METALS IN SOUTHEAST ASIA AND AUSTRALIA (AFTER MERTIE, 1969)

Country & Area	Type of Deposit	Platinum Metals	Possible Source Rock
Upper Burma	placer	Platinum and Osmiridium	serpentine intrusions of the Patkois and the Arakan Yomas
Philippines	Zinc-Copper (lode)	Platinum-group metals	by-product of zinc-copper smelting.
Kalimantan, Indonesia (Borneo)	gold and diamond placers	Platinum and Osmiridium	serpentinite in the Bobaris and Ratoos Mountains.
North Sumatra, Indonesia	contact-metamorphic (a peculiar lode)	Platinum	contact metamorphism of limestone to grossularite and wollastonite
New Guinea (numerous localities)	gold placer	Platinum and Osmiridium	peridotite and serpentinite
Australia, New South Wales and a number of gold fields	placer	Platinum	no information
Australia, Tasmania, Heazelwood & Adamsfield districts.	placer	Osmiridium	serpentinite

placers or lodes, cannot be ruled out entirely. In this respect the tributary streams comprising Sungai Penggong, Sungai Cheroh, Sungai Chembatu, Sungai Mambang, Sungai Semeriong, Sungai Batu and Sungai Bekil should hold particular interest to future prospectors.

In the short term, the value of osmiridium as a by-product of placer tin mining along the Sungai Semantan is not fully appreciated by the tin miners. In fact the osmiridium has been discarded in preference to the gold found together with it in the "amang". Furthermore, the osmiridium, with a platy crystal habit has the tendency, despite its high density, to float readily by surface tension and is lost over the sluice-gates of the "palong". Thus by considering the amount of osmiridium retained with the "amang" and the portion that is lost over the sluice-gates, it is possible to infer that this platinum-group metal occurs in significant amounts among the tin placer deposits of Sungai Semantan.

THE "FOOTHILLS"

The "Foothills" (Haile *et al.*, 1977) consists of a 3.2 to 8.0 km subparallel ridges of arenaceous-rudaceous rocks with intervening valleys of argillaceous rocks, schists, and serpentinite. It stretches without a break north-northwestward from the state of Malacca to south Kelantan, a distance of about 321.9 km (200 miles) (Figure 1). This rock sequence forms a topographically well-defined belt along the eastern flank of the Main Range granite. East of this belt, and at a much lower elevation, is a suite of softer rocks generally of a younger age.

Apart from its unique topographic feature, the belt of foothills contains a sequence of rocks with characteristic eugeosynclinal affinity. Besides the chert and essentially arenaceous nature of the lithology, it also contains the largest and most well-defined belt of serpentinite bodies in Peninsular Malaysia. The characteristic rock-types within this sequence are, quartz-mica schist, quartz-graphite schist, amphibolite schist, serpentinite, phyllite, slate, hornfels, argillite, siltstone, sandstone, subgreywacke chert, and conglomerate with some red beds.

Recent workers (Alexander, 1968, Haile *et al.*, 1977 and Darmarajan, 1975) on this foothills group of rocks have identified three distinct litho-stratigraphic units. There is a basement schist unit which is overlain unconformably by a chert subgreywacke unit. Overlying, and in places truncating, both the two lower units are thick lenses of conglomerate which form the long narrow ridges of the foothills (Figure 3).

The schist unit consists essentially of quartz-mica schist, quartz-graphite schist, amphibolite schist, and phyllite. The serpentinite intrudes, and is confined only to within this schist unit. In the Bentong area this schist has been correlated to the "Kuala Lumpur Schist" on the west side of the Main Range (Yin, 1962).The "Kuala Lumpur Schist" is of pre-Silurian age.

In the chert-subgreywacke unit, the common rock-types are argillite, siltstone, subgreywacke and chert. In the Karak and Jelebu areas, graptolite fossils have been found in carbonaceous slate interbedded with the chert and subgreywacke (Jaafar, 1976 and Shu, 1981). They are of Early Devonian age. Hornfelses are often found associated with the intrusion of the Main Range granite to the west.

The eastern boundary of the foothills is often demarcated by the conglomerate unit which represents a fluviatile to continental environment of deposition. Being more resistant to weathering, it is responsible for the formation of long parallel ridges which characterizes the foothills. Due to the lack of fossil evidence and a much extended area of occurrence, it is conceivable that more than one age of conglomerate is represented. The possible timespan is from Middle Devonian to Late Mesozoic.

In the Cheroh area (Lim, 1972), the chert-subgreywacke unit is not represented in the foothills group of rocks. The nearest occurrence is in the adjacent Raub area to the immediate south. The foothills in this area varies from 2.4 to 4.8 km ($1\frac{1}{2}$ to 3 miles) wide (Figure 2). The eastern boundary is demarcated by a 2.4 km ($\frac{1}{2}$ mile) wide conglomerate ridge. The rest of the foothills is underlain by quartz-mica schist and amphibolite schist

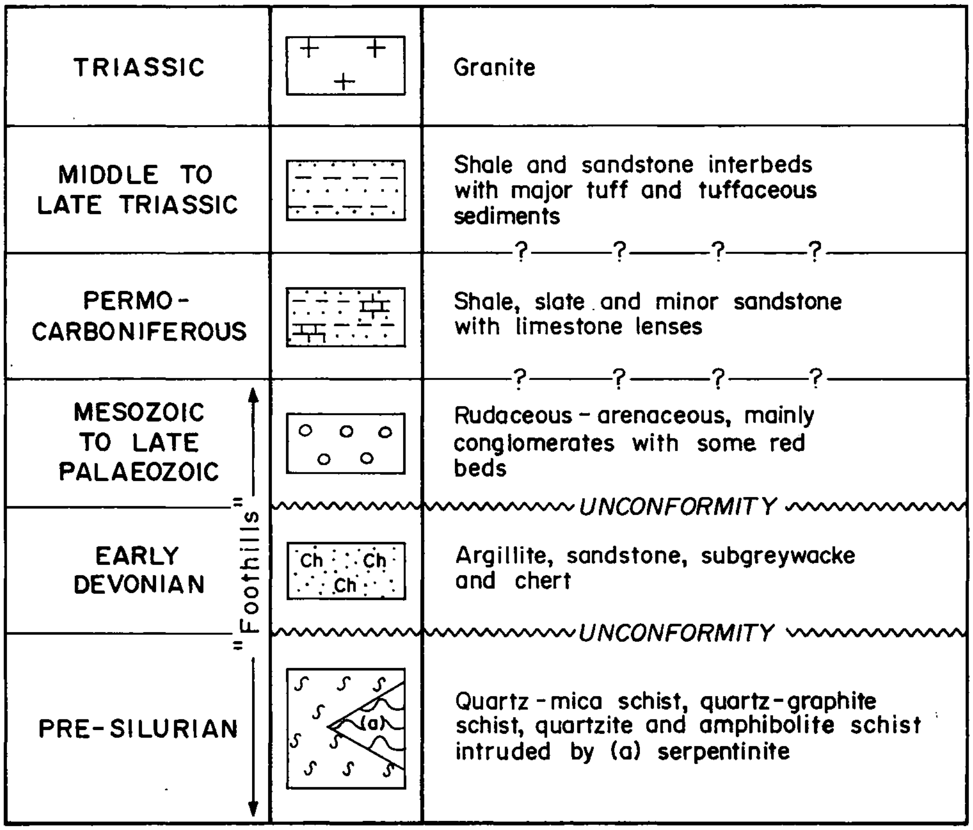

Fig. 3. Generalized stratigraphy of the "Foothills" and the younger rocks to the East

with a minor component of phyllite. Intruding these schists is one of the largest serpentinite bodies found in the "Foothills". It is 9.7 km (6 miles) long by 1.2 km (¾ mile) wide, elongated along the trend of the foothills.

THE SERPENTINITE

Although the serpentinite bodies found within the "Foothills" are small by world standard, nevertheless they represent the only notable serpentinite belt in Peninsular Malaysia. The present known length of this belt is about 273.6 km (170 miles), from Gunong Ledang, at the Malacca-Johore state boundary, north to the Sungai Betis area in the state of Kelantan.

The origin of the serpentinite had intrigued local geologists for many years. The postulations vary from ultrabasic bodies to high-grade thermally metamorphosed calcareous rocks (Jaafar 1976). These uncertainties arose from the lack of diagnostic minerals or textures which could point to the original ultrabasic rocks. Subsequently some Geological Survey geologists, working in their respective foothills area, detected relict olivine and pyroxene grains in their serpentinite. The chemical composition of most of the serpentinite samples also showed small percentages of chromium and nickel content. This, together with the presence of chromite in alluvial concentrates from the Raub (Richardson, 1939) and Betis areas led them to conclude that the serpentinite bodies had been formed from a suite of ultrabasic rocks by paulopost hydrolysis. Now, the discovery of osmiridium near the Cheroh serpentinite further strengthen the view that the original rock is a peridotite, representative of an ophiolite suite which characterizes the eugeosynclinal affinity of the "Foothills".

The emplacement of the serpentinite (ultrabasic) bodies is believed to have occurred during the earliest stage of the geosyncline formation, which being restricted to the basal schist unit of the "Foothills", must be of early Palaeozoic times. The age of this emplacement is pre-Devonian (Shu, 1981) for no serpentinite has been found intruding into the overlying non-metamorphosed rock units. These serpentinized ultrabasic bodies were probably injected along previously developed zones or lines of structural weakness within the schist basement.

CONCLUSION

The discovery of osmiridium is a strong indication in the ultrabasic origin of most, if not all, of the serpentinite bodies found within the "Foothills". This in turn would represent the largest, if not the only recognizable, ophiolite belt in Peninsular Malaysia. This ophiolite suite is of at least Early Palaeozoic age.

At present, the osmiridium is only recoverable as a by-product of placer tin mining along the Sungai Semantan. The likelihood of finding economical placer as well as lode deposits of platinum-group metals by tracing the alluvial deposits upstream should not be overlooked. Likewise, closer attention should be paid on similar serpentinite bodies found elsewhere along the "Foothills" for the possibility of finding any of the platinum-group of metals.

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