PART II DETAILED DISCUSSIONS

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CHAPTER 1 GEOLOGICAL SURVEY AND GEOCHEMICAL SURVEY

1 - 1 Ground Truth Survey

Ground truth survey was carried out in the following localities. These are within the area selected, during the first year of this project, as promising for porphyry copper mineralization.

First year ground truth: Mocha-Soledad, Queen Elizabeth, Diana, La Planada.

Second year ground truth: Chacarilla, West Queen Elizabeth, Tignamar.

The results of the above ground truth surveys are reported below. The results of K-Ar age determination, thin section microscopy, polished section microscopy, X-ray diffraction analysis, fluid inclusion measurements, ore assay, and analysis for rock geochemical survey are listed in the Appendix.

The threshold values for geochemical anomalies were determined as follows. A total of 288 samples including rock geochemical and ore assay samples of the seven localities where ground truth was carried out were processed. And the inflection points of the cumulative frequency distribution were taken as the threshold values and were divided into 5~7 steps. The fundamental statistic of each area is shown in Table 2-1-1. Also contents below the limit of detection were treated as half of the detection limit for statistical purposes.

1-1-1 Mocha-Soledad district

The sampling localities are shown in Figure 2-1-1, geological map in Figure 2-1-2, schematic geological section in Figure 2-1-3, location of mineral showings in Figure 2-1-4, alteration mineral distribution in Figure 2-1-5, and rock geochemical anomaly distribution in Figure 2-1-6.

The geology of this district consists of Lower Cretaceous System, The Upper Tertiary System, and Quaternary System.

The Lower Cretaceous System consists of rhyolitic to andesitic lava and pyroclastics and these are intruded by intrusive bodies. The intrusive bodies are composed of quartz diorite, granodiorite, and quartz porphyry, and the latter two rocks intrude the former rock. In this study, Cretaceous was adopted as the age of the quartz diorite intrusion following the data of

Table 2-1-1 Basic Static Value of Rock Samples in the Ground Truth Area

Mocha-Soledad	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	1069	22	69	11	56	10	0.008	34	1.1
Median	142	10	67	6	58	10	0.005	12	0.8
Standard deviation	3081	27	56	16	25	0	0.010	69	1.3
Minimum	13	3	8	1	10	10	0.005	3	0.3
Maximum	16260	139	219	70	93	10	0.053	305	6.8
Number of sample	28	28	28	28	25	25	25	28	28

Queen Elizabeth	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	2913	800	51	25	97	20	0.107	11	6.9
Median	23	30	22	7	73	10	0.014	3	0.2
Standard deviation	10592	5855	87	67	80	72	0.395	38	40.5
Minimum	1	5	3	1	30	10	0.005	3	0.1
Maximum	62830	46517	630	446	430	536	2.081	290	313.5
Number of sample	63	63	63	63	54	54	54	63	63

Diana	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	105	22	29	14	95	17	0.038	38	0.2
Median	65	9	21	7	85	10	0.016	3	0.2
Standard deviation	152	37	28	16	65	37	0.094	84	0.2
Minimum	12	1	3	1	31	10	0.005	3	0.0
Maximum	870	154	136	70	455	253	0.556	417	1.2
Number of sample	44	44	44	44	43	43	43	44	44

La Planada	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	9603	29	59	182	119	13	0.005	16	0.9
Median	1074	31	47	89	89	10	0.005	12	0.5
Standard deviation	18730	24	60	394	91	11	0.010	16	0.8
Minimum	123	1	3	10	55	10	0.000	3	0.1
Maximum	62210	86	214	1951	433	52	0.040	71	3.1
Number of sample	23	23	23	23	15	15	15	23	23

Chacarilla	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	25	7	48	6	34	10	0.064	8	0.2
Median	13	1	10	5	12	10	0.008	3	0.1
Standard deviation	39	15	145	4	55	0	0.219	18	0.2
Minimum	3	1	1	1	2	10	0.005	3	0.1
Maximum	187	67	783	18	203	10	1.210	102	1.0
Number of sample	30	30	30	30	30	30	30	30	30

West Queen Elizabeth	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	686	12	48	6	23	10	0.018	10	0.3
Median	18	6	22	5	13	10	0.005	3	0.1
Standard deviation	4661	22	100	6	40	0	0.043	23	1.0
Minimum	5	1	1	1	1	10	0.005	3	0.1
Maximum	35992	151	665	36	250	10	0.219	161	5.9
Number of sample	60	60	60	60	59	59	59	60	60

Northern Tignamar	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	72	24	42	3	56	26	0.332	5	0.6
Median	70	11	13	4	17	10	0.009	4	0.2
Standard deviation	54	52	105	2	140	43	0.873	3	0.9
Minimum	10	1	1	1	5	10	0.005	3	0.1
Maximum	182	204	403	9	540	164	3.077	11	3.6
Number of sample	14	14	14	14	14	14	14	14	14

Southern Tignamar	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	Sb (ppm)	Hg (ppm)	Au (ppb)	Ag (ppm)
Average	20	38	23	3	56	10	0.453	4	0.1
Median	14	9	6	3	25	10	0.208	3	0.1
Standard deviation	17	94	35	2	75	0	0.943	2	0.1
Minimum	3	1	1	1	3	10	0.005	3	0.1
Maximum	67	434	152	9	272	10	4.899	9	0.4
Number of sample	26	26	26	26	26	26	26	26	26

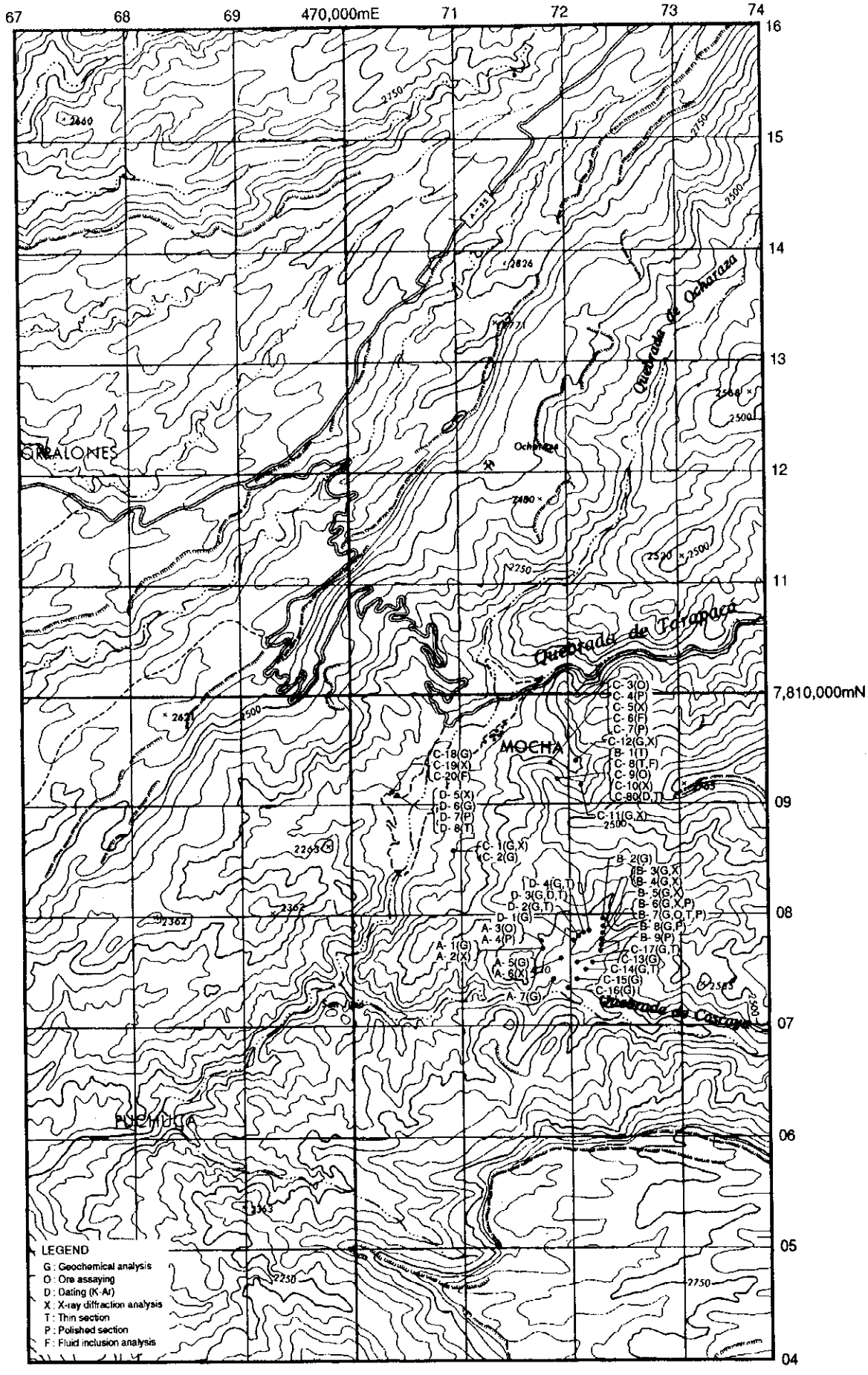


Fig.2-1-1 Sample Location Map of the Mohca-Soledad Area

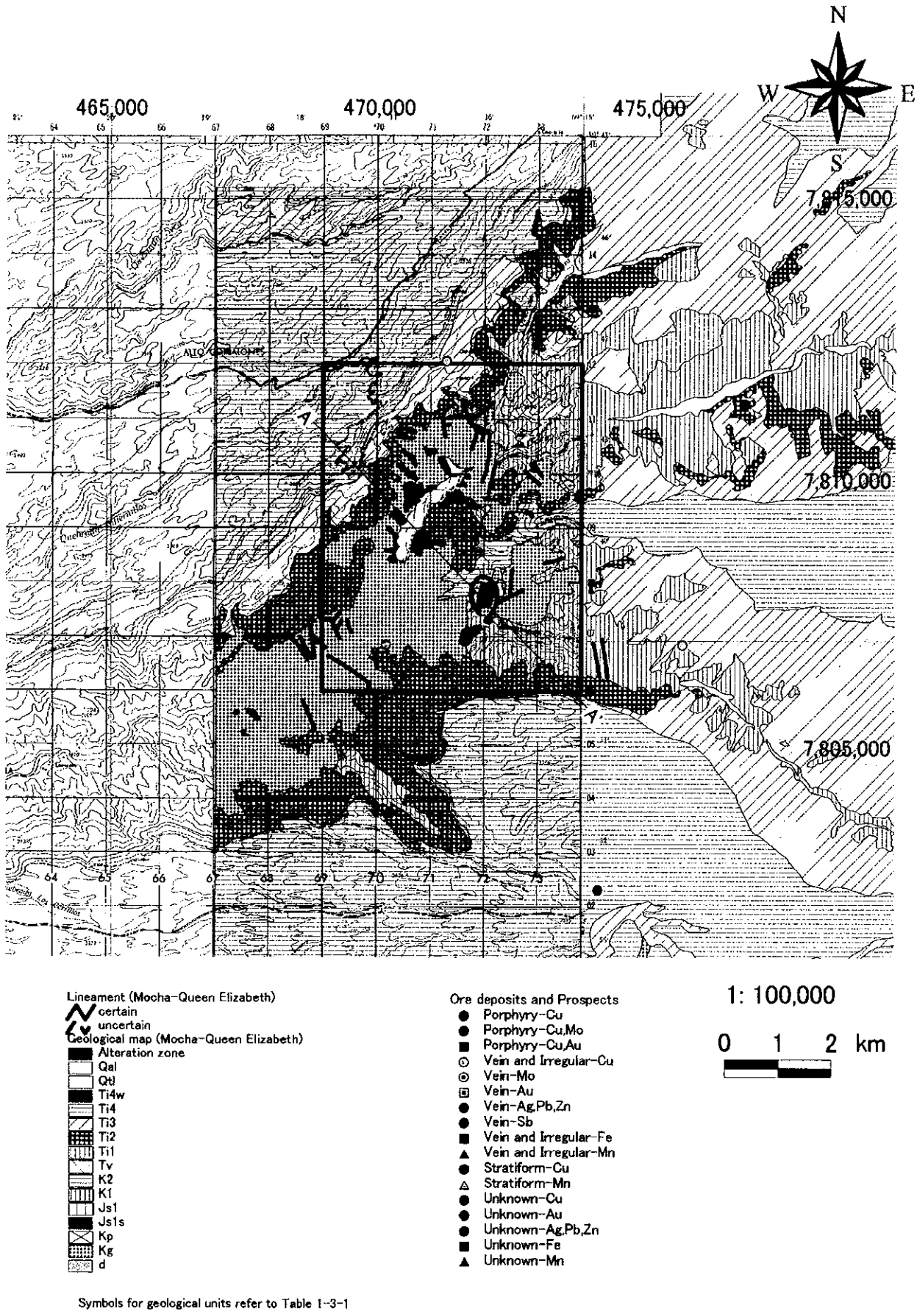
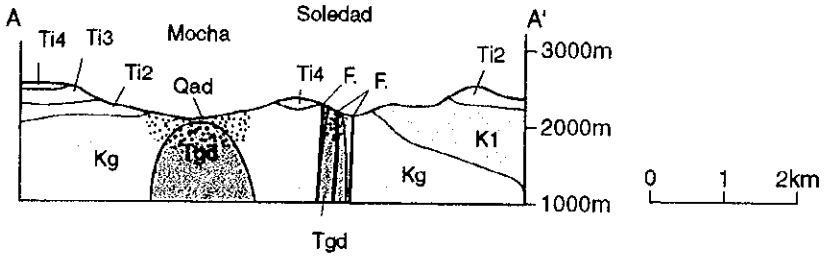


Fig. 2-1-2 Geological Map of the Mocha - Soledad Area

Mocha - Soledad



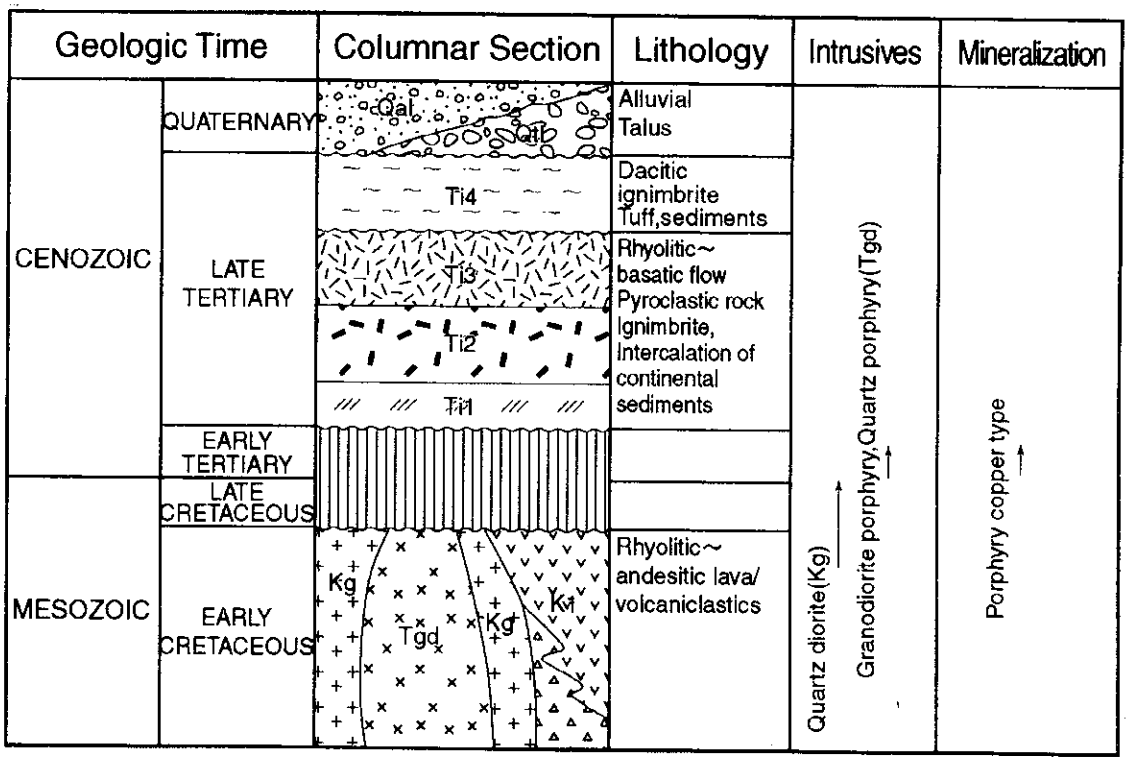


Fig.2-1-3 Schematic Stratigraphic Columns and Profiles of the Mocha - Soledad Area

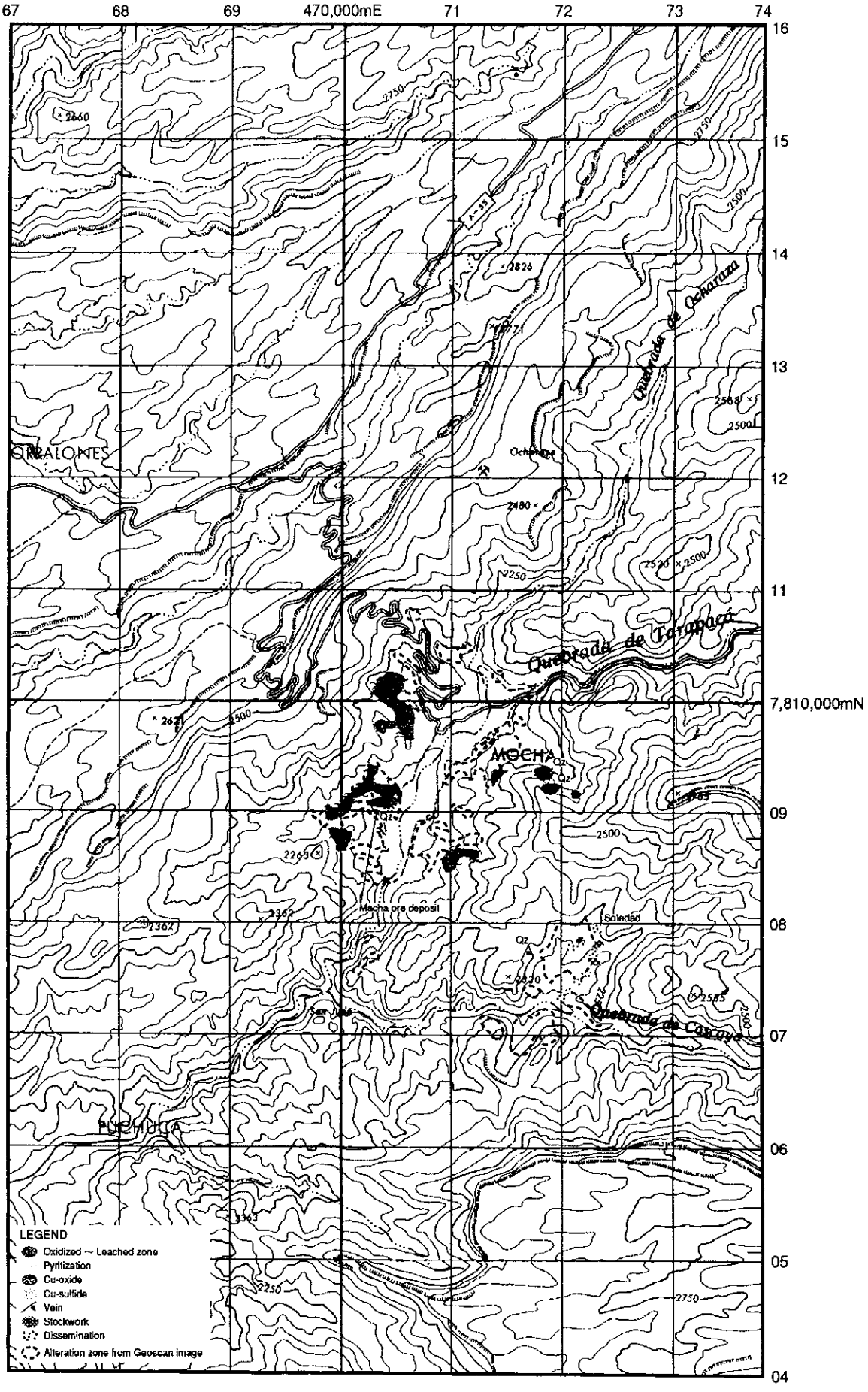


Fig.2-1-4 Mineralization Map of the Mohca-Soledad Area

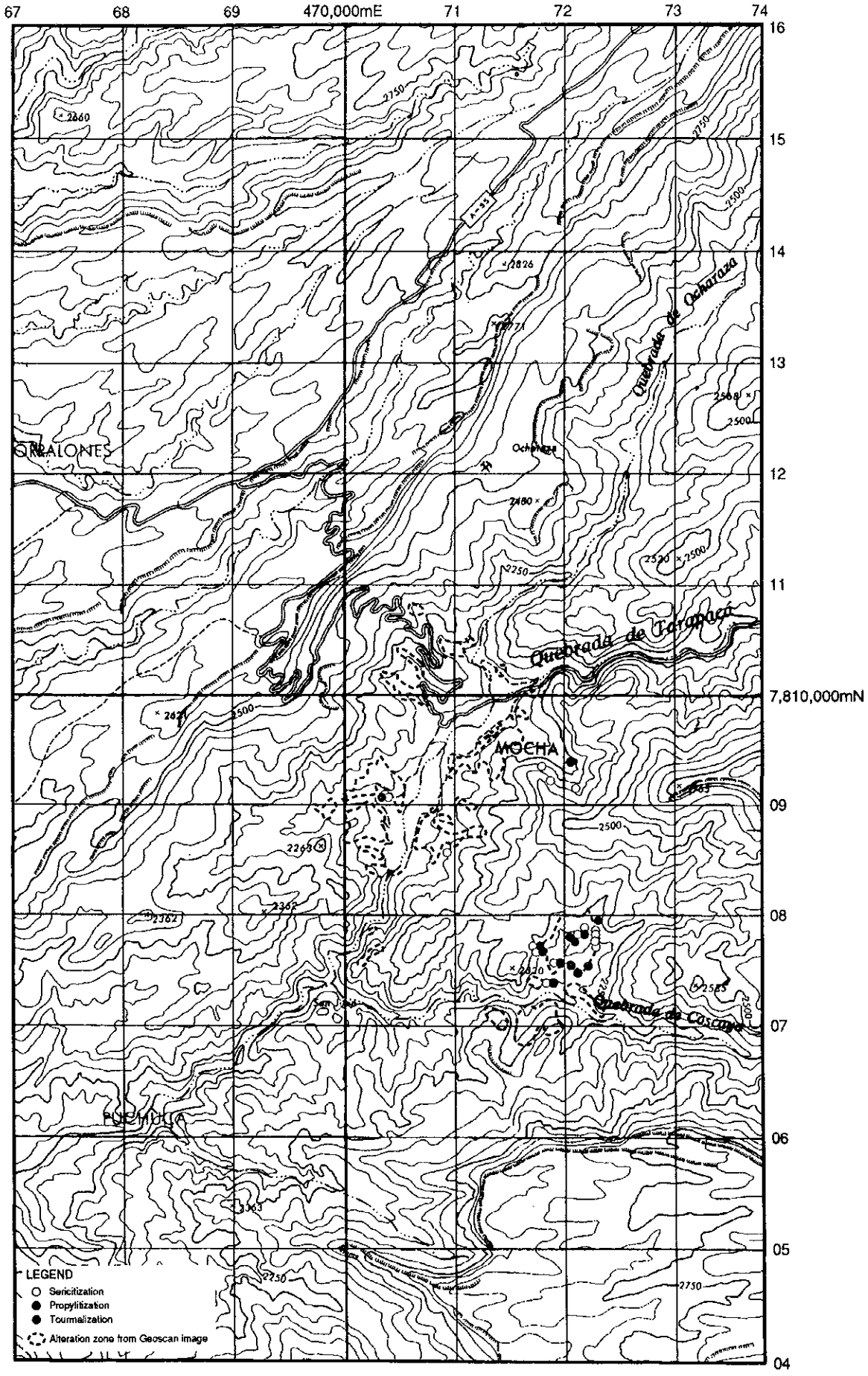


Fig.2-1-5 Distribution Map of Alteration Minerals at the Mohca-Soledad Area

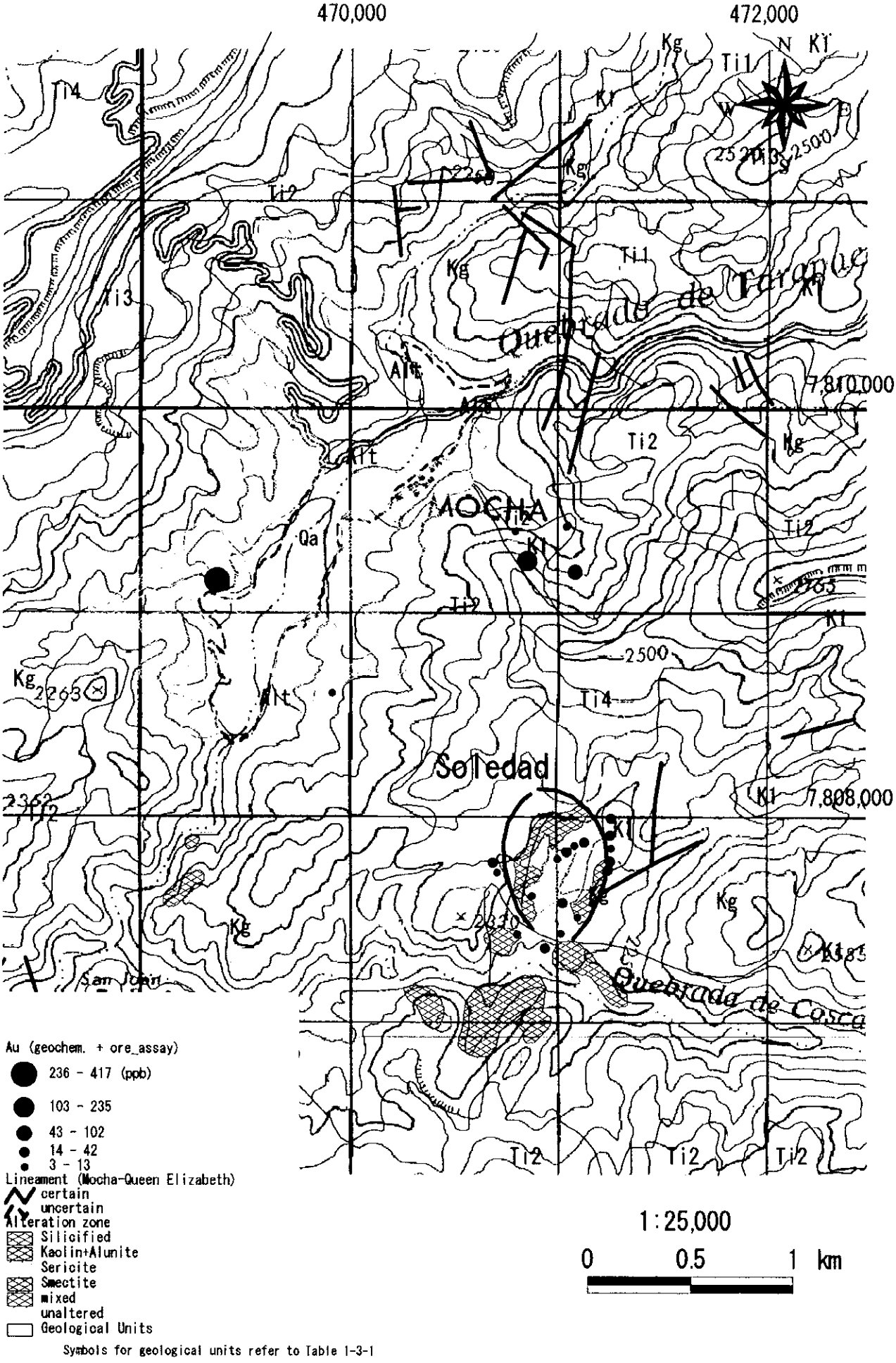


Fig. 2-1-6 (1) Geochemical Anomaly Map in the Mocha – Soledad Area (Au)

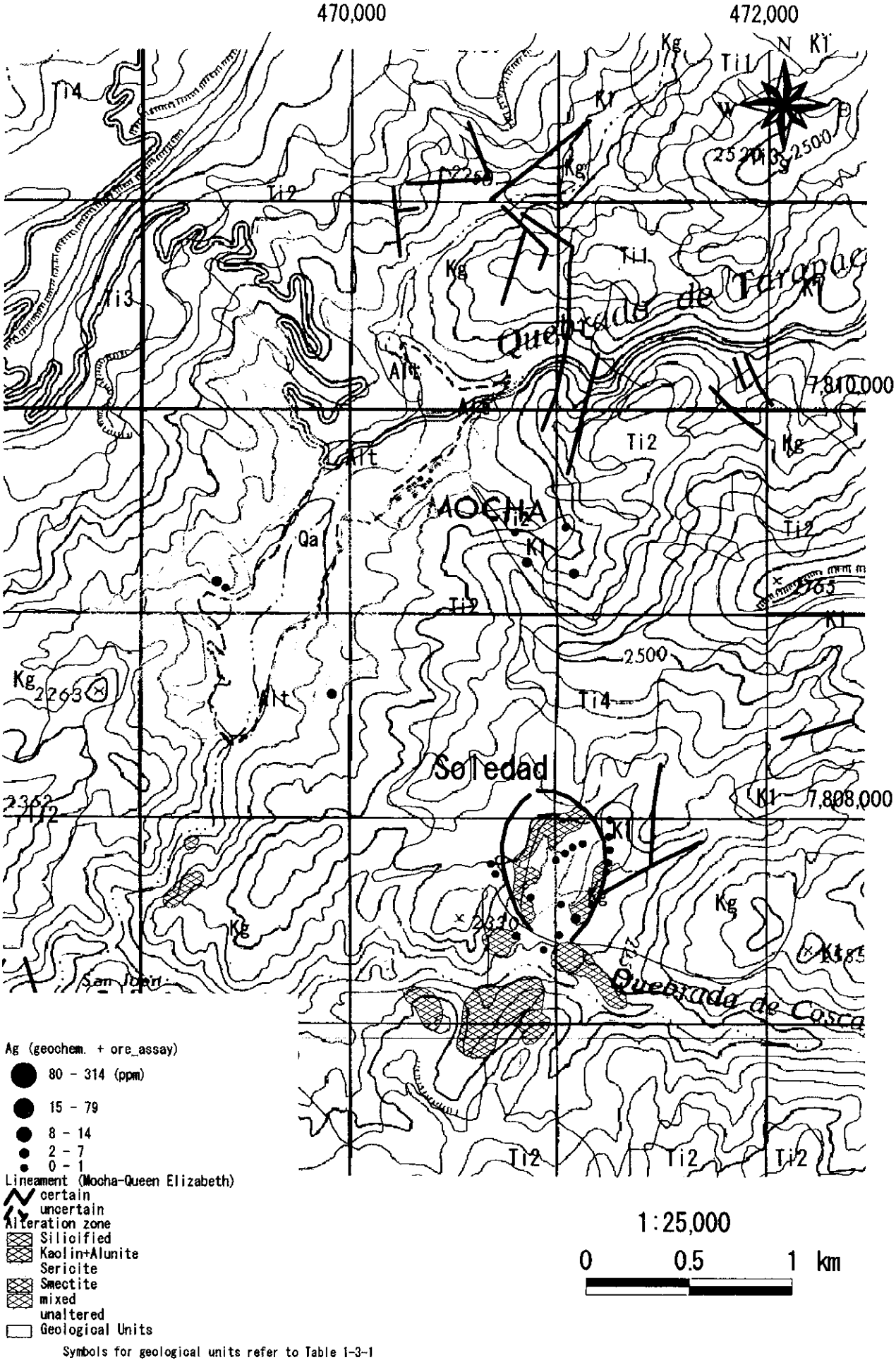


Fig. 2-1-6 (2) Geochemical Anomaly Map in the Mocha – Soledad Area (Ag)

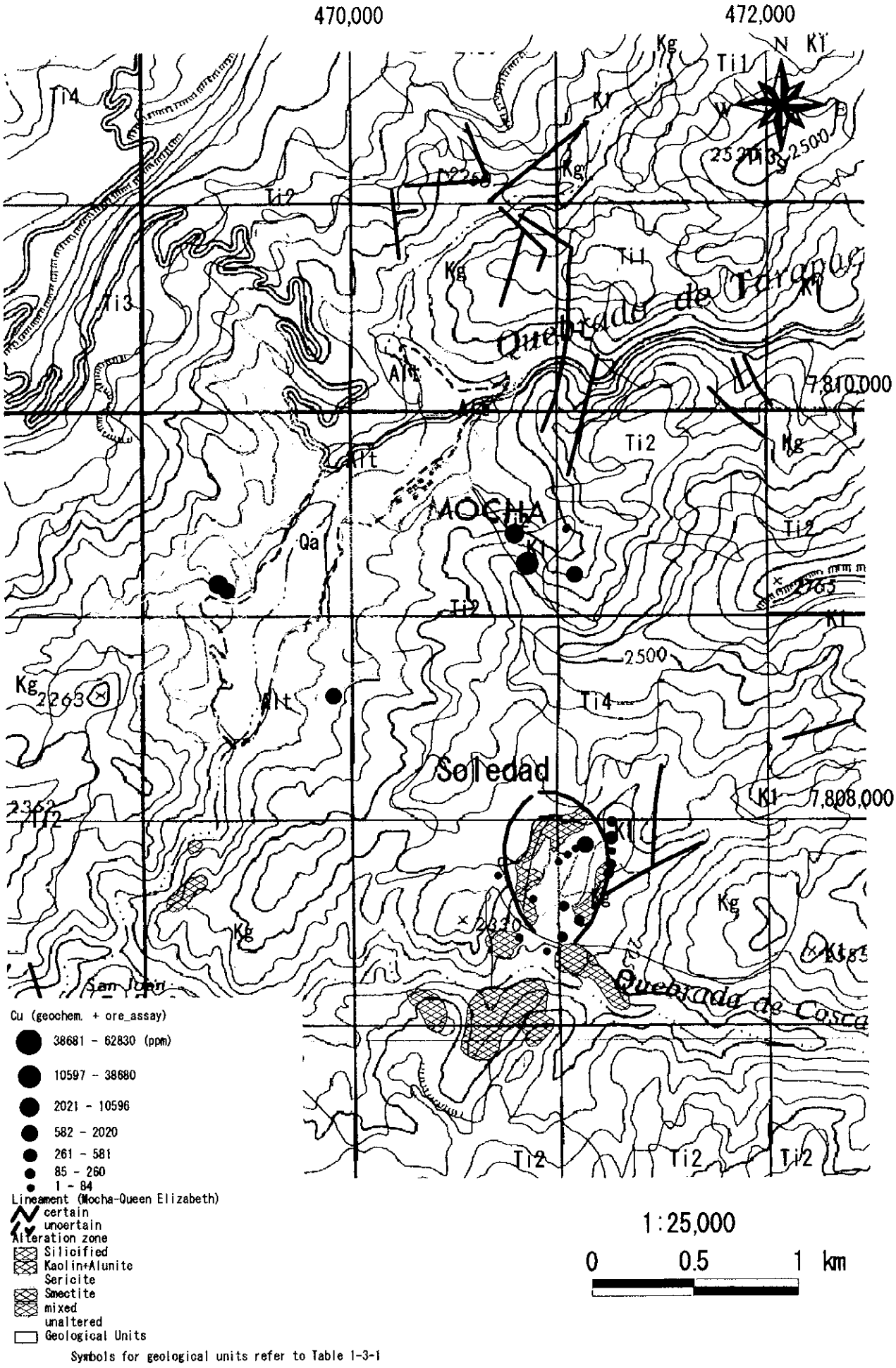


Fig. 2-1-6 (3) Geochemical Anomaly Map in the Mocha – Soledad Area (Cu)

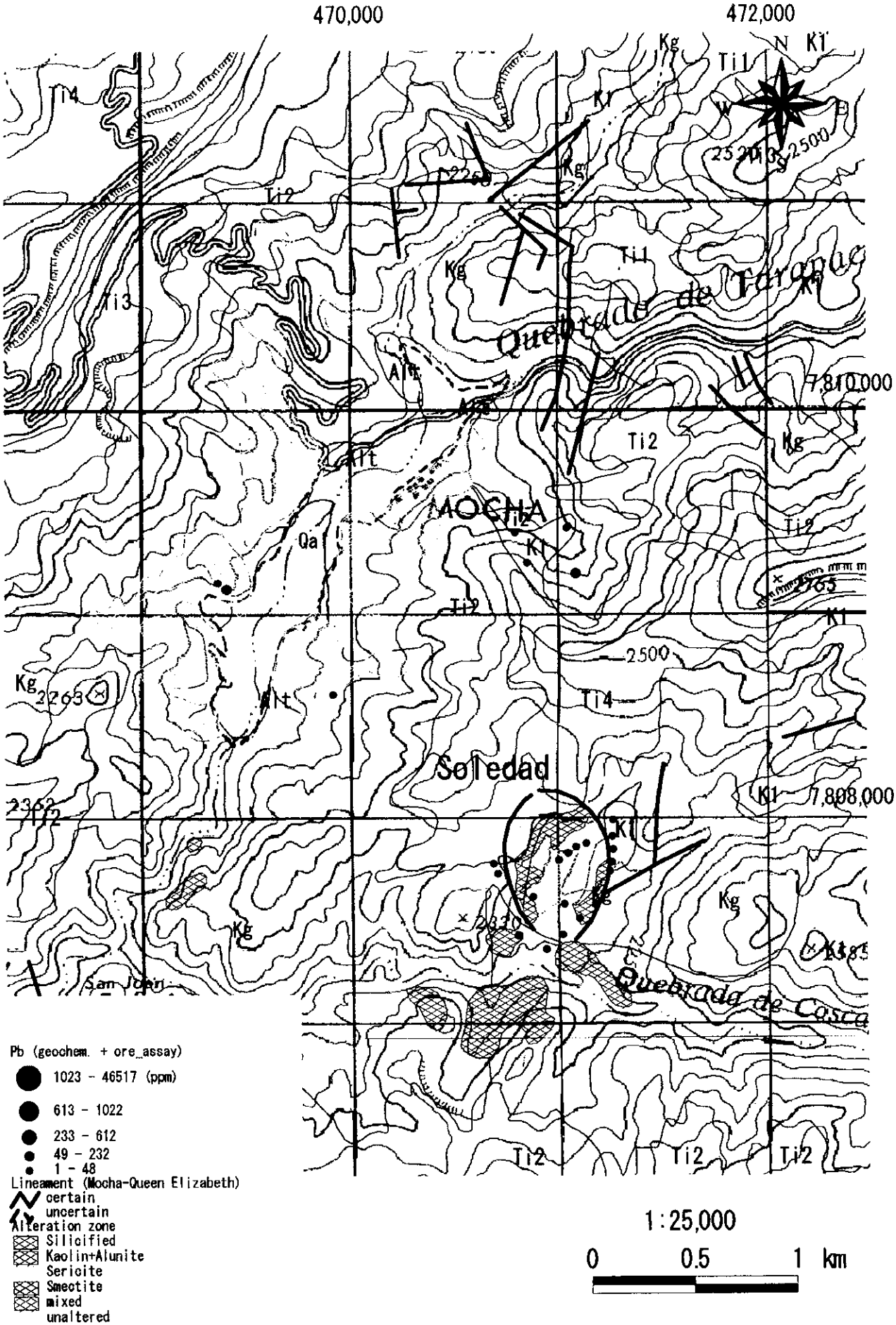


Fig. 2-1-6 (4) Geochemical Anomaly Map in the Mocha - Soledad Area (Pb)

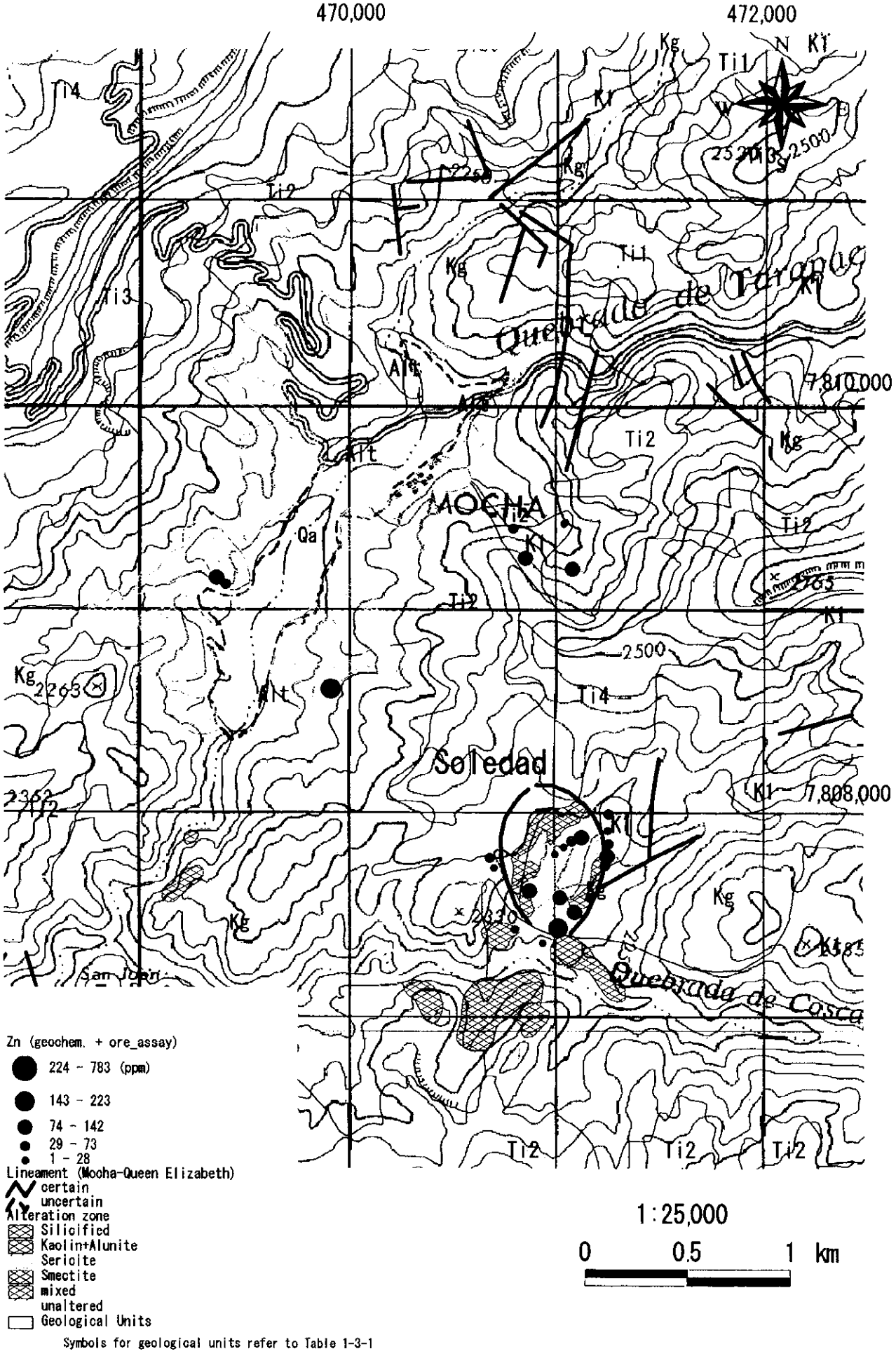


Fig. 2-1-6 (5) Geochemical Anomaly Map in the Mocha – Soledad Area (Zn)

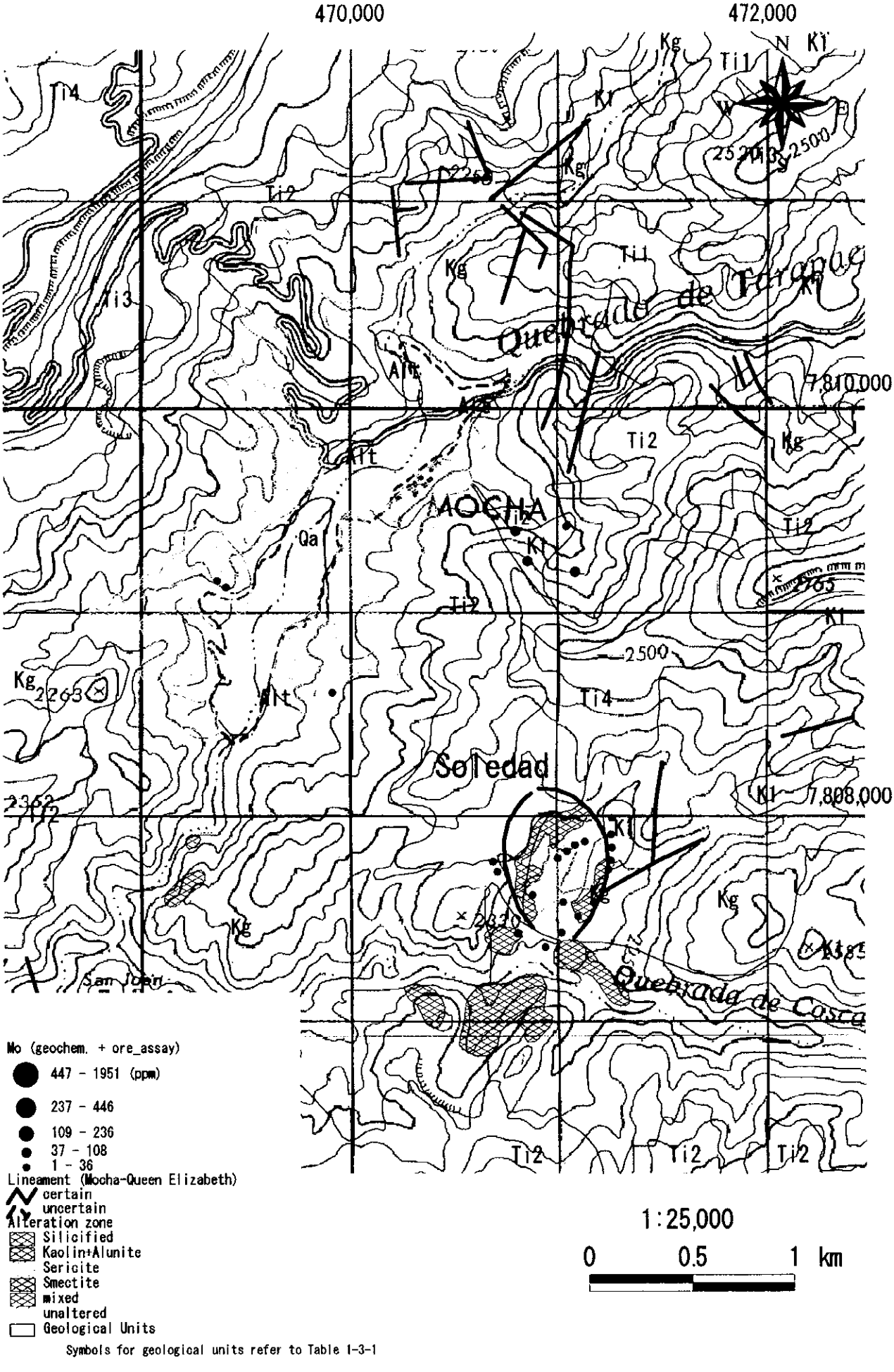


Fig. 2-1-6 (6) Geochemical Anomaly Map in the Mocha – Soledad Area (Mo)

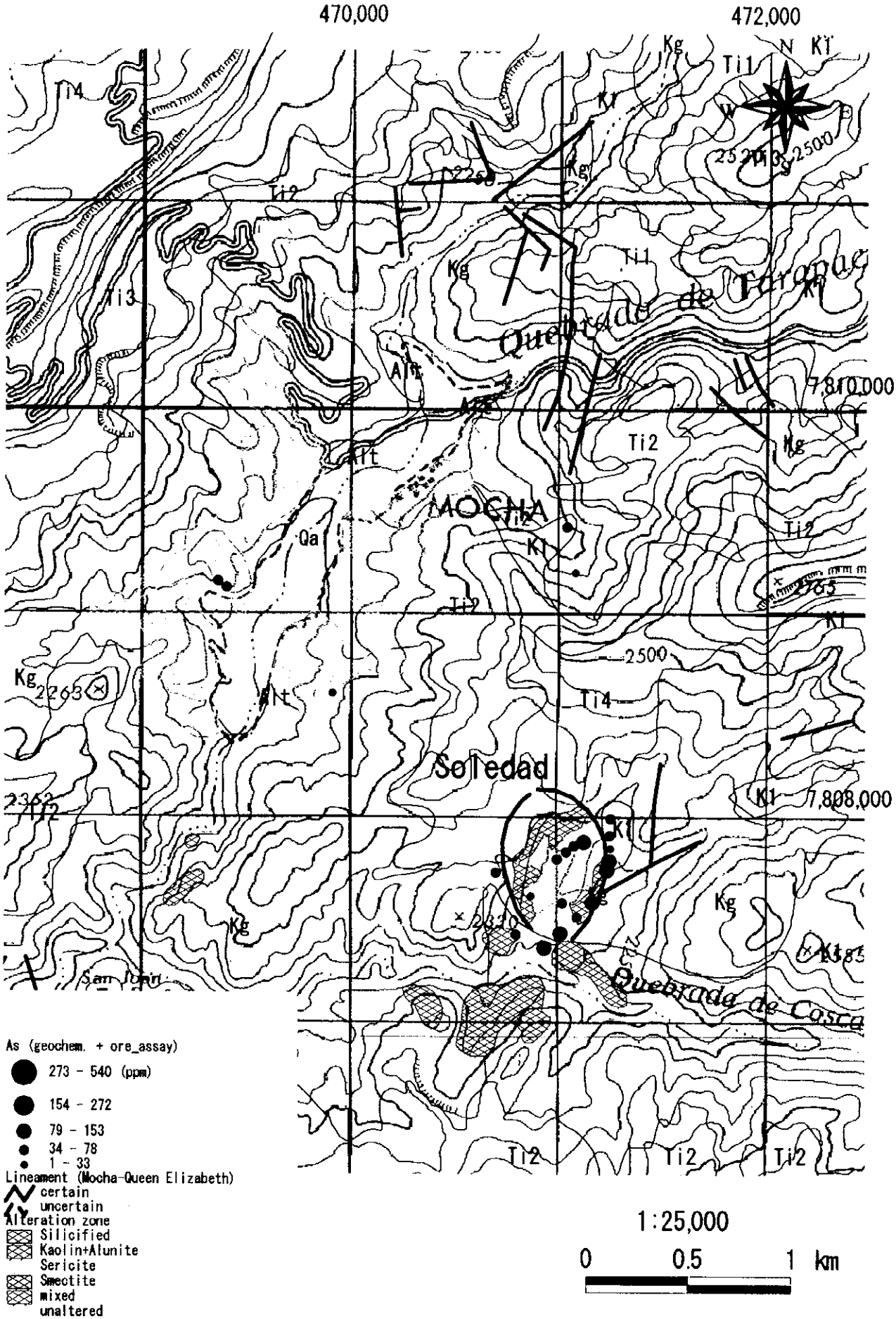


Fig. 2-1-6 (7) Geochemical Anomaly Map in the Mocha – Soledad Area (As)

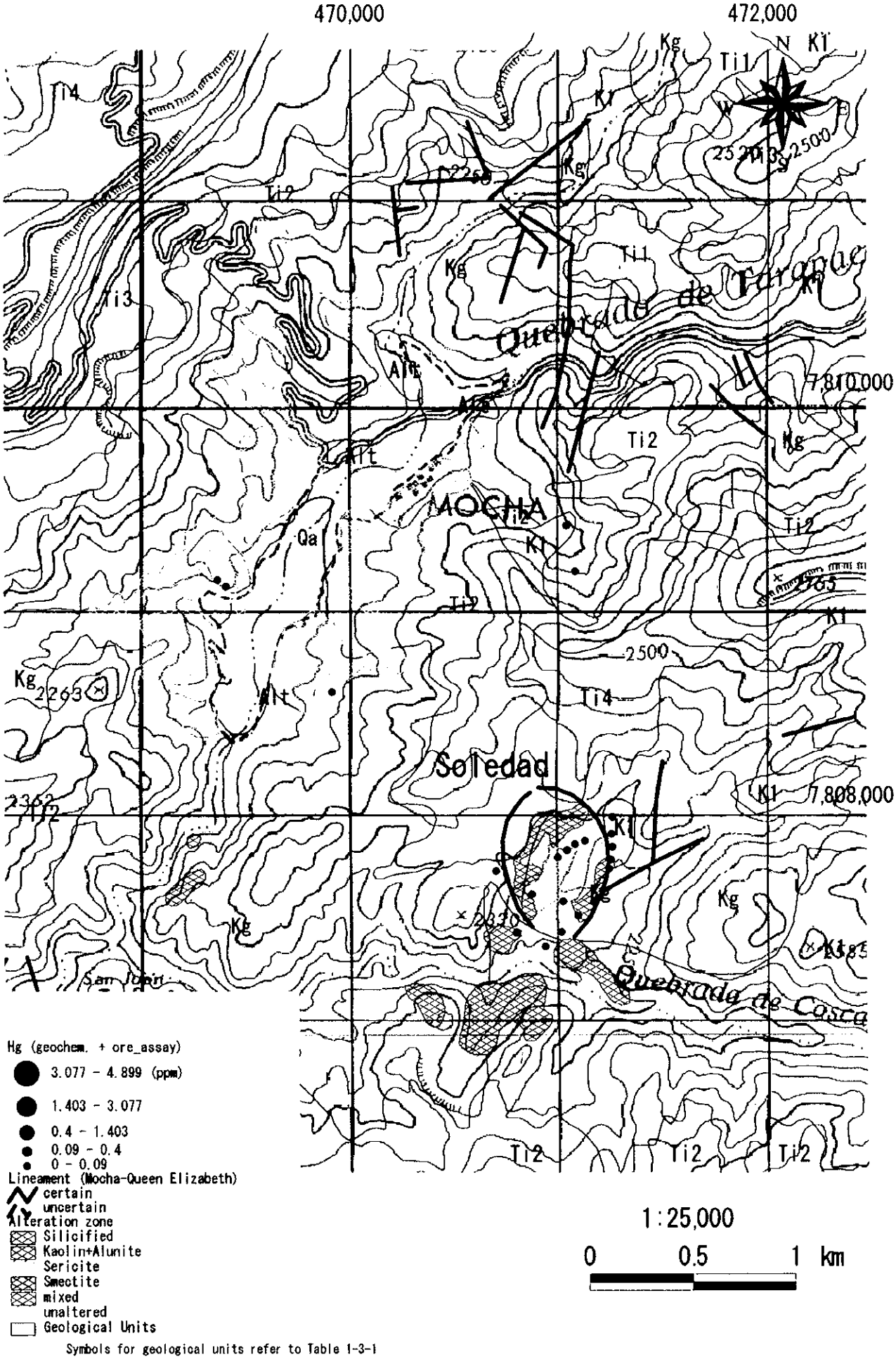


Fig. 2-1-6 (8) Geochemical Anomaly Map in the Mocha – Soledad Area (Hg)

published geological maps. But that of the granodiorite and quartz porphyry is estimated to be early Eocene from the age of the alteration associated with porphyry-type mineralization, which will be mentioned later. Both the Lower Cretaceous System and the intrusive bodies are unconformably overlain by Upper Tertiary System.

The Upper Tertiary System consists of Miocene・Pliocene rhyolitic~basaltic lava・pyroclastic rocks・ignimbrite, dacitic ignimbrite・tuff, and intercalated terrigenous sediments.

The Quaternary System consists of alluvium and talus deposits.

In the Mocha district, oxidized-leached zones consisting of limonite, hematite, jarosite and other altered minerals are widely distributed and these are directly overlain by ignimbrite. In the lower parts of the oxidized-leached zones, network quartz veinlets are developed in the sericite alteration zones in quartz porphyry host rock, and chrysocolla, atacamite, and other oxidized copper minerals as well as chalcopyrite are disseminated. In this district, secondary enrichment zone is confirmed by drilling and a reserve of about 6 million tons of Cu 0.4% ore has already been defined. Also a similar mineralized zone exists within the sericite-tourmaline alteration zone of quartz porphyry host rock in the eastern part of this district, but it has not yet been drilled.

In the Mocha district, fluid inclusions in quartz grains from the network quartz veins consist of gas-liquid two-phase inclusions and poly-phase inclusions containing solid phase. The poly-phase inclusions with daughter minerals are considered to be the primary material. The daughter minerals are NaCl, KCl, and opaque minerals including chalcopyrite. The range of average NaCl disappearance temperature is 332~399℃ and the average salinity (NaCl) ranges from 40.5 to 42.3wt%, these values are typical of porphyry copper mineralization.

In the Soledad district located on the southeastern side of the Mocha district, intrusion of granodiorite and quartz porphyry was confirmed in the central part of annular structure found by satellite remote sensing. Sericite-tourmaline alteration zone is developed in these intrusive bodies and the Cretaceous System in the vicinity. But quartz veins are few and mineralization consists mainly of pyrite dissemination with small amount of chalcopyrite. The K-Ar age of the biotite in the altered quartz porphyry is 52.1±2.0Ma.

Notable geochemical anomaly is high Au-Cu anomaly in the Mocha district and Cu-Zn-As

anomaly in the Soledad district.

1-1-2 Queen Elizabeth district

The sampling localities are shown in Figure 2-1-7, geological map in Figure 2-1-8, schematic geological section in Figure 2-1-9, location of mineral showings in Figure 2-1-10, alteration mineral distribution in Figure 2-1-11, and rock geochemical anomaly distribution in Figure 2-1-12.

The geology of this district consists of Lower Cretaceous System, Upper Tertiary-Quaternary System, and Quaternary System.

The Lower Cretaceous System consists of andesitic to dacitic lava · pyroclastics and intercalation of shale and sandstone. Intrusive bodies penetrate these units. The intrusive bodies are composed of quartz diorite, granodiorite, and quartz porphyry in the order of their age of activity. The age of the quartz diorite intrusion is considered to be Cretaceous following published geological maps, but that of the granodiorite is inferred to be middle to late Eocene from the age of the biotitization of the host rocks of the vicinity, which will be mentioned later. Both the Lower Cretaceous System and the intrusive bodies are unconformably overlain by Upper Tertiary-Quaternary System.

The Upper Tertiary-Quaternary Systems consist of Pliocene-Pleistocene andesitic to basaltic lava and pyroclastic rocks.

The Quaternary System is composed of fluvial deposits, alluvium, colluvium, lacustrine deposits, mudflow deposits, and talus deposits.

There are alteration zones in three parts of this area, namely northern, central, and southern parts. The former two occur in Cretaceous System and the latter in granodiorite · quartz porphyry and their vicinity.

The northern alteration zone is composed mainly of acidic alteration with abundant quartz accompanied by kaolin, and also small sericitic alteration occurs in this part. Quartz veins and pyrite dissemination are developed only locally.

The central alteration zone consists of sericite-tourmaline alteration, but ore minerals are

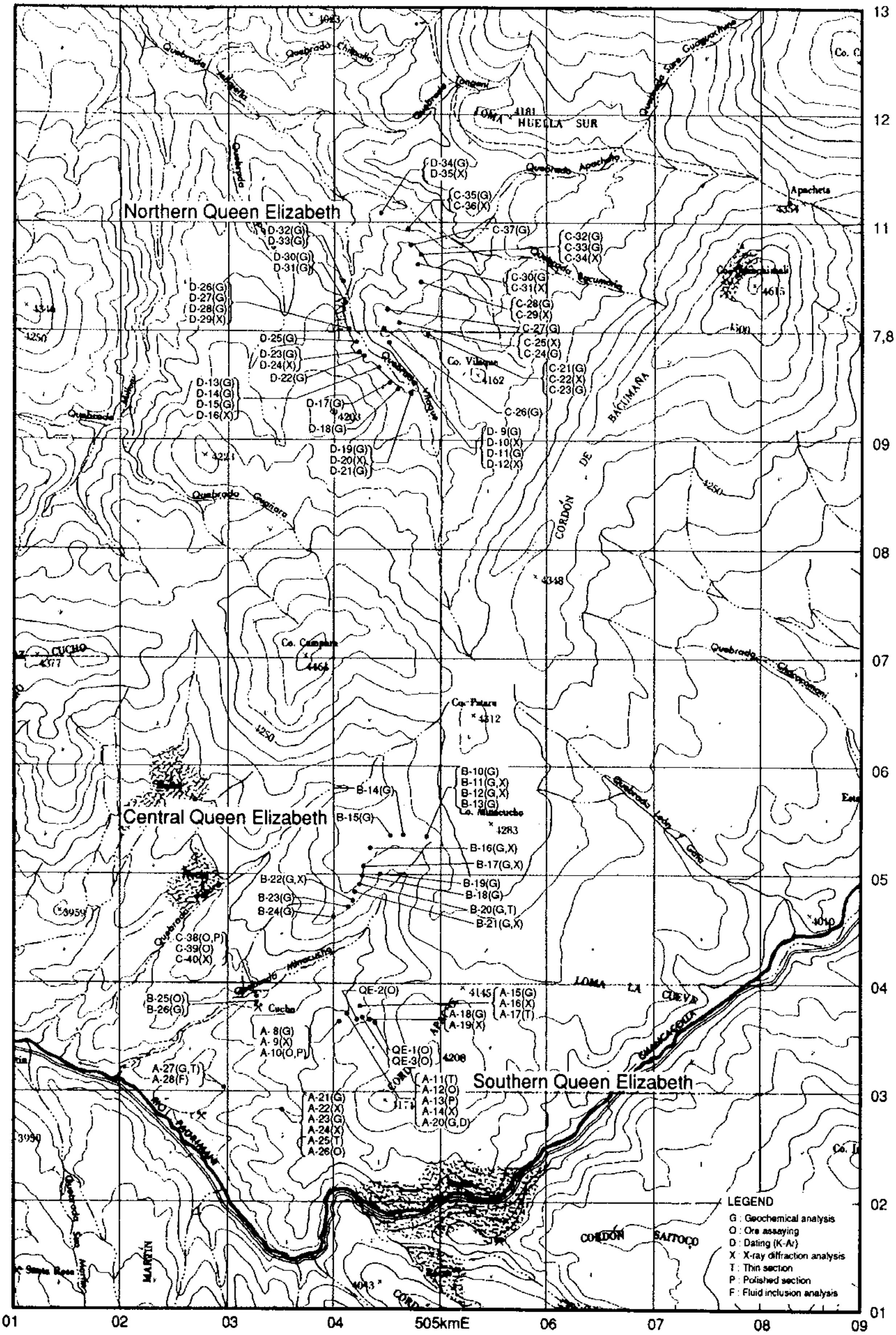
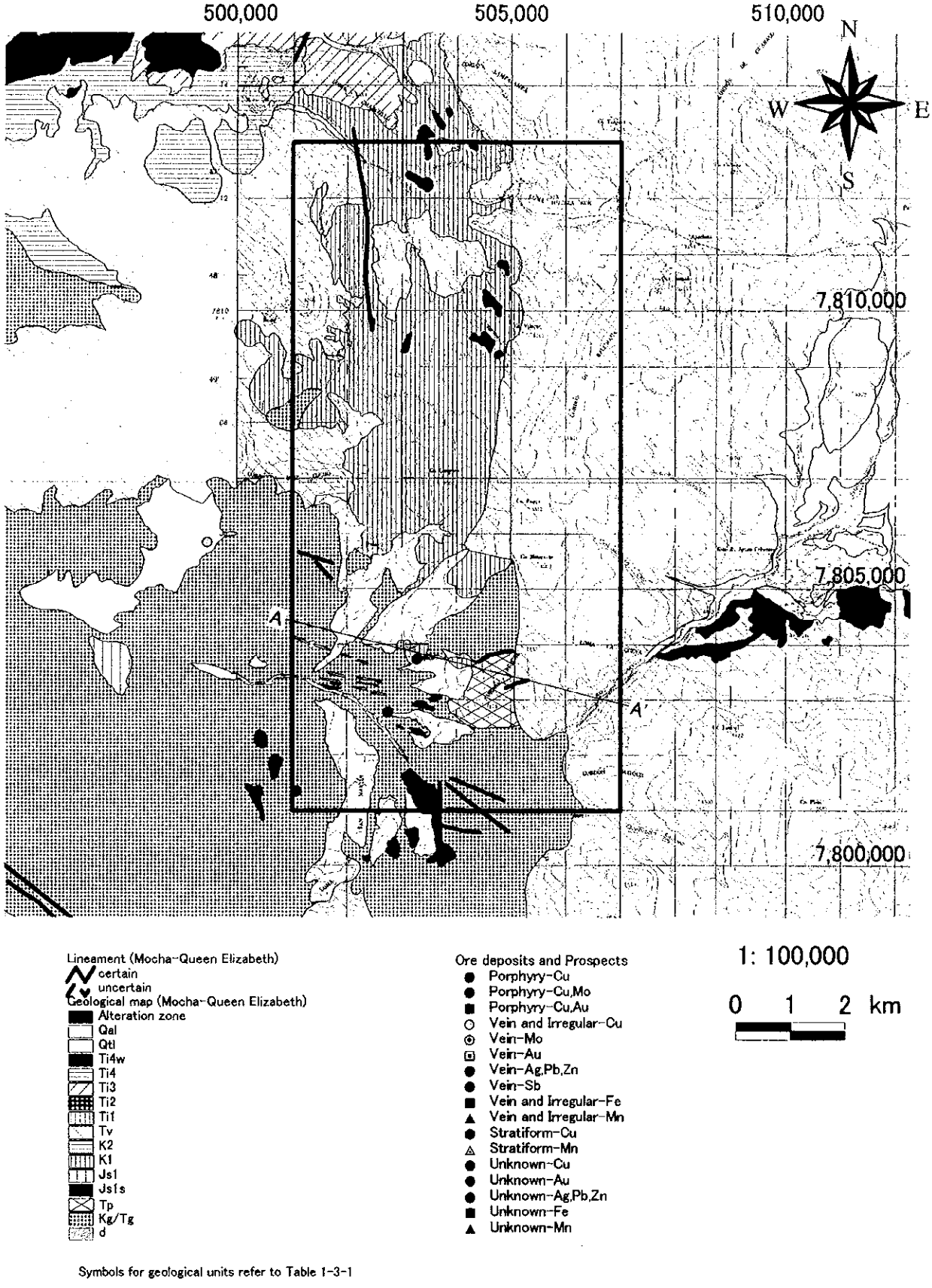


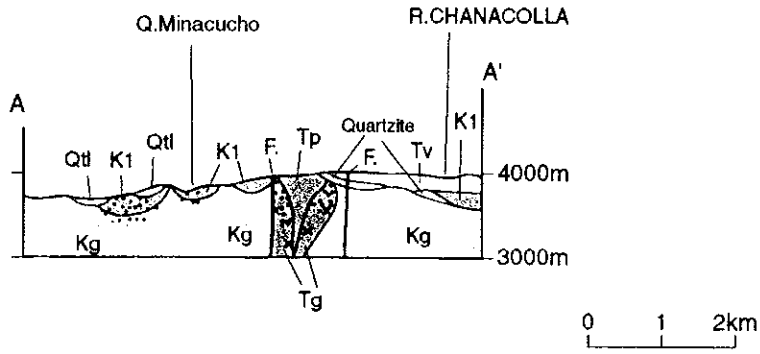
Fig.2-1-7 Sumple Location Map of the Queen Elizabeth Area



Symbols for geological units refer to Table 1-3-1

Fig. 2-1-8 Geological Map of the Queen Elizabeth Area

Queen Elizabeth



Geologic Time		Columnar Section	Lithology	Intrusives	Mineralization
CENOZOIC	QUATERNARY		Fluvial,Alluvial, Colluvial,Lacust-rine,Mudflow,Talus	Granodiorite(kg) Granodiorite porphyry(Tg) Quartz porphyry(Tp)	Porphyry copper type Epithermal type
	QUATERNARY-TERTIARY	Tv	Andestic～basaltic lava/ volcaniclastics		
	LATE-MIDDLE TERTIARY				
	EARLY TERTIARY				
MESOZOIC	LATE CRETACEOUS				
	EARLY CRETACEOUS	Tp K1 Tg Tg Kg Kg K1	Andesitic～dacitic lava/volcaniclastics Intercation of sediments (shale, sandstone)		

Fig.2-1-9 Schematic Stratigraphic Columns and Profiles of the Queen Elizabeth Area

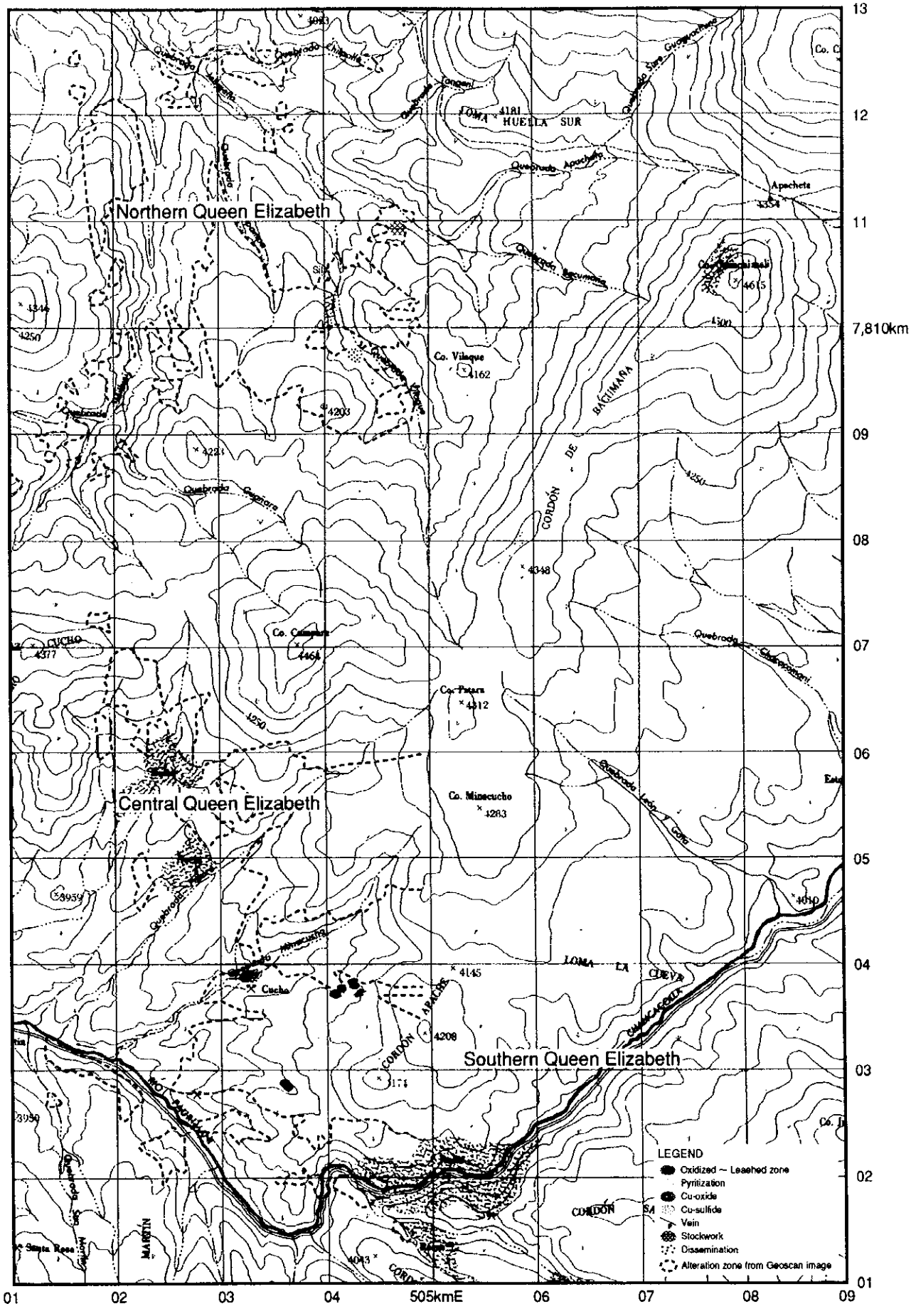


Fig.2-1-10 Mineralization Map of the Queen Elizabeth Area

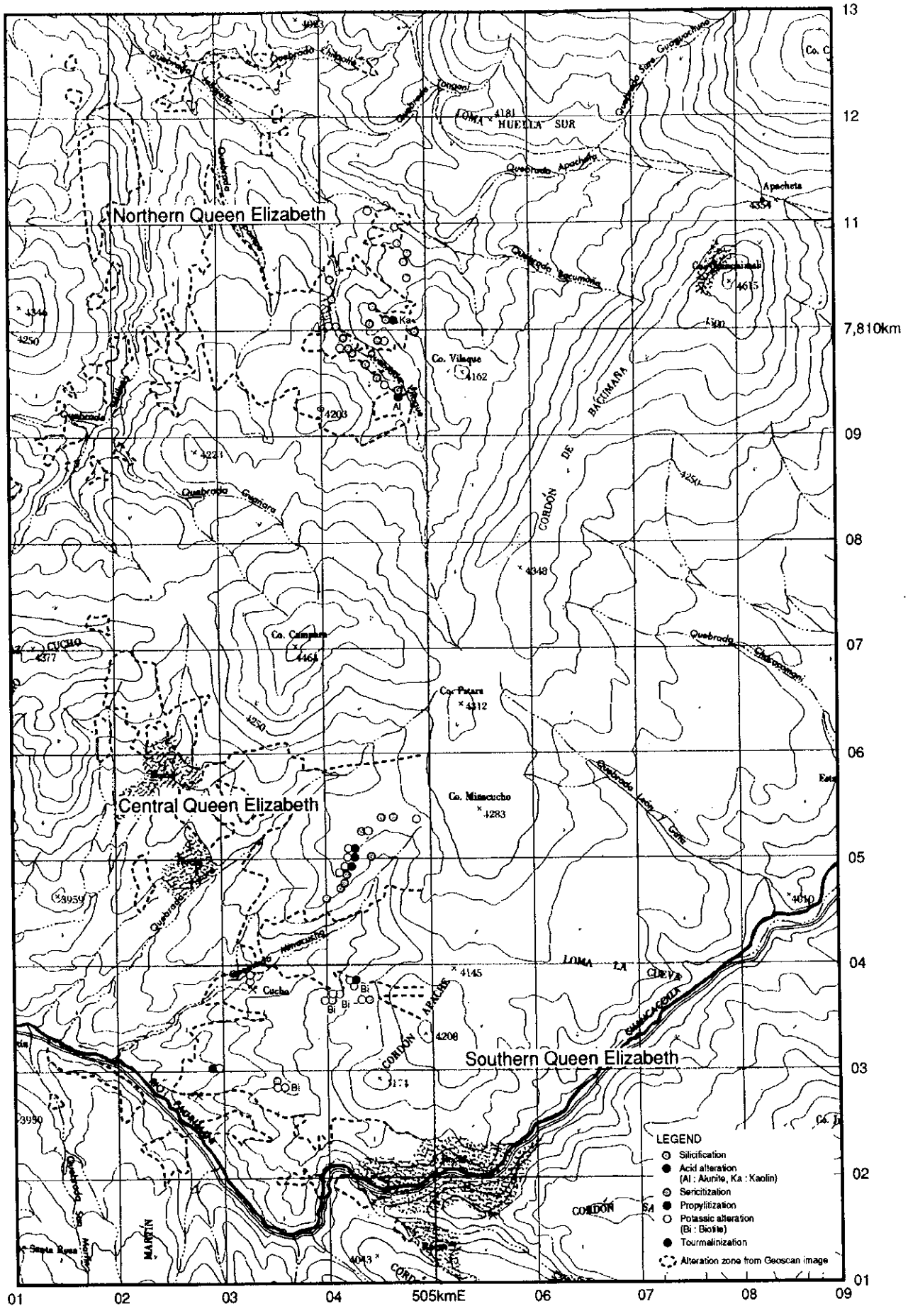


Fig.2-1-11 Distribution Map of Alteration Minerals at the Queen Elizabeth Area

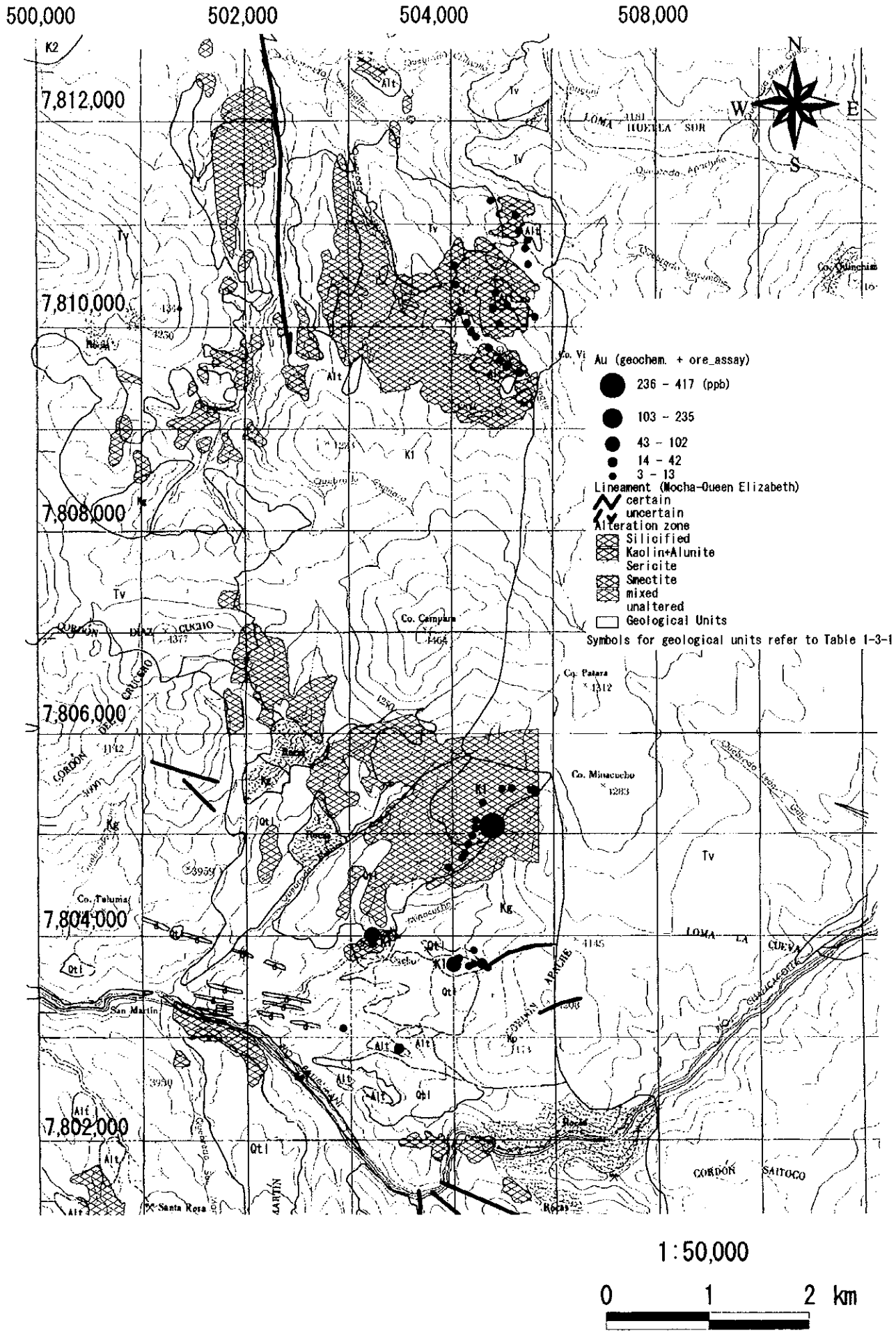


Fig. 2-1-12 (1) Geochemical Anomaly Map in the Queen Elizabeth Area (Au)

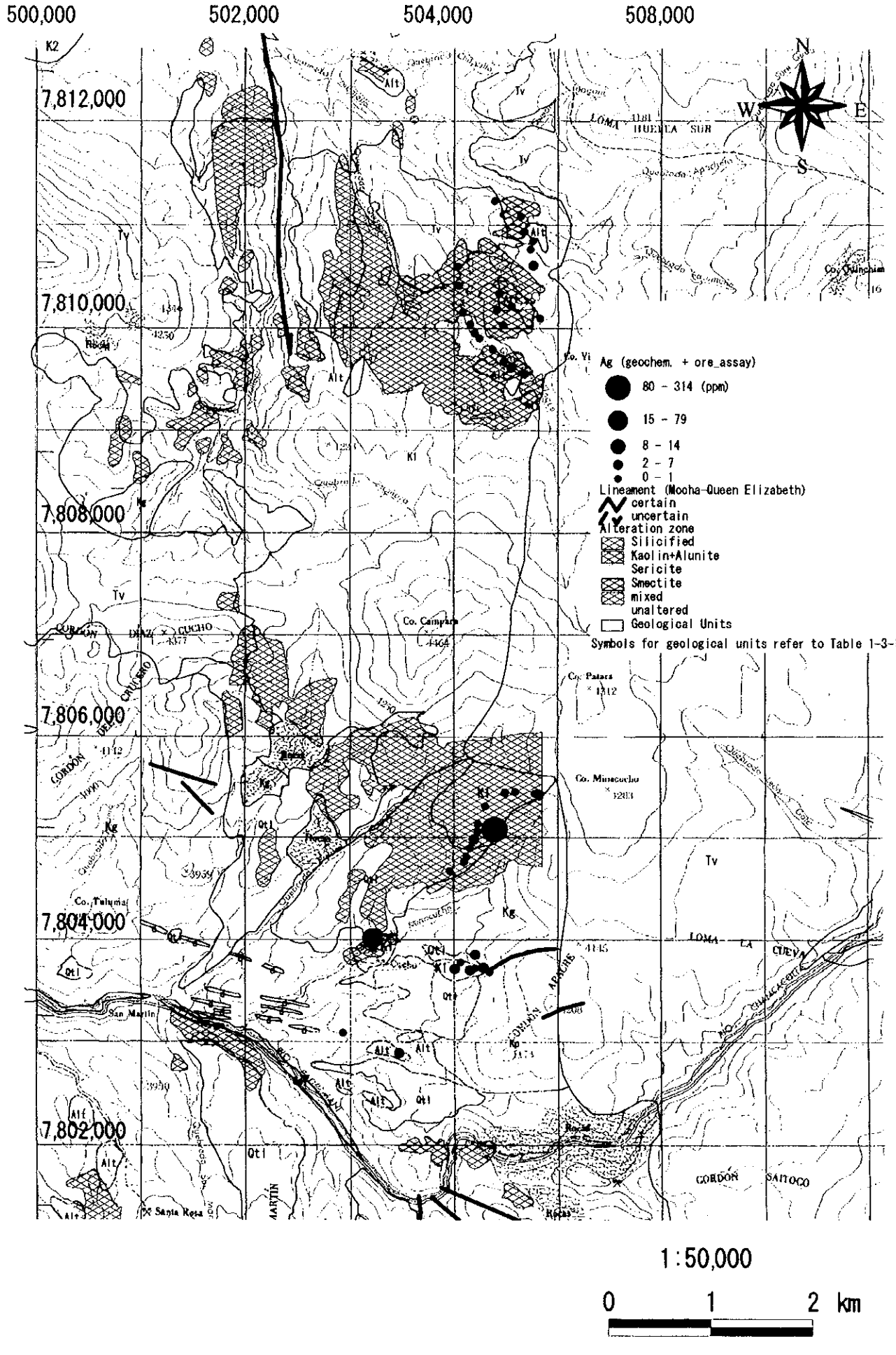


Fig. 2-1-12 (2) Geochemical Anomaly Map in the Queen Elizabeth Area (Ag)

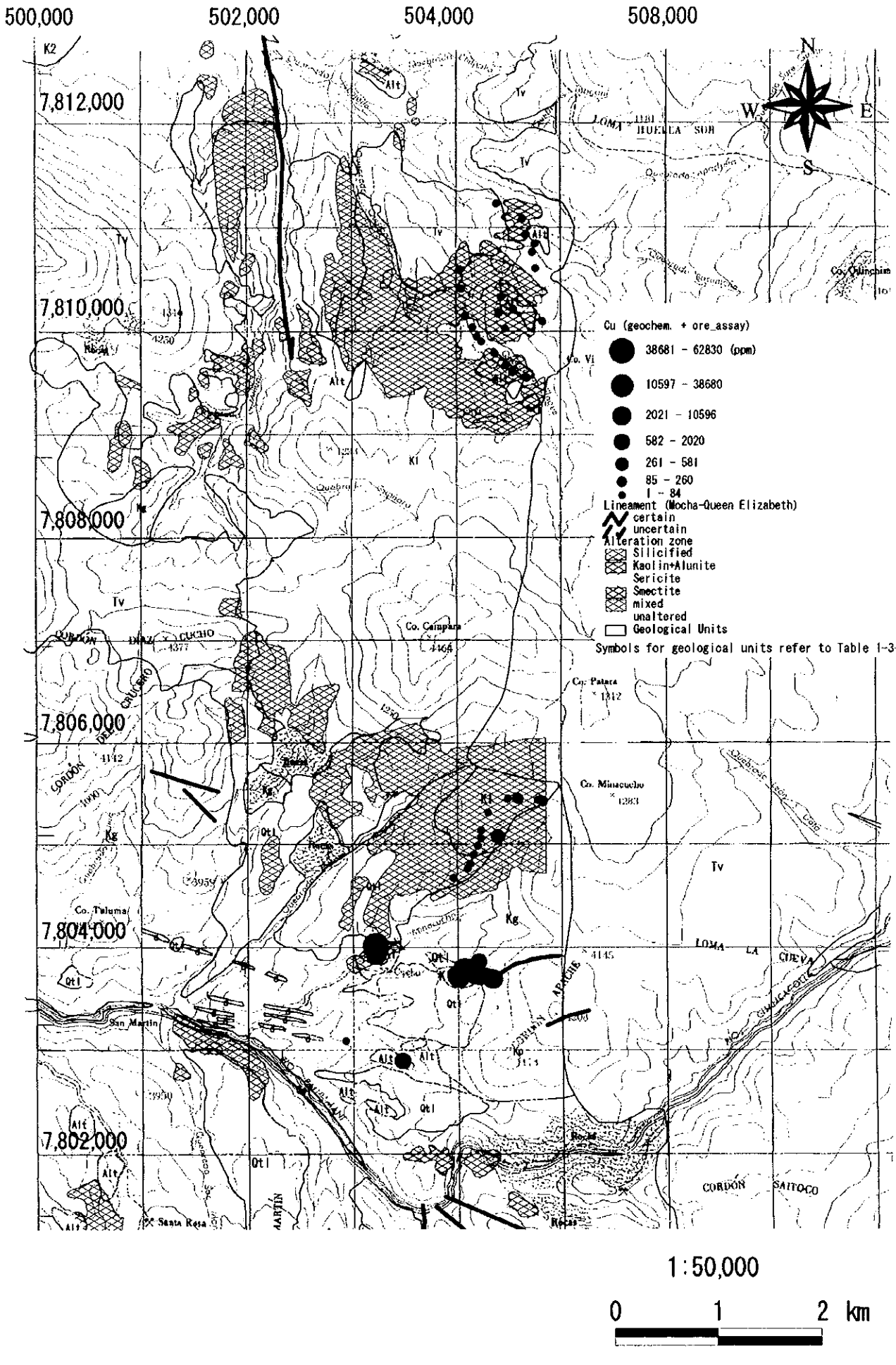


Fig. 2-1-12 (3) Geochemical Anomaly Map in the Queen Elizabeth Area (Cu)

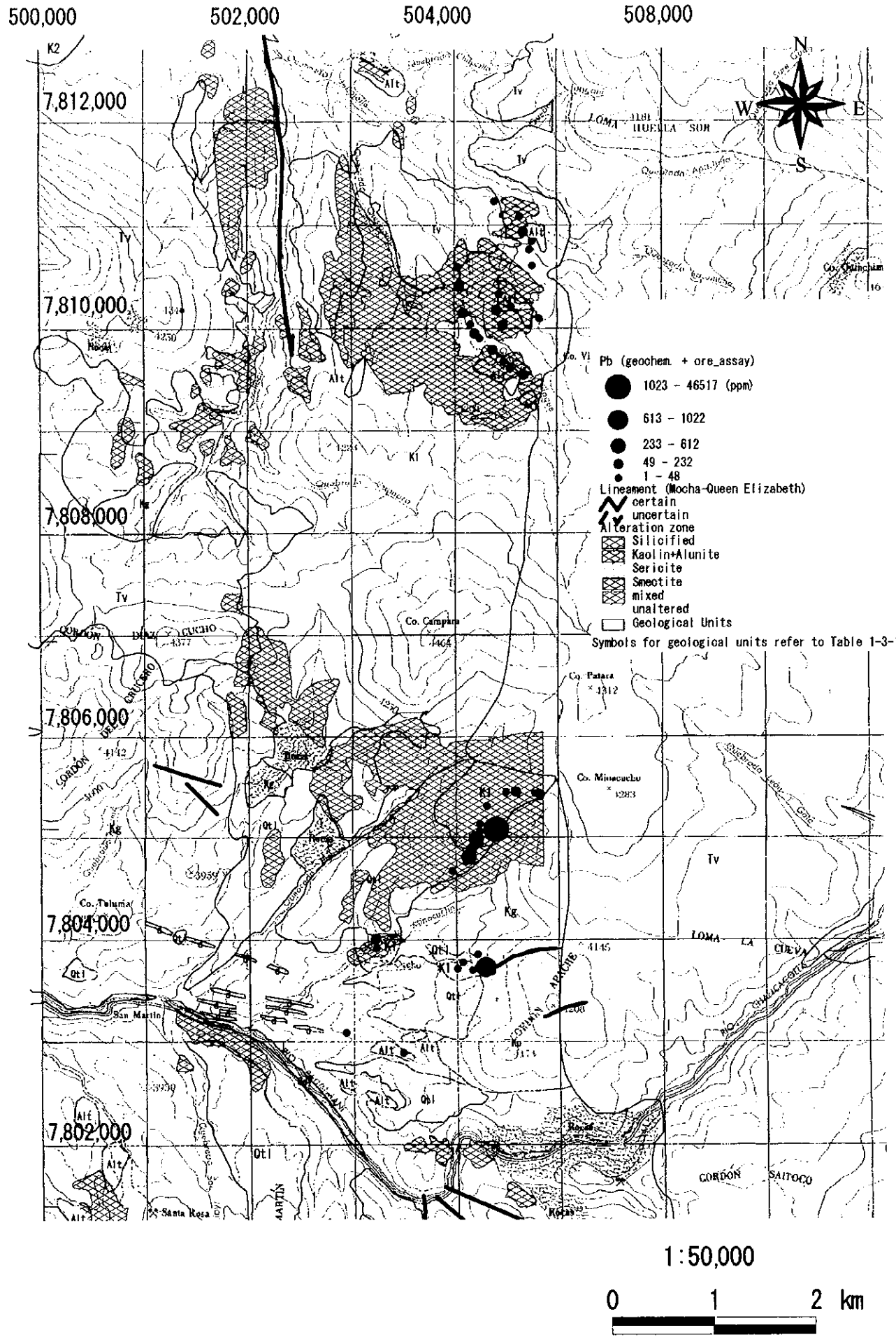


Fig. 2-1-12 (4) Geochemical Anomaly Map in the Queen Elizabeth Area (Pb)

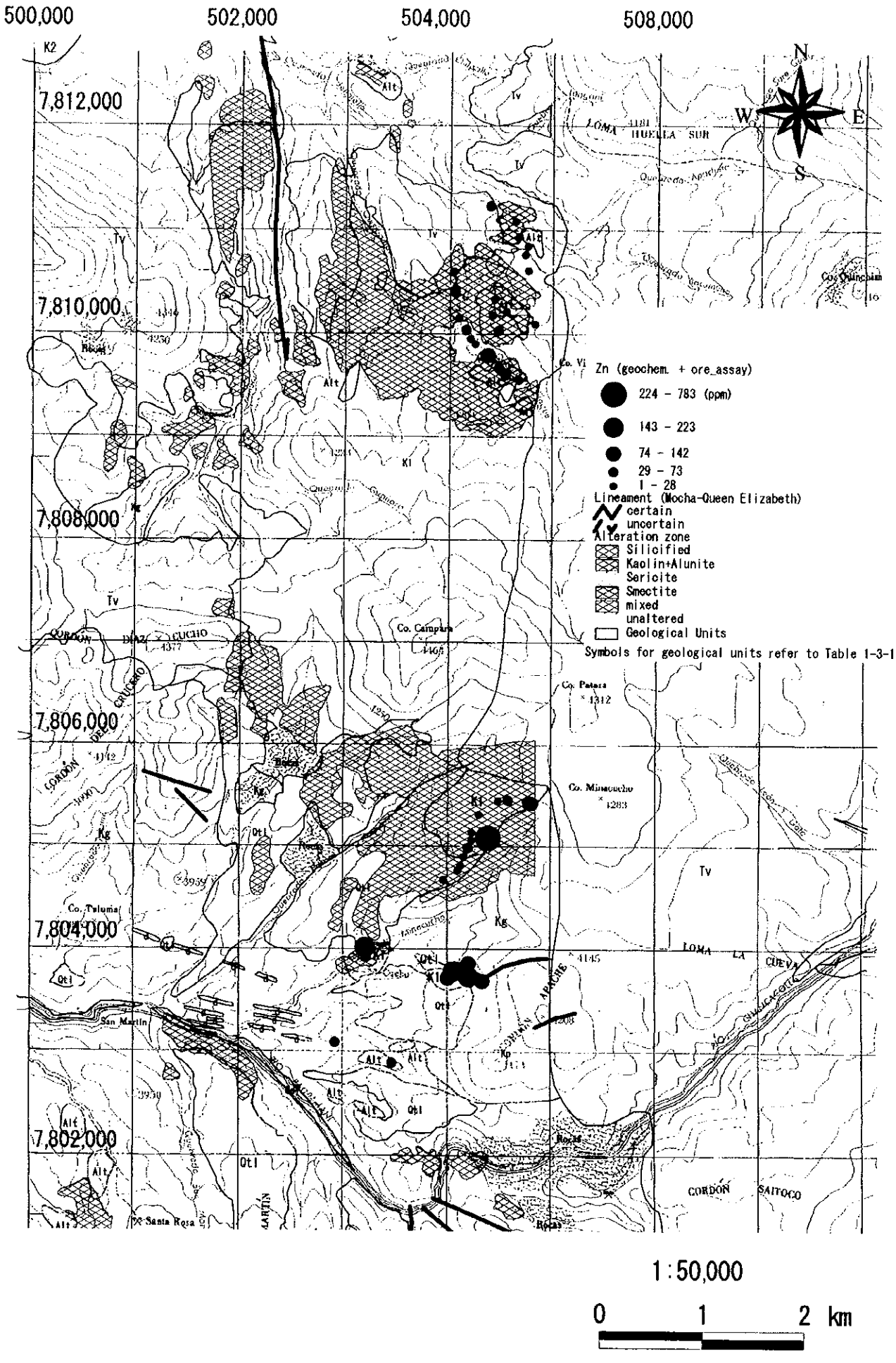


Fig. 2-1-12 (5) Geochemical Anomaly Map in the Queen Elizabeth Area (Zn)

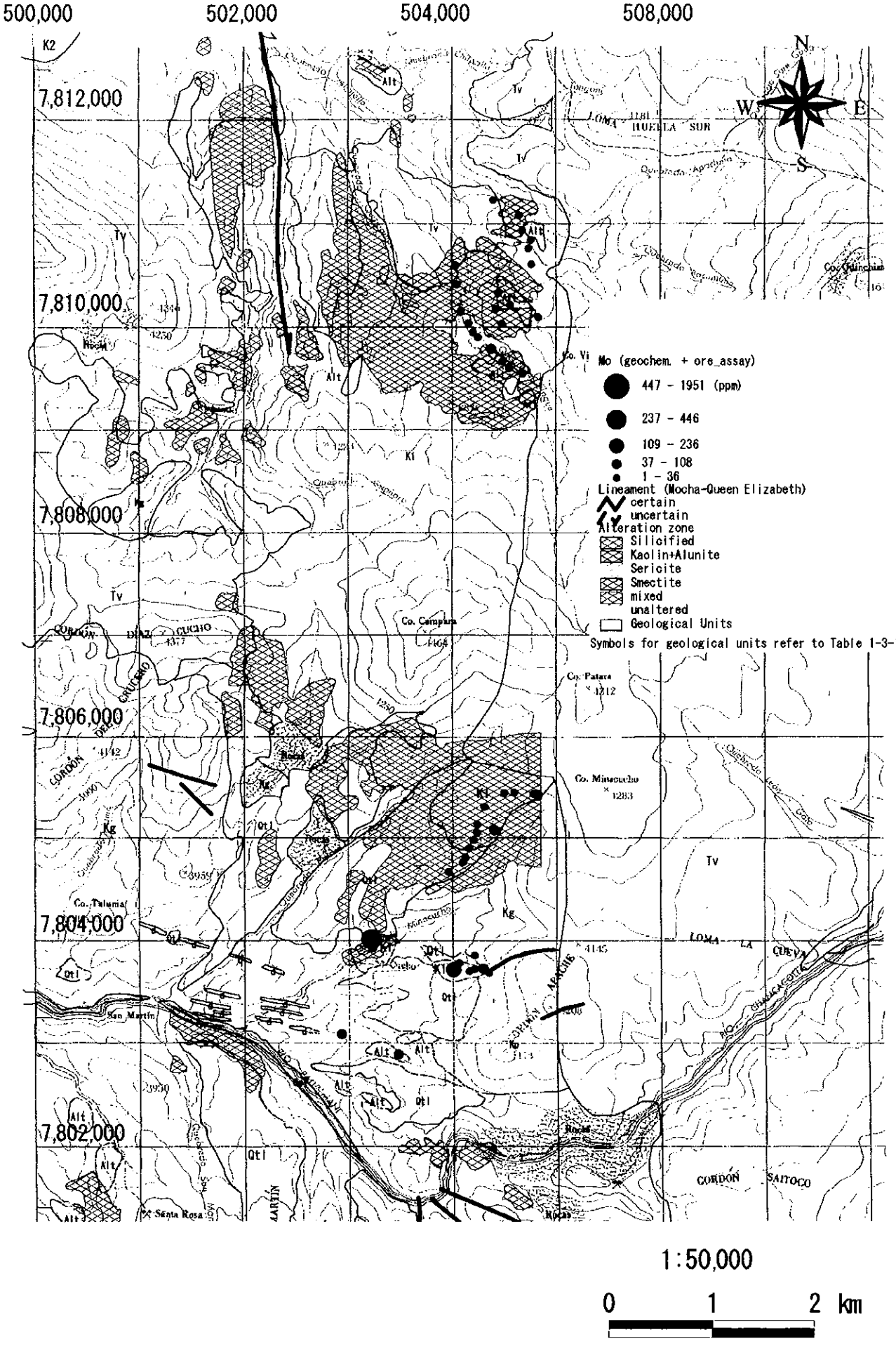


Fig. 2-1-12 (6) Geochemical Anomaly Map in the Queen Elizabeth Area (Mo)

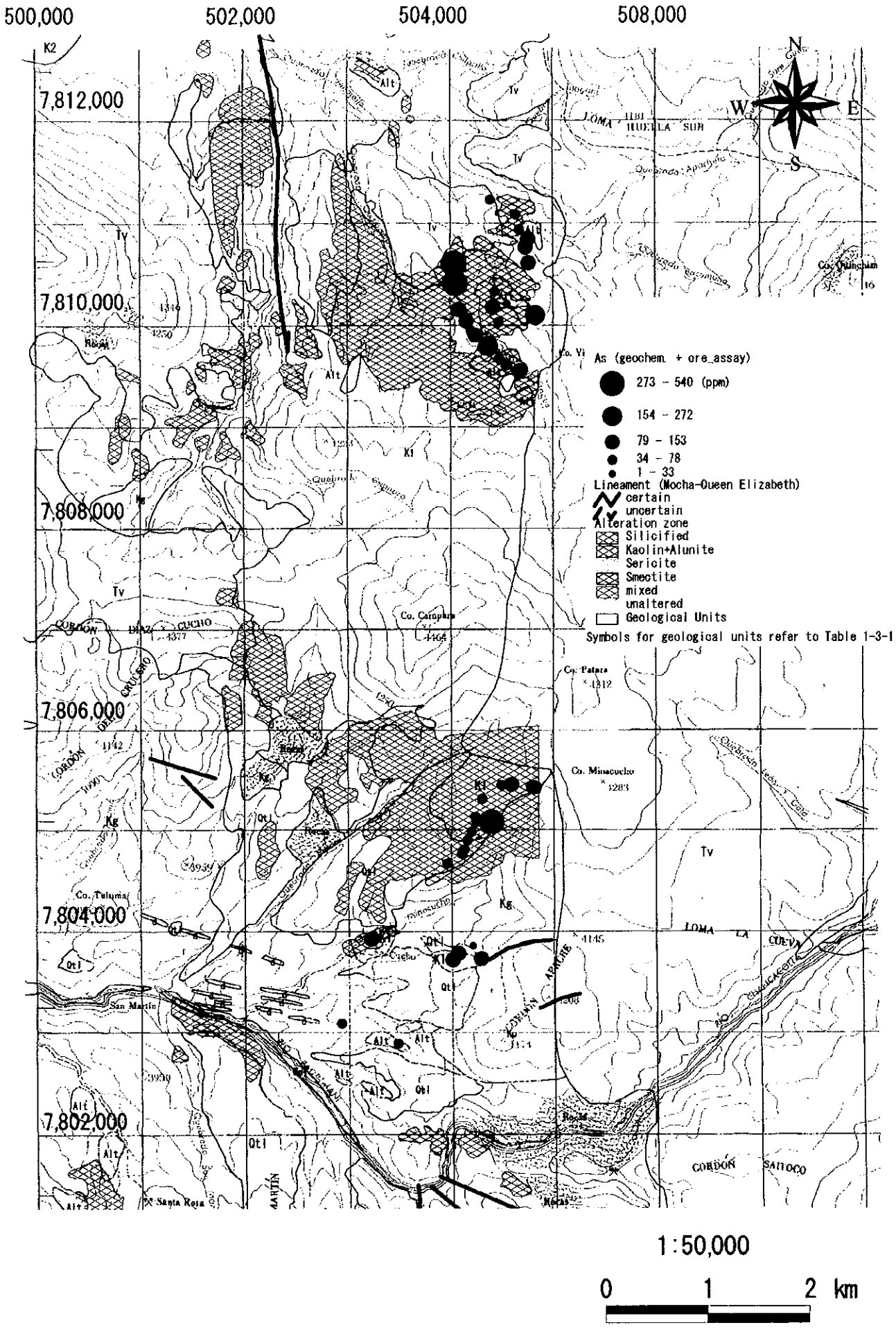


Fig. 2-1-12 (7) Geochemical Anomaly Map in the Queen Elizabeth Area (As)

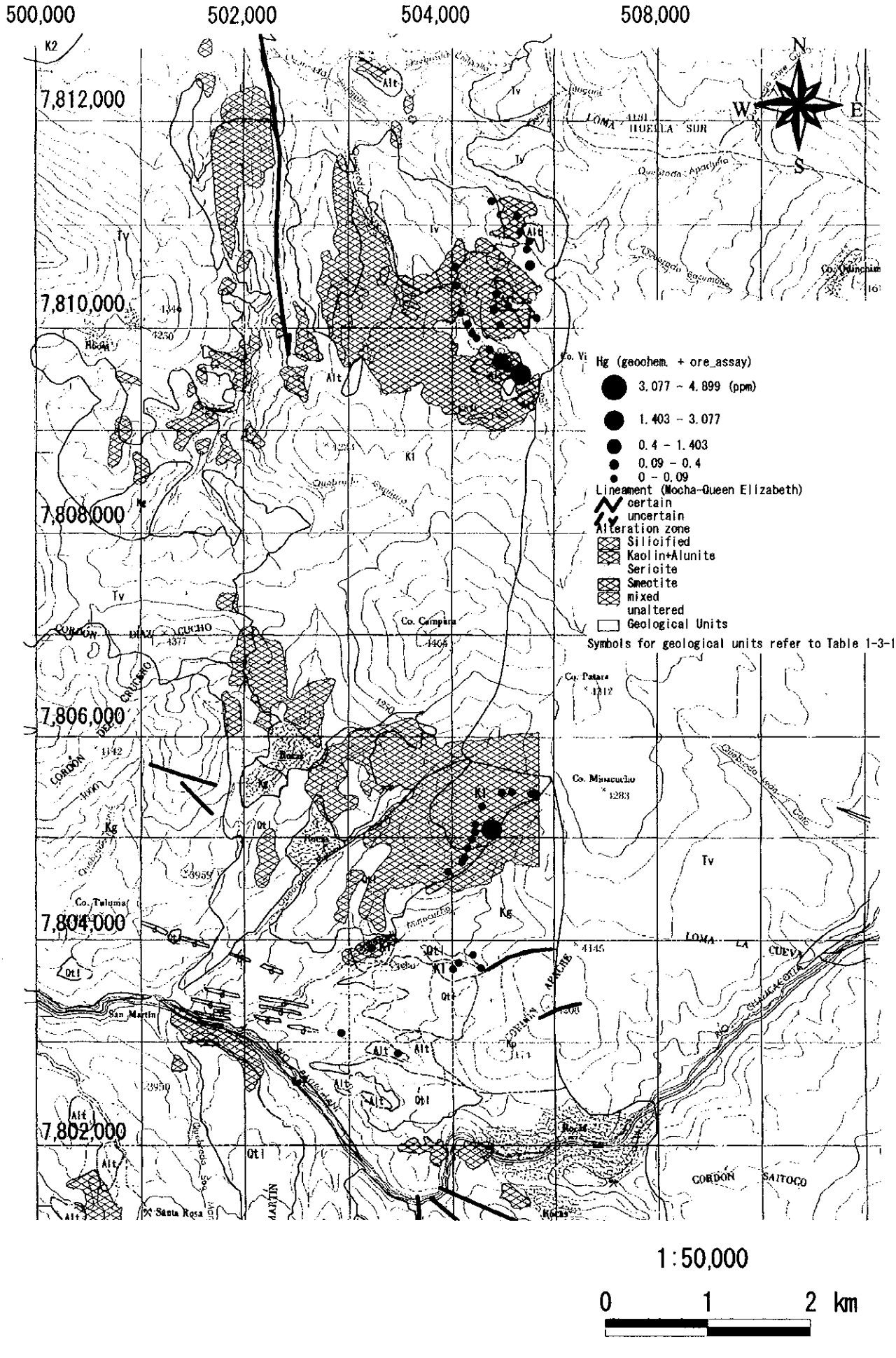


Fig. 2-1-12 (8) Geochemical Anomaly Map in the Queen Elizabeth Area (Hg)

not observed.

The southern alteration zone is developed in granodiorite and the Cretaceous System in the vicinity and consists mainly of biotitization and sericitization. Propylitic alteration and tourmaline alteration also occur in this part. The K-Ar age of the biotite in the Cretaceous andesite is 38.0±1.4Ms. Network quartz veinlets are widely developed and green to brown oxidized copper minerals are disseminated over 400m in the vicinity of biotite alteration zone. Fluid inclusions in quartz grains from the quartz network veins are gas inclusions with gas occupying more than 80vol% . The average gas disappearance temperature is 424℃, a typical value for porphyry copper mineralization. At the mineral showing in Cucho on the western side, green oxidized copper minerals are disseminated accompanied by chalcopyrite and pyrite. Drilling has not been carried out in these mineral showings. On the other hand, quartz porphyry occurs in the southeastern side, but parts of the porphyry are strongly crushed and the boundary with the Cretaceous sandstone is silicified. This quartz porphyry is strongly sericitized, but ore minerals are not observed. Drilling was carried out in the quartz porphyry zone and the silicified-sericitized zone in the vicinity, but promising orebodies have not been reported.

Notable rock geochemical anomalies are; high Cu-Mo anomaly in the southern alteration zone, high Au-Ag-Pb-Zn-As-Hg anomaly in the central zone, and high As-Hg anomaly in the northern zone.

1-1-3 Diana district

For this district, sampling sites are shown in Figure 2-1-13, geological map in Figure 2-1-14, schematic geological column in Figure 2-1-15, location of mineral showings in Figure 2-1-16, distribution of alteration minerals in Figure 2-1-17, and rock geochemical anomaly distribution in Figure 2-1-18.

The geology of this district consists of Jurassic, Upper Tertiary-Quaternary Systems.

The Jurassic System is composed of basalt, chert, andesite, siltstone, and quartzite, and is intruded by Cretaceous and Tertiary intrusive bodies. The intrusive rocks are quartz diorite, granite, and porphyry. The Jurassic System and the intrusive rocks are overlain unconformably by Upper Tertiary-Quaternary Systems.