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TASMANIA

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Prospecting for Mercury in Tasmania

BY

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Issued under the authority of
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FOREWORD.

MERCURY or quicksilver is a metal which by reason of its unusual properties has always claimed considerable attention and interest. Its ores were worked by the ancients prior to the commencement of the Christian era, and the metal riveted the attention of the alchemists in the Middle Ages. It entered largely into their hypotheses and experiments. They imagined, curiously enough, that it was present in all other metals. Consequently a certain amount of mystery sprang up in connection with it, and it took a peculiar and fantastic place in their schemes of medicine as a potent therapeutic agent. These extravagancies of the uninstructed past have, however, given place to modern industrial applications of extreme value.

The desirability of prospecting for these ores at the present time has suggested the issue of this Circular. The Department hopes that it will afford information to those who may wish to take part in the search for so useful a metal.

Deposits of cinnabar, which is the ore from which quicksilver is generally extracted, have not yet been found in Tasmania, but the prospecting for them has not been very persistent, and in the few instances in which some sort of a search has been made, it is to be feared that the seekers did not have a very clear idea of the nature and characteristics of the mineral for which they were looking, nor of the indications which might be expected. Some criteria for guidance will be found in the present Circular.

Besides being used in the electrical industry, quicksilver is now in considerable demand in the manufacture of fulminates for explosives. The European conflict has to some extent affected the free movement of the metal from one country to another, and the discovery of payable deposits at the present time would have the advantage of exceptionally high market prices.

W. H. WALLACE,
Secretary for Mines.

Hobart, December, 1917.

Prospecting for Mercury in Tasmania.

USES OF MERCURY AND ITS MARKETS.

The property which quicksilver possesses of combining with other metals and forming alloys with them makes it useful in extracting gold and silver from their ores. The same amalgamating property was formerly utilised in silvering mirrors with a tin-quicksilver alloy. The metal has a high specific gravity (13.59) and this, with its fluidity and its uniform expansion under heat, makes it suitable for the construction of certain instruments employed in physical science (thermometers, barometers, &c.). Quicksilver enters into the composition of various trade amalgams, and mercurial compounds have medicinal and other applications. A very important use is in the manufacture of fulminate for explosives.

Quicksilver is disposed of in the market in wrought iron flasks, which in England, America, and Austria contain 75 lbs. of metal, but in other countries about 76 lbs. The present price in London is quoted as between £20 and £25 per flask. Since the outbreak of war the price has mounted to double and triple what it was in pre-war time, when it was only £8 or £9 per flask.

The market is an irregular one, and has to be watched by mine-owners, who are often compelled to wait till a demand stimulates prices. The metal, as Mr. C. G. Dennis remarks in "Mineral Industry for 1915" (page 617), "is not a commodity that can be produced and sold from day to day, or even from month to month. It is something that has to wait for a market; consequently it requires considerable capital to operate a quicksilver mine after the mine is equipped and producing."

The statistics of the world's output of quicksilver are not easily or precisely ascertainable, but from what can be gathered on the subject, it appears that the production is between 4000 and 5000 tons per annum.

Spain, Italy, Austria, and the United States are the chief producing countries, accounting for about three-

fourths of the total output. Russia, Hungary, and Mexico put out limited quantities. The American production jumped from 21,033 flasks in 1915 to 29,932 flasks in 1916. The Commonwealth of Australia imported 1000 flasks (33 tons) during the fiscal year 1915-16, valued at £16 per flask.

ORES OF MERCURY.

Cinnabar: Sulphide of mercury (HgS). (Composition: mercury, 86.2 per cent.; sulphur, 13.8 per cent. Hardness, 2-2.5. Specific gravity, 8.)

Metacinnabarite: Black sulphide of mercury; amorphous.

Calomel: HgCl_2 . Chlorine, 15.10 per cent.; mercury, 84.90 per cent. White with adamantine lustre.

Native Quicksilver: Is present in most mercury-producing mines, generally in the form of globules. Remarkable for being fluid at ordinary temperatures. It is silver-white and is volatile at all temperatures above 19°C . It becomes solid at $39-40^\circ \text{C}$. It is generally a secondary occurrence due to oxidation processes connected with cinnabar and mercurial fahl ore. What may be considered primary quicksilver is rare.

Native Amalgam: AgHg . Silver and mercury. Brilliant silver-white.

Montroydite. } Oxychlorides of mercury found in calcite
Terlinguaite. } veins and on stalactites in lower Creta-
Eglestonite. } ceous limestone at Terlingua in Texas.

Tiemannite: HgSe . Selenide of mercury; blackish-grey.

Onofrite: Sulpho-selenide of mercury. At San Onofre in Mexico.

Coloradoite: HgTe . In gold-telluride veins in Western Australia. This and the two preceding minerals are primary and rare.

Coralline Ore: A variety of cinnabar of liver-brown colour. Hepatic cinnabar; inflammable.

Idrialite: Inflammable cinnabar.

Coccinite: Iodide of mercury.

Ammiolite: Antimonate of copper mixed with cinnabar.

Lehrbachite: Selenide of lead and mercury.

Livingstonite: Sulphantimonite of mercury. The mineral, when pure, contains as much as 53.1 per cent. mercury.

A few other varieties are met with, but are unimportant. Mercury is sometimes associated with native silver; with dyscrasite (silver antimonide); with tetrahedrite, and

with lead and zinc ores. Cinnabar is practically the sole ore of commercial importance.

MODE OF OCCURRENCE AND DISTRIBUTION.

The most important productive quicksilver mines in the world are those of Almaden in Spain, Idria in Austria, and in Southern Russia. Other active mines are in the United States, Mexico, Peru, Italy, Transylvania, China, &c.

The Almaden mines are more than 2000 years old. The cinnabar here occupies the interspaces of the grains in beds of Silurian porous quartzite, and partly replaces the sandstone or quartzite itself. The important mines of Idria have been worked since the fifteenth century; the ores have impregnated Triassic beds of shale and dolomite. In Italy the Monte Amiata mines have been large producers; the cinnabar is in limestone (Jurassic to Tertiary). In the Russian Donetz region the mineral fills rock joints and occurs as impregnations in sandstones of Carboniferous age. Near Belgrade, in Servia, cinnabar and native quicksilver occur in hydro-thermally altered serpentine which has been reduced to a mixture of quartz, opal, and iron carbonate. The mineral occupies cavities in the cavernous siliceous rock. In the Carpathians cinnabar exists as an alteration product of mercurial fahl ore. In China deposits of quicksilver ores are in magnesian limestone, and in the form of nests and disseminations, besides being aligned along the bedding-planes of the strata. In New Zealand the ore is met with as a hot spring deposit; the same applies to Nevada and Venezuela. In California the occurrences are extremely varied—the ore occupies fissures with shattered fillings, or it forms pipes and shoots in opaline material at junctions of serpentine and basalt with sandstone, and is in many instances directly and obviously related to hot springs activity.

Cinnabar has been met with in several localities in New South Wales, and there has been a small production of quicksilver. Alluvial and vein cinnabar deposits exist in Queensland; and in Victoria native mercury and cinnabar occur in the Jamieson River basin. Native quicksilver has also been found in South Australia. The coloradoite of the gold-tellurium veins of Western Australia is an exceptional instance of a mercury compound formed under high temperature conditions. One of the

most interesting features of mercury deposits is that the deposition of ore belongs essentially to a shallow zone, and the process is observable in operation at the present day in hot springs regions.

A recent identification of mercury in Tasmania was made by Mr. R. A. A. Johnston, mineralogist to the Geological Survey of Canada, when testing specimens of the zeolite laumontite, which is found in the tin-wolfram-bismuth lode of the S. and M. Mine at Moina. A metallic cloudiness was observed on the wall of the closed tube, and the deposit was concentrated and found to be mercury. The lodes in this mine are of Devonian age, and the zeolitic material appears to form an integral part of the lode, but the possibility has to be considered of it having been deposited under the influence of overlying basalt.

The association of hydro-carbons (petroleum and bitumen) with some cinnabar deposits is noteworthy. At the New Idria Mine, in California, petroleum has been met with in some quantity, and in some of the mines in Northern California it occurs to an extent which is inconvenient. At the New Almaden cinnabar mine bitumen is quite common. At Idria, in Austria, the ore yields idrialite or combustible cinnabar. The coralline ore of Idria is a variety of cinnabar mixed with bituminous material. Inflammable marsh gas also occurs in the Californian quicksilver mines.

These hydro-carbons are regarded as having influenced the deposition of cinnabar. The association is, however, in all probability fortuitous, being dependent on the proximity of strata charged with hydro-carbons.

TREATMENT OF THE ORE.

The Almaden ore is unusually rich, its metallic content being said to average 8 per cent. But the average investor is content if he has a mine which will yield $\frac{3}{4}$ to 1 per cent., though ores as low as 0.30 to 0.40 are now regarded as payable. In California 1 per cent. ore is considered high grade, and 0.50 per cent. is a common working quality.

The low-grade ores which are being worked are encouraging numerous attempts in the direction of concentration previous to furnace treatment.

Concentration hitherto has proceeded along dry lines, as with wet dressing the ore slimes too much, and the losses are heavy. The crude ore is crushed in stone breakers and rolls, and classified by means of trommels and various screens. This applies especially to the poorer types of ore. Rich grade ores are crushed, dried, and charged direct into the furnace.

The dressed ore is roasted, and the mercury vapours condensed in cooling chambers and pipes. The types of furnaces and kilns and the details of treatment vary in different countries, and with different classes of ore.

Theoretically the treatment is simple, but in practice difficulties arise from the metal being so extremely volatile, and excessive losses occur. A good deal of the condensed metal sinks into the ground and foundations at quicksilver works, owing to its fluidity and weight.

Recent experiments at the University of California have shown that important improvements on present methods can be effected. The State Mining Bureau is conducting these investigations, and the following is an account of the preliminary results:—⁽¹⁾

“It is doubtful if the Scott fine-ore furnaces in operation in California are averaging 75 per cent. extraction. In addition, they are notorious for the quicksilver absorbed by the furnace and condenser walls; also soot is formed which has to be retreated for contained mercury. The products of fuel combustion being mixed with the vaporised mercury cause condensing troubles.

“The Bureau's experiments have shown that high extraction (above 90 per cent.) can be obtained by water concentration on tables, with friable ores in which the cinnabar is distinctly crystalline. Crushing by rolls produces a minimum of slimes. If, however, the pulp contains a cinnabar slime, either from “paint” ores, or by reason of having to crush fine to release the sulphide, the extraction by tables will be low. In such cases, though, it can be improved by classification, and treating the different sizes on separate tables. The slimed cinnabar can be recovered by flotation. A high extraction has been obtained by flotation test in finely-ground (.80 mesh)

⁽¹⁾ “The Mining Journal,” August 11, 1917.

fresh ores, utilising either pine oil derivatives or eucalyptus oils. We say "fresh" ores, because, contrary to common conception, cinnabar on exposure does oxidise sufficiently to affect flotation results, as some of our tests have indicated. Good results were obtained by table concentration on an ore carrying natural quicksilver.

"The concentrates being obtained have yet to be roasted. Retorts are of limited capacity; and the concentrates, because of their high specific gravity, require stirring to prevent packing. A small furnace of the Scott type could be used, with a narrower shaft and narrow shelf-slit; such as in use at the New Idria mine for treating soot. Here, again, we have the fuel combustion products mixed with the quicksilver vapour, and the attendant condensing difficulties. Some form of rotary roaster may be adapted, or a small-size unit of the McDougall or Wedge type of mechanically rabbled furnace muffle-fired.

"The ultimate decision between a straight furnace reduction or concentration and roasting of concentrates will be a matter of comparative costs, coupled with comparative extractions. The initial installation of a Scott fine-ore furnace unit is high (including condensers, &c., £1000 per ton—day capacity). In some instances the cost has been materially less than this figure, but this is now the exception rather than the rule. The extraction is low (in the majority of cases probably less than 75 per cent.); cost of operation is low (50 c. to 75 c. per ton for large units, economically managed, though this does not include high cost repairs, interest or depreciation on the high initial installation capital). A concentrating plant of equal capacity will require less than one-tenth the initial capital expenditure, and a correspondingly lower depreciation charge; it will give 25 per cent. to 30 per cent. higher extraction; but the operating cost, on account of finer crushing, will be 30 per cent. to 50 per cent. higher. These points will have to be determined upon for each individual property."

PROSPECTING.

The prospector who takes an intelligent interest in the mode of occurrence of the minerals which he seeks cannot fail to note that a very frequent feature of deposits of

cinnabar is their association with hot springs, past or present. Consequently the silica which forms the gangue or matrix is not quartz, but opal or chalcedony. This is another way of stating that the deposits are in close connection with igneous eruptions, or (in the case of springs in sedimentary beds) their after-actions. The prepondering tendency for the mineral to occur in association with eruptive belts of Mesozoic, Tertiary, and even recent age, indicates the basaltic and diabasic rocks in Tasmania and their contiguous sedimentaries as more favourable than the rocks of higher antiquity. The point is to search in these for developments of opaline or chalcedonic silica. Opaline silica is an alteration and replacement product, the result of infiltration. It is a common deposit from thermal waters. It replaces the woody tissue of fossil trees; it is frequent in serpentine as a magmatic residue. It is pseudomorphous after various minerals.

The hot springs in Nevada, California, and New Zealand afford evidences of the presence of cinnabar. In Tasmania very few still active warm springs exist. Examples are those at Kimberley, and near Southport; but these do not appear to have any connection with eruptive sources.

Evidence of former thermal activity is furnished by the chalcedonisation and opalisation of pebbles in drifts below Tertiary basalt in numerous parts of the island. Fossil wood found in these gravels has frequently been opalised by the infiltration of heated waters from the overlying covering of lava. If tracts of the basalt can be found traversed by veins of opaline silica, such parts of the igneous rock are places which should be examined.

Fundamentally analogous conditions are illustrated by the well-known occurrences of common opal $1\frac{1}{2}$ mile north and north-west of Bothwell. Outcrops of Gondwana sandstone (Triassic?) show patches and seams of jasperoid and common opal on the plain which is bounded on the south-west and north-east by ranges of intrusive diabase rock. The heated waters from the igneous rock have evidently produced the seams of opal and chalcedony, and in places have thoroughly opalised the sandstone. These conditions would favour the deposition of cinnabar should mercury be present in the igneous rock.

The above two instances typify the kind of conditions which prospectors should look for.

Among the older rocks in Tasmania opaline occurrences in serpentine should be examined. Examples of these are met with along the siliceous outcrop of Purcell's lode in the serpentine of the Bald Hill. The limonite gossan is mixed with chalcedonic and opaline silica which has probably been due to infiltration of terminal magmatic aqueo-siliceous solutions into the joint channels of the rock. This occurrence has not yet been tested for mercury.

Mercurial solutions appear quite specially to have saturated zones of porous and shattered country rock, and to have unloaded their burden along the joints of strata. Consequently such zones should not escape attention. Brecciated jasperoid quartz is a congenial gangue in which cinnabar may be disseminated.

The vermilion colour of cinnabar is so vivid that a very little mineral makes the rock appear much richer than it really is. Its high specific gravity will assist the prospector in determining the nature of his samples. The mineral, however, is frequently associated with bituminous matter, and the colour then becomes brown to black.

Sometimes (in Alaska) it weathers a rusty brown, and owing to being coated with oxide of iron cannot be determined with the naked eye. The ore is frequently earthy and friable.

The association of bitumen with some of the varieties of mercurial ore is peculiar, and apparently has some significance from a genetic point of view.

Cinnabar may be looked for in alluvial gold gravels where these have been derived from rocks containing deposits of the ore. The best field test for the prospector in this case is his dish; the grains of cinnabar, heavy and scarlet red, are recognised without difficulty.

Specimens of alleged cinnabar have been brought in from the Port Davey district, but on examination proved to be hematite.

Amalgam, which was thought to be native, has been met with on old Tasmanian goldfields, but the discoveries have been discredited owing to their circumstances and localities.

Mention may here be made of the characters of native quicksilver. It is a tin-white metallic liquid, found generally in the form of globules, occupying cavities in

the rock. Cinnabar occurs in a massive-granular form or as minute flakes or crystals. It is soft and sectile. Pure cinnabar heated before the blow-pipe volatilises completely. It is insoluble in warm hydro-chloric acid, and this serves at once to distinguish it from hematite. If powdered cinnabar is moistened with hydro-chloric acid, and rubbed on bright copper, the latter becomes silver-white. The deep red streak of cinnabar is very characteristic. The powder is always red. In the closed tube with dry carbonate of soda it gives a sublimate of metallic mercury.

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10th December, 1917.