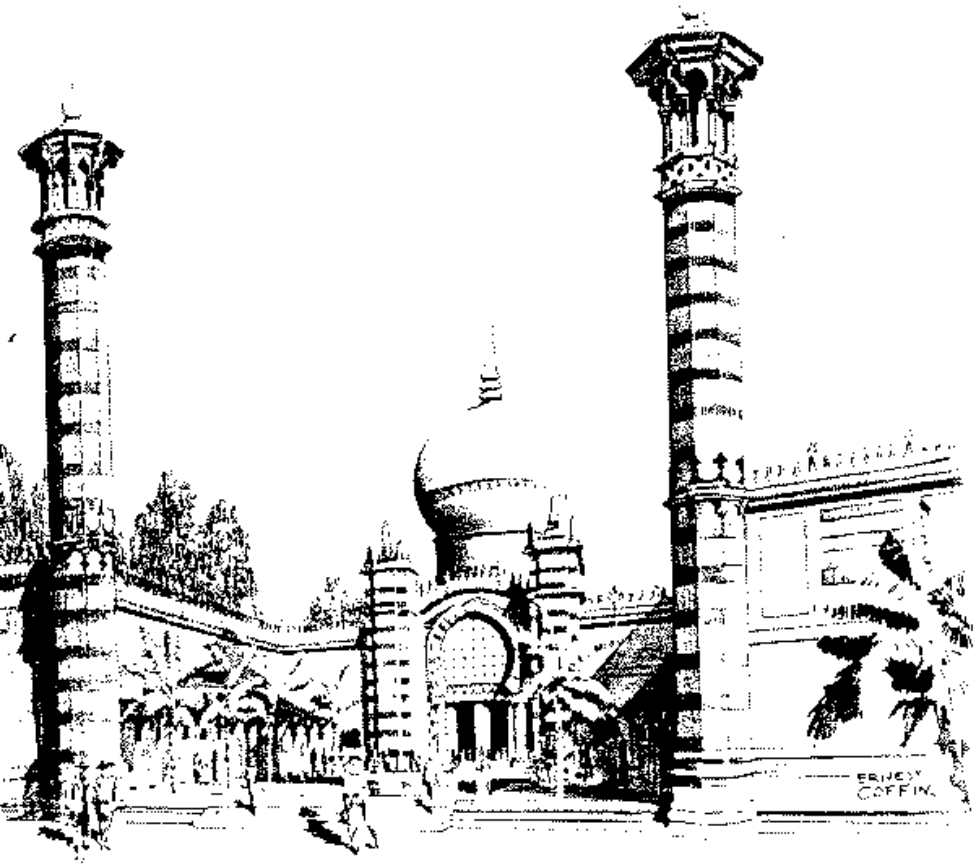

Malaya Pavilion
British Empire Exhibit
Wembley, 1924

MINING IN MALAYA

MALAY STATES INFORMATION AGENCY

88, CANNON STREET, LONDON, E.C.4.

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Mining in Malaya

BY

G. E. GREIG, A.R.S.M.

ACTING SENIOR WARDEN OF MINES, FEDERATED MALAY STATES

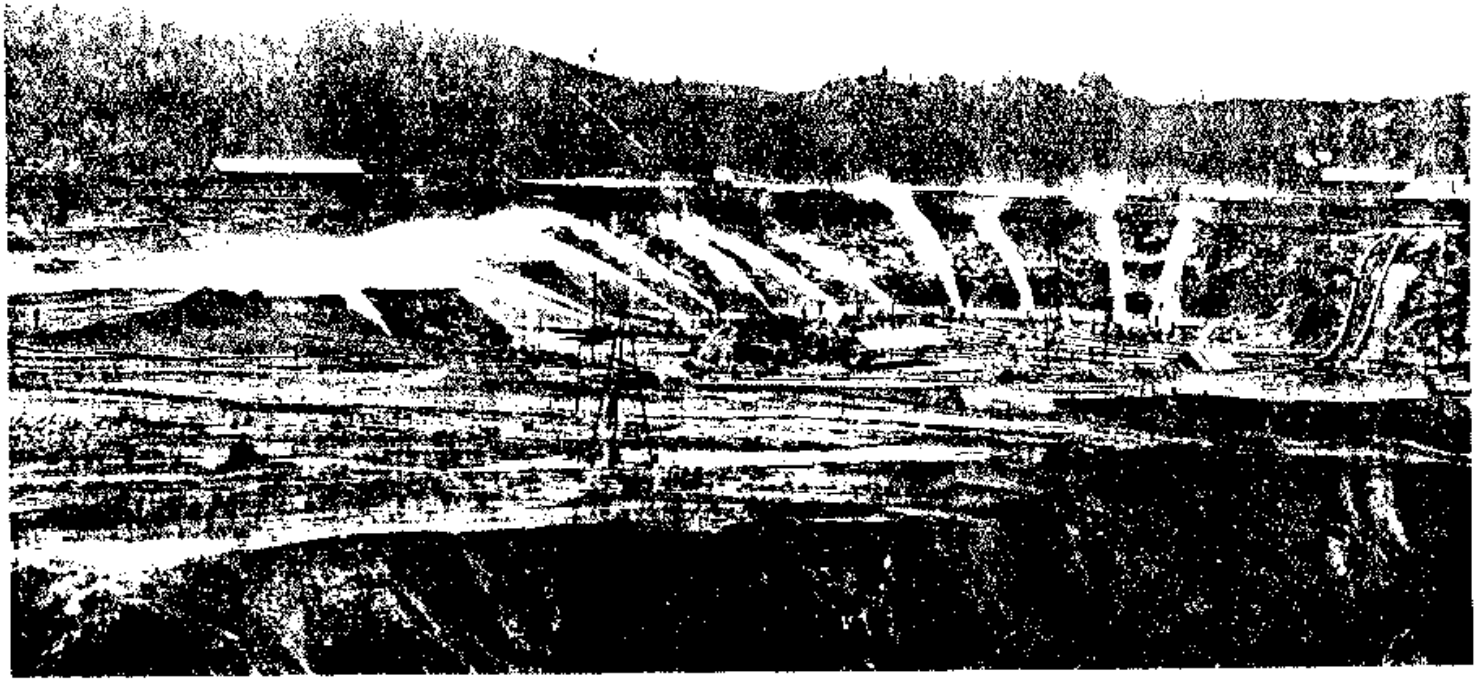
WITH PREFACE BY

FRANK E. MAIR, A.R.S.M., M.I.M.M.

MALAY STATES INFORMATION AGENCY

88 CANNON STREET, LONDON, E.C.4

1924



HYDRAULIC MONITORS AT WORK.
(Société Française des Mines d'Etain de Tekkah).

PREFACE

THE Federated Malay States have been for many years now the largest producers of tin ore in the world, but the metal obtained therefrom is known on the Metal Market as "Straits tin."

The country also holds the distinction of having the largest hydraulic tin-mine in the world and one of the largest tin-lode mines.

The extraordinary progress of the Protectorate within the last few decades is intimately related to the exploitation of the tin-fields, for the revenue obtained from the mining industry directly and indirectly has been utilised by the Administration for the development of the country.

At one time the working of the mines was almost entirely in the hands of the Chinese and the country owes much to their energy and enterprise in the past. Even now they are responsible for approximately 60 per cent. of the country's total production.

It is well known that the tin deposits of the world are very limited and restricted, and the Federated Malay States have been fortunately circumstanced in possessing deposits which enabled them to compete successfully with other fields in the cost of production.

The deposits worked are for the most part alluvium, and as a natural consequence the richer deposits were exploited first, when only hand labour was available.

It has been fully realised by the Administration, however, that if production is to be maintained and ore produced at a profit, lower-grade deposits must be worked, and that this is only possible by the use of machinery and labour-saving appliances.

British, Australian, French and American capitalists

have already recognised the attractive possibilities of these fields, and a number of companies have been formed for the purpose of systematically working these lower-grade deposits.

The mining industry in the Federated Malay States may be said now to be in a transitional state. The primitive methods which were so effective for the working of the richer deposits can no longer produce tin ore at a profit, but before it is possible to work economically the lower-grade areas, considerable initial capital expenditure must be incurred for necessary equipment.

In these circumstances, the publication of this memorandum by the Acting Senior Warden of Mines, detailing conditions of working and local legislature, etc., is opportune and should prove of inestimable value to those whose attention is directed to the future possibilities of these Malayan tin-fields.

FRANK E. MAIR, A.R.S.M., M.I.M.M.

PENZANCE,
November 10, 1923.

MINING IN MALAYA

Introduction.

TO speak of mining in Malaya is to speak of tin-mining. There are other minerals mined, such as gold and coal, but tin-mining preponderates to such an extent that it almost completely holds the field. Similarly, when tin-mining is spoken of, it is assumed generally that mining in alluvium is implied, owing again to the fact that by far the greater part of the mining is and has been of that nature.

Conditions have altered very considerably since the inception of mining in Malaya. The gradual increase in the use of machinery, combined with its ever-increasing efficiency, has enabled the miner to tackle successfully deposits which, owing either to their depth, poverty of content, or wetness, could not be worked in the past at a profit. The introduction of machinery has, however, been gradual, and little or no attempt has been made in the past to supply power to mining localities through central power-stations. There are several reasons for this, such as the temporary nature of a great number of the Chinese mines, and the consequent uncertainty of the continuance of the demand for power.

As the richer and more easily worked deposits are becoming worked out, greater care has to be taken to mine efficiently and economically. The result of this is that the proportion of ore won by European methods as against Chinese methods is continually increasing.

The conditions above expressed call for mining on a large and comprehensive scale adequately capitalised in order that the ground may be mined cheaply and efficiently.

The occurrence of tin in the Malay Peninsula appears

History of Tin-mining.

to have been known from very early days. There are more or less reliable records extant that Ptolemy was cognisant of these deposits at the time when the first Cornish tin-mines were being worked. That the Chinese have been working these deposits for the last several centuries is much more certain. Their records of the early part of the fifteenth century speak of tin being found in the mountains of Malacca, and that men were sent to look after the mining of it.

D'Albuquerque, the Portuguese conqueror of Malacca, mentions the suppression of the current Malay tin coinage in that settlement in favour of his own Portuguese tin coinage. Chinese records again mention tin as an article of export from Johore and Pahang. The Dutch in the seventeenth and eighteenth centuries endeavoured to keep a monopoly of the tin produced in Kedah and Perak.

Towards the end of the eighteenth century the annual output from Perak was estimated at 5,000 pikuls, which rose to 8,500 pikuls in Newbold's time. The bulk of this tin was won by Malays in Kinta and Batang Padang. Intan, in Upper Perak, has been producing tin ore for the last three hundred years at least. The discovery of the rich tin-fields of Larut, however, was the main cause of the exploitation of Malaya for tin, and the faction fights which took place there between the various clans of Chinese in the seventies led to British interference, and so eventually was evolved the present administration.

Geology.

The oldest known rocks belong to the Carboniferous age and are mostly calcareous in character. They are composed of calcareous shales and limestones. Fossils have been found which definitely place some of these rocks in the Carboniferous age, but there is evidence that others of them may be of Permian or Permo-carboniferous age.

These rocks, which have been found to reach a thickness of as much as 5,000 feet, are in places found associated with shales and quartzites, and are known as the Raub Series, owing to the big deposits of them at that place.

Younger deposits than the above consist of shales and quartzites. They are widely spread and sometimes have radiolarian chert interbedded with them. Other chert deposits between the Raub Series and the shales and quartzites are known as the Chert Series. The age of the shales and quartzites ranges from the Trias to the Middle Jurassic, as far as can be judged from available evidence. Before the completion of the deposition of the Raub Series and during the deposition of part of the shales and quartzites, volcanic rocks were erupted, and are found in many places

LIMESTONE HILL, SHOWING HEAVY FALL.

in Pahang. These volcanic rocks are known as the Pahang Volcanic Series and consist of the usual volcanic rocks, lavas, ashes, quartz-porphyry, etc. The limestone of the Raub Series forms the numerous limestone hills of the Peninsula. The quartzite of the younger Mesozoic deposits forms some of the finest mountains in the country, such as Tahan in Pahang, Kendrong and Krunei in Upper Perak and Kedah Peak.

Subsequent to the deposition of the shales and quartzites considerable earth-movements took place, resulting in the intrusion of large masses of granite towards the surface. Some of this granite carried tin ore, which was deposited

both in the granite and the surrounding rocks. The tin-bearing granite is usually rich in silica, whereas the hornblende granite carries no tin. Flow of the unconsolidated magma produced a gneissose structure in some of the granite. This is found in large areas in Upper Perak above the Temengor River. Gneiss formed by crushing of the granite subsequent to consolidation is found elsewhere. These large intrusive masses of granite form the mountains of the main range and elsewhere and are Mesozoic in age, but there are indications of a much older granite, though none has been found *in situ*.

The next phase was the denudation of the superincumbent strata. Only three small patches of Tertiary deposits remain as far as is known: that at Rantau Panjang in Selangor, whence comes the coal; another at Enggor on the Perak River, with a small seam of coal; and the third on the borders between Perlis and Singgora, also carrying coal in small quantities. The alluvial deposits on the coast are very large. A bore of 352 feet was put down near the Bernam River, but it failed to reach bottom. Another is down to 437 feet and is still in alluvium. These deposits contain much decayed vegetation and the water from them is brackish. Marsh gas is sometimes found.

The inland alluvials are the source of most of the tin ore found in the country. In places gold is found mixed with the tin ore, and in Pahang and elsewhere gold is found alone. Another recent deposit found in alluvium is that known as laterite. This takes two forms. One, found in Malacca, is like the Indian laterite; it can be easily cut into blocks for building purposes and it hardens on exposure. The other more common variety, a ferruginous red earth, is used for minor roads, paths, etc.

Though there are hot springs in many places, the country is free from volcanoes or severe earthquakes.

Physiography.

The Malay Peninsula lies between the first and the sixth parallel and between east longitudes 100° and 104°. It has for its main physiographical feature the great chain of granite mountains, in places rising to

over 7,000 feet, forming the main range, which stretches from beyond the north of Perak in the north to the Negri Sembilan in the south. This great granite intrusion is flanked on the west by limestone intermingled with deposits of schist and clays. Farther west other granite ranges appear.

On the east in Pahang quartzite and shales flank the main range. Quartzite appears farther east, but on and near the coast granite again supervenes. One of the features to the east of the main range is a huge isolated mass of granite known as the Benom Range, which rises to a height of 6,916 feet. In the north of Pahang rises Gunong Tahan, a mountain 7,186 feet high and the highest in the Peninsula. This mountain forms part of a range, composed of quartzites, shales and conglomerates, which lies partly in Pahang and partly in Kelantan.

The physical features of the country are very fine. The mass of the jungle-covered main range with its many high mountains forms a magnificent background to the valleys beneath it. These valleys are the more picturesque on account of the appearance of isolated precipitous limestone cliffs, which appear so frequently in various parts of the country. Denudation by weathering, and possibly by heavy tidal action in the past, is responsible for their appearance. They are crowned with thick vegetation, which sometimes spreads down the sides. The subsidiary hills add to the beauty of the landscape. Some sunrise effects are extremely fine, with the mist lying in the valleys and the heavy shadows; but it is in the evening at sunset that the whole beauty is seen. The sunsets are at times almost beyond description and their colour-effect on the trees is wonderful.

The country is watered by many streams of various sizes, of which the Pahang River (about 250 miles long) and the Perak River (170 miles long) are the largest. The latter river has an average flow of roughly 9,000 cubic feet per second. The country where it has not been mined, or where there is no agriculture, is all under more or less heavy jungle, which consists of a close agglomeration of

small and medium-sized trees with occasional large and sometimes enormous trees. In places large clumps of bamboo occur. Beneath the trees there is usually a thick growth of smaller vegetation. The whole earth is impregnated with suppressed vegetation, which at once appears when a clearing is made.

Climate and Rainfall.

The climate is hot and moist. The temperature varies on the average between 95° F. in the daytime and 68° at night (the latter unfortunately somewhat infrequent), with a mean of about 80°. The humidity is great, being about 82 per cent.

The country is subject to two monsoons, the south-west from May to October and the north-east from November to March. The west side of the Peninsula is protected from the former by the bulk of Sumatra and from the latter to a large extent by the main range. The result is that climatic changes are slight on the west side, though there is a tendency towards drier weather in June, July and August and wetter weather in the last three months of the year.

The east side feels the full force of the north-east monsoon, especially on the coast. In the district of Kinta (the principal mining district) the two wettest months are November and March or sometimes April. It is very seldom that there is a spell of more than three weeks without any rain, and even then the dew is extremely heavy.

In the hills the rainfall is very heavy, an average of 258 inches a year being observed over a space of seven years in one observation post. On the plains, however, as little as 60 inches a year was observed in one station. The average rainfall on the plains may be taken at 90 inches.

Modes of Occurrence: Tin.

The tin ore, invariably in the form of the oxide cassiterite, is found in many shapes and forms. Sometimes, but rarely, it is found in large crystals, but usually it occurs as a sand of various size of grain from pieces the size of a pea down to the finest flour. The colour, though generally a brownish black, varies from clear white, green and ruby-red to almost pure black.

It usually occurs in layers of detrital gravel derived from the granite with quartz and white clay underlying alluvium, which may or may not contain tin ore. It is found *in situ* both as an original mineral and in stringers and veins in the granite, and in veins in schists and mixed with arsenical and iron pyrites in the limestone. It has been found in the form of a brown sand cemented together by calcite. This was in a famous deposit known as the Jehoshaphat (originally Josephat) Mine. It is found in considerable quantity disseminated through the huge deposits of boulder-clay which are such a feature of Gopeng and elsewhere.

The richest deposits are found at the junction of the limestone and other rocks with the granite, so that, in such a valley as Kinta flanked on either side by granite hills with limestone in the centre, a bird's-eye view will show a continuous series of mines both working and old on either side of the valley with a stretch of agriculture running down the centre. There are, of course, exceptions to this, and much tin has been won from deposits lying on the limestone.

On the east coast of Pahang there is an extensive deposit in sedimentary rocks which is worked by the Pahang Consolidated. A large series of lodes occurs and continues through to the granite. They bear a strong resemblance to the Cornish deposits. This mine is one of the biggest tin producers in the world.

The presence of granite does not necessarily mean the presence of tin ore, the occurrence of which is most uneven, but it may be taken that the more acid the granite is the more likely it is that there will be tin ore, and vice versa.

Wolfram is found with the tin ore in various places in the Peninsula, the largest deposits being in Kedah and Trengganu. Tourmaline is usually found with it.

Tungsten Ores.

Scheelite is found near the limestone contacts in Perak and Selangor. Fluorspar is commonly found with it, and sometimes in a very concentrated form.

Gold occurs in various parts of the country, but chiefly in Pahang and Negri Sembilan in association with the volcanic series and less acid granites. It is found along a belt of country stretching from the southern boundary of Negri Sembilan through Pahang into Southern Kelantan and Lower Siam. It is also found in Upper Perak in the head waters of the Perak River. It is found mixed with tin ore in the Bidor district to a small extent, the amount recovered being about 100 ounces a month.

Gold.

Monazite is found disseminated all over the country, but in small quantities, and is generally associated with tin ore, from which it is separated magnetically. The market is uncertain.

Monazite.

China clay occurs in many places and is very abundant. It is of good quality, and is now being successfully exploited.

China Clay.

Limestone occurs as large isolated masses, and is in a form that can be and is worked into marble of various colours.

Limestone.

Phosphate is found in the caves in the limestone hills.

Phosphate.

In the remains of the Tertiary beds is found coal of a lignite variety and containing but little oil. It is successfully mined at Rantau Panjang in Selangor and provides fuel for the mines and the railway.

Coal.

It is not considered that the possibilities of finding oil are at all favourable, the evidence available being either negative or against such a possibility. An attempt has, however, been made by boring near the mouth of the Bernam River, but so far without success, although a depth of 537 feet has been reached.

Oil.

Tin-mining at the present day may be divided into the following various forms :

Present Mining Methods : Tin-mining.

(i) Open-cast mining (*a*) with trucks and rails, (*b*) by hand labour only.

(ii) Gravel pumping (*a*) with water under pressure, (*b*) with water without pressure.

(iii) Hydraulicing. (*a*) using water under natural pressure. (*b*) using water under artificial pressure. (*c*) using water without pressure.

(iv) Dredging by (*a*) buckets. (*b*) suction cutters.

(v) Shafting (*a*) in lodes, (*b*) in alluvial ground.

(vi) "Dulang" or panning.

LAHAT MINES LTD. NORTH OPEN-CAST.

(i) (*a*) With trucks and rails. Some enormous excavations have been made in this way. Lahat Mines Ltd. has two open-cast mines adjoining each other of a total area of 37 acres and a depth of 200 feet. A further depth of 130 feet has been reached by shafts. Nearly 4,000,000 cubic yards have been excavated by hand since 1912. Tronoh Mines' open-cast before it was finished had a length of 1,850 feet, a width of 320 feet, and a depth of 150 feet, showing that about 4,000,000 cubic yards had been cut and lifted into trucks by hand labour. The Sungei Besi Mine is larger, being 2,180 feet long, 794 feet

Open-cast Mining.

wide, with a depth of about 100 feet: about 5,500,000 cubic yards of ground have been taken out of it.

All the ground is cut by hand labour using the changkol (a form of hoe). The tin-bearing ground cut is either lifted by baskets or allowed to fall into trucks, which are either run by hand or by a light locomotive to inclines up which they are hauled in trains of two or more to the surface. The contents of the trucks are dumped into puddlers, which may be either of the open circular description, using harrows hauled round by arms mounted on a vertical axis, or of the enclosed type, where the ground is broken up by a series of knives mounted on a horizontal axis. The resultant mixture, with water added, is then sent down sluices in which the ore is caught. Before reaching the tin-bearing ground, or "karang," as it is called, the overburden has to be stripped, and this work continues as the mine deepens. This is treated in a similar way to the "karang," viz. by hand labour and trucks, the contents of which (if valueless) are dumped beyond the limits of the open-cast. Considerable pumping machinery has to be employed at times, especially in the vicinity of limestone near the contact. The various forms of prime mover will be described under "Machinery."

The method described above is used both by Europeans and Chinese.

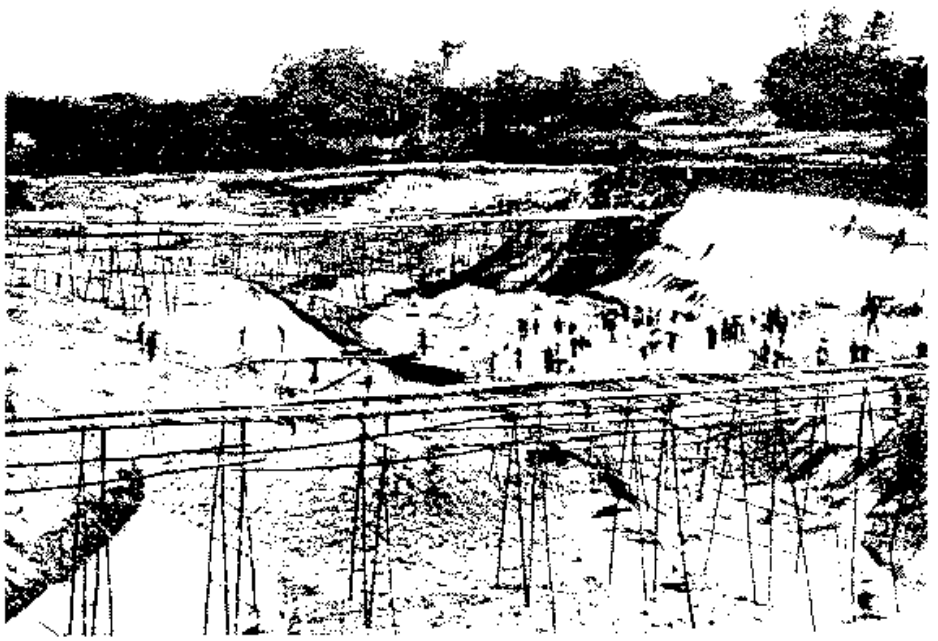
(*b*) By hand labour only. This is a purely Chinese method. The ground cut is put into flat baskets, which are hung on either side of a pole and so carried by coolies up a notched log to the surface. This is admirably shown in the illustration on the front cover, which was made by Mrs. Hamerton, of Haytor Estate, Kapar, at the request of Government.

Another method of raising the tin-bearing gravel is to churn it into a mud and lift that mud from one ledge to another by means of a tin bucket at the end of a long pole till the surface is reached. Wet mines are dewatered by means of an ingenious chain pump made of wood, in which boards set at right angles to a wooden chain lie close fitting

OPEN-CAST MINE, SUNGEI BESI

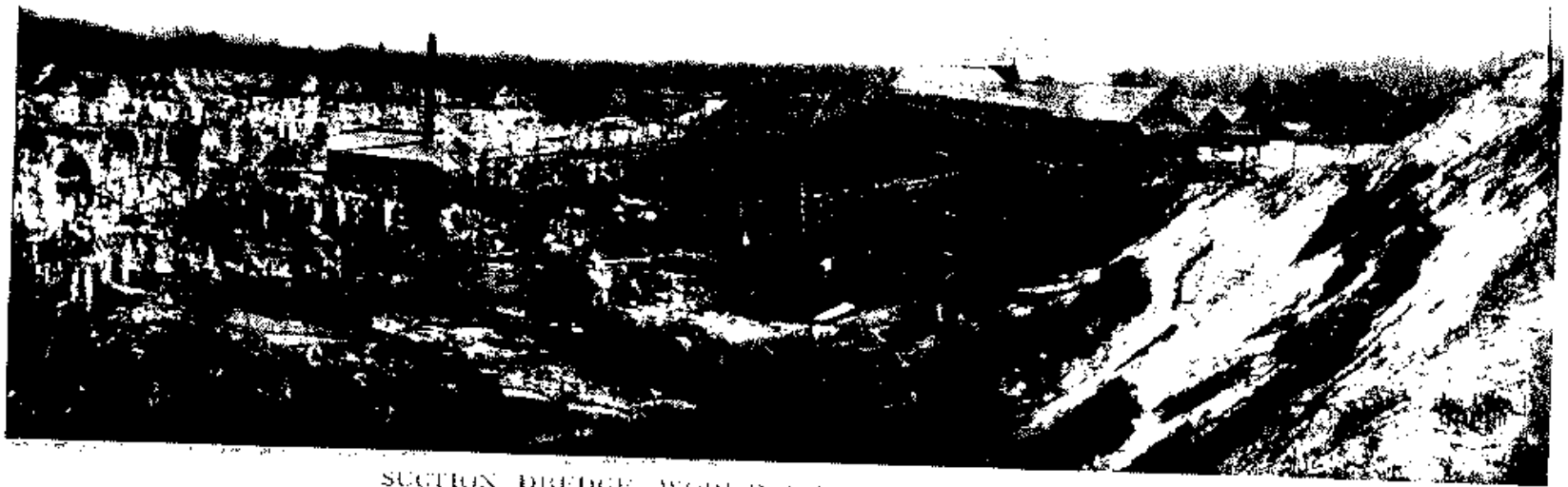
in a wooden trough set so that its base is in the sump and its upper end high enough for the water to flow away. On revolving the chain, either by a tread-mill or by a water-wheel, the mine water is brought to the surface. In other mines a portable steam engine or an oil engine is used in conjunction with a turbine pump to dewater the mine. Pulsometers are sometimes employed.

The "karang," having been brought to the surface, is,



CHINESE OWNED MINE (SERENDAH).

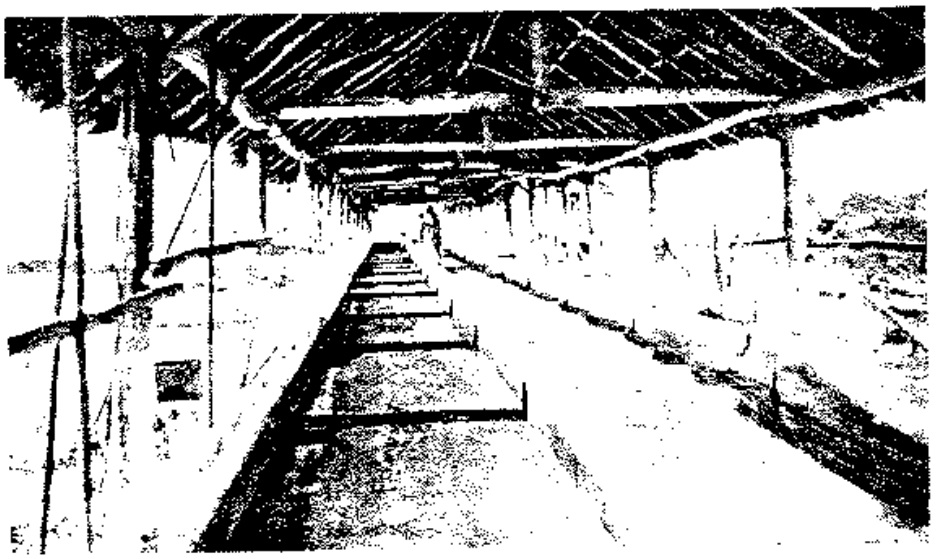
if necessary, puddled in a square pit by hand and then carried to the cleaning sluices called "landshutes." These are coffin-shaped boxes. Water is brought into the head of the box and the "karang" is introduced by a coolie at the side. A coolie stands in the water and rakes the concentrates up with a changkol. The waste matter is dug out and carried away by other coolies, often female. This process is the subject of the other admirable study by Mrs. Hamerton shown on the back cover.



SUCTION DREDGE, WORKING IN LIMESTONE COUNTRY.
(Buwang Tin Ltd.)

(ii) (*a*) Using water under pressure. There are only one or two mines now working under this once very popular method. On a pontoon are mounted two large pumps, one for pumping water through a monitor or jet, and the other for lifting the resulting gravel, sands and water. The necessary machinery for driving these pumps is also installed on the pontoon. The monitor or jet cuts away the ground and the gravel pump lifts it to the surface, where the ore is concentrated in the usual sluices. When it is desired to move the pontoon, the paddock is allowed to fill with water and the pontoon

Gravel Pumping.



CONCENTRATING SLUICES.

is floated and so moved with ease to another place. The paddock is then pumped out by the gravel pump. This method has lost its popularity owing to its cost and the advent of the more efficient bucket dredge, though a very up-to-date steam electric plant is working successfully at Rawang. Its use is confined to Europeans.

(*b*) With water without pressure. In this method water is allowed to fall down the face of the excavation and the ground is churned up with it by coolies, who lead the resulting mud to the sump of a gravel pump, which lifts the mixture to the surface whence it flows down concen-

trating sluices. The waste material is confined within the limits of a dumping-ground and the water is frequently returned to the mine for further use. The gravel pumps vary in size from 6 inches, a popular size among the Chinese, to 14 inches for the larger mines. The power used is either steam, oil, or, where available, electricity.

(iii) *(a)* Using water under natural pressure. A dam is made in a suitable place in a stream-bed and elevated as much as is necessary above the level of the mine. The impounded water is then either sent down pipes direct to the mine or is led by means of ditches to a box known as the pressure-box, whence it flows down pipes to the mine. The water, which is now under pressure, the amount of which depends on the height of the pressure-box above the mine, is allowed to emerge from a monitor which is like a fireman's jet on a large scale. This jet, playing upon the face of the mine, cuts it down with ease, and the resulting mixture flows down a ditch or wooden sluice where the tin ore is concentrated, usually by women using a round, shallow, wooden dish called "dulang."

Hydraulicing.

When conditions are such that there is not sufficient fall for the mixture, an elevator is employed to lift it to such a height that the requisite fall is procured. The usual form of elevator consists of a jet of water issuing under pressure from a nozzle, which is set in a cast-iron frame and has a pipe erected above it in such a manner that the jet shoots straight up the pipe. Orifices are connected by an annular pipe to a pipe leading to the sump, and the material brought down by the monitor is sucked up and lifted to the head of the sluice-boxes. Gravel pumps are sometimes employed to do this work. An instance of the latter is that of the Société Française des Mines d'Etain de Tekkah (usually known as French Tekka), which uses the first 300 feet of fall for the purpose of developing electrical power and the remainder for procuring water under pressure on the mine.

The quantities of water used and the pressures obtained vary very considerably, from installations using only 100 cubic feet a minute under a pressure of 50 lb. to the

big pipe line of Gopeng Consolidated and Kinta Tin-mines, which carries 6,000 cubic feet of water a minute and produces a pressure of 170 lb. per square inch on the mine. The size of the jets used varies from 1 inch diameter to 3 inches. The power produced by these larger-sized monitors working under high pressures is considerable, and the ground is cut extremely quickly by them. A 3-inch jet working under a pressure of 170 lb. would have a potential energy at the

HYDRAULICING WITH MONITORS.
(Société Française des Mines d'Etain de Tekkah.)

jet of about 340 h.p. Compared with some installations in America they are, however, small. Some of the latter use 11-inch nozzles working under a pressure of 430 lb. and develop 15,000 h.p. per jet.

An adaptation of the process described above has just been introduced by Mr. Powell, of New Zealand. The main departure of this method from the usual consists in taking the intake pipe of the elevator, which normally extends only to the sump, right up to the face. The result is that

the ground cut enters the suction pipe at once and the necessity for maintaining levels or blowing the cut ground into the sump is done away with. Cutting can therefore be carried out continuously, resulting in a much greater output for the amount of water consumed. The wear on the suction pipes and elevator detracts somewhat from the advantages of this process, which is, however, at the present only in the trial stage.

(*b*) Using water under artificial pressure. This method is similar to that described above, except that the pressure water

PIPE LINE.
(Gopeng Consolidated Co. Ltd.)

is supplied by a pump, either turbine or reciprocal, driven by any suitable form of power.

(*c*) Using water without pressure. This is known locally as "lampan" working. Water is led through a ditch cut at the foot of a face. The face is cut in steps, starting from the top, and when the foot of the face is reached, the steps are cut away working upwards. The ground so barred down falls into the ditch, where the waste earth is washed away and the tin ore remains. This is cleaned up and concentrated later.

It will be seen that hydraulicing produces considerable quantities of waste material, or tailings, the proper reten-

tion of which is a matter of anxiety both to the Government and the miners, and, in certain cases, of considerable expense to the latter. Where no great volume of flood-water is to be allowed for, or where there is no large natural stream to contend with, the problem resolves itself into the construction of suitable impounding earthworks and a masonry spillway, so designed as to take the maximum estimated flow of water. The spillway should also be capable of being raised quickly and easily.

Dredging.

(iv) (*a*) By buckets. All the bucket dredges used in this country conform more or less to standard but vary considerably in size and age. A number are converted gold-dredges obtained from Australia and New Zealand, but the majority are new. In the latest construction the tendency is to increase both the size and the power. The principle is simple. A number of steel buckets of capacities varying between 5 and 12 cubic feet are joined together by a chain made of steel plates or are linked up close together. The latter is the more modern practice. In one instance of the former kind an apron of steel is placed between each bucket to catch and so save loose ground which may spill from the buckets. The chain of buckets is mounted on a steel ladder, at the upper end of which is placed the receiving hopper. The lower end is hung by a steel rope and by means of shieves can be raised or lowered as required. On revolving the upper wheel or tumbler on which the chain of buckets is mounted, the chain is caused to move, and so by suitably adjusting the lower end, usually at an angle of 45°, the buckets scrape along the face, fill themselves with ground and are carried up to the hopper into which they drop their contents, and so down to repeat the process over again. The ground cut drops from the hopper into a revolving cylinder, or trommel, of steel plates with suitably sized holes punched in them. Water under pressure is fed into the interior of the cylinder by means of which, and aided by the revolving motion, the ground is broken up. Any ground that is not so broken is usually run off

TYPICAL EXAMPLE OF A LAMPAN.

down a shoot, though it is sometimes carried off by a belt conveyor. The broken ground is sent into a series of sluices in which the tin is concentrated.

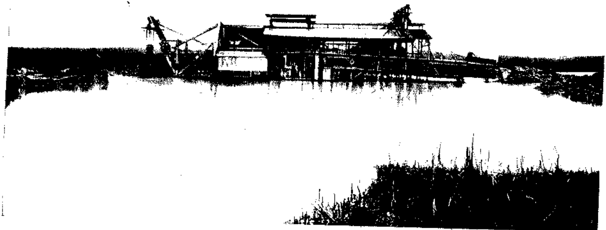
The whole machinery is mounted on a steel or wooden pontoon which floats in the working paddock. Reinforced concrete is used for the hull in one instance. With three exceptions the power employed is steam, the exceptions being two dredges driven electrically by a steam electric plant and another operated by a hydro-electric plant. The dredge is held up to its work by means of head ropes controlled by winches, and it is pulled backwards and forwards against the face by means of side ropes.

This method of mining has proved most successful in this country. It is cheap, and much ground of low value which would otherwise have been left untouched is being worked profitably. Where the bed-rock is soft, the whole of the tin-bearing ground can be excavated, but losses appear when the bed-rock consists of limestone pinnacles, amid the interstices of which a certain amount of ground is lost at present owing to its inaccessibility.

At the end of 1922 the number of bucket dredges working in Malaya was forty-one. There were also two under construction. Twenty-seven more had been proposed, but their construction was delayed owing to the existing trade depression. The flat country round Taiping is now almost entirely given over to bucket dredging, and there are fourteen dredges at work there.

This method of mining produced 4,656 tons of tin in 1921, out of a total production of the Federated Malay States of 34,489 tons.

(*b*) By suction cutters. There is at present only one example of this method, which is employed extensively elsewhere for dredging harbours. It is, however, attracting considerable attention. A large wheel or cutter, bearing a considerable resemblance to that type of electric fan which exhausts the air from a room, is mounted on a revolving steel shaft. Beneath the shaft is a pipe, the end of which is turned up so as to form a shell round the cutter. The



BUCKET DREDGE

upper end of the pipe is connected with powerful gravel pumps. The revolving cutter breaks up the ground, the pumps suck it and water up the pipe, whence the mixture flows into sluice-boxes, where tin ore is saved. The pioneers of this method are very hopeful of success, but in the absence of longer experience it is as yet impossible to say whether it is likely in the end to prove a more efficient method than that of dredging by buckets.

(v) (*a*) In lodes. One of the largest tin-producing mines in the world is that of the Pahang Consolidated on the east coast of Pahang. As already explained under the head of Modes of Occurrence, the mine consists of a series of lodes in sedimentary rocks which bear a strong resemblance to the Cornish Kellas, and these lodes continue through to the granite. At least forty of such lodes have been worked, and some are of considerable size. The method of exploitation employed is the usual one for mining in hard ground, viz. levels and stopes; but, thanks to the configuration of the ground, adit levels can be used to a considerable extent. Other ores besides cassiterite are found, and a certain amount of copper is recovered by passing the concentrates through hot sulphuric-acid vats. The ore has to be roasted and the arsenic is recovered in flues and put on the market. This mine has now reached a depth of 1,218 feet, and produces an average of 1,600 tons of metallic tin a year. There are a few other lode-mines in hard rock working for tin, but some have been closed down owing to the low price of the metal.

Shafting.

(*b*) In alluvial ground. Where the ore-bearing gravel is either very deep or is a thin deposit, it is extracted by means of numerous small shafts. Formerly some of the larger mines used to take out the ore by means of shafts, but that practice was given up in favour of the more efficient open-cast method. The shafting under discussion is done almost entirely by Chinese. The shafts vary from small circular holes, just large enough to take a man squatting, to double-compartment shafts properly timbered from top to bottom. The shafts lie about 30 feet from each other

PAHANG CONSOLIDATED LODE MINE, SUNGEI LEMBING (PAHANG).

and the ore-bearing gravel is excavated between them. Artificial ventilation is seldom employed, and then only in the form of a wind-shoot of canvas, possibly aided by a coolie with a palm-leaf fan.

Water is removed by buckets and a winch or by a pulsometer pump if in any quantity. This method of mining is unsound, as it is apt to leave good ore in the ground.

DULANG WASHING. TAMIL WOMEN.

"Dulang" or Panning.

(vi) This is a method which, though by no means peculiar to this country, is extensively employed for winning tin ore, owing to the enormous tracks of tin-ore-bearing alluvium scattered about the country. Women do most of this work, and are either employed by miners to concentrate the ore in the sluices, or work on their own in streams and rivers. They also do some business in conveying stolen ore to the ore buyers. The method employed is simple, but requires some skill. A shallow wooden dish about 30 inches in diameter and 3½ inches deep is dug into the sluice or stream-bed and a quantity of sand and water is thus put into the dish. The dish is now subjected to a peculiar motion more or less of the nature known as vanning, by means of which the waste material is washed over the edge and the ore remains.

It is arduous work in the heat of the day, entailing as it does continual standing in water with the back bent. Those women employed in the large hydraulic mines are, however, sheltered by a roof. Tin ore to the extent of 42,716 pikuls was sold by licensed dulang women working individually during 1921. This represents 5 per cent. of the total ore won in that year.

Output.

The following figures will convey some idea of the amount of ore won by these various methods and the part it has taken in supplying the world's needs for the various uses to which tin is put, such as tin and terne plates, alloys such as bronzes, gunmetal, fusible alloys, babbit metal and other similar "bearing" alloys, type-metal and pewter, tinfoil, collapsible tubes and block-tin articles. In addition, compounds of tin are used in dyeing and calico printing, and the chloride is used for weighting silk before dyeing.

EXPORT OF TIN FROM THE F.M.S. SHOWING PERCENTAGE OF WORLD'S OUTPUT.

Year.	Output in tons.	Percentage.
1900	43,111	54
1901	47,475	52
1902	47,258	52
1903	50,842	54
1904	51,733	56
1905	50,991	56
1906	48,617	50
1907	48,429	52
1908	50,835	50
1909	48,743	46
1910	43,862	42
1911	44,148	40
1912	48,420	39
1913	50,126	37
1914	49,042	40
1915	46,766	37
1916	43,870	36

EXPORT OF TIN FROM THE F.M.S. SHOWING PERCENTAGE OF WORLD'S OUTPUT—*continued.*

Year.	Output in tons.	Percentage.
1917 . . .	39,833	32
1918 . . .	37,370	31
1919 . . .	36,934	31
1920 . . .	34,934	30
1921 . . .	34,490	33
1922 . . .	35,286	30

The world's output of tin was increased considerably from 1900 owing to Bolivia entering the field as a serious competitor to the Federated Malay States as a tin producer. The output from this country, according to the most reliable figures available, increased from 10,000 tons in 1900 to 22,750 tons in 1910 and 29,000 tons in 1920.

Coal-mining.

The only coal now being mined is at Rantau Panjang, in Selangor, 25 miles distant from Kuala Lumpur. There lie the remains of the Triassic beds that once covered the country, and in them is found the coal. It is thus described: "It has a pitch-black colour and breaks with a conchoidal fracture. It is fairly hard, and has a specific gravity of 1·2–1·3. It does not coke and burns with a long flame." Its great characteristic, however, is its tendency to spontaneous combustion due to oxidisation. About 10,000,000 tons have been proved.

The two seams are worked in two ways. Originally an incline was sunk on the upper seam, which averages 40 feet in thickness, and the coal was worked by pillar and stall. It was found, however, that the liability to spontaneous fires was too great, and whole sections of the mine had to be bricked off in consequence. Recently a most successful method of sand filling was introduced, which enables the whole of the coal to be won by the long-wall method and eliminates all chance of fires. There is no gas in the coal. Where the seams outcrop, the coal has been worked open-cast with success. The lower seam is 25 feet thick. The output from the mine has risen from 170,000 tons in 1918

SPILLWAY OF TAILINGS DAM

to 300,000 tons in 1921. The whole of the coal is consumed locally and proved a godsend to consumers of power during the war, when foreign coal was either unobtainable or procurable only at a prohibitive cost.

Gold-mining.

Gold is now only mined on an extensive scale on the Raub Australian Gold Mining Company's Concession. The deposit is in the nature of a lode in calcareous rocks of the Raub Series. It is the only gold-mine, as such, that remains of many, though it is quite conceivable that others may be reopened when transport facilities improve, and interest has already awakened in one or two of the other gold deposits in Pahang. The Raub mine has now been working for thirty years and has reached a depth of 940 feet. It produces about 14,000 oz. of gold a year. The average content of the rock is between 3 and 4 dwt. to the ton. The power is obtained from a hydro-electric power-station on some falls seven and a half miles off. About 16,000 h.p. are developed. The method of mining is the usual one of shafts and levels and the ground is taken out by stoping. The ore is treated in the usual mill. New plant to treat the ore by the cyanide process is in process of erection.

Alluvial gold is recovered, mixed with the tin, from several other localities, such as Kenaboi and other places in the Negri Sembilan, Bentong in Pahang, and Bidor in Perak, where about 1,000 oz. a year are won. Gold is also recovered by primitive methods by Malays in the Lipis area. The total output of gold for the last twenty years has been about 313,000 oz.

Wolfram and Scheelite Mining.

Wolfram is usually mined as a by-product with tin ore, though in certain places it is mined for its own worth, as in Trengganu and Kedah. It is found in veins and in mass and is usually mined by open-cast methods.

Scheelite, calcium tungstate, is found usually associated with limestone. Where found in quantity, it is mined by open-cast methods.

Like many other industries, the mining of tungsten ores

has suffered its ups and downs. During the war period, the output from the Federated Malay States rose to 650 tons a year owing to the high price, but it has now fallen to about 60 tons a year.

Transport has improved enormously in the last twenty years. A main railway line (metre gauge) from Penang to Singapore provides accessibility for machinery, fuel, etc., to most of the main mining centres. Subsidiary feeders, such as Port Weld to Taiping (mainly used for transporting mangrove firewood), Teluk Anson to Tapah Road junction, Port Swettenham to Kuala Lumpur (a large amount of machinery enters the country this way), Port Dickson to Seremban, and Malacca to Tampin, all help to make the transport problem easier. Another line in course of construction from Gemas in the Negri Sembilan through Pahang to join the East Coast Siamese line is already helping and will, as it extends, help more towards the same desirable object as well as opening up the country. Another line from Bukit Mertajam, near Penang, goes north through Kedah and Perlis and connects with the Siamese line to Bangkok. Fed by the railways, of which there are 1,021 miles, including the Johore line, is a very large system of metalled roads, in all 2,446 miles, which connects all the more important mining centres. There is now hardly a mine of any importance that cannot be reached by road. In addition there are 177 miles of unmetalled cart-roads and 1,800 miles of bridle-roads and paths.

Transport.

Transport of supplies from the railways is carried out by motor-lorries, steam-tractors and bullock-carts. The lorries take a load up to three tons, and the bullock-carts up to 15 cwt. officially, but can and do carry up to 1½ ton. In addition heavy machinery is transported on trucks drawn by teams of bullocks or by some form of tractor.

Passenger traffic outside the railways is now catered for almost entirely by motor-cars, mostly of American make, and motor-buses. Rickshaws in the towns are still used, and gharries are seen in some of the outlying places and

for short connections. The individual gets about in his car, on a motor-cycle with or without a sidecar, by a "push bike," or, where these cannot be used, on foot. A few people ride horses or ponies.

In certain places where the conditions call for it, elephants and sometimes cattle are used for the transport of supplies.

BAGGAGE ELEPHANT, UPPER PERAK.

The average load for an elephant is about 800 lb., depending on the bulk of the load. Where elephants are not obtainable and in very hilly areas, all supplies are carried by coolies. They are capable of carrying as much as 150 lb., but the average load is about 100 lb. They sometimes travel very fast.

The cost of transport at the present time (1922) is as

given below ($1 = 100 cents = 2*s.* 4*d.* 1 pikul = 100 katis = 133⅓ lb. 1 kati = 1⅓ lb.):

(*a*) By rail. Passenger fares are:

First class,	6¼	cents	per	mile	=	about	1½*d.*
Second ,,	3⅜	,,	,,	,,	=	,,	1*d.*
Third ,,	2½	,,	,,	,,	=	,,	¾*d.*

Luggage is carried free up to 100 katis, first class.

Goods are carried at rates varying from a minimum of ½ cent per pikul per mile (equal to ·75*d.* per ton per mile), according to the class of the goods. These charges are subject to considerable reduction for long distances. Machinery is scheduled as Class 4, and costs 1⅓ cent per pikul per mile, which is equivalent to 4½*d.* per ton per mile.

Petrol at present (1922) costs $1·20 (2*s.* 9½*d.*) a gallon, and is obtainable nearly everywhere. Motor-cars can be hired at the rates of about a shilling a mile or 2½*d.* per mile per passenger.

(*b*) Coolie hire. When camping, coolies are paid by the day: but when on the march, they are paid as a rule at so much per kati (1⅓ lb.). The rates vary according to the distance, but 5 cents per kati up to 15 miles a day and 6 to 7 cents per kati above 15 miles a day is the average cost. This is equivalent to about 8*s.* a day.

Labour: Chinese.

The mainstay of the mining industry and of many other industries in this country is the Chinese. He has done and is doing most of the work. He is extremely industrious. He is prepared, if need be, to work the whole day to obtain what he considers necessary to meet his requirements. On the other hand, if he is working for himself and has made that daily amount, he is disinclined to do any more work that day. He very seldom gives any trouble, and on the whole is most tractable and obedient. In times of high prices and much profit, he takes what he can get; but when the slump comes, he comes down with it and carries on in a most admirable

way. If a Chinese mine-owner can convince his coolies that his mine has lost money, they are often willing to accept as little as 20 per cent. of their wages with very little demur.

The various clans of Chinese that come to Malaya include Cantonese, Hakka or Khehs, Hokkiens, Teochews, Kwangsais and Hylams. Work by shafting is almost entirely confined to Hakkas or Khehs, while Hylams usually work as domestic servants, but become miners or rubber planters when the occasion seems profitable. Hokkiens form most

TRANSPORT OF TIN ORE ON RAFTS.

of the shopkeepers. There are now very few Teochews engaged in mining. In 1921 there were 92,000 Chinese employed as miners, including 12,000 "dulang" women, who are mostly of the redoubtable Kheh clan.

Chinese methods are best shown when dealing with water, with which they are exceedingly clever. They are capable of bringing water from any distance by ditches or bamboo pipes and of distributing it without any survey except of the order of what they would call "look-see." They also show to great advantage in open-cast working and "lampan." They make most admirable labour underground. Their houses are, in large mines, airy, clean, and

tidily kept. The "dulang" women are out all day standing in water, working their "dulangs" or pans, and are frequently to be seen carrying a baby on their backs. In the evening they cut up the firewood, cook the food and do the housework.

Recruiting is done in China, and the coolies arrive and depart according to the demand. Indentured labour was abolished in 1914. The Chinese coolie is employed in one of three ways. He may work for a daily wage, or by con-

STERN WHEELER ON KUANTAN RIVER.
(Pahang Consolidated Company, Ltd.)

tract or on what is called the tribute system. At present (1922) conditions are the reverse of flourishing, and the coolie works for a very moderate wage. It amounts to about 30 cents a day, which is equivalent to 8½*d*. In addition to this, he is housed and fed free. He has to supply his own clothes, but not tools. Normally it may be said that the average coolie working on wages receives about 50–60 cents a day, equivalent to 1*s*. 2*d*. to 1*s*. 5*d*.

The working hours are usually eight, with extra payment for overtime. The contract coolie works under a contractor, who receives as a general rule from $15—$20 (35*s*. to 47*s*.)

for each "chang," or 50 cubic yards of ground, cut and carried away. The tribute coolie usually forms one of a gang who, having had their supplies advanced to them by a mining speculator, work the ground and share all profits that are left after the lessor has had his tribute paid to him. The head of the gang and any foremen receive a slightly larger share than the rest.

The coolies are housed admirably on the large mines in big, airy structures with high roofs. These houses are made of poles and the walls and roof are made of "attap." Attaps are usually made from the leaf of the nipah palm. Each frond is cut off and bent over a stick, and other fronds are added until the stick is full. The ends of the fronds are tied, and the result is a kind of board made of these fronds. These attaps are placed one on top of the other from the top of the roof down, each stick being about two inches below its upper neighbour. The whole is plaited together and makes a perfectly watertight roof for a year or two, when the attaps begin to give way to the destructive climate. Inside, the building will have an office where the accounts are kept, a store for keeping the tools and tin ore, and a kitchen, which consists of fires under enormous iron dishes in which the rice is boiled, while a small shop to provide simple needs, such as matches and tobacco, is often included. The remainder of the house will be devoted to the beds of the coolies. These beds consist of planks laid on a framework about two and a half feet high, and usually hold two coolies. Mosquito curtains are invariably used, and a grass mat, but not mattresses. At the head of the bed are the coolie's personal belongings in a box, and he uses a blanket, usually a red one. Pillows take the curious and, one would have thought, most uncomfortable form of a lump of wood, a square piece of earthenware, or a rattan framework covered with black oil-cloth. These pillows are placed under the head about the level of the ear, so that there is a space under the nape of the neck while the head is supported. It is therefore cooler than a soft pillow.

The coolies' staple food is rice, prepared according to the custom of their clan. The majority boil the rice with very little water and eat it in a dry condition, but the Hokkiens and Teochews prefer to eat the watery rice that is obtained by boiling a little rice in a lot of water. In addition to rice, vegetables and sometimes meat and fish both fresh and dried are added. The amount and frequency of this addition depends on the prosperity or otherwise of the industry. As a rule, three meals are taken a day, the first at dawn, the second at 10.30, and the third about

TIN STEALERS' MINE.
(3,500 feet above sea level.)

5 p.m. Tea without sugar or milk is mostly drunk, but water when thirsty. Very few Chinese mining coolies have their wives with them. As a rule the coolie's female relations remain in China, and he is very good in remitting money for their sustenance. Certain Chinese firms undertake to forward these remittances for a small charge, and the undertaking is carried out so satisfactorily that there are few, if any, complaints.

The above description applies to the bigger and more flourishing mines. When conditions reach the stage of a struggle for a bare existence, the coolies, who will be

tributers, live in hovels made of anything handy, such as old kerosene tins beaten out, leaves, etc. etc. Under all circumstances, however, their neatness and cleanliness are remarkable.

Malays seldom live on the mines, but have their houses elsewhere, generally on their own piece of land. A typical Malay house is raised on wooden posts a few feet above the ground and is approached by a ladder. The floor is usually of large bamboo, split and hammered out flat after the joints or partitions have been removed. The walls are either "attap" or the same flattened bamboo interwoven. Their food consists of rice as a staple with curry added. Meat, fruit and vegetables are also eaten.

Malays.

The Malay does not as a rule indulge in mining himself, being generally content to hold the land and sublease the mining rights to a Chinese. There are, however, certain functions in mining which a Malay fulfils admirably, such as engine driving, overseering pipe-lines, managing hydraulic monitors, electrical work, surveying, etc. The women are largely employed in concentrating the ore by "dulangs" in the big sluice-boxes, and in their bright sarongs are a very attractive sight. In 1921 there were 2,307 Malays and Javanese employed in mining.

Of natives of India, South Indians such as Tamils, Telegus and Malayalis predominate. They are very good at moving earth, which they carry in baskets on their heads, unlike the Chinese, who carry it in baskets slung at either end of a pole over the shoulder. Some of them make very fair engine drivers.

Indians.

The other races of India are grouped together, irrespective of their origin, as "Bengalis." Most of the so-called "Bengalis" come from the Punjab. As far as actual mining is concerned they do but little, but can, if occasion arises, shift ground with considerable efficiency. They are mostly employed indirectly as bullock-cart drivers. In 1921, 3,525 Indians of all kinds were employed in mining. Recruiting in India is under Government control and an

CHINESE HAULAGE PLANT.

assessment per coolie is charged, the money going to a fund for assisting immigration to Malaya.

Other Eastern Races.

Of other eastern races there are very few. Occasionally Japanese, Siamese and Sakais are found working, but their numbers only amounted to 70 in all in 1921.

Europeans, etc.

Western races are represented in the Malayan tin-mining industry by British (both home and Colonial), French in some number, and a few Italians, Austrians, Swedes and Swiss. Lately the country has been the scene of an American invasion in the form of the Yukon Gold Company, which arrived in about 1919 and has since set about its business with great energy and thoroughness. The Company has acquired considerable tracts of land, brought dredges and machinery from Alaska and elsewhere, and is now busily engaged in erecting dredges and power-stations in Perak and Selangor. The number of Europeans actively engaged in mining has increased considerably in the last few years, as the following figures show:

1913	195
1919	225
1920	274
1921	327

The advent of the bucket dredge is largely responsible for this increase.

Machinery.

The machinery employed in the Federated Malay States for mining purposes is driven by most of the usual sources of energy. The machines themselves vary from the comparatively humble but useful 12 h.p. portable steam boiler and engine, which is so extensively used for driving water and gravel pumps, to the most elaborate batteries of Babcock and Wilcox boilers fitted with every known device for economising steam, such as chain grates, superheaters and steam economisers. Water-tube boilers have become very popular. Diesel engines in sets up to 200 b.h.p. and in batteries of 3 sets are largely

extensively employed, usually to drive dynamos. Other forms of oil engines, such as semi-Diesel, are used for various purposes, but generally for driving pumps. Suction-gas plants are similarly employed both for pumping and electrical work. Water under pressure is employed on Pelton wheels for driving dynamos and gravel-pumps. Wire-rope ways are used in one case for conveying the ore from one hill to the mill on the adjoining hill. The Chinese use a primitive form for lowering their ore-bearing ground from the limestone cliffs to the valley below. It consists of a pair of heavy wires strung taut between the cliff and the ground and a light rope which passes round a pulley on the top. The full baskets are slung on the upper end of the rope and by their fall pull up the empty ones. Water is pumped out of the mines by the Chinese chain pumps worked by foot or by a waterwheel, by turbine pumps actuated by steam, by hydraulic elevators, by Cornish pumps in the deep mines and by reciprocating pumps electrically driven, as in the Malayan collieries. Lighting is done by electricity, or one or other of the various forms of incandescent-mantle lamps. In small mines, where required, and in underground workings, candles are used, except on inspection, when occasionally an acetylene lamp is employed. The bucket dredges are mostly driven by steam, using wood fuel.

The following table shows the extent to which the various forms of machinery were employed in 1921:

Nature of Power.	No.	Horse-power.
Steam . . .	394	46,182 i.h.p.
Oil . . .	649	19,553 b.h.p.
Gas . . .	258	13,892 b.h.p.

The amount of hydraulic power developed in the same year was about 22,000 h.p.

Fuel.

Steam engines use either the local coal known as Rawang coal, or firewood, the latter being to a large extent obtained from the extensive mangrove swamps near the coast. The Diesel engines use the oil produced for their use, and the gas plants imported anthracite or

local charcoal. The supply of Rawang coal is equal to the demand, but in many cases it is found that more economy results from the use of mangrove firewood, where the mines are near the source of supply, as at Taiping. The local coal does not keep very well. It is apt to heat up and can only be prevented from igniting by being kept in water. It costs now from $7 to $11 (16*s.* 4*d.*—25*s.* 8*d.*) a ton free on rail, the price varying with the quality. The present (1922) price of foreign coal is $25 (58*s.* 4*d.*) a ton. Anthracite costs about $40 (93*s.* 4*d.*) a ton, firewood $8 (18*s.* 10*d.*) a ton and Diesel oil $16.50 (38*s.* 6*d.*) per drum of 65 gallons. The possibility of using liquid fuel in bucket-dredge boilers has lately been discussed and a trial has been made.

Legislation and Acquisition of Mining Land.

Mining land can be acquired in any of three ways:

(i) By purchase from the lessee.

(ii) By applying for and obtaining a prospecting licence, and subsequently selecting an area for a lease.

(iii) By direct application to Government for a lease.

As a rule nowadays, unless the land is obviously required to form part of a scheme of work, mining land, unless purchased under (i), is obtained by means of a prospecting licence. Application for this is made through the local District Officer, and sufficient detail must be given to enable the latter to know within reasonable limits the situation of the land. A report is called for from the Mines Department, and final approval is in the jurisdiction of the British Resident. The fee for a prospecting licence is not less than $100, equivalent to about 11 guineas. It entitles the holder to prospect for the mineral or minerals described in the licence and to dispose of such minerals as he may find during his prospecting. If his prospecting work has been sufficient to satisfy the Resident, he is entitled to select such areas to be leased to him as were described in the licence. Unless he does sufficient prospecting, this right of selection is denied him.

A mining lease is acquired by application to the local Land Office. This application must show the position of

TIN MINING LAND, NEAR KUALA LUMPUR.

the land and such details as will enable the land officer to find it accurately and the surveyor to survey it. At the same time a cash deposit must be made. On the application being approved by the Resident, the land is surveyed and a lease is issued. If the applicant wishes to commence mining operations without delay or before survey can be completed, a mining certificate may be issued. This certificate shows the boundaries of the land approximately and is surrendered on completion of the lease. Premium is charged for the lease at rates from $10 (£1 3*s*. 4*d*.) per acre upwards. A mining lease conveys the following rights to the lessee:

(i) The right to work and win all minerals described in the lease and to dispose of them.

(ii) The right to put such buildings on the land as may be necessary and to grow such vegetables and keep such live stock as are required for the labour force employed.

(iii) The exclusive right to all jungle produce found on the land for his own use, but such produce cannot be removed beyond the boundaries of the land.

The following is a brief summary of the conditions by which the lease is governed:

(i) Rent must be paid. It is usually $1 (2*s*. 4*d*.) an acre per annum.

(ii) Boundaries must be kept open.

(iii) Work must start within six months of date of issue of lease.

(iv) Within a further six months the requisite number of coolies must be employed. This number is usually one coolie per acre, and power-producing machinery is allowed for at the rate of eight coolies per horse-power.

(v) There must not be a lapse from these labour conditions of more than twelve months.

(vi) The lessee may be required to work any lodes found on his land.

(vii) The work must be done in an orderly, skilful and workmanlike manner.

(viii) Government officers shall have free access to the land.

(ix) Such notices as are required shall be exhibited.

(x) Material such as stone, gravel, etc., may be removed without payment, if required by the State for a public purpose.

(xi) Proper account books must be kept.

(xii) Reasonable access to adjoining land must be allowed.

(xiii) Proper precautions shall be taken to ensure the health and safety of all labour employed on the land.

Breach of conditions numbered (i), (iii), (iv) or (v) render the lease liable to forfeiture. The lease may be sublet, in which case the conditions described above are still binding on the lessee as well as on the sub-lessee. Leases may be renewed if the conditions have been carried out to the satisfaction of the Resident.

The control of all water is in the hands of the State. Licences to use water for mining purposes, if for over twelve months, are issued by the Resident under the Mining Enactment. Licences up to twelve months may be issued by the Warden, while the Inspector has powers to distribute water in minor cases.

Mining is subject to the following regulations, which may be found in detail in the Mining Enactment of 1912:

(1) The use and storage of explosives are governed by rules.

(2) Accidents involving death or serious bodily injury must be reported. The circumstances are investigated by the Mines Department and, if carelessness or blame is attributable to anyone, the matter is taken into court.

(3) A mine manager may draw up a code of rules for the local government of the mine, and these, if approved, have all the force of law.

(4) Overburden can only be deposited on unworked land by permission of an Inspector who may issue directions as to where overburden or tailings shall be deposited. Mines producing tailings, as nearly all mines do, have to control them in dams and so forth, in such a way that the effluent

water does not carry more than 800 grains of solid matter per gallon. This entails in some cases tailings-retention works of very considerable magnitude, especially on mines using water under pressure through monitors. It is difficult in some cases to effect the necessary control, especially where the mining is in the hills, where there are no suitable sites of sufficient capacity to hold the tailings. The result is that the dam has to enclose the whole of the river in the valley and has to be capable of passing safely any flood water that may come down owing to excessive rains.

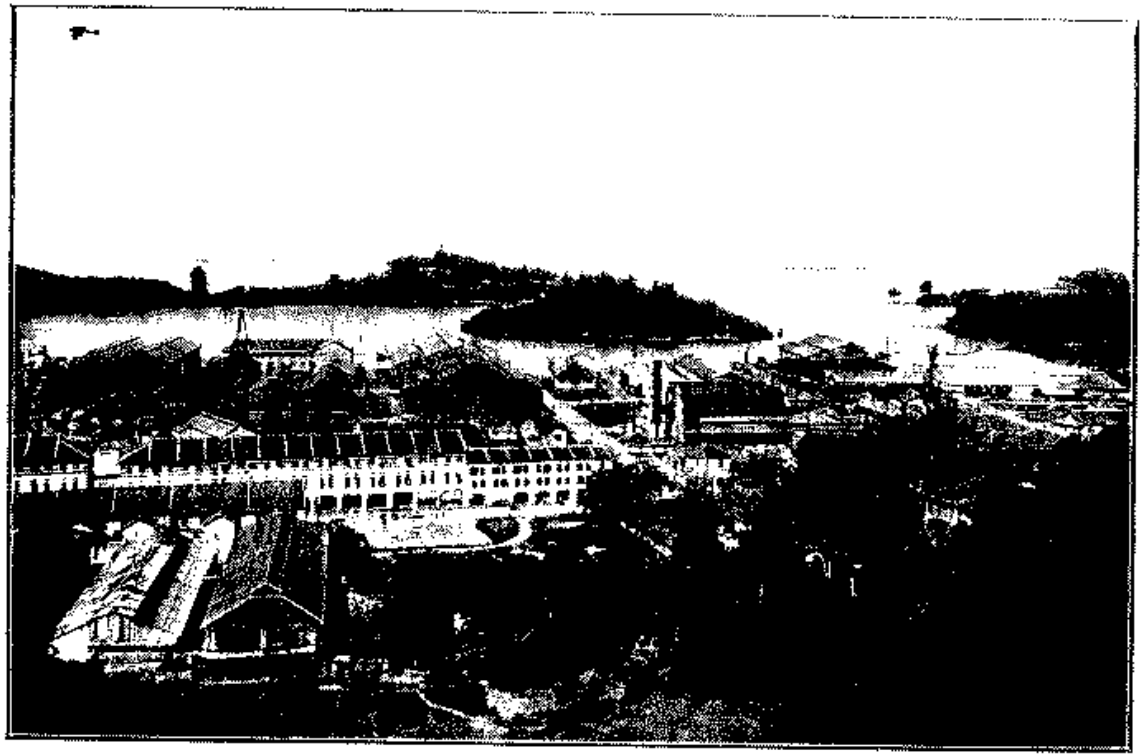
(5) Shafting can only be carried out under licence. There are also various rules governing the control of mining underground.

(6) Hydraulic mining of any kind also can only be carried out under licence.

The industry is controlled by the Mines Department, which consists of a Senior Warden of Mines, Wardens of Perak and Selangor, Assistant Wardens of Negri Sembilan and Pahang and a number of Inspectors, who, when qualified, become Assistant Wardens. All these officers are recruited from approved Schools of Mines and furthermore must have served for at least three years on some mine. Control over the ore-buying business is exercised by an Inspector under the Mineral Ores Enactment, and the use and safety of machinery is controlled by Inspectors under the Machinery Enactment. Electrical machinery is similarly governed by an Inspector under the Electricity Enactment. All these Enactments and the officers under them are under the administrative control of the Senior Warden of Mines.

Disposal of Tin Ore.

After the tin ore in the form of a dark-coloured sand has been won from the mine and cleaned up, it is put into canvas bags and sold to one of the local tin-ore buyers, who may be Chinese or a branch of one of the two smelting companies, the Straits Trading Company and the Eastern Smelting Company. The parcel of ore is weighed and assayed for its metallic contents, and the price offered is in accordance with that result and the current price of tin, less export duty, smelting charges



KEPPEL HARBOUR, SINGAPORE.

and transport. The assay is usually done by cyanide in the English houses, but, strange though it may appear, the Chinese can approximate to the true contents within 1 per cent. by a process of careful cleaning, weighing and keen observation.

Eventually all the ore with the exception of about 12 per cent. which is smelted locally finds its way to the big smelteries of the two companies in Singapore and Penang. The result is what is known as "Straits Tin," and is refined up to as high as 99·939 per cent., but averages 99·9 per cent. Apart from its fineness, it possesses peculiarly liquid properties when melted, which make it more suitable for the tin-plate industry than other tin, which may possibly be even finer. The locally smelted Chinese tin is refined in Singapore and finds a market in India, China and Japan.

The charges the miner has to pay are, as has been said, three :

Export Duty and Charges.

(1) Export duty.
(2) Smelting charges.
(3) Transport.

If the ore is of low grade or is contaminated with other minerals, which have to be separated before the ore can be smelted, a further cut in price is made.

The export duty now in force is on a sliding scale. It represents the following percentages *ad valorem* at the various prices per ton of metallic tin :

Price per ton of Tin. £	Duty per cent.
100	10·0
120	11·0
140	11·9
160	12·5
180	12·9
200	13·3
220	13·6
240	13·8

Price per ton of Tin. £	Duty per cent.
260	14·0
280	14·1
300	14·3
320	14·4
340	14·5
360	14·6
380	14·8
400	14·9

This duty is deducted by the ore buyer when he makes the purchase and is collected by Government at the various ports. Provided the ore is to be smelted in the Straits Settlements, Australia or England, this is the only duty charged. If the ore is shipped elsewhere, an additional duty of $30 a bhara (3 pikuls), equal to £3 10*s.* per 400 lb., is charged. The smelting charges average about $2.20 per pikul, equivalent to £4 6*s.* a ton. Transport charges vary, but average about $1.60 per pikul, equivalent to £3 12*s.* 8*d.* a ton.

Present Living Conditions in Malaya.

One of the first things that anyone who is interested in or contemplates proceeding to a new country wishes to know is the conditions under which the people live. The following remarks apply more especially to the European miner.

The climate being hot and damp, the lightest clothes are worn and the least exercise induces profuse perspiration, so that as far as possible such clothes should be washable. After sun-down the heat is less and it is quite possible to wear thin tweed suits. For anyone who has much outdoor work to do, khaki drill is the most suitable material. A thin flannel or cotton shirt with or without a cotton vest is usually worn. A coat, also of khaki drill, is useful for the carrying capacity of its pockets. The cost of a suit of khaki is about 17*s.* 6*d.* Excellent canvas boots can be obtained locally from the Chinese boot makers at a cost of about $5 (11*s.* 8*d.*) a pair.

The most important part of wearing apparel is the hat. Owing to the humidity of the atmosphere the effect of the sun is very strong, in fact much stronger at a temperature of 95° in Malaya than, for instance, in the drier parts of Australia at 120°, where a straw hat is sufficient. The most suitable sun-hat for much outdoor work is that which takes the form of a large helmet. It is made of pith and is covered with khaki drill. It is very light, and gives great protection to the sensitive back of the neck and at the same time ventilates the head well. It is preferable to wear a large size, which rests on the top of the head by straps, than to wear a helmet which fits closely round the head. Such a hat is generally known as a "pig-sticker." It costs from 10*s*. 6*d*. to 15*s*. For ordinary use in towns and offices, a hat made of cork and covered with white cloth is used. The double felt hat known as a double terai is also very suitable. People vary a great deal in the degree in which the sun affects them, but it is always advisable to take no risks whatever between 7 a.m. and 5 p.m. The length of the day varies but slightly, the greatest difference being about half an hour, darkness setting in between 6.15 and 6.45 p.m. Similarly the dawn varies between 5.30 and 6 a.m.

In the daytime in offices white suits are usually worn. Tunic coats buttoning up to the collar and worn with a vest are still popular in some places, but coats and shirts have largely replaced them. A white suit—coat and trousers—costs about 14*s*. All possible clothing requirements can be supplied by the local shops, though many consider it better and cheaper to order from home.

The usual houses built on mines are of wood and are sometimes bungalows, in other words one-story houses, and sometimes two-story houses. The latter form of house is preferable if the occupier is married, as it engenders a feeling of security in the chatelaine. The typical house consists of a living-room, a dining-room and two or more bedrooms with bathrooms attached. Verandahs are essential to keep out both the glare and heat. The walls are of

CHINESE COOLIES' DWELLING HOUSE.

wood and should be, but seldom are, double. The roof is generally of "attap," already described. The bathroom is of course constantly used, and the method is novel to anyone straight from home. A large wooden tub, or much better a Shanghai jar, is filled with water. The bather stands outside the tub and pours cold water over himself by aid of a tin pail. It is an extremely refreshing form of bath. Some, however, who are addicted to fever, cannot so indulge and have to use tepid water.

The quality of the food-supply varies considerably with the distance from the main towns. When transport is available, supplies of excellent meat, butter, etc., can be obtained from the Cold Storage Company, which has depots in Kuala Lumpur, Ipoh, Taiping and Seremban. These are supplied from Singapore, and most of the meat and butter comes from Australia and New Zealand. Potatoes are obtained from India, but the rest of the vegetables are supplied locally, and are unfortunately rather tasteless. Salads such as lettuces, etc., if grown by Chinese vegetable gardeners should not be eaten, as they may induce typhoid. Chickens, ducks and eggs are easily obtainable, and local meat in the form of pork and buffalo can be eaten but is unpalatable. With the present transport facilities, however, it is seldom necessary to rely on these latter.

The cost of living of course varies greatly with the locality, the tastes of the individual and the conditions on the mine. In the towns there is much more scope for spending money, but the following figures, which have been obtained from mines situated in every part of the Federated Malay States, will give an idea of what it costs an Assistant on a mine to live quietly.

It may be taken that the management of a mine will supply the following free: house, furniture (sometimes necessities only), firewood, lighting (usually electric), medical attendance (sometimes for employee only, not his wife), and generally a rough servant or water-carrier, and sometimes a gardener as well.

Figures have been received stating that a single man

CHINESE MINE BUILDINGS ON A MOUNTAIN SIDE.

can live quietly at an inclusive cost on a mine of from $125 to $250 a month. This is equivalent to £175 to £350 a year. By inclusive cost is meant all food and reasonable liquor, clothes and amusements. The first figure is very low, but if the individual combines with others to live in a mess, the cost of living is largely reduced. Married people as Assistants on mines would need about $350 to $450 a month (say from £500 to £600 a year) at least. These figures represent the minimum, and do not allow for anything except living in a very quiet way, nor do they allow for the expenses of illness of the wife or children.

Health.

With the exception of malaria, the country is extraordinarily free from disease. This happy condition of affairs may be attributed to the natural healthiness of the climate, strongly reinforced by very strict quarantine at the ports of entry and very prompt action by the medical authorities in the event of an outbreak. A few cases of smallpox are heard of, and sometimes, but not often, cholera will break out among the dwellers on the big rivers. Malaria is unfortunately common, and there are several conditions which will make it prevalent. It is imparted by the bite of a type of mosquito known as *anopheles*, of which several varieties are known in Malaya as being carriers of malaria. They are not naturally infected with malaria, but imbibe it when feeding on the blood of an infected subject, and so pass it on to their next victim. The whole subject is exceedingly complicated, and although much is known now, there are many points that still require research.

There are many preventive measures. As the mosquitoes breed in water, care should be taken that no stagnant water, even in the smallest quantity, should be left in the vicinity of the house. Even such things as bamboos used for supporting climbing plants may, by the water caught at the joint near the open end, be dangerous. Mosquitoes like dark places, and cupboards, etc., should therefore be swept out at intervals.

The mosquito-net which covers the bed at night is a most

important preventative. It should be made without any entrance door, but opinions are divided as to whether it should be tucked in under the mattress (which keeps mosquitoes out, but does not prevent infection from bites on any part of the body which may be touching the net), or should be about a foot or more larger than the bed and long enough for the end to lie on the floor and be held down by weights in pockets.

Ditches and drains which are suspected of holding mosquitoes should be sprayed with suitable oil. Opinions are divided as to the use of quinine as a prophylactic, and also as to the quantity that should be taken. To avoid the possibility of infection is the only real safeguard. On getting an attack of fever, unless the patient is so familiar with his particular variety that he knows what to do, a doctor should be consulted, so that by blood examination the form of malaria, if it is malaria, may be found and the proper course taken to combat it.

General.

The foregoing will perhaps convey an impression of the nature of the mineral deposits in the country, the methods adopted for winning them from the ground and the conditions under which such work is carried out.

The last twenty years have seen many changes in the nature of tin-mining. The exhaustion of the majority of the very rich deposits, and the almost complete abandonment of the old Chinese system of employing several thousand coolies on an open-cast mine and making much profit by use of the truck system, have called for mining under much more stringent conditions of economy in later years. The present tendency is to obtain large areas and work them on a large scale with cheap power. More attention is being paid to the use of electricity on dredges and elsewhere, developed both hydraulically and by steam. The bucket dredge, popular though it is on account of the low running cost per cubic yard, is not an ideal form of mining in many areas. Where the bottom is soft, as with shale, etc., the ore-bearing ground can be cleaned up very thor-

oughly; but where the bottom is very eroded limestone, as it is in so many places, it is impossible for the buckets to clean up all the ore, and such as remains between the pinnacles is probably lost for ever. In this respect the suction dredge is more satisfactory in that the ground lying among the limestone pinnacles can be got at and removed. As a rule, however, it is expensive to work under these conditions, as practically all the ground has to be laboriously dug out and carried away by hand. Proposals are on foot, however, to deal with this loss in limestone country, even when operating by bucket dredges. The gradual exhaustion of the workable areas on the flat country will lead to more attention being paid to the hills.

It is conceivable that in the future, with tin at a sufficiently attractive figure and an abundance of cheap power, those hills which contain workable deposits of ore will be mined by water under pressure, the tin ore recovered, and the tailings sent down to the valley below, where they will be impounded. The opportunities of discovering more lode deposits will be thus greatly enhanced by the removal of the alluvium.

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