CHAPTER 4 GEOCHEMISTRY AND MINERAL POTENTIAL

During the course of this project, a total of 43,459 stream sediment samples were collected from the project areas and they were chemically analysed for the following ten elements; Cu, Pb, Zn, Ag, As, Mn, Ni, Co, Mo and Hg; also where warranted, Cr, Sb, Sn and W were analysed additionally.

The following methods were used for the statistical processing of the geochemical data. Areas appropriate for geologic and geochemical consideration were selected and analytical data of the samples from each of these areas were processed as a single population. The entire survey area was divided into 2 km × 2 km (N-S and E-W) cells with pre-selected datum points. Univariate analysis of cell average values, moving average values and high-pass filter values were carried out and multivariate (factor) analysis was also employed in order to identify the association among anomalous elements. The extracted anomalies were subjected to geological scrutiny with regard to possible mineralization.

In addition to the above, 2,367 samples were panned for heavy minerals and the concentrates were analysed for Au, Ag and Ga. In cases where deemed necessary, modal mineral analysis of the concentrates were carried out.

4.1 The Philippine Arc

4.1.1 Northern Sierra Madre Region

The analysis of the processed geochemical data covering the Northern Sierra Madre area revealed a number of prominent anomalies that could be related to possible mineralization (Table 14, Pls. I-1, II-1). Of the seven anomalous areas identified, three areas appear to be most promising: Area I, Dimakawal area in the southernmost part of the region; and Area II, Port Bicobian area in the central east coast; and Area III, Tuguegarao River area in the northern part of the region.

Table 14 Geochemical Anomalous Areas in Northern Sierra Madre Region

No.	Anomalous Areas	Location	Cell Average										High-pass Filter										Factor Analysis				
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr	No. 1	No. 2	No. 3	No. 4	No. 5
I	Vicinity of Dimakawal mineral showing (Southeastern edge of the area)	122°13' E 16°35' N	○	○	○			○			○		○	○	○		○	○			○			○	○	○	○
II	West side of Port Bicobian (The central east coast)	122°24' E 17°16' N	○					○	○	○	○	○							○	○	○			○		○	
1	North side of Capisayan (Northern part of the area)	121°54' E 18°02' N	○		○			○					○		○			○						○			
2	West side of Awang Cove (The east coast)	122°06' E 17°41' N		○					○					○				○	○					○		○	
3	Upstream Tuguegarao River	122°00' E 17°37' N	○		○		○							○	○		○							○	○	○	
4	South side of Divilacan Bay (The central east coast)	122°18' E 17°16' N	○		○			○	○	○	○	○	○		○			○	○	○	○			○			○
5	West side of Dimatatno Point (The southern east coast)	122°18' E 16°35' N							○	○	○	○							○	○			○		○		

○: Elements with anomalous values
Roman numerals (I~II) indicate promising areas Arabic numerals (1~5) indicate anomalous areas

Area I is characterized by Cu-Pb-Zn-Mn-Hg anomaly in the cell average data and by Cu-Pb-Zn-As-Mn-Hg anomaly after high-pass filter processing was performed. The association is indicative of vein type mineralization possibly dominated by Cu with associated Pb and Zn. The area is underlain mainly by basalt and volcanic derived sedimentary units of the Abuan and Dipadian Formations. Its proximity to a known Cu-Mn mineralization (Dimakawal deposit) further enhances its prospectivity as a possible base metal deposit. Results of the heavy mineral geochemical survey also indicated anomalous values in terms of Au and Ag.

In Area II, Cu-Mn-Ni-Co-Hg-Cr anomaly was encountered. This area, including Port Bicobian, is underlain by units of the Isabela Ultramafic Complex, Bicobian Basalt and Dikinamaran Chert. The rock assemblage favors the occurrence of cyprus-type massive sulfide deposit, bedded manganese, nickel sulfide-nickel laterite and orthomagmatic chromite as well as placer chromite concentration. The Cu, Hg and Mn anomalies are all within the basalt and possibly indicate Cu-Mn mineralization similar to that of the Bicobian and Lacson deposits (refer to section 3.1.1.4). The Ni-Co-Cr association is typical of ultramafic terranes. They may, however, also indicate chromite and nickel sulfide mineralization in the area comparable to deposits found in Wasayan, Dibenelang, Dikapisan and Disukad (section 3.1.1.4).

The anomalies identified in Area III (upstream of Tuguegarao River) include Cu, Pb, Zn and As and might indicate either a vein-type base metal or porphyry copper mineralization. The lithologic units underlying the area consist of andesite (Abuan Formation), dacite (Mt. Cresta Formation), and diorite/granodiorite (Northern Sierra Madre Batholith). The anomalies could well be associated with the observed chloritization and seritization accompanying pyrite impregnation along the intrusive contact of the diorite with the andesite. The alterations could also indicate possible mineralization at the deeper levels of the intrusion. Mineralization of the porphyry copper type are found in Casablangan and Dinacdacan and these are similarly hosted by dacite flows of the Mt. Cresta Formation.

Factor analysis carried out on the geochemical data of the Northern Sierra Madre region resulted in the identification of five factors showing close inter-element associations. These five factors account for roughly 83.2 percent of the total variance in the data. Factor 1 is a Co-Ni-Cr association and is considered a lithology factor (reflects lithologic type) indicating ultramafic rocks. High values or scores for this factor are observed in areas dominated by mafic-ultramafic sequences of the Isabela Ultramafic Complex. Anomalous zones for this factor correspond almost exclusively to the aforesaid rock type.

Factor 2 is a Cu-Zn-Mn factor possibly indicating base metal mineralization (vein type and massive sulphide mineralization) associated with basaltic to andesitic rock units. Anomalous areas identified for this factor cover mainly areas underlain by units of the Abuan Formation. The Dimakawal area (Area I), Bicobian (Area II) and the upstream part of Tuguegarao River (Area III) are all found anomalous in terms of Factor 2.

Factor 3 is a Pb-Hg factor which indicates possible vein-type or porphyry copper mineralization. High values for the factor are found mainly along areas of the Northern Sierra Madre Batholith and the Abuan Formation. Areas I and III are again tagged anomalous for the factor. This supports the contention of its being an indicator for these types of deposits.

Factor 4 is essentially a molybdenum (Mo) factor. Although typically indicative of porphyry Cu/Mo type of mineralization, anomalous zones were also defined along the entire length of the Isabela Ultramafic Complex. The most prominent anomalies, however, are found within the intrusive contact zone of the batholith and the Abuan/Mt. Cresta Formations. Areas II and III are both anomalous for this factor and most likely reflect their base metal affinity.

Factor 5 is again a single element factor dominated by arsenic (As). Arsenic is an element associated with many types of deposits especially vein-type gold and base metal mineralization and porphyry copper deposits. Anomalous zones defined for the factor include Areas I and III and could possibly have arisen from base metal mineralization in these areas. Other anomalous zones fall within areas of calcareous rocks (Cabagan Formation, Callao and Kanaipang Limestone). These are not reflective of mineralization and are most likely due to preferential enrichment of the As in the rock units.

In terms of mineral potentials, the NSM region is highly prospective for vein-type, cyprus-type massive sulphide, porphyry copper/molybdenum, bedded manganese, nickel and cobalt and chromite mineralizations. This is indicated by the favourability of the lithologic host rocks to these types of mineralization and results of the geochemical survey carried out in the region. The three areas earlier delineated as anomalous based on the survey are considered most promising and prospective for the discovery of mineral deposits and consequently warrant further detailed exploratory work. The existence of deposits proximal to these anomalous zones and the similarities in their geological attributes further enhance the favorability of each site for additional exploration work.

4.1.2 Southern Sierra Madre and Polillo

Analysis of the stream sediment geochemical data and geology of the Southern Sierra Madre and Polillo Region (SSM) resulted in the identification of seven anomalous areas of which four were considered promising (Table 15). The four promising

anomalous areas include: Area Ⅰ, middle reaches of the Umiray River; Area Ⅱ, northeastern portion of Montalban, Rizal; Area Ⅲ, southeastern part of Polillo Island; and Area Ⅳ, western side of Tignoan (Pls. Ⅰ-1, Ⅱ-2).

Table 15 Geochemical Anomalous Areas in Southern Sierra Madre Region

No.	Anomalous Areas	Location	Cell Average										High-pass Filter										Factor Analysis				
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	No. 1	No. 2	No. 3	No. 3	No. 5
Ⅰ	Middle reaches of Umiray River	121°21'E 15°00'N	○		○		○	○					○		○		○	○	○	○			Post ○	Post ○	Pre ○	Post ○	Pre ○
Ⅱ	Northwest of Montalban	121°12'E 14°46'N	○		○		○		○	○				○	○					○			○	○	○	○	○
Ⅲ	Southeastern part of Polillo	121°59'E 14°47'N		○							○		○	○			○				○	○		○			○
1	Upper reaches of Umiray River	121°22'E 14°51'N	○	○	○	○	○	○		○	○		○	○	○	○	○	○		○	○		○	○	○	○	○
2	Vicinity of Santa Ines.	121°19'E 14°44'N					○		○								○	○	○		○				○	○	○
3	West of Tignoan	121°33'E 14°35'N	○					○		○		○	○					○					○	○	○	○	○
4	Southeast of Burdeos	121°57'E 14°50'N	○		○				○								○			○			○	○	○	○	○

○: Elements with anomalous values

Pre : Before rotation Factor for Factor Analysis Post : After rotation Factor for Factor Analysis

Roman numerals (Ⅰ~Ⅲ) indicate promising areas Arabic numerals (1~4) indicate anomalous areas

Area Ⅰ is underlain mainly by the Bayabas Formation consisting of basaltic to andesitic flows, agglomerate and tuff, and intercalated sedimentary rocks. It is characterized by multi-element anomaly dominated by Cu, Pb, Zn, Ag, As, Mn, Co and Mo. The complex association possibly reflect vein-type and porphyry copper mineralization as well as the underlying rock units. The proximity of the area to a known gold-bearing quartz vein deposit (Marcopper Matani) and a porphyry copper deposit (Lumbay Colossal) further support this contention. The Cu-Mo anomaly could be due to the porphyry copper system. The Pb-Zn-Ag-As anomaly could be related to the gold-bearing quartz vein system. The Mn-Co association, on the other hand, could be reflective of the basaltic host rock of the mineralization.

Area Ⅱ lies in an area of Cretaceous pillow and massive basalts, red chert, siliceous mudstone/shale, and basaltic sedimentary rocks of the Barenas-Baito Formation. Anomalous values for Cu, Pb, Zn, As, Ni, and Co were identified in this area in both

the cell average as well as high pass filter data. The element association is indicative of kuroko-type massive sulphide mineralization similar to that found in Puray which is also hosted by basalt and dacite of the Barenas-Baito Formation (see section 3.1.2.4). The anomaly could, therefore, represent possible mineralization in the area and was consequently tagged as promising.

Area III lies in the southern part of Polillo Island (Pl. II-2) and is underlain predominantly by diorite/granodiorite of the Polillo Intrusives. It occurs within alteration zones of the diorite and was classified anomalous in terms of Cu, Pb, As and Mo. This indicates a possible porphyry copper mineralization but considering the nature of mineralization in the area, (Marcopper Polillo; section 3.1.2.4) it could be more of a porphyry molybdenum type. The presence of sulphide dissemination, within argillized sections of the diorite further enhances the prospectivity of the area for this type of deposit.

The anomaly encountered in Area IV consists of the association Cu-Mn-Co-Hg. This occurs within an area of agglomerate, volcanic breccia, volcanic flows and tuff with intercalated sedimentary rocks of the Tignoan Formation. The area was also considered anomalous in terms of gold (Au) and silver (Ag) in the panned concentrate samples. Both anomalies could be due to the gold and sulphide-bearing quartz veins observed cutting across the Bayabas and Tignoan formation. In most cases, the quartz veins were found to contain significant amounts of copper and silver with variable gold tenors. Gold panning activities in various areas of the SSM region (Angelo, Papaya, Umiray and Boso-Boso Rivers) may have these veins as likely sources.

Factor analysis carried out on the stream sediment geochemical data resulted in the identification of four factors on which further synthesis were carried out. On the basis of the factor scores calculated for each sample, anomalous areas were identified for each factor.

In terms of Factor 1, Areas I , II and IV were classified as anomalous. This factor is characterized by the Cu-Zn-Mn-Co association and most likely reflects base metal mineralization. As discussed earlier, all three areas are favorable for this type of mineralization.

Factor 2 is a Pb-Ag factor which could be associated with precious and base metal vein deposits. All four areas were found anomalous for this factor. Vein-type

mineralization is most prominent in Area I and IV and less conspicuous in the other two areas. Their significance in the latter, however, can not be discounted at this stage.

The third factor is a Ni-Co factor. This combination is commonly associated with mafic-ultramafic rocks. The anomalies delineated for this factor in Areas I, II and IV are, therefore, most likely due to the basalts and related units underlying these areas.

Factor IV is essentially an arsenic (As) factor but its relationship to any type of mineralization is uncertain at the present time.

The Southern Sierra Madre region including Polillo Island holds significant potential for future discovery of gold and base metal deposits. The distinctive lithologic character of the region as well as its unique geologic/tectonic setting makes it a reasonable target for porphyry Cu/Mo deposits; vein-type precious and base metal deposits; kuroko-type massive sulphide deposits; and placer Au-Ag deposits. The type and number of geochemical anomalies identified as well as mineral showings/deposits encountered during the survey all point to the prospectivity of the region for these types of mineralization. While there are no major metallic mineral producer in the region at the present time, the above areas warrant further detailed exploration activities.

Small-scale mining activities for gold are presently conducted in many parts of the region (section 3.1.2.4). The amount of gold recovered or being recovered at the moment and the extent and nature of the source has not been established to date. A more systematic study is needed to define these parameters. A good potential, however, is believed to exist for the region of becoming an important gold-producing district in the country.

4.1.3 Masbate-Central/East Panay-Guimaras Island-Southwest Negros Region

The processing and analysis of the geochemical data of Masbate, Panay and Guimaras Islands were carried out on a regional basis with the data being treated as one population. The processing of the Southwest Negros data, on the other hand, was carried out together with those of Cebu, Siquijor and Bohol Islands (JICA·MMAJ, 1990).

4.1.3.1 Masbate Island

The geochemical processing of the data resulted in the identification of six anomalies in the island (Table 16). These include the Cu-Pb-Ag-Hg anomaly on the east side of Mt. Uac; Mn-Co anomaly along the southwest peninsula (Balud, Calumpang Area); Zn-Mo anomaly along the northwest coast; As-Mo anomaly in the southeast part; Cu-As anomaly near Aroroy; and a Cu anomaly encompassing the Conical Peak area (Pls. I-2, II-3). On the basis of these geochemical indications and the geology of these anomalous sites, two important promising areas were delineated. Area I stretches from the southern part of Aroroy to west side of Masbate town covering the Conical Peak area. Area II encompasses a large portion of the central part of the island surrounding Mt. Uac.

Table 16 Geochemical Anomalous Areas in Masbate

No.	Anomalous Areas	Location	Cell Average										High-pass Filter										Factor Analysis		
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	No. 1	No. 2	No. 3
I	East of Mt. Uac	123°26'E 12°30'N	○	○		○						○	○	○		○						○	○		○
II	South of Aroroy	123°29'E 12°23'N	○	○	○		○				○		○	○	○		○						○		○
	Vicinity of Conical Peak	123°40'E 12°23'N	○	○	○		○				○		○	○			○	○				○			○
1	Vicinity of Bunducan	124°01'E 11°45'N		○	○	○	○				○	○	○	○	○		○	○		○	○		○	○	○
2	Vicinity of Mandaon	123°17'E 12°14'N				○		○		○			○					○							
3	Vicinity of Balud	123°12'E 12°02'N						○	○	○								○	○	○			○		○

○: Elements with anomalous values
Roman numerals (I~II) indicate promising areas Arabic numerals (1~3) indicate anomalous areas

The first promising area identified covers the anomalous zones delineated near Aroroy and Conical Peak. The rock units underlying the area include the Mt. Nabongsoran Andesite Porphyry, Aroroy Diorite, Lamon Formation and Sambulawan Formation. Numerous gold bearing quartz veins within silicified zones were encountered throughout the area. Mineral showings and deposits such as Aroroy Mine, Baleno, Capsay, Luya, Concepcion, Matanglad and XYZ are also found within this area. The proliferation of numerous mineral showings and deposits within Area

I and the Cu-As anomaly found therein make it highly prospective for vein-type gold and base metal mineralization.

Area II contains the Cu-Pb-Ag-Hg anomalous zone detected in the stream sediment geochemical data. It more or less coincides with the disposition of the Miocene Mobo diorite and Lamon andesite. Hydrothermal alteration (chloritization and sericitization) possibly related to mineralization associated with the activity of the Philippine Fault is distinctive in the area. Mineral showings encountered include the gold-bearing quartz veins in Umabay, Handalc, Baang, Marintoc and Dogosongan (see section 3.1.3.4b). The geochemical anomaly and the lithologic character of the area are both indicative of gold-bearing base metal vein-type mineralization characteristic of the area.

The Mn-Co anomaly in the southwest portion of the island appears to be related to Mn mineralization associated with the basalt and metamorphics. Deposits of this type (Balud, Calumpang and Taisan) are common within this area.

The other two anomalies, Zn-Mo in the northwest and As-Mo in the southeast, fall within limestone area. Their exact relationship with known mineralization is unclear and they may actually be totally unrelated to any mineralization.

Factor analysis of the data resulted in the identification of anomalous areas in terms of the three factors considered. Both Areas I and II were classified anomalous under Factors 1 and 3. Factor 1 is a Co-Zn-Mn-Cu-Ni factor possibly indicative of base metal mineralization. This is inferred to be directly related to the base metal vein-type mineralization found in both areas. Factor 3, on the other hand, is a Mo-As factor. This commonly indicates porphyry-type mineralization, but in the present case, it probably is more indicative of Au and/or base metal deposits.

4.1.3.2 Central/East Panay and Guimaras Island

Five anomalous areas were identified in this region following the analysis of the geochemical data. These include the Cu-Pb-Zn anomaly located south of Pilar; Cu-Pb-Zn-As-Mn-Co-Mo anomaly along the east coast of Panay; Mn-Co anomaly south of Iloilo Basin; Zn-As anomaly along the western coast of Guimaras; and the Pb-Mn anomaly near Roxas City in northern Panay (Table 17, Pls. I-2, II-3). Of the five anomalies delineated, the ones in Pilar (Area I) and the east coast of Panay (Area II) are considered promising.

Table 17 Geochemical Anomalous Areas in Central and East Panay and Guimaras Island

No.	Anomalous Areas	Location	Cell Average										High-pass Filter										Factor Analysis		
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	No. 1	No. 2	No. 3
I	South of Pilar	123°00'E 11°27'N	○	○	○			○					○	○	○								○		○
II	Southern part of east coast	123°05'E 11°20'N	○	○	○		○	○			○		○	○	○		○	○		○	○		○	○	○
1	Vicinity of Roxas	122°45'E 11°30'N	○					○		○				○				○					○		
2	Southern part of Iloilo Basin	122°41'E 10°41'N	○					○		○			○		○			○	○	○				○	
3	Northwestern part of Guimaras Is.	121°59'E 11°51'N									○		○					○		○	○				○

○ ; Elements with anomalous value
Roman numerals (I~II) indicate promising areas Arabic numerals (1~3) indicate anomalous areas

Area I lies in an area underlain by the Sibala Formation, Bayuso Volcanics and Yating Monzonite. Vein-type mineralization like Pari and Loay are situated within this area and the anomaly is most likely associated with a similar deposit type. The mineralization could have accompanied hydrothermal activity during or after the emplacement of the monzonite. The most interesting area should be along or adjacent to its intrusive contact with the older rock units.

Area II covers a large portion of the eastern coast stretching from San Dionisio in the north to Anilao in the south. It is underlain mainly by the Sibala Formation, Sara Diorite and Odiongan Volcanics. Mineralization found within the area include Concepcion (Cu), Dawis (Cu), Del Pilar (Cu), Sto. Tomas (Cu), Anilao (Mn) and Masonson Hill (Cu). The mineral deposits appear to be related to hydrothermal activities attendant to the intrusion of the Sara Diorite and the younger Odiongan Volcanics. Wide zones of alteration are developed within the older units and are especially conspicuous in the San Dionisio-Concepcion-Ajuy area (Map II-3). The anomalous values identified during the geochemical survey is most likely related to mineralization (base metal and gold veins or porphyry copper) associated with these altered zone.

The three other anomalies all fall within areas of sedimentary units remote from any kind of mineralization. Their significance with respect to mineralization is unclear up to the present time and as such are given low priority for follow up programmes.

In terms of factor analysis, Area I was classified anomalous under Factor 1, whereas Area II was found anomalous for Factor 3. As discussed previously, Factor I (Co-Mn-Zn-Cu-Ni) is a base metal factor most likely indicating base metal mineralization. The lithologic character of Area I clearly favors deposits of this type. Factor 3, on the other hand, is a Mo-As factor that could indicate either porphyry Cu/Mo or Au mineralization. The geology of Area II is suitable for either deposit. The anomaly is centered in and around Mt. Buraay (north of San Dionisio municipality) coinciding with an intrusive body (Odiongan Volcanics) in that area.

4.1.3.3 Southwest Negros

The geochemical analysis and interpretation of the stream sediment data of Southwest Negros resulted in identifying two anomalous areas, one of which is considered promising (Table 18, Pls. I-2, II-4). Anomaly 1 is a Cu-Pb-Zn-Co-Ni-As-Hg-Mo anomaly delineated in an area situated 15 to 20 km east of Sipalay municipality. This is considered promising Area I. It is underlain by the Pagatban Diorite, limestone and basic pyroclastic units of the Basak Formation. The multi-element character of the anomaly could be due to the complex interplay of lithologic variability and mineralization. The Cu-Pb-Zn-Hg association is indicative of base metal mineralization. The Ni-Co association could be due to the basic character of the volcanic/pyroclastic unit. The Mo-As association on the other hand could indicate porphyry copper mineralization which is fairly common in the area. A number of porphyry copper deposits are situated within the area. These include the Sipalay deposit of Maricalum Mining Corp., Calatong River I and II, and many smaller prospects. The intense alteration zones observed in the area, the favorable geology and the geochemical anomaly all point to its being a good prospect for porphyry copper type mineralization.

The second anomalous area identified is located upstream of the Bayawan River in the southern part of Southwest Negros. It is characterized by a Zn-Ni-Co-As-Hg anomaly in an area of basic pyroclastic rocks. The anomaly may still indicate base metal mineralization (vein or massive sulphides) associated with the basic pyroclastic units.

Table 18 Geochemical Anomalous Areas in Southwest Negros

No.	Anomalous Areas	Location	Cell Average									High-pass Filter								Factor Analysis				
			Cu	Pb	Zn	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	As	Mn	Ni	Co	Mo	Hg	No. 2 Post	No. 3 Pre	No. 3 Post	No. 4 Post	No. 5 Post
I	15 km southwest of Sipalay Town	122°33' E 9°40' N	○	○	○						○										○	○	○		
1	Middle reaches of Bayawan River in southern part	122°48' E 9°32' N	○	○				○	○		○				○	○		○		○	○	○	○	○	

○ ; Elements with anomalous value

Pre : Before rotation Factor for Factor Analysis

Post : After rotation Factor for Factor Analysis

Roman numeral (I) indicates promising area

Arabic numeral (1) indicates anomalous area

The multivariate analysis of the data was carried out together with the data from Cebu, Bohol and Siquijor Islands (Consolidated Report on Cebu-Bohol-Siquijor and Southwest Negros, JICA-MMAJ, 1989). This resulted in the identification of areas in Southwest Negros that are anomalous in terms of factor analysis. Area I was found anomalous for Factors 2 and 3. Factor 2 is a Pb-As-Hg factor possibly related to epithermal vein-type mineralization whereas Factor 3 is a Cu-Mo factor indicating porphyry copper mineralization. The identification of the area as being anomalous for the two factors supports the prospectivity of the area for porphyry-type mineralization.

The Masbate-Central/East Panay-Guimaras-Southwest Negros Region is considered to hold significant mineral potential. The geology and tectonic setting of this region as well as the results of the geochemical studies indicate the possibilities of locating porphyry copper, base metal and gold bearing epithermal mineralization. The presence of sizable deposits of these types of mineralization (e.g. Sipalay and Aroroy Mines) clearly supports this evaluation. Also the potentials for discovering massive sulphide base metal and bedded manganese deposits should also be borne in mind. Future directions in mineral exploration in the region should fully take into account the results of this RP-Japan geochemical survey.

4.1.4 Cebu-Bohol-Siquijor-Southern Leyte Region

Processing and analysis of the geochemical data for Cebu, Bohol and Siquijor were carried out as one data population (Consolidated Report on Cebu, Bohol, Siquijor,

Southwest Negros, JICA-MMAJ, 1990), whereas that of Southwest Leyte was included with those of Samar, Siargao and Dinagat under a separate consolidated report (JICA-MMAJ, 1990).

4.1.4.1 Cebu Island

Four nomalous areas in terms of the elements analyzed were delineated in the island, and two were considered promising (Table 19, Pls. I-2, II-4). Area I lies 10 km southeast of Toledo in the west coast of the island and is underlain by the Mananga Group, Cebu Formation and Lutopan Diorite. It is characterized by a Cu-Pb-Ag-Zn-Co-Mo anomaly reflective of porphyry copper mineralization. The anomaly is considered significant because the area is within a region of known mineralization. It lies west of the Atlas Mine and is proximal to the Haypay, Sigpit Lutopan and Botong Sinsin (hydrothermal vein and dissemination) mineral showings. It most likely indicates a mineralization similar to the deposits in the vicinity the area.

Table 19 Geochemical Anomalous Areas in Cebu

No.	Anomalous Areas	Location	Cell Average									High-pass Filter									Factor Analysis				
			Cu	Pb	Zn	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	As	Mn	Ni	Co	Mo	Hg	No. 2 Post	No. 3 Pre	No. 3 Post	No. 4 Post	No. 5 Post
I	West of Atlas Mine	123°44' E 10°20' N	○		○	○		○	○	○		○	○	○		○		○	○		○	○	○	○	
II	West of Liloan	123°56' E 10°23' N	○	○	○	○						○	○	○	○						○	○	○	○	○
1	Northern part of the area	123°58' E 11°05' N	○	○	○	○	○	○	○		○			○	○	○	○			○	○			○	○
2	Southern part of the area	123°20' E 9°26' N		○	○					○	○		○	○					○	○	○	○	○		○

○; Elements with anomalous values
Pre ; Before rotation Factor for Factor Analysis
Post ; After rotation Factor for Factor Analysis
Roman numerals (I~II) indicate promising areas
Arabic numerals (1~2) indicate anomalous areas

Area II is situated approximately 15 km northeast of Cebu City and lies between Liloan and Compostela in the east coast. It covers the area delineated as a Pb-Zn-As-Mn anomaly adjacent to the Consolacion 2 and 3 mineral showings. The area is underlain by the Tunlob Schist, Malubog Formation and Talamban Diorite. Mineralization encountered within this area consists of veins and sulfide disseminations in silicified or argillized volcanic rocks. High values for Au, Cu and

Zn were noted especially in the Consolacion 2 and 3 deposits. The anomaly most likely reflect a similar mineralization type although a massive sulfide base metal deposit is not totally discounted.

The other anomalous areas identified include scattered single element anomalies for Mn, Mo, Zn, Co and Ni in Northern Cebu (mainly limestone area) and southern Cebu. Low priority is given for these anomalies as their detailed nature and relationship to geology and known mineralization are uncertain at present.

Factor analysis carried out on the Cebu data revealed the two promising areas as being anomalous in the factors identified. Both areas were classified anomalous for Factors 2, 3 and 4. Factors 2 and 4 are both arsenic (As) factor whereas Factor 3 is a Mo factor. All three factors, however, indicate the favorability of the two areas for base metal hydrothermal mineralization.

4.1.4.2 Bohol-Siquijor Islands

Like in the previous area (Cebu), geochemical processing of the data for the two islands resulted in the tagging of several anomalous zones in terms of the elements analyzed (Table 20, Pls. I-2, II-4). Although numerous single element anomalies are identified, only the most prominent are considered and discussed here. These include the As-Mn anomaly near Buenavista (north coast of Bohol); the multi-element anomaly for Cu, Pb, Zn, As, Mn, Ni and Co near Jagna, southeastern Bohol; Cu-Pb-Mn anomaly along the west side of Siquijor; and the Pb-Zn-As-Mo anomaly near Carmen in the central part of Bohol. Of these four, only the first two are considered significant when assessed in terms of the known geology and mineralization in their respective areas. None of these anomalies are, however, considered promising.

The anomaly near Buenavista occurs within an area underlain by Ubay Volcanics and characterized by porphyry copper-type mineralization (e.g. Bonakan, Compacot and Baas prospects). The anomaly is not particularly impressive when compared with those of Cebu or Southwest Negros, but extensive alteration is present in the area, which should be considered in future evaluation of the area.

Table 20 Geochemical Anomalous Areas in Bohol and Siquijor Islands

No.	Anomalous Areas	Location	Cell Average									High-pass Filter									Factor Analysis				
			Cu	Pb	Zn	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	As	Mn	Ni	Co	Mo	Hg	No. 2 Post	No. 3 Pre	No. 3 Post	No. 4 Post	No. 5 Post
1	North coast of Bohol	124°07'E 10°05'N	○			○	○		○	○					○	○					○	○	○		
2	Southeastern Bohol	124°33'E 9°41'N	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○	○	○					
3	Central part of Bohol	124°15'E 9°42'N		○	○	○	○			○	○		○	○	○	○			○	○	○			○	
4	Western part of Bohol	123°52'E 9°45'N		○	○	○	○				○		○	○	○	○			○	○					
5	West coast of Siquijor	123°30'E 9°11'N	○	○			○	○	○		○				○	○		○							

○; Elements with anomalous values
Pre ; Before rotation Factor for Factor Analysis Post ; After rotation Factor for Factor Analysis
Arabic numerals (1~5) indicate anomalous areas.

The second anomaly in the southeastern part of Bohol occurs in an area underlain by the Carmen Formation and Jagna andesite. Except for residual manganese showings, no conspicuous mineralization is observed. Only minor alteration patterns were noted during the survey. The nature of multi-element anomaly is not clear, but its occurrence within an area favorable to mineralization warrants a further study of its significance.

Factor analysis was carried out only for the data covering the northern half of Bohol. This resulted in the definition of areas anomalous in terms of the factors derived during the analysis. The anomaly in Buenavista was classified as anomalous under Factor 2 (As) and Factor 3 (Mo). This suggests a possible porphyry copper mineralization which is consistent with the known geology of the area.

4.1.4.3 Southern Leyte and Panaon Island

Geochemical analysis of the stream sediment data of southwest Leyte revealed six anomalous zones of which three were considered to be promising within this region (Table 21, Pls. I-2, II-5). Area I with distinct multi-element anomaly is located in the northeastern side of Panaon Island. The area is underlain mainly by andesite flows and breccia of Miocene age. Mineralization observed adjacent to the area consisted of gold-bearing quartz veins in highly silicified and/or argillized andesite

and pyroclastics. The complex multi-element anomaly (Cu, Pb, Zn, Ag, As, Ni, Co, Mo, Hg) could be indicative of a comparable mineralization type. The area could fall within a mineralized zone extending from Pinut-an in the south to Caligangan in the north, more or less following the disposition of the andesite flows and pyroclastics. The trend is also consistent with the northwest trend of the Philippine Fault that transects the region.

Table 21 Geochemical Anomalous Areas in Southern Leyte

No.	Anomalous Area	Location	Cell Average										High-pass Filter										Factor Analysis				
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Mo	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Mo	No. 1	No. 2	No. 3	No. 4	No. 5
I	Northeast of Panaon Island	125°13' E 10°08' N	○	○	○	○	○		○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○	○
II	North of Sogod	124°58' E 10°25' N	○	○	○		○	○		○		○	○	○	○		○	○	○	○	○		○	○	○		○
III	North of Maasin	124°51' E 10°11' N	○				○		○		○		○				○	○	○	○	○			○	○		
1	Vicinity of Saint Bernard	125°10' E 10°19' N		○							○	○												○			
2	Ten Kilometer east of Inopacan	124°56' E 10°30' N	○	○	○				○	○	○	○												○			
3	Five Kilometer west of Silago	125°10' E 10°30' N	○	○	○			○		○	○												○	○			

○: Elements with anomalous value

Roman numerals (I~III) indicate promising areas Arabic numerals (1~3) indicate anomalous areas

Area II is located on the northern part of Sogod municipality and is characterized by high values for Cu, Pb, Zn, As, Mn, Ni, Co and Hg. The area is underlain by andesite and basalt which are sheared and altered in some sections. The complex element association possibly indicates base metal vein-type mineralization hosted by the basic volcanic rocks. This is most likely similar to the Sogod mineralization found within the area (section 3.1.4.4b).

Area III with Cu-As-Mn-Ni-Co-Hg anomaly covers an area immediately north of Maasin, southern Leyte. It is underlain mainly by serpentinized peridotite, diabase, basalt and pelagic sediments, and coralline limestone. The element association most likely indicate the ultramafic character of the area and the possibility of ultramafic related type of mineralization. In this particular case, the presence of nickeliferous

laterite is most probable. This is further indicated by th proximity of the area to a known nickel laterite deposit in Maasin.

Factor analysis carried out on the geochemical data of this region resulted in the identification of the following inter-element relations. In Area I, located north of Panaon, the analysis revealed anomalies in terms of all Factors 1 to 5. The factors are: 1. Co-Mn-Zn; 2. Pb-Hg-As; 3. Mo; 4. Ni and 5. Cu. This fact shows that this area is indeed very highly promising from geochemical as well as geological point of view.

Area II, north of Sogod was also classified anomalous for Factors 2 and 3. This again is indicative of a possible base metal mineralization in the area as typified by the Sogod mineral showing.

Area III, north of Maasin, was classified anomalous in terms of Factors 1, 2 and 3. The identification of the area as anomalous on Factor 1 is consistent with its geology and likely mineralization type.

The Cebu-Bohol-Siquijor-Southern Leyte Region is considered to have a very high potential for discovery of new porphyry copper and gold-bearing vein-type deposits. Some of the largest porphyry copper bodies in the Philippines occur within this region (e.g. Carmen, Lutopan and Biga, Atlas Mines) particularly in Cebu (section 3.1.4.4a). Prospects for discovering these deposits appear to be good also in Bohol which have essentially similar geologic and tectonic setting. Potential for the occurrence of gold-bearing vein-type mineralization is significant for southern Leyte and Panaon Island. Mineralization in this case is relatively young and probably influenced by the activity of the Philippine Fault. It is only recently that interest has been focused on the region for this type of mineralization.

4.1.5 Samar-Leyte-Dinagat Region

The geochemical analysis and interpretation of the stream sediment data for this region was carried out on a per island basis instead of the regional basis as was done with other regions. Both univariate and multivariate analyses were applied for the Leyte, Dinagat and Siargao data. In the case of the Samar data, multivariate analysis was not carried out because sampling in the area was incomplete. A number of prominent anomalies are identified after the analysis (Tables 22-24, Pls. I-1, II-5).

4.1.5.1 Samar Island

In this island, geochemical sampling was achieved primarily along the eastern and western portions. Analysis of the geochemical data revealed eight anomalous areas of which three are considered significant. These include the northeastern side of Wright, Western Samar, the northwestern portion of Balangiga, Western Samar, and the western side of Dolores, northern Samar (Table 22). None of these anomalies, however, could be classified as promising at the present state of knowledge of the geology of the region.

Table 22 Geochemical Anomalous Areas in Samar

No.	Anomalous Area	Location	Cell Average										High-pass Filter									
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr
1	Northeast of Wright	125°09' E 11°52' N					○	○			○		○	○	○		○	○		○		○
2	Northwest of Balangiga	125°23' E 11°09' N							○	○	○	○							○	○	○	○
3	East of Dolores	125°23' E 12°02' N							○		○	○					○	○				○

○: Elements with anomalous value
Arabic numerals (1~3) indicate anomalous areas

The anomaly identified in Wright consists of high values in the high pass filter data for Cu, Pb, Zn, As, Mn, Co and Cr. The area is underlain mainly by andesite, dacite, dacite tuff and spilitic flows with interbedded shale and metamorphosed sedimentary rocks. Mineralization encountered near the area consisted primarily of Kuroko-type massive sulfide deposits exemplified by the Pasiko Creek, Tiga and Uli Creek mineral showings. The element association displayed by the anomaly clearly indicates the base metal affiliation of the area. This most likely represents mineralization similar to those found near the area.

In Balangiga, a Ni-Co-Hg-Cr anomaly was identified in an area underlain by undifferentiated ultramafic rocks and basic to intermediate volcanic flows. The element association indicates an ultramafic affinity and could possibly represent mineralization associated with the host rock. These could include chromite, nickel sulfide and/or nickel laterite deposits. No mineral showings, however, were identified during the survey in the area.

The anomaly in Dolores consists of a Ni-Hg-Cr association in the cell average data and an As-Mn-Cr association in the high pass filter data. The area is underlain by a sequence of tuffaceous sandstone and shale of Miocene age. The element association is more indicative of ultramafic rock affiliation. The significance of this anomaly is not clear with the present knowledge of the geology and evidence of mineralization is not known in this area.

4.1.5.2 North/East Leyte and Biliran Island

The processing and analysis of the data from this area was done together with the data of Southwest Leyte but the discussion of the latter results was done in the earlier section (4.1.4.3). Five anomalous zones were delineated of which one is considered promising in the Leyte-Biliran area (Table 23). Area to the west of Tacloban City is characterized by a Cu-Zn-Ni-Co anomaly. It is an area underlain by basalt and andesite with minor intercalated sediments. The anomaly most likely indicate a cyprus-type base metal mineralization similar to the Bagacay deposit found adjacent to the area. The deposit also occur within the Cretaceous basalt unit associated with thrusted ophiolite sequences in the northeast coast. This area is considered to be promising for future prospecting.

Table 23 Geochemical Anomalous Areas in Northern Leyte

No.	Anomalous Area	Location	Cell Average										High-pass Filter										Factor Analysis				
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Mo	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Mo	No. 1	No. 2	No. 3	No. 4	No. 5
I	West of Tacloban	124°46'E 11°17'N	○		○				○	○			○		○				○	○			○	○		○	○
1	Central part of Biliran Island	124°31'E 11°34'N	○		○		○	○		○	○		○		○		○	○		○	○	○					○
2	Southwest of Tacloban	124°46'E 11°12'N			○			○		○								○		○			○	○			
3	West of Dulag	124°53'E 10°54'N							○								○	○	○				○	○		○	
4	Four kilometer Southwest of Villaba	124°29'E 11°03'N	○				○	○	○		○	○										○			○	○	○

○: Elements with anomalous value

Roman numerals (I) indicates promising area Arabic numerals (1~4) indicates anomalous areas

Another anomaly lies to the southwest of Tacloban. It is defined by a Zn-Mn-Co anomaly in an area of serpentinized peridotite. It is most likely associated with the Antipolo mineral showing found in the locality. The exact nature of the mineralization is uncertain but it probably developed following the alteration (serpentinization) of the underlying ultramafic host.

The other anomalous zones identified include the Cu-Zn-As-Mn-Co-Hg-Mo anomaly in central Biliran Island and the As-Mn-Ni anomaly west of Dulag in the east coast. The former could be related to vein-type base metal mineralization in Quaternary volcanic rocks. The area also host a native sulphur deposit that has been mined on a small scale during the past. The other anomaly could also be related to vein-type mineralization associated with young volcanic rocks intruding and overlying much older basalt, andesite and sediment intercalations. No mineral showings however were noted in the area during the previous survey.

Factor analysis carried out on the geochemical data (see also section 4.1.4.3) revealed Area I as being anomalous in terms of Factors 1 and 2. Factor 1 is a Mn-Co-Zn factor probably indicating mafic-ultramafic affiliation, whereas Factor 2 is a Hg-Pb factor associated with base metal mineralization. The classification as being anomalous in Factor 1 arose from the ultramafic character of the host rocks underlying them. The anomaly on Factor 2, on the other hand, indicates the prospectiveness for base metal mineralization.

4.1.5.3 Dinagat and Siargao Islands

In the Dinagat and Siargao Island group eight anomalous and three promising areas were delineated following the analysis of the stream sediment geochemical data (Table 24, Pls. I-2, II-5). Although most of the islands in the group were covered during the survey, only Dinagat, Bucas Grande and Masapelid showed favorable results.

Area I lies on the northern part of Libjo along the west coast of Dinagat. It is characterized by a Zn-Mn-Ni-Co-Cr anomaly indicating close affinity to ultramafic host lithology and/or ultramafic related mineralization. The area is underlain mainly by dunite and peridotite and has long been considered prospective for orthomagmatic as well as placer chromite deposits and nickel laterite deposits.

Table 24 Geochemical Anomalous Areas in Dinagat and Siargao

No.	Anomalous Areas	Location	Cell Average										High-pass Filter										Factor Analysis				
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr	No. 1	No. 2	No. 3	No. 4	No. 5
I	Noth of Libjo	125°30' E 10°15' N					○	○	○	○	○	○			○			○	○	○		○	○	○	○	○	○
II	Northern part of Masapelid Island	125°39' E 09°41' N	○	○			○				○		○	○	○		○	○			○			○	○	○	○
III	Vicinity of Mt. Gaboc	125°41' E 09°51' N			○		○	○	○	○	○	○						○	○	○	○	○	○	○	○	○	○
1	Northern part of Bucas Grande Island	125°53' E 09°46' N	○		○		○	○	○	○	○	○			○			○	○	○	○	○	○	○	○	○	○
2	Vicinity of Mt. Redondo	125°39' E 10°22' N							○	○			○	○					○	○			○				
3	Vicinity of mouth of San Jose River	125°39' E 10°10' N							○	○			○	○						○		○	○	○		○	○

○: Element with anomalous value

Roman numerals (I~III) indicate promising areas Arabic numerals (1~3) indicate anomalous areas

Area II encompasses the southern portion of Masapelid Island. It is a Cu-Pb-Zn-As-Mn-Hg anomaly situated in an area underlain by the Pliocene Mabuhay Andesite. Results of the heavy mineral sampling carried out in the area also revealed anomalous values for Au, Ag and Ga. These indicate an area favorable to gold-bearing vein-type mineralization associated with young volcanic rocks. The anomaly could be related to the Cangumod mineral showing found in southern Masapelid. The proliferation of small scale gold panning activities within the area further attests to its favorability as a target for gold and base metal mineralization. The recent diamond drilling programme undertaken within a portion of the area (MGB, 1986) confirmed the mineralization at depth. Follow-up surveys in adjacent sites are necessary to delineate additional bodies or extensions of mineralization.

Area III is situated in the vicinity of Mt. Gaboc in the southernmost part of Dinagat Island. It displays a Mn-Ni-Co-Hg-Cr anomaly and is similarly underlain by peridotite and dunite units of the Dinagat Ultramafic Complex. As in the previous area, this is considered a good prospect for chromite and nickel/cobalt mineralization.

Another notable anomalous area delineated in Bucas Grande Island covers its northern half. Like in the two other areas, it is characterized by a Zn-Mn-Ni-Co-Hg-Cr anomaly and is also underlain by dunite and peridotite of the Dinagat Ultramafic Complex. This area is again considered a possible target for chromite and nickel/cobalt mineralization.

The Samar-Leyte-Dinagat-Siargao region is considered to hold high potentials for chromite, nickel and precious metal mineralization. Its distinctive geologic character and tectonic setting and the development it underwent during the past has given it an unique mineral deposit assemblage. Except for some deposits in Dinagat (Nonoc, Hinatuan, Malayan Wood, Acoje) and Samar (Bagacay) which are presently being exploited, most of the prospects and mineral showings in the region have yet to be developed. Follow up exploration programmes are also called for to better qualify the prospects and targets identified during the previous surveys.

4.2 Rifted Continental Terrane

4.2.1 Palawan Island

The processing and analysis of the stream sediment geochemical data of Palawan were carried out in two separate batches corresponding roughly to the geological division of the island into the northern and southern part. This was undertaken to simplify the analysis of the data as well as clarify the geochemical anomalies obtained.

4.2.1a South Palawan

The analysis of the data from southern Palawan resulted in the delineation of five anomalous areas of which two are classified promising (Table 25, Pls. I -2, II -6). Area I covers the Pulute Range and is characterized by anomalous values for Cu, Mn, Ni and Co. It is underlain by the Espina Basalt and Stavely Range Gabbro with slivers of thrusted ultramafic rocks. The element association is indicative of cyprus-type massive sulfide mineralization possibly hosted by the basalt. The Ni-Co association could also be related to lateritic nickel concentration. Laterite blankets wide portions of mafic-ultramafic areas in the island.

Table 25 Geochemical Anomalous Areas in Palawan

	No.	Anomalous Area	Location	Cell Average											High-pass Filter										Factor Analysis			
				Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr	Sb	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Hg	Cr	Sb	No. 1	No. 2	No. 3	No. 4
NORTH	1	Eastern part of Busuanga Island	120°16' E 12°05' N	○		○		○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○			
	2	East of El Nido	119°30' E 11°15' N			○		○	○		○					○	○		○				○			○		○	○
	3	Vicinity of Mt. Capoas	119°20' E 10°58' N	○		○		○	○	○	○	○					○		○			○	○	○	○	○		○	○
	4	West of Tinitian	119°08' E 10°07' N					○						○					○					○				○	
SOUTH	1	North of Puerto Princesa	118°40' E 9°55' N	○		○			○	○	○	○	○			○	○					○				○	○	
	II	Long Point in western coast to Panacan in eastern coast	118°20' E 9°30' N			○		○	○	○	○	○	○			○	○		○	○	○	○	○	○		○	○		
	I	Vicinity of Plute Range	117°49' E 8°56' N	○	○	○		○	○	○	○	○				○				○	○	○					○	○	
	2	North of Brookes Point	117°25' E 8°34' N	○		○		○	○	○	○					○	○		○	○	○					○	○	○	
	3	Eastern part of Balabac Is.	117°04' E 7°54' N	○		○		○	○																		○	○	

○: Elements with anomalous value

Roman numerals (I~II) indicate promising area Arabic numerals (1~4) indicate anomalous area

The anomalous zone encompassing Area II stretches from Long Point in the northwest coast to Narra in the southeast coast. The area is entirely within the Mt. Beaufort Ultramafics and shows a multi-element anomaly dominated by Mn, Ni, Co and Cr and significant values for Pb, Zn, As and Hg. The Mn-Ni-Co-Cr association is very consistent with the underlying ultramafic rocks as was observed in other localities. The high Cr values could also be indicative of chromite mineralization whose occurrence is fairly common within and adjacent to the area (section 3.2.4a). The most important deposits in the area include Berong (Cr), Romarao (Cr) and Ibatong (Ni).

Anomaly 1 lies north of Puerto Princesa along the northwest coast. It is underlain by the Mt. Beaufort Ultramafics, the Sulu Sea Mine Formation and partly by the Espina

Basalt. The multi-element anomaly of Cu, Pb, Zn, Mn, Ni, Co, Hg and Cr could be due to the various lithology types encountered in the area. The Cu-Pb-Zn-Mn anomaly could be due to massive sulphide mineralization associated with the Espina Basalt. The Ni-Co-Cr association could be related to the ultramafic (with chromite and nickel mineralization) rocks. The Hg anomaly could be due to hydrothermal mercury mineralization which is fairly well developed in the area. Mercury mining was once active in the area as evidenced by the now closed Palawan Quicksilver Mine. Prospects for sulfide and chromite mineralization have also been reported in the area.

Anomaly 2 lies southwest of Area I and covers mainly Mt. Landangun of Pulute Range. It is similarly underlain by the Espina Basalt and the Mt. Beaufort Ultramafics. Anomalous values for Pb, Mn, Ni and Co in the high-pass filter data would indicate possible cyprus-type massive sulfide mineralization and lateritic nickel concentration probably associated with the basalt and ultramafic units. The proximity of known deposits further enhances the potential of the area for similar deposits (section 3.2.4e).

Factor analysis carried out on the South Palawan geochemical data showed three important factors accounting for more than 90 percent of the total variance in the data. Factor 1 is a Ni-Co-Cr factor which reflects ultramafic lithology and possibly chromite or nickel mineralization. Factor 2 is a Zn-Cu factor possibly indicative of massive sulfide mineralization associated with basalt. High values for this factor more or less coincide with the distribution of the Espina Basalt. Factor 3 is an As factor. It appears to be associated mainly with the clastic (Panas and Pandian Formations) and carbonate rocks (Alfonso XIII Formation) in the island.

In terms of anomalies, only Anomaly 2 was found anomalous for Factor 1. This is consistent with its being an ultramafic area and its having a high prospectivity for chromite and nickel mineralization. This anomaly was also found anomalous for Factor 2. This could be due to possible nickel-copper sulfide (pentlandite-chalcopyrite) disseminations in the ultramafic and chromite sequences.

Areas I , II and Anomaly 1 were all identified as anomalous for Factor 2 and 3. This again indicate the favorability of the the areas for massive sulfide mineralization. The As factor or Factor 3 in this case could be associated with the sulfide mineralization and not reflective of lithology.

4.2.1b North Palawan

In the North Palawan area, analysis of the geochemical data revealed four anomalous areas. Non, however, are considered promising in terms of prospectivity comparable to other promising areas. (Table 25, Pls. I -1, II -7).

Anomaly 2 covers an area stretching from El Nido in the north to Mt. Kapoas in the south. It is an area characterized by the Liminangcong Chert, Bacuit Formation and stocks of the Kapoas Granite. Anomalous values for Pb, Zn, As and Hg were identified in the area. These could have arisen from sulfide bearing hydrothermal veins associated with the granodiorite stocks. Possible tin mineralization associated with the intrusive bodies is postulated for the area.

Anomaly 4 is located northwest of Tinitian and east of Cleopatra Needle. It is underlain predominantly by the Caramay Schist and was found anomalous for As and Sb. The high values for these elements may be due to Sb-bearing quartz veins transecting the schist. Mineralization of this type had been delineated in Lasgas, Iraan, Fabrica and Bolo-bolo (section 3.2.4b). In these areas, the Sb occurs as stibnite veins associated with quartz veins and silicified rocks trending roughly parallel to the foliation of the schist.

Two factors accounting for 78.8 percent of the total variance in the data were considered after factor analysis was carried out. Factor 1 is a Co-Ni-Mn-Cu-Zn factor representing base metal mineralization related to hydrothermal veins. Anomaly 2 was delineated anomalous for this factor, again indicating its favorability for base metal deposition. Factor 2 is mainly an Sb factor and, therefore, indicative of Sb mineralization. Anomaly 4, however, was not identified as anomalous for this factor. A possible reason for this is that the anomaly for Anomaly 4 is reflected in Factor 3 (As factor) instead of Factor 2. In the pre-Varimax Rotation stage, Sb and As were coupled under Factor 2. But they were separated into 2 factors after rotation. Both of these elements, however, are considered indicators of Sb mineralization in the area and as such either factor could be used for detecting anomalous zones.

4.2.2 Romblon Island Group

Statistical treatment and processing of the stream sediment geochemical data of Romblon were carried out together with those of Masbate Island and Panay (see

consolidated report on Panay, Romblon and Masbate, JICA-MMAJ 1989). Two anomalies are identified, one in both Sibuyan and Tablas Islands (Table 26, Pls. I -2, II -3). Of the two, one is considered promising or possibly related to mineralization.

Table 26 Geochemical Anomalous Areas in Sibuyan and Tablas Islands

No.	Anomalous Areas	Location	Cell Average										High-pass Filter										Factor Analysis		
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	No. 1	No. 2	No. 3
I	Central part of Sibuyan Is.	122°34' E 12°26' N							○	○									○	○			○		
1	Southern part of Tablas Is.	122°00' E 12°09' N									○										○			○	○

○: Elements with anomalous value

Roman numeral (I) indicates promising area Arabic numeral (1) indicates anomalous area

The anomaly in Tablas lies on the southern portion of the island. It is essentially a Mo anomaly and is found within the Romblon Metamorphics. The anomaly cannot be related to any known type of deposit in the area although it might be indicative of porphyry Cu/Mo mineralization. Low priority is given to this area for any follow up programme.

In Sibuyan Island, a Ni-Co anomaly was delineated in the central part. It is considered promising within the Romblon Island Group. The area (Area I) is underlain by ultramafic rocks and the anomaly could be indicative of chromite and/or nickel-cobalt mineralization. The latter could either be disseminated sulfides in the host rock or concentration in laterite blanket over the ultramafics.

Factor analysis carried out on the data revealed Area I as being anomalous under Factor 1. This is a Co-Zn-Mn-Cu-Ni factor most likely reflecting ultramafic lithology or ultramafic related mineralization (chromite, nickel sulphide, laterite). This is consistent with the known geology of the area.

As for Factor 2 (Pb-Hg-As factor), only the Tablas anomaly was found anomalous in this factor. The element association possibly reflects hydrothermal mineralization within the area.

Factor 3 is a Mo factor. It could reflect base metal mineralization of the porphyry type. The anomaly in Tablas and classified as being anomalous in terms of Factor 3.

4.2.3 Buruanga Peninsula and Antique Range (West Panay)

The analysis of the geochemical data resulted in the delineation of four anomalous zones in the Buruanga Peninsula and Antique Range area (Western Panay) (Table 27, Pls. I-2, II-3). These anomalous zones include the Cu-Pb-Ag-Ni-Co anomaly northeast of San Jose, Antique; Cu anomaly northeast of Tibiao, Antique; Ni-Co anomaly south of Tangalan (east of Kalibo) Aklan and the As-Mn-Hg anomaly in Buruanga Peninsula. The first three are considered promising and consequently numbered Areas I, II, III.

Table 27 Geochemical Anomalous Areas in Antique Range and Buruanga Peninsula of Panay

No.	Anomalous Area	Location	Cell Average										High-pass Filter										Factor Analysis		
			Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	Cu	Pb	Zn	Ag	As	Mn	Ni	Co	Mo	Hg	No. 1	No. 2	No. 3
I	Northeast of San Jose	122°00' E 10°46' N	○	○		○	○	○	○	○	○		○	○	○	○		○	○	○			○		○
II	West of Kalibo	122°15' E 11°47' N						○	○	○					○			○	○	○			○		○
III	Notheast of Tibiao	122°12' E 11°24' N	○												○								○		
1	Buruanga Peninsula	121°59' E 11°51' N		○			○	○	○	○		○	○	○	○		○	○	○	○		○	○		○

○: Elements with anomalous value

Roman numerals (I~III) indicate promising areas Arabic numeral (1) indicates anomalous areas

Area I lies within a region of clastic sedimentary rocks, gabbro and ultramafic rocks (Antique Ophiolite). The anomaly is most likely related to massive sulfide mineralization similar to the mineral showings encountered in Carawisan and Nagdayao Creeks. Indications for chromite and nickel-laterite mineralization also exist in the area.

Area II lies along the northern tip of the Antique Range east of Kalibo, Aklan. The area is underlain mainly by units of the upper Miocene to lower Pliocene Lagdo Formation, basalt flows and breccia, and small bodies of serpentinite. The anomaly indicates possible nickel laterite deposit derived from serpentinites. Mineral showings encountered within the area include Maslog Creek (Cu), Osman and Manomong Creek (Cu). Copper mineralization could be associated with the basalts

or the intruding Pacol Diorite. Numerous manganese prospects were also reported in the area.

The anomalous zone of Area III is underlain by units of the Mt. Baloy Volcanics and Pacol Diorite. Although no mineral showings have sofar been identified in the area, the Cu anomaly could be indicative of vein-type or porphyry copper-type mineralization. This could be similar to the Osman mineral showing found in the northern side of Pacol Diorite.

The anomaly in the Buruanga Peninsula consists of the association Cu-Pb-Zn-As-Mn-Ni-Co-Hg. The area is underlain by schist, slate, chert and crystalline limestone of the Buruanga Metamorphics and the anomaly could be due to the complex lithologic assemblage found therein. Indications of mineralization include stratabound manganese showings, copper and iron deposits.

As what was done with the Romblon data, factor analysis classified Areas I, II and III as being anomalous in terms of Factors 1 and 3. Factor 1 (Co-Zn-Mn-Cu-Ni) indicates ultramafic lithology and chromite/nickel mineralization. Factor 3, on the other hand, (Mo-As) reflects base metal mineralization. The coincidence of the anomalies for the two factors in all three areas could be due to the association of the mineralization with the underlying rock units (e.g. vein-type mineralization along the contact of the intrusive and the ultramafic).

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Geological and geochemical evaluation of the mineral potential was attempted in six regions of the Philippine Archipelago. The basis for the selection of these regions was that the knowledge of the mineral potential of these regions was less clear due to the lack of systematic exploration in the areas. They are, in the mobile belt; Northern Sierra Madre, Southern Sierra Madre-Polillo, Masbate-Central/East Panay-Southwest Negros, Cebu-Bohol-Siquijor-Southwest Leyte, Samar-Leyte-Dinagat, and in the stable belt; Palawan-Romblon-Antique Range.

The objective of the project was to delineate areas for future exploration and development of mineral resources as well as contributing to the understanding and assessment of the mineral potential of the country. With this stated objective in mind, geological and geochemical study and reconnaissance survey of the above regions were carried out. Namely, the tectonic development and the geologic features of the Philippine Archipelago have been reviewed, key areas within the regions surveyed geologically, the known important mineral showings of the project areas surveyed, and 43,459 stream sediment samples collected, chemically analysed and evaluated together with 2,367 panned concentrates.

As a result of the above, 70 geochemically anomalous areas have been discovered from the surveyed regions. They are listed in the tables in chapter 4 and are plotted on the overlay sheets over the geologic map (Pls. II-1~7) attached to this report. The nature of the anomalies as well as the statistical processing of the data are reported in the JICA·MMAJ Consolidated Reports for each region.

It is needless to mention that these anomalies do not necessarily indicate or are caused by mineralization. These were evaluated geologically and geochemically and 25 of the anomalies were identified to be related to some form of mineralization. They are considered to warrant further detailed exploratory work and were classified as "Promising anomalous areas" (Fig. 18). The types of mineralization believed to be associated with these 25 promising areas are; porphyry Cu in six areas, base metal veins in five areas, gold-bearing veins in five areas, orthomagmatic chromite in five areas, massive sulfide in four areas and nickeliferous laterites in four areas. These

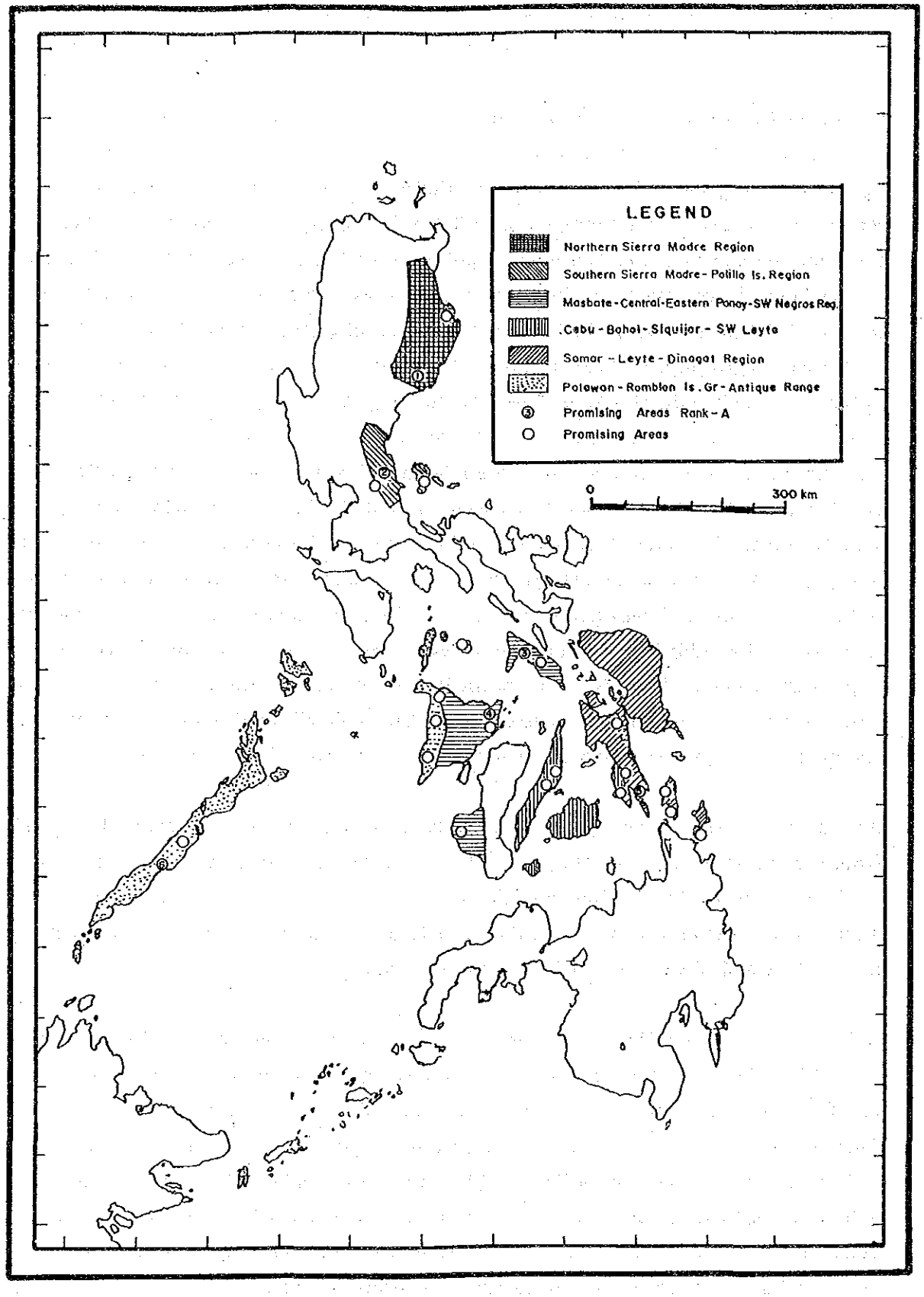

Figure 18 Location of Promising Areas

anomalies and promising areas have been prioritized for each region in the order of their prospectivity and described in detail (Chapter 4).

Of the above promising areas, six areas which are considered to possess particularly high mineral potential and interest for future prospecting are delineated from the whole project area. They are classified as "Promising areas, rank A" and are plotted on the overlays, Plates II-1~7, and Figure 18. It is difficult to compare the prospectivity among those areas in regions with different geological environment and different geochemical data population. Therefore, these areas are not prioritized.

These "rank A" areas are extracted from all of the regions surveyed except Cebu-Bohol-Siquijor. Although there is a very important porphyry-type deposit in Toledo, Cebu and the vicinity is indeed prospective and is selected as the most promising area of the region, it is felt that the area is well prospected and well known and that, with the objectives of this project, less known areas would have higher priority for future exploration activities. Thus the area is not delineated as "rank A". Same consideration is made for the vicinity of Sipalay Mine in Southwest Negros.

These six areas are, from north to south: Dimakawal area, Northern Sierra Madre; Middle reaches of Umiray River, Southern Sierra Madre; Area joining Mt. Uac and Aroroy, Masbate; Area joining Pilar and Concepcion, East Panay; Area joining Panaon and Sogod, southern Leyte; and Area joining Long Point, Narra and Pulute Range, Southern Palawan.

It is concluded that these promising areas, particularly those six areas ranked as "A-class" indeed warrant future detailed exploratory work.

5.2 Recommendation

Based on the results obtained by the project as laid out in this report, it is recommended that detailed exploration be carried out in the areas identified as promising, particularly in those six areas which are considered to possess very high mineral potential.

The methods to be used in the future exploration activities would include detailed geological survey, soil and rock geochemical prospecting, geophysical prospecting and other necessary means to be applied in the manner best suited for individual areas.

The target for these exploratory activities in these areas are, from north to south:

(1) Dimakawal area, Northern Sierra Madre.

Hydrothermal base-metal sulfide mineralization, porphyry copper and/or veins are expected.

(2) Middle reaches of Umiray River, Southern Sierra Madre.

Hydrothermal gold-bearing base-metal mineralization, veins and/or porphyry-type are expected.

(3) Area joining Mt. Uac and Aroroy, Masbate.

A wide area where gold and base metal showings occur, gold-silver, base metal hydrothermal mineralization, veins and/or porphyry-type are expected.

(4) Area joining Pilar and Concepcion, East Panay.

A follow-up survey has been conducted in Concepcion area and hydrothermal base metal and gold mineralization has been found.
Gold and base metal veins are expected.

(5) Area joining Panaon and Sogod, Southern Leyte.

Gold mineralization exemplified by the St. Bernard Mine is expected in the vicinity of northern Panaon and base metal mineralization near Sogod. This area sits along the Philippine Fault.

(6) Area joining Long Point-Narra-Pulute Range, Southern Palawan.

Orthomagmatic chromite mineralization, Ni laterite concentration are expected from this ophiolite area. Massive sulfide mineralization is possible in the western part. Follow-up survey has been carried out in the eastern part and chromite mineralization has been confirmed.

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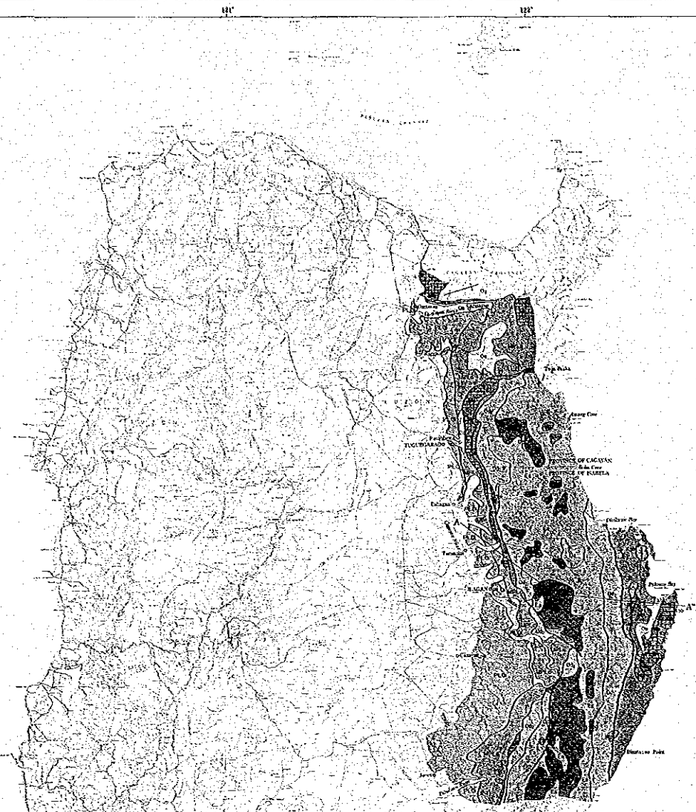
Geologic Map of Surveyed Area for Terminal Report

Scale 1:1,000,000

P1. I-1

The Mineral Exploration-Mineral Deposits
of Two Contrasting Geologic Environment
in
THE REPUBLIC OF THE PHILIPPINES
(Modified from MGB Data)

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1990



NORTHERN SIERRA MADRE

- CENOZOIC
  - QUATERNARY
    - HOLOCENE: Alluvium
    - PLEISTOCENE: Kanaipang Limestone
  - TERTIARY
    - PLIOCENE: Itogon Formation
    - MIOCENE: Cabagan Formation; Callao Limestone; Lubuagan Formation; Diorico Formation; Dalton Limestone; Palanan Sediments; Northern Sierra Madre Batholith; Dibuluan Formation
    - OLIGOCENE: Mashé Green Tuff; Mt. Cresta Formation; Dipodian Formation
    - EOCENE: Aluan Formation
- MESOZOIC CRETACEOUS: Dibitanagan Chert; Ilocobian Basalt; Isabela Ultramafic Complex; Isabela Ophiolite
- Thrust; Normal Fault; Anticline; Syncline

A–A'–A" Section

SOUTHERN SIERRA MADRE

- CENOZOIC
  - QUATERNARY
    - HOLOCENE: Alluvium
    - PLEISTOCENE: Guadalupe Formation; Karbagan Formation
  - TERTIARY
    - PLIOCENE: Potete Formation; Languyen Limestone
    - MIOCENE: Angat Formation; Tignoan Formation; Burdeos Formation
    - OLIGOCENE: Binarguean Formation; Antipolo Diorite; Bayabas Formation; Maybangain Formation
    - EOCENE: Bahacolan Formation; Pebble formation
    - PALEOCENE: Lepa Granodiorite; Kanan Formation; Kinabuan Formation; Anawan Formation
- MESOZOIC
  - CRETACEOUS: Baresuss Halto Formation; Pubilo Ultramafic Complex; Buso-buso Mafic Complex; Katablegan Metamorphics
  - JURASSIC: Masiid Schist
- Strike-Slip fault; Thrust; Normal fault; Anticline; Syncline

A–A' Section

B–B' Section

ed Area

SOUTH CHINA SEA

LUZON

PHILIPPINE SEA

SOUTHERN SIERRA MADRE

- CENOZOIC
  - QUATERNARY
    - HOLOCENE — Qa — Alluvium
    - PLEISTOCENE — Qt — Guadalupe Formation
  - TERTIARY
    - PLIOCENE — Kalagan Formation
    - Bataraza Formation
    - Langoyan Limestone
    - MIOCENE — Angat Formation
    - Tigmoan Formation
    - Burdeos Formation
    - OLIGOCENE — Binangonan Formation
    - Antipolo Diorite
    - Bayabas Formation
    - EOCENE — Mayhangdan Formation
    - Babacolan Formation
    - Pollilo Intrusives
    - PALEOCENE — Lupa Granodiorite
    - Kanan Formation
    - Kinabuan Formation
    - Anawan Formation
- MESOZOIC
  - CRETACEOUS
    - Barenas-Balte Formation
    - Pollilo Ultramafic Complex
    - JURASSIC — Boso-boso Mafic Complex
    - Kataklingan Metamorphics
    - Matsiit Schist

Strike-Slip fault — Thrust
Normal fault — Anticline
Syncline

A–A' Section

B–B' Section

NORTHERN SIERRA MADRE

- CENOZOIC
  - QUATERNARY
    - HOLOCENE — Qa — Alluvium
    - PLEISTOCENE — Kanalpong Limestone
  - TERTIARY
    - PLIOCENE — Ilagan Formation
    - Cabagan Formation
    - Cuftao Limestone
    - MIOCENE — Lubuagan Formation
    - Dariko Formation
    - Ibulao Limestone
    - Palanan Sediments
    - Northern Sierra Madre Batholith
    - Dibuluna Formation
    - Maslpi Green Tuff — Dipadian Formation
    - OLIGOCENE — Mt. Cresta Formation
    - EOCENE — Abuan Formation
- MESOZOIC CRETACEOUS
  - Dalinaoan Chert
  - Ilocobian Basalt — Isabela Ophiolite
  - Isabela Ultramafic Complex

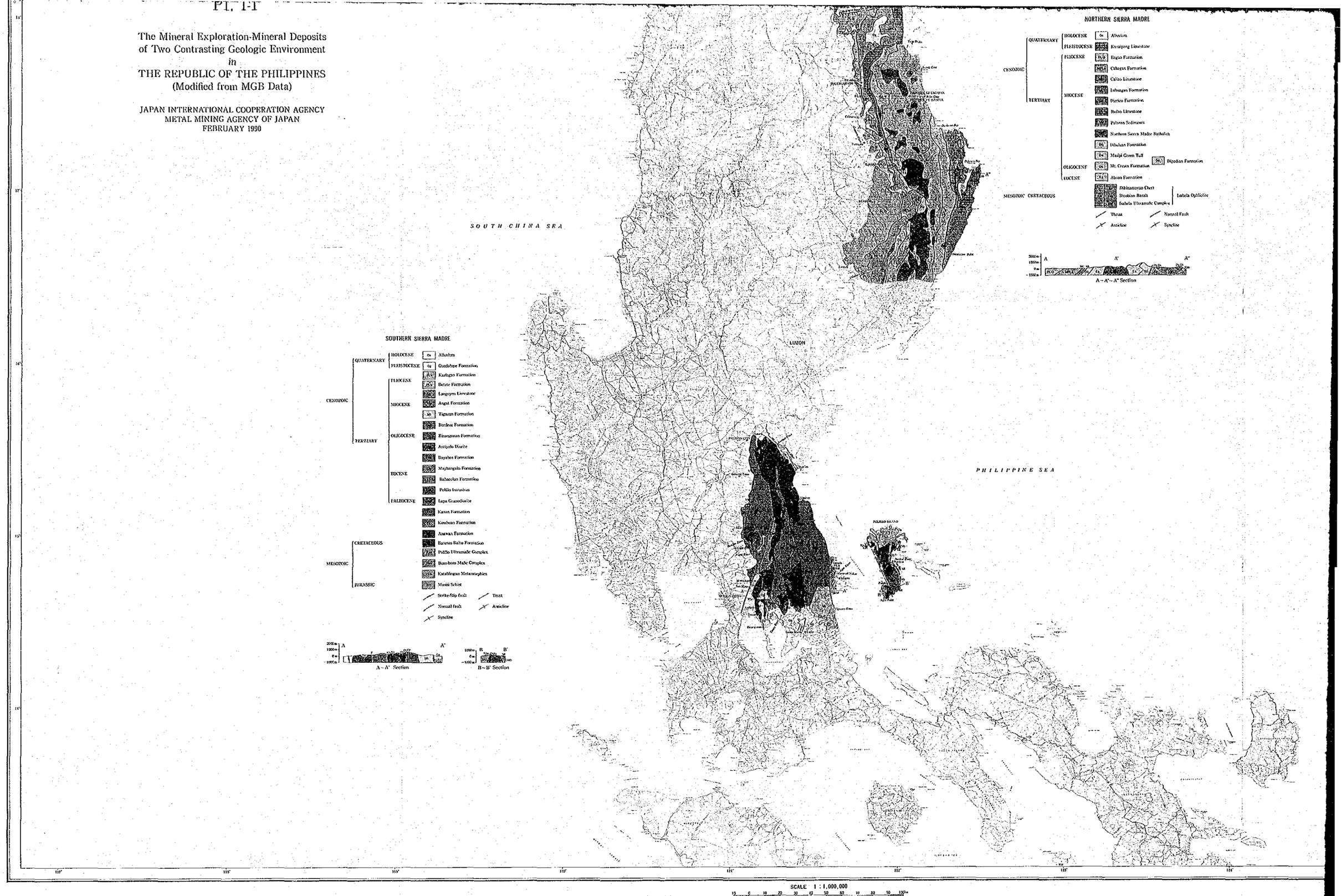
Thrust — Normal Fault
Anticline — Syncline

A–A'–A'' Section

PL. 1-1

The Mineral Exploration-Mineral Deposits of Two Contrasting Geologic Environment *in* THE REPUBLIC OF THE PHILIPPINES (Modified from MGB Data)

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1990



SOUTH CHINA SEA

PHILIPPINE SEA

LUZON

POLILLO ISLAND

NORTHERN SIERRA MADRE

CENOZOIC
- QUATERNARY
  - HOLOCENE — Qa — Alluvium
  - PLEISTOCENE — Qk — Kanaipang Limestone
- TERTIARY
  - PLIOCENE — Pbg — Bagan Formation
  - PLIOCENE — Pab — Labugan Formation
  - PLIOCENE — Pcb — Cabu Limestone
  - MIOCENE — Mlb — Lubuagan Formation
  - MIOCENE — Mbr — Berlco Formation
  - MIOCENE — Mbu — Bulan Limestone
  - MIOCENE — Mpl — Palanan Sediments
  - MIOCENE — Mi — Northern Sierra Madre Batholith
  - OLIGOCENE — Obu — Dibuluan Formation
  - OLIGOCENE — Omg — Masigi Green Tuff
  - OLIGOCENE — Mc — Mt. Cresta Formation — Dipaldian Formation
  - EOCENE — Ea — Alcala Formation

MESOZOIC CRETACEOUS
- Dikhamaran Chert
- Bicobian Basalt
- Isabela Ultramafic Complex — Isabela Ophiolite

Thrust — Normal Fault — Anticline — Syncline

A – A' – A" Section

SOUTHERN SIERRA MADRE

CENOZOIC
- QUATERNARY
  - HOLOCENE — Qa — Alluvium
  - PLEISTOCENE — Qg — Guadalupe Formation
- TERTIARY
  - PLIOCENE — Pkg — Kashgan Formation
  - PLIOCENE — Pbt — Butete Formation
  - PLIOCENE — Pl — Languyen Limestone
  - MIOCENE — Mag — Angat Formation
  - MIOCENE — Mt — Tignoan Formation
  - MIOCENE — Pmd — Burdeos Formation
  - OLIGOCENE — Bin — Binanuaran Formation
  - OLIGOCENE — Ad — Antipolo Diorite
  - OLIGOCENE — Pby — Bayabas Formation
  - EOCENE — Mby — Mayhangnin Formation
  - EOCENE — Rb — Rabacolan Formation
  - EOCENE — Pi — Polillo Intrusives
  - PALLOCENE — Lg — Lupa Granodiorite
  - PALLOCENE — Kn — Kanan Formation
  - PALLOCENE — Kb — Kinabuan Formation
  - PALLOCENE — Ag — Anawan Formation

MESOZOIC
- CRETACEOUS — Bb — Barenas-Balite Formation
- CRETACEOUS — Pu — Polillo Ultramafic Complex
- JURASSIC — Bb — Boso-boso Mafic Complex
- JURASSIC — Mm — Matalingan Metamorphics
- JURASSIC — Ms — Massi Schist

Strike-Slip fault — Thrust — Normal fault — Anticline — Syncline

A – A' Section

B – B' Section

SCALE 1 : 1,000,000

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Use of the map pattern and the color chart is approved by Geological Survey of Japan (1989 G.S.J. No. 1980)

Geologic Map of Surveyed Area for Terminal Report

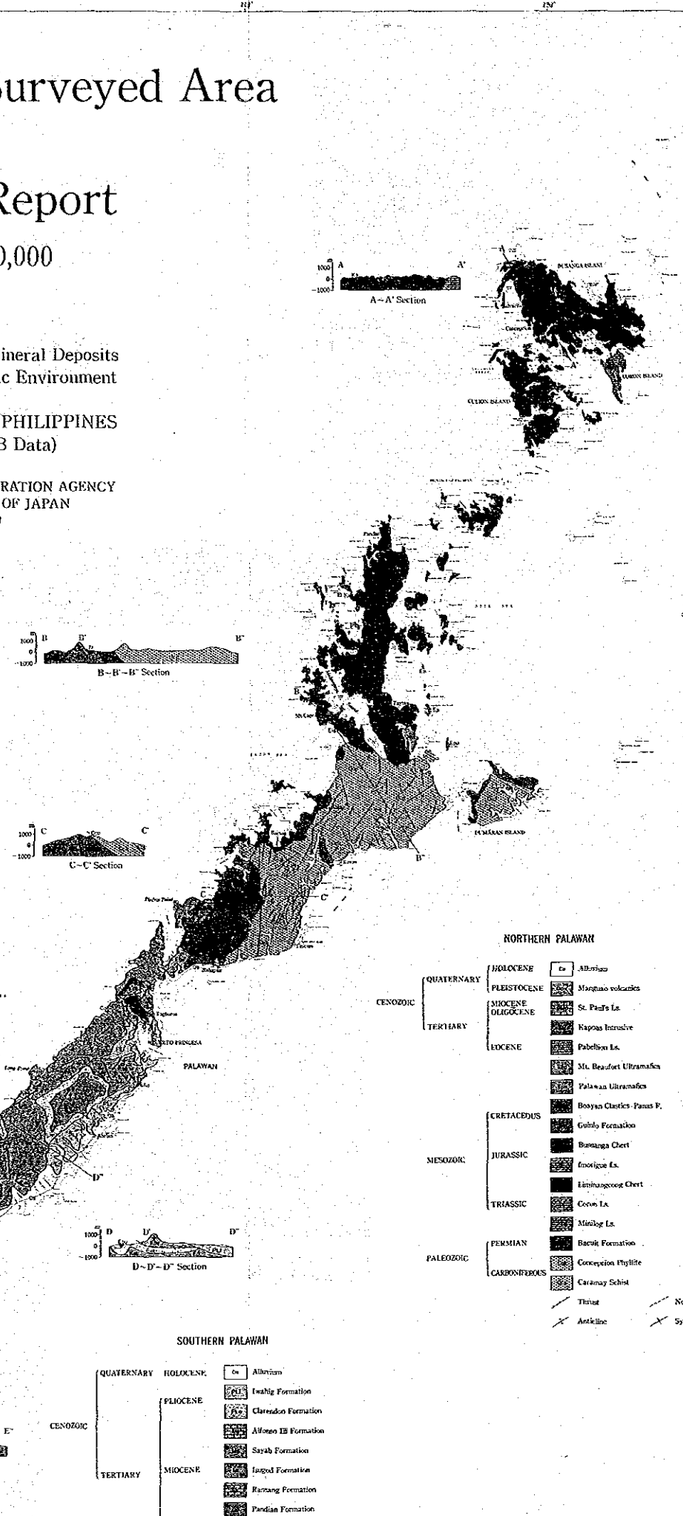
Scale 1:1,000,000

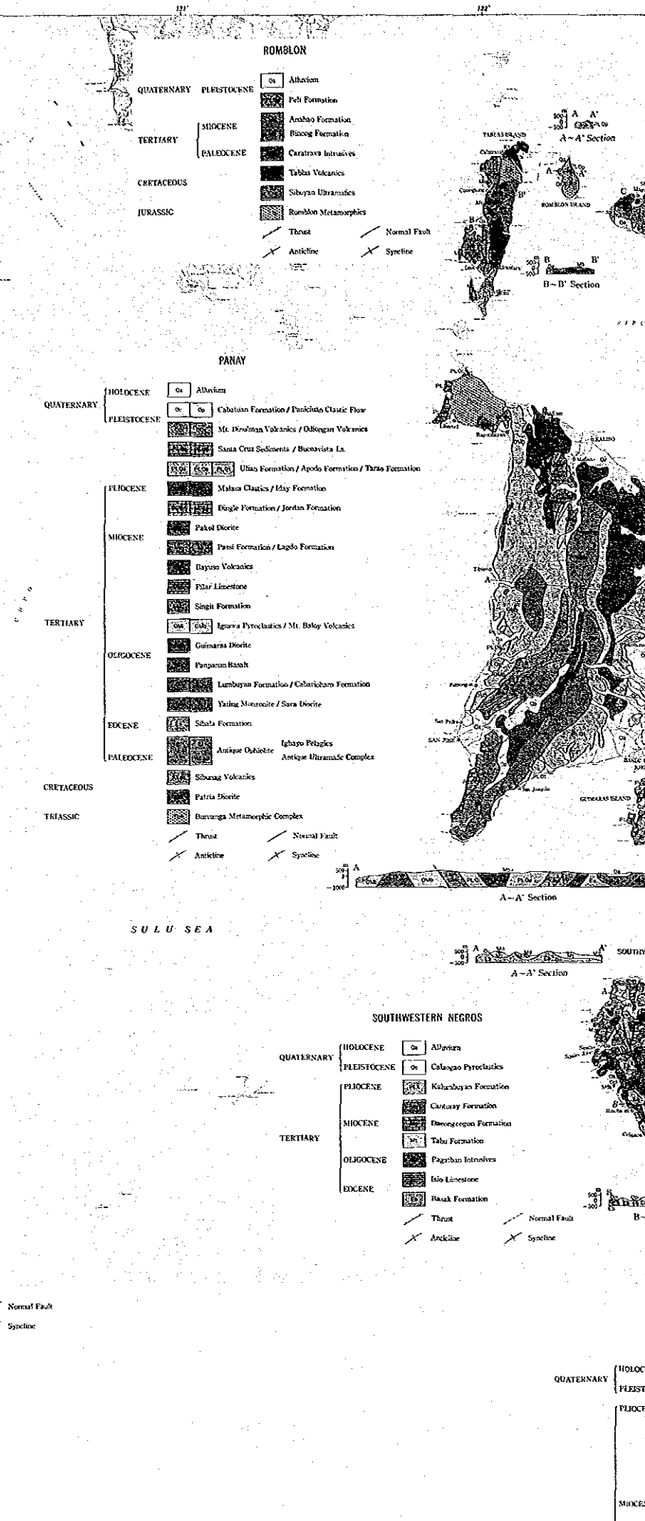
Pl. I-2

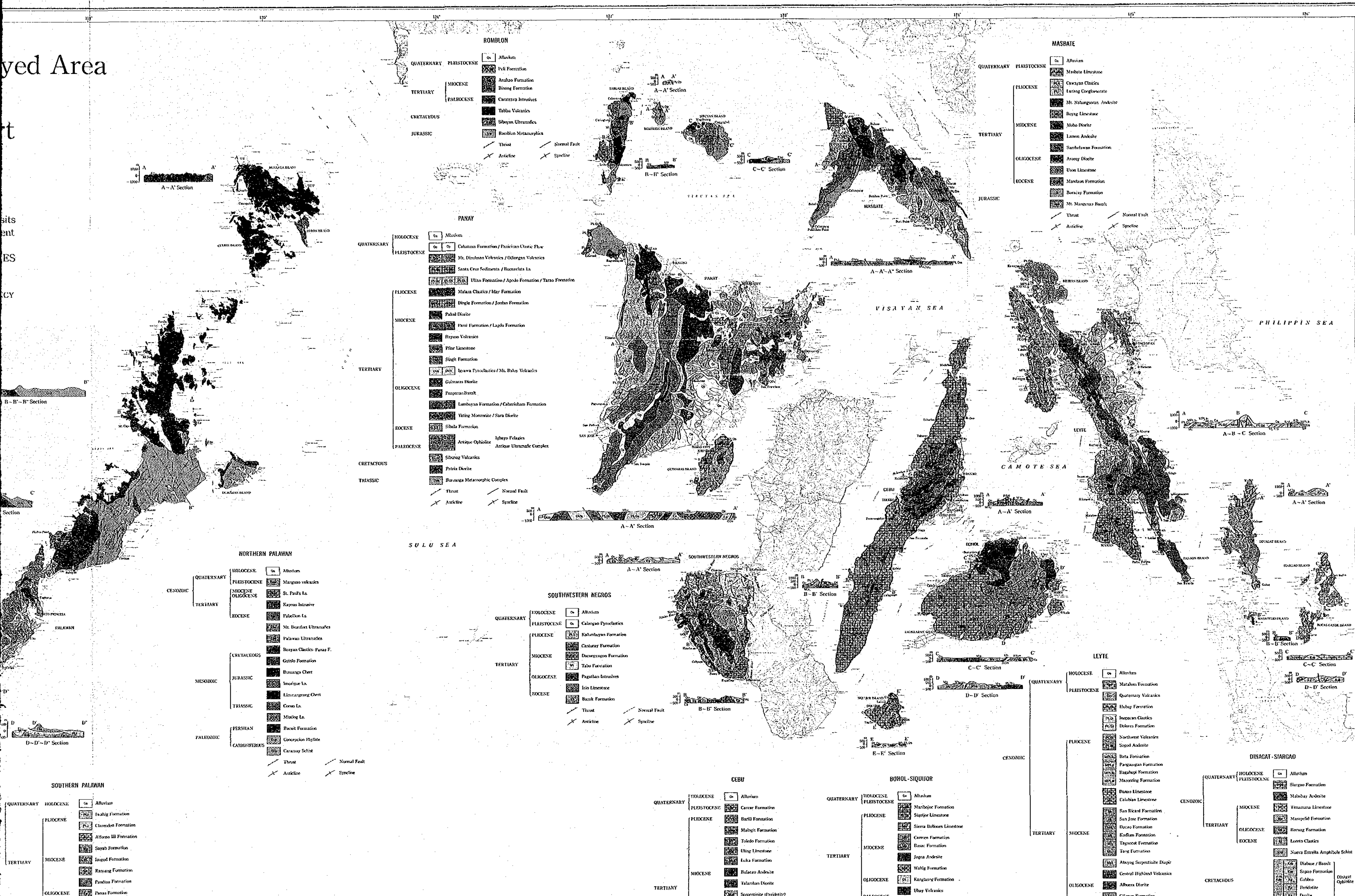
The Mineral Exploration-Mineral Deposits
of Two Contrasting Geologic Environment
in
THE REPUBLIC OF THE PHILIPPINES
(Modified from MGB Data)

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

FEBRUARY 1990







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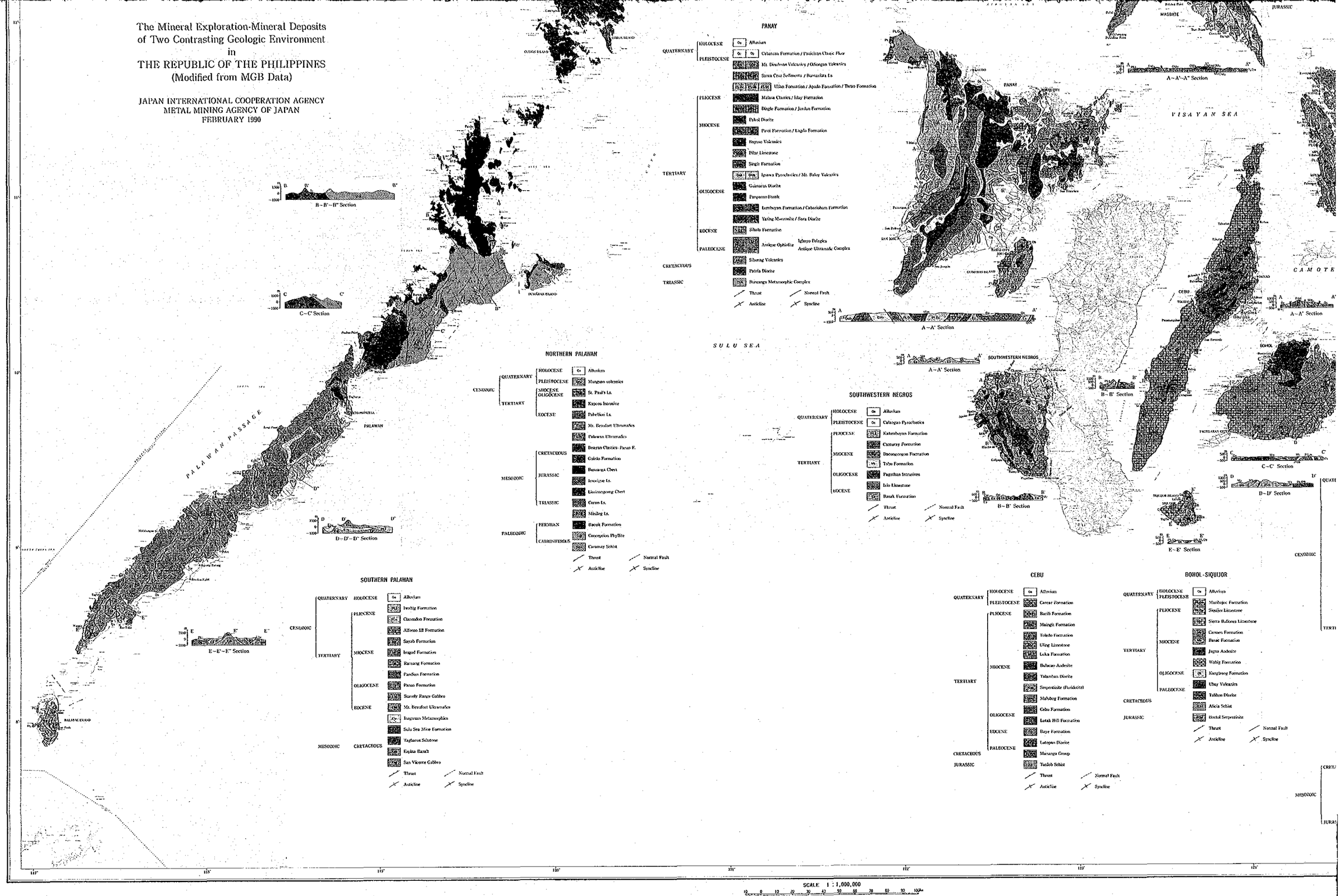
ROMBLON
QUATERNARY PLEISTOCENE Alluvium
Peli Formation
TERTIARY MIOCENE Anahao Formation
Binoog Formation
PALEOCENE Carataya Intrusives
CRETACEOUS Tablas Volcanics
Sibuyan Ultramafics
JURASSIC Romblon Metamorphics
Thrust
Normal Fault
Anticline
Syncline
A–A' Section
B–B' Section
C–C' Section
SIBUYAN SEA
MASBATE
QUATERNARY PLEISTOCENE Alluvium
Masbate Limestone
TERTIARY PLIOCENE Cawayan Clastics
Lanang Conglomerate
Mt. Nabongsoran Andesite
Buyag Limestone
MIOCENE Mobo Diorite
Lanon Andesite
Sambulawan Formation
OLIGOCENE Aroroy Diorite
Uson Limestone
EOCENE Mandaon Formation
Boracay Formation
JURASSIC Mt. Mangonas Basalt
A–A'–A" Section
PANAY
QUATERNARY HOLOCENE Alluvium
PLEISTOCENE Cabatuan Formation / Panicuan Clastic Flow
Mt. Dinulman Volcanics / Odiongan Volcanics
Santa Cruz Sediments / Buenavista Ls.
Ulian Formation / Apdo Formation / Tarao Formation
TERTIARY PLIOCENE Malaan Clastics / Mau Formation
Dingle Formation / Jordan Formation
MIOCENE Pabol Diorite
Passi Formation / Lagdo Formation
Bayuno Volcanics
Pilar Limestone
Singit Formation
Igsawa Pyroclastics / Mt. Baloy Volcanics
OLIGOCENE Guimaras Diorite
Panparan Basalt
Lumbuyan Formation / Cabatuhan Formation
Yating Monzonite / Sara Diorite
EOCENE Sibala Formation
PALEOCENE Antique Ophiolite Igbayo Pelagics
Antique Ultramafic Complex
CRETACEOUS Sibunag Volcanics
Patria Diorite
TRIASSIC Buruanga Metamorphic Complex
VISAYAN SEA
PHILIPPINE SEA
CAMOTE SEA
SULU SEA
NORTHERN PALAWAN
CENOZOIC QUATERNARY HOLOCENE Alluvium
PLEISTOCENE Marigano volcanics
TERTIARY MIOCENE OLIGOCENE St. Paul's Ls.
Kapoas Intrusive
EOCENE Pabellon Ls.
Mt. Beaufort Ultramafics
Palawan Ultramafics
Boayan Clastics - Panas F.
MESOZOIC CRETACEOUS Guinlo Formation
JURASSIC Busuanga Chert
Imorigue Ls.
Liminangcong Chert
TRIASSIC Coron Ls.
Minilog Ls.
PALEOZOIC PERMIAN Bacuit Formation
CARBONIFEROUS Concepcion Phyllite
Caramay Schist
SOUTHERN PALAWAN
QUATERNARY HOLOCENE Alluvium
TERTIARY PLIOCENE Iwahig Formation
Clarendon Formation
Alfonso III Formation
MIOCENE Sayab Formation
Isugod Formation
Ransang Formation
Pandian Formation
OLIGOCENE Panas Formation
SOUTHWESTERN NEGROS
QUATERNARY HOLOCENE Alluvium
PLEISTOCENE Calaogao Pyroclastics
TERTIARY PLIOCENE Kabankalan Formation
MIOCENE Cansuray Formation
Dacongcogon Formation
Tabo Formation
OLIGOCENE Pagatban Intrusives
Isio Limestone
EOCENE Basak Formation
CEBU
QUATERNARY HOLOCENE Alluvium
PLEISTOCENE Carcar Formation
TERTIARY PLIOCENE Barili Formation
Malbog Formation
Toledo Formation
Uling Limestone
Luka Formation
MIOCENE Bulacao Andesite
Talamban Diorite
Serpentinite (Peridotite)
BOHOL-SIQUIJOR
QUATERNARY HOLOCENE PLEISTOCENE Alluvium
Maribojoc Formation
Siquijor Limestone
TERTIARY PLIOCENE Sierra Bullones Limestone
MIOCENE Carmen Formation
Basac Formation
Jagna Andesite
Wahig Formation
OLIGOCENE Kanglasog Formation
Ubay Volcanics
PALEOCENE Tabyo Diorite
LEYTE
CENOZOIC QUATERNARY HOLOCENE Alluvium
PLEISTOCENE Mataloon Formation
Quaternary Volcanics
Hubay Formation
Inopacan Clastics
Dolores Formation
TERTIARY PLIOCENE Northwest Volcanics
Sogod Andesite
Bata Formation
Panganan Formation
Bagahupi Formation
Maasering Formation
Dusao Limestone
Calubian Limestone
MIOCENE San Ricardo Formation
San Jose Formation
Dacao Formation
Kadlum Formation
Tagnocot Formation
Tanig Formation
Abuyog Serpentinite Diapir
Central Highland Volcanics
OLIGOCENE Albuera Diorite
EOCENE Gibonon Formation
DINAGAT-SIARGAO
CENOZOIC QUATERNARY HOLOCENE PLEISTOCENE Alluvium
Siargao Formation
Malabay Andesite
TERTIARY MIOCENE Tamamana Limestone
Mainit Formation
OLIGOCENE Bacuag Formation
EOCENE Loreto Clastics
Nueva Estrella Amphibolite Schist
CRETACEOUS Diabase / Basalt
Sepao Formation
Gabbro
Peridotite
Dunite
Dinagat Ophiolite
A–B–C Section
D–D' Section
E–E' Section
D–D'–D" Section
B–B'–B" Section

The Mineral Exploration-Mineral Deposits of Two Contrasting Geologic Environment in THE REPUBLIC OF THE PHILIPPINES (Modified from MGB Data)

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1990



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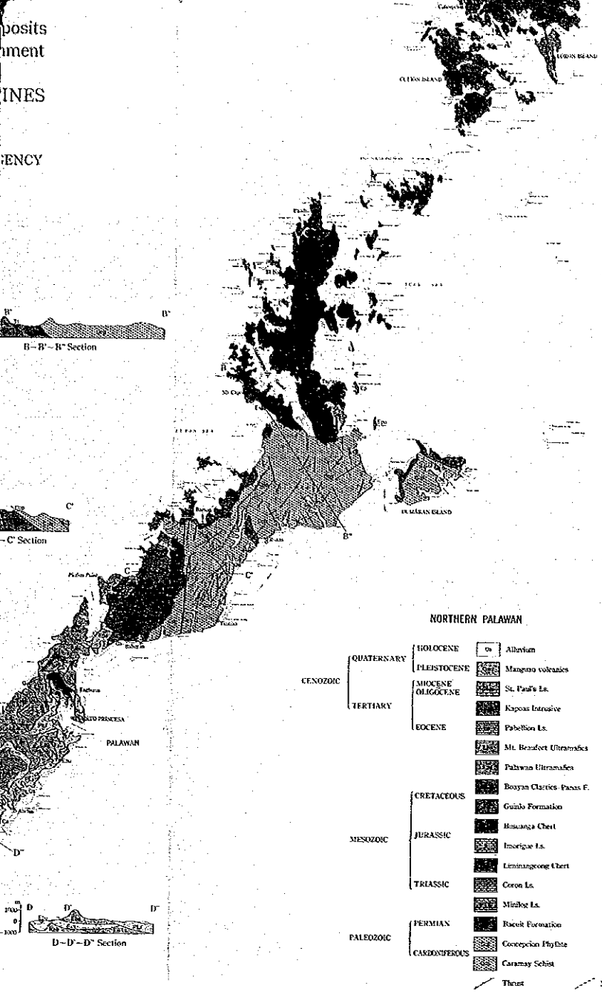
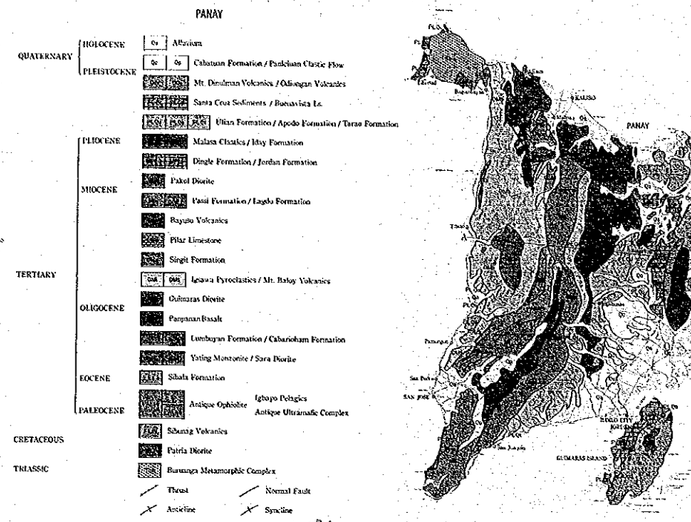
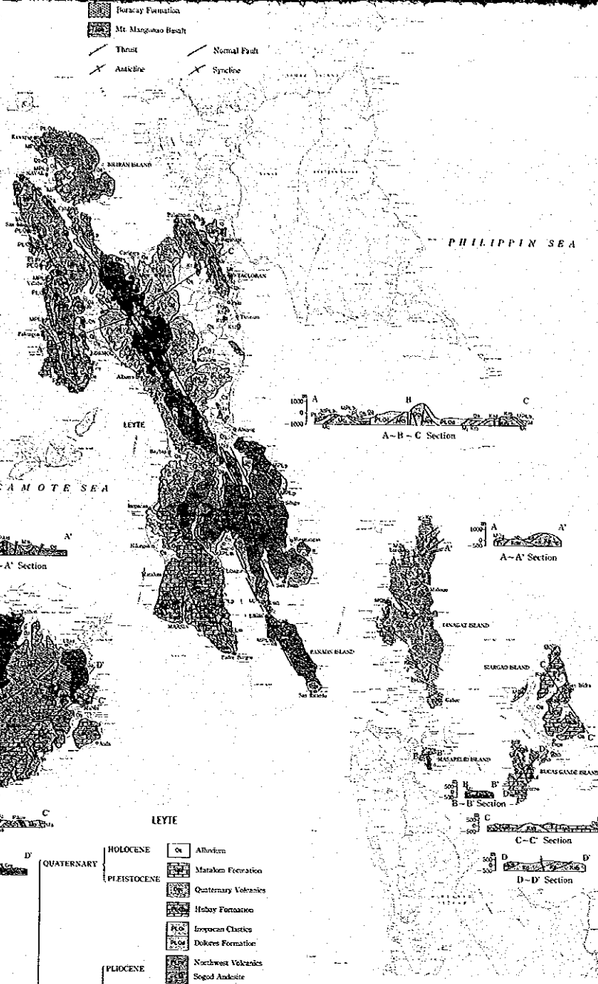
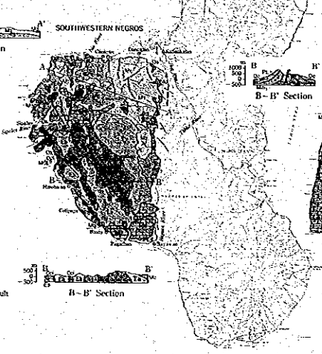
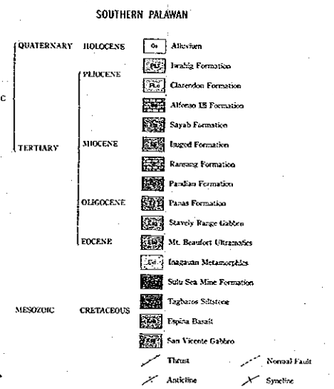
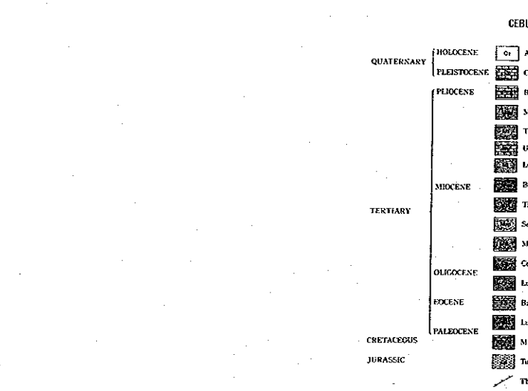


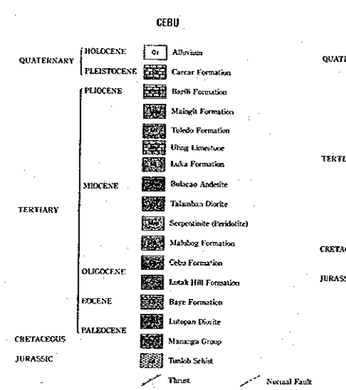


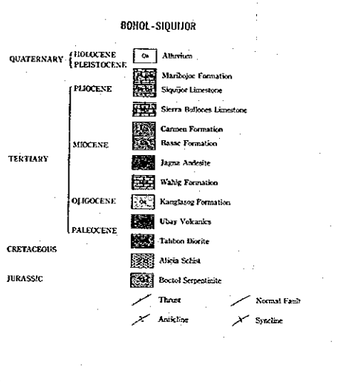


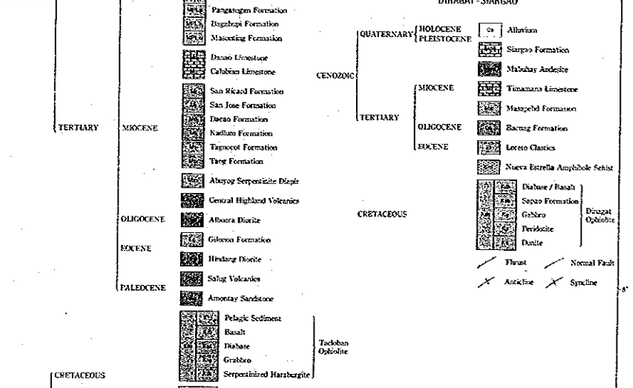










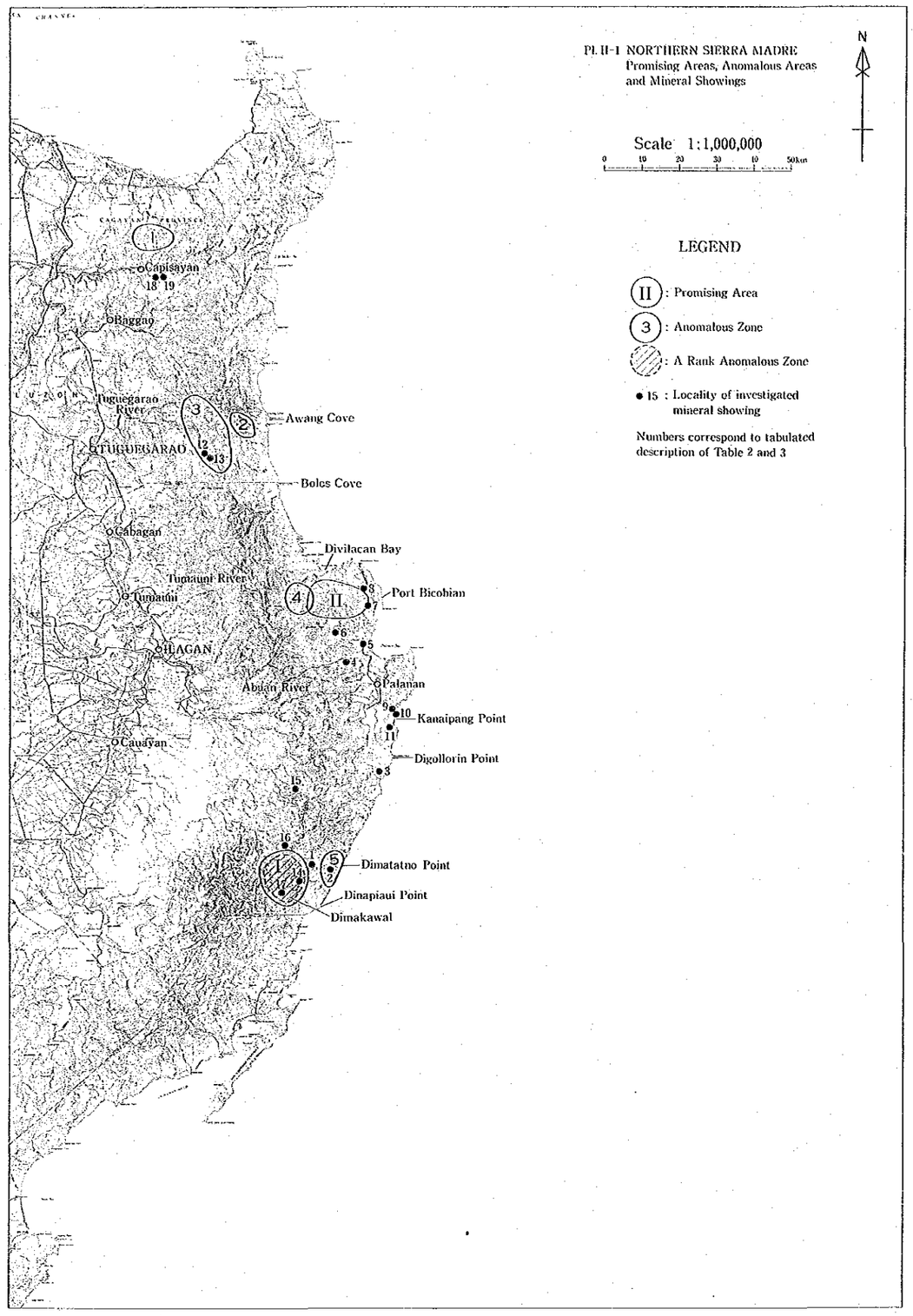


119° 120° 121° 122° 123° 124° 125° 126°

SCALE 1 : 1,000,000

10 0 10 20 30 40 50 60 70 80 90 100km

Printing : Midorikawa Map Printing Co., Ltd.
Use of the map pattern and the color chart is approved by Geological Survey of Japan (1989 G.S.J. No. 1993).


Capisayan
18 19
Baggao
Tuguegarao River
TUGUEGARAO
12
13
Awang Cove
Boles Cove
Cabagan
Divilacan Bay
Tumauni River
Tumauini
Port Bicobian
8
7
6
5
4
ILAGAN
Abuan River
Palanan
9
10
Kanaipang Point
11
Digollorin Point
3
15
16
14
Dimatatao Point
Dinapiaui Point
Dimakawal
Cauayan
I
II
3
4
5
PI. II-1 NORTHERN SIERRA MADRE
Promising Areas, Anomalous Areas
and Mineral Showings
N
Scale 1:1,000,000
0 10 20 30 40 50km
LEGEND
II : Promising Area
3 : Anomalous Zone
: A Rank Anomalous Zone
● 15 : Locality of investigated mineral showing
Numbers correspond to tabulated description of Table 2 and 3

Pl. II-2 SOUTHERN SIERRA MADRE
Promising Areas, Anomalous Areas and Mineral Showings

Scale 1:1,000,000

0 10 20 30 40 50km

LEGEND

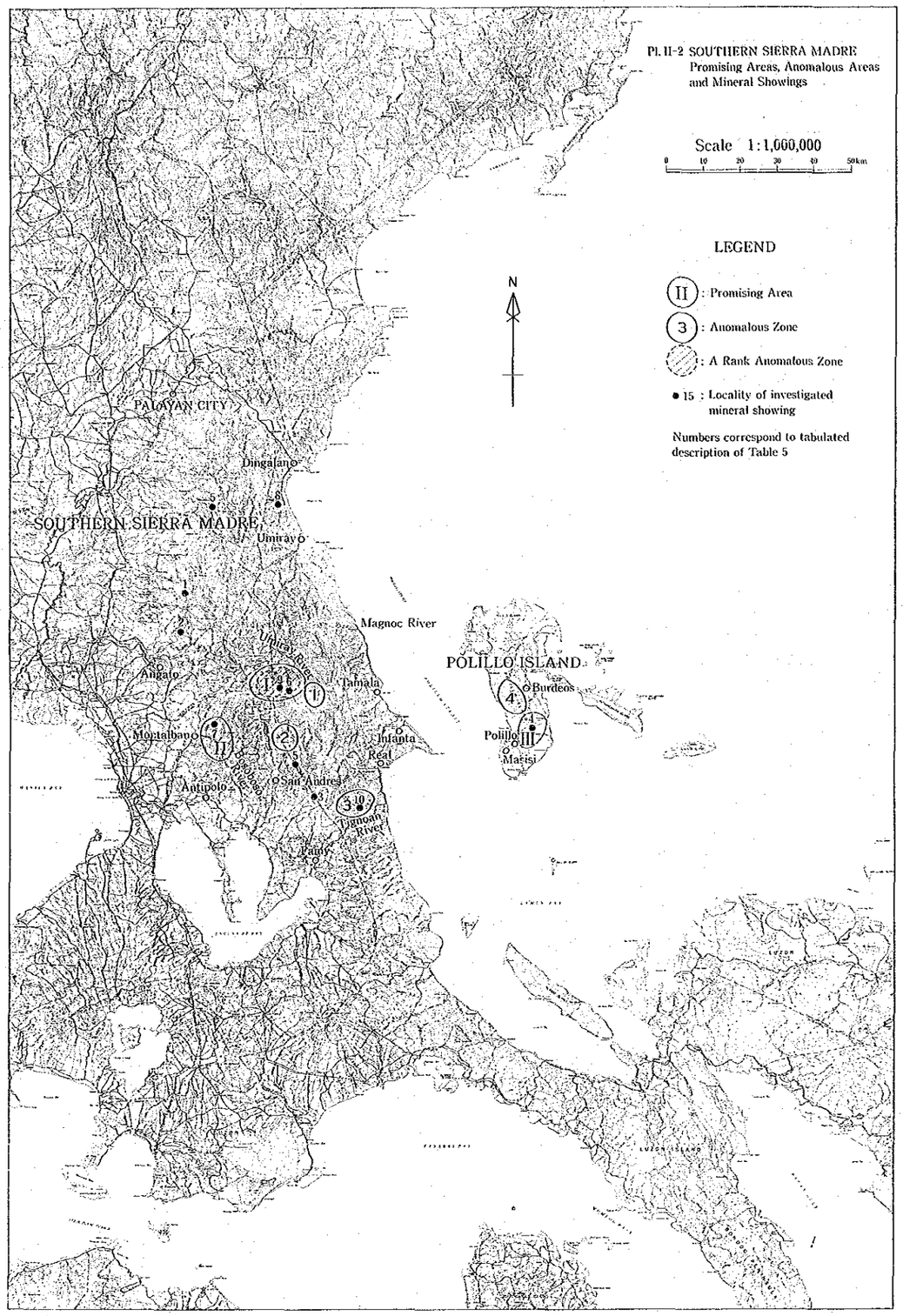
II : Promising Area

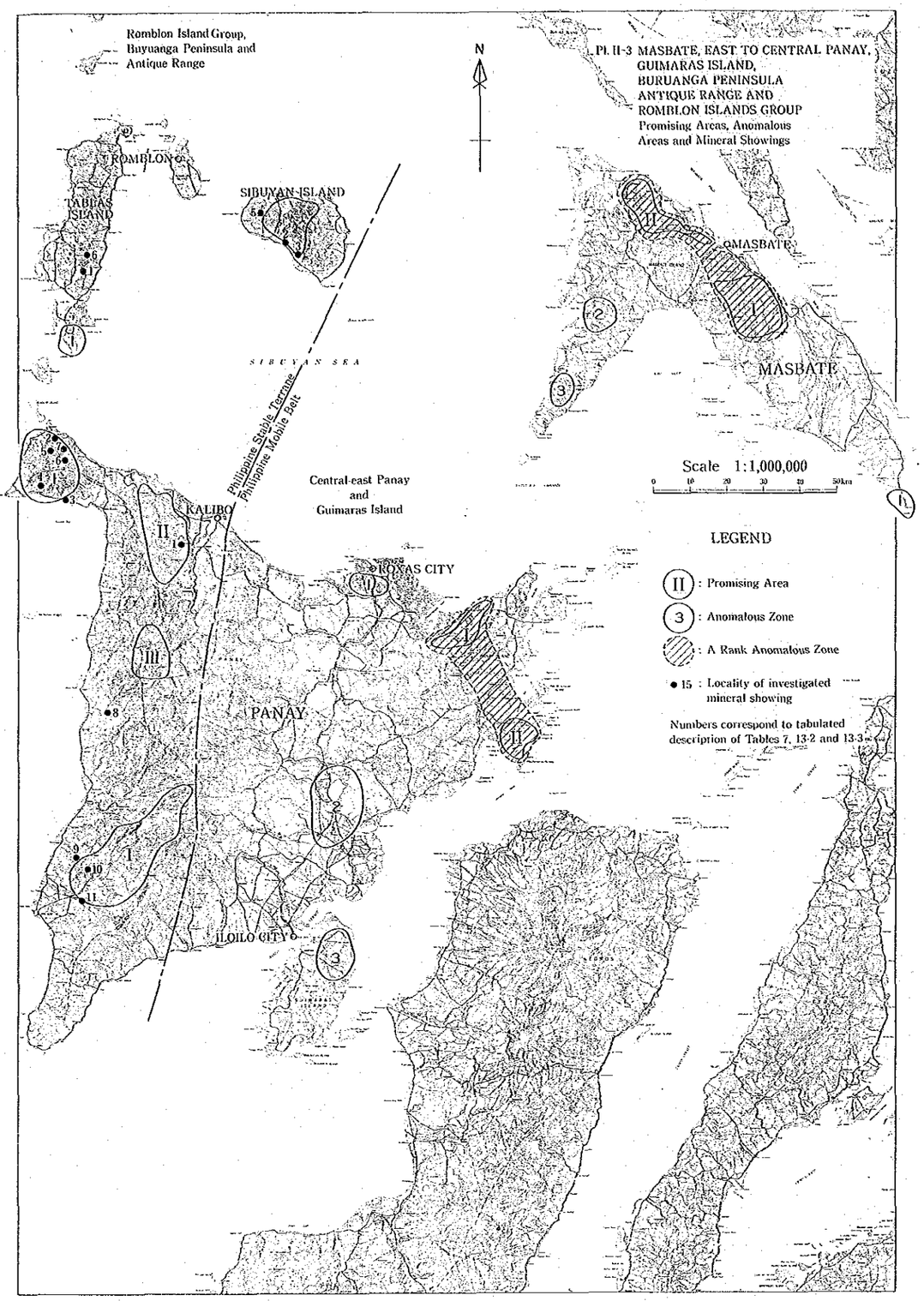
3 : Anomalous Zone

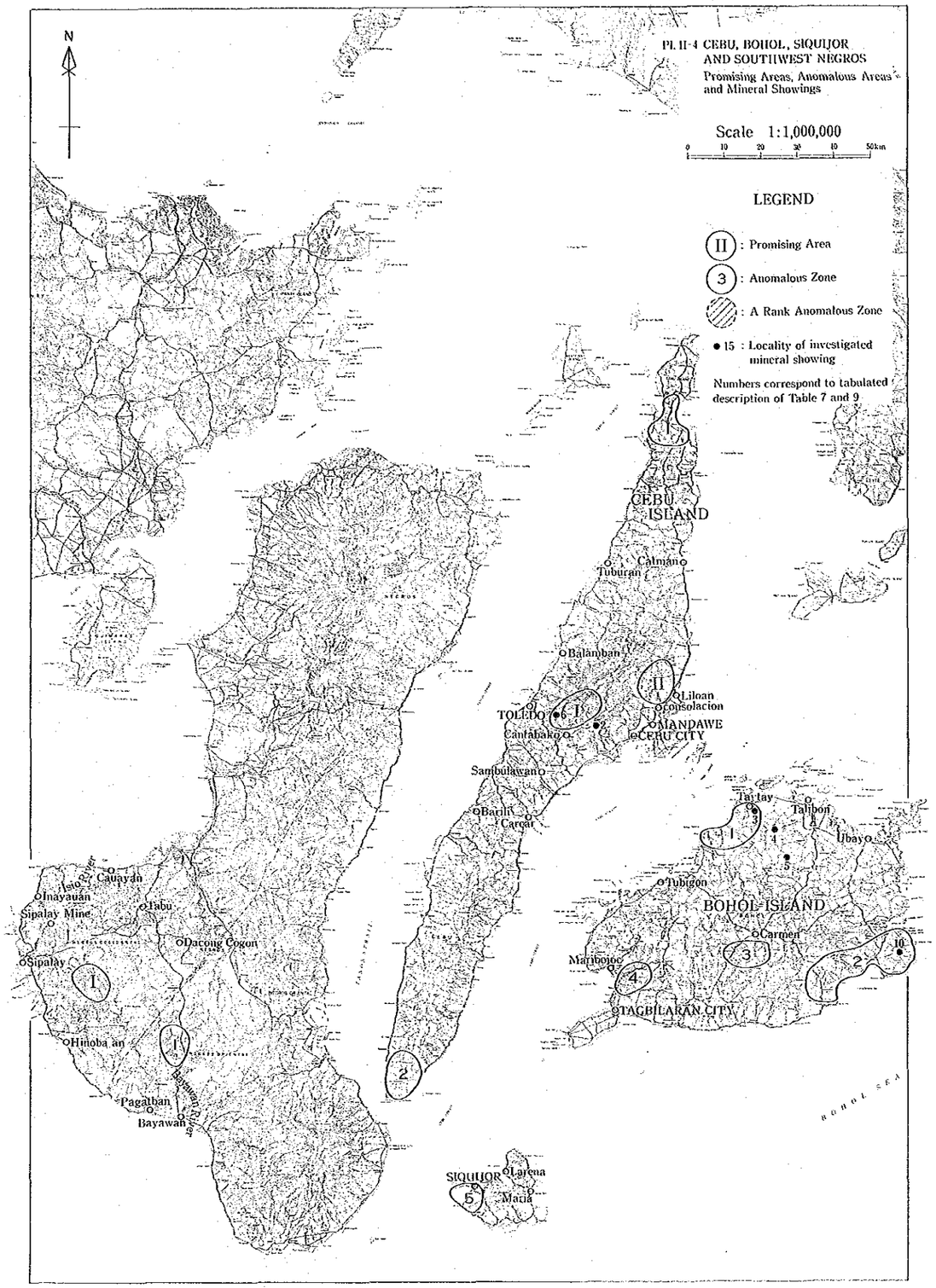
: A Rank Anomalous Zone

● 15 : Locality of investigated mineral showing

Numbers correspond to tabulated description of Table 5




Romblon Island Group,
Buyuanga Peninsula and
Antique Range
N
Pl. II-3 MASBATE, EAST TO CENTRAL PANAY, GUIMARAS ISLAND, BURUANGA PENINSULA ANTIQUE RANGE AND ROMBLON ISLANDS GROUP
Promising Areas, Anomalous Areas and Mineral Showings
ROMBLON
TABLAS ISLAND
SIBUYAN ISLAND
SIBUYAN SEA
Philippine Stable Terrane
Philippine Mobile Belt
MASBATE
Central-east Panay and Guimaras Island
KALIBO
ROXAS CITY
PANAY
ILOILO CITY
Scale 1:1,000,000
0 10 20 30 40 50km
LEGEND
II : Promising Area
3 : Anomalous Zone
: A Rank Anomalous Zone
● 15 : Locality of investigated mineral showing
Numbers correspond to tabulated description of Tables 7, 13-2 and 13-3


N
Pl. II-4 CEBU, BOHOL, SIQUIJOR AND SOUTHWEST NEGROS
Promising Areas, Anomalous Areas and Mineral Showings
Scale 1:1,000,000
0 10 20 30 40 50km
LEGEND
II : Promising Area
3 : Anomalous Zone
: A Rank Anomalous Zone
● 15 : Locality of investigated mineral showing
Numbers correspond to tabulated description of Table 7 and 9
CEBU ISLAND
Calman
Tuburan
Balamban
TOLEDO
Cantabako
Liloan
Consolacion
MANDAWE
CEBU CITY
Sambulawan
Barili
Carcar
Talay
Taliboh
Ubay
Tubigon
BOHOL ISLAND
Carmen
Maribojoc
TAGBILARAN CITY
BOHOL SEA
Cauayan
Inayauan
Sipalay Mine
Tabu
Dacong Cogon
Sipalay
Hinoba an
Pagatban
Bayawan
SIQUIJOR
Larena
Maria

Pl. II-5 SAMAR, LEYTE, DINAGAT AND SIARGAO
Promising Areas, Anomalous Areas and Mineral Showings

Scale 1:1,000,000

0 10 20 30 40 50km

LEGEND

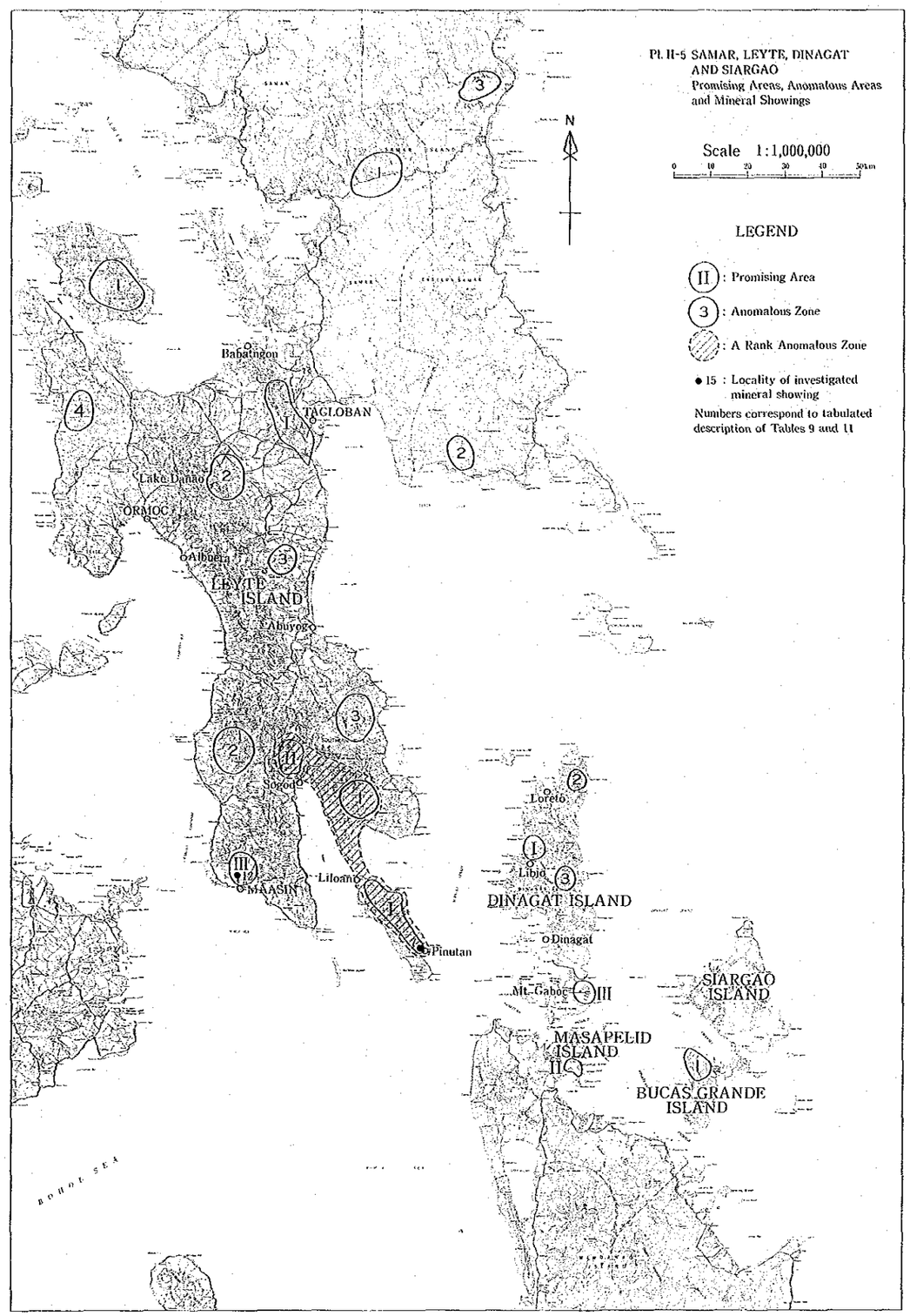
II : Promising Area

3 : Anomalous Zone

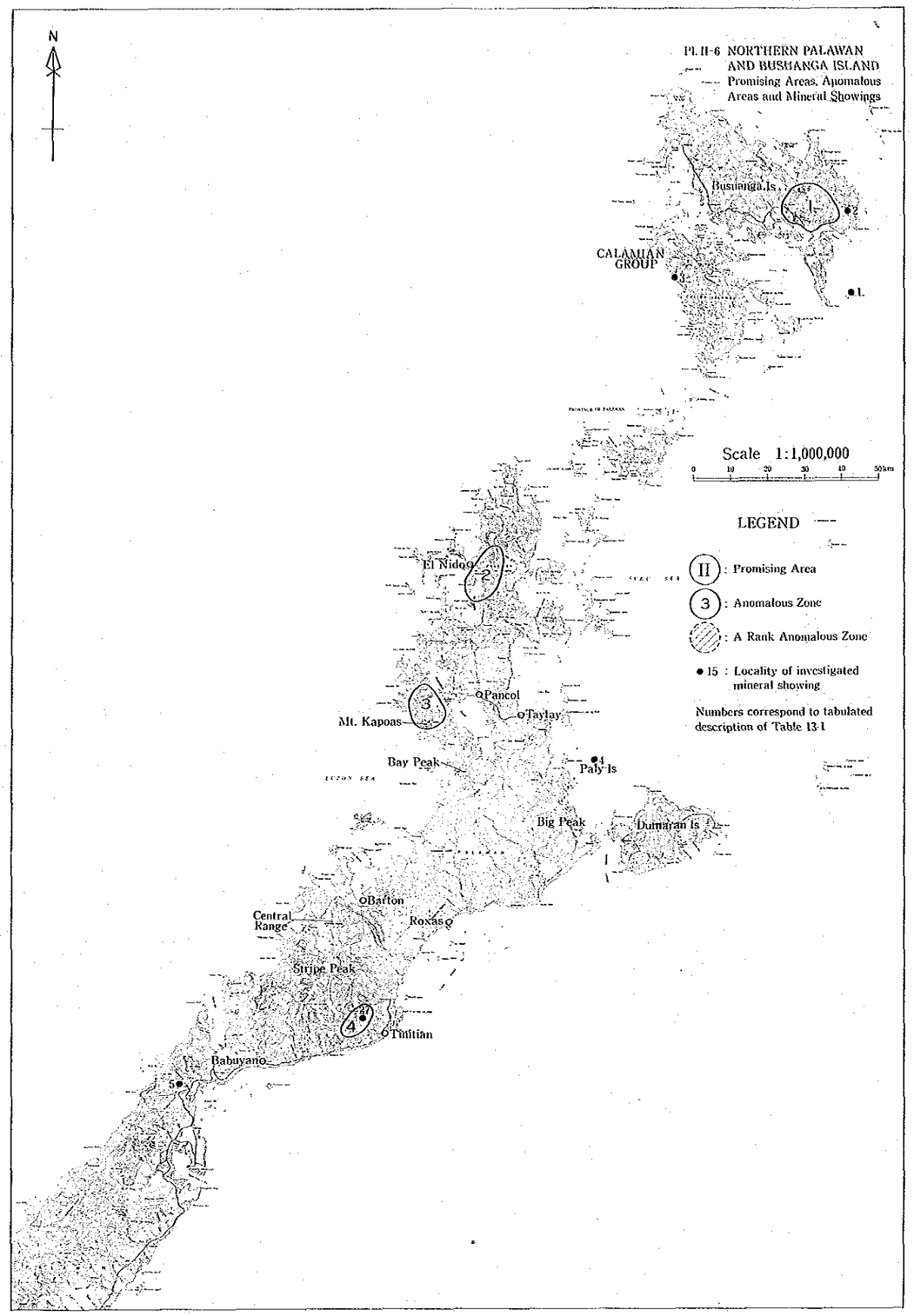
: A Rank Anomalous Zone

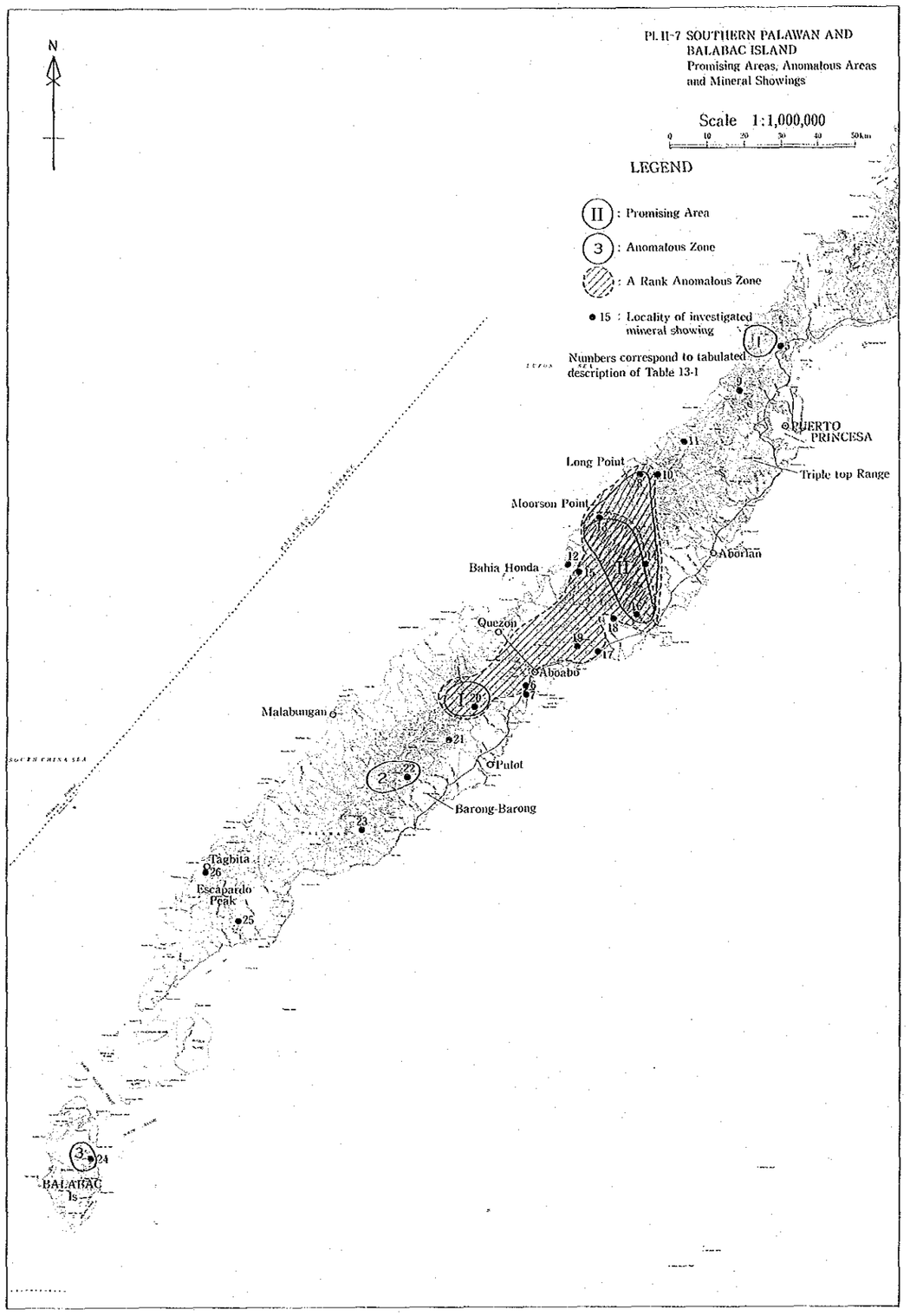
● 15 : Locality of investigated mineral showing

Numbers correspond to tabulated description of Tables 9 and 11



Pl. II-6 NORTHERN PALAWAN AND BUSUANGA ISLAND
Promising Areas, Anomalous Areas and Mineral Showings




Pl. II-7 SOUTHERN PALAWAN AND BALABAC ISLAND
Promising Areas, Anomalous Areas and Mineral Showings
Scale 1:1,000,000
0 10 20 30 40 50km
LEGEND
II : Promising Area
3 : Anomalous Zone
: A Rank Anomalous Zone
● 15 : Locality of investigated mineral showing
Numbers correspond to tabulated description of Table 13-1
PUERTO PRINCESA
Triple top Range
Long Point
Moorson Point
Aborlan
Bahia Honda
Quezon
Aboabo
Malabungan
Pulot
Barong-Barong
Tagbita
Escapardo Peak
BALABAC Is
SOUTH CHINA SEA