Chapter 5 Discussion on Mineralization

5-1 Geological Structure, Characteristic and Control of Mineralization in Bicol North Area

Bicol North Area is located at the northwest end of the central area of three geological zones in the Bicol Area. Almost of area is covered by igneous rocks of Pliocene to Recent. In the area of the northeast and the west of the area are in the north zone and southwest zone individually. The ophiolite sequence and sedimentary rocks are distributed.

The northwest to west-north-west and northeast trends are dominant in the central zone which is the main part of the survey area. (Fig.II-5-1) The direction controls the mineralization and alteration of the central zone. The direction is generally paraller to west-north-west to east-south-east Legaspi liniamentin of the south of Bicol Peninsula.

No active mines are present in the area, but Nalesbitan Au-Cu high sulfidation epithermal deposit and Tuba mesothermal vein-type deposit occur in the northwest of the area. At the end of northeast of the area, the small deposit, most likely a skarn type gold deposit, Benit deposit is existing. Nalesbitan deposit is associated with geothermal breccia produced the fault jog of northwest strike left-dilational fault without vuggy-residual silica (Sillitoe et al., 1990)

Alteration zones are related to Nalesbitan deposit and Tuba deposit, and are found in lots of places. The biggest alteration in the area is around the south foot of Susungdalaga Mountain. The alteration zone can be traced about 13km and 1 to 3 km wide in the direction of west-north-west to east-south-east up to Alawihaw-Baliwag alteration zone. At around Alawihaw alteration zone, high temperature hot spring and sinter were observed. Therefore, the low sulfication-type mineralization related to Labo geothermal zone at the south foot of Mt.Labo is expected. In Layaton Malaki - Maniknik - Baliwag alteration zone , silicified rocks are domonant, and alunite and energite were observed. Therefore, it was probably formed by high-sulfidation-type mineralization relating to Pliocene volcanic activity. Katakian alteration zone at the south of Tuba deposit is associated with silicification in Tigbinan Formation and quartz veins in sericite-argillization zone. Therefore, it could be mesothermal deposit similar to Tuba deposit. On the other hand, because of the existence of rocks with abound magnetite vein and epidote and the intrusion of Palacale granite, skarn-type mineralization could be considered. The alteration seems to be related to northeast trend.

Salubosogin-Yakalan alteration zone is located at the east of Nalisbitan deposit. Two types of hydrothermal alteration zones were recognized and delineated consisting principally of silicification and argillization associated with minor chloritization. The wallrock and faults situation are similar to Nalesbitan deposit. Vuggy quartz was observed with floats but could not be seen at outcrop. It seems that the erosion level might be shallower than Nalesbitan deposit but the similar mineralization could be expected. Besids, some small alteration zones were observed in the upstream of Labo River in the east of the area. Silicification zones and argillization zones with mainly kaolinite are distributed in Magasawan-Bato and Binangkawan-Taktak alteration zones. The existence of plug was expected by airborne geophysical survey. So, the part of alteration zone might show the upper portion of epithermal mineralization as steam heated -type mineralization.

In Exciban-Larap occurrences in the north of the area, zonation of hydrothermal alteration was observed and massive sulfide ore with mainly pyrite is distributed. The sulfide ore is associated with a small amount of chalcopyrite and chalcocite and shows high value of Au; 19.55ppm. The phenocrysts and veinlets of quartz, chlorite, and epidote were observed and pyrite dissemination

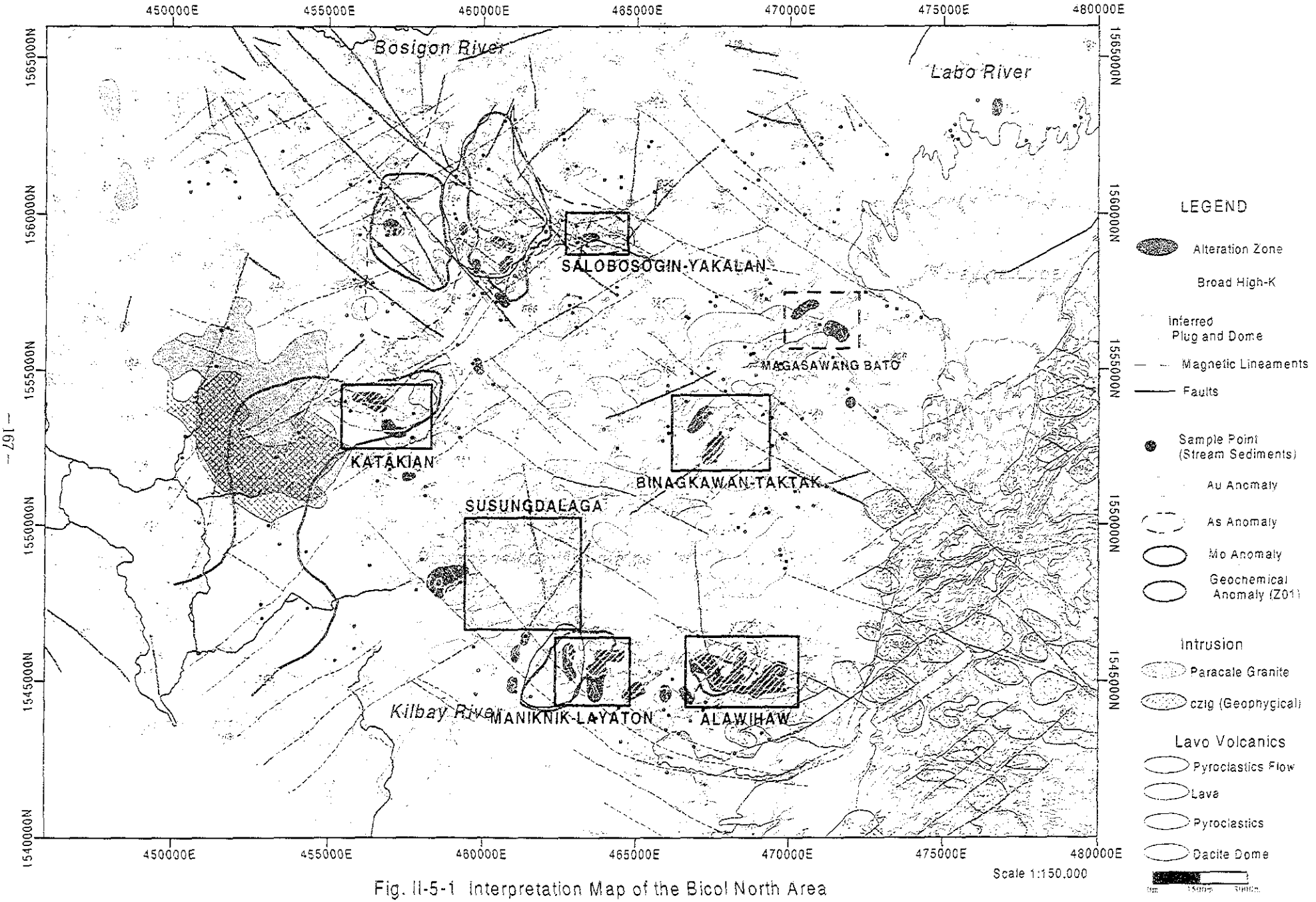
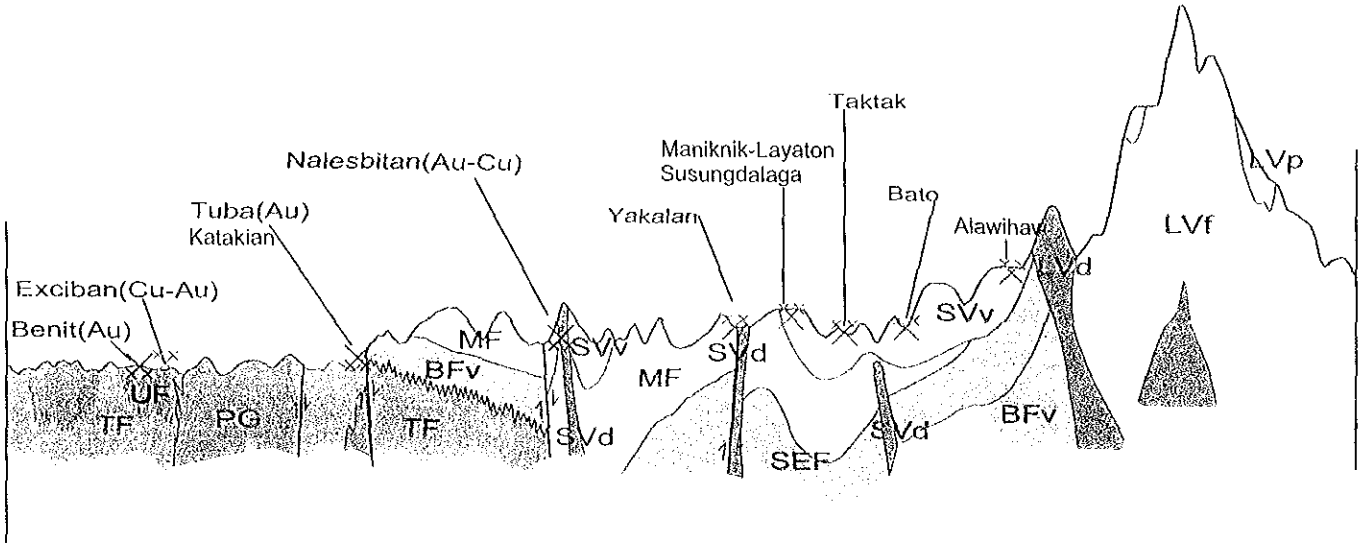


Fig. II-5-1 Interpretation Map of the Bicol North Area



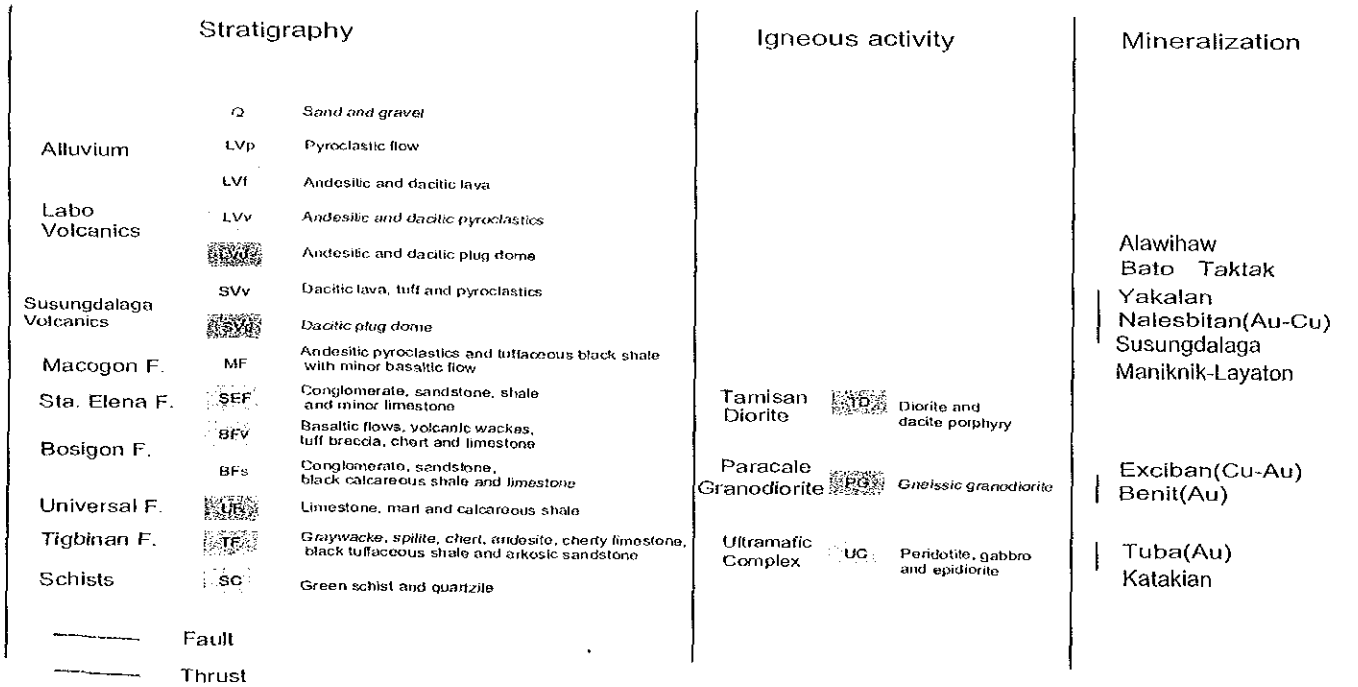


Fig.II-5-2 Schematic Locality of Ore Deposit and Mineral Occurrences in the Bicol North Area

and veinlets were observed. The intrusion of diorite is existing. Therefore, the possibility of porphyry copper-type deposit or mesothermal vein-type deposit is expected.

The schematic geological profile of deposits and occurrences are shown in Fig.II-5-2.

5-2 Summary of Promissing areas

The targets in the survey area are epithermal to mesothermal gold±copper mineralizations. As the promising areas for further exploration, extensive alteration zone, geochemical anomaly of gold related elements, and broad high potassium gamma-ray spectral zone are overlapped. In addition, the existence of the related plugs and domes are necessary for the high sulfidation or porphyry copper mineralization. The following areas are consistent with above factors: the areas around Nalesbitan, Katakian alteration zone, Maniknik-Layaton Malaki alteration zone, Alawihaw alteration zone. ,Magasawan-Bato alteration zone, Binangkawan-Taktak alteration zone, and Salobosogin-Yakalan alteration zone at the east of Nalesbitan. In addition, Exciban-Larap occurrences which is expected as porphyry copper-type deposit or mesothermal vein-type deposit, is included in the expected areas.

Nalesbitan has been already evaluated by many mining facilities, therefore any further exploration is no longer necessary in this project. The characteristic of these areas, except Nalesbitan are described as follows:

(Katakian Alteration Zone)

The alteration zone extends in the area of Cretaceous, Tigbinan Formation and Pliocene, Sta. Elena Formation. The Paracale Granite intrudes to the west of this zone on a large-scale, and the inferred another body intrudes to the east of the area. The filed mapping is described silicification and sericitic argillization with quartz veins and abundant pyrite dissemination. Magnetite sfringers and calc-silicate rocks is found at some outcrops. The geochemical anomaly of Au is detected and the anomaly of Au related elements extend broadly to downstream. K-gamma-anomaly is extended broadly to the southeast of the area. The type of mineralization occurs a skarn-type contact metasomatic mineralization related to plutonic bodies or mesothermal vein-type mineralization such as Tuba.

(Maniknik-Layaton Malaki Alteration Zone)

The pervasive silicification in Susungdalaga Volcanics is observed in the zone. The silicified rocks are accompanied by expected vuggy silica containing enargite in vugs and abundant alunite. These evidences show that the silicified zone was formed by typical high- sulfidation- type mineralization. The stream sediments geochemical anomaly of Au related elements are higher than the backgroundand and Mo- anomaly is detected in the area.

(Susungdalaga Area)

The area is defined by broadly high potassium gamma-ray anomalies extending from Maniknik-Layaton alteration zone to north by 5 km. The north area is called Susungdalaga area. No geochemical anomaly is detected in the stream sediment samples, but abundant silicified floats bearing Au were reported at Tonton River neighbor of the north of Baliwag Creek by JICA and MMAJ (1999). An inferred older volcanic eruptive center are expected from the result of airborne geophysical survey. There is a possibility of high- sulfidation mineralization in the area. Usually the potentiality of highsulfidation trends to become higher toward a volcanic center because of its neccesity of the injection of magmatic fluid to the hydrothermal system. It is expected that the pervasive alteration zone at the south flank of Susungdalaga Mountains was formed by a

hydrothermal flow from the area.

(Alawihaw Alteration Zone)

The argillization, pyritization, and partly silicification of Susungdalaga Volcanics are observed in the area. These rocks contain quartz veins. Hot springs at high temperature and recent silica-carbonate sinter terrace are also found in the alteration zone. The geochemical anomalies of Au, Cu, and As are detected around the alteration zone.

It indicates that the alteration zone is formed by low-sulfidation system, and at least a part of the alteration zone is related to the active Labo geothermal field on the southwest flank of Mt. Labo.

(Salobosogin-Yakalan Alteration Zone)

The alteration is related to northwest trending faults set cutting Macogan Formation same as in Nalesbitan in the center of the area. Along the faults, argillization zone which may be around silicification zone and alteration zone, were observed. The shear zone is filled up by quartz vein with sulfide ore. The area has potential of Nalesbitan-type high sulfidation mineralization accompanied by silicified breccia. Au-anomaly is detected in silicification zone along faults. The maximum value shows Au; 0.012ppm. The mineralization is characterized in breccia in silicification zone alond faults. It seems that the center of mineralization might not be exposed. So, the mineralization might be shallower than Nalesbitan.

The interpretation map is shown in Fig.II-5-3. The schematic model of ore deposit is shown in Fig.II-5-7.

(Magasawan-Bato Alteration Zone)

In the area, Susungdalaga Volcanics is widely distributed. In the north of the area, the sedimentary rocks of Sta. Elena Formation (Upper Miocene) is limitedly distributed as the form of window. Northeast to east-north-east and northsouth trending faults were observed. In the southwest of the area, the intrusion of plug is inferred by airborne survey.

The mineralization was observed along mainly east-north-east stractural line and pyrite dissemination was observed in gouge. Under geochemical survey, the gold anomaly is widely distributed along the fault trending northsouth and the east-north-east direction in silicification zones. The maximum value shows Au; 0.283ppm. High sulfidation epithermal deposit may be expected. But the area might not be well eroded and the only shallow portion of geothermal alteration may be exposed. Sta. Elena Formation is distributed in the north of the area. The gold anomaly by soil geochemical survey conducted in the southwest of the area where the intrusion of plug is inferred, may be higher potential, because Susungdalaga Volcanics may be thin.

The interpretation map is shown in Fig.II-5-4. The schematic model of ore deposit is shown in Fig.II-5-7.

(Binangkawan-Taktak Alteration zone)

In the area, northeast and northwest to west-south-west trends are dominant. Susungdalaga Formation is widely distributed in the area. In the northeast of the area, the intrusion of plug is expected under airborne survey.

The area along Taktak River is silicified, silicification and argillization zone were observed in the limited zone along faults. Drussy quartz was also observed. The pocket and pyrite dissemination were observed in the silicified zone of dacitic pyroclastics. At the north side of northeast trending fault, gold anomaly is detected under geochemical survey. The maximum value shows Au; 0.305ppm. Because arsenopyrite was also observed, high sulfidation epithermal mineralization is expected.

The interpretation map is shown in Fig.II-5-5. The schematic model of ore deposit is shown in Fig.II-5-7.

(Exciban-Larap Occurences)

In the area, north-south trend is dominant. Eocene, Universal Formation is distributed. The area is underlained by bedding of sandstone and shale, and basalt. The faults and joints with various directions were minutely observed. The gouge with pyrite was observed. The zones are cut every a few meters. The zonation of geothermal alteration was observed and massive suifide with dominantly pyrite are distributed. The sulfide is associated with a small amount of chalcopyrite and chalcocite, which shows high value of Au; 19.55ppm. The phenocrysts and veinlets of quartz, chlorite and epidote were observed and veinlet of pyrite dissemination was observed. The geochemical anomalies of Au-Cu deposit are concentrated from the silicification zone in the south of the area where mining adits are located, to the pocket-shaped silicification zone in the east to northeast of the area. The maximum value shows Au; 7.551ppm and Cu; 222.1ppm. And diorite is distributed nearby. Therefore, porphyry copper-type deposit or mesothermal vein-type deposit are expected.

The interpretation map is shown in Fig.II-5-6. The schematic model of ore deposit is shown in Fig.II-5-7.

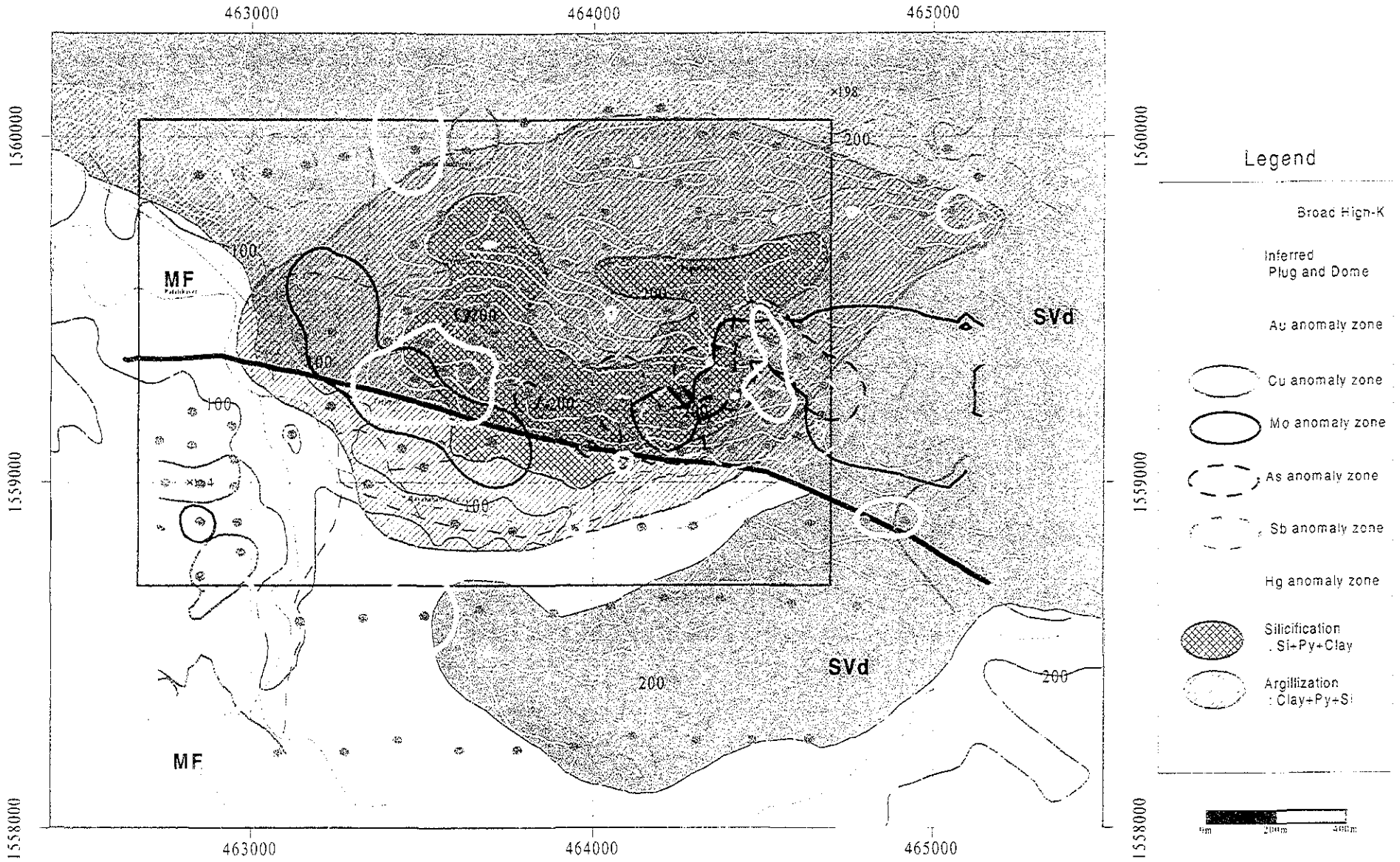


Fig.II-5-3 Interpretation Map of the Salubosogin-Yakalan Area.

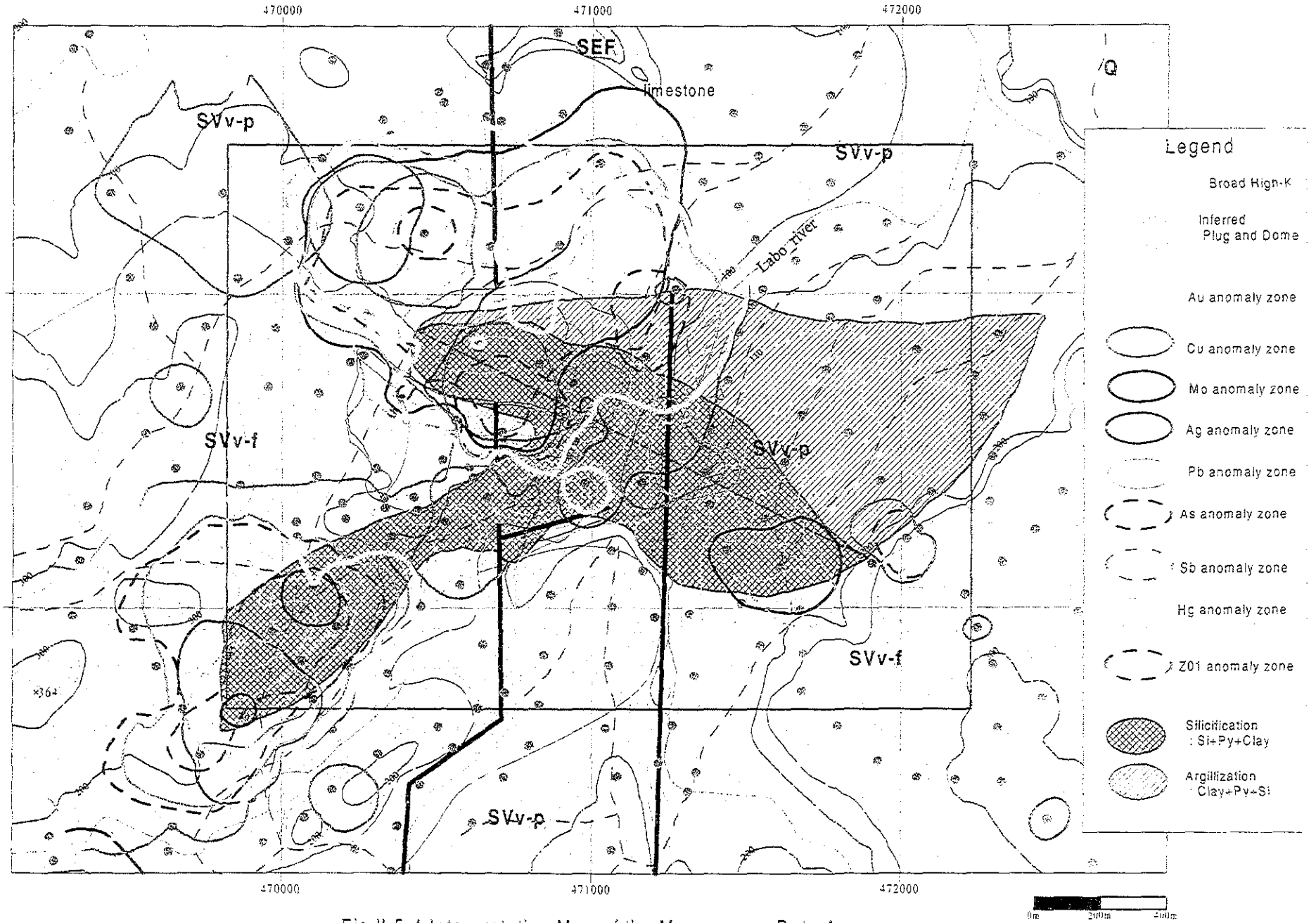


Fig.II-5-4 Interpretation Map of the Magasawan-Bato Area.

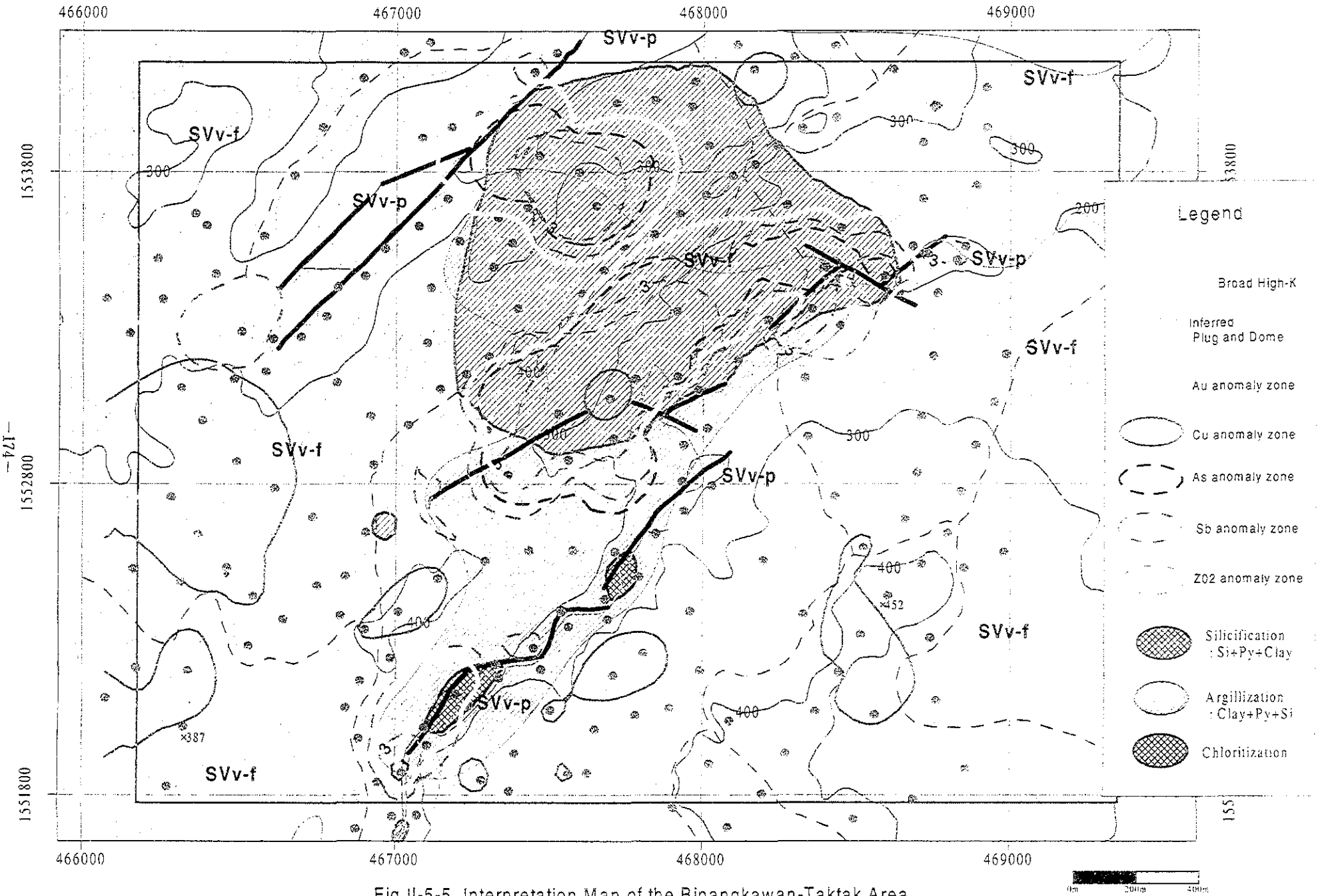
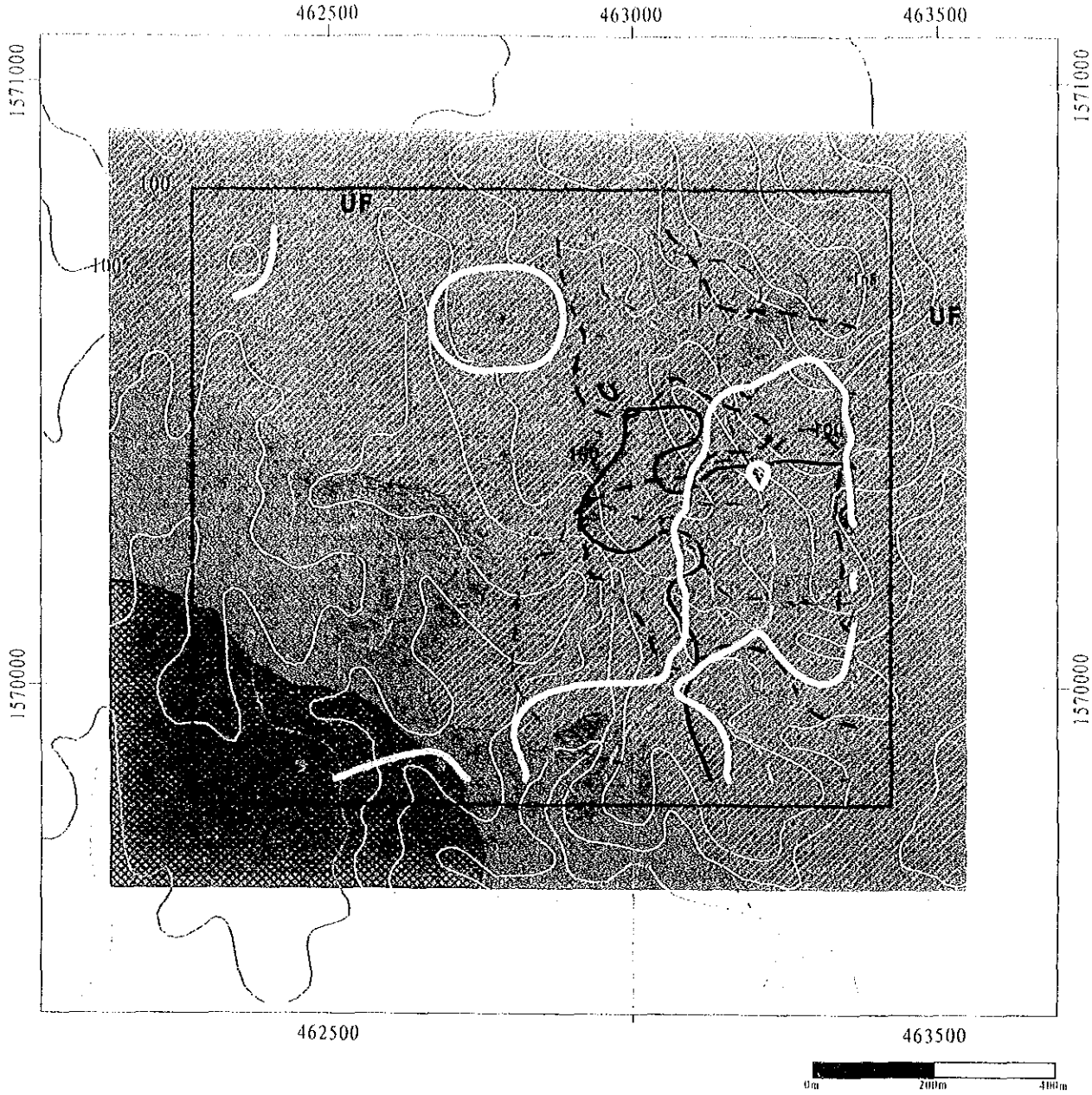


Fig.II-5-5 Interpretation Map of the Binangkawan-Taktak Area.



Legend

- Au anomaly zone
- Cu anomaly zone
- Mo anomaly zone
- Bi anomaly zone
- As anomaly zone
- Sb anomaly zone
- Z01 anomaly zone
- Z02 anomaly zone
- Silicification : Si+Py+Clay
- Argillization : Clay+Py+Si
- Prophyllitization : Ep+Chl+Py

Fig.II-5-6 Interpretation Map of the Exciban-Larap Area.

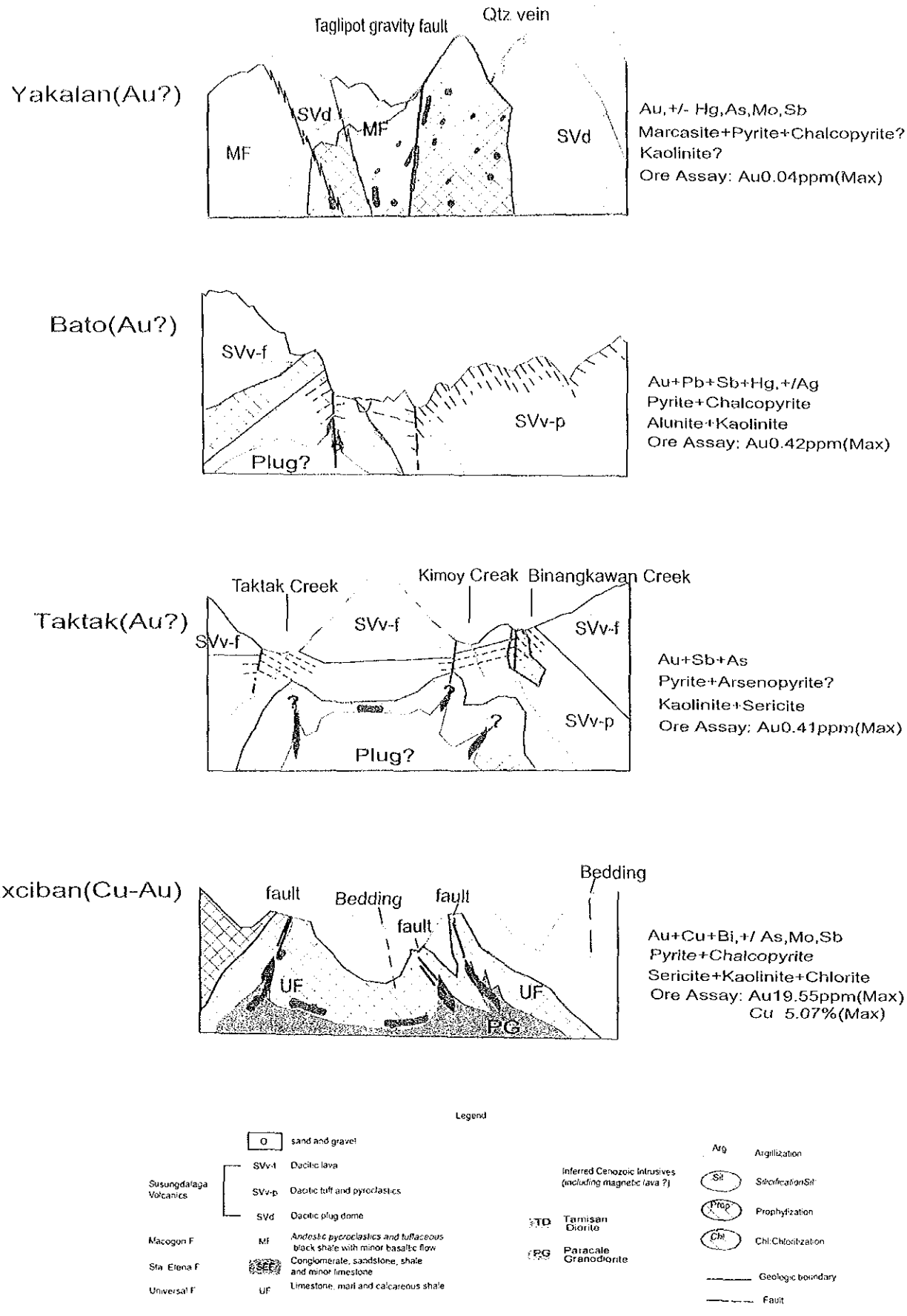


Fig. II-5-7 Schematic Model of Ore Deposit and Mineral Occurrences in the Bicol North Area