Table II-2-8 Geology of Larap-Exiban area
From BMG(1984)

stratigraphy	*lithology*	*age*	
Ophiolite sequence	ultramafic rocks, gabbro → surpentinized	pre-Cretaceous?	
Universal Formation	conglomerate, sandstone, shale, limestone	Late Paleocene - Eocene	
Larap Volcanics	andesite, tuff breccia, lapilli tuff, welded tuff	Oligocene	
Bosigon Formation	conglomerate, shale, sandstone, limestone, basalt,	Early Miocene	
Santa Elena Formation	conglomerate, sandstone, shale, limestone	Late Miocene	
Vinas Formation	sandy limestone, shale	Pliocene	
Macogon Formation	dacitic volocaniclastics, tuffaceous shale, basalt	Pliocene	
Intrusives			
Paracale Granodiorite	medium-coarse gr. granodiorite	Middle Miocene	14.9 Ma (Bt; Wolfe, 1981)
	Pl, Kf, Bt, Qtz; foliation at the margin		17.1±0.9 Ma (Bt; UN, 1987)
Tamisan Diorite	Hbl diorite - quartz diorite	Middle Miocene	
	medium gr. Pl, Hbl, Qtz		
Dacite porphyry	Qtz, Pl, Bt phyric, small stocks	Pliocene	2.4±0.3 Ma (UN, 1987)
Syenite	dike - sill in Larap		
Andesite	dike - sill, Pl, Hbl phyric		

15 ppb, Cu: 632 ppm and Mo: 137 ppm, which indicates the accumulation of elements characterizing the porphyry type. X-ray diffraction of the country rock shows: potassium feldspar, quartz, halloysite, plagioclase, sericite and amphibole. Since their thin sections have not been examined, it is difficult to distinguish minerals which were yielded by alteration from those by metamorphism. According to the visual observation, it does not seem to be primary but hydrothermal alteration or hornfels products. Halloysite seems to have been yielded by weathering.

PTH386 is the same green hornfelized andesite as the country rock of PTH385. Magnetite stringer can be observed. Magnetite stain is also observed. From the production conditions, it is understandable that this magnetite was yielded by hydrothermal alteration.

PTH387 has greenish gray hornfels as a country rock and a developed stockwork of quartz veinlets (Appendix 14: PH34). The country rock has experienced silicification. It seems to be andesite because of its fine feldspar phenocryst. Stain of magnetite is observed. Under the microscope, it is possible to see that plagioclase phenocryst is completely replaced by albite, epidote and quartz. Amphibole phenocryst (judging from its outlook) is replaced by epidote (pistacite) and green biotite. The matrix also has a combination of abundant fine-grained green biotite, epidote, potassium feldspar and quartz. Garnet (andradite) also is rarely found. Thus, PTH387 has a assemblage of skarn minerals. Magnetite stain and a small amount of pyrite are also recognized. Quartz veins are about 0.5 cm wide and a space between veins is 3 to 10 cm. Fluid inclusion temperatures of the quartz veins were measured. They were: Th=283 to 355°C. The salinity was 5.71 to 7.02 wt% NaCl equiv. No hypersaline inclusion can be observed.

＜Penarco Mine＞

This is a skarn iron deposit. At the site of a small open pit mine which still has old three benches, massive magnetite orebody is also in existence. Among the rocks (PTH388), magnetite, pyrite, biotite, epidote and pyroxene can be observed. The biotite is hydrothermal. The microscope shows the texture of a hypabyssal rock. It consists of anhedral phlogopite-like biotite and mosaic potassium feldspar matrix. Many of the potassium feldspar were produced by metamorphism or hydrothermal alteration (secondary). It seems that a small amount of primary plagioclase also existed. Quartz, however, is small in amount. Except for those produce by alteration, there is no primary one. It is like syenite or monzonite. Matrix consists of fine-grained green biotite and magnetite produced by alteration and the rim of phlogopite-like biotite has turned green. Pyrite and chalcopyrite in small amount are also observed. They exist often with quartz. Limestone is also observed, which seems to be one of the host rock. Philippine Iron Mining Co., Ltd. has reported that they also found limestone in the deep bottom when they carried out drilling.

＜Pangono Prospect＞

There are some old mines where gold was mined, but it is not known whether they belonged to Pangono Prospect. The direction of the old mines is N70°E. Its alteration is weak and the alteration temperature seems to be low. The country rock is dacite porphyry (PTH389). Feldspar phenocrysts between 3 mm and 1 cm are significant. Under the microscope, rocks appear to have been completely silicified and replaced by potassium feldspar. PTH390 is a silicified rock which was collected at the same silicified host rock adjacent to the vein of the outcrop as PTH389. There is pyrite dissemination. Its alteration is mixed layer clay alteration. X-ray diffraction proves: potassium feldspar, quartz, chlorite, sericite/smectite mixed layer clay, and pyrite. Judging from the occurrence, mineralization of this area can be epithermal, but the analysis results are Au: 260 ppb, Ag: 1.4 ppm, As: 184 ppm, Pb:1350 ppm and Zn:618 ppm, showing a tendency of mineralization of base metals in addition to gold mineralization. This is similar to that of sub-epithermal low sulfidation vein observed in other prospects of this area.

<Igang Prospect>

PTH391 and 392 correspond to Igang Prospect in UNDP (1987). Stockwork of quartz veinlets have developed (Appendix 14: PH35). The veins are 3 mm to 1 cm and a space between veins is 15 to 40 cm. The country rock (PTH392) is dark green amphibolite. Pyrite dissemination is significant, has oxidized and decomposed to generate acidic alteration. The analysis results of the quartz vein (PTH391) are Au: not/ss, Cu: 309 ppm and Mo: 52 ppm. Unfortunately, the sample is not enough for analysis of gold, but, it shows the typical element accumulation of the porphyry type mineralization.

The fluid inclusion temperature of the quartz vein was measured. It was Th= 217 to 281°C. The salinity was between 3.23 and 7.73 wt% NaCl equivalent. From the temperature and the salinity, it seems to be a sub-epithermal vein.

PTH393 is a so called mesothermal quartz vein. The country rock is argillized plutonic rock (diorite?). After argillic alteration, it was strongly weathered. It seems that diorite intruded into amphibolite of PTH392. It is possible to assume that mineralization occurred with this intrusion due to the same type of hydrothermal activity as in Paracale area. Two quartz veins which are 20 cm and 6 cm wide respectively have intersected (Appendix 14: PH36). The wider quartz vein has a strike of N60°W and the dip of 75°E. This vein is cut by a quartz vein of N40°E and 74°W and resulted in displacement. The analysis of a 20 cm wide vein resulted in Au<5 ppb, which does not indicate mineralization. The fluid inclusion temperature is Th= 185 to 237°C. The concentration of salt is between 2.74 and 6.16 wt% NaCl equivalent.

According to a local guide, Normandy Company of Canada came to this site last year with Altai Resources Company (Mr. Oriarte's company which owns the mine claim of this area).

PTH394 is a quartz vein of an old mine which PIM Company investigated. The direction of the old mine is N70°E. The local guide, however, said that the quartz vein meets at right angles with the old tunnel. In the vein, there are pyrite and chalcopyrite and the latter is coated with covellite.

PTH395 was an outcrop of an old mine which was excavated by local residents up to 1993. At the mouth, quartz veins (PTH396) having width of 5 cm and 8 cm respectively are observed. The host rock is hornblende granodiorite and tonalite (PTH395). Under the microscope, it was found that compared with Tamisan Diorite, PTH395 had less mafic minerals and more quartz. Hornblende and biotite became fine-grain by mylonitization. Inside the mine, development of quartz vein stockwork was observed. The width of veins varies between 0.5 and 4 cm. The space between veins is between several cm and 20 cm (Appendix 14: PH37). The analysis results is: Au: 10 ppb, Cu: 436 ppm and Mo: 126 ppm; thus, its tendency of concentration of elements is characterized by a feature of porphyry type mineralization.

<Batobalani Pit>

Batobalani Pit is about 1 km apart from the Batobalani village or can be reached in a 15 minute walk.

Tigbinan Formation and Universal Formation of the Paleocene-Eocene are distributed and both formations are intruded by Tamisan Diorite. Extremely altered andesite was mainly found. They were featured particularly with a large amount of plagioclase phenocryst and partially contained a small amount of hornblende. Since comparatively upper part of the Universal Formation consist of more andesite lava than sedimentary rocks (according to the BMG Region V geologist), it seems that upper Universal Formation than that in Mt. Bagacay Area is distributed. Although outcrops of the Tamisan Diorite could not be verified, many floats below 50 cm in diameter of fine-grained diorite containing much hornblende ordinarily were confirmed.

Batobalani Pit was excavated in a small scale ridge extending in WNW-ESE. In this Pit, Philippine Iron Mine (PIM), a state-run enterprise, carried out open pit mining of iron ore for about 10 years since 1947. Ores were first transported overland about 15 km to Larap in the northwest and exported to Japan. Its production and other details are unknown. The open pit has been already covered with low bushes and weeds. Since it was dangerous to enter, the outcrop could not be confirmed. The ores or floats were about 20 cm in diameter at maximum, characterized by much finer grains than those in Malapingan of Mt. Bagacay area. The ores in Batobalani area are generally highly oxidized due to the size, and their most part was replaced with hematite, which is a common occurrence (PSM287: Au: 25 ppb and Cu: 630 ppm). Copper mineral was not found among iron ores. In the surrounding areas, there was no panning site of placer gold.

<Submakin Prospect>

Submakin Prospect locates about 2 km south-southwest of the Batobalani Pit and a four-wheel-drive vehicle can be drawn up to it from Batobalani village. Like Batobalani Pit, PIM started mining of Submakin Prospect in 1947 and closed it in 1967 when they were dissolved. Just as in Batobalani, a shipping destination of their ores and production are not known. The deposit was originated in the Universal Formation of Paleocene-Eocene. Distribution of intrusion in the surrounding areas is not known.

In the survey area, outcrops of iron ore containing much magnetite were confirmed. They were verified at two places in the south and the north of the area. The outcrop of the southern part has formed a small cliff at the direction of N80°W and continues about 100m. The part adjacent to such an iron ore consists of andesite with a significant argillized alteration (smectite) and their boundary is extremely clear. The iron ore is similar to that of Batobalani Pit but it differs from the other in the points of coarser grains and partially contained abundant copper, lead and zinc. Near the outcrop in the northern part, there is an abandoned ore storage. The sample PSM289 collected there includes green copper mineral which seems to be malachite and blue sulfate (Au: 415 ppb, Ag: 34 ppm and Cu: 1.29%). There are also galena and sphalerite (Pb: 6.43 % and Zn: 9.5 %). In the iron ore crop, quartz veinlets are also observed (PSM290: Au: 90 ppb, Ag: 1.2 ppm, Cu: 194 ppm, Pb: 250 ppm and Zn: 470 ppm). The quartz vein is about 5 to 10 cm wide and extends in strike N25°E and a dip of 35°E. Its structure is colorless or white coarse-grained quartz. In the vein, there are druses where euhedral quartz crystals below 5 mm in direction of c-axis are observed. The homogenization temperature and the salinity of the fluid inclusion are 180 to 241°C and 5.41 to 8.14 wt% NaCl equivalent respectively.

<Meycuayan Prospect>

Meycauayan Prospect is a name which indicates the entire drainage on a small scale which locates 4 km west of the Batobalani village. Up to the mouth of the drainage, it is accessible by a four-wheel-drive vehicle. The Meycuayan Prospect is a prospect of copper and molybdenum which locates 4 km west of Batobalani village. According to the existing materials (UNDP, 1987), it consists of a mineralized quartz vein stockwork of a quartz-sericite alteration zone with diorite. In the neighboring area, the development of an acidic alteration zone of pyrophyllite-diaspore quartz-alunite is recognized(UNDP, 1987). Values of geochemical anomaly of the soil which have been reported are Cu: 250 ppm and Mo: 63-208 ppm.

The field survey was carried out along the drainage in the west of Batobalani village. The outcrops observed in the lower reaches of the drainage near Batobalani village consisted of hornblende andesite which was abundant with plagioclase mostly unaltered. Andesite was broadly distributed in the survey area. At the upstream of the drainage or near Meycauayan prospect, diorite has intruded into the andesite and a hydrothermal alteration zone is distributed nearby. Within the range of the field survey which took place, the hydrothermal alteration zones were found in the northeast and the south parts of diorite respectively. Meycauayan prospect among them is included in the alteration zone of the south.

The diorite is a rock type which contains much fine-and medium-grained hornblende and which is compared with Tamisan Diorite and the diorite itself sometimes has partially altered to kaolinite clay. The alteration in the northeast of diorite can be observed along the branch drainage of about 500 m northeast of diorite. In this area, andesite slightly silicified is distributed (PSM293). The andesite is significantly stained and partially consists of clay of pyrite and kaolinite. In the area where silicified andesite distributes, prospecting by PIM took place toward the end of the 1960s and prospecting roadways of unknown length were dug in addition to one 250 ft vertical bore hole. The object of the prospecting seems to be gold, but results are unknown.

The alteration zone in the southern diorite is distributed centering the drainage of Meycauyan Prospect which extends in the direction of southwest. Like the alteration zone in the northeast, slightly silicified and argillized andesite outcrops are distributed (PSM294, PSM295: quartz, sericite, chlorite/smectite mixed layer clay, and goethite; Au: 20 ppb, Cu: 287 ppm, Mo: 125 ppm and Zn: 302 ppm). Extremely silicified floats are observed. Blocks having a diameter of about 2 m at maximum are observed (PSM297 and PSM298). Strongly silicified rocks existed only as floats, but could not be found their outcrops. Such altered andesite and strongly silicified rocks often happen to accompany quartz veinlets having a diameter of about 2 mm (PSM294 and PSM 298). The distribution area of altered andesite seems to have been noticed as a panning site of placer gold in the past.

In the south of the altered andesite distribution area or the neighboring area of the southern edge of the drainage, outcrops of tonalite-granodiorite are recognized. (PSM296a: Cu: 173 ppm). This rock contains comparatively large amount of quartz and potassium feldspar and is different from Tamisan Diorite in the point of its coarser-grains and mineral abundance. Coarse-grain pyrite is observed. Under the microscope, in addition to the pyrite, minute chalcopyrite can be seen. Aplite dike veins are observed (PSM296b: Cu: 87 ppm). Five to six veins are found in the outcrops of about 3 m wide. The widest vein is 10 cm, the strike is N25°E and the dip is vertical. This vein group has the same parallel structure.

The mineralization of this area is considered, just like Bagacay area, to have been yielded under the condition which is comparable with the porphyry type environment. Meycauayan Prospect was expected to bear porphyry type copper and molybdenum, but neither of phyllic alteration nor quartz stock network vein was found during this survey. However, part of altered andesite with abundant limonite (PSM295) and quartz diorite with abundant pyrite (PSM296a) have copper concentration at a geochemical anomaly level. It may be confirmed as a source rock which has brought geochemical anomaly in soil mentioned in the previous report.

<Tumbaga Prospect>

From a trunk road connecting Batobalani with Jose Panganiban, an unpaved road leads to the scene.

Hills including a 304 m peak have distribution of porphyritic andesite or diorite porphyry; on the flat land below the altitude 100 m on the northern side of the hills, there is a tendency for andesite, andesitic tuff or tuffaceous sandstone (PKY328) to distribute. Although there are no outcrops which show the relationship of both nor other information which enables a comparison with the surrounding geology, it may be appropriate to consider that the former corresponds to Tamisan Diorite and the latter to Universal Formation or Larap volcanic rocks.

Even now, in this area, a few groups of small scale miners are exploiting Au (Appendix 14: PY49, 52; PY51, 50). Pyrite-quartz veinlets have developed over a wide area. Alteration of the vein edge (PKY332) is characterized by sericite alteration. In addition, alteration porphyritic andesite (PKY332) which is considered to be the host rock is also characterized by sericite alteration. The vein strikes well concentrate on N10°E while dips vary from 55°E to 40°W. The interval of the veins are almost even. It is considered to be a stockwork controlled by the strike N10°E. According to the small scale miners who engage in mining there, veinlet swarm which are seen near the earth's surface gather at the depth of (several meters) to form a main vein. The output of gold is not known. We have obtained the information that the cutoff grade is 2.5 g/t. Once 25 g of Au was collected from ores of about 40 kg (which corresponds to a shipping bag of ores or 625 g/t of Au by simple conversion, according to local information). Analysis results of the samples collected by this survey were generally 5 g/t of Au, including the maximum 8.39 g/t of Au (PKY329: vein width 2 cm). In addition, the results showing Cu mineralization including the maximum 0.35 % of Cu (PKY330) were also obtained.

Measured fluid inclusion homogenization temperatures of the samples of quartz veins PKY327A, 329 and 333 were respectively 295 to 319°C, 199 to 240°C and 267 to 295°C. The salinities were respectively 5.41 to 6.88 wt% NaCl equiv., 0.35 to 0.71 wt% NaCl equiv. and 5.41 to 6.45. wt% NaCl equiv. As for the inclusion of PKY327A and 333, boiling can be estimated because a vapor-liquid ratio has been greatly changed.

Judging from the above observation, this area has stockwork type gold deposits which seem to exist with porphyry and significant mineralization of Cu. In the future, it will be necessary to carry out a systematic survey to evaluate this area as a bulk minable low grade copper and gold deposit.

<Paracale National Mine>

From a trunk road connecting Batobalani with Jose Panganiban, an unpaved road leads to the site.

On the earth's surface, tuff, tuffaceous sandstone or andesite are distributed. In the mine (depth: several ten meters), ultrabasic rocks were verified in waste rocks probably due to the distribution of ultrabasic rocks (Appendix 14: PY57). In addition to a pyrite-quartz vein (Manila vein) having N10 to 20°E strike and 1 to 0.3 m width and the total length of 500 m, 2 veins (Belmeho vein and the other) are the major veins. It was told that Au grade of Manila vein is 30 g/t at maximum. The ore texture of Appendix 14: PY55 and PY56 are very characteristic. The samples obtained during this survey show: Au grade 14.0 g/t at maximum (PKY336: the vein width is over 20 cm). Furthermore, Cu grade of 0.78 % (PKY336) at maximum was also obtained.

This is a stockwork type gold deposit which probably exists with porphyry. Cu mineralization is also significant. It is necessary to evaluate them systematically as bulk minable low grade copper and gold deposits.

<Capacuan Mine>

This area is known as an Fe deposit zone and open cut mining used to take place in the past (Appendix 14: PY58). From a trunk road connecting Batobalani with Jose Panganiban, an unpaved road leads to the site.

The site of the old open pit mining had been severely altered by weathering and it was difficult to specify original rocks. Distribution of metasedimentary rocks was, however, confirmed from place to place.

Oxidization by weathering is significant, but some pyrite-magnetite veins were confirmed. Copper oxide mineral (chalcanthite) was rarely observed. The sample of pyrite-magnetite vein (PKY339) shows Cu grade 4.73 %. Au grade was 20 ppb.

It seems to be iron deposit having stockwork type magnetite veins as a primary ore deposit. Copper mineralization was confirmed. Its grade was high (PKY339) and it may be also a porphyry Cu-Fe deposit judging from its relation with the peripheral geological deposits. It is necessary to evaluate its Cu mineralization.

7) Potential

There are many deposits and prospects. Judging from the occurrences, quartz fluid inclusion temperatures and the assemblage of alteration minerals, the deposits and prospects which are distributed in this area are placed in the conceptual model of a magma-hydrothermal system as shown in Fig. II-2-18. Namely, that environment may be in higher temperature of hydrothermal system near intrusives stocks.

Many sites in this area were surveyed in the past. At present also, some places surrounding the prospects are being explored. We cannot say, however, that most of prospects and their surrounding areas are sufficiently investigated and that they require further thorough exploration. Particularly, near Tumbaga and Matalang, it is possible that porphyry deposits bearing comparatively high grade gold exist; therefore, systematic investigation is highly recommended.

UNDP (1987) reported that this area has distribution of small scale but much dacite porphyry which belongs to the period of 2.3+/-0.3 Ma. During the investigation of this time, a part of it was observed in Pangono area, but it was impossible for us to clarify the characteristics of the original rocks due to their strong alteration. Since the alteration is epithermal, it can be estimated that this area has a distribution of igneous activities of Pliocene epoch like the Central Belt, it may be small though. There is a possibility of distribution of epithermal gold deposits with them.

8) Mine Claim

Many MPSA have been set up.

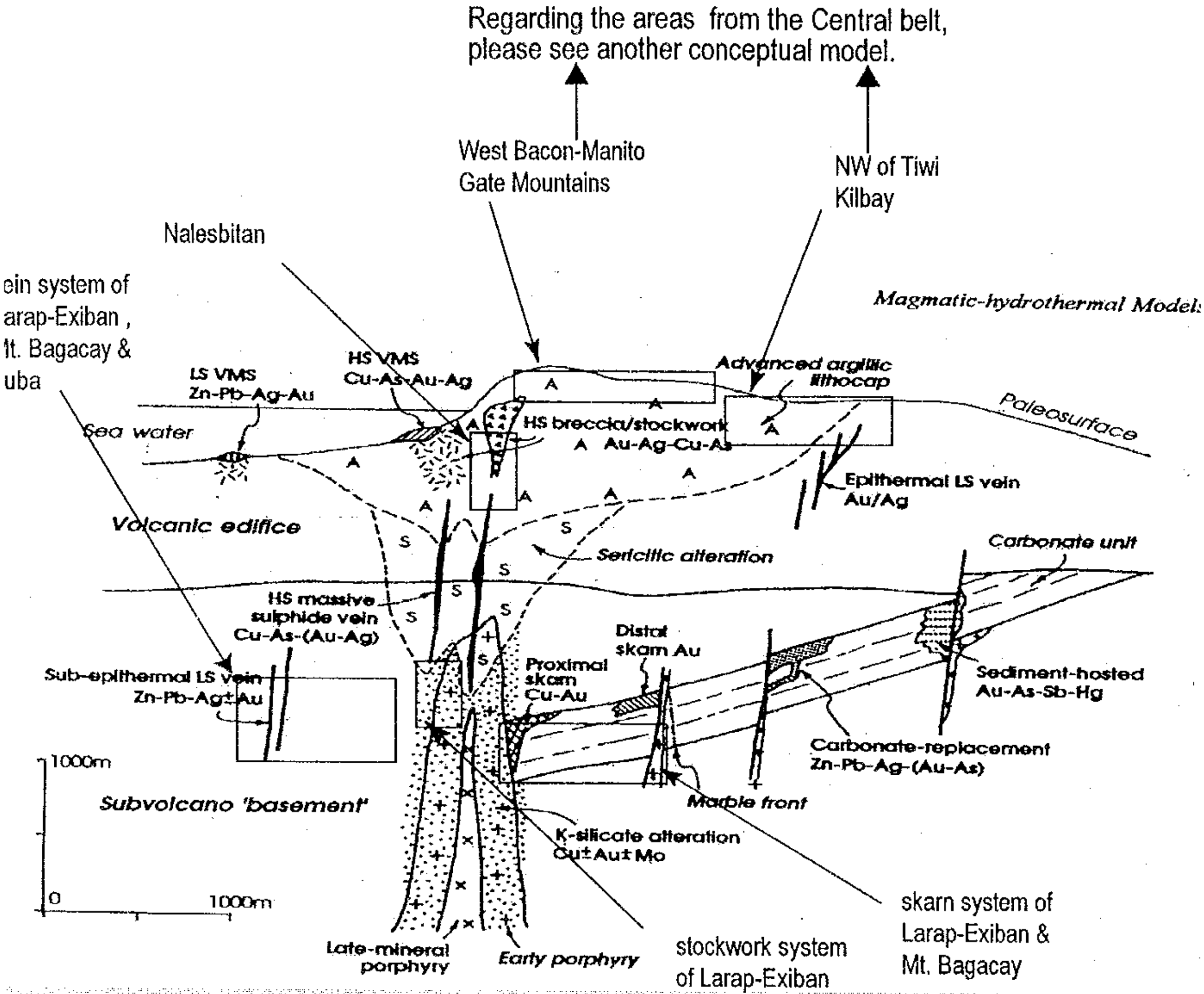


Figure 1. Idealized lateral and vertical zoning of deposit types and principal metals in an intrusion-centered system. The system contains a carbonate unit in the "basement" and a partly submarine volcanic edifice in its upper parts. Note outward zoning in carbonate host rock from porphyry Cu → proximal skarn → distal skarn → carbonate replacement → sediment-hosted, and in the volcanic edifice from high-sulfidation (HS) epithermal and VMS → low-sulfidation (LS) epithermal and VMS. Upward zoning is from porphyry Cu → high-sulfidation massive sulfide vein → Au-rich stockwork, breccia and VMS, and is only modestly telescoped (see text). The faults and veins depicted perpendicular to the section are more likely to be subparallel to it in order to intersect the stock. The occurrence of all these deposit types in a single system is not implied. Modified from Sillitoe (1989) and Sillitoe & Bonham (1990).

Fig. II-2-18 The location of the survey areas on the conceptual model of magma-hydrothermal system. taken from Sillitoe (1995)

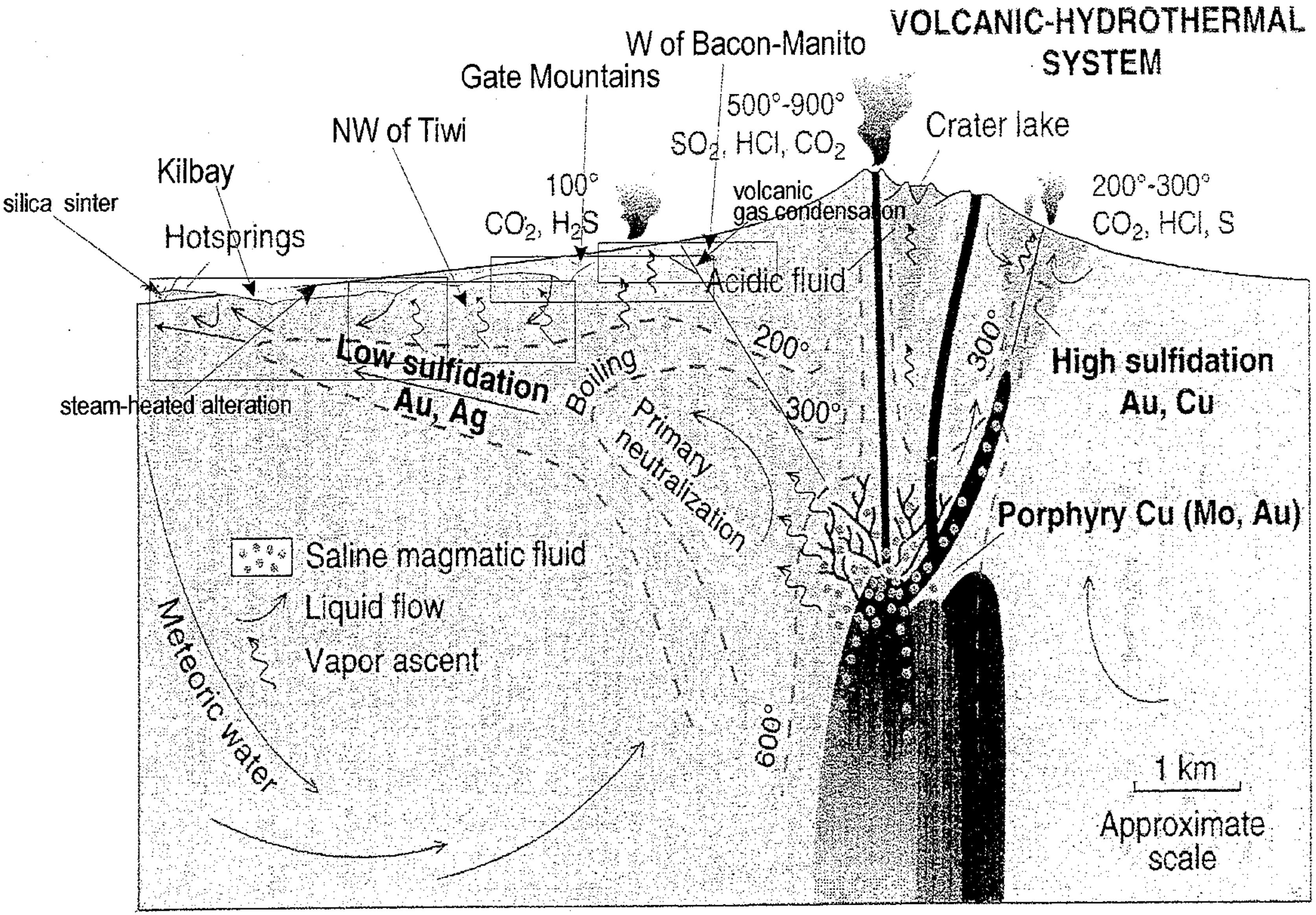


Fig. II-2-19 The conceptual location of the areas from the Central Belt on the schematic cross-section from showing shallow sub-volcanic intrusions and associated stratovolcano, and environments deduecd for formation of porphyry Cu, and high- and low-sulfidation epithermal ore deposits.(modified Fig, 1.1 of "Epithermal gold deposits: Styles, characterictics, and exploration", Special Pub. No.1, Resource Geology)

Chapter 3 Discussion

3-1 Re-examination of Airborne Geophysical Data

Airborne geophysical survey indicated that low magnetic and high potassic responses may show the alteration zone. Magnetic "flat region" (Irvine and Smith, 1990) also seems to be the alteration zone. We took account of the indication choosing the survey route in the field survey. Radiometric and magnetic anomalies may not always express the real ground situation. Here we tried to re-examine the magnetic and radiometric data in comparison with the results of the field survey. And we will show the usefulness of the airborne geophysical data in area where there is difficult access and poor exposure due to rugged topography and thick vegetation like the Bicol area.

3-1-1 Airborne Magnetics

1) Legazpi Area

Areas that have an anomalous magnetic low signature are (Fig.II-3-1):

a. WNW-ESE trending gullies along the Bac-Man Fault
b. The eastern portion of the Bac-Man Fault that includes the gullies of Cawayan Crater
c. Within the upstream section of the Buyo-Calpi River, adjacent to the Bac-Man Fault Zone.
d. EW trending gullies of the Cawayan River up to the Bac-Man Fault zone.
e. NE trending gullies of the Pili-Cumadcad River
f. NE trending gullies adjacent to Salvacion Spring.

Fig.II-3-1 also shows the location of hydrothermal alteration zones. The hydrothermal alteration zones in the EW trending Gullies of Cawayan River (d) correspond to areas with a magnetic low signature and magnetic "flat" regions. The low magnetic signature in the upstream section of the Buyo-Calpi River adjacent to the Bac-Man Fault Zone (c) also represents a zone of hydrothermal alteration.

The airborne magnetic data shows that an area with a low magnetic signature exists in the eastern portion of the Bac-Man Fault zone and includes the gullies of the Cawayan Crater. This low magnetic signature is due to the presence of the hydrothermal alteration zone of the Bac-Man geothermal field.

From field observations a sporadic distribution of hydrothermal alteration zones occur within the three areas (a, e and f), in contrast to the continuous low magnetic zone within the area. The hydrothermal alteration zone may also be continuous but unfortunately, the outcrops are covered by landslide debris. The alteration associated with areas "b" and "d" may be comparable to that of areas "a", "e" and "f" since they are adjacent to the same fault zone.

Fig.II-3-1 also shows the location of a gravity high region and low resistivity zone (Los Banos and Oliver, 1997; Layugan, 1986). The figure also shows the inferred faults as reflected by the gravity distribution. The WNW- trending gullies along the Bac-Man Fault bound the southern margin of the high gravity region.

Circular shaped magnetic responses in the NE of the area, initially thought to represent an intrusive body (Fig. II-3-1), are located apart from a high gravity region, reducing the probability of this hypothesis. The NE trending fault, inferred from the gravity distribution, corresponds to the inferred fault from interpretation of the airborne geophysics data along the Pili River. This Pili sinistral fault cuts and displaces the WNW trending Bac-Man fault as can be seen in pseudo-depth slice 3 (Appendix 3). An elongate NE-SW trending resistivity area, obtained by the PNOC, is located between zones "e" and "f".

2) Irosin Area

In this area, zones with a high magnetic response have a rough distribution through the S and SW. Zones that have a low magnetic response occur throughout the NW region of the study area (Appendix 1).

Areas that have a major low magnetic (LG) response are (Fig. II-3-2):

a. NW part of the area (sporadic low magnetic responses)
b. EW trending LG north of Mt. Calunan
c. Mt. Tabontabon
d. North of Mt. Maraot Banwa
e. WNW trending LG near Tugas
f. WNW trending LG near Mt. Sujac
g. Small sub-circular magnetic anomaly surrounding the mountain located at 1390000mN, 610000mE
h. Southern margin of the Project area (extending towards the sea)
i. Sporadic occurrences scattered within the vicinity of Gate Mountains except the areas "e", "f", "g" and "h"

Within the Irosin area, most of the rocks have a Pliocene age, especially near Gate Mountains. During the Pliocene epoch, a polar reversal occurred. Therefore, it is necessary to consider the existence of a reversed remanent magnetic signature. This type of magnetic signature may be applicable in areas "a", "c" and "i", whereas in areas "b" and "d" it is uncertain due to lack of data.

Rock samples from the sporadic low magnetic response within the NW portion of the area provide an age of 1.60 ± 0.10 Ma (Appendix 15 and 16). This age may indicate that the volcanic rocks distributed around Mt. Culangalan to Mt. Sisigon are due to a reverse polarity chron.

Among the areas with a low magnetic signature, dense magnetic contours may indicate that the volcanic rocks have a reverse remanent magnetic signature. The broad contour of low magnetic readings may coincide with the presence of an ignimbrite erupted from the Irosin Caldera. Within the Caldera, a magnetic flat region might be due to thick lake sedimentary deposits and/or alluvium.

A zone of relative high magnetic anomalies lie parallel to the densely contoured area located along a fault valley (Fig.II-3-2 arrow). This zone of high magnetic anomalies may indicate the presence of a remnant magnetic surface, partially destroyed by hydrothermal alteration or weathering which occurred along the fault. Similar magnetic signatures occur near Mt. Tabontabon.

Delfin et al. (1993) estimated the age of the Tabontabon volcanic rocks as >1.10～<2.14 Ma. A strong magnetic low signature is located at Mt. Tabontabon, while, at the side of the Caldera wall a high magnetic signature is evident (Fig.II-3-2). The phase one field survey identified a hydrothermal alteration zone, with smectite-kaolinite-pyrite mineral associations, distributed along the Caldera wall. The high magnetic response could be due to the presence of remanent reverse magnetisation and/or localised destruction of magnetite caused by hydrothermal alteration.

Low magnetic responses at the small sub-circular feature ("g") and at the western portion of Gate Mountains ("i") may also be due to a reverse remanent magnetisation. Rock samples from a low magnetic area along the Gate Mountains indicate an age of 2.60 ± 0.3 Ma and 2.47 ± 0.28 (Appendix 15 and 16). The rock with an age of 2.60 ± 0.3 Ma is a black basaltic andesite.

Within the Irosin area, the location of low magnetic anomalies seems to have little relation to the hydrothermal alteration zones observed during the field survey. However, the low magnetic anomaly areas "e" and "f" are located near but do not coincide exactly with zones of hydrothermal alteration. Instead, the altered zone is located within a "magnetic flat region" of medium response.

3) Tiwi

The locations of the major low magnetic regions in the Tiwi area are (Fig.II-3-3):

a. Upstream of the Cayohosan River: near 1489000mN, 560000mE, trending WNW
b. Along the Inalait River
c. Upstream portion north of Buhi Lake: near 1492500mN, 556500mE: trending NE
d. Southern margin of the area: 1485500mN, 559000mE, with a ENE elongation
e. Eastern margin of the area
f. Jaroan River: trending NE
g. WSW of Mislbis village
h. SE of Mayon village: trending ENE

The upstream portion of Cayohosan River has an apparently low magnetic signature for the Tiwi area. The anomaly area also exhibits a "magnetic flat region". The anomaly has a WNW trend and is located between the ridge and the valley. The low magnetic anomaly and magnetic flat region correspond with a hydrothermal alteration zone. During the field survey, it became evident that the location of the magnetic flat region directly coincides with the location of the hydrothermal alteration zone.

The occurrence of a hydrothermal alteration zone within areas "b" and "c" also indicates the presence of alteration along a fault zone.

The ENE trending elongate low magnetic anomaly indicated within the south of the area is not interpretable due to lack of field data.

The magnetic anomaly along the eastern margin of the project area corresponds with the location of the Tiwi geothermal field. An ENE trending low magnetic anomaly occurs along the Kagumihan fault (Gambil and Beraquit, 1993). Low magnetic anomalies also occur in an area locally called "Old Springs". These low magnetic anomalies may indicate a hydrothermal alteration zone along the modern geothermal field.

Looking closely at the NE trending low magnetic anomaly exhibited near Jaroan River, the anomaly is not directly located along the river but is located along the NW slope between Jaroan River and the adjacent parallel ridge. During the field survey, no altered outcrop or float was found in the downstream section of the Jaroan River. This indicates that the magnetic low does not correspond to an altered area, but uncertainty exists due to lack of sufficient data.

WSW of Mislbis Village and SE of Mayon Village areas exhibit hydrothermal alteration. Confirmation of this alteration was achieved during the field survey by the existence of hydrothermal alteration zones along the downstream and middle portion of the river. The locations of the magnetic flat regions also indicate the occurrence of alteration.

We could therefore conclude that the distribution of low magnetic anomalies within the Tiwi Project area corresponds to areas of hydrothermal alteration.

3-1-2 Airborne Radiometrics

1) Legazpi Area

The following conclusions have been derived from comparative analyses of the Radiometric Total Count (RTC)(Appendix 5) and each of the three individual (K, Th, U) Count images (Appendix 6):

- The Potassium Count dominates the RTC distribution pattern.
- Thorium Count tends to be high in the western part of the area. The young volcanic terrain of the Bac-Man geothermal field tend to have a low Thorium Count.

The following conclusions have been recognized from correlation between the Radiometric Total Count (RTC) and the Digital Terrain Model (DTM)(Appendix 4).

- Radiometric low anomaly zones tend to be distributed along areas with medium to high topographic relief. Radiometric high values are located along the gullies of the upstream portions of rivers.
- Large, broad areas with a low radiometric signature are located in the N and NW part of the area.
- Areas that have high potassium anomalies are located along the uppermost gullies of the following rivers (Fig.II-3-1).
  - ① along Buyo-Calpi River
  - ② along Cawayan River
  - ③ streams located near Bac-Man fault
  - ④ along Pili-Cumadcad River

The hydrothermal alteration along the Buyo-Calpi and Cawayan Rivers is coincident with a high potassium count. The alteration is characterized by silicified and argillized zones that consist of cristobalite, alunite, kaolinite and smectite. This alteration can be characterized as steam-heated acid alteration (see Field Survey). In both rivers, landslide scarps and altered outcrops are observed.

Limited exposures of hydrothermal alteration zones outcrop along the streams near the Bac-Man fault and the Pili-Cumadcad River, due to thick piles of landslide debris composed of boulders and volcanic rocks.

The following areas have low Radiometric or Potassium anomalies (Fig.II-3-1).

⑤ Danao Lake: extremely low Total Radiometric and Potassium Count

⑥ Gentle slope zone area from Danao Lake to the southern portion of Cawayan crater: parallel to the Bac-Man fault zone.

⑦ SE of Danao Lake

⑧ Upstream portion of Bayong River

⑨ Upstream portion of Balasbas River

The above areas have a low radiometric or potassium count. These areas are characterized by a gentle slope and a wide valley covered by thick soil, vegetation, and little to no rock exposure.

Chemical analysis of the collected samples within the Bicol area, manifest low Potassium Counts because generally acid alteration zones contain small amounts of potassium. A high potassium content could be due to the presence of alunite, but still its value will not be higher than the potassium content of the surrounding unaltered volcanic rocks. Chemical analysis of such volcanic rocks reflects a high content of potassium (Fig.II-3-4 and Appendix 18). Consequently, if the volcanic rocks were exposed equally everywhere, a higher potassium count could appear in the non-altered host volcanic rocks and not in the altered zones.

We conclude that the high Potassium Count within the Legazpi study area is due to exposed rocks (no soil and/or thick vegetation) found along rivers and steep riverbanks. Therefore, the high potassium count areas coincide with exposed rock, altered zone, and fault zone or landslide zone since most of these areas have outcrops and less vegetation.

2) Irosin Area

The following conclusions have been derived from a comparative analyses on the Radiometric Total Count (RTC)(Appendix 5) and each of the three individual (K, Th, U) Count images (Appendix 6):

- Potassium and Thorium Counts dominate the RTC distribution pattern. This is a little different from the situation within the Legazpi area. The Uranium Count pattern is similar to that of thorium.
- RTC anomalies are recognized in the following areas.
  ① NW of Sta. Magdalena
  ② NW part of the area
  ③ Gate Mountains area
  ④ Twin dome of Mt. Malobago

The NW portion of Sta. Magdalena exhibits extremely high Potassium Counts and an absence of Thorium anomalies. A field survey in this region identified the presence of an acidic pyroclastic flow (Jusi and Laud, 1998). At the NW end of the anomaly, a sub-circular magnetic high response is present in Appendix 2 (first vertical derivative image) and Appendix 3 (TMI RTP Pseudo Depth Slice 3). The anomalous area is located in a broad valley. The high anomalous potassium response was due to the presence of the exposed pyroclastic flow deposits and is located from an inferred small caldera at the NW end of the anomaly area.

The anomalous zone along the NW part of the study area corresponds to the location of ignimbrite along the Irosin Caldera. The high potassium response is probably due to the presence of ignimbrite.

The Thorium Count dominates the high RTC of the Gate Mountains. Distributions of lower radiometric responses are concentrated at the northern and southern portion of Mt. Sujac. The hydrothermal alteration areas located north of Mt. Sujac are characterized by low topographic relief. To the south of Mt. Sujac a lower response is associated with high relief at the center. An explanation for the low radiometric response is difficult to derive from the present data, since the volcanic rocks only contain minor quantities of incompatible elements such as K, Th, and U.

Within the twin dome of Mt. Malobago, the high potassium response forms at the periphery of the twin dome. The centers of the domes are characterized by a lower potassium response. The low potassium response at the flat center of the dome could be due to the existence of thick soil and vegetation. Subsequently, the higher potassium response along the periphery could be due to less vegetation and a conglomeration of exposed landslide volcanic debris.

3) Tiwi Area

The following conclusions have been derived from a analyses of the Radiometric Total

Count (RTC)(Appendix 5) and each of the three individual (K, Th, U) Count images (Appendix 6):

- Potassium Count dominates the RTC pattern in the Legazpi area.
- The distribution pattern of the Thorium Count is similar to that of the Potassium Count. However, there are small differences between the two as follows.
  - The eastern side of the Tiwi area has a high potassium response but low thorium response.
  - The center of the area, between the high relief north and south of the study area, has a high thorium response but low potassium response.

The Tiwi geothermal field possibly causes the former observation. The Tiwi geothermal system is characterized by a low sulfidation alteration and is further characterized by silica sinter and adularia mineralization. The high potassium response was probably due to the high potassium metasomatic field of the Tiwi geothermal system.

The latter area is characterized by low relief and associated thick soil and vegetation. The alluvial/colluvial material will mask any radiometric signature from the rock.

The following conclusions have been recognized from correlation between the Radiometric Total Count (RTC)(Appendix 5 and 6) and the Digital Terrain Model (DTM)(Appendix 4).

- The correlation is similar to that of the Legazpi area with RTC and Potassium Count low in high relief regions, and high in low relief regions.
- The distribution of high RTC corresponds to the low magnetic responses. The following areas have high RTC (Fig. II-3-3).

① Upstream of Cayohosan River: near 1489000mN, 559000mE, ENE-trend valley
② Along Inalait River
③ North of Buhi Lake: near 1492500mN, 556500mE, NE trend valley
④ SE of Buhi Lake
⑤ NE slope of Mt. Malinao to the Tiwi geothermal field
⑥ Along the Barils and Jaroan River: ENE trending valley
⑦ Along the curved valley SE of Mayon village
⑧ SE of Mayon village: ENE trend valley
⑨ Sub-circular response of NE part of the area.
⑩ Northern margin of the project area

All of the areas above have high RTC and a corresponding low magnetic response, except for the sub-circular area in the NE part of the area and the northern margin of the project area (⑨ and ⑩). These two areas do not have a low magnetic response. These are located within a mid- to high-magnetic response zone. A correlation of areas with a high potassium response with the distribution of dome-shaped dacite bodies is possible. The high potassium anomaly may be due to high content of K_2O of the rocks, as the dacites belong to a High-K series on the SiO_2-K_2O diagram (Appendix 17 and 18).

The other high anomalous areas almost overlap areas with a low magnetic response. Areas with a high potassium response may also indicate a zone of hydrothermal alteration.

Hydrothermal alteration may occur in the upstream portion of Cayohosan and Inalait rivers and along the NE slope of Mt. Malinao (①, ② & ⑤). This is due to the presence of a low sulfidation type of alteration found within the adjacent valleys and creeks.

However, along the Barils and Jaroan Rivers and the SE portion of Mayon Village ("⑦" and "⑧"), areas of silicified alteration were developed. The alteration consists mainly of quartz, alunite, and pyrite as alteration minerals. These silicified rocks have a small proportion of K_2O.

The method of using high potassium anomalies to identify areas with a high possibility of locating an altered area (especially a hydrothermal alteration zone) appears to be successful. Nevertheless, this method is limited to the identification of alteration in areas that are either partially or entirely exposed.

3-1-3 Summary

The conclusions to the airborne magnetic and radiometric survey are below.

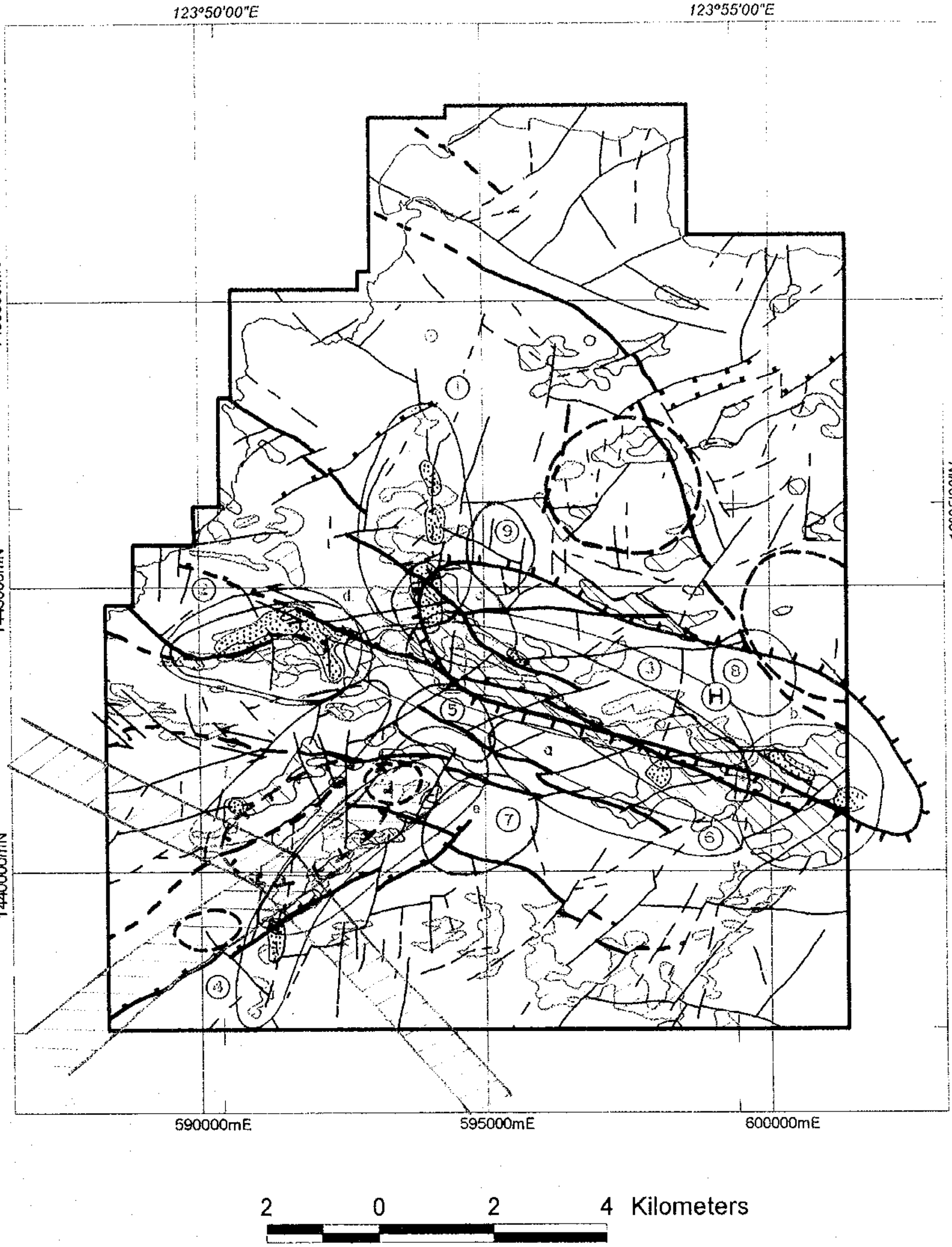


Fig. II-3-1 Interpretation map of the airborne geophysics combined with the field survey, Legazpi area Legends on following page.

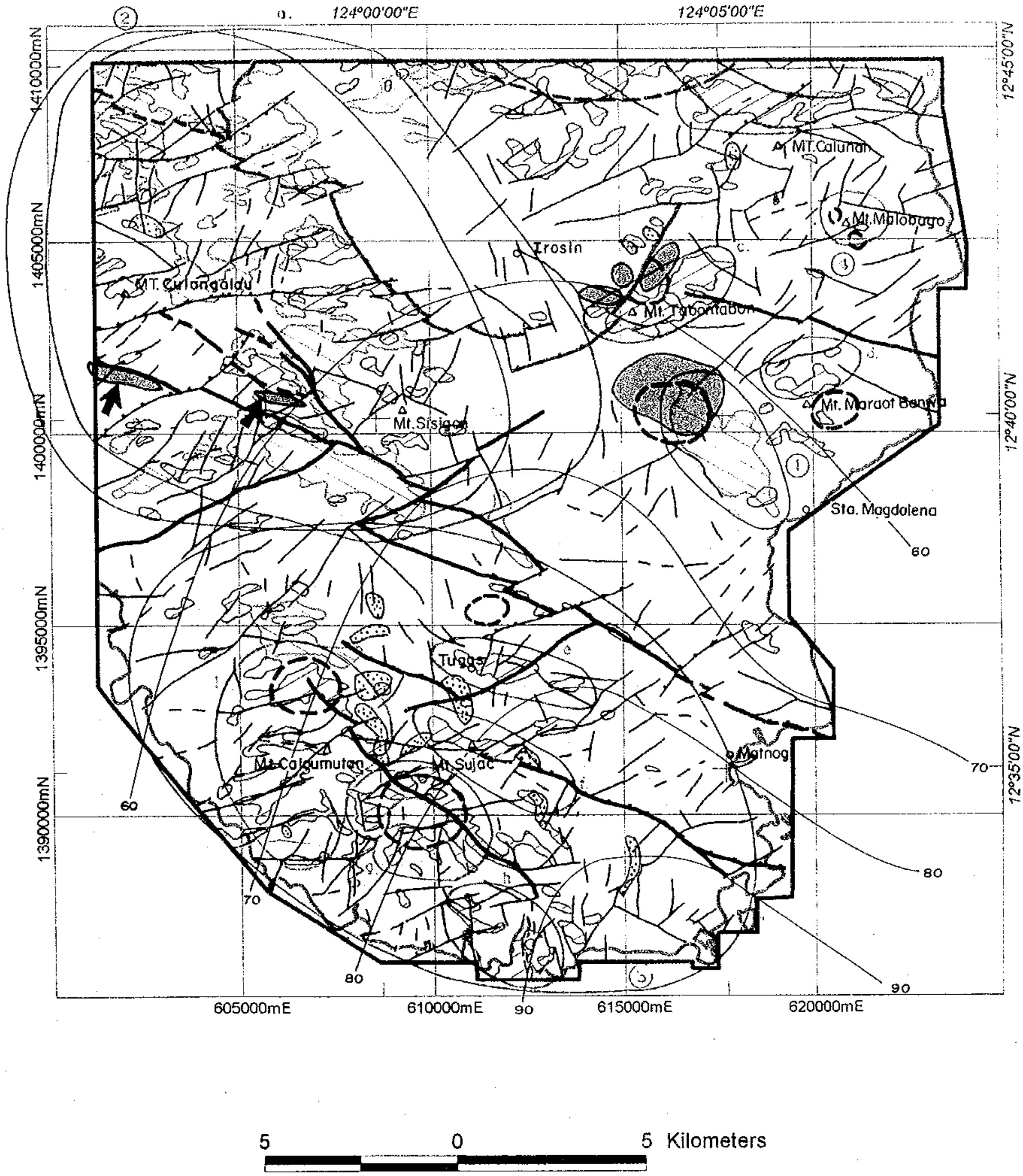


Fig. II-3-2 Interpretation map of the airborne geophysics combined with the field survey. Irosin area Legends on following page.

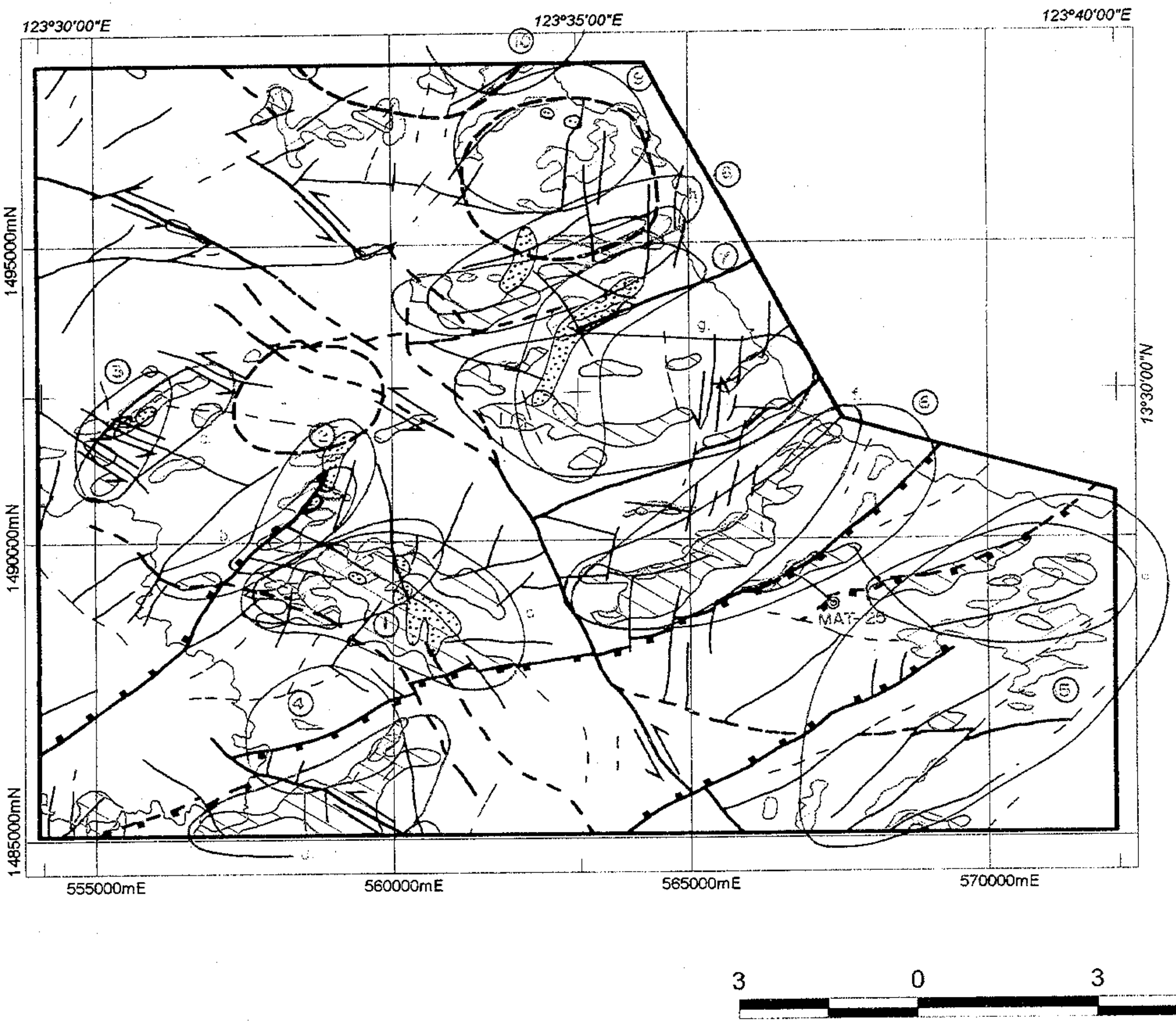


Fig. II-3-3 Interpretation map of the airborne geophysics combined with the field survey. Tiwi area

Legends on following page.

Legend

Zone of reduced magnetic signature

Areas of increased potassium signature

Major Faurt - Confident,Inferred

Minor Faurt - Confident,Inferred

Circular anomalies,possible volcanic vents or intrusive bodies

Hydrothermal Alteration Zone

Gravity High from PNOC Survey (Los Banos and Oliver,1997)

Low resistivity center from PNOC Survey (Layugan,1986)

Inferred Fault from the Gravity Distribution from PNOC Survey (Los Banos and Oliver,1997)

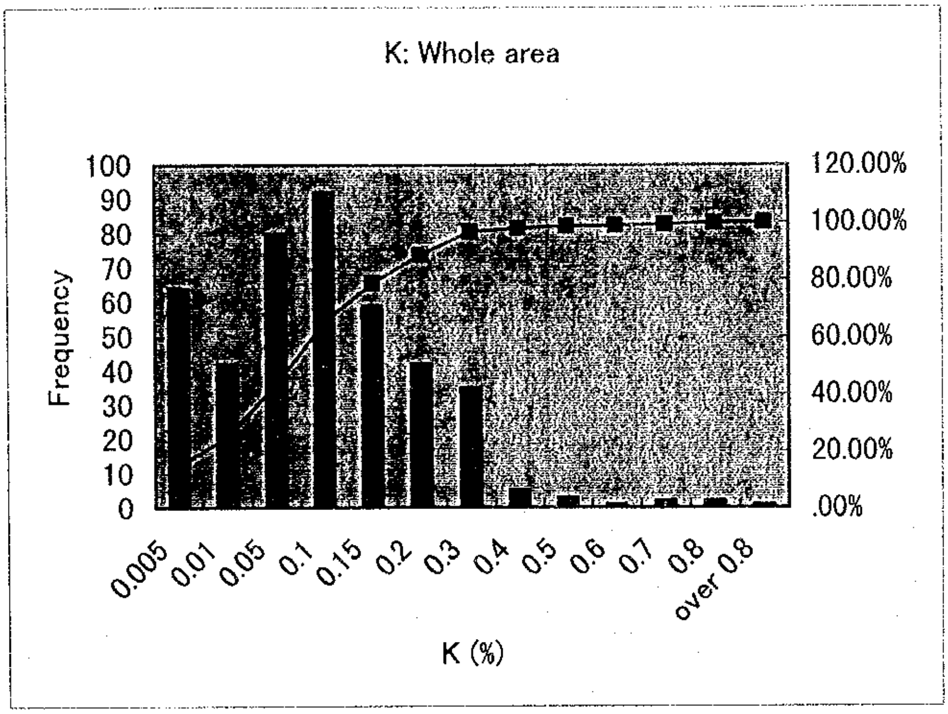
a location of the zone of reduced magnetic signature

a location of the area of increased potassium signature

a location of the area of low potassium count

Areas of increased magnetic signature

Bouguer contour(miligal)



range	Frequency	cumulative %
0.005	64	14.95%
0.01	42	24.77%
0.05	80	43.46%
0.1	92	64.95%
0.15	59	78.74%
0.2	42	88.55%
0.3	35	96.73%
0.4	5	97.90%
0.5	3	98.60%
0.6	1	98.83%
0.7	2	99.30%
0.8	2	99.77%
over 0.8	1	100.00%

Fig. II-3-4　K content histogram of altered rocks from the Bicol Area

Airborne Magnetics

Airborne magnetic anomalies within the study areas may have been caused by:

- Anomalously low or high original content of magnetite in the rocks,
- A secondary destruction of magnetite, and
- A Reversed Remanent Magnetisation

The airborne data identified several "magnetic flat regions". A magnetic "flat region" is shown by a gentle gradient of the magnetic field. This "flat" magnetic signature can apply to both high and low magnetic anomalies. Topographic flat and destruction of magnetite cause reduction of the gradient of the magnetic field. The destruction of magnetite is primarily due to hydrothermal alteration within an epithermal system, although other processes such as weathering can play a part.

Based on field observations from the three project areas, most of the magnetic lows and magnetic flat regions are characterized by zones of hydrothermal alteration and/or landslide areas that expose some clay minerals.

Airborne Radiometrics

If hydrothermal alteration occurs at the surface, a high radiometric Potassium anomaly is likely to be developed. However, in the project areas, the radiometric Potassium anomalies are observed concentrated in areas with exposed rocks and /or float conglomeration, but not necessarily altered zones. The high potassium anomalies do not extend across ridges or flat topographic areas that have a thick soil or vegetation cover. We can therefore conclude that potassic alteration has either not occurred, or is masked by recent alluvial or colluvial deposits.

Based on field observations, the variation in the distribution of Thorium approximates to the distribution of different lithological units within the project areas. This could be due to the little difference of Thorium content between soil and rocks.

We can conclude that areas with low magnetic signature have a high potential to be the pathways for fluids. The low magnetic signature appears to develop due to demagnetization by hydrothermal fluids. We can also conclude that the interpretation of geology and hydrothermal alteration from magnetic and radiometric signatures is particularly useful where there is difficult access and poor exposure due to rugged topography and thick vegetation like the Bicol area.

3-2 Characteristics of geology and mineralization of the Bicol Area

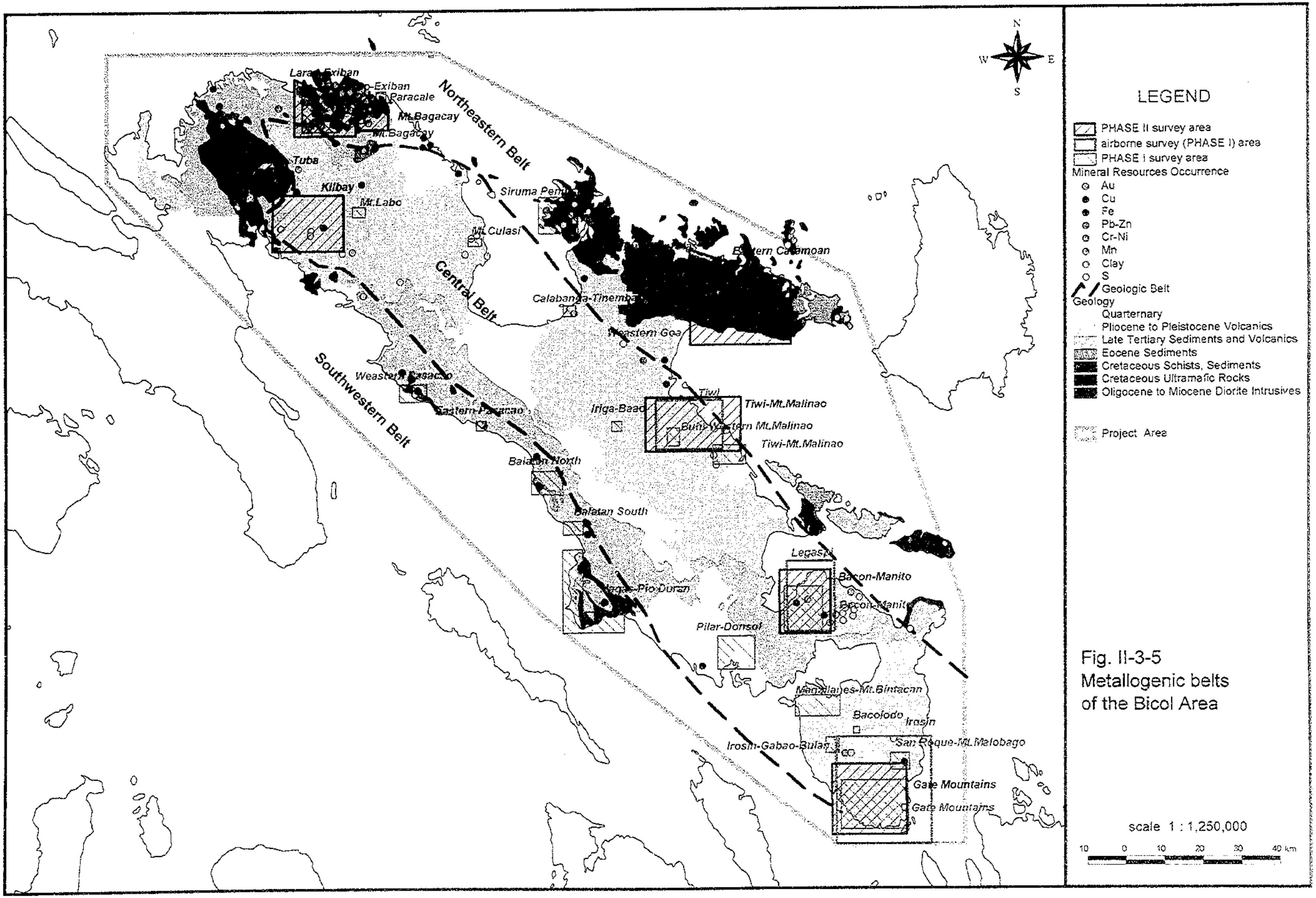


Fig. II-3-5
Metallogenic belts
of the Bicol Area

Based on the result of the phase-I survey the Bicol area is divided into 3 belts, namely Northeastern Belt, Central Belt, and Southwestern Belt, according to the distribution of the geological and mineralization features within the area as shown in Fig. I-1-2. However, later survey has revealed that the andesite of Bagacay is formed during the middle Miocene and that the volcanic rocks formed during Pliocene distributes widely in the Kilbay area. As a result, the geological map made up during the phase-I survey was partially changed when preparing Fig. II-3-5. Here, the three Belts are re-defined as follows.

The Central Belt is defined as a zone in which Pliocene to recent volcanic rocks distributed in the central part of the Bicol Peninsula. Northeastern Belt and Southwestern Belts are the zones, not including the Central Belt, where Cretaceous basements including the ophiolite sequence is distributed with the intrusion of the Tertiary intrusives. In these Belts, the northeast part of the Bicol area is called the Northeastern Belt, and the area lying along southwest coast is called the Southwestern Belt. Of these Belts, the Southwestern Belt is covered with the Tertiary sedimentary rocks, so that its distribution area is intermittent and narrow.

In the Northeastern Belt, there are many ore deposits and mineral showings. The mineralization is mainly divided into three types as follows reflecting the geology. One is the mineralization related to ultramafic rocks. The second is the mineralization related to green schists and mica schists. And third is that related to Miocene intrusives. Of these, an important one is the hydrothermal deposit deriving from the activity of the magma during the Miocene in the Belt. The hydrothermal deposits consist of the porphyry copper type deposit, skarn type deposit and vein type deposit.

The vein type deposits have been considered as epithermal deposit (Mitchell and Leach, 1991). However the occurrences of the vein and alteration, the mineral assemblages, and the thermometric study of fluids inclusions indicate that the temperature and depth of the formation are higher and deeper than the typical epithermal deposits. Moreover the vein system occur within or close to the Miocene intrusives. Those data may show the most of the vein type deposits are "mesothermal" or sub-epithermal low sulfidation type deposits.

There are several known copper mineral showings in the Southwestern Belt. Gold is also accompanying the copper.

As far as these ore showings are concerned, however, it is difficult to identify the nature of the mineralization, since the scale is small, and the data based on sufficient survey are not available. Nevertheless, judging from that there is a distribution of diorite near the copper and gold prospects, there is the possibility that they can be so-called mesothermal vein type ore deposits associated with the intrusion.

The northwest end of the Central Belt has a distribution of Nalesbitan ore deposit, which is a epithermal high sulfidation type deposit. Further, the phase II survey has clarified that there is a distribution of the epithermal low sulfidation type mineralization in Kilbay area lying along the northwest end of the Central Belt. In western part of Bacon-Manito, Gate Mountains and northwestern part of Tiwi-Mt. Malinao area of the Central Belt, the feature of alteration suggest the existence of epithermal system. But geochemical analyses of the altered rock suggest no more than the potential presence of the gold and copper in terms of geochemical anomaly level.

Considering the relationship between the mineralization and geological structure, many of the mineral vein type ore deposits in the Northeastern Belt are controlled by NNE to NE-trending fracture system. Especially, in Paracale, Larap-Exiban and Bagacay areas, the mineral veins of the NNE-trending are predominant. Since these deposits are considered to have been formed in Miocene. The fracture system may be built in response to the tectonic events occurred during the Miocene. However, the nature of the fracture system could not be clarified through this survey.

On the other hand, in the Central Belt, more particularly, in the areas of Legazpi, Irosin and Tiwi, which have been covered by airborne geophysical survey, WNW-trending left-lateral fault and ENE-trending fault are predominant, though relatively small faults of NS system exist. The hydrothermal alteration zones distribute along these faults. In these three areas, the left-lateral WNW-trending faults are the oldest faults, and these faults suggest to have been the passages of the hydrothermal solution. The same result has been obtained through the lineament analysis by using the satellite image. Further, in the Nalesbitan deposit lying in the northwest end of the Central Belt, the dilational jog lying along the left-lateral WNW-trending fault is considered controlling the mineralization (Sillitoe, et al., 1990). Similarly, in the Kilbay area situated in the northwest end of the Central Belt, the faults and quartz veins of WNW to NW-trending and a number of quartz veins of NE to ENE-trending were observed. A WNW-trending topographical feature lying along the south side of Susungdalaga Mountains suggest the existence of faults, and these faults seem to control a distribution of hydrothermal alteration zone. A dilational zone is considered to develop along these left-lateral WNW-trending faults, and such geological structure is considered to be a promising area for the formation of ore deposit.

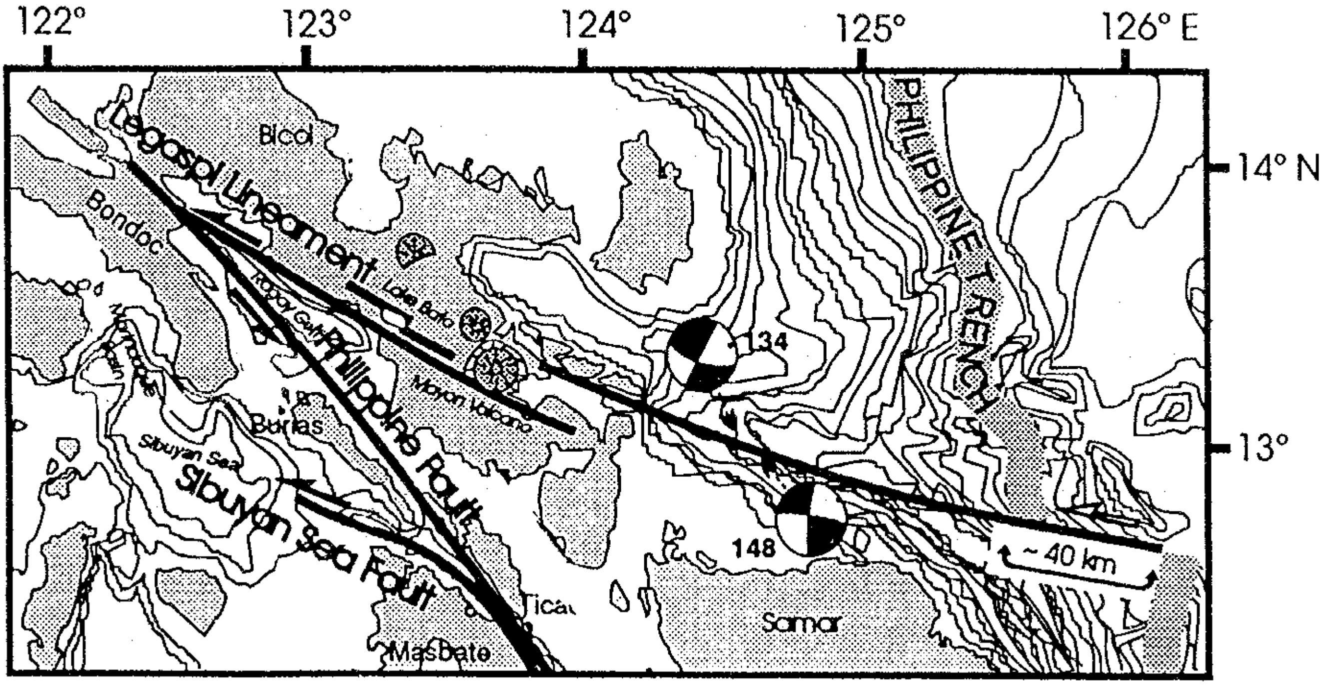


Fig. II-3-6 Structural sketch map of the region where the Philippine Fault intersects with the Sibuyan Sea Fault and the Legazpi Lineament. Taken from Aurelio et al. (1997)

The structures described above may possibly be characterized in the context of a broader regional setting.

The most significant structure is the Legazpi Lineament in the Bicol area. The WNW-ESE trending Lineament extends offshore until it reaches the Philippines Trench to the east. From bathymetric data, the lineament appears to displace the trench left-laterally for about 40km(Fig. II-3-6) (Aurelio et al., 1997). The WNW-trending left-lateral fault distributed in the Central Belt is considered to have probably been caused by the tectonic event similar to that of the Legazpi Lineament.

The pushing force of the Philippine Sea Plate is still acting even after the Philippines archipelago came to collide with the Palawan block in late Miocene. Visayas area at present is stuck because of the collision with the Palawan block, but Luzon island including north half of Bicol Peninsula may be able to move towards the South China Sea lying west because of its viscosity. It is thought that such movement has caused the formation of the Legaspi Lineament, the Sibuyan Sea Fault, and the WNW-trending faults observed in the Bicol area. These fault can be considered to be still active.

The geology and structure of the Bicol area have been constructed in the regime of interaction of the Eurasian Plate, the Philippine Sea Plate, and the Australian Plate. So it seems possible for us to describe the evolution of the geologic structure of not only Bicol area but also that of the Philippine archipelago as the whole, if we could describe the space-time evolution of the plates movements. This attempt, however, is becoming realistic gradually through a number of researches.

3-3 Geochemical features of the three belts and each of the areas

In order to delineate the geochemical characteristics of the three belts and each area in which field survey was conducted, the results of chemical analysis are plotted in the Fig.II-3-7, and shown in the histograms in Appendix 23. The examined data is from the altered rocks including silicified rocks, argillized rocks, and quartz veins distributed in the whole area.

The numbers of samples are as follows:

Northeastern Belt:	80 samples
Central Belt:	323 "
Southwestern Belt:	17 "

We examined the following 13 elements, which may reflect the style of mineralization and host rock geology: Au, Ag, As, Bi, Co, Cr, Cu, Hg, Mo, Ni, Pb, Sb, and Zn. Even taking into account the difference in the size of population of above sampling, the characteristics as are shown below are apparent.

Au:

The number of the samples with high gold content collected in the Northeastern Belt was largest of all. In the Northeastern Belt, the samples with high gold content concentrate in Bagacay area, Paracale area and Larap-Exiban area. Eastern Caramoan Peninsula is also an area where the samples with high gold content were taken. According to the histogram (Appendix 23), 20 samples out all samples collected in the Northeastern Belt have the gold content of 1,000 ppb or more and also have a frequency peak.

Most of the samples collected in the Central Belt are below the marginal value of detection (Appendix 23). Of the samples collected in the Central Belt, most of the samples having relatively high gold content are those collected in Kilbay area.

In the Southwestern Belt, the samples collected in Nagas-Pio Duran area (Panganiran Peninsula) show relatively high gold content.

Ag:

According to the histogram, the samples having relatively high Ag content were collected in the Northeastern Belt, while most of the samples collected in the Central Belt and Southwestern Belt have the contents of marginal value of detection or close to it. According to the distribution diagram of Fig. II-3-7b, in the Northeastern Belt, samples with high content, similar to that of Au, concentrate in Bagacay area, Paracale area and Larap-Exiban area. In the Central Belt, samples having relatively high contents were collected in Kilbay area. Further, in Gate Mountains area, there are distribution of areas where samples with the contents slightly higher than the average were collected. In the Southwestern Belt, the samples having high contents were collected in Tuba area.

As:

According to the histogram, the Northeastern Belt and the Central Belt have a similar tendency to each other, that is, the samples collected in these two belts tend to show low As content in many instances. As seen from Fig. II-3-7c, the samples with high As contents concentrate in Kilbay area of the Central Belt. Further, the high content distributed in Gate Mountains area is found to derive from the altered rock in the Bacolodo area where hot spring is existing. Samples having relatively high contents were collected in Eastern Caramoan Peninsula of the Northeastern Belt.

Bi:

Result of sampling indicates low Bi values in all the Belts, though the samples collected in the Northeastern Belt show relatively high concentration of Bi. Samples also indicate the presence of relatively high content in Tuba area. In these areas distribution of many intrusions were found, and this is considered to reflect the distribution of the mineralization associated with the intrusions. The relatively high values observed with respect to the samples collected in the Central Belt reflects the existence of highly silicified rock float with pyrite dissemination in Mt. Culasi area.

Co:

Samples with relatively high contents were collected in all the Belts. The many samples collected in the Northeastern Belt tend to show relatively high Co contents. This may reflect the distribution of ultrabasic rock in the belt.

Cr:

For the Cr, many of the samples have shown relatively high Cr contents. Many of the samples collected in the Northeastern and Southwestern Belts tend to show relatively high Cr contents. This may reflect the distributions of the ultrabasic rocks in both belts. In the Central Belt, the samples collected in Kilbay area have shown relatively high contents. One sample collected in the western part of Bacon-Manito area has also shown relatively high contents.

Cu:

Many of the samples collected in the Northeastern Belt have shown relatively high Cu contents. As for the Central Belt, some of the samples collected in Kilbay area have shown relatively high contents. The Southwestern Belt includes Nagas-Pio Duran area (Panganiran Peninsula) where samples showing relatively high contents are also collected.

Hg:

Most of the samples collected in all the areas are less than the detection limit. Some of the samples from the Central Belt and Southwestern Belt, though small in number, have shown relatively high contents of Hg. Concerning the Central Belt, many of the high-Hg-content samples were collected in Kilbay area.

Mo:

The Northeastern Belt and Southwestern Belt have similar tendencies. However, the

Northeastern Belt has provided a greater number of samples having relatively high Mo contents. In the western part of Bacon-Manito area, high-Mo-contents sample were collected from the boring core of geothermal field.

Ni:

The Northeastern Belt and southwestern Belt tended to provide greater numbers of relatively high-Ni-content samples. This is considered to reflect that there are distributions of the ultrabasic rocks in both of these two belts. Kilbay area of the central Belt has also provided the samples having relatively high Ni contents.

Pb:

Many of the samples collected in the Northeastern Belt have shown relatively high Pb contents. The Central Belt comprises Kilbay area where the samples having relatively high Pb content, almost equivalent to that observed in the Northeastern Belt, were collected. One sample with relatively high Pb contents was collected from the drilling core of geothermal exploration in the northwestern part of Tiwi-Mt. Malinao, and the presence of sphalerite and galena could be observed with naked eye.

Sb:

Higher values are distributed in Kilbay area of the central Belt. In the Northeastern Belt, Mt. Bagacay area and Eastern Caramoan Peninsula areas have provided the samples having relatively high Sb contents, but, in general, the values of Sb content in these areas on the lower side.

Zn:

Samples collected in the Northeastern Belt tend to have relatively high Zn contents. Samples having relatively high Zn contents were collected from the drilling core of geothermal exploration in the northwestern part of Tiwi-Mt. Malinao area of the Central Belt as in the case of the sampling for Pb.

To summarize the foregoing, the Northeastern Belt has provided the samples showing highest contents of those elements discussed above, namely, Au, Ag, Bi, Cu, Co, Cr, Ni, Pb and Zn. In various areas of the Central Belt, samples, almost equal in number, were collected and so it is possible to compare the areas where the samples were collected. Kilbay area of the Central Belt has provided the samples having the highest concentrations of Au, Ag, As, Cu, Ni, Pb and Sb. The Southwestern Belt have provided the samples showing relatively high

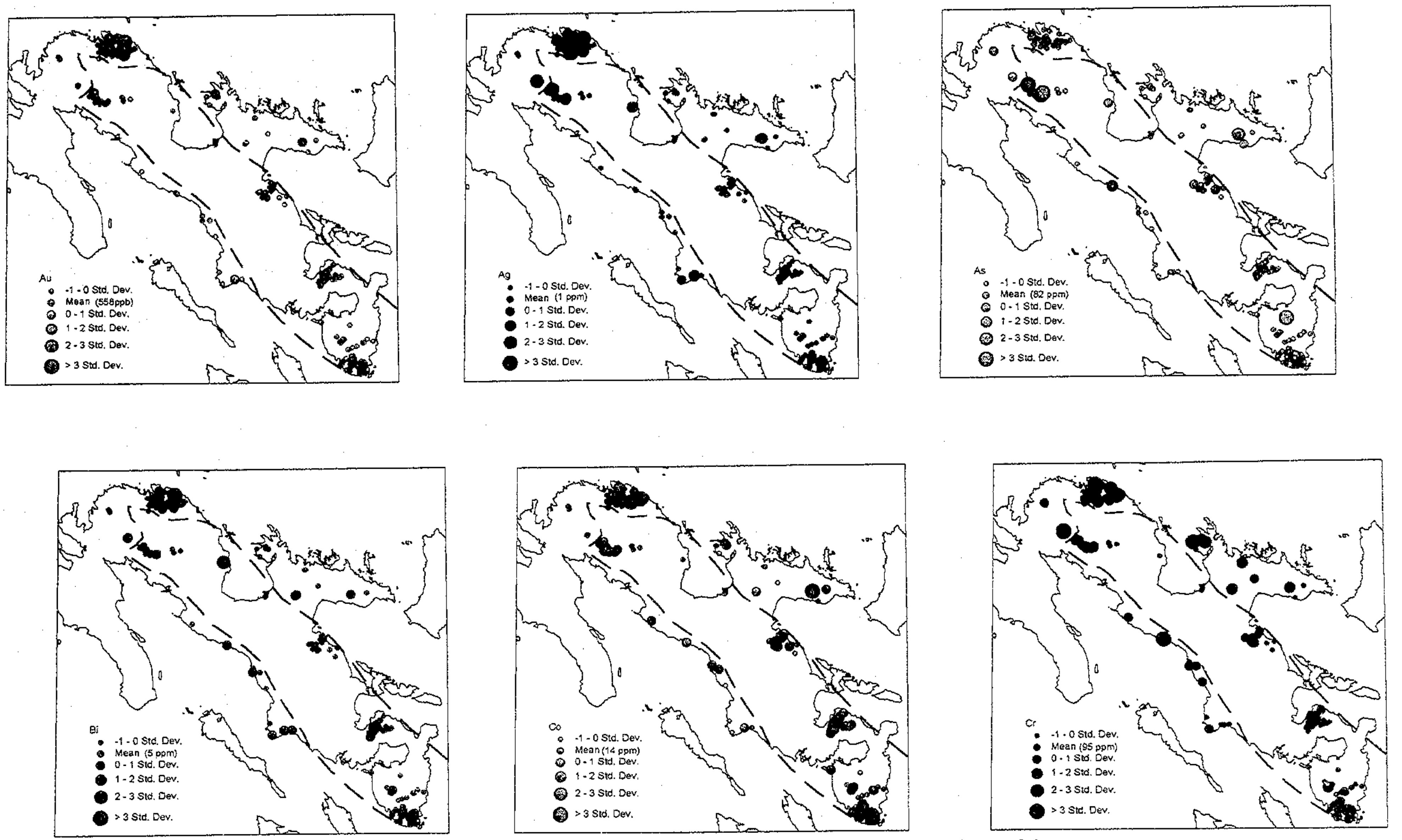


Fig. II-3-7 Geochemical distribution map of the Bicol Area (Au ~Cr)
a: Au, b: Ag, c: As, d :Bi, e: Co, f: Cr

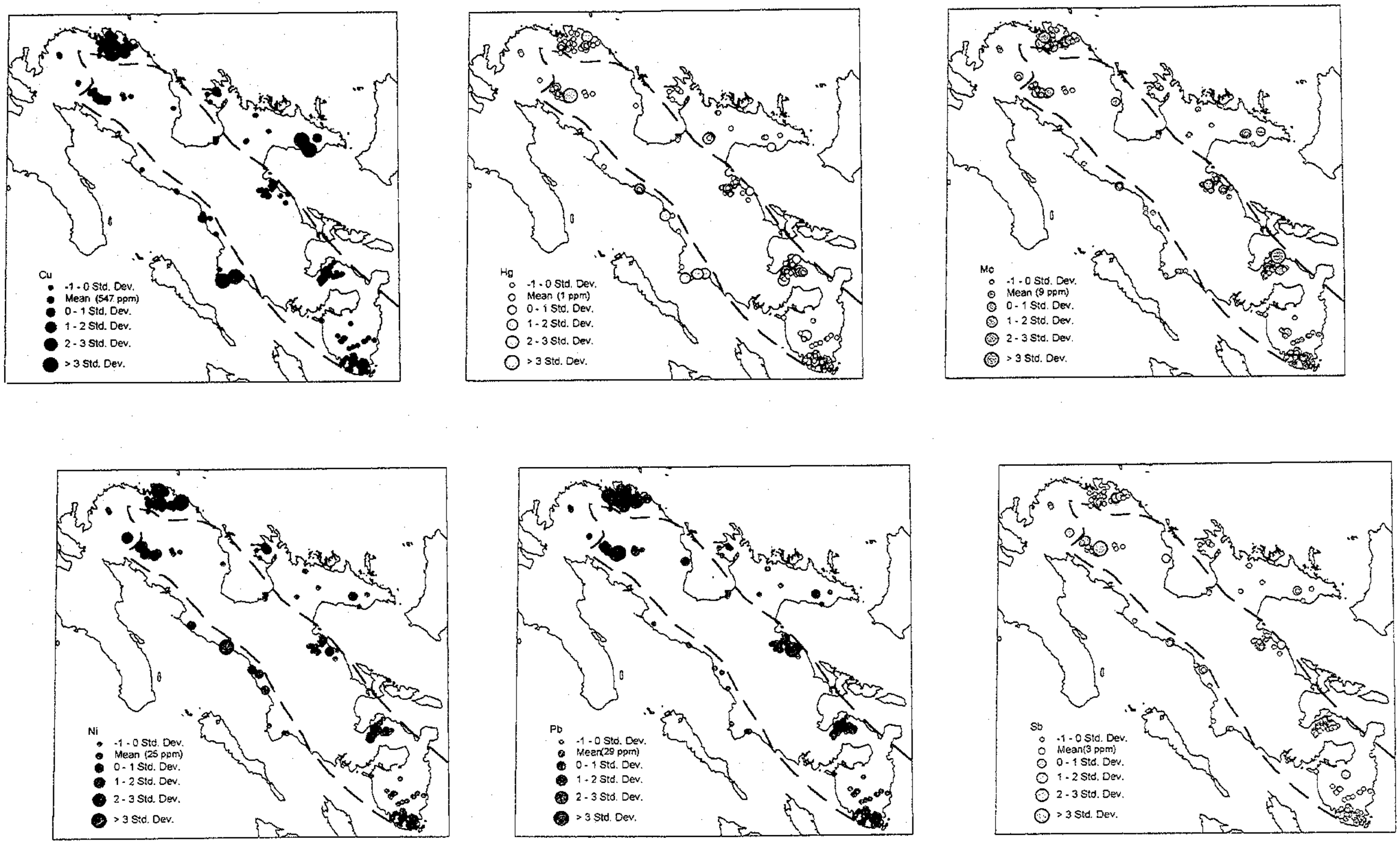


Fig. II-3-7 Geochemical distribution map of the Bicol Area (Cu ~ Sb)
g: Cu, h: Hg, i: Mo, j: Ni, k: Pb, l: Sb

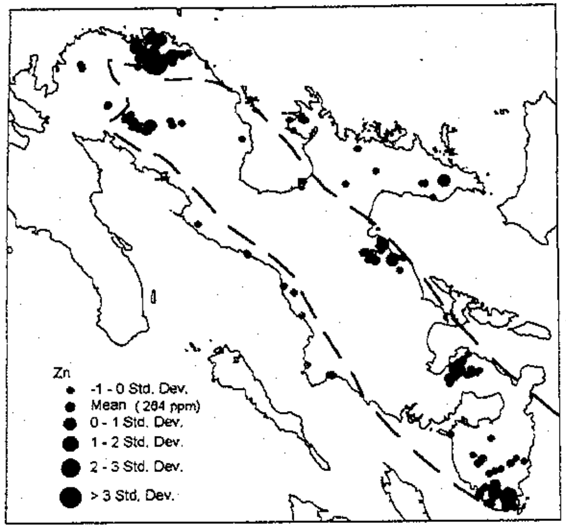


Fig. II-3-7 Geochemical distribution map of the Bicol Area (Zn)

contents of As, Bi, Cr, Cu and Ni, this tendency is rather similar to that of the Northeastern Belt. The above geochemical features of the three belts may reflect the style of mineralization and geology distributed in the belts. In other words, it may reflect the erosion level of the belts. The geochemical feature of each area is summarized up in Table II-3-1.

3-4 Selection of Promising areas

The process of selection of promising areas during the 2-year survey is summarized and presented as flowcharts on front page of this report.

In the Phase I, 24 areas were selected based on the analyses and compilation of the existing data, and the satellite image analyses, and the selected areas were physically surveyed. In the phase II, 8 areas selected in the phase I were physically surveyed and the result was evaluated.

The purpose of the project is to find out promising areas in the Bicol area, where are good for further exploration project. When we select the further exploration project, we would like to choose it as a governmental oriented project such as a project under technical cooperation scheme between the government of Philippine and Japan. So we put a priority to the criterion of the selection into the potential and the condition of the mining rights.

The potential for the existence of an ore deposit was evaluated in consideration of the geological features, occurrence of the deposits and mineral showings and analyses of quartz vein and alteration rock. We placed the surveyed areas on the conceptual model of the magma-hydrothermal system as shown in Fig.II-2-18 and Fig.II-2-19. The positioning is based on the geological setting, the mineral assemblage of the hydrothermal alteration and the style of the mineralization observed in each area.

If any ore deposit itself had not been located or exposed on the ground surface in the area, we examined the possibility of existence of mineralization at the depth judging from the result of reference to the magma-hydrothermal conceptual model.

Concerning the mine claims, the areas where no mine claim was established are put higher priority. If the mining claim are already applied for the areas, MPSA application area got higher priority than FTAA.

The features of the eight areas are given in Table II-3-1.

The skarn type and stockwork type mineralization observed in Larap-Exiban and Mt. Bagacay area should be positioned near the porphyry Cu-Au system as show in Fig. II-2-18. The vein type Au-base metal mineralization observed in Larap-Exiban, Mt. Bagacay, and Tuba area might be correspond to sub-epithermal vein mineralization which is often observed in the periphery of the porphyry system.

Concerning Tuba area, it is difficult to evaluate its potential, since the survey for the Tuba mine itself has not been conducted yet. However, in the southern part of Tuba area, there is the distribution of hydrothermal alteration zone, and not only the anomaly relating to the gold but also the presence of Cr containing muscovite were observed in the quartz vein. Such features are observed in the vein distributing in Paracale area. It indicates the similarity of geological setting and mineralization between Tuba area and Paracale area. Therefore, Tuba area has a high potential like Paracale area. And there is a lot of room for exploration.

Concerning the eastern part of Caramoan Peninsula, available data is not sufficient for evaluation.

On the other hand, four areas from the Central Belt are located in shallower part of the epithermal environment in Fig. II-2-18. More detail positions of the four areas are shown in Fig. II-2-19.

In Western Bacon-Manito and Gate Mountains area, we can see steam-heated acid alteration zone and volcanic gas condensed alteration. Some contribution of volcanic gas is observed in the two areas.

Concerning the Western Bacon-Manito area, the high and low sulfidation epithermal systems can be expected by analogy with the drilling data of the Bac-Man geothermal field, but the concentrations of the pathfinders elements in this area are estimated to be low.

It has been clarified that there is the distribution of alteration zone of considerable scale in Gate Mountains area. Compared with Western Bacon-Manito area, hydrothermal activity in Gate Mountains area seems to be a little bit older than that in Western Bacon-Manito area. Because the mixed-layer clay alteration zone is also partially distributed in this area, and it is considered that the portion is to some extent deeper than that of Western Bacon-Manito area is exposed. This is also supported the fact that the volcanic rock of Gate Mountains area is older than the volcanic rock of the Western Bacon-Manito area. It has not been clarified, however, whether or not the mineralization of high sulfidation system or low sulfidation system can be expected in the depth of the steam heated acid alteration zone in the area. Some silicified rocks of the area have anomalies of gold, copper and molybdenum. But the potential at the depth is considered to be not so high, since no mineralization of gold has been recognized in the quartz vein in the mixed layer clay zone.

In the northwestern part of Tiwi-Mt. Malinao area and Kilbay area, we found low sulfidation style alteration zones characterized by such as quartz veining in sericite/smectite mixed layer clay alteration and silica sinter terrace. Based on the observation, the northwestern part of Tiwi-Mt. Malinao and the Kilbay area should be positioned to the upper part of low sulfidation epithermal system. In those two area, we can see a little bit deeper part of epithermal system than that of the Western Bacon-Manito and Gate Mountains (Fig. II-2-19). However, the chemical analysis of the altered rocks show that the potential of northwestern part of Tiwi-Mt. Malinao might be low.

In Kilbay area, through this survey, it has been clarified that a shallow to medium portion of the low sulfidation epithermal system of the system is exposed and that the quartz veins in mixed layer clay zone have gold mineralization. It is considered that, therefore, there is a high potential of the presence of hydrothermal gold deposit of the low sulfidation system. The altered rocks including quartz vein of Kilbay area show higher values of pathfinder elements for epithermal gold deposits as discussed in the preceding section 3-3. Further, it has also been observed that the hydrothermal alteration zone is distributed along the WNW-trending fault system, which is considered controlling the mineralization of the Central zone (refer to previous section 3-2). This condition is similar to that is observed in Nalesbitan gold deposit situated about 10 km north of Kilbay area. So it is considered that there is a high possibility of the existence of an ore deposit lying along the structure.

In the northwest end of the Central Belt, the gold mineralization is distributed in Kilbay area and Nalesbitan deposits. Why does the gold mineralization concentrate in the northwest end of the Central Belt? We think the reason is as follows at present.

In the central Belt, a graben may be formed simultaneously with or prior to the start of the volcanic activity in Pliocene. The graben was not developed completely, and so it can be estimated that the basements including Late Miocene intrusives are distributed at relatively shallow levels in the northwest end of the Central Belt. The mineralization distributed in the Northeastern and Southwestern Belt occurred with relation to the Miocene intrusive rocks. Namely, the basements including Miocene intrusive rocks are, so to speak, contaminated by Miocene mineralization. The hydrothermal system formed by the magma related to the westward subduction of the Philippine Sea Plate in Pliocene is considered to have been able to concentrate the metallic elements to higher degrees by circulating through the basements contaminated by the mineralization took place in Miocene. This is supported by the fact that the Ni content of the altered rocks in Kilbay area is relatively high. Thus, it can be inferred that the epithermal systems accompanying the mineralization have developed in the region covering Kilbay area and Nalesbitan area.

From the above discussion, the following four areas may have high potentiality.

Kilbay area

Larap-Exiban area, and

Mt. Bagacay area

Choosing the area for further exploration project from the eight areas, we should examine the other factors, such as the condition of mining claims, access, and peace and order. In terms of the conditions of mining claims, Kilbay area is most appropriate for the further exploration project because of its vacancy of mining claims. Within the above three areas, Kilbay area still remains room in which the applications for mine claims have not been made yet. Most of Larap-Exiban and Mt. Bagacay areas are covered by MPSA and application of MPSA. In addition, the two areas have been prospected for many years and there is limited potential for new, near-surface discoveries of the same type of mineralization. However, much of the areas lie within areas of poor outcrop exposure and some potential for further discoveries of such as a porphyry type deposits exists at depth. Concerning the access to the area, Larap-Exiban area and Mt. Bagacay area are better than Kilbay area. And all the areas are faced with the same extent of of security problem.

In conclusion, an expanded Kilbay area, which includes Nalesbitan and Tuba area, is considered to be the most promising and appropriate area as the area for further exploration.

Table II-3-1 Summary of the evaluation of the eight areas

area	metallogenic belt	geology and host rock of alteration	observed alteration/mineralization	structure	interpretation of the positions on the conceptual magma-hydrothermal system	possible mineralization style	geochemical relative features of altered rocks	mining rights
Western part of Bacon-Manito	Central Belt	Pleistocene andesite	steam heated acid alteration, volcanic gas condensation, vein/hydrothermal breccia/silicification	Major fault: WNW trending left lateral fault (alteration, geothermal reservoir), ENE trending fault (alteration); Minor fault: NS trending fault	shallower part of epithermal system	epithermal gold mineralization in deeper part	moderate in Co, Cr, and Hg; low in Au, Ag, As, Bi, Cu, Mo,Ni, Pb, Sb, and Zn	AFTAA*
Gate Mountains	Central Belt	Pliocene to Pleistocene andesite	rather wide distribution of alteration zone steam heated acid alteration, volcanic gas condensatio partly mixed layer clay alteration vein/hydrothermal breccia/silicification	Major fault: WNW trend left lateral fault (alteration), ENE trending fault	shallower part of epithermal system	epithermal gold mineralization in deeper part	moderate in As, Bi, Co, Cr, and Hg; low in Au, Ag, Cu, Mo, Ni, Pb,Sb, and Zn	a few AMPSA*, exploration permit
Northwestern part of Tiwi	Central Belt	Pleistocene andesite to dacite	steam heated acid alteration, silicification, mixed layer clay alteration, propylitic alteration, Qtz veining in mixed layer clay zone	Major fault: NW～WNW trend left lateral fault (alteration), ENE trending fault (alteration, geothermal reservoir); Minor fault: NS trending fault	shallow to middle part of low sulfidation epithermal system	epithermal low sulfidation gold mineralization in deeper part	moderate in Co; low in Au, Ag, As, Bi, Cr, Cu, Hg, Mo,Ni, Pb Sb, and Zn	vacant or PGI?
Eastern Caramoan	Northeastern Belt	Pre-Cretaceous Ophiolite sequence, Cretaceous metasediments, Cretaceous? intrusive, Oligocene? intrusives	dike rock related Cu dissemination? shear zone hosted Cu mineralization?	WNW trending left lateral fault (ex. Minas fault), NE trending fault,	lack of data	volcanogenic massive sulfide?, mesothermal vein (shear zone hosted?), skarn type mineralization	high in Cu; moderate in Au, Ag, and As; low in Bi, Co, Cr, Hg, Mo, Ni, Pb, Sb, and Zn	AFTAA, MPSA
Kilbay	Central Belt	Pliocene dacite	silica sinter, steam heated acid alteration, mixed layer clay alteration, propylitic alteration, Qtz veining with Au, Ag mineralization	Major fault: WNW～NW trending fault (vein mineralization, alteration); ENE～NE trending fault (vein mineralization, alteration), Minor fault: NS trending fault	shallow to middle part of low sulfidation epithermal system	epithermal low sulfidation gold mineralization in deeper part	high in As, Hg, Pb, and Sb; moderate in Au, Ag, Co, Cr, Cu, Mo, Ni, and Zn; low in Bi; highest in Au, Ag, As, Cu, Ni, Pb, and Sb in the Central Belt	mostly vacant, MPSA,
Tuba	Southwestern Belt	Ophiolite sequence, Cretaceous metasediments, Tertiary intrusives	Cr-bearing muscovite, Qtz veining with Au, Ag mineralization	NE trending fault (vein mineralization)?	sub-epithermal mineralization?	sub-epithermal mineralization	high in Ag, Cr; moderate in As, Bi, Mo, Ni and Sb; low in Au, Co, Cu, Hg, Pb, and Zn	MPSA
Mt. Bagacay (include Paracale)	Northeastern Belt	Ophiolite sequence, Paleocene to Eocene sediments, Middle Miocene andesite (Bagacay Andesite), Middle Miocene Trondhjemite(Paracale Granodiorite), Late Miocene quratz monzodiorite (Tamisan Diorite),	skarn type alteration, sericite alteration, skarn type magnetite ore with Cp, Py, and Au; Qtz vein with Py, Cp, Sp and Au	NNE～NE trending fracture (vein mineralization), NW trending fault, NS trending fault, EW trending fault	sub-epithermal environment, porphyry to near porphyry system	porphyry type Cu, Au, Mo mineralization, skarn-type Fe, Cu, Au mineralization, sub-epithermal vein Au, base metal mineralization	high in Au, Ag, Bi, Co, Cr, Cu, Ni, Pb, and Zn; moderate in As, Mo, Sb; low in Hg;	MPSA
Larap-Exiban	Northeastern Belt	Ophiolite sequence, Paleocene to Eocene sediments, Miocene sediments, syenite Middle Miocene trondhjemite(Paracale Granodiorite), Late Miocene quratz monzodiorite (Tamisan Diorite), Late Pliocene dacite?	potassic alteration, sericite alteration, skarn type magnetite ore with Cp, Py and Au; Qtz vein with Py, Cp, Ga, Sp and Au; stockwork Qtz vein with magnetite dissemination	NNE～NE trending fracture (vein mineralization), NW trending fault, NS trending fault	sub-epithermal environment, porphyry to near porphyry system	porphyry type Cu, Au, Mo mineralization, skarn-type Fe, Cu, Au mineralization, sub-epithermal vein Au, base metal mineralization	high in Au, Ag, Bi, Cu, Pb, and Zn; moderate in As, Co, Cr, Mo, Ni; low in Hg, Sb;	MPSA

* AFTAA: application for FTAA, AMPSA: application for MPSA

PART III CONCLUSION AND SUGGESTIONS

Chapter 1 Conclusion

The Bicol area can be divided into the following three zones by its geology, the age, distribution, and occurrence of mineralization and alteration. These zones can be recognized as metallogenic belt.

Northeastern Belt
Central Belt
Southwestern Belt

As a result of this survey in the Bicol area, the following three areas were selected as high potential area for mineralization.

Kilbay area
Mt. Bagacay area
Larap-Exiban area

If the Bicol area is divided into three metallogenic provinces, the Kilbay area is situated in the Central Belt and has a high potential for the existence of an epithermal gold deposit. In addition, mine claims are seldom established and exploration activities are rarely performed in these areas. Therefore, the Kilbay area and its surroundings are considered to be the most promising as a new exploration project area.

Among the metallogenic provinces, the Mt. Bagacay area and Larap-Exiban area are situated in the Northeastern Belt, and are selected as a high potential area for the existence of a porphyry-type gold and copper deposit, skarn-type ore deposit, and sub-epithermal vein-type ore deposit. Considering many applications for a mine claim (MPSA) are made in the Mt. Bagacay area and Larap-Exiban area and these areas have been explored for a long time, priority is given to the Kilbay area.

However, because the surface of the earth is covered with vegetation, little rock is exposed. The depths have not been surveyed much for a porphyry-type ore deposit. Therefore, it is conceivable that there is still room for exploration.

Chapter 2 Proposals for future survey

As mentioned in the section "Selection of promising area" in Part II Chapter 3, the Kilbay area was selected as a promising area. When considering a new exploration project, it is advisable to explore not only the range of survey in Phase II but an area expanded to the northwest shown in Fig. III-2-1 (we call it "Kilbay – Nalesbitan – Tuba area" in this Chapter). The reasons are given below.

Firstly, the central position of the hydrothermal system in the Kilbay area surveyed in Phase II area has not been located yet. It was made clear that a hydrothermal alteration zone accompanied by gold mineralization is also distributed on the north of the Susungdalaga Mountain. It will be possible to clarify the center of the hydrothermal activity by discovering the extension.

Secondly, the Nalesbitan ore deposit is distributed approximately 10 km north of the Kilbay area. This is the only gold deposit discovered so far in the Central Belt. This gold deposit is an epithermal deposit of the high-sulfidation system. A mineralization occurs in the "dilational jog" in the WNW-ESE direction (Sillitoe et al., 1990). Therefore, a hydrothermal ore deposit may exist along a fault in this NW-SE direction. The SE extension of this Nalesbitan trend may extend to the north of the Susungdalaga Mountain or the vicinity of the catchment basin of the Labo River.

Recently it has been made clear that the Lepanto gold deposit and the Far South East (FSE) porphyry-type gold and copper deposit are formed simultaneously in the same magma-hydrothermal system (Arribas et al, 1995; Hedenquist et al., 1998). They are controlled by the Lepanto fault of the NE-SW system. As Sillitoe et al. (1990) pointed out, a porphyry-type ore deposit may exist in the depths on the extension of the Nalesbitan trend on the analogy of the Lepanto-FSE ore deposit. In addition, the Victoria ore deposit, an epithermal low sulfidation gold deposit, has been recently discovered near the Lepanto-FSE ore deposit. A gold deposit of the low sulfidation system similar to the Victoria ore deposit might exist in the Kilbay area.

Thirdly, hot springs as high as 80℃ rise even now in the Kilbay-Alawihaw creek, among the Kilbay area surveyed in Phase II. These hot springs have relatively high silica and salt concentrations. This fact suggests that deep hydrothermal solution may rise and hydrothermal solution as high as approximately 150℃ may exist in the depths. Consequently, it is not convenient to explore a gold deposit near the Kilbay-Alawihaw creek because of high temperatures. It is advisable to explore other places, where the area expanded to northwest, with lower underground temperatures.

Fourthly, a gold deposit of a vein-type is distributed in the Tuba area. From its geological setting, it is estimated that this gold deposit has an origin and a formation age similar to those of vein type gold deposits distributed in the Paracale area.

It is advisable to cover this area first by the airborne geophysical survey. As described in Part II Chapter 3, it is because the detailed analysis of magnetic and radiometric responses is very effective to know the lithological distribution, geological structure, and distribution of alteration zones. In particular, in a place such as the Bicol area that is covered with thick vegetation and cannot be surveyed satisfactorily due to its hard accessibility and security problem, the airborne geophysical survey is a very effective method. Then a detailed field survey is required.

The present survey made it clear that a "dilational zone" caused by a left lateral WNW-trending fault system and a ENE-NE-trending fault system intersecting diagonally with that is promising as a passage of hydrothermal solution. Therefore, it is necessary to discover a possible area where such a "dilational zone" develops by the airborne geophysical survey and to make field survey around this zone. From their K-Ar age, since it is judged that Susungdalaga volcanic rocks were formed in the Gilbert chron, volcanic rock corresponding to the reverse geomagnetic polarity epoch of this period may exist. The magnetic data needs to be carefully analyzed.

The following areas could be the candidate areas for a further exploration project in the Bicol Region, although the priorities are lower than the above-mentioned area. Those areas are also shown in Fig. III-2-1.

Larap – Mt. Bagacay
Gate Mountains
Northwestern part of Tiwi – Mt. Malinao
Caramoan Peninsula

The Larap – Mt. Bagacay area includes the Larap – Exiban area and the Mt. Bagacay area, which are surveyed in Phase II. Though many MPSA covered this area and the area has been explored for a long time. However, This area may still have high potential for porphyry type Cu – Au deposits, vein type gold – base metal deposits, and placer gold deposits which may be secondary deposits of the former two deposits.

This Survey shows the extension distribution of hydrothermal alteration zone in the Gate Mountains and the Northwestern part of Tiwi – Mt. Malinao area for the first time. The Survey does not show high potential for the gold mineralization in the both areas. However, we can expect more extension of the hydrothermal alteration zone in the both areas. In that sense, there may be room for further exploration in the both areas.

In Gate Mountains area, there is no drilling data near the area. That is one of the reasons why we could not evaluate the potential of the deeper part of the hydrothermal alteration zone convincingly. We can expect much more extension of hydrothermal alteration zone along the WNW-trending fracture. In order to check the potential of the deeper part of the hydrothermal alteration zone, we recommend a drilling survey at a deeper part of the WNW-trending fractures.

We found the quartz vein within sericite/smectite mixed clay zone in the Northwestern part of Tiwi – Mt. Malinao area. We evaluate the potential for the gold mineralization in the deeper part of the alteration zone, because those quartz veins do not have any gold mineralization. However, we also found out the extensive steam-heated acid alteration zone in the northeastern part of the area. Underneath of the acid alteration area may have room for further exploration.

In Caramoan Peninsula, the field survey of Phase I was conducted in the Siruma Peninsula and Tamban – Olas area in the western part of the Caramoan Peninsula. Phase II field survey was conducted in eastern part of the Caramoan Peninsula. Though we do not have enough data to evaluate the potential of the Caramoan Peninsula, this area may have higher potential from the following point of view.

The Tertiary intrusives are distributed in the ophiolite sequence in western part of the Caramoan Peninsula. In this geological setting, there is a possibility that volcanogenic massive sulfides related to the ophiolite sequence exist and the Tertiary intrusives could re-distribute and re-concentrate the mineralization. In particular, the geological settings of Tamban – Olas area is similar that of the Paracale district. Tamban – Olas area may have potential for the same type of gold deposit in the Paracale district. As a whole, gold and copper showings accompanied with green schist and mica schist are distributed in the Caramoan Peninsula. In part, gold and copper mineralization occurred in the shear zone of the schists. We might expect the shear zone hosted mesothermal lode type deposit in the area. However, the area is covered by the application of FTAA as a whole.

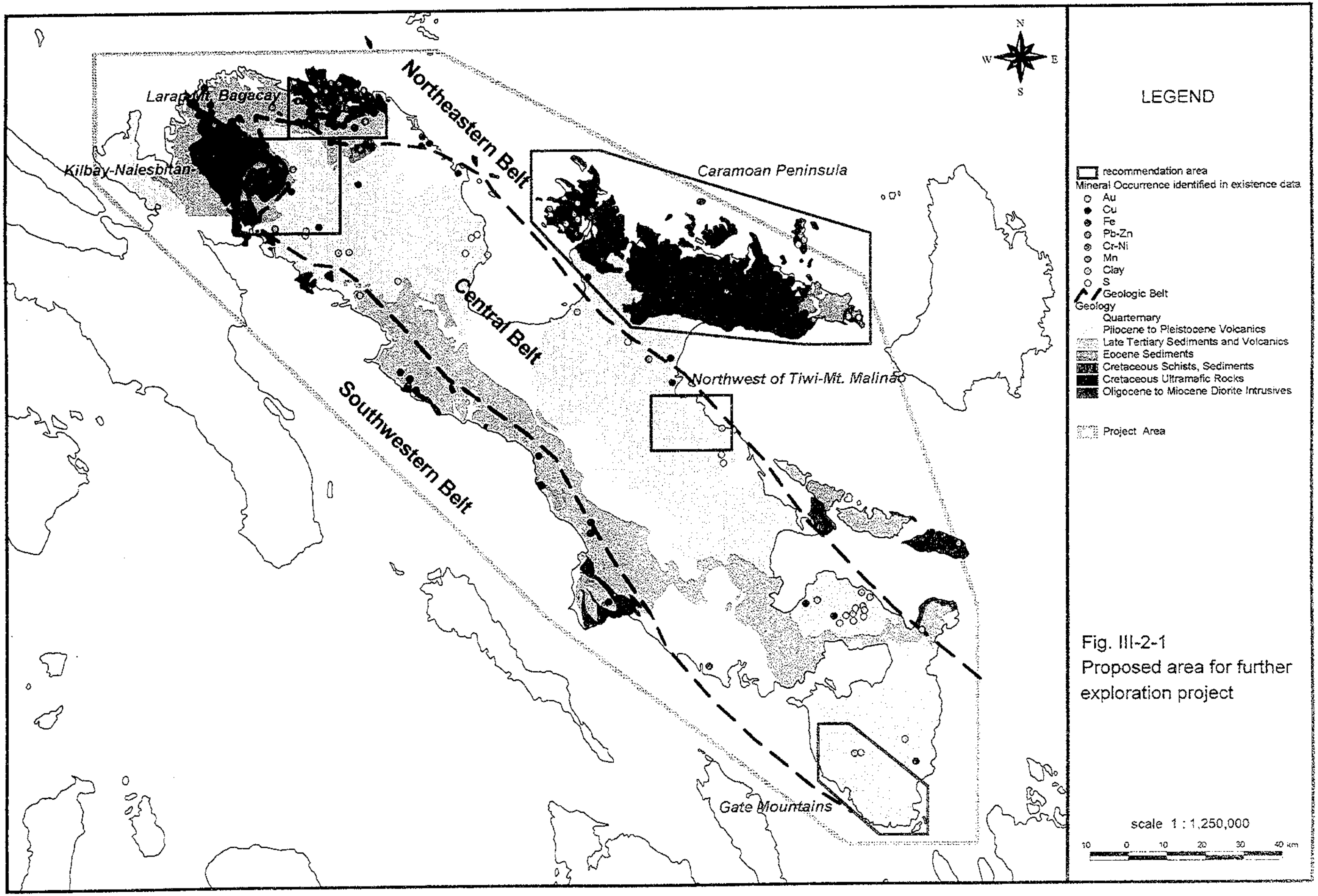


Fig. III-2-1
Proposed area for further exploration project

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