Chapter 2 Stream Sediment Geochemical Survey

2-1 Sampling and Chemical Analysis

Stream sediment geochemical survey was carried out in the first phase for the purpose of defining hidden mineralized zones which would otherwise be undetected by geological survey, as well as for clarifying the extensions of mineral occurrences encountered through the geological traverse.

Fine sand samples of -80 mesh were collected from sediments in big tributaries along the major drainage systems. The number of stream sediment samples collected during the survey this phase was 1,514, which corresponded to a sampling density of approximately one sample per 1.3 km^2. The samples, after being air-dried in the field, were analyzed at the Analytical and Experimental Center of GSV for 8 elements: Au, Ag, Cu, Pb, Zn, As, Sb, and Hg. The methods of analysis and limits of detection are shown in Table 2-5.

2-2 Statistical Data Processing

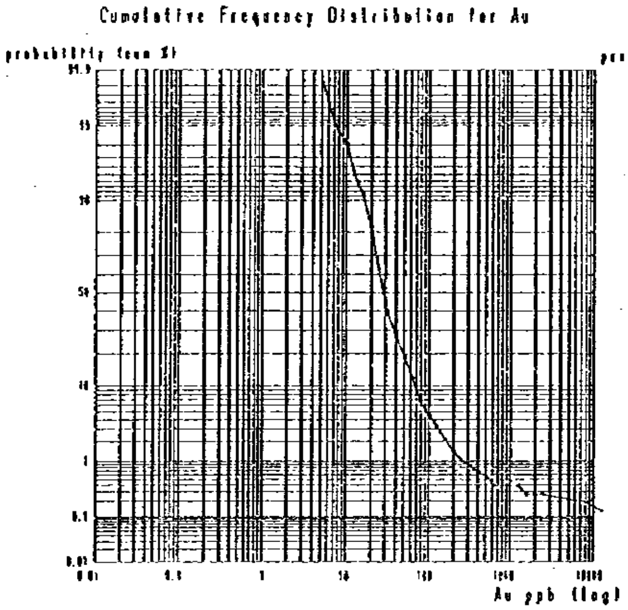
The distribution of geochemical data of some elements tends to show a close approximation to the logarithmic normal distribution in most cases. After the mode of distribution being examined, the common logarithmic conversion of the respective analytical values was adopted, if necessary, in the statistical data processing. When an analytical value was less than the detection limit, a value half of the lower limit was substituted in the calculation.

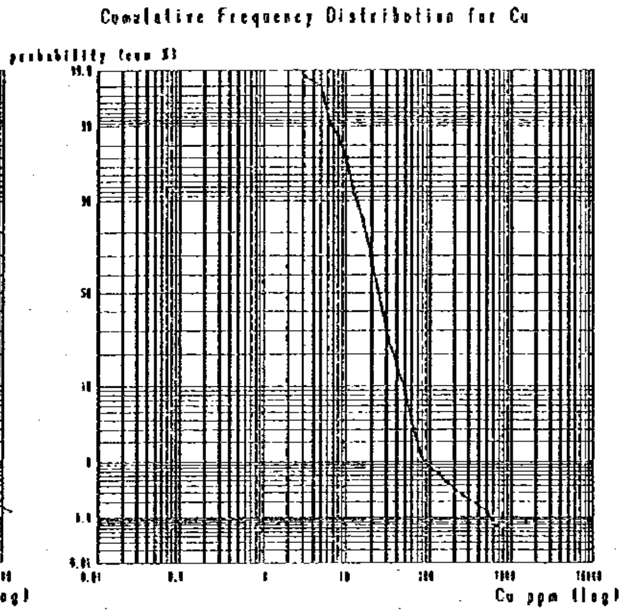
At first, statistical properties of geochemical data were checked. Basic statistical figures were calculated. Distribution histograms of each element were drawn out. Correlation coefficients among 8 elements were examined.

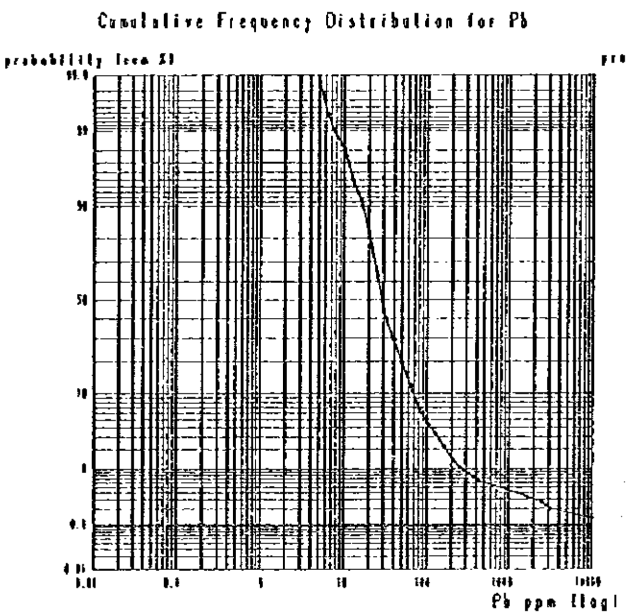
Then the selection of threshold values for anomalies was made. The cumulative frequency distribution of each element which showed the logarithmic normal distribution was plotted on the logarithmic probability graph using computer. If an element displayed any significant curvature, then the threshold was determined from the corresponding value on the curve. If any specific curvature was not recognized on the curve, then the threshold was calculated by the value of twice (or one time in some cases) the standard deviation added to the mean of the element. The thresholds of Au, Cu and Pb were obtained on the logarithmic probability graphs. While those of Ag, Zn, As, Sb and Hg were determined by the statistical calculation mentioned above.

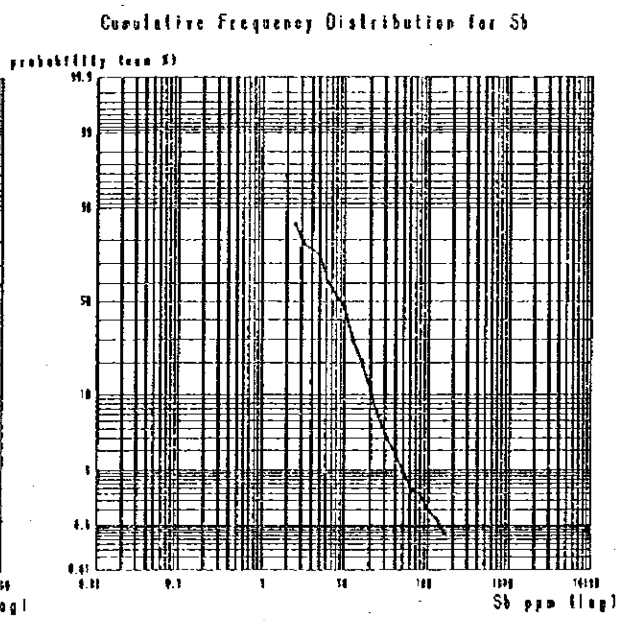
A series of maps showing geochemical anomalies of stream sediments for each element was produced. Values of each sample were expressed by one of two kinds of symbols (anomalous or non-anomalous) on the map. Geochemical anomalies for each element were cross-checked on the maps. The results of geological survey, especially those of the distribution of mineralized and alteration zones, were also referred. Gold mineralization and associated alteration were presented by the distribution of most of the analyzed elements in the stream sediment geochemistry. The Au anomalies of stream sediments were well-correlated with the occurrences of gold mineralized zones. The distributions of some other elements such as Ag, As and Hg also well-corresponded to the mineralized zones. The association of these geochemical elements was explained by the mineral assemblage of ores. Consequently these elements were thought to be good indicators of gold mineralization in this area. One strong Pb anomaly was detected in the Cuc Duong area (nothwestern area). Anomalies of the other elements such as Au and Zn accompany with the Pb anomaly. This anomaly was interpreted as the galena mineralization described in the section below.

These results were integrated together, and several significant anomalous zones were outlined. Several significant potential mineralized areas thus chosen are described in the next section. The distribution of geochemical anomalies was drawn by computer shown in the appendices.









Au, Cu and Pb have a distinctive curvature on the curve.
The other elements such as Sb, on the other hand, show no specific point.

Fig. 2-4 Cumulative Frequency Distribution Graphs of Stream Sediment Geochemistry

Table 2-4 Major Analytical Results of Stream Sediment Samples (1)

Sample No.	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	As ppm	Sb ppm	Hg ppm
A053	25	0.8	105	8,725	878	220	49	0.06
A054	23	1.0	111	9,925	922	271	54	0.05
A094	64	<0.2	42	45	133	2	4	<0.03
A213	500	0.5	78	112	111	91	16	0.12
A214	97	0.3	85	115	97	108	16	<0.03
A215	2,290	0.9	46	112	66	664	14	0.11
A216	250	0.7	28	52	41	122	23	0.05
A219	1,940	0.9	55	77	57	988	10	0.24
A220	418	0.3	72	400	30	311	11	0.03
A221	2,418	0.6	39	93	58	1,060	7	0.08
A223	571	0.2	56	91	66	71	14	0.03
A224	358	0.3	21	73	24	44	11	<0.03
A225	61	0.5	41	54	91	11	8	<0.03
A231	96	<0.2	29	26	24	<1	3	0.72
A232	65	<0.2	23	41	50	<1	6	0.29
A233	66	<0.2	23	125	34	<1	2	0.16
A238	112	<0.2	17	39	47	60	2	0.08
A239	1,272	0.2	23	50	29	708	8	0.16
A240	1,073	0.3	23	51	46	615	7	0.11
A241	714	0.2	30	56	56	298	11	0.07
A243	74	0.2	34	59	66	67	7	<0.03
A247	446	<0.2	23	36	17	19	11	<0.03
A252	589	<0.2	59	40	46	14	<1	0.10
A253	96	<0.2	33	59	69	50	<1	0.31
A256	1,036	0.3	27	34	33	135	1	0.20
A259	607	<0.2	24	26	36	38	7	0.05
A260	1,821	<0.2	24	31	37	48	5	<0.03
A261	194	<0.2	17	23	36	13	3	0.05
A264	642	<0.2	21	21	27	13	6	<0.03
A265	732	0.4	28	113	51	534	7	0.30
A266	714	0.3	21	100	38	472	6	0.10
A267	1,142	0.2	29	73	43	1,208	4	0.13
A268	1,411	0.2	30	77	39	1,021	9	0.09
A274	85	0.2	14	21	23	11	2	0.03
B008	90	<0.2	6	24	31	7	3	<0.03
B012	356	<0.2	18	17	16	22	5	<0.03
B013	432	<0.2	27	29	36	12	9	<0.03
B014	455	<0.2	21	23	32	6	9	<0.03
B016	315	<0.2	12	34	35	6	3	<0.03
B018	1,184	<0.2	83	29	49	333	13	<0.03
B020	526	<0.2	13	22	18	7	9	<0.03
B022	2,053	<0.2	123	34	51	710	17	<0.03
B024	1,474	<0.2	150	38	57	891	18	0.04
B026	947	<0.2	45	44	96	232	10	0.03
B027	1,316	<0.2	213	43	65	1,361	23	0.07

Table 2-4 Major Analytical Results of Stream Sediment Samples (2)

Sample No.	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	As ppm	Sb ppm	Hg ppm
B028	1,316	<0.2	146	35	48	1,199	21	0.04
B029	1,368	<0.2	220	43	63	1,421	24	0.06
B030	1,736	0.2	154	52	68	932	22	0.07
B031	7,211	0.5	510	69	100	7,013	70	0.16
B036	1,105	<0.2	28	37	30	162	16	<0.03
B037	1,789	<0.2	30	34	34	177	16	0.29
B038	12,295	0.4	30	40	36	1,421	16	0.94
B039	173	<0.2	32	33	48	76	9	0.09
B040	137	<0.2	24	25	32	43	13	<0.03
B042	88	<0.2	23	28	32	24	7	<0.03
B043	163	<0.2	20	28	35	11	7	<0.03
B044	134	<0.2	19	26	33	31	7	<0.03
B045	89	<0.2	20	20	30	11	7	<0.03
B063	62	<0.2	32	38	47	4	11	<0.03
B066	124	<0.2	36	34	38	49	11	<0.03
B119	157	<0.2	13	15	14	7	8	<0.03
B379	59	<0.2	30	23	37	2	3	0.12
C059	16	1.4	46	1,047	201	386	34	0.07
C061	20	1.1	75	3,055	431	397	28	0.04
C062	22	2.4	45	1,174	302	355	29	0.03
C063	106	<0.2	32	67	55	23	10	<0.03
C064	20	1.2	79	2,382	450	346	41	0.05
C297	2,054	<0.2	29	27	33	118	3	0.39
C299	80	<0.2	29	23	39	50	<1	<0.03
C309	70	<0.2	17	12	14	15	8	0.03
C313	74	<0.2	23	19	28	11	1	<0.03
C315	77	<0.2	20	18	25	10	<1	<0.03
C316	59	<0.2	24	22	28	17	5	<0.03
C323	200	<0.2	18	17	30	11	2	<0.03
C328	60	<0.2	18	13	18	12	4	0.03
C351	54	<0.2	17	13	23	6	5	<0.03
C373	98	<0.2	18	19	26	3	9	<0.03
C424	283	<0.2	15	6	5	6	1	<0.03
D074	201	<0.2	17	25	27	9	1	<0.03
D308	941	<0.2	32	42	47	225	<1	0.11
D309	294	<0.2	45	95	61	47	7	0.05
D311	735	<0.2	33	56	47	280	11	0.08
D312	529	<0.2	35	46	41	280	19	0.07
D314	588	<0.2	33	37	39	174	7	0.05
D315	232	<0.2	25	38	31	170	24	0.07
D316	51	<0.2	18	25	17	42	1	<0.03
D317	107	<0.2	18	38	41	142	17	0.05
D318	156	0.2	27	44	31	85	<1	0.04
D319	71	<0.2	30	37	34	72	6	0.04
D321	175	<0.2	25	32	33	129	<1	0.03

Table 2-4 Major Analytical Results of Stream Sediment Samples (3)

Sample No.	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	As ppm	Sb ppm	Hg ppm
D324	65	<0.2	21	55	26	65	4	0.10
D331	84	<0.2	15	28	29	33	2	<0.03
D335	586	0.3	41	168	67	82	15	0.09
D338	51	<0.2	18	44	26	38	4	<0.03
D340	53	<0.2	24	123	44	36	9	<0.03
D342	123	<0.2	22	49	35	31	10	<0.03
D343	71	<0.2	18	46	27	64	15	<0.03
D344	236	<0.2	36	31	30	166	20	0.04
D347	280	<0.2	28	29	32	136	14	0.08
D349	52	<0.2	26	25	24	16	5	0.06
D357	50	<0.2	19	24	15	27	5	0.03
D364	149	0.2	27	108	40	50	29	<0.03
D365	112	<0.2	13	28	17	32	5	<0.03
D366	1,238	0.8	27	161	30	110	101	0.16
D368	500	<0.2	20	90	38	54	14	<0.03
D370	112	<0.2	15	62	29	61	31	0.12
D421	92	<0.2	36	59	36	353	14	0.09
D422	625	<0.2	43	64	60	143	28	0.05
D424	286	<0.2	30	38	33	120	2	<0.03
D425	85	<0.2	40	41	60	62	20	0.23
D427	794	0.3	31	70	42	484	19	0.10
D428	647	<0.2	30	58	45	300	15	0.14
D429	1,500	<0.2	26	49	31	115	14	0.17
D430	353	0.2	46	70	44	824	27	0.40
D431	2,448	0.4	32	87	48	992	28	0.52

Table 2-5 Methods of Analysis and Limits of Detection of Stream Sediments Samples

Element	Method of Analysis	Detection Limit	Upper Limit
Au	Fire assay with AA finish	1ppb	10ppm
Ag	Total digestion with AA finish	0.2ppm	350ppm
Cu	Nitric aqua regia with ICP finish	1ppm	1%
Pb	ditto	1ppm	1%
Zn	ditto	1ppm	1%
As	HCl/KClO3 extraction with ICP finish	1ppm	1%
Sb	ditto	1ppm	1%
Hg	Total digestion with AA finish	0.03ppm	350ppm

*AA means Atomic Absorption method.

2-3 Anomalies of Stream Sediment Geochemistry

Upper Reaches of S. (Suoi) Ca: Numerous Au anomalies and several anomalies of As and Cu of stream sediments were found along the southern side of the upper reaches of S. Ca. They showed significant anomalous values: up to 7,211 ppb Au (B031), up to 7,013 ppm As (ditto) and up to 510 ppm Cu (ditto). Weak Ag and Hg anomalies were also detected in this area. The distribution of these anomalies is well-correlated with the remarkable panning anomalies. Gold-bearing quartz veins in the Khe Dui prospect of the Da Mai area are situated at the upstream of this anomalous zone. Another group of Au anomalies of stream sediments was also detected on the other (southern) side of the ridge of the Da Mai area.

Northeast of N. (Nui) Bo Cu: Intensive Au anomalies of stream sediments were detected along a branch of S. Ca which flows from Nui (mount) Bo Cu. The maximum values reached to 12,295 ppb Au (B038). A few anomalies of As (up to 1,421 ppm) occurs in the same zone. Panning anomalies also occur in this zone. This zone is situated to the east of the upper reaches of S. Ca anomalous zone.

Middle Reaches of S. Hoan: Extensive Au anomalies and several anomalies of Ag, As, Pb and Hg of stream sediments were detected in this zone. They showed significant anomalous values: up to 2,418 ppb Au (A221), up to 1,060 ppm As (ditto), etc.. Many panning anomalies are also concentrated in this zone. These anomalies occur within and along the downstreams of the Khe Gang, Khe Hoac and Cay Thi prospects of the Gang area, where gold-bearing quartz veins were found.

Upper Reaches of S. Ngan Me: From the lower reaches to the upper reaches of S. Ngan Me, a series of stream sediment anomalies was found continuously. They showed significant anomalous values: up to 2,448 ppb Au (D431), and up to 1,208 ppm As (A267). Extensive panning anomalies are also distributed. The Ba Khe prospects (Ba Khe, West Ba Khe, Upper Reaches of Ba Khe, etc.) of the Ngan Me area are located at the upstream of these anomalies.

Upper Reaches of S. Bai Vang: A couple of Au anomalies was discriminated along the upper reaches of S. Bai Vang. Although the level of Au anomalies is high (up to 2,054 ppb, C297), the other elements are comparatively low. A group of panning anomalies was also distributed in this zone. This zone is situated to the east of the Ngan Me area.

Cac Duong: Several strong Pb anomalies were discovered at Cac Duong in the northwestern area. The Pb anomalies reach to 9,925 ppm (A054). Au (up to 106 ppb, C063), Zn (up to 922 ppm, A054) and As anomalies are accompanied. Values of Ag and Hg are also slightly anomalous. Gold was observed in two pan concentrate samples in this zone.

2-4 Discussion

Several significant anomalous zones were outlined through the stream sediment geochemical survey this phase. The major anomalous zones thus defined are: upper reaches of S. Ca, northeast of N. Bo Cu, middle reaches of S. Hoan, upper reaches of S. Ngan Me, upper reaches of S. Bai Vang, and Cuc Duong.

Upper Reaches of S. Ca: Numerous Au anomalies (up to 7,211 ppb) and several anomalies of As (up to 7,013 ppm), Cu (up to 510 ppm), Ag and Hg of stream sediments were found. They are well-correlated with the remarkable panning anomalies. These anomalies were interpreted to be originated from gold-bearing quartz veins in the Da Mai area.

Northeast of N. Bo Cu: Intensive Au anomalies (up to 12,295 ppb) and a few As anomalies (up to 1,421 ppm) were detected. Panning anomalies also occur in this zone. The source of these anomalies was interpreted to be the eastern extension of gold mineralization in the Da Mai area.

Middle Reaches of S. Hoan: Extensive Au anomalies (up to 2,418 ppb) and several anomalies of Ag, As (up to 1,060 ppm As), Pb and Hg of stream sediments were detected. Many panning anomalies are also concentrated in this zone. These anomalies were interpreted to come from the gold prospects of Khe Gang, Khe Hoac and Cay Thi.

Upper Reaches of S. Ngan Me: Continuous stream sediment anomalies (up to 2,448 ppb Au, and up to 1,208 ppm As) were found from the lower reaches to the upper reaches of S. Ngan Me. Extensive panning anomalies are also distributed. These anomalies were interpreted to be originated from the gold-bearing quartz veins in the Ngan Me area.

Upper Reaches of S. Bai Vang: An Au anomalous zone (up to 2,054 ppb) of stream sediments was discriminated along the upper reaches of S. Bai Vang, where a group of panning anomalies was distributed. This zone is situated to the east of the Ngan Me area, and the source of the anomalies was interpreted to be the eastern extension of gold mineralization in the Ngan Me area.

Cac Duong: Several strong Pb anomalies (up to 9,925 ppm) were discovered at Cac Duong. Au (up to 106 ppb), Zn (up to 922 ppm), As, Ag and Hg anomalies are accompanied. Two panning anomalies were found in this zone. The geology of this zone is composed of the Bac Son limestone and Son Hiem shale, these are fault-contacted in the ENE-WSW direction. Wastes of lead smelting were found at the upper reaches of S. Cau Ran in this area. Based on these evidences, lead mineralization, probably that of galena vein type, may be exist in this anomalous zone.

The correspondence of metallic elements is well each other as far as the gold mineralization is concerned. Generally, they occur in the concentrated form at some small areas. As showed the best association with Au. Ag, Hg and in some area Cu follow to As. Unfortunately detection limits of Ag and Hg were considerably rougher than the required level.

Panning anomalies were matched almost exactly with the stream sediment anomalies in the survey area.

Chapter 3 Panning Survey

3-1 Sampling and Heavy Mineral Identification

Panning survey was carried out in the Bo Cu area in the first phase for finding alluvial mineral showings originated from gold and other mineralization zones.

Pan concentrate samples were collected from trap sites in every active branch channel about 50 to 100 m upstream from the junction. Three backetfuls of sand and gravel which were about 3 liters were gathered and carefully panned out. A traditional Vietnamese hexagonal pan was used. A panned sample of about 5 grams was obtained finally at every point. Fineness and number of gold grains were measured, and the heavy mineral composition was examined roughly by roupe in the field and systematically under the binocular microscope in the laboratory.

The procedure of gold and heavy mineral analysis is illustrated in Fig. 2-5. Four hundred and five panned samples were collected this phase in the Bo Cu area.

3-2 Occurrences of Gold and Heavy Minerals

Gold was detected in 133 samples either by naked eye in the field (66 of them) or under the microscope in the laboratory (120 of them). It stands nearly 33 percent of the total amount of samples obtained in the Bo Cu area. It is composed of coarse to very fine carat of gold up to 2.6 mm by 1.5 mm (B019P taken at S. Ca). Gold grains generally show a golden color, typical metallic luster, clean surface and rugged relief. They are anhedral, irregular particles. Some of them show a foliage-like shape; others a needle shape. The flaky grains are found in only 2 occurrences.

The major heavy minerals observed in pan concentrates are: zircon, rutile, ilmenite, garnet, tourmaline, apatite, leucoxene, siderite, monazite, anatase, corundum, magnetite, hematite, limonite and the other iron-oxides. Sulfide minerals such as pyrite, arsenopyrite, chalcopyrite, galena, sphalerite and cinnabar were found in pan concentrates mainly near mineralized zones. Other minerals identified in the panned samples under the microscope are: xenotime, chromite, psilomelane, brookite, sillimanite, diaspore, boemite, cassiterite, native copper, pyromorphite, native lead, and cerussite.

Some heavy and sulfide minerals display a good association with gold in pan concentrates. A small amount of tourmaline sometimes accompanied by gold. Arsenopyrite was observed in most samples in which gold was found. Chalcopyrite was detected in two samples in which gold was found along S. Ca. Pyrite was observed in most pan concentrates, and no particular association with gold has been recognized. Cinnabar was detected in 39 samples. Most of them are very small grains. Gold was counted in 12 out of the 39 samples;

it has not any intimate relationship. No silver mineral was found in pan concentrates in the Bo Cu area.

Galena was found in 6 samples. Three of them were obtained in the pan concentrates near the occurrences (or supposed occurrences) of galena veins: Cuc Duong (C064P), Deo Len Muc (C186P), and Tan Lap (C203P).

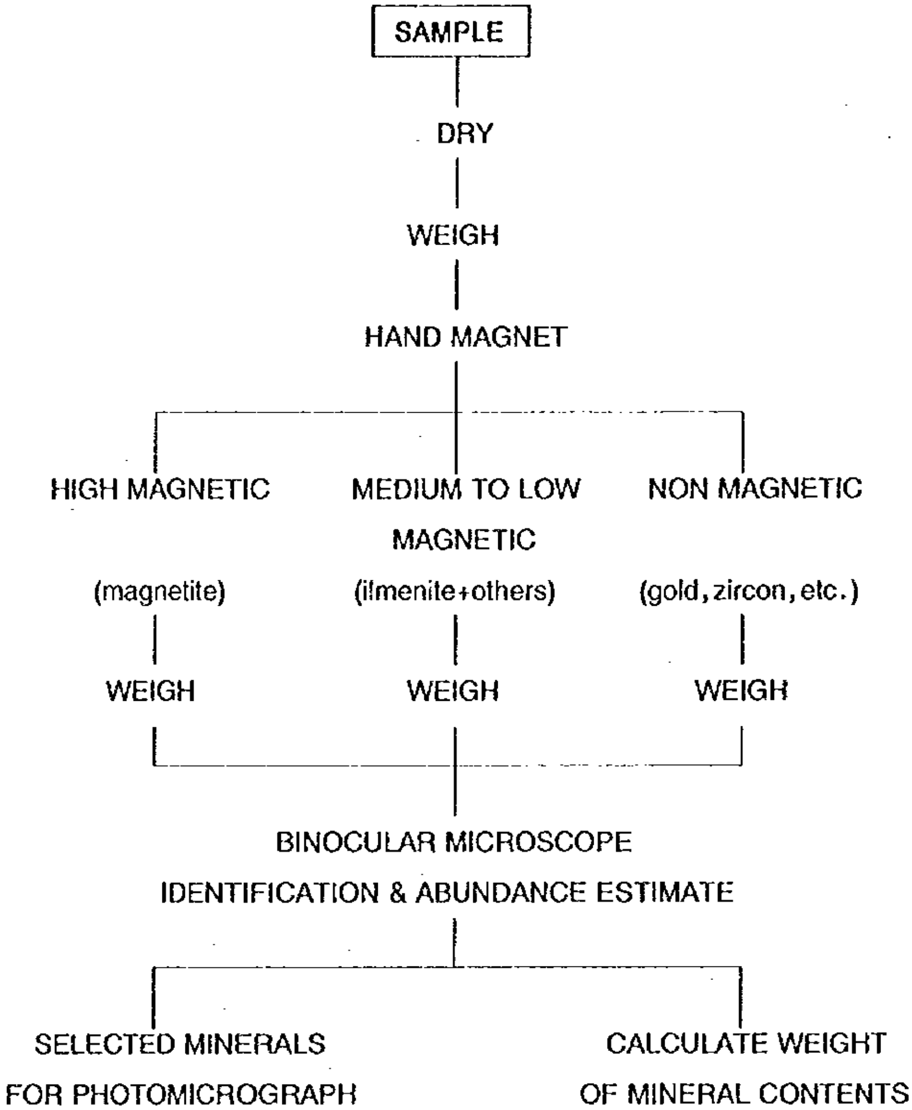


Fig. 2-5 Flow Chart of Gold and Heavy Mineral Analysis

3-3 Anomalies of Panning Survey

The major localities where gold, some indicator minerals for gold mineralization and other base-metal mineralization were detected by panning survey are the following places:

Upper Reaches of S. Ca: Many gold grains were obtained in almost all panned samples along the southern side of the upper reaches of S. Ca. Arsenopyrite was frequently found in the same samples. Chalcopyrite was detected in two samples. Gold-bearing quartz veins of the Da Mai area occur at the upstream of this anomalous zone. This panning anomalous zone almost overlaps to the stream sediment anomaly. Gold grains were also found in some pan concentrates along the upper reaches of S. Hoan situated at the other side of the ridge of the Da Mai area.

Northeast of N. Bo Cu: Gold grains were detected in almost all panned samples taken along a branch of S. Ca in this area. Arsenopyrite was found in two samples. Stream sediment anomalies also occur in this zone.

Middle Reaches of S. Hoan: Gold grains were obtained in some panned samples taken along S. Hoan and its branches (Khe Gang, Khe Hoac, Cay Thi, etc.). Arsenopyrite was found in some of the samples. The distribution of the panning anomalies almost overlaps to the stream sediment anomalies.

Upper Reaches of S. Ngan Me: Many panning anomalies comprising gold and arsenopyrite occur from the upstream to the downstream of S. Ngan Me.

Upper Reaches of S. Bai Vang: Gold grains were detected in nearly ten panned samples at the upper reaches of S. Bai Vang. Arsenopyrite was returned in two of them. A couple of stream sediment anomalies occur in this area as well. Several panning anomalies also occur at Xuan Luang and along S. Dien, both are situated to the east of the upper reaches of S. Bai Vang and in which alluvial gold is known.

Cac Duong: Gold grains were detected in three panned samples in this area. Galena and arsenopyrite were found in one sample each. It corresponds to the Pb and Zn anomalous zone of the stream sediment geochemistry.

The other localities where gold grains were detected in pan concentrates in the first phase survey are as follows:

·Khe Ma (a branch of S. Ca, situated to the east of the northeast of N. Bo Cu)
·Upper Reaches of Khe Can (a branch of S. Hoan)

·South of S. Mo Ga (nothwestern area)
·S. Ban Dac (northeastern area)
·S. Dong Voi (a branch of S. Trung)
·S. Canh Nau (a branch of S. Soi)
·S. Tan Thanh (southwestern area)
·S. Oc (southwestern area)

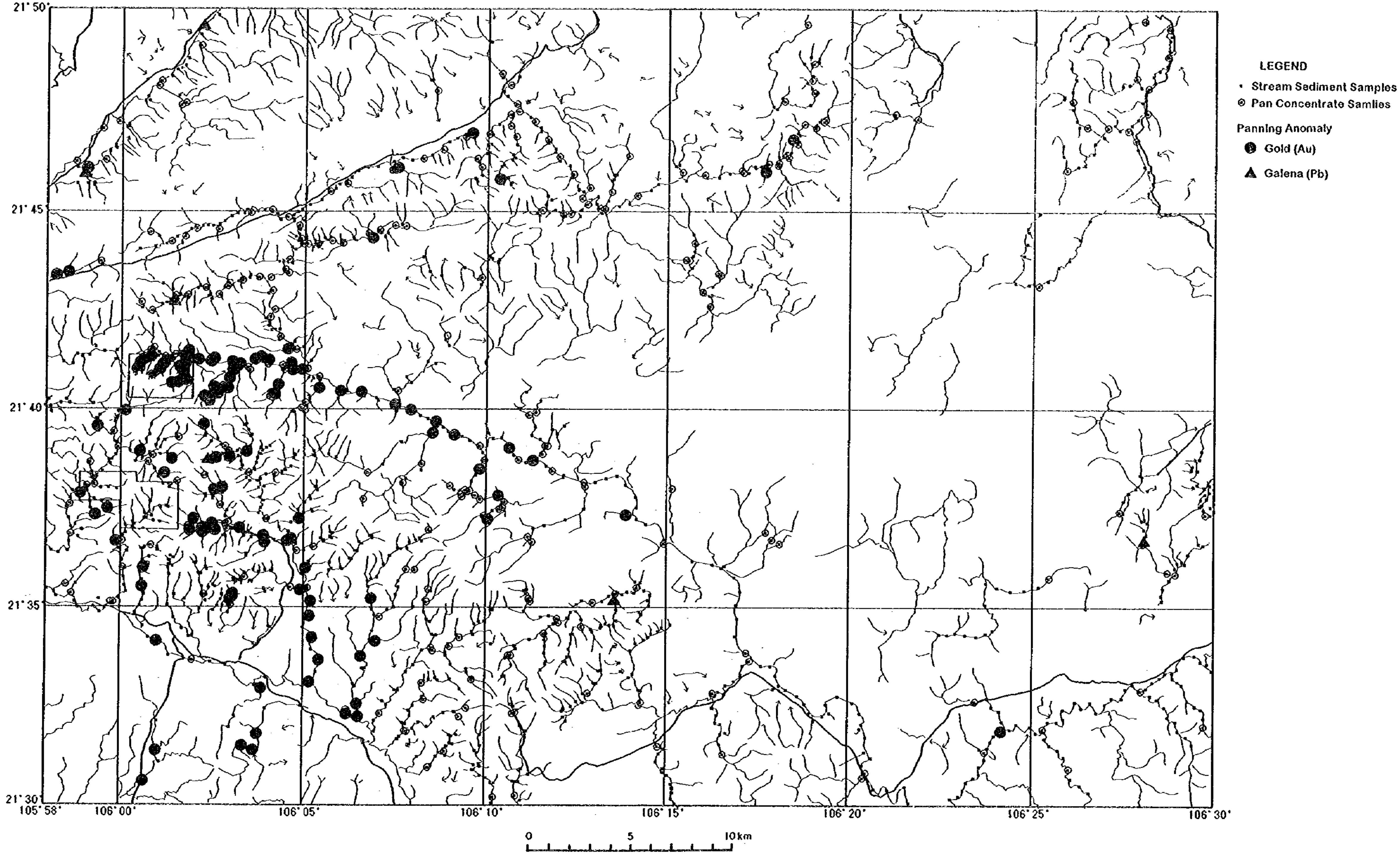


Fig. 2-6 Anomalies of Panning Survey in the Bo Cu Area

3-4 Discussion

Several significant anomalous zones were outlined through the panning survey this phase. The major anomalous zones thus defined are: upper reaches of S. Ca, northeast of N. Bo Cu, middle reaches of S. Hoan, upper reaches of S. Ngan Me, upper reaches of S. Bai Vang, and Cac Duong.

Upper Reaches of S. Ca: Many gold grains frequently accompanied by arsenopyrite and some by chalcopyrite were obtained in almost all panned samples in this locality. This panning anomalous zone almost corresponds to the stream sediment anomalous zone, and was interpreted to be originated from gold-bearing quartz veins of the Da Mai area.

Northeast of N. Bo Cu: Gold grains were detected in almost all panned samples taken along a branch of S. Ca in this area. Arsenopyrite was found in two samples. This panning anomalous zone almost corresponds to the stream sediment anomalous zone, and was interpreted to be the eastern extension of gold mineralization in the Da Mai area.

Middle Reaches of S. Hoan: Gold grains and arsenopyrite were obtained in some panned samples. The distribution of the panning anomalies almost overlaps to the stream sediment anomalies. These anomalous zones were interpreted to be originated from the gold-bearing quartz veins in the Gang area.

Upper Reaches of S. Ngan Me: Many panning anomalies comprising gold and arsenopyrite occur from the upper reaches to the lower reaches of S. Ngan Me, and was interpreted to come from the gold-bearing quartz veins in the Ngan Me area.

Upper Reaches of S. Bai Vang: Gold grains and arsenopyrite were detected in ten and two panned samples respectively at the upper reaches of S. Bai Vang, where a couple of stream sediment anomalies occurs. This anomalous zone is located to the east of the Ngan Me area, and the source of anomalies was thought to be the eastern extension of gold mineralization in the Ngan Me area.

Cac Duong: Gold grains were detected in three panned samples. Galena and arsenopyrite were found in one sample each. It corresponds to the stream sediment anomalous zone. As mentioned in the chapter of stream sediment survey, these panning anomalies may indicate the existence of galena veins in this area.

The other localities where gold grains were detected in pan concentrate samples in the first phase survey are: Khe Ma, upper reaches of Khe Can, south of S. Mo Ga, S. Ban Dac, S. Dong Voi, S. Canh Nau, S. Tan Thanh, and S. Oc. Khe Ma is located to the east of the northeast of N. Bo Cu anomalous zone, and the gold mineralization of the Da Mai area is expected to extend to this localities for nearly 5 km. Gold grains and some arsenopyrite were detected along the upper reaches of Khe Can. It is situated to the east of the Gang area. Several gold anomalies in pan concentrates were also detected along Khe Cam, a branch of S. Bai Vang and located to the far east of the upper reaches of the

Khe Can anomaly. Gold mineralization is expected to occur between the upper reaches of Khe Can and Khe Cam. Regarding the other six localities, some were interpreted to be accompanied by alluvial gold occurrences. Others were thought to be originated from gold-bearing quartz veins because quartz floats were seen near the panning anomalies.

Gold was detected in 133 samples either by naked eye in the field or under the microscope in the laboratory. It is composed of coarse to very fine carat of gold up to 2.6 mm by 1.5 mm. Gold grains generally show a golden color, typical metallic luster, clean surface and rugged relief. They are anhedral, irregular particles. Some of them show a foliage-like shape; others a needle shape. The flaky grains were occasionally found. From these features, gold grains in the Bo Cu area was thought to have been transported not far from the source.

Some heavy/sulfide minerals displayed a good association with gold in pan concentrates, and those associations can be explained by the mineral assemblage of gold-bearing quartz veins in the Da Mai, Gang or Ngan Me areas. Tourmaline and arsenopyrite showed a significant correspondence with gold. Chalcopyrite showed some intimate relationship with gold. Whereas, cinnabar did not show any relationship with gold in this area.

Galena was found in 6 samples. Three of them were from the pan concentrates near galena veins.

The results of panning survey were well-matched with the results of stream sediment geochemical survey this phase.

Chapter 4 Detailed Geological Survey

4-1 Introduction

Gold-bearing quartz veins are developed in five areas: Da Mai, Gang, Ngan Me, Cay Thi, and Bai Vang. These were regarded to be a mesothermal gold deposit. The occurrence of gold-bearing quartz veins in the Da Mai, Gang (including Cay Thi) and Ngan Me areas was surveyed in the first phase.

Quartz veins are hosted mainly by sandstone and sericite schist of the Mo Dong Formation, and partly - those in the southern part -- by sandstone and schist of the Than Sa Formation. Quartz veins generally show E-W, WNW and ENE trend. Two groups were distinguished in the dips: steep S dip and gentle S dip. The width of each quartz vein changes variously, ranging from a few centimeters up to 2 m. Tiny gold grains are observed by naked eye in some localities. Gold is sometimes accompanied by sulfide minerals; pyrite and arsenopyrite are the two most common minerals. Weak sericitization and chloritization were commonly observed in the host rocks beside the quartz veins. The major occurrences of gold-bearing quartz veins are described in the following sections with some representative sketches of 1:50 to 1:100 scale.

The number of samples collected in the survey are: more than 100 ore samples for assaying, 40 vein and alteration zone samples for X-ray diffraction analysis, 31 ore samples for ore mineralogy, and 11 quartz samples for fluid inclusion studies. The results of these studies are shown in Tables 2-6 to 2-10. The Schumidt's stereo net projections of quartz veins are illustrated in Fig. 2-13. The results of the fluid inclusion studies are explained in a section below.

4-2 Da Mai Area

Tens of quartz vein outcrops and people's mining pits/adits are distributed on the flank and up to the top of the ridge (about 400 m above sea level) in the Da Mai area. The local people's mining activity in the Da Mai area has a relatively long history among the other areas in the Bo Cu area. The Division No. 1 of GSV started survey in 1988, and saw several mining pits/adits dug at a creek (now called the East Da Mai creek). The people's activity may be looked back to 1985 or earlier. In 1990, the Division No. 1 made trenching survey in this area, and found some new quartz veins. A few months later, local miners rushed to the new veins, and a couple of mining camps was established along the creek and on the flank of the ridge.

Gold-bearing quartz veins in the Da Mai area are hosted by sandstone, shale and sericite schist of the Mo Dong Formation. The width of veins ranges from a few centimeters to 1 m. The major trend of vein systems is E-W to ENE. Most of the veins dip steeply to S with some exceptions of the N-dip. The average strike and dip of quartz veins is N79°E, 77°S by the stereo net analysis (Fig. 2-13). Gold is generally accompanied by a small amount of sulfide minerals. Arsenopyrite and pyrite are the two most common sulfide minerals; chalcopyrite and covelline were occasionally found in a bonanza of gold. The vein quartz in the Da Mai area is characterized by grayish color. It is probably caused by the sulfide content. The host rock beside the vein is slightly altered. The major alteration minerals are quartz and sericite.

The major prospects in the Da Mai area are: Da Mai (at the southern side of the ridge), Khe Dui (at the northern side of the ridge), and Goc Sen (at the top of the ridge). The Khe Dui prospect is situated 1 km east-northeast of the Da Mai prospect. Veins in these two prospects show the similar ENE trend. At the other side of the Da Mai prospect over the ridge (along a branch of S. Ca), there is another group of quartz veins named North Da Mai. Local people recently started mining there. Based on the results of geochemical survey, the gold mineralization of the Da Mai area extends to the east through the Northeast of N. Bo Cu until Khe Ma for approximately 5 km.

The details of the occurrences of quartz veins in the major prospects are described as follows.

Da Mai: Gold-bearing quartz veins occur at two localities - East Da Mai creek and West Da Mai creek - in the Da Mai prospect. The East Da Mai creek is the oldest mining place in the Bo Cu area. More than ten old adits are distributed along the creek. The veins are subdivided into three groups: ENE, E-W, and NW. They commonly dip 80 degrees to S. Shallow part of the veins have been almost mined out. Only low-grade ores remain now. According to the Division No. 1 data, gold assays up to 36.38 g/t Au at 90 cm in width were returned. The West Da Mai Creek is the new people's mining place. Several adits were dug on the slope of the creek near the ridge. The veins trend E-W to WNW in this creek. They generally dip either S or N at about 60 degrees. Some veins dip gently. Quartz veins up to 1 m in width were found there. The glade of gold is rather low. The host rock adjacent to veins were sheared.

Khe Dui: Along Khe Dui (a branch of S. Ca), many gold anomalies were detected during the geochemical survey this phase. More than ten shafts, adits and prospecting pits are distributed along the upstream of the Khe Dui creek. The quartz veins in the Khe Dui prospect are arranged in the ENE-WSW direction for about 500 m. They generally dip to S at 60 to 80 degrees. The host rocks are sandstone and schist. Sheared, argillized and sulfide disseminated zones were sometimes observed along the veins.

Goc Sen: The Goc Sen prospect is located 500 m due south to the Khe Dui prospect. Several shafts and pits were dug at and near the top of the dividing ridge whose altitude is about 400 m above sea level. Quartz veins trend nearly E-W with a steep S dip. The mining activity has just started in this prospect, and every shaft/pit is still shallow. Gold grains were observed in one of ore samples collected in the Goc Sen prospect under the microscope. This sample contains a significant amount of arsenopyrite. A small amount of pyrite, pyrrhotite, galena and tetrahedrite was observed in the gold-rich part together with arsenopyrite under the microscope.

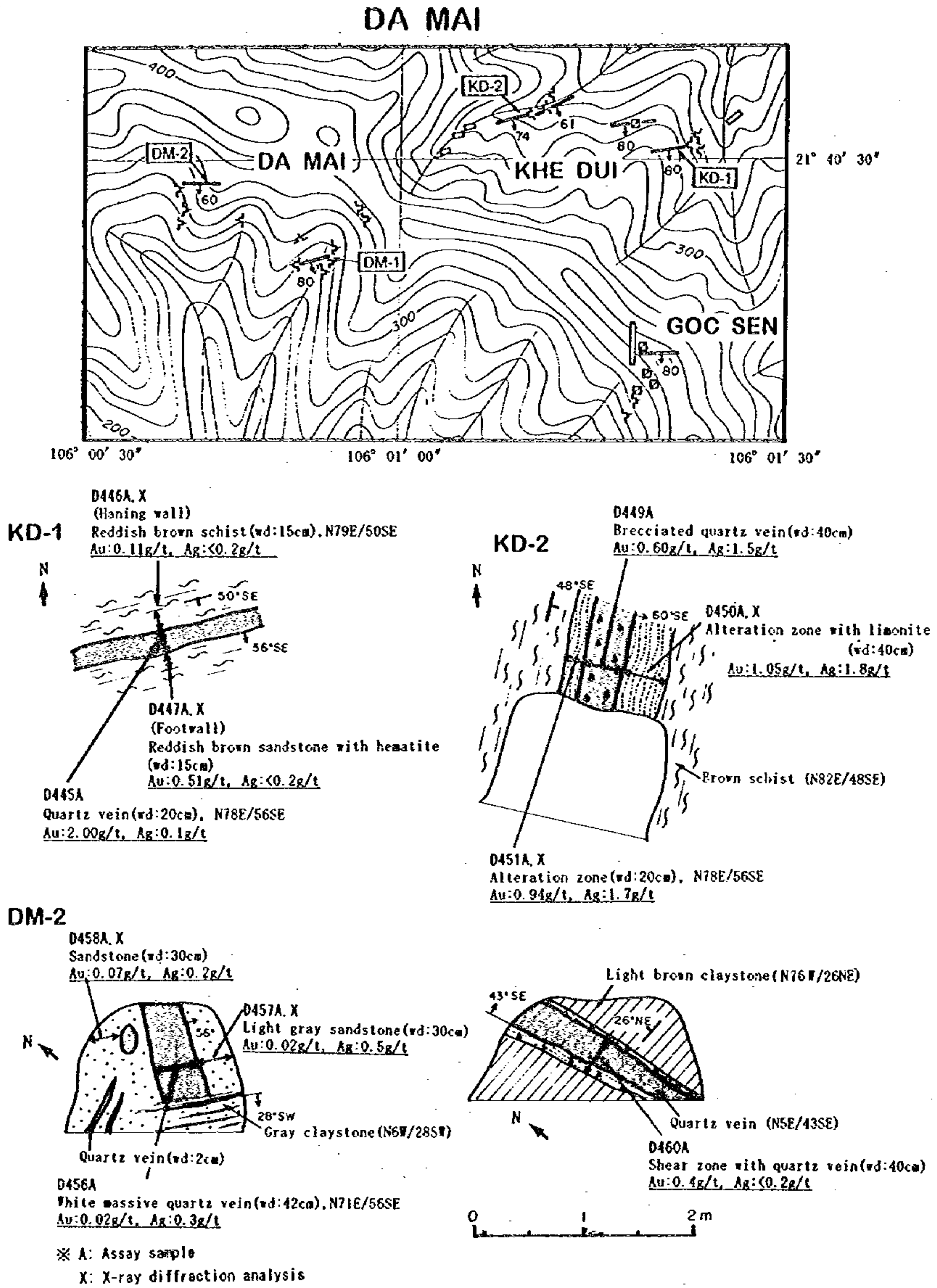


Fig. 2-7 Sketch of Quartz Veins in the Da Mai Area

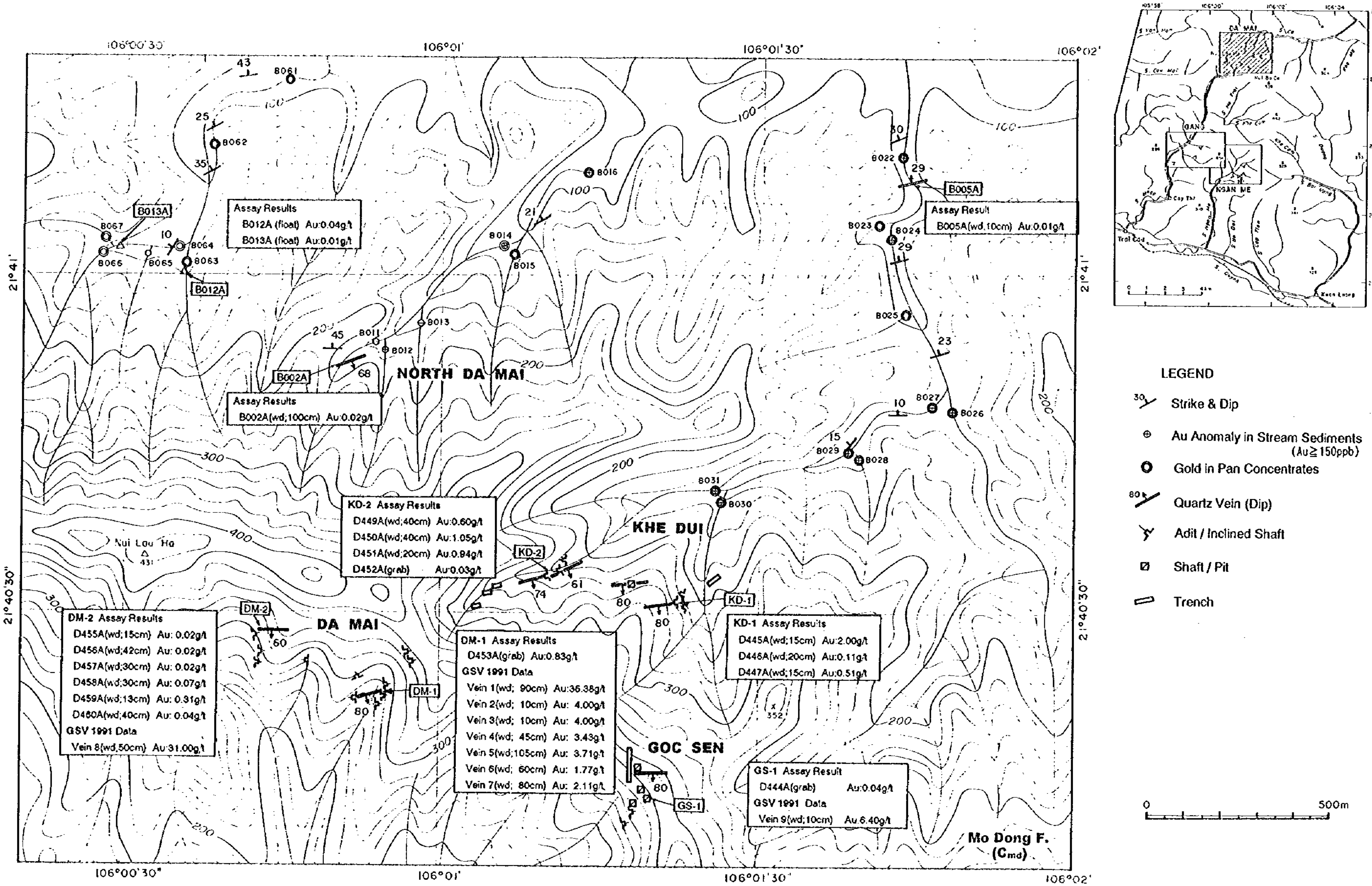


Fig. 2-8 Results of the Detailed Survey in the Da Mai Area

4-3 Gang Area

The Gang area, which lies along the middle reaches of S. Hoan, had been known to local people as an alluvial gold mining place in the past. The first quartz vein containing gold has been discovered by a local prospector at the Khe Gang creek in 1987, and hard rock mining started.
Since then, numerous quartz veins have been found and tens of shafts and adits were dug over the area.

Gold-bearing quartz veins in the Gang area are hosted by sandstone, shale, sericite schist and black slate of the Mo Dong and Than Sa Formations. The width of veins ranges from about 10 cm to 1 m. The major trend of vein systems is E-W to WNW. Most of the veins dip gently to S. Veins of N-S and NE systems locally occur. The average strike and dip of quartz veins is N87°E, 28°S by the stereo net analysis (Fig. 2-12). This vein structure is concordant to the general trend of the bedding of the host sediments in the Gang area. However, some veins crosscut the host bedding at a narrow angle. Gold is generally accompanied by some sulfide minerals. Pyrite and arsenopyrite are the two major sulfide minerals. Other sulfide minerals found under the microscope are: chalcopyrite, covelline, and pyrrhotite. The host rocks beside the vein are slightly altered. Silicification and sericitization are the major wall-rock alteration. Chloritization and kaolinization were locally observed.

The major prospects in the Gang area are: Khe Gang (a branch of S. Hoan), Khe Hoac (another branch south of Khe Gang), and Cay Thi (the next branch south of Khe Hoac). The G-1 vein which was discovered by the Division No. 1 in 1992 is located about 1 km northwest of the Khe Gang prospect. This vein has the trend of N-S to NNW strike with the dip of 60°W. Assay results up to 29.77 g/t Au at 50 cm in width were obtained. Another vein called G-2 was known approximately 500 m upstream of the Khe Gang creek from the Khe Gang prospect. The G-2 vein shows E-W system dipping 20°-35°S.

The details of the occurrences of quartz veins in the major prospects are described as follows.

Khe Gang: More than 20 shafts (vertical and inclined) were dug over an area of 800 m long by 100 to 200 m wide stretching E-W along the southern side of the Khe Gang creek. The host rocks are sandstone and schist of the Mo Dong Formation. The veins generally strike E-W and dip gently to S (at 20° to 40°). The widths of veins are up to 1 m. One of quartz samples collected in the Khe Gang prospect contains a significant amount of sulfide minerals. A mineral assemblage comprising pyrite, arsenopyrite, pyrrhotite, chalcopyrite, covelline, bornite and galena was observed under the microscope. The activity of local miners is almost at the waning stage now.

Khe Hoac: The Khe Hoac prospect is located at the northern side of Khe Hoac which is the next creek south of Khe Gang. There are more than 10 shafts and adits spreading from WNW to ESE for about 500 m. Quartz veins are hosted by sandstone and shale of either the Mo Dong or Than Sa Formation. This prospect is located along the boundary of these two formations. The widths of veins are 10 to 55 cm. Some quartz samples contain visible gold grains. The vein quartz has a chalcedonic to transparent clear appearance, partly showing rose or pearl color. A trace of sulfide, mainly pyrite, was observed in this part. The gold shows an aggregate of tiny particles, some big one exhibits a shrunken foliage-like shape.

Cay Thi: The Cay Thi prospect is located approximately 1 km WSW of the Khe Hoac prospect. About 50 shafts and pits are distributed from the creek to the top of hills in this area. They are arranged in an area of 500 m long by 100 to 200 m wide. The zone is stretching WNW to ESE. They are hosted by black slate, shale, siltstone and schist of the Than Sa Formation. Two zones of quartz veins were found; both are dipping gently to S (at 20° to 30°). The upper zone, consisting of several quartz veins, is hosted by shale and siltstone. The lower zone, comprising a few quartz veins, occurs within gray to black slate. These two zones run parallel at 40 m apart. Some significant assay results were obtained from quartz veins in the Cay Thi prospect. The best result is 20.23 g/t Au at 10 cm in width (D393A). This is from the quartz vein of 5 cm in width + shear zones of a few cm at both sides. The vein shows N70°W, 20°S. It is hosted by light brown schist. The mode of occurrence of this vein is shown in Fig. 2-9.

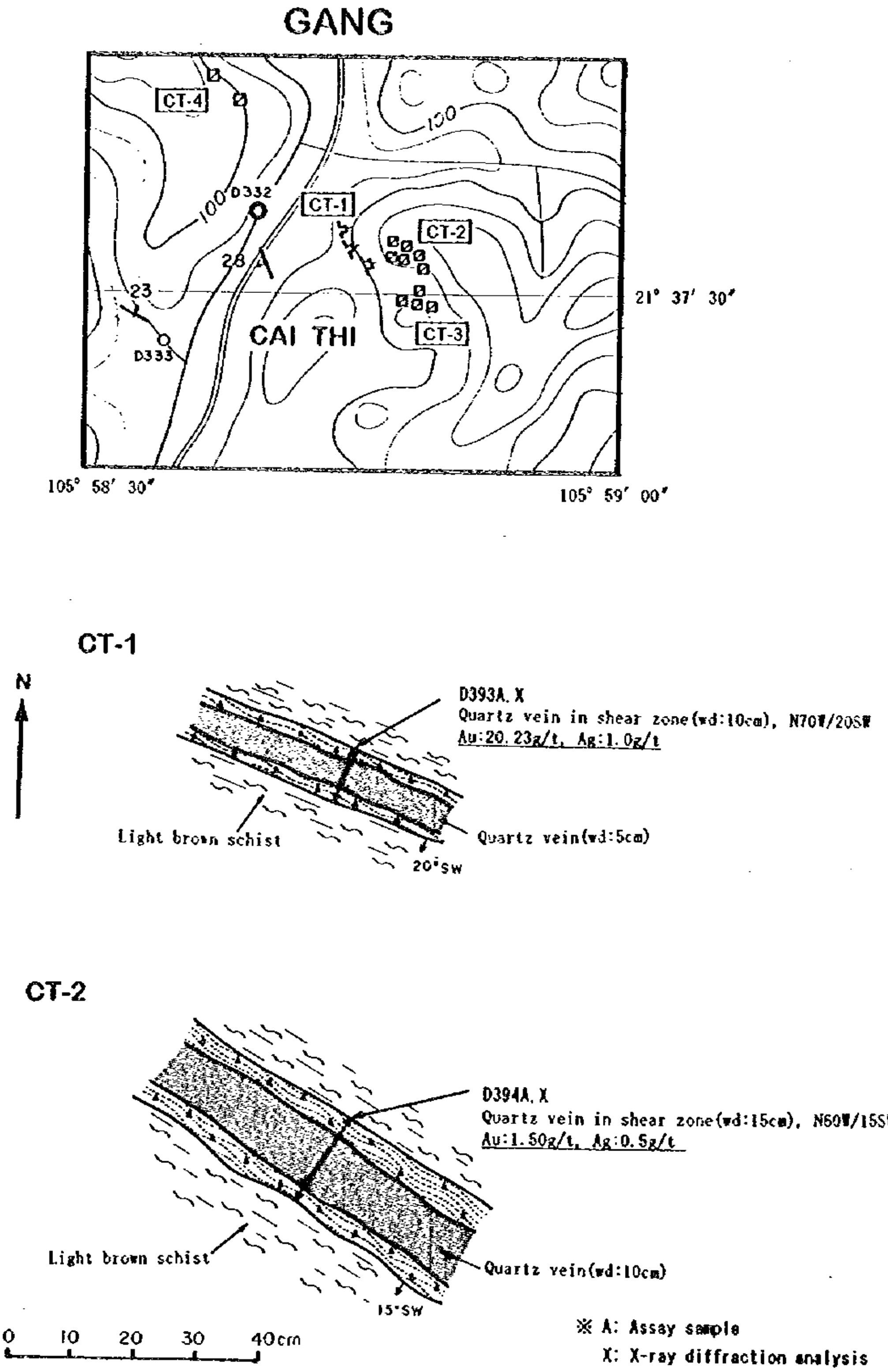


Fig. 2-9 Sketch of Quartz Veins in the Gang Area

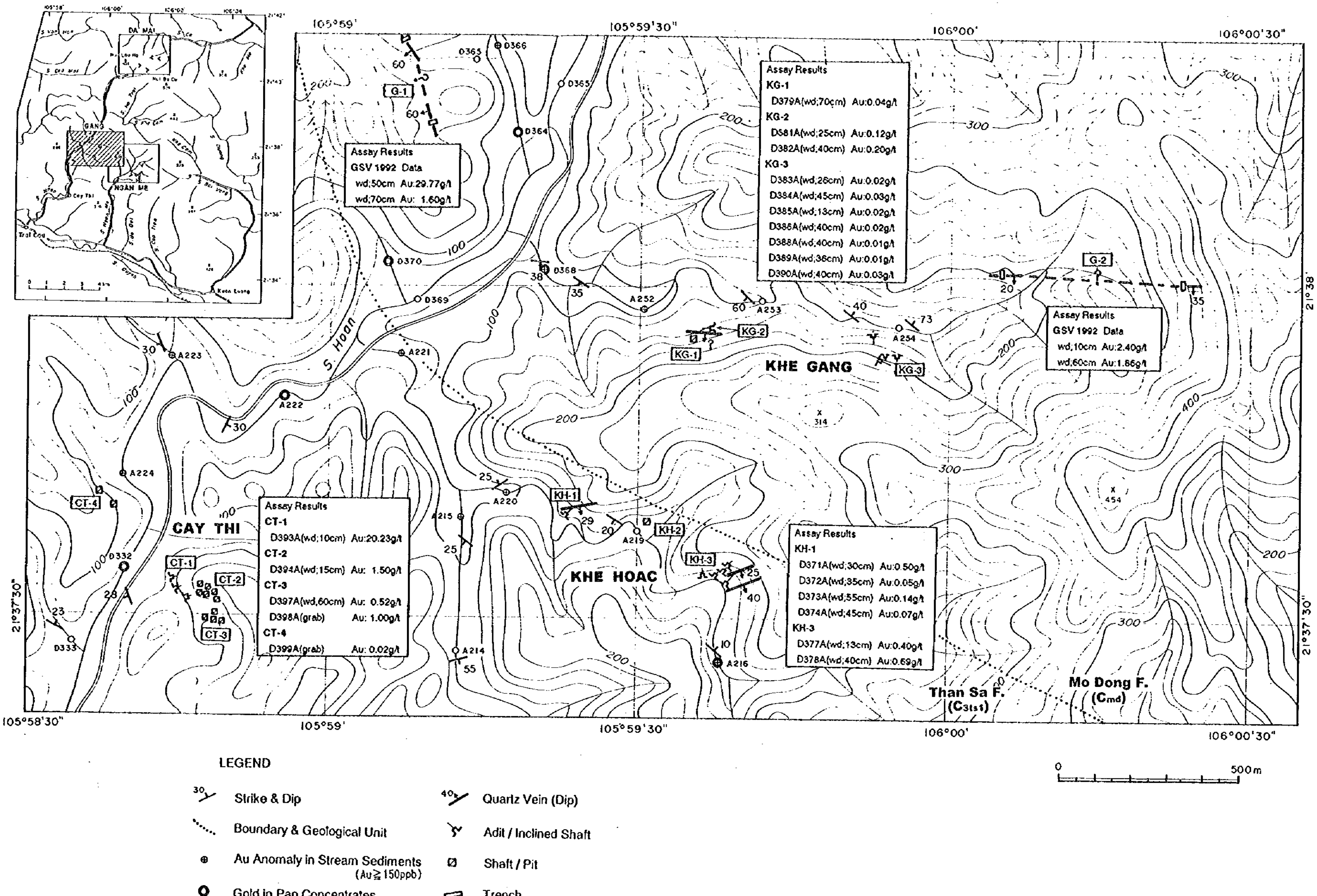


Fig. 2-10 Results of the Detailed Survey in the Gang Area

4-4 Ngan Me Area

The Ngan Me area is located some 2.5 km east of the Gang area. Local miners came to this area in 1989, and mining activities started. The Division No. 1 made a survey (including trenching) from 1990 for about two years. Major gold-bearing quartz veins occur near Ba Khe (which means a junction of tree creeks) which lies at the upper reaches of S. Ngan Me. The other localities where many quartz veins occur are: an area between the Left Ba Khe creek and the Middle Ba Khe creek , and the West Ba Khe creek. These groups of quartz veins contain some gold although any systematic sampling has not been done yet.

Gold-bearing quartz veins in the Ngan Me area are hosted mainly by sandstone, shale and phyllite of the Mo Dong Formation. The geology of the southwestern corner of the Ngan Me area consists of sandstone, phyllite and schist of the Than Sa Formation (lower member). Host rocks of the West Ba Khe zone belong to the Than Sa Formation. The width of veins changes place to place from a few centimeters up to 2 m. Veins often show a lens-like shape. The main trend of vein systems is E-W to ENE. Two groups of veins - one is steeply dipping to S, and another is gently dipping to S - were distinguished on the basis of the stereo net analysis as shown in Fig. 2-13. The content of sulfide minerals in quartz veins is rather little comparing to the other areas. A small amount of pyrite was seen in some veins. A trace of arsenopyrite, pyrrhotite, chalcopyrite, covelline, sphalerite, galena was observed in some part of the veins. Host rocks beside the veins are sheared and slightly altered. The major alteration observed in the country rocks are: silicification, sericitization, and chloritization. Based on the results of geochemical survey this phase, significant gold anomalies were found along the upper reaches of Bai Vang which is located about 2 km due east of the Ba Khe prospect.

The mode of occurrence of quartz veins in the major prospects are described as follows.

Ba Khe: Many local people are currently working in the Ba Khe prospect. More than fifty adits, cross-cuts and inclined shafts are distributed in the direction of E-W along the upper reaches of S. Ngan Me for about 900 m. Quartz veins are hosted by black phyllite and sandstone of the Mo Dong Formation. The width of quartz veins changes variously; some part show a lens-like shape. Branching and joining of quartz veins were frequently observed. At the eastern end of the creek there are several quartz veins cropped out on the river bed. Native gold grains were found from one of the samples collected at that locality. A small amount of pyrite with a trace of other sulfide minerals such as chalcopyrite, sphalerite and galena was recognized near the gold grain under the microscope.

Left Ba Khe-Middle Ba Khe: Numerous quartz veins occur at the upper reaches of the Middle Ba Khe creek and also upper reaches of the Left Ba Khe creek. Quartz veins generally show massive features. The width reaches up to 2 m. Some of them contain a significant amount of sulfides - mainly pyrite. The Left Ba Khe zone is situated about 700 m west of the Middle Ba Khe zone. These two localities are arranged in a one zone running nearly E-W. Gold assays from these quartz veins were low this time.

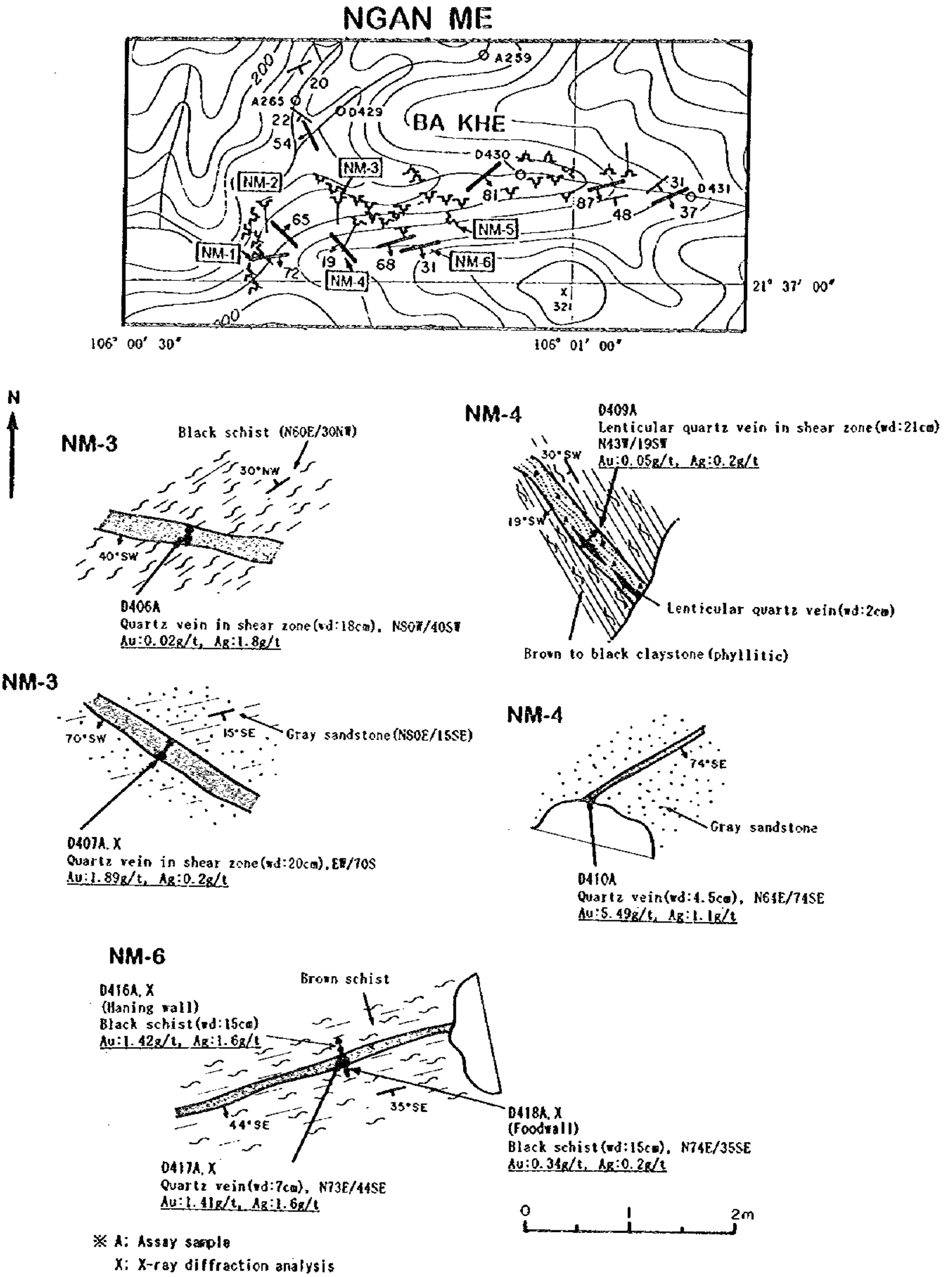


Fig. 2-11 Sketch of Quartz Veins in the Ngan Me Area

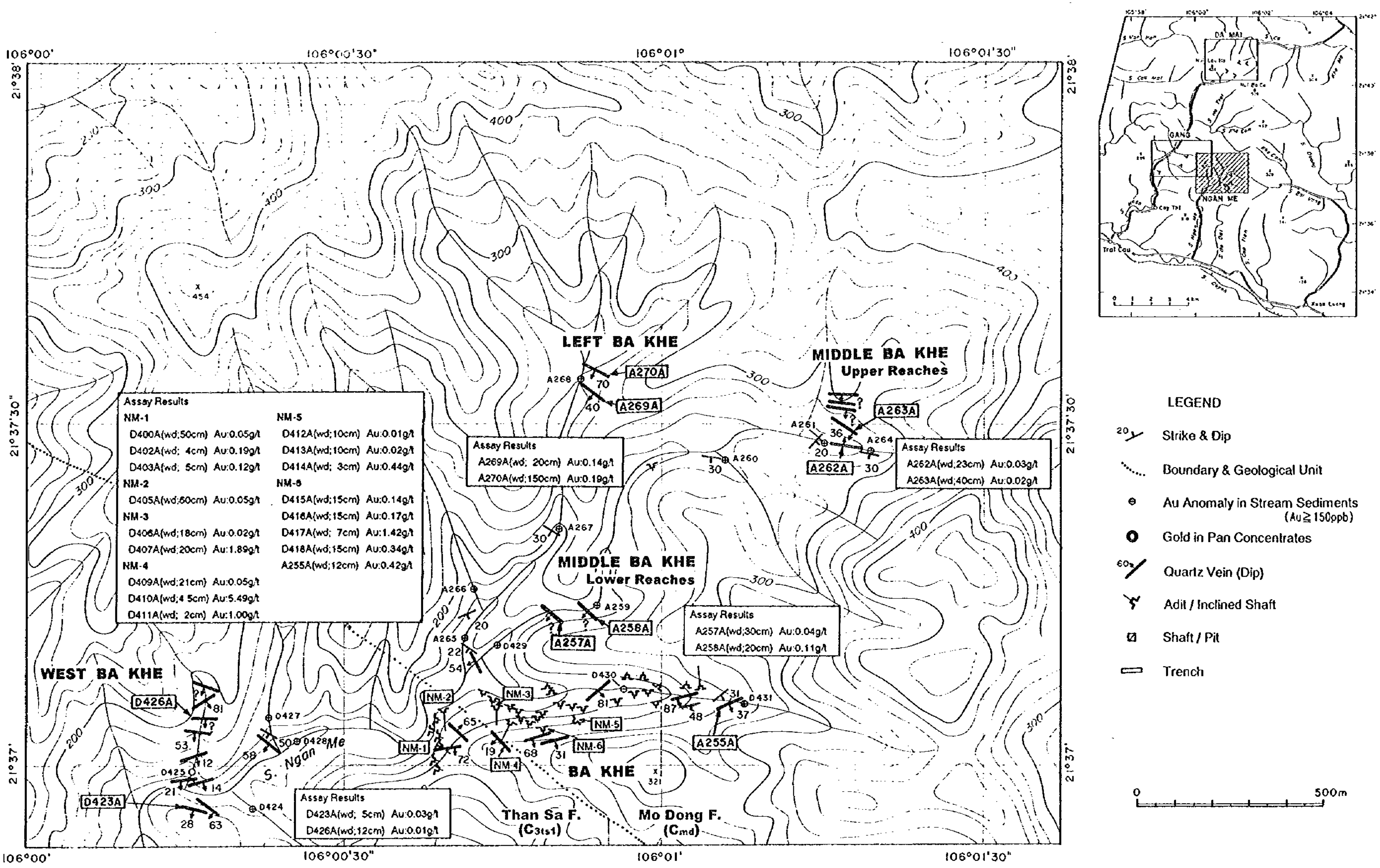
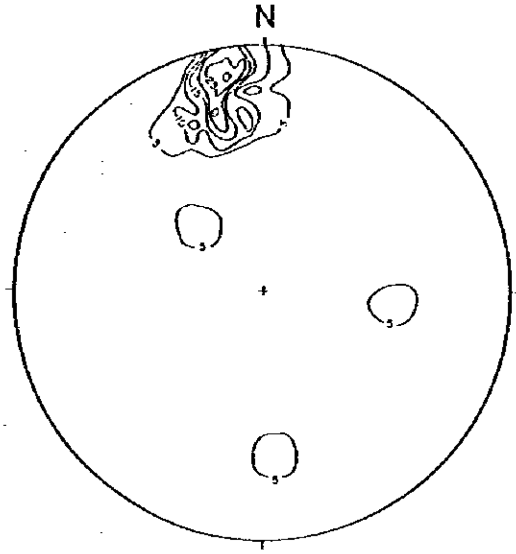
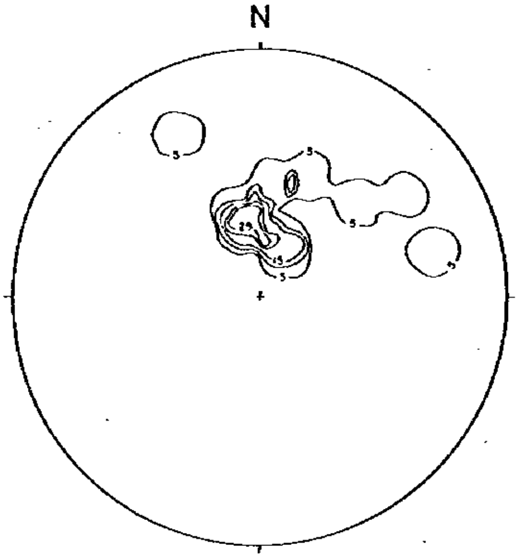


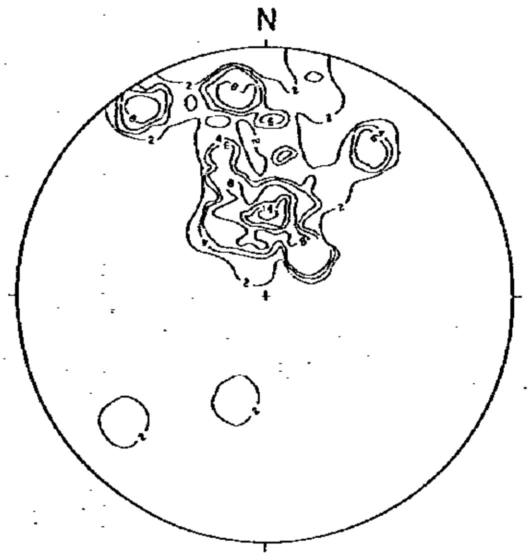
Fig. 2-12 Results of the Detailed Survey in the Ngan Me Area



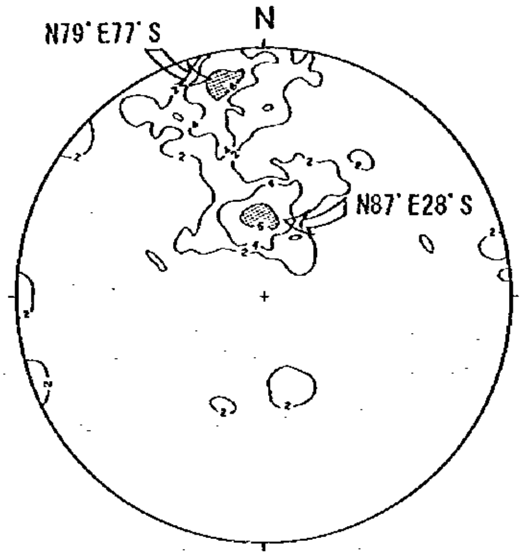
(a) Da Mai Area (n=15)



(b) Gang Area (n=11)



(c) Ngan Me Area (n=31)



(a)+(b)+(c)+Surrounding Area (n=122)

Fig. 2-13 Stereo Net Projection of Quartz Veins in the Detailed Survey Area

Table 2-6 Results of X-Ray Diffraction Analysis (1)

Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites				S-Salts			Carbonates			Silicates			Fldsp		Miscellaneos Minerals								
				Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	An	Al	Gy	Ja	Ca	Dl	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Sp	Gn	Ep	Rd	Ho	At
B002X	Phyllite near Qz vein	Cmd	Da Mai			△																		◎	·										
B003X	Silicified sandstone	Cmd	Da Mai			○																		○	△										
B013X	Silicified sandstone	Cmd	Da Mai	·		△																		△				△	○						
B018X	Black slate	C-Pbs	Tan Lap																					◎											
B019X	Slate, Gn disseminated	C-Pbs	Tan Lap																△											△	◎				
B027X	Graphite schist	Cmd	S. Tram			△													△	△				○											
B028X	Schist	Cmd	S. Tram			△																		◎			△								
D371X	HW (sheared Sch) of Qz lens	C3ts	Khe Hoac			△																		◎	·										
D372X	Qz lens in sheared zone		Khe Hoac			·																		◎											
D373X	FW (sheared Sch) of Qz lens	C3ts	Khe Hoac			△																		◎	△										
D378X	Qz vein		Khe Hoac			△																		○	△										
D379X	Shear zone with Qz lens		Khe Gang			△																		○	△										
D382X	Qz vein		Khe Gang		△	△																		△	△										
D383X	Qz vein		Khe Gang			△																		◎											
D384X	FW of Qz vein	Cmd	Khe Gang			△		△																△	△										
D385X	Qz lens		Khe Gang			△																		△	△										
D386X	Qz vein		Khe Gang		△	△																		○	△										
D388X	HW (sheared Sch) of Qz vein	Cmd	Khe Gang		·	△																		△	△										
D389X	Qz vein		Khe Gang			△																		◎	·										
D390X	FW (sheared Sch) of Qz vein	Cmd	Khe Gang			△																		◎	·										
D393X	Qz vein + sheared Sch		Cay Thi			△		△																◎	△										
D394X	Qz vein + sheared Sch		Cay Thi			△		△																△	△										
D399X	Qz		Cay Thi																△											·	·				
D405X	Sheared SS with Qz lens		Ngan Me		△	△																		◎	△										
D407X	Qz vein		Ngan Me		△	△																		◎	△										
D412X	Qz vein		Ngan Me		△	△																		◎											
D414X	Qz vein		Ngan Me			△		△																◎	·										
D416X	HW (shaeared Sch) of Qz vein	Cmd	Ngan Me		△	△																		△	△										
D417X	Qz vein		Ngan Me		△	△																		○	△										
D418X	FW (Sch) of Qz vein	Cmd	Ngan Me		△	△																		△	△										
D423X	Qz vein		Ngan Me			△																		◎											
D426X	Qz vein		Ngan Me																					◎			△								
D446X	HW (sheared Sch) of Qz vein	Cmd	Khe Dui			△																		◎	△										
D447X	FW (sheared Sch) of Qz vein	Cmd	Khe Dui			△																		△	△				△						
D450X	FW (sheared Sch) of Qz vein	Cmd	Khe Dui			△																		△	△	·			·						

Abundance of Minerals : ◎ ;Abundant, ○ ;Common, △ ;Few, · ;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Pr;Pyrophyllite, Mx;Mixed-Layer Mineral, Ha;Halloysite, Cp;Clinoptilolite, Md;Mordenite, Lm;Laumontite, An;Analcime, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Dl;Dolomite, Si;Siderite, Cr; α -Cristobalite, Tr;Toridymite, Qz;Quartz, Pl;Plagio-clase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Sp;Sphalerite, Gn;Galena, Ep;Epidote, Rd;Rhodochrosite, Ho;Hornblende, At;Anatase
HW;Hanging Wall, FW;Footwall, Sch;Schist, SS;Sandstone (The name of Rock Unit is explained in Table 2-2.)

Table 2-6 Results of X-Ray Diffraction Analysis (2)

Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites				S-Salts			Carbonates			Silicates			Fldsp		Miscellaneos Minerals								
				Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	An	Al	Gy	Ja	Ca	Dl	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Sp	Gn	Ep	Rd	Ho	At
D451X	HW (sheared Sch) of Qz vein	Cmd	Khe Dui			△																		○	△				·						
D453X	Qz		Da Mai		△	△																		◎											
D457X	HW (SS) of Qz vein	Cmd	Da Mai			△																		◎	△										
D458X	FW (SS) of Qz vein	Cmd	Da Mai			△																		△	·										
D459X	FW (sheared claystone) of Qz	Cmd	Da Mai			△																		○	△										

Abundance of Minerals : ◎ ;Abundant, ○ ;Common, △ ;Few, · ;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Pr;Pyrophyllite, Mx;Mixed-Layer Mineral, Ha;Halloysite, Cp;Clinoptilolite, Md;Mordenite, Lm;Laumontite, An;Analcime, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Dl;Dolomite, Si;Siderite, Cr; α -Cristobalite, Tr;Toridymite, Qz;Quartz, Pl;Plagio-clase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Sp;Sphalerite, Gn;Galena, Ep;Epidote, Rd;Rhodochrosite, Ho;Hornblende, At;Anatase HW;Hanging Wall, FW;Footwall, Sch;Schist, SS;Sandstone (The name of Rock Unit is explained in Table 2-2.)

Table 2-7 Results of Ore Microscopy

Sample No.	Locality	Minerals										Remarks
		Py	As	Cp	Sp	Gn	Cv	Au	Tt	Po	Io	
A255M	Ba Khe	△	·	·	·	·	·	·		·	·	Qz vein, Au x 1grain, Scorodite found.
A270M	Ba Khe	△		·			·				·	Qz vein
A281M	Lang Hoang			·							·	Gossan, Pyrolusite and Psilomellane found.
B007M	Da Mai	△	·						·	·		Qz float, Energite? found.
B018M	Tan Lap	·			·	○			·			Galena ore, Anglesite & Cerussite found.
B019M	Tan Lap	·			△	○	·		·			Galena ore, Anglesite found.
B024M	S. Tram	·	·	·							·	Qz float, Scorodite found.
B028M	S. Xom	·		·							·	Qz vein, Py disseminated.
C043M	Bai Vang	△		·			·	·		·	·	Qz vein, Au x 5, Scorodite found.
C048M	Bai Vang	△									·	Qz vein
D317M	S. Ngan Me	·		·			·			·		Qz vein
D375M	Khe Hoac	·									·	Qz vein
D376M	Khe Hoac		△									Qz vein, Scorodite found.
D380M	Khe Gang	·								·	·	Qz vein
D387M	Khe Gang											Qz vein
D389M	Khe Gang	△	·	·		·	·			·	·	Qz vein, Bornite found.
D391M	Khe Gang	△								·	·	Qz vein
D392M	Khe Gang	·									·	Qz vein
D398M	Cay Thi	△		·			·			·		Qz vein
D399M	Cay Thi	△		·			·			·	·	Qz vein, Chalcocite found.
D404M	Ngan Me	·								·		Qz vein
D408M	Ngan Me	△		·						·		Qz vein
D419M	Ngan Me	·	·	·	·	·				·		Qz vein
D420M	Ngan Me	·		·		·	·			·		Qz vein
D423M	Ngan Me	·									·	Qz vein
D426M	Ngan Me	△		·			·				·	Qz vein
D444M	Goc Sen	·	○			·		·	·	·	·	Qz vein, Au x 20, Scorodite found.
D448M	Khe Dui	·		△			·				·	Qz vein, Chalcocite found.
D452M	Khe Dui	·									·	Qz vein
D453M	Da Mai	△									·	Qz vein
D455M	Da Mai	·									·	Qz vein

Abundance of Minerals : ○ ; Common, △ ; Rare, · ; Trace

Abbreviations : Py;Pyrite, As;Arsenopyrite, Cp;Chalcopyrite, Sp;Sphalerite, Gn;Galena, Cv;Covelline, Au;Native Gold, Tt;Tetrahedrite-Tennantite, Po;Pyrrhotite, Io;Iron Oxide

Table 2-8 Assay Results of Ore Samples (1)

Sample No.	Width cm	Au g/t	Ag g/t	Cu %	Pb %	Zn %	As %	Sb %	Hg ppm	Locality
A217A	20	0.06	<0.2	0.01	0.02	0.01	0.09	<0.01	<0.03	Khe Hoac
A218A	float	1.41	<0.2	0.01	0.03	0.01	0.06	<0.01	0.04	Khe Hoac
A255A	12	0.42	1.4	0.01	0.02	<0.01	0.33	<0.01	0.04	Ba Khe
A257A	30	0.04	<0.2	<0.01	<0.01	0.01	<0.01	<0.01	<0.03	Middle Ba Khe
A258A	20	0.11	<0.2	<0.01	<0.01	0.01	<0.01	<0.01	<0.03	Middle Ba Khe
A262A	23	0.03	0.3	<0.01	<0.01	<0.01	0.01	<0.01	<0.03	Middle Ba Khe
A263A	40	0.02	0.8	<0.01	<0.01	<0.01	0.01	<0.01	<0.03	Middle Ba Khe
A269A	20	0.14	1.0	0.01	0.02	<0.01	0.02	<0.01	<0.03	Left Ba Khe
A270A	150	0.19	3.8	0.05	0.07	<0.01	0.05	<0.01	<0.03	Left Ba Khe
A281A	grab	0.13	12.6	<0.01	1.93	0.10	0.11	0.01	<0.03	Lang Hoan
A282A	grab	0.09	11.7	<0.01	0.34	0.13	<0.01	<0.01	0.11	Lang Hoan
B001A	float	0.01	0.8	<0.01	0.32	0.01	<0.01	<0.01	0.07	Da Mai
B002A	10	0.02	0.4	0.03	<0.01	0.01	0.01	<0.01	<0.03	Da Mai
B003A	5	0.02	0.8	0.01	0.46	0.01	0.01	<0.01	<0.03	Da Mai
B004A	float	0.05	1.0	<0.01	0.01	<0.01	<0.01	<0.01	<0.03	Da Mai
B005A	10	0.01	0.3	<0.01	0.01	0.01	<0.01	<0.01	<0.03	Da Mai
B007A	float	0.38	2.0	0.48	0.01	<0.01	0.05	0.01	<0.03	Da Mai
B008A	15	0.01	1.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	Da Mai
B009A	5	0.01	1.2	<0.01	0.01	<0.01	<0.01	<0.01	<0.03	Da Mai
B010A	10	0.02	1.3	<0.01	0.05	0.01	<0.01	<0.01	<0.03	Da Mai
B011A	13	0.04	0.6	<0.01	0.02	<0.01	<0.01	<0.01	<0.03	Da Mai
B012A	float	0.04	5.7	<0.01	0.43	0.09	0.04	<0.01	<0.03	Da Mai
B013A	float	0.01	15.3	<0.01	0.24	0.18	0.02	<0.01	<0.03	Da Mai
B014A	7	0.01	1.2	<0.01	0.35	0.01	<0.01	<0.01	<0.03	Doc Trung
B016A	6	0.01	1.4	<0.01	0.26	0.01	<0.01	<0.01	0.03	Nui Sue Cat
B017A	7	0.01	1.7	<0.01	0.01	<0.01	<0.01	<0.01	<0.03	Nui Sue Cat
B018A	float	0.01	282.3	0.07	10.36	1.09	0.03	0.04	2.71	Tan Lap Mine
B019A	float	0.01	178.3	0.10	9.84	6.88	0.04	0.07	7.40	Tan Lap Mine
B020A	5	0.01	1.8	<0.01	0.01	<0.01	<0.01	<0.01	<0.03	Lung Than
B021A	5	0.01	<0.2	0.01	<0.01	0.01	0.01	<0.01	<0.03	Lung Than
B022A	60	0.02	0.3	0.01	<0.01	0.01	<0.01	<0.01	<0.03	S. Tram
B023A	12	0.02	3.3	<0.01	0.05	0.01	0.03	<0.01	<0.03	S. Tram
B024A	float	0.91	19.0	<0.01	<0.01	<0.01	0.57	0.04	<0.03	S. Tram
B025A	70	0.03	<0.2	0.01	0.36	0.06	<0.01	<0.01	0.07	S. Tram
B026A	7	0.03	1.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	S. Xom Nac
B027A	5	0.09	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	S. Xom Nac
B028A	30	0.06	207.1	0.01	0.03	<0.01	0.01	<0.01	<0.03	S. Xom
B029A	float	0.64	2.0	0.02	0.04	0.01	0.60	<0.01	<0.03	S. Bo Da
B030A	3	0.01	<0.2	<0.01	<0.01	0.02	0.01	<0.01	<0.03	S. Bo Da
C031A	50	0.01	73.1	0.01	8.85	0.06	0.04	0.01	0.13	Tan Lap Mine
C032A	120	0.01	99.6	0.01	9.33	0.39	0.04	0.01	0.26	Tan Lap Mine
C033A	70	<0.01	162.9	0.01	5.63	0.07	0.03	<0.01	0.54	Tan Lap Mine
C043A	200	0.50	1.4	0.01	0.10	<0.01	0.02	<0.01	<0.03	Khe Rua
C048A	20	0.01	<0.2	0.01	0.09	<0.01	0.01	<0.01	<0.03	Khe Cam
C049A	200	0.02	<0.2	<0.01	0.05	<0.01	<0.01	<0.01	<0.03	Khe Dinh
C053A	200	0.01	<0.2	<0.01	0.06	<0.01	0.01	<0.01	<0.03	S. Nhoan
D312A	float	<0.01	<0.2	<0.01	0.00	<0.01	0.01	<0.01	<0.03	S. Ngan Me
D323A	float	0.02	4.2	<0.01	0.37	0.08	<0.01	<0.01	<0.03	S. Ngan Me
D367A	float	0.01	<0.2	<0.01	0.02	<0.01	<0.01	<0.01	<0.03	S. Hoan
D371A	30	0.50	<0.2	0.03	0.13	0.01	0.12	0.01	<0.03	Khe Hoac
D372A	35	0.05	<0.2	0.01	0.04	<0.01	0.04	<0.01	<0.03	Khe Hoac
D373A	55	0.14	<0.2	0.01	0.02	<0.01	0.03	<0.01	<0.03	Khe Hoac
D374A	45	0.07	<0.2	0.02	0.03	0.01	0.03	<0.01	<0.03	Khe Hoac
D377A	13	0.40	0.6	0.01	0.01	<0.01	0.10	<0.01	0.05	Khe Hoac
D378A	40	0.69	0.5	0.01	<0.01	<0.01	0.02	<0.01	0.06	Khe Hoac
D379A	70	0.04	1.7	0.01	0.04	0.01	0.01	<0.01	0.04	Khe Gang
D381A	25	0.12	0.5	0.01	<0.01	<0.01	0.01	<0.01	0.04	Khe Gang
D382A	40	0.20	1.1	0.01	0.01	0.01	0.01	<0.01	0.04	Khe Gang
D383A	26	0.02	<0.2	0.01	0.01	<0.01	<0.01	<0.01	0.04	Khe Gang
D384A	45	0.03	<0.2	0.01	<0.01	<0.01	<0.01	<0.01	<0.03	Khe Gang
D385A	13	0.02	0.3	0.01	0.02	<0.01	<0.01	<0.01	0.03	Khe Gang

Table 2-8 Assay Results of Ore Samples (2)

Sample No.	Width cm	Au g/t	Ag g/t	Cu %	Pb %	Zn %	As %	Sb %	Hg ppm	Locality
D386A	40	0.02	1.0	0.01	<0.01	<0.01	<0.01	<0.01	<0.03	Khe Gang
D388A	40	0.01	<0.2	0.01	<0.01	0.01	0.01	<0.01	<0.03	Khe Gang
D389A	36	0.01	0.6	0.01	<0.01	<0.01	0.01	<0.01	<0.03	Khe Gang
D390A	40	0.03	0.4	<0.01	<0.01	<0.01	0.04	<0.01	<0.03	Khe Gang
D393A	10	20.23	1.0	0.01	0.01	0.01	0.02	<0.01	<0.03	Cay Thi
D394A	15	1.50	0.5	0.01	0.01	0.01	0.02	<0.01	<0.03	Cay Thi
D397A	grab	0.52	0.7	0.01	<0.01	<0.01	0.06	<0.01	<0.03	Cay Thi
D398A	grab	1.00	1.4	<0.01	0.01	<0.01	0.01	<0.01	<0.03	Cay Thi
D399A	grab	0.02	0.3	0.01	<0.01	<0.01	<0.01	<0.01	<0.03	Cay Thi
D400A	5	0.05	0.3	0.01	0.01	<0.01	0.02	<0.01	<0.03	Ngan Me
D402A	4	0.19	0.2	0.01	0.07	0.01	0.10	<0.01	<0.03	Ngan Me
D403A	5	0.12	<0.2	0.01	0.15	0.01	0.10	<0.01	<0.03	Ngan Me
D405A	60	0.05	0.5	0.01	0.01	0.01	0.01	<0.01	<0.03	Ngan Me
D406A	18	0.02	1.8	0.01	<0.01	<0.01	0.01	<0.01	<0.03	Ngan Me
D407A	20	1.89	0.2	0.01	<0.01	<0.01	0.43	<0.01	<0.03	Ngan Me
D409A	21	0.05	0.2	0.01	0.01	<0.01	0.01	<0.01	<0.03	Ngan Me
D410A	5	5.49	1.1	0.01	0.03	0.01	0.04	<0.01	<0.03	Ngan Me
D411A	2	1.00	<0.2	<0.01	<0.01	<0.01	0.01	<0.01	<0.03	Ngan Me
D412A	10	0.01	0.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	Ngan Me
D413A	10	0.02	0.2	0.01	<0.01	<0.01	0.01	<0.01	<0.03	Ngan Me
D414A	3	0.44	0.2	0.01	0.01	<0.01	0.08	<0.01	<0.03	Ngan Me
D415A	15	0.14	0.4	0.01	0.03	0.01	0.06	<0.01	<0.03	Ngan Me
D416A	15	0.17	0.2	0.01	<0.01	0.01	0.20	<0.01	<0.03	Ngan Me
D417A	7	1.42	1.6	<0.01	0.04	<0.01	0.28	<0.01	<0.03	Ngan Me
D418A	15	0.34	0.2	0.01	0.06	0.01	0.06	<0.01	<0.03	Ngan Me
D423A	5	0.03	0.2	0.01	0.01	<0.01	0.01	<0.01	<0.03	Ngan Me
D426A	12	0.01	0.3	0.01	<0.01	<0.01	0.02	<0.01	<0.03	Ngan Me
D444A	grab	0.04	0.6	<0.01	<0.01	<0.01	0.03	<0.01	<0.03	Goc Sen
D445A	20	2.00	<0.2	0.06	0.01	<0.01	0.12	<0.01	<0.03	Khe Dui
D446A	15	0.11	<0.2	0.05	0.01	<0.01	0.06	<0.01	<0.03	Khe Dui
D447A	15	0.51	<0.2	0.08	0.01	<0.01	0.13	<0.01	<0.03	Khe Dui
D449A	40	0.60	1.5	0.02	<0.01	0.01	0.24	0.01	0.03	Khe Dui
D450A	40	1.05	1.8	0.01	0.01	0.01	0.21	<0.01	0.03	Khe Dui
D451A	20	0.94	1.7	0.06	0.01	0.01	0.09	0.01	<0.03	Khe Dui
D452A	grab	0.03	0.3	<0.01	<0.01	<0.01	0.01	<0.01	<0.03	Khe Dui
D453A	grab	0.83	0.5	<0.01	<0.01	<0.01	0.04	<0.01	<0.03	Da Mai
D455A	15	0.02	0.4	<0.01	<0.01	<0.01	0.01	<0.01	<0.03	Da Mai
D456A	42	0.02	0.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	Da Mai
D457A	30	0.02	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	Da Mai
D458A	30	0.07	0.2	0.01	<0.01	<0.01	0.02	<0.01	<0.03	Da Mai
D459A	13	0.31	0.3	0.01	<0.01	<0.01	0.05	<0.01	<0.03	Da Mai
D460A	40	0.04	<0.2	0.02	0.01	<0.01	0.01	<0.01	<0.03	Da Mai

Table 2-9 Methods of Analysis and Limits of Detection of Ore Samples

Element	Method of Analysis	Detection Limit	Upper Limit
Au	Fire assay with AA finish	0.01ppm	150ppm
Ag	Total digestion with AA finish	0.2ppm	350ppm
Cu	Nitric aqua regia with ICP finish	0.01%	5%
Pb	ditto	0.01%	5%
Zn	ditto	0.01%	5%
As	HCl/KClO3 extraction with ICP finish	0.01%	5%
Sb	ditto	0.01%	5%
Hg	Total digestion with AA finish	0.03ppm	1%

*AA means Atomic Absorption method.

4-5 Fluid Inclusion Studies

4-5-1 Methodology

Quartz chips were collected, and provided for fluid inclusion studies. Eleven quartz chips were sampled this phase in the detailed survey area. The breakdown is: four from the Da Mai area, three from the Gang area, and four from the Ngan Me area. All samples were taken from quartz veins.

The observation of quartz chips was made in the field according to the description criteria usually required in the field survey. The observation of fluid inclusions under the microscope was undertaken in the laboratory. The morphological observation of fluid inclusions is understood to be important for estimating an environment under which fluid inclusions and their host minerals were formed. Therefore, it is necessary to work very carefully before going into the thermometric measurement. General process of the microscopic observation consisted of the following contents:

- •Distinction between primary/pseudosecondary inclusions and secondary ones
- •Observation of size, shape and surface smoothness
- •Estimation of filling degrees (approximate liquid to gas volumetric ratios of inclusions)
- •dentification of solid crystal in inclusions when exists
- •Search for any evidence indicating fluid boiling phenomena

Most of the important samples were micro-photographed on the microscopic observation.

Measurements of homogenization temperature of liquid-gas and polyphase inclusions were made with the heating-stage under the microscope. Forty measurements for each sample were made in average, and the results were statistically processed. An arithmetic mean was adopted as the representative value for each sample. The standard deviation among the values of homogenization temperature in each sample was checked. The results of homogenization temperature measurements were plotted on the map and examined geologically.

4-5-2 Results of Studies

Measurements of homogenization temperature were relatively difficult because most of the fluid inclusions in quartz chips were fine. The average diameter is 10 microns. Fluid inclusions of larger than 30 microns in diameter were seldom found. As a result of this fine nature of fluid inclusions, the homogenization temperature may indicate relatively lower than the actual formation temperature of the main stage of gold mineralization. The results of the measurements are listed in Table 2-10.

Morphology of Fluid Inclusion

The number of fluid inclusions which were investigated under the microscope was 458. More than eighty percents of them are liquid-rich two-phase inclusions. Gas-rich two-phase inclusions are less than 20 % of them. The actual percentage of gas inclusions may probably be much less. The possibility of miss-identification still exists despite the careful observation. Because fluid inclusions are three-dimensional objects which are being observed in only two dimensions, inclusions having consistent liquid-to-gas ratios may appear to have variable phase ratios. This result may indicate that the boiling of fluid has occurred locally during the formation of quartz vein.

CO_2 gas was detected in the vapor part of some two-phase inclusion in one sample (D420F) taken from the Ngan Me area.

A polyphase inclusion was found in one sample (D376F). It came from a quartz sample in Khe Hoac. Halite was distinguished as a daughter mineral. From the occurrence of halite in inclusions, the salinity of this liquid is estimated to be considerably high.

Homogenization Temperature

Values of homogenization temperature of each fluid inclusion are distributed from 140°C up to 302°C. Most of them fall into a range of 168° ~ 240°C. Mean values of homogenization temperature of samples which showed a significant value of gold range from 159°C to 239°C. The values of homogenization temperature could be classified into two groups from the distribution on the frequency histogram shown in Fig. 2-14. One group has a mean value of about 185°C, and ranges from 140°C to about 230°C. Another has a mean of 260°C with a range of 230°C to 302°C.

The comparison of features of fluid inclusions among three areas was checked as follows:

Da Mai area: The mean temperature of each sample ranging from 175°C to 200°C. Mainly composed of very fine liquid-rich inclusions.

Table 2-10 Results of Fluid Inclusion Studies

Sample No.	Locality	Number of Measured Inclusions	Mean Homogenization Temperature (°C)	Standard Deviation	Kind of Inclusions (Liquid-rich/Gas-rich/Polyphase)	Remarks
A255F	Ba Khe	51	196	27.3	Liquid-rich + Gas-rich	Native gold observed (microscope)
D375F	Khe Hoac	46	219	42.2	Liquid-rich + Gas-rich	Two groups of Homogenization Temp.
D376F	Khe Hoac	58	234	38.1	Liquid-rich + Polyphase	Two groups of Homogenization Temp.
D391F	Khe Gang	47	239	38.0	Liquid-rich	Two groups of Homogenization Temp.
D408F	Ngan Me	56	190	23.5	Liquid-rich	
D419F	Ngan Me	35	185	17.4	Liquid-rich + Gas-rich	
D420F	Ngan Me	53	198	26.3	Liquid-rich + Gas-rich(CO_2)	
D444F	Goc Sen	46	203	20.5	Liquid-rich	Native gold observed (microscope)
D448F	Khe Dui	25	176	14.1	Liquid-rich (very small)	
D453F	Da Mai	12	159	17.6	Liquid-rich (very small)	
D455F	Da Mai	29	186	24.5	Liquid-rich	
Total		458	204	35.9		

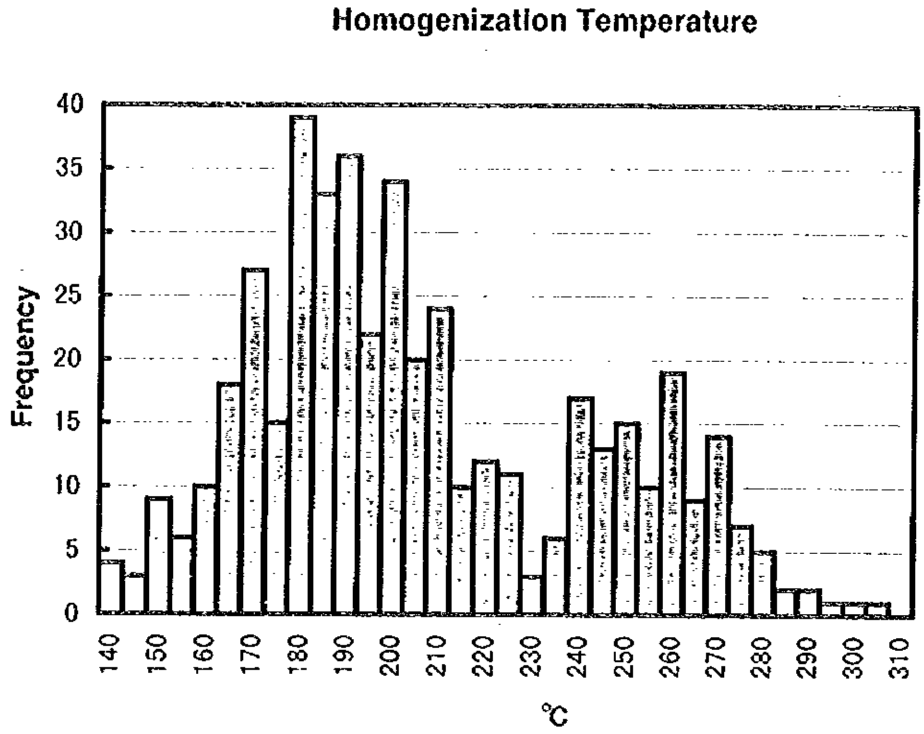


Fig. 2-14 Histgram of Homogenization Temperature of Fluid Inclusions

Gang area: Relatively high mean temperature. Two groups of temperature values were clearly observed. The lower one is 180° to 190°C, and the higher one 255° to 280°C in the mean temperature. Some consist of liquid-rich inclusions. The mixture of liquid-rich and gas-rich inclusions, however, were found in anther sample. A polyphase inclusion was discovered in one sample.

Ngan Me area: The mean temperature is concentrated at around 190°C (180° to 200°C). The inclusions in this area are mostly liquid-rich plus some gas-rich. An inclusion with CO_2 gas was found in one sample in this area.

Although samples checked by the fluid inclusion studies were limited, a significant difference of homogenization temperatures were distinguished in fluid inclusions among these areas. Some samples from Khe Hoac and Khe Gang in the Gang area showed distinctive higher range of homogenization temperature values together with the lower range.

4-6 Discussion

Three promising areas for mesothermal type gold deposits have been extracted through the detailed geological survey this phase within the Bo Cu area, although the priority exists due to the limitation in the amount of exploration work. Those are: Da Mai, Gang, and Ngan Me areas. Moreover, several anomalous zones have been closed-up as interesting extensions of these promising areas by the regional geochemical exploration. They are: North of N. Bo Cu and Khe Ma both located to the east of the Da Mai area, Khe Can located to the northeast of the Gang area, Bai Vang located to the east of the Ngan Me area, and Khe Cam located to the northeast of the Ngan Me area.

Tens of shafts, adits and quartz vein outcrops are distributed within a high altitude range from the flank up to the ridge of approximately 400 m above sea level in the Da Mai area. Three major vein groups are known in the Da Mai Area. Among those, it was interpreted that the Khe Dui and Da Mai could form a consecutive zone from having the same trend and their distribution in the direction of ENE-WSW. This zone has a width of 200 to 300 m and extends more than 1 km to the strike direction. These veins have already mined out near the surface. However, the lower side and the extension of this zone are untouched. It is thought that the detailed exploration of this zone is necessary. Three areas - Da Mai, NE of N. Bo Cu, and Khe Ma (latter two were outlined by the geochemical survey this phase) -- are thought to be a series of gold mineralization zones stretching from east to west continuously. Further work is required for the examination of this zone.

In the Gang area, there are three major zones of gold-bearing quartz veins: Khe Gang, Khe Hoac, and Cay Thi. Two more veins -- G-1 and G-2 veins -- are known in the area additionally. They have a general E-W to WNW strike direction, and are characterized by the gentle S dip commonly. This trend is concordant with the general geologic structure of the Cambrian System in this part. The host rocks form an anticline, and the Gang area is situated on the southern wing of the anticline. In Cay Thi, two gentle dipping veins are observed. They occur 40 m apart vertically, and run parallel each other. The details of correlation among these vein groups have not been surveyed this phase. The genesis of the fracture systems of quartz veins, together with the correlation, are the major matters for the next stage investigation.

In the Ngan Me area, three prospects were distinguished: Ba Khe, Left Ba Khe-Middle Ba Khe, and West Ba Khe. The West Ba Khe zone is situated about 500 m west of the Ba Khe prospect. It lies in the western extension of the Ba Khe mineralized zone. Therefore, gold mineralization in the Ba Khe prospect is expected to continue to the West Ba Khe prospect. The gold anomalous zone at the upper reaches of S. Bai Vang detected by geochemical survey is located about 2 km east of the Ba Khe prospect. It is likely that the gold mineralization continues to the east until the Bai Vang area. If so, then this mineralized zone extends for nearly 3.5 km in the E-W direction. This is one of the interesting prospect for the next stage survey.

It was said that the gold-bearing quartz veins in the detailed survey area belonged to the mesothermal type gold deposit. This matter is thought to be confirmed according to the following evidences obtained during the survey this phase:

Geologic environment that the veins are hosted mainly by sedimentary and metamorphic rocks of the Cambrian system.

Gangue minerals of vein (consisting almost only of quartz).

Ore mineral assemblage (particularly, arsenopyrite, pyrite, chalcopyrite and galena are accompanied).

The occurrence of pyrrhotite and bornite which probably means comparatively high temperature type deposit is admitted.

Alteration features (mainly composed of silicification, sericitization and chloritization) .

Significantly low Ag/Au ratio (=1.5 averaging of 88 ore samples in the detailed survey area)

Results of fluid inclusion studies indicating the mesothermal conditions of vein formation.

Three areas show their own characteristic features in the vein trend, mineral assemblage and fluid inclusion property outlined as follows:

Da Mai area: Veins of steeply dipping S. Relatively sulfide-rich. Fluid inclusions of relatively low homogenization temperature and fine size.

Gang area: Veins of gently dipping S. Two groups of homogenization temperature -- higher and lower -- coexist.

Ngan Me area: Two groups of vein trends -- steeply dipping and gently dipping -- occur in the same area. Homogenization temperature is rather low.

These varieties are understood to be originated from the difference of structure and conditions of their formation. The spatial relation with the heat source -- probably somehow related to the granitic intrusion -- is considered to be the main factor concerned.

The place of the mineralization in this area is presumed within a marginal part of the South China plate according to the results of the regional geological survey. It suggests that the gold mineralization in this area probably belongs to the category of the continental type gold deposit.

Table 2-11 Summary of Geological and Geochemical Surveys in the Da Mai Area

	Da Mai	Khe Dui	Goc Sen	N Da Mai
Location	Upper reaches of S. Hoan (Consisting of East Da Mai & West Da Mai)	Upper reaches of S. Ca	At the top of the ridge between S. Ca & S. Hoan	Upper reaches of S. Ca (Next branch west of Khe Dui)
(I) Host Rocks	Cmd SS, phyllite, shale, psammitic Sch, Ser-Sch	Cmd SS, shale, Ser-Sch	Cmd SS, shale, Ser-Sch	Cmd SS, shale, Ser-Sch
(II) Alteration	Sil, Ser weak-Mont (occasionally)	Sil, Ser		
(III) Ore Deposit (1) Vein System & Structure	E-W, ENE, NW mostly steeply dipping S	E-W, ENE mostly steeply dipping S	E-W, 80S	ENE, 68S
(2) Ore Minerals	Py	Py, Cp, Cv, CC	Py, As, Gn, Tt, Po, Au	
(3) Gangue Minerals	Qz (gray color)	Qz	Qz	Qz
(4) Homogenization Temp.	159C & 186C, small, liquid-rich	176C, very small, liquid-rich	203C, liquid-rich	
(5) Major Assay Results	36.38g/t Au @90cm (GSV) 0.83g/t Au (D453A)	31.00g/t Au @50cm (GSV) 2.00g/t Au @15cm (D445A)	6.40g/t Au @ 10cm (GSV)	
(IV) Geochemical Features	Some stream sediment anomalies along the down-stream	Many stream sediment & panning anomalies		Some stream sediment & panning anomalis
(V) Remarks	Mining started before 1987. Adit>15	Shaft/Adit>10 Visible gold	Shaft/adit>6	

Table 2-12 Summary of Geological and Geochemical Surveys in the Gang Area

	Khe Gang	Khe Hoac	Cay Thi	G-1	G-2
Location	Middle reaches of S. Hoan	Middle reaches of S. Hoan (Next branch south of Khe Gang)	Middle reaches of S. Hoan (Next branch south of Khe Hoac)	Middle reaches of S. Hoan (NW of Khe Gang)	Upper reaches of Khe Gang
(I) Host Rocks	Cmd SS, shale, black slate, Ser-Sch	Cmd & C3ts SS, shale	Cmd & C3ts SS, shale, siltstne, black slate	Cmd SS, shale, black slate, Ser-Sch	Cmd SS, shale, black slate, Ser-Sch
(II) Alteration	Sil, Ser, Chl, Kao (occasionally)	Sil, Ser	Sil, Ser, Kao		
(III) Ore Deposit (1) Vein System & Structure	E-W, 20-30S	E-W, ENE, WNW gently dipping S	E-W, ENE, WNW gently dipping S Two zones of veins	N-S, NWN, 60W	E-W, 20-35S
(2) Ore Minerals	Py, As, Cp, Gn, Cv, Po, Bn	Py, As	Py, Cp, Cv, Po, Cc		
(3) Gangue Minerals	Qz	Qz	Qz	Qz	Qz
(4) Homogenization Temp.	239C (high+low), liquid-rich	219C & 234C (high+low) liquid-rich+gas-rich polyphase (halite)			
(5) Major Assay Results			20.23g/t Au @10cm (D333A)	29.77g/t Au @50cm (GSV)	2.40g/t Au @10cm (GSV)
(IV) Geochemical Features	Some stream sediment & panning anomalies	Some stream sediment & panning anomalies	Some stream sediment & panning anomalies		
(V) Remarks	Shaft>20 Visible gold	Shaft,adit>10 Visible gold	Shaft,pit>50 Visible gold	Pit (GSV)	Pit (GSV)

Table 2-13 Summary of Geological and Geochemical Surveys in the Ngan Me Area

	Ba Khe	Middle Ba Khe-Left Ba Khe	West Ba Khe
Location	Upper reaches of S. Ngan Me	Upper reaches of S. Ngan Me (North of Ba Khe)	Upper reaches of S. Ngan Me (West of Ba Khe)
(I) Host Rocks	Cmd SS, shale, phyllite, Ser-Sch	Cmd SS, shale, Sch	C3ts SS, shale, Sch
(II) Alteration	Sil, Ser, Chl Kao (occasionally)		
(III) Ore Deposit (1) Vein System & Structure	E-W, ENE, WNW , Some steeply dipping S Others gently dipping S	E-W, ENE, WNW Some steeply dipping S Others gently dipping S	E-W, ENE, WNW Some steeply dipping S Others gently dipping S
(2) Ore Minerals	Py, As, Cp, Gn, Cv, Po, Au	Py	
(3) Gangue Minerals	Qz	Qz	Qz
(4) Homogenization Temp.	Mean temp=around 190C mixture of liquid-rich & gas-rich, CO2 detected in inclusion		
(5) Major Assay Results	5.49g/t Au @4.5cm (D410A)		
(IV) Geochemical Features	Many stream sediment & panning anomalies along the downstream	Some stream sediment & panning anomalies	Some stream sediment & panning anomalies
(V) Remarks	Adit/shaft>50 Visible gold	Many massive Qz veins	Many massive Qz veins

Chapter 5 Geophysical Survey (CSAMT Method)

5-1 Outline of the Survey

(1) Objectives

The objectives of the geophysical survey using Array CSAMT method are to investigate the relationship between resistivity and geologic structure and extract resistivity anomalies related to mineralization in the Da Mai, Gang and Ngan Me areas (Fig. 2-15) in the Bo Cu Prospects.

(2) Exploration Method

Array CSAMT method

(3) Amounts of Geophysical Survey

Amounts of geophysical survey are as follows:

(Total length of lines	: 30 km
(Measuring points	: 330 points
(Laboratory test	: 25 pcs

5-2 Survey Method

5-2-1 Methodology

The MT method (Magnetotelluric method) is the exploration to estimate subsurface structure from determining resistivity distribution in the earth. The method uses alternating electromagnetic wave as a signal. Since the depth of sounding is dependent on frequency, the method is capable of exploring from surface to several km in depth by varying the frequency.

The CSAMT (Controlled Source Audio-frequency Magnetotelluric) method applied to this survey belongs to MT method and measures data in the audio frequency range with artificially controlled source. Recently, the method has been often utilized in exploring mineral deposit, geothermy, hot spring and groundwater on account of the following advantages.

(S/N ratio can be made higher due to the use of artificially controlled source.

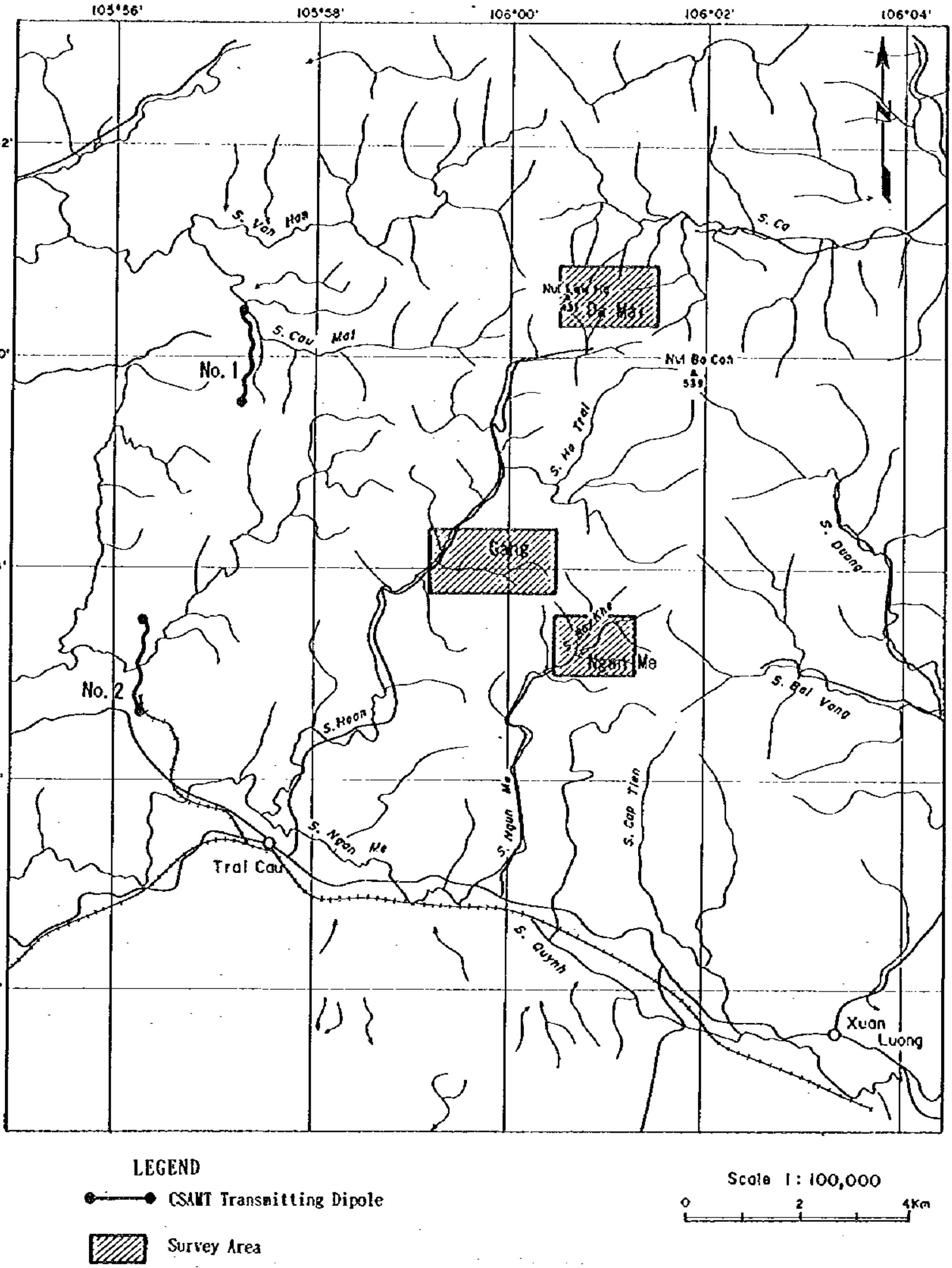


Fig. 2-15 Location Map of the Geophysical Survey Areas

• The measurement can be made more quickly due to the use of high frequencies.

• It is easy to transport the equipment even in steep mountain areas because they are compact and light.

The theory and measurement of the CSAMT method are the same as MT method, with the exception of using artificially controlled source. The Array CSAMT method can carry out the measurement of serial points on a survey line simultaneously.

The field set-up for the Array CSAMT method is illustrated in Fig. 2-16. A set of current electrodes (transmitting dipole) laid out apart from measuring points generates electromagnetic wave as a signal source. The electric field Ex parallel to the transmitting dipole and the horizontal magnetic field Hy perpendicular to the transmitting dipole are measured at a receiving point. The Array CSAMT method measures the electric field of several points with serial potential electrodes simultaneously. The apparent resistivity of the earth is calculated with these quantities. The equation for this calculation is as follows.

$$\rho a = (1/5f) \cdot \left| Ex/Hy \right|^2 \qquad (2\text{-}5\text{-}1)$$

ρa : Apparent resistivity (ohm·m)

f : Frequency (Hz)

Ex : Electric field intensity (mV/km)

Hy : Magnetic field intensity (gamma)

To the effective depth of exploration, the skin depth (2-5-2) is utilized. It shows the depth where the amplitude of incident electromagnetic wave decays to 1/e (37%).

$$\delta = 503\,(\rho/f)^{1/2} \qquad (2\text{-}5\text{-}2)$$

If a transmitting dipole is near measuring points, the assumption that primary field is plane electromagnetic wave is not held in low frequency range. In this frequency range, MT theory is not able to apply to CSAMT data. This phenomenon is called the Near-Field effect. If the Near-Field effect occurs, apparent resistivity increases monotonously as frequency decreases.

5-2-2 Field Survey

Two sets of transmitting dipole were laid out as shown in Fig. 2-15. The transmitting dipole No. 1 which is located in the approximately 6 km west of the Da Mai area was applied to the measurement of this area. The current electrode No. 2 which is located in approximately 5 km west of the Gang area was applied to the measurement of the Gang and Ngan Me areas. Both dipoles are N-E in direction and about 1.6 km in spacing.

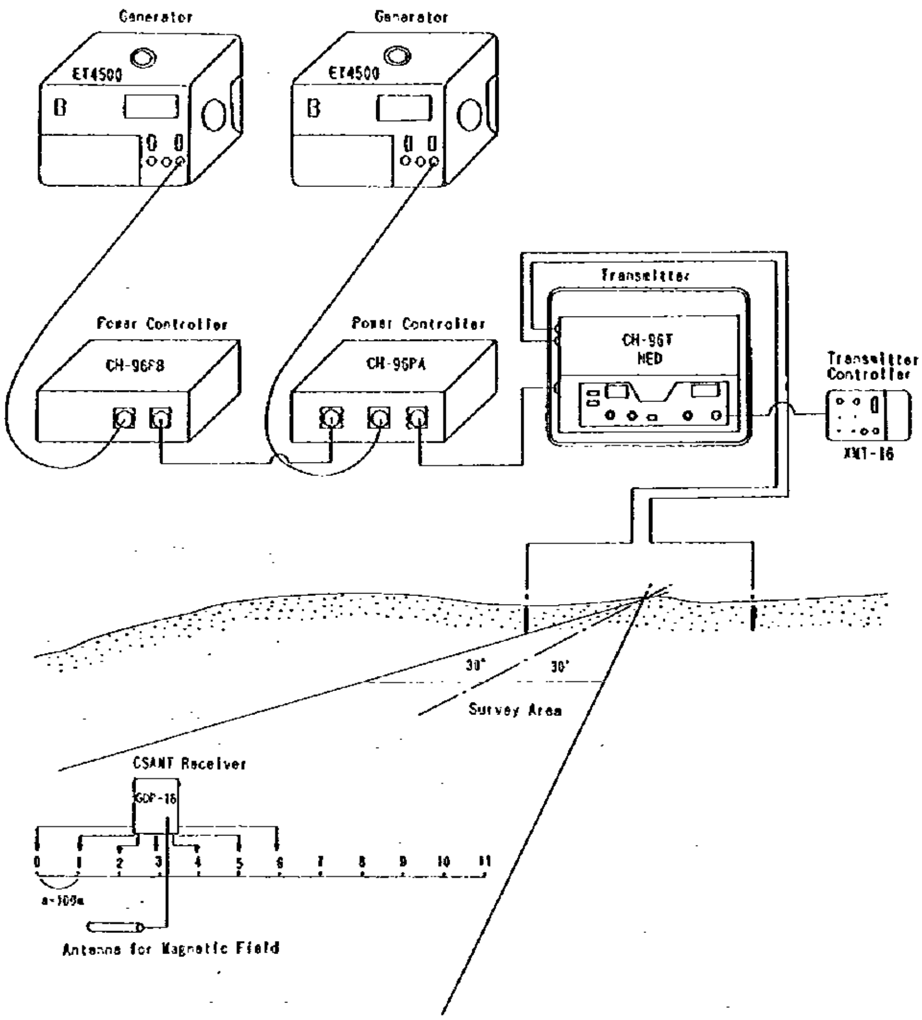


Fig. 2-16 Field Set-up for Array CSAMT Method

The survey lines (1 km in length, N-E in direction and 200 m in interval) are laid out as shown in Figs. 2-17 to 2-19.

The spacing of measuring points and potential electrodes are 100 m. Ten frequencies of 4, 8, 16, 32, 64, 128, 256, 512, 1,024, and 2,048 Hz were measured. Maximum 6 points were simultaneously measured.

The equipment used in this survey is shown in Table 2-14.

5-2-3 Laboratory Test

Resistivity and chargeability of rock samples in the survey areas were measured in laboratory. The same method as in the field measurement was applied. Twenty five samples were measured in laboratory.

Table 2-14 List of the Geophysical Survey Equipments

ITEM	MODEL	SPECIFICATION
Transmitter	Chiba CH-96T Transmitter Chiba CH-96A Power Controller Chiba CH-96B Power Controller	Output Voltage : 70, 120, 180, 250, 330, 420, 520, 630, 750, 880 V Output Current : 0~15 A Wave Form : Rectangular Wave Frequency Range : DC~10,000 Hz Weight : 110 kg
Transmitter Controller	Zonge XMT-16 Transmitter Controller	Frequency Range : DC~8,192Hz Power : 12V Battery Weight : 5.8 kg
Engine Generator	Honda ET4500 Engine Generator (2pcs)	Output Power : 4.5 kW Output Voltage : 200 V Weight : 78 kg
Receiver	Zonge GDP-16/8 Data Processor	Frequency Range : 1/8~8,192Hz Sensitivity : 0.03 μV Power : 12V Battery Weight : 23 kg
EM Antenna	Zonge ANT/1B	Coil : Ferrite Coil Weight : 6.2 kg
Electrode		Current : Stainless Rod Potential : Non Polarization $CuSO_4$ Porous Pot

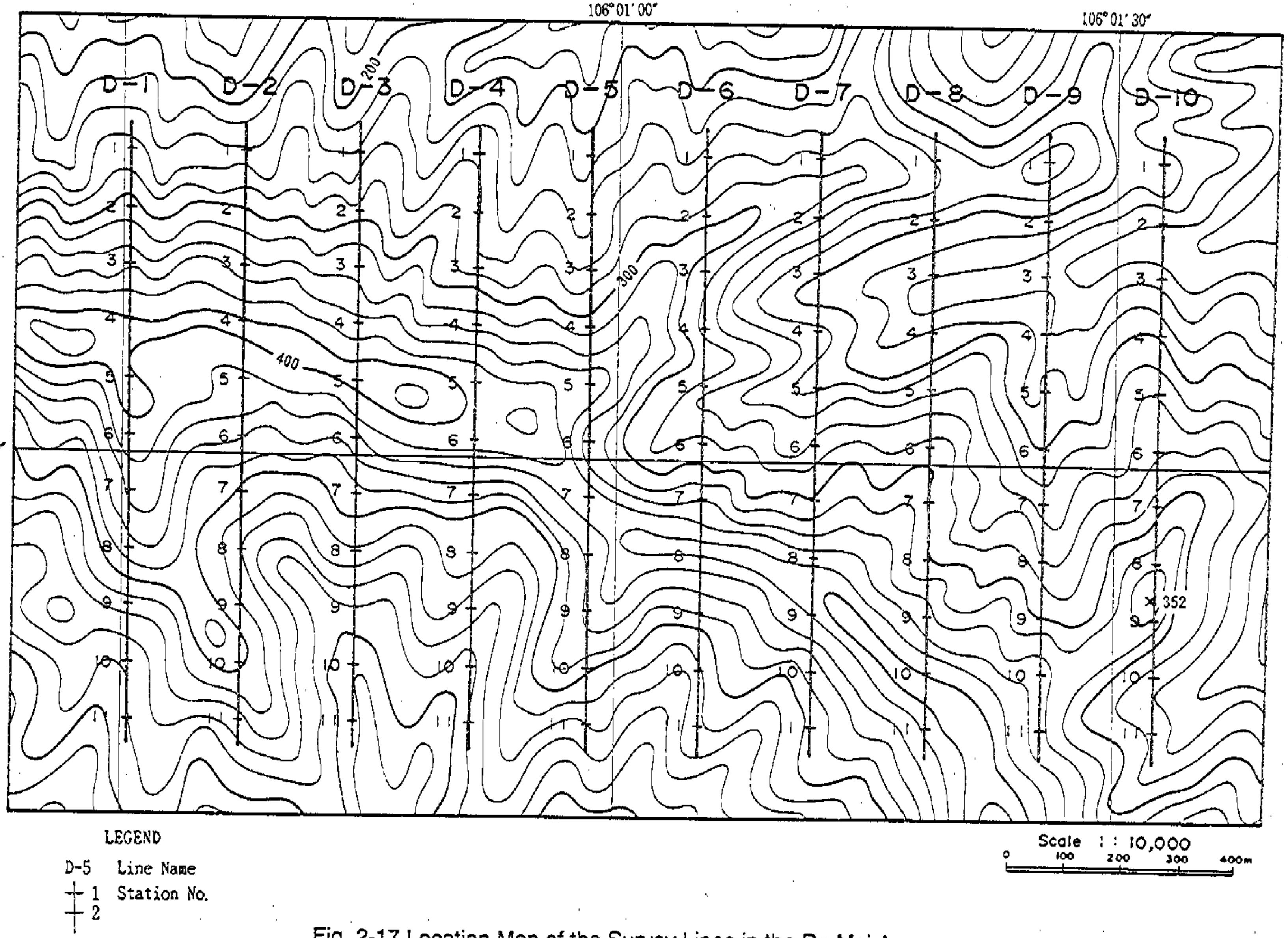


Fig. 2-17 Location Map of the Survey Lines in the Da Mai Area

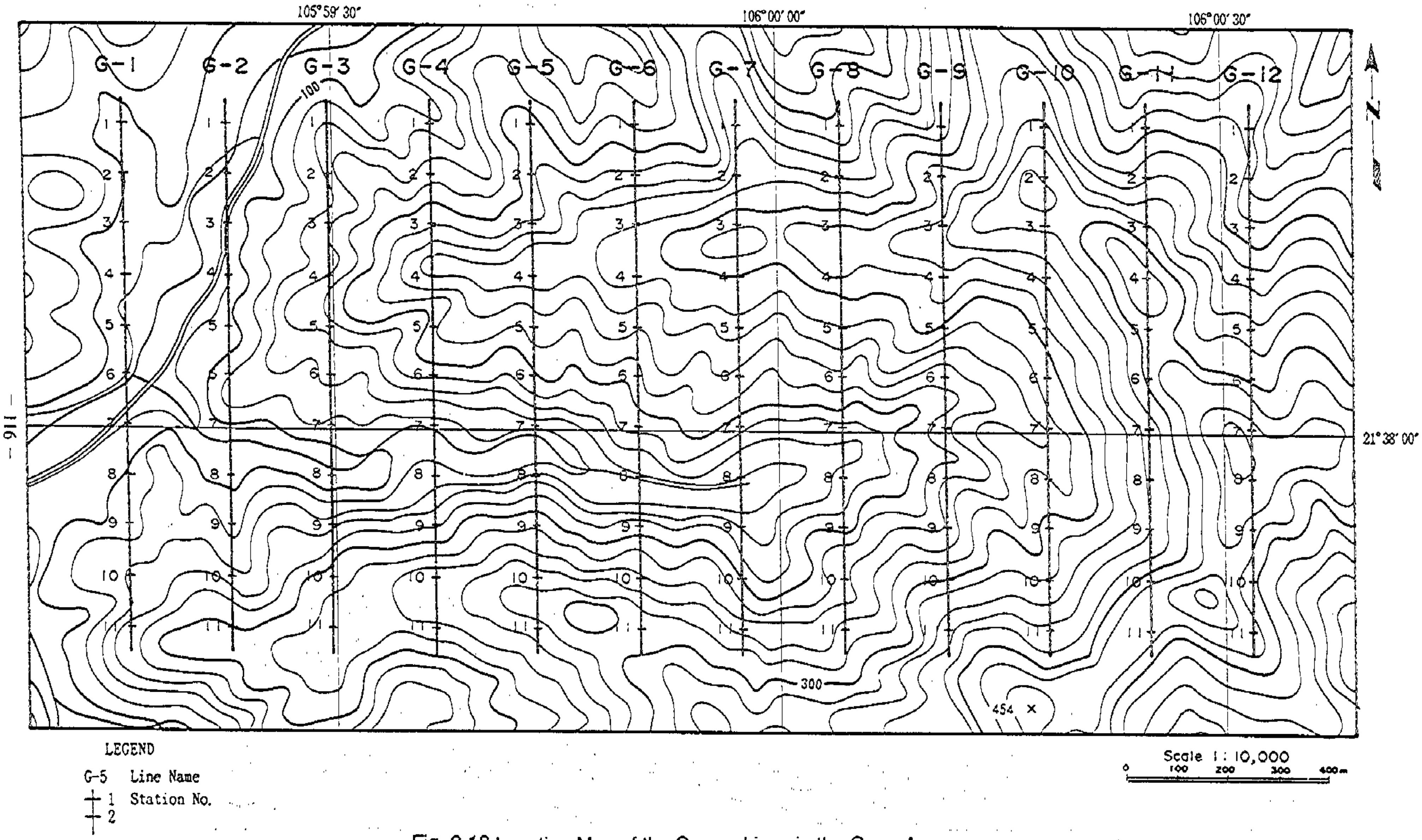


Fig. 2-18 Location Map of the Survey Lines in the Gang Area

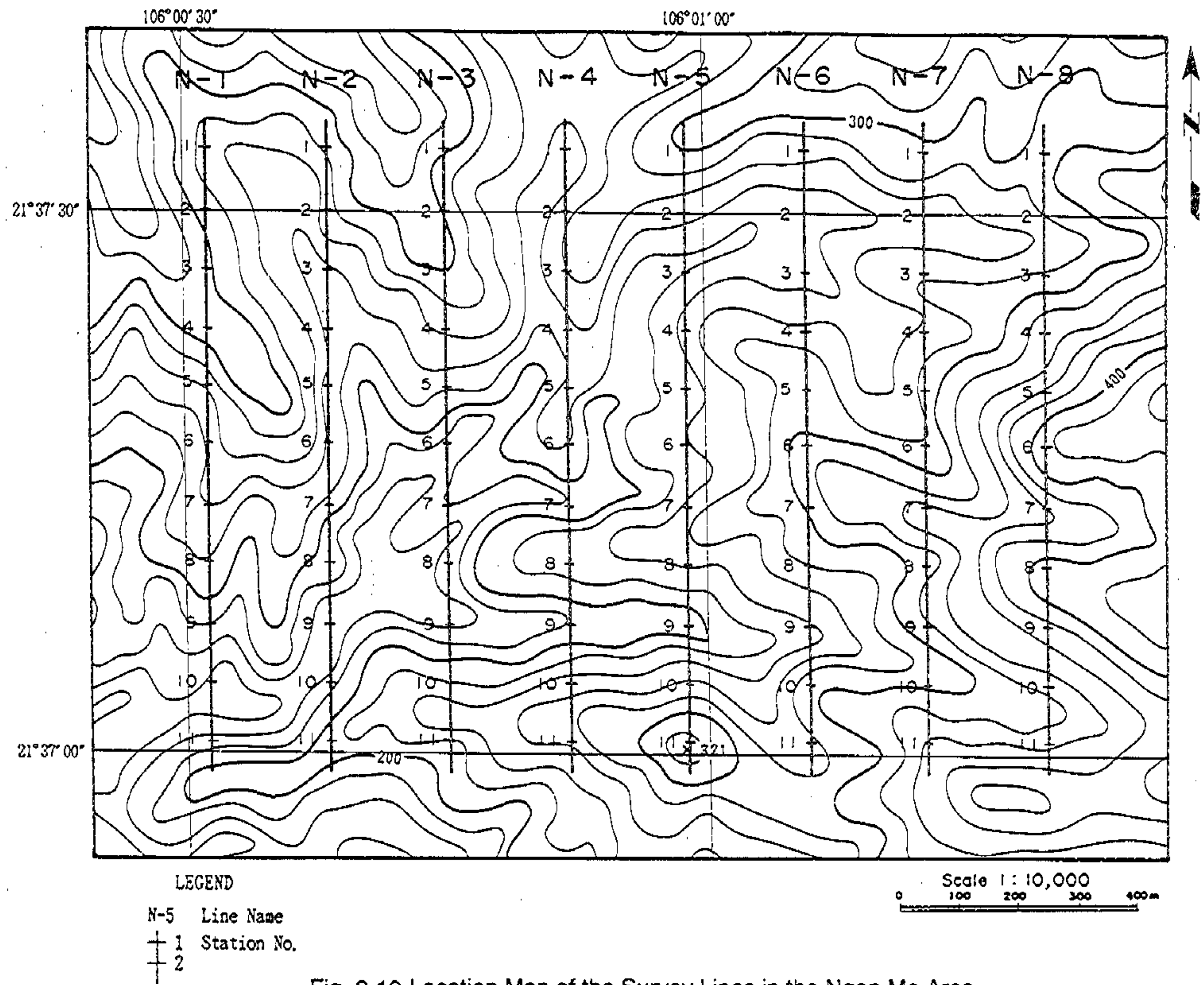


Fig. 2-19 Location Map of the Survey Lines in the Ngan Me Area

5-2-4 Analytical Method

The analysis was carried out according to the flow chart as shown in Fig. 2-20.

(1) Pseudosection of Apparent Resistivity

In this section, apparent resistivity is plotted for each line. The vertical axis of the section is frequency. The data of higher frequencies are plotted in the upper of the section and those of lower frequencies are plotted in the lower of the section dependent on the skin depth.

(2) Contour Map of Apparent Resistivity

In this map, the apparent resistivity of the specific frequency is plotted and their contours are drown.

(3) 1-D Inverse Analysis

This analysis assumes that resistivity structure is horizontal multi-layered structure, and determines the optimum parameter (resistivity and thickness) of horizontal multi-layered structure model for each measuring point. The apparent resistivity curve calculated for the optimum model is best fitted to the observed apparent resistivity curve. These parameters are calculated with the non-linear least squares method.

(4) Resistivity Structure Section (1-D Inverse Analysis)

In this section, the resistivity column of every measuring point is delineated on each line using the results of the 1-D inverse analysis.

(5) 2-D Inverse Analysis

This analysis assumes that resistivity structure is two dimensional structure, and determines the optimum resistivity distribution of two dimensional model for each line. The distribution of apparent resistivity calculated for the optimum model is best matched to the distribution of the observed apparent resistivity. It was assumed that the CSAMT data in this survey are TM mode data. The finite element method is applied to the forward analysis and the non-linear least squares method with smoothness constraint is applied to the optimization of resistivity distribution.

(6) Resistivity Structure Section (2-D Inverse Analysis)

In this section, the resistivity distribution below each line is drawn using the results of the 2-D inverse analysis.

(7) Resistivity Structure Map (2-D Inverse Analysis)

In this map, the resistivity distribution at the specific level is drawn using the results of the 2-D inverse analysis.

(8) Integrated Interpretation Map

In this map, the geophysical results are integrated with the geologic information.

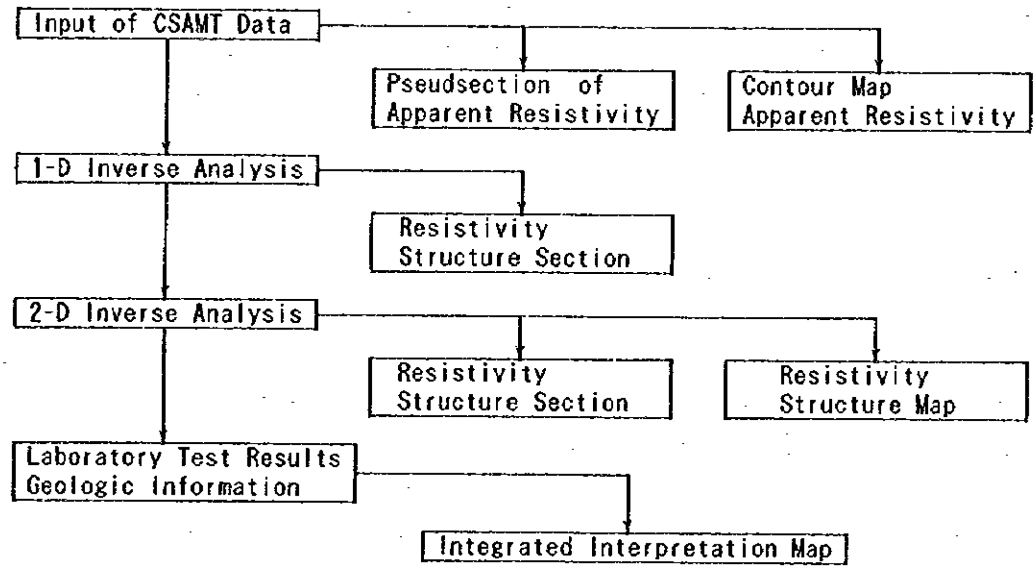


Fig. 2-20 Flow Chart of the Analytical Method

5-3 Survey Results

5-3-1 Da Mai Area

(1) Apparent Resistivity

The pseudosections of the apparent resistivity of every line are shown in Figs. 2-21 to 2-23 and the contour maps of the apparent resistivity of 3 frequencies (1,024, 128 and 16 Hz) are shown in Figs. 2-24 to 2-26. The Near-Field effect increasing apparent resistivity monotonously occurred in those of 64 Hz and less. Thus these data are not regarded as the MT information. The apparent resistivity more than 64 Hz on all lines is extremely high (more than 2,000 ohm-m) and little changeful in the pseudosections.

The apparent resistivity of 1,024 and 128 Hz show the similar distribution. The apparent resistivity shows a tendency to be low in the ridge parts and high in the valley parts. The direction of the resistivity distribution is E-W according to the topography, on the whole. The high resistivity zones more than 5,000 ohm-m were detected in the southern part continuing in the E-W direction, at No. 2 on lines D-1 to D-3, and No. 3 and No. 4 on lines D-7 to D-10.

(2) Resistivity Structure (1-D Analysis)

The 1-D analysis for the Da Mai area was carried out on the data more than 64 Hz which are not Near-Field. The resistivity structure sections drawn with the 1-D analysis are shown in Figs. 2-27 to 2-29. The analysis gave the two layered structure composed of low resistivity layer in the shallow zone up to the depth of 100-200 m and high resistivity one in the deep zone, as a whole.

(3) Resistivity Structure (2-D Analysis)

The resistivity structure sections drawn with the 2-D analysis are shown in Figs. 2-30 to 2-32. The resistivity structure maps of 3 levels (SL 100m, SL 0m, and SL -200m) are shown in Figs. 2-33 to 2-35. Removing the topographic effect (low resistivity in the ridge parts and high resistivity in the valley part were reduced) made the resistivity distribution more smooth than the apparent resistivity distribution. The analysis gave resistivity more than 2,000 ohm-m to the resistivity structure, except for the surface in the north-eastern part. On the whole, the relatively low resistivity areas are distributed in the shallow zone up to the depth of 200-300 m and the high resistivity areas are distributed broadly in the deep zone. The high resistivity zones tend to extend to the surface at Nos. 7 and 8 on lines D-3 to D-5, and in the southern part of lines D-7 to D-9.

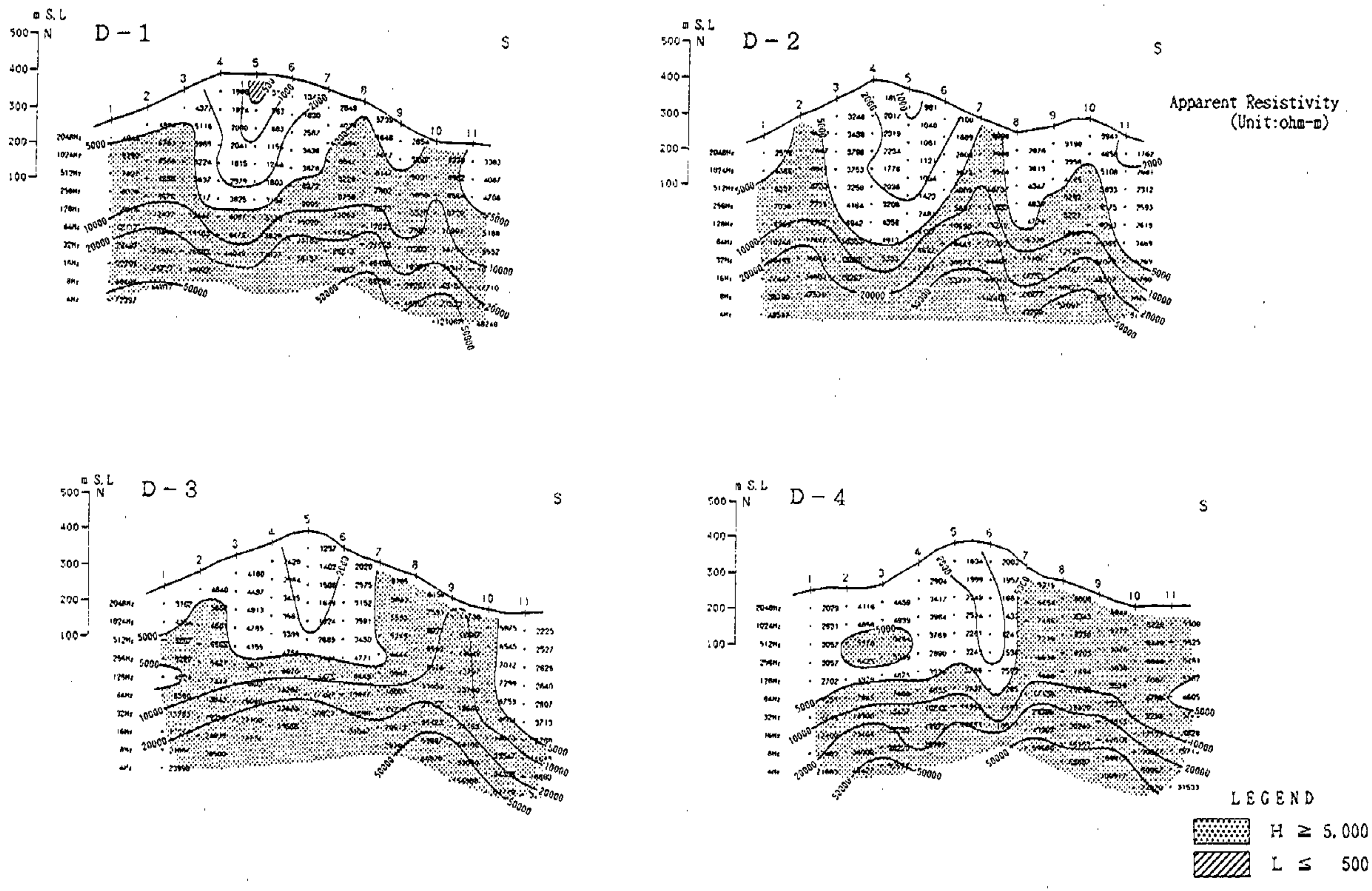


Fig. 2-21 Pseudosection of Apparent Resistivity (Line D-1 to D-4)

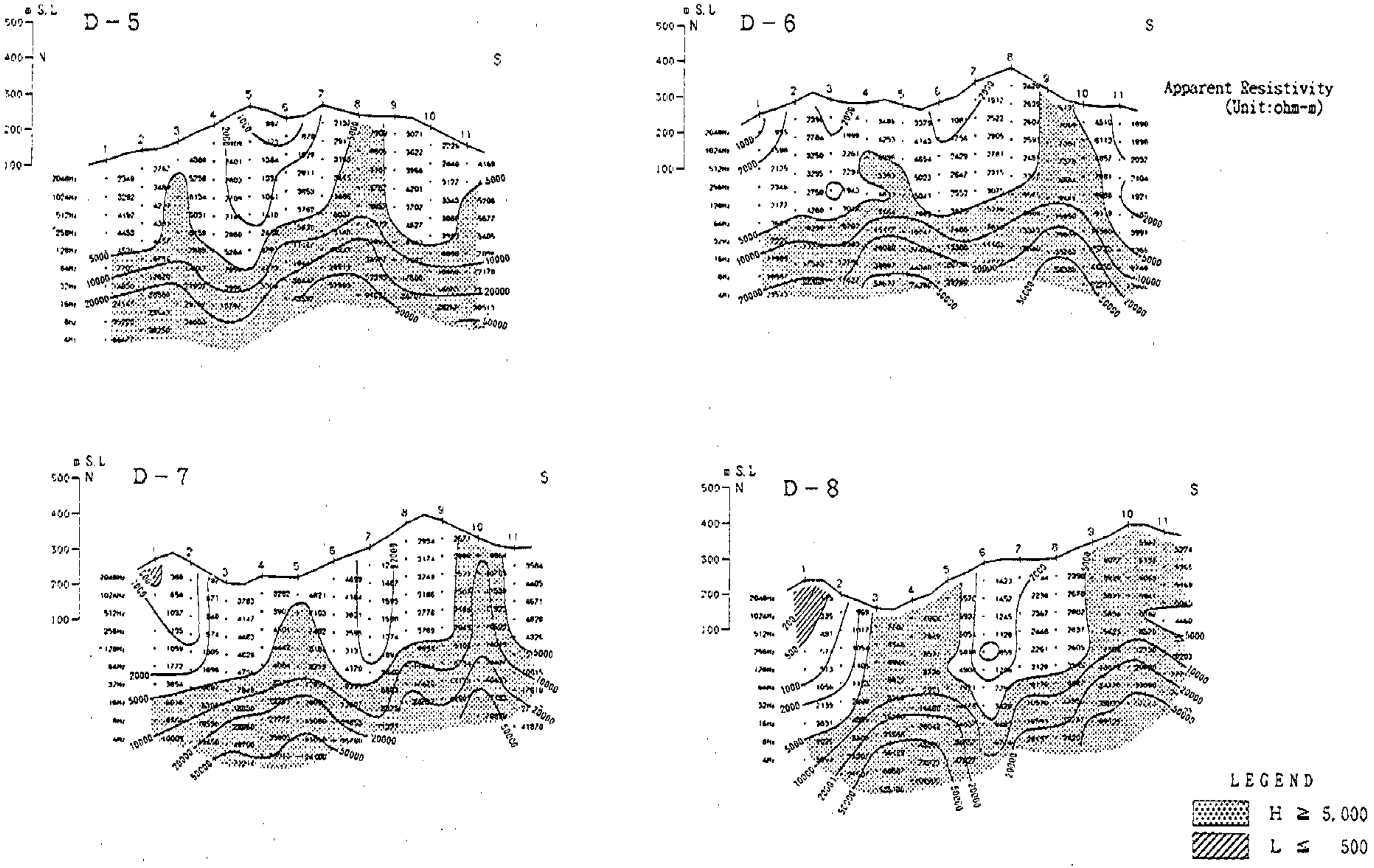


Fig. 2-22 Pseudosection of Apparent Resistivity (Line D-5 to D-8)

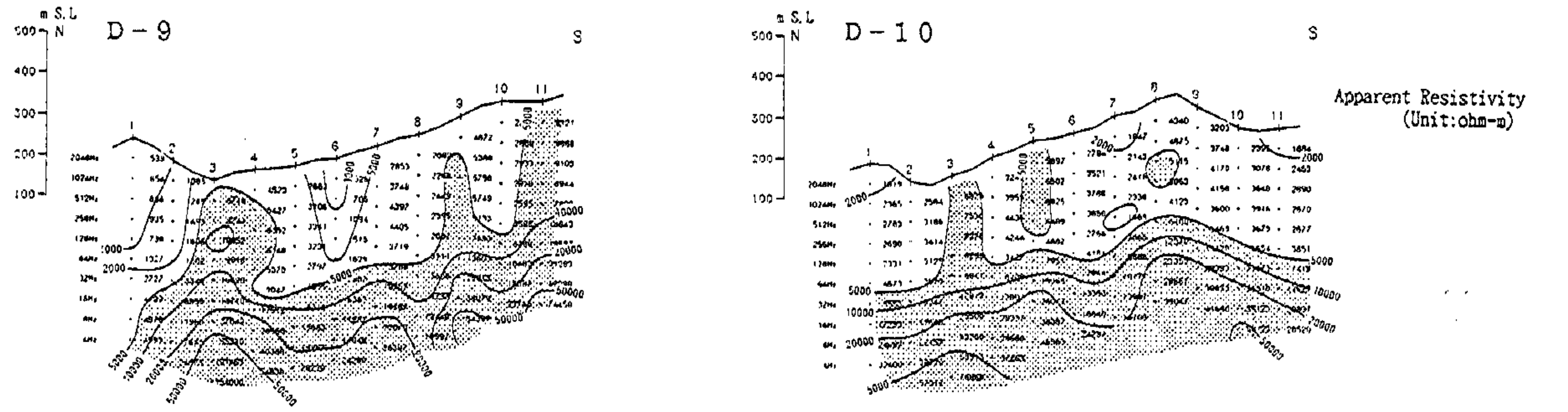


Fig. 2-23 Pseudosection of Apparent Resistivity (Line D-9, D-10)

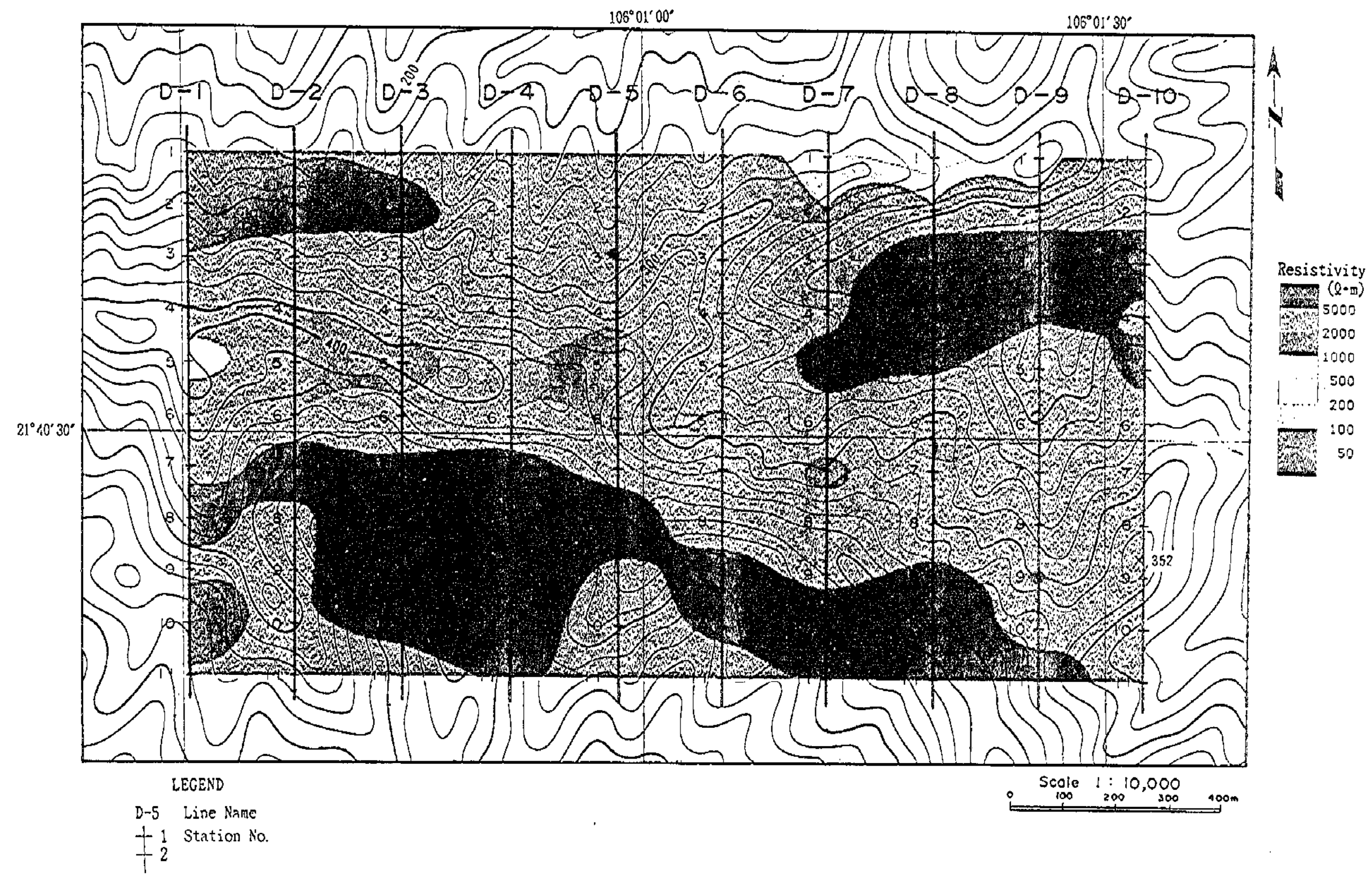


Fig. 2-24 Contour Map of Apparent Resistivity in the Da Mai Area (1,024 Hz)