The lineaments trending E to W are superb in the area where the volcanic rocks (NV3) are distributed, in the direction southeast of Albay to north of Sorsogon, accompanied by the lineaments trending NE to SW and N to S.

The lineaments trending NW to SE and NE to SW are concentrated in the area where the volcanic rocks (NV2 and NV4) and the same from Bulsan volcanoes (V1) are distributed, accompanied by the lineaments trending N to S.

2.2.5 Alteration zone Extraction

The candidates for the alteration zones were sampled from the screen performing the LANDSAT-TM comparison operation (Figure II-2-10). The survey areas are clearly classified into two: one is with concentrated lineaments, and the other is with less number of lineaments. When these lineaments are compared to the analytical units, the areas with concentrated candidates for the alteration zones correspond to those where the sediment in alluvial soil is distributed and to the collapsed strata or to the sedimentary rocks in the vicinity of specific volcanoes. For other analytical zones, a certain number of the candidates for the alteration zones were sampled, but the number tends to decrease in the areas where volcanic rocks and basement rocks are distributed. The following describes the areas where the candidates for the alteration zones are concentrated.

From Queson to northwest of Carimanes Sur, the candicates for the alteration zones are distributed in a wide range where the sedimentary rocks (N1, N3 and M1), the analytical units, (hereinafter this term is abbreviated), are distributed. These candidates mainly consists of iron oxide zones showing greenish colors in the comparison operation screen, also accompanied by argillizated zones showing reddish colors.

From the south and central Camarines Sur to the central Albay, the candidates for the alteration zones are concentrated in the areas where the sediment in alluvial soil (Q) is distributed. These candidates mainly consist of argillizated zones showing reddish colors in the comparison operation screen, also accompanied by iron oxide zones showing greenish to bluish colors.

In Panganiran Peninsula west of Albay and the southeast, the candidates for the alteration zones are distributed in the areas where the sedimentary rocks (N1, M1 and Pg) and the sediment in alluvial soil (Q) are distributed. These candidates mainly consist of iron oxide zones showing greenish colors in the comparison operation screen for the areas where the sedimentary rocks are distributed, and reddish colors where the sediment in alluvial soil is distributed.

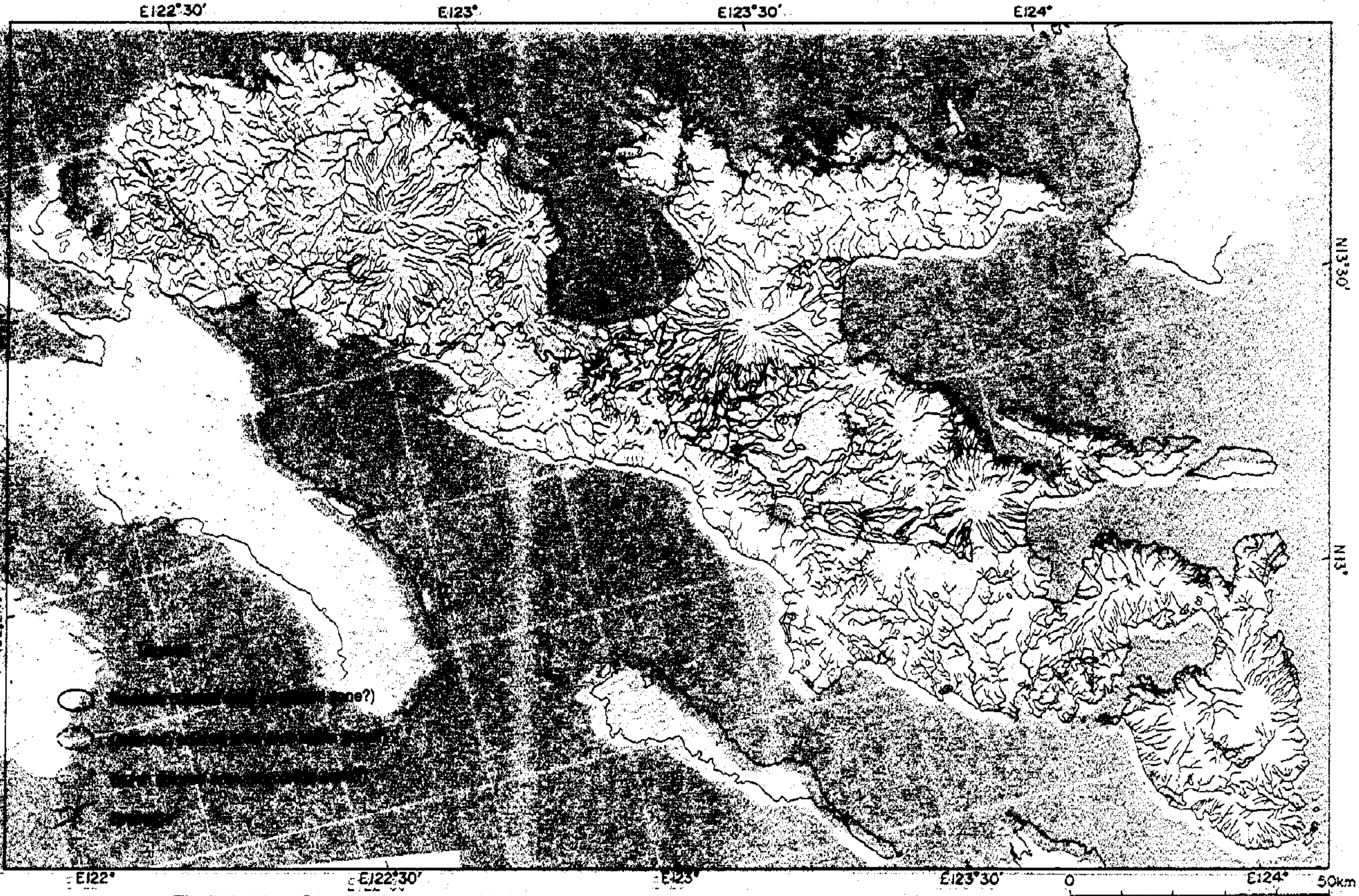
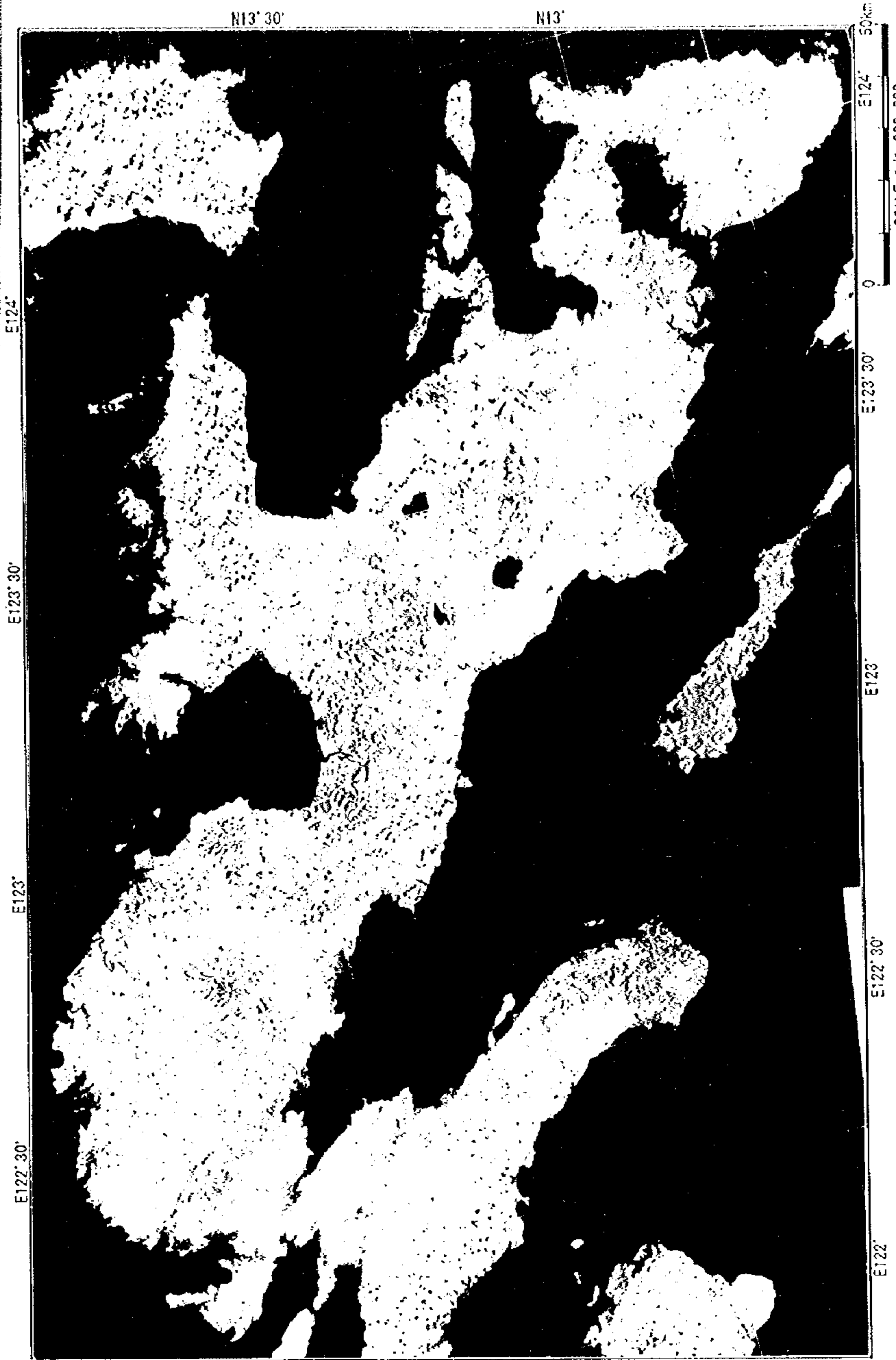


Fig.II-2-10 Distribution map of inferred alteration area from Landsat –TM rational image analysis (BGR:3/1 5/4 5/7)


N13°30'
N13°
50km
E124°
SCALE 1/1,000,000
0
E123°30'
E123°
E122°30'
E122°
E124°
E123°30'
E123°
E122°30'
N14°
N13°30'

In the north of Sorsogon, the candidates for the alteration zones are distributed in the areas where the sedimentary rocks (N3) and the sediment in alluvial soil (Q) are distributed. These candidates mainly consist of iron oxide zones showing greenish and bluish colors in the comparison operation screen for the areas where the sedimentary rocks are distributed, and reddish colors where the sediment in alluvial soil is distributed.

In the south of Sorsogon, the candidates for the alteration zones are distributed in the areas where the volcanic rocks (NV2 and NV4) and the sediment in alluvial soil are distributed. These candidates mainly consist of iron oxide zones showing greenish colors in the comparison operation screen for the areas where the volcanic rocks are distributed and reddish colors where the sediment in alluvial soil is distributed.

2.2.6 Summary of Satellite Image Analysis

(1) Summary of results of analysis

In photogeological interpretation of LANDSAT-TM false-color images and JERS-1/SAR black-and-white images 38 geological interpretation units are interpreted and summarized into 23 interpretation units on the basis of correlation with existing information and analysis. The geological units based on analysis are 11 analysis units for basement rocks and sedimentary rocks, 10 analysis units for volcanic rocks and 2 analysis units for granites. Roughly, they are distributed in terms of zones from the northeast of Bicol Peninsula in the order basement rocks-volcanic rocks-sedimentary rocks, running NW-SE parallel to the Philippine Fault. Volcanic rocks are distributed once again in the southern part of the Sorsogon Peninsula.

Bedding trace, fold structure, faults and ring structure are interpreted in the way of geological structure. Bedding trace and fold structure show a NW-SE system in harmony with the above-mentioned zonal distribution. Possible faults include not only the NW-SE ones parallel to the Philippine Fault but also one with a direction of NW-SE. Caldera topography and volcanic topography are noted in ring structure. In the central part of the Sorsogon Peninsula is noted a ring structure indicating caldera topography with a diameter of approximately 15 km and surrounding the half of the Bulsan volcano on the southwest side. The geological units are distributed roughly concentrically around the volcanic topography. There is a clear difference between areas in which there is concentrated distribution of lineaments extracted from both LANDSAT-TM and JERS-1/SAR images and areas in which there is sparse distribution thereof.

Comparing with geological unit analysis results, areas with concentration of lineaments are areas of distribution of volcanic rock, sedimentary rock, basement rock and granites. On the other hand, areas with sparse distribution lineaments are areas of distribution of lowland sediments, collapsed strata around volcanos and some sedimentary rock. NW-SE lineaments parallel to the Philippine Fault and NE-SW lineaments are the most numerous, but N-S, E-W and intermediate-direction lineaments are also noted.

The distribution of alteration zone candidate areas extracted from LANDSAT-TM rationing image is clearly divided into a region of concentration and a sparse region. If compared with the results of geological unit analysis, the region with concentration of alteration zone candidate areas corresponds to distribution of lowland sediments and to some collapsed volcanic successions and sedimentary rocks. A few alteration zone candidate areas were extracted from other geological units, but there is a noticeable trend of few alteration candidate areas in areas of distribution of volcanic rock and basement rock.

(2) The Usefulness and Limits of Satellite Image Analysis

In this survey LANDSAT-TM image data and JERS-1/SAR image date were used for interpretation and analysis of geology and alteration zones. Let us now consider the usefulness and limits of such image analysis in this survey by comparing the features of those two kinds of images with the features of the survey areas.

LANDSAT-TM has 7 bands in the visible to shortwave infrared to thermal infrared range, the bands that are used for geological analysis being bands 1-5 and band 7. Since the ground resolution of LANDSAT-TM is 30 m x 30 m, in a 1:250,000 image it is 0.12 mm/pixel. Since all of those bands are optical sensors, they are subject to the influence of sun elevation and the atmosphere.

In this survey, considering the fact that the regioncovered by the survey is a region with tropical rain forest vegetation, the photogeological interpretation and analysis was based on LANDSAT-TM false color images. In the LANDSAT-TM image data used in the survey there were many areas where the ground surface was covered by clouds or the shadows of clouds in spite of the fact that days with fewer clouds were selected from among the total number of days of observation. Geological interpretation could be accomplished well for almost all of the areas without clouds, but it was not possible to trace the continuity of interpretation units in the vicinity of clouds.

Furthermore, as a test it was attempted to extract alteration zones on the basis of LANDSAT-TM rationing image. The region covered by the survey is a region with vegetation, without extensive areas of exposed rock. That being the case, rationing processing was carried out after first extracting areas without vegetation by setting threshold values for digital numbers and vegetation indices. Thus, in a way it was possible to obtain rationing images expressing alteration zone candidate areas, but there are also several problems, and it is not really possible to produce images that are sufficiently useful for extraction of alteration zones.

The first problem is the ticklishness of threshold values and rationing values. In mosaic images using scenes with different photographing periods different sun directions and elevations make for different topographical shading, difference in vegetation, difference in sensor characteristics, etc., and processing cannot be done with the same conditions with different scenes. In this study in order to minimize such influences processing was done on the basis of setting of different threshold values and rationing processing parameters for each scene, but even at that there still remained slight difference between scenes in the processing results obtained. For instance, the processing results of P114/R051 on the east side and P115/050 on the west side showed comparatively similar color tone trends, but great difference was noted in the color tone trend of the processing results of P115/050 on the west side. Particularly around Mt. Labo in the case of use of P115/R050 no alteration zone candidate areas are noted, but with P115/R051 there is distribution of many red alteration zone candidate areas. That being the case, in interpretation of alteration zones in this survey use was made of P114/R051 on the east side and P115/050 on the west side as images showing similar color tone tendencies. A second problem is the fact that nonvegetation areas are in the form of scattered points. Because of that the processing results in the same scene are also spotty, and it was not possible to accomplish analysis in terms of continuous surface areas.

Furthermore, it was attempted to extract alteration zones related to deposits and mineral showings by classification with "instructors" consisting of spectrum information on alteration zones distributed around known deposits. But it was not possible to obtain good results because of the extremely high vegetation cover rates and insufficient correction of LANDSAT-TM brightness values between scenes. In regions like this spectrum analysis taking full advantage of the LANDSAT-TM characteristic of multiple band data is very difficult.

As for JERS-1/SAR, the images are only 1 band (black and white), but because of the active sensor (synthetic aperture radar; SAR) sun elevation and the atmosphere do not have any influence.

However, there is distortion of the topography due to the "fall in" phenomenon that is characteristic of synthetic aperture radar. Since the ground resolution of JERS-1/SAR is 12.5 m x 12. 5 m, in 1:250,000 images it is 0.05 mm/pixel.

In this survey photogeological interpretation and analysis were carried out using JERS-1/SAR black-and-white images. The ground resolution seems to be somewhat lower than 12.5 m because of influences such as noise-reduction processing, but it was possible to interpret the image units more clearly than in the case of LANDSAT-TM. Furthermore, since, unlike LANDSAT-TM, there is no influence of clouds, it was possible to interpret the entire surface area of the region covered. Most of the geological units are based on JERS-1/SAR data. In extraction of lineaments there is a tendency for high frequency of appearance in directions angular to the direction of radar irradiation, but the extraction results matched those obtained on the basis of LANDSAT-TM quite well. There was also "fall in" of the topography at volcanos with high elevation.

2.3 Selection of Promising Areas

Promising areas in terms of deposit endowment were selected on the basis of the results of satellite image analysis and the results of comprehensive analysis. In selection such promising areas, it was decided to use only the satellite image analysis results for reference and not to add information on existing deposits and mineral showings. Here, bearing in mind that it is gold deposits and copper deposits that we are concerned with, we narrowed down the list of candidate areas on the basis of the following criteria:

1) Areas of distribution Quaternary volcanic rock and surrounding sediments, lowland sediments and reef limestone were not included as candidate areas because of their low probability of endowment and the thick vegetation coverage.

2) Places with dense concentration of lineaments were considered to be promising because of expectation of fracture systems forming deposits, it being considered that areas of intersection of NW-SE lineaments and lineaments at an angle to them have particularly high deposit endowment potential.

3) Of the extracted alteration zones, those distributed in areas other than those eliminated in 1) above, but not including those that clearly do not reflect geology and alteration zone.

Eleven areas were selected as promising areas in terms of deposit endowment on the basis of the above criteria (Table II-2-4, Fig. II-2-11). The geology of the areas selected as being promising in terms of deposit endowment consists mainly, in terms of the analysis units, of basement rock, Miocene sedimentary rock and Tertiary volcanic rock. Six of the promising areas are areas such as the Paracale deposit area and Nalesbitan deposit area that include known metallic ore deposits, and many of them are areas in which NW-SE lineaments and lineaments at an angle to them intersect. The other five promising areas do not have any known metallic ore deposits or mineral showings. Of those five, two--the Panganiran Peninsula area and the Balan-Calibag area--have lineaments that cross NW-SE lineaments at an angle. The remaining three areas are all characterized by NS lineaments. Furthermore, in Table II-2-4 the names of areas in which the ground truth survey was carried out that correspond to the names of promising areas extracted on the basis of lineaments or that are included in such promising areas are listed in the column "Ground truth survey areas".

It should also be noted that some of the areas excluded for the reason explained in 1) above have intersection of NW-SE lineaments with lineaments at an angle to them. For instance, the Sibago area in the western part of Sorsogon Province is surmised to have a latent NW-SE large structure in addition to NS and NE-SW lineaments. Furthermore, if one compares the distribution of known deposits and lineament distribution, it can be seen that the known deposits of the Malatop-Mapulot area correspond to a sparse area in terms of lineaments. That area corresponds to a place where lineaments are locally sparse in a region of concentration of lineaments instead of being an area in a broad region of sparse lineaments. The Maplama-Pantao (Tuba) area can be cited as a similar area. The positions of those areas, too, are indicated in Fig. II-2-11.

2.4 Summary

In this survey division into geological units, interpretation of bedding traces, fold structures, faults and ring structures and extraction of lineaments were carried out on the basis of photogeological interpretation of LANDSAT-TM false color images and JERS-1/SAR black-and-white images. In addition, alteration zone candidate areas were extracted from LANDSAT-TM rationing images. Such satellite image analysis has shown that in the Bicol region there is development of NW-SE lineaments parallel to the Philippine Fault and that there is also distribution there of many NE-SW lineaments at right angles to the Philippine Fault. Also noted were N-S lineaments and E-W lineaments. Furthermore, it was possible to identify well the wide-area geological distribution. On the basis of comparative study of such analysis results and

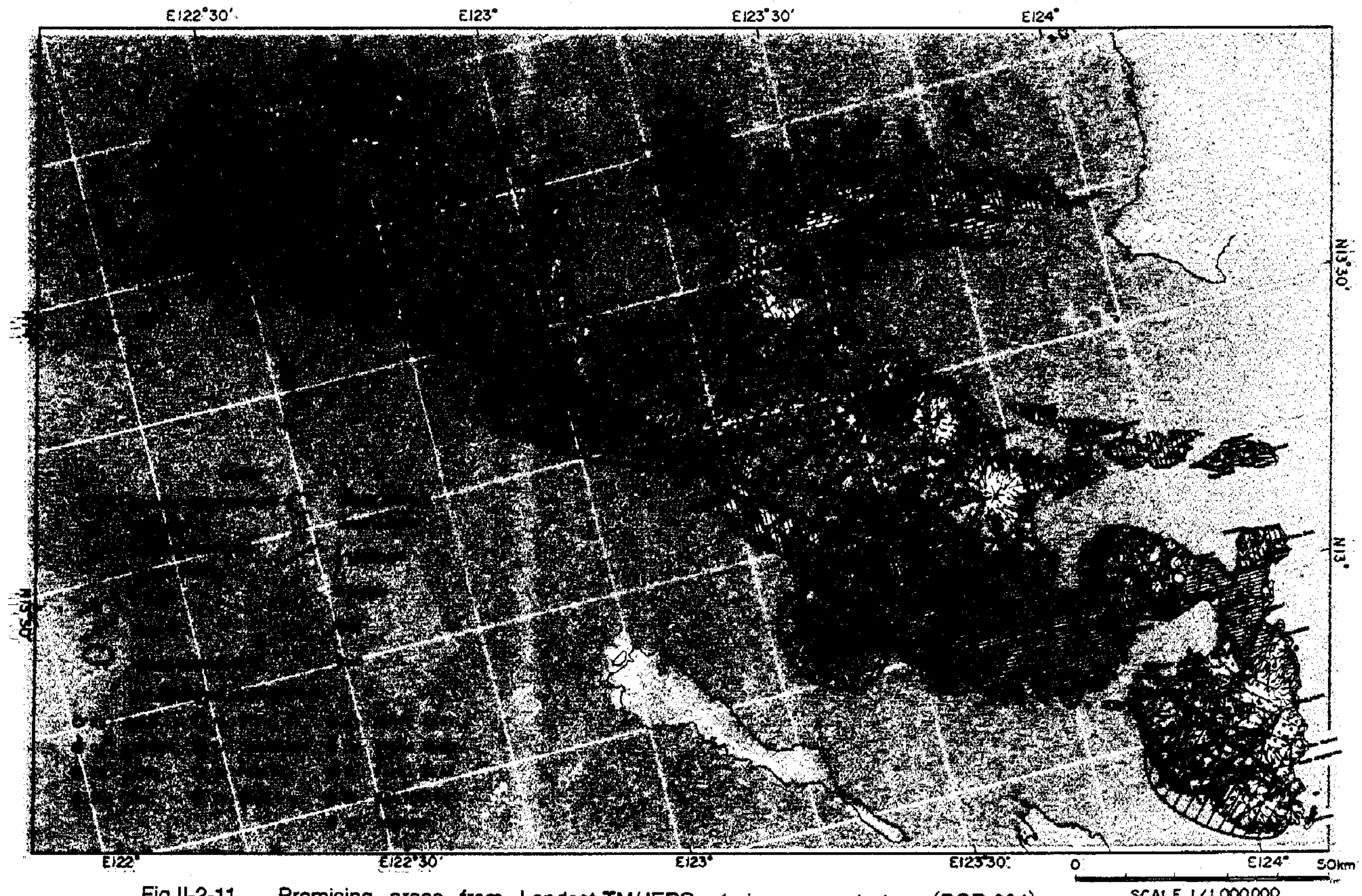
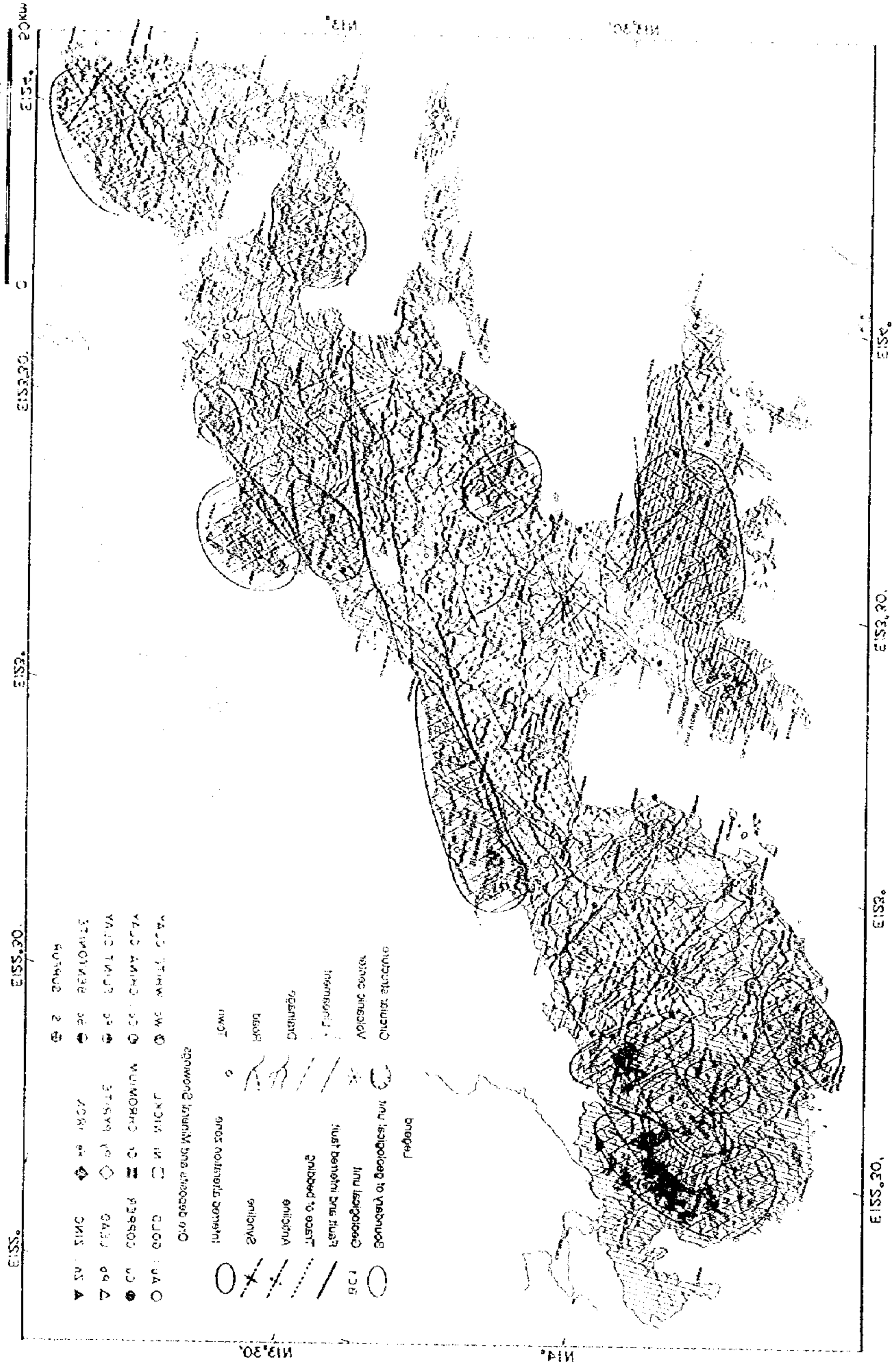
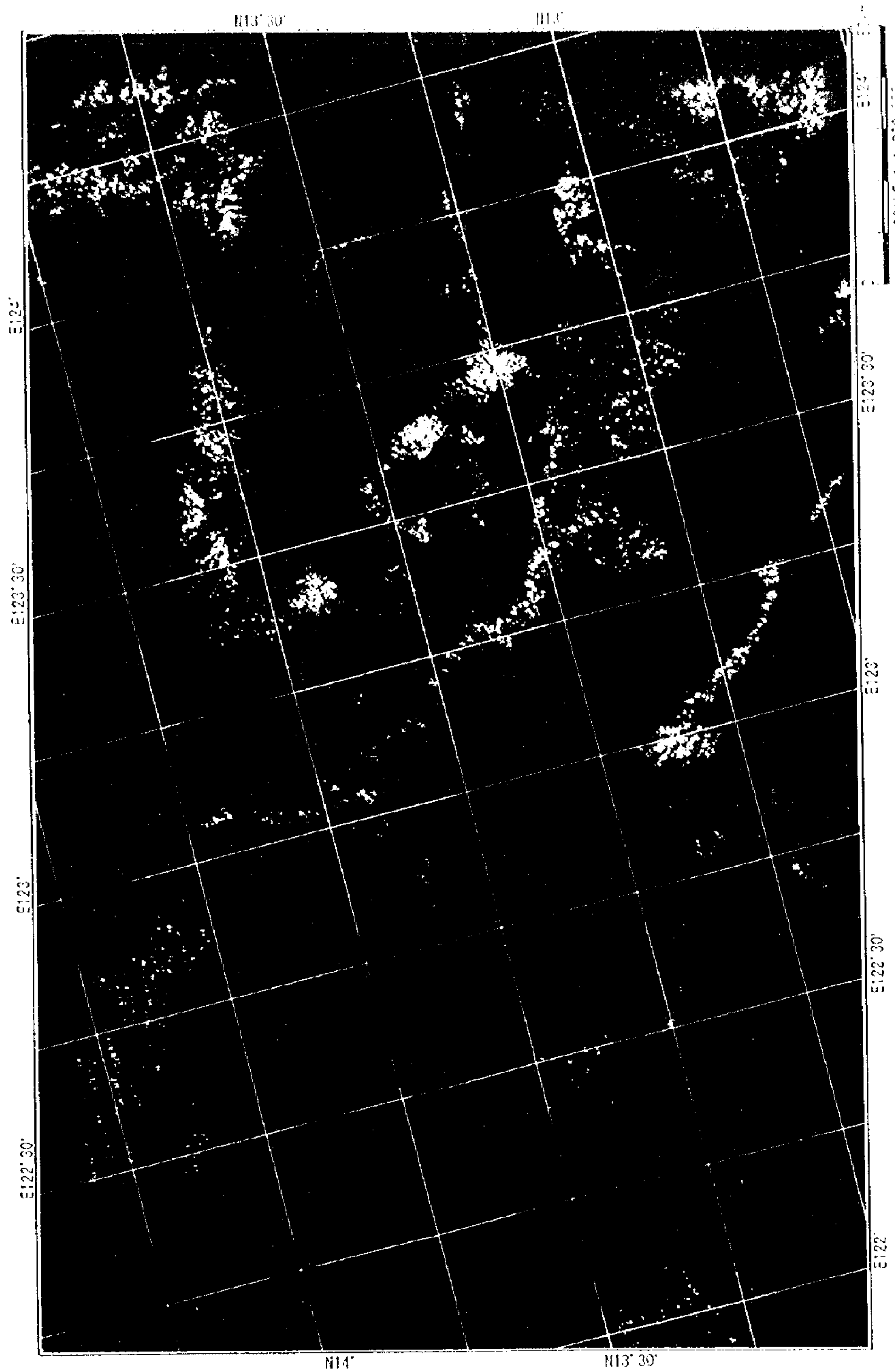


Fig.II-2-11 Promising areas from Landsat-TM/JERS- 1 image analysis (BGR:234)

Fig.II-2-11 Promising areas from Landsat-TM/JERS-1 image analysis (BGR:234)





existing information on geology and deposits criteria were set for selection of areas promising in terms of metallic ore deposit endowment, and 11 such promising areas were extracted. Six of them are areas that include known metallic ore deposits and mineral showings, and the other five are areas without any know metallic ore deposits or mineral showings.

Chapter 3: Ground Truth Survey

3.1 Selection of Candidate Areas for Ground Truth Survey

Conditions such as the following were taken into consideration as criteria for selection of the areas covered by the ground truth survey:

- places recognized as deposits, mineral showings or alteration zones on the basis of existing data
- areas of dense concentration of lineaments or places of intersection of several lineaments as determined on the basis of satellite image analysis
- anomaly areas determined in wide-area airborne magnetic surveying

Among the places determined on the basis of the above criteria, it was decided to give priority in the survey, as far as possible, to areas that have not yet been determined to be mining areas. Regarding the area from the central to the eastern part of the Caramoan Peninsula, it has not been included in the ground truth survey because of extremely poor accessibility and bad security conditions there in spite of its high potential in terms of volcanic massive sulfide deposits and the fact that it was extracted as a promising area in the lineament analysis as well. The reasons for selection of the particular areas are given in the following account of the findings of the ground truth survey for each of them.

3.2 Results of the Ground Truth Survey

The ground truth survey was carried out with Legazpi, Iroshin, Naga and Daet as base camps. The survey was carried out with three teams, each basically consisting of 1-2 Japanese geological technicians and 1-2 Filipino counterparts and a driver of a 4WD vehicle. In principle, the survey work was done on the basis of daily excursions from and back to the base camps. The existing data on the selected areas, the situation concerning establishment of mining areas and the check list for the survey as prepared before it was implemented are given in simplified form in Table II-3-1.

The account of the survey presented below is roughly along the lines of the procedures followed in the different areas. For each area the description of the survey is broken down into the items "location", "accessibility", "geology", "alteration", "mineral showings", "evaluation" and "mining claims". The geological descriptions are based on existing data as well. In the accounts concerning alteration and mineral showings an effort was made to include mention of the results of

Table II-3-1(a) Candidate areas for the ground truth survey

Areas	From references	From Landsat and SAR data analysis	From geophysical data	Interpretation of the existing data	Mining Claims	Need to check
Bacon-Manito	sulfur prospect, acid alt., silicification, skarn-like alt., geothermal area, E-W trending reservoir	intersection of lineations of NW, NE, and N-S	low resistivity zone	possibility of epithermal and porphyry-type deposit	PNOC	Steam-heated or high-sulfidation or supergene?
Tiwi-Mt. Malinao	geothermal field, silica sinter, sulfur prospect, alteration, geothermal area, hydrothermal breccia	few lineation		possibility of epithermal deposit	PGI geothermal reservation	silica veinlet and mineralization exist or not
Nagas-Pio Duran	limestone, andesite, diorite, gypsum, silicification, pyrite, chalcopyrite, bornite	intersection of lineations of NW, NE, and N-S		possibility of Carlin-type, skarn and Porphyry-type deposit	FTAA, MPSA	jasperoid exist or not, age of diorite and limestone
Pilar-Donsol	few reference, limestone, Fe prospect	few lineation, NE-trend lineation		possibility of Carlin-type, skarn and Porphyry-type deposit	FTAA, MPSA	diorite exist or not along the NW lineation, age of limestone
Irosin- Gabao-Bulan	pre-caldera volcanics, acid alteration, hot spring discharge from N70E-trending fracture.	ring structure, NW-trending lineation	low resistivity zone	steam-heated alteration, possibility of epithermal gold	MPSA	silica veinlet and mineralization exist or not
Bacolod-Mt.Juban	caldera- and post-caldera volcanics	intersection of lineations of NW, NE, and NNE-	low resistivity zone	steam-heated alteration, possibility of epithermal gold	MPSA	alteration zone exist or not
San Roque-Bulusan	post- and pre-caldera volcanics, andesitic rock	few lineation	low resistivity zone	steam-heated alteration, possibility of epithermal gold	MPSA	alteration zone exist or not
Gate Mountains	alteration, pre-caldera volcanics	WNW-trending lineation	low resistivity zone, high gravity, low	steam-heated alteration, possibility of epithermal gold	MPSA	what kind of alteration

Table II-3-1(b) Candidate areas for the ground truth survey

Areas	From references	From Landsat and SAR data analysis	From geophysical data	Interpretation of the existing data	Mining Claims	Need to check
Siruma Peninsula	White clay (kaolinite), Qz veinlet, sericite, panning gold	intersection of lineations of NE and N-S-trend		steam-heated or high sulfidation	FTAA, MPSA	Steam-heated or high-sulfidation or supergene?
Malobago	few reference, limestone	intersection of lineations				alteration zone exist or not
Western Pasacao	Lower limestone, Middle Miocene diorite, Cu prospect	WNW-trending lineation, intrusives		possibility of Carlin-type, skarn, and Porphyry-type	FTAA, MPSA	sericite or potassic alt, age of diorite and limestone
Oas	few reference	intersection of lineations				alteration zone exist or not
Iriga-Baao	few reference, Pliocene volcanics	intersection of lineations of NW, NE-trend			MPSA	alteration zone exist or not
Buhi-Western Mt. Malinao	few reference, Pliocene volcanics	intersection of lineations			vacant	alteration zone exist or not
Balatan	limestone, diorite, gypsum, pyrite, bleaching, anhydrite	intersection of lineations of WNW, NE-trend		possibility of Carlin-type, skarn ,and Porphyry-type	FTAA, MPSA	sericite or potassic alt, age of diorite and limestone
Silmod	few reference		low magnetic			alteration zone exist or not
Calabanga-Tinembac	silicification, pyrite, cristobalite, kaolinite, acid leaching, chalcedonic silica	ENE-trending lineation		steam-heated alteration, possibility of epithermal gold	MPSA	
Paracale	many references, vein type, fault, shear zone, gold associate with base metals	intersection of lineations of NW, NE-trend		possibility of skarn, and Porphyry-type deposit	MPSA	
Larap	many references, Fe, Cu, Mo, Au, U skarn and porphyry-type	intersection of lineations of NW, NE-trend		possibility ofskarn,and Porphyry-type deposit	MPSA	
Bulala	acid alteration (kaolinite, alunite, silica), silica sinter	intersection of lineations of ENE and WNW-trend		steam-heated alteration, possibility of epithermal gold	FTAA, MPSA	real sinter, Qz vein
Nalesbitan-Tuba	high-sulfidation type gold	intersection of lineations of ENE, WNW, and NS-	low magnetic anomaly	possibility of Porphyry-type deposit	FTAA, MPSA	Nalesbitan trend, sericite or potassic alt exist or not
Mt. Culasi	sulfur prospect, alteration area, Plio-Pleistocene	intersection of lineations of NW, NE, and NS-trend		possibility of epithermal gold	MPSA	age of volcanic rock
Mt. Labo	geothermal area	intersection of lineations of NW, NE, and NS-trend		possibility of epithermal gold	PNOC, MPSA	alteration zone exist or not

laboratory testing of the samples collected in the survey. As for the evaluations, the focus is placed on how promising the areas in question are from the viewpoint of the kinds of mineralization that can be expected instead of relative evaluation. The information given on the mining claim is based on the maps concerning the situation with respect to establishment of mining claims that were compiled on the basis of information collected during the stay in the Philippines. Also prepared on the basis of existing data were geological charts for the different areas on which the locations of collection of samples are also shown.

3.2.1 The Bacon-Manito Area (Fi. II-3-1, Fig. II-3-2)

Reason for selection: This area is located in the southeastern part of the Bicol Peninsula. In it there is distribution of volcanic rock from the Pliocene to the Eocene. It is an area in which geothermal energy development is being carried out by PNOC. There is therefore reason to hope for endowment in terms of epithermal gold deposits accompanying young geothermal activity. Furthermore, considering the topographical characteristics of the area west of the area where such geothermal development is taking place, distribution there of older volcanic rock than to the east can be surmised. That leads one to believe that there is a possibility of existence of a somewhat older geothermal system on the western side of the Bacon-Manito area than the known geothermal system, and hence the conclusion that the possibility of epithermal gold deposit endowment is greater on the western side.

The area has been surveyed in detail by PNOC as regards such aspects as geology and distribution of alteration zones. Furthermore, there has been geochemical prospecting for the purpose of identifying mineral resources. Therefore this ground truth survey was implemented on the basis of such data in the Calpi area, the Masulog area, the Pili-Cumadcad area and the Cawayan River area. The first three of those areas are areas with distribution of alteration zones and gold anomalies as determined in the geochemical prospecting. Furthermore, the results of the geophysical prospecting carried out in the geothermal surveying of the Calpi area show that in it there is distribution of zones with low resistivity below 50 ohm-m extending in the same north-south direction as the Calpi Creek (see Fig. II-3-2). The Cawayan River area was included in the ground truth survey because of expectation of existence of alteration considering the survey results for the Calpi area and Pili-Cumadcad are.

(1) Calpi Area (Fig. II-3-3)

Location: This area is located in the western part of the Bacon-Manito area about 5 km south

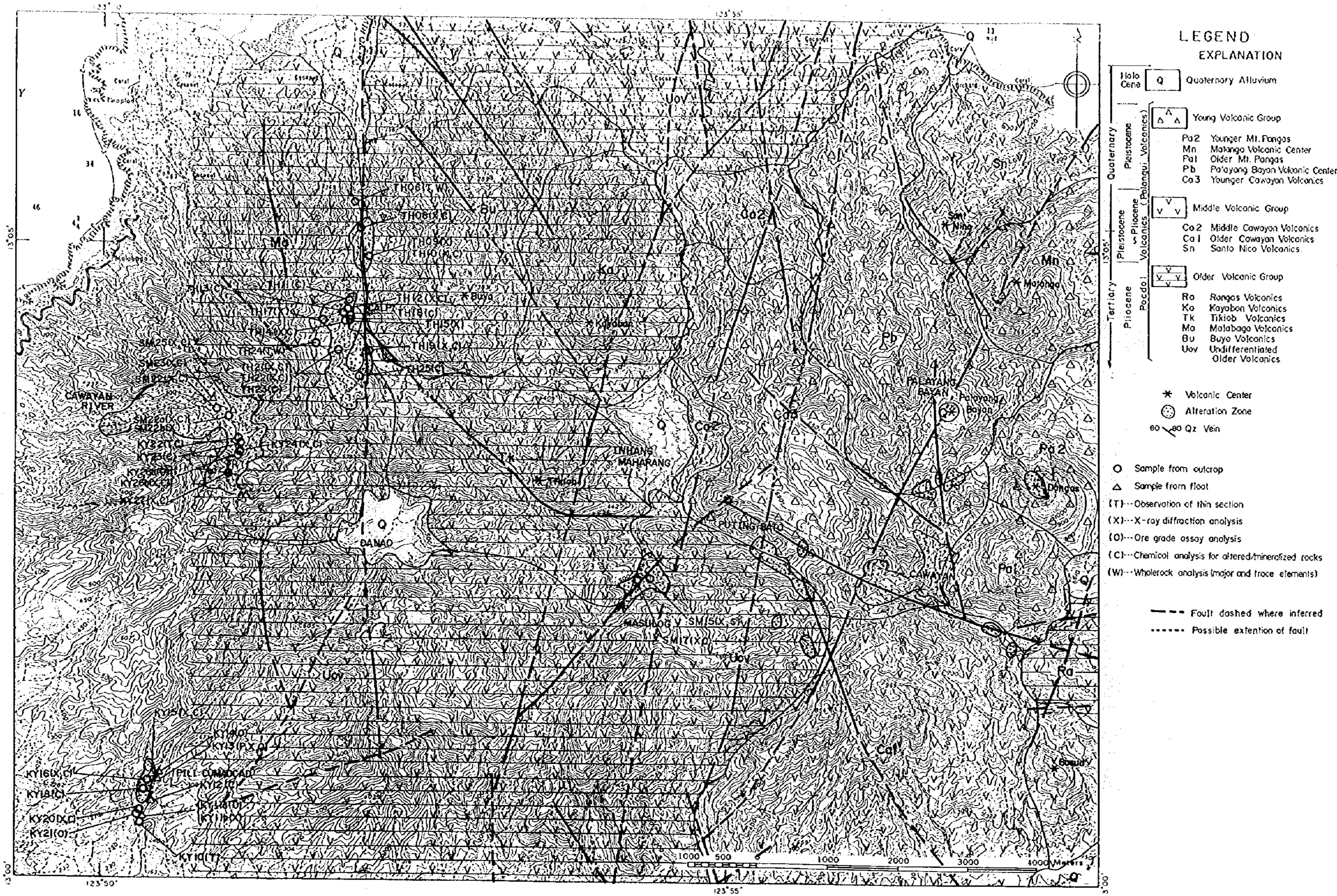


Fig.II-3-1 Geological map of the Bacon－Manito Area and sample locations

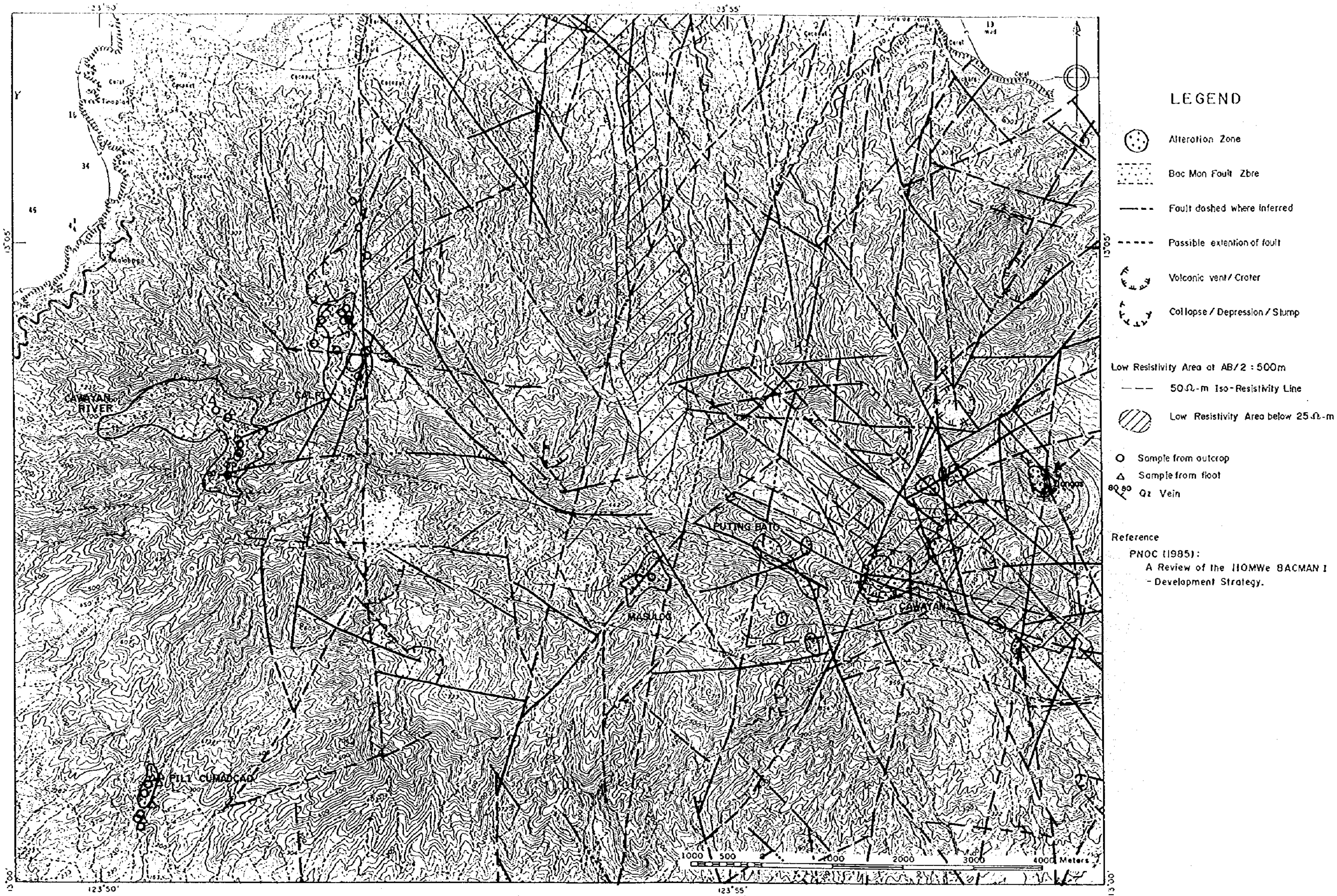


Fig.II-3-2 Fracture and Low-resistivity distribution in the Bacon－Manito Area

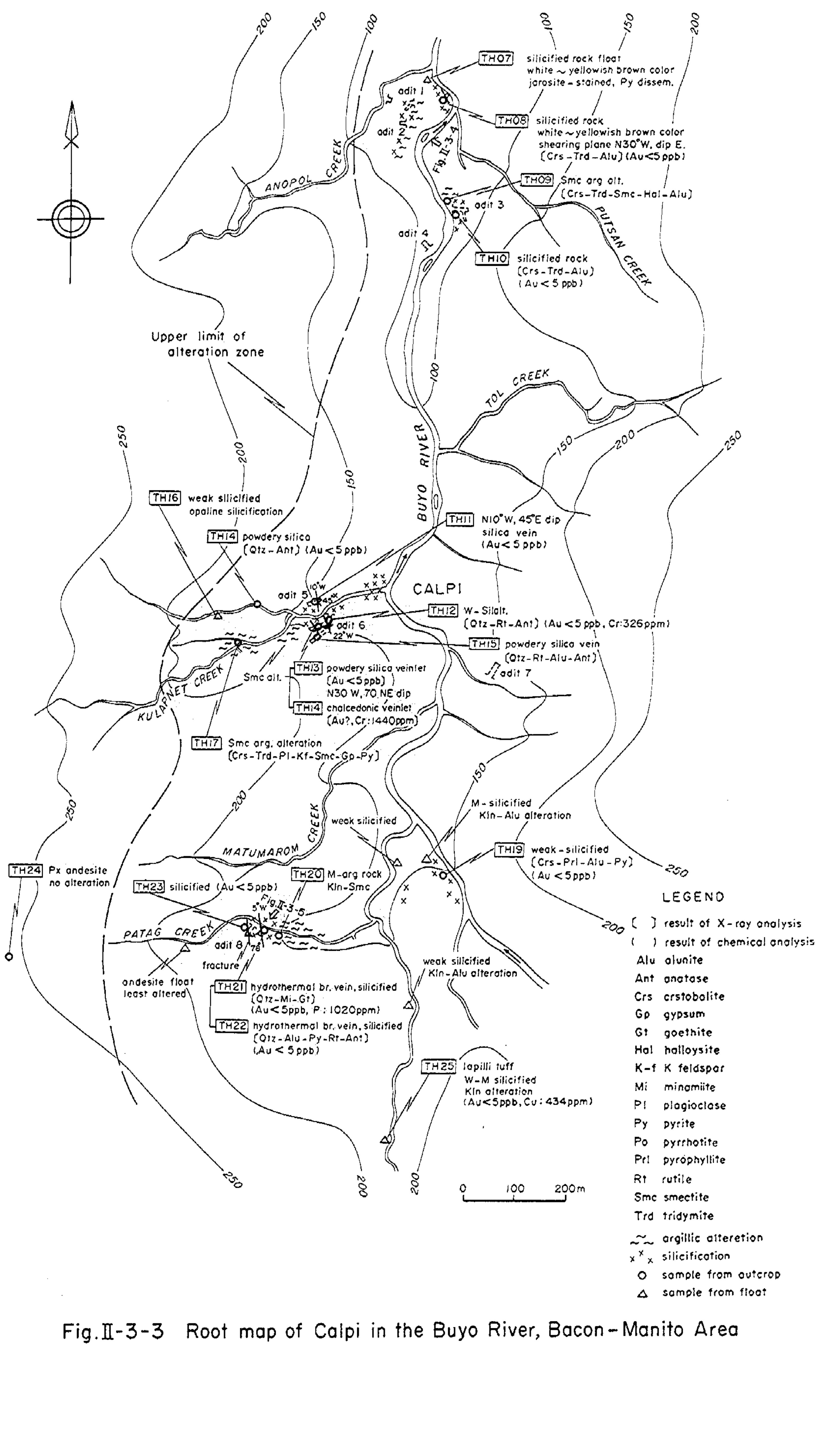


Fig. II-3-3 Root map of Calpi in the Buyo River, Bacon - Manito Area of Manito in the vicinity of 13°05' 00" N, 123°52' 00" E. A deep north-south creek occurs along a system of fractures in the same direction. Both slopes of the creek have development of landslides.

Accessibility: A road that is paved at places goes from Legazpi to the entrance to the Calpi Creek. It takes about 1 hour to there by car. It takes about 1 more hour to walk from the entrance of the creek to the alteration zone where old mining pits are to be found.

Geology: This area is underlain by dark gray to black pyroxene andesitic lava and pyroclastic rock.

Alteration: On both banks of the creek there is wide distribution of white to yellowish brown colored alteration zone. The alteration zone is composed of smectite, kaolinite and silicification alteration zones. There are also many limonitized silicified rock floats. Pyrite dissemination is to be observed at places that have escaped oxidation. The silicification is opaline. The alteration zones spread horizontally, the alteration appearing to be more intense at the pyroclastic rock parts. That is thought to be due to restriction of hot fluid passages by permeability. Such alteration zones are to be observed up to an elevation of about 230 m, the upper limit being traceable as approximately parallel to the contour lines.

Adits 1 and 2 on Fig. II-3-3 now have collapsed walls and represent only depressions of about 1 m (Fig. II-3-4). Lava overlies the volcanic breccia almost horizontally. The lava parts have undergone slight silicification (TH08: Alu >> Try, Crs), and the lower pyroclastic rock part has been subjected to smectite alteration. Under adit 3 there is white argillization (TH09: Smc >> Alu > Crs, Try > Hal), and the old pit entrance 4 m above the river bed is silicified (TH10: Crs >> Try > Alu). The circumstances are considered to be the same as in the case of the adit 1 and 2 outcrops: development of the silicification zone was controled by the paleo-water level.

At Kulapnet Creek west of Calpi there are adits 5 and 6. At the entrance to adit 5 there is vein-like quartz with a width of about 1 cm (strike of N10°W, dip of 45°NE; TH11: Au < 5 ppb). Adit 6 has a total length of about 40 m. In the middle of he adit 6, it splits into two branches (Fig. II-3-3). Inside the adit there is week to intense silicification alteration, with existence of white powdery silica in vein-like form (TH13: Au < 5 ppb, 15: Qtz >> Rt > Alu, Ant). In the powdery silica zone some of the parts with intense silicification are developed in vein-like form (TH14: Qtz >> Ant), and chalcedonic quartz stringers (2 mm wide) are also to be observed (TH18). On the upstream side of the old adit, too, smectite alteration zone continues there, but at an elevation of

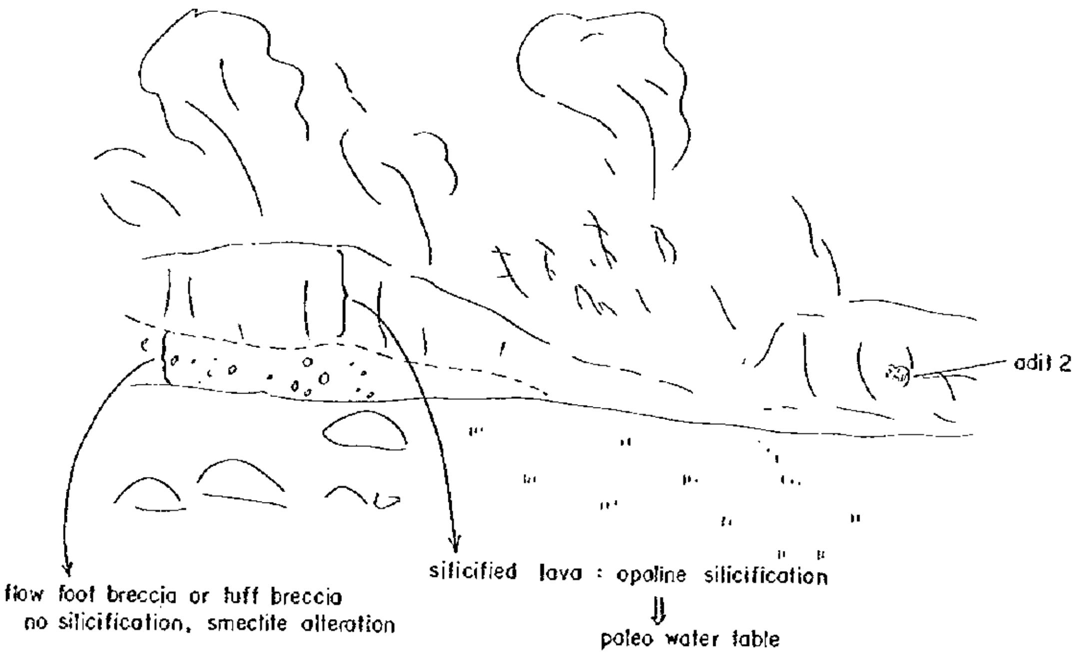


Fig.II-3-4 Occurrence of steam-heated alteration at Calpi in the Buyo River, Bacon-Manito Area

about 200 m almost all of the floats become unaltered andesite. Upstream from there there is a hillock with an elevation of about 200 m. That is where the creek bifurcates. That hillock is considered to have remained as a monadnock because of silicification. From that hillock the direction of the main creek bends to N65°W.

At Patag Creek is to be found adit 8 (Fig. II-3-3). Before it on the downstream side silica-pyrite veins are to be observed (Fig. II-3-5). The direction of Patag Creek is N65°W, which coincides with the above-mentioned direction of the main creek (Fig. II-3-2). There are two silica-pyrite veins, one with a width of 1-2 cm and another with a width of about 10 cm. Their strike is N5°W, and their dip is 78°W. Those veins have clasts of silicified rubble and fine pyrite dissemination. Those veins are considered to be hydrothermal brecciation veins. X-ray diffraction shows that those veins are composed of quartz-minamiite-goethite (TH21) and quartz-alunite-pyrite-rutile-anatase (TH22). In contrast to the surrounding cristobalite-kaolinite alteration, that hydrothermal brecciation vein shows higher-temperature assemblages of alteration minerals. The same kind of alteration zone is to be observed at the main creek with southeast direction from the above-mentioned hillock.

Mineral showings: The veins of the above-mentioned old adit and the nearby hydrothermal brecciation veins are all Au < 5 ppb, i.e. without any gold mineralization. A phosphorus (P) anomaly value of 1020 ppm was detected in the quartz-minamiite silicified hydrothermal brecciation veins.

Evaluation: The alteration zones observed in this area are characterized by opaline to chalcedonic silicification and smectite-kaolinite alteration. The alteration having occurred at a low temperature of around 100°C. Furthermore, the fact that they extend horizontally and that there are silicification zones are controled by the paleo-water table lead one to believe that the alteration zones in this area are steam-heated alteration zones formed on the basis of lateral flow. Therefore it is surmised that the upflow zones are on the side further upstream, and there is the possibility of existence of epithermal deposits in the lower part of such upflow zones. Almost all of the samples from the surface silicification alteration zones have values of less than 5 ppb Au. However, one cannot conclude that there is no possibility of existence of mineralization on the basis of the fact that metal elements are not concentrated due to the fact that the alteration is steam-heated. The existence of hydrothermal brecciation veins consisting of quartz and alunite in the steam-heated acidic alteration zones is an indication that some deep fluids come up to the paleo-water table. One of the explanation for high phosphorus anomalies in the silicified rock accompanied by minamiite is as follows, woodhauseies remained in the core of the minamiite

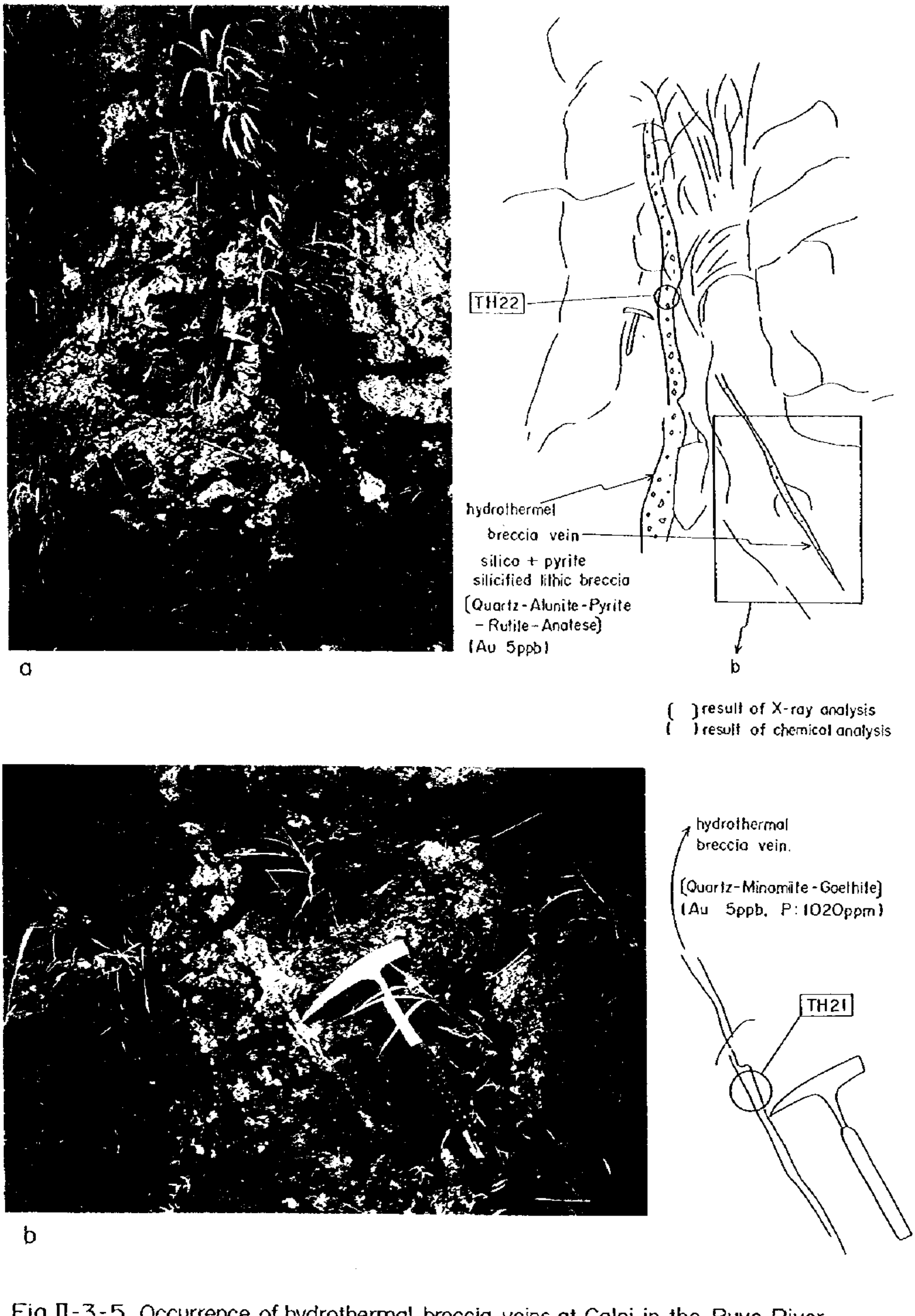


Fig. II-3-5 Occurrence of hydrothermal breccia veins at Calpi in the Buyo River, Bacon-Manito Area.

could have responsibility for high phosphorous anomalies, and the woodhauseites might be fromed in deeper and higher temperature conditions. It is necessary to check on EPMA, but if that is so, it would appear to suggest that magmatic gas rose, and that is good reason for expecting the existence of high-sulfidation type mineralization in deep down part of this area.

Mining claim: PHILIPPINE NATIONAL OIL COMPANY (PNOC) (however, the west side of the Bacon-Manito geothermal energy development region mining claim is scheduled to be released next year.

(2) Masulog Area

Location: 13 km northeast of Sorsogon and 1 km southwest of Putting Bato, in the vicinity of 13°02' 30" N, 123°54' 00" E.

Accessibility: It takes 1 hour by vehicle using the road running northward from the village of Tublijon, which can be reached by the national highway from Legaspi to Sorsogon. It takes another 40 minutes to get to the area on foot through the creek.

Geology: According to the PNOC's geological map, the volcanic rocks distributed in this area corresponds to Young Cawayan Volcanics (two pyroxene andesite to Hbl two pyroxene andesite) of the Pocdol volcanics and Tikolob Volcanics (two pyroxene andesite). The area is situated in the Bac-Man fault zone running E-W at a place sandwiched between the NE-SW trending Masulog fault and the Dumadlangan fault. According to the isoresistivity map (AB/2 = 500 m), it is situated in a low resistivity area running in the south-north direction (Fig. II-3-2).

Alteration: According to observation at the site it shows weak to medium silicification alteration and smectite-kaolinite argillic alteration, with intense dark gray pyritization at some places. It is considered to be steam-heated alteration.

In the results of X-ray diffraction analysis kaolinite and alunite (minamiite) were detected from the SM15 altered rock sample, and cristobalite and halloysite were detected from the SM17 altered rock sample, which indicates medium- to low-temperature acidic alteration.

According to PNOC-EDC (1990) (AL/SR-01), alunite + kaolinite + silica + sulfur is the main type of alteration.

Mineral showings: The following is an account of PNOC's survey findings as follows:

- Au: A maximum value of 0.10 ppm in the rock samples and a maximum value of about 0.05 ppm in the stream sediment samples.
- Cu: A maximum value of 800 ppm in the rock samples, extracted as high-concentration anomaly.

Furthermore, in the results of the geochemical analysis of the present survey 147 ppm of Cu was detected from the SM17 altered rock sample as a geochemical high-concentration anomaly.

Evaluation: In the results of the geochemical prospecting by PNOC although Au was somewhat higher than the background level, it had only a threshold level, with no extraction of an anomaly.

Mining claim: PHILIPPINE NATIONAL OIL COMPANY (PNOC) (However, the west side of the mining claim of the Bacon-Manito geothermal energy development area is scheduled to be leased again next year.)

(3) Pili-Cumadcad Area

Location and Accessibility: It is situated in the southwestern part of the Bacon-Manito area and corresponds to the middle reaches of the Pili River, which flows into Sorsogon Bay. Although a comparatively deep valley is formed in the vicinity of the survey area, there is also a part away from the river where the terrain has comparatively gentle undulation, probably because of an old landslide.

It is possible to reach the PNOC forestry station in the survey area by vehicle by way of an unpaved road from the national highway.

Geology: Two pyroxene andesite lava was confirmed at outcrops.

Alteration: Since the outcropping conditions are poor, very rarely was it possible to confirm altered rock at outcrops. Although the two pyroxene andesite lava distributed along the Pili River is practically unaltered, once in a while it is possible to confirm rock with silicification to acidic alteration as floats with unknown source rock. Many floats of altered rock were confirmed on the eastern slope of the right bank of the Pili River, but only slightly altered andesite resulting from clouding of plagioclase was confirmed at outcrops.

Most of the altered rock found as floats represents silicification to acidic alteration with dissemination of fine pyrite, with only rare occurrence of vesicular silicified rock or opaline silicified rock.

It appears that the altered rock that has undergone silicification alteration is distributed in a way matching the geochemical anomalies identified in previous surveys. Besides cristobalite and tridymite, the rock with silicification alteration often is accompanied by alunite and sometimes by pyrite.

Mineral showings: The geochemical anomalies reported by PNOC-EDC (1990, internal document) were a maximum value of 0.18 ppm for Au from the stream sediment samples and a maximum value of 0.02 ppm from the rock samples. In the vicinity of the creek where those anomalies were detected the above-mentioned altered rock was found as floats.

Analysis of the altered rock showed values of less than 5 ppb for Au, i.e. nothing worth mentioning.

Evaluation: Although the age is not known, hydrothermal activity occurred in two pyroxene andesite as the host rock. Judging from the state of distribution of the altered rock, it is surmised that hydrothermal activity occurred within a range that includes the anomalies identified in the stream sediment geochemical prospecting. Furthermore, considering the assemblage of alteration minerals and the mode of occurrence, it can be surmised that hydrothermal activity formed steam-heated acidic alteration zones, and from the existence of opaline silicified rock one can conclude that the alteration zones presently found on the surface represent alteration zones at comparatively shallow depths.

From the state of distribution of the altered rock floats, the geochemical anomalies reported by PNOC-EDC (1990, internal document) could originate in pyrite dissemination silicification to acidic alteration, but no appreciable concentration of gold was found in the collected samples.

Considering the assemblage of alteration minerals, it is possible to surmise involvement of hydrothermal activity under low-temperature acidic conditions, and if one also considers the scale of distribution of the alteration zones, those alteration zones could represent outcropping steam-heated acidic alteration zones. Therefore the upflow area of neutral hot fluid responsible for epithermal gold mineralization should be sought deeper down or in surrounding parts. The fact that no samples indicative of gold mineralization were found at the surface in this area is considered to be a reflection of the fact that precipitation of gold does not occur in the steam-heated environments.

Assuming that the distribution of geochemical anomalies very nearly reflects the distribution of alteration zones, there would appear not to be very much continuity with the similar alteration zones distributed to the northwest. It is more probable that there is intermittent distribution of small-scale similar hydrothermal systems with a northwest trend. It should at least be possible to narrow down promising areas in the horizontal direction by considering the relationship between such alteration zones in terms of their characteristics, mutual spatial distribution and period of formation, also bearing in mind especially permeability, geological structure and other factors restricting flow of the hot fluid in the history of development of a hydrothermal system.

Mining claim: A geothermal reservation established in it, the owner being PNOC.

(4) Cawayan River Area

Location: It is situated in the northwest part of the Bacon-Manito area and corresponds to the basin of the Cawayan River, which flows into Poliqui Bay. It is located 7 km south-southwest of Manito in the vicinity of 13°03' to 13°04' N, 123°50' 00" to 51' 30" E. From its upper reaches to its middle to lower reaches the Cawayan River forms a comparatively wide valley terrain, but on both banks there is development of steep cliffs.

Accessibility: The entrance to the Cawayan River can be reached by vehicle in 30 minutes on the road from Legaspi to Manito. After that the area is reached by walking through the river for 1 hour.

Geology: From only limited outcropping of unaltered to only slightly altered rock, the geology of this area consists of melanocratic two pyroxene andesite lava and homogeneous pyroclastic rock as well as volcanic mud-flow deposits. According to the PNOC's geological map, this area is located in the Malobago volcanics (two pyroxene andesite to olivine-bearing two pyroxene andesite) in the Pocdol volcanics. The upper reaches of the Cawayan River are located in the Bac-Man fault zone, which has an E-W direction, in the vicinity of the Liboton fault running in the E-W direction and a small fault running in the ENE-WSW direction. Furthermore, it is located in the westward protruding part of the low resistivity area centering on Calpi.

Alteration: Argillization alteration zones are to be found over a wide range from the middle to the middle-upper reaches of the Cawayan River. At the lower reaches as well collapsed cliffs and other phenomena surmised to represent argillic alteration zones are to be observed at the mid-slope parts of the side slopes. The predominant alteration is intense to medium argillic alteration consisting mainly of smectite gray to dark gray in color because of dissemination of minute pyrite. Once in a while it occurs close to silicified rock with pyrite dissemination. Near the river bottom of the Cawayan River the silicification is observed, the color becoming red to reddish brown at places due to limonite dissemination, and at some places argillic alteration due to kaolinite is to be seen. Such kaolinite is considered to have been produced by acidic fluid resulting from weathering of pyrite. It is surmised that such alteration continues to an elevation of 230 m.

In the X-ray diffraction analysis of the altered rocks of this area, quartz and alunite were detected from the part with silicification, and cristobalite, tridymite, kaolinite, alunite and sometimes smectite were detected from the part with argillization. Both indicate medium- to low-temperature acidic alteration. The acidic alteration minerals detected by X-ray diffraction are kaolinite and alunite, but sometimes there is also accompanied by pyrophyllite. The silica minerals are quartz or cristobalite and tridymite. Some of the silicified rock bodies in the smectite argillic alteration zone observed at the medium to upper reaches of the river, forms ledge with a width of 2 m, and some have a structure hanging down from upper silicified rock bodies. A vein-like silicified rock with a width of 2 m (KY26) strikes N80°W and dips 80°N. Furthermore, a massive medium-silicified andesite lava outcrops with low pyrite content and accompanied by alunite was found at the middle to lower reaches. In the X-ray diffraction analysis of that sample (SM21) quartz and traces of alunite and rutile were detected. At outcrops at the middle to lower reaches of the river consisting of two pyroxene andesite lava at the upper part and homogeneous volcanic breccia at the lower part the lava part is practically unaltered, whereas smectite argillic alteration with a low to medium degree of development is to be observed in the volcanic breccia part (Fig. II-3-6). The alteration is observed in restricted strata with high permeability.

Mineral showings: In the survey by PNOC the highest value for gold detected in the stream sediment of the lower reaches was 0.05 ppm, and the highest value for copper detected from rock samples from the upper to middle reaches was 170 ppm, both representing only threshold levels. Nor were high-concentration anomalies for any other constituents noted.

In the geochemical analysis of the altered rock and silicified rock in this ground truth survey no mineral showings were identified other than a result of 25 ppb Au in vein-like silicified rock.

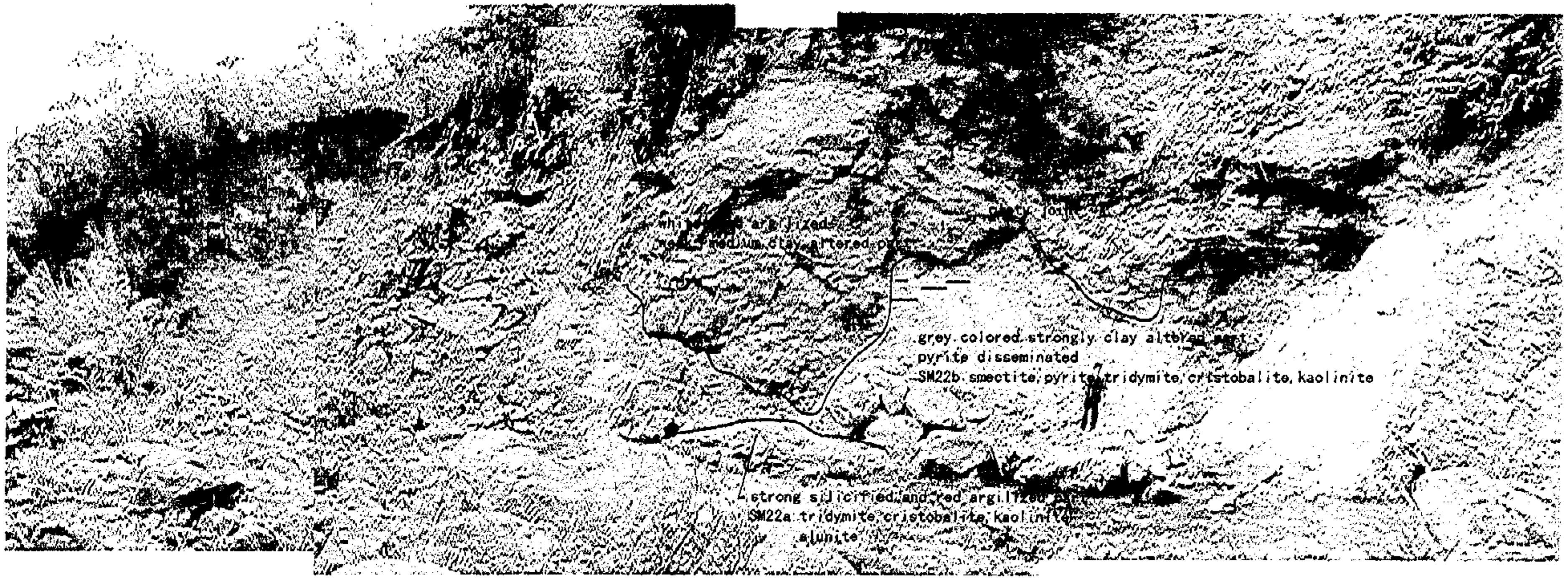


Fig.II-3-6 Outcrop of steam heated acid altered rock in the Cawayan River, Bacon-Manito Area

PNOC-EDC (1990, internal document) reported an As geochemical anomaly (maximum value of 16 ppm in rock), but in this survey no corresponding geochemical anomalies were identified.

Evaluation: Cristobalite and tridymite were detected as altered silica minerals, and the nature of the hydrothermal activity as surmised from the assemblage of alteration minerals, including the fact of accompaniment of smectite, is low-temperature (about 100°C) alteration, probably steam-heated alteration. Furthermore, in view of marked pyrite dissemination there is considered to be some overprinting of acidic alteration by oxidation decomposition thereof. Some of the massive silicified rock (e.g. SM21 and SM23) shows a assemblage of alteration minerals suggestive of a hypogene strongly acidic environment in view of such things as occurrence of quartz as a silica mineral and coexistence with alunite. Also considering the fact that the alteration minerals are indicative of involvement of low-temperature hydrothermal activity, this area is considered to correspond to a relatively shallow part of the hydrothermal system, with partial preservation of the vicinity of the paleo-water table of the period of hydrothermal activity. That being the case, there is expectation of gold mineralization farther down. Furthermore, it is considered that it will be difficult to find any direct indications of gold mineralization in the vicinity of the present ground surface in the way of detection of gold geochemical anomalies.

Regarding the mode of flow of the hot fluid, it is surmised that lateral flow of the kind that develops in the peripheral part of the hydrothermal system is predominant since there is control by permeability contrast due to generally prevalent difference in mode of occurrence of the volcanic rock although some vein-like silicified rock is to be observed. However, the fact that vein-like silicified rock (KY26) thought to have been formed from rather low-temperature hydrothermal activity for which there cannot be much expectation of precipitation of gold showed an analysis value of 25 ppb Au is noteworthy as being strongly indicative of the possibility that circulation of the hot fluid thickening the gold was restricted by a high-angle fracture with a strike of N80°W.

Although the apparent extent of the alteration zone is quite wide, covering several kilometers along the Cawayan River, continuity in the vertical direction is poor--only about an estimated 100 m at most. Furthermore, assuming that the extent of the argillic alteration zone in the area as a whole is restricted by the mode of occurrence of the volcanic rock, it is expected that in the southern part, where there is surface distribution of the upper level unaltered lava, there is greater limitation of surface extension of the argillic alteration zone, and there is possibility of not being able to trace association with nearby alteration zones.

Mining claim: A geothermal reservation has been established in this survey area, the owner being PNOC. (However, the west side of the mining claim of the Bacon-Manito geothermal energy development area is scheduled to be released next year.)

Evaluation of the Bacon-Manito Area: In view of its mode of occurrence and the assemblage of alteration minerals, most of the altered rock distributed in this area is considered to be a low-temperature steam-heated acidic alteration zone formed near the paleo-water table. Within a such low-temperature acidic alteration zone, silicified rock and hydrothermal brecciation veins are distributed and those are composed of quartz-alunite or quartz-minamiite. Au and Cu anomaly values have been noted in them. Those are considered to represent higher-temperature acidic alteration and to have been formed by fluids with a considerable volcanic gas contribution. There is a possibility that volcanic gas rose directly to near the surface and condensed. In such an environment it is also possible that the high-sulfidation type mineralization has occurred at a certain depth.

As for the analysis values, the highest obtained for gold in the present ground truth survey is 25ppb Au, whereas values of 100ppb Au and 180ppb Au were obtained by PNOC in its survey. The distribution of gold is restricted and roughly coincides with the low resistivity area. It is estimated that in the Bacon-Manito area the gold potential is comparatively high in the low resistivity part extending from the Cawayan River to Calpi. Since, as already mentioned, the alteration zones distributed in this area are steam-heated acidic alteration zones, the precipitation of gold had not been occurred in this zone. However, since samples from which a value of 25 ppb Au was obtained were taken from vein-like silicified rock, at some deeper places fluid could rise along cracks to near the surface. This indicate the possibility of existence of gold mineralization at a depth. There were also samples with comparatively high analysis values for Cu and Zn as well (434 and 146 ppm Cu and 112 ppm Zn). Also characteristic is the large number of samples with phosphorus values in excess of 1,000 ppm. Such characteristics support that at some places in this area there was injection of volcanic gas into the altered zones.

According to a PNOC internal document, distribution of the IP low-resistivity zone is distributed north-south along the Manitohan River, the direction becoming east-west in the Bac-Man fault zone, where it extends eastward along the Bac-Man fault (Fig. II-3-2). Hot springs are also distributed in areas of distribution of IP low-resistivity zones, and it is surmised that the IP low-resistivity zones are indicative of passage of hot fluid. Considering that, we could speculate that the present flow channels of the hydrothermal system correspond to the IP low-resistivity zones, and that an upflow zone in the vicinity of the Cawayan crater, with flow from there to the east and to the south along the low-resisitivity zones. The low-resistivity zones that have been