3.2.18 Calabanga-Tinembac Area (Figure II-3-30)

Reason for selection: In Sibobo, located almost at the center of this area, silicified and kaolinite alteration zones are distributed, and the presence of pyrite has been mentioned (Carranza, E.J.M. and Slise P.C., 1989:BI-07). These are considered shallows indicators of shallow hydrothermal gold deposits.

Location: This area is located about 20 km northeast of Naga, trending San Miguel Bay.

Accessibility: The route continues from Naga to the survey area via Calabanga. Paved roads are available throughout the whole distance, facilitaing the access.

Geology: Andesite lava and andesite pyroclastic rocks are distributed, and overlain by lahar deposits. In the andesite, hornblende andesite, pyroxene andesite and basaltic andesite are distributed, but each era of these rocks is unknown. The pyroxene andesite and lahar deposits are situated in higher stratigraphic unit are supposed to be originated in Mt. Isarog in Pleistocene.

Alteration: Figure II-3-31 shows the photo and sketch of outcropping silicified rocks where silica have been produced in the past. The silicified rocks are hydrothermal breccia in pipe shape as shown in Figure II-3-31. The boundaries between the hydrothermal breccia pipe and argillized country rocks are sharp, strikes N65°E and dips 62°N. The ratio of matrices in the hydrothermal breccia is small as shown in Figure II-3-31. According to the result of X-ray diffraction, the silicified breccia contains quartz, alunite and rutile, and the matrices consist of the fragments in this breccia. Argillizated country rocks contacting brecciated zones have altered to smectite. The mineral assemblage determined by x-ray diffraction is cristoabalite, smectite and halloysite, and this assemblage shows influence of hydrothermal fluid at lower temperature, compared to that in the silicified breccia zones where the silica is in quartz. It is impossible to discriminate the original rocks contained in the country rocks due to extreme alteration. From the above said mode of occurrence, it is inferred that the silicified breccia zones were formed by the hydrothermal solutions blowing up on the palaeo water table. These silicified breccia zones are able to follow to the coast (TH70).

On the outcrops about 150 m away from the above said ones, hornblende andesite alterd to smectite crops out. The result of X-ray diffraction shows this andesite contains cristoabalite, smectite and alunite as alteration minerals. The hornblende andesite has been disseminated by pyrite. Laharic deposits comprising the pyroxene andsite originated from Mt. Isarog mount

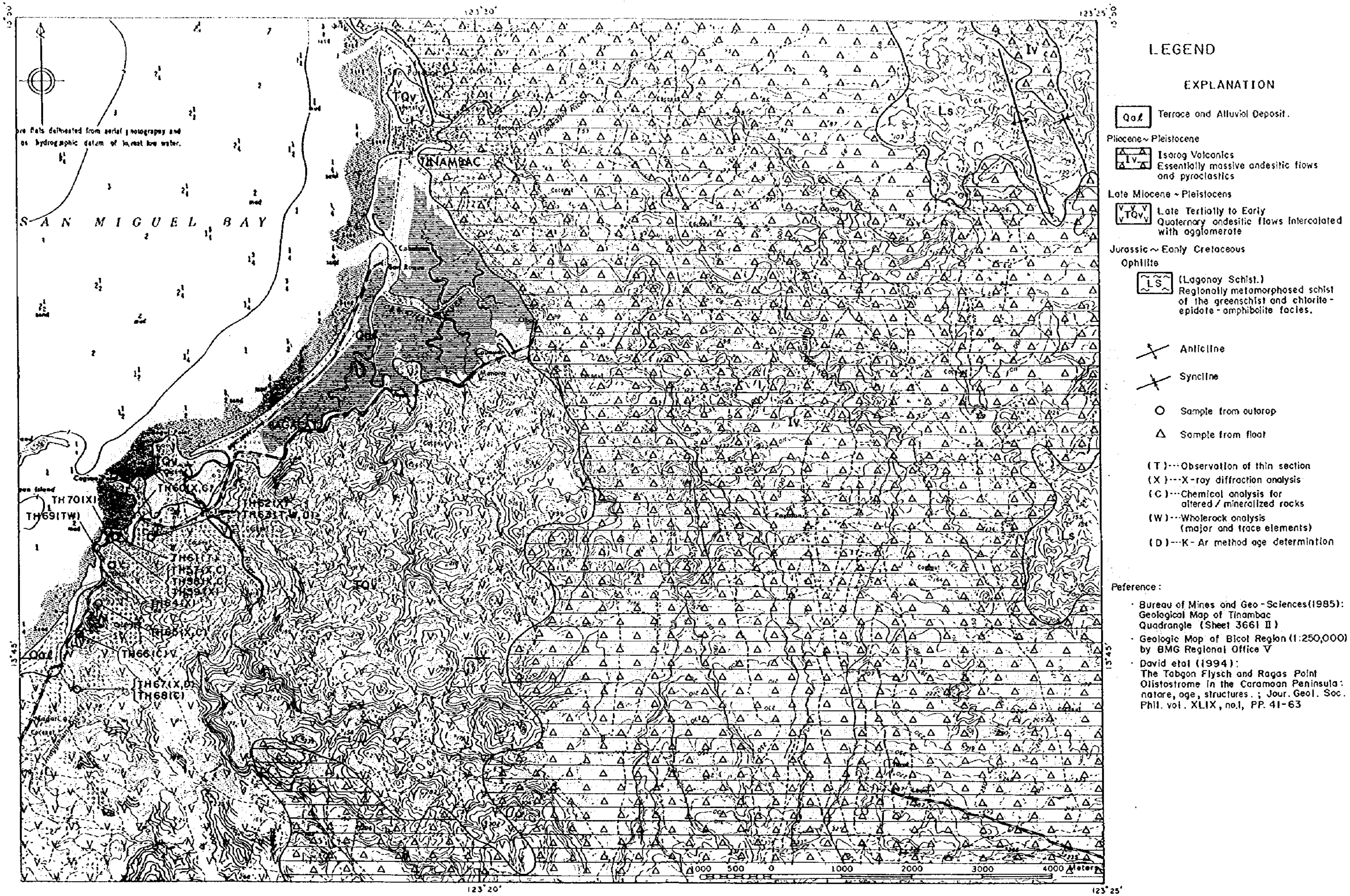



Fig.II-3-30 Geological map the Calabanga-Tinembac Area and sample locations

(a)

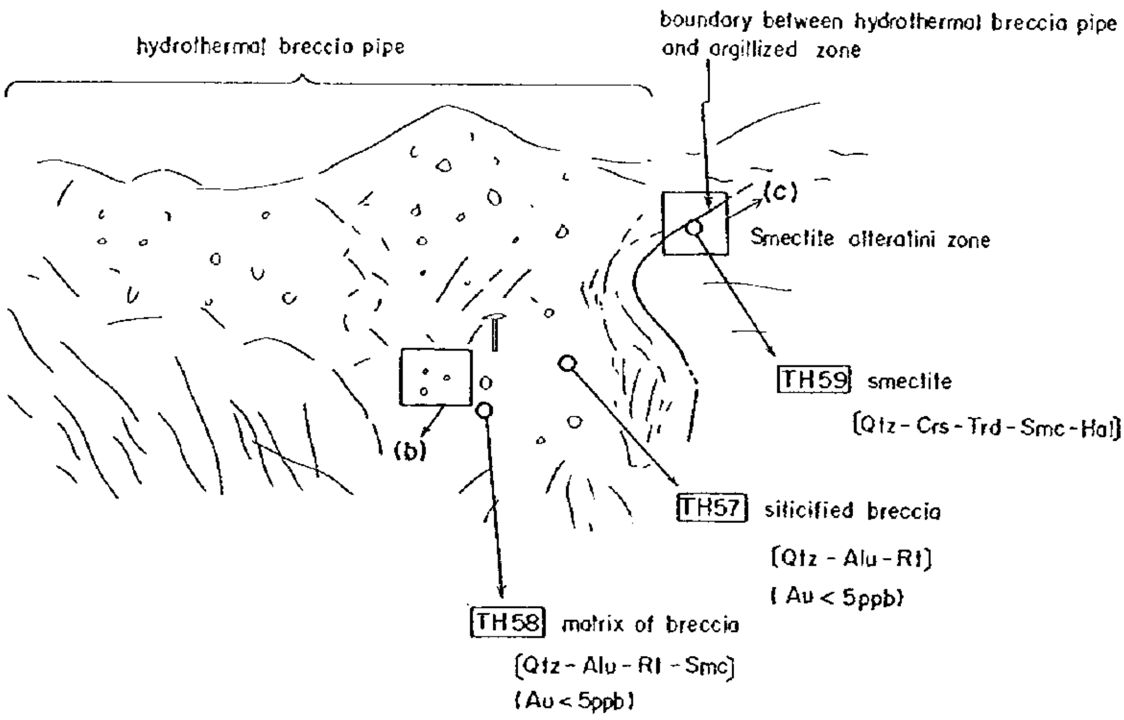


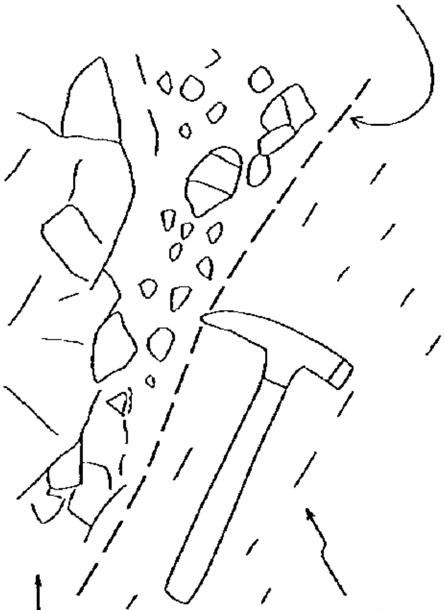

Fig. II-3-31 (a)(b)(c) Occurrence of hydrothermal breccia pipe in Sibobo, Calabanga-Tinembac Area.

(b)

A close-up of hydrothermol breccia pipe.

Matrix is filled up with fine fragments of silicified breccia.

(c)



overlaying this andesite. There are silicified zones on the hill located southwest of the quarry, where powdery silica crops out. This silicification includes quartz, alunite and rutile according to X-ray diffraction. Silicified or argillized alteration zones are distributed also 1.5 km SSE of the outcrops in hydrothermal breccia located in Sibobo (Fig. II-3-30). These zones are more than 1 km traceable alongside the irrigation water channel intermittently. The presence of pyrite dissemination as well as natural sulfur is observed. About 0.8 km south of these outcrops, there are acid-silicified alteration zones accompanied by thih quartz fveins (width: 0.2-1.5 cm), where alunite crystals are observed to an extent allowing visual discrimination (TH67). The mode of occurrence of the alunite in the form of coarse-grained sheets suggests the alteration caused by high sulfidation rather than that caused by steam-heated acid alteration (Sillitoe, 1993).

Mineral showings: As a result of assay, gold content of silicified breccia was less than 5 ppb without mineralization. However, in the acid alteration zones located along the channel, the analysis of some silicified rocks showed gold concentration reaching 15 ppm. The same samples also showed extreme copper concentration reaching 90 ppm. The veins including quartz together with coarse-grained alunite (TH68) showed gold concentration less than 5 ppb without gold mineralization.

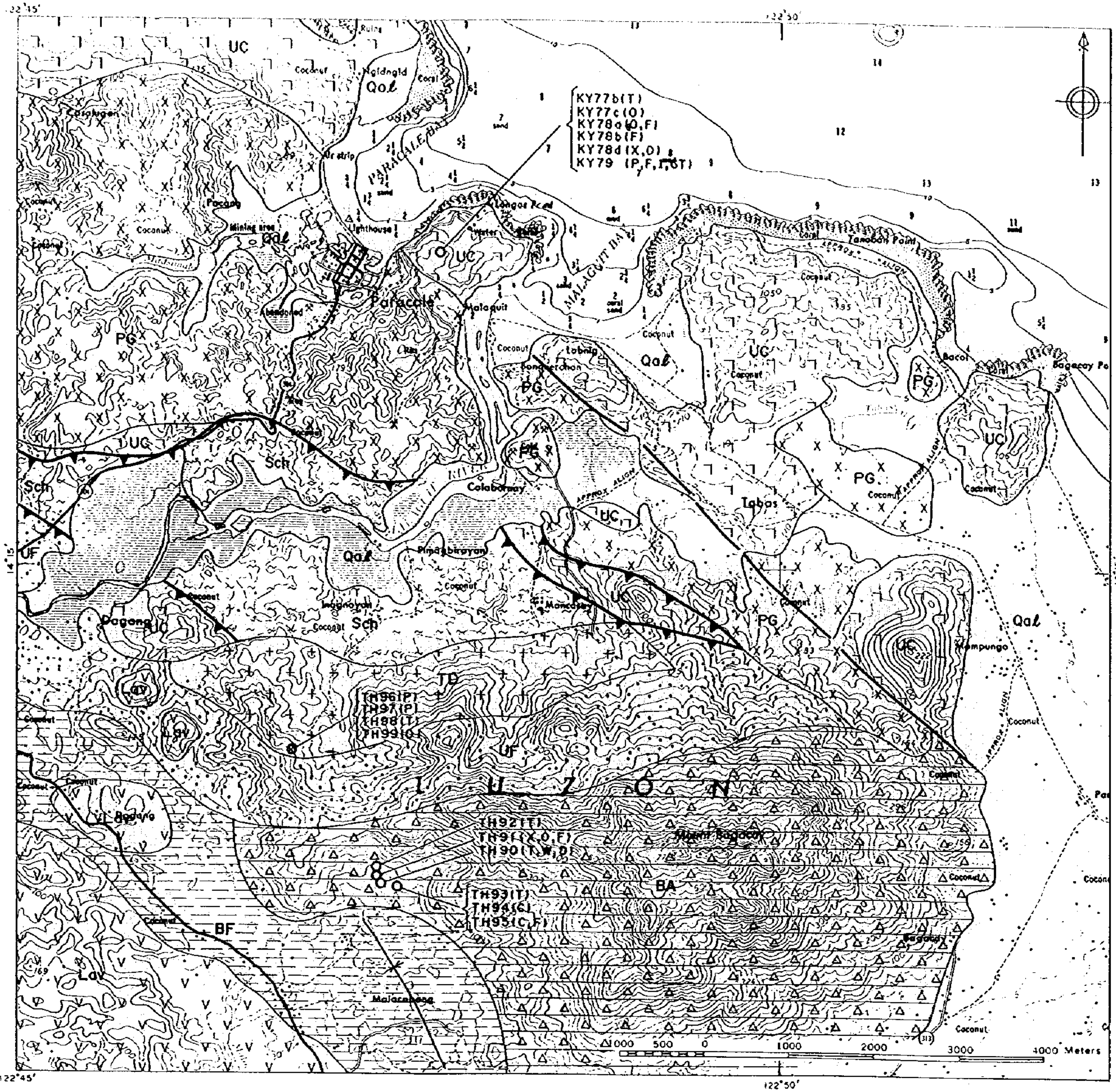
Evaluation: The alteration zones in this area are sparse and intermittent. The alteration mineral assemblage shows that of low temperature, indicating the this alteration zone formed near the palaeo water table, most probably. However, there are acid alteration zones associated with alunite in a size allowing visual discrimination partially. Gold mineralization is also observed although the concentration is low (15 ppb Au). Based on these fact, hydrothermal solution rise from deeper depths is conceivable. The presence of the high sulfidation-type mineralization is also considered possible.

Mining claim: The mining rights have been partially applied for approval.

3.2.19 Paracale District (Figure II-3-32)

Reason for selection: This area was one of the most important gold-producing district not only in Bicol but also in Philippines. At present, no systematic mine other than United Paragon's Longos Mine is operated.

Location and Accessibility: It takes about one hour by car from Daet City.




LEGEND

EXPLANATION

Qaℓ — Terrace Gravel and Alluvial Deposits

Late Pliocene

BA — Bagacay Andesite
Massive flows of porphyritic andesite

Early Miocene

BF — Basigan Formation
Rhyhmic beds of sandstone and black calcareous shale

Late Oligocene

Lav — Larap Volcanics
Thermally altered andesitic flows, breccias and tuffs

Paleocene ~ Eoceue

UF — Universal Formation
Consists of conglomerate, arkose, silty tuffaceous and calcareous shale and graywacke, thermally altered marbleized limestone, marl and calcareous shale

Jurassic ~ Early Cretaceous

Ophiolite

UC — Ultramafic Complex
Interlayered serpentinized peridotite, dunite, pyroxenite, gabbro and epidiorite

Sch — Schists
Regionally metamorphosed high grade schist of amphibolite facies and low grade schist of the green-schist and albite-epidote-amphibolite facies and quartzites

Intrusive Rocks

Miocene

TD — Tamisan Diorite
Quartz diorite and dacite porphyry associated with andesite and syenite

Oligocene

PG — Paracale Granodiorite
Medium to coarse grained or gneissose granodiorite and biotite-bearing andesite

Faults

Thrust fault

Syncline

O Sample from outcrop

(T) ··· Observation of thin section
(P) ··· Observation of polished thin section
(X) ··· X-ray diffraction analysis
(O) ··· Ore grade assay analysis
(C) ··· Chemical analysis for altered/mineralized rocks
(W) ··· Wholerock analysis (major and trace elements)
(F) ··· Fluid inclusion test
(D) ··· K-Ar method age determination
(I) ··· Stable isotope analysis
(GT) ··· Geothermometer analysis

Reference:


· Bureau of Mines and Geo-Sciences (1984):
Geological Map of Paracale Quadrangle (Sheet 3562 I)
· David et al (1994):
The Tabgon Flysch and Ragas Point Olistostrome in the Caramoan Peninsula: nature, age, structures and their tectonic implications.; Jour. Geol. Soc. Phil. vol. XLIX, no.1, PP. 41-63


Fig.II-3-32 Geological map of the Paracale Area, the Mt. Bagacay Area and sample locations

Geology: This area is underlain by the marginal portion of granodiorite called "Parakaretrondhjem". Ultrabasic rocks are distributed at the depths exceeding some dozen to ten dozen meters from the surface and northward, according to the drill logs of United Paragon. Transitions zones are present near the boundary, showing slightly intricated geological relations.

Alteration: Obvius alteration halloes were observed on both sides of each vein, making alteration to illite conspicuous. As a result of X-ray diffraction, argillized halloes following the quartz veins showed a mineral assemblage of chlorite, pyrophyllite and dolomite.

Mineral showings: There are gold concentraion in quartz veins in this area, but copper, lead and zinc are also contained in the deposits. In many cases, the base metals form skarn-like massive ore lucking quartz on the boundaries between granitic diorite and ultrabasic rocks (KY79). For these ores KY79, measurement of geochemical temperature was applied using sulfur isotopes contained in sphalerite and galena. As a result, the temperature was 417°C (from Kajiwara and Krue, 1971) or 431°C (from Ohmoto, 1979).

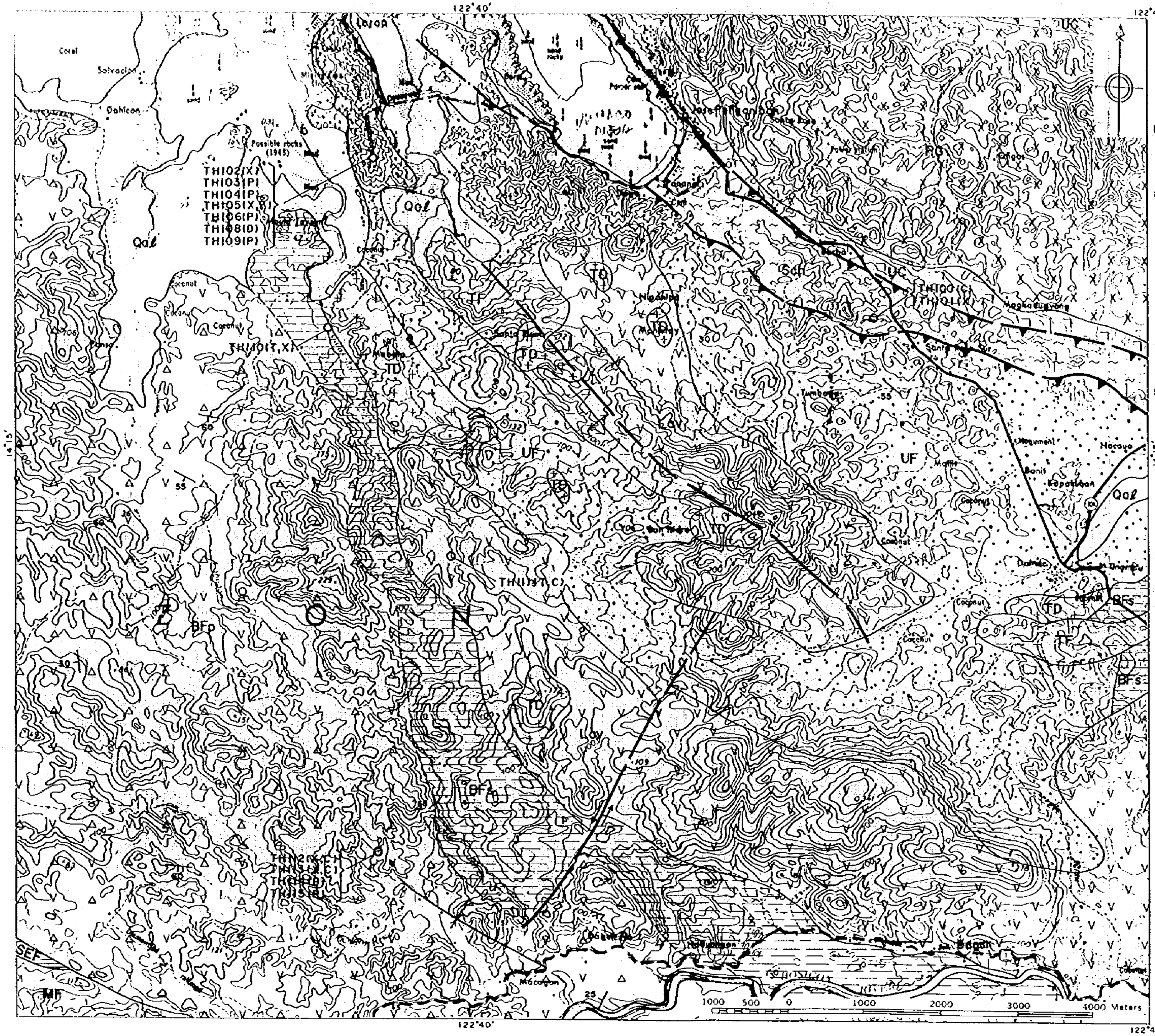
The fluid inclusion homogenization temperature of the samples KY78 showing the following concentration was average 288.3°C ranging 276to 301°C and the salinity was 6.01-9.34%, while this contains 57 g/t Au, 48 g/t Ag, 140 ppm Cu, 1,780 ppm Zn.

Evaluation: Discovery of further gold deposits accompanied by the base metals produced through high salinity hydrothermal fluid process is expected.

Mining claim: Although the number of mines in systematic operation at present is one, prospecting in the areas with the distribution of granitic diorite bodies known as the gold deposit zones is being executed by various persons and enterprises. Mining is also being continued by the smale-scale miner in a wide range.

3.2.20 Larap-Exiban Area (Figure II-3-33)

Reason for selection: In this area, former mines with the results of producing gold are distributed, and numerous places for mineralization are present. The mines in Larap formerly produced a large amount of iron ores, and all of them was exported to Japan. From the condition of the products yielded from the iron deposits and other minerals following them, the production environment of these deposits are similar to those of porphyry copper deposits. Consequently, the presence of porphyry copper deposits is conceivable in the surroundings. From this point of view,




LEGEND

EXPLANATION

| | |
|---|---|
| Qal | Terrace Gravel and Alluvial Deposits |
| **Late Pliocene** | |
| MF | Macogon Formation<br>Essentially andesitic pyroclastics and tuffaceous black shale with intercalated minor basaltic flows |
| **Late Miocene** | |
| SEF | Sta. Elena Formation<br>Thick interbedded sequence of conglomerate, sandstone, shale and minor limestone |
| **Early Miocene** | |
| BFs | Bosigon Formation — Sandstone and black calcareous shale |
| BFpv | Bosigon Formation — Basaltic flows, volcanic wackes, tuff-breccias |
| **Late Oligocene** | |
| Lav | Larap Volcanics<br>Thermally altered, andesitic flows, breccias and tuffs |
| **Paleocene ~ Eocene** | |
| UF | Universal Formation<br>Consists of conglomerate, arkose, silty tuffacious and calcareous shale and graywacke; thermally altered marbleized limestone, marl and calcareous shale |
| TF | Tigbinan Formation<br>Sequence of meta sediments: graywacke, spilite, chert andesite, cherty limestone, black tuffaceous shale and arkosic sandstone |
| **Upper Cretacious** | |
| UC | Ultramafic Complex<br>Interlayered serpentinized peridotite, dunite, pyroxenite, gabbro and epidiorite |
| **Jurassic Early Cretaceous Ophiolite** | |
| Sch | Schists<br>Regionally metamorphosed, high grade schist of amphibolite facies and low grade schist of the green-schist and albite-epidote-amphibolite facies and quortzites |
| **Intrusive Rocks Miocene** | |
| TD | Tamison Diorite<br>Quartz diorite and dacite pophyry associated with andesite and syenite |
| PG | Paracale Granodiorite<br>Medium to coarse grained or granodiorite and biotite-bearing andesite |

Faults — Syncline
Thrust fault — Anticline
Strike and dip of beds
O Sample from outcrop

(T) --- Observation of thin section
(P) --- Observation of polished thin section
(X) --- X-ray diffraction analysis
(C) --- Chemical analysis for altered/mineralized rocks
(F) --- Fluid inclusion test
(D) --- K-Ar method age determination

Reference :
·Bureau of Mines and Geo-Sciences (1984): Geological Map of Jose Panganiban Quadrangle (Sheet 3562 IV)
·David etal. (1994): The Tabgon Flysch and Ragas Point Olistostrome in the Caramoan Peninsula: nature, age, structures and their tectonic implications.; Jour. Geol. Soc. Phil. vol. XLIX, no.1, PP.41-63

Fig.II-3-33 Geological map of the Larap-Exiban Area and sample locations

Philex Mining Corp. is investigating the gold deposits in the Larap mine at present.

Location: Larap-Exiban area is located north of Camerines Norte State. Larap mines are located about 45 km northwest of Daet, about 25 km northwest of Labo. Exiban mines are located about 25 km west of Labo.

Accessibility: The route begins at Daet, via Labo and reaches the Larap mines through Paganilan. The route for Exiban mines runs via Labo, passes the national roads toward Manila and enters northe near Macogan. Every mine is accessible by car.

Geology: Field surveys were carried out in the former Tidi mines, Larap mines, Panguno prospect and in Exiban mines. The former Tidi mines and Larap mines are situated in the area where the Universl formation in Eocene are distributed. Panguno prospect is situated in the area where Larap volcanic rocks, presumed to have underlain by the Universal formation in Oligocene, are distributed. Exiban mines are situated in the area where the Bosigon formation, formed underlain by above said formations in the Lower Miocene, are distributed.

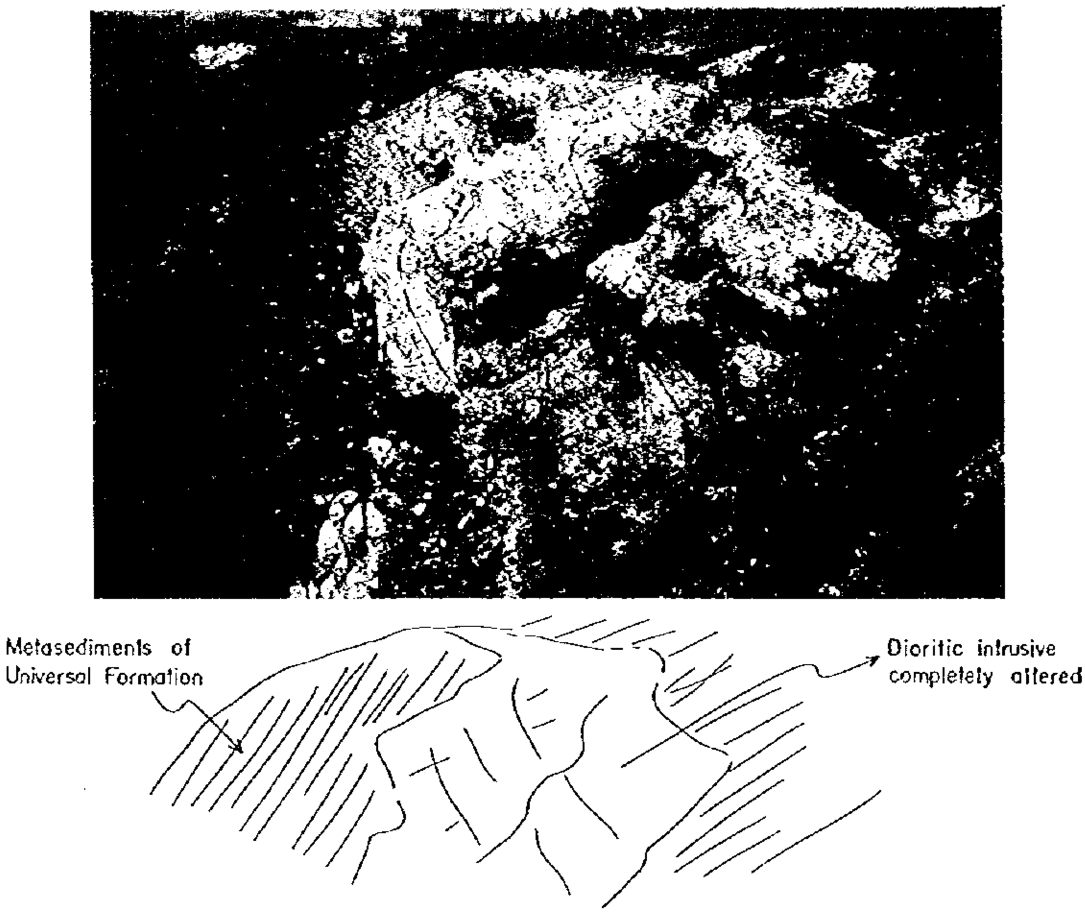
Alteration and mineral: Tidi mines are located about 3 km southeast of Panganiban, on the way from Labo to Panganiban. Small-scale miners were excavating gold ores in these mines, and Benget Corp. began strip mining in 1988. At present, the mining is interrupted. Gold mineralization is observed in the shear zones or in the quartz veins running therein. The country rocks are in conglomerate, sandstone and shale in the Universal formation. The bedding planes strikes N35°W and dips 70°W. The alteration includes silicification and argillization. The X-ray diffraction showed the following constituents: quartz, kaolinite, sericite/smectite mixed-layer clay, and alunite. The alteration during mineralization has been overprinted by supergene alteration. Pyrite and a small amount of chalcopyrite are observed. The silicified rocks showed the following analytical values: 2,180 ppb Au, 22.6 ppm Ag, 1,775 ppm Cu, and 420 ppm Pb. United Nations (1987) regarded Tidi deposits as acid sulfate type epithermal gold deposits. United Nations also obtained the temperatures ranging 210 to 240°C by measuring the fluid inclusion homogenization temperature in the barite. On the other hand Mithell and Leach (1991) concluded that the veins were present in silicified zones, and the above said deposits were present in the alteration zones consisting of quartz, illite and pyrite. According to the result of the survey carried out this time, the alteration minerals in the silicified zones were quartz and sericite-smectite mixed-layer clay minerals.

Although acidic alteration zones including kaolinite have been also distributed, it is considered that the supergene acidic alteration caused by the pyrite dissolution by oxidation has been overprinted on the hypogene neutral alteration zones.

Bessemer pits in Larap mines were surveyed. At present, the open pit sites remain with the most part submerged. The country rocks are the sedimentary rocks belong to the Universal formation. On the upper steps of the pits, granitic rocks intruding into the sedimentary rocks are observed (Figure II-3-34). The granitic rocks subjected to intense alteration have been overall argillized with the mafic minerals turned to be magnetite. The X-ray diffraction showed kaolinite, geothite and quartz, overprinted by the supergene acid solutions brought by dissolusion of the sulfide minerals by oxidation. These granitic rocks may have related to the generation of Larap deposits. Inside the pits, massive magnetite and hematite still crops out, and quartz veins are also observed. Molybdenite is also observed in the quartz veins (TH106). A large amount of biotite also occurs together with magnetite. The diameters of "book biotic" range 2 to 3 cm, and the thickness of overlapped biotite also reaches 2 to 3 cm (Figure II-3-35). This biotite is supposed to be formed by hydrothermal alteration. The quartz crystals (TH105) developed in the druses are considered to be originated in the last stage of the hydrothermal activities. The fluid inclusion homogenization temperatures range 181 to 217°C (average 205°C, and the sault concentration ranges 21.7 to 23.0 wt % in NaCl equivalent. In addition, bluish green copper minerals indicating the existence of copper mineralization in the sedimentary rocks in the alteration zones distributed in the outcrops are observed.

A visit was paid to Philex Investigation Office to observed the boring cores. A substantial number of boring operations has been executed in Bessemer pits as the core and in the surroundings thereof. According to the result of the analysis regarding the boring cores made so far, the highest gold ore grade was said 2 g per ton. No limestone has been captured in any boring located in the vicinity. During the boring operation (SDD-2) performed at the eastern edge of the pits, the depth of excavation reached 535 m in vertical direction. Down to the depth of 300 m, andesite including epidote, magnetite, etc. is observed. Chalcopyrite and bornite are also observed. Near a depth of 200 m, lapilli tuff is observed with the appearance of propylitic alteration and silicification. At a depth of 400 m, mudstone is distributed.

In Pangono prospect, Atlas Co. is executing drilling in about 50 pits (depth 100-300 m, United Nations, 1987). The country rocks are dark green to dark gray siltstone and andesite tuff. There are quartz thin veins (width 2-4 mm) with disseminated pyrite. The country rock alteration is propilytization. It is considered that the smectite alteration has occurred in the supergene deposits, indicating the environment in the depths at a higher temperature rather than that of epithermal gold



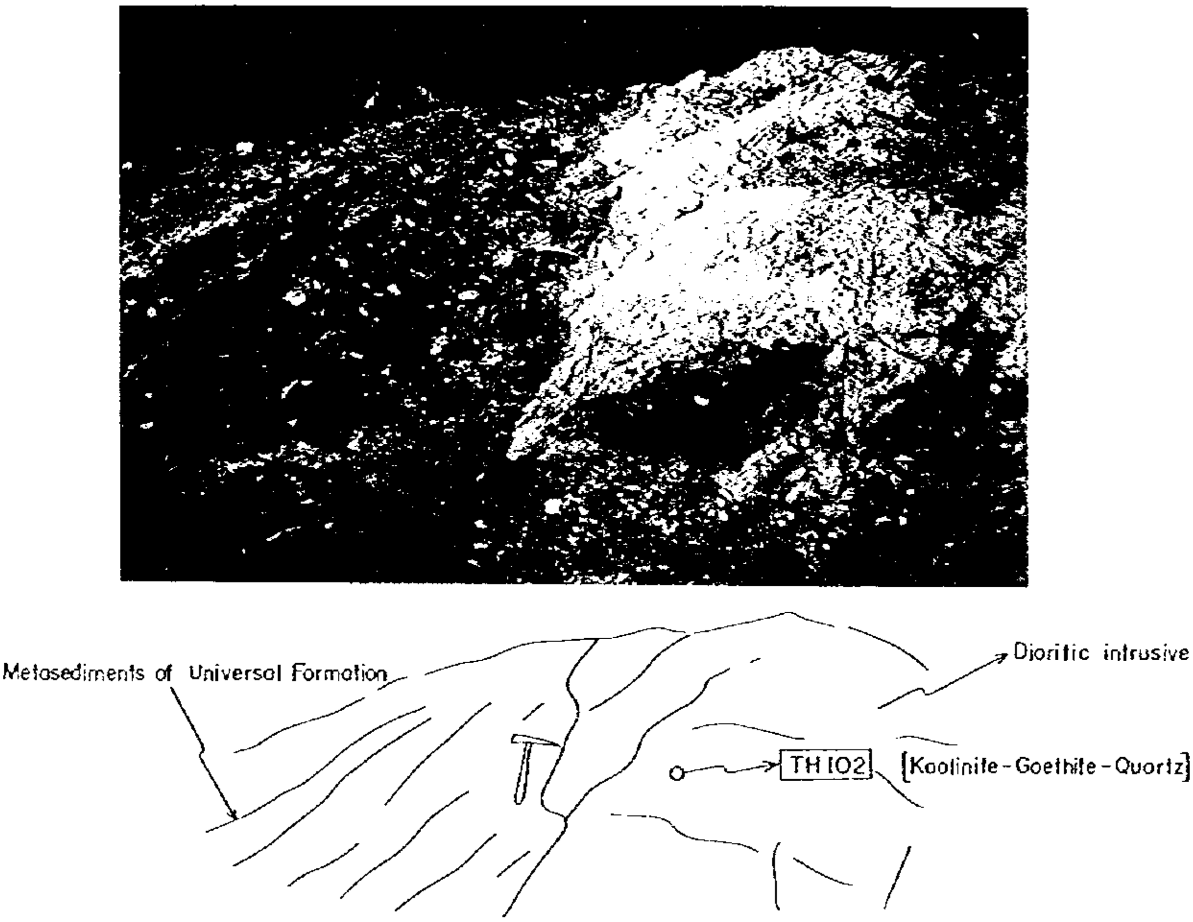




Fig.II-3-34 Occurrence of intrusive rocks at Bessmir Pit, Larap Mine

Fig.II-3-35 Occurrence of hydrothermal biotites at Bessemer Pit, Larap Mine

deposits.

In Exiban mines, there are settlements make their living by gold panning. The entrances of the tunnel are located a little deeper from the settlements. The entry was made through a drift located on a level of 50 m, and the drifts on the same level were surveyed. The shafts are vertical and connected by the drifts on several levels, but most of them have collapsed. It is said the gold has been concentrated in the shear zones, and a small number of quartz veins is also present. Although extensive alterations caused by the silicification and argillization are observed, many alterations caused by the latter are considered overprinted supergene deposits.

The shear zones strike N10°W and dip 75°W. Au concentration reaching 250 ppb was obtained from the clay and clasts in the shear zones. It is conceivable that these are mesothermal-type deposits accompanied by shear zones rather than high sulfidation-type epithermal gold deposits.

Evaluation: Every deposit shows an environment in deeper depths and exposed to a higher temperature than an epithermal environment. The types of mineral deposits expected to be discovered in this area are those of porphyry copper-gold deposit and gold and base metals vein-type deposit developing in the periphery of the porphyry-type deposits. Larap deposits are in iron scarn accompanied by mineralized copper, molybdenum and gold, suggesting the presence of porphyry copper and gold deposits in the periphery. In addition, a large number of stocks in plutonic rock from the middle Miocene, called Tamisan diorite, is present in this area. United Nations (1987) reported the exposure of a large number of rock bodies in the dacite porphyry from Oligocene. Therefore, mineralizations related to these stocks can be expected. In this area where the levels of conceived mineral deposits are exposed, it is possible to discover new mineral deposits on the surface provided that existing mineral deposits and the periphery of the spots with mineralization are carefully surveyed. Based on this, many investigations have been made so far. However, as the exposure is limited because of the dense vegetation, room for further investigations is allowable.

Mining claim: Applications have been made for the most of the mining rights. In the most part of this area, overlapped applications have been made for both MPSA and FTAA.

3.2.21 Mt. Bagacay Area (Figure II-3-32)

Reason for selection: Volcanic rocks from Pliocene are distributed. Intrusive rocks in diorite are also distributed. According to the literature, there are vein type gold deposits at the southern foot of Mt. Bagacay, located west, where the mining has been in operation although in a small scale (Llave, 1975: CN80). During the trench survey performed by Llave (1975), the values of 21.5 g/t Au and 7.0 g/t Ag were noted along the veins (width: 40 cm). The silicified veins occurs from the shear zones. The ore and gangue minerals mentioned in the said literature are pyrite and chalcopyrite.

At the northern foot of Mt. Bagacay, located west, some iron deposits are distributed (for example, Agusan mines). The iron minerals are in massive magnetite and hematite. As the sulfides, pyrite, magnetite and chalcopyrite are mentioned. The yield of garnet and epidote together with the said minerals was reported (Calcon et al., 19??). These iron minerals deposits are considered Skarn type, similar to those yiedled in Kamaishi mines. Therefore, these are similar to the environment where porphyry-type deposits are generated.

Location: Located NE of the State of Camarines Norte, about 20 km NW of Daet, about 7 km north of Labo.

Accessibility: Mt. Bagacay is accessible on the way from Daet to Parcale via Labo.

Geology: The Universal formation considered those from Eocene are distributed, and Tamisan diorite from the middle Miocene has intruded it through. These formations are further covered with the volcanick rocks of Mt. Bagacay considered those from Oligocene.

Alteration: At the beginning of the field survey, abandoned vein type gold mine in the southern foot of west of Mt. Bagacay was examined. The country rocks have been silicified (have become hornfelsic?), and the original rocks are unknown. The country rocks are covered with the hornblende andesite. The hornblende andesite has large hornblende phenocryst, and the length reaches 2 cm partially. Within the scope of the survey performed, the hornblende andesite has not been altered. Silicified rocks have been distributed in the creek where the samples TH91 were collected, and the floats of quartz veins were observed. The quartz veins are accompanied by pyrite with the edges altered to light greenish gray to white. The X-ray diffraction showed the assemblage of quartz, sericite and pyrite. At the locarity the samples TH93 and TH94 were collected, old tunnels are present. The tunnels have driven along the veins with a width of 50 cm to 2 m. From this condition, the veins were supposed to strike N70°E, and dip 42°NW. The country rocks, pyroclastic rocks in andesite, have been silicified. According to the local people, the quartz veins remaining in the old tunnels occured gold together with galena.

Chalcopyrite was observed in the quartz veins left in the waste. The fluid inclusion homogenization temperatures in the quartz veins rangeed 241 to 291°C (average 268°C) and 264 to 291°C (average 279°C), and the salinity ranged 10 to 11 weight % and 7 to 10 weight % for the samples TH91 and TH95, respectively.

The abandoned open pits in Agusan mines were also surveyed. The country rocks are altered pyroclastic rocks and sedimentary rocks, the same as those in the above said gold deposits. These rocks have become hornfelsic. The presence of bluish green copper oxide deposits was observed in the iron oxide minerals, indicating the presence of copper oxidation in addition to iron oxidation.

Mineral showings: The quartz veins collected at the abandoned gold mines at the southern foot of west of Mt. Bagacay, showed the following analytical values: 6,780 ppb Au, 6.2 ppm Ag, 3,810 ppm Cu (TH94) and 2,600 ppb Au, 6.6 ppm Ag, 4,710 ppm Cu (TH95). Au concentration in the quartz vein boulders collected in the creek in the periphery was 880 ppb Au.

The assay result of the samples (TH99) disseminated by green copper oxides collected from the abandoned open pits in Agusan mines are as follows: 60 ppb Au, 38.8% Cu, 749% Co, 151 ppm Ni. High nickel and cobalt contents suggest the presence of ultrabasic rocks in the periphery.

Evaluation: For the vein type gold deposits at the southern foot of west of Mt. Bagacay, the following two origins are conceivable: One is pluton-related mineralization by the igneous activities of Tamisan diorite, and the other is the epithermal mineralization by the magma produced younger Bagacay andesite. Based on the ground truth examined this time, it is conceivable that the mineralization in this type of veins is not epithermal mineralization but that occurring at a higher temperature accompanied by plutonic rocks. Namely, the quartz contained in the veins is comparatively coarse-grained without crustiform banding as observed in the quartz veins contained in epithermal deposits, and was deposited from hydrothermal solutions at higher temperature. The fluid inclusion homogenization temperature of the quartz also showed a high temperature reaching about 270℃, and the salinity was also high reaching about 10 weight %. The characteristics of the veins including high content of base metals in addtion to that of Au are similar to those of gold and base metal veins often observed as the marginal facies of porphyry copper deposits. Based on the above said results, the presence of porphyry copper deposits in this area is conceivable, and the performance of further survey in the periphery is desirable.

Agusan mines are regarded as iron skarn deposits formed by Tamisan diorite intruded into the Universal formation. This type of iron skarn may develop to be porphyry copper deposits in proportion to copper mineralization.

Pinagbirayan Munti area, where precise explorations were carried out as the second promising deposits assigned by United Nations (1987), is located west of Bagacay gold deposits. According to the survey in Tabas area carried out by United Nations (1987), the presence of biotite, wollastonite and andalusite was observed as alteration minerals. Two samples out of them contain pyrophyllite, an acidic alteration substantially close to a porphyry system. From the alteration minerals distributed as said above, the presence of the porphyry system in a substantially close position is conceivable.

Mining claim: Applications have been made for the most of the mining rights. In the most part of this area, overlapped applications have been made for both MPSA and FTAA.

3.2.22 Bulala Area (Figure II-3-36)

Reason for selection: Existing literature mentions the potential presence of acidic alteration zones comprising kaolinite and alunite in this area as well as that of silica sinter. Based on this description, the presence of epithermal gold deposits in this area is thought yo be resonable.

Location and Accessibility: This area is easily accessible due to the national roads passing nearby. The mines exploited for clay minerals mainly comprising kaoline called "flint clay" are located a little deep from one of the paths branching out of the national road. Other than this, paths running along the ridges extending in the direction northwest to southeast and the antenna work roads constructed on the peak located 250 m northwest of the peak are feasible. To reach this area, it takes two hours by car from Daet City.

Geology: Around this survey area, metamorphic rocks mainly consisting of green crystalline schist is distributed, but the hill country in the survey area consists of slightly porphyritic andesite. Although the direct relations between these two sections are unknown, it is highly conceivable that the whole country hill almost forms an intrusive rock body.

Alteration: Scattered presence of disseminated zones in highly concentrated pyrite is conceivable in the andesite subjected to remarkable alteration to limonite (mainly comprising goethite), accompanied by the acidic alteration featuring slite silicification and kaolin minerals. The arrangement trends NW to SE in the direction of hill elongation. The limonite dissemination zones or acid alteration zones tend to be surrounded by the alteration zones caused by smectite

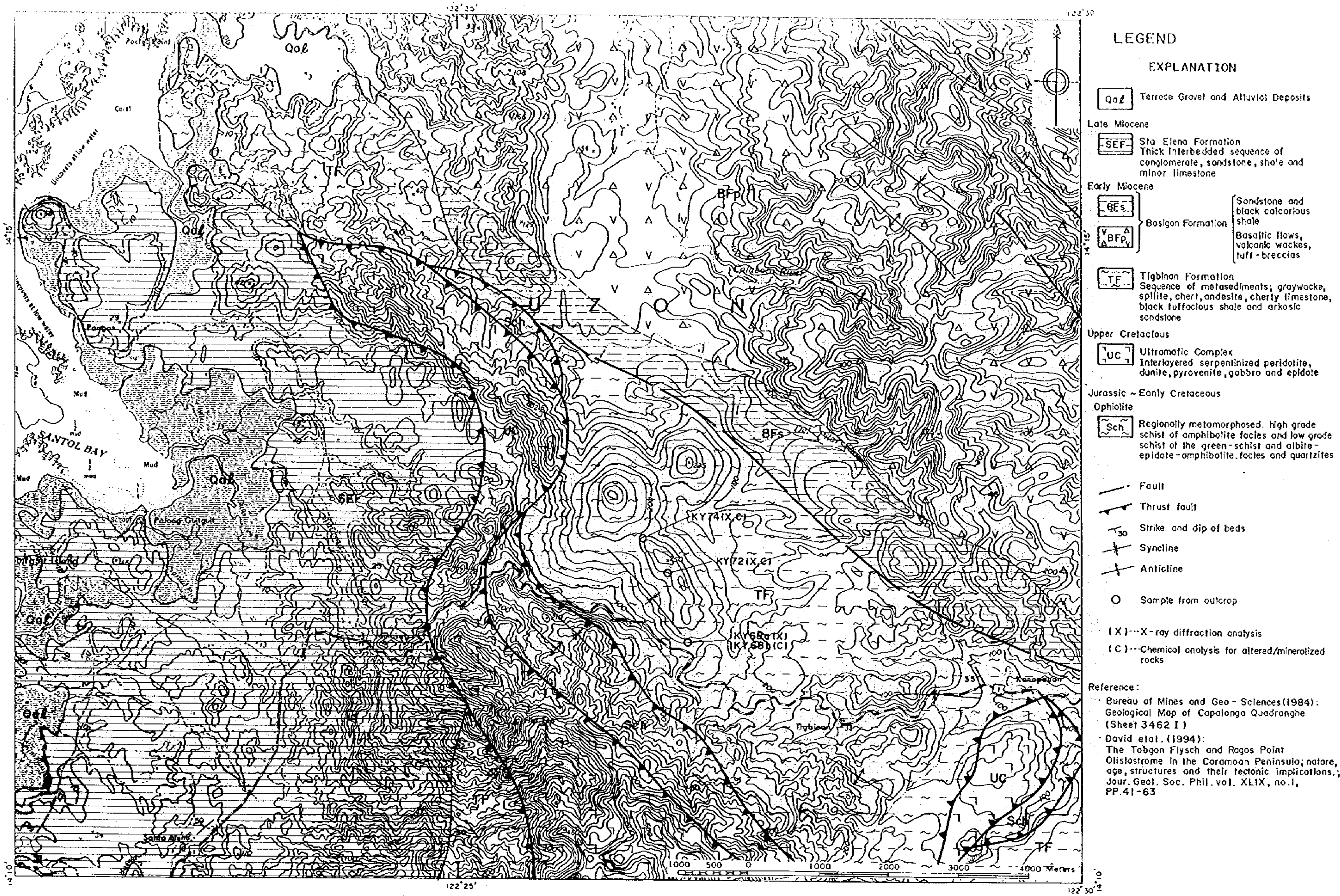



Fig.II-3-36 Geological map of the Bulala Area and sample locations argillization.

The boulders in silica sinter reported by Zepeda (1968:CN-34) was not found despite the survey performed in the place mentioned in his report. The presence of neither obvious silicified alteration zone nor silicified floats were confirmed.

The results of X-ray diffraction showed commonly presence of quarts and kaoline in this alteration zone, accompanied by hematite and anatase in some cases. No alteration minerals indicating high temperature nor influence of strong acid solution are detected from the samples.

Mineral showings: Highly disseminated pyritite typically forming kaoline minerals and limonite zones due to supergene alteration is observed locally. Although the analytical result did not show gold mineralization, the following values were obtained: 116 ppm As (KY68a), 142 ppm Cu (KY74)

Evaluation: In the acid alteration zones in slightly silicified limonite, alteration minerals indicating the participation of high-temperature hydrothermal processes are missing. Thus, it is presumed that these zones were formed by the supergene alteration of the andesite exposed to strong pyrite dissemination. United Nations (1987) made similar explanation on this appearance. Despite the presence of disseminated limonite, the degree of silicification is generally low. The presence of the smectite alteration zones distributed in the acid alteration zones in the form of windows suggests extremely limited range of the acid fluid distribution caused by the supergene alteration. Although gold mineralization is not observable, the transfer, concentration and precipitation of metallic minerals caused by the hydrothermal activities have arisen. The information of the pyrite originated in this area is insufficient and unknown.

Mining claim: The application for FTAA has been made.

3.2.23 Mt. Culasi Area (Figure II-3-37)

Reason for selection: This area consists of volcanic bodies. The alteration zones are mentioned in existing information. The presence of epithermal deposits is considered potential. Lineaments trending NE to SW and those trending N to S have developed. For the airborne magnetic survey, low magnetic anomaly in a linear structure trending E to W is observable south of Mt. Culasi.

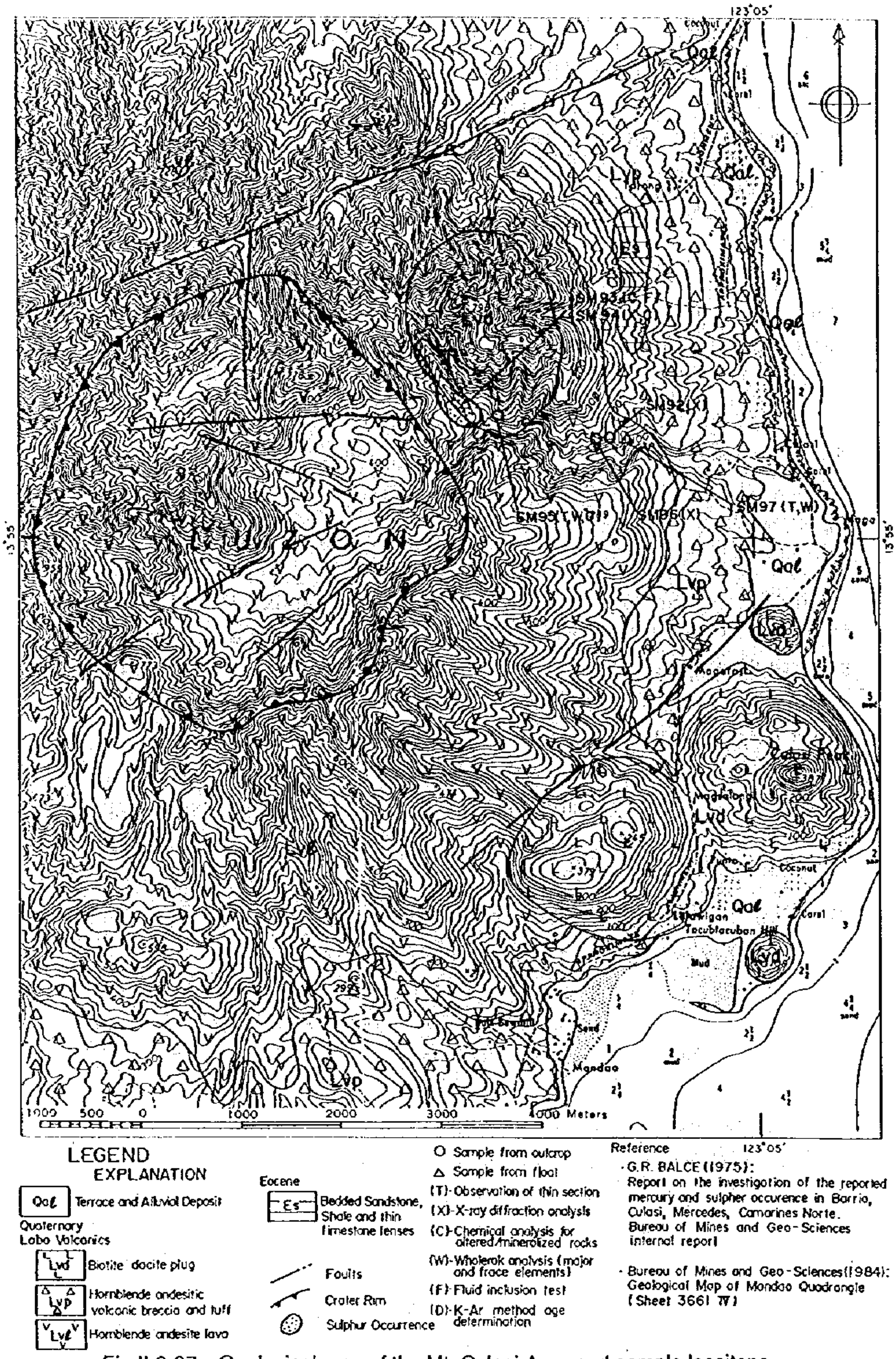



Fig.II-3-37 Geological map of the Mt. Culasi Area and sample locaitons

Location: This area is located about 3 to 5 km west of the settlements in Culasi, Mercedes, the State of Camarines Norte, ranging 13° 55' to 13 ° 57' N, 123 ° 02' to 123° 04'.

Accessibility: It takes about 30 minutes to go from Daet to Mercedes by car driving on the paved roads, and about 20 minutes to go from Mercedes to the settlements in Culasi by car driving on the unpaved roads.

Geology: According to Balce, G. R. (1975: CN-44), the oldest rocks in this area consist of the sandstone, shale and lenticular limestone from Eocene, distributed narrowly in the slopes along the seaside located about 2 km NW of the settlements in Culasi. In addition, massive andesite, dacite lava, tuff and tuff breccia called "Labo volcanics" are widely distributed.

The peak reaching 798 m among the hills including Culasi Peak, Tacubtacuban Hill and Mt. Culasi consists of the plugs of biotite dacite, and other portions consists of hornblende andesite and pyroclastic rock.

Alteration: In the areas with the distribution of massive andesite lava, some zones mostly altered gray by argillization, running parallel, are observed. In the aggregate, silicification and pyritization are not predominant, but outcropping crystallized sulfur veins and huge boulders are observed in the south to southeast portions of the peak of Mt. Culasi reaching a height of 798 m located upstream Manaspre creek. Around 240 m above sea level of upstream of Manaspre creek located south of the peak of Mt. Culasi, there are highly silicified floats coloured white to gray, where partially dissseminated pyrite, kaolinite altered to argillization and to limonite formed alongside the cracks are observed. (Fig II-3-38)

As a result of X-ray diffraction analysis, cristobalite, smectite and halloysite were detected in slightly silicified and argillized tuff breccia (SM92). In the vicinity, halloysite, alunite and hematite were detected from the argillic altered dacite (SM96). The both formations indicated the alteration caused by low-temperature acid in the shallows. On the other hand, from highly silicified floats at 240 m above sea level situated upstream Manaspre creek in south of the peak of Mt., quartz, cristobalite and tridymite were detected together with pyrite, indicating the alteration also caused by hydrothermal activities at a low temperature.

Mineral showings: The strong silicified float samples taken from upstream Manaspre creek which having highly silicified portions did not show any clear high concentration anomaly.

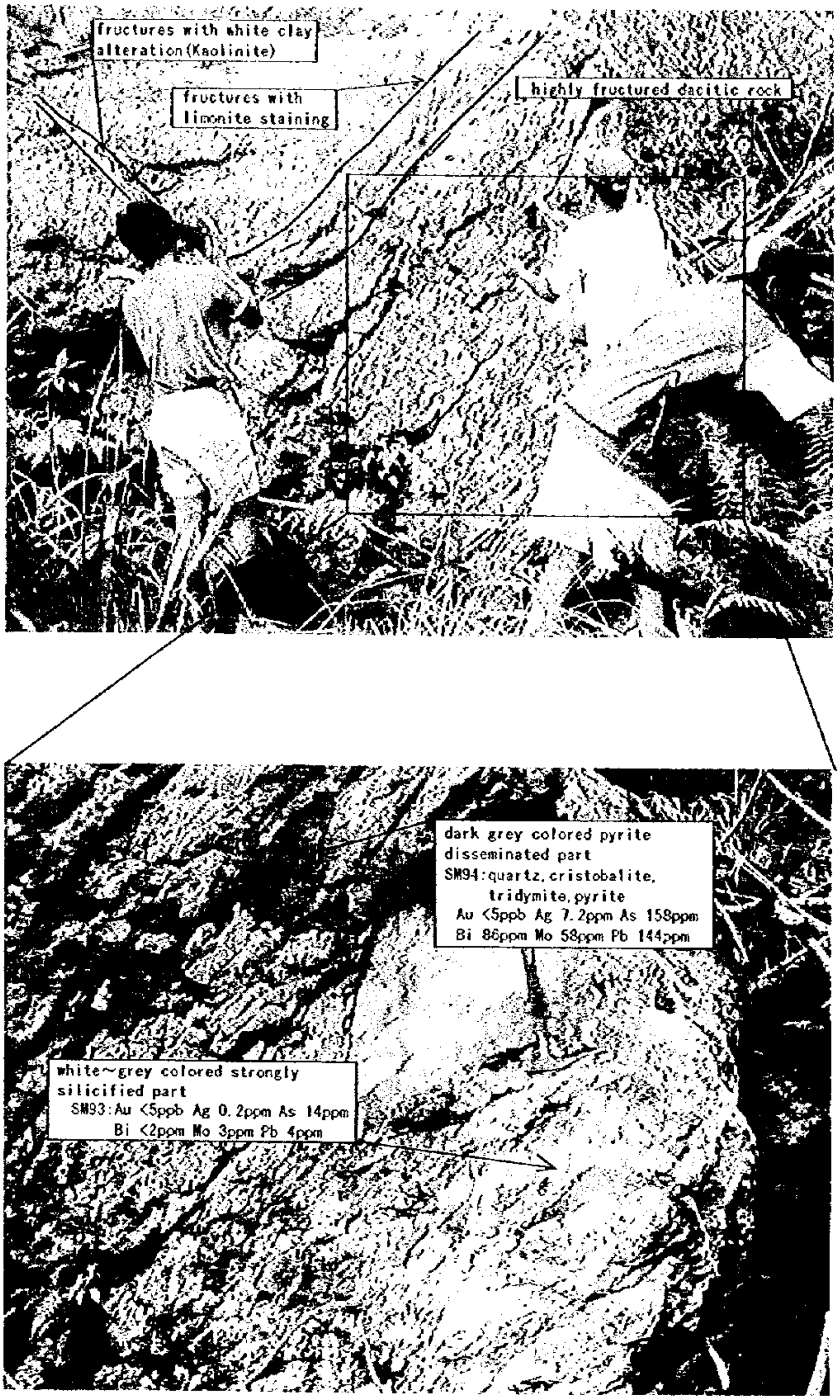



Fig.II-3-38 Big altered rock float at upper Manasopre Creek, Mt. Culasi

However, the samples which having portions of highly disseminated by the pyrite to dark gray showed the following high concentration anomaly: 7.2 ppm Ag, 158 ppm As, 58 ppm Mo, 144 ppm Pb. From the presence of sulfur deposits and high concentration anomaly of Ag, As, Bi, Mo, and Pb, precipitation of metallic elements by fumarolic activities of the volcano are conceivable. This suggests us the presence of mineralization in the depths.

Evaluation: The alteration observable on the surface of the earth is steam-heated one, but high concentration anomaly of As, Bi, Mo and Pb is observable. Thus, minerlization in the depths is potential.

Mining claim: MPSA applicable to sulfur mining

3.2.24 Mt. Labo Area (Figure II-3-39)

Reason for selection: Volcanic rocks from Pliocene to Pleistocene are distributed in this area, where geothermal development is in operation by PNOC. Therefore, epithermal gold deposits accompanied by the activities of recent geothermal system is expected. The lineaments in NE-SW to ENE-WSW systems show extreme development. Those in NW-SE system with satisfactory continuity shows also a comparative extent. According to the airborne magnetic prospecting performed by JICA-MMAJ (1985: PH16), fault structures based on airborne magnetic extensive anomaly has been surmised in the direction of NW to SE, south of Mt. Labo, linear structures revealed by low magnetism anomaly were observed in the direction of WNW to ESE, north of Mt. Labo.

According to the resistivity data presented by M. C. Zaide-Delfin et al. (1995:CN-96), an area with a resistivity of 10 ohm-m (AB/2=1000 m) is widely developed west to southwest of Mt. Labo with wide expansions trending north to southwest.

Location: This area is located across Camarines Norte and Camarines Sur in the periphery of Mt. Labo, 15 km SSW of Labo, in the vicinity of 13° 55'-14° 03' N, 122° 40'-123 ° 00' E.

Accessibility: To reach Mt. Labo geothermal heat development area, it takes about 20 minutes by car driving on the national roads to the entrance of unpaved roads starting from Daet toward the geothermal heat development area. From this entrance, it takes about 20 minutes by car driving on unpaved roads to arrive at the base camp located in the geothermal heat development area.

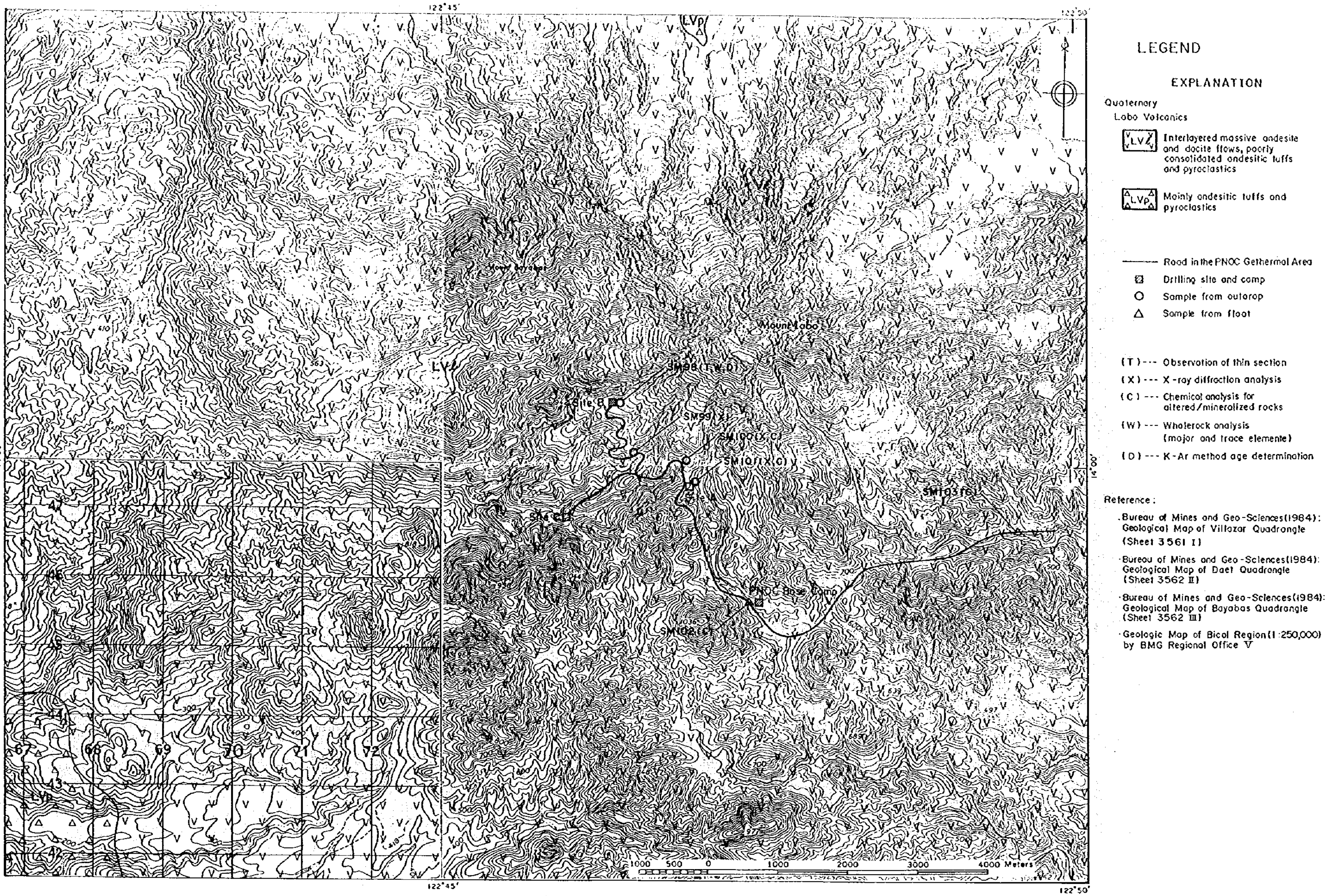



Fig.II-3-39 Geological map of the Mt. Labo Area and sample locations

Geology: In this area, the geothermal development area is present WSW of the peak of Mt. Labo. So far, 8 drillings have been performed in site A, B and C for the survey.

In site B, fall out tephra with a thickness of about 1 m was observed on coarse-grained biotite hornblende dacite with a height of 2 m. The dacite is estimated to be the constituent rocks forming the central cone. From the carbon-fourteen method, PNOC estimated the age of the tephra to be 80,000 years, the latest volcanic product in Mt. Labo area.

According to M. C. Zaide-Delfin et al. (1995:CN96), the basement rocks in this area are the metamorphic rocks from Pre-Cretaceous and the ultrabasic rocks from Cretaceous, observable north and west of Mt.Labo, unconformably overlain by the sedimentary rocks and volcanic rocks from Neogene. The granodiorite porphyry from Palaeogene and diorite from the middle Miocene have intruded into these rocks.

In the geothermal development area, the geology observable in the surface and those in the drill core consist of Susong Dalaga formation from upper Miocene, Vinas formation from Pliocene and Labo volcanic rocks from Pleistocene in ascending order.

Susong Dalaga formation crops out in west of Mt. Labo and observed -1,200 m to -400 m above sea level in the drill core. This formation mainly consits of hornblende andesite lava, volcanic breccia and tuff.

Vinas formation uncnformably overlain by Susong Dlaga formation and consists of sandstone, tuff, calcareous siltstone and limestone subjected to thermal metamorphism.

Labo volcanic rocks are produced by the eruptions of Mt. Labo in Pleistocene (about 0.42-0.08 Ma) and distributed in a wide range. These volcanic rocks consist of four members as follows: the basal unit consists of hornblende andesite, basalt, dacite lava and volcanic mud-flow sediment, lava domes of biotite-pyroxene-hornblendic dacite and biotite hornblende andesite domes, the central cone consists of pyroxene andesite, hornblende andesite and dacite lava, and pyroclastic flow deposits of andesite to dacite composition.

In the geothermal development area located WSW of the peak of Mt. Labo, there are fault structures in the gravity trending NE to SW and NW to SE, where three large faults (Ibatan fault, Pagtigbungan fault and Labo fault) have formed a horst graben structure. About half the number of the hot springs in this area is situated in the grabens. The most of them are concentrated in the faults in NE-SW system and the extensions.

Alteration: During the field survey, the alteration smectite and kaolinite in gray color accompanied by pyrite dissemination and limonite dissemination was observed along the road running south to west of Mt. Labo facing the site A, B and C. Particularly in the vicinity of the site A, the argillization has remarkably advanced, accompanied by medium to high silicification.

According to the result of X-ray diffraction analysis, quartz, cristobalite, trydimite, smectite, halloysite and pyrite were detected from the samples (SM101) collected from the outcrops of the altered rocks. From the samples (SM100) collected from the outcrops of altered rocks along the road facing the junction to the road from the site A to site B and C, quartz, cristobalite, trydimite, kaolinite, smectite, alunite and goethite were detected. From the samples (SM99) collected from the outcrops of altered rocks along the road from the junction to the site B, cristobalite, alunite and pyrite were detected. The alteration mineral assemblage of each sample indicates the alteration occurred at low temperatures in acidic conditions.

According to M. C. Zaide-Delfin et al. (1995:CN96), the hydrothermal alteration near the surface is almost limited within the area close to that of present hydrothermal activities, and the sulfur precipitation and acid sulfate alteration zones are distributed in the periphery of acid sulfate hot springs characterized by acid sulfate in 600m above sea level. On the other hand, the presence of hot spring precipitation is observed in neutral springs and chloride springs.

The alteration observable in the drill core includes acid alteration zones observed in the shallowth and near the surface, and neutral alteration zones and high-temperature acid alteration zones observed in the depths.

The acid alteration zones in the shallows consist of fine-grained acicular alunite, opal, cristobalite and kaolinite. It is considered these components were created by the mixture of the ground water and the gases rising from the depths at a ambient temperature of 100°C or lower. According to M. C. Zaide-Delfin et al. (1995:CN96), the drillings LB-1D/LB-5D performed from the site A where these acid alteration zones are observed were located near the immediatery above the upwelling plumes where hot fluids rise from the present geothermal convection system. Compared to these borings, they say the drillngs LB-2D/LB-6D from the site B where such acid alteration zones are not observed, and those LB-3D/LB-4D from the site C intersected apart from the main upwelling plumes.

In the neutral alteration zones, the presence of alteration minerals including the mixture of smectite, mixed layer clay mineral of illite and smectite, illite, chlorite, quartz, calcite, dolomite, epidote, anhydrite, pyrite, laumontite, wairakite, garnet, actinolite is observed. Rarely, secondary biotite is observed in the rock fragments of hte breccia. The presence of epidote, anhydrite and wairakite indicates influence of neutral hydrothermal fluid. The high temperature acid alteration zones in the depths are observed at deeper than 300 m above sea level in the drillings LB-1D/LB-5D from the site A. In the alteration minerals, diaspore, pyrophillite, dickite and tabular alunite are observed. In particular, the borings LB-5D are accompanied by topaz, lazulite and copper sulfides (chalcopyrite, kobellite and chalcocite). Consequently, the presence of intrusive rocks is conceivable. However, due to the fact the above said minerals are not yielded form LB-5D, it is estimated no gas is directly incoming from the magma in this area.

Mineral showings: The samples (SM100) collected from the outcrops of altered rocks in the vicinity of the site A contain 5 ppb Au at the most. From the drill core of LB-3D in the site C, chalcopyrite occurs together with anhydrite and pyrite. In addition, chalcopyrite, covellite and chalcocite occur in LB-5D alongside the acid alteration zones in the depths.

Evaluation: The alteration observed on the surface is steam-heated one. From the data obtained from the drillings, the presence of the conditions responsible for the formation of epithermal deposits is potential. However, based on the fact that the geothermal activities are quite young and alteration zoning, the favorable place for gold deposits is surmised to be located in the considerable depth. Thus, it will be necessary in the future to investigate the alteration zones situated in Kilbay where older volcanic rocks unit are exposed widely and mineral occurrence or clay alteration have been reported.

Mining claim: For the area located west of Mt. Labo, FTAA, mining lease, placer and lode applications have been made. However, the area located south to east remains blank or PNOC geothermal reservation has been made.

3.3 Summary of the Survey Results

Based on the existing data and the result of satellite image analysis, the candidates for ground truth survey were selected. The situation of mine claim setting, accessibility and security are also taken into consideration, in selection of the ground truth survey area. As a result, the field survey covering 24 areas mentioned in the preceding section was conducted. The ground truth survey results were collated from the viewpoint comprising position, accessibility, geological features, alteration, mineralization and mine claim, and the potentiality (potential presence of mineral deposits and room for exploration) in each area was evaluated.

Table II-3-2 shows the outlined summarization of the survey results obtained from the above areas. Table II-3-3 shows the outlined summarization of the assay results of the samples collected in the survey area, fluid inclusion data and main assemblages of alteration minerals. For Au, Cu, Pb and Zn, the highest two assay values in each area are shown. Relative evaluation of these areas, namely, the extraction of promising areas will be described in the next chapter. Here, the common characteristics applicable to plural areas are mentioned.

1. In the steam-heated acid alteration zones including Bacon-Manito and Irosin, the presence of alunite was commonly observed, suggesting that hydrogen sulfide derived from the steamcould be comparatively large amount with high acidity. In some part of the steam-heated acid alteration zones, quartz and alunite (minamiite in some cases) occur as silicified rocks and hydrothermal breccia. Au, Cu and P are detected in the quartz-alunit (or minamiite) rocks on a geochemical anomaly level. Mo and As also show anomalous concentration in some cases. This yielding condition shows the rise of the fluids from the depths to the vicinity of the surface, suggesting possible mineralization occurred in the depths.

2. For the samples collected in the hydrothermal alteration zones (mainly steam-heated alteration zones) where comparatively young volcanick rocks are distributed, As shows comparatively high concentration but Sb is hardly detected overall. The highest Hg concentration is 7 ppm. There are some areas yielding Hg in 1 ppm, but the concentration in all other areas is less than 1 ppm. Hg detection is considered possible in steam-heated emvironment, but the majority may have leached out during the supergene alteration process.

3. The fluid inclusion homogenization temperatures of the quartz veins collected from the areas distributed in Camerines Norte (paracale, Larap-Exiban and Mt. Bagacay) showed comparatively high values, indicating high salinity. In alteration minerals, the assemblage of quartz and

Table II-3-2(a) Summary of the ground truth survey

| blocks | Areas | Results of Ground Truth | | | Interpretation from the results of the Ground truth | Mining Claims | Priority |
|---|---|---|---|---|---|---|---|
| | | mineralization | alteration | host rocks, geology and structures | | | |
| Legaspi | Bacon-Manito | gold geochemical anomalies; Central geothermal area: drilling cores have Au mineralization | silicification, opaline silica, kaolinite, alunite, smectite, pyritization, silica+pyrite veinlets, native sulfur | the Pocdol Volcanics: Px andesite ～basaltic andesite, WNW trending lineation and N-S trending lineation are dominant; geothermal drill intersects intrusive at about 1,725～2,210m; geothermal fluids: neutral pH | The western part of Bacon-Manito geothermal area is promising. The alteration found along Calpi, upstream portion of Cumadcad and the upstream portion of Cawayan could be a part of a epithermal system. The paleo volcanic cone (Danao Lake) could be the center of these system. | PNOC | 1st |
| | Calpi | gold geochemical anomalies | silicification, opaline silica, kaolinite, alunite, smectite, pyritization, silica+pyrite veinlets | Px andesite lava and pyroclastics | steam-heated alteration, silica-pyrite veinlet, hydrothermal brecciation | PNOC | |
| | Masulog | gold geochemical anomalies | silicification, opaline silica,smectite, pyrite | Px andesite lava | steam-heated alteration | PNOC | |
| | Pili-Cumadcad | gold geochemical anomalies | silicification, pyritization, kaolinite, | Px andesite lava and pyroclastics | steam-heated alteration | PNOC | |
| | Cawayan River | | pervasive, smectite, silicification, pyritization, silica-pyrite veinlet in smectite | Px andesite lava and pyroclastics, smectite dominate in volcanic breccia (flow foot breccia), | steam-heated alteration in distal area due to lateral flow, but few possibility of upflow. | PNOC | |
| | Tiwi-Mt. Malinao | gold mineralization in silica sinter; drilling core has sphalerite, galena and chalcopyrite with adularia at depth | silica sinter: deep chloride fluid upflow; deep seated acid alteration; kaolinite silicification with pyrite | andesite lava and pyroclastics; lower: schist, upper: andesite | low-sulfidation environment, deep chloride fluid upflow, steam-heated acid alteration, | PGI geothermal reservation | 1st |
| | Nagas-Pio Duran | oxide copper (azurite, brochantite) mineralization in Qz veinlet, gypsum deposits | gypsum, smectite, kaolinite; contact metasomatic alteration? | dioritic pluton, ultramafic rocks, limestone, sedimentary rocks, ENE-WSW, NW-SE lineaments | copper mineralization related to diorite intrusion, a few possibility of skarn deposit, gypsum deposits are seemed supergene products, | FTAA, MPSA | 3rd |
| | Pilar-Donsol | no mineralization | no alteration | no diorite, no volcanics, young calcareous shale, coral limestone | we can not expect any mineralization | FTAA, MPSA | |

Table II-3-2(b) Summary of the ground truth survey

| blocks | Areas | Results of Ground Truth | | | Interpretation from the results of the Ground truth | Mining Claims | Priority |
|---|---|---|---|---|---|---|---|
| | | mineralization | alteration | host rocks, geology and structures | | | |
| Irosin | Irosin- Gabao-Bulan | | silicification, pyritization, kaolinite, smectite, quartz vein | Px andesite～basaltic andesite lava and pyroclastics | steam-heated alteration, possibility of epithermal gold | MPSA | |
| | Monte Calvario | | silicification, kaolinite, alunite, smectite, pyritization, quartz vein, | Px andesite～basaltic andesite lava and pyroclastics | steam-heated alteration | MPSA | 1st |
| | Gabao | | floats (smectite, silicification, pyrite) | basaltic andesite lava, pumice tuff uppermost pumice flow includes greenish altered pebble sized | steam-heated alteration in distal area due to lateral flow, but few possibility of upflow. | MPSA | 1st |
| | Sisigon | | float (silicification, pyrite) | Px andesite lava | steam-heated alteration | ex.permit | |
| | Irosin south | | silicification, kaolinite, pyrite, very few alteration | Px andesite～basaltic andesite lava and pyroclastics | steam-heated alteration | ex.permit | |
| | Magallanes - Mt. Bintacan | | kaolinite or halloysite: weathering? Mt Bintacan: no altered floats | Magallanes: very weak argillic alteration, weathering Mt Bintacan: Px andesite | weathering or steam-heated alteration? | vacant ex.permit | |
| | Bacolod | | hot spring, smectite, no silica | ? | steam heated hot spring? | vacant | |
| | San Roque- Mt. Malobago | | float: silicification, pyrite, | andesite; Bt dacite dome | steam-heated alteration | vacant ex.permit | |
| | Gate Mountains | | silicification, pyritization, kaolinite, smectite, native sulfur, | Px andesite～basaltic andesite lava and pyroclastics | northern and western parts of the Gate Mountains are promising, possibility of epithermal gold | MPSA | 1st |
| | Tugas - Mt. Sujac | | silicification, pyritization, kaolinite, smectite, native sulfur, | | steam-heated alteration, some hydrothermal fluid come up | MPSA | |
| | Sisigon-Matnog | | silicification, pyritization, kaolinite, smectite, | andesitic tuff breccia, | | ex.permit | |
| | Matnog-Culasi | | (silicification) float | Px andesite with thin capping of limestone in some shore line, | altered boulders coming from upstream area | vacant ex.permit | |
| | Culasi-Manurabi | | few alteration, smectite alt. in accretional lapilli | Px andesite～basaltic andesite lava and pyroclastics, accretional lapilli | area is covered by thick old pyroclastics and new pyroclastics with tuffaceous matrix | ex.permit | |
| | Butang-Sua | | (silicification, pyritization, kaolinite, smectite) float | Px andesite, Ol-Px basalt; NW-SE lineaments | steam-heated alteration; the altered floats may come from SW of Gate | MPSA | |

Table II-3-2(c) Summary of the ground truth survey

| blocks | Areas | Results of Ground Truth | | | Interpretation from the results of the Ground truth | Mining Claims | Priority |
|---|---|---|---|---|---|---|---|
| | | mineralization | alteration | host rocks, geology and structures | | | |
| Naga | Siruma Peninsula | placer gold, Mn deposits, copper mineralization | white clay: silica, kaolinite, illite? Qz vein/lens have no alteration halo | green schist, | The area is underlain by an old oceanic crust (ophiolite sequence) where siruma area is the younger lithology. The source of Au is a the origin of placer gold seems to be mesothermal lode in the schist | FTAA, MPSA | 3rd |
| | Tamban-Olas | placer gold, gold mineralization in quartz vein, | Qz vein/lens have no alteration halo, calcite+quartz veining in the schist | green schist, green rocks, mica schist | the origin of placer gold seems to be mesothermal lode in the schist, re-deposition of gold caused by diorite intrusion | FTAA, MPSA | 3rd |
| | Western Goa | | thick quartz vein with pyrite | mica schist | mesothermal lode? | vacant | 3rd |
| | Malobago | no checked | no checked | no checked | | vacant | |
| | Western Pasacao | copper mineralization (oxide copper) | silicification, gypsum deposit, propylitic alter. | Px andesite, diorite; NW-SE lineament, NE-SW lineament | | FTAA, MPSA | 2nd |
| | Eastern Pasacao | copper mineralization (oxide copper) | Qz veinlet and Cal veinlet in volcanics, Qz vein stockwork in diorite floats | andesite-basalt on schist, diorite, young limestone | copper mineralization related to diorite intrusion, no possibility of Carlin type deposit | FTAA, MPSA | 2nd |
| | Iriga-Baao | perlite deposit | no alteration | basaltic andesite lava, Bt dacite~rhyolite interbedding scoria and pumice tuff; indicating bimodal volcanism | | MPSA | |
| | Buhi-Western Mt. Malinao | | silicification, kaolinite-smectite alteration, pyritization, chalcedonic vein | NW-SE lineament | possibility of epithermal deposit | vacant | 1st |
| | Balatan north | Camagahan: copper oxide, chalcopyrite in Qz vein and dissem. in diorite; Caorasan: gypsum with Py; Manit: gypsum | Camagahan: Qz vein, propylitic alt.; Caorasan: Qz vein pyritization; Manit: pyritization, Qz vein | Camagahan:host rock :diorite overlain by limestone . Caorasan: propylitic altered basaltic rock | alteration seems to be controlled by NW-SE fractures; Cu mineralization seems to be situated in diorite and gypsum deposits in volcanic rocks | FTAA, MPSA | 2nd |
| | Balatan south | | floats (propylitic alteration) | basaltic rocks, diorite floats | | FTAA, MPSA | 2nd |
| | Silmod | no checked | no checked | no checked | | vacant | |
| | Calabanga-Tinembac | | silicification, hydrothermal brecciation, silica veinlet, kaolinite-smectite alteration, pyritization, | host rocks: Hbl andesite and Px andesite covered by young Px andesite(laharic deposit?) from Mt. Isarog | high-sulfidation style alteration? some alteration zone extend under the young laharic deposits | vacant MPSA | |

Table II-3-2(d) Summary of the ground truth survey

| blocks | Areas | Results of Ground Truth | | | Interpretation from the results of the Ground truth | Mining Claims | Priority |
|---|---|---|---|---|---|---|---|
| | | mineralization | alteration | host rocks, geology and structures | | | |
| Daet | Paracale | gold, copper, zinc and lead mineralization in Qz vein | Qz vein has illite alteration halo, propylitic alt | granodiorite (Paracale Trondjhemite), ultramafic rocks Igneous activity responsible for the mineralization is unknown. | peripheral mineralization of porphyry-system rather than epithermal precious and base metal mineralization? Relatively high temperature and high | MPSA | 1st |
| | Larap - Exiban | Tidi: gold in shear zone, Qz vein, Larap: magnetite, green copper, molybdenite. | Tidi: supergene alteration overprint; Larap: skarn type alteration; Pangono: propylitic alteration, Qz veinlet network; Exiban: silicification, supergene alt overprint | Universal F: sandstone, shale, conglomerate | possibility of skarn, porphyry-type deposit, and peripheral mineralization of porphyry-system or epithermal? | MPSA FTAA | |
| | Mt. Bagacay | gold and copper mineralization in Qz vein, magnetite massive ore, oxide copper mineralization in the Fe deposit | silicification, quartz vein with illite or mixed layer clay alteration, | host rocks; andesitic pyroclastics: hornfels, young Hbl andesite covers metavolcanics and metasediments diorite intrusion | diorite intrusion makes hornfels and causes contact metamorphism and metasomatism, massive magnetite ore with some copper may be produce in skarn like environment | MPSA | 1st |
| | Bulala | | frint clay: silica+kaolinite, host rocks: andesite; Pl phenocryst→kaolinite, pyritization, no silica sinter, | host rocks: andesite porphyry of distinct relief relative to surrounding peaks; andesite porphyry provably intruded into the schist | supergene process of pyrite disseminated andesite. The source of the pyrite is unknown. | FTAA, MPSA | 1st |
| | Nalesbitan-Tuba | no checked: not accessible | no checked: not accessible | no checked: not accessible | possibility of porphyry-type deposit, Nalesbitan trend is promising: by analogy with the Lepanto-FSE | FTAA, MPSA | |
| | Mt. Culasi | sulfur deposit | silicification(opaline silica), pyritization, smectite | host rocks: Hbl andesite and dacite NE- | steam heated alteration | MPSA | 3rd |
| | Mt. Labo | drill core: chalcopyrite, covellite, chalcocite | silicification, smectite, kaolinite, pyritization; core: illite, Ill/Smc, epidote, wairakite, anhydrite | Px-Hbl andesite, Hbl andesite, Bt-Hbl dacite | steam heated alteration; from drill core: we can expect copper mineralization in depth and the existence of intrusive rock | PNOC, MPSA | 3rd |

Table II-3-3 Geochemical, temperature and alteration data of the ground truth survey areas

| | Chemical feature | | | | | Temperature | Salinity | Alteration |
|---|---|---|---|---|---|---|---|---|
| | Au | Cu | Pb | Zn | Others | | | |
| Paracale | 57.19ppm(c), 35ppb | | 1780ppm | | Ni:150ppm Bi:600ppm | 276~301°C, Av.288°C; 258~324°C, Av. 290°C; 200~252°C, Av. 222°C (c) | 6.0~9.3wt%; 0~0.3wt%; 0.3~1.0wtS | Chl-Prl-Dol |
| Larap-Exiban | 2180ppb, 250ppb | 1775ppm, 397ppm | 420ppm | | | 181~217°C, Av. 205°C | 21.7~23wt% | Qtz-Ser, Qtz-S/S,Qtz-K-f |
| Mt.Bagacay | 6780ppb, 2600ppb | 38.8%, 4,710ppm | | | Ni:151ppm, Co:749ppm | 241~291°C, Av.268°C; 264~291°C, Av.279°C | 10~11.2wt%; 7.1~9.3wt% | Qtz-Ser, |
| Bulala | | | | | As:116ppm | | | Qtz-Kln-Py |
| Siruma Peninsula | 2200ppb, 55ppb | 565ppm, 160ppm | | | Co:51ppm, Cr:643ppm | 142~182°C, Av. 161°C | 0.3~1.0wt% | (Qtz-Ser)-Kln |
| Tamban-Olas | 10ppb, | 311ppm | | | | | | n.a. |
| Western Goa | 60ppb | 284ppm | | | | 128~171°C, Av. 150°C | 1.4~2.0wt% | (Qtz-Pl-Ser-)Kln |
| Western Pasacao | | | | | | 107~151°C, Av. 123°C | 0~0.3wt% | Qtz-Pl-Cal-Dol |
| Eastern Pasacao | 80ppb, 35ppb | | | | Ni:,180ppm, Co:51ppm, Cr.897ppm, P:1560ppm, As:1080ppm | 168~234°C, Av.198°C; 208~251°C, Av 234°C; 161~202°C, Av.187°C | 0.2~0.5wt%; 0.9~1.4wt%; 2.7~3.9wt% | Qtz-Pl-K-f, Qtz-Dol-Mgs, |
| Balatan | 210ppb, 15ppb | 3970ppm, 208ppm | | | Fe:>15%, P:1,110ppm | 103~142°C, Av.122°C | 0~0.4wt% | Qtz-Pl-S/S, Qtz-S/S-Gyp-Py, Qtz-Pl, Cal, Qtz-Pl-C/S |
| Nagas-Pio Duran | 640ppb, 55ppb | 14500ppm 13900ppm | | 1810ppm | | 193~242°C, Av.220°C; 147~191°C, Av.168°C | 1.7~3.2wt%; 0.3~0.7wt% | n. a. |
| Pilar-Donsol | n. a. | n. a. | n. a. | n. a. | n. a. | n. a. | n. a. | n. a. |
| Nalesbitan | — | — | — | — | — | — | — | — |
| Mt. Labo | | | | | | | | Crs-Kln-Smc-Alu, Crs-Smc-Hly |
| Kilbay | — | — | — | — | — | — | — | — |
| Mt. Culasi | | | 144ppm | | Mo:58ppm, As:158ppm, Bi:86ppm | 107~142°C, Av. 124°C | 0~0.3wt% | Crs-Alu, Crs-Pl-Hly |
| Calabanga-Tinenbac | 15ppb | | | | | | | Qtz-Alu, Crs-Smc, Crs-Alu |
| Iriga-Baao | n. a. | n. a. | n. a. | n. a. | n. a. | n. a. | n. a. | n. a. |
| Buhi-Western Mt. Malinao | | | | | | 288~334°C, Av.309°C; 141~168°C, Av. 154°C | 0~0.7wt%; 0~0.18wt% | Trd-Kln-Alu, Qtz-Py |
| Tiwi-Mt. Malinao | 85ppb(c), | | 674ppm(c) | 722ppm(c) | As:108ppm(C), P:2110ppm(C), | 223~251°C, Av.237°C; 241~288°C, Av.262°C; 232~283°C, Av.270°C: 208~283, Av.237°C(C) | 1.9~2.4wt%; 0.4~1.2wt%; 0.2~0.5wt%; 0.7~1.0wt% | Qtz-K-f-Ser, Qtz-Ser-Anh, Qtz-Chl-Ab |
| Bacon-Manito | 25ppb | 434ppm, 146ppm, | | 112ppm | P:1200ppm, Cr:1440ppm | n. a. | n. a. | Crs-Alu, Crs-Kln-Alu, Crs-Alu-Ba, Crs-Smc-Alu, Crs-Kln-Prl-Py,Crs-Prl-Alu, Crs-Hal, Qtz-Alu, Qtz-Mi, Kln-Mi-Goe, |
| Magallanes-Mt. Bintacan | | | | | | n. a. | n. a. | Crs-Hal-Geo, Crs-Hal-Alu |
| Bacolodo | | | | | As:1930ppm, P:1290ppm | n. a. | n. a. | Pl-S/S-Cal |
| Irosin-Gabao-Bulan | 10ppb, | 123ppm | | 124ppm | Fe:13.05%, P:2120ppm, | n. a. | n. a. | Qtz-Smc-C/S, Qtz-S/S-Hal, Qtz-Kln-Smc-Dol, Qtz-Mi, Qtz-Kln-Alu, Crs-Kln-Alu, Crs-Kln-Smc |
| San Roque-Mt. Malogabo | | | | | | n. a. | n. a. | Crs-Alu-Kln, Crs-Alu |
| Gate Mountains | 150ppb | 212ppm, 118ppm | | | Mo:36ppm, Fe:10.85%, | n. a. | n. a. | Crs-Kln, Crs-smc-Hal-Alu, Crs-Alu, Qtz-Alu, Qtz-Pl-Smc-Gyp-Py |
| | >10ppb second | >100ppm second | >100ppm second | >100ppm second | Ni:>100ppm Co:>50ppm Cr:>500ppm P:>1000ppm Mo:>20ppm Mg:>8% Fe:>10% As:>100ppm Bi:>50ppm | | | |

Qtz:Quartz
Crs:Cristobalite
Trd:Trydimite
Smc:Smectite
S/S:Sericite/Smectite interlayered clay
Ser:Sericite
Hal:Halloysite
Kln:Kaolinite
Alu:Alunite
Mi:Minamiite

Gyp:Gypsum
Anh:Anhydrite
Pl:Plagioclase
Ab:Albite
Py:Pyrite
Goe:Goethite
Cal:Calcite
Dol:Dolomite

sericite is donimant. These data indicate the mineralization in these areas occurred in a high-temperature environment positioned in depths close to the intrusive rocks.

## Chapter 4: Airborne Geophysical Survey

### 4.1 Survey Area

The following areas were selected on the basis of the results of analysis of existing data, analysis of satellite images and the ground truth survey for airborne geophysical survey (aeromagnetic and aeroradiometric measurement). The survey area covers the Tiwi, Legazpi and Irosin project areas in Bicol peninsula comprising approximately 5,600 line kilometers over those areas delineated on the maps. (Fig. II-4-1)

1) Tiwi Area (North from Buhi)
2) Legaspi Area (Bacon -- Manito Area)
3) Irosin Area (South from Irosin)

The latitudes and longitudes of four corners of each rectangular areas are shown as follows;

1) N13° 33':E123° 40'-N13° 26':E123° 40'-N13° 26':E123° 30'-N13° 33':E123° 30'
2) N13° 10':E123° 56'-N13° 00':E123° 56'-N13° 00':E123° 49'-N13° 10':E123° 49'
3) N12° 45':E124° 10'-N12° 30':E124° 10'-N12° 30':E123° 56'-N12° 45':E123° 56'

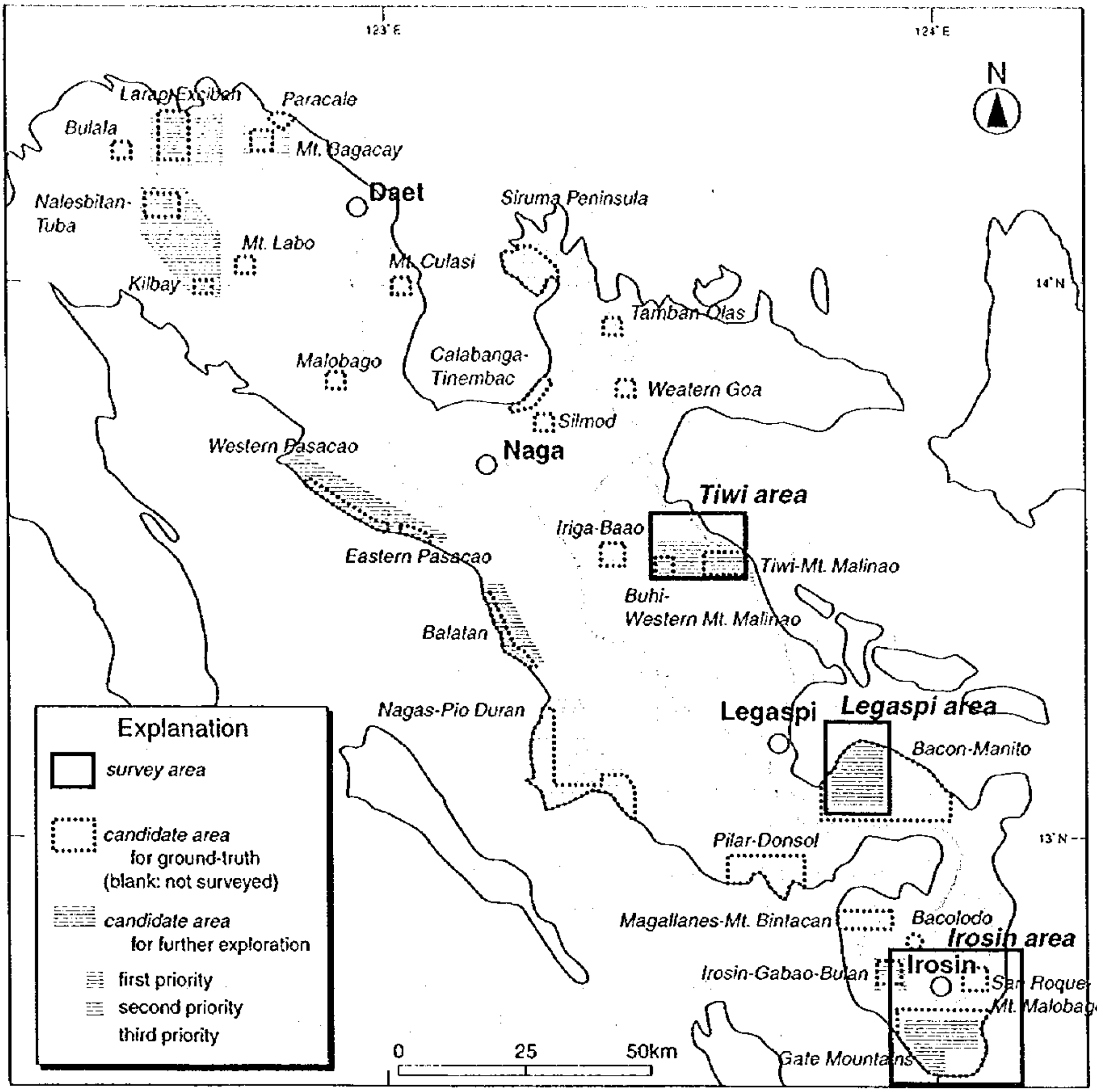
The sea area is excluded from those areas.

Three areas were selected on the basis of the following selection criteria from among the areas extracted as promising areas in the ground truth survey:

a. Priority to areas with possibility of existence of epithermal gold ore deposits.
b. Priority to areas for which FTAA has not been set up as mining rights.

From the viewpoint of potential regarding ore deposit endowment, the areas around the existing ore deposits in the Camarines Norte is also promising, but those areas were not selected as not meeting the above selection criteria.

Each areas were decided on the basis of the following view points:




## SURVEY AREA

| | | | | |
|---|---|---|---|---|
| Tiwi area : | N13°33' | E123°30' | N13°33' | E123°40' |
| | N13°26' | E123°30' | N13°26' | E123°40' |
| Legaspi area: | N13°10' | E123°49' | N13°10' | E123°56' |
| | N13°00' | E123°49' | N13°00' | E123°56' |
| Irosin area: | N12°45' | E123°56' | N12°45' | E124°10' |
| | N12°30' | E123°56' | N12°30' | E124°10' |

Figure II-4-1 Areas for Airborne Geophysical Survey

(1) Tiwi Area

- The northwest side of Mt. Malinao has undergone considerable topographical dissection and is older than Mt. Malino. Assuming that hydrothermal ore deposits exist, it is possible that they will be found at more shallow places than Mt. Malinao area.
- In the ground truth survey, a lot of silicified rock and quartz vein floats were noted on the east shore of Lake Buhi, which suggests wide distribution of a epithermal alteration zone in this area and points to the possibility of the existence of epithermal ore deposits.
- In satellite image analysis, the density of lineaments is high and NE trending and NW trending lineaments are crossed in this area.
- From the fact that low-sulfidation style mineralization has been confirmed in geothermal drilling in the Tiwi active geothermal system, there is a possibility of existence of ore deposits of the same kind in this area.
- Because of poor access in the ground truth survey and the lack of existing data, it was not possible to adequately determine the distribution of the alteration zone. We expect that the airborne magnetic survey could give us more information for further exploration.
- The anomaly map of the regional airborne magnetic survey carried out by the World Bank (flight line intervals of about 2 km; data that has not undergone polar magnetic conversion), shows some small magnetic anomalies in this area. And the detailed airborne magnetic survey could elucidate the extent of the alteration zone or geothermal system.

(2) Legazpi Area

- The ground truth survey showed wide distribution of the alteration zone, which indicates the shallow parts of the epithermal system, and it is possible that epithermal gold ore deposits exist in deeper parts.
- At the east part of this area, there is an active geothermal system. The alteration zone is distributed in the somewhat old volcanic rock zone to the west part of this area. It is possible that the hydrothermal fluid in the western side of this area used the same trending fractures as the present reservoir. It will be possible to narrow down the promising area if it is possible to analyze those fractures in airborne magnetic survey.
- The east side of the Bacon-Manito area was excluded from the airborne magnetic survey area. That is because the volcanic rock distributed in this area is too young to form hydrothermal ore deposits. They are very deep even if they have been formed.
- In the satellite image analysis there is dense concentration of crossing of NS trending and EW trending lineaments.

(3) Irosin Area

- In this area Pliocene to Pleistocene volcanic rock is distributed. The ground truth survey made it clear that the alteration zone of the shallow parts of the epithermal system is distributed in it.
- Satellite image analysis shows dense concentration of crossing of NE trending and NW trending lineaments as well as NS trending lineaments. The ground truth survey have also made it clear that there is distribution of a comparatively wide alteration zone along the NW trending lineaments, and it is considered that airborne magnetic survey will make it possible to further clarify the relationship between the fracture system and the alteration zone.
- This areas is larger than the others, but access is poor, and there is little existing data on it. It is therefore considered that a more efficient survey will be possible starting next year thanks to increase of the quantity of data by means of airborne magnetic survey.

4.2 Measurement Plans

For measurement it is necessary to keep the height above the ground constant and as close to it as possible in order to obtain data of good precision. It has been decided to make the measurements by helicopter considering the pronounced unevenness of the terrain of the area as a part of the peninsula with many volcanos. The flight line intervals will be 200 m, and the height above the ground will be 80 m. The charts of the flight line plans are given in Fig. II-4-2, Fig. II-4-3 and Fig. II-4-4. The measurement specifications is shown below. They are the same as those for plans for implementation of airborne magnetic and radiometric survey by Australian government in northern Luzon and in Mindanao, Philippines. They are also the same as in a survey project carried out in Japan by the MMAJ in the Hoku-satu/Kushikino area of Kyushu and in the northern area of Hokkaido. They might be called as the standard type for that kind of survey.

Survey Specifications

Flight line spacing : 200m
Flight line direction : North-South
Tie line spacing : 1,000m
Tie line direction : East-West
Sensor height : 80m
Magnetometer sample interval : ~5m
Magnetometer cycle rate : 0.1 seconds

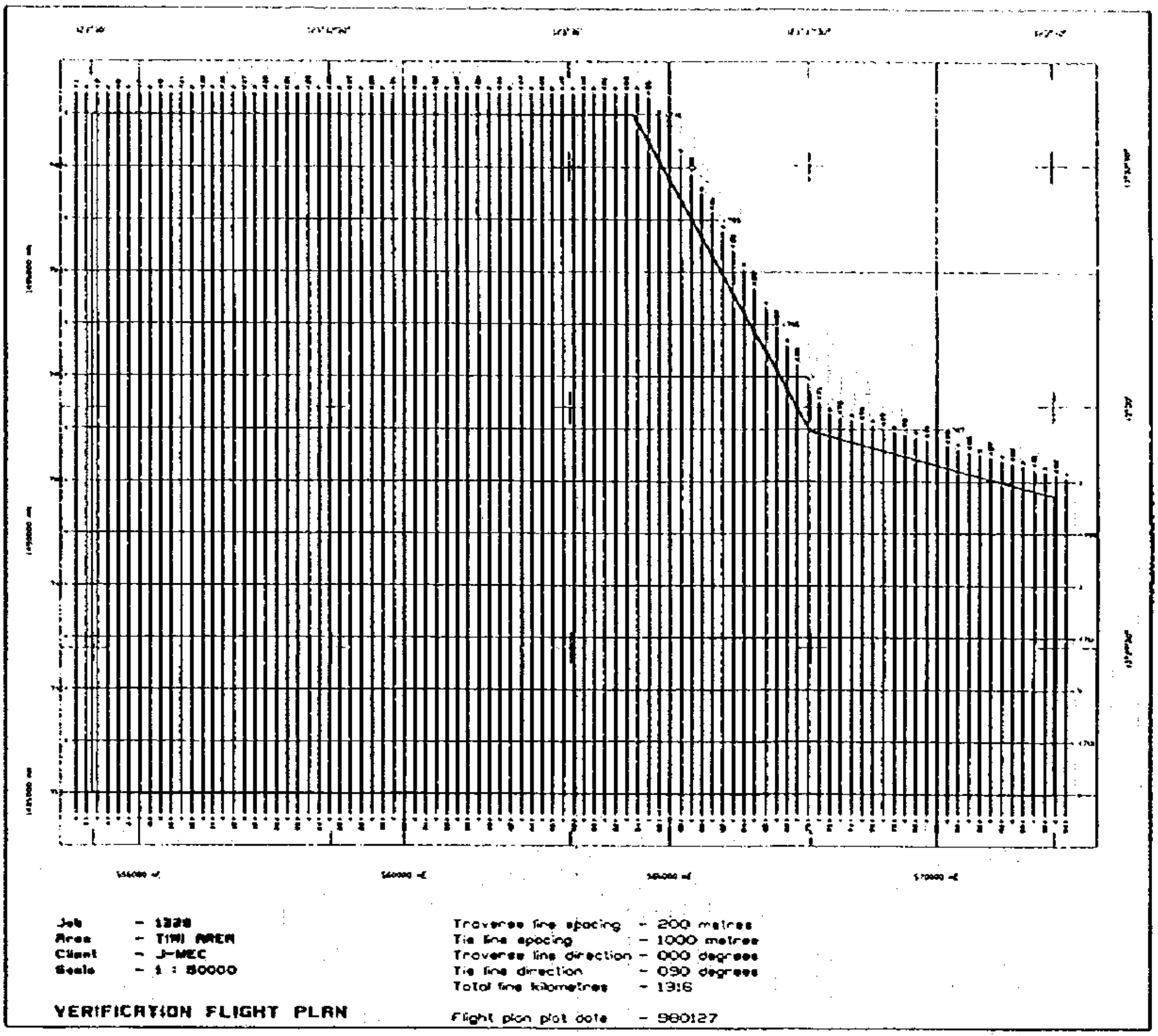



Figure Ⅱ-4-2 Flight Plan of Tiwi Area

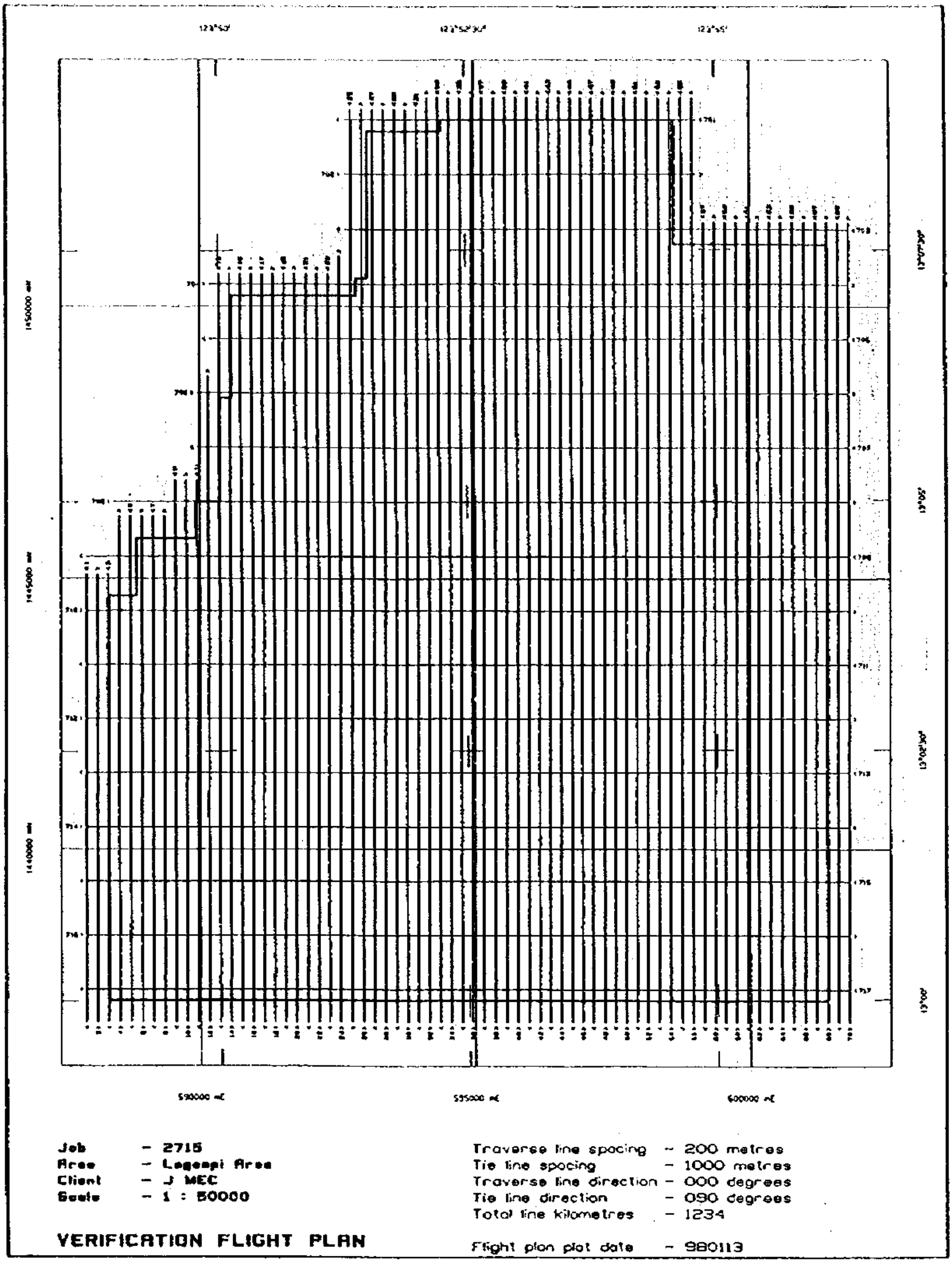



Figure Ⅱ-4-3 Flight Plan of Legaspi Area

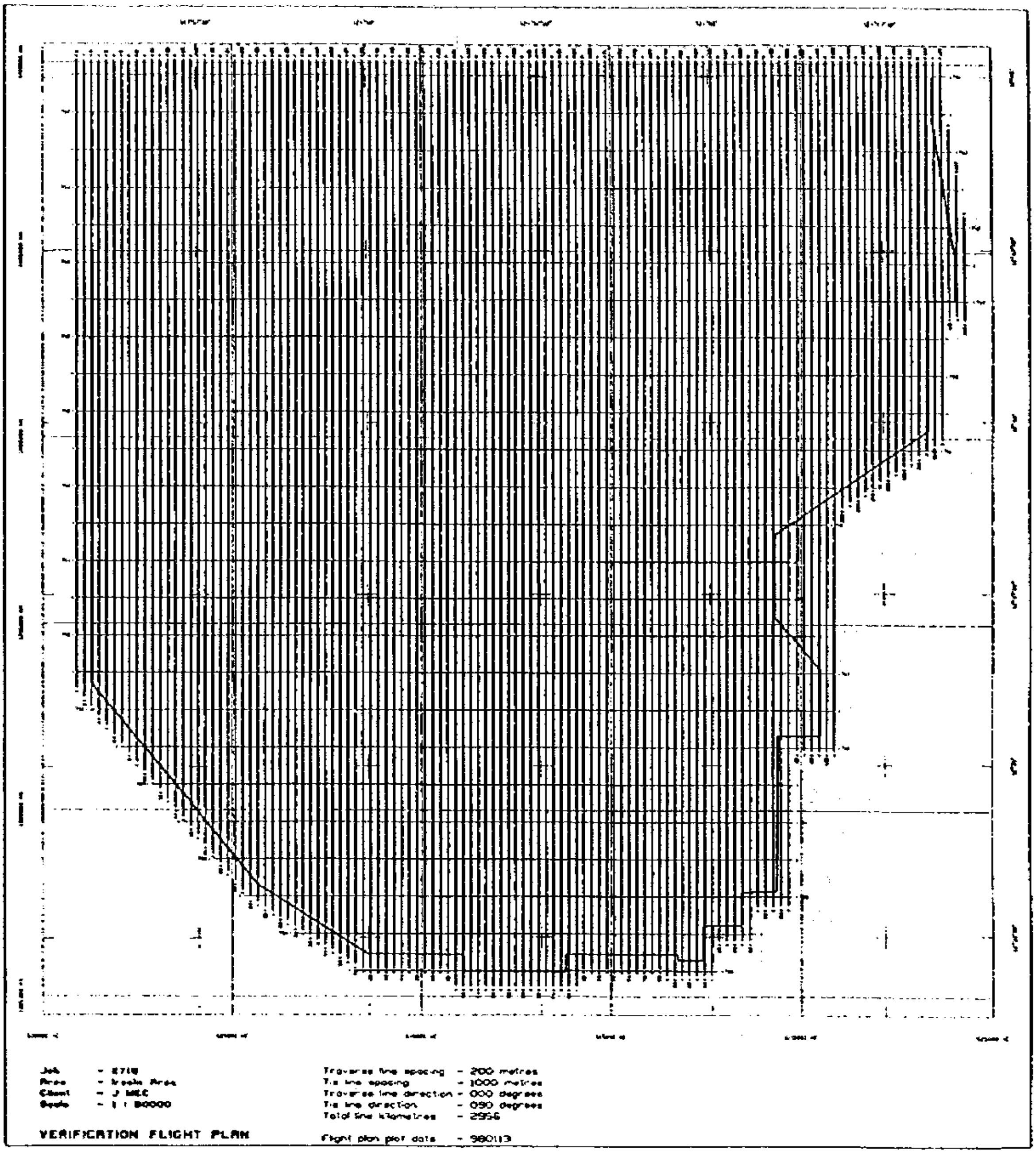



Figure II-4-4 Flight Plan of Irosin Area

Magnetometer resolution : 0.001 nT

Radiometric sample interval : ~50m

Radiometric cycle rate : 1 second

GPS cycle rate : 1 second

4.3 Data Acquisition Company

World Geoscience Co. Ltd.(WGC) was chosen to acquire airborne geophysical data because WGC has good experiences with Australian government and Japanese government(MMAJ) to acquire airborne geophysical data in the Philippines and in Japan. Airspan company was also chosen to fly a helicopter for this survey because the company has also good experiences with WGC on the Australian project to fly helicopter for airborne geophysical survey in the Philippines.

4.4 Geophysical Equipment

The following equipment is installed into a suitable helicopter for the survey:

1) Scintrex VIW2321/CS2 split beam cesium vapour sensor and pre-amp with a Picodasmagnetometer. This is mounted in a boom arrangement attached to the helicopter skids.
2) Picodas PDAS 1000 acquisition system with real time and post-processing compensation options for the magnetic aircraft maneuver noise.
3) Picodas PGAM 256 channel self calibrating spectrometer.
4) One 16.75 liters NaI crystal sensors.
5) Radar altimeter.
6) Barometric altimeter.
7) Video tracking system
8) Differential GPS satellite navigation system.
9) Picodas PNAV 2001 navigation system.
10) Pentium 486PC with DC2120 cartridge drive/floppy disk and color printer.
11) WGC in house Data Quality Control/Viewing Software.
12) Picodas Post Differential Correction Software.

4.5 Data Acquisition

The following data is recorded on disk and later copied onto magnetic tape:

1) Real time
2) Radar Altitude
3) Barometric Altitude
4) Magnetometer Reading (uncompensated)
5) Magnetometer Reading (compensated)
6) Downward Total Count (uncorrected)
7) Downward Potassium (uncorrected)
8) Downward Uranium (uncorrected)
9) Downward Thorium (uncorrected)
10) Downward Cosmic Reading
11) The full radiometric spectrum between 0.3 Mev and 2.995 Mev, measured in 255 equal channels for each one second sample.
12) Position WGS-84 latitude (from navigation system)
13) Position WGS-84 longitude (from navigation system)
14) Develco 3 axes fluxgate magnetometer information
15) Manually inserted information such as flight number, line number, at appropriate times.