Table II-2-4 Geology of Kilbay area
From Zaide-Delfin et al. (1995) and BMG (1984)

stratigraphy	*lithology*	*age*
<<Labo geothermal field>>		
basement	ophiolite sequences? but drill holes did not encounter the basement even at -1,900m in elevation.	pre-Cretaceous ?
Susong Dalaga Volcanics (Susong Dalaga Formation)	hornblende andesite flows, agglomerate, and tuffs	Upper Miocene — Santa Elena Formation? distributed in west of Mt. Labo
Vinas Formation	shallow marine sedimentary rocks, sandstone, air-fall tuffs, wacke, and conglomerate	Pliocene not encountered in any of the six wel
Labo Volcanics	Basal unit: hornblende andesite, basalt, dacite lavas and lahars Lavadomes: Bt-Px-Hbl dacite and Bt-Hbl andesite domes Centralcone: Px andesite, Hbl andesite and dacite lava, laharic beccias	Pleistocene 0.42 to 0.08 Ma
	Pyroclastic flows: andesitic to dacitic block and ash flows	80,000 years BP
<<Kilbay>>		
basement	schists: ophiolite sequences?	pre-Cretaceous ?
Upper Tertiary Volcanics (Susong Dalaga Volcanics?)		
Plio-Pleistocene sediments (Vinas Formation?)		

dacite. They underwent medium-level argillization and partial silicification, and a pyrite stain was observed. The X-ray diffraction revealed that the lapilli are composed of plagioclase, quartz, chlorite/smectite mixed layer clay, sericite/smectite mixed layer clay, jarosite, and pyrite. They underwent a slightly higher-temperature alteration than they look.

PTH320 is an outcrop of argillized alteration in which a fault is observed (Appendix 14: PH15, PH16). There is a pyrite stringer in the same direction (N15° E) as that of the fault, and the fault almost concurred with the hydrothermal alteration. The X-ray diffraction revealed that PTH320 is part of a quartz, pyrite, sericite/smectite mixed layer clay.

PTH321 and 322 are quartz veins in the same alteration outcrop (Appendix 14: PH17, PH18, and PH19). It underwent a medium-level argillization and medium to strong silicified alteration. The X-ray diffraction was not conducted. However, because they are almost the same as PTH320, the sampling point is considered to be a mixed layer clay alteration zone, too. The quartz vein of PTH321 is 1 to 6 mm wide, has a strike of N40° W, and has a vertical dip. It is accompanied by pyrite. Very fine-grained sulfide? with a bluish green black metallic luster is observed. The analysis showed that PTH321 contains Au: 275 ppb and Cu: 718 ppm, relatively high values. PTH322 has also a black sulfide (pyrite ?) stringer in a quartz vein. PTH322 has almost the same value of analysis, Au: 250 ppb and Cu: 727 ppm, as PTH321. Because no polished section was prepared, this mineral could not be identified. It can be presumed that the mineral contains Au and Cu. The fluid inclusion temperature of quartz of PTH322 is Th = 339 to 366 ℃, Salinity = 0.0 to 0.35 wt% NaCl equiv. Quartz is chalcedonic. The homogenizing temperature indicates an anomalously high value, compared to an apperance. There is a possibility that temperature of a "pseudoprimary" inclusion (Sander and Black, 1987) caused by the recrystallization of chalcedonic quartz is measured (Sander and Black, 1988).

PTH323 is an outcrop of silicified rock. It is almost parallel to the surface of the river and develops horizontally (Appendix 14: PH20). A hydrothermal brecciation texture can be also seen.

A lot of quartz veins are observed in the kaolinite alteration zone on this side before the creek winds eastward (Appendix 14: PH21). The X-ray diffraction revealed that the host rock of quartz veins (PTH324) is composed of quartz, kaolinite, and alunite. Two types of quartz vein are observed. One type is black chalcedonic quartz veins (PTH325). There are seven almost parallel 0.5-cm- to 10-cm-wide quartz veins. Their strike and dip are N70° E, 42° N, and N80° E, 50° N, respectively. The other type of quartz vein (PTH326) is a white or gray color. A lot of almost parallel 0.5-cm- to 3-cm-wide veins are observed. Their strike and dip are N60° W and 40° S, respectively, and these quartz veins cut across the above-mentioned black quartz veins (Appendix 14: PH22). Also, these quartz veins are cut by a fault of N65° W and 42° N (Appendix 14: PH23). Furthermore, these quartz veins and the fault are cut across by a fault of N60° E and 60° S. The altered host rock of PTH324 has an anomaly value of Au: 45 ppb and Cu: 860 ppm. The X-ray diffraction showed that black quartz veins are composed of quartz, pyrite, rutile, anatase, and kaolinite and have anomaly values of Au: 180 ppb, Cu: 828 ppm, and Mo: 34 ppm. Gray quartz veins of PTH326 contain Au: 215 ppb, Cu: 529 ppm, and P: 3260 ppm and both quartz veins have weak gold and copper mineralization.

Beyond this point, a lot of highly silicified rocks are observed as boulder floats. As an outcrop, a light greenish gray low-temperature propylitic alteration zone extends. PTH327 is an albite, quartz, sericite/smectite mixed layer clay, and chlorite/smectite mixed layer clay. As one goes upstream, the alteration tends to become weaker.

PTH329 is an outcrop of strongly silicified rock. It is vuggy quartz. This is a texture caused by supergene. The analysis revealed that it contains Au<5 ppb. PTH330 is an outcrop of highly silicified rock mostly composed of quartz (Au: 25 ppb).

A low-temperature propylitic alteration zone extends from PTH331 to the survey end point of this route. Some places have a strong pyrite stain. The water/rock ratio seems to have been relatively higher in such places than in other places. In PTH332, a assemblage of a quartz, plagioclase, chlorite/smectite mixed layer clay, calcite, sericite/smectite mixed layer clay, rhodochrosite, and pyrite is detected.

<Alawihaw-Kilbay creek>

Relatively fresh hornblende-biotite dacite and andesite (PTH333) are distributed at the mouth of the creek. The whole-rock analysis showed that this rock contains 64.52% of SiO_2 and is dacite of the Medium K series. The K-Ar age of this rock is 3.75+/- 0.42 Ma, indicating the Early Pliocene. Namely, the Labo volcano belongs to Late Pleistocene to Recent, while a volcanic rock distributed in this area is older than that of Mt. Labo area.

Hot springs rise at PTH335 (Appendix 14: PH24). A nearby outcrop has a medium-level argillization and pyrite dissemination. It underwent a smectite alteration. Cu: 115 ppm, a value of analysis at an anomaly level, was detected, but gold is below the detection limit. Quartz veinlets (PTH336) are observed at the outcrop. There are three quartz veinlets: 4 cm-wide, 2 cm-wide, and 0.5 cm-wide veinlets. The thickest one was collected from these three veinlets. This veinlet is accompanied by fine-grained pyrite. The analysis showed that it has values at an anomaly level, containing Au: 20 ppb, Ag: 0.8 ppm, Cu: 577 ppm, Pb: 1060 ppm, and Zn: 2310 ppm.

Silica-carbonate sinter (PTH337) can be observed near the hot spring rising point (Appendix 14: PH24). Sinter is about 1 meter thick. It is distributed almost horizontally or at a slight incline over 30 to 40 m from the level of the present surface of the river to the level of 2 to 3 m above that (Appendix 14: PH25, PH26). PTH334 is a float originating from this sinter. A banded structure of several centimeter wide calcite and quartz is observed (Appendix 14: PH27). The analysis showed that it contains Au<5 ppb, Ca>15%, Sr: 2000 ppm. The value of Sr is high. The fluid inclusion homogenizing temperature of calcite of PTH334 is 104 to 145 ℃ and the salinity is 0 – 0.35wt% NaCl equiv.

Alawihaw creek is characterized by a high arsenic content.

Silicified altered rock continues on both shores of the creek in the NE direction. Banahao Mining Inc. excavated a tunnel to explore gold in 1970's (Appendix 14: PH28). A site where a channel sampling was conducted along the wall was also observed. A goethite vein was collected from this outcrop (PTH338). Its strike and dip are N30° W and 70° W, respectively. It has relatively high values of Au, Cu, and As, containing Au: 535 ppb, As: 164 ppm, Cu: 226 ppm, Mo: 66 ppm, and Zn: 104 ppm. A quartz vein accompanied by pyrite (PTH339) is also recognized. The quartz vein is 12 cm wide. Its strike and dip are N30° E and 76° E, respectively. The analysis showed that it contains Au: 90 ppb and As: 6070 ppm. The value of arsenic is the second highest of all the samples. PTH340 is also a 1.5 cm-wide quartz vein, and its strike and dip are N45° E, 50° SE, respectively. It is in yellowish brown argillized andesite. PTH341 is a quartz vein of an outcrop that continues from PTH340. It is a ceramic quartz vein and is accompanied by pyrite. It is 20 cm wide, and its strike and dip are N60° E, 72° S. The analysis showed that it contains Au: 5 ppb, As: 1080 ppm, and Pb: 1020 ppm. Arsenic and lead have high values.

A weakly argillized outcrop (PTH342) is found right at the entrance of Alawihaw Creek in the narrow sense of the word, and a fault having a strike of N20° W and a vertical dip is observed. PTH344 is a ceramic quartz vein found in a weakly argillized country rock (PTH343: quartz, dolomite, kaolinite, sericite/smectite mixed layer clay, and pyrite). It is thought that the vein also contains a considerable amount of dolomite. The analysis showed that it contains Au: 20 ppb, Ca = 13.85%, and Mg: 5.82%. The value of Mg is the highest of all the samples.

PTH345 is a landslide outcrop. It underwent argillized alteration and has a pyrite stain. A quartz vein can be observed along a fault (N70° W, 55° S). It contains Au: 165 ppb, Ag: 3.2 ppm, As: 102 ppm, and Pb: 226 ppm. The gold, silver, and arsenic contents are relatively high. A hot spring rises on this side of this outcrop. From its taste, the hot spring seems to be of SO_4-Cl type, and its temperature may be about 60℃.

PTH346 is a black silicified vein rich in pyrite. It looks like a quartz vein and a texture indicating the replacement of a host rock can be observed. Its strike and dip are N50° W, 40° N and it is 3 to 10 cm wide. The analysis showed that it contains Au: 60 ppb, As: 1430 ppm, Hg: 28 ppm, Sb: 350 ppm, Tl: 50 ppm. All of elements characteristic of an epithermal system have anomaly values. In particular, Sb has the highest value of all samples. Both Hg and Tl have the second highest value.

PTH347 underwent white argillization. The X-ray diffraction revealed that it contains quartz, sericite/smectite mixed layer, and pyrite and belongs to a typical mixed layer clay zone. The analysis showed that it contains Au<5ppb, As: 54 ppm, Sb: 12 ppm. Arsenic and antimony have anomaly values. PTH348 is a quartz vein in an outcrop of PTH347. The analysis showed that this quartz vein contains Au: 160 ppb, Ag: 0.8 ppm, As>10000 ppm, Hg: 69 ppm, Mo: 54 ppm, Sb: 94 ppm, Tl: 140 ppm, and Zn: 688 ppm. It has a geochemical anomaly characteristic of an epithermal gold deposit area. The value of gold is not so high, but As, Hg, and Tl have the highest value of all the samples collected in this survey. A hot spring rising point is situated immediately above the PTH347 outcrop. It is of SO_4-Cl type and its temperature may be 60℃ or more. Consequently, it can be concluded that the alteration found in the host rock was caused not by the present hot spring activity but by the past, higher-temperature hydrothermal activity.

PTH349 is hydrothermal breccia. The host rock is lapilli tuff or tuff breccia (pyroclastic flow sediments). It is weakly silicified and has a pyrite stain. It is composed of quartz, pyrite, sericite/smectite mixed layer clay, and anatase. A mixed layer clay zone is exposed. The analysis showed that PTH349 contains Au<5 ppb, As: 156 ppm, Hg: 3 ppm, Sb: 12 ppm. It has anomaly of elements characteristic of a shallow part of an epithermal system.

PTH350 is a carbonaceous substance collected from the same outcrop as that of PTH349. It may be carbonized wood in pyroclastic flow sediments. The X-ray diffraction showed that it is only composed of quartz and pyrite, and no other minerals were detected. It contains Au<10 ppb, As: 372 ppm, Hg: 4 ppm, and Sb: 22 ppm. It has anomaly of elements characteristic of a shallow part of an epithermal system, but no secondary enrichment of gold to carbon materials were found.

Alawihaw Creek running from the north and Kilbay Creek running from the south meet together at an elevation of about 120 m. Biotite hornblende andesite and dacite are distributed from this intersection to the point 500 m away to the south. Argillized alteration and partial silicified alteration are also observed. Argillized and altered rock assumes a gray color and is accompanied by a large amount of pyrite. The X-ray diffraction showed that it is composed of quartz, kaolinite, and a sericite/smectite mixed layer clay (PSM276). The analysis revealed that it contains Au: 10 ppb and As: 42 ppm. The value of arsenic at an anomaly level was detected. Small-scale outcrops of 20- to 30-m wide silicified rock are distributed in such argillized rock. The silicified rock is separated from the neighboring argillized rock by a clear border. PSM277 is a float of silicified rock, which contains Au: 95 ppb, Cu: 175 ppm and As: 106 ppm. Every element has values at an anomaly level.

<Bacaco>

This area is situated 10 km northeast of Del Gallego or 8 km west-southwest of Mt. Labo. Although mostly unpaved, the roadway extends from Del Gallego to Mansalaya and it is passable. From there on, the road is so bad even a four-wheel drive would have great difficult in advancing. The survey area is accessible only on foot from the point 1.5 km before the mouth of the Alawihaw creek. An access road was built in 1970's when Banahao Mining Inc. started drilling exploration. The access road was damaged so badly it is not available at present.

Pyrite, mixed layer clay argillized alteration zone extend widely. In addition, strongly silicified rock accompanied by a limonite stain is continuously distributed in some area. Silicified rock may be produced in the form of block in the argillized alteration zone (PKY288: 20 ppb Au). Quartz veinlets can be very rarely recognized (PKY289: 5 ppb Au, Appendix 14: PY25). In addition to these quartz veinlets, 4 m-wide pyrite – silicified zone containing 4 cm-wide quartz veins (PKY294: 340 ppb Au) exist in weakly silicified and argillized alteration andesitic pyroclastic rock (Appendix 14: PY27). PKY290 (float) as a quartz vein sample having clear quartz crystals and PKY294 were collected. Their homogenization temperatures of fluid inclusions are 239 – 264 ℃ and 250 – 269 ℃, respectively. Their salinities are 0.71 – 1.91 wt% NaCl equiv. And 0 – 0.18wt% NaCl equiv., respectively.

<Tabion Munti>

The Tabion Munti area is situated in the Tabion Munti village 7 km east-northeast of Del Gallego, and it is a relatively flat area near the junction of Tabion Munti River and Bukis River. Although this area is accessible by vehicle from Del Gallego, the roads are bad. It takes about 40 minutes from Del Gallego.

Unaltered andesitic tuff breccia is exposed in the Tabion Munti River. Generally, fragments of andesite contain hornblende as phenocryst minerals and some fragments containing quartz and biotite are also recognized. It is presumed that they are part of the Labo volcanic rocks.

Mined clay deposits are generally massive deposits. A horizontal bedded structure is recognized (Appendix 14: PK22) because there are tuffaceous thin layers considered to be ash fall or thin layers containing carbonaceous substances, and this may be a sedimentary clay deposit. Because no alteration is recognized in andesitic pyroclastic rocks around a clay deposit zone, it is concluded that no geological phenomena suggesting a hydrothermal activity exist around this area including the clay deposit.

<Susungdalaga Mountains South>

This area is situated 9 km northeast by north of Del Gallego or in the south of the Susungdalaga mountain. Although mostly unpaved, the roadway extends from Del Gallego to Mansalaya and it is passable. From there on, the road leads to the north. There is a place where the Kilbay River can be crossed and the road is passable by four-wheel drive. Biotite hornblende dacite (PKY297) is widely distributed. The whole-rock analysis revealed it contains SiO_2 = 64.58%. The K-Ar age determination indicates 4.32+/-0.48 Ma. Two or more faults with a strike of N80° – 60° W develop almost parallel. There is often a great difference in the degree of alteration between the right and left sides of the fault.

Light greenish gray argillized and altered rock (PKY298) is found at the mouth of the creek. Tourmaline was detected through the X-ray diffraction. The chemical analysis showed the rock contains Mo: 62 ppm and V: 309 ppm, which are values at an anomaly level.

An argillized alteration mainly composed of pyrite, mixed layer clay minerals in the host rock of biotite hornblende dacite is intermittently recognized. In particular, the degree of alteration at an elevation of 180 m is remarkable. Silicified rock (PKY305) in the form of block often develops in an argillized alteration zone (PKY304). The argillized alteration zone was generally controlled by the WNW-ESE-trending fault system and seems to be distributed widely in its south block. Unaltered or weak propylitic alteration is often recognized on the north side of the fault. This suggests that the hydrothermal fluid flow was controlled southward by the hydraulic gradient during a hydrothermal activity.

Two or more silicified rocks (PKY301A, 302B, 302C, Appendix 14: PY31) in the form of vein of the N-S system were found. No mineralization was recognized in these rocks. A combination of minerals in a part (PKY302C) having a remarkable leaching by acid alteration was quartz, kaolinite, alunite, and goethite. Some silicified rocks indicated Au: 90 ppb (PKY303) and Au: 25 ppb (PKY309).

This area is known to as a panning site. Although the details are unknown, gold has been mined (information from residents).

<Molocboloc Creek>

It takes about 30 minutes from the Molocboloc village to the east ridge of the Molocboloc Creek at an elevation of 80 m by four-wheel drive.

An outcrop of unaltered hornblende andesite was recognized in the creek at an elevation of 70 m and on the 180-meter peak. Boulders of highly silicified rock composed almost of silica are distributed at elevations above 130 m in the creek (PSM280). Floats increase both in quantity and diameter in the upstream area. Almost all floats are composed of silicified rock at a point of an elevation above 160 m, and floats with a diameter of 20 meters can be often observed. However, no outcrops can be recognized. This situation continues up to elevations of 200 meters where a survey was conducted. Probably, the source of silicified rock floats may be very near. Such an occurrence of silicified rock is similar to the situation around the Alawihaw – Kilbay Creek. Silicified rock is accompanied by a limonite stain and is yellow or brown color. Silica is composed of quartz and has fine or medium grain.

<Tonton River>

This route is situated on the north of Susungdalaga Mountains. It is about 15 km distant from Mt. Labo. It is located about 12 km away westward from the present geothermal system position. It cannot be thought that this area is hydrologically influenced by the present geothermal system. Consequently, if a hydrothermal alteration zone existed on this route, it would have been caused by other older hydrothermal system unconnected with the present geothermal system. This route was surveyed to verify this. Although an outcrop of hydrothermal alteration could not be recognized, a lot of large floats of hihgly silicified rock were observed. It was confirmed that an epithermal alteration zone is distributed on this route, too. It was also confirmed that this hydrothermally altered rock has gold mineralization.

PTH351 is an outcrop of volcanic breccia. Breccia consists of hornblende-pyroxene andesite. In some cases, the size of feldspathic phenocryst is about 1 cm. Mafic phenocryst is opacitized or hematitized. The breccia has a diameter of 1 cm to 80 cm and is subpebble. Matrix underwent a smectite alteration. Because a pyrite stain is observed, it is thought that the breccia underwent a hydrothermal alteration. Gold is below the detection limit.

PTH352 is an outcrop of a riverbed. It is composed of biotite dacite. It is light greenish gray. Its vitreous matrix underwent a smectite alteration. Biotite, quartz, and plagioclase phenocryst can be recognized. PTH353 is also an outcrop of biotite dacite. It transitions to volcanic breccia. Since biotite is relatively fresh, the K-Ar age determination was conducted. The K-Ar age of biotite is 3.45+/-0.39 Ma, indicating Early Pliocene in age. The whole-rock analysis showed that it contains 65.21% of SiO_2 and is dacite of the Medium K series (Appendix 18).

PTH354 is an argillized and altered outcrop. The source rock is the above-mentioned volcanic breccia. A pyrite stain is observed. The X-ray diffraction showed that it is composed of halloysite, cristobalite, biotite, and marcasite. Biotite is primary magmatic mineral of the host rock. The analysis revealed that it contains Au<5 ppb and it has no gold mineralization. A few floats of silicified rock are observed nearby. Some floats (PTH357) of limestone 50 cm to 1 m across can be also observed.

PTH358 is an outcrop of lava with developed columnar joints to platy joints (Appendix 14: PH29). Large plagioclase phenocrysts of about 1 cm are observed. Generally, it is aphanitic. Under a microscope, serpentine and iddingsited olivine are recognized, a large amount of augite and hypersthene of microphenocryst size is also observed. It turned out that this rock is composed of pyroxene andesite – basaltic andesite. It has a pseudomorph of hornblende, which has completely been replaced with an aggregate of fine-grained pyroxene and opaque minerals. This is basic rock and differs in nature from the neighboring acid volcanic rocks. Since a fault (Strike: N8° E, Dip: 80° W) separates this rock from dacitic volcanic breccia, it is presumed that this rock is occurred in the form of sill or dike.

A lot of floats of silicified rock are observed in the creek at elevations of 130 m to 160 m (PTH359, PTH360, and PTH362). The source rock of highly silicified rock of PTH359 is lapilli tuff. The rock has a strong pyrite dissemination. The analysis showed it contains Au: 830 ppb, Ag: 1.6 ppm, As: 2500 ppm, and Sb: 18 ppm. Gold mineralization can be recognized.

PTH360 is also a float of highly silicified rock. Boulders of the same quality are found around here. It can be presumed that there is an outcrop in this neighborhood. From the distribution, it is thought there is an outcrop on the right shore. The analysis showed PTH360 contains Au: 590 ppb, Ag: 2 ppm, As: 746 ppm, and Sb: 18 ppm. It has almost the same composition as PTH359.

PTH361 is an outcrop of biotite dacite. Its matrix is light greenish gray and underwent a low-temperature propylitic alteration. The X-ray diffraction revealed it is composed of plagioclase, smectite, calcite, cristobalite, and biotite. Greenish gray indicates smectite color. Biotite is a primary phenocryst of the source rock. PTH362 is also a float of silicified rock. Black to gray chalcedonic quartz veinlets can be observed. This rock has pyrite dissemination. The analysis showed it contains Au: 825 ppb, Ag: 6 ppm, and As: 690 ppm. Gold and silver mineralization can be recognized.

According to a local guide, gold was mined by panning near the mouth of the Tonton River. PTH363 and PTH364 are floats of a quartz vein found in the panning site. This quartz vein is not of the epithermal type, and it has the characteristics of high-temperature quartz. The values of analysis of these two rocks are Au: 20 ppb and 40 ppb, respectively. They contain by far less gold than the epithermal silicified rock distributed in the middle reaches of the Tonton River. They have no anomaly values of As, Sb, etc. The manner of element concentration is different from that of the middle reaches of the Tonton River. It seems that these quartz veins originate from the sup-epithermal vein existing in the Cretaceous basement, which is considered to be widely distributed in the lower part of volcanic rock.

7) Potential

A mixed layer clay alteration zone widely develops in this area. Also, silicified alteration seems to develop in the upper part of the argillized alteration zone. The silicified alteration is thought to be a steam heated type alteration zone. The existence of silica/carbonate sinter shows that the very shallow part of the low sulfidation epithermal system also remained. These occurrences may indicate that shallow to medium depth of the low sulfidation epithermal system exposed in this. Figure II-2-18 and Figure II-2-19 show the conceptual position of magma – hydrothermal system of this area. It can be thought that almost the same temperature area as that in the northwestern area of Tiwi – Mt. Malinao is exposed at this conceptual position. However, compared to the northwestern part of Tiwi – Mt. Malinao, gold mineralization is often recognized in altered rock and quartz veins in the Kilbay area. Ag, As, Co, Cu, Hg, Mo, Ni, Tl, Pb, Sb, and Zn anomalies are also recognized. From this fact, it is conceivable that this area has a high potential for gold mineralization.

The existence of silica/carbonate sinter suggests a deep hydrothermal solution saturated at one time with silica rose to the surface, and it is thought a predominant hydrothermal system existed. According to Zeide – Delfin et al. (1995), the temperature of hot springs still rising in this area is 45 to 85 ℃. The SiO_2 content is 70 to 300 ppm and the chlorine concentration is 1700 to 2700 mg/kg. They have relatively high silica content and chlorine concentration. This fact suggests a deep hydrothermal solution close to 150 ℃ rises in the depths even now. However, from the occurrence of the alteration zone, it is presumed that this hydrothermal system is different from the present geothermal system of Mt. Labo and it is a hydrothermal system of an older period. The K-Ar age determination of the argillized altered country rock revealed that volcanic rock older than that of Mt. Labo is distributed in this area and supported the above-mentioned presumption.

It was made clear that the alteration/mineralization zone of this area is distributed over approximately 11 km in the WNW-ESE direction from the Alawihaw-Kilbay Creek to the Tonton River. Quartz veins and faults distributed in this area have the WNW to NW-trend and NE to ENE-trend. A fault topography of the WNW-trending was observed along the south side of the Susungdalaga Mountains. The distribution of a hydrothermal alteration zone seems to be controlled along this.

The Nalesbitan deposit, a high-sulfidation system epithermal gold deposit, is distributed approximately 8 km north of the Tonton River. The Nalesbitan deposit is controlled and formed by a left lateral fault of the WNW-ESE system (Sillitoe et al., 1990). It is expected that mineralization zone of the same type or a porphyry type exists on the extension of this fault (Sillitoe et al., 1990). It is estimated that this extension on the southeast side extends toward the north of the Susungdalaga Mountains of this area.

The north of the Susungdalaga Mountains, namely the neighborhood of the fountainhead of the Labo River, could not be surveyed this time because of hard accessibility and a tight schedule. However, from the above circumstances, it is desirable that a wider area, including the Nalesbitan and Tuba area to be described later and the vicinity of the fountainhead of the Labo River, be surveyed.

8) Mine claim

The MPSA is concluded only in the Tabion Munti clay deposit zone. Other areas are free from exploration rights. Note that a PNOC's geothermal reservation may be established around the Alawihaw-Kilbay Creek.

2-2-6 Tuba Area

1) Reason for selection

Since geological setting of Tuba Area is seemed to be similar to that of Paracale Area, metalliferous vein-type deposits containing relatively high-temperature gold and base metal which is similar to those existing in Paracale Area may also exist in this area. Compared with other places in Camarines Norte, not much survey has been conducted here because of difficulty of access to this area.

NNE to NE-trending fractures control most of the vein-type deposits in Paracale Area. It is desirable to conduct survey also in Tuba area mainly on the areas where lineaments in the same direction are distributed near intrusive rocks.

There is another possibility where epithermal deposits similar to Nalesbitan Deposit are distributed in this area. Although this area is included in the Southwestern Metallogenic Belt from a geological viewpoint, since it is located extremely near the area where Pliocene volcanic lava is distributed, Pliocene hydrothermal system may also be distributed if fracture systems similar to those of Nalesbitan Deposit has been developed. It is necessary to investigate vein alteration zone in known prospects to determine whether the existing deposits are of the same type as that in Paracale or epithermal deposits. In case they are of the former type, the fracture systems in the same direction place near intrusive rocks which is considered as Tertiary and in the place surrounding the known prospects should be surveyed. In case they are of the latter type, the fracture systems in common with the above two places should be pursued taking into account the position from Nalesbitan Deposits.

2) Location and transportation

It takes about fifteen minutes to drive on a paved road from Tagkawayan to Del Gallego, and then about thirty minutes to drive by a four-wheel vehicle of the same type on an unpaved road from Del Gallego to Mapulot village. Although it was possible in the past to go from Mapulot village to a prospect by a four-wheel vehicle, car traffic in this route is now unavailable because of lack of sufficient maintenancet. Therefore, it took about an hour to go on foot to cover a distance of 4 km.

3) Survey routes and points (Fig. II-2-11)

Survey Route	Survey Point
The Tuba Mine	Is gold mineralization noted here the same as that in Paracale

	Area or is it an epithermal gold deposit?
Tuba South (Mapulot)	Intrusive rocks in this area is considered as those in Early Oligocene in correspondence with Paracale granodiorite distributed in Larap-Exiban Area. Consequently, although no statement as a prospect can be traced, existence of similar mineralization was expected.

Owing to a problem of peace and order, we had to give up our survey on the area of Tuba Mine and its surroundings which had been our major purpose. Therefore, the followings refer to the results of our survey on Tuba South (Mapulot) which was the only place we could investigate.

4) Outline of our survey results

Fig. II-2-12 shows the geological features, distribution of altered zones and the points where specimen was sampled.

5) Geology

Granodiorite of Early Oligocene is said to have intruded in Tigbinan Formation of Late Cretaceous mainly consisting of mudstone, sandstone, and tuff (Fernandez, 1984) (Table II-2-5). As a geological feature, they are covered and intruded, especially in southern part, with sedimentary rocks (Bosigon Formation) of Early Miocene and andesite (dike) whose age is unknown.

Northern Mapulot route which we surveyed, sedimentary rocks were not observed as outcrops, and distribution of andesite was distinguished.

6) Alteration and mineralization

<Tuba South (Mapulot)>

The intrusive rocks are not identified in this survey route. Since microscopic observation revealed existence of lapilli, the rock may possibly be lapilli tuff distributed in this route. Altered outcrops were found on a low relief mound of 1 km wide and 2.5 km long extending in north-eastern direction. Silicified rocks were intermittently observed in outcrops extending for a distance of about 700 m, and distribution of floats was observed from the southernmost part southward to a point of 500 m from there. As a result of X-ray diffraction, these silicified rocks were found to consist of sericite/smectite mixed layer clay (probably Cr rich sericite), brucite, and pyrite (PSM271:Au:20ppb). In addition, microscopic observation revealed the existence of clinopyroxene (PSM273: Au:75ppb).

Silicified rocks are mainly massive and consist of brecciated in part. Moreover, pyrite dissemination was observed. The pyrite is euhedral crystal of 1mm or less in diameter.

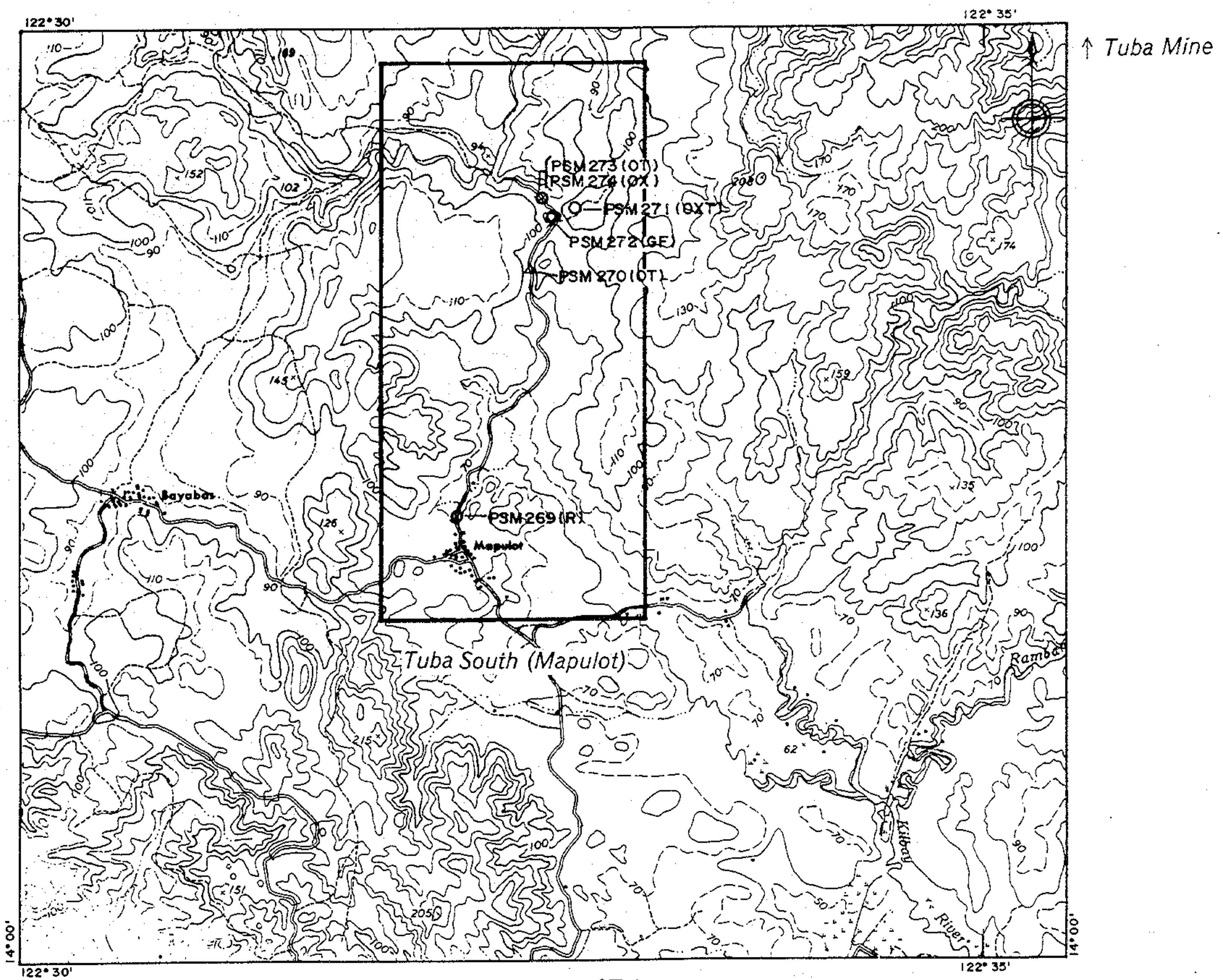

Fig. II-2-11 Root map of Tuba area

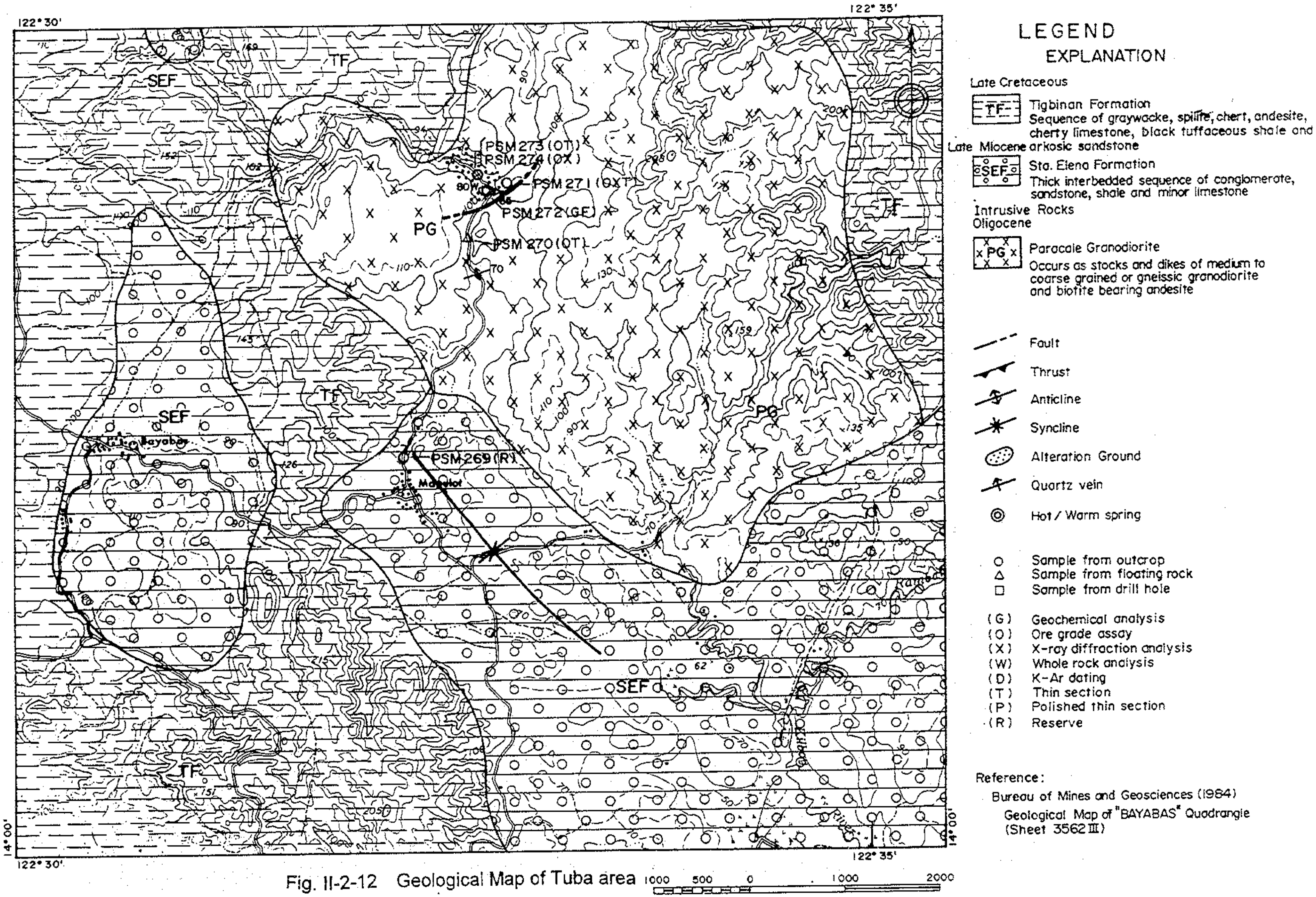

Fig. II-2-12 Geological Map of Tuba area

Table II-2-5 Geology of Tuba area
From BMG (1984)

stratigraphy	*lithology*	*age*
Ophiolite sequence	ultramafic rocks, gabbro → surpentinized	pre-Cretaceous?
Tigbinan Formation	graywacke, spilite, chert, cherty limestone, limestone, arkose sandstone, black shale andesite	Late Cretaceous
Bosigon Formation	conglomerate, shale,	Early Miocene
Santa Elena Formation	conglomerate, sandstone, shale, limestone	Late Miocene
Vinas Formation	sandy limestone, shale	Pliocene
Labo Volcanics	Hbl andesite, Hbl Bt dacite	Pleistocene
Intrusives	granodiorite	Oligocene - Miocene?

Existence of a green ore was noted (PSM 270, 273). As a result of microscopic observation and X-ray diffraction, the green ore was considered as a Cr bearing muscovite (fuchsite).

On the surface of some outcrops were produced natural sulfur in fines and fine-grained gypsum indicating secondary oxidization. Quartz vein was also observed in silicified rocks (PSM272: Au:210ppb, Ag: 10.4ppm, As: 112ppm). The quartz vein was around 10 cm wide at maximum, extending in the direction of N80° W, 65° S. The vein consisted of colorless coarse-grained quartz in accompanying some disseminated pyrite. Its fluid inclusion homogenization temperature was 226 - 273° C and salinity was 1.57 – 3.23 wt% NaCl equiv. Argillized white rock (PSM274: sericite/smectite mixed-layer and chlorite/smectite mixed-layer) with pyrite may be developed on the outer ridge of silicified rock. The boundary between the argillized rock and the silicified rock is rather sharp. According to residents in Mapulot village, the mineralization was discovered after the World War II and once a small-scale mining was conducted. No tunnel or pit remains there. It is unknown for what the excavation was conducted.

7) Potential

Chrome bearing muscovite (fuchsite) in altered rocks and quartz vein are also seen in a quartz vein in Santa Barbara of Paracale Area (as stated below). From this, it is presumed that ultrabasic rocks exist also in the wall rocks around Tuba area. As initially presumed, geological setting of this area was similar to that of Paracale Area. Moreover, since gold mineralization was noted in silicified rocks and quartz vein, we may conclude that this area has as high potentials as Paracale Area.

8) Mine claim

Although FTAA was applied for at the time of Phase I Survey, its application of this time was apparently withdrawn. However, application for MPSA was applied.

2-2-7 Mt. Bagacay Area

1) Reason for selection

This area was selected as an area subject to our field survey of Phase I Survey in view of its high mineralization potential. In Phase I Survey, Agusan Mine as an iron/copper skarn and Malacabana North with distribution of vein-type gold and base metal deposits were surveyed. As a result, gold and copper mineralization relative to "Tamisan Diorite" was found in Agusan Mine. It was also clarified that some vein deposits were distributed in Malacabana North whose generation temperature and salinity were relatively high. From their occurrence and natures of its concentrated elements, it was suggested that their origin may have been related to copper/gold deposits of porphyry type. In the report of UNDP (1987) Survey, in Tabas Area east to this area, existence of an altered zone is and assemblage of altered minerals such as biotite, wollastonite, andalusite, and pyrophyllite in such zone located were noted. Such environment shows a possibility where porphyry type copper/gold deposits may exist in this area. Therefore, survey should be made on surroundings of intrusive rock centering on the prospects which were not subject to our check in Phase I Survey.

2) Location and transportation

This area is located in the northeastern part of Bicol Peninsula. The area is belonging to Camarines Norte and is adjacent to the southern side of Paracale Area which is famous for gold production. Our survey was conducted centering on the foot of Mt. Bagacay.

3) Survey route and points (Figs. II-2-13 and II-2-16).

Survey Route	Survey Point
Pinagbirayan South	Nagpangasan Prospect, Babel Prospect, and Pinagbirayan Prospect where iron skarn prospects are distributed around Tamisan Diorite.
Nico Mine	Gold prospects of vein type are distributed.
Mancasay	Existence of Fe prospect is referred to in UNDP (1987), and it was expected to find skarn deposits accompanying Tertiary Diorite. It was presumed that Tertiary Diorite would accompany porphyry type mineralization. The skarn deposit was considered as peripheral mineralization of porphyry type mineralization in skarn deposits.
Mampungo	Survey was conducted to confirm existence of a clay deposit. Hydrothermal mineralization was expected in its surrounding if the clay deposit was produced with hydrothermal solution.
Dagang Prospect – Malapingan Prospects	Since distribution of iron prospect was considered as a result of skarn-type mineralization, existence of porphyry-type mineralization was expected in its surroundings.
Mt. Bunutan	In order to compare the Tamisan Diorite with typical the Paracale Granodiorite, our survey was conducted on the area around Mt. Bunutan located in the center of the area where the Paracale Granodiorite was distributed. Another purpose was to observe fresh rocks if possible and measure its K-Ar age.
Benguet Mine	Since it was impossible to sample fresh the Paracale

	Granodiorite, we visited the open pit of the mine to get them. Observation of typical mineralization in the Paracale Granodiorite.
Santa Barbara Prospect	Since this place came to be known recently as a zone to generate high quality gold, small-scale miners were actively working there. We conducted a field survey to grasp relations between this gold and vein-type gold deposits in Paracale district.

Out of the above survey routes, Paracale Granodiorite, Benguet Mine, and Santa Barbara are not included in Mt. Bagacay Area. These routes were selected to compare for reference with the geological features and deposits in this area or Larap-Exiban Area (as stated in the next section).

4) Outlines of survey results

Figs. II-2-14 and II-2-17 show geological features, altered zones, prospect distribution, and locations of sampling points.

A lot of Cu/Fe skarn deposits/prospects and vein-type gold and base metal deposits/prospects, and pyrophyllite clay deposits were distributed centering on Mt. Bagacay and its foot. In each prospect, altered rocks and quartz vein contained relatively high-grade gold.

5) Geological features

In this area, ophiolite sequence which is regarded as early Cretaceous is distributed as a base. Covering this irregularly, Universal Formation from Late Palaeocene to Eocene has been distributed (Table II-2-6), and to cover this Formation, Bagacay Andesite of Middle Miocene (13.4$\pm$0.09 Ma: Phase I survey) is distributed. Tamisan Diorite intruded into them. The result of K-Ar chronology measurement of hornblende Tamisan Diorite was 6.96 $\pm$0.78 Ma (PTH367), representing Late Miocene (Table II-2-7).

6) Alteration and mineralization

< Pinagbirayan South >

This area is located about 4.5 km west-northwest from the top of Mt. Bagacay. It is about 1 km east of Agusan Mine which was surveyed in Phase 1. Access was available to go in a four-wheel vehicle from Pinagbirayan village to the entrance of a creek, and then we went on foot. The three prospects surveyed were Nagpangasan Prospect, Babel Prospect and Pinagbirayan Prospect. Nagpangasan and Babel Prospects were located 500 m to 1 km east of the position indicated in UNDP (1987).

Nagpanhgasan Prospect:

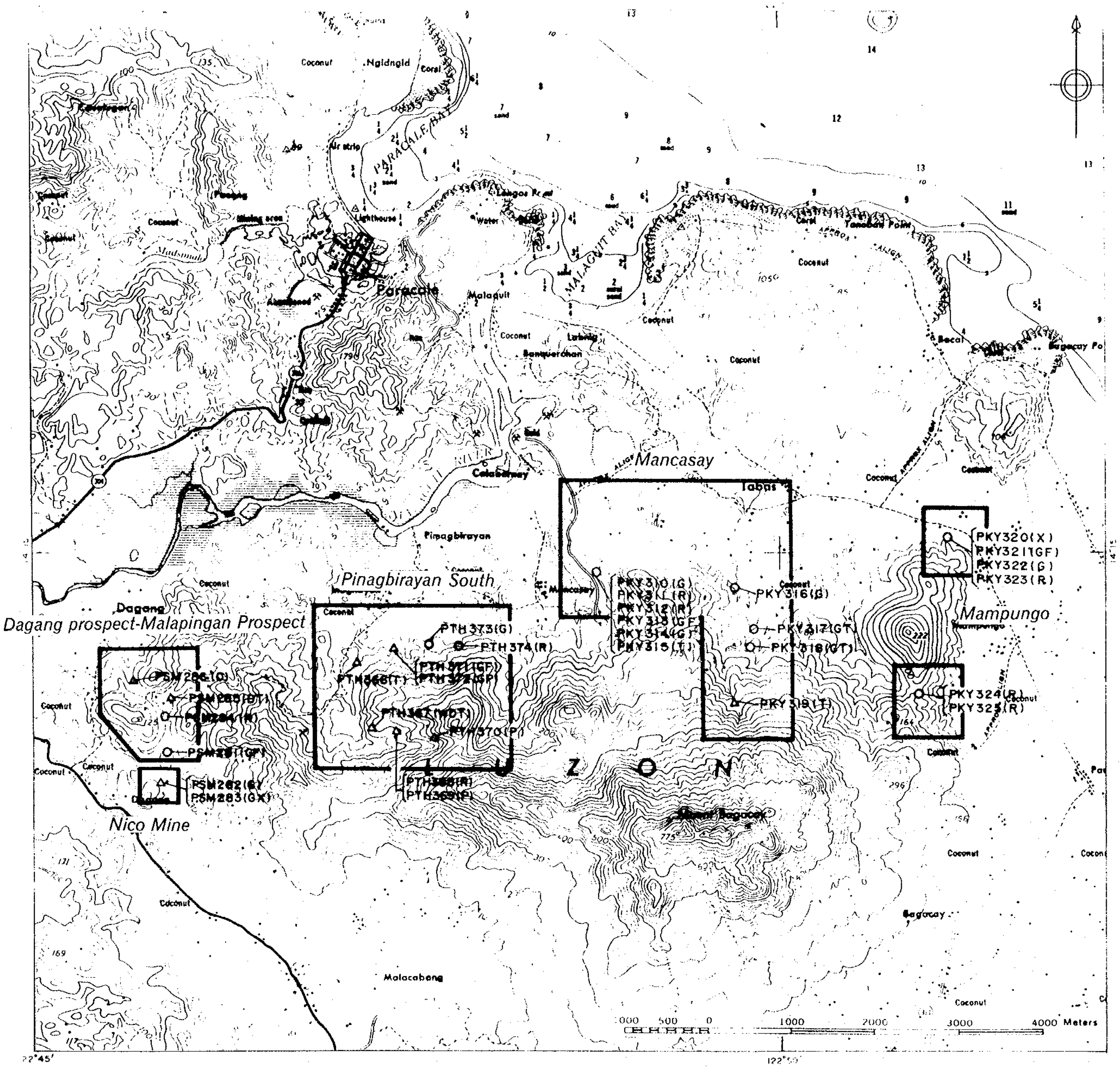

Fig. II-2-13 Root map of Mt. Bagacay area

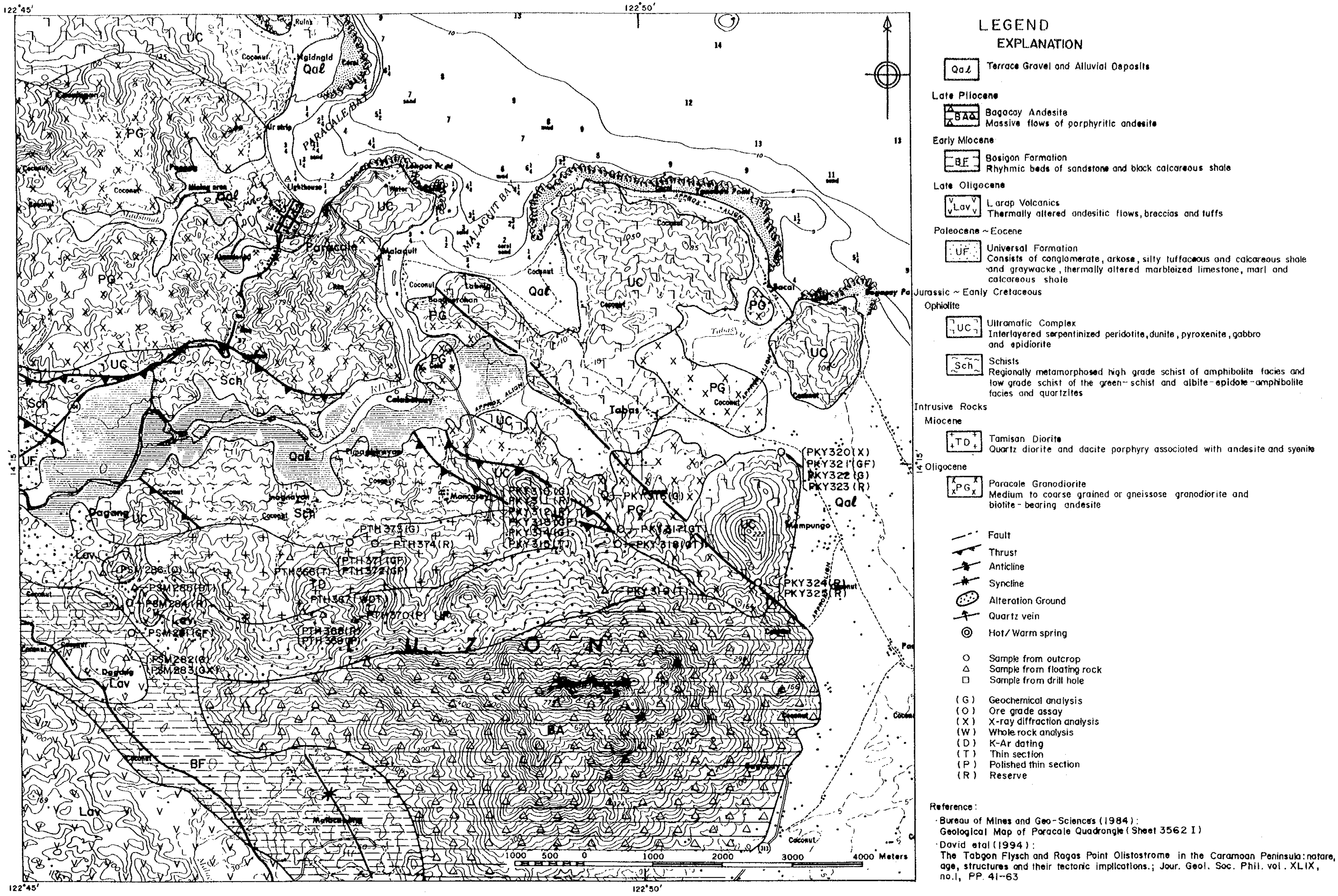

Fig. II-2-14 Geological Map of Mt. Bagacay area

Table II-2-6 Geology of Mt. Bagacay 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
Bagacay Andesite	hornblende andesite	*Middle Miocene 13.40±0.7 Ma (K/Ar Hbl: this survey)*
Intrusives		
Paracale Granodiorite	medium-coarse gr. granodiorite Pl, Kf, Bt, Qtz; foliation at the margin	Middle Miocene 14.9 Ma (Bt; Wolfe, 1981) 17.1±0.9 Ma (Bt; UN, 1987)
Tamisan Diorite	Hbl diorite - quartz diorite medium gr. Pl, Hbl, Qtz	Middle Miocene

Floats of around 10 m in diameter are distributed in an open creek (PTH366, PTH367). Existence of hornblende, plagioclase, quartz, and sphene was confirmed. Mode composition of both PTH366 and PTH367 is classified as quartz monzonite (Fig.II-2-15). Results of the whole-rock analysis were: SiO2=55.99%, relatively basic but more acid compared with diorite. The hornblende form the rock was dated by the K-Ar method as 6.96±0.78 Ma, representing Late Miocene in age. Chemical characteristics shown in a spider diagram represent characteristics of a subduction-related magma (Appendix 20).

There was an open pit in Nagpangasan Prospect which was said to have been mined till the middle of 1950s. Although we could not find any skarn in the pit, floats of skarn were discovered in near the pit (PTH 369). Through microscopic observation, we noted the existence of diopside, quartz, garnet, and magnetite.

Babel Prospect:

According to a local guide, the place called Babel Prospect exist in two places, i.e. halfway up the mountain and at the foot of the mountain. Floats (PTH370) distributed in Babel Prospect halfway up the mountain were silicified aplite. Microscopic examination revealed plagioclase phenocryst in porphyritic texture. Dissemination of pyrite and magnetite is observed. Fine grained chalcopyrite is also observed. In addition, we noted the existence of recrystallized biotite in fines, epidote, and hematite were noted. In Babel Prospect at the foot of the mountain, we collected samples of quartz vein as floats (PTH371, PTH 372). PTH371 consists of high-temperature quartz accompanying pyrite in cubic crystals. Its fluid inclusion homogenization temperature was 173 – 235° C. Salinity was 4.65 – 8.28 wt% NaCl equiv. Chemical analysis indicate rather high values: Au: 28.27g/t, Ag: 31g/t, As:74ppm, Bi:78ppm, Cu:1315ppm, Pb: 254ppm, Sb:32ppm, and Zn:1040ppm. In particular, Au had the highest value among all the samples collected during the survey of this time. As a remarkable characteristic of the results obtained this time, the values of not only Cu, Pb, and Zn but also those of As, Sb, and Bi were high. PTH372 was a rock with stockwork of quartz veinlet of about 1 cm wide. Microscopic observation revealed that much muscovite was growing in the host rock of quartz vein. Dissemination of fine-grained pyrite and chalcopyrite was also observed. Chalcopyrite were surrounded by covellite. Coarse-grained pyrite was found in quartz vein, and fined-grained chalcopyrite was observed as inclusion in the pyrite. Analysis data were: Au: 995ppb, Ag:10.8g/t, As:92ppm, Cu:1305ppm, Pb:1630ppm, Mo:114ppm, and Sb:20ppm, indicating similar chemical characteristics to those of PTH371. Only difference from PTH371 was higher value of Mo.

Pinagbirayan Prospect:

PTH373 was goethite vein sampled from outcrops mostly representing Pinagbirayan Prospect with its width of 3 – 4 cm, strike/dip: N60° W, and 60° N. Boxwork texture was noted in iron oxide, indicating that sulfide mineral was oxidized. Probably, gold accompanied by this sulfide ore became free gold in the process of its oxidization and decomposition. Analysis data were: Au: 4330ppb, Cu: 960ppm, Fe>15%, and Bi:8ppm.

There was an ore storage where we sampled lumps of magnetite ore (PTH374: oxidized to Hematite).

< Nico Mine >

Access to Nico Mine from Dagang village was available by driving about 1 km in a four-wheel vehicle on an unpaved road.

In the area surveyed, Universal Formation mainly consisting of shallow marine sedimentary rocks of Paleocene to Eocene and Larap Volcanics consisting of altered andesite of Later Oligocene were distributed. Tamisan Diorite intruded the above two. In the vicinity of Dagang village, distribution of Tamisan Diorite was almost in consistent with a small hill of 125m above sea level extending in the east-to-west direction. On the other hand, Universal Formation and Larap Volcanics tend to be developed in topographically low places. With regard to the texture of Tamisan Diorite, it was in fine to medium grains consisting of hornblende and plagioclase (PSM284, 285). Microscopic observation revealed its texture of porphyritic nature. The phenocryst is consist of hornblende and plagioclase. The matrix is consist of quartz, plagioclase, and potassium feldspar. Results of K-Ar dating using hornblende were: 10.80 ± 1.20 Ma indicating Middle to Late Miocene.

Nico Mine was a gold deposit of vein type discovered during the World War II. It was once operated in a small scale based on foreign capitals. A new and an old shafts were excavated in the site, but since both of them were collapsed, it was impossible to directly observe such veins. The old shaft was excavated in 1941 by an American company. According to local residents, its depth was about 120 m. However, other details such as the period of mining, quantity and quality of mined product are unknown. Since the shaft was already buried and the place around it was covered by bush, it was impossible to find floats in a certain scale. The new shaft was about 50 m south to the old shaft and its depth was said to be 70 to 80 cm. A small-scale ore storage still remains in the site. Since its operation was considered illegal at that time, the operation was apparently stopped soon as advised by BMG. In the surroundings of this new shaft, existence of quartz vein and altered andesite floats was confirmed. Quartz vein floats consist of white quartz in coarse and medium grains accompanying pyrite dissemination in coarse grains (PSM281: Au:2730ppb, Ag:1.0ppm). In some cases, green oxidized copper ore is found attached to it. Results of fluid inclusion homogenization temperature and salinity measurements of quartz grains were: 197 – 264° C and 10.49 – 12.05 wt% NaCl equiv. respectively (Appendix 13). Andesite was remarkably silicified and its appearance was in gray color on the whole (PSM282: Au:10ppb). Hornblende and plagioclase as phenocrysts were observed in andesite, but both of them became pseudomorph due to alteration, accompanying some quantity of coarse-grained pyrite dissemination.

Panning site of alluvial gold was distributed at a distance of 300 m to the south of Nico

Mine, and personal excavation was actively conducted at least till recent years. In the panning site, a lot of excavation pits of 2 – 5 m in diameter were distributed for about 200 m around, and all the peripheral outcrops consisted of hornblende andesite in the same manner as in the case of Nico Mine. However, the degree of its silicification was slightly lower, and the degree of its argillization (secondary alteration?) which mainly consisted of kaolinite (halloysite?) was higher in part than andesite as seen in Nico Mine. Specimen PSM283 (quartz, sericite) indicating gold quality of 5.2 g/t was sampled from the outcrops of vein-like silicified rocks which was produced in andesite near the panning pit with lower alteration. This vein-type silicified rock (andesite) had width of 30 – 50 cm, strike of N35° E, and vertical dip. Conspicuous silicification and a cavity which seemed to have leached plagioclase were noted accompanying euhedral pyrite stain in coarse grains. Hematite stain was also noted which seemed to have been produced accompanying oxidized decomposition of pyrite.

In addition to the two gold deposits referred to above, a personal underground drilling in a small scale was traced in Malapingan village about 700 m to the southeast of Nico Mine. The excavation was conducted in search for pyrite quartz vein containing gold, rooted in sandstone and mudstone of Universal Formation and extending in the direction of N20° E. The underground mining was said to have been conducted on an underground level of about 10 m developed for about 50 m as a drift. The width of the vein appeared to be less than 1 m. All the coarse grains were carried out to a nearby cyanide refinery. Only broken pieces of a few mm in grain diameter were found on the surface, and no sampling was available. Outcrops of andesite hornblende like those in Nico Mine were distributed on the north side of the tunnel, and propylitic alteration could be observed there.

<Dagang Prospect - Malapingan Prospect>

In villages located from Dagang to Malapingan near Nico Mine, iron ore excavation was conducted by old Japanese Army during World War II.

Although no outcrops were confirmed, existence of iron ore mainly consisting of magnetite was confirmed in a creek located within the area surveyed. Its large distribution was observed in a creek of NW-SE direction on the northern side of a small hill, in height of 125 m above sea level and located north to Dagang Village. A lot of ore floats of about 50 cm or less in diameter were observed here. Ores consisted mostly of coarse-grained magnetite. In general, they were in pebble shape in good sorting, accompanying hematite as minerals oxidized in various degrees, and sometimes accompanying covelline as well (PSM286). Iron ore production was discontinued at the end of the world war, and details including the achieved production amount are unknown.

<Mancasay>

This area is located 5 km to the SSE of Paracale. Easy access was available through streets surrounding Mt. Bagacay.

On a flat land to the north of Mt. Bagacay, leucocratic granitic rocks was observed in a pit for gold excavation. In addition, existence of conglomerate and intensively weathered granitic rocks (PKY315) was confirmed in outcrops. Owing to the lack of outcrops, detailed relations among them were unknown. By microscopic observation, mafic minerals of PKY315 was determined as hornblende. Because of plagioclase, quartz, and potassium feldspar observed as felsic minerals, this rock presumably belonged to Tamisan Diorite members. At the north foot of Mt. Bagacay, ultrabasic rock (PKY317) and diorite (PKY318) were observed in outcrops. Most of the floats covering the river bed were andesite (PKY319), and many of them include gabbroic xenolith.

Owing to unfavorable conditions of outcrops, alteration was not observed. Although the survey of this time was conducted in search for iron prospects, it was unable to reach any iron prospect. Hearing from local residents brought us no information on iron prospects.

However, existence of gold prospects were widely known and excavation was actively performed. Weathered reddish-brown soil containing limonite and quartz vein was excavated (Appendix 14: PY34, 35). By breaking it into pieces and panning, gold grains were recovered. Weathered and oxidized reddish-brown soil (PKY310)sampled during our survey was analyzed indicating: Au:35ppb and quartz vein (PKY313) contained in soil indicated Au:60ppb, and some specimen showed Cu content of more than 1000ppm. Fluid inclusion homogenization temperature of quartz vein specimen PKY313 was 349 – 372° C, and salinity, 10.24 – 16.62wt% NaCl equiv. Polyphase of fluid inclusion with daughter mineral such as halite was also observed, suggesting the existence of fluid with higher salinity.

Au prospect in this area was considered to have characteristics similar to those of deposits distributed in Paracale district. In addition to Au mineralization, Cu mineralization was also noted.

<Mampungo>

With paved road available from Labo, traffic conditions in this area were fairly good.

Granitic rocks containing mica were distributed in this area. Ultrabasic rocks were distributed in various places like roof pendants of the granitic rock.

The granitic rocks have been argillized because of weathering. They were excavated as feldspar clay or silica sand in Mampungo Mine (Appendix 14: PY39) and Dancalan Mine. Quartz veins were developed in granitic rocks. Quartz vein in Mampungo Mine often showed greenish color. This was the same as in the case of Tuba and Santa Barbara as stated below, and presumably such quartz contain chrome-muscovite. Chemical analysis did not reveal any Au or Cu mineralization. Fluid inclusion homogenization temperature of quartz vein (PKY321) was 282 – 331° C, and salinity was 0.18 – 4.49 wt% NaCl equiv. Polyphase fluid inclusion, including halite daughter crystals were observed. From this, we presume the existence of fluid activities with higher salinity.

<Mt. Bunutan >

PTH375 represents quartz vein included in Paracale Granodiorite which is exposed along the ridge from Santa Fe Sur to Mt. Bunutan. Three to four quartz veins were noted having width of 2 - 4 cm and strike of N10° E, and dip: 46° E. They were high-temperature quartz with anomaly of: Au: 375ppb, Ag:11.4ppm, Cu:134ppm, and Pb:914ppm.

Placer Pacific Co. has conducted gold exploration from the north foot to northwest foot of Mt. Bunutan. PTH376 – 379 are the specimens sampled from the survey site, and PTH 376 represents a quartz vein in an old mine extending in the direction of N10 – 20° E with its width of 5 – 10 cm. The wall rock of the vein altered to sericite. Pyrite, chalcopyrite as well as covelline to cover it were observed. Analysis data were: Au: 1190ppb, Ag:2.8ppm, Cu:428ppm, and Zn:534ppm. Relatively large fluid inclusion was observed (many of them having diameters of 100 μ or more) and its homogenization temperature was 211 – 242° C, and its salinity, 6.01 – 8.41wt% NaCl equiv. Since vapor-liquid ratios of its inclusions widely differ among one another, its boiling was presumed. PTH377 was also a quartz vein sampled from crops of another old mine. Although its wall rock has been argillized, biotite initially produced from the original rock remained, and a lot of sericite was produced accompanying pyrite, chalcopyrite, and sphalerite. It is said that Benguet Co. conducted drilling here in 1984. Pyrite and molybdenite were observed in the quartz vein in the garden of a private house. PTH378 was an outcrop of Paracale Granodiorite near the top of Mt. Bunutan. Foliation of biotite was developed in this rock, and its texture similar to that of mylonite was noted.

PTH379 was a float of ultrabasic rock altered to serpentine. This is an country rock of Paracale Granodiorite .

<Benguet Mine>

Since it was impossible to collect much of fresh Paracale Granodiorite from Mt. Bunutan, we visited an open pit in Benguet Mine to obtain such fresh samples and observe typical mineralization occurred in Paracale Granodiorite. Benguet Mine was sold to Base Metals Company. Although an employee of the company was stationed at its office at the mine, its mining operation had been suspended. Apparently they are exploring in a nearby location.

PTH380 was a quartz vein sampled from the storage in the open pit (Appendix 14: PH30). This was high-temperature quartz, and a lot of chalcopyrite as well as pyrite and covellite are observed in it. Through microscopic observation, quartz as well as sericite were observed. The quartz vein of PTH 381 has dog-tooth like quartz. We measured its fluid inclusion temperature, resulting: Th=253 – 324° C, and salinity, resulting: 5.86 – 7.02%NaClequiv. Paracale Granodiorite cropped out in the open pit (Appendix 14: PH30). Stockwork of thin quartz vein was developed and similar to mineralization of porphyry type (Appendix 14: PH31). Major quartz vein as in the cases of PTH380 and 381, apparently distributed in the direction of about N40° E (Appendix 14: PH30).

Quartz-sericite alteration is predominate in the granodiorite cropped out in the pit. Supergene kaolinite alteration is also observed. Most of limonite was goethite, and existence of hematite was also noted, but jarosite was only in a small quantity. From the assemblage and quantities of oxidized iron ores, it seemed that there was not much pyrite as sulfide minerals.

PTH382 is least altered Paracale Granodiorite excavated from the underground. The texture is similar to that of the rocks near Mt. Bunutan showing mylonitic texture. It's main mafic mineral was biotite in greenish color. Through microscopic observation, felsic minerals are plagioclase, quartz, and potassium feldspar. Mafic minerals are biotite and minor amount of pyroxene and opaque minerals. Biotite is in green color, partly altered to chlorite, and occurs threading its way among plagioclase grains. Potassium feldspar was small in quantity. Quartz broken into fine grains were apparently recrystallized

Fig. II-2-15 shows modal composition of the rock. Modal composition was classified into the category of tonalite. However, in view of the quantity of mafic minerals accounting for about 10% of the total quantity, it may be called trondhjemite rock (Giese et al., 1986). The results of the whole rock analysis were: SiO_2=62.92%, Na_2O=6.52%, K_2O=1.14%.

Table II-2-7 Comparison between the Paracale Granodiorite and the Tamisan Diorite

	Paracale Granodiorite	Tamisan Diorite
principle mafic mineral	biotite	hornblende
texture	mylonitic texture(biotite: foliation, quartz: granulation)	subhedral granular
modal composition	tonalite～trondhjemite	quartz monzodiorite
whole rock chemistry	acidic SiO_2=62.92%	intermediate ～ basic SiO_2=55.99%
Radiometric age dating	14.9 Ma(Biotite: K/Ar : Wolfe ,1981)	19.4 ± 1.5 Ma (whole rock: K/Ar: UNDP, 1987)
	14.4 Ma (Rb/Sr isochron: Giese et al, 1986)	6.96 ± 0.76 Ma (hornblende: K/Ar: this survey)
	17.1 ± 0.9 Ma (biotite: K/Ar : UNDP,1987)	10.60 ± 1.20 Ma (hornblende: K/Ar: this survey)
	18.6 ± 0.3 Ma (biotite: Ar/Ar : Geary et al., 1988)	
	17.20 ± 1.90 Ma (biotite: K/Ar: this survey)	

As indicated in the above table, Paracale Granodiorite differs from Tamisan Diorite with respect to their age and chemical composition. From this we understand that the above two were formed in different magmatism.

<Santa Barbara Prospect>

No problem in traffic was noted because of unpaved road running from Jose Panganiban.

From existence of waste materials remaining in the former pit, we presume distribution of Paracale Granodiorite of schistose structure and ultrabasic rocks in shallow and deeper locations respectively.

Au mineralization was observed in pyrite-quartz vein. Small-scale miners excavated in these oxidized zones (Appendix 14: PK60). Although no detailed observation was made, it is presumed that veins represent stockwork developed in Paracale Granodiorite and ultrabasic rocks. Quartz vein tends to show light green color in depth (PKY340B), sometimes accompanying sphalerite and galena (PKY340A: Au:510ppb, Ag: 8ppm, Al:3.9%,

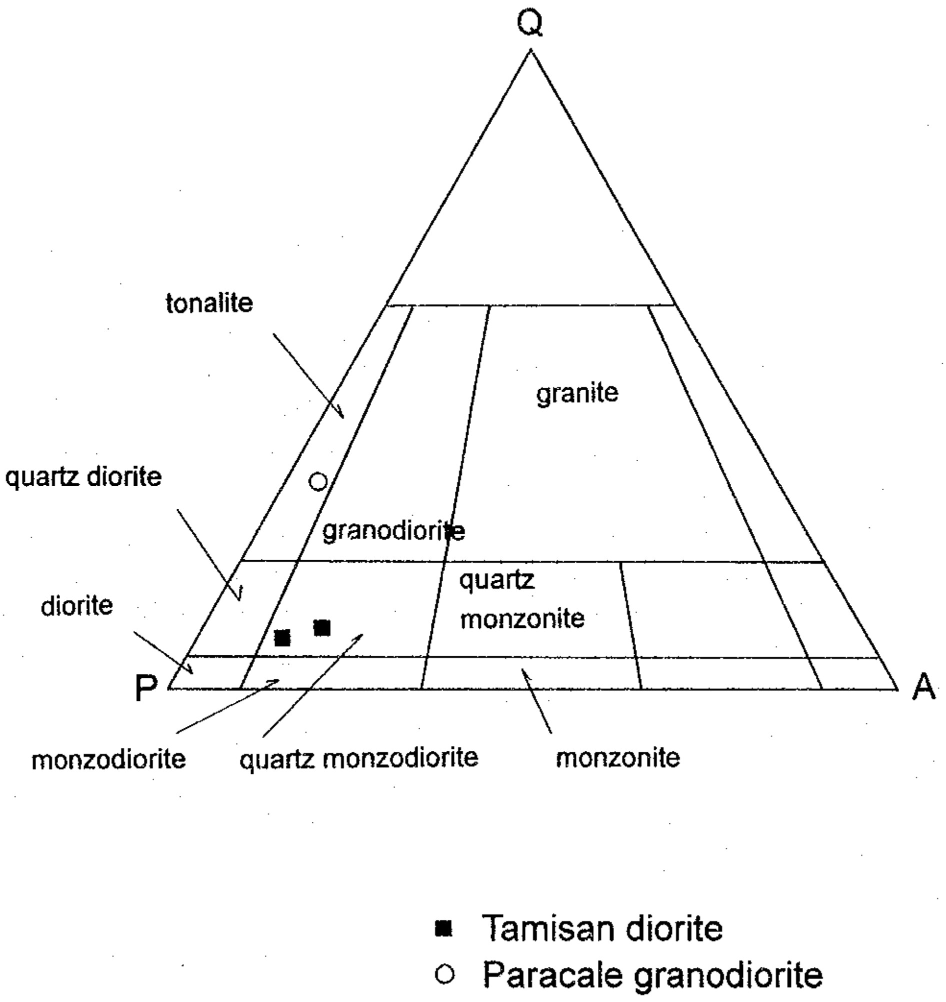

Fig. II-2-15 Modal composition of the Paracale granodiorite and the Tamisan Diorite

Cr:980ppm, Cu:780ppm, Pb:5700ppm, and Zn: 2540ppm). Microscopic observation revealed that green color was attributable to Cr containing muscovite (fuchsite) produced among quartz grains. Au grade of the specimen selected from thin limonite-quartz vein (Ore: PKY340C) was 4.46g/t (Cr: 845ppm, Cu:194ppm, Ni:653ppm).

7) Potential

Many ore deposits and prospects are distributed on the foot of Mt. Bagacay. Those are copper and iron skarn deposits and prospects, gold and base metal deposits of vein type and prospects, and pyrophyllite clay deposits. Altered rocks and quartz vein in each prospect contained gold in relatively high grade. These prospects were apparently distributed around Tamisan Diorite, suggesting that Tamisan Diorite was responsible for the mineralization. Measurement of fluid inclusion temperatures of quartz vein sampled from the vein-type prospects in the area, their mineralization was not epithermal gold mineralization as pointed out by Mitchell and Leach (1991), but sub-epithermal mineralization produced in a deeper part near intrusive rocks. These mineralization actions as well as skarn-type mineralization were often observed near porphyry type deposits. Fig. II-2-18 shows conceptual positions of mineralization observed in this area on the model of magma-hydrothermal system. Typical porphyry-type mineralization was not found during our survey of this time. Therefore, it is desirable to conduct further survey also covering the top of Mt. Bagacay. Or else, in view of high gold potential noted in this area, a full-scale survey should be conducted more in detail searching for secondary gold deposits.

8) Mine Claim

A lot of MPSA have been established.

2-2-8 Larap-Exiban Area

1) Reasons for Selection

This area was surveyed in detail by the United Nations (UNDP, 1987) and was also investigated by private organizations. For the Phase I Survey also, this area was selected for the survey area of high mineralization potential. During the Phase I Survey, Larap Mine (Bessemer pit) of the iron and copper skarn and Pangono South, Tidi Mine and Exiban having a distribution of vein type gold and base metal deposits were surveyed.

There is a possibility that the origin of the iron and copper skarn and the vein type gold and base metal deposits are related to that of porphyry type copper and gold deposits. Therefore, we considered that to survey this area again from this point of view. Near Exiban, there is also a possibility of bearing epithermal gold deposits.

This area is comparatively large and many mineral deposits and prospects are distributed; therefore, it is difficult to narrow down exploring places. In this area, there is a distribution of many intrusive rock stocks. Most of its deposits and prospects are considered to have formed under the influence of these intrusive rocks. Consequently, after well grasping the distribution of these intrusive rocks, the survey in detail of this area will be carried out.

2) Survey routes and points (Fig. II-2-16)

Survey Route	Survey Point
Matalang Prospect	About Matalang Prospect, porphyry type mineralization has been reported.
Penarco Mine	Penarco Mine was actually mined as an iron skarn deposit and porphyry type mineralization is expected to exist nearby.
Pangono Prospect	There some small gold mines abandoned.
Igang Prospect	Since prospect of copper and molybdenum at Igang Prospect is reported. Porphyry type mineralization is expected.
Batobalani Pit Submakin Prospect Meycauayan Prospect	Also in this area adjacent to Bagacay area, there are iron deposits of Submakin Prospect and Batobalani Pit. In the west of this area, there is Meycauayan Prospect of copper and molybdenum. Neither of the prospects was surveyed in phase I; therefore, the survey took place this year.
Tumbaga Prospect	This is an already known gold deposit zone. Still at present, some small scale miners are mining Au. Their objects for mining are limonite-quartz veins or an oxidized zone of the iron pyrites-quartz veins near the earth's surface. Through crushing, sieving and panning, gold is collected. This survey was carried out with an expectation of getting useful information for modeling the deposit in the Larap-Exiban area which includes this area.
Paracale National Mine	This is an already known gold deposit zone.
Capacuan Mine	This area is known as a Fe deposit zone and open pit mining used to take place once. From the surrounding geological environment, it is presumed to be a Fe deposit with porphyry; consequently, this survey was carried out with an expectation of getting useful information for modeling of the deposits in the Larap-Exiban area which includes this area.

3) Location and Transportation

This area locates in the northeast of Bicol Peninsula and belongs to the Camarines Norte. Along the southern border of the area, a national road runs from east to west and a paved road runs to the north of the area; thus, it is rather conveniently situated. There is also an unpaved road toward the inside, which have made access to the existing prospects relatively easy.

4) Outline of Survey Results

Figure II-2-17 shows the geology, alteration zones, distribution of prospects and locations of sample collection of this area. Due to safety concerns, not all the prospects scheduled for survey at the beginning were explored, but the possibility of bearing of porphyry type deposits was verified through mineralization of gold and copper in quartz veinlet stockwork.

5) Geology

In this area, ophiolite sequence of the pre-Cretaceous system is distributed as the basement. Being overlaid with this unconformiably, Universal Formation of the post-Paleocene-Eocene is distributed and over them, Larap volcanic rocks of the Oligocene are distributed in the west border of this area (Table II-2-8). Into these, Tamisan Diorite stocks of Middle to Late Miocene are intruding. In addition, small rocks of dacite porphyry are distributed (UNDP, 1987). In the north-east of this area, Paracale Granodiorite (BMG, 1984) or Paracale Trondhjemite (Giese et al., 1986) intrude into ultrabasic rocks of the ophiolite sequence.

6) Alteration and Mineralization

＜ Matalang Prospect ＞

In Matalang Prospect, there are still several old mines. Philippine Iron Mining (PIM) had conducted drilling of about 15 to 20 holes. At Tumabaga Prospect also which is near to Matalang Prospect, it is said that drilling took place many times.

In some of altered country rocks near the old mines, many black and needle-like plagioclase are observed (PTH383). They seem to be andesite hornfels. Pyrite dissemination is also observed. Under the microscope, it is seen that the plagioclase has altered to albite, sericite and epidote. In the matrix, fine-grained green biotite are produced, and epidote and opaque minerals are observed. At outcrops of old mines, there are green quartz veins (PTH384) having a strike of N45°W and a dip of 60°SW accompanied with pyrite and copper pyrite. Fibrous and radial greenish gray actinolite is observed. Quartz looks green because of actinolite.

PTH385 was collected at the outcrop where stockwork of quartz veinlets is developing. In the greenish gray country rock, 1 to 3 cm wide quartz veins run at an interval of 3 to 20 cm as stockwork. (Appendix 14: PH32: The quartz veins look black in the photo.) Among them, those in the trend of N40°E and N70°E are dominant. The dip is almost vertical. According to Mr. Arnel Jusi of BMG Region V, this kind of stockwork zone continues at least 400 m in the direction of east and west. The analysis results of the quartz veins are Au:

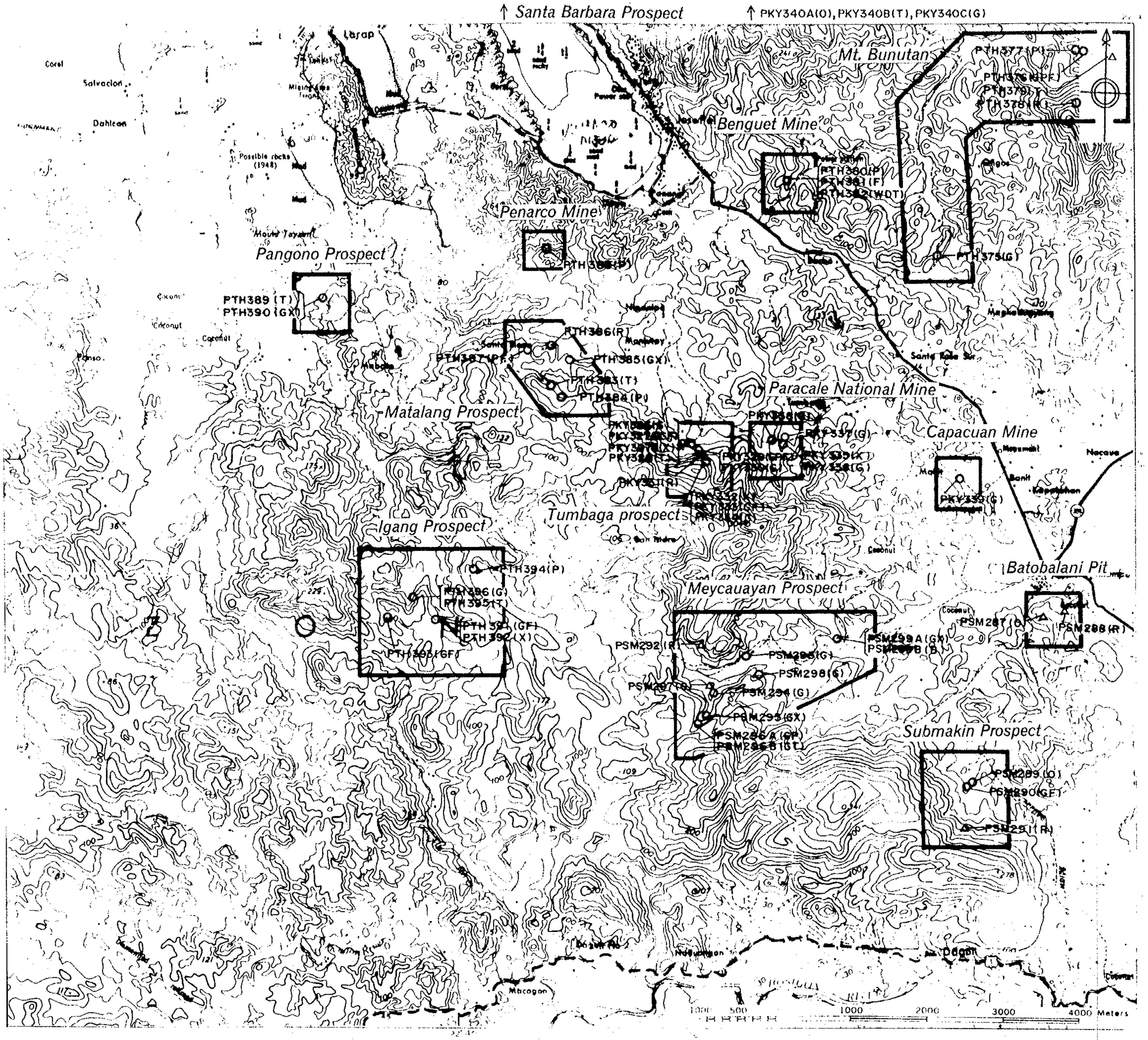

Fig. II-2-16 Root map of Larap-Exiban area

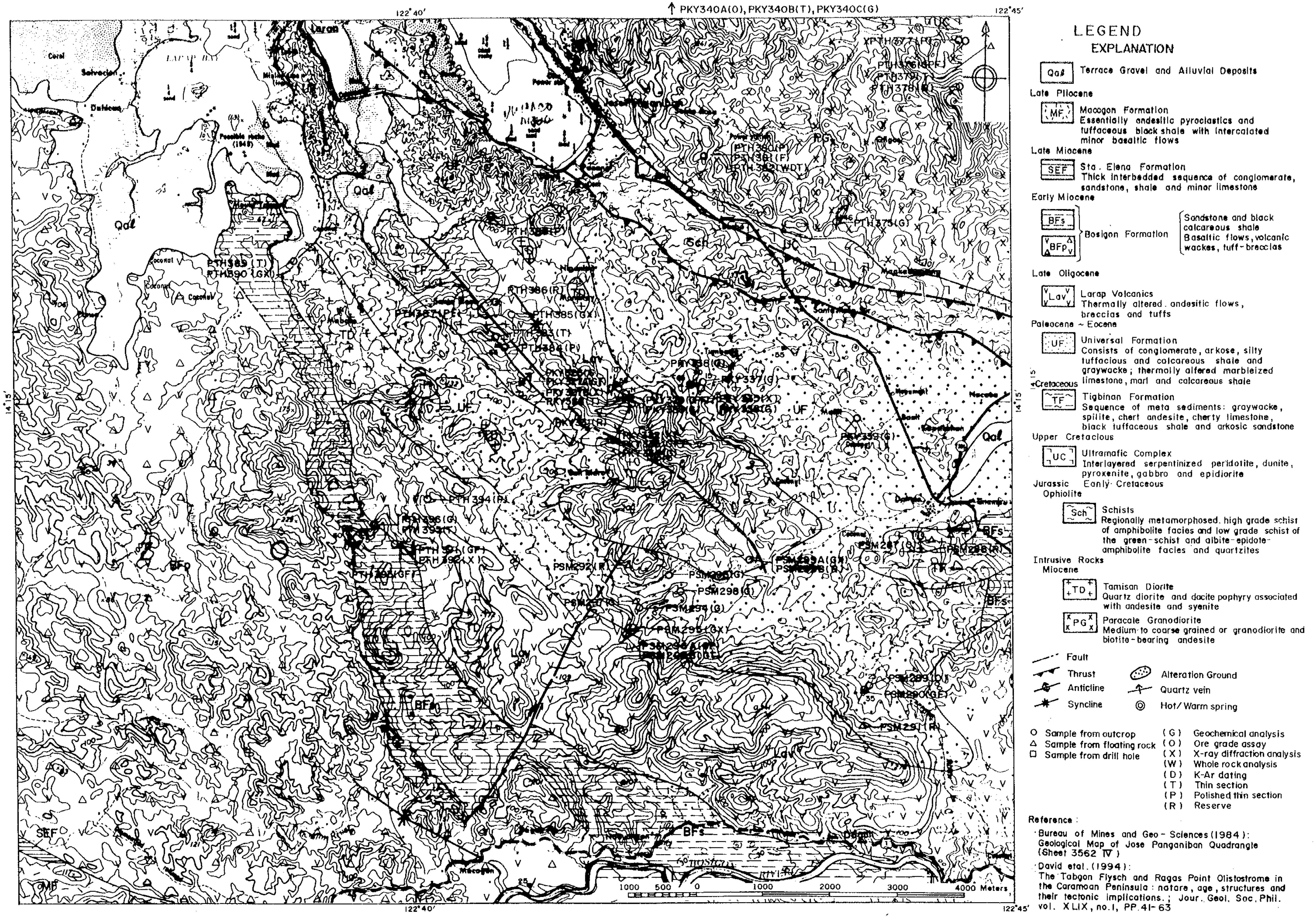

Fig. II-2-17 Geological Map of Larap-Exiban area