MEMORANDUM ON THE MINERAL RESOURCES OF THE PHILIPPINE ISLANDS.

By GEORGE F. BECKER.

INTRODUCTION.

This brief memorandum probably covers all the main discoveries in the geology of the Philippines which are of economic interest. It is drawn up from data recorded in the Spanish Mining Bureau (Inspeccion de Minas) but not published, manuscript mine reports by the late William Ashburner, verbal information obtained in Manila, and various technical publications of Semper, Santos, Roth, Drasche, Abella, and others.

Only about a score of the islands are known to contain deposits of valuable minerals. These are arranged below in the order of their latitude, to give an idea of their geographical distribution and to facilitate finding the islands on the map. The latitude of the northern end of each is taken as that of the island. The character of the valuable minerals stated in the table will afford a general notion of the resources of the islands.

Mineral-bearing islands and their resources.

Island.	Latitude (north end)	Character of mineral resources.
	° ′	
Luzon	18 40	Coal, gold, copper, lead, iron, sulphur, marble, kaolin.
Catanduanes	14 8	Gold.
Marinduque	13 34	Lead, silver.
Mindoro	13 32	Coal, gold, copper.
Carraray	13 21	Coal.
Batan	13 19	Do.
Rapu-Rapu	13 15	Do.
Masbate	12 37	Coal, copper.
Romblon	12 37	Marble.
Sámar	12 36	Coal, gold.

Mineral-bearing islands and their resources—Continued.

Island.	Latitude (north end).	Character of mineral resources.
	° ′	
Sibuyan	12 30	Gold.
Semirara	12 7	Coal.
Panay	11 56	Coal, oil, gas, gold, copper, iron, mercury (?).
Biliran	11 43	Sulphur.
Leyte	11 35	Coal, oil, mercury (?).
Cebú	11 17	Coal, oil, gas, gold, lead, silver, iron.
Negros	11	Coal.
Bohol	10 10	Gold.
Panaon	10 10	Do.
Mindanao	9 50	Coal, gold, copper, platinum.
Sulú Archipelago	6 30	Pearls.

The distribution of each mineral or metal may now be sketched in somewhat greater detail. In many cases the information given in this abstract is exhaustive, so far as the available material is concerned. The coal fields of Cebú, however, have been studied in some detail by Mr. Abella, and in a few other instances more extended information has been condensed for the present purpose.

COAL.

So far as is definitely known, the coal of the Philippine Islands is all of Tertiary age, and might better be characterized as a highly carbonized lignite. It is analagous to the Japanese coal and to that of Washington, but not to the Welsh or Pennsylvania coals. Such lignites usually contain considerable combined water (8 to 18 per cent) and bear transportation ill. They are also apt to contain much sulphur, as iron pyrite, rendering them subject to spontaneous combustion and injurious to boiler plates. Nevertheless, when pyritous seams are avoided and the lignite is properly handled it forms a valuable fuel, especially for local consumption. In these islands it would appear that the native coal might supplant English or Australian coal for most purposes. Lignite is widely distributed in the archipelago; some of the seams are of excellent width, and the quality of certain of them is high for fue in this class.

Coal exists in various provinces of the island of Luzon (Abra, Camarines, Bataan, Sorsogon). The finest beds thus far discovered appear to be those in the small island of Batan, lying to the east of the southern portion of Luzon, in latitude 13° 19′. These seams vary from 2 feet 6 inches to 14 feet 8 inches in thickness. Analyses have

been made in the laboratory of the Inspeccion de Minas, and the mean of seven analyses gives the following composition:

Analysis of coal from Batan, one of the Philippine Islands.

Constituent.	Per cent.
Water	13.52
Volatile matter	37.46
Fixed carbon	44.46
Ash	4.56
Total	100

One pound of this coal will convert 6.25 pounds of water at 40° C. into steam at 100° C. The heating effect is about three-fourths that of Cardiff coal. The same beds are known to exist in other small adjacent islands, Carraray and Rapu-Rapu. A number of concessions for coal mining have also been granted on the main island of Luzon just south of Batan, at the town Bacon. No doubt the beds here are either identical or at least closely associated with the coal seams in the little islands.

The coal field of southern Luzon is said to extend across the Strait of San Bernardino into the northern portion of Sámar. Here coal is reported at half a dozen localities, but I have been able to ascertain no details as to the thickness or quality.

In Mindoro there are large deposits of coal in the extreme southern portion (Bulacao) and on the small adjacent island of Semirara. This fuel is said to be similar to that of Batan.

The islands of Masbate and Panay contain coal, the deposits of which thus far discovered do not seem of much importance. Specimens from the southwestern portion of Leyte, analyzed in the laboratory of the Inspeccion de Minas, are of remarkably high quality, but nothing definite about the deposit is known to me.

The first discovery of coal in the archipelago was made in the island of Cebú in 1827. Since then lignitic beds have been found on the island at a great variety of points. The most important croppings are on the eastern slope within some 15 or 20 miles of the capital, also named Cebú. Though a considerable amount of coal has been extracted here, the industry has not been a profitable one hitherto. This is, at least in part, due to crude methods of transportation. It is said, however, that the seams are often badly faulted.

At Uling, about 10 miles west of the capital, the seams reach a maximum thickness of 15½ feet. Ten analyses of Cebú coal are at my disposal. They indicate a fuel with about two-thirds the calorific effect of Cardiff coal, and with only about 4 per cent ash. Large quantities of the coal might, I suspect, contain a higher percentage of ash.

The island of Negros is nearly parallel with Cebú, and appears to be

of similar geological constitution, but it has been little explored and little of it seems to have been reduced to subjection by the Spaniards. There are known to be deposits of coal at Calatrava, on the east coast of Negros, and it is believed that they are of important extent. In the great island of Mindanao coal is known to occur at eight different localities, but no detailed examinations of any kind appear to have been made. Seven of these localities are on the east coast of Mindanao and the adjacent small islands. They indicate the presence of lignite from one end of the coast to the other. The eighth locality is in the western province called Zamboanga, on the Gulf of Sibuguey.

PETROLEUM.

In the island of Cebú petroleum has been found associated with coal at Toledo, on the west coast, where a concession has been granted. It is also reported from Asturias, to the north of Toledo, on the same coast, and from Alegria, to the south. Natural gas is said to exist in the Cebú coal fields. On Panay, too, oil is reported at Janinay, in the province of Iloilo, and gas is reported from the same island. Petroleum highly charged with paraffin is also found on Leyte, at a point about 4 miles from Villaba, a town on the west coast.

GOLD.

Gold is found at a vast number of localities in the archipelago, from northern Luzon to central Mindanao. In most cases the gold is detrital, and is found either in existing water courses or in stream deposits now deserted by the current. These last are called "aluviones" by the Spaniards. It is said that in Mindanao some of the gravels are in an elevated position and adapted to hydraulic mining. There are no data at hand which indicate decisively the value of any of the placers. They are washed by natives, largely with cocoanut shells for pans, though the batea is also in use.

In the province of Abra, at the northern end of Luzon, there are placers, and the gravel of the river Abra is auriferous. In Lepanto there are gold-quartz veins as well as gravels. Gold is obtained in this province close to the copper mines. In Benguet the gravels of the river Agno carry gold. There is also gold in the province of Bontoc and in Nueva Écija. The most important of the auriferous provinces is Camarines Norte. Here the townships of Mambulao, Paracale, and Labo are especially well known as gold-producing localities. Mr. Drasche, a well-known German geologist, says that there were 700 natives at work on the rich quartz veins of this place at the time of his visit about twenty-five years ago. At Paracale there are parallel quartz veins in granite, one of which is 20 feet in width and contains a chute in which the ore is said to assay 38 ounces of gold to the ton. One may suspect that this assay hardly represented an average sample. Besides the localities mentioned, many others in this province have been worked by the natives.

The islands of Mindoro, Catanduanes, Sibuyan, Sámar, Panay, Cebú, and Bohol are reported to contain gold, but no exact data are accessible.

At the south end of the small island of Panaon, which is just to the south of Leyte, there are gold-quartz veins, one of which has been worked to some extent. It is 6 feet in thickness and has yielded from $6 to $7 per ton.

In the island of Mindanao there are two known gold-bearing districts. One of these is in the province of Surigao, where Placer and other townships show gravels and veins. The second district is in the province of Misamis. Near the settlement of Imponan, on the Gulf of Macajalar, there are said to be many square kilometers of gravels carrying large quantities of gold with which is associated platinum. The product of this district was estimated some years since at 150 ounces per month, all extracted by natives with bateas or cocoanut-shell dishes.

COPPER.

Copper ores are reported from a great number of localities in the Philippines. They are said to occur in the following islands: Luzon (provinces of Lepanto, Benguet, and Camarines), Mindoro, Capul,[1] Masbate, Panay (province of Antique), and Mindanao (province of Surigao). Many of these occurrences are probably unimportant. The great island of Mindanao, being practically unexplored, is full of possibilities, but as yet no important copper deposit is known to exist there. An attempt was made to work the deposit in Masbate, but no success seems to have been attained. On the other hand, northern Luzon contains a copper region which is unquestionably valuable. The best-known portion of this region lies about Mount Datá, a peak given as "2,500 meters?" in height, lying in latitude 16° 53′, longitude 120° 58′ east of Greenwich, or 124° 38′ east of Madrid. The range of which Datá forms one peak trends due north to Cape Lacay-Lacay, and forms a boundary for all the provinces infringing upon it.

Datá itself lies in the province of Lepanto. In this range copper ore has been smelted by the natives from time immemorial and before Magellan discovered the Philippines. The process is a complicated one, based on the same principles as the method of smelting sulphosalts of this metal in Europe and America. It consists in alternate partial roasting and reduction to "matte" and eventually to black copper. It is generally believed that this process must have been introduced from China or Japan. It is practiced only by one peculiar tribe of natives, the Igorrotes, who are remarkable in many ways.

Vague reports and the routes by which copper smelted by natives comes to market indicate that there are copper mines in various portions of the Cordillera Central, but the only deposits which have been examined with any care are those at Mancayan (about 5 miles west of

[1] I am unable to find this island, which probably is a very small one.

Mount Datá) and two or three other localities within a few miles of Mancayan. The deposits of Mancayan are described as veins of rich ore, reaching 7 meters in width and arranged in groups. Mean assays are said to show over 16 per cent of copper, mainly as tetrahedrite and allied ores. The gangue is quartz. The country rock is described as a large quartzite lens embedded in a great mass of trachyte. An attempt has been made by white men to work these deposits, but with no considerable success. The failure does not seem to have been due to the quality or quantity of ore found.

LEAD AND SILVER.

A lead mine has been partially developed near the town of Cebú, on the island of the same name.

The most important deposit of argentiferous galena is said to be at Torrijos, on the small island of Marinduque (latitude 13° 34′). A metric ton, or 1,000 kilograms, is said to contain 96 grams of silver, 6 grams of gold, and 565.5 kilograms of lead.

In Camarines, a province of Luzon, lead ores occur, but are worked only for the gold they contain.

IRON.

There is iron ore in abundance in Luzon, Caraballo,[1] Cebú, Panay, and doubtless in other islands. In Luzon it is found in the provinces of Laguna, Pampanga, and Camarines Norte, but principally in Bulacan. The finest deposits are in the last-named province, near a small settlement named Camachin, which lies in latitude 15° 7′ and longitude 124° 47′ east of Madrid. A small industry exists here, wrought iron being produced in a sort of bloomery and manufactured into plowshares. The process has not been described in detail, so far as I know. It would appear that charcoal pig iron might be produced to some advantage in this region. The lignites of the archipelago are probably unsuitable for iron blast furnaces.

QUICKSILVER.

Rumors of the occurrence of this metal in Panay and Leyte have failed of verification. Accidental losses of this metal by prospectors or surveyors sometimes lead to reports of the discovery of deposits, and ochers are not seldom mistaken for impure cinnabar.

NONMETALLIC SUBSTANCES.

Sulphur deposits abound about active and extinct volcanoes in the Philippines. In Luzon the principal sulphur deposits are at Daclan, in the province of Benguet, and at Colasi, in Camarines. The finest

[1] I have not found this island on the map.

deposit in the archipelago is said to be on the little island of Biliran, which lies to the northwest of Leyte.

Marble of fine quality occurs on the small island of Romblon (latitude 12° 37′). It is much employed in churches in Manila for baptismal fonts and other purposes. Marbles are also quarried at Montalban in the province of Manila, and at Binangonan in the province of Marong.

There are concessions for mining kaolin at Los Baños, in Laguna Province.

Pearl fisheries exist in the Sulú Archipelago, and are said to form an important source of wealth.