1-4 Mineralization

1-4-1 Introduction

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

Quartz veins are hosted mainly by sandstone and schist of the Mo Dong Formation, and partly -- those in the eastern part of the Da Mai area and in the southwestern part of the Ngan Me area -- by sandstone and schist of the Than Sa Formation. Quartz veins generally show E-W, WNW and ENE trend. Two major groups were distinguished in their dips: south dip and north dip. The width of each quartz vein changes variously, ranging from a few centimeters up to 3 m. Tiny gold grains were observed by naked eye in some localities. Gold is sometimes accompanied by sulfide minerals; pyrite and arsenopyrite are the two most common minerals. Strong silicification, chloritization and weak sericitization 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.

More than 500 quartz veins of outcrops and in the mining pits/adits were surveyed in the second phase. Additional 500 vein data surveyed by GSV in 1989 to 1991 were analyzed this time. Trends of quartz veins were statistically investigated using the Schumidt's stereo net. The Schumidt's stereo net projections of quartz veins are illustrated in Figs. 2-5 and 2-8. Sketches of the representative veins are shown in Figs. 2-4 and 2-7. Major results of ore assays are shown in Table 2-4. The results of mineralogical analyses of ore, gangue and alteration minerals are shown in Tables 2-1 to 2-3. The results of the fluid inclusion studies are explained in a section below. Major results of the detailed survey in the Da Mai and Ngan Me areas are briefly summarized in Figs. 2-6 and 2-9 respectively.

1-4-2 Da Mai Area

Hundreds 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. It is approximately 7 km (E-W) by 2 km (N-S) in area. Gold-bearing quartz veins in the Da Mai area are hosted by sandstone, shale and sericite schist of the Mo Dong and Than Sa Formations. The width of veins ranges from a few centimeters to 2 m. The major trend of vein systems is E-W to ENE. Most of the veins dip steeply to S with some exceptions of N-dip. 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 bonanzas of gold. The vein quartz in the Da

Table 2-1 Results of Microscopic Observation of Thin Sections

Sample No.	Locality	Rock Name	Formation	Texture	Phenocryst/Crystal Fragment Qz	Kf	Pl	Bi	Hb	Px	Ol	Ep	Op	Groundmas/Matrix Qz	Kf	Pl	Hb	Px	Gl	Alteration & Remarks
	Da Mai Area																			
A003T	Da Luon	Schist	Cmd	Lepb	△								·							Mainly composed of clay,Se,Ch
A022T	Khe Thuon	Schist	Cmd	Lepb	·								·							Mainly composed of clay,Se,Ch
A041T	Lang Vang	Qz Vein	--	--	●								·							Some Se
A062T	Dong Cao	Dolomite	Cmd	Gran	△								·							Mainly composed of dolomite,Ca
A075T	Khuon Da	Limestone	C3ts1	Gran	·								·							Mainly composed of Ca
A078T	Khuon Da	Schist	C3ts1	Lepb	○								△							Mainly composed of Qz,clay,Se,Ch
A094T	Khe Cuc Tac	Schist	Cmd	Clas	△		·						·							Mainly composed of clay,Se,Ch
A105T	Khe Cuc Tac	Shale	Cmd	Clas	△								△							Mainly composed of clay,Se,Ch
B007T	Khe Dui	Schist	Cmd	Clas	△								·							Mainly composed of clay,Se,Ch
B016T	Khe Dui	Qz Vein (White)	--	--	●								·							Some Se,Ms,Ca
B018T	Khe Dui	Qz Vein (White)	--	--	●								·							Some Se,Ch,Ms
B029T	Khe Ma	Sandstone	Cmd	Clas	○		·						·							Mainly composed of Qz,Ca,Ms,Se,Ch
B070T	S. Hoan	Sandstone	C3ts1	Clas	●		△						·							Mainly composed of Qz,Se,Ch
B077T	S. Hoan	Schist	Cmd	Lepb	△								·							Mainly composed of clay,Se,Ch
	Ngan Me Area																			
A119T	S. Ho Mai	Schist	Cmd	Lepb	△		·						·							Mainly composed of Se,Ch
A149T	S. Na Hon	Schist	C3ts1	Lepb	·								·							Mainly composed of Se,Ch
A208T	Khe Can	Quartzitic Sandstone	Cmd	Clas	●		·						·							Mainly composed of Qz,clay,Se,Ch
B098T	Ba Khe	Qz Vein (White/L-gray)	--	--	●								·							Some Se,Ch,Ca,clay
B104T	Ba Khe	Qz Vein (White/L-gray)	--	--	●								·							Some Se,Ms
B123T	Ba Khe	Quartzitic Sandstone	Cmd	Clas	●		·	·					·							Mainly composed of Qz,clay,Se,Ch
B172T	Khe Cam	Schist	Cmd	Clas	●		△						·							Mainly composed of Qz,Se,Ch

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

Formation Names : Cmd;Mo Dong, C3ts1;Than Sa Lower, Onm;Na Mo, D1bb;Bac Bun, D1ml;Mia Le, D2nq;Na Quan, C-Pbs;Bac Son, P2dd;Dong Dang, T1ls;Lang Son, T1-2sh;Song Hiem, T2nk;Na Khuat, T-Cg;Granite Intrusive

Textures : Pycl;Pyroclastic, Clas;Clastic, Porp;Porphyritic, Lepb;Lepidoblastic, Glom-gr;Glomerophyric granular, Hypd-gr;Hypidiomorphic granular, Ophi;Ophitic, Int-gr;Inter-granular, Hol-pp;Holocrystalline-porphyritic, Comp;Compressed, Gran;Granular

Minerals : Qz;Quartz, Kf;Potash Feldspar, Pl;Plagioclase, Bi;Biotite, Hb;Hornblende, Px;Pyroxene, Ol;Olivine, Ep;Epidote, Op;Opaque Minerals, Gl;Glass, Ch;Chlorite, Se;Sericite, Ca;Carbonates, Ms;Muscovite

Table 2-2 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	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Sp	Gn	Ep	Rd	Ho	At
	Da Mai Area																																		
A002X	Qz vein	--	Da Luon		△	○																		◎	○										
A005X	Qz vein	--	Da Luon		△	△																		◎	·										
A009X	Qz vein	--	Da Luon			○																		◎	△										
A011X	Qz vein	--	Da Luon		·	·																		◎	·										
A016X	Qz vein	--	Gac Ba		·	△																		◎	△										
A017X	Qz vein	--	Gac Ba			△		·																◎	·			·?							
A034X	Qz vein	--	Lang Vang		○	△																		◎	·										
A035X	HW (altered Sch) of Qz vein	Cmd	Lang Vang		○	○																		○	△			·							
A057X	Sch in altered zone	Cmd	Dong Cao		○	○																		◎	○										
A067X	Sch	C3ts1	Khuon Da		·	○																		○	△			·							
A091X	Qz vein	--	Cuc Tac			△		·																◎	·			·?							
A094X	Altered zone near Qz vein	Cmd	Cuc Tac		△	○																		○	△										
B010X	Qz vein	--	Khe Dui		·	△														·				◎	△										
B011X	Qz vein	--	Khe Dui			·																		◎	△										
B012X	Qz vein	--	Khe Dui			△		·																◎	△										
B013X	Qz vein	--	Khe Dui			·																		◎	·										
B014X	Qz vein	--	Khe Dui		·	○																		◎	△			·							
B015X	Qz vein	--	Khe Dui	·?	·	○																		◎	△		·								
B016X	Qz vein	--	Khe Dui		△	○																		○	△		△								
B017X	Altered zone near Qz vein	Cmd	Khe Dui		○	○																		○	△										
B018X	HW (altered Sch) of Qz vein	Cmd	Khe Dui		△	·																		◎	·										
B056X	Qz vein	--	Dong Cao		△	·																		◎	·			·							
B084X	Sch near Qz vein	Cmd	S. Hoan			△		·?																◎	·										

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, Ak;Ankerite, 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 2-1.)

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

Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites				S-Salts			Carbonates			Silicates			Fldsp		Miscellaneous Minerals								
				Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	An	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Sp	Gn	Ep	Rd	Ho	At
	Ngan Me Area																																		
A123X	Qz vein	--	Ho Mai		·	△																		◎	·										
A143X	Sch near Qz vein	C3ts1	Na Hon			·																		◎	·										
A144X	HW (sandstone) of Qz vein	C3ts1	Na Hon			·																		◎		·									
A148X	HW (sandstone) of Qz vein	C3ts1	Na Hon		·	·		·											·?					◎	·	·		·							
A151X	Qz vein	--	Na Hon			△		·?																◎	·		·								
A156X	Qz vein	--	S. Ngan Me			·																		◎	·	·?									
A158X	Sandstone	C3ts1	S. Ngan Me			○		·																○	△			·							
A165X	Altered zone with Qz veinlets	Cmd	Khe Chuoi			·																		◎		·									
A166X	Qz vein	--	Khe Chuoi			·																		◎	·	·		·							
A167X	Qz vein	--	Khe Chuoi			·																		◎	·										
B096X	Altered sandstone with Qz vein	Cmd	Ba Khe		△														·					◎	△		·								
B098X	Qz vein	--	Ba Khe		·	·																		◎	·										
B104X	Qz vein	--	Ba Khe	·?		·																		◎	·		·								
B110X	Qz vein and HW sandstone	Cmd	Ba Khe			·																		◎		·									
B117X	Qz vein	--	Ba Khe			·																		◎	·										
B123X	Qz vein	--	Ba Khe			·																		◎	·										
B126X	Qz vein	--	Ba Khe			·																		◎	·										
B127X	Qz vein	--	Ba Khe		·	○																		◎	·		△					·?			

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, Ak;Ankerite, 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 2-1.)

Table 2-3 Results of Ore Microscopy

Sample No.	Locality	Minerals										Remarks
		Py	As	Cp	Sp	Gn	Cv	Au	Tt	Po	Io	
	Da Mai Area											
A002P	Da Luon	△		•	•	•				•	•	Qz vein (L-gray)
A003P	Da Luon			•						•		Black Schist (Cmd), Graphite trace
A005P	Da Luon	△									•	Qz vein
A009P	Dat Dau	•									•	Qz vein
A016P	Gac Ba										•	Qz vein
A019P	Khe Thuon	•									△	Qz vein.
A041P	Lang Vang										•	Qz vein
A043P	Lang Vang	•									•	Qz vein (White)
A096P	Khe Cuc Tac	△									•	Qz vein (L-gray)
A111P	Da Trang	△		•							•	Qz vein (White)
A248P	Khe Dui		•								•	Qz vein (White/L-gray), visible Au.
A264P	Khe Dui	△		•				△			•	Qz vein (White/L-gray), visible Au. Gold grains (0.01 to 0.3 mm) occur as free gold and are contained in arsenopyrite.
B001P	Khe Dui	•		•						•	•	Qz vein (White)
B010P	Khe Dui	△		•	•							Qz vein (White/L-gray), Ca associated
B011P	Khe Dui										•	Qz vein (White)
B012P	Khe Dui	•									•	Qz vein (White)
B013P	Khe Dui	•									•	Qz vein
B015P	Khe Dui	△	•	•	•							Qz vein (White/L-gray)
B017P	Khe Dui	•		•			•				•	Qz vein (White/L-gray)
B047P	Ngoc An	•									•	Qz vein (L-gray)
	Ngan Me Area											
A124P	S. Ho Mai	△	•	•			•			•	•	Qz vein (White)
A139P	S. Ngan Me	•		•							•	Qz vein (White/L-gray)
A148P	S. Na Hon	•									•	Qz vein (White/L-gray)
A150P	S. Na Hon	△		•	•	•				•		Qz vein (White)
A151P	S. Na Hon	•									△	Qz vein (L-gray), Magnetite, Hematite associated.
A165P	Khe Chuoi	•	•								•	Qz vein (L-gray)
A166P	Khe Chuoi	•									•	Qz vein (L-gray)
B096P	Ba Khe	•		•						•	•	Qz vein (White/L-gray)
B104P	Ba Khe	△		•							•	Qz vein (White/L-gray), Py disseminated.
B127P	Ba Khe	○	△	•		•	•			•	•	Qz vein (White/L-gray), Py disseminated.
B133P	Khe Dong	△	•	•		•	•			•	•	Qz vein (White/L-gray)
B137P	Khe Dong	△		•	•		•			•	•	Qz vein (White)
B150P	Khe Goc Tro	○	△	•	•	•					•	Qz network (White/L-gray)

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 2-4 Assay Results of Ore Samples (1)

Ser. No.	Sample No.	Width (cm)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Fe (%)	Location	Remarks
Da Mai Area										
1	A002A	20	0.013	0.6	0.002	0.003	0.011	6.20	Da Luon	L-gray Qz vein, Py diss.
2	A005A	15	0.010	<0.5	0.002	0.004	0.003	1.15	Da Luon	Qz vein.
3	A009A	20	0.210	2.3	0.004	0.007	0.026	7.65	Dat Dau	Qz vein.
4	A011A	50	0.070	0.8	0.008	0.012	0.019	1.97	Dat Dau	L-gray Qz vein, Py diss.
5	A016A	20	0.008	<0.5	0.002	0.002	0.003	2.84	Left Side of Gac Ba	Qz vein.
6	A017A	15	0.010	0.7	0.004	0.005	0.003	5.05	Left Side of Gac Ba	Qz vein.
7	A019A	30	0.398	<0.5	0.003	0.006	0.002	1.30	Right Side of Thuon	White Qz vein.
8	A034A	30	0.010	<0.5	0.001	0.410	0.004	2.60	Lang Vang	L-gray Qz vein.
9	A041A	10	0.017	<0.5	0.002	0.130	0.002	2.36	Lang Vang	Qz vein.
10	A043A	20	0.006	<0.5	0.002	0.007	0.004	2.93	Lang Vang	White Qz vein.
11	A048A	20	0.006	<0.5	0.003	0.007	0.002	2.50	Dao	White/L-gray Qz vein.
12	A088A	20	0.459	<0.5	0.002	0.006	0.003	3.75	Cuc Tac	L-gray Qz vein.
13	A089A	25	3.598	0.6	0.002	0.018	0.005	4.09	Cuc Tac	L-gray Qz vein
14	A090A	115	0.037	<0.5	0.004	0.002	0.007	5.68	Cuc Tac	White/L-gray Qz vein.
15	A095A	70	0.067	<0.5	0.001	0.003	0.003	3.41	Cuc Tac	L-gray Qz vein.
16	A098A	15	0.007	<0.5	0.001	0.003	0.001	0.63	Cuc Tac	White/L-gray Qz vein.
17	A099A	10	1.539	0.6	0.005	0.008	0.007	3.90	Cuc Tac	White Qz vein.
18	A105A	5	2.232	<0.5	0.002	0.007	0.004	1.59	Cuc Tac	White Qz vein.
19	A225A	21	0.125	<0.5	0.004	0.007	0.003	3.49	Da Mai - adit	L-gray Qz vein.
20	A226A	6	0.033	<0.5	0.001	0.001	0.001	1.36	Da Mai - adit	L-gray Qz vein.
21	A227A	45	0.285	<0.5	0.002	0.004	0.002	2.02	Da Mai - adit	Qz vein.
22	A236A	23	0.010	<0.5	0.005	0.002	0.003	2.27	W-Da Mai - new road	White Qz vein.
23	A239A	5	0.008	<0.5	0.002	0.004	0.002	2.29	W-Da Mai	L-gray Qz vein, Limo diss.
24	A240A	10	0.043	<0.5	0.002	0.002	0.003	3.99	W-Da Mai	Qz vein.
25	A241A	10	0.050	<0.5	0.007	0.002	0.005	9.84	W-Da Mai	Qz vein.
26	A242A	5	0.175	<0.5	0.002	0.006	0.004	4.17	W-Da Mai	Qz vein.
27	A243A	10	0.050	<0.5	0.001	0.003	0.002	3.81	W-Da Mai	Qz vein.
28	A244A	8	6.890	<0.5	0.002	0.004	0.003	3.22	W-Da Mai	Qz vein.
29	A248A	33	0.071	<0.5	0.001	0.001	0.001	1.58	Khe Dui	White/L-gray Qz vein, visible Au
30	A261A	13	0.436	<0.5	0.008	0.003	0.002	1.17	Khe Dui	White/L-gray Qz vein, visible Au.
31	A263A	45	13.385	4.0	0.014	0.001	0.001	1.06	Khe Dui	White/L-gray Qz vein, visible Au.
32	A264A	8	55.704	<0.5	0.004	0.003	0.002	2.06	Khe Dui	White/L-gray Qz vein, visible Au.
33	B010A	20	0.070	<0.5	0.003	0.006	0.004	2.55	Khe Dui	White/L-gray Qz vein, Py diss.
34	B011A	40	0.047	<0.5	0.003	0.004	0.004	4.71	Khe Dui	White Qz vein, Limo diss.
35	B012A	60	0.007	<0.5	0.002	0.004	0.004	3.90	Khe Dui	White Qz vein, Limo diss.
36	B013A	20	0.007	<0.5	0.001	0.001	0.001	0.91	Khe Dui	White Qz vein, Limo diss.
37	B014A	20	0.108	<0.5	0.004	0.011	0.008	6.16	Khe Dui	White Qz vein, Limo diss.
38	B015A	150	1.117	<0.5	0.005	0.004	0.003	2.12	Khe Dui	White/L-gray Qz vein, Limo diss.
39	B016A	100	0.043	<0.5	0.005	0.009	0.004	4.14	Khe Dui	White Qz vein, Limo diss.
40	B017A	10	0.010	<0.5	0.002	0.019	0.006	3.37	Khe Dui	White/L-gray Qz vein, Limo diss.
41	B018A	80	0.007	<0.5	0.002	0.004	0.004	3.10	Khe Dui	White Qz vein, Limo diss.
42	B029A	40	0.695	<0.5	0.002	0.003	0.003	4.23	Khe Ma	L-gray Qz vein, Py diss.
43	B031A	40	0.850	63.2	0.034	0.417	0.124	12.22	Khuon Phung	Qz vein, Limo diss.
44	B041A	20	0.030	<0.5	0.001	0.004	0.004	4.47	Nuoc An	White Qz vein, Limo diss.
45	B047A	15	0.003	<0.5	0.002	0.008	0.004	2.31	Nuoc An	L-gray Qz vein, Py diss.
46	B050A	20	0.053	<0.5	0.001	0.003	0.001	2.69	Dong Cao	L-gray Qz vein, Limo diss.
47	B066A	15	0.003	<0.5	0.001	0.002	0.003	3.08	S. Hoan	White/L-gray Qz vein, Limo diss
48	B084A	15	0.043	<0.5	0.005	0.009	0.006	3.42	S. Hoan	L-gray Qz vein, Limo diss.
49	B092A	25	0.010	<0.5	0.002	0.002	0.002	2.41	S. Hoan	White Qz vein.

Table 2-4 Assay Results of Ore Samples (2)

Ser. No.	Sample No.	Width (cm)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Fe (%)	Location	Remarks
Ngan Me Area										
50	A123A	10	0.190	1.0	0.003	0.003	0.003	2.31	Ho Mai	White Qz vein.
51	A138A	15	0.006	<0.5	0.002	0.005	0.001	1.06	Ho Mai	L-gray Qz vein.
52	A148A	100	0.037	0.6	0.005	0.004	0.008	10.39	Na Hon	White/L-gray Qz vein.
53	A151A	4	0.010	<0.5	0.002	0.006	0.003	1.97	Na Hon	L-gray Qz vein.
54	A156A	2	0.012	0.5	0.003	0.004	0.003	3.27	S. Ngan Me	White/L-gray Qz vein.
55	A165A	8	0.015	1.6	0.004	0.006	0.001	2.74	Khe Chuoi	L-gray Qz vein.
56	A166A	20	0.033	<0.5	0.002	0.030	0.003	4.23	Khe Chuoi	L-gray Qz vein
57	A167A	60	0.040	0.7	0.003	0.002	0.001	2.79	Khe Chuoi	White Qz Vein.
58	A208A	30	0.005	<0.5	0.015	0.008	0.006	3.32	Khe Can	Qz vein.
59	B096A	40	0.030	<0.5	0.002	0.012	0.005	3.80	Ba Khe	White/L-gray Qz vein, Py diss.
60	B098A	25	0.733	0.6	0.002	0.009	0.002	2.55	Ba Khe	White/L-gray Qz vein, Py diss.
61	B104A	30	0.020	<0.5	0.001	0.005	0.001	1.20	Ba Khe	White/L-gray Qz vein, Py diss.
62	B110A	50	0.263	<0.5	0.004	0.005	0.002	2.79	Ba Khe	L-gray Qz vein, Py diss.
63	B117A	20	0.010	<0.5	0.002	0.005	0.003	3.22	Ba Khe	White Qz vein, Py diss.
64	B123A	10	0.340	<0.5	0.002	0.003	0.002	2.16	Ba Khe	White/L-gray Qz vein, Py diss.
65	B126A	10	0.095	<0.5	0.003	0.012	0.002	2.36	Ba Khe	White Qz vein, Limo diss.
66	B127A	20	0.475	0.5	0.005	0.047	0.002	2.84	Ba Khe	White/L-gray Qz vein, Py diss.
67	B130A	15	0.017	<0.5	0.002	0.003	0.002	1.83	Ba Khe	L-gray Qz vein, Py diss.
68	B133A	250	0.677	1.6	0.029	0.014	0.003	7.41	Dong	White/L-gray Qz vein, Py diss.
69	B137A	20	0.025	<0.5	0.007	0.005	0.001	2.31	Dong	White Qz vein, Py diss.
70	B150A	30	0.133	1.0	0.009	0.033	0.003	3.37	Goc Tro	White/L-gray Qz vein, Py diss.

Table 2-5 Methods of Analysis and Limits of Detection of Ore Samples

Element	Method of Analysis	Detection Limit	Upper Limit
Au	Fire assay with AA finish	0.001ppm	150ppm
Ag	Total digestion with AA finish	0.5ppm	350ppm
Cu	Nitric aqua regia with ICP finish	0.001%	5%
Pb	ditto	0.001%	5%
Zn	ditto	0.001%	5%
Fe	HCl/KClO3 extraction with ICP finish	0.01%	30%

*AA means Atomic Absorption method.

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, sericite and chlorite.

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 (Da Mai creek). The people's activity may be looked back to 1985 or earlier. In 1989 and 1990, the Division No. 1 made trenching survey in this area, and found some new quartz veins. Ore reserves estimated by the Division at that time were 500 kg Au for hard rock gold (shallow part) and 600 kg Au for alluvial gold (along S. Ca).

The major prospects in the Da Mai area are: Da Mai-Khe Dui, NE of N. Bo Cu, and Khe Ma-S. Khuon Da. The details of the occurrences of quartz veins in the major prospects are described below.

Da Mai-Khe Dui Prospect

Gold-bearing quartz veins occur at several localities -- Da Mai creek, West Da Mai creek, Khe Dui creek, Goc Sen, Da Luon creek, Khe Thun creek, North Da Mai, and Dong Rao creek -- in the Da Mai-Khe Dui prospect. The major groups of gold-bearing quartz veins are subdivided into three: Da Mai creek veins, Khe Dui creek veins, and West Da Mai creek veins.

Da Mai creek is the oldest mining place in the Bo Cu area. More than ten old adits are distributed along the creek. The trend of veins is mostly E-W to ENE-WSW with steep S-dip. Quartz veins are hosted mainly by an alternating bed of sericite schist and sandstone. According to the Division No. 1 data, gold assays up to 36.38 g/t Au at 90 cm in width were returned. Two kinds of quartz were observed: white quartz and gray to light gray quartz. Sulfide minerals are relatively little in veins in this place.

Along Khe Dui creek (a branch of S. Ca), many gold anomalies were detected during the geochemical survey in the first phase. More than ten shafts, adits and prospecting pits are distributed along the upstream of Khe Dui creek. The quartz veins in the Khe Dui prospect are arranged in the E-W direction. They generally dip to S at 50 degrees. Some of the veins strike NE-SW. The host rocks are sandstone and schist. Sheared, argillized and sulfide disseminated zones were sometimes observed along the veins. The vein quartz sometimes shows gray color. Veins in Khe Dui creek usually contain a small amount of sulfide minerals. Visible gold was frequently observed in quartz veins in Khe Dui creek. Assay results up to 55.704 g/t Au at 8 cm (A264A) and 13.385 g/t Au and 4.0 g/t Ag at 45 cm (A263A) were obtained through the detailed survey this phase.

Several adits were dug on the slope of West Da Mai creek near the ridge. The trend of veins is E-W to ENE-WSW in this creek. They dip nearly vertical. Some veins dip to N. Quartz veins up to 1 m in width were found there. Quartz of the veins generally shows gray color. They are hosted by sandstone and schist. The host rocks adjacent to veins were sheared. Assay results up to 6.890 g/t Au at 8 cm (A244A) were returned from samples in this place.

From Goc Sen to the east, 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. Veins occur until Da Luon creek.

In Da Luon, Dat Dau and Gat Ba, which are branch creeks of S. Ca and are located about 1.5 km east of Da Mai creek, quartz veins show E-W trend with dips of 20 to 60 degrees S and NW to NNW trend with dips of 40 to 70 degrees E. The widths of veins range from a few centimeters up to 1.9 m. The widths decrease to the east. Veins are hosted by gray sericite schist and shale (weakly schistose) of the Mo Dong Formation. Local people's mining adits and shafts are distributed in these creeks.

Significant amounts of quartz veins occur at Khe Thun (North Da Mai), Khe Ma and Khe Khuon Phung, which are branches of S. Ca and are located about 1 km north of Da Mai creek. They show mainly E-W trend with dips 20 to 40 degrees both S and N. There are few which show NW trend. The width changes from 10 cm to 1 m. They are hosted by sericite schist and sandstone of the Mo Dong Formation. Sulfide rich quartz veins were found in Khe Khuon Phung (0.850 g/t Au, 63.2 g/t Ag, 12.22 % Fe at 40 cm, B031A). People's mining activity is relatively scarce in this place.

From Dong Rao creek to the mainstream S. Ca situated 0.5 km north of Khe Dui, tens of quartz veins occur in gray schist, sandstone and siltstone of the Mo Dong Formation. Quartz veins show E-W to ENE trend with dips of 20 to 50 degrees S and N. Some veins show NNE to NE trend. People's mining activity has not been observed.

Results of stereo net analysis showed two significant concentrations of vein trends: E-W trend with dips of 53° S and E-W trend with dips of 40° N.

Sulfide minerals observed under the microscope in the Da Mai-Khe Dui area are: pyrite, arsenopyrite, pyrrhotite, chalcopyrite, covelline, chalcocite, tetrahedrite, sphalerite, galena, scorodite, and limonite. Native gold of up to 0.3 mm in diameter was observed in some samples from Khe Dui (A264P). Native gold frequently occurs as free gold in quartz veins. It also occurs in a form accompanied by sulfide minerals such as arsenopyrite. Native gold contained in scorodite like a micro-vein was found in a sample (A264P).

NE of N. Bo Cu Prospect

This prospect (approximately 2.5 km in E-W by 2.0 km in N-S) is located at the northeast of N. Bo Cu, which is covered by several branch creeks of S. Ca -- Ba Khe, S. Giao, S. Dong Cao, and S. Nuoc An. Quartz veins are hosted mainly by gray schist and sandstone of the Mo Dong Formation. Some of them in the northeastern part of the prospect are hosted by sandstone and schist of the Than Sa Formation (of the Lower Member). Two major trends of quartz veins were distinguished: E-W trend with 73° S , and E-W trend with 20° N. Other trends such as NW, NNW, NE and NNE were also found locally. Veins of the E-W trend occur mainly in the central to the western parts of the prospect near Da Luon. Whereas those of the NW, NNW, NE and NNE trends occur mainly in the eastern part of the prospect. The widths of veins are from a few centimeters to 1 m. They contain a small amount of sulfide minerals such as pyrite. A few local people's adits exist at Ba Khe (different creek from Ba Khe in the Ngan Me area).

<u>Khe Ma-S. Khuon Da Prospect</u>

This prospect is situated in the most eastern part of the Da Mai area. Tens of quartz veins, though narrow in width, occur along Khe Ma (different from Khe Ma in the Da Mai-Khe Dui prospect) and S. Khuon Da, both is branches of S. Ca. Quartz veins are hosted by sandstone, schist and shale of the Than Sa Formation (of the Lower Member). Various trends were recognized: WNW to NW with dips of 50 to 70 degrees to S, NE to ENE with dips of 40 to 50 degrees to N, and others. They are concentrated in the ENE trend with 52° N dip on the stereo net. Veins in the southern part mainly show WNW to NW trend. Whereas those in the northern part show NE to ENE trend. No people's mining activity was observed except for alluvial gold.

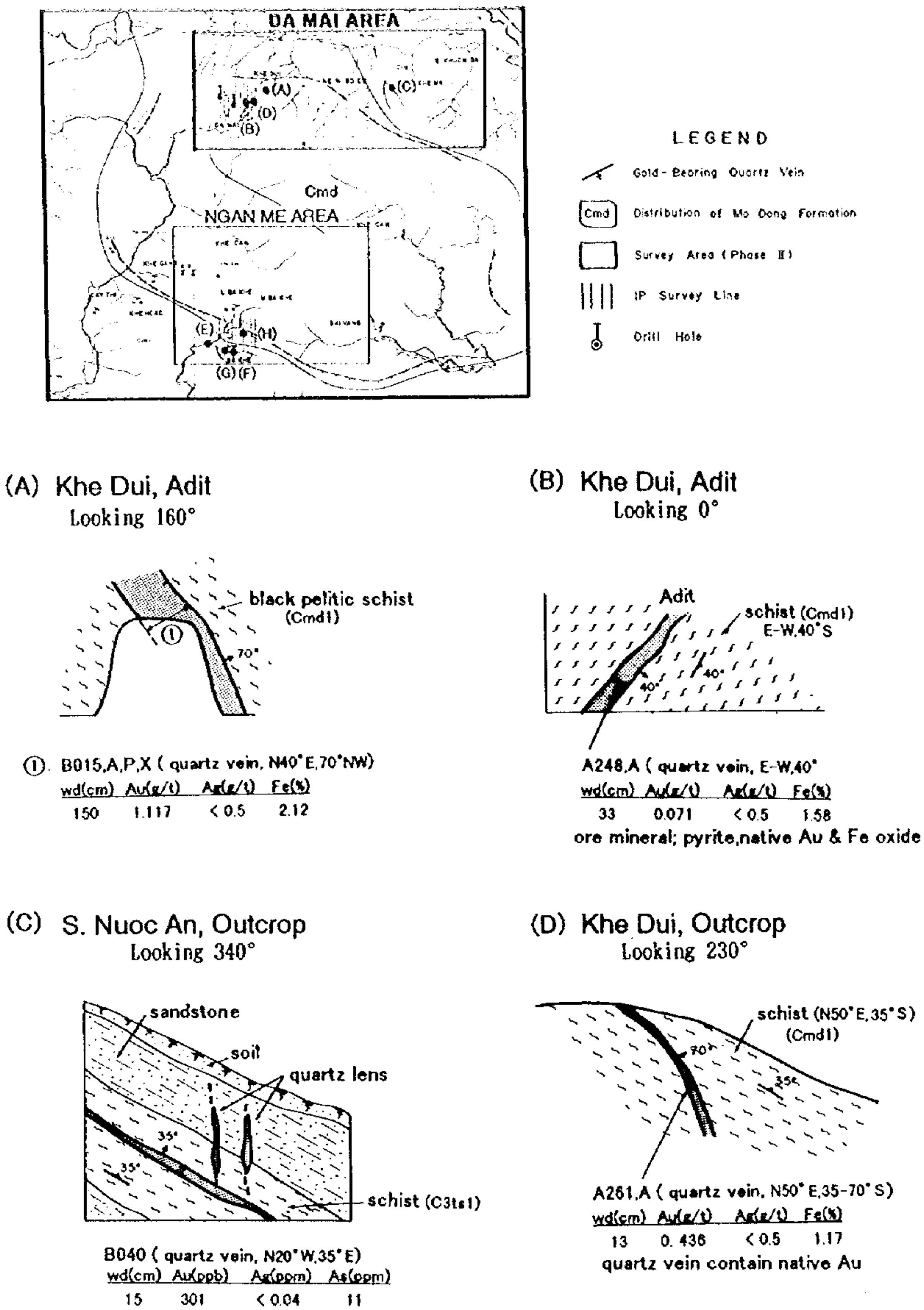
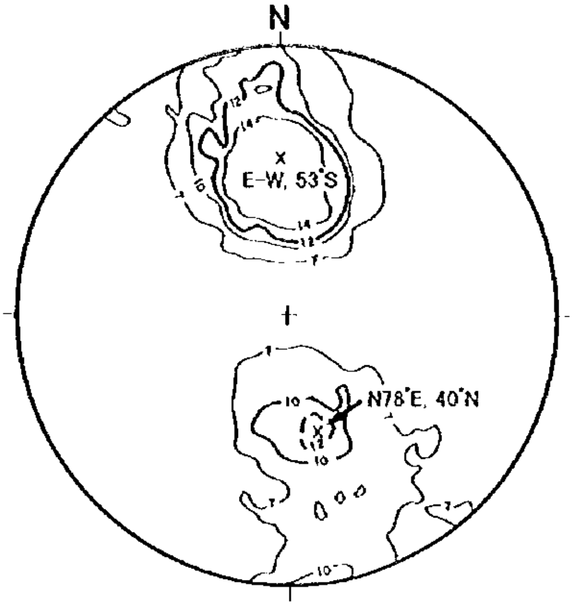
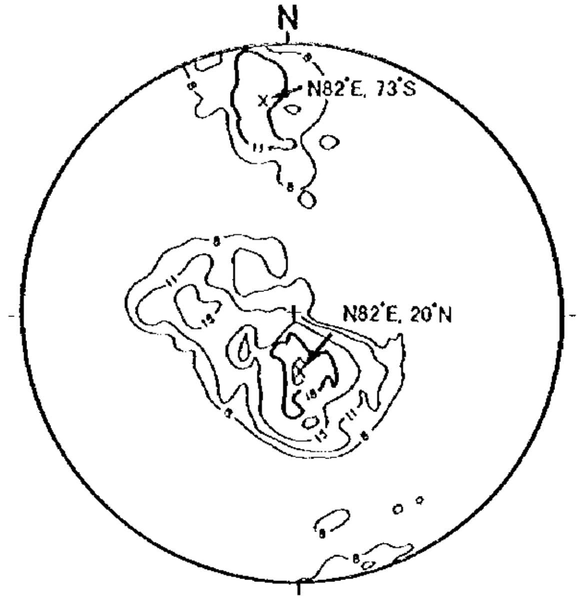


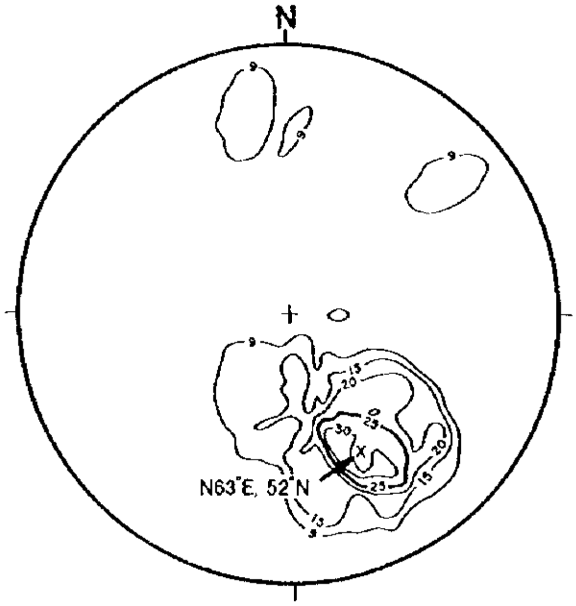
Fig. 2-4 Sketch of Quartz Veins in the Da Mai Area



Da Mai-Khe Dui Prospect (N=484)

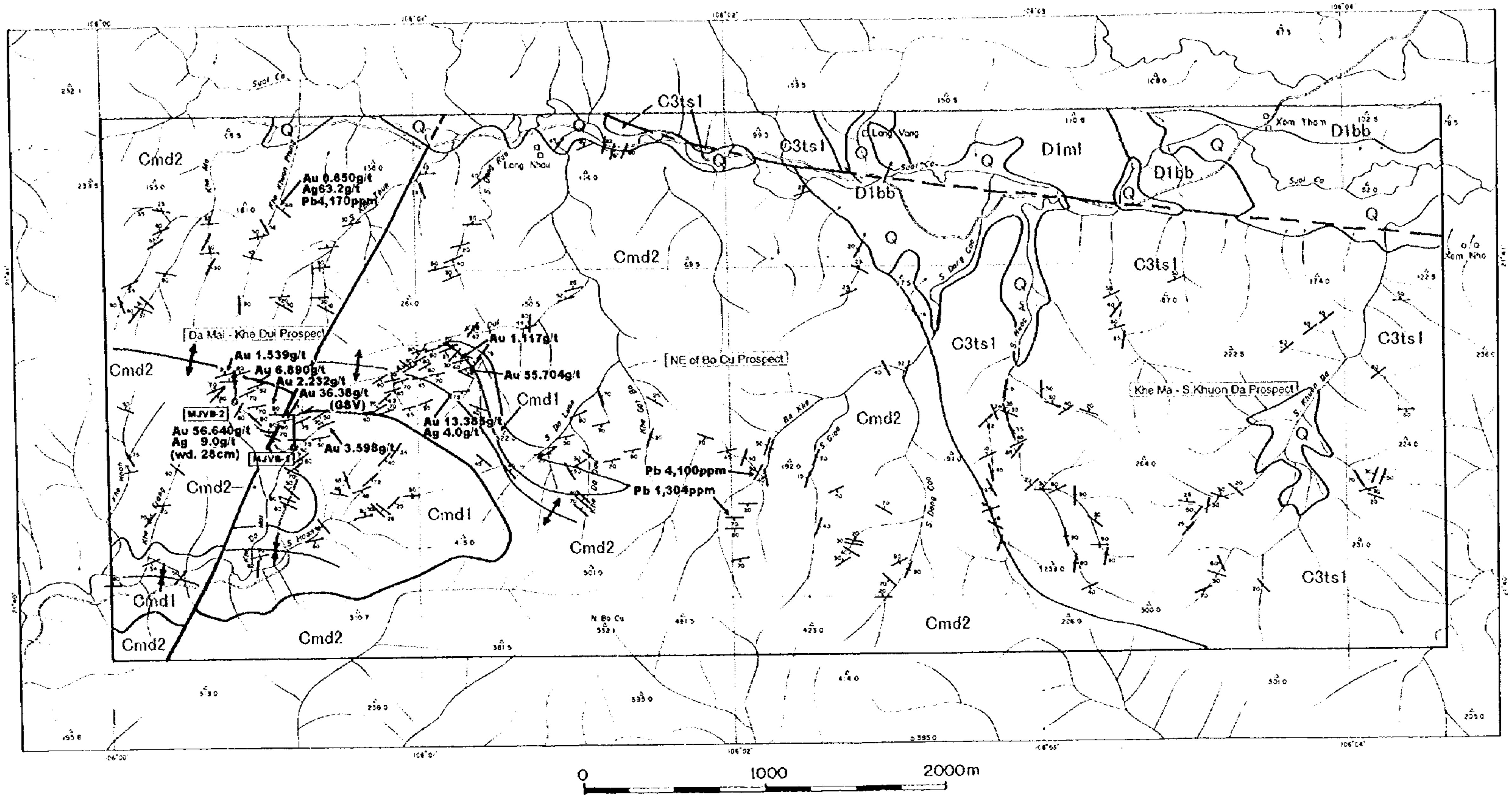


NE of N. Bo Cu Prospect (N=77)



Khe Ma-Khuon Da Prospect (N=35)

Fig. 2-5 Stereo Net Projection of Quartz Veins in the Da Mai Area



LEGEND

Quaternary	Q	Alluvial Deposits
Devonian	D1ml	Mia Le Formation
	D1bb	Bac Bun Formation
Cambrian	C3ts1	Lower Than Sa Formation
	Cmd2 / Cmd1	Mo Dong Formation 2. Mainly composed of sandstone 1. Alternation of schist & sandstone

- Fault
- Anticlinal Axis
- Synclinal Axis
- Drill Hole
- Gold-bearing Quartz Vein

Fig. 2-6 Results of the Detailed Survey in the Da Mai Area

1-4-3 Ngan Me Area

The Ngan Me area is located some 3 km south of the Da Mai area. Local miners came to this area in 1989; since then 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 lies at the upper reaches of S. Ngan Me. Ore reserves estimated by the Division at that time were 1,500 kg Au for hard rock gold (shallow part) and 130 kg Au for alluvial gold (along S. Vai Bang).

Gold-bearing quartz veins in the Ngan Me area are hosted mainly by sandstone, black shale and schist 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 (of the 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 6 m. Veins often show a lens-like shape. The main trend of quartz 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. A small amount of pyrite was seen in quartz 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 is: silicification, sericitization, and chloritization.

The major prospects in the Ngan Me area are: Ba Khe, Middle Ba Khe-Left Ba Khe, Bai Vang, Khe Can, and Khe Cam. The details of the occurrences of quartz veins in the major prospects are described below.

Ba Khe Prospect

Many local people are currently working in the Ba Khe prospect. More than one hundred adits, cross-cuts and inclined shafts are distributed in the direction of E-W along the upper reaches of S. Ngan Me and its branch creeks for about 1 km covering Ba Khe (Right Ba Khe creek), Na Hon, upper reaches of Ngan Me main stream and West Ba Khe. Quartz veins are hosted by sericite schist, sandstone and black shale 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. Major trends of quartz veins are E-W with dips of 45 S.

At the south of Ba Khe over a ridge, there is several people mining places called Na Hon. Most of quartz veins show E-W to WNW-ESE trend with dips of 40 to 70 S. Some show N-S trend with steep E-dip. They are hosted by sandstone, schist and black shale of the Mo Dong and Than Sa (of the Lower Member) Formations. They are interpreted to be parallel veins in the Ba Khe creek.

At the West Ba Khe and along the main stream of S. Ngan Me, quartz veins of mainly E-W system crop out extensively. It is located about 500 m west of Ba Khe. There are two kinds of vein dips: gently S-dip and steeply S-dip. The width changes from a few centimeters up to 3 m. They are hosted mainly by sandstone and schist of the Than Sa Formation (of the Lower Member). Local people started mining recently.

Sulfide minerals observed under the microscope in the Ba Khe prospect are: pyrite, arsenopyrite, pyrrhotite, chalcopyrite, covelline, sphalerite, galena, and limonite.

Middle Ba Khe-Left Ba Khe Prospect

Numerous quartz veins occur within an area of 1.5 km (E-W) by 1 km (N-S) located about 500 m north of Ba Khe. It lies over such creeks as Ba Khe Giua (Middle Ba Khe), S. Ho Lon (Left Ba Khe) and S. Ho Mai Con. Most of the quartz veins exhibit E-W trend with dips of 45° S. Some are NE-SW to ENE-WSW trend dipping to S at 20 to 50 degrees. Quartz veins generally show massive features. The width reaches up to 2 m. Some of them contain a significant amount of sulfides - mainly pyrite. A few people's prospecting adits were found.

Bai Vang Prospect

The Bai Vang prospect is located about 2 km east of Ba Khe. Quartz veins are distributed in an area of 1 km by 1 km consisting of Goc Tre creek, La Dong creek, S. Toc and S. Ong Ho. They occur in sandstone and schist of the Mo Dong Formation. The major trend of the quartz veins are E-W. They dip mainly to S steeply (average 56° S). Some of the quartz veins show NE-SW to ENE-WSW with dips of 60 to 80 degrees N. The widths vary from a few centimeters to 2 m. Alluvial mining is carried out by local people in this prospect.

Khe Can Prospect

The Khe Can prospect is located about 2 km north of Ba Khe. Many quartz veins occur along creeks at the northeast of N. Ba Chom whose altitude is 417 m above sea level. They are hosted by sandstone and schist of the Mo Dong Formation. The major trend of the quartz veins is E-W with dips of 35° S. Another trend of NW-SE with dips of 20° N was also observed. The widths are a few centimeters up to 6 m. People's mining activity was not observed.

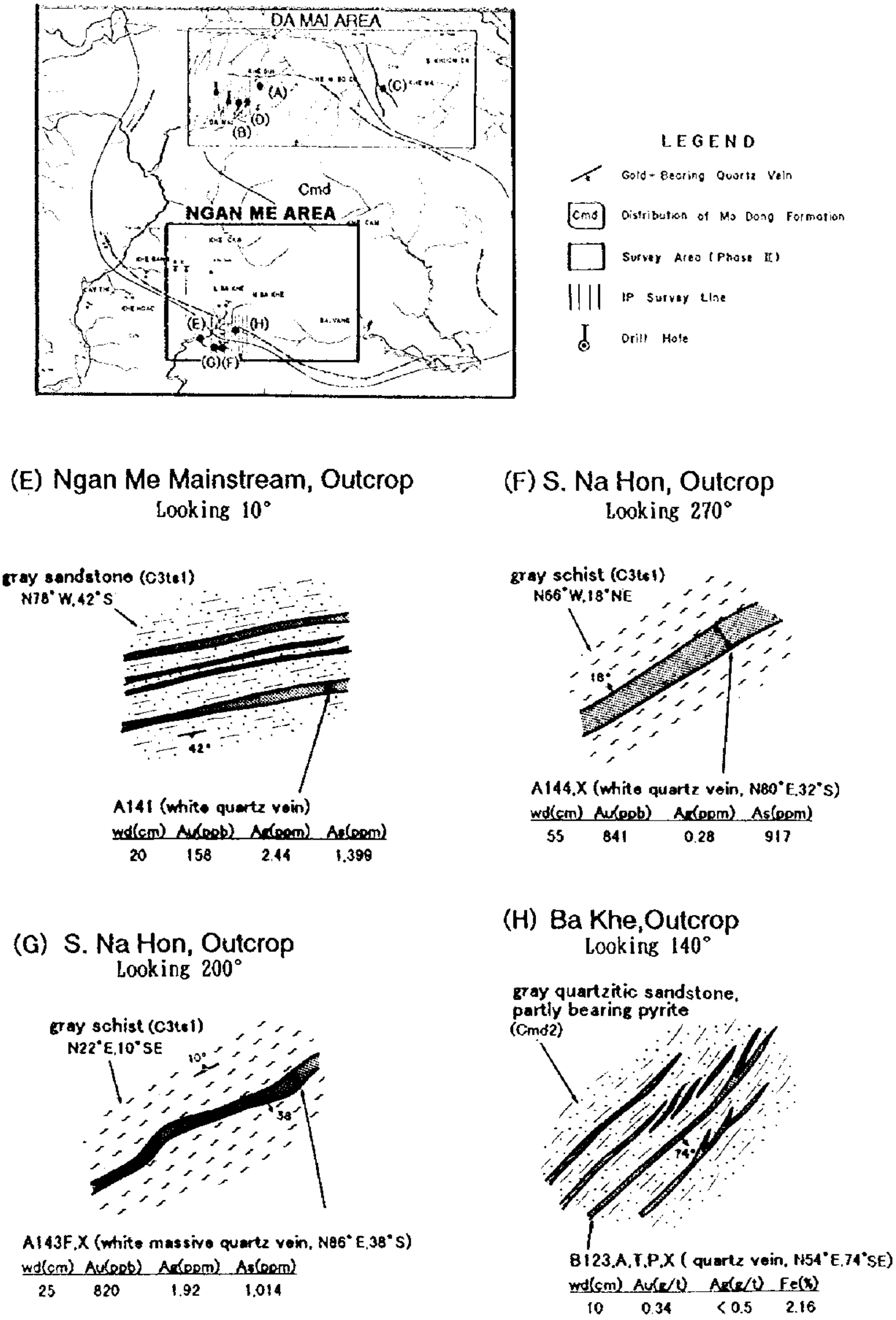


Fig. 2-7 Sketch of Quartz Veins in the Ngan Me Area

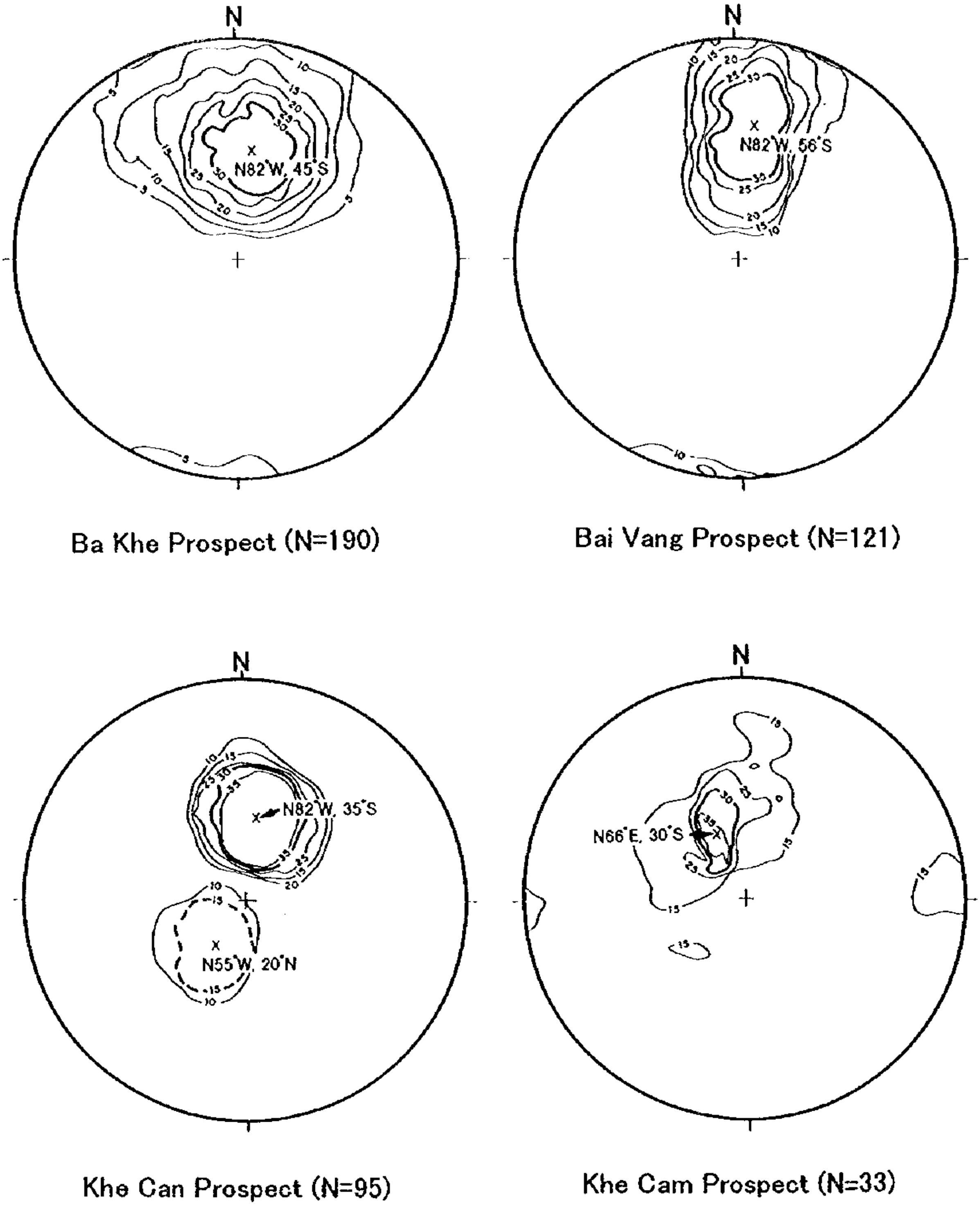


Fig. 2-8 Stereo Net Projection of Quartz Veins in the Ngan Me Area

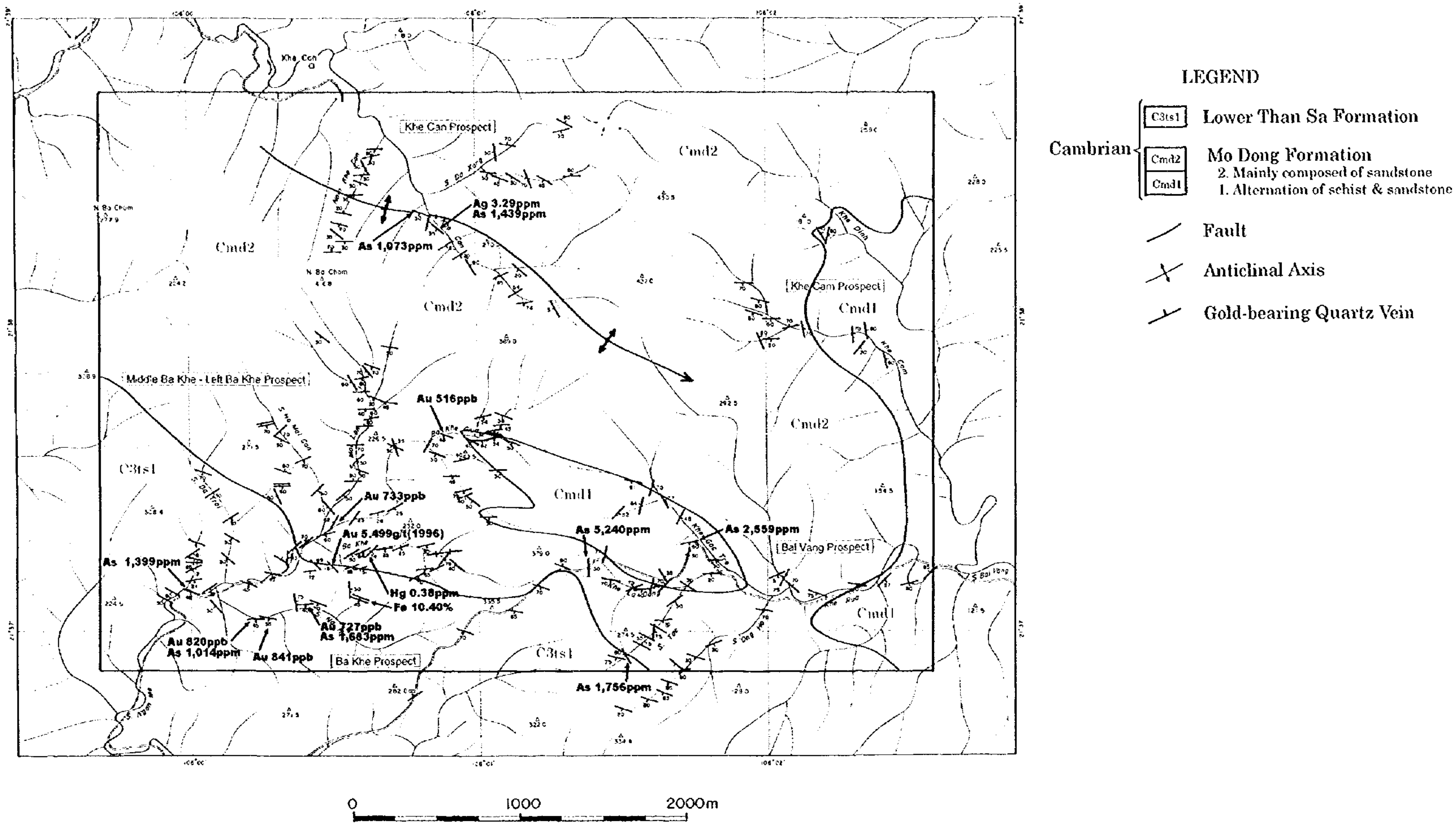


Fig. 2-9 Results of the Detailed Survey in the Ngan Me Area

Khe Cam Prospect

The Khe Cam prospect is located about 3 km northeast of Ba Khe. Tens quartz veins occur along branch creeks of Khe Cam which is one of the branch creeks of Bai Vang. They are hosted by sandstone and schist of the Mo Dong Formation. The major trend of the quartz veins is ENE with dips of 30° S. The widths of veins are a few centimeters to 2 m. People's mining activity was not observed.

1-5 Fluid Inclusion Studies

1-5-1 Methodology

Quartz chips were collected, and provided for fluid inclusion studies. Thirty quartz chips were sampled in total this phase. The breakdown is: nineteen from the Da Mai area, and eleven 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, shapes and surface smoothness
- •Estimation of filling degrees (approximate liquid to gas volumetric ratios of inclusions)
- •Identification 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. More than 340 measurements on homogenization temperature for 24 samples were made, and the results were statistically processed. Although fluid inclusions were observed in the remaining 6 samples, they were too small to be measured by the heating stage. An arithmetic mean was adopted as the representative value for each sample. The results of homogenization temperature measurements were plotted on the map and examined geologically. Measurements of salinity of liquid-gas and polyphase inclusions were made with the freezing-stage under the microscope. A total of 7 measurements on salinity for 5 samples were made.

1-5-2 Results of Studies

Measurements of homogenization temperature were relatively difficult because most of the fluid inclusions in quartz chips were fine. The diameter is usually smaller than 10 microns. Fluid inclusions of larger than 20 microns in diameter were seldom found. Because 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. Measurements of salinity were very difficult because of the same reason as in the measurements of the homogenization temperature. The results of the measurements are listed in Table 2-6.

Morphology of Fluid Inclusion

The number of fluid inclusions which were investigated under the microscope was 347. 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. This result may indicate that the boiling of fluid has occurred locally during the formation of quartz vein.

Polyphase inclusions were found in 8 samples. They were collected from quartz veins in both Da Mai and Ngan Me areas. 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 121°C up to 377°C. Most of them fall into a range of 140° ~ 340°C. The values of homogenization temperature were classified into two groups from the distribution on the frequency histogram shown in Fig. 2-10. One group has a peak value of about 190°C, and ranges from 121°C to about 220°C. Another has a peak of 290°C with a range of 220°C to 377°C.

The comparison of features of fluid inclusions between two areas was checked.

Da Mai area: The mean temperature of each sample ranging from 174°C to 296°C. Mainly composed of fine liquid-rich plus gas-rich inclusions. Five polyphase fluid inclusions were found.

Ngan Me area: The mean temperature ranges from 190°C to 299°C. It shows slightly narrower range but almost same as in the Da Mai area. The inclusions in this area are mostly liquid-rich. Some polyphase inclusions coexisting with liquid-rich ones were observed in 3 samples.

Although samples checked by the fluid inclusion studies were limited, the difference of homogenization temperatures between two areas was not so significant.

Salinity

Samples for the measurement of freezing temperature were selected from quartz chips of which homogenization temperature was measured. Most of fluid inclusions were too small for the freezing stage. Seven measurements on salinity for 5 fluid inclusions were carried out in this study. Liquid-rich inclusions of which salinity was measured were coincided with those in which polyphase inclusions were observed. Such samples tend to show high homogenization temperatures in the higher range of the temperature distribution. The brake-down of samples on salinity measurement are: four from the Da Mai area, and one from the Ngan Me area.

Salinity calculated from the freezing temperatures of fluid inclusions ranges from 1.2 to 8.7 NaCl equivalent %. The arithmetic mean of seven salinity values is 5.1 NaCl %.

Table 2-6 Results of Fluid Inclusion Studies

Ser. No.	Sample No.	Locality	Number of Measured Inclusions	Homogenization Temperature Minimum (°C)	Maximum (°C)	Mean (°C)	Salinity (1) (NaCl eq.%)	(2) (NaCl eq.%)	Kind of Inclusions (Liquid-rich/Gas-rich/Polyphase)	Remarks
		Da Mai Area								
1	A002F	Da Luon	31	152	377	270	5.5		L+G+P	L-gray Qz vein, Py diss.
2	A005F	Da Luon	33	121	292	174	1.2	4.2	L+G+P	Qz vein.
3	A009F	Dat Dau	3	151	229	190			L+G	Qz vein.
4	A016F	Left side of Gao Ba	0	Too small to measure						Qz vein.
5	A017F	Left side of Gao Ba	0	Too small to measure						Qz vein.
6	A019F	Right side of Thuon	0	Too small to measure						Qz vein.
7	A034F	Lang Vang	6	157	249	210			L+G+P	L-gray Qz vein.
8	A090F	Cuc Tac	4	193	235	214			L+G	White/L-gray Qz vein, Py diss.
9	B010F	Khe Dui	3	227	251	239			L+G	White/L-gray Qz vein, Py diss.
10	B011F	Khe Dui	3	195	235	215			L+G	WhiteQz vein, Limo diss.
11	B012F	Khe Dui	3	231	274	253			L+G	WhiteQz vein, Limo diss.
12	B013F	Khe Dui	23	250	348	296	5.1		L+G	Qz vein.
13	B016F	Khe Dui	4	177	245	211			L+G	WhiteQz vein, Limo diss.
14	B017F	Khe Dui	36	223	356	266			L+G	White/L-gray Qz vein, Limo diss.
15	B023F	Khe Ma	29	226	332	290	8.7		L+G	L-gray Qz vein.
16	B033F	Khuon Phung	6	211	277	238			L+G+P	White/L-gray Qz vein, Limo diss.
17	B045F	Ngoc An	0	Too small to measure						White/L-gray Qz vein, Limo diss.
18	B084F	S. Hoan	20	141	315	210			L+G	L-gray Qz vein, Limo diss.
19	B090F	S. Hoan	5	214	222	218			L+G+P	White Qz vein, Py diss.
		Ngan Me Area								
20	A120F	Ho Mai	2	191	308	250	Too small to measure		L	White/L-gray Qz vein.
21	A123F	Ho Mai	30	196	350	299	5.2	5.7	L+G+P	White Qz vein.
22	A131F	Ho Mai	5	167	245	212			L+G	White Qz vein, Py diss.
23	A143F	Na Hon	4	164	215	190			L+G	Qz vein.
24	A150F	Na Hon	39	147	316	232			L+G	White Qz vein.
25	A189F	Stok	0	Too small to measure						Qz vein.
26	B096F	Ba Khe	3	191	225	208			L+P	White/L-gray Qz vein, Py diss.
27	B098F	Ba Khe	4	162	253	215			L+P	White/L-gray Qz vein, Py diss.
28	B104F	Ba Khe	13	186	325	217			L+G	White/L-gray Qz vein, Py diss.
29	B110F	Ba Khe	38	194	345	267			L+G	L-gray Qz vein, Py diss.
30	B123F	Ba Khe	0	Too small to measure						White/L-gray Qz vein, Py diss.

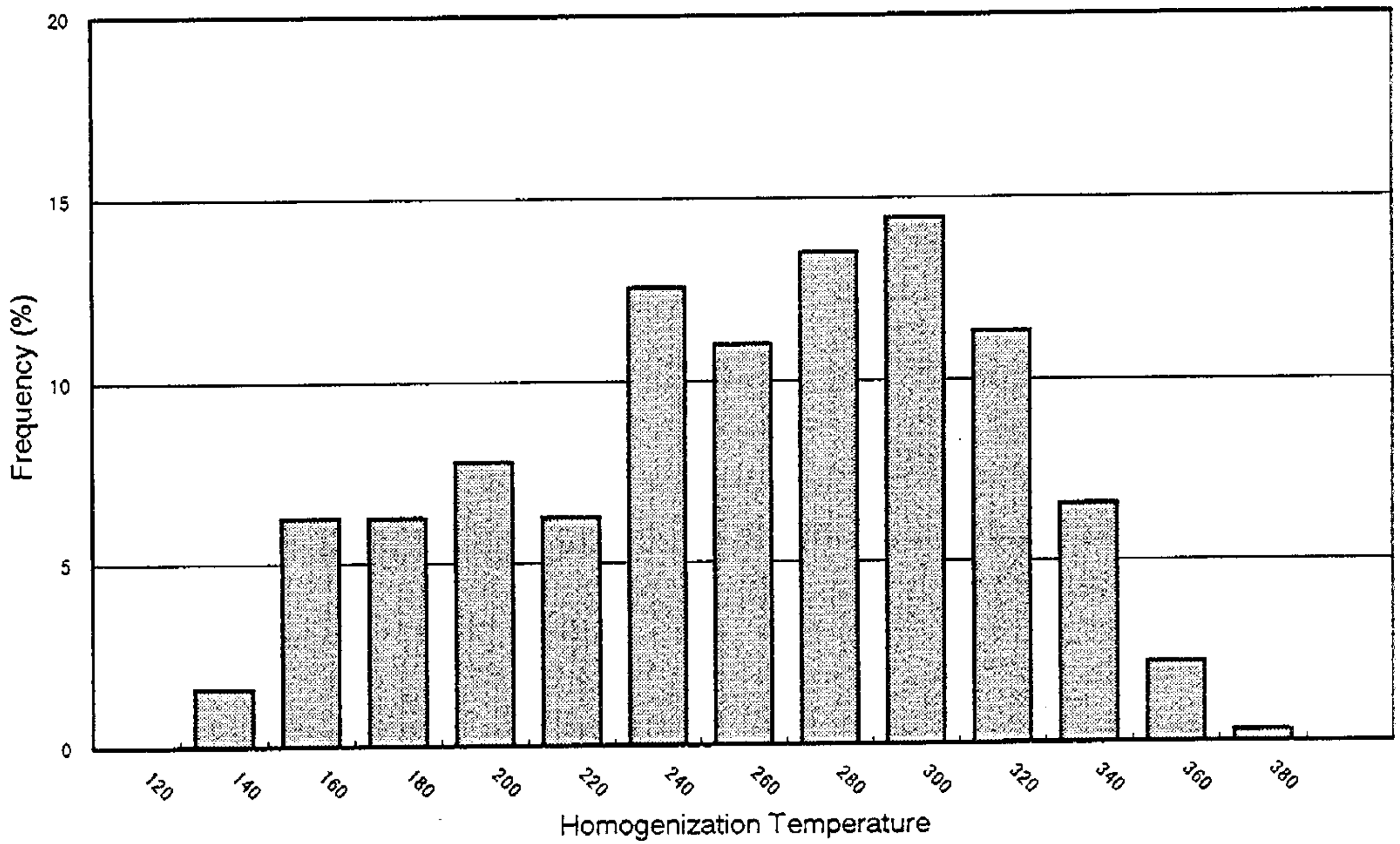


Fig. 2-10 Histogram of Homogenization Temperature of Fluid Inclusions in the Da Mai and Ngan Me Areas

1-6 Discussion

The geology of the Bo Cu area consists of sedimentary and metamorphic rocks of Cambrian, Ordovician, and Devonian to Jurassic systems. Acidic volcanics occur in the lower-middle Triassic system. The major part of these geologic units exhibits the NE to ENE direction which represents the characteristics of the regional geologic structure, and forms a complex folding structure. The Bo Cu area is cut into many blocks by tectonic faults. Intrusive of a large-scale igneous complex was not found in this area; only small stocks of granite occur within and in the vicinity of the Bo Cu area. The Bo Cu area is structurally characterized by a series of anticlines and synclines named Bac Son anticlinorium comprising Bo Cu anticline, Bac Son anticline and Trang Xa-Nhat The syncline. The major directions of these folding axes are NE to ENE in the northwestern to the eastern part. Whereas in the southwestern part of the area, there is a distinctive anticlinal structure whose axis trends WNW. Most of gold-bearing quartz veins occur at the crest and on the wing of this anticline. The main orogenic activity in the Bo Cu area was interpreted to be occurred in the Triassic or later period. The formation of the Bo Cu anticline, the formation of regional tectonic faults and acid volcanic activity in the Song Hiem Formation unanimously indicate the importance of this period.

Gold-bearing quartz veins in the Bo Cu area belong to the mesothermal-type gold deposit. The occurrence of gold veins is characterized structurally by the spatial closeness to the Bo Cu anticline. Two promising areas for the mesothermal gold deposit were extracted through the survey in the first phase within the Bo Cu area, and the detailed survey was carried out in this phase.

Concerning the geological settings and vein structure, each area shows its characteristic feature.

The Da Mai area is located on the northern wing of the Bo Cu anticline. The veins were divided into two groups in their trends: (1) E-W system with dips of steep S, and (2) E-W system with dips of gentle N. Although the basic trends are like these, there is small change in the prospects. In the Da Mai-Khe Dui prospect, the most remarkable trend is E-W with 53°S, and next is E-W with 40°N. It changes slightly to the east in the NE of N. Bo Cu prospect, where there are E-W trend with 73°S and E-W trend with 20°N. In the Khe Ma-S. Khuon Da prospect which is situated in the most eastern part of the Da Mai area, veins of the E-W trend with dips of steep S become obscure; veins of N-dip are distinct (ENE-WSW with 52°N). Veins appear to be formed in fissures of tensional nature. Most of the veins are discontinuous, not so long.

The Ngan Me area is situated from the central to the southern wing of the Bo Cu anticline. The vein systems show mainly E-W trend with dips of gentle to steep S. They also change slightly from prospect to prospect. In the Ba Khe and Middle Ba Khe-Left Ba Khe prospects, veins of E-W trend with moderately (45°) S-dips are common. In the Bai Vang prospect which lies to the east of the Ba Khe prospect, veins of E-W trend with steep S-dips become common. In the Khe Can and Khe Cam prospects, both is situated near the crest of the Bo Cu anticline, E-W to ENE-WSW trends with dips of gentle S are dominant. The Ba Khe group of veins sometimes exhibits a lens-like shape.

They are branching and thickening /thinning quite frequently. Massive quartz veins up to 6 m in width occur in the Middle Ba Khe-Left Ba Khe and Khe Can prospects.

The mineralization in these two areas has its characteristic feature.

In the Da Mai area, some veins are relatively rich in sulfide minerals. Veins which contain a significant amount of sulfide minerals are those in Khe Dui and in Khe Khuon Phung in the Da Mai-Khe Dui prospect. Sulfide minerals identified in the Da Mai-Khe Dui area are: pyrite, arsenopyrite, pyrrhotite, chalcopyrite, covelline, chalcocite, tetrahedrite, sphalerite, galena, scorodite, and limonite. Native gold of up to 0.3 mm in diameter was found in some samples from Khe Dui. Native gold frequently occurs as free gold in quartz veins. It also occurs in a form accompanied by sulfide minerals such as arsenopyrite and scorodite. Ag/Au ratio in samples is generally low in this area. The average Ag/Au ratio calculated from analytical results of both ore and rock-chip samples is about 1. Alteration around quartz veins is not so strong in the Da Mai area. Host rocks of several centimeters to a few meters from veins were altered. Alteration observed in this area is: silicification, chloritization, sericitization, and carbonitization. Results of fluid inclusion studies revealed that the formation temperature of quartz varied in a broad range: from low to medium temperature up to significantly high temperature (over 370 °C). The salinity of fluid inclusions indicated that the ore fluid was relatively thick in NaCl content (up to 8 %). Polyphase inclusions were identified comparatively often in quartz. Halite was observed as solid crystals in such inclusions.

In the Ngan Me area, most of the veins are relatively poor in sulfide minerals. Veins which contain a significant amount of sulfide minerals are those in Ba Khe and in Na Hon in the Ba Khe prospect. Sulfide minerals observed in the Da Mai-Khe Dui area are: pyrite, arsenopyrite, pyrrhotite, chalcopyrite, covelline, sphalerite, galena, and limonite. Ag is slightly high in samples this area. The average Ag/Au ratio calculated from analytical results of both ore and rock-chip samples is around 4. Alteration around quartz veins is not so strong in the Ngan Me area. Host rocks of several centimeters to a few meters from veins were altered. Alteration observed in this area is: silicification, chloritization, sericitization, and carbonitization. Results of fluid inclusion studies were not so different from those in the Da Mai area. They showed that the formation temperature of quartz varied in a broad range; similar but slightly narrower variation than those in the Da Mai area. The salinity of fluid inclusions showed moderately thick in NaCl content (about 5 %). Polyphase inclusions were identified in quartz.

In short, two areas show their own features in the vein trend, mineral assemblage and fluid inclusion property. Da Mai area: occurring two groups of vein trends in the same area -- E-W trends with dips of steep S and with dips of gentle N, relatively rich in sulfide minerals, low Ag/Au ratio, fluid inclusions of broad range of homogenization temperature, relatively high salinity and fine size; Ngan Me area: veins of E-W trend with dips of gentle to steep S, relatively rich in Ag content, broad variation of homogenization temperature and moderately high salinity in fluid inclusion property. 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 was presumed within a marginal part of the South China plate according to the results of the regional geological survey in the first phase. It suggests that the gold mineralization in this area probably belongs to the category of the continental-type gold deposit.

Table 2-7 Summary of Geology and Mineralization in the Da Mai and Ngan Me Areas

	Da Mai Area			Ngan Me Area				
	Da Mai-Khe Dui	NE of N. Bo Cu	Khe Ma-S, Khuon Da	Ba Khe	Middle Ba Khe-Left Ba Khe	Bai Vang	Khe Can	Khe Cam
Location	Upper reaches of S. Hoan (NW of N. Bo Cu)	Southern side of the middle reaches of S. Ca (NE of N. Bo Cu)	Southern side of the upper reaches of S. Ca (ENE of N. Bo Cu)	Upper reaches of S. Ngan Me	North of Ba Khe	Upper reaches of S. Bai Vang	Upper reaches of Khe Can (S of N. Bo Cu)	North of Bai Vang (SE of N. Bo Cu)
(I) Host Rocks (1) Kind of Host Rocks	Sandstone, sericite schist (Cmd)	Sandstone, sericite schist (Cmd & C3ts1)	Sandstone, sericite schist, siltstone (C3ts1)	Sandstone, sericite schist, black shale (Cmd & C3ts1)	Sandstone, sericite schist (Cmd)	Sandstone, sericite schist (Cmd)	Sandstone, sericite schist (Cmd)	Sandstone, sericite schist (Cmd)
(2) Folding & Fault	On the northern wing of the Bo Cu anticline Local anticline (E-W to WNW) & syncline (E-W) Fault (NNE)	On the northeastern wing of the Bo Cu anticline	On the northeastern wing of the Bo Cu anticline	On the southern wing of the Bo Cu anticline	On the southern wing of the Bo Cu anticline	On the southern wing of the Bo Cu anticline	On the southern wing and near the crest of the Bo Cu anticline Local anticline (WNW)	On the crest of the Bo Cu anticline
(II) Alteration	Silicification, chloritization, sericitization, carbonitization	Silicification, chloritization, sericitization, carbonitization	Silicification	Silicification, chloritization, sericitization, carbonitization	Silicification	Silicification, chloritization, sericitization, carbonitization	Silicification	Silicification
(III) Ore Deposit (1) Vein System & Structure	E-W, 53S E-W, 40N	E-W, 73S E-W, 20N	ENE, 52N	E-W, 45S	E-W, 45S	E-W, 56S	E-W, 35S NW, 20N	ENE, 30S
(2) Ore Minerals	Py, As, Cp, Sp, Gn, Cv, Cc, Tt, Po, Io, Au	Py, Io	Py, Io	Py, As, Cp, Sp, Gn, Cv, Po, Io, Au	Py, As, Io	Py, As, Cp, Sp, Gn, Io	Py, Io	Py, Io
(3) Gangue Minerals	Qz, Ca	Qz	Qz	Qz, Ca	Qz	Qz	Qz	Qz
(4) Major Assay Results	36.36g/t Au @90cm (GSV) 55.704g/t Au @8cm (1997) 13.365g/t Au @45cm (1997) 60.2g/t Ag @40cm (1997)			140.95g/t Au @70cm (GSV) 5.49 g/t Au @ 4.5 cm (1998)				
(IV) Rock-Chip Geochemistry	Several strong anomalies (Au, Ag, Cu, Pb, Zn, As)	Some anomalies (Au, Pb)	Au anomalies	Several strong anomalies (Au, Pb, As, Hg)	Some anomalies (Au, Pb, As)	Some anomalies (Au, Cu, Pb, As, Sb)	Some anomalies (Au, Pb, As)	
(V) Mining & Prospecting Activity	Mining by local people Pitting (GSV)	Mining by local people	Mining by local people	Mining by local people Pitting (GSV)	Mining by local people Pitting (GSV)	Mining by local people Pitting (GSV)		

*Abbreviation same as in Tables 2-1 to 2-4

Chapter 2 Rock-Chip Geochemical Survey

2-1 Sampling and Chemical Analysis

Rock-chip geochemical survey was carried out in the second 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.

Quartz vein and altered rock samples were collected from every outcrop and some old pits/adits in the survey area. The number of rock-chip samples collected during the survey this phase was 314, which corresponded to a sampling density of approximately eight samples in one square kilometer. In addition to these rock-chip samples, a total of 70 ore assay samples were collected from some prospecting pits/trenches and people's adits. The results of assays were examined together with the geochemical results. The samples of the rock-chip geochemistry were analyzed at the Analytical and Experimental Center, Department of Geology and Minerals of Vietnam for 8 elements: Au, Ag, Cu, Pb, Zn, As, Sb, and Hg. The methods of analysis and limits of detection are shown in Table 2-10.

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 the standard deviation added to the mean of the element. The thresholds of Au, Ag, Cu, Pb, Zn, As and Sb were obtained on the logarithmic probability graphs. While that of Hg was determined by the statistical calculation mentioned above. Fig. 2-11 shows the representative logarithmic probability graphs drawn by computer.

A series of maps showing geochemical anomalies of rock-chips 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 rock-chip geochemistry. The Au anomalies of rock-chips were well correlated with the occurrences of gold mineralized zones, of course. The distributions of Pb and As significantly corresponded to the mineralized zones. The distributions of the other elements such as Cu, Zn and Sb also corresponded to the gold mineralized zones to some extent. The kind of elements and degree of these correspondences varied from prospect to prospect. 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.

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.

Table 2-8 Major Analytical Results of Rock-Chip Samples in the Da Mai Area

Ser. No.	Sample No.	Width (cm)	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Location
1	A001	130	4	0.05	58	47	236	74	11	<0.03	Da Luon
2	A006	70	49	0.35	53	69	163	66	11	<0.03	Da Luon
3	A008	60	3	3.40	56	38	137	44	25	<0.03	Da Luon
4	A036	70	12	0.08	99	57	52	208	8	<0.03	Lang Vang
5	A044	10	7	0.05	18	13	18	169	8	<0.03	Lang Vang
6	A059	150	29	0.13	20	41	19	140	6	<0.03	Dong Cao
7	A092	--	27	0.11	29	17	16	434	2	<0.03	Cuc Tac
8	A097	5	106	0.08	39	66	29	192	11	<0.03	Cuc Tac
9	A100	10	18	0.64	78	25	51	53	22	<0.03	Cuc Tac
10	A102	15	179	0.12	162	6	9	7	4	<0.03	Cuc Tac
11	B005	15	47	0.10	29	10	14	198	7	<0.03	Khe Dui
12	B008	20	33	0.07	34	14	44	21	2	<0.03	Khe Dui
13	B009	100	2	0.25	32	277	59	24	7	<0.03	Khe Dui
14	B020	10	9	0.70	101	299	65	23	2	<0.03	Khe Ma
15	B024	20	19	0.31	30	36	25	156	6	<0.03	Khe Ma
16	B027	50	24	0.07	49	153	145	2	9	<0.03	Khe Ma
17	B030	20	13	0.10	40	119	57	18	9	<0.03	Khe Ma
18	B035	120	49	2.79	68	196	118	567	16	<0.03	Khe Ca
19	B040	15	301	<0.04	30	31	48	11	6	<0.03	Nuoc An
20	B048	40	53	<0.04	37	26	67	1	1	<0.03	Nuoc An
21	B055	15	36	0.04	31	30	73	7	15	<0.03	Dong Cao
22	B072	20	52	0.07	55	27	52	25	5	<0.03	S. Hoan
23	B075	40	32	0.04	25	14	35	13	6	<0.03	S. Hoan
24	B078	100	223	<0.04	58	19	75	<1	10	<0.03	S. Hoan
25	B081	7	59	0.22	45	268	51	14	2	<0.03	S. Hoan
26	B083	15	41	0.21	63	17	24	38	4	<0.03	S. Hoan

Table 2-9 Major Analytical Results of Rock-Chip Samples in the Ngan Me Area (1)

Ser. No.	Sample No.	Width (cm)	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Location
1	A116	10	7	0.12	21	22	12	1377	10	<0.03	Ho Mai
2	A122	--	26	0.65	40	397	40	51	9	<0.03	Ho Mai
3	A126	20	72	0.60	43	28	17	3675	25	<0.03	Ho Mai
4	A129	8	3	0.07	15	10	12	163	3	<0.03	Ho Mai
5	A131	80	3	1.40	338	231	18	178	15	<0.03	Ho Mai
6	A136	10	39	0.04	19	8	20	18	5	<0.03	Ho Mai
7	A139	20	33	0.53	38	81	39	71	9	<0.03	S. Ngan Me
8	A140	15	83	0.17	16	13	13	32	6	<0.03	S. Ngan Me
9	A141	20	158	2.44	102	119	47	1399	10	<0.03	S. Ngan Me
10	A142	10	49	0.14	47	25	20	84	8	<0.03	Na Hon
11	A143	25	820	1.92	19	323	7	1014	7	<0.03	Na Hon
12	A144	55	841	0.28	22	1	13	917	8	<0.03	Na Hon
13	A145	7	264	0.43	43	9	17	67	7	<0.03	Na Hon
14	A146	15	727	0.25	21	12	10	1683	7	<0.03	Na Hon
15	A147	15	102	0.06	18	7	8	97	5	<0.03	Na Hon
16	A154	3	269	0.07	28	20	20	938	9	<0.03	S. Ngan Me
17	A155	30	37	0.14	22	12	25	39	7	<0.03	S. Ngan Me
18	A157	112	131	0.28	32	21	25	56	7	<0.03	S. Ngan Me
19	A158	10	33	0.07	53	39	56	237	12	<0.03	S. Ngan Me
20	A159	5	55	0.13	25	9	17	68	9	<0.03	Ho Mai
21	A160	4	70	0.10	30	23	28	105	5	<0.03	Ho Mai
22	A161	200	18	0.09	92	50	23	148	12	<0.03	Ho Mai
23	A162	20	40	0.54	82	19	18	149	12	<0.03	Ho Mai
24	A169	300	26	0.33	74	31	51	407	3	<0.03	Da Voi
25	A171	8	110	0.35	44	41	35	135	12	<0.03	Da Voi
26	A172	20	30	0.14	33	35	9	200	2	<0.03	Da Voi
27	A181	--	16	<0.04	43	12	120	32	2	<0.03	Ong Ho
28	A183	30	11	1.71	71	603	53	109	7	0.04	Stok
29	A184	10	33	0.26	90	10	13	19	4	<0.03	Stok
30	A189	80	145	0.33	61	41	71	1756	44	<0.03	Stok
31	A190	10	81	0.29	34	36	63	144	8	<0.03	Stok
32	A191	10	10	0.22	97	38	40	57	7	<0.03	Da Xang
33	A196	10	10	0.54	69	41	23	177	6	<0.03	Da Xang
34	A207	30	10	0.12	43	23	61	156	2	<0.03	Khe Can
35	A209	80	5	0.58	77	69	45	45	2	<0.03	Khe Can
36	B097	50	1	0.65	45	69	18	142	6	<0.03	Ba Khe
37	B099	100	9	0.06	41	19	134	65	4	<0.03	Ba Khe
38	B101	20	16	0.06	22	18	18	288	9	<0.03	Ba Khe
39	B102	30	3	0.14	125	61	43	64	10	<0.03	Ba Khe
40	B103	20	18	0.17	24	23	15	684	17	<0.03	Ba Khe
41	B105	30	9	0.41	59	204	36	71	9	<0.03	Ba Khe
42	B106	20	17	0.05	42	46	38	146	7	<0.03	Ba Khe
43	B108	100	7	0.37	68	33	123	187	8	<0.03	Ba Khe
44	B112	8	516	0.36	25	90	29	1914	9	<0.03	Ba Khe
45	B114	20	36	0.07	28	24	43	289	7	<0.03	Ba Khe
46	B116	25	15	0.13	57	34	27	415	5	0.03	Ba Khe
47	B121	7	45	0.09	19	16	17	72	8	0.08	Ba Khe
48	B122	8	150	0.23	30	17	52	409	7	0.38	Ba Khe
49	B124	20	67	0.11	50	61	39	646	7	0.06	Ba Khe

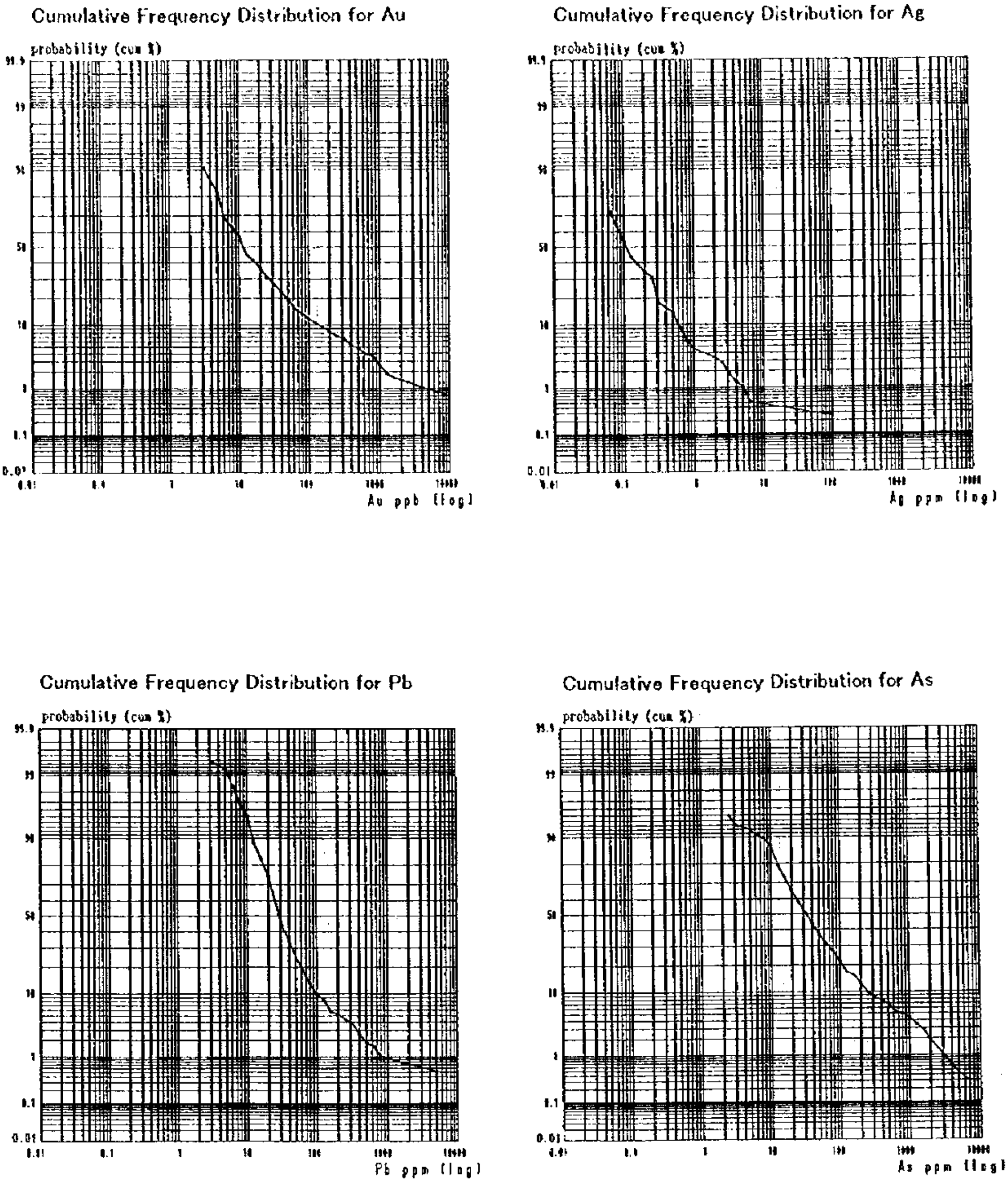
Table 2-9 Major Analytical Results of Rock-Chip Samples in the Ngan Me Area (2)

Ser. No.	Sample No.	Width (cm)	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Location
50	B125	15	30	0.06	16	10	9	61	8	0.03	Ba Khe
51	B128	30	2	0.08	33	9	5	41	6	0.04	Ba Khe
52	B129	10	36	0.10	44	27	55	314	8	0.04	Ba Khe
53	B131	5	96	0.15	37	30	16	159	6	<0.03	Ba Khe
54	B132	70	18	0.07	40	37	29	211	7	0.03	Dong
55	B138	40	19	0.27	133	34	14	5	4	<0.03	Along new road
56	B139	30	20	0.13	26	26	16	198	6	<0.03	Along new road
57	B140	20	46	0.81	46	305	54	2559	39	<0.03	On new road
58	B141	50	68	0.27	23	19	10	19	3	<0.03	On new road
59	B142	30	5	0.07	84	671	6	5240	6	<0.03	On new road
60	B143	75	160	1.29	45	102	18	270	10	<0.03	On new road
61	B146	20	20	0.08	34	23	15	489	13	<0.03	New road
62	B149	15	9	0.16	22	24	18	834	31	<0.03	Goc Tro
63	B155	10	63	0.07	29	19	22	10	2	<0.03	Khe Can
64	B156	30	3	0.21	118	34	44	1073	7	<0.03	Khe Can
65	B157	100	20	3.29	44	526	24	1439	9	<0.03	Khe Can
66	B163	40	38	1.00	41	115	16	31	7	<0.03	Khe Can
67	B164	50	7	0.25	34	109	38	39	4	<0.03	Khe Can
68	B177	300	3	0.15	22	111	11	99	7	<0.03	Khe Rua

Table 2-10 Methods of Analysis and Limits of Detection of Rock-Chip Samples

Element	Method of Analysis	Detection Limit	Upper Limit
Au	Fire assay with AA finish	1ppb	10ppm
Ag	Total digestion with AA finish	0.04ppm	100ppm
Cu	Nitric aqua regia with ICP finish	1ppm	3%
Pb	ditto	1ppm	3%
Zn	ditto	1ppm	3%
As	HCl/KClO3 extraction with ICP finish	1ppm	3%
Sb	ditto	1ppm	3%
Hg	Total digestion with AA finish	0.03ppm	350ppm

*AA means Atomic Absorption method.



Most of the elements such as Au,Ag,Pb,As have a distinctive curvature on the curve.

Fig. 2-11 Cumulative Frequency Distribution Graphs of Rock-Chip Geochemistry

2-3 Anomalies of Rock-Chip Geochemistry

2-3-1 Da Mai Area

Da Mai-Khe Dui prospect: Numerous Au anomalies and several anomalies of Cu, Pb, Zn and As of rock-chips were found in the Da Mai-Khe Dui prospect. Strong and concentrated anomalies of Au were detected at Da Mai, West Da Mai and KheDui. Some Cu anomalies (up to 162 ppm), Pb anomalies (up to 299 ppm) and As anomalies were associated with Au anomalies at West Da Mai, Khe Dui and Da Mai respectively. Au anomalies occur sporadically at the surrounding locations such as Goc Sen, Da Luon, North Da Mai and Khe Thun. At Khuon Phung of North Da Mai, distinctive Au, Ag, Pb and Zn anomalous values were obtained.

Northeast of N. Bo Cu prospect: Significant Au anomalies (up to 301 ppb) of rock-chips were detected at S. Nuoc An in the Northeast N. Bo Cu prospect. A few anomalies of Pb occurs at Lang Vang (Ba Khe) in the Northeast N. Bo Cu prospect.

Khe Ma-Khuon Da prospect: Sporadic Au anomalies were detected at Khe Ma and S. Khuon Da in the Khe Ma-Khuon Da prospect.

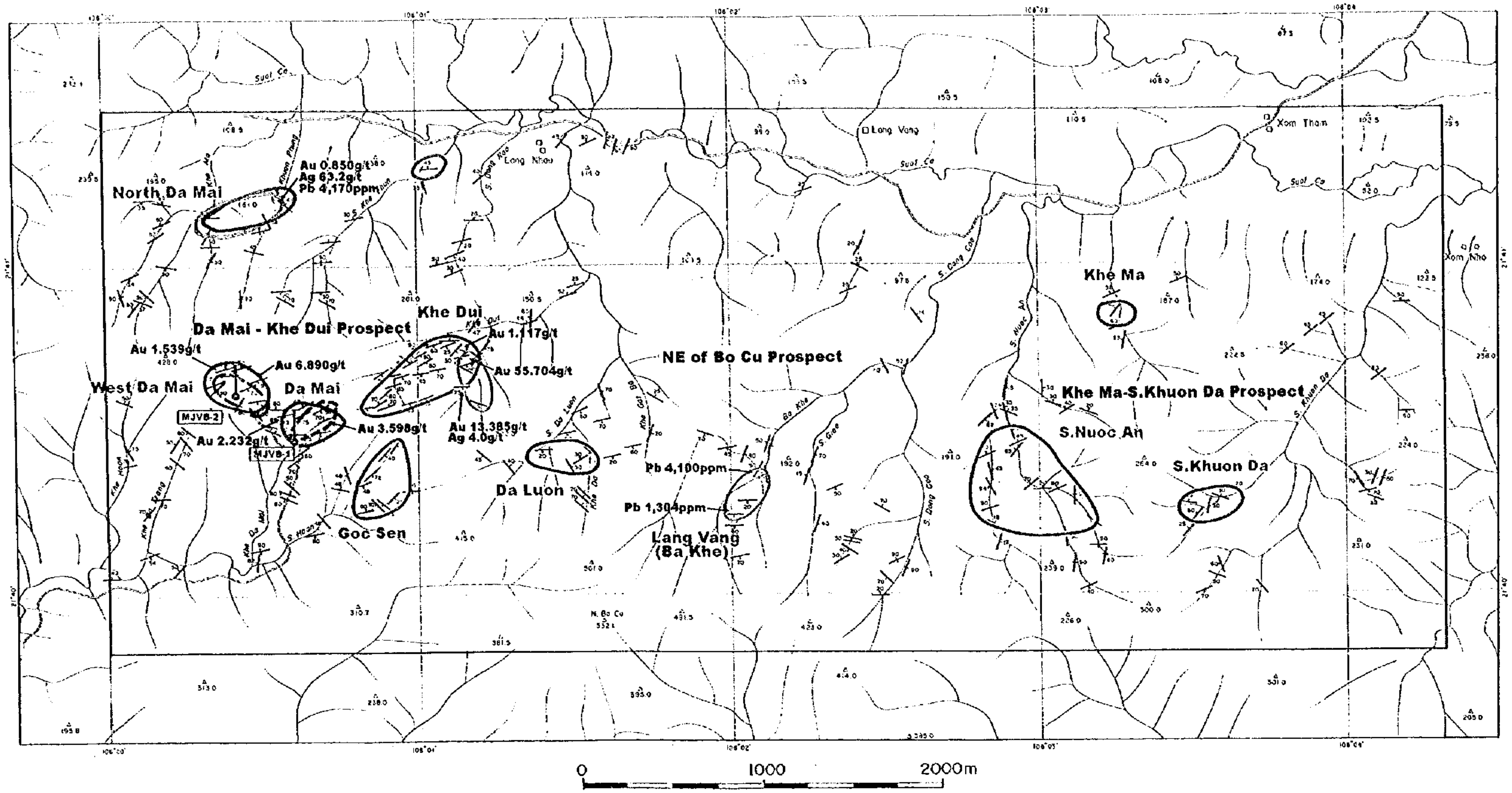
2-3-2 Ngan Me Area

Ba Khe prospect: Intensive Au anomalies (up to 841 ppb) occur at Ba Khe and the surrounding locations (Na Hon, S. Ho Mai Can and West Ba Khe) in the Ba Khe prospect. Good correspondence of As anomalies (up to 3,675 ppm) with Au were recognized in these locations in the Ba Khe prospect. Pb and Hg (up to 0.38 ppm) anomalies also found at Ba Khe.

Middle Ba Khe-Left Ba Khe prospect: Several Au anomalies was detected at Middle Ba Khe and Left Ba Khe. Pb and As anomalies also occur at these locations.

Bai Vang prospect: A series of Au anomalies are distributed along the upper reaches of Bai Vang. Several basemetal anomalies (Cu, Pb up to 671 ppm, As up to 5,240 ppm, Sb up to 45 ppm and Fe) are associated with Au anomalies in the Bai Vang prospect.

Khe Can prospect: A few Au anomalies were found along Khe Can. Anomalies of Pb and As were also detected near the Au anomalies.



LEGEND

Au Anomly (≧ 31ppb)

Cu Anomly (≧ 62ppm)

Pb Anomly (≧ 90ppm)

As Anomly (≧ 115ppm)

Gold-bearing Quartz Vein

Fig. 2-12 Major Anomalies of Rock-Chip Geochemical Survey in the Da Mai Area

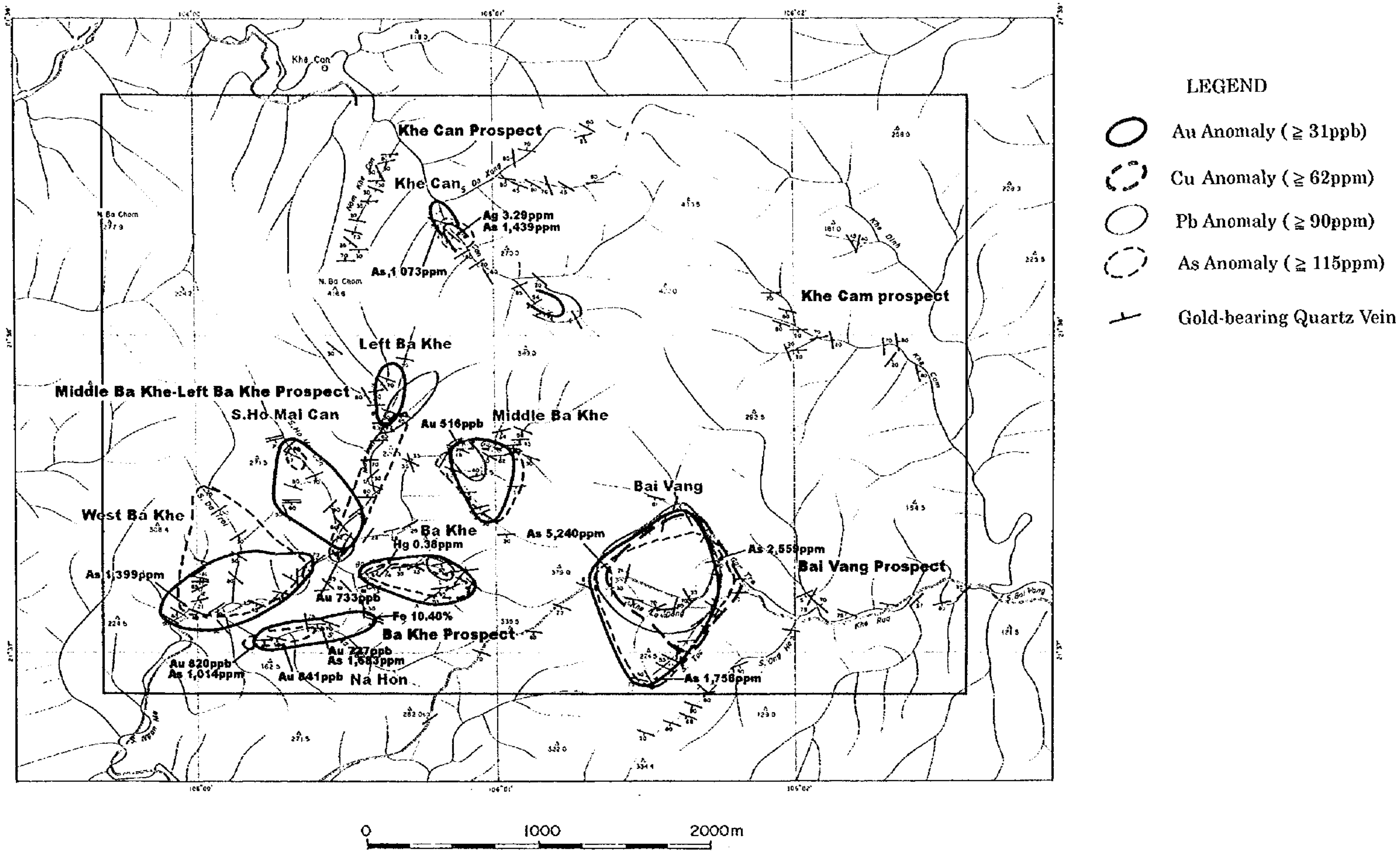


Fig. 2-13 Major Anomalies of Rock-Chip Geochemical Survey in the Ngan Me Area

2-4 Discussion

Rock-chip geochemical survey was carried out 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. Quartz vein and altered rock samples were collected from every outcrop and some pits/trenches in the survey area. The results of ore assays were examined together with the geochemical results. Several significant anomalous zones were outlined through the rock-chip geochemical survey. The major anomalous zones thus defined are: Da Mai-Khe Dui, Northeast of N. Bo Cu and Khe Ma-Khuon Da prospects in the Da Mai area, Ba Khe, Middle Ba Khe-Left Ba Khe, Bai Vang and Khe Can prospects in the Ngan Me area. Among these localities, intensive Au anomalies were found at (1) Da Mai-Khe Dui-West Da Mai zone in the Da Mai area, and (2) Ba Khe-West Ba Khe-Na Hon zone in the Ngan Me area. These two zones are also characterized by the co-occurrence of anomalies of various basemetal elements, especially Pb and As.

The correspondence of basemetal elements to Au is very well both in the Da Mai and Ngan Me areas. Generally, they occur in a concentrated form at some small areas. As shown above, the best association with Au was observed in As. Next was in Pb. The other elements also showed some significant correspondence to Au. It was not clear in Hg because the detection limit of the analysis was not enough to the discussion.

Each zone has a specific feature in the intensity and assemblage of anomalous elements. In the Da Mai-Khe Dui-West Da Mai zone, Au anomalies occur very intensively. It is remarkably high in the level of Au. Within this zone, West Da Mai is characterized by the occurrence of Cu anomalies. Whereas, Khe Dui is characterized by the occurrence of Pb anomalies. Da Mai is rather monotonous; only weak As anomalies were detected together with Au anomalies. In the Ba Khe-Na Hon-West Ba Khe zone, As anomalies, very intense ones, occur almost all over the zone. Weak Hg anomalies and strong Fe association were found in this zone. These characteristic features can be explained by the mineral assemblage of gold-bearing quartz veins.

Chapter 3 Geophysical Survey (Time Domain IP Method)

3-1 Outline of Survey

(1) Objectives

The objectives of the geophysical survey using time domain IP method are to extract IP anomalies related to mineralization and investigate the relationship between geophysical and geologic structure in the Da Mai and Ngan Me areas (Fig. 2-14). These results provide a base for the selection of drilling site.

(2) Exploration Method

Time domain IP method

(3) Amounts of Geophysical Survey

Amounts of geophysical survey are as follows.

・ Field survey

	Total length of lines	Survey lines	Measuring points
Da Mai area	10 km	10 lines	800 points
Ngan Me area	10 km	10 lines	800 points

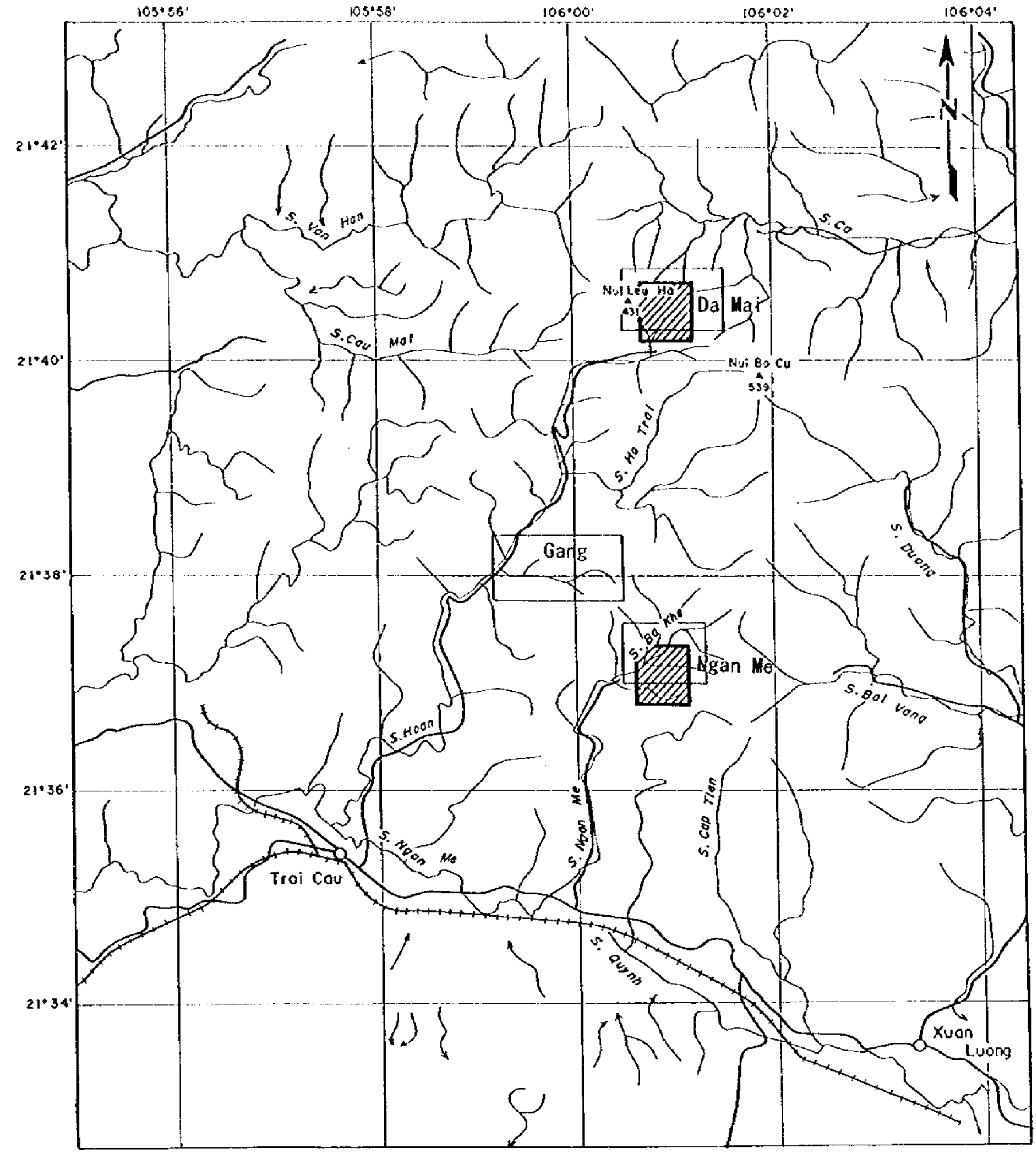
・ Laboratory test 20pcs

3-2 Survey Method

3-2-1 Methodology

The IP method is the exploration method to observe electric polarization effect (IP effect) in the earth. The IP effect is caused by the following phenomena.

When direct current flows through the rocks containing metallic minerals, electric potential difference is generated between the surface of metallic minerals and pore water around it. This electric potential causes a store of electric charge and induces electric polarization. The electric



Survey Area

Survey Area(Phase I)

Scale 1: 100,000

0 2 4Km

Fig. 2-14 Location Map of the Geophysical Survey Areas

charge is discharged gradually after current is cut off. It forms the residual voltage decaying with the passage of time. However, the IP effect occurred not only in the rocks containing metallic minerals, but also in some sedimentary rocks containing graphite or clay.

In the time domain IP method, on and off alternating current in the shape of rectangular wave, as shown in Figure 2-15, is generally used as transmitter current. Received voltage is composed of the primary voltage Vp observed during current on and the decay voltage (secondary voltage Vs) observed during current off. Chargeability is calculated with received voltage as index to express quantity of IP effect.

The chargeability M is defined in the following equation. It is the proportion of time integral of secondary voltage to primary voltage. Its unit is mV/V.

$$M = 1 / Vp / (t2 - t1) \cdot \int_{t1}^{t2} Vs \ dt \qquad (2\text{-}3\text{-}1)$$

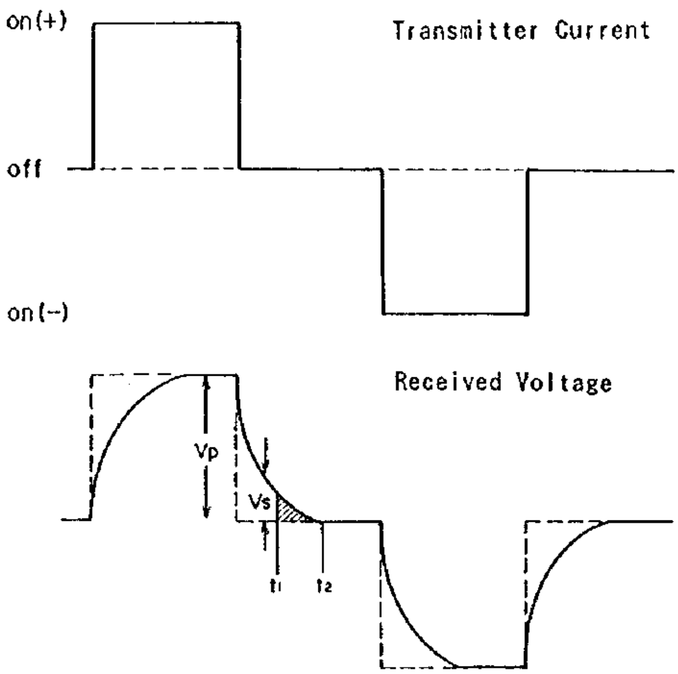


Fig. 2-15 Wave Form of Transmitter Current and Received Voltage

3-2-2 Field Survey

The survey lines (1 km in length, N-E in direction and 100 m in interval) are laid out as shown in Fig. 2-16 to 2-17.

The specifications of measurement are as follows.

Electrode configuration	: Dipole-dipole array
Interval of measuring points	: 50 m
Electrode separation index	: 1 to 5
Electrode spacing	: 50 m
Observed quantity	: Electric potential and chargeability
ON/OFF time	: 2 s
Time at the beginning of Vs measurement	: 500 s
Time at the end of Vs measurement	: 1,050 s

The equipment used in this survey are shown in Table 2-11.

3-2-3 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 samples were measured in laboratory.

3-2-4 Analytical Method

The analysis was carried out according to the flow chart as shown in Fig. 2-18.

(1) Apparent Resistivity Pseudsection

In this section, apparent resistivity is plotted at the depth of a(n+1)/2 just under the middle point of the used electrodes for each line.

(2) Apparent Resistivity Map

In this map, the apparent resistivity of the specific electrode separation index is plotted.

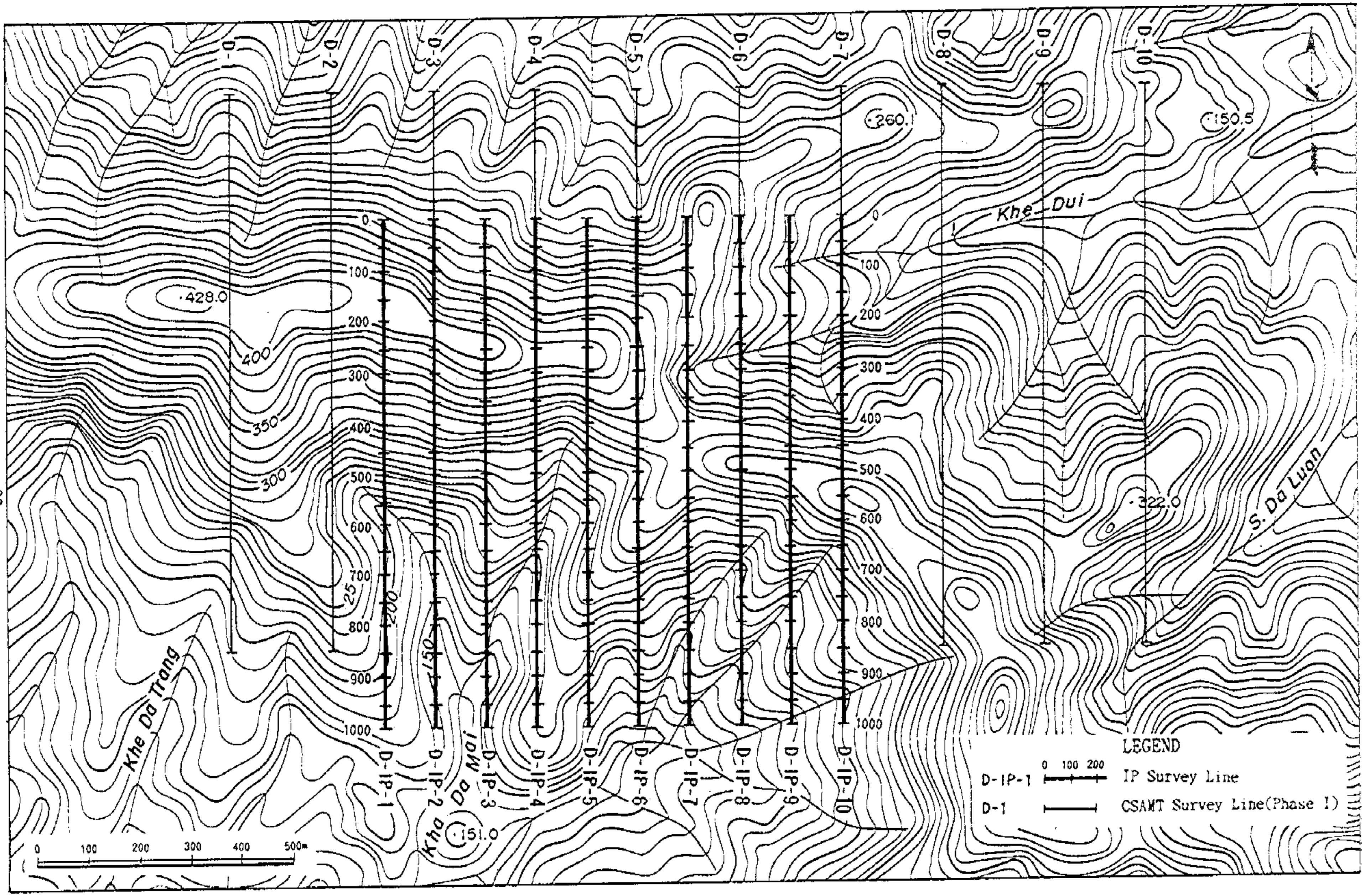


Fig. 2-16 Location Map of the Survey Lines in the Da Mai Area

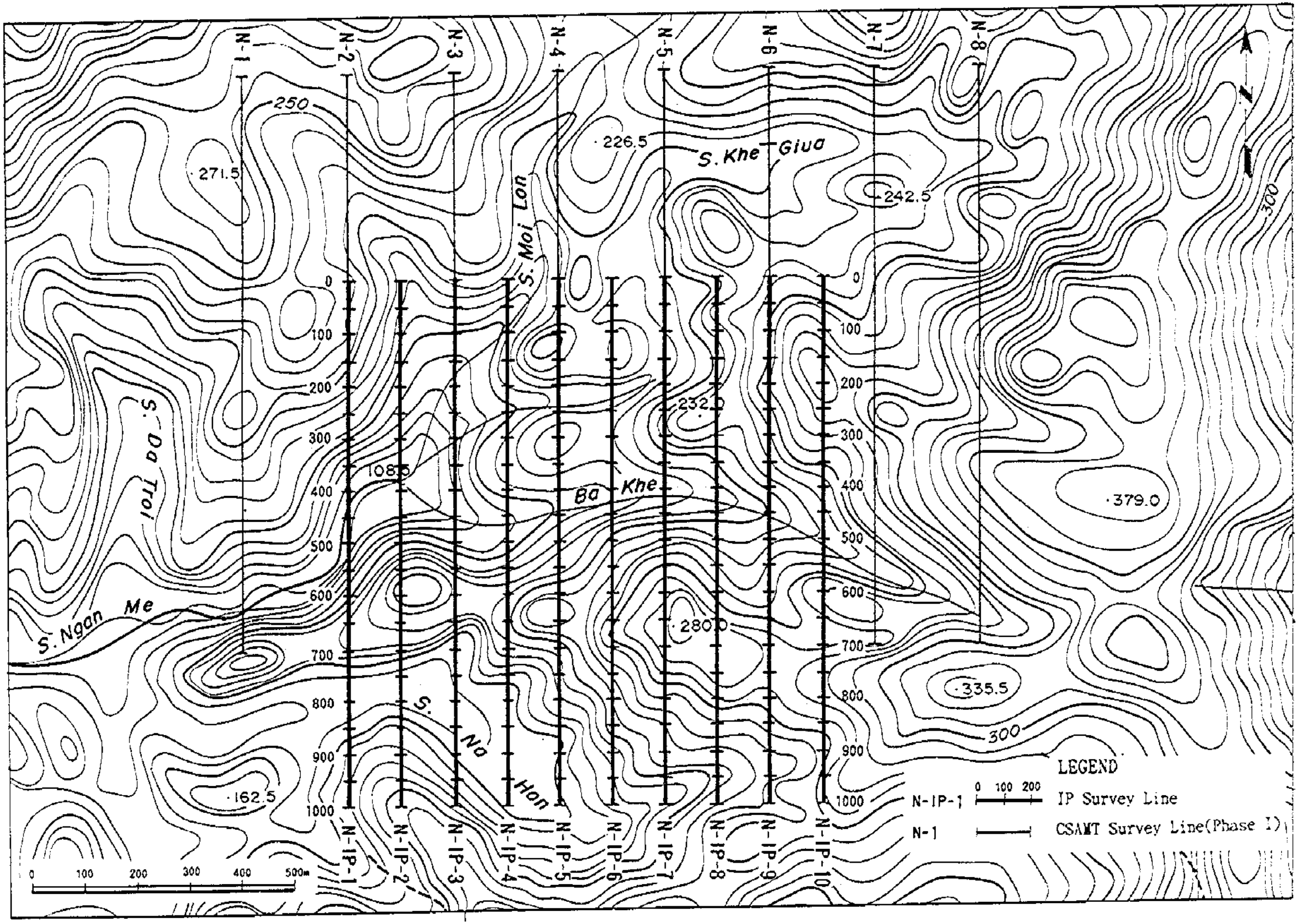


Fig. 2-17 Location Map of the Survey Lines in the Ngan Me Area

(3) Apparent Chargeability Pseudsection

In this section, apparent chargeability is plotted at the depth of a(n+1)/2 just under the middle point of the used electrodes for each line.

(4) Apparent Chargeability Map

In this map, the apparent chargeability of the specific electrode separation index is plotted.

(5) 2-D Inversion

This analysis assumes that structure is two dimensional, 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 that of the observed apparent resistivity. 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.

After resistivity distribution is obtained, chargeabilitry distribution is determined with the least squares method on the assumption that a observed chargeability is weighted average value of chargeability using the sensitivities of apparent resistivity as a weighting function.

(6) Resistivity Section

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

(7) Resistivity Map

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

(8) Chargeability Section

In this section, the chargeability distribution below each line is drawn using the results of the 2-D inversion.

(9) Chargeability Map

In this map, the chargeability distribution at the specific level is drawn using the results of the 2-D inversion.

(10) Integrated Interpretation Map

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

Table 2-11 List of the Geophysical Survey Equipment

ITEM	MODEL	SPECIFICATION
Transmitter	Chiba CH-96T Transmitter Chiba CH-96A 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 : 67 kg
Engine Generator	Honda ET4500 Engine Generator (2pcs)	Output Power : 4.5 kW Output Voltage : 200 V Weight : 78 kg
Receiver	Scintrex Time Domain IP/Resistivity Receiver	On/Off Time : 1, 2, 4, 8, 16, 32 s Resolution (V_P) : 10 μV Resolution (M) : 0.01 mV/V Power : 12V Battery Weight : 5.8 kg
Electrode		Current : Stainless Rod Potential : Non Polarization $CuSO_4$ Porous Pot

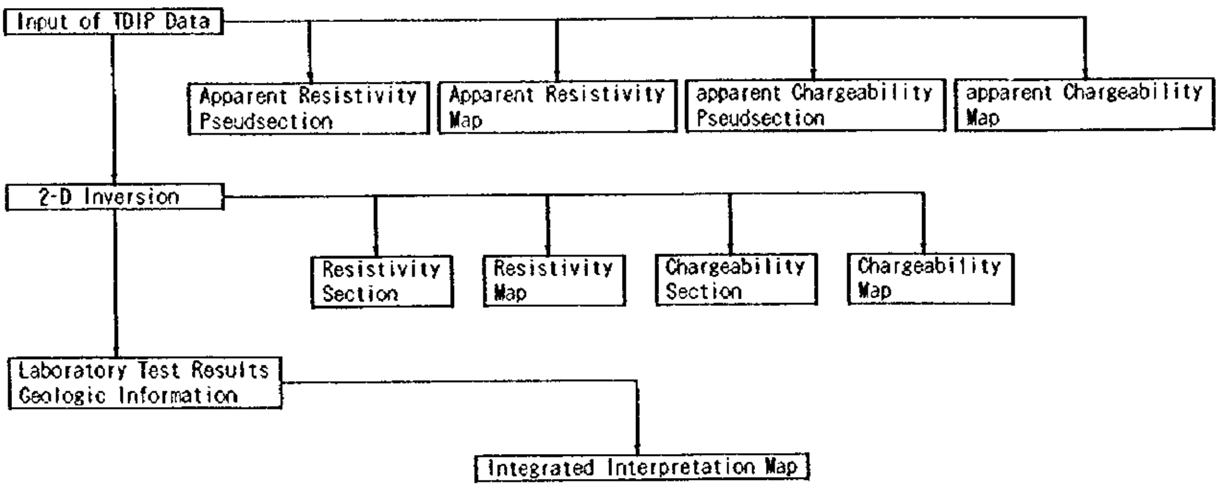


Fig. 2-18 Flow Chart of the Analytical Method

3-3 Survey Results

3-3-1 Da Mai Area

(1) Observed Data

1) Apparent Resistivity

The pseudosections of the apparent resistivity of every line are shown in Fig. 2-19 to 2-20 and the maps of the apparent resistivity of n=1, 3 and 5 are shown in Fig. 2-21 to 2-23. The apparent resistivity in the Da Mai area is 316 to 1,000 ohm-m and its distribution is little changeful, on the whole. The mean value is about 500 ohm-m. Can be seen from the maps, the apparent resistivity shows a tendency to be higher in the deeper zone. In the map of n=5, all high resistivity areas more than 1,000 ohm-m emerge in the ridge parts. It seems to be due to the topographic effect.

2) Apparent Chargeability

The pseudosections of the apparent chargeability of every line are shown in Fig. 2-24 to 2-25 and the maps of the apparent resistivity of n=1, 3 and 5 are shown in Fig. 2-26 to 2-28. The apparent chargeability in the Da Mai area is mostly lower than 10 mV/V and therefore the background value of chargeability in this area seems to be lower than 10 mV/V. The strong chargeability anomaly area more than 30 mV/V was detected in the northern part of lines D-IP-8 to D-IP-10. This area shows a tendency to be higher in the deeper zone. The weak chargeability anomaly area was detected in the south of this strong anomaly. This weak anomaly area disappears in the deep zone.

(2) Analytic Results (2-D Inversion)

1) Resistivity

The resistivity sections drawn with the 2-D inversion are shown in Fig. 2-29 to 2-32. The resistivity maps of 3 levels (SL 250 m, SL 200 m and SL 150 m) are shown in Fig. 2-33 to 2-35. The resistivity in the Da Mai area is higher than 316 ohm-m and changes gently, as a whole. It shows a tendency to be higher in the deeper zone. In the map of SL 150m, high resistivity more than 1,000 ohm-m is distributed broadly. These tendencies are similar to the results of CSAMT method carried out on the first phase survey.

2) Chargeability

The chargeability sections drawn with the 2-D inversion are shown in Fig. 2-36 to 2-39. The chargeability maps of 3 levels (SL 250 m, SL 200 m and SL 150 m) are shown in Fig. 2-40 to 2-42. The chargeability in the Da Mai area is mostly lower than 10 mV/V and therefore the background value of chargeability in this area is lower than 10 mV/V.

The strong chargeability anomaly zone more than 30 mV/V were extracted in the northern part of lines D-IP-8 to D-IP-10. This anomaly zone has a WNW-ESE direction and is composed of two parallel anomalies, as shown in the map of SL 200m. This anomaly zone tends to further continue to the east of the survey area and extend to the deeper zone. Besides, the weak anomaly zone more than 15 mV/V is extracted in the central part of survey area. This anomaly zone has a WNW-ESE direction, also. However, it tends not to extend the deeper zone.

The resistivity value in the strong chargeability anomaly zone is 316 to 1,000 ohm-m, on the whole. This value is the background resistivity of the Da Mai area. The distinctive relationship between resistivity and chargeability is not found out in this area.

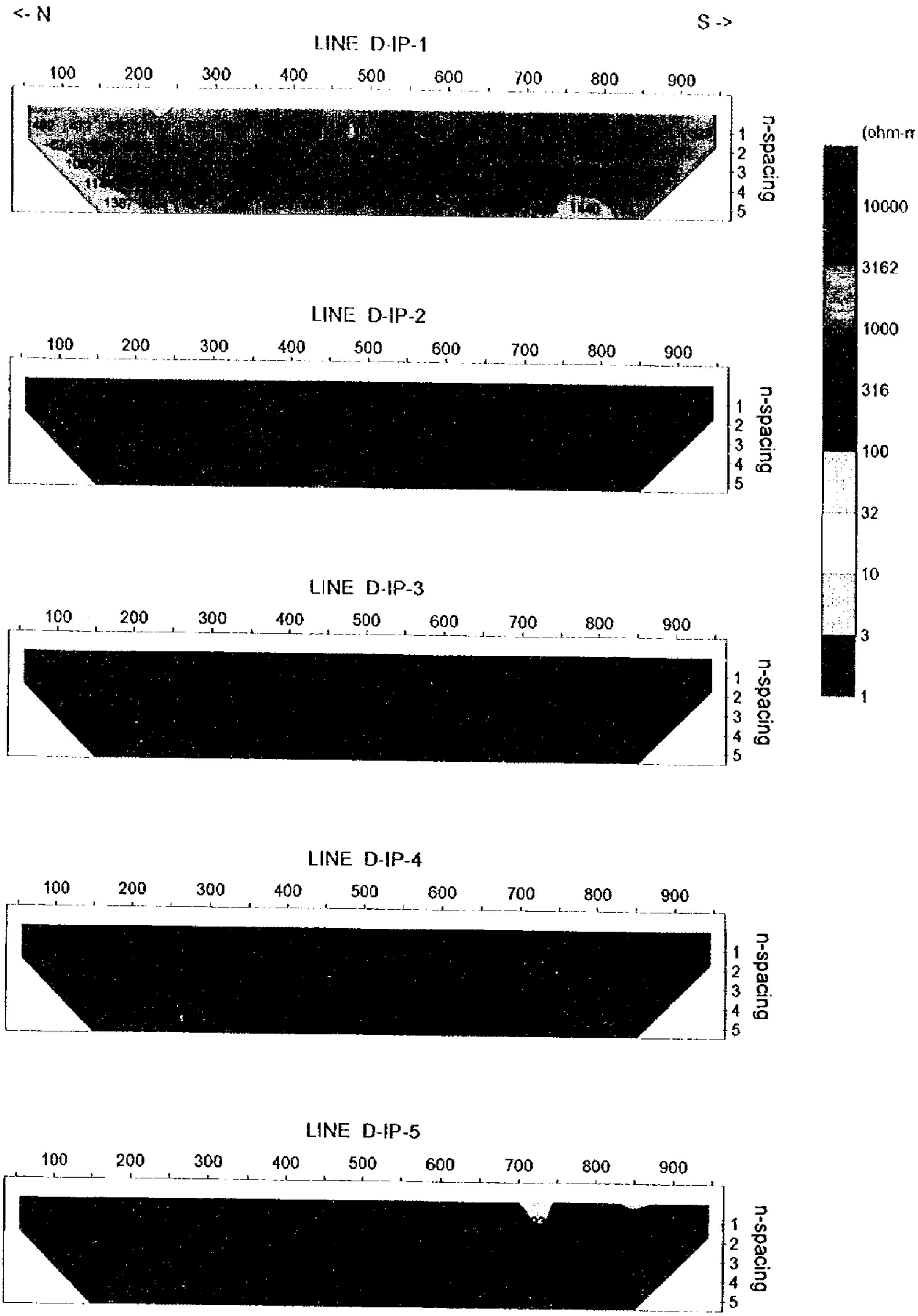


Fig. 2-19 Apparent Resistivity Pseudo-Sections (Lines D-IP-1 to D-IP-5)

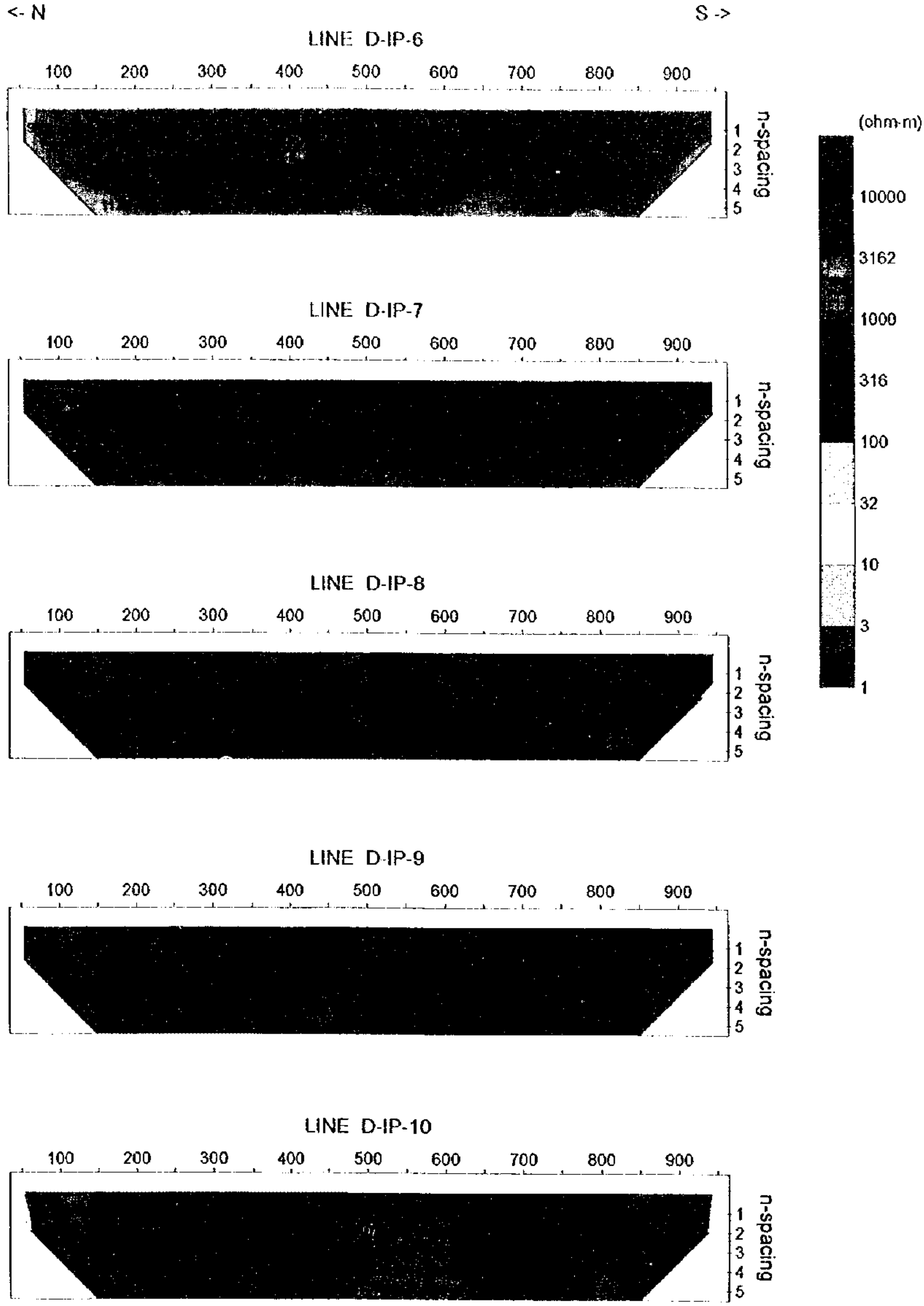


Fig. 2-20 Apparent Resistivity Pseudo-Sections (Lines D-IP-6 to D-IP-10)

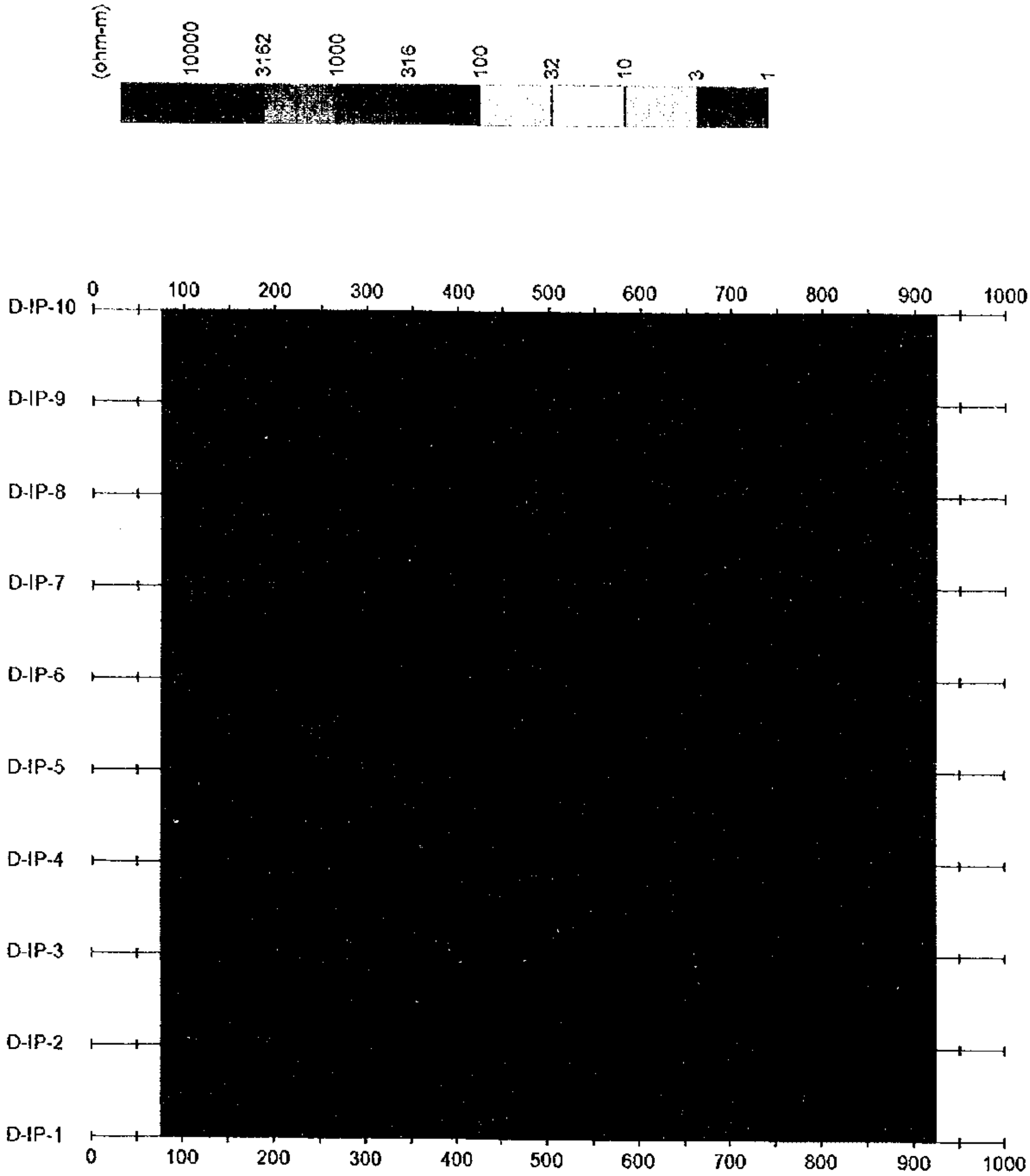


Fig. 2-21 Apparent Resistivity Map in the Da Mai Area (n=1)

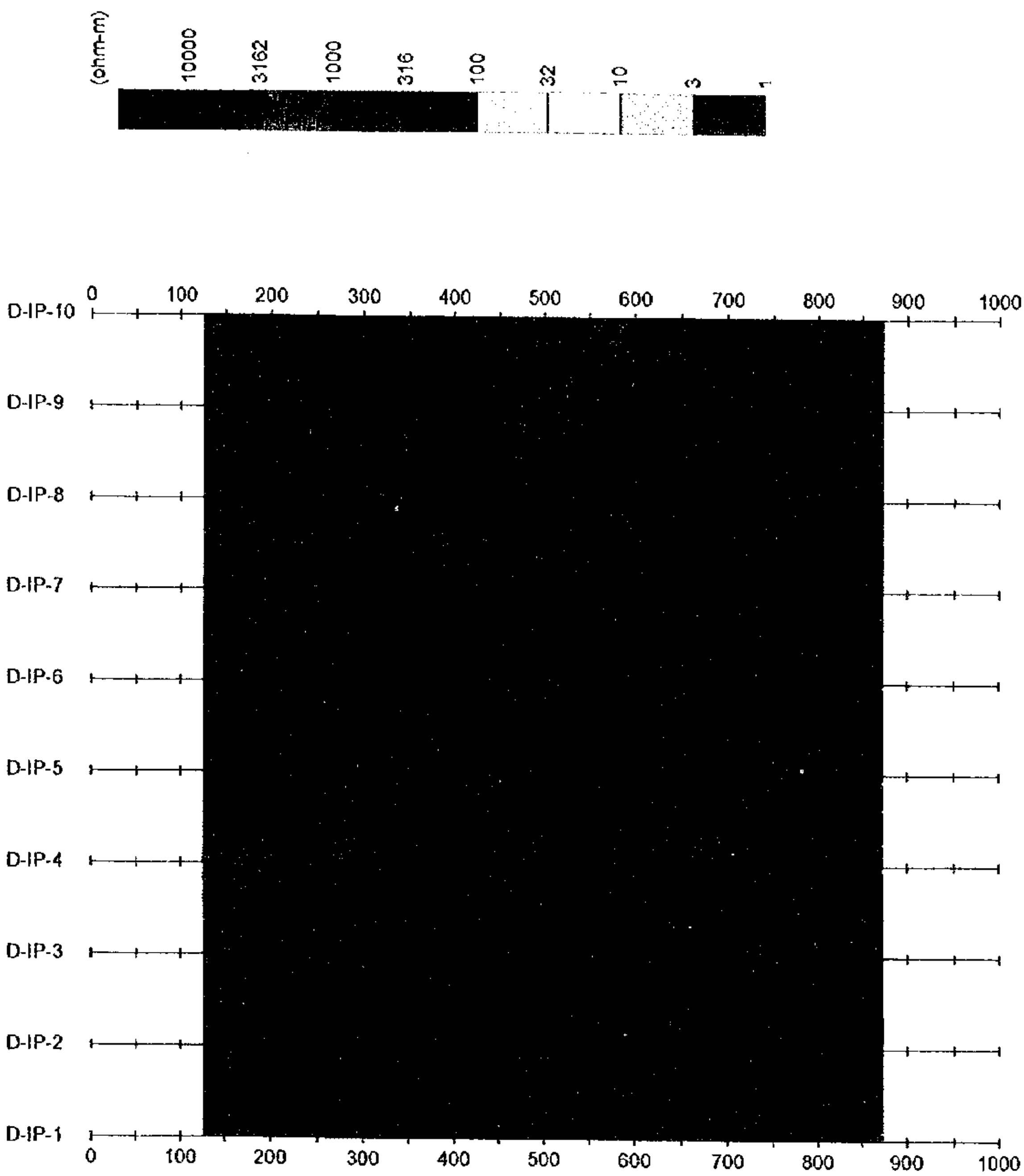


Fig. 2-22 Apparent Resistivity Map in the Da Mai Area (n=3)

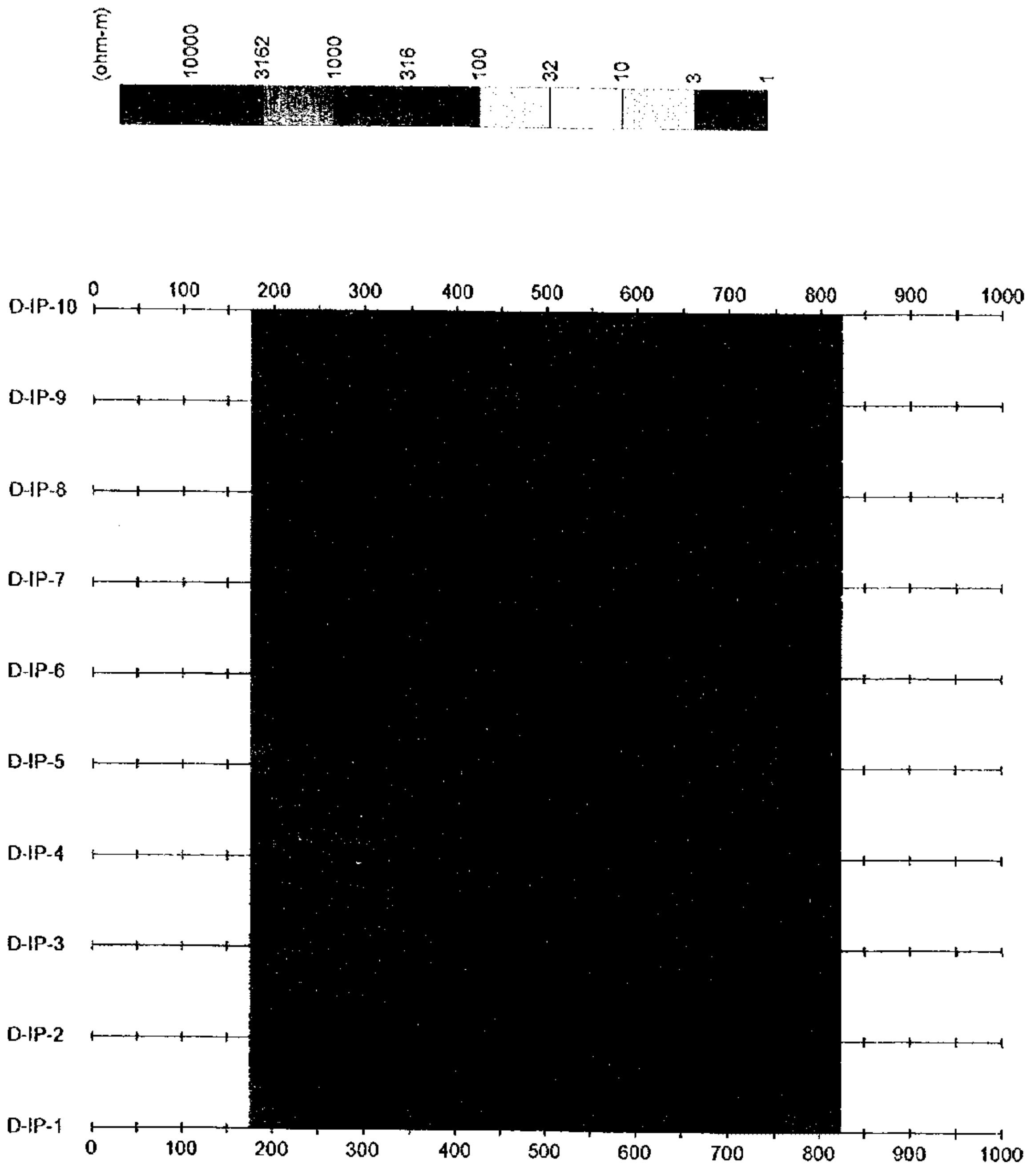


Fig. 2-23 Apparent Resistivity Map in the Da Mai Area (n=5)

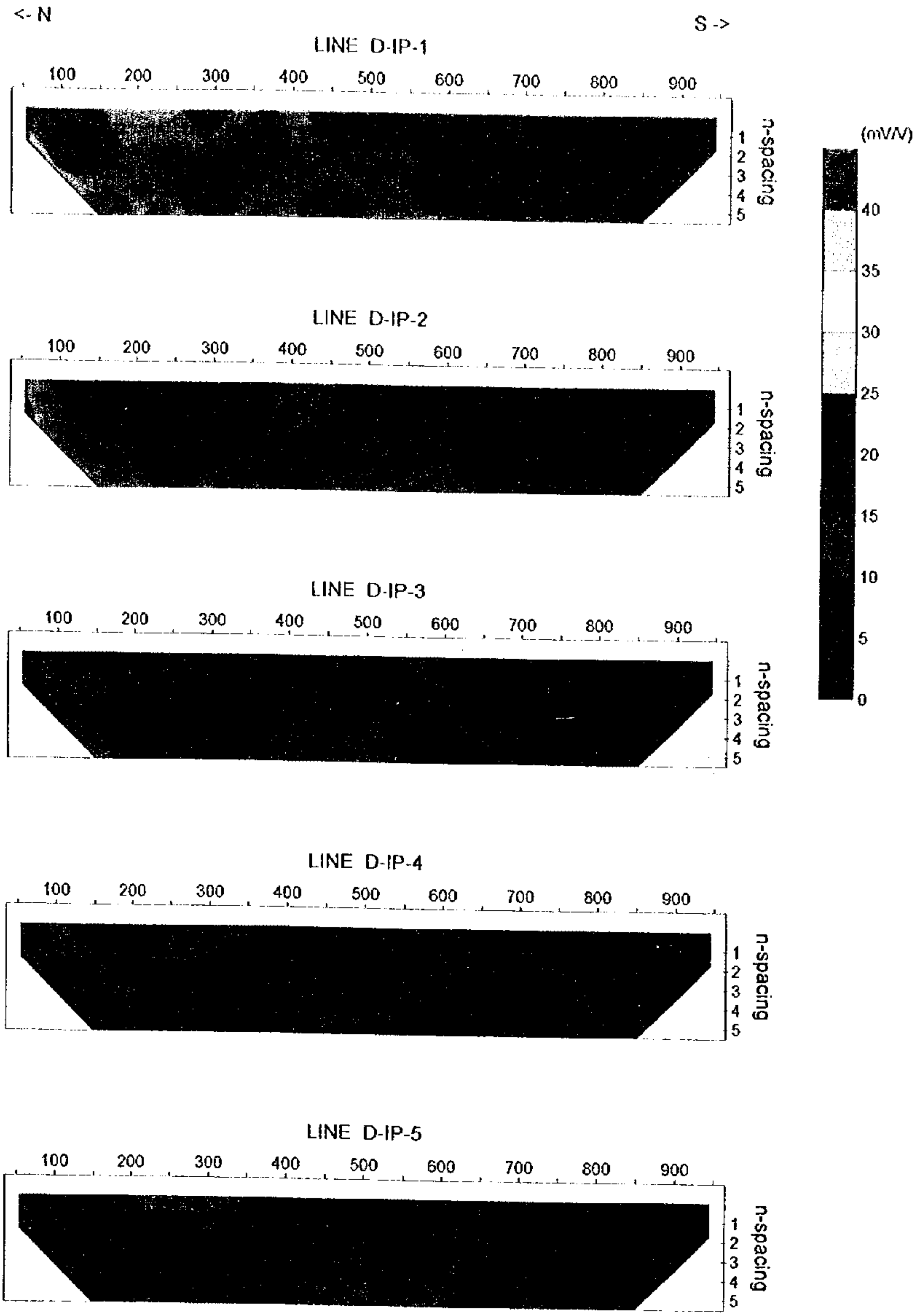


Fig. 2-24 Apparent Chargeability Pseudo-Sections (Lines D-IP-1 to D-IP-5)

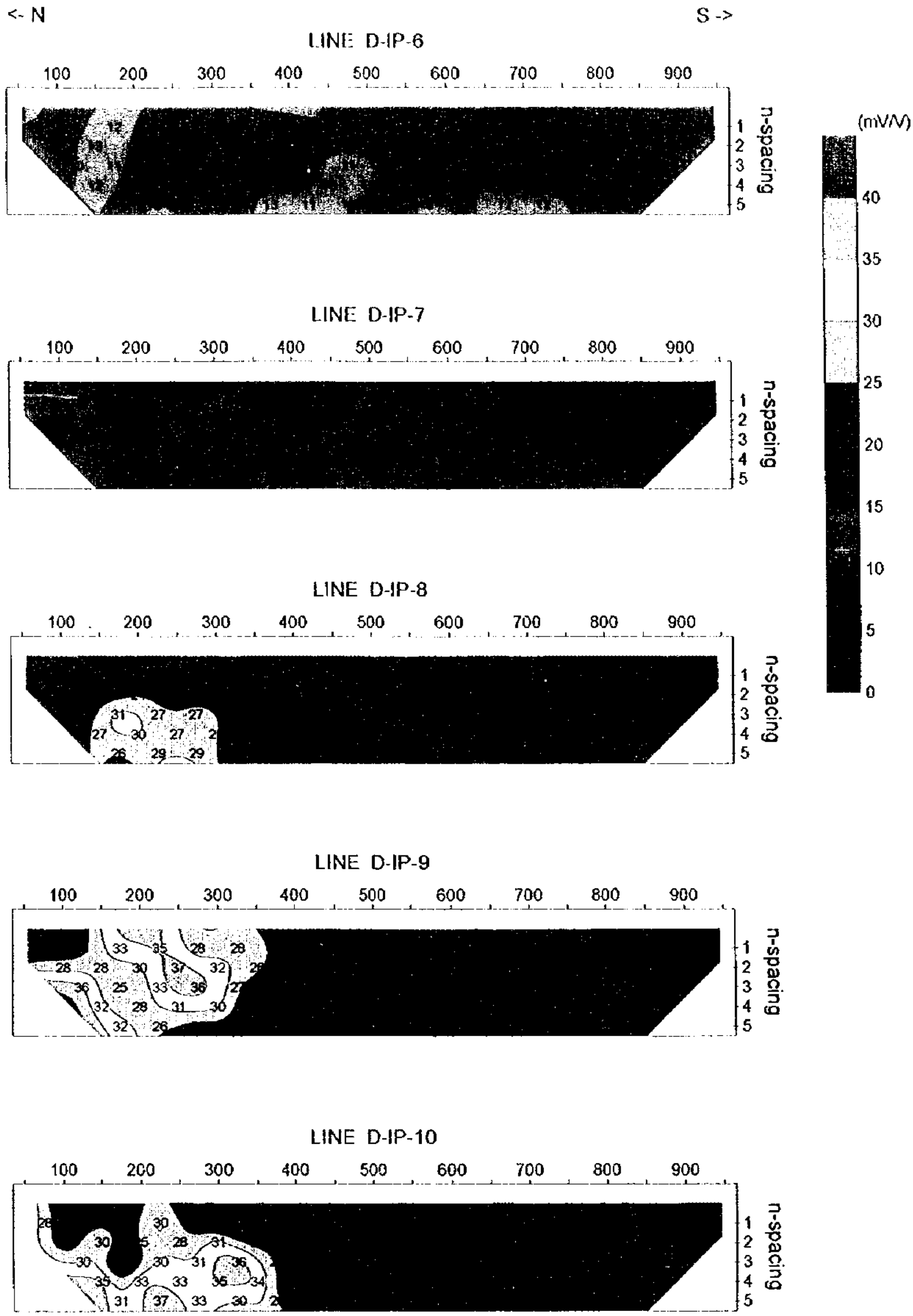


Fig. 2-25 Apparent Chargeability Pseudo-Sections (Lines D-IP-6 to D-IP-10)

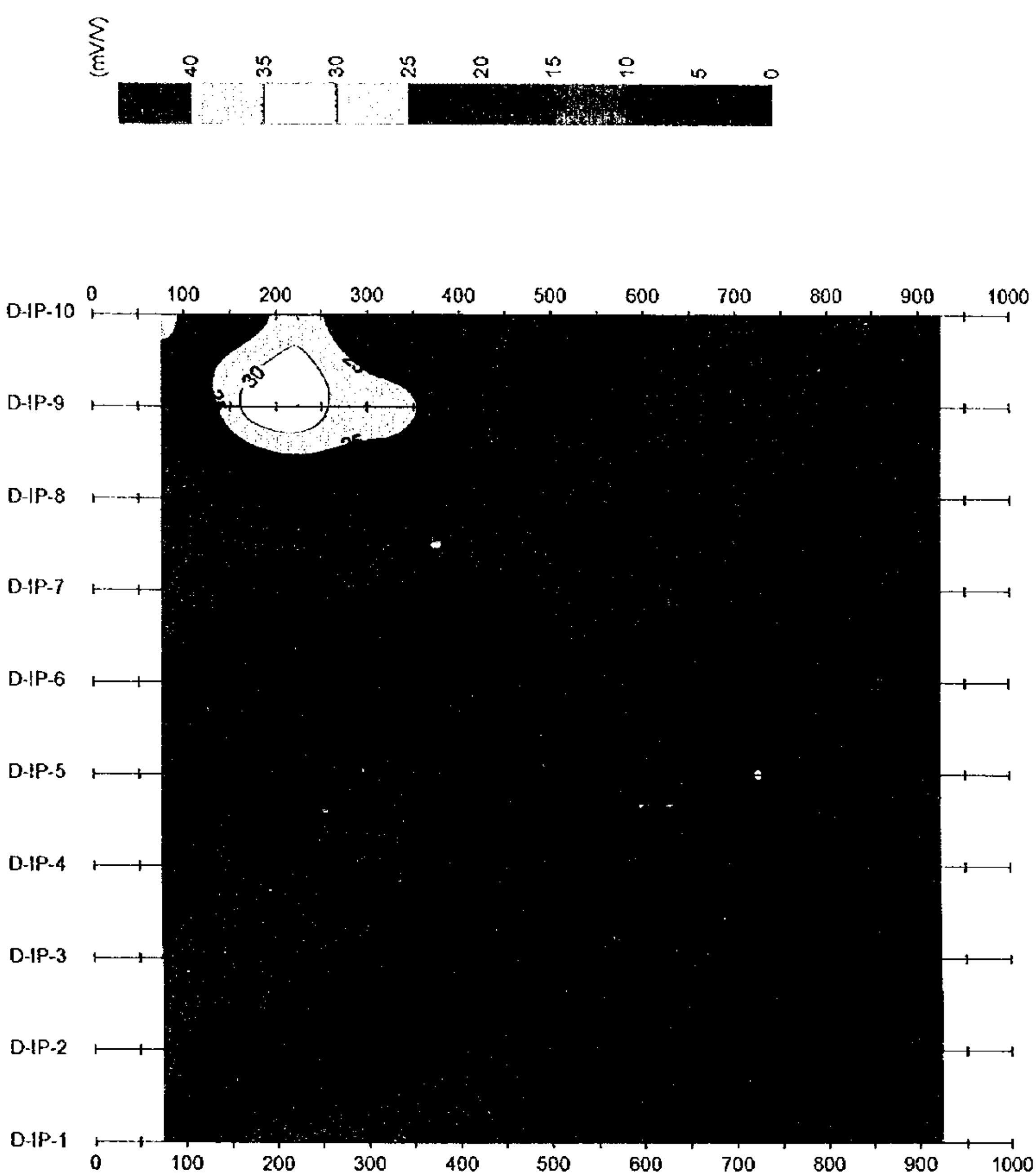


Fig. 2-26 Apparent Chargeability Map in the Da Mai Area (n=1)

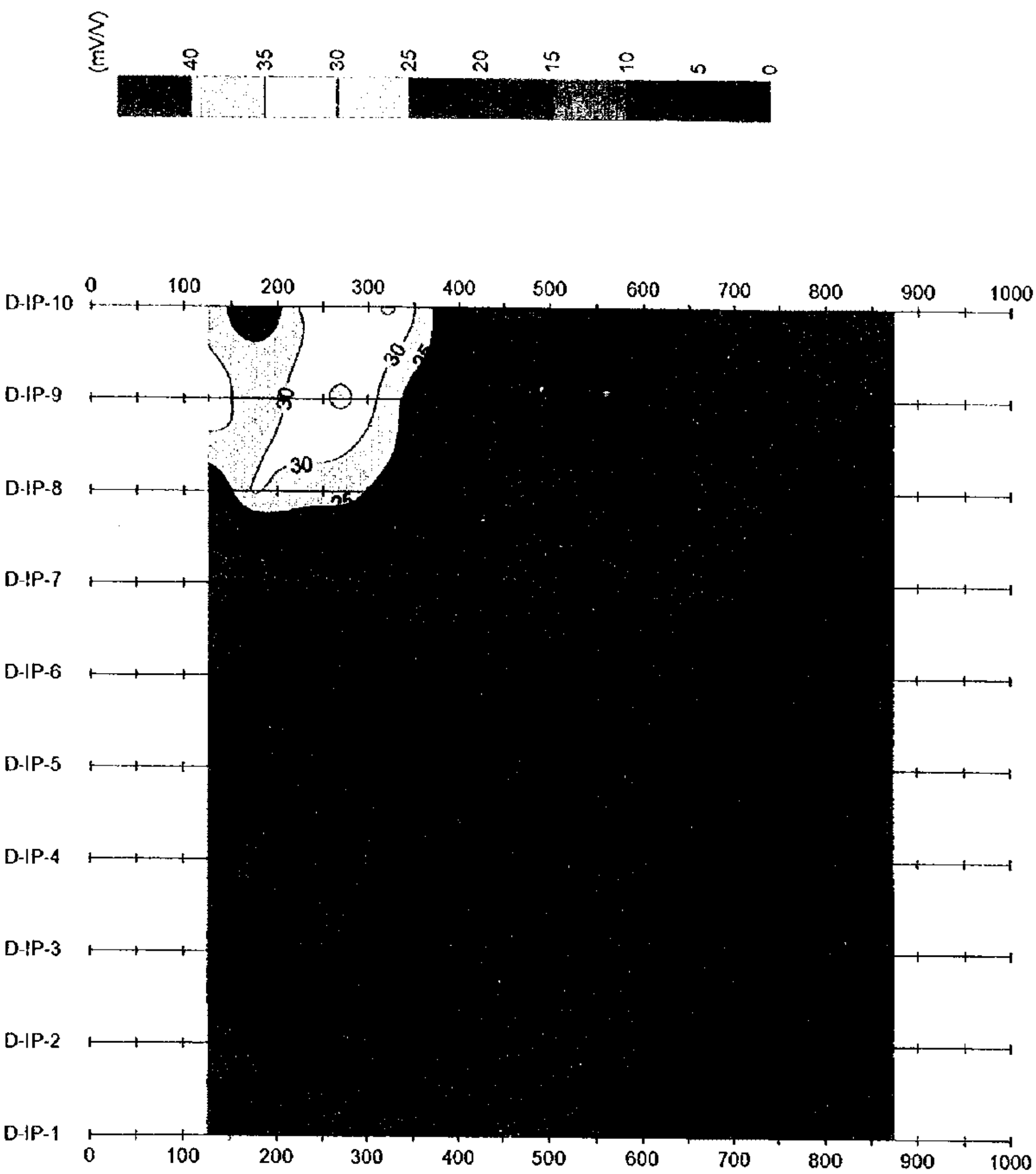


Fig. 2-27 Apparent Chargeability Map in the Da Mai Area (n=3)

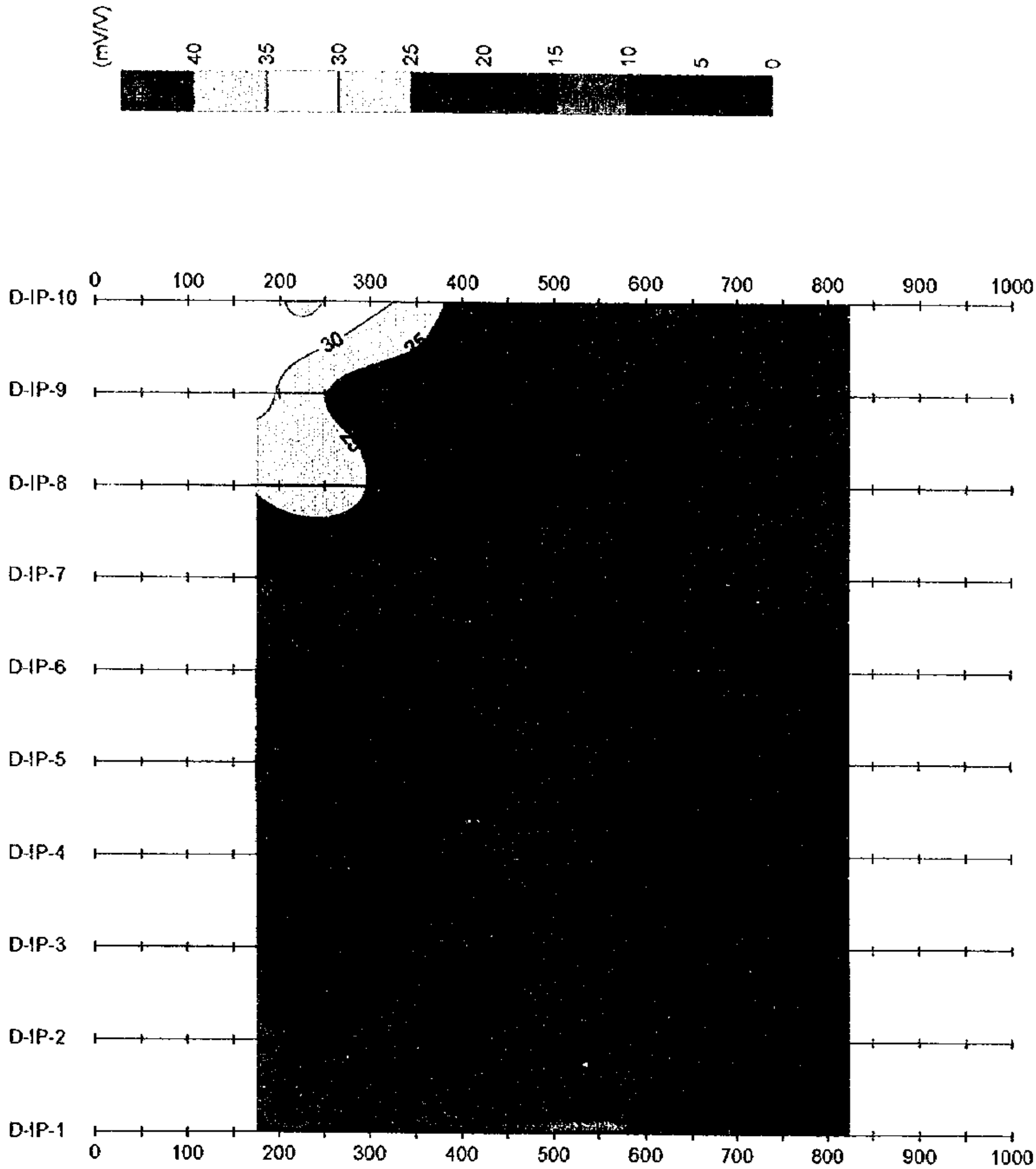


Fig. 2-28 Apparent Chargeability Map in the Da Mai Area (n=5)

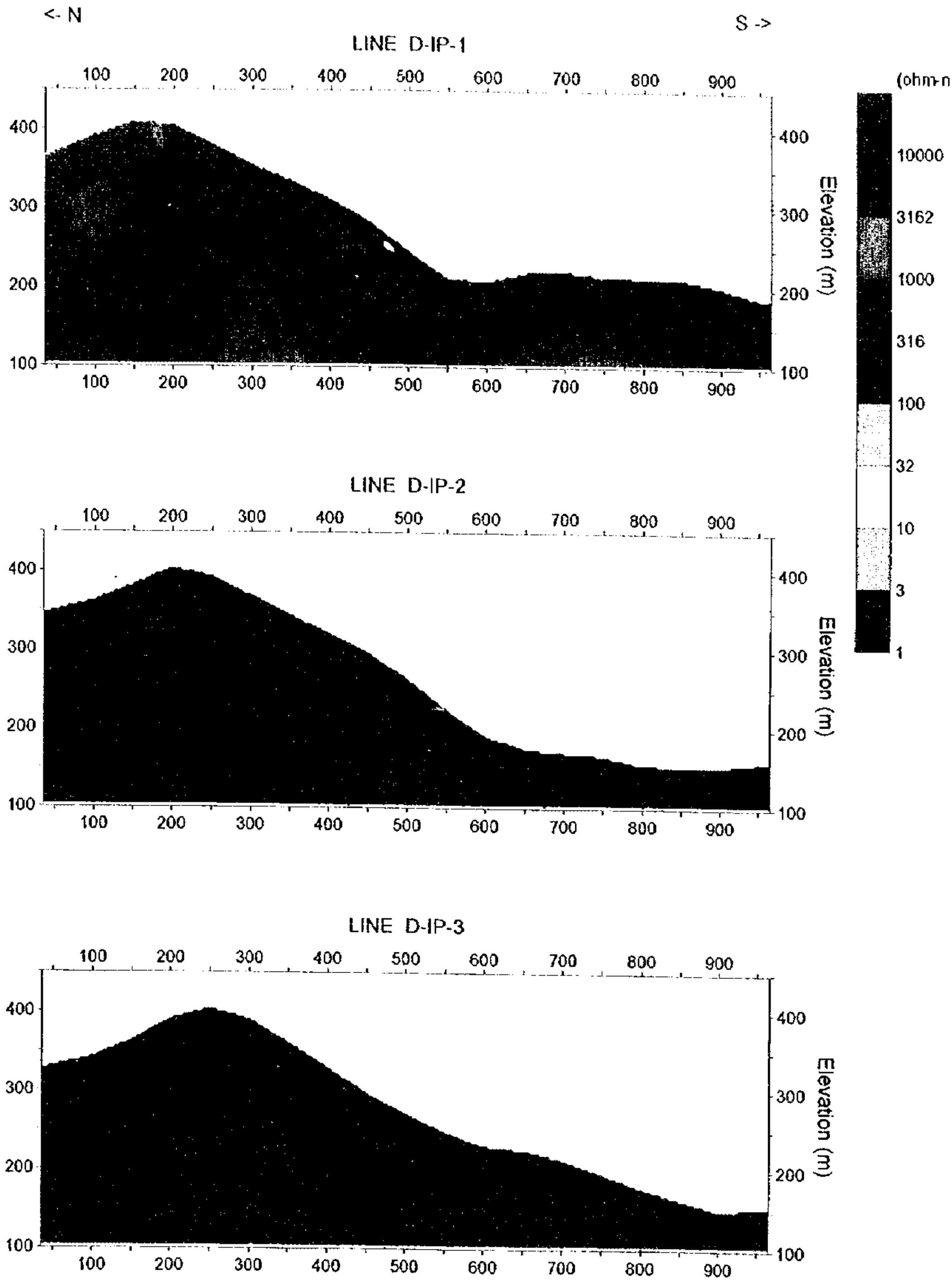


Fig. 2-29 Resistivity Sections (Lines D-IP-1 to D-IP-3)

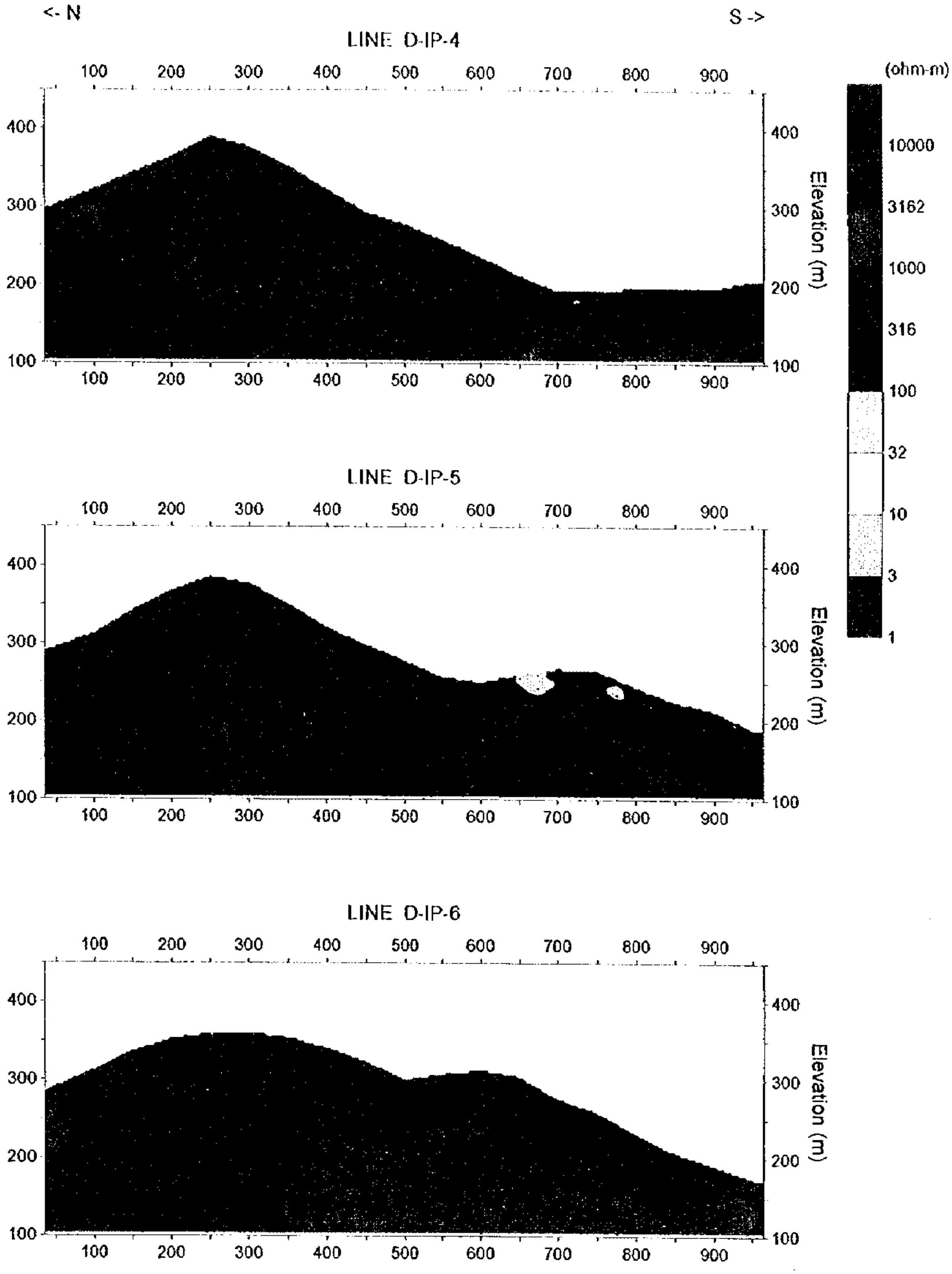


Fig. 2-30 Resistivity Sections (Lines D-IP-4 to D-IP-6)

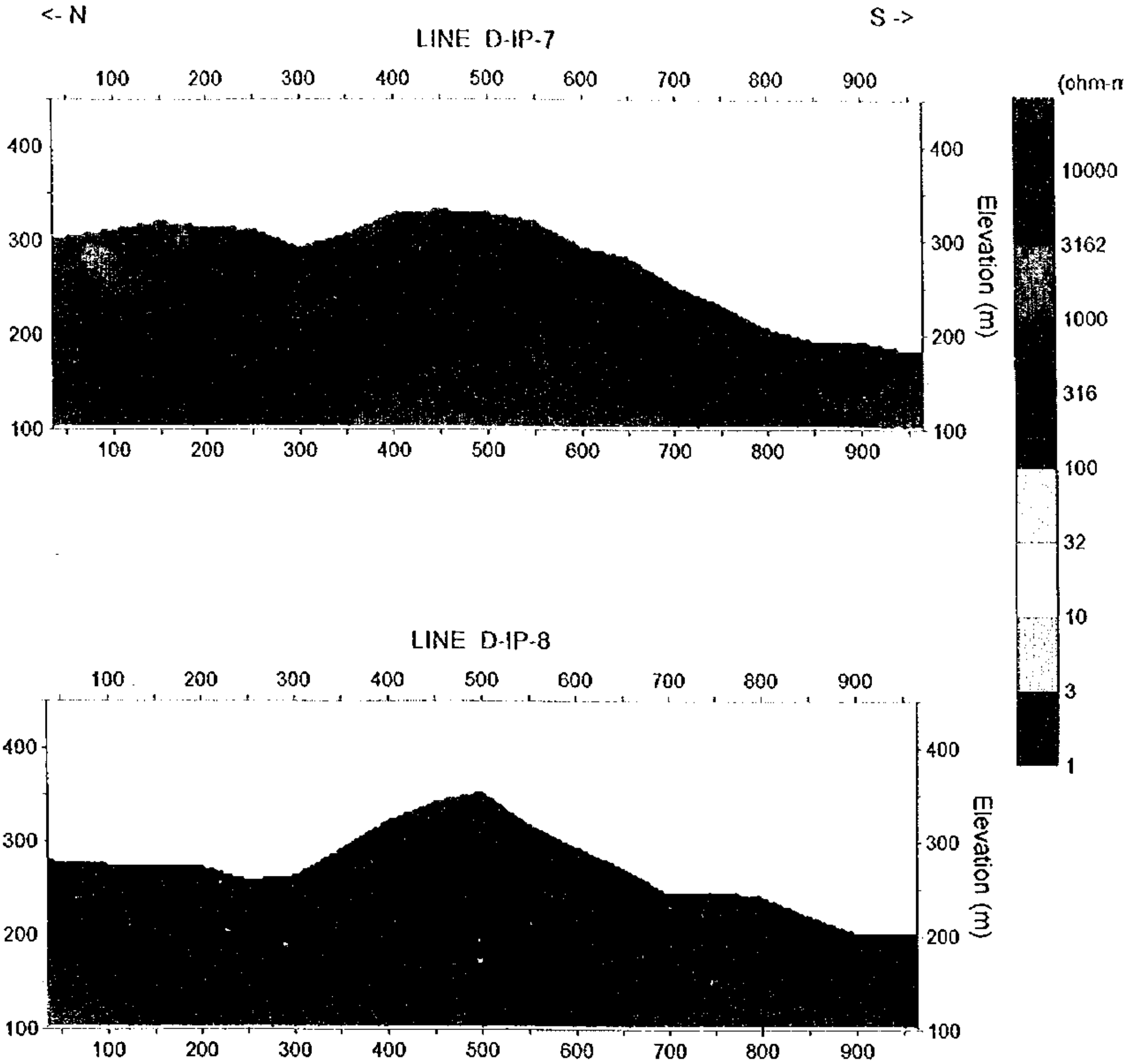


Fig. 2-31 Resistivity Sections (Lines D-IP-7 to D-IP-8)

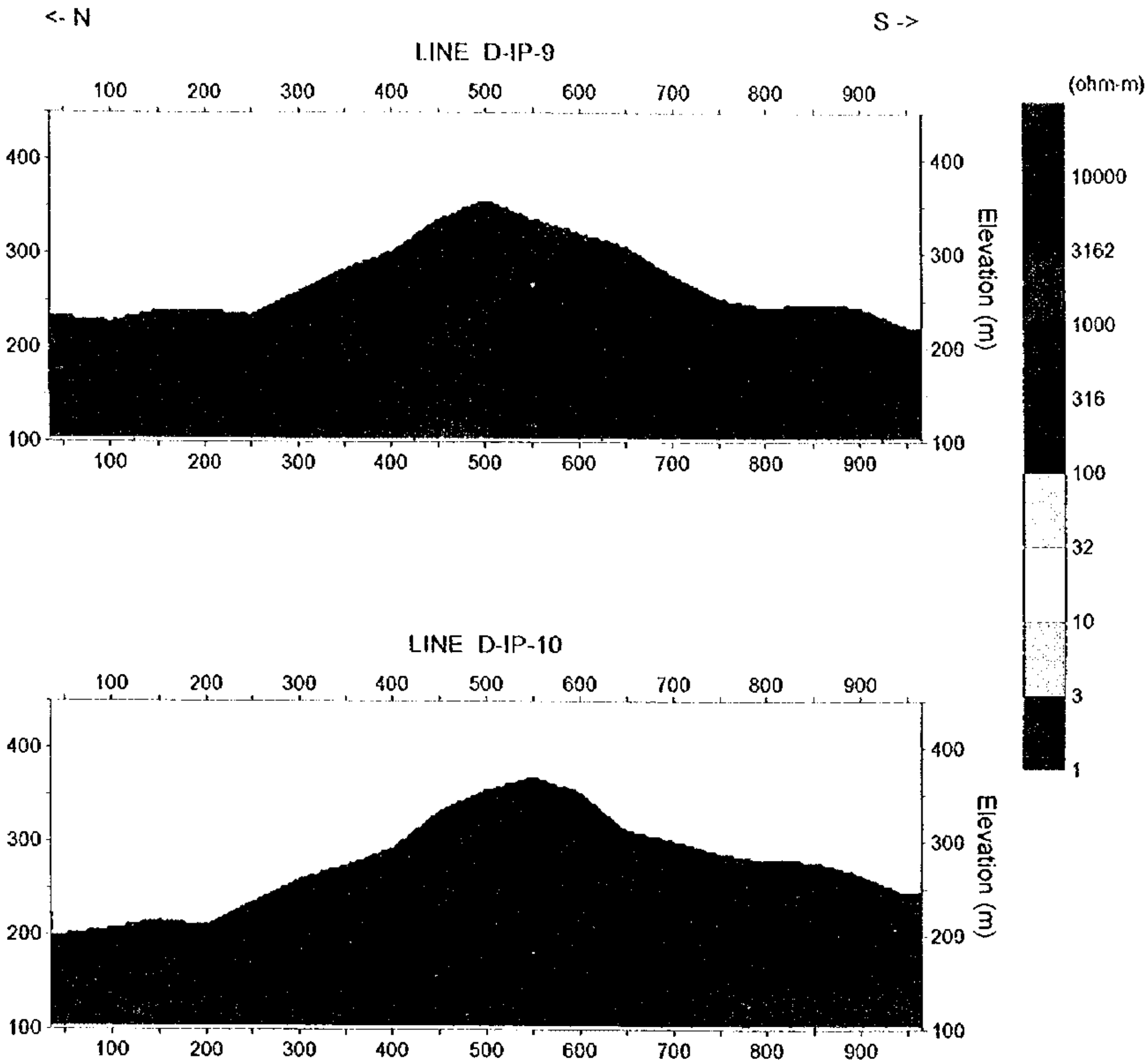


Fig. 2-32 Resistivity Sections (Lines D-IP-9 to D-IP-10)

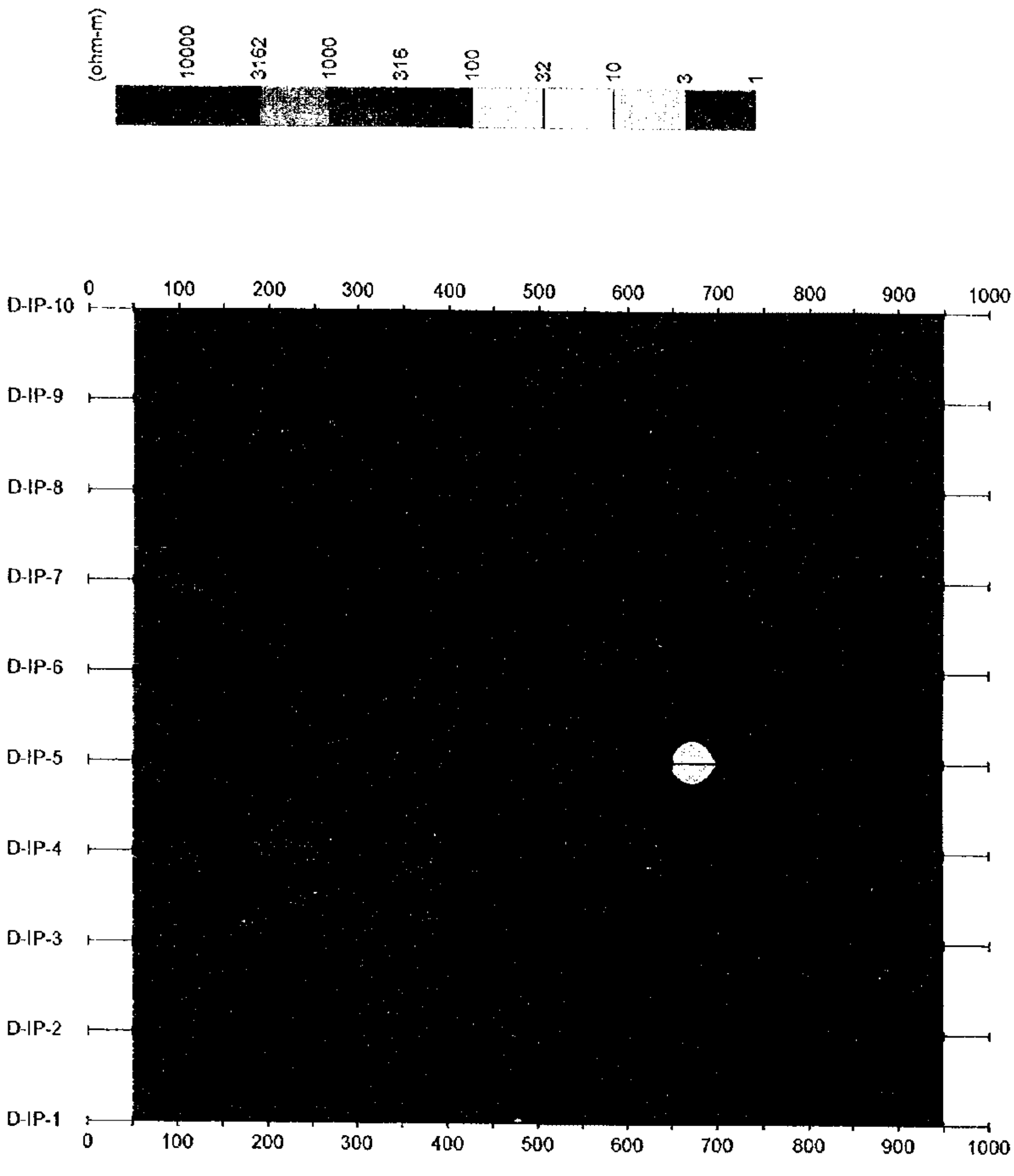


Fig. 2-33 Resistivity Map in the Da Mai Area (SL 250m)

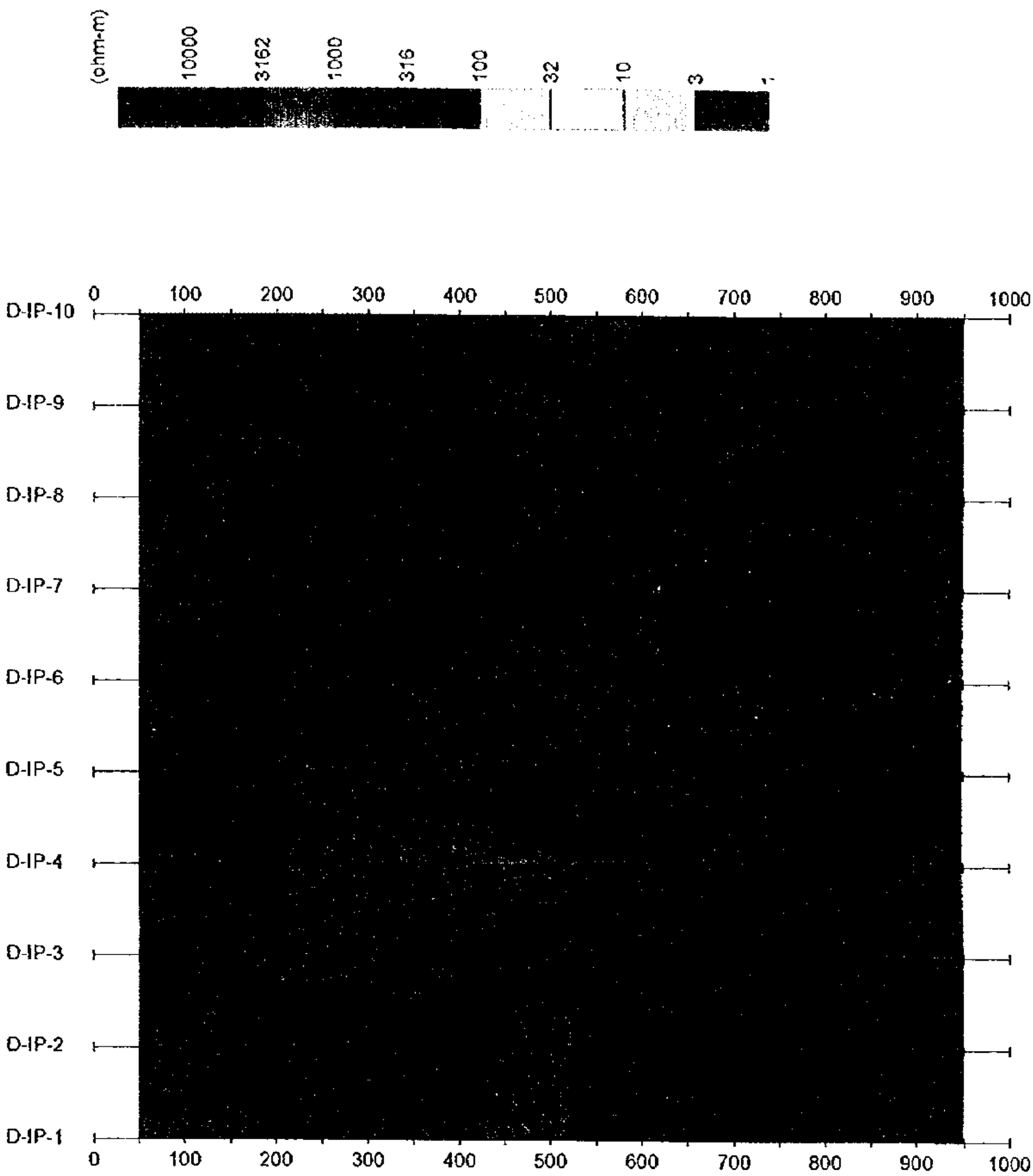


Fig. 2-34 Resistivity Map in the Da Mai Area (SL 200m)

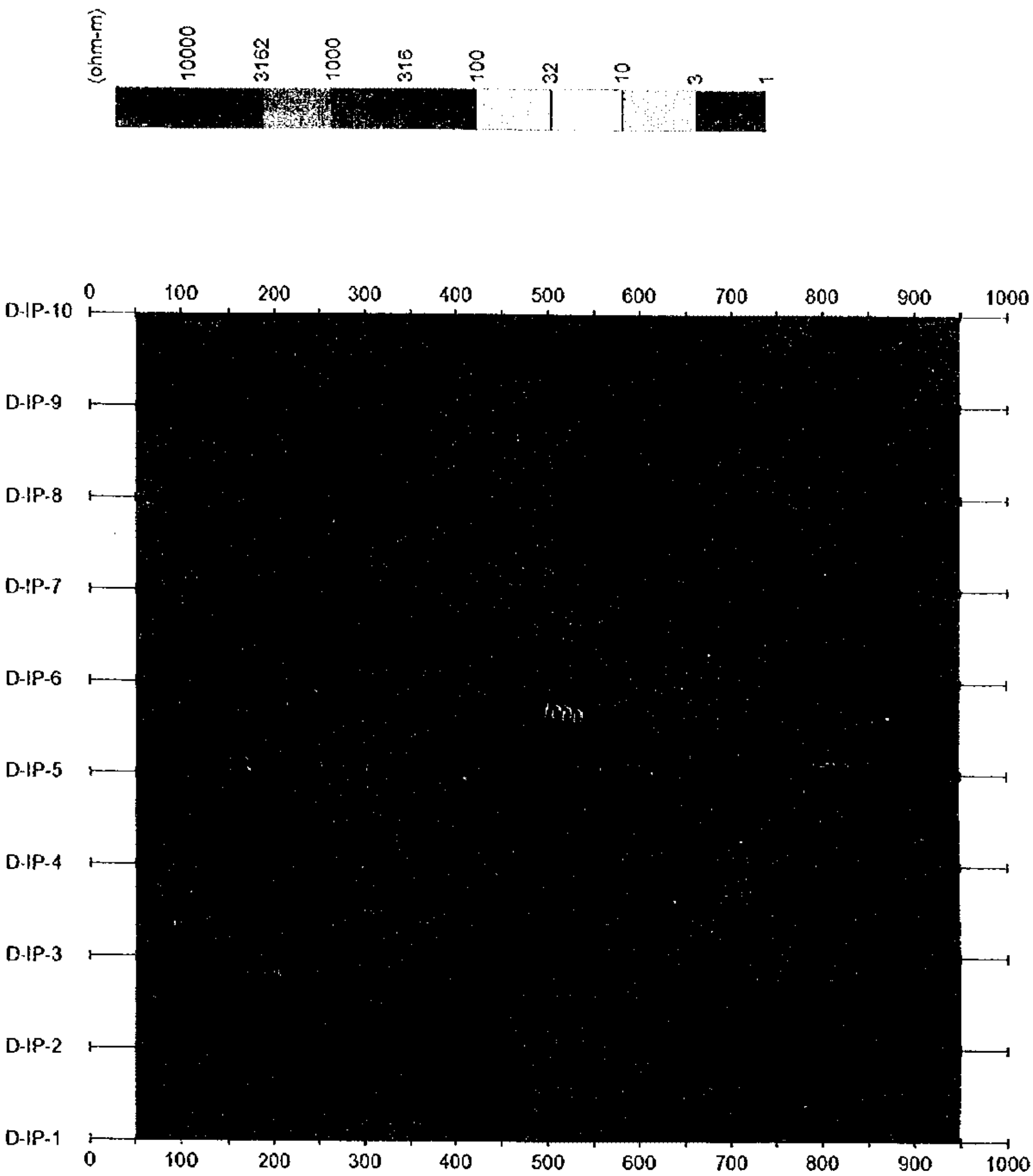


Fig. 2-35 Resistivity Map in the Da Mai Area (SL 150m)

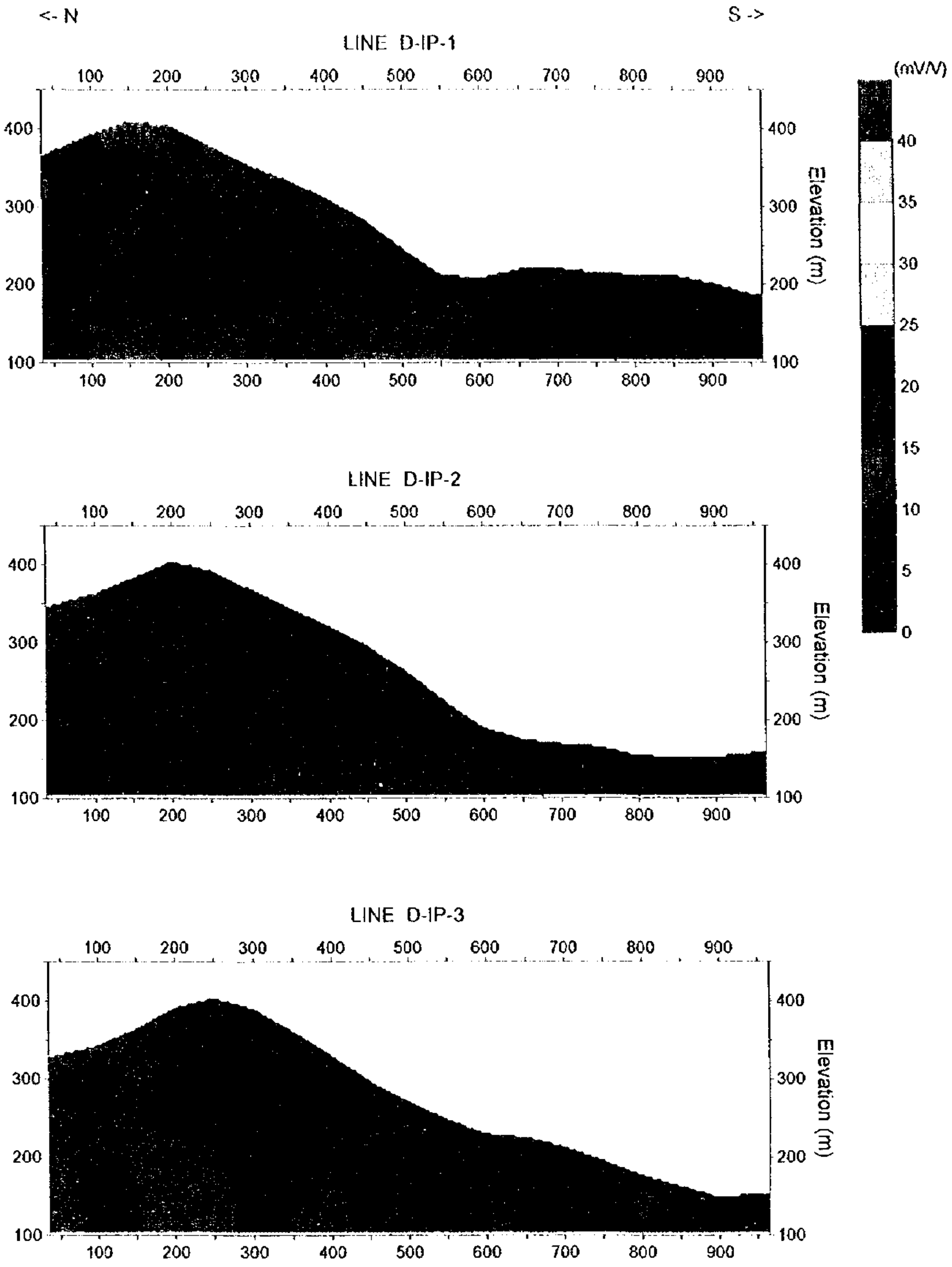


Fig. 2-36 Chargeability Sections (Lines D-IP-1 to D-IP-3)

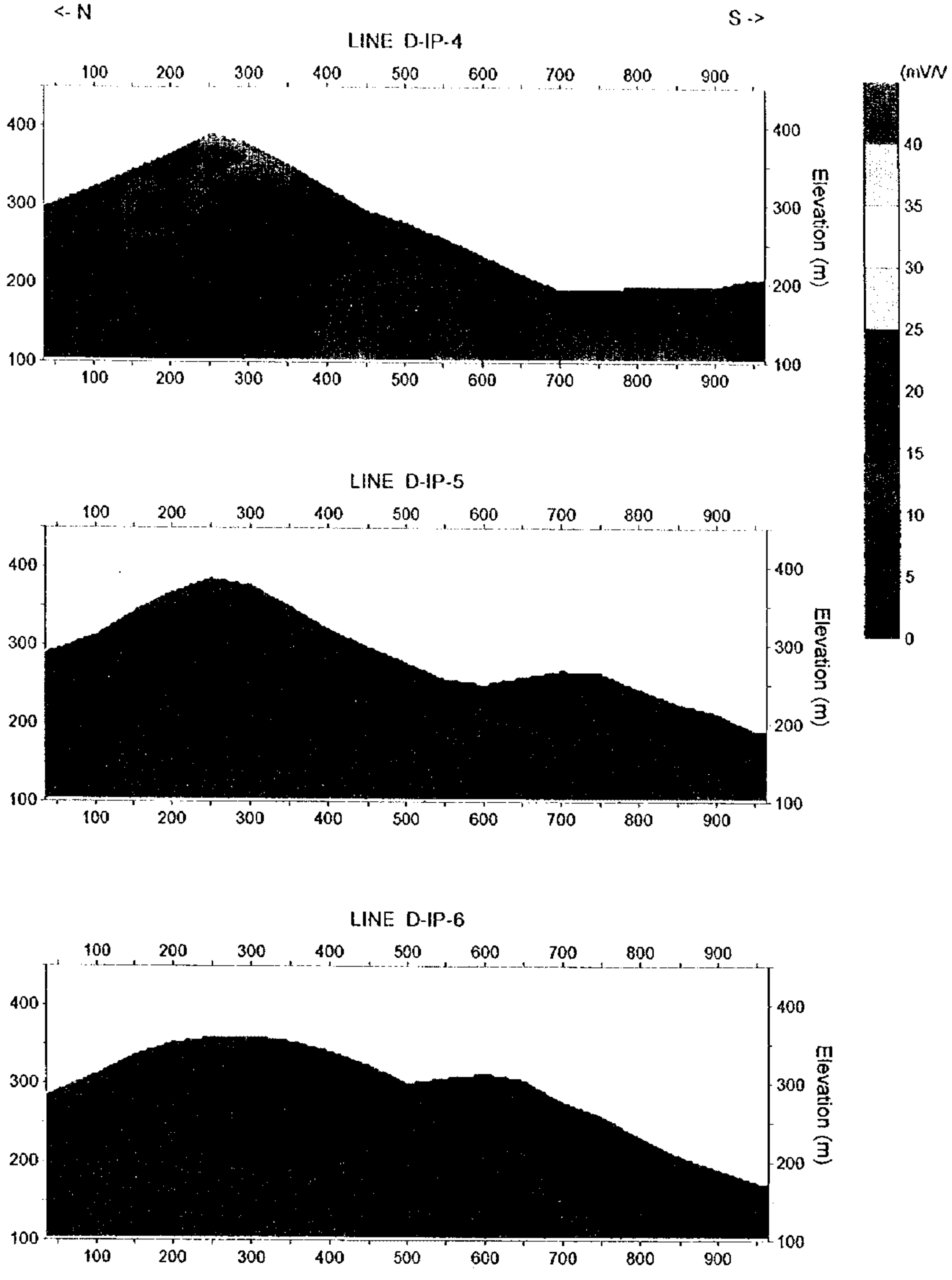


Fig. 2-37 Chargeability Sections (Lines D-IP-4 to D-IP-6)

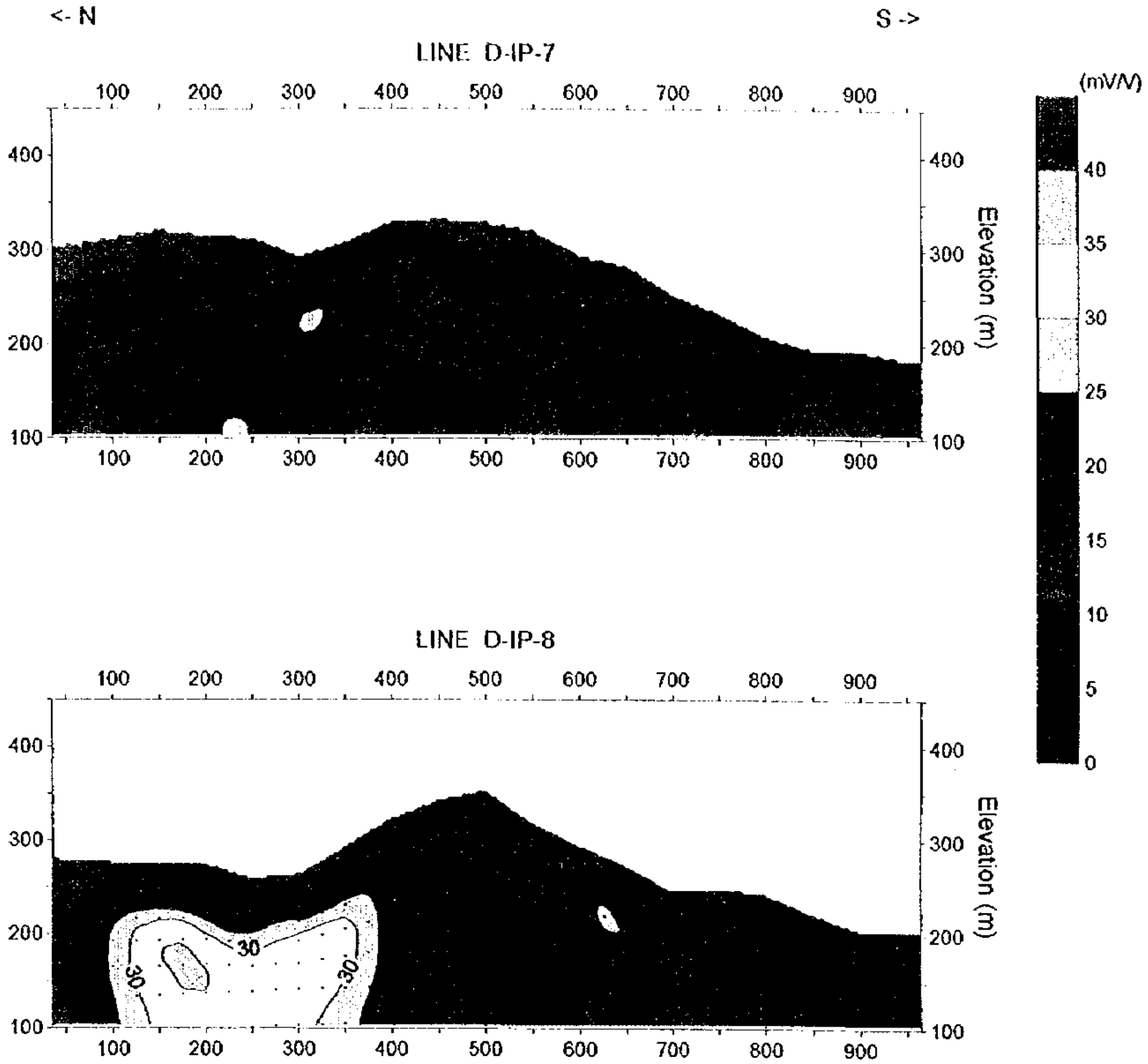


Fig. 2-38 Chargeability Sections (Lines D-IP-7 to D-IP-8)

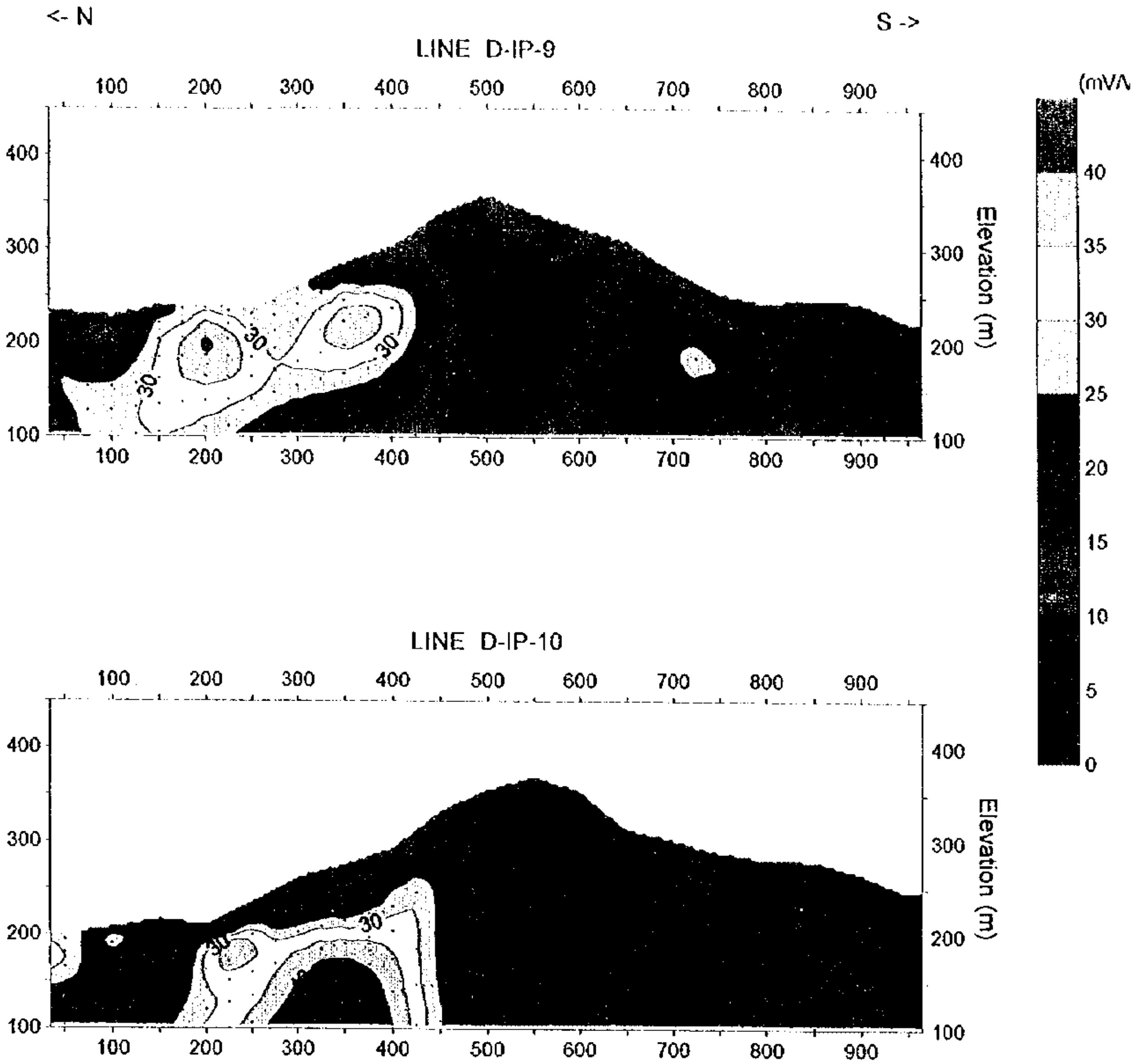


Fig. 2-39 Chargeability Sections (Lines D-IP-9 to D-IP-10)

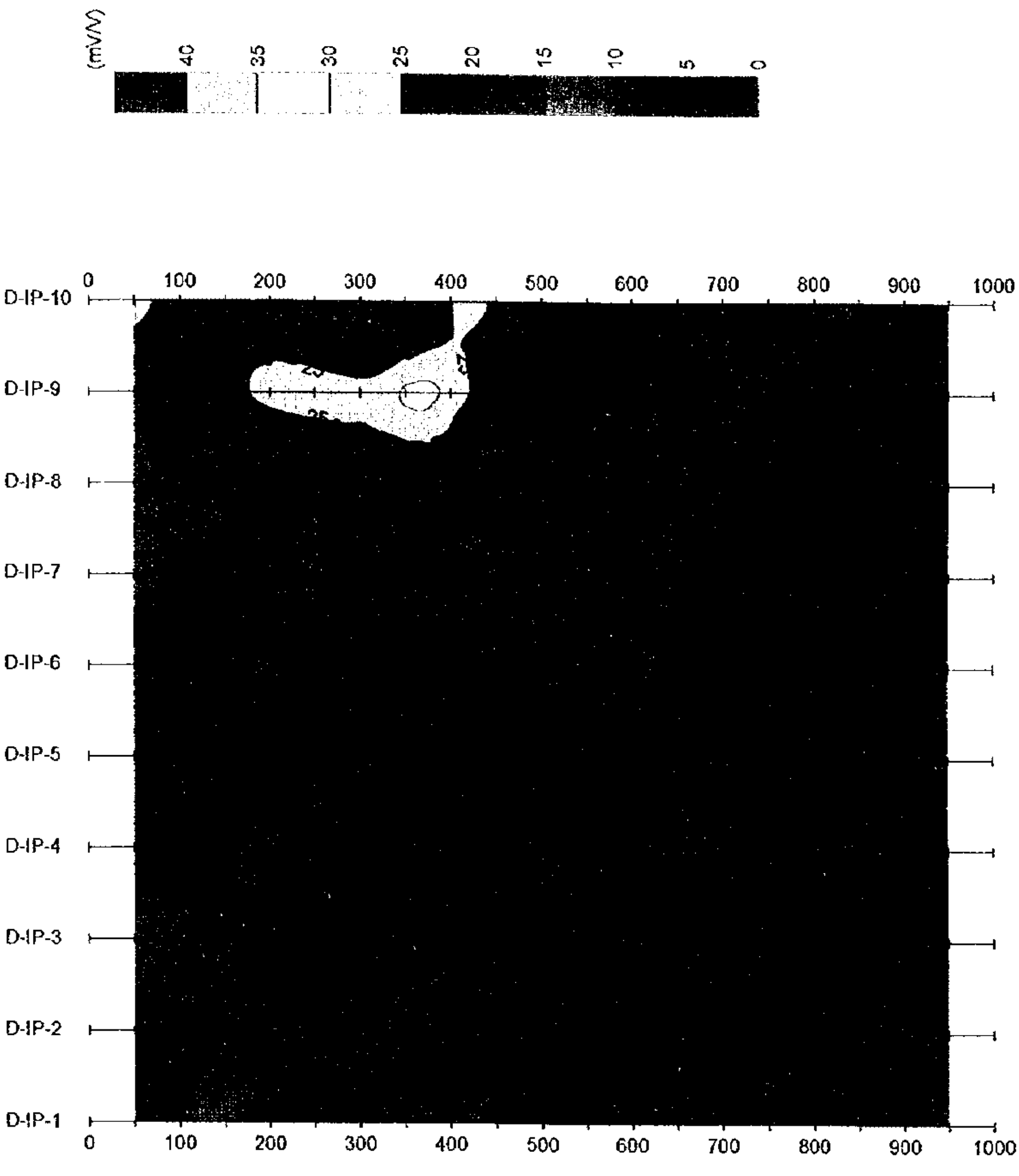


Fig. 2-40 Chargeability Map in the Da Mai Area (SL 250m)

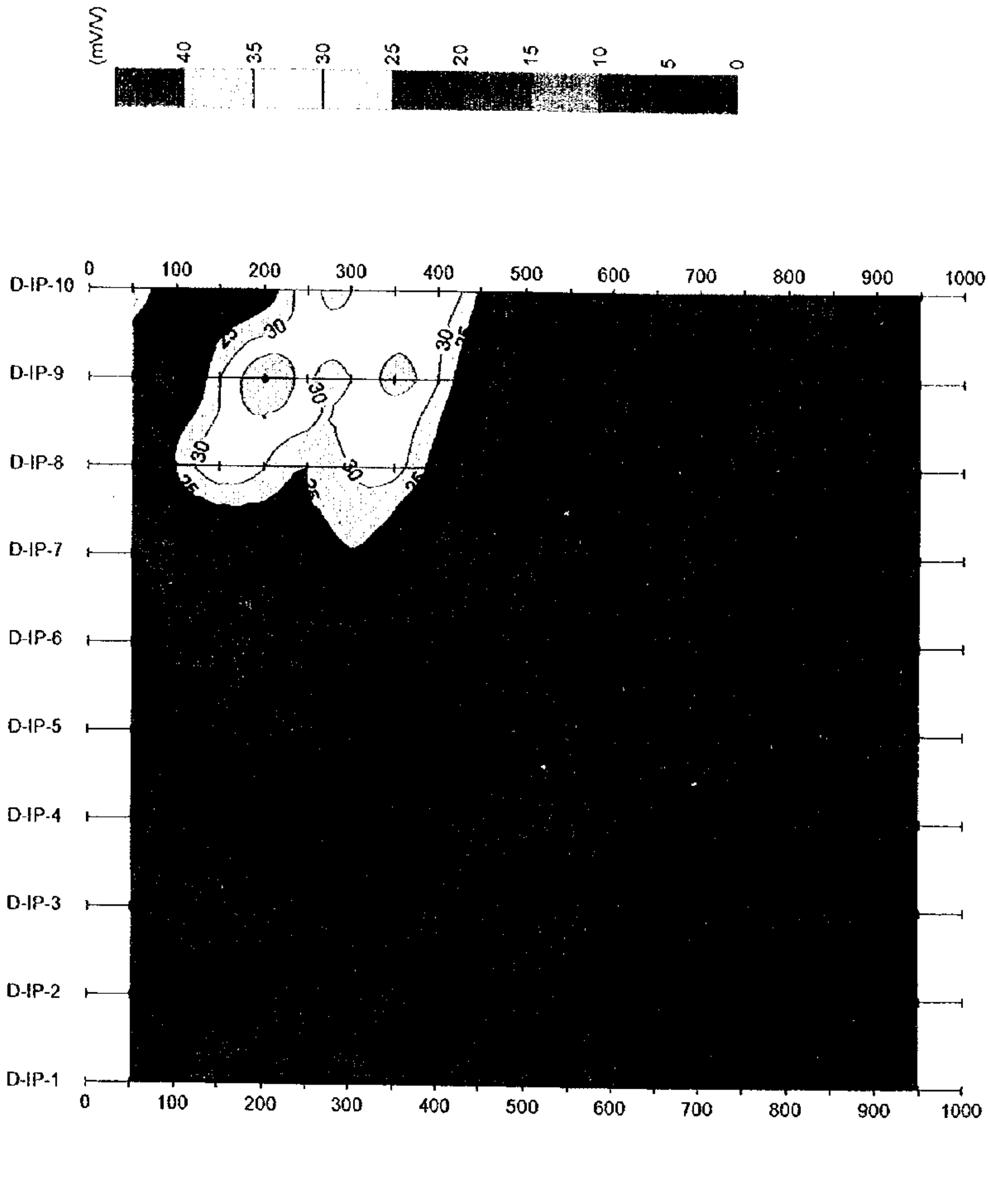


Fig. 2-41 Chargeability Map in the Da Mai Area (SL 200m)

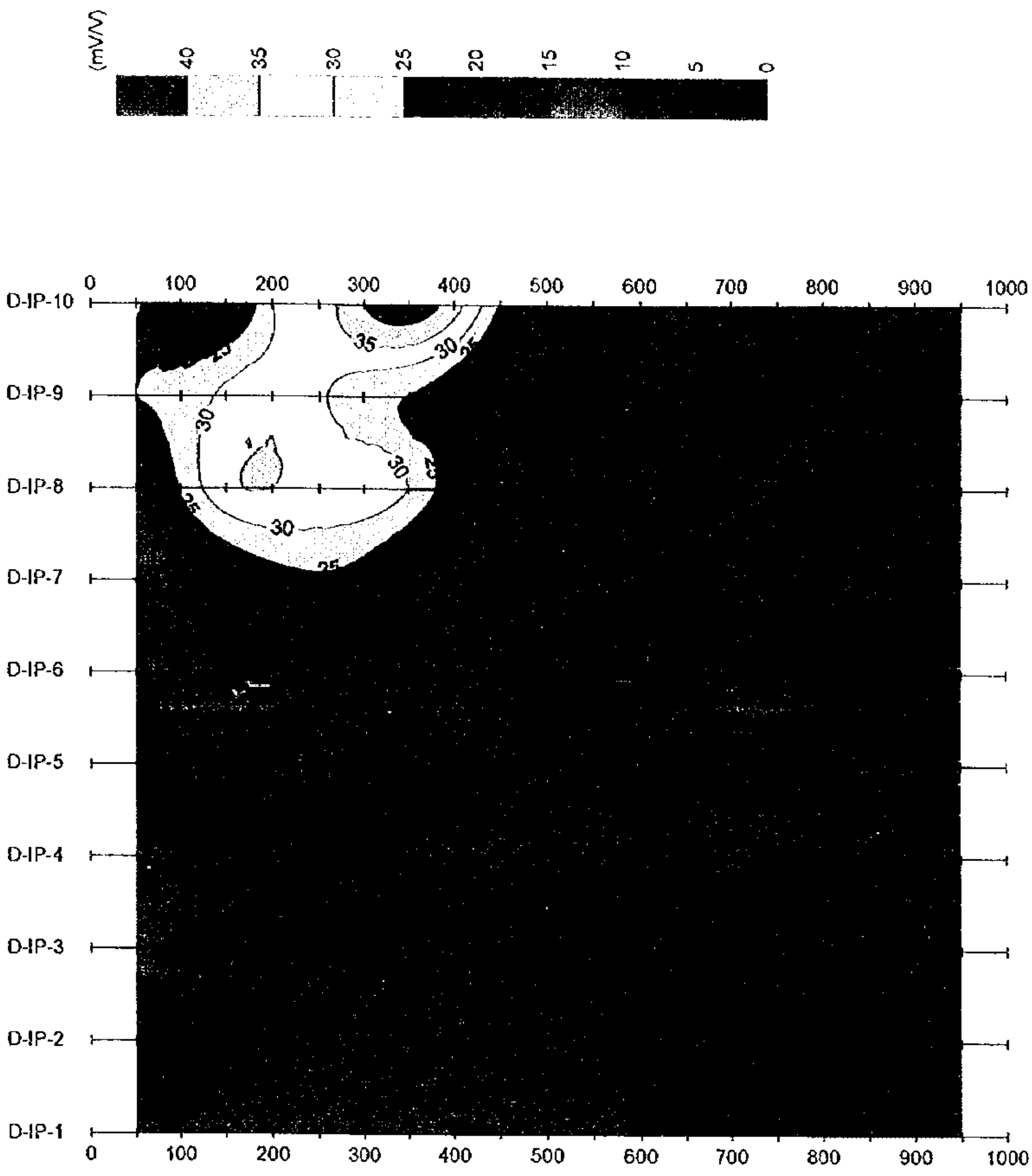


Fig. 2-42 Chargeability Map in the Da Mai Area (SL 150m)