

Chapter 3 Lahuy Island

3-1 Geology

3-1-1 Regional Geology

Torres (1978) described the geology and mineralization of Au prospects in Gata.

According to the geologic map of Gibgos Area (MGB, 1985), the geology of the island comprises the Lahuy Formation of late Miocene. K-Ar dating accomplished on four rock samples in the survey, however, showed the ages between 93.0 ± 3.0 Ma and 41.0 ± 1.0 Ma corresponding to the ages of late Cretaceous and late Eocene. The age of the Lahuy Formation seems to be older than Miocene. Therefore, the age of the formation is set on late Cretaceous in this report.

The Lahuy Formation is mainly composed of andesitic volcanic rocks with tuffaceous sandstone, shale and conglomerate. The volcanic rocks consist of lava, tuff and tuff breccia. Compositionally they are mainly andesitic, but partly dacitic lava and basaltic tuff breccia are observed. Tuffaceous sandstone, shale, conglomerate are intercalated in these volcanic rocks and strike NE-SW to NW-SE and gently dip east.

Gata which is situated in the southwestern part of the island has been known to be gold occurring place since 1930s. This area was selected as the detailed survey area, where the geological and geochemical surveys was carried out in detail. The Lahuy Formation in the area is subjected to strong hydrothermal alteration. In contrast to the rocks in the other area of the island (reconnaissance survey area) is rather fresh. A presence of fault is inferred between the detailed survey area and the reconnaissance survey area, and the western block (the detailed survey area) is thought to be uplifted.

The geologic map of Lahuy Island was shown in Fig. 24.

3-1-2 Geology of the Detailed Survey Area

The Lahuy Formation of the detailed survey area is composed of four parts. One is made up of tuffaceous sandstone and tuff which is distributed at the southeastern part of the area. Next one is andesitic pyroclastic rocks which widely expose from north to south of the area. The other one is made up of tuffaceous sandstone and conglomerate which exposes at the northwestern part of the area. The last one is dacitic dike which cut the first two parts. The geology of the detailed survey area was shown in Fig. 25.

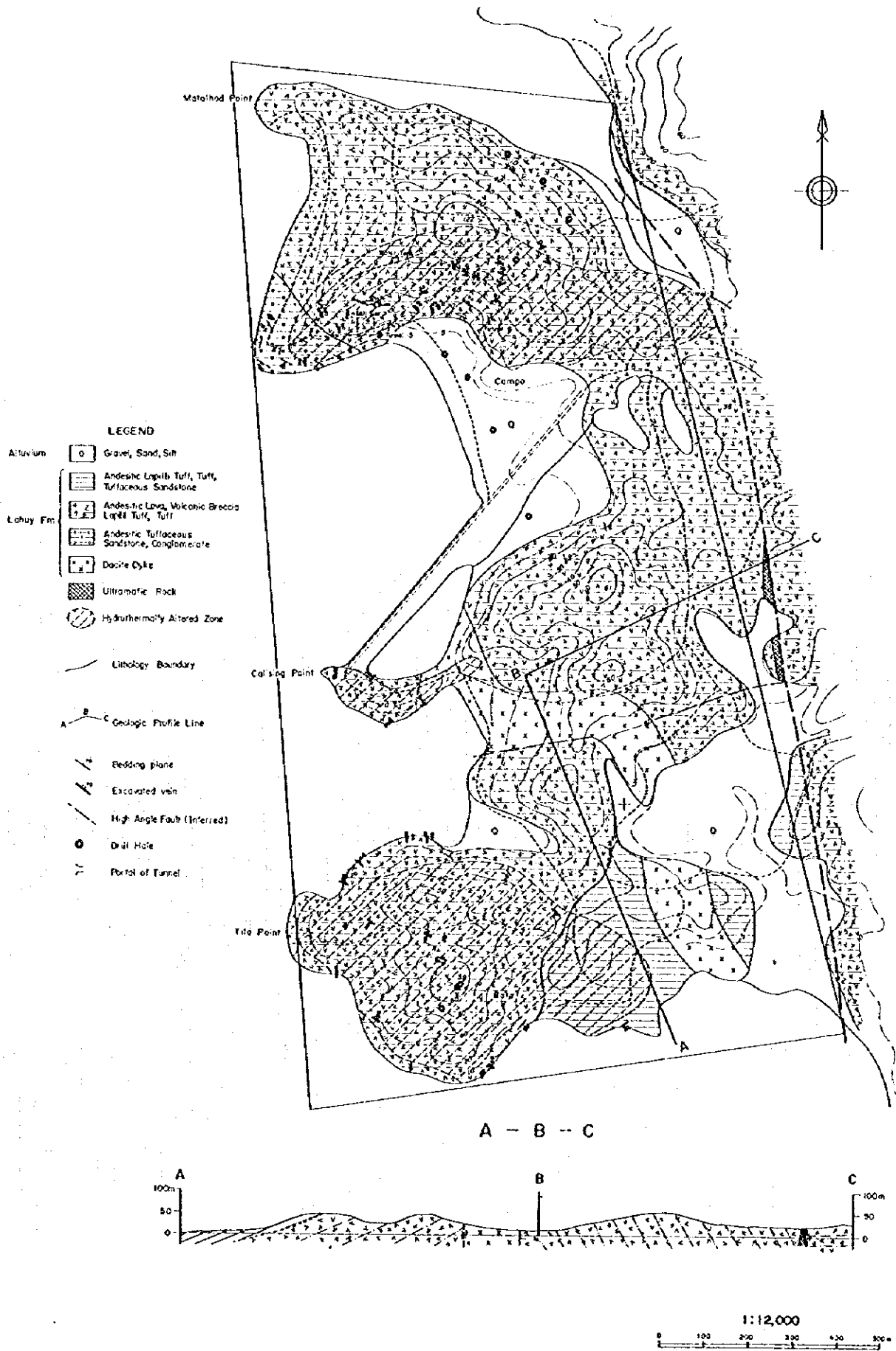


Fig. 25 Geologic Map of the Detailed Survey Area in Lahuy Island

In the southeastern part of the detailed area, tuffaceous sandstone, lapilli tuff and partly tuff breccia which strike NE-SW and gently dip southwest expose. These rocks are gray to greenish gray in color and subjected to hydrothermal alteration along fractures. They conformably overlie andesitic pyroclastic rocks which expose at the North in the area. The andesitic pyroclastic rocks consist of lava and tuff breccia. At Calising Point, the central part of the area, andesitic lava shows conspicuous flow structure. Along coast lava and tuff breccia are relatively fresh and show greenish gray in color. They have been strongly altered around gold prospects and have become white.

Along the northern slope of the eastern hill of Calising Point there are at least two cycles of tuff breccia and lava. These sequence have NNW-SSE strikes and steep east dips.

The greenish gray colored alternated beds of tuffaceous sandstone and conglomerate are exposed at the West of Campo, northwest part of the area. They show NW-SE strikes and almost vertical dips. At Campo Mineral Occurrence, the rocks are too intensely altered to identify the rock type, and an andesitic lava exposes along the northern coast.

From the East of Gata Mineral Occurrence to the East of Calising Point a dacitic dike cuts through andesitic pyroclastic rocks, tuffaceous sandstone and lapilli tuff. This rock looks rather fresh in the naked eye and shows dark green in color and has porphyritic texture with phenocrysts of feldspar, amphibole, quartz. The dike has been affected a hydrothermal alteration and has become white at the East of Calising Point.

At the southeastern part of the area, the Lahuy Formation shows NE-SW strikes and generally SE dips, whereas at the northern to central parts the formation shows NW-SE to NNW-SSE strikes and vertical to steep east dips. The presence of an E-W trending fault is inferred between the northern to central parts and the south part, and the dacitic dike may have intruded along the fault. Ultramafic rock sampled at the east end of the detailed survey area implies the presence of a N-S trending fault.

3-1-3 Mineralization

There were active mining activities at Campo and Gata Mineral Occurrences before the second world war and after the war several times of exploration were done on the area. Now local people are doing small scale mining in this area.

The rocks around Gata and Campo Mineral Occurrences and Calising Point have been intensely altered. There are many tunnels, pits and trenches in these places. The ore occurs

as quartz and clay veins. At Gata Mineral Occurrence N-S to NW-SE to E-W trending veins are dominant whereas at Campo Mineral Occurrence E-W to NW-SE trending veins are dominant. Quartz veins accompany with galena, sphalerite, chalcopyrite, pyrite and amethyst at Campo Mineral Occurrence. According to local people, if galena, sphalerite and amethyst are recognized at the ore, the ore will tend to be rich in Au. Sphalerite is clear with low content of Fe.

The maximum assay value for Au is 46.8g/t and the minimum value is <0.03g/t. The average of assay values for Au is 6.0g/t.

3-2 Geochemical Survey

3-2-1 Methodology

The soil geochemical survey for the whole island area, the soil and rock geochemical surveys for the detailed survey area were conducted. The chemical data were analyzed by the same method as Catanduanes Island.

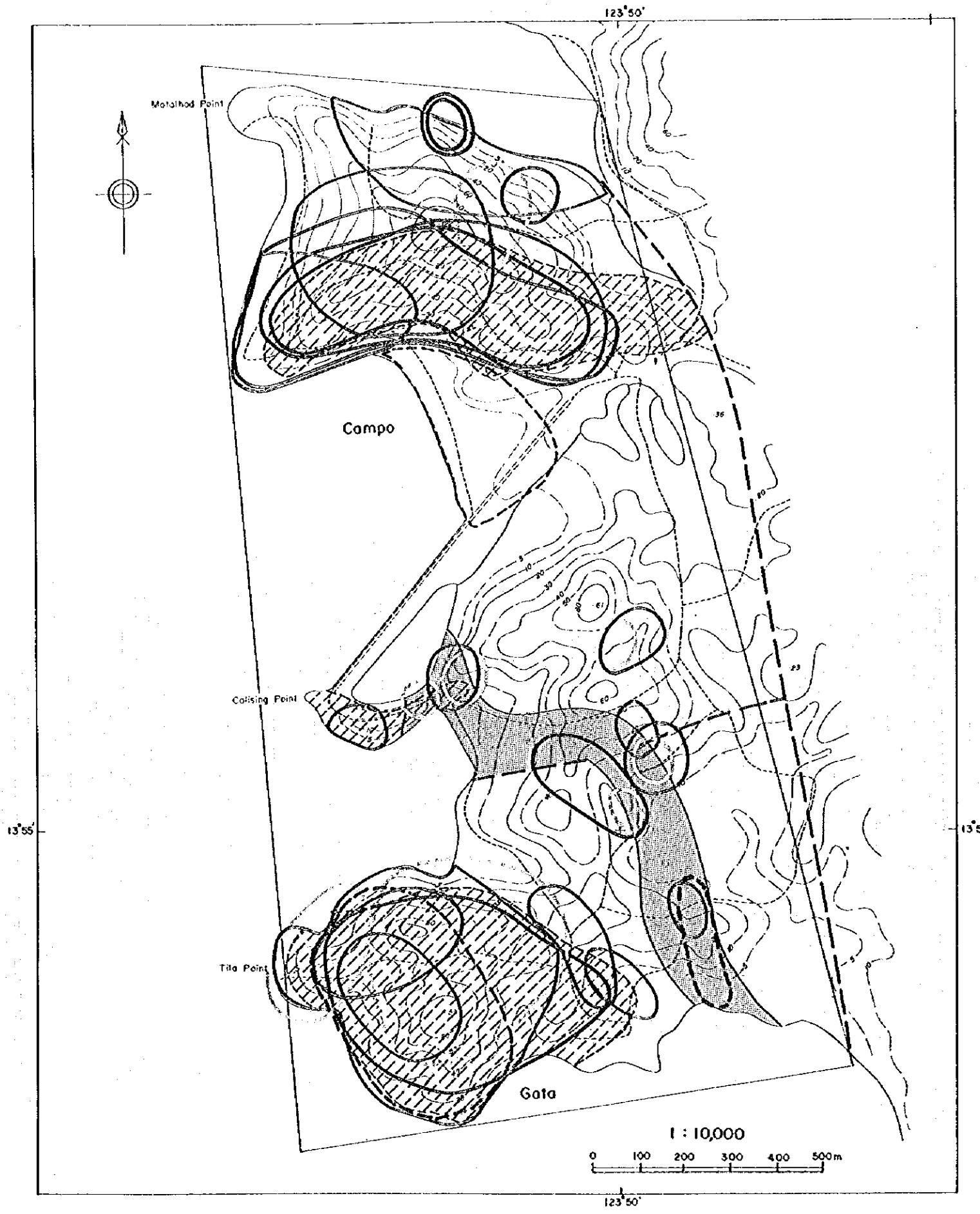
3-2-2 Results of the Geochemical Survey in the Detailed Survey Area

The very clear results were obtained through the geochemical survey in the Detailed Survey Area.

In the rock geochemical survey, Au shows strong positive correlation with Pb, and Ag, As, Cu and (Zn) have positive correlations with each other. The first principal component on the PCA indicates the mineralization of Au, Ag, Cu, Pb and Zn. The high scores of the first principal component are exclusively located at Campo Mineral Occurrence and Gata Mineral Occurrence.

In the soil geochemical survey, Au shows strong positive correlation with Pb, and also Au, Cu, Pb and Zn have the positive correlation with each other. The first principal component on the PCA also indicates the mineralization of Au, Ag, Cu, Pb, Zn and Mo. The high scores of the first principal component are exclusively located at Campo Mineral Occurrence and Gata Mineral Occurrence (Fig. 26).

The geochemical survey in the Detailed Survey Area revealed that Au, Ag, Cu, Pb, Zn and Mo behaved in the same manner in the mineralization of Lahuy Island.



LEGEND

PCA of Rock Samples

Anomaly	High Score	Low Score
Z - 01 (Au, Ag, As, Cu, Pb, (S))		
Z - 02 (As, Mo, -Zn, (-Fe))		
Z - 03 (S, Ag)		
Z - 05 (Fe, (-Sb))		

PCA of Soil Samples

Anomaly	High Score	Contaminated Zone (Placer Gold)
Z - 01 (Au, Ag, Cu, Pb, Zn, Mo, S, (As))		
Z - 02 (Fe, -As, (-Ag))		

Geology

- Hydrothermally Altered Zone
- Dacitic Dyke
- Fault (Inferred)

Fig. 26 Comprehensive Map of Lahuy Island (Detailed Survey Area)

3-2-3 Results of the Geochemical Survey in the Reconnaissance Survey Area

The high scores of the fourth principal component, having the large factor loading of Hg, are detected at the eastern extension of Campo Mineral Occurrence in the Reconnaissance Survey Area, where the second principal component (Mo, Au, Pb) and the third principal component (As and S) overlap each other.

High scores of the second and third principal components are distributed near the Southwest of Gogon and the southern end of the island. The floats of chalcedonic quartz veins and Mn coated rocks were recognized in some parts in the Reconnaissance Survey Area.

3-3 Discussion

The principal component analysis on the rock geochemical survey comes to pick out two factors; mineralization and weathering.

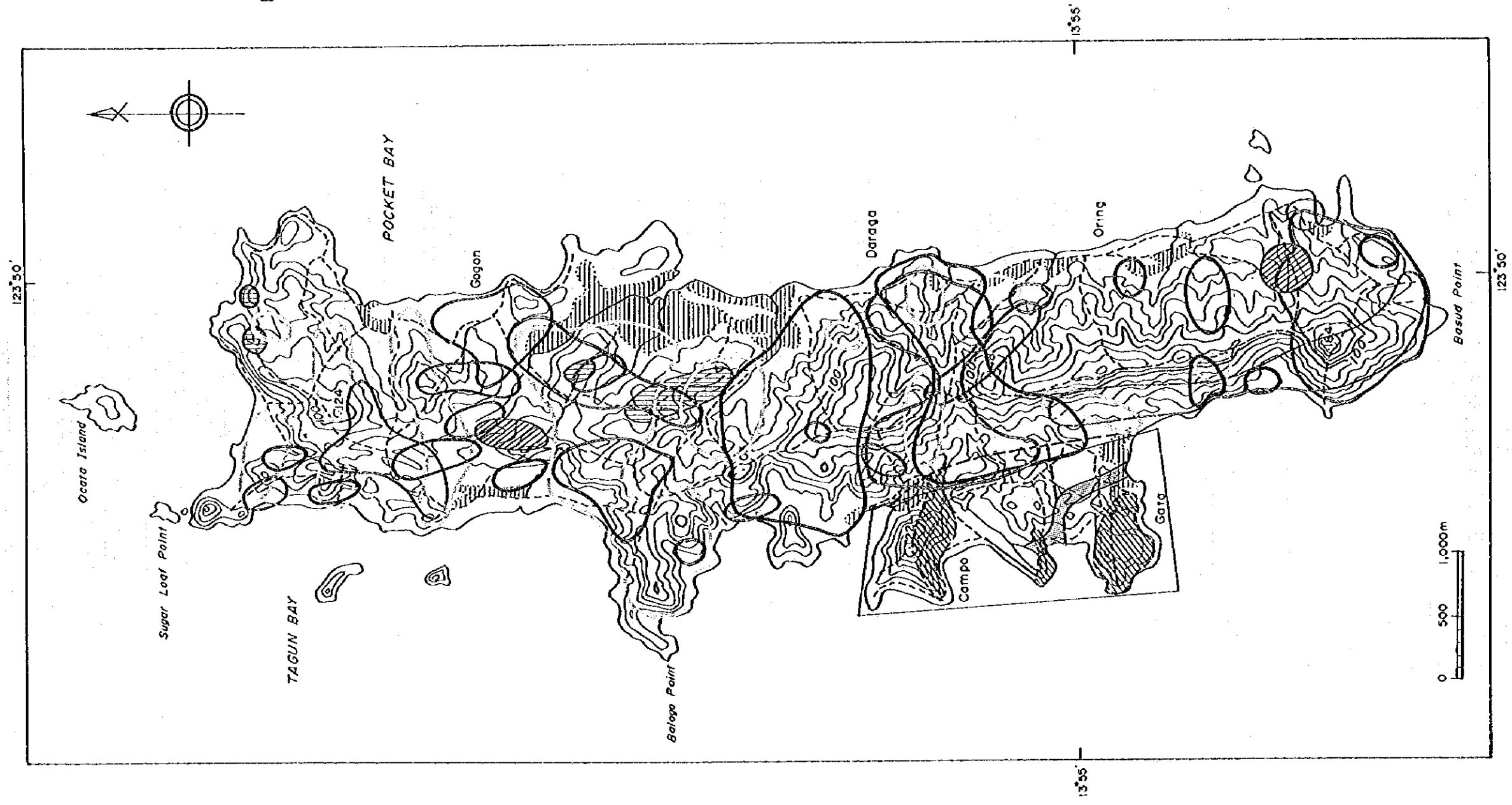
(1) Mineralization; The high to moderate scores of the first principal component are distributed in the known mineral occurrences. The first principal component is composed of the factors of Au, Ag, Cu, Pb, Zn, As and (S) and it implies the mineralization of Campo Mineral Occurrence and Gata Mineral Occurrence. This is almost harmonious with the results of the first principal component of soil geochemical survey.

(2) Weathering; The principal components except the first component tend to show positive scores in Campo Mineral Occurrence and negative scores in Gata Mineral Occurrence. This may originate from the difference in the weathering, leaching of elements and erosion between the two occurrences. The topography of Campo Mineral Occurrence is considerably steep while that of Gata Mineral Occurrence shows gentle slope.

The homogenization temperature of quartz inclusions taken in the Detailed Survey Area ranges from 230° C to over 300° C. The temperature can be enough to explain the fact that Hg contents of many samples are under the detection limits.

On the other hand, high scores of the fourth principal component having the large factor loading of Hg are detected at the eastern extension of Campo Mineral Occurrence in the Reconnaissance Survey Area. This is harmonious with the geological model: The Detailed Survey Area has been uplifted by the fault and the deeper portions have been exposed on the surface in comparison with the Reconnaissance Survey Area. The above-mentioned eastern

extension has the highest potentiality in the Reconnaissance Area because the second principal component (Mo, Au, Pb) and the third principal component (As and S) also overlap each other (Fig. 27). The analyzed values, however, are generally low in content and the anomalies are not so strong as to indicate the existence of the deposit at the workable shallow depth. Accordingly, the exploration and development of the mine in the Reconnaissance Area will be accompanied by difficulties.



LEGEND

PCA of Soil Samples
High Score Anomaly

Z-01 (Fe, Cu, Zn)

Z-02 (Au, Pb, Mo)

Z-03 (As, S)

Z-04 (Hg, -S)

Geology

Dacitic Dyke

Hydrothermally Altered Zone

Area of Chalcedony Floats

Area of Mn - Coated Floats

High Angle Fault (Inferred)

Fig. 27 Comprehensive Map of Lahuy Island (Reconnaissance Survey Area)

PART III CONCLUSIONS AND RECOMMENDATIONS

PART III CONCLUSIONS AND RECOMMENDATIONS

Chapter I Conclusions

1-1 Catanduanes Island

(1) The geological survey including stream sediments geochemical survey for the whole area were carried out in the First Phase Survey. The survey resulted in picking out Carorongon Area, East of Bato Area, Dugui Too Area and East of Bato River Area as the promising areas.

(2) The Second Phase Survey was focused at Carorongon Area from the results of the First Phase Survey. Based on the results of the survey, the following areas were chosen as the potential areas for mineralization; Carorongon Mineral Occurrence, Taganopol Mineral Occurrence, Ananon North Area, Kadlakogod Area and Kampayas Area.

(3) Based on the results of the past two years, trenching and drilling surveys for Carorongon Area and a detailed geochemical survey for Kampayas Area were conducted in The Third Phase Survey. The results of these surveys were as follows;

Carorongon Area

① The geology of Carorongon Area is composed of greenschist and metagabbro of the Catanduanes Formation. The greenschist originated from shale, siltstone, sandstone and lapilli tuff which have basic composition. The schistosity generally show the NW-SE direction subparalleling the faults in sheared zone. The metagabbro has schistosity subparalleling the faults in sheared zone as those of the greenschist. The metagabbro usually occurs in the form of sheets in the Catanduanes Formation such as strata.

② The geological structure is characterized by NW-SE trending faults which are cut by E-W and NE-SW trending faults. The extended directions of sheared zone and silicified zone mainly define the NW-SE trend, but some quartz veins containing high gold grade have the E-W trend.

③ From the results of trenching survey, the gold mineralization is said to be related to hydrothermal alteration and the quartz veins within the whole series of trenches. The direction of quartz veins is generally NW-SE and decreases in frequency to N-S, E-W and NE-SW, however the quartz veins with high Au grade are mainly in NW-SE and E-W directions. Within the trench T-3, the silicified zone containing 4.2 g/t Au and about 4 m in

width is recognized and the quartz vein striking $N75^{\circ} E$ and dips $85^{\circ} NW$ contains 58.8 g/t Au and about 15 cm in width.

④ From the results of drilling survey, the silicified zones were found to continue to deeper levels from surface. The strongly silicified zones were proved to continue 30 m below the surface in 4 holes (MJPC-3, 4, 5, 6) which were carried out on platform 2. Some other silicified zones exist at deeper levels (44 - 86 m below the surface) than the above-mentioned silicified zone and were recognized in the holes MJPC-8 and 9 that were carried out on platform 3. Major portion of the mineralization usually occurs within the metagabbro intrusives and the contacts between the metagabbro and the greenschist.

⑤ Based on the results of ore analysis, only Au has the high potential, though there are some samples containing slightly high concentrations of Cu and Zn. As to the Au grade, values of 1.5 g/t (MJPC-5, 26.80 - 30.85 m) were determined in the silicified zone at shallower levels and values of 1.2 g/t (MJPC-8, 83.20 - 84.20 m) were determined in the silicified zone at deeper levels.

Kampayas Area

① The geology of Kampayas Area is mainly composed of sedimentary rocks of the Catanduanes Formation. These rocks are cut by the andesite porphyry and diorite of Batalay Intrusives. As to the mineralization, there are silicified zones and quartz veins in some places.

② The variation of each element on the geochemical survey in Kampayas Area is controlled by the NNE-SSW oriented fault, by the diorite body at the ridge around peak 379 m and by the strongly silicified zone at the eastern part of Kampayas Creek. The NNE-SSW oriented fault passing by the ridge of peak 379 m could have served as channelways for the andesite porphyry and some hydrothermal solutions.

③ As to the Au content, unaltered to weakly altered rocks yield values several times as compared with the Clarke number, and the strongly altered rocks are at dozens times. Of particular interest are the silicified rocks with high frequency of quartz veins wherein the quartz veins frequently yield values of 0.1 to 0.3 g/t Au. In Kampayas Area, the maximum Au value was determined in the quartz vein of about 20 cm in width along the NNE-SSW oriented fault passing by the ridge of peak 379 m. The value is 0.3 g/t Au.

④ The results of K-Ar dating revealed the ages ranging from 33.6 ± 2.1 Ma to 26.7 ± 0.6 Ma. These ages which estimate for Batalay Intrusives correspond to the period of Oligocene. Based on these results, at least, the main mineralization in Kampayas Area occurred due to the hydrothermal activity related to Batalay Intrusives.

1-2 Lahuy Island

The soil geochemical survey for the whole island area, the soil and rock geochemical surveys for the detailed survey area were conducted in parallel with the geological survey in the First Phase Survey. The results of these surveys were as follows;

(1) A significant indication appears at the known mineral occurrences in the Detailed Survey Area. The results of the principal component analysis for the geochemical survey suggest that gold bearing sulfide copper, lead and zinc mineralization occurred there.

(2) No strong geochemical anomaly was found in the geochemical survey for the whole island, however, a similar type of anomaly were found at the East of the Detailed Survey Area, the Southwest of Gogon and the southern end of the island.

(3) It is supposed, based on the geological survey results, that the mineral occurrences of the Detailed Survey Area have been uplifted, and deeper parts of the formation are exposed there. It is evaluated that the three areas of (2) have potential for the same type of the ore deposit as that of Gata Mineral Occurrence.

Chapter 2 Recommendations for Future Activity

2-1 Catanduanes Island

(1) Carorongon Area; It seems that the ore deposits recognized in Carorongon Area is sub-economical to develop at present because the deposits are slightly low gold grade as a whole and of limited size particularly concerning the high gold portions. It is notable, however, that the gold contents of metagabbro tend to be more than 0.1 g/t where the metagabbro was altered. Therefore, Carorongon Area and its vicinity must have a huge gold potential. At present, it is difficult to conclude whether the survey area was the centers of hydrothermal activity which brought about the gold mineralization or not.

After the detailed survey, we must delineate the potential areas for gold mineralization near Carorongon Area. In this case, it is imperative that the junctions of the NW-SE oriented faults consistent with the extension of the silicified zones and the E-W or NE-SW oriented faults of later tectonism could be of highest potential.

(2) Kampayas Area; In Kampayas Area, the highest gold potential areas are believed to be near the ridge of peak 379 m and at the intersections of the NNE-SSW and E-W oriented faults in the southern part of the survey area. In particular, the site for forming a gold deposit is preferable at the above-mentioned intersections of the faults because the big quartz veins of about 20 cm (0.3 g/t Au) to 1 m in width and geochemical high gold anomalies are observed near the intersections. Therefore, we recommend to continue the additional surveys such as a geophysical survey or drilling survey.

It is highly possible that a promising gold mineralization exists at the relatively higher part (above the 200 m in altitude) in the following reasons; There are many soil samples yielding high values of 0.1 to 2.6 g/t Au at the ridge around peak 379 m and in the southern part. High gold anomalies (more than 10 g/t Au) were recognized by the stream sediments geochemical survey of the Second Phase Survey at the eastern creek of the ridge. The quartz vein (KCR-08) of about 1 m in width at 200 m in altitude includes fluid inclusions showing the temperature ranging from 203 to 285° C (Ave. 248° C) and has low value of 0.02 g/t Au. On the other hand, the quartz vein (KCR-09) of about 20 cm in width at 270 m in altitude shows fluid inclusions homogenizing at ranging from 189 to 262° C (Ave. 217° C) and has relatively high value of 0.3 g/t Au. Therefore, it is recommended that the additional surveys

be conducted above the 200 m in altitude.

Moreover, it is proposed that the geological and geochemical detailed surveys be conducted in the eastern extension of Carorongan Area and Kampayas Area because the geochemical high gold anomalies extend to the area.

2-2 Lahuy Island

In the Detailed Survey Area, promising indications for ores were found on the known mineral occurrences in the geological and geochemical surveys.

In the Reconnaissance Survey Area, geochemical anomaly zones were found at the East of the Detailed Survey Area, the Southwest of Gogon and the southern end of the island. The analyzed values of those anomalies, however, are generally low. Conditions for new mine developing are tough in the island. Furthermore, it is supposed that ores, if exist, would be sit in fairly deep underground, and the invasion of sea water in the mining site would be occurred due to the close location to the sea.

It seems that the ore deposits recognized in Lahuy Island is sub-economical to develop at present because the deposits are slightly low gold grade as a whole and of limited size particularly concerning the high gold portions.

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