

17. *On some TIN-DEPOSITS of the MALAYAN PENINSULA.* By PATRICK DOYLE, Esq., C.E. (Read January 8, 1879.)

[Communicated by Rev. T. WILTSHIRE, M.A., F.G.S.]

THERE is a striking resemblance in the mineral characteristics of all parts of the Malayan Peninsula, especially in regard to the mode of occurrence of the deposits of tin-ore (cassiterite).

The Malayan tin-field, including the islands of Banca and Billeton, extends over 17 degrees of latitude and 10 of longitude; but the observations of Messrs. Logan, Horsfield, and others, in different parts of this area, correspond with those which have been noted in Larnt. The peninsula consists of granitic rock overlain generally by sandstone, and frequently also by laterite or cellular clay-ironstone, and, to the north, by limestone. A granitic mountain-range extends along the whole length of the peninsula, on both sides of which, but especially on the western or Sumatran one, are extensive alluvial plains, but little above the level of the sea. Iron, tin, and gold are the principal metals. Ores of the first are found everywhere; and tin has hitherto been found in all parts where search has been made.

Perak is the second Malay State on the west side of the peninsula, counting from the north; and Larnt, its chief province, is an irregular strip of land about 70 miles long and varying from 10 to 25 miles broad, bordering the coast.

Larnt, for some ten miles inland from the sea, is a level plain; then the mountain-ranges begin and rise to a height of nearly 5000 feet, running in an almost unbroken line in a northerly direction, with detached hills at intervals at their base. All the land at the foot of these ranges is more or less stanniferous. This strip is in length above 50 miles, with an average breadth of six. Its level is even now being altered by the alluvium brought down from the hills by a rainfall which exceeds 150 inches per annum.

All the ore worked up to the present time has been found in the alluvium derived from the mountain-ranges, *i. e.*, in mining language, in stream-works. The ore has been traced up to veins in the rock, but these have not hitherto been worked.

The tin-beds are composed of the débris of granitic rocks mixed with the ore; the latter varies in size from particles like fine sand to fragments as large as a hazel-nut, the deposit becoming coarser as the mountains are approached\*.

\* The following specimens were presented in illustration of this paper:— (1) *Fine Tin-sand*, obtained from the alluvial flats between the coast and the mountain-range—Larnt, Perak, Malayan Peninsula. (2) *Coarse Tin-sand*, found in alluvial deposits in the interior, beyond the mountain-range and from thirty to forty miles from the coast—Kintá, Perak. (3) *Tin-gravel*, found under boulders at varying altitudes of from 500 feet to 1500 feet above sea-level on the western slopes of the mountain-range—Larnt, Perak. (4) *Tin-ore in its matrix*, obtained from “pockets” of the hills at an elevation of 2000 feet—Larnt, Perak. (5) The *Tin-tray*, which holds the specimens, is made of the tin obtained from the smelting of the above ores, and manufactured in Larnt.

There can be no doubt that these beds have been formed by degradation of the mountains; these, as has been stated, consist of granitic rock, in which the tin-stone associated with iron-ore occurs in veins.

We still see the processes at work, though in a modified form, by which deposits have been spread over large areas during long periods of time; and the rotting trunks of trees, with other remains frequently met with in the workings, tend to prove that some of the deposits may be properly called "recent."

Sections of the mines show that the strata beneath the surface consist of alternating bands of sand and dark clay of different colours, the latter sometimes being largely present. These strata appear to indicate strong current-action. The separate fragments in the lowest (or tin-bearing) layer bear clear evidence of the same.

These fragments are of quartz, felspar, mica, and schorl; and among these are occasionally found masses of clay, most of which are so friable as to crumble to pieces when touched. In some, particles of quartz yet remain projecting from the surface, so as to give it a regular striated aspect, from which felspar separates as a white powder. Many of the more solid fragments have rounded angles, and are evidently derived from veins such as still occur in different parts of the country.

Beneath the tin-bearing stratum is a peculiar white clayey substance which becomes friable on drying and is called "Kong tay" by the Chinese. This is sometimes yellow, sometimes white or somewhat bluish. It consists of kaolin, sometimes mixed with fine quartz-sand, and is a decomposition-product of felspar. The kong has been bored to a depth of 20 feet; but nothing except this "porcelain clay," mixed with more or less quartz-sand, has been found.

Opinions differ as to whether this clay invariably underlies the stanniferous deposits. In the Larnt district there is little doubt that it does generally, the only exception to the rule being where the tin-stratum rests on sandstone, which, however, some have thought to be only the same clay with a large admixture of the quartz-sand already mentioned.

The following are sections of stream-deposits in different localities and will give a very fair general idea of the district:—

I.		ft. in.
Vegetable mould .....	1	3
Loam .....	1	0
Sand .....	4	0
Bluish clay .....	3	6
Darkish clay .....	3	9
Stratum with ore.....	6	0
		19 6
II.		
Mould-soil .....	3	0
Clay varying from dark yellow to pale grey	12	0
Light gravelly drift .....	3	0
Stratum with ore .....	6	0
		24 0

THE MALAYAN PENINSULA.

III.		ft. in.
Mould-soil .....	4	0
Sand varying from white to brown .....	4	0
Dark grey sand .....	6	0
Stratum with ore .....	4	0
Pipe-clay .....	(?)	
	18	0

IV.		ft. in.
Red loam .....	2	0
Sand drift.....	5	6
White grey clay .....	4	6
Black clay with trunks of trees.....	2	0
Stratum of ore .....	5	0
Pipe-clay .....	(?)	
	19	0

V.		ft. in.
Red loam .....	4	0
Sand drift.....	8	9
Whitish-grey clay .....	9	3
Stratum of ore .....	6	0
Sandstone.....	(?)	
	28	0

VI.		ft. in.
Red earthy loam .....	5	0
Whitish-grey clay .....	3	6
Drift sand.....	8	6
Stratum of ore.....	8	0
Sandstone.....	(?)	
	25	0

Some idea of the irregular stratification of the deposits in the tin-field may be obtained from the fact that in a working of less than 100 feet square the details of the sections of each of its sides differed, though, of course, there was a general similarity.

The depth at which the tin-ground is struck depends upon position and locality. There is probably no working at a greater depth than 30 feet. All the mining in Larnt is by open excavations. A mean derived from measurements of the depths of 43 mines in the Kamuntin Section gives an average of 9.91 feet, the greatest and least depths respectively being 21 feet and 4 feet. The greatest known thickness of the tin-stratum is 10 feet. The mean thickness, from measurements in the above 43 mines, is 4.87 feet, the range being from 2 to 7.5 feet. The spring-level of the country may be taken generally at a depth of 6 feet below the surface of the ground.

The workings cover an area of nearly 4 square miles of country, affording occupation for nearly 7000 labourers (Chinese), and yield an aggregate "output" of about 13,000 bharas, equivalent to 52,232 cwt. of tin per annum\*. The industry is fast developing under the British rule and bids fair to eclipse, in a period far from remote, the

\* The ore, when smelted (by the rude native process), yields from 60 to 62 per cent. of metal.

production of the other states of the peninsula and islands of the archipelago.

#### DISCUSSION.

Mr. W. W. SMYTH remarked that the details given in the paper corresponded closely with those of stream-works in other localities. Information on such subjects was important to capitalists. Large areas of alluvial deposits appeared to be rich in tin-ore in many places on the east side of the Bay of Bengal. So far as he knew, this was the first description of the region of Perak, and he trusted we should have more. He called attention to the association here, as in Queensland and elsewhere, of tin with granite. Mynheer van Groot had informed him that in the islands of Bellaton and Banka the tin was associated with slaty rocks curiously like those of Cornwall and Devon, probably, though on slight fossil evidence, of Devonian age.

Mr. J. H. COLLINS remarked that the similarity mentioned by Mr. W. W. Smyth extends to the associated minerals also; for wolfram and gilbertite were abundant in the specimens on the table, as in the stanniferous granites of Cornwall.