2–2 Details of Each Ore Deposit

The details of ore deposits in Mindo Island are as follows.

2–2–1 Placer Gold

According to some recent unpublished data from the BMG, placer gold production in Mindoro Island is estimated 50 g/day in Mindoro Oriental and 10 g/day in Mindoro Occidental.

The placer gold dusts in Mindoro Oriental are being collected from the rivers, running in the Halcon metamorphics area, by using "sluice box" or panning. The Dulangan River (No. 1 in Fig. 11) and the Binaybay River (No. 2) between Puerto Galera and San Teodoro in the northern part are famous as a gold field. No igneous activities can be found in the Halcon metamorphics area, and it has recently become clear that gold dusts occur in the residual soil on a mountainsides, both of which suggest the placer gold has originated from the Halcon metamorphics.

On the other hand, the placer gold dusts in Mindoro Occidental are being collected in the upper reaches of the Labangan (No. 3), northeast of San Jose. The gold field corresponds to the area of Bongabong conglomerate (which is correlated to the Punso conglomerate after Miranda (1980)). The gold dusts here are considered to have originated from the conglomerate bed.

As the fluvial sand has locally deposited at the places where the current speeds slow down, the scales of the gold deposits are estimated very small.

2–2–2 Copper

Six copper showings (Nos. 5, 6, 7, 8, 9, 10) are located near the Mindoro Fault and the Wasig Fault in the eastern central part and one showing (No. 4) is located in the northern part and another showing (No. 11), in the southern part. All of them are related to the dioritic rocks.

Four showings of Masnon (No. 6a), Manamburao (No. 6b), Shawood (No. 6c) and Bambanon (No. 7) in the upper reaches of the Pula River, are composed of chalcopyrite – pyrrhotite – quartz veins with a few sphalerite and pyrite, which have filled the fault fissures developed in the Lumintao basalt or the Ultramafic complex.

It is considered that the mineralization is related to the dioritic rocks and has filled the fissures of a NE–SW system made by the prominent geological structural line of a NNW–SSE system.

The vein widths are so narrow as 0.10 – 0.30 m except Manamburao which has 1.10 m in width. The copper grades are mostly less than 2.5% but high grades as 8 – 14 g/T Au and 12 – 15% Cu are seldom observed in the veins in the Ultramafic complex.

Geochemical soil survey carried out in the area covering these showings, disclosed that Cu,

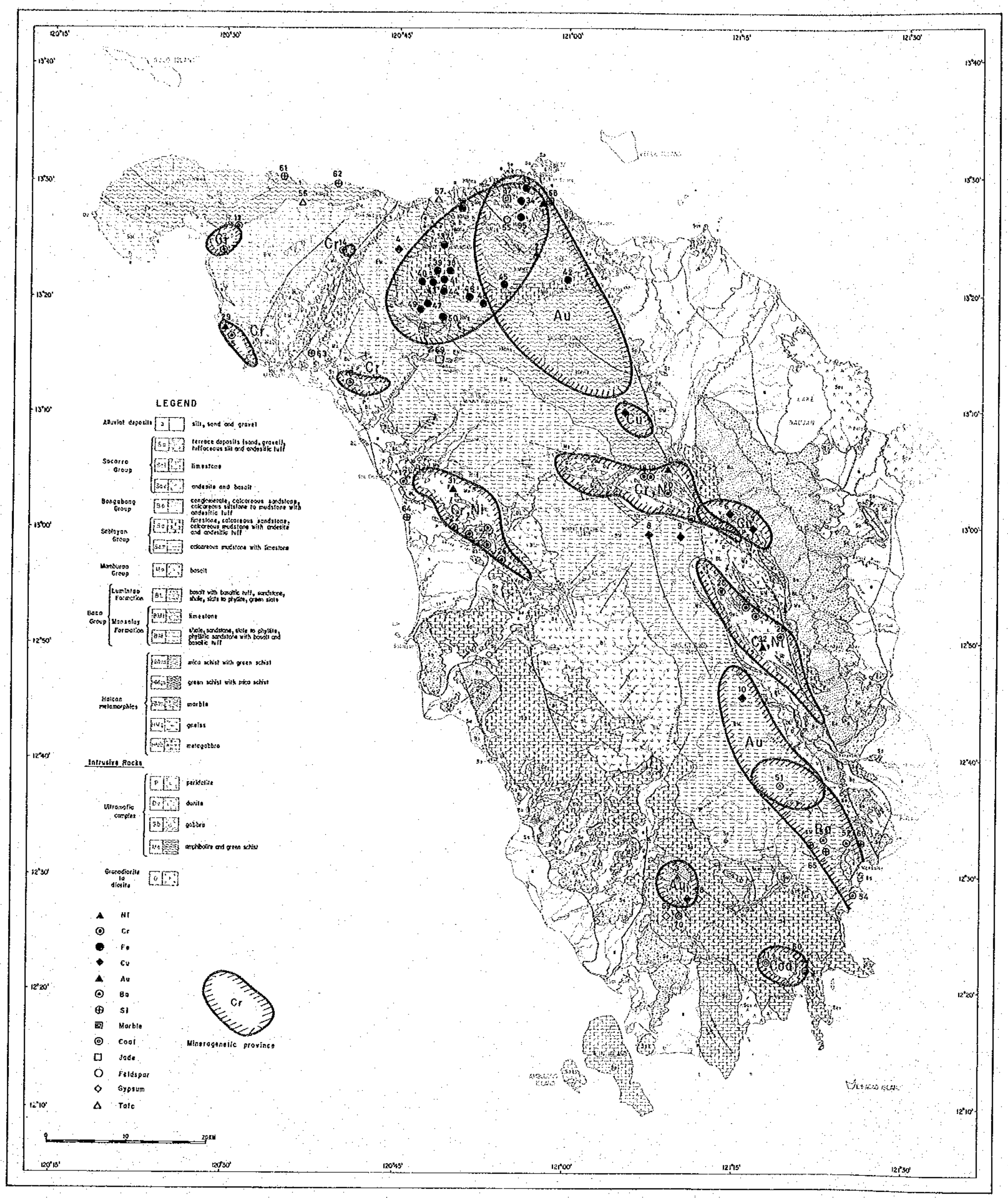

Fig. 11 Mineragenetic Province of the Survey Area

Pb and Zn contents were generally low (Cu: 3–168 ppm, Pb: 0–38 ppm, Zn: 3–151 ppm) and there were few geochemical anomalies. These facts suggest the copper mineralization is very small in scale, considering in connection with very weak rock alteration.

Acliang and Pojo showings (No. 10) located in the middle course of the Bongabong River in the southern part is the veins filling the fissility of the Mansalay Formation. The ore minerals are mainly composed of pyrrhotite with a few amount of chalcopyrite and pyrite. There are a Ultramafic complex in the 10 km east and a quartz diorite body in the 10 km east-southeast. According to the BMG report (1974) acidic dikes are exposed near the showings and so the mineralization is considered to be related to the dioritic rocks.

2–2–3 Chrome

Chromite showings occur only in the Ultramafic complex and many outcrops and float zones have been found.

As stated before, there are large-scale Ultramafic bodies (Ogos, Bongabon and Pinting with an area of more than 200 km^2) which are distributed along the geological structural lines on the eastern and the western sides, and small-scale bodies (Paluan, Igsoso, San vicente, Liwliw and Balete with an area of some km^2). In the former bodies a layered structure consisting of dunite, harzburgite and lherzolite is recognizable.

The geological survey found chromite showings in all Ultramafic bodies except for Balete. Their shape, ore texture, scale and host rock are listed in Table 6.

Table 6 Characteristics of Chromite Showing

Name of Mineral Showings		Type	Texture of Ore	Extension	Host Rock	Remarks
Ogos No. 1	(18)*	layered, disseminated	idiomorphic ~ hypidiomorphic	W: 6.5m, L: 10m+	dunite	
Ogos No. 4	(21)	disseminated, network	idiomorphic ~ xenomorphic	disseminated zone W: 5 m+	harzburgite	
Banus No. 2	(27)	layered, lenticular	idiomorphic ~ xenomorphic	max. size of one orebody T: 1 m, L: 4 m	dunite	It is composed of many small lenticular bodies
Masbo	(25)	massive, lenticular	idiomorphic ~ hypidiomorphic	max. size of one orebody W: 0.3 m, L: 1.5 m	dunite	Orebodies occur in the sheared zone
Pintin west / *central* / east	(22) / (23) / (24)	*massive, lenticular*	idiomorphic ~ xenomorphic generaly cataclastic	size of orebody on No. 1 showing max. 1.0 x 0.2 x 0.2 m	harzburgite	No. 1 showing consists of a few lenticular bodies
San Vicente	(14)	massive, lenticular	idiomorphic, cataclastic	max. size of one orebody W: 0.1 ~ 0.5 m, L: 3 m	harzburgite	Orebodies occur in the sheared zone
Igsoso	(15)	layered, disseminated	xenomorphic	No. 1: 0.4 x 1.9 x 6.0 m	dunite	
Liwliw	(16)	massive, lenticular	xenomorphic, cataclastic	max. size of one orebody 0.1~0.2 x 3.0 x 1.5 m	harzburgite	Orebodies are distorted by small faults or shearing.

* ... This number corresponds to the number in the inventory map and table.

As is evident in the table, the layered or banded orebodies tend to occur in dunite in the densely spotted or disseminated form. Most of the crystals have an idiomorphic form and have no shear fractures, which indicates that the crystals have not moved since crystallization. On the other hand, the massive orebodies occur along faults or have been dislocated by fault. The crystals have xenomorphic and fragmental forms with a cataclastic texture, indicating some movement after crystallization. The orebodies of this type are in pod – or lens-forms which result from either compression or tension.

The occurrences of San Vicente orebody in harzburgite and Ogos orebody in dunite will be discribed as the typical chromite deposits.

San Vicente Orebody (No. 14)

The ore deposit is located on the top of the hill and can be reached by 40 minutes on foot from the highway. The Ultramafic complex found in the area is small in size (1.5 km x 1.0 km) and is intruded by gabbro and fine-grained diorite.

The chromite deposit is composed of massive orebodies of a pod shape in harzburgite. The bodies are clearly bordered from the wall rock by the small faults or sheared zones of a NE–SW system. The thickness of 0.40 m is measured in the outcrop, but it might be more than 2.00 m in the center, judging from the size of the boulders. The scale of orebody is considered to be some tens tons. Under the microscope, the ore of the outcrop consists of euhedral crystals of chromite, 1 – 2 mm in size, and a very small amount of acicular magnetite (0.01 mm wide), in which shear planes are intersecting each other at 30°.

Analytical values:

Sample No.	Cr_2O_3 %	Fe %	SiO_2 %	Al_2O_3 %	MgO %	Ni %	Co ppm
TR2–060 (outcrop)	27.35	10.12	2.88	32.78	18.66	0.14	139

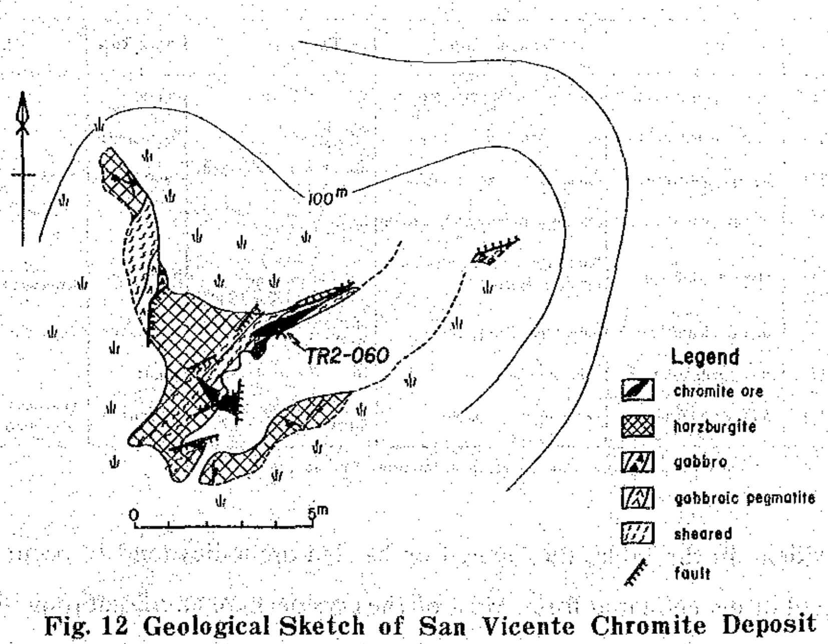

Fig. 12 Geological Sketch of San Vicente Chromite Deposit

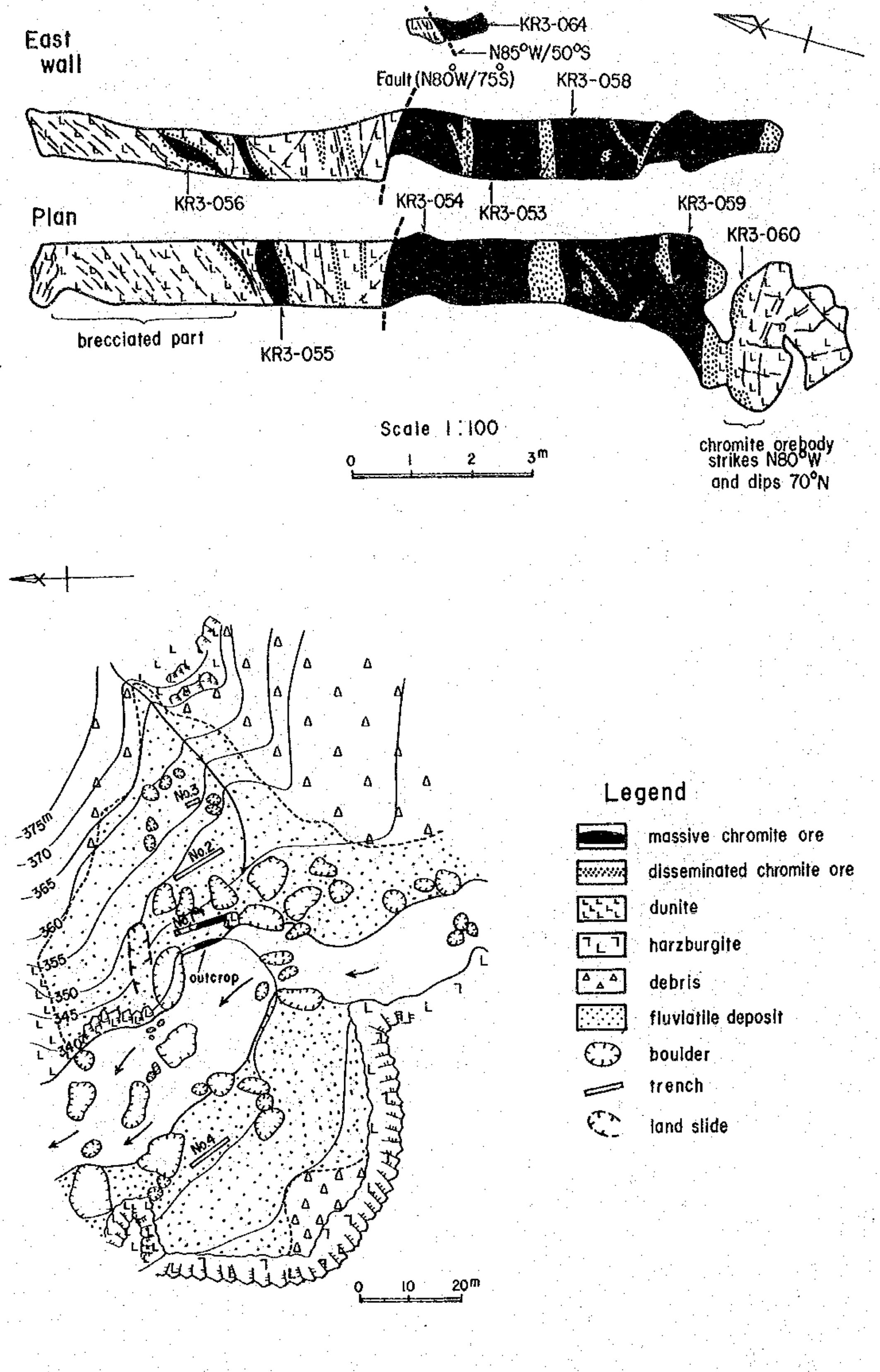

Fig. 13 Geological Sketch of Ogos Chromite Orebody (No.1 Trench)

Ogos Orebody (No. 18)

The deposit is found in a branch of the Ogos River, the western tributary of the Magawawangtubig River, 10 km south-southwest of Villacerveza.

The Ultramafic complex exposed here has a size of 22 km in an E–W direction and 10 km in a N–S direction, mainly consisting of dunite, harzburgite and lherzolite. A layered structure is apparent.

The Ogos orebody, which has been found by the geological survey, occur in dunite in the layered form. It shows a banding structure which grades from densely spotted in the center to disseminated towards the wall, tending to become finer in the grain size, and finally to the dunite with some chromite dissemination. The Ogos orebody has been confirmed to be 6.5 m thick, and it is expected to extend for some tens meters.

Microscopically, the ore is composed of euhedral and slightly rounded chromite (0.5 – 1.5 mm in size). The grain in the central part is somewhat coarser (0.3 – 2.0 mm in size). No shearing fractures can be observed.

Average analitical values are shown below.

Sample No.	Cr_2O_3 %	Fe %	SiO_2 %	Al_2O_3 %	MgO %	Ni %	Co ppm
Central part	33.71	12.35	17.54	9.47	21.63	0.13	191
Marginal part	27.05	12.69	13.24	14.80	23.05	0.13	173

The chemical components of chromite vary a little in different localities. Namely, the ores in the Bongabong body are rich in Cr and Fe (Cr_2O_3 45%, Fe 12%, Al_2O_3 13%) and they are classified into "metallurgical" as well as the ores of Acoje Mine in Zambales. Some of the ores in the Pintin body are rich in Al_2O_3 (Cr_2O_3 32% Fe 9% Al_2O_3 25%) and are classified into "Refractory" as well as the ores of Masinroc Mine in Zambales. Most of the ores in the Ogos body which is located at the middle of the two bodies, show an intermediate components.

Most of the mineralized zones are discontinuous except for the Ogos body and their scales are supposed to be small as a few tons – 100 tons.

2–2–4 Iron

Many iron deposits are scattered in the Sablayan limestone area near the ridge in the northern part of the central ranges. All of them are contact metasomatic deposits which are related to the intrusion of quartz diorite – diorite of Palaeogene. The ore minerals are mainly magnetite and hematite with skarn minerals. There are three relatively large-scale deposits (Nagsabongan, Lasala and Lapa-ao) in the upper reaches of the Mamburao River and one deposit (Dayap) in the upper reaches of the Pagbahan River. Ground magnetic survey was carried out for the former deposits to confirm their extension. The details of each deposit are as follows.

Nagsabongan Deposit (No. 39)

The deposit is located on the northern slope of the Nagsabongan creek, the eastern branch of the Mamburao River. The elevation is 700 m above sea level. The outcrop with a size of 130 m (E–W) x 50 m (N–S) x 40 m (height), extends along the creek forming a very steep cliff.

The ore minerals are mostly composed of magnetite with a small amount of fine grained (0.02 mm in size) pyrite and chalcopyrite. Hematitization has advanced along cleavages developed in the magnetite.

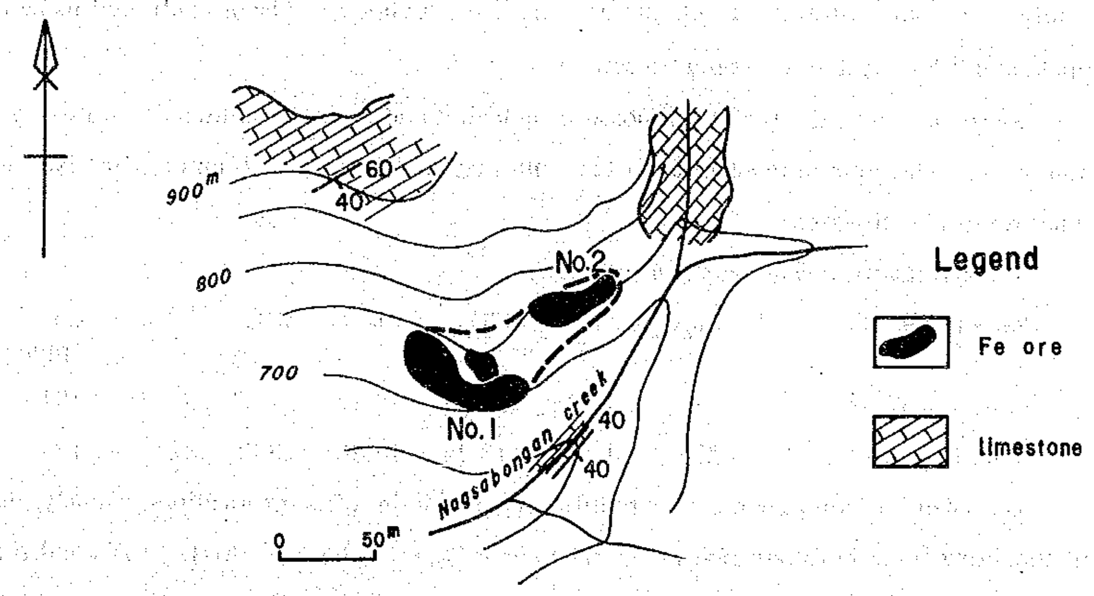

Fig. 14 Geological Map of Nagsabongan Iron Deposit

Average analytical values of outcrops:

Fe %	Cu ppm	V ppm	TiO_2 ppm	P ppm
67.32	61	12	44	111

A stock of quartz diorite has intruded in the west of the outcrop, around which an epidote skarn zone is distributed.

Based on the results of ground magnetic survey, the magnetic globe with a radius of 100 m can be speculated for the magnetite orebody. A reserve of 8 x 10^6 tons is expected, when a radius is 100 m, a specific gravity is 4.0 and a safety rate is 50% ($4/3\pi$ x 100^3 x 4.0 x 50%). The magnetic survey has disclosed another magnetic anomalous zone on the eastern slope of the Nagsabongan creek. On the same assamption, its reserve is estimated as 4 x 10^6 tons ($4/3\pi$ x 80^3 x 4.0 x 50%).

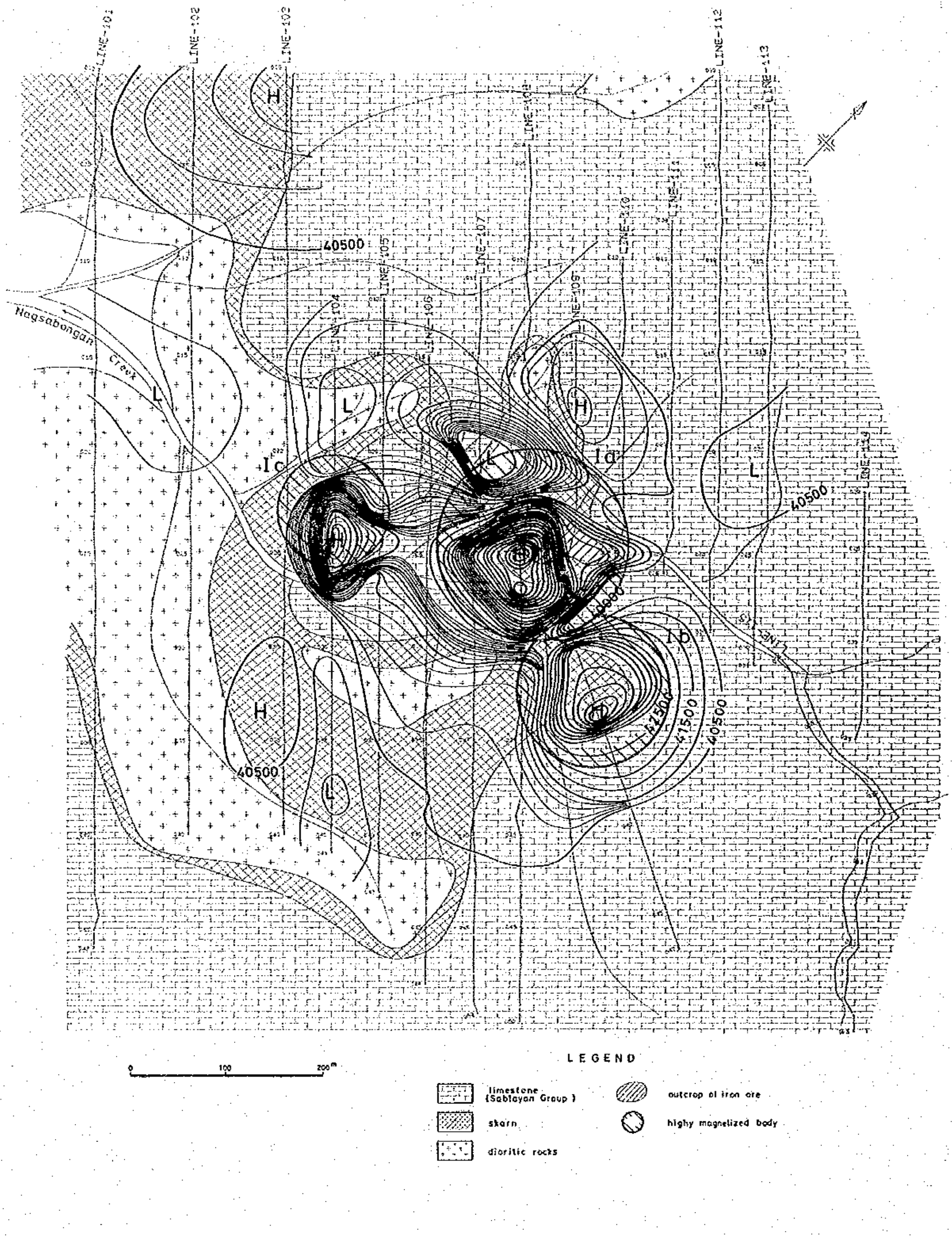

Fig. 15 Interpretation Map of Ground Magnetic Data on Nagsabongan Iron Deposit

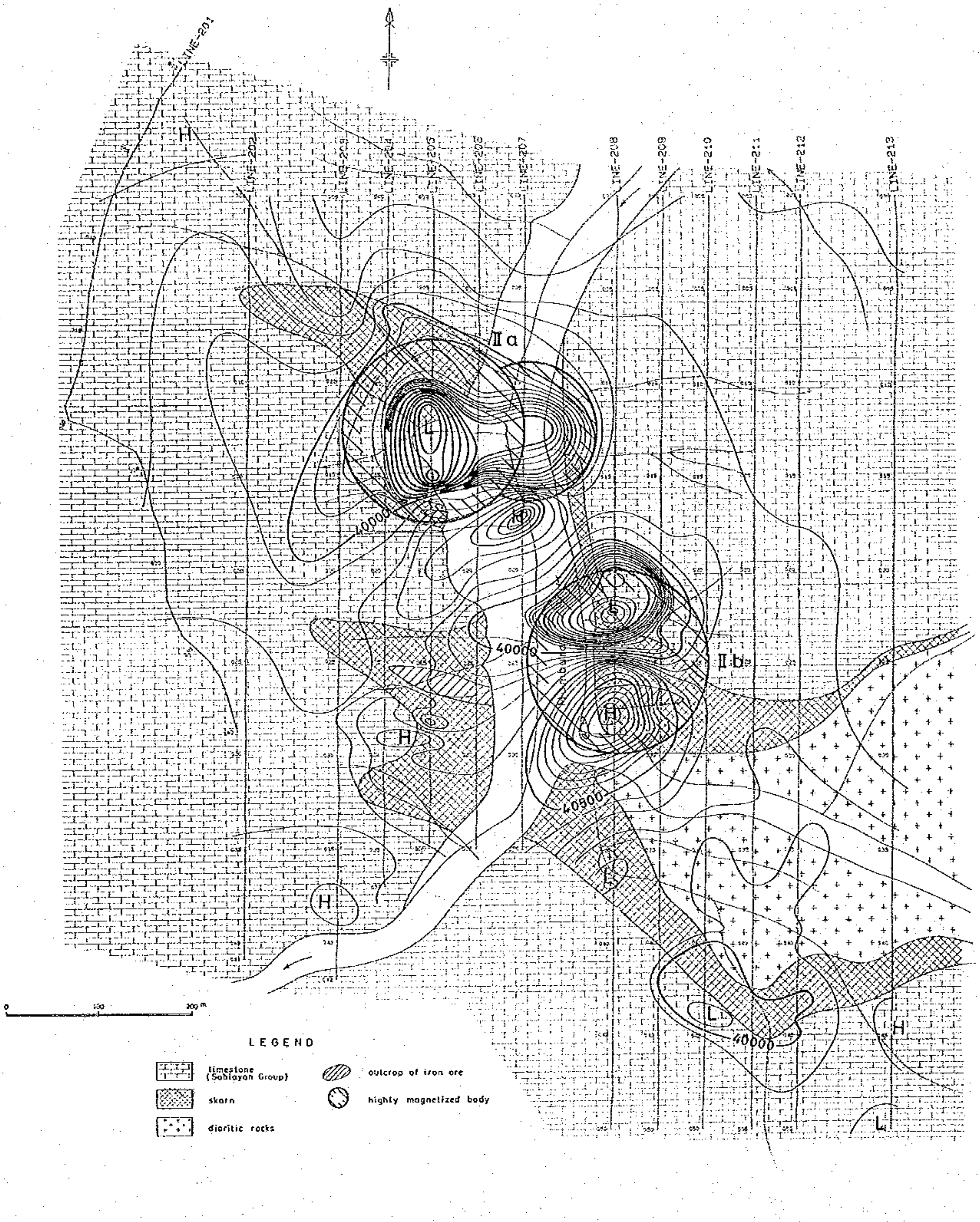

Fig. 16 Interpretation Map of Ground Magnetic Data on Lasala Iron Deposit

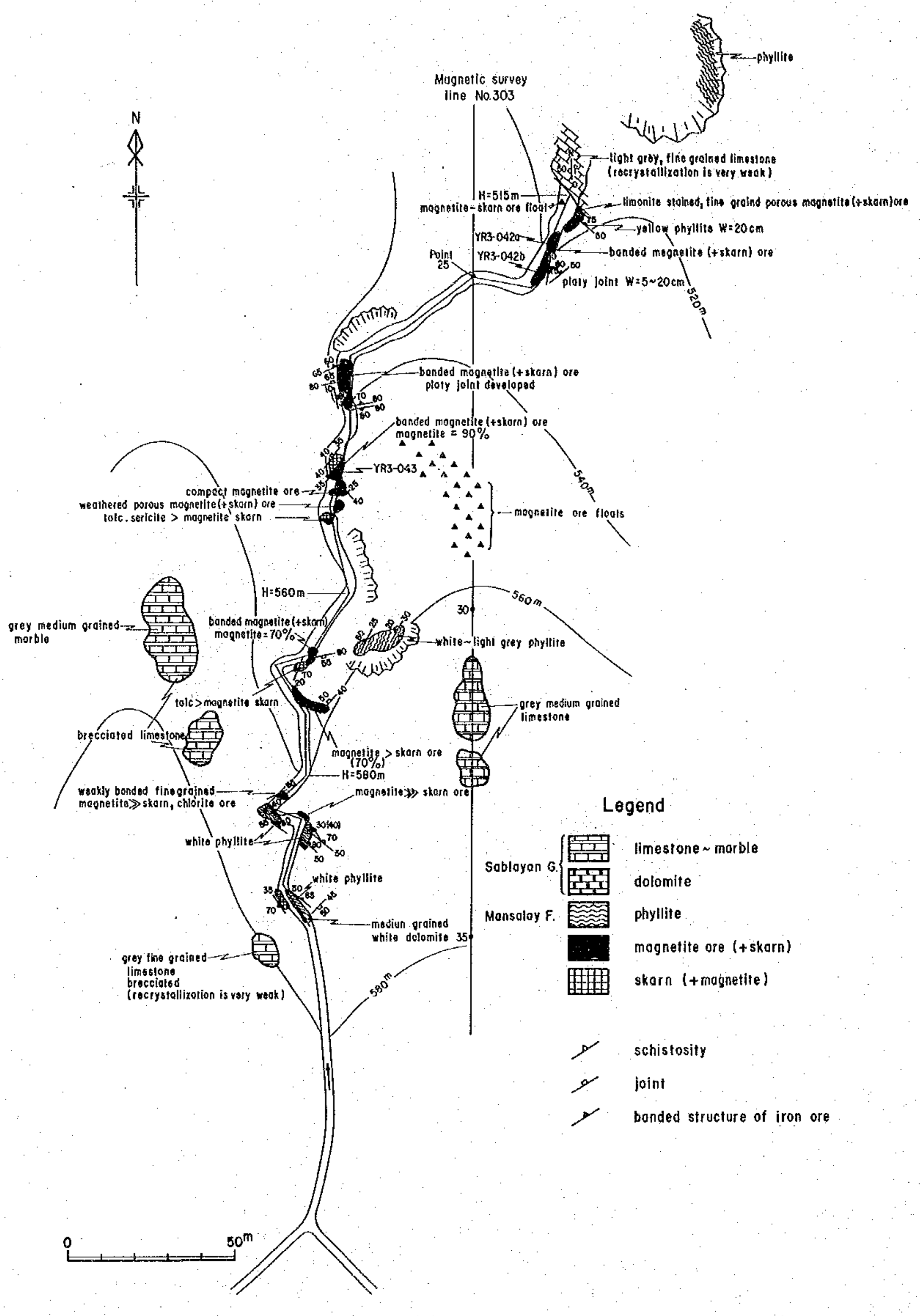

Fig. 17 Geological Route Map of Lapa-ao Iron Deposit

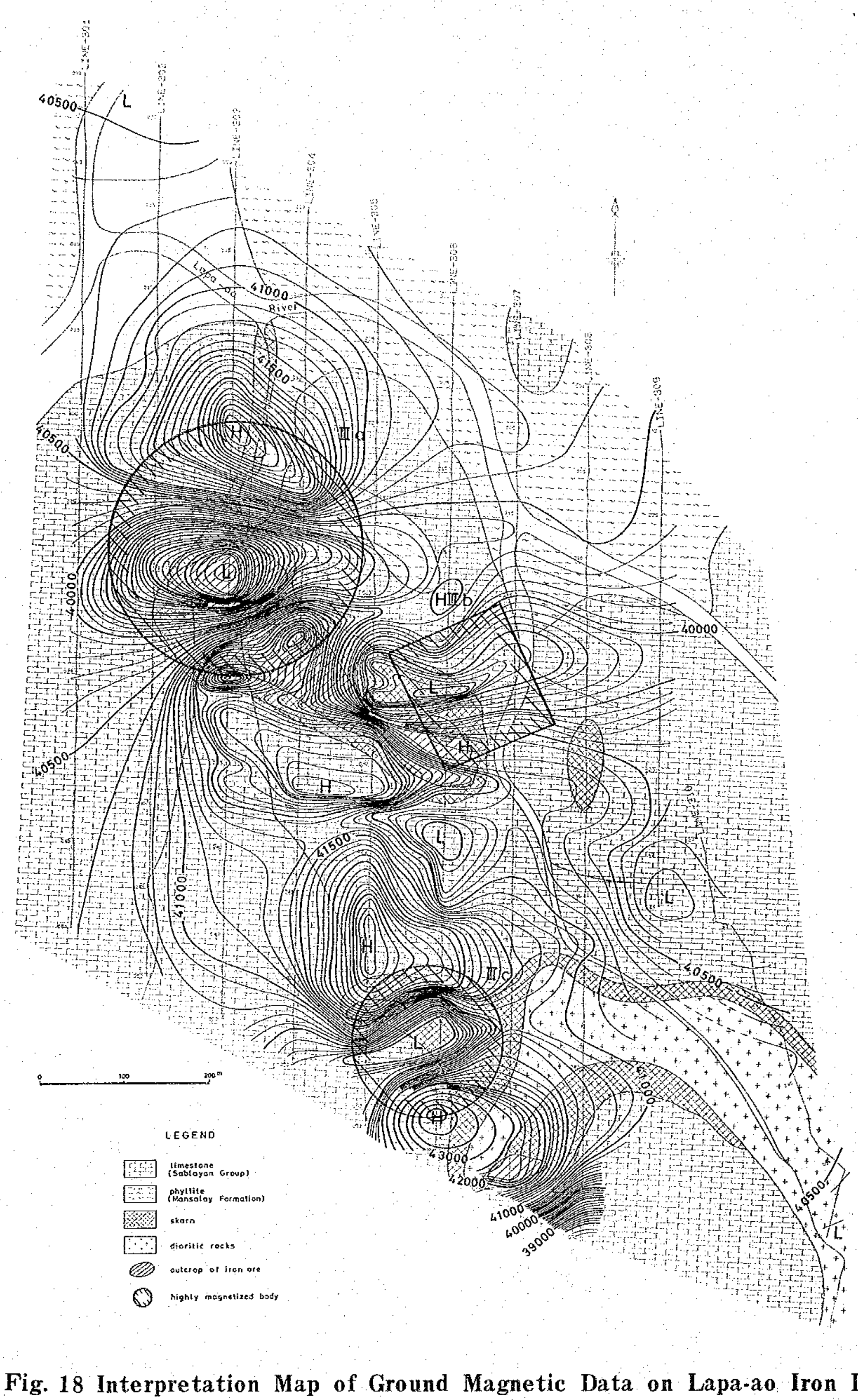

Fig. 18 Interpretation Map of Ground Magnetic Data on Lapa-ao Iron Deposit

Average analytical values of outcrops:

Fe %	Cu ppm	V ppm	TiO_2 ppm	P ppm
61.10	455	94	183	348

Lasala Deposit (No. 40)

The deposit is located at the place of about 400 m above sea level, 3 km southwest of the Nagsabongan deposit. It was explored by the Mayorga Mining Company in the period from 1961 to 1964. There are many traces of trenching on the western slope of the Mamburao River.

Two magnetic anomalous zones lie facing each other with the river between. As the centers of these two zones are located on the riverbank where fluvial gravels are accumulated, their occurrence are obscure.

From the shape of magnetic anomalies, globe models can be applied for the magnetic bodies. The reserve of IIa body is estimated at 10×10^6 tons ($4/3\pi \times 100^3 \times 4.0 \times 0.5 + 4/3\pi \times 75^3 \times 1/2 \times 4.0 \times 0.5$) and the reserve of IIb body, 8×10^6 tons ($4/3\pi \times 100^3 \times 4.0 \times 0.5$).

Average analytical values of outcrops:

Fe %	Cu ppm	V ppm	TiO_2 ppm	P ppm
61.10	455	94	183	348

Lapa-ao Deposit (No. 49)

The deposit is located in the upper reaches of the Lapa-ao River, 3.5 km south of the above-mentioned Lasala. Its elevation is 500 – 550 m above sea level.

The outcrops are intermittent for about 200 m along a tributary of the Lapa-ao River. The ore minerals and the texture of the Lapa-ao deposit are quite same as those of the Nagsabongan and the Lasala deposits but skarn is rich in the Lapa-ao.

Average analytical values of outcrops:

	Fe_2O_3 %	SiO_2 %	Al_2O_3 %	S %	P %	TiO_2 %	As %
Massive ore	53.39	4.70	0.35	0.19	0.047	0.009	0.001
Middling	31.98	–	–	–	0.021	0.020	–

The magnetic anomalous zone centering at the outcrops extends toward southeast. Speculated magnetic models are a globe (radius: 150 m reserve: $4/3\pi \times 150^3 \times 4.0 \times 50\% = 28 \times 10^6$ ton) and a cylinder (radius: 90 m, length: 150 m, reserve: $90^2 \pi \times 150 = 8 \times 10^6$ ton).

2–2–5 Barite

The barite deposits are of the vein type, occurring in the Mansalay Formation in the southeastern part. There are three deposits including Taoga and Mansiol, and one showing.

The Taoga deposit (No. 51) had been closed since 1974 and was reopened by Filihispano Inc. in 1982. At present they are mining two barite veins which are located on the mountain slope of 700 m in elevation, striking N40E and dipping 30S, with a 0.50 – 1.20 m width, and which have a 84% grade of $BaSO_4$ and carry a small amount of gold (1.5 g/T) in the alteration zone near the boundary.

The Mansiol point deposit (No. 54) is composed of barite veins which were checked by the Phase II trenching. They strike N20E and dip 70N and continues more than 90 m with a 1.20 – 1.60 m width. The deposit is in preparation for exploitation.

As shown in Fig. 19, the barite showings in this area are arranged in a NW–SE direction. On the extention with a NW direction, lie a silicified zone carrying gold and a copper showing, suggesting that this arrangement may be due to the anticlinal structure of the Mansalay Formation or the Mindoro Fault along which the Palaeogene dioritic rocks were intruded and were accompanied with gold, copper and barite mineralizations of the post igneous activities.

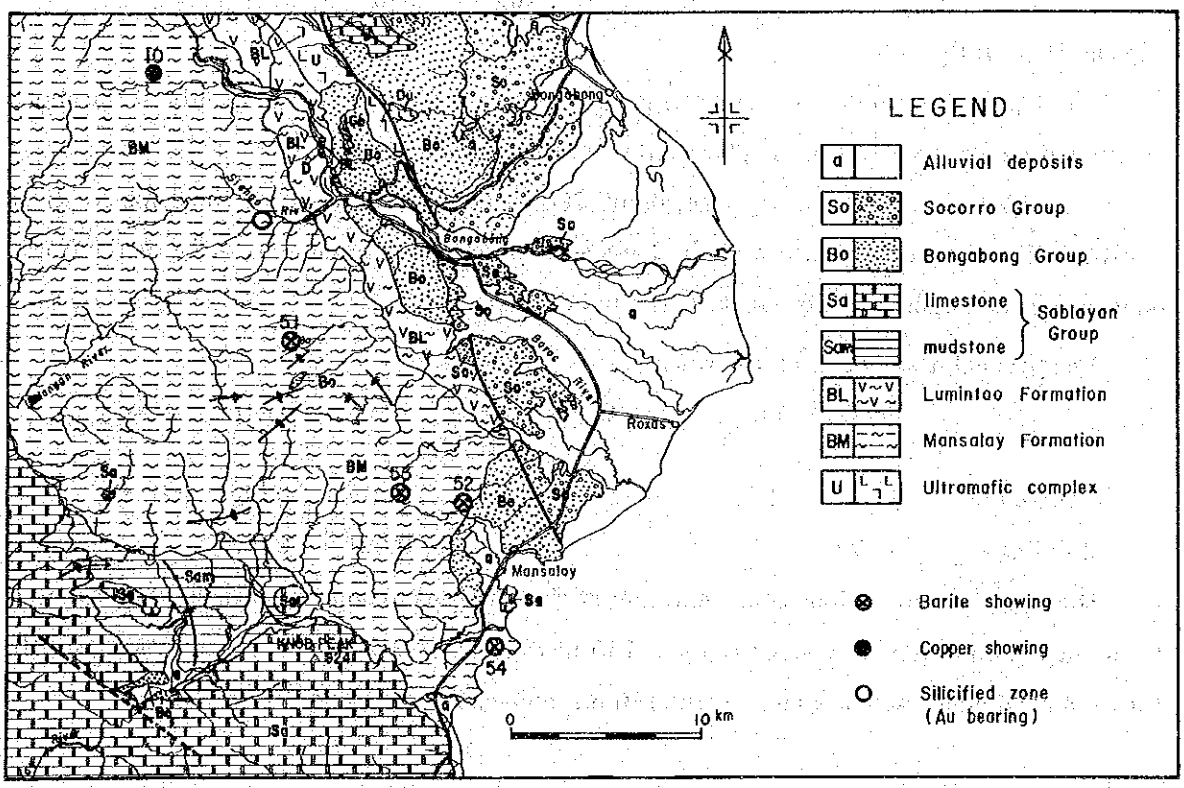

Fig. 19 Location Map of Mineral Showings in the Mansalay Area

2–2–6 Silica Sand

The silica sand deposit in this island can be divided into two types. One is the beach sand derived from the Halcon metamorphics and the another, weathered arkose of the Mansalay Formation. The former type deposits are distributed in the northwest part in a small scale, with a 80 – 97% SiO_2 grade and a few thousands tons reserve. The later type deposits are two beds of coarse grained arkose which are exposed on the mountain slope, 3 km northwest of Mansalay. According to the BMG report (1974), analitical values range from 74.5% to 86.8% SiO_2. As the rock is highly indurated, the technical and economical studies on quartz separation will be needed.

2–2–7 Marble

The marble deposits are recrystallized limestone of the Halcon metamorphics. Two mines (No. 67 and No. 68) are producing marble of 2 km^3/day. The marble is white in color and fine grained. Its thickness is 50 – 200 m with a lateral extension of 800 – 2,000 m.

2–2–8 Jade

The jade is a dark green soft rock which are found in the Mansalay limestone. It occurs at only one place of the upper reaches of the Pagbahan River in the west and the Monte Cristy Mine (No. 69) is under operation.

On the mining site there are six quartz veins in limestone and the contact parts with a 1.00 – 1.50 width have been altered to jade. Here, the soft and dark colored jade is more valuable. It is, however, difficult to foresee the places of good parts because the quality changes laterally and vertically.

The related igneous rock is considered to be a dioritic rock of Eocene to Oligocene occurred 2.5 km north of the deposit.

2–2–9 Coal

The coal deposits occur only in the southern area, namely in Napician and Siay areas in Bulalacao and in Alitaytan area in the northeast of San Jose. All of them are embeded in the Sablayan Group. The coal seams in Bulalacao are intercalated by sandstone-mudstone alternation of lower group, while in San Jose, by sandstone in the limestone formation.

The coal deposits in Bulalacao have been known since long ago, and the development plans were made many times. In the period from 1952 to 1953 the BMG surveyed this area with the

USGS and recently the CDCP* carried out a systematic drilling exploration in the Napician area but did not come to the major level in the production.

The coal seams in the Napician area occur in the fine to medium grained sandstone. Six seams more than 0.75 m thick were drilled by the CDCP (Fig. 21).

Two coal seams with a 2.00 m thickness are exposed and can be traced for 3 km, though they are folded by anticlinal and synclinal structures of the NE–SW system (Fig. 20).

The calorific values correspond to the high-volatile C bituminous coal in the American coal standard (ASIM 1964). The BMG reserves above –200 m level (1955) is 6,770 thousand tons.

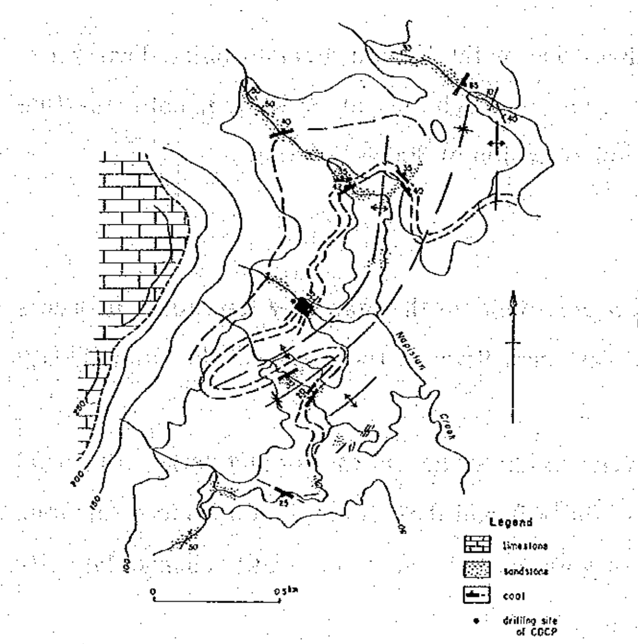

Fig. 20 Geological Map of Napisian Coal Field

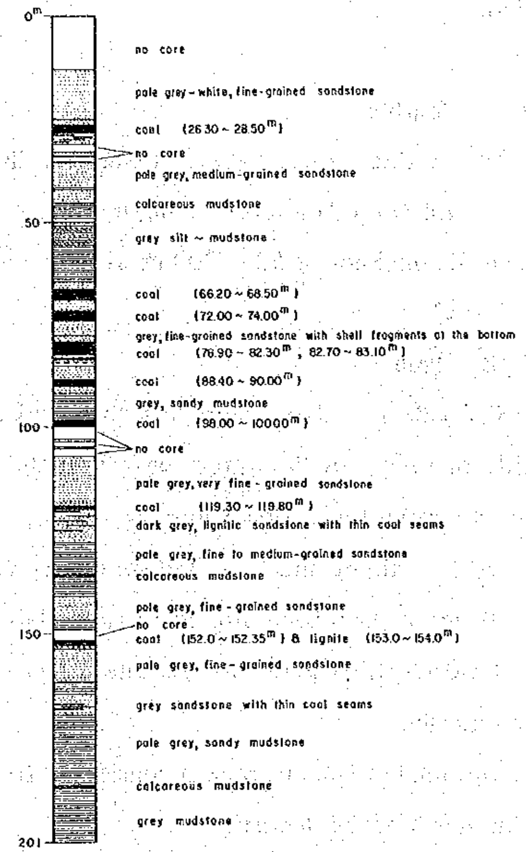

Fig. 21 Core Log of Napisian Coal Field

However, it is pressumed that the following problems might arise over the exploitation.

(1) the quality of coal is not so good (calorific value of moisture–and ash–free: 11,100 – 12,600 BTU/lb),

(2) inclinations of the coal seams are steep (35° – 40°)

(3) disturbance of coal seams caused by folding is expected.

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* Construction and Development Corp. of the Philippines.

There are three coal seams with more than 0.75 m thickness in the Siay area. The BMG reserve above –200 m level (1955) is 460 thousand tons. The calorific values are the same as the Napisian's, corresponding to the high – volatile C bituminous coal.

III. GEOCHEMICAL SURVEY

CHAPTER 1. GEOCHEMICAL SURVEY FOR STREAM SEDIMENT

1–1 Survey Method

The geochemical survey for stream sediment was carried out with geological survey to get basic data on the mineralization in Mindoro Island.

In Phase I, 425 pcs of stream sediment samples of –80 mesh fractions were collected from the tributaries of main creeks, which keep 1 km distance in each other. To check adaptability of the geochemical survey, they were analysed for 10 elements as Cu, Ni, Cr, Pb, Zn, W, Ag, Fe, Mn and Mo.

In Phase II, geochemical survey for stream sediment was carried out in the same manner for the areas remaining untouched by Phase I and detailed survey with a high sampling dencity, for the areas with a high potential for mineral resources.

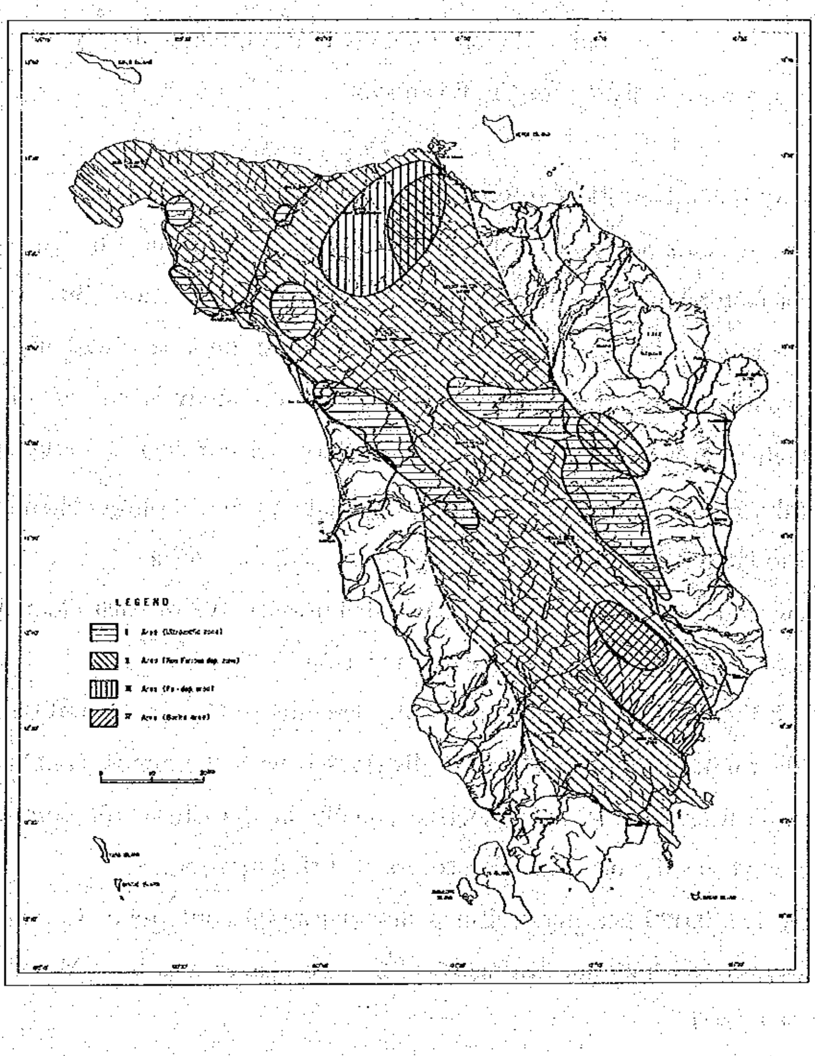

Fig. 22 Geochemical Subdivision

The Phase I survey determined the mineralized area of each mineral (mineragenetic province), 1109 pcs of stream sediment samples collected in Phase II were classified into the following four areas, and chemical analyses were made for the most effective elements for each areas.

I-Area ... The area where the Ultramafic complex is distributed and Cr of Ni deposits can be expected.
Analytical elements: Cu, Pt, Ni, Cr, Fe, Co.

II-Area ... The area where Au, Ag, Cu, Pb and Zn deposits can be expected.
Analytical elements: Au, Ag, Cu, Pb, Zn

III-Area ... The area where Fe deposits can be expected.
Analytical elements: Au, Cu, Fe, Co, V, Ti, P

IV-Area ... The area where barite deposits can be expected and Au mineralization may overlap the barite mineralization.
Analytical elements: Au, Ag, Cu, Pb, Zn, Ba

In Phase III, 27 pcs of stream sediment samples were supplementaryly taken in the copper mineralized area and were analyzed for Cu, Pb and Zn.

1–2 Data Analysis and Results of Interpretation

Among ten elements analyzed in Phase I, five elements of Ag, Cu, Zn, Ni and Cr were determined by a factor analysis as having relation with mineralization. But Ag anomalies (its threshold value is as low as 0.9 ppm) occurred in the limestone area where no igneous activities had been observed. In Phase II, Ba element was added for analysis instead of Ag in order to define the mineralized area of barite, because Ag behavior was considered doubtful.

Consequently, interpretation was synthetically made on the whole geochemical data collected from Phase I to Phase III for five elements of Cu, Zn, Ni, Cr and Ba.

A histogram and a cumulative frequency distribution curve of each element are shown in Figs. 23 and 24, and their statitic values are listed in Table 7.

As shown in Fig. 23, the histograms of four elements of Cu, Zn, Cr and Ba approximate to the lognormal distribution. But Ni values are distributed with the almost equal frequency in the whole classes, indicating that Ni has dispersed equally in the Ultramafic complex and has not been concentrated at specific places in the process of differentiation.

Plate II is a 1:250,000 geochemical map showing metal contents of Cu, Zn, Ni, Cr and Ba by using point-symbols which are distinguished by two classes, viz., t (= M + S.D.) – t (= M + 2S.D.) and t = M + 2S.D. <

The outline of geochemical anomalies is as follows.

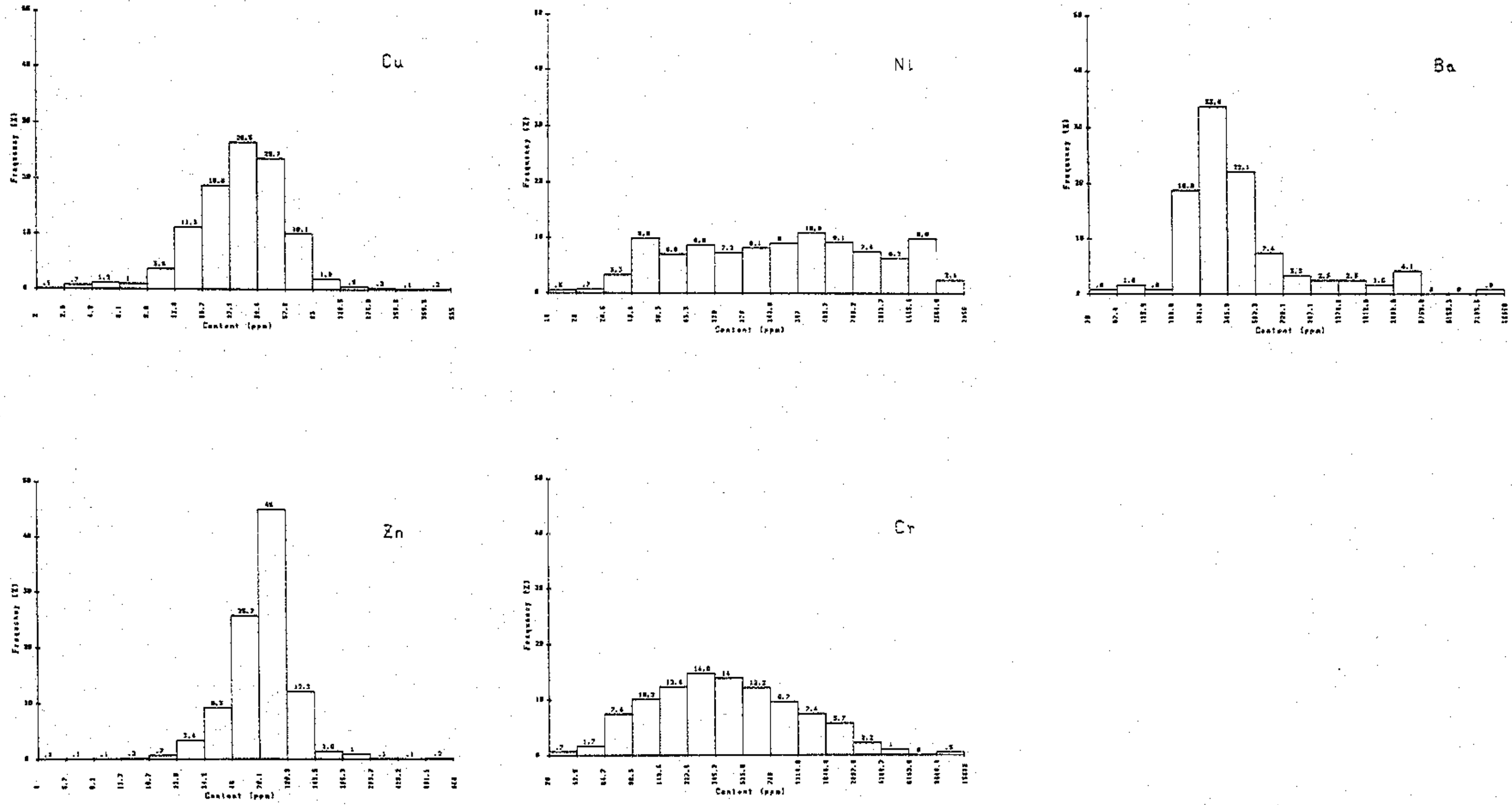

Fig. 23 Histogram of Geochemical Data (Stream Sediment)

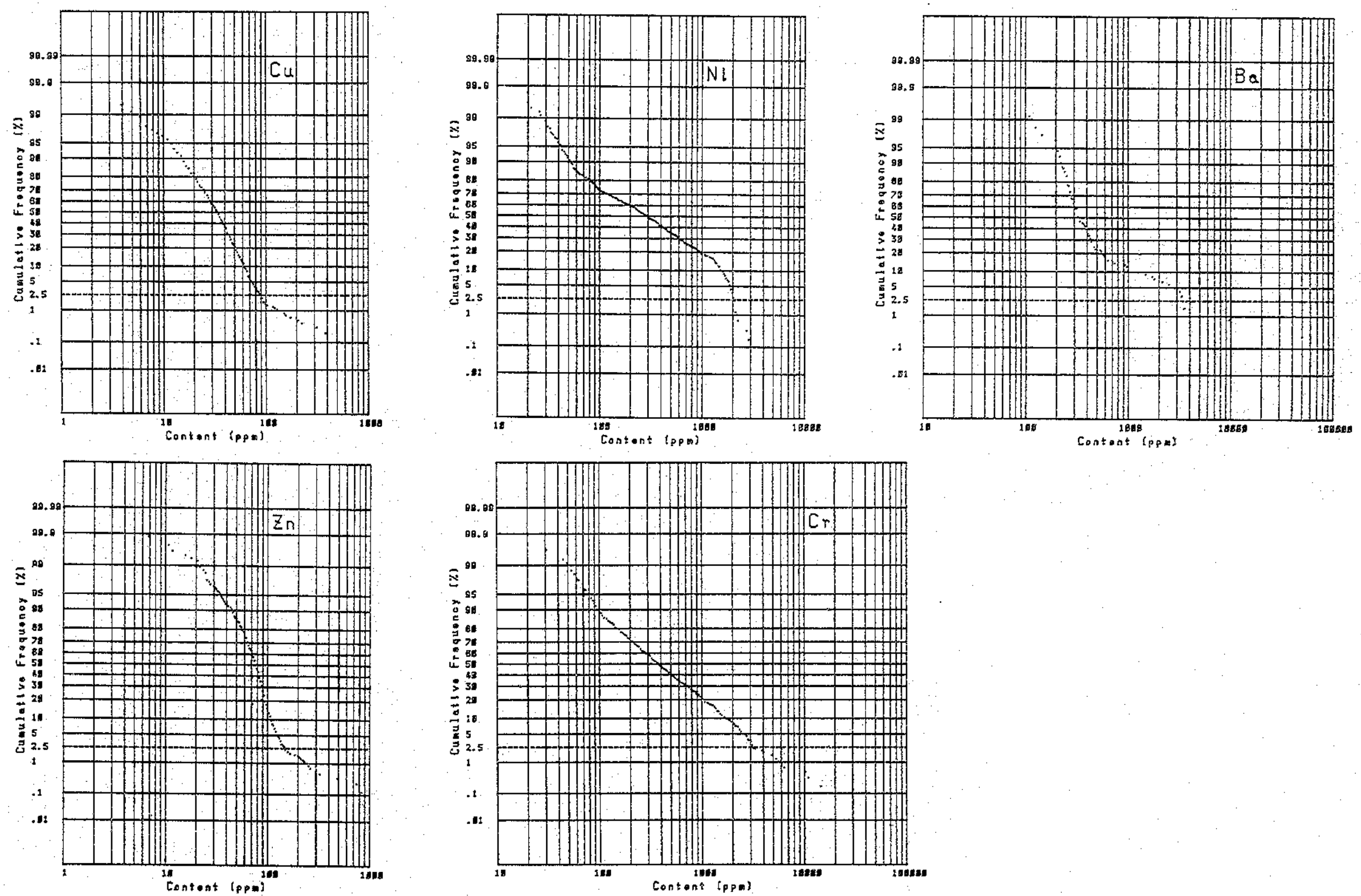

Fig. 24 Cumulative Frequency Distribution of Each Element

Table 7 Statistic Values of Geochemical Data (Stream Sediment)

(in ppm)

	Cu	Zn	Ni	Cr	Ba
Number of Samples (pcs)	1,558	1,071	913	913	213
Minimum	1	7	26	45	50
Maximum	225	755	2,950	15,000	10,000
Geometric Mean (M)	31.3	73.0	278	401	478
Standard Deviation (Log)	0.286	0.189	0.536	0.473	0.342
$10^{\text{Log M + S.D.}}$	58	113	956	1,192	1,051
$10^{\text{Log M + 2S.D.}}$	107	174	3,283	3,541	2,309
Number of Anomalous Samples	10	14	0	12	7

1. In the Siange River, the tributary of the Bongabong River, Cu–anomalies (Cu: 100 – 450 ppm) are accompanied with Zn–anomalies (Zn: 160 – 520 ppm). Since there are a silicified zone on the southern slope of the Siange River and a showing of Acliang & Pajo (No. 10) in the north, a copper mineralized zone is supposed to extend in the N–S direction.

Cu–anomalies obtained near the road may be caused by antificial pollution. Weak anomalies covering the Lumintao and the Rayusan River basins are in the basalt area, suggesting that the anomalies may depend on the lithology.

2. A weak anomalous zone of Zn (152 – 204 ppm) accompanied with Cu (39 – 158 ppm) in the Rayusan River is in the Mansalay slate zone. As any mineralization is not found, it is possibly caused by the difference of lithology.

3. Ni and Cr-anomalies are well coincided with the distribution of the Ultramafic complex. Weak anomalies of Ni (956 – 2,950 ppm) are distributed evently, and so they overlap Cr-anomalies. The Cr-anomalies with values over t (3,541 ppm) are not found in the Pintin body in the west but are concentrated in the Ogos body in the east. This Cr distribution fits well the panning results and also corresponds to the localities of the outcrops.

The anomalies extending from the Pula and the Balete Rivers show very high values as 2,426 – 10,565 ppm Cr. But geological survey proved that the anomalies originated from the pebbles of Ultramafic complex which are included in the Bongabong conglomerate.

4. The anomalous zone of Ba is distributed mainly in the southern slop of the upper reaches of the Baroc River where the Taoga barite deposit is located. The anomalous area is only 10 km^2 but the anomalies mass around the Taoga deposit, and so a new barite deposits can be expected.

CHAPTER 2. GEOCHEMICAL SURVEY FOR SOIL

2–1 Survey Method

In Phase III, geochemical survey for soil was carried out in the area (2 km x 3 km) to determine the scales of 3 mineralized zones of Manamburao, Masnon and Shawood, all of which are located in the upper reaches of the Pula River.

A rectilinear sampling grid (200 m x 100 m) was applied for getting soil sample at the B horizon, and the interval of traverse line was narrowed to 100 m near the mineralized zones. The number of soil samples is 591.

The samples were screened into –80 mesh fractions after natural drying and were digested in the mix acid for 2 hours. The filtrates were quantitatively analyzed for Cu, Pb and Zn by means of ICAP.

2–2 Data Analysis and Results of Interpretation

As the soil samples were composed of the Bongabong Sandstone, Lumintao basalt, Mansalay slate and peridotite, a histogram and a cumulative frequency distribution curve were made for each formation and the statistic values were computed. As a result, it has become clear that analytical data of each formation approximates to lognormal distribution except for Pb element, and means and standard deviations are almost the same values. So, all data were processed in the lump because the numbers of data are too small to be processed statistically, when the data are grouped by formation.

Table 8 Statistic Values of Geochemical Data (Soil)

		Cu	Pb	Zn
Number of Sample	(pcs)	591	591	591
Minimum	(ppm)	3	0	3
Maximum	(ppm)	168	38	151
Geometric Mean (M)	(ppm)	31.2	7.0	42.3
Standard Deviation	(Log)	0.207	0.342	0.187
$10^{\text{Log M + S.D.}}$		50.2	15.3	65.1
$10^{\text{Log M + 2S.D.}}$		80.9	33.6	100.1

The distributions of values of 3 elements viz, Cu, Pb and Zn are shown in Fig. 25, where isoplethes of 10% values from the highest are drawn together with those of 2.5% values (=threshold values) in order to illustrate the general trends of anomalies.

From the synthetic study on the distribution of metal contents and the detailed geological survey results, the followings can be obtained.

(1) Anomalies of Cu, Pb and Zn in soil, do not continue much but tends to be isolated. The Manamburao outcrop is the only place where the anomalies of three elements have overlapped each other and no anomalies have been obtained in the Masnon and the Shawood areas.

(2) The overlapped anomalies of Cu, Pb and Zn in soil were only observed at the Manamburao, where a relatively high anomalous zone (Cu 75 – 168 ppm, Pb 20 – 43 ppm, and Zn 80 – 126 ppm) tends to extend in a NE–SW direction. As veins of the outcrops have filled fault-fissures of N–S, E–W and NE–SW systems, mineralization is considered to have progressed along the weak zone with a NE–SW direction.

(3) Although two showings of Masnon and Shawood have very high contents of Au and Cu (their widths are small) and one vein continues more than 50 m, the values of three elements in soil are as low as the background values. Little rock alteration is also observed. Accordingly the mineralization is possibly very local.

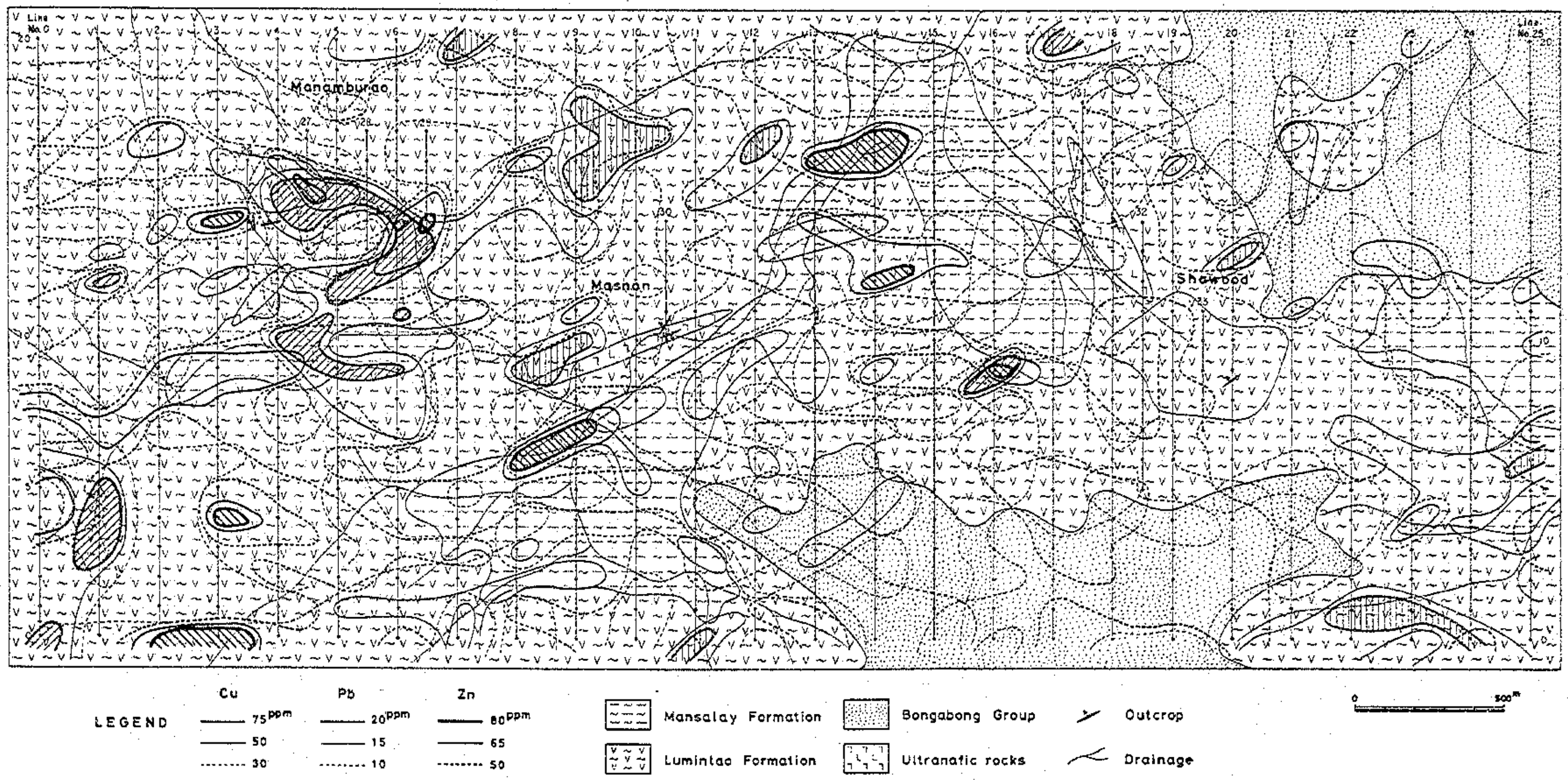

Fig. 25 Geochemical Anomalies in E-area (Soil)

CHAPTER 3. GEOCHEMICAL SURVEY FOR HEAVY MINERALS

3–1 Survey Method

In order to clarify the distribution of heavy minerals in all over Mindoro Island, a total of 105 samples were collected in Phase I at the foot of mountains of all water systems, where the current speed slows down. The samples of a fixed quantity (2,000 cm^3) deposited on riverbeds were panned by professional panners.

The concentrates were separated into 8 types, such as chromite, magnetite etc. by stereoscopic observation, microscopic study of thin and polished sections and X-ray diffractive analysis.

The Phase II survey aimed at delineating the concentrated areas of chromite, a total of 101 samples were collected by means of panning a fixed volume (1,000 cm^3) of stream sediment which was taken from each tributary in the Ultramafic complex. Magnetic minerals and light minerals in the concentrates were removed by hand magnet and heavy liquid (clerici liquid) respectively. At last chromite was picked by hand under the microscope.

3–2 Data Analysis and Interpretation of the Results

At first, the panned samples of the Phase I survey were subdivided into 13 types from the differences in crystal form, transparency, color and luster. But after microscopic observation and X-ray diffractive analysis, they were grouped into 5 major components, such as, magnetite, chromite, pyrite, garnet and pyroxene and 3 minor components, such as, quartz, feldspar and sericite.

Among these components, significant heavy minerals are magnetite, chromite and pyrite whose distributions were studied as follows.

(a) Chromite

High percent of chromite tends to concentrate more on the east side than on the west and high chromite concentration always agrees with the ultramafic zone. The anomalies in the Sablayan, Bongabong and Socorro Groups are supposed to be caused by ultramafic particles in their sandstones.

(b) Magnetite

Magnetite shows a similar distribution to the chromite with a high concentration in the ultramafic zone. While, any anomalies could not be obtained in the upper reaches of the Mamburao and the Pagbahan Rivers where some magnetite deposits are known and many ore floats are scattered. There is a reason to consider that the magnetite grains might have been removed when sieving because the distance between the sources and sampling site was too short for floats to become fine.

(c) Pyrite

The percentages of pyrite tend to be rather high in the areas of the Halcon metamorphics and the Mansalay Formation, suggesting that pyrite concentration is due to the lithology. But pyrite concentration near the Siange Cu-Zn anomalous zone may owe not only to lithology but to mineralization.

(d) Others

Placer gold is chiefly middle grained (0.5 – 1.0 mm in size) and rounded. It is experimentally known that the gold grains occur in coarse grained sands filling interstices between big boulders. But for the panning of superficial sand on the riverbeds, a satisfactory result could not be obtained.

In Phase II, weights of chromite in the panned samples were measured. As shown in Fig. II-5, in the Ogos complex the high values were obtained in the Ogos deposit creek, tending to extend westward. An anomalous area was found on the eastern boundary of the complex in the drainage basin of the Agluban River, suggesting the occurrence at the different horizon of chromite from the Ogos deposit. It was, however, confirmed in Phase III that this anomaly owed to a chromite network in harzburgite.

In the Bongabong complex, the chromite concentration was limited in the eastern slope and nothing came out on the Bongabong drainage basin side. In short, a strong anomalous zone was detected in the area extending from the Banus orebody to the upper reaches of the Sumagi River, where a small-scale chromite showings were found in Phase III.

In the Ultramafic complex distributed in the western side, a close relationship was observed between chromite showing and amount of chromite. In the Pintin body, chromite tends to concentrate on the eastern side more than on the western side.

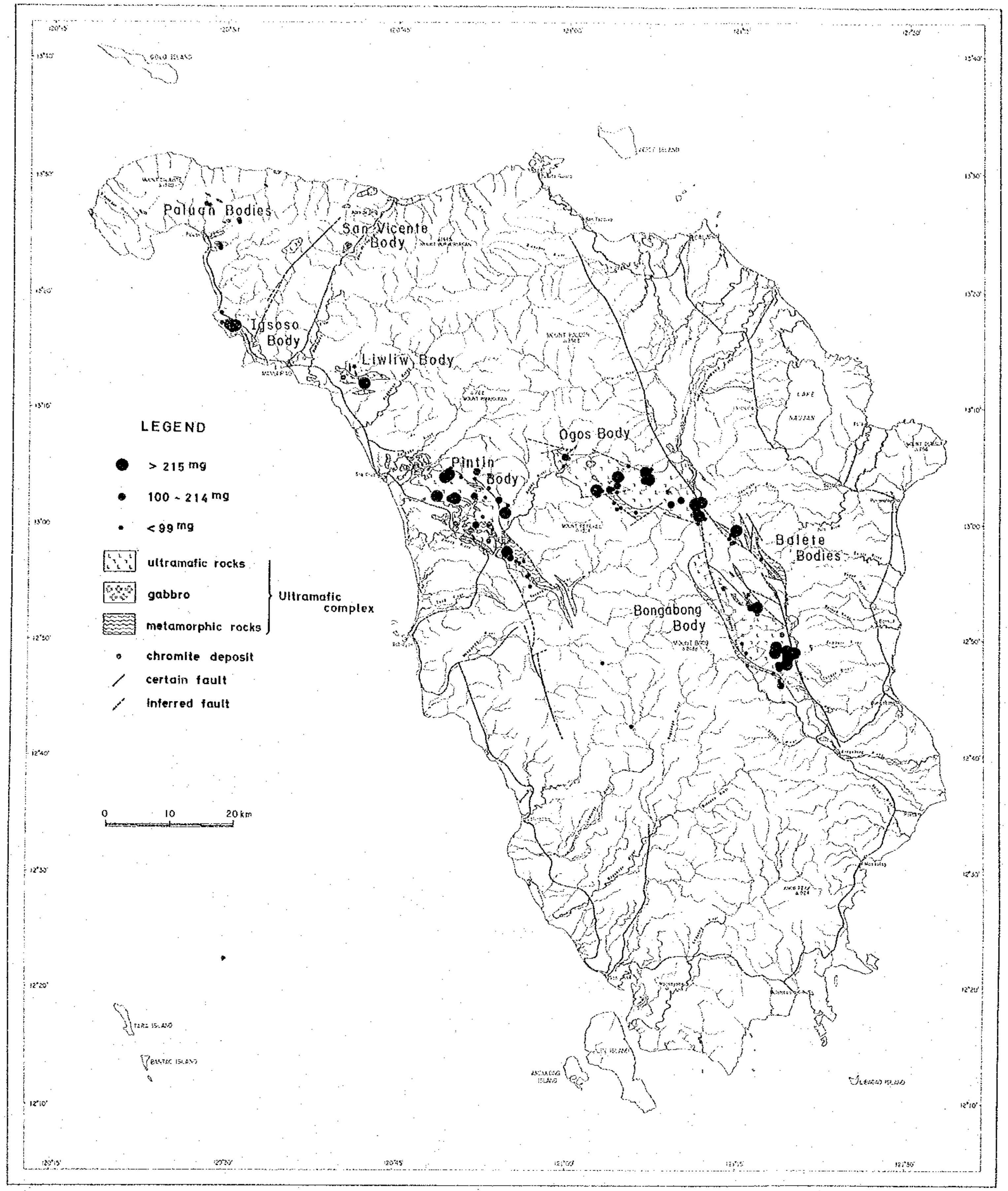

Fig. 26 Distribution of Heavy Mineral (Chromite)

IV. CONCLUSION AND RECOMMENDATION

CHAPTER 1. CONCLUSION

From the results of the geological survey, the geochemical survey and the magnetic survey carried out in all over Mindoro Island over 3 years, the following conclusions summarized are obtained.

1. Roughly speaking, the geological structure is characterized by the uplift zone which trends NW–SE. The older pre-Jurassic – Jurassic formations are distributed in the central area and younger formations accumulate zonally on both sides of these, showing an anticlinal structure. The most distinct structures in the area has a NW–SE system represented by the Mindoro Fault and the Wasig Fault along which Late Mesozoic Ultramafic complex and Palaeogene dioritic rocks intruded with various mineralizations.

2. The main ore deposits are placer gold, copper, chrom, iron, barite and coal.

(1) Placer gold is considered to be originated from the Halcon metamorphics and the Bongabong Group and has not been brought by the mineralization of post igneous activities. The scale of deposits is not supposed to be so big that the mining method using sluice box and panning is good enough because the fluvial sand including placer gold is not so large in volume.

(2) Copper mineralization is the vein type, filling fissures developed in pre-Jurassic – Jurassic formation, and is related to Palaeogene dioritic rocks intrusion. Geochemical soil survey verified that the mineralized zone located in the upper reaches of the Pula River was very limited and was not worth exploiting.

(3) Chrome mineralization occurs in the Ultramafic complex and is classified into two types, viz, layered and massive. The complex body in the eastern central part is composed of dunite, harzburgite and lherzolite, some of which show a layered structure. The Ogos orebody found in this survey is a layered body with a 6.5 m width, a 33% grade and some tens in length (can be expected), occurring in dunite. The new outcrop (1.0 m width, Cr_2O_3 42%) located 10 km in the east, lies at the almost same horizon in dunite as the Ogos', so the Ogos orebody can be expected to extend eastwards.

The other showings are small in scale (less than 100 tons).

(4) Iron deposits are the metasomatic deposits which are formed by Tertiary dioritic rocks which intruded into the Jurassic and Tertiary limestone beds. The ground magnetic survey carried out in the three promising areas of Nagsabongan, Lasala and Lapa-ao has verified that each deposit is expected to have a probable ore of $12 - 36 \times 10^6$ tons.

(5) Barite deposits located in the southeast are the deposits of the vein type, filling fissures in the Mansalay Formation, and are related to Tertiary dioritic rocks. A geochemical anomalous

zone (Ba; 1,260 – 10,000 ppm) was found in the upper reaches of the Barac River, which is close to the Taoga working mine. This may be an indication of new ore deposit but is considered small in scale from the geological point of view.

(6) Coal deposits occur in the Miocene alternated beds of sandstone and mudstone, with calorific values ranging from 11,100 to 12,600 BTU/lb, which correspond to high-volatile C bituminous coal (American Standard of Coal Classification).

The BMG's reserves are about 7 million tons. However, their development seems to be difficult under the present situation, because of the following problems.

(1) the quality of coal is not high enough (2) inclinations of the coal seams are steep (35° – 40°) and (3) disturbance of coal seams caused by folding is expected.

CHAPTER 2. RECOMMENDATION

In Mindoro island, 53 mineral showings were reported and additional 19 showings have been found by the survey.

The survey results have been summarized in the inventory map and the inventory table. Among the listed showings, chromite and iron deposits are promising from geological and economic-geological points of view and the following exploration can be recommended for these deposits.

1. Chromite Showings in the B-area

The Ogos orebody occurs in dunite in the layered or banded form and is the largest in scale (width: 6.5 m, Cr_2O_3 33% and length may be some tens m). As the body is expected to extend toward east from the geological point of view, the exploration to confirm its extension is recommended. To achieve this, a trench survey using heavy equipment etc. is considered to be carried out.

2. Iron Deposits in the D-area

The ground magnetic survey estimated the ore reserve of each deposit, viz, Nagsabongan, Lasala and Lapa-ao, as a 10^7 ton level. As the Fe-grade may range largely towards depth, a drilling exploration is recommended to get more detailed data on ore reserves and grades.

Table 9 Inventory Table of the Survey Area

(1)

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alteration	Occurrence	Accessibility	Remarks
1*	Dulangan	13°28'06", 120°57'47" Dulangan, Ori. Middle courses of Dulangan R.	Gold	Placer	1 km along Dulangan R.	Fluvial dep.	Native Au	0.3 ~ 0.5 g/man/day	—	Matrix filling the interstice between large boulders is rich in gold. Gold comes from the Halcon Metamorphics.	10 mins ride from Puerto Galera and 5 mins hike.	Ore reserve estimation is difficult because of its peculiar occurrence.
2*	Binaybay	12°22'42"~24'36"N 120°54'24"~58'24"E Binaybay, Ori. Upper reaches of Binaybay R.	Gold	Placer	10km along Binaybay R.	Fluvial dep.	Native Au	0.5 ~ 1 g/man/day	—	do	30 mins ride from San Teodoro and 20 mins hike.	do
3*	San Jose	12°30'N, 121°07'E San Jose, Occ. Upper reaches of Labangan R.	Gold	Placer	2km along Labangan R.	Fluvial dep.	Native Au	0.2 ~ 0.5 g/man/day	—	do	30 mins ride from San Jose. A jeepable road leads to the panning site.	do
4	Balao	13°24'~25'N, 120°45'E Abra de Ilog, Occ. 5~6km SE of Abra de Ilog.	Copper	Vein	W: 0.02 ~ 0.2m	Hb-diorite	Py-Cp	Au: 1.0 g/T Cu: 0.14 ~ 0.18%	?	Py and rare Cp are in Qz veinlets and stringers. Green hornfels and garnet skarn are produced around diorite body.	?	
5*	San Andres	13°10'N, 121°05'E Naujan, Ori. Upper reaches of Bukayao R.	Copper	Vein	3 outcrops within 3.5km W: No.1, 0.5~2.0m No.2, 1.0m No.3, 2.0m	Mica schist (Halcon M.)	Py-Cp-Bo-Po-Qz	(BMG) Cu (JICA-MMAJ) Layang R. 5.99% Dacdan Ck 1.86% W=0.10m Bukayao Grand R. 0.95~5.95% Cu:0.15~0.37% Bukayao Munt 4.69~9.92%				
6* (a)	Mindoro Consol Mining Corp. (Masnon dep.)	13°01'15"N,121°14'30"E Socorro, Ori. 25km W. of Pinamalayan	Copper	Vein	4 outcrops in 50mx40m Massive sulphide lens W: 0.15~0.3m	Serpentinized peridotite	Py-Cp-Po-Mc-Chl	(BMG) Cu (JICA-MMAJ) O.C. No.1 2.95%~0.45 2 4.06%~2.05 3 4.38% 4 2.39%~2.77%(w=0.27m)	None	Massive sulphide lenses are developed along faults and sheared zone.	1 hr ride from Pinamalayan to Potol na Boto and 1.5 days hike by Pula R.	
6* (b)	do	13°01'20"N, 121°14'E do	Copper	Vein	4 outcrops in 600mm x 200m Qz. vein W: 0.2 ~ 2.2m	Basalt (Lumintao F.)	Py-Cp-Hm	(BMG) Cu (JICA-MMAJ) O.C. No.5 0.38% 6 0.17%~2.21%(w=1.10m) 7 0.27% 8 11.41% 9 0.17%~2.12%(w=0.20m)	None	Sulphide veinlets and dissemination are in quartz vein.	do	Cu-mineralization is considered to be very limited because of no alteration and geochemical anomalies.
6* (c)	do (Shawood dep.)	13°01'30"N,121°15'E do	Copper	Vein	2 outcrops 700mm apart (1) sheared zone W: 0.2m (2) Qz, vein and massive sulphide lens W: 1.6m	Serpentinized peridotite and basalt (Lumintao F.)	Cp-Py Cp-Py-Po-Hm	(BMG) (JICA-MMAJ) O.C. No.10 Cu 10.20%~15.33%(w=0.15m) Au 5.47g/t 11 1.39% ~0.45%(w=0.2m) 12 2.35% Au 1.90g/t	None	(1) Chalcopyrite vein along sheared zone. (2) Massive sulphide lenses occur in hematite rich gossan.	do	
7*	Zion Expl Corp. (Bambanon dep.)	13°00'N, 121°16'E Socorro, Ori. 22km W. of Pinamalayan	Copper	Vein	(1) Massive sulphide lens W: 0.1 ~ 0.3m (2) Qz, lens W: 0.5m	Serpentinized peridotite, basalt and slate (Lumintao F.)	Po-Py-Cp-Qz	Cu: 0.49% Cu: 0.42%	None	Massive sulphide lenses occur in peridotite, and Qz lenses with Py and Cp dissemination, in volcanics and sediments.	4 hrs hike from Putol na Boto Bambanon Ck., a branch of Mayo R.	Small scale ?

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alteration	Occurrence	Accessibility	Remarks
8	Buraboy	12°59'27"N, 121°07'24"E Sablayan, Occ. Upper reaches of Magasawangtubig R.	Copper	Vein	W: 0.2m Mineralized zone: 2m	Ser. schist (Halcon M.)	Py-Cp-Qz	N.D.	?	Mineralization along schistosity	?	
9*	Aglubang	12°59'25"N,121°10'E Sablayan, Occ. 35km W of Pinamalayan	Copper	Bedded	Floats (7 pcs.) max. 3x2x1m in size.	Phyllitic schist?	Py-(Cp)-Qz	(JICA-MMAJ) Float (massive) Cu : 0.40% Pb : 0.71% Zn : 8.52%	–	Strata-bound?	1 day hike along Aglubang R. from Villacervesa.	New bedded cupriferous pyrite deposits can be expected.
10	Acliang & Pajo	12°45'N, 121°15'30"E Bongabong, Ori. Middle courses of Bongabong R.	Copper	Vein	?	Ser-Chl-Amph-schist	Cp-Po-Py	N.D.	?	Sulphide veins and stringers are along the schistosity. Py and Cp disseminate in biotite quartz diorite.	1 hr ride from Bongabong bridge and a half day hike in the river.	Ore floats were collected but showing has not been checked by the survey team.
11	Amico Copper Co.	12°28'N, 121°11'E San Jose, Occ. 5.7km E of Hagdaman Peak	Copper	Vein	Very small	Interbeded sandstone, silty shale and mudstone (Sablayan G.)	Py-Cp	Cu: 0.04 ~ 0.05%	?	Sulphide veinlets, pockets and dissemination in the calcareous concretions in the shale.	?	Outcrops could not be found.
12*	Mariri	13°26'N,121°31'E Paluan, Occ. 5km NE of Paluan	Chromite	Ortho-magmatic	0.7mx0.7m	Serpentinite	Cr.	(JICA-MMAJ) Cr_2O_3 : 40.31%	Serp.	Massive ore deposit in small ultramaphic (serpentinite) body.	30 mins ride and 1hr hike from Paluan.	Small scale ?
13*	Mariil	13°24'15"N,120°28'45"E Paluan, Occ. 3km SE of Paluan	Chromite	Ortho-magmatic	Unknown (three ore deposits)	Harzburgite ≫ dunite gabbro, microdiorite	Cr.	(JICA-MMAJ) Stockpile Cr_2O_3 : 50.50% 45.82% Float Cr_2O_3 : 48.93%	Serp.	Not clear. The chromite ore is found as a gravel or breccia (cobble ~ pebble size) along the creek.	20 mins ride and 20 min hike from Paluan.	Stock pile : 2T Small scale ? Laterite thickness av. 1m (0.24% Ni).
14*	San Vicente	13°24'N, 120°40'E Abra de Ilog. Occ. 8km SW of Abra de Ilog.	Chromite	Ortho-magmatic	Small lens (5~6 bodies) maximum size L: 3m, W:0.1~0.5m Horizontal extension is more than 30m judging from distribution of outcrop and floats.	Harzburgite	Cr.	(JICA-MMAJ) Cr_2O_3 : 29.11% Al_2O_3 : 19.99%	Serp.	Ore bodies occur in sheared zone of harzburgite, trending N60°~65°E with 70°S~75°N dip. Ore is massive and rich in alumina.	10 mins ride and 20 mins hike from the Mamburao–Abra de Ilog high way.	Stock pile 3T and floats 8T. 9 trenches Ore reserve may not exceed 100T.
15*	Igsoso	13°16'45"N,120°30'30"E Igsoso, Occ. 10km NW of Mamburao	Chromite	Ortho-magmatic	No.1: 0.4x1.9x6.0m No.2: unknown	Dunite	Cr.	(JICA-MMAJ) Massive Cr_2O_3 : 43.00% Banded Cr_2O_3 : 34.14%, 38.85%	Serp.	Layered, disseminated and massive ore.	30 mins hike from the Paluan–Mamburao highway.	Pit, trench: 23 stock pile (No.2 outcrop):10T. Some extension and new deposits can be expected.
16*	Liw liw	13°12'30"N,120°40'45"E Mamburao, Occ. 8.5km E of Mamburao	Chromite	Ortho-magmatic	4 outcrops: No.1: 0.1~0.2x3.0x1.5m 15T No.2: 0.1x2.0x8m No.3: 0.1~0.4x3.0x12m 5T No.4: 0.05x1.0x5m	Harzburgite	Cr.	(JICA-MMAJ) Stockpile (massive) Cr_2O_3: 40.31%, 36.50%	Serp.	Layered and massive probably removed by shear, occurring in harzburgite near the boundary of dunite. Disseminated and massive ores.	30 mins ride and 10 mins hike from Mamburao.	Stock pile: 20T Geochemical anomaly was obtained on the east side.
17*	Barabon	13°04'N, 120°45'30"E Sta Cruz, Occ. 3km E of Sta Cruz.	Chromite	Ortho-magmatic	Lenticular W: 0.3 ~ 0.8m L: ?	Ultramafic complex	Cr.	N.D.	Serp.	Chromite deposit occurs along thrust faults in the Ultramafic rocks in the shape of pad and lens with steep dip.	10 mins ride from Sta Cruz.	Outcrops could not be found. very small ?

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alteration	Occurrence	Accessibility	Remarks
18*	Ogos No.1	13°04'30"N,121°06'30"E Sta Cruz, Occ. 40km W of Pinamalayan.	Chromite	Ortho-magmatic	Thickness: 65m	Dunite	Cr.	(JICA-MMAJ) Margin (disseminated) Cr_2O_3: 29.99% Middle (dis~dense) 31.39% Center (dense spotted) 28.28% Top (weathered sandy) 37.05%	Serp.	Layered, massive and disseminated ore.	1 day hike along the Ogos R. from Villacerveza.	Extension cannot be checked by trenching, because of deep fluvial deposit.
19*	Ogos No.2	13°04'39"N,121°07'30"E Sta Cruz, Occ. 39km W of Pinamalayan	Chromite	Ortho-magmatic	Lenticular W: 1m L: ?	Dunite	Cr.	(JICA-MMAJ) Cr_2O_3 : 39.92%, 44.11%	Serp.	Layered and massive ore.	1 day hike along the Ogos R. from Villacervesa.	1 km E of No.1 showing.
20*	Ogos No.3	13°03'N, 121°09.E Sta Cruz, Occ. 36km W of Pinamalayan	Chromite	Ortho-magmatic	Lenticular W: 0.1m L: ?	Dunite	Cr.	(JICA-MMAJ) Cr_2O_3 : 37.20%	Serp.	Massive ore, striking N70°W and dipping 55°SW.	1 day hike along the Baraboi R. from Villacervesa.	
21*	Ogos No.4	13°01'N, 121°11'E Sablayan, Occ. 33km W of Pinamalayan	Chromite	Ortho-magmatic	Network zone W: 5m + L: 2m	Harzburgite	Cr.	(JICA-MMAJ) Cr_2O_3 : 45.82%	Serp.	Chromite veinlets are in a network.	1 day hike along the Aglubong R. from Villacervesa.	
22*	Pintin west	13°00'N, 120°50'E Sta Cruz, Occ. 13km SE of Sta Cruz	Chromite	Ortho-magmatic	2 outcrops No.1: small lenticular bodies. max. 1.0x0.2x0.2m No.2: 1.0x0.15x0.15m	Harzburgite	Cr.	(JICA-MMAJ) Cr_2O_3 : No.1 ... 39.81%, 38.93%, 38.14% 41.30% No.2 ... 40.19%, 39.92%	Serp.	Massive ore	1 hr ride and 10 mins hike from Sablayan.	Trenching work was conducted in this survey.
23*	Pintin central	o 12°59'30"N, 120°51'30"E o 13°00'N, 120°53'E o 12°58'30", 120°53'E Sta Cruz, Occ. 19km SE of Sta Cruz	Chromite	Ortho-magmatic	1 outcrop and 5 sites of float Floats ϕ max. 0.4m	Harzburgite	Cr.	(JICA-MMAJ) Cr_2O_3: Outcrop ..... 51.40% Floats 50.03%, 53.55% 48.94%, 47.62%	Serp.	Massive ore	1 hr ride and 1 hr hike from Sablayan.	Trenching work was conducted in the past. Stockpile: 2~3T.
24*	Pintin east	12°57'N,120°54'30"E Sablayan, Occ. 20km NE of Sablayan	Chromite	Ortho-magmatic	4 sites of float Floats ϕ max. 0.4m	Harzburgite	Cr.	(JICA-MMAJ) floats Cr_2O_3: 33.18%, 30.30%, 56.10%, 33.88%	Serp.	Massive ore	45 mins ride and 1hr hike from Sablayan.	2 sites show the high content of Al_2O_3.
25*	Masbo	12°54'30"N,121°14'E Sablayan, Occ. 25km W of Bansud	Chromite	Ortho-magmatic	2 outcrops lenticular bodies max. 1.5x0.3m 1 site of float Floats ϕ max. 1m	Dunite	Cr.	(JICA-MMAJ) Cr_2O_3: Outcrop ... 44.98%, 41.85% Floats 41.47%	Serp.	Massive ore, in the fracture zone trending NW–SE.	2 days hike along the Bongabong R. from Balete.	
26*	Banus No.1	12°53'N, 121°16'E Gloria, Ori. 20km W of Bansud	Chromite	Ortho-magmatic	Lenticular W: 5cm L: 2m	Dunite	Cr.	(JICA-MMAJ) Cr_2O_3: 41.23%	Serp.	Layered and massive ore.	4hrs ride by logging truck and 3.5hrs hike along the Banus R. from Bulbogan.	
27*	Banus No.2	12°52'30"N,121°16'45"E Gloria, Ori. 19km W of Bansud	Chromite	Ortho-magmatic	Mineralized zone T: 3.5m L: 45m max. scale of one body T: 1m L: 4m	Dunite	Cr.	(JICA-MMAJ) Cr_2O_3: 37.97%, 46.11%, 41.44% 43.50%, 36.05%, 43.43% 45.43%	Serp.	Layered and massive ore, with a gentle dip.	4hrs ride by logging truck and 3hrs hike along the Banus R. from Bulbogan.	Trenching work was conducted in this survey.
28*	Bansud	12°56'30"N,121°19'E Bansud, Ori. 15km W of Bansud	Chromite	Ortho-magmatic	Mineralized zone T: 0.8m L: 30m max. scale of one body T: 0.2m L: 3m	Dunite	Cr.	(JICA-MMAJ) Cr_2O_3: 42.02%, 46.12%	Serp	Layered and massive ore, striking N47°W and dipping 25°SW.	1hr ride and 2hrs hike along the Bansud R. from Bansud.	

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alteration	Occurrence	Accessibility	Remarks
29	Igsoso	13°17'N, 120°30'E Igsoso, Occ. 12km NW of Mombulao	Nickel	Residual	very small	Ultramafic complex	Nickeliferous laterite	N.D.	Serp.	Secondary enrichment of Ni in the ultramaphic rocks.	0.5km hike from the Mamburao-Paluan highway.	No information could be gotten.
30*	Aglubang	13°05'N, 121°09'E Sablayan Occ. Near Villacervesa	Nickel	Residual	Ore reserve: 49 MT. (0.94% Ni) Thickness: 3~11m (av. 5.5m)	Ultramafic complex	Nickeliferous laterite	(JICA-MMAJ) check samples Ni: 0.94% 0.46%	Serp.	Laterite covers almost all the slope and floats of the ultramafic rocks.	30 mins hike from Villa-cervesa.	Explored by Anglo Philippine Oil Corp. Eagle Pass & Aglu-bang prospect are included in this area.
31*	Paragpagan	13°03'N, 120°50'E Sta Cruz, Occ. 12km E of Sta Cruz	Nickel	Residual	L: 1400m W: 800m Thickness: 0.3~6.0m	Harzburgite	Nickeliferous laterite	(BGM and others) (JICA-MMAJ) Laterite Ni: 0.82% 2.66% Laterite sand Ni: 0.79% 1.82%	Serp.	Secondary enrichment of Ni in the ultramafic rocks.	1 hr hike from the sublayan—Mamburao highway.	Ore reserve: 4~5MT (after BMG 19774)
32	Blueridge Mining Corp.	12°49'30"N,121°17'30"E Bongabong & Bansud Ori. 1.8km WSW of Bansud	Nickel	Residual	?	Ultramafic complex	Nickeliferous laterite	Geochemical samples Ni: 0.80~2.95%	Serp.	Secondary enrichment of Ni (and Co) in the ultramafic rocks.	?	
33	Baletero	13°29'N, 120°56'E Puerto Galera, Ori. 2.5km SW of Puerto Galera.	Iron	Contact	Thickness: 2m	Schist, marble (Halcon M.)	Mt-Hm-Spec-Mn	N.D.	?	Iron body, paralleled to the schistosity, is formed by replacement of marble in the schist.	?	No information on the deposit could be collected.
34	Batalong Bato	13°28'21"N,120°55'30"E Puerto Galera, Ori. 4km SW of Puerto Galera	Iron	Contact	Thin layer of Mt. Floats ϕ max. 1m	Marble (Halcon M.)	Mt.	N.D.	?	Floats are in limited amount.	?	do
35	Savoran	13°27'N,120°54'47"E Puerto Galera, Ori. 8km SW of Puerto Galera	Iron	Contact	No.1 W: 1.0m No.2 W: 0.01m	Mica schist (Halcon M.)	Hm-Mt-Lm-Mn	N.D.	?	Ore bodies tend to parallel to the schistosity.	?	do
36	Camarong	13°27'38"N,120°50'30"E Abra de Ilog. Occ. Camarong R.	Iron	Contact	Iron blocks (ϕ1.5m) are concentrated along a 2.5m length.	Xenolith of limestone in gneiss (Halcon M.)	Mt-Py	Fe: 49.21%	?	Iron floats are found along on N80°E direction on the southern slope.	?	No information was obtained.
37	Barayao	13°24'12"N,120°48'58"E Abra de Ilog, Occ. Head water of Obala R.	Iron	Contact	L: 5m W: 15m	Marble, Gneiss Schist (Halcon M.)	Mt	N.D.	Skarn	Similar to Dayap (50). Mt veins and pockets in garnet-epidote skarn, which is developed near the contact between gneiss and schist.	?	
38	Little Baguio	13°22'13"N,120°49'18"E Abra de Ilog, Occ. 15km SE of Abra de Ilog.	Iron	Contact	2 float areas: No.1 cobble size Mt in a small scale. No.2 iron blocks (ϕ1m)	Marble, (Sablayan G.)	Mt-Hm	N.D.	Skarn	The deposit is composed of two float areas. Several tunnels were driven.	?	
39*	Nagsabongan	13°22'12"N,120°48'36"E Abra de Ilog, Occ. Headwater of Mamburao R.	Iron	Contact	Extension L: 200m+ Thickness Upper, W: 20m+ Lower, W: 50m+	Marble, (Sablayan G.)	Mt-Hm	Shipping grade >60% Fe (JICA-MMAJ) Fe: 56 ~ 70%	Skarn	There is a massive outcrop in limestone	2 days hike from Abra de Ilog by trail or from Cabacao along Mamburao R.	Ore reserve may be over 10 MT by magnetic survey. Elizalde Co, explored by means of dip needle, trench and drilling. No record has remained.

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alternation	Occurrence	Accessibility	Remarks
40*	Lasala	13°21'N, 120°47'E Abra de Ilog, Occ. Upper reaches of Mamburao R.	Iron	Contact	Extension: Ore outcrops and floats are chiefly observed in an area of 130m(EW)x 100m(NS).	Marble, skarn (Sablayan G.)	Hm-Mt-Py-Cp	(JICA-MMAJ) Banded / Massive Fe: 28.23% / 54～68%	Skarn	The deposits occur under the river bed on the western slope where epidote skarn is developed.	2 days hike from Abra de Ilog by trail or from Cabacao along Mamburao R.	Ore reserve is about 18MT based on magnetic survey result. Mayorga Minign Corp. also explored by dip needle, pit (2), trench (22), tunnel (2) and diamond drilling.
41*	Tiraca	13°21'50"N,120°49'E Abra de Ilog, Occ. 15km SE of Abra de Ilog	Iron	Contact	L: 7m W: 5m	Limestone (Sablayan G.)	Mt	(JICA-MMAJ) Float (massive) Fe: 59.73%	Skarn (weak)	Bedded, striking N50E, dipping 70E	3 days hike from Abra de Ilog or Cabacao.	Trenching: 7m Small scale.
42	Binaybay	13°21'24"N,121°00'E Binaybay Baco, Ori. 12km W of Baco	Iron	Contact	Floats (max. 1.5m in size) localized in 15mx15m	Schist and marble (Halcon M.)	Hm-Mt	Fe: 61.19%	Skarn	Floats or blocky concentration An adit exploration suggests the block concentration was connected to an ore body underneath.	?	No information was collected in Binaybay.
43*	Ak ak	13°21'15"N,120°48'E Abra de Ilog, Occ. 14km SE of Abra de Ilog	Iron	Contact	L: 10m W: 5m	Limestone (Sablayan G.)	Mt	Outcrop (massive) Fe: 51.55%	Skarn	Bedded ? in limestone (N40°W, 20°S)	2 days hike along trail from Abla de Ilog or along Mamburao R. from Cabacao.	Small scale.
44	Aglombogan	13°20'25"N,120°49E Abra de Ilog, Occ. Headwater of Malaylay R.	Iron	Contact	Unknown	Marble, phyllite (Sablayan G.)	Hm-Mt	N.D.	Skarn	Mt has replaced marble along bedding planes as a lens.	?	
45	Tibano	13°21'00"N,120°54'24"E Mamburao, Ori Upper reaches of Malaylay R.	Iron	Contact	Massive iron blocks: W: 8m Floats: av. 1m in 1500x50m	Skarn (Halcon M.)	Mt-Py-Mn	Fe: 66.74%	Skarn	Iron deposit occurs in skarn at the contact between meta quartz diorite and schist.	?	
46	Bulos	13"20'N,120°51'08"E Puerto Galera, Ori. Upper reaches of Malaylay R.	Iron	Contact	Iron block: av. 1.5m	Marble, (Sablayan G.)	Mt-Hm	N.D.	?	Iron block.	?	
47*	Cobanga-on	13°19'25"N,120°47'38"E Abra de Ilog, Occ. Upper reaches of Mamburao R.	Iron	Contact	Small lense (7 bodies) maximum size L: 3m W: 2m max float is 7x7x2m in size	Marble, phyllite green phyllite (Mansalay F.) Diorite	Mt, Hm(Cp)	(JICA-MMAJ) Fe=55.36%	Skarn	The deposit consists of many small lenticular ore bodies and occurs in limestone lens-bearing green phyllite.	2 days going up along Mamburao R. from Cabacao.	Reserve may be small, because limestone is poorly developed in this area.
48	Lagnas	13°19'21"N,120°52'30"E Puerto Galera, Ori. Upper reaches of Malaylay R.	Iron	Vein, Dissemination	Extension: 1,300m	Basalt, phyllite (Sablayan G.)	Mt-Hm	Fe: 30～53%	Skarn	Four ore bodies crop out probody along a pre-ore fault of a N70°W direction which has controlled mineralization in this area.	?	
49*	Lapa-ao	13°18'54"N,120°47'E Abra de Ilog, Occ. Upper reaches of Mamburao R.	Iron	Contact	L: 350m+ Thickness: 44m,46m, 28m (3 layers)	Limestone, phyllite (Sablayan G.)	Mt	(JICA-MMAJ) Fe: 33～69%	Skarn	Ore bodies are massive and occur near boundary between diorite and Sablayan limestone. The ore contains skarn, often showing a banded structure.	2 days going up along Mamburao R. from Cabacao.	Reserve is about 35MT based on magnetic survey result.

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alternation	Occurrence	Accessibility	Remarks
50*	Dayap	13°17'41"N,120°48'38"E Mamburao, Ori. Upper reaches of Pagbahan R.	Iron	Contact	Outcrop, Thickness No.1=2m No.2=2m No.3=10m	Phyllite, skarn (Mansalay F.)	Mt-Py	(BMG) Fe: 67.37% (JICA-MMAJ) Fe:56.73%, 70.43%, 65.37%	Skarn	Bedded deposits occur in epidote-chlorite-skarn.	3 hrs ride along Pagbahan R. in dry season and 1 day hike.	Very poor accessibility.
51*	Taoga (Filhispano Inc.)	12°37'30"N,121°19'45"E Mansalay, Ori. 18km NW of Mansalay	Barite	Vein	Outcrops No.1 W: 0.50m No.2 W: 1.20m	Sandstone (Mansalay F.)	Ba-Py-Qz	(JICA-MMAJ) $BaSO_4$: 83.79%	Py, sil	Barite veins trend N45°E~N120°E with a dip of 55°~70°S.	A logging road of 80km from Mansalay reaches the mine site.	Reserve may be some thousands ton.
52	Wigan	12°33'N, 121°25'E Mansalay, Ori. 4km NW of Mansalay	Barite	Vein	Outcrop: 10x15m	Sandstone (Mansalay F.)	Ba	N.D.	?	Barite is exposed in several pits from 0.5–1.0m deep. Floats (φ:few cm) are scattered around the ridge.	?	
53*	Mansalay Mining Corp.	12°31'43"~12°33'29"N 12°21'03"~121°24'08"E Mansalay, Ori. 7km WNW of Mansalay	Barite	Vein	W: 1.2~1.9m H: 3m L: 17.5m	Sandstone (Mansalay F.)	Ba	N.D.	Py, chl	The vein striking N50°W dipping 78°S.	30 mins hike from logging road.	SE extension of the vein is recommended to be checked.
54*	Mansiol point	12°28'30"N,121°25'45"E Mansalay, Ori. 6km SSW of Mansalay	Barite	Vein	W: 1.6m (Max.) L: 90m (Float zone)	Sandstone (Mansalay F.)	Ba	N.D.	None	Barite floats are scattered in a N25°E direction.	20 mins hike from the Bulalacao –Mansalay highway.	Reserve is probably 1~2x10⁴T above sea level. Under mining preparation.
55	Ligwayan	13°26'41"N,120°54'31"E Puerto Galera, Ori. 8.5km SSW of Puerto Galera	Feldspar	Dike Sill	Outcrops: No.1, L: 25~30m No.2, L: 8, H: 1.5m No.3, W: 1.5m	Gneiss, schist (Halcon M.)	Fd-Clay	N.D.	?	Deposit is composed of friable feldspar, clay or quartz-feldspathic schist.	?	
56	Wawa	13°27'35"~28'07"N 120°36'06"~37'03"E Abra de Ilog, Occ. 12km WNW of Abra de Ilog	Talc	Lens	No importance	Talc schist in serpentinite (Halcon M.)	Tc	N.D.	?	Talc schist are discontinuous lenses in serpentinite.	?	
57	Metropolitan Mining Corp.	13°27'30"~13°29'N 120°48'~120°49'E Abra de Ilog, Occ. 12km WNW of Abra de Ilog	Talc	?	?	Marble, schist (Halcon M.)	Tc-Cal	N.D.	?	Talc may have been contamination from the interlayered schist and/or developed in the marble.	?	Stockpile : 130T
58	Amico Copper Co.	12°28'N, 121°11'E San Jose, Occ. 19km NE of San Jose	Gypsum	Vein	Very small W: 1~10mm	Calcareous sediments (Sablayan G.)	Gy	N.D.	?	Selenite appears to represent minute bedding planes and fracture fillings in the sediments.	?	
59	Alitaytayan	12°26'30"N,121°09'E San Jose, Occ. 13.5km NE of San Jose	Gypsum	Vein	Very small	Shale (Sablayan G.)	Gy	N.D.	?	Thin veins of selenite disparse in the weathered shale.	30 mins ride and 3km's hike from San Jose.	No information was obtained.
60*	Polola	12°23'N,121°20'45"E Bulalacao, Ori. 6km N of Bulalacao	Gypsum	Vein	W: 1~2cm L: <5m ?	Siltstone (Sablayan G.)	Gy	N.D.	None	Fissure-filling.	Near the Mansalay–Bulalacao highway.	Very small scale.

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alternation	Occurrence	Accessibility	Remarks
61*	Mananao	13°30'20"N,120°35'E Paluan, Occ. 14km NE of Paluan	Gravita, (construction material)	Beach sand	L: 1km W: 20m H: 0.3m	Metamorphic rocks, segregated quartz (Halcon M.)	Qz, rock gravel	–	None	The beach sand is composed of quartz, mica schist, phyllite and green schist.	1.5 hrs from Wawa by boat.	Gravita and quartz gravel are being collected by sieve and hand picking.
62*	Maria Cristina Chemical Industries	13°29'30"N,120°39'40"E Abra de Ilog, Occ. 8km NW of Abra de Ilog	Silica	Beach sand	L: 1.2km, W: 20m H: 0.3m Positive reserve: 3,600T	Metamorphic rocks, segregated quartz (Halcon M.)	Qz	Qz=20%	None	Deposits consist of Qz-sand, pebble, cobble and boulders.	0.5 hr from Wawa by boat.	do
63*	Mamburao	13°15'N,120°37'22"E Mamburao, Occ. 4km NE of Mamburao	Silica	Beach sand	1km along the beach	–	Qz	Qz < 30%	None	The beach sand is composed of Qz, Sh, Hb, Chl, Mt, Serp. fragments in the order of abundance.	Near Mamburao	Study is needed from an economic point of view. (63*–64*)
64*	Barahan	13°01'N,120°46'E Sta Cruz, Occ. 7.5km SSE of sta cruz	Silica	Beach sand	2~3km along the beach.	–	Qz	Qz=40%	None	Components are Qz=slate ≫ green rock (10%) ≫ basalt > mica schist > Mt. Grain size of sand is getting bigger toward depth.	A jeepable road is leading to this place.	
65*	Mansalay Mining Corp.	12°31'43"~33'29"N 121°21'03"~24'08"E Mansalay, Ori. 7km WNW of Mansalay	Silica	Bedded	Outcrops: No.1 W: 1~3m,400ha No.2 W: 1~2m, L: 200m No.3 W: 2.5m. L: 15m	Arkose (Mansalay F.)	Qz	Average of 16 samples SiO_2: 74.5~86.8%	None	Bedded arkose bed in the Mansalay F.	Near the logging road to Taoga Barite mine.	As arkose is highly indulated, a study on quartz grain separation is needed from the technical and economical points of view. (65*–66*)
66*	Falcon Mineral Inc.	12°33'N,121°25'N Mansalay, Ori. 3km NW of Mansalay	Silica	Bedded	H: 20m+,	Arkose (Mansalay F.)	Qz	(JICA-MMAJ) Refined stock pile SiO_2 : 82.40%	None	do	30 mins ride from Mansalay.	
67*	Marblecraft	13°29'N,120°55'E Puerto Galera, Ori. 5km SW of Puerto Galera	Marble	Bedded	L: 2km+(E-W) Thickness: 200m±	Pelitic schist (Halcon M.)	Marble	Good quality	Recryst.	Marble occurs in pelitic schist, striking E-W, dipping 0~20 N.	There is a truck road of about 10km long from Puerto Galera to mine site.	Marble craft Inc. reopened operation in April, 1983. Workers: 16 men.
68*	Dulangan	13°28'N,120°58'E Dulangan, Ori. 1km W of Dulangan	Marble	Bedded	Reserve: 110MT (provincial data, 1981)	Schist (Halcon M.)	Marble	Good quality	Recryst.	Marble are interbeded in green schist and mica schist.	Near the highway	Under operation $2m^3$/day
69*	Monte Cristy Mining Co.	13°14'N,120°49'E Mamburao, Occ. Upper reaches of Pagbahan R.	Jade	Vein	W: 2m	Limestone (Mansalay F.)	Jade	Good quality	Ser.	Champion jade vein with 2m wide occurs in limestone. All in all, there are 7 parallel veins, but others are in a low grade or on a small scale.	From the Sablayan–Mamburao highway 1.5hrs ride along Pagbahan R. in the dry season.	Operation Workers: 30 persons stockpile: about 10T.
70*	Alitaytayan	12°26'30"N,121°09'E San Jose, Occ. 13.5km NW of San Jose	Coal	Bedded	2 seams : upper: 0.6m thick lower: 1.05m thick, 18m extension	Sandstone, carbonaceous shale (sablayan G.)	Coal	(JICA-MMAJ) 12,624 BTU/lb (High-volatile C bituminous)	None	Two seams occur in interbeds of sandstone and carbonaceous silty sediments.	30 mins ride and 3km hike from San Jose.	Small scale ?

No.	Name of Deposit or Prospect	Location	Mineral Commodity	Type	Extension	Host Rock	Mineral Assemblage	Ore Grade	Alternation	Occurrence	Accessibility	Remarks
71*	Napisian Bulalacao	12°22'38"N,121°18'03E Bulalacao, Ori. 9km NNW of Bulalacao	Coal	Bedded	Thickness: 0.4~2.5m+ coal seams with 0.25m thick are 4. Reserve: 6,776,000T	Sandstone, shale (Sablayan G.)	Coal	(JICA-MMAJ) Samples taken from 3 outcrops show 11,587~12,652 BTU/lb, corresponding to high volatile C bituminous coal.	None	Coal measures consist of a heterogeneous succession of clastic materials, at least 10 coals and few impure limestone, shales and clay.	Near the Bulalacao–Mansalay highway.	Recently explored by BMG and CDCP. Some problems on the development may exist such as, (1) poor quality (2) steeply inclined (3) folded.
72*	Siay Bulalacao	12°21'57"N,121°21'40"E Bulalacao, Ori. 5km NE of Bulalacao	Coal	Bedded	Thickness: 1.4m, 1.0m 0.2m, 0.2m Reserve: 460,000T	Sandstone, shale (Sablayan G.)	Coal	(JICA-MMAJ) Two samples show 11,447 and 12,814 BTU/lb. (subbituminous -B, High ~ volatile C bituminous).	None	Seven or more coal seams with a 10cm+ thickness may present. 1 seam in Siay and 1 seam in Tambangan occur in mudstone or siltstone.	20 mins ride and 30 mins hike from the above highway.	Same problems as above are considered.

* : checked deposits or prospects

Abbreviation ; Cp : Chalcopyrite, Py : Pyrite, Po : Pyrrhotite, Bo : Bornite, Cc : Chalcocite, Mc : Marcasite, Cr : Chromite, Mt : Magnetite, Hm : Hematite, Spec : Specularite, Lm : Limonite, Chl : Chlorite, Epi : Epidote, Qz : Quartz, Hb : Hornblende, Ser : Sericite, Mn : Manganese, Tc : Talc, Gy : Gypsum, sil : Silicification, py : Pyritization, Serp : Serpentinization, O.C. : Outcrop, N.D. : No Data

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APPENDICES

Table A—1 List of Larger Foraminifera

Group or Formation Name	Sablayan Group																			Socorro Group								Halcon metamorphics		Mansalay F.			Sablayan G.
Sample No.	WR-204	WR-41	WR-202	WR-203	HR-10	YR-09	WR-34	WR-201	WR-154	TR2-005	YR2-024a	YR2-025	YR2-034 (float)	YR2-036 (float)	TR2-029	TR2-039	TR2-127	TR2-137	YR2-002	HR-40	HR-205	HR-206	FR-05	WR-04	WR-30	WR-03	WR-37	FR-42	FR-111	YR-21	YR-22	WR-64	WR-42
Location	Bugsanga R.	Bugsanga R.	Bugsanga R.	Bugsanga R.	North of Calintaan	Rayusan R.	Foot of Eplog Hill	Hagdanan Peak	West of Pocanil Bay	Tributary of Balangan R.	Tributary of Caguray R.	Tributary of Caguray R.	Tributary of Amnay R.	Epaz Point	Tributary of Mongpong R.	Tributary of Mongpong R.	Banus R.	Banus R.	Caguray R.	East of Sablayan	Labangan R.	Labangan R.	West of Mamburao	Caguray R.	NW of Buruncan Point	Caguray R.	NE of Magsaysay	Odala River	Subaang River	Rayusan R.	Rayusan R.	Balangan R.	Bugsanga R.
Geologic Age / Species of Larger Foraminifera	Eocene	Late Eocene	Early Eocene	Oligo.–Miocene	Miocene	Miocene	Miocene	Miocene	?	Late Eocene	Late Eocene	Late Eocene	Middle?–Late Eocene	Oligocene	Oligocene–Early Miocene	Oligocene–Early Miocene	Early–Late Miocene	Early–Late Miocene	?	Pleistocene	Pleistocene	Pleistocene	Pleistocene	Pleistocene	Pleistocene	Pleistocene?	?						
Acervulina inhaerens Schultze			X		X			X	X										X	X		X		X				No Larger Foraminifera					
Alveolinids sp.					X					X																							
Amphistegina radiata (Fichtel and Moll)								X		X			X	X	X	X	X		X	X	X	X	X	X	X	X	X						
Asterocyclina sp.												X																					
Baculogypsinoides spinosus Yabe and Hanzawa																						X											
Biplanispira mirabilis (Umbgrove)		X								X	X																						
Borelis sp.																											X						
Calcarina delicata Todd and Post																				X	X		X	X									
C. spengleri (Gmelin)																									X								
Cycloclypeus sp.								X		X		X			X	X	X	X							X								
Discocyclina (Asterocyclina) sp.		X																															
D. cf. dispansa (Sowerby)											X																						
D. sp.										X																							
Eorupertia sp.																					X												
Flosculinella sp.						X																											
Gypsina globulus (Reuss)					X		X			X	X					X	X	X		X					X		X						
G. vesicularis (Parker and Jones)										X		X				X		X									X						
Halkyardia minima (Liebus)	X												X																				
Heterostegina cf. borneensis Van der Vlerk																X																	
H. sp.				X						X				X																			
Homotrema rubrum (Lamarck)								X										X						X	X								
Lepidocyclina (Eulepidina) cf. monstrosa Yabe															X																		
L. (Eulepidina) cf. planata (Oppenoorth)				X											X	X																	
L. (Eulepidina) sp.														X																			
L. (Mulitilepidina) luxurians (Tobler)																	X																
L. (Nephrolepidina) angulosa Provale																		X															
L. (Nephrolepidina) ferreroi Provale																	X	X															
L. (Nephrolepidina) cf. isolepidinoides Van der Vlerk														X																			
L. (Nephrolepidina) japonica (Yabe)																X		X															
L. (Nephrolepidina) sumatrensis (Brady)																X	X																
L. (Nephrolepidina) tournoueri (Lemoine and R. Douville)					X																												
L. (Nephrolepidina) sp.							X	X																									
Marginopora vertebralis Blainville									X																								
Miniacina miniacea (Pallas)																	X	X	X		X												
Miogypsina (Lepidosemicyclina) thecidaeformis Rutten)																X	X	X															
M. (Miogypsinoides) complanata (Schlumberger)																X																	
M. (Miogypsina) thecidaeformis Tan Sin Hok						X																											
M. (Miogypsina) sp.					X																												
Nummulites cf. fabianii (Priver)										X																							
N. fichteli (Michelotti)			X											X																			
N. sp.	X																																
Operculina complanata Defrance			X																														
O. alina cf. complanata (Defrans)										X							X																
O. venosa (Fichtel and Moll)																		X				X											
O. sp.				X				X														X											
Planorbulinella larvata (Parker and Jones)						X	X	X		X		X						X		X				X	X	X	X						
Rotalia sp.																																	
Rupertina? sp.										X					X	X	X																
Sorites sp.						X																											
Spiroclypeus leupoldi Van der Vlerk																X																	
S. vermicularis Tan											X																						
S. sp.		X																															
Victoriella sp.								X																									

Table A–2 List of Smaller Foraminifera

	Group or Formation Name	Mansalay F.	Sablayan G.	Sablayan G.	Sablayan G.	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Socorro G.
	Sample No.	FR-20	YR-08	HR-207	YR2-015	HR-120	HR-114	WR-109	WR-110	WR-15	HR-112	HR-118	HR-101	YR2-006	YR2-007	HR-152
	Location / Species of Smaller Foraminifera	Abra de Ilog	Rayusan River	Labangan River	Gagura River	Pula River	Balete River	Road to Barite Mine	Road to Barite Mine	Bongabong River	Balete River	Pula River	Tangon River	Caguray River	Caguray River	San Teodoro
Benthonic Foraminifera, Arenaceous	Cyclammina cf. pacifica Beck								X							
	C. sp.								X							
	Cribrostomoides sp.		X													
	Gaudryina udryina sp.		X													
	Haplophragmoides sp.		X													
	Martinottiella sp. p.		X													
	Plactina sp.		X													
	Trochammina sp.		X													
	Aren. Foram. gen. and sp. indet.		X						X							
Benthonic Foraminifera, Calcareous	Ammonia sp.									X						
	Anomalina glabrata Cushman									X						
	Bolivina robusta														X	
	B. sp.															X
	Bolivinita quadrilatera														X	
	Bulimina cf. buchiana				X											
	B. marginata													X		
	B. striata													X	X	
	B. sp.		X													
	Cassidulina subglobosa														X	
	C. subglobosa Brady									X						
	C. cf. yabei Asano and Nakamura									X						
	C. sp.									X		X	X			
	Cellanthus craticulatum													X		
	Chilostomella oolina				X											
	Cibicides dorsopustutosus														X	
	C. praecintus													X		
	Clavulinoides sp.														X	
	Cymbaloporetta squammosa													X		
	Dentalina emaciata Reuss															X
	D. sp.		X			X				X	X		X			X
	Dorothia sp.														X	
	Eponides wubonatus (Reuss)					X				X	X	X	X			
	E. sp.					X				X	X	X				
	E. sp. p.		X													
	E. haidingerii (d'Orbigny)											X	X			
	Fissurina marginata segueza										X					
	F. sp.		X													
	Florilus boueanum				X											
	Gyroidina orbicularis d'Orbigny									X	X					X
	G. soldanii ii													X		
	Hemicristellaria gemmata													X	X	
	Hoglundina elegans														X	
	Hyalinea balthica														X	
	Karreriella bradyi													X	X	
	Lagena striata (d'Orbigny)											X				
	L. sp.		X			X					X	X				
	Lagenonodosaria hirsuta														X	
	L. pauciloculata (Cushman)										X					
	L. sp.										X					
	Lenticulina kobulus Asano									X						
	L. nikobarensis (Schwager)										X					X
	L. orbicularis (d'Orbigny)									X						
	L. sp.										X					
	Marginulinopsis bradyi				X											
	Melonis pacificum (Cushman)											X				
	Nodosaria longiscata													X		
	N. sp.									X	X					

	Group or Formation Name	Mansalay F.	Sablayan G.	Sablayan G.	Sablayan G.	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Bongabong Group	Socorro G.
	Sample No.	FR-20	YR-08	HR-207	YR2-015	HR-120	HR-114	WR-109	WR-110	WR-15	HR-112	HR-118	HR-101	YR2-006	YR2-007	HR-152
	Location / Species of Smaller Foraminifera	Abra de Ilog	Rayusan River	Labangan River	Gaguray River	Pula River	Balete River	Road to Barite Mine	Road to Barite Mine	Bongabong River	Balete River	Pula River	Tangon River	Caguray River	Caguray River	San Teodoro
Benthonic Foraminifera, Calcareous	Planulina ariminensis				X											
	P. wuellesatorfi (Schwager)			X		X	X			X	X	X	X			
	P. sp.			X			X			X						
	Planularia sp.		X													
	Pilenia bulloides (d'Orbigny)											X				
	P. sp.											X				
	Pseudorotalia schroeteriana														X	
	Quinqueloculina sp.															X
	Rectobolivina bifrons													X		
	Rotalia calcar													X		
	R. sp.												X			
	Sigmoilopsis schlumbergeri													X		
	Siphogenerina striata													X		
	Uvigerina aculeata d'Orbigny					X										
	U. ampullacea														X	
	U. canariensis													X	X	
	U. crassicostata Schwager											X				
	U. cushmani														X	
	U. excellens Todd			X		X										X
	U. peregrina													X	X	
	U. sp.			X									X			X
	Virgulina complanata Egger			X												
	Cal. Foram. gen. and sp. indet.		X			X			X		X		X			X
Planktonic Foraminifera	Catapsydrax dissimilis				X											
	C. unicavus				X											
	Cyclammina cancellata				X											
	Globigerina bulloides Blow													X	X	
	Globorotalia fohsi robusta Bolli									X			X			
	G. fohsi lobata Bermudez							X		X			X			
	G. menardii (d'Orbigny)			X		X		X	X	X	X	X	X			X
	G. menardii menardii (d'Orbigny)										X		X			
	G. sp.			X		X		X		X		X	X			X
	Globigerinoides conglobatus													X		
	G. obliquus													X		
	G. quadrilobatus group													X	X	
	G. trilobus (Reuss)			X		X		X	X	X	X	X	X			X
	G. rubra (d'Orbigny)							X		X	X		X	X	X	
	G. inmaturus Leroy							X		X	X		X			
	G. sp.		X	X				X	X	X		X				X
	Globigerina falconesis Blow							X		X			X			
	G. bulloides Blow					X	X	X	X			X	X			
	G. menardii (d'Orbigny)													X	X	
	G. praebulloides Blow									X	X					
	G. pseudopima														X	
	G. tosaensis														X	
	G. trilobus (Reuss)						X									
	G. tumida														X	
	G. sp.		X	X			X	X	X	X	X	X	X			X
	Globoqudrina sp.				X											
	Globorotalia crassaformis													X	X	
	Haplophragmoides compressa				X											
	Neogloboquadrina dutertrei													X		
	Orbulina universa d'Orbigny							X	X	X	X		X	X		
	Pla. Foram. gen. and sp. indet.		X	X		X		X		X	X					
	Pulleniatina obliquiloculata													X	X	
	P. primalis														X	
	Sphaeroidinella dehiscens													X		
	No Smaller Foraminifera	X														

Table A−3 Chemical Composition and C.I.P.W Norm

(1)

Rock Type		Ultramafic Complex (ultramafic rocks and associated rocks)																	
		Pintin Body											Liwliw Body			Igsoso Body			
Location		Pintin R.	Pintin R.	Pintin R.	Pintin R.	Pintin R.	Pintin R.	Amnay R.	Amnay R.	Pintin R.	Pintin R.	Casiligan R.	Liwliw	Liwliw	Liwliw	Igsoso	Igsoso	Igsoso	Igsoso
Sample No.		KR2−020	KR2−021	KR2−026	KR2−033	KR2−040	KR2−048	SR1−038	YR1−005	KR2−030	KR2−036	SR2−140	KR2−54	KR2−077	KR2−078	KR2−061	KR2−063	KR2−064	KR2−066
Rock Name		harzburgite	dunite	ortho-pyroxenite	dunite	harzburgite	harzburgite	harzburgite	au hy gabbro	au hy gabbro	au gabbro	au hy gabbro	lherzolite	hornblendite	dunite	dunite	hb gabbro	au ho gabbro	au gabbro
Chemical Composition	SiO_2	39.50	40.60	43.80	39.40	42.30	38.80	33.51	47.89	44.00	41.40	46.20	40.30	44.30	42.50	41.50	46.90	48.80	54.50
	TiO_2	0.01	0.00	0.02	0.01	0.00	0.00	0.01	0.21	2.33	0.24	0.20	0.02	0.98	0.00	0.00	1.28	1.15	1.00
	Al_2O_3	0.76	0.47	1.26	0.56	0.54	0.49	0.80	20.55	14.40	16.90	19.20	1.55	12.00	0.34	0.26	16.30	15.00	15.20
	Fe_2O_3	8.28	7.46	5.56	7.46	6.46	7.94	4.35	0.84	8.24	5.08	3.46	7.44	7.69	7.34	6.82	4.69	6.55	8.15
	FeO	0.59	0.88	2.53	0.49	1.46	0.65	1.90	4.92	3.47	2.06	2.17	0.77	6.22	0.41	0.43	5.12	3.64	2.64
	MnO	0.13	0.13	0.14	0.12	0.13	0.09	0.09	0.12	0.26	0.13	0.12	0.10	0.48	0.11	0.05	0.23	0.20	0.20
	MgO	36.80	38.80	44.30	41.30	41.10	40.50	40.32	7.75	7.82	10.90	8.89	40.10	15.00	39.50	41.70	7.89	7.60	5.83
	CaO	0.81	0.37	2.12	0.63	0.94	0.38	2.02	13.93	12.60	15.20	12.00	0.93	9.91	0.36	0.31	13.80	9.31	4.26
	Na_2O	0.12	0.08	0.05	0.12	0.00	0.03	0.02	1.89	1.50	1.48	1.58	0.09	1.45	0.12	0.04	1.42	2.84	4.86
	K_2O	0.15	0.23	0.19	0.38	0.23	0.32	0.01	0.06	0.28	0.39	0.21	0.39	0.27	0.08	0.27	0.54	0.76	0.46
	P_2O_5	0.40	0.30	0.21	0.31	0.20	0.32	0.01	0.02	0.16	0.08	0.06	0.29	0.19	0.30	0.29	0.13	0.22	0.35
	Cr_2O_3	0.30	0.28	–	0.39	0.34	0.24	–	–	–	0.03	–	0.29	0.05	0.29	0.85	0.04	–	–
	NiO	0.23	0.23	–	0.24	0.24	0.59	–	–	–	0.01	–	0.20	0.02	0.26	0.35	0.01	–	–
	BaO	0.00	0.00	0.00	0.00	0.00	0.00	–	–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	L.O.I	12.20	11.00	0.40	9.60	7.00	10.50	16.20	1.59	1.10	2.10	2.00	9.10	2.10	9.90	9.00	0.90	2.00	5.20
	Total	100.00	100.83	100.58	101.01	100.94	100.85	99.24	99.77	96.16	96.00	96.09	101.57	100.66	101.51	101.87	99.25	98.07	100.65
C.I.P.W. Norm	q									2.42		0.31						2.78	7.76
	c																		
	or	0.89	1.36	1.12	2.25	1.36	1.89	0.06	0.35	1.65	2.30	1.24	2.30	1.60	0.47	1.42	3.19	4.49	2.72
	ab	1.02	0.68	0.42	0.76		0.25	0.17	15.99	12.69	12.52	12.95	0.76	12.27	1.02		12.02	24.03	41.12
	an	1.09		2.65		0.79		2.06	47.41	31.73	38.32	44.90	2.67	25.44			36.51	25.94	18.30
	ne																		
	di wo	0.13		2.71	0.46	1.07		1.79	9.00	12.41	15.27	5.95	0.02	9.39			12.99	7.86	0.23
	di en	0.10		2.14	0.36	0.85		1.55	5.88	10.73	13.19	4.96	0.02	5.50			7.03	6.79	0.20
	di fs	0.02		0.27	0.04	0.10			2.50			0.23		3.43			5.51		
	hy fs	3.21	3.03	1.28	1.23	2.52	1.65		1.67			0.79	1.68	0.11	3.47	2.11	2.20		
	hy en	21.13	22.32	10.08	10.44	20.72	13.66	3.37	3.92	8.75		17.18	13.04	0.17	28.62	21.93	2.81	12.14	14.32
	ol fo	49.35	52.02	68.76	64.52	56.62	61.05	66.93	6.66				60.84	22.20	48.85	57.41	6.88		
	ol fa	8.26	7.80	9.66	8.38	7.59	8.14	0.03	3.12				8.66	15.25	6.52	6.10	5.94		
	mt							6.31	1.22	5.28	6.35	5.02						9.05	6.26
	hm									4.60	0.70							0.31	3.83
	il	0.02		0.04	0.02			0.02	0.40	4.43	0.46	0.38	0.04	1.86			2.43	2.18	1.90
	ru																		
	ap	0.93	0.70	0.49	0.72	0.46	0.74	0.02	0.05	0.37	0.19	0.14	0.67	0.44	0.70	0.67	0.30	0.51	0.81
	cc																		
	cr	0.44	0.41		0.57	0.50	0.35				0.04		0.43	0.07	0.43	1.25	0.06		
	tr	0.72	0.72		0.75	0.75	1.85						0.63	0.06	0.82	1.10	0.03		
	sp		0.12				0.13								0.08				
	MgO																		
	FeO																		
	lc																		
	Total	87.31	89.16	99.62	86.62	93.33	89.71	82.31	98.17	95.06	89.34	94.05	91.76	97.79	90.98	91.99	97.90	96.08	97.45
S.I.*		80.10	81.77	84.17	83.02	83.45	81.92	86.52	50.13	36.70	54.75	54.51	82.19	48.97	83.25	84.65	40.13	35.53	26.57
MgOx100 /(FeO+MgO)		98.42	97.78	94.60	98.83	96.57	98.42	95.50	61.17	69.26	84.10	80.38	98.12	70.69	98.97	98.98	60.65	67.62	68.83

* S.I. = MgOx100/($MgO+Fe_2O_3+FeO+Na_2O+K_2O$)

Rock Type		Ultramafic Complex																
		Bongabong Body							Ogos Body						Other Bodies			
Location		Bansud R.	Samagui R.	Samagui R.	Banus R.	Banus R.	Rosanna R.	Rosanna R.	Ogos R.	Ogos R.	Ogos R.	Ogos R.	Aglubang R.	Alagag R.	Paluan	Mariil	San Vicente	Binuangan R.
Sample No.		SR1−065	KR2−082	KR2−085	TR2−131	TR2−132	YR2−080	YR2−081	KR2−102	KR2−104	KR2−108	KR2−110	SR2−155	YR2−115	FR1−006	KR2−067	TR2−064	YR2−043
Rock Name		harzburgite	harzburgite	ortho-pyroxenite	lherzolite	dunite	harzburgite	dunite	harzburgite	dunite	dunite	harzburgite	dunite	dunite	harzburgite	harzburgite	harzburgite	dunite
Chemical Composition	SiO_2	40.12	41.00	43.10	37.20	34.80	43.30	34.20	45.10	40.00	37.50	42.50	38.60	36.10	38.48	39.80	40.30	40.10
	TiO_2	0.02	0.01	0.00	0.01	0.00	0.01	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.00
	Al_2O_3	1.52	1.33	0.41	0.85	0.20	1.16	0.14	1.71	0.24	0.20	1.07	0.69	0.33	1.76	1.06	1.42	0.72
	Fe_2O_3	4.12	7.14	5.03	6.71	7.39	4.70	5.93	5.66	6.91	6.61	5.51	6.56	4.75	6.99	7.98	7.46	5.22
	FeO	3.70	0.76	2.59	0.66	0.75	2.33	1.03	1.12	0.88	1.52	2.32	0.79	0.85	1.11	0.80	0.49	0.49
	MnO	0.12	0.14	0.13	0.11	0.12	0.12	0.10	0.13	0.11	0.12	0.13	0.11	0.11	0.12	0.11	0.12	0.10
	MgO	38.65	40.70	47.70	40.00	44.30	43.30	47.90	33.10	43.00	46.20	42.70	41.90	46.50	34.19	42.30	38.10	40.60
	CaO	1.21	0.30	0.58	1.61	0.41	1.43	0.31	9.78	0.60	0.45	1.28	1.01	0.36	4.60	0.27	1.07	0.51
	Na_2O	0.02	0.07	0.10	0.09	0.12	0.08	0.09	0.22	0.11	0.02	0.06	0.11	0.18	0.02	0.03	0.06	0.15
	K_2O	0.01	0.05	0.05	0.15	0.05	0.20	0.04	0.04	0.01	0.04	0.00	0.14	0.09	0.01	0.07	0.04	0.07
	P_2O_5	0.01	0.32	0.18	0.27	0.33	0.22	0.27	0.17	0.26	0.24	0.22	0.31	0.24	0.01	0.30	0.28	0.26
	Cr_2O_3	–	0.32	0.48	0.20	0.22	0.33	0.27	0.34	0.21	0.56	0.27	0.35	0.44	–	0.31	0.33	–
	NiO	–	0.22	0.25	0.21	0.24	0.22	0.26	0.13	0.22	0.24	0.21	0.23	0.01	–	0.23	0.22	–
	BaO	–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	–	0.00	0.00	0.00
	L.O.I	10.11	10.00	1.00	11.50	9.70	2.80	9.90	3.80	12.00	6.20	4.00	9.90	10.00	12.44	9.50	10.00	7.10
	Total	99.61	102.36	101.60	99.57	98.63	100.20	100.44	101.37	104.55	99.90	100.27	100.70	99.96	99.76	102.76	99.91	95.32
C.I.P.W. Norm	q																	
	c																	
	or	0.06	0.30	0.30	0.89		1.18		0.24	0.06			0.83		0.06	0.41	0.24	0.41
	ab	0.17	0.59	0.85	0.76		0.68		1.86	0.93		0.51	0.93		0.17	0.25	0.51	1.27
	an	4.03		0.52	1.47		2.22		3.56	0.13	0.34	2.65	0.98		4.68		3.48	0.83
	ne					0.41		0.27			0.09			0.65				
	di wo	0.30		0.49	1.98		1.44		18.31	0.48	0.14	0.94	0.84	0.09	7.55			
	di en	0.67		0.40	1.58		1.15		14.39	0.38	0.11	0.75	0.67	0.07	6.52			
	di fs	0.02		0.04	0.18		0.12		1.88	0.04	0.01	0.09	0.07	0.01				
	hy fs	0.96	2.86	1.08	0.53		1.66		0.32	1.43		2.03	0.85			1.99	2.80	1.84
	hy en	25.94	23.17	10.64	4.53		16.02		2.42	12.43		17.07	7.80		16.58	15.08	21.54	19.16
	ol fo	48.81	54.00	75.52	65.54	74.05	63.54	74.28	45.99	66.07	80.13	62.04	67.20	78.14	43.48	62.62	51.41	57.37
	ol fa	2.00	7.35	8.41	8.39	9.35	7.26	7.27	6.63	8.35	9.67	8.12	8.07	6.72		9.10	7.37	6.08
	mt	5.97													3.88			
	hm														4.31			
	il	0.04	0.02		0.02		0.02		0.13						0.06			
	ru																	
	ap	0.02	0.74	0.42	0.63	0.76	0.51	0.63	0.39	0.60	0.56	0.51	0.72	0.56	0.02	0.70	0.65	0.60
	cc																	
	cr		0.47	0.71	0.29	0.32	0.49	0.40	0.50	0.31	0.82	0.40	0.52	0.65		0.46	0.49	
	tr		0.69	0.78	0.66	0.75	0.69	0.82	0.41	0.69	0.75	0.66	0.72	0.03		0.72	0.69	
	sp		1.62													1.30		0.13
	MgO					1.88		5.34			0.25			1.70				
	FeO					0.29		0.64			0.04			0.18				
	lc					0.23		0.19			0.19			0.42				
	Total	89.49	91.81	100.16	87.45	88.04	96.98	89.84	97.03	91.90	93.10	95.77	90.20	89.22	87.31	92.63	89.22	87.69
S.I.*		83.12	83.54	85.99	84.02	84.20	85.56	87.11	82.46	84.46	84.94	84.40	84.65	88.79	80.79	82.65	82.56	87.26
MgOx100 /(FeO+MgO)		91.26	98.17	94.85	98.38	98.34	94.89	97.89	96.73	97.99	96.81	94.85	98.15	98.20	96.86	98.14	98.73	98.81

* S.I. = $MgO \times 100/(MgO+Fe_2O_3+FeO+Na_2O+K_2O)$

Rock Type		Ultramafic Complex									Lumintao Formation						Mansalay F.		Mamburao G.
		Other Bodies					Metamorphic Rocks				Volcanic Rocks			Associated Intrusive Rocks			Volcanic Rocks		Volcanic R.
Location		Balete R.	Balete R.	Balete R.	Marill	San Vicente	BongabongR.	Rayusan R.	Ogos R.	Amnay R.	Lumintao R.	Lumintao R.	Igsoso	Pintin R.	Liwliw	Lumintao R.	Binunagin R.	San Vicente	Banilad Ck.
Sample No.		KR2-094	KR2-091	TR2-151	KR2-068	KR2-071	WR1-012	YR1-012	KR2-112	TR2-046	KR2-009	KR2-014	KR2-073	KR2-029	KR2-074	KR2-017	FR1-015	TR2-069	FR-017
Rock Name		harzburgite	au hy gabbro	hb gabbro	diorite porphyry	trondhjo-mite	green schist	amphibolite	green schist	amphibolite	basalt	basalt	basalt	dolerite	dolerite	gabbro	basalt	basalt	basalt
Chemical Composition	SiO_2	41.00	49.30	43.40	60.60	68.90	50.38	50.84	47.10	47.60	48.00	48.80	50.00	50.80	47.20	45.50	46.37	46.30	50.52
	TiO_2	0.02	0.25	0.86	0.73	0.15	1.48	1.04	1.48	1.99	0.98	1.10	0.80	1.29	0.55	1.05	2.82	1.19	1.73
	Al_2O_3	1.93	17.50	14.20	16.30	12.30	15.21	15.92	14.10	16.90	15.60	14.90	15.20	14.90	14.10	16.50	15.20	15.60	15.77
	Fe_2O_3	6.95	4.02	6.25	2.03	1.36	2.80	2.38	7.44	7.74	7.91	6.94	7.15	8.59	5.36	6.35	4.87	6.65	5.99
	FeO	0.63	1.12	2.36	0.88	0.10	7.83	6.97	2.64	3.08	2.67	3.23	2.13	2.27	3.16	3.17	5.93	1.87	5.68
	MnO	0.12	0.15	0.16	0.05	0.01	0.18	0.16	0.21	0.39	0.18	0.18	0.17	0.18	0.19	0.18	0.13	0.18	0.22
	MgO	41.50	10.10	10.10	3.67	0.43	6.91	7.08	7.96	6.57	5.85	6.33	6.99	4.95	8.16	11.20	3.94	7.92	3.77
	CaO	0.81	12.40	9.72	4.81	4.25	11.16	10.48	12.00	8.22	9.91	9.93	9.63	8.43	14.40	8.16	9.81	7.83	7.65
	Na_2O	0.22	1.73	2.99	6.71	4.48	2.50	2.68	2.30	2.87	2.64	2.77	3.50	4.69	0.49	2.72	4.68	2.66	4.60
	K_2O	0.07	0.14	0.19	0.20	0.10	0.18	0.66	0.18	1.43	0.72	0.46	0.18	0.27	0.15	0.35	1.10	2.14	1.16
	P_2O_5	0.29	0.05	0.11	0.10	0.07	0.16	0.10	0.37	0.35	0.25	0.30	0.29	0.35	0.06	0.34	0.63	0.36	0.31
	Cr_2O_3	0.35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	NiO	0.20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	BaO	0.00	0.00	0.00	0.00	0.00	–	–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	L.O.I	7.90	2.80	7.00	1.60	1.90	1.09	0.91	2.10	1.80	3.10	2.50	4.10	2.20	2.10	3.90	2.34	4.40	2.40
	Total	101.99	99.56	97.34	97.68	94.05	99.88	99.22	97.88	98.94	97.81	97.44	100.14	98.92	95.92	99.42	97.82	97.10	99.80
C.I.P.W. Norm	q		1.88		7.35	34.52	2.16	0.43	2.87	1.06	4.73	5.47	3.17	2.51	8.16				0.47
	c																		
	or	0.41	0.83	1.12	1.18	0.59	1.06	3.90	1.06	8.45	4.25	2.72	1.06	1.60	0.89	2.07	6.50	12.65	6.86
	ab	1.86	14.64	24.62	56.78	37.91	21.15	22.68	19.46	24.29	22.34	23.44	29.62	39.69	4.15	23.02	38.05	22.51	38.92
	an	2.12	39.57	24.76	13.77	13.16	29.75	29.46	27.62	29.01	28.59	26.86	25.23	18.81	35.83	31.78	17.22	24.31	18.96
	ne			0.37													0.84		
	di wo		9.03	9.49	3.94	1.24	10.26	9.14	12.32	3.96	7.91	8.53	8.62	8.66	14.70	2.71	6.08	5.09	7.09
	di en		7.80	8.21	3.41	1.07	6.16	5.61	10.64	3.42	6.83	7.38	7.45	7.48	12.33	2.34	4.42	4.40	4.92
	di fs						3.56	3.00							0.50		1.10		1.59
	hy fs	1.81					6.39	6.42							0.32				1.45
	hy en	15.73	17.36		5.73		11.05	12.02	9.18	12.94	7.74	8.39	9.96	4.85	8.00	13.92		7.64	4.47
	ol fo	60.92		11.88												8.16	3.78	5.39	
	ol fa	7.73															1.04		
	mt		3.37	5.64	0.88		4.06	3.45	4.90	5.43	6.35	7.78	5.10	4.16	7.77	7.76	7.06	3.17	8.68
	hm		1.69	2.36	1.42	1.36			4.06	3.99	3.53	1.57	3.63	5.72		1.00		4.47	
	il	0.04	0.47	1.63	1.39	0.23	2.81	1.98	2.81	3.78	1.86	2.11	1.52	2.45	1.04	1.99	5.36	2.26	3.29
	ru																		
	ap	0.67	0.12	0.25	0.23	0.16	0.37	0.23	0.86	0.81	0.58	0.70	0.67	0.81	0.14	0.79	1.46	0.83	0.72
	cc																		
	cr	0.52																	
	tr	0.63																	
	sp	1.00																	
	MgO																		
	FeO																		
	lc																		
	Total	93.44	96.76	90.33	96.08	90.24	98.78	98.32	95.78	97.14	94.71	94.95	96.03	96.74	93.83	95.54	92.91	92.72	97.42
S.I.*		84.06	59.03	46.14	27.21	6.65	34.17	35.81	38.79	30.29	29.56	32.08	35.04	23.83	47.11	47.08	19.20	37.29	17.78
MgOx100 /(FeO+MgO)		98.50	90.02	81.06	80.66	81.13	46.88	50.39	75.09	68.08	68.66	66.21	76.64	68.56	72.08	77.94	39.92	80.90	39.89

* S.I. = MgOx100/($MgO+Fe_2O_3+FeO+Na_2O+K_2O$)

Rock Type		Intrusive Rocks – Acidic to Intermediate Rocks				Halcon Metamorphics						
Location		Camarong R.	Mamburao R.	Sinambalan	Sinanbalan	Camarong R.	Agbuyi Ck.	Alag R.	San Teodoro	Puerto Galera	Paluan R.	Alag R.
Sample No. / Rock Name		FR1–041 grano-diorite	FR1–024 quartz diorite	TR2–107 diorite porphyry	TR2–111 quartz porphyry	FR1–039 gneiss	FR1–113 gneiss	FR1–103 green schist	SR1–090 green schist	TR2–161 mica schist	YR2–039 green schist	FR2–073 mica schist
Chemical Composition	SiO_2	71.27	58.81	48.60	61.10	72.64	70.18	62.42	45.24	71.30	57.60	57.30
	TiO_2	0.19	0.74	1.09	0.58	0.18	0.35	0.65	1.45	0.68	0.60	0.69
	Al_2O_3	16.13	16.62	17.10	15.60	15.02	15.24	14.90	15.34	14.20	13.50	16.30
	Fe_2O_3	0.59	2.56	7.08	4.30	0.52	0.51	3.44	2.24	2.42	5.55	5.75
	FeO	1.08	3.81	2.39	0.92	1.37	2.19	3.16	8.73	0.32	2.54	0.46
	MnO	0.02	0.10	0.13	0.08	0.06	0.06	0.16	0.21	0.00	0.23	0.09
	MgO	0.35	3.84	4.26	2.56	0.84	1.47	2.44	8.08	0.58	5.98	2.46
	CaO	2.92	3.87	7.20	2.18	1.57	2.41	5.07	8.83	0.31	2.85	2.22
	Na_2O	5.07	4.09	2.52	3.92	4.61	4.45	1.43	2.44	0.48	2.73	3.52
	K_2O	0.83	2.68	2.45	3.19	1.54	1.14	2.81	0.62	3.01	0.14	3.44
	P_2O_5	0.14	0.20	0.75	0.32	0.08	0.11	0.18	0.15	0.09	0.29	0.41
	Cr_2O_3	–	–	–	–	–	–	–	–	–	–	–
	NiO	–	–	–	–	–	–	–	–	–	–	–
	BaO	–	–	0.00	0.00	–	–	–	–	0.00	0.00	0.00
	L.O.I	0.69	1.82	2.00	3.10	1.06	1.19	2.00	4.29	3.70	5.10	2.80
	Total	99.28	99.14	95.57	97.85	99.49	99.30	98.66	97.62	97.09	97.11	95.44
C.I.P.W. Norm	q	31.66	9.86	5.49	18.50	34.67	31.46	30.16		55.71	26.98	16.39
	c	1.92	0.69		2.50	3.11	2.57	2.25	0.22	9.80	4.37	3.73
	or	4.91	15.84	14.48	18.85	9.10	6.74	16.61	3.66	17.79	0.83	20.33
	ab	42.90	34.61	21.32	33.17	39.01	37.65	12.10	20.65	4.06	23.10	29.79
	an	13.57	17.20	28.11	8.72	7.27	11.24	19.80	28.48	0.95	12.24	8.33
	ne											
	di wo			1.13								
	di en			0.98								
	di fs											
	hy fs	1.22	3.85			1.90	3.13	2.19	10.49			
	hy en	0.87	9.56	9.63	6.38	2.09	3.66	6.08	17.34	1.44	14.89	6.13
	ol fo								1.95			
	ol fa								1.30			
	mt	0.86	3.71	4.97	1.55	0.75	0.74	4.99	3.25		7.20	
	hm			3.65	3.23					2.42	0.59	5.75
	il	0.36	1.41	2.07	1.10	0.34	0.66	1.23	2.75	0.68	1.14	1.16
	ru									0.32		0.08
	ap	0.32	0.46	1.74	0.74	0.19	0.25	0.42	0.35	0.21	0.67	0.95
	cc											
	cr											
	tr											
	sp											
	MgO											
	FeO											
	lc											
	Total	98.59	97.19	93.57	94.74	98.43	98.10	95.83	90.44	93.38	92.01	92.64
S.I.*		4.42	22.61	22.78	17.19	9.46	15.06	18.37	36.54	8.52	35.30	15.74
MgOx100 /(FeO+MgO)		24.48	50.20	64.06	73.56	38.01	40.16	43.57	48.07	64.44	70.19	84.25

* S.I. = $MgO \times 100/(MgO+Fe_2O_3+FeO+Na_2O+K_2O)$

Table A–4 Result of K-Ar Dating

Sample No.	Rock Name	K (%)	Rad ^{40}Ar (%)	Rad ^{40}Ar (scc/gm x 10^{-5})	Isotopic Age (m.y.)
FR-39	gneiss	1.27 1.27	63.5 63.8	0.121 0.125	24.7 ± 0.8
FR-41	granodiorite	0.61 0.61 0.61 0.61 0.61	56.9 59.4 61.1 60.9 59.2	0.079 0.084 0.094 0.106 0.118	40.2 ± 6.8 lowest value 33.0 highest value 49.1
FR-103	green schist	1.88 1.88	79.6 80.9	0.278 0.285	37.8 ± 1.1
FR-24	quartz diorite	2.47 2.47	80.6 81.8	0.293 0.295	30.4 ± 0.9
YR-12	amphibolite	0.73 0.73	51.5 50.1	0.071 0.073	24.6 ± 0.9

Remarks: The analyses were performed on whole rock material.

$$\text{Isotopic Age (m.y.)} = \frac{1}{\lambda\epsilon + \lambda\beta} \ln \left[\frac{\lambda\epsilon + \lambda\beta}{\lambda\epsilon} \times \frac{\text{Rad } ^{40}Ar}{^{40}K} + 1 \right]$$

$\lambda\epsilon = 0.581 \times 10^{-10}\ yr^{-1}$

$\lambda\beta = 4.962 \times 10^{-10}\ yr^{-1}$

$^{40}K = 1.167 \times 10^{-4}$ atom per atom of natural potassium

Table A–5 Result of Rb-Sr Dating

Sample No.	Rock Name	Location	Rb (ppm)	Sr (ppm)	Rb/Sr	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$
TR2–161	muscovite schist	Puerto Galera	150.4	54.5	2.76	7.98	0.71311 ± 0.00008
YR2–112	muscovite-chlorite schist	Catuiran River	66.4	153.8	0.43	1.25	0.71667 ± 0.00008
YR2–112 (mica)	muscovite	do	117.9	84.5	1.40	4.04	0.71678 ± 0.00009
TR2–046	amphibolite	Tributary of Amnay River	10.0	144.5	0.07	0.20	0.70866 ± 0.00010
TR2–047	amphibolite	do	36.7	155.8	0.24	0.68	0.70619 ± 0.00008
YR2–077	epidote amphibolite	Rosanna River	4.61	178.6	0.03	0.075	0.70293 ± 0.00010

Remarks: The model age calculated for the sample YR2–112 is 2.8 million years, using the data generated from the mica separate and whole rock material.

Table A—6 Assay Result of Ore Samples

(1)

	Sample No.	Location	Occurrence	Au g/T	Ag g/T	Cu %	Pb %	Zn %	Cr_2O_3 %	Ni %	Co ppm	Fe %	SiO_2 %	Al_2O_3 %	MgO %	S %	P %	Ca %	Ba %	Na %	K %	As %	TiO_2 %	V ppm
Gold and Copper Ores	FR1–034	Mamburao R.	Mal stained skarn (float)	0.1	1.0	0.75	–	–	–	–	–	7.48	–	–	–	0.23	–	–	–	–	–	–	–	–
	FR1–043	Odala R.	Py dissemination	0.1	1.4	0.12	–	–	–	–	–	21.39	–	–	–	18.23	–	–	–	–	–	–	–	–
	SR1–036	Abra de Ilog R.	silicified shale	0.0	0.8	0.00	–	–	–	–	–	3.99	–	–	–	2.35	–	–	–	–	–	–	–	–
	SR1–046	Matabong R.	Mal. stained amphibolite	0.0	1.6	0.13	–	–	–	–	–	7.13	–	–	–	0.22	–	–	–	–	–	–	–	–
	FR1–114	Binaybay R.	Qz-vein	0.0	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	FR1–115	do	do	0.0	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	FR1–116	do	do	0.0	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	FR2–078	do	do (float)	0.0	0.3	0.00	0.00	0.01	–	–	–	1.92	–	–	–	0.23	–	–	–	–	–	–	–	–
	FR2–079	do	Cp-Py network (do)	0.0	0.8	0.26	0.00	0.00	–	–	–	5.99	–	–	–	9.86	–	–	–	–	–	–	–	–
	WR1–142	Acliang & Pajo Dep.	Cp-Po vein	0.0	2.2	0.69	–	–	–	–	–	37.70	–	–	–	29.81	–	–	–	–	–	–	–	–
	WR1–183	San Andres Dep.	Cp-Py vein	0.0	1.3	0.37	–	–	–	–	–	7.63	–	–	–	1.81	–	–	–	–	–	–	–	–
	WR1–185	do	do	0.0	0.9	0.15	–	–	–	–	–	18.52	–	–	–	6.66	–	–	–	–	–	–	–	–
	FR2–024	Sibakay R.	massive Py ore (float)	0.00	4.2	1.41	0.01	1.05	–	–	–	39.18	–	–	–	39.68	–	–	–	–	–	–	–	–
	TR2–044	Amnay R.	massive Py ore (do)	0.00	12.9	0.42	0.12	0.81	–	–	–	44.36	–	–	–	44.70	–	–	–	–	–	–	–	–
	TR2–152	Dulangan R.	Cp-Py vein (do)	0.02	0.3	0.06	0.00	0.02	–	–	–	2.83	–	–	–	1.41	–	–	–	–	–	–	–	–
	TR2–157	do	Py-Qz vein (do)	0.02	0.1	0.00	0.00	0.00	–	–	–	1.20	–	–	–	1.45	–	–	–	–	–	–	–	–
	WR1–018	Taoga Dep.	chloritized sandstone	0.2	1.3	0.00	–	–	–	–	–	8.95	–	–	–	10.84	–	–	–	–	–	–	–	–
	WR1–021	do	argillized sandstone	1.5	2.5	0.00	–	–	–	–	–	10.55	–	–	–	10.54	–	–	–	–	–	–	–	–
	WR1–052	Bugsanga R.	Py-Cp vein	0.4	1.5	0.00	–	–	–	–	–	6.63	–	–	–	7.87	–	–	–	–	–	–	–	–
	WR1–130	Siange R.	Py-Qz vein	2.9	3.4	0.00	–	–	–	–	–	21.26	–	–	–	19.90	–	–	–	–	–	–	–	–
	SR2–127	Masnon Dep.	Cp-Po-Py vein	2.42	1.8	2.77	0.00	0.03	–	–	–	46.73	–	–	–	34.50	–	–	–	–	–	–	–	–
	FR3–030	do	do	tr	tr	0.45	0.10	0.20	–	–	–	40.86	–	–	–	23.61	–	–	–	–	–	–	–	–
	FR3–031	do	do	14.80	5.3	2.38	0.14	0.20	–	–	–	48.88	–	–	–	31.72	–	–	–	–	–	–	–	–
	FR3–032	do	do	3.70	1.6	2.05	0.13	0.20	–	–	–	46.69	–	–	–	29.34	–	–	–	–	–	–	–	–
	SR2–133	Manamburao Dep.	Cp-Py-Bo-He vein	0.11	4.7	2.12	0.01	0.05	–	–	–	19.59	–	–	–	20.04	–	–	–	–	–	–	–	–
	SR2–136	do	Cp-Py-Qz vein	0.90	1.9	2.21	0.00	0.15	–	–	–	14.58	–	–	–	9.24	–	–	–	–	–	–	–	–
	SR2–149	Shawood Dep.	Cp vein	5.47	3.0	15.33	0.00	0.12	–	–	–	24.17	–	–	–	19.55	–	–	–	–	–	–	–	–
	FR3–025	do	Cp-Po vein	8.33	4.5	11.93	0.16	0.20	–	–	–	21.99	–	–	–	15.24	–	–	–	–	–	–	–	–
	FR3–026	do	do	1.90	1.2	0.28	0.17	0.20	–	–	–	37.65	–	–	–	18.91	–	–	–	–	–	–	–	–
	FR3–034	do	do	tr	tr	2.49	0.10	0.20	–	–	–	11.67	–	–	–	4.74	–	–	–	–	–	–	–	–
	FR3–035	do	do	tr	tr	11.95	0.23	0.61	–	–	–	22.76	–	–	–	15.47	–	–	–	–	–	–	–	–
	FR3–023	Mayu R.	Py dissemination	tr	tr	0.36	0.12	0.20	–	–	–	22.37	–	–	–	15.42	–	–	–	–	–	–	–	–
	FR3–024	do	do	1.10	5.6	1.01	0.10	0.30	–	–	–	10.94	–	–	–	12.42	–	–	–	–	–	–	–	–
	SR2–165	Aglubang R.	massive Py ore (float)	0.44	20.7	0.40	0.71	8.52	–	–	–	28.27	–	–	–	37.63	–	–	–	–	–	–	–	–
	FR3–033	do	do	0.67	4.9	0.42	0.12	0.20	–	–	–	48.64	–	–	–	25.16	–	–	–	–	–	–	–	–

	Sample No.	Location	Occurrence	Au g/T	Ag g/t	Cu %	Pb %	Zn %	Cr_2O_3 %	Ni %	Co ppm	Fe %	SiO_2 %	Al_2O_3 %	MgO %	S %	P %	Ca %	Ba %	Na %	K %	As %	TiO_2 %	V ppm
Chrome Ore	FR1–007	Paluan Dep.	massive Cr ore (stockpile)	–	–	–	–	–	44.88	0.07	–	4.59	–	4.16	10.68	–	–	–	–	–	–	–	–	–
	FR1–008	do	peridotite	–	–	–	–	–	0.03	0.02	–	0.44	–	12.37	16.00	–	–	–	–	–	–	–	–	–
	KR2–069a	Mariri Dep.	massive Cr ore (stockpile)	–	–	–	–	–	50.50	0.02	4	10.14	4.48	6.69	4.38	–	–	–	–	–	–	–	–	–
	KR2–069b	do	do (do)	–	–	–	–	–	45.82	0.02	5	10.86	5.74	5.57	5.07	–	–	–	–	–	–	–	–	–
	KR2–070	do	do (float)	–	–	–	–	–	48.93	0.02	8	10.00	1.22	6.75	2.88	–	–	–	–	–	–	–	–	–
	YR2–037a	do	do	–	–	–	–	–	40.31	0.06	20	10.00	8.44	6.65	6.45	–	–	–	–	–	–	–	–	–
	KR2–060	Igsoso Dep.	banded Cr ore	–	–	–	–	–	34.14	0.08	26	8.57	13.14	5.88	14.14	–	–	–	–	–	–	–	–	–
	KR2–062	do	do	–	–	–	–	–	38.85	0.16	21	10.14	13.92	4.29	10.89	–	–	–	–	–	–	–	–	–
	KR2–065	do	massive Cr ore (stockpile)	–	–	–	–	–	43.00	0.07	28	11.29	3.66	9.66	5.99	–	–	–	–	–	–	–	–	–
	KR2–055a	Liwliw Dep.	do (do)	–	–	–	–	–	40.31	0.04	17	9.00	5.72	10.68	6.78	–	–	–	–	–	–	–	–	–
	KR2–055b	do	do (do)	–	–	–	–	–	36.50	0.03	13	7.86	7.78	9.39	9.37	–	–	–	–	–	–	–	–	–
	KR2–072	San Vicente Dep.	disseminated Cr ore (float)	–	–	–	–	–	5.23	0.36	164	10.29	34.14	1.38	31.45	–	–	–	–	–	–	–	–	–
	TR2–060	do	massive Cr ore	–	–	–	–	–	29.11	0.08	70	10.14	2.38	19.99	8.59	–	–	–	–	–	–	–	–	–
	YR1–030	Sibacoi R.	do	–	–	–	–	–	49.52	0.07	–	3.14	2.39	–	6.93	–	–	–	–	–	–	–	–	–
	KR2–050a	Pintin Dep.	do (float)	–	–	–	–	–	50.03	0.09	19	14.57	4.00	5.35	4.63	–	–	–	–	–	–	–	–	–
	KR2–050b	do	do (do)	–	–	–	–	–	53.55	0.07	16	15.29	2.24	4.69	2.42	–	–	–	–	–	–	–	–	–
	SR2–042	Paragpagan Dep.	laterite	–	–	–	–	–	1.87	0.69	422	22.43	9.46	3.38	10.79	–	–	–	–	–	–	–	–	–
	SR2–044	do	do	–	–	–	–	–	2.66	0.92	1,418	45.43	2.28	2.44	0.73	–	–	–	–	–	–	–	–	–
	FR3–013	Pintin Dep.	massive Cr ore	–	–	–	–	–	51.40	0.22	264	17.69	2.96	8.74	11.64	–	–	–	–	–	–	–	–	–
	KR3–005	do	do	–	–	–	–	–	33.18	0.16	207	9.86	6.78	26.06	18.74	–	–	–	–	–	–	–	–	–
	KR3–006	do	do	–	–	–	–	–	30.30	0.12	144	9.14	9.02	24.79	18.98	–	–	–	–	–	–	–	–	–
	KR3–007	do	do	–	–	–	–	–	56.10	0.25	3.00	11.88	6.34	8.76	13.64	–	–	–	–	–	–	–	–	–
	KR3–011a	do	do	–	–	–	–	–	48.94	0.17	274	13.81	6.76	12.38	12.44	–	–	–	–	–	–	–	–	–
	KR3–011b	do	do	–	–	–	–	–	47.62	0.25	314	19.33	8.65	7.76	9.08	–	–	–	–	–	–	–	–	–
	KR3–013	do (Tr, No.1)	do	–	–	–	–	–	39.81	0.32	336	26.63	10.91	6.28	6.97	–	–	–	–	–	–	–	–	–
	KR3–014	do (Tr, No.2)	do	–	–	–	–	–	40.19	0.23	230	14.89	11.26	11.63	14.49	–	–	–	–	–	–	–	–	–
	KR3–019a	do (Tr, No.1)	do	–	–	–	–	–	38.93	0.19	272	19.13	12.96	9.35	13.30	–	–	–	–	–	–	–	–	–
	KR3–019b	do (do)	do	–	–	–	–	–	38.14	0.14	240	15.05	18.00	10.62	15.84	–	–	–	–	–	–	–	–	–
	KR3–020	do (do)	do	–	–	–	–	–	41.30	0.31	323	26.89	5.46	6.68	6.77	–	–	–	–	–	–	–	–	–
	KR3–023	do (Tr, No.2)	do	–	–	–	–	–	39.92	0.16	254	14.80	10.11	12.63	15.41	–	–	–	–	–	–	–	–	–
	SR1–039	Amnay R.	peridotite	–	–	–	–	–	0.38	0.22	–	5.43	–	0.83	43.44	–	–	–	–	–	–	–	–	–
	SR1–060	do	do	–	–	–	–	–	0.38	0.21	–	5.43	–	1.31	38.40	–	–	–	–	–	–	–	–	–
	WR1–160	Aglubang Dep.	nikeliferous laterite	–	–	–	–	–	3.87	0.46	–	28.70	–	7.30	3.56	–	–	–	–	–	–	–	–	–
	KR2–105a	Ogos Dep.	disseminated Cr ore	–	–	–	–	–	29.99	0.10	68	14.14	9.80	7.75	14.32	–	–	–	–	–	–	–	–	–
	KR2–105b	do	dense spotted Cr ore	–	–	–	–	–	31.39	0.09	50	12.29	9.12	7.80	13.83	–	–	–	–	–	–	–	–	–

	Sample No.	Location	Occurrence	Au g/T	Ag g/T	Cu %	Pb %	Zn %	Cr_2O_3 %	Ni %	Co ppm	Fe %	SiO_2 %	Al_2O_3 %	MgO %	S %	P %	Ca %	Ba %	Na %	K %	As %	TiO_2 %	V ppm
Chrome Ore	KR2–105c	Ogos Dep.	weathered sandy Cr ore	–	–	–	–	–	28.28	0.07	26	10.86	6.22	7.55	11.82	–	–	–	–	–	–	–	–	–
	KR2–106	do	do	–	–	–	–	–	37.05	0.04	24	13.29	5.58	9.09	6.20	–	–	–	–	–	–	–	–	–
	FR3–015	do	massive Cr ore	–	–	–	–	–	45.82	0.20	265	14.00	6.61	9.49	15.17	–	–	–	–	–	–	–	–	–
	GR3–105	do	disseminated Cr ore	–	–	–	–	–	6.19	0.30	254	11.57	35.58	1.29	34.42	–	–	–	–	–	–	–	–	–
	KR3–051a	do	massive Cr ore	–	–	–	–	–	39.57	0.21	194	11.02	9.97	14.44	21.12	–	–	–	–	–	–	–	–	–
	KR3–051b	do	do	–	–	–	–	–	44.11	0.14	243	9.79	10.89	10.06	18.06	–	–	–	–	–	–	–	–	–
	KR3–052	do	do	–	–	–	–	–	35.23	0.15	575	29.34	5.89	9.97	6.29	–	–	–	–	–	–	–	–	–
	KR3–053	do (Tr.)	do	–	–	–	–	–	33.71	0.13	191	12.35	17.54	9.47	21.63	–	–	–	–	–	–	–	–	–
	KR3–054	do (do)	do	–	–	–	–	–	30.16	0.11	143	11.30	14.65	15.23	22.64	–	–	–	–	–	–	–	–	–
	KR3–055	do (do)	do	–	–	–	–	–	18.19	0.16	152	8.85	27.44	11.10	28.47	–	–	–	–	–	–	–	–	–
	KR3–056	do (do)	do	–	–	–	–	–	23.25	0.16	160	9.77	22.57	12.43	26.27	–	–	–	–	–	–	–	–	–
	KR3–058	do (do)	do	–	–	–	–	–	29.85	0.13	173	11.21	14.89	16.88	21.95	–	–	–	–	–	–	–	–	–
	KR3–059	do (do)	do	–	–	–	–	–	37.36	0.11	196	13.51	8.13	18.15	15.09	–	–	–	–	–	–	–	–	–
	KR3–060	do (do)	do	–	–	–	–	–	27.05	0.13	173	12.69	13.25	14.80	23.05	–	–	–	–	–	–	–	–	–
	KR3–064	do (do)	do	–	–	–	–	–	30.64	0.10	160	11.79	12.45	18.39	19.05	–	–	–	–	–	–	–	–	–
	YR3–150	do (Siyabu)	do	–	–	–	–	–	37.20	0.07	192	10.80	11.81	11.97	20.89	–	–	–	–	–	–	–	–	–
	TR2–130a	Bongabong (Banus)	do	–	–	–	–	–	34.50	0.05	46	12.43	11.80	6.42	19.56	–	–	–	–	–	–	–	–	–
	TR2–130b	do (do)	do	–	–	–	–	–	27.08	0.13	23	8.71	19.08	3.97	31.63	–	–	–	–	–	–	–	–	–
	YR3–114	do	do	–	–	–	–	–	42.02	0.10	184	11.65	8.02	10.09	19.79	–	–	–	–	–	–	–	–	–
	YR3–116	do	do	–	–	–	–	–	46.12	0.08	203	11.65	6.77	10.76	18.43	–	–	–	–	–	–	–	–	–
	YR3–120	do (Banus)	do	–	–	–	–	–	37.97	0.11	186	10.98	10.73	10.90	21.02	–	–	–	–	–	–	–	–	–
	YR3–121	do (do)	do	–	–	–	–	–	46.11	0.10	187	11.88	4.86	12.69	17.15	–	–	–	–	–	–	–	–	–
	YR3–122	do (do)	do	–	–	–	–	–	41.44	0.07	270	18.90	10.11	8.89	17.36	–	–	–	–	–	–	–	–	–
	YR3–123	do (do)	do	–	–	–	–	–	43.50	0.12	192	11.47	8.70	10.77	18.48	–	–	–	–	–	–	–	–	–
	YR3–135	do (Masba)	do	–	–	–	–	–	44.98	0.09	186	11.59	8.58	9.79	19.24	–	–	–	–	–	–	–	–	–
	YR3–140	do (do)	do	–	–	–	–	–	41.85	0.10	171	12.17	6.18	15.65	16.85	–	–	–	–	–	–	–	–	–
	YR3–142	do (do)	do	–	–	–	–	–	41.47	0.12	188	9.86	8.11	13.64	19.47	–	–	–	–	–	–	–	–	–
	YR3–161	do (Banus)	do	–	–	–	–	–	41.23	0.09	171	10.08	9.11	12.85	19.73	–	–	–	–	–	–	–	–	–
	YR3–165	do (do)	do	–	–	–	–	–	36.05	0.10	182	10.70	12.63	12.40	17.71	–	–	–	–	–	–	–	–	–
	YR3–166	do (do)	do	–	–	–	–	–	43.43	0.10	193	11.73	7.06	13.40	16.80	–	–	–	–	–	–	–	–	–
	YR3–167	do (do)	do	–	–	–	–	–	45.43	0.08	189	12.01	4.87	13.00	16.27	–	–	–	–	–	–	–	–	–
Iron Ore	FR2–036	Nagsabangan Dep.	massive Mt ore	–	–	–	–	–	–	–	–	61.36	0.98	0.30	–	0.07	0.023	–	–	–	–	0.011	0.011	–
	FR2–037	do	do	–	–	–	–	–	–	–	–	60.82	0.80	0.30	–	0.03	0.019	–	–	–	–	0.014	0.017	–
	KR3–028a	do	do	–	–	0.006	–	–	–	–	–	67.32	–	–	–	–	0.011	–	–	–	–	–	0.007	12
	KR3–028b	do	do	–	–	0.003	–	–	–	–	–	56.42	–	–	–	–	0.043	–	–	–	–	–	0.079	106

	Sample No.	Location	Occurrence	Au g/T	Ag g/T	Cu %	Pb %	Zn %	Cr_2O_3 %	Ni %	Co ppm	Fe %	SiO_2 %	Al_2O_3 %	MgO %	S %	P %	Ca %	Ba %	Na %	K %	As %	TiO_2 %	V ppm
Iron Ore	KR3–028c	Nagsabongan	massive Mt ore	–	–	0.044	–	–	–	–	–	69.46	–	–	–	–	0.006	–	–	–	–	–	0.012	11
	YR3–054	do	do	–	–	0.036	–	–	–	–	–	64.56	–	–	–	–	0.026	–	–	–	–	–	0.008	23
	YR3–064	do	do	–	–	0.011	–	–	–	–	–	69.92	–	–	–	–	0.017	–	–	–	–	–	0.020	28
	FR2–039	Tiraca Dep.	do	–	–	–	–	–	–	–	–	59.73	0.22	0.21	–	0.05	0.013	–	–	–	–	0.024	0.009	–
	FR2–041	Ak. Ak Dep.	do	–	–	–	–	–	–	–	–	51.55	6.18	0.23	–	0.26	0.032	–	–	–	–	0.003	0.028	–
	FR1–031	Lasala Dep.	massive He ore	–	–	–	–	–	–	–	–	54.13	2.44	0.25	–	0.20	0.000	–	–	–	–	0.021	0.024	–
	TR2–090	do	banded Mt-He-Qz ore	–	–	–	–	–	–	–	–	28.23	53.60	0.36	–	0.52	0.025	–	–	–	–	0.002	0.004	–
	TR2–093	do	massive Mt-Qz ore	–	–	–	–	–	–	–	–	49.09	19.88	0.25	–	0.02	0.055	–	–	–	–	–	–	–
	GR3–028	do	massive Mt ore	–	–	0.005	–	–	–	–	–	68.49	–	–	–	–	0.011	–	–	–	–	–	0.046	156
	GR3–030	do	do	–	–	0.198	–	–	–	–	–	54.87	–	–	–	–	0.125	–	–	–	–	–	0.052	47
	GR3–031	do	do	–	–	0.008	–	–	–	–	–	63.04	–	–	–	–	0.014	–	–	–	–	–	0.030	148
	YR3–040a	do	do	–	–	0.027	–	–	–	–	–	59.96	–	–	–	–	0.014	–	–	–	–	–	0.014	81
	YR3–040b	do	do	–	–	0.029	–	–	–	–	–	62.30	–	–	–	–	0.014	–	–	–	–	–	0.011	80
	YR3–041	do	do	–	–	0.006	–	–	–	–	–	57.90	–	–	–	–	0.030	–	–	–	–	–	0.010	51
	TR2–096	Lapa-ao Dep.	do	–	–	–	–	–	–	–	–	52.77	3.30	0.30	–	0.02	0.017	–	–	–	–	0.001	0.007	–
	TR2–097	do	do	–	–	–	–	–	–	–	–	54.00	6.10	0.40	–	0.35	0.076	–	–	–	–	0.000	0.011	–
	KR3–032a	do	do	–	–	0.024	–	–	–	–	–	55.41	–	–	–	–	0.007	–	–	–	–	–	0.005	22
	KR3–032b	do	do	–	–	0.003	–	–	–	–	–	63.85	–	–	–	–	0.004	–	–	–	–	–	0.010	71
	KR3–032c	do	do	–	–	0.003	–	–	–	–	–	60.24	–	–	–	–	0.007	–	–	–	–	–	0.010	71
	YR3–042a	do	Mt-skarn ore	–	–	0.024	–	–	–	–	–	30.74	–	–	–	–	0.018	–	–	–	–	–	0.017	70
	YR3–042b	do	do	–	–	0.024	–	–	–	–	–	33.11	–	–	–	–	0.024	–	–	–	–	–	0.016	73
	YR3–043	do	massive Mt ore	–	–	0.004	–	–	–	–	–	69.30	–	–	–	–	0.006	–	–	–	–	–	0.008	71
	TR2–109	Cobanga-on Dep.	do	–	–	–	–	–	–	–	–	55.36	7.72	1.02	–	0.02	0.060	–	–	–	–	0.000	0.028	–
	FR1–045	Dayap Dep.	do	–	–	–	–	–	–	–	–	50.48	14.06	0.81	–	0.24	0.000	–	–	–	–	–	–	–
	FR3–005	do	do	–	–	0.021	–	–	–	–	–	56.73	–	–	–	–	0.002	–	–	–	–	–	0.046	83
	FR3–006	do	do	–	–	0.022	–	–	–	–	–	70.43	–	–	–	–	0.013	–	–	–	–	–	0.016	33
	FR3–007	do	do	–	–	0.009	–	–	–	–	–	65.37	–	–	–	–	0.003	–	–	–	–	–	0.012	32
Others	SR1–091	San Teodoro	limonitized schist	–	–	–	–	–	–	0.14	–	4.05	–	–	–	0.15	–	–	–	–	–	–	–	–
	WR1–017	Mansalay	silica sand (stockpile)	–	–	–	–	–	–	–	–	0.45	82.40	5.05	–	–	–	–	–	0.35	2.54	–	–	–
	WR1–022	Taoga Dep	barite vein	–	–	–	–	–	–	–	–	0.12	2.55	0.00	–	–	–	0.01	49.30	–	–	–	–	–

Abbreviation : Cp: chalcopyrite, Mal: Malachite, Po: Pyrrhotite, Py: Pyrite, Cr: Chromite, Mt: Magnetite, He: Hematite, Qz: Quartz

Table A—7 Result of Chemical Analysis of Coal

Sample No.	Location	Occurrence	Moisture (%)	Volatile matter (%)	Fixed Carbon (%)	Ash (%)	Moisture & Ash Free		B.T.U/ℓb	
							Volatile matter (%)	Fixed Carbon (%)	As a whole	Moisture & Ash Fee
HR1 – 204	Alitaytayan	coal seam of the Sablayan G.	18.0	39.4	36.0	6.6	52.3	47.7	9,452	12,624
FR2 – 045	Tambargan	do	18.7	37.7	32.3	11.3	53.9	46.1	7,684	11,120
FR2 – 046	Siay Creek	do	16.6	34.9	29.2	19.3	54.4	45.6	7,161	11,447
FR2 – 047	do	do	14.2	40.3	29.4	16.1	57.8	42.2	8,766	12,814
SR2 – 086	Napisian	do	11.1	32.9	28.6	27.4	53.5	46.5	6,872	11,587
SR2 – 098	do	do	15.2	40.5	33.4	10.9	54.8	45.2	8,911	12,201
SR2 – 099	do	do	13.5	43.4	36.8	6.3	54.1	45.9	10,083	12,652