PART II SURVEY RESULTS

CHAPTER 1 EXISTING DATA ANALYSIS

For the existing data analysis, such existing data as geological literatures, geological maps, topographical maps and aerial photographs were collected, arranged and analyzed. To be concrete, existing information and data concerning the geological features, geological structure, mineral deposit and the result of geochemical prospecting of the project area was compiled and analyzed to understand the outline of geological features, geological structure, mineral deposit and potential ore fields.

In the survey area, gold ore deposits were recognized in greenstone and it is considered that the ore deposit is closely associated with granodioraites. Based on this information, the field survey area (about 2,500km^2), where the greenstone belt had been distributed and many intrusions of granodiorites rock body had been recognized, was extracted from the project area (12,000 km^2), according to the result of the existing data analysis and the geologic interpretation of satellite image data. The detail of the analysis is described in Part1-Chapter3, and the collected data is listed in the reference.

CHAPTER 2 GEOLOGIC INTERPRETAION OF SATELITE IMAGE DATA

2-1 Key objective

The key objective is to full understand the regional geologic structure of the survey area and to prepare the basic map for regional potential evaluation of the survey area as well as by photo-geologic interpretation of the satellite image.

2-2 Survey area

The survey area for geologic interpretation of the satellite image data covers both the San Jose and the Arroyo Grande Areas and the gross area amounts to 12,000km^2. The location of the survey area is indicated in Fig. II-2-1 along with the coverage of the satellite image.

2-3 Image data used

The image data used for this survey is listed in Tab. II-2-1.

2-4 Image product

The image products generated by this survey are listed in Tab. II-2-2.

2-4-1 Digital mosaicing

A digital mosaicing method was applied to JERS-1/SAR images and LANDSAT/TM data. The principal data processing procedures are recounted below. The acquired digital mosaic imagery of JERS-1/SAR is shown in Fig. II-2-2.

(1) JERS-1/SAR image data

Bit conversion process

Antenna pattern correction

Noise reduction (median filter)

(2) LANDSAT/TM data

Image inspection

(3) Both data in common

Extraction of relative position information between images

Contrast adjustment

Image mosaic

Contrast enhancement process

Geometric conversion (UTM, Zone21, WGS84)

Annotation

2-4-2 TM false color image

The band combination B:G:R = 1:4:5, which is adequate to define the survey area, was applied for the false color composition. Fig. II-2-3 shows the TM false color imagery processed.

2-4-3 TM band ratio image

The band rationing B:G:R = 3/1:5/4:5/7, which has been considered to be the most suitable for the discrimination of the alteration zone, was adopted for this false color composition. The color composed by each band rationing can be used to discriminate the following minerals. Fig. II-2-4 shows the TM band ratio imagery processed.

Color	B=3/1	G=5/4	R=5/7	Discriminating mineral
Red	△	△	○	Clay
Yellow ~ brown	△	○	○	Clay + hematite
Green	△	○	△	Hematite
Green ~ blue	○	○	△	Iron mineral
Blue	○	△	△	Iron mineral
Magenta	○	△	○	Clay + iron mineral
White	○	○	○	Clay + iron mineral

Note) ○: excellent potential to discriminate, △: medium to unlikely potential to discriminate

2-5 Contents of photo-geological interpretation

The interpretation of image data was performed, conforming to the photo-geological interpretation procedure, using a paper-printed image on a scale of 1:250,000. The reference factors of interpretation are color or tone on the screen, pattern and distribution density of drainage system, resistance to rock erosion, bedding or layering, vegetation and land-use. The existing geological map used to refer to the geologic units as a comparison, was the "Carta Geológica , produced by Ministerio de Industria y Energía (1980)" on a scale of 1:500,000. In addition, geological structure including lineament and alteration zone were also extracted.

2-6 Result of photo-geological interpretation

2-6-1 JERS-1/SAR image data

(1) Description of the image

The image data used was in good condition, but had the following features due to the relation between the L-band that the SAR in question had used, and the features of the targeted surface. The enhancement effect of topographic feature using geometric distortion of the SAR data is insufficient because the surface of the survey area is extremely flat.

Mosaic texture had appeared on the imagery corresponding to the variety and growth stages of crops

because the targeted area was widely used for cultivation. This was an obstacle to the geological interpretation.

Microwave was irradiated in the direction from east to west. As a result, the orthogonal roads with this direction and, electric cables and fences along the roads tend to be enhanced. Basically the drainage system is reasonably highlighted on the imagery. However there are some areas where the extraction of the primary drainage system is difficult. A part of the drainage system is expressed with strong luminance, which is considered due to an accumulation of arboret on the stream that has an influence on the optical reflection as well as a double reflection between the arboret and the water surface. Accordingly, existence of water is estimated in nearly all areas of the drainage system.

(2) Geologic interpretation

First, gneisses of Proterozoic (comparison geologic unit pCCcb series in the geological map on a scale of 1:500,000) and sedimentary rocks of post-Mesozoic (K, T and Q series in the same map) can be discriminated in terms of the distribution on the surface and land-use. The former is characterized by rolling topographical relief and developed drainage system, while the latter by terrace-like distribution on the platform, strong land-use and an undeveloped drainage system.

As for the gneisses of Proterozoic, further discrimination is difficult for the whole survey area. However gneiss pCCcp and other rocks including granites pCCG and pCC, and greenstone pCCps, which are comprised in the gneisses, can be discriminated in a specific area. Granites pCCG and pCC show rather rough topographic features being compared with gneiss pCCcb and greenstone pCCps, and their luminance tends to be strong on the screen. Gneiss pCCcb and greenstone pCCps shows very similar evidence. However, the latter can be traced by means of its bedded structure.

In general terms, greenstone pCCps is distributed both in the east and west part of the survey area. It is pointed out and expected that, there is a possibility of another unreported distribution lying midway between them. In the east of the survey area, discrimination between gneiss pCCcb and greenstone pCCps is difficult. However, it is considered that the distribution is almost the same as the existing geological map.

(3) Extraction of geological structure

In the south of the survey area, the faults are developed having two predominant trends of ENE-WSW and NW-SE. The former trending faults are older, and the latter divides them to form the survey area into a blocked structure in a NW-SW direction. Some of the granitic rocks (pCCG and pCC) are distributed in association with the ENE-WSW trending faults. The emplacement is estimated at approximately the same age as when the faults were formed. Lineament is developed with an intermediate density and demonstrates a tendency to have predominant trends NW-SE and NE-SW.

(4) Extraction of the alteration zone

In this imagery, the lineament density tends to be high around the old mines or mineral showings. However it is difficult to directily extract the alteration zone.

2-6-2 LANDSAT/TM data

Using the result of the above-mentioned JERS-1/SAR image data interpretation, the features of the image of the survey area were resumed on the TM imagery. The geological aspects are described below.

(1)Description of the image

The image data used was in good condition, and had the following features.

①The solar altitude and sun azimuth (clockwise from the north) at the time of taking the image, were 34° and 53° , respectively. As the survey area has a flat topographic feature, low solar altitude is better. The solar altitude at the winter solstice of the survey area is around 20° , and it provides good conditions. The sun azimuth generally has an oblique trend as against the geological trends of the survey area, and that presents suitable conditions for the geological interpretation.

②The topography of the survey area is generally flat. However minute relief is shown on the imagery and topographical feature and drainage system can be sufficiently extracted.

The surface of the targeted area was widely used for cultivation. This is an obstacle when the distinctive spectrums depending on rocks and soils are extracted in the area covered by vegetation.

(2)Geologic interpretation

The geologic interpretation map is shown in Fig. II-2-5, and the geologic interpretation chart is summarized in Tab. II-2-3 along with the interpretation result of JERS-1/SAR image. Features of each geologic unit are described below.

[Unit gn1]

This geologic unit manifests such features as magenta in color, dendritic pattern of the drainage system and extremely high drainage density. This unit is characterized by high resistance to rock erosion and rough texture. Bedding is developed in the unit and the degree of land-use is common. The unit is widely distributed in the whole survey area and compares with the gneiss of Proterozoic pCCcb.

[Unit g]

This geologic unit manifests such features as magenta in color, parallel pattern of the drainage system and extremely high drainage density. This unit is characterized by high resistance to rock erosion and lineated texture. Bedding is developed in the unit and the degree of land-use is common. The unit is widely distributed both in the south part of the Arroyo Grande area and also the south part of the San Jose area and, compares with the gneiss of Proterozoic pCCG.

[Unit gs]

This geologic unit manifests such features as green and red patched color, sub-parallel pattern of the

drainage system and high drainage density. This unit is characterized by high resistance to rock erosion and lineated texture. Bedding is extremely well developed in the unit and the degree of land-use is strong. The unit is distributed both in the central part of the Arroyo Grande area, the central part of the San Jose area in a direction of E-W and compares with the greenstone of Proterozoic pCCps.pCCsj.

[Unit sh]

This geologic unit manifests such features as magenta in color, sub-dendritic pattern of the drainage system and high drainage density. This unit is characterized by intermediate resistance to rock erosion and rough texture. Bedding is developed in the unit and the degree of land-use is high. The unit is distributed in the south part of the Arroyo Grande area in a direction of E-W and compares with the gneisses of Proterozoic pCCApd.

[Unit gn2]

This geologic unit manifests such features as green and red patched color, sub-dendritic pattern of the drainage system and high drainage density. This unit is characterized by intermediate resistance to rock erosion and smooth texture. Bedding is moderately developed in the unit and the degree of land-use is high. The unit is distributed in the south part of the Arroyo Grande area in a direction of E-W and compares with the gneiss of Proterozoic pCCcb. This unit is differentiated from the Unit gn1, being bounded by the above-mentioned Unit g, Unit gs and Unit sh. In the southwest part of the Arroyo Grande area, there are some fields where the compartmentation of Unit g1 and Unit g2 is difficult.

[Unit Ka]

This geologic unit manifests such features as magenta in color, sub-parallel pattern of the drainage system and high drainage density. This unit is characterized by intermediate resistance to rock erosion and rough texture. Bedding is not developed well in the unit and vegetation is sparse. The unit is distributed in the southeast part of the Arroyo Grande area and compares with the sedimentary rocks of Cretaceous Ksm and Kla1.

[Unit Kb]

This geologic unit manifests such features as green and red patched color, dendritic pattern of the drainage system and high drainage density. This unit is characterized by intermediate resistance to rock erosion and rough texture. Bedding is not well developed in the unit and the degree of land-use is high. The unit is distributed in the north part of the San Jose area and compares with the sedimentary rocks of Cretaceous Klm.

[Unit T-K]

This geologic unit manifests such features as green and red patched color, dendritic pattern of the drainage system and low drainage density. This unit is characterized by low resistance to rock erosion and flat terrace-like texture. Bedding is not well developed in the unit and the degree of land-use is high. The unit is distributed both in the west part of the Arroyo Grande area and the western part of the San Jose area and, compares with the sedimentary rocks of Cretaceous Ksa.

[Unit Q]

This geologic unit manifests such features as green and red patched color, dendritic pattern of the drainage system and low drainage density. This unit is characterized by low resistance to rock erosion and flat terrace-like texture. Bedding is not developed in the unit and the degree of land-use is high. The unit is distributed in the south part of the Arroyo Grande area and compares with the sedimentary layer of Quaternary Q1. The topographical feature is similar to the Unit T-K.

[Unit a]

This geologic unit manifests such features as black in color, braided pattern of the drainage system and low drainage density. This unit is characterized by extremely low resistance to rock erosion and even texture. The vegetation is dense and compares with the alluvial layer of Quaternary Q.

[Unit G]

This geologic unit manifests such features as purple in color, sub-dendritic pattern of the drainage system and extremely high drainage density. This unit is characterized by extremely high resistance to rock erosion and extremely rough texture. The topographical relief is rough in the even area, and land-use is hardly recognized. The unit intrudes throughout in the whole of the survey area and compares with the intrusive granitic rocks (pCCG, pCC).

(3) Extraction of geological structure

In the south of the survey area, the faults are developed having two predominant trends of ENE-WSW and NW-SE. The former trending faults are older, and the latter divides them to form the survey area into a blocked structure in a NW-SW direction. Some of the intrusive granitic rocks (pCCG and pCC: corresponding to the geologic unit G) are distributed in association with the ENE-WSW trending faults. The emplacement is estimated at approximately the same age as when the faults were formed.

The fold structure is small-scale, locally predominate in the domain structure, and is not a predominant structure in the whole area.

2-7 Result of lineament analysis

2-7-1 Extraction of lineament

Extraction of lineament was carried out by using both the JERS-SAR image data and LANDSAT/TM image data. In consequence of a comparison of both results, in the case of JERS-SAR image, many roads and boundaries between vegetation were misidentified as a lineament, and that seriously affected the accuracy. Accordingly, the final lineament map was completed, after each lineament extraction from the JERS-1/SAR image data was checked and verified one by one on the LANDSAT/TM imagery. Other lineament which was extracted only from the LANDSAT/TM imagery was also added. The result of the extraction of lineament is shown in Fig. II-2-6.

2-7-2 Lineament analysis

Generally, the lineament is developed without discriminating predominant trends, while the N-S

trending lineaments are developed in the east part of the Arroyo Grande area as well as the San Jose area. No lineament that has a predominant E-W trend is developed in any part of the area. The lineaments are densely found in the northern part of the Mahoma mine and form a high-density zone of ring arrangement. Lineament density is higher in the eastern part of the Arroyo Grande area, when compared with the other areas. The lineament density map is shown in Fig. II-2-6 along with the lineament extraction result.

2-8 Extraction of alteration zone

In this imagery, the lineament density tends to be high around the old mines or mineral showings. However it was difficult to directily extract the alteration zone. The ore deposit type expected in this survey area is gold ore deposit accompanying shear zone, which is generally subjected to mineralization of greenschist facies, and is also subjected to mineralization of amphibolite facies by contact metamorphism especially around the intrusive rock. Accordingly, depending on the wall rock composition, alteration zones of silicification and sericitization are usually targeted for extraction.

The color appeared on the TM band ratio image can largely be classified roughly into magenta and cyan. The former is a composite of blue and red, and provides a high pixel value of both bands rationing 3/1 and 5/7. This color suggests the existence of clay and goethite. However, it was not enough to extract the possible alteration zone because it is pervasive all over the survey area. The latter is a composite of blue and green, and provides a high pixel value of both bands rationing 3/1 and 5/4. This color suggests the existence of iron minerals. The color is pervasive all over the survey area and is also recognized in the geologic unit G. Although this color can determine the lithofacies, it was not enough to extract the possible alteration zone as in the former case.

2-9 Result of image analysis

Considering the expected ore deposit type, the potential of the ore bearing area analyzed at this stage, requires at least the following necessary conditions.

①Existence of faults developed in predominant trends ENE-WSW and NW-SE.

②It is situated in or near the area which Unit gs and Unit G are distributed.

③Lineament, which is considered to reflect the geological structure, is concentrated, although the scale range is different from the faults.

As for ①, it is considered that the faults as well as ③ provide space for ore deposits to lie. However, it is necessary to figure out the timing of activity in relation to Unit G. As for ② it is pointed that Unit gs is important as a supply source of hydrothermal solusion, and Unit G as a heat source. Based on these aspect, the interpretation map of satellite imagery resuming the result of geological interpretation is shown in Fig. II-2-7. As a result, the following two areas can be appointed as the locations that fill all these requirements.

<u>San Jose area</u>

①Around the Mahoma mine

②The area about 20km west from the Mahoma mine

Arroyo Grande area

①Further west than the northwest part of the area

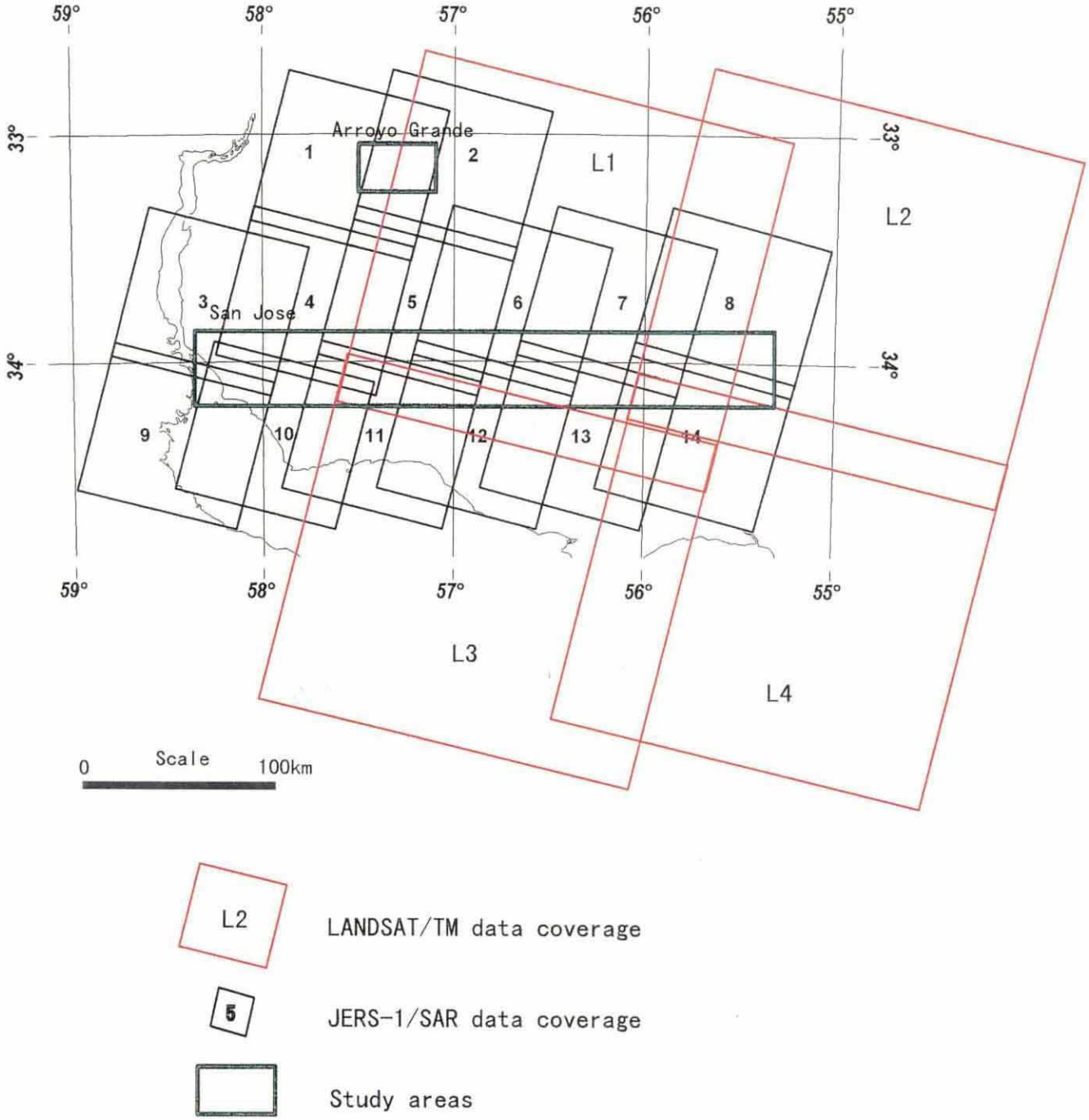


Fig.II-2-1 Coverage map of satellite imagery

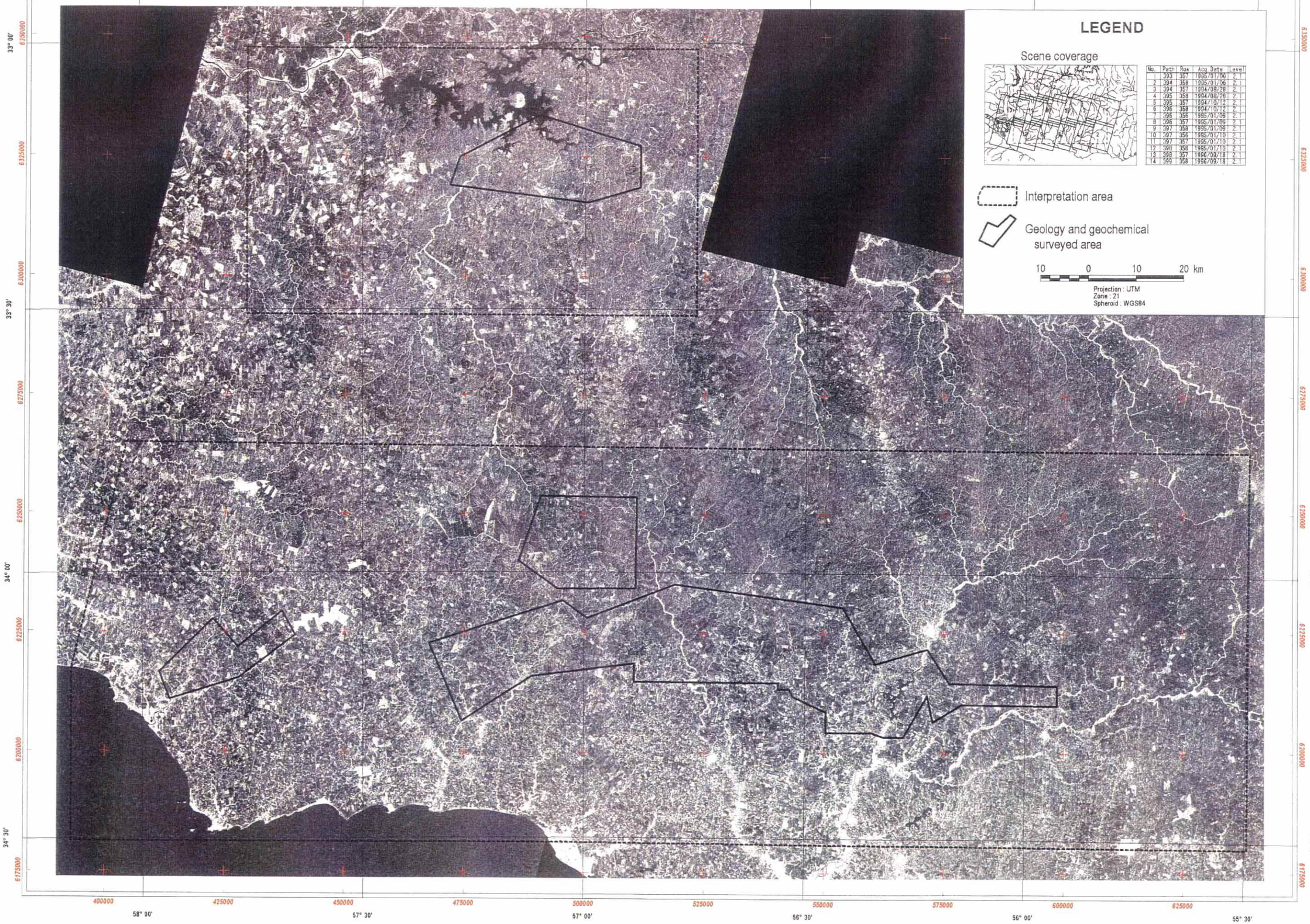


Fig.II-2-2 Digital mosaic of JERS-1/SAR imagery

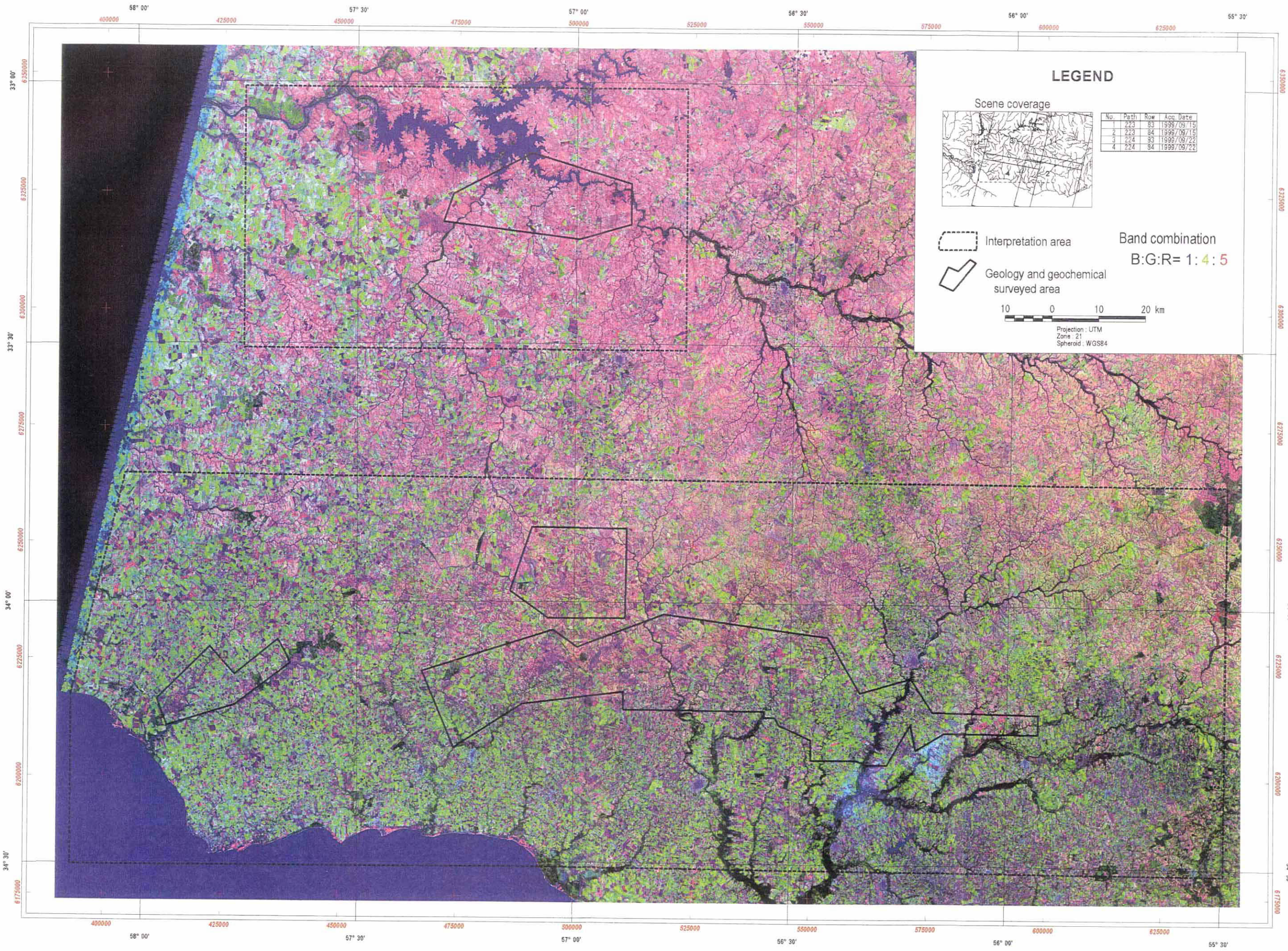


Fig.II-2-3 Digital mosaic of LANDSAT/TM imagery

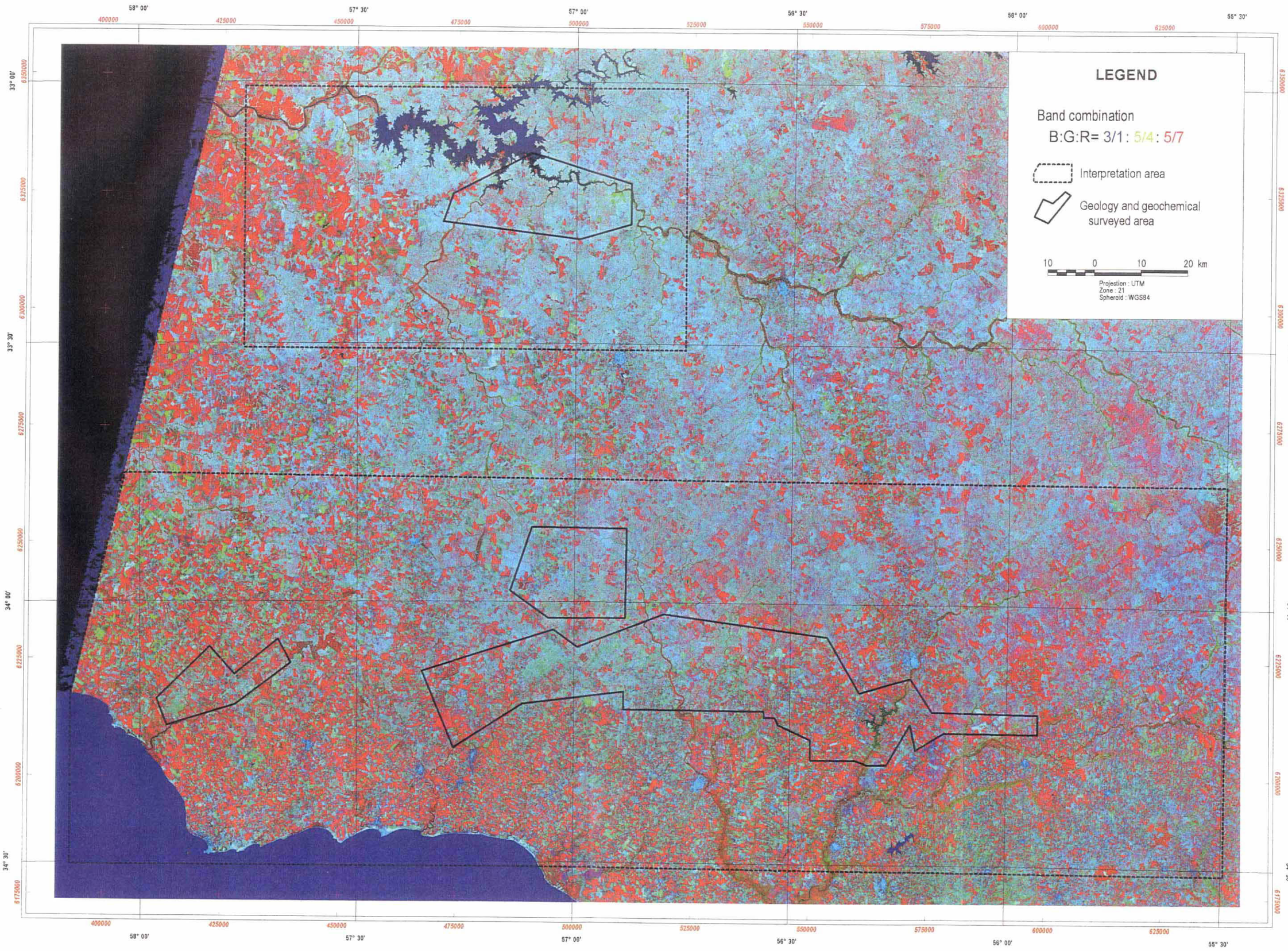


Fig.II-2-4 Band ratio imagery of LANDSAT/TM data

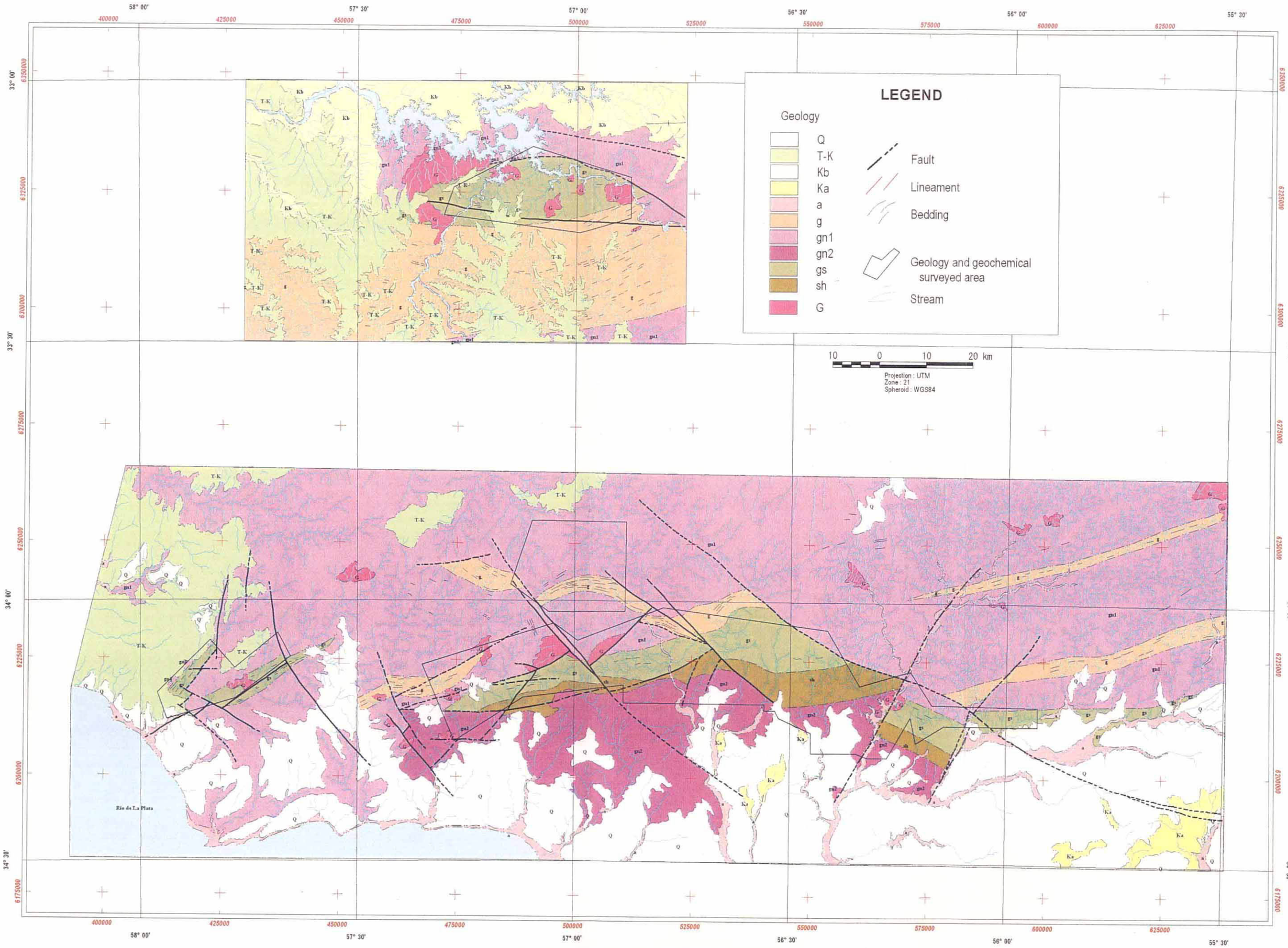


Fig.II-2-5 Geologic interpretation map

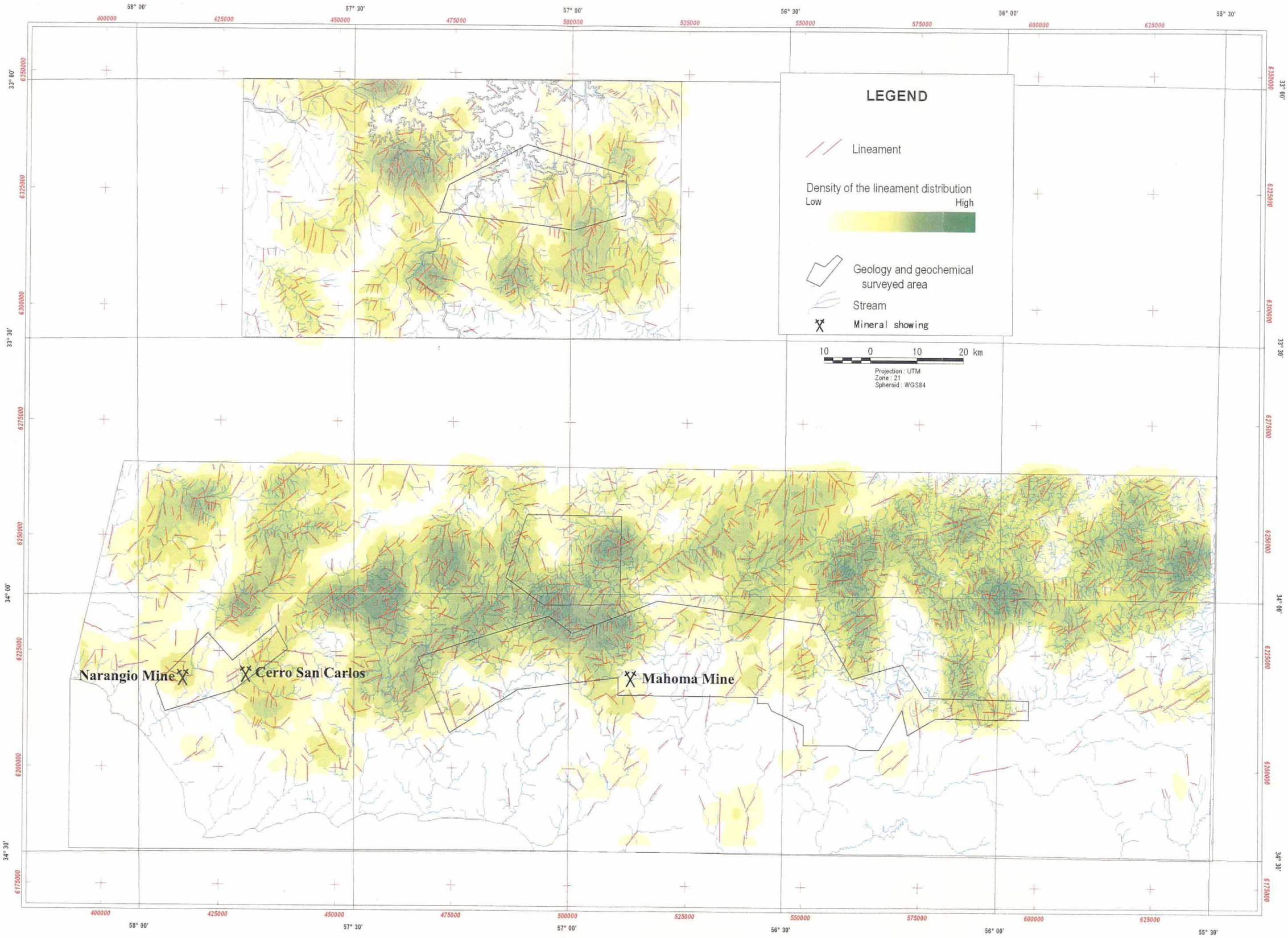


Fig. Ⅱ-2-6 Lineament extraction and its density map

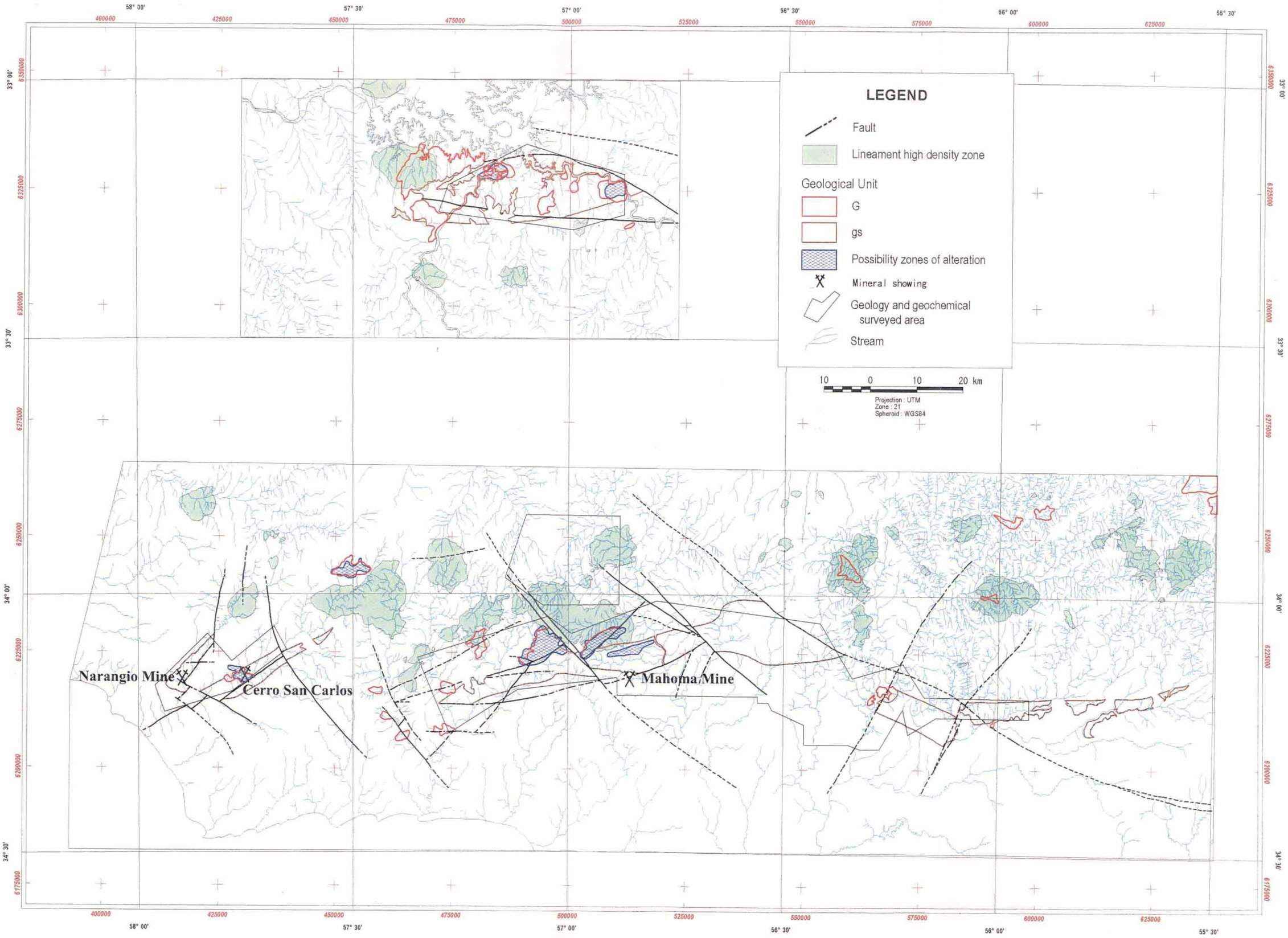


Fig. Ⅱ-2-7 Interpretation map of satellite imagery

Tab.II-2-1 Image data used

JERS-1/SAR Imagery

Path-Row	Date	Processed Level	Spatial Resolusion	Band used	Off-nadir Angle	Polarization	Projection
P397-R356	10/01/95	L2.1	18.0m	L-Band	35°	HH	UTM
P396-R356	09/01/95	L2.1	18.0m	L-Band	35°	HH	UTM
P398-R357	18/09/96	L2.1	18.0m	L-Band	35°	HH	UTM
P397-R357	10/01/95	L2.1	18.0m	L-Band	35°	HH	UTM
P396-R357	09/01/95	L2.1	18.0m	L-Band	35°	HH	UTM
P395-R357	12/10/94	L2.1	18.0m	L-Band	35°	HH	UTM
P394-R357	28/08/94	L2.1	18.0m	L-Band	35°	HH	UTM
P393-R357	06/01/95	L2.1	18.0m	L-Band	35°	HH	UTM
P399-R358	18/09/96	L2.1	18.0m	L-Band	35°	HH	UTM
P398-R358	10/01/95	L2.1	18.0m	L-Band	35°	HH	UTM
P397-R358	09/01/95	L2.1	18.0m	L-Band	35°	HH	UTM
P396-R358	12/10/94	L2.1	18.0m	L-Band	35°	HH	UTM
P395-R358	28/08/94	L2.1	18.0m	L-Band	35°	HH	UTM
P394-R358	06/01/95	L2.1	18.0m	L-Band	35°	HH	UTM

LANDSAT/ETM+ Imagery

Path-Row	Date	Processed Level	Bands	Spatial Resolution			Projection
P224-R083	22/09/99	L1G	Band 1 to 7 & P	30m(VNIR & SWIR)	60m(TIR)	15m(Pan)	UTM
P223-R083	15/09/99	L1G	Band 1 to 7 & P	30m(VNIR & SWIR)	60m(TIR)	15m(Pan)	UTM
P224-R084	22/09/99	L1G	Band 1 to 7 & P	30m(VNIR & SWIR)	60m(TIR)	15m(Pan)	UTM
P223-R084	15/09/99	L1G	Band 1 to 7 & P	30m(VNIR & SWIR)	60m(TIR)	15m(Pan)	UTM

Tab.II-2-2 Image products

Products	Image data used	Scene number	Band used	Scale for interpretation	Projection	Spheroid	Zone
Digital mosaic of SAR	JERS-1/SAR	14	L	1:250,000	UTM	WGS84	21
Digital mosaic of TM	LAMDSAT/ETM+	4	B:G:R=1:4:5	1:250,000	UTM	WGS84	21
TM band ratio	LAMDSAT/ETM+	4	B:G:R=3/1:5/4:5/7	1:250,000	UTM	WGS84	21
Investigation areas - San Jose east area - San Jose west area - Arroyo Grande area							

Tab.II-2-3 Geologic interpretation chart

LANDSAT/TM mosaic

Geologic units	Color	Drainage		Resistance	Texture	Bedding(layering)	Vegetation/Landuse	Remarks	Comparison
		Pattern	Density						
a	black	braided	low	very low	even	-	dense		Q
Q	green/red	dendritic	low	low	even	none	strong use	terrace-like	Q1
T-K	green/red	dendritic	low	low	even	poor	strong use		Ksa
Kb	green/red	dendritic	high	intermediate	rough	poor	strong use	San Jose area	Klm
Ka	magenta	sub-parallel	high	intermediate	rough	poor	less	Arroyo Grande area	Ksm, Kla1
gn2	green/red	sub-dendritic	high	intermediate	smooth	commom	strong use		pCCcb
sh	magenta	sub-dendritic	high	intermediate	rough	developed	strong use		pCCApd
gs	green/red	sub-parallel	high	high	lineated	very developed	strong use		pCCp.s.-sj.
g	magenta	parallel	very high	high	lineated	very developed	common use	very layered	pCCG
gn1	magenta	dendritic	very high	high	rough	developed	common use		pCCcb
G	purple	sub-dendritic	very high	very high	very rough	none	low use	intrusives	pCC γ

Footnote : comparison with existing map "Carta Geologica"procuced by Ministerio de Industria y Energia (1980), in scale of 1:500,000.

JERS-1/SAR mosaic

Geologic units	Tone	Drainage		Resistance	Texture	Bedding(layering)	Vegetation/Landuse	Remarks	Comparison
		Pattern	Density						
a	light grey	braided	low	very low	even	-	dense		Q
Q	grey	dendritic	low	low	even	none	strong use	terrace-like	Q1
T-K	grey/white	dendritic	low	low	even	poor	intense use		Ksa
Kb	grey	dendritic	high	intermediate	rough	poor	strong use	San Jose area	Klm
Ka	dark grey	sub-parallel	high	intermediate	rough	poor	less	Arroyo Grande area	Ksm, Kla1
gn2	grey	sub-dendritic	high	intermediate	smooth	commom	strong		pCCcb
sh	dark grey	sub-dendritic	high	intermediate	rough	commom	strong use		pCCApd
gs	dark grey	sub-parallel	high	high	lineated	developed	strong use		pCCp.s.-sj.
g	grey	parallel	very high	high	lineated	very developed	common	very layered	pCCG
gn1	grey	dendritic	very high	high	rough	developed	common		pCCcb
G	light grey	sub-dendritic	very high	very high	very rough	none	poor	intrusives	pCC γ

Footnote : comparison with existing map "Carta Geologica"procuced by Ministerio de Industria y Energia (1980), in scale of 1:500,000.

CHAPTER 3 GEOLOGICAL SURVEY

3-1 Coverage and Purpose

The geological survey was carried out on the three areas, i.e. the main part of the San Jose area, the western part of the San Jose area and the Arroyo Grande area, in order to grasp the geological features and structure of the project area. The survey area is shown in Fig. II-3-1.

The main part of the San Jose area is located around the provincial capital of San Jose de Mayo of San Jose Province, about 80km northwest of the Capital Montevideo. The western part of the San Jose area is located to the northeast of the provincial capital Colonia of Colonia province facing the La Plata River. The Arroyo Grande area is located in the south of Rio Negro province, about 200km northwest of the Capital Montevideo. The topography surrounding these areas, consists of pastures forming flat peneplains that spread out over the locations.

3-2 Methodology

For the geological survey, geological description, photography and rock sampling were performed covering the outcrops and floats in the survey area, and a geological sketch of an outcrop was also carried out as the occasion demanded. Especially at the mineral showings, the location was obtained by summary survey and the detailed geological sketch was also made. For the field survey, the magnified topographical map drawn on a scale of 1:50,000 and the aerial photograph on a scale of 1:40,000 were both carried by the teams for reference while working on site. A route map was prepared on the basis of the topographical map, marking up the location of outcrops, geological distribution, rock sampling points and, the strike and dip of the schistosities and veins. Rock samples were taken, keeping in mind that the samples sufficiently represent the typical rocks and the lithofacies of the survey area, as well as the mutual correlation. GPS was used to confirm the location of outcrops and floats, and the latitude and longitude were obtained.

3-3 Result of laboratory experiments and analyses

The laboratory experiments and analyses were conducted on the rock samples gathered on the geological field survey, in order to set up the analysis of the survey area. The implemented items of the laboratory experiments and analyses were cut and described the thin sections and polished sections, X-ray diffractive analysis, whole rock analysis, chemical analysis, fluid inclusions analysis (homogenization temperature+salinity), and radiometric dating (K-Ar dating). The description of the thin sections, results of the whole rock analysis and results of radiometric dating are shown in Tab. II-3-1, 2 and 3, respectively, while the results of other experiments and analysis are described below. The location of the rock sampling point is plotted on the geological map Plate II-3-1, 2, 3 and 4, along with the items of laboratory analyses experimented on the sample.

3-4 Result of geological survey

3-4-1 Stratigraphy

The geological formation of this area mainly consists of basement complex (pCCcb, pCCanf), greenstone (pCCsjo, pCCsj, pCCps and pCCag), and ancient granite intrusive rocks (pCCG) and younger granite intrusive rocks (pCC). Cretaceous, Neogene and Quaternary systems unconformably overlay them. The geological map and the schematic stratigraphic columns are shown in Fig. II-3-2, 3 and 4, respectively.

(1) Basement complex (pCCcb, pCCanf)

The basement complex is distributed in the western extremity and east part of the main part of the San Jose area, and to the north of the western part of the San Jose area and also along the southern edge of the Arroyo Grande area. The basement contacts the upper formations with the NW-SE fault boundary in the western part of the San Jose area, and with the E-W fault boundary in the Arroyo Grande area, respectively. The basement complex is mainly composed of gneiss, schists, quartzite, amphibolite and granites, and accompanied by migmatite and hornfels. Granites shows weak foliation attributed to metamorphism. Quartz schist, metasandstone and siliceous rocks are predominant in the western part of the San Jose area. Amphibolite (pCCanf) is indicated apart from other lithofacies in the geological map because its distribution range is relatively massed.

Based on the microscopic examination, the quartz schist (Sapmle No. AR022) shows porphyroclastic texture, where quartz is imbedded as relict mineral in the matrix which has a well developed schistosity and consists of quartz, biotite and muscovite. The epidote amphibolite (AR059) is composed of amphibolite, epidote, quartz and titanite, and imbeds prismatic to granular porphyroblasts of amphibolite. The granite (FR010) shows weak foliation, and imbeds phenocryst of quartz, potassium feldspar, plagioclase and biotite. The sample subjected to age dating (AR126: amphibolite) is composed of quartz, plagioclase, amphibolite and epidote, and shows weak schistosity. In rare cases, quartz occurs as a small relict accompanying plagioclase.

(2) Greenstone

The greenstone is composed of the San Jose formation (pCCsjo) subjected to a relatively high grade metamorphism, and such formations subjected to a weak metamorphism as the Paso Severino (pCCps), the Cerros de San Juan (pCCsj) and the Arroyo Grande (pCCag) formations.

In the main part of the San Jose area, the San Jose formation subjected to a relatively high grade metamorphism is distributed on the south part of the E-W fault boundary, while the Paso Severino formation subjected to a weak metamorphism on the north side. In the western part of the San Jose area, the Cerros de San Juan formation subjected to a weak metamorphism is distributed, which partially has a fault contact with the basement complex. In the Arroyo Grande area, the Arroyo Grande formation subjected to a weak to moderate metamorphism is widely distributed. The common lithofacies of these four formations which are constituent of greenstone, are schist rocks (greenschist, mica schist and quartz schist), metavolcanic rocks and metasedimentary rocks.

(i) San Jose formation

The San Jose formation mainly consists of greenschist, mica schist, quartz schist, gneiss, metarhyolite, metabasalt, green rock, quartzite, metasandstone, slate, phyllite and amphibolite.

The quartz schist (DR034) shows porphyroclastic texture, where quartz and plagioclase are imbedded as relict mineral in the matrix, which has a developed schistosity and consists of plagioclase, muscovite and quartz. The amphibolite (CR006) is composed of quartz, plagioclase, epidote, amphibolite and actinolite, and in some cases quartz porphyroblast is imbedded. A weak preferred orientation in alignment of massive or tabular minerals is recognized. The green rock (BR029) is massive rock consisting of fine-grained epidoto, titanite, chlorite, quartz, albite, carbonate minerals and magnetite. Considering the mineral assemblage, it is determined that the green rock is low grade metamorphic basic igneous rock.

(ii) Paso Severino formation

The Paso Severino formation consists of greenschist, mica schist, quartz schist, metabasalt, metagabbro, metasandstone, slate, phyllite and amphibolite.

The greenschist (AR026) is composed of such mineral assemblage characteristic of greenschist facies as quartz, albite, chlorite, actinolite and epidote but preferred mineral orientation is not recognized. The quartz schist (ER003) consists of fine-grained minerals of quartz, plagioclase, calcite, chlorite and muscovite, and shows a massive structure. The metabasalt (BR039) is recrystallized with a new metamorphic mineral assemblage of albite, actinolite, chlorite and epidote, although the former basalt porphyritic structure with phenocryst of peridotite is relict. The metagabbro (CR010) is completely replaced with a metamorphic mineral assemblage of chlorite, calcite, epidote, titanite, prehnite and actinolite and, the major part of the former texture of original rock disappears. The amphibolite (CR018) consists of such metamorphic minerals as hornblende, quartz, plagioclase and magnetite. The original igneous texture are not preserved at all. A weak foliation attributed to the preferred orientation of hornblende is recognized.

(iii) Cerros de San Juan formation

The Cerros de San Juan formation consists of greenschist, mica schist, quartz schist, talc, dolomite, metabasalt, metagabbro, metasandstone, slate, phyllite, amphibolite and dolerite.

According to the microscopic examination of the dolerite (AR106), phenocryst of peridotite is imbedded in the matrix consisting of fine-grained plagioclase and augite. It includes such alteration minerals as serpentinite, chlorite, actinolite, talc and magnetite.

(iv) Arroyo Grande formation

The Arroyo Grande formation consists of greenschist, mica schist, quartz schist, gneiss, metabasalt, metagabbro, metasandstone, slate, phyllite and amphibolite.

The metasandstone (ER077) consists of such metamorphic minerals as quartz, plagioclase, potassium feldspar and muscovite. In rare cases, it shows porphyroclastic texture, where quartz and potassium

feldspar are imbedded as relict mineral in the matrix of fine-grained metamorphic minerals. A weak foliation is recognized.

(3) Cretaceous system (Ksa)

Cretaceous system overlays unconformably the lower layer in the Arroyo Grande area and mainly consists of siliceous rock, agate and fine-grained sandstone.

(4) Neogene system (Tr)

Neogene system is scattered in the eastern part of the main part of the San Jose area and the central part of the western part of the San Jose area and overlays the lower layer unconformably. It mainly consists of mudstone, fine-grained sandstone, conglomerate and breccia.

(5) Quaternary system (Q)

Quaternary system mainly consists of sand, gravel and clay.

3-4-2 Intrusive rocks

(1) Ancient granite intrusive rocks (pCCG)

Ancient granite intrusive rocks are distributed as stock intrusive rock in the west to middle east parts of the main part of the San Jose area, the western part of the San Jose area and the central to northern parts of the Arroyo Grande area. The lithofacies mainly consists of middle to coarse-grained equigranular or porphyritic biotite granite, muscovite granite, granodiorite, diorite and quartz diorite, and is subjected to metamorphism. Ancient granite intrusive rocks are strongly weathered over all and disseminated by limonite. Generally the appearance occurs as massive intrusive rock, while it is subjected to cataclasis near the faults. Particularly, near the E-W and NW-SE faults in the middle west part of the main part of the San Jose area, it is observed that the foliation subjected to mylonitization and concordant with the fault directions is well developed.

Based on the microscopic examination, the biotite granite (GR004) shows blastoporphyritic texture, where quartz, potassium feldspar, plagioclase and biotite are imbedded as phenocryst and, relict minerals of plagioclase and potassium feldspar are included. The muscovite granite (AR056) includes quartz, potassium feldspar, plagioclase, muscovite and slight biotite as phenocryst, where the quartz has a mosaic texture. The granodiorite (CR001) includes quartz, plagioclase, amphiborite and slight magnetite as phenocryst. Wavy extinction in quartz and a slight deformation of the crystal structure in phenocryst are recognized. The granite (BR012) taken from near the E-W fault in the western part of the San Jose area is subjected to mylonitization. Such relict minerals as potassium feldspar, plagioclase, biotite and magnetite are recognized in the matrix of recrystallized fine-grained quartz. Most of the ancient granite intrusive rocks include such alteration minerals as muscovite, chlorite, epidote and carbonate minerals.

The sample subjected to age dating (BR001: biotite granite) is composed of quartz, potassium feldspar,

plagioclase, biotite, slight muscovite, apatite, magnetite and ilmenite, accompanying such alteration minerals as muscovite, chlorite, epidote, carbonate minerals and titanite. It is subjected to mylonitization and phenocryst of potassium feldspar and plagioclase is included in the matrix of recrystallized fine-grained quartz.

(2) Younger granite intrusive rocks (pCC)

Younger granitic rocks are scattered in the whole survey area of the main part of the San Jose area, the western part of the San Jose area and the Arroyo Grande area as stock intrusive rock. The lithofacies mainly consist of middle to coarse-grained equigranular or porphyritic biotite granite, muscovite granite, two mica granite, hornblende granite, leucogranite, granodiorite, diorite and tonalite, and partially accompanies aplite. It is rather heterogeneous when compared with the ancient granite intrusive rocks. Younger granite intrusive rocks usually form hillocks that are scores of meters higher than the surrounding flat topographic features, and the outcrop is in better condition than the surrounding area. Generally the appearance occurs as massive intrusive rock, and in some cases the foliation is developed being subjected to mylonitization. Based on the microscopic examination, the younger granite intrusive rocks include mainly quartz, potassium feldspar and plagioclase as phenocryst, such mafic minerals as biotite and muscovite or hornblende and biotite, and minor constituents of apatite, zircon, titanite and magnetite.

The features obtained by the microscopic examination on the samples subjected to the age dating process are as follows. AR125 (two mica granite) is mainly composed of quartz, potassium feldspar, plagioclase, muscovite and biotite, accompanying a trace of garnet and ilmenite. It is subjected to carbonitization and limonitization. It shows porphyroclastic fabric by mylonitization, where relict minerals of quartz, potassium feldspar and plagioclase are included.

AR128 (muscobite granite) is mainly composed of quartz, potassium feldspar, plagioclase and muscovite, with an accompanying trace of magnetite. It is subjected to chloritization and limonitization. It shows porphyroclastic texture by mylonitization, where relict minerals of quartz, potassium feldspar, plagioclase and muscovite are included. Grain size of the recrystallized quartz suggests multiple stage of shearing and recrystallization. AR129 (biotite granite) is mainly composed of quartz, potassium feldspar, plagioclase and biotite, accompanying a trace of zircon, apatite and magnetite. It is subjected to chloritization and limonitization. AR127 (leucogranite) is mainly composed of quartz, potassium feldspar and plagioclase, accompanying metamorphic mineral of muscovite.

(3) Intrusive rock : dolerite (dd)

Dolerite is distributed as a NE-SW dike in the central part and western edge of the main part of the San Jose area and intrudes principally in younger granite intrusive rocks (pCC). It is characterized by green massive lithologic character. Based on the microscopic examination, dolerite (CR048) shows massive epidote amphibolite facies composed of such metamorphic minerals as hornblende, plagioclase, epidote and magnetite.

(4) Intrusive rock : gabbro (gb)

Gabbro intrudes in the San Jose and Paso Severino formations mainly in the middle west part of the main part of the San Jose area, and crops out as stock. The lithologic character is dark-green gray hard dense rock facies. Based on the microscopic examination, gabbro (BR006 and BR015) is mainly composed of peridotite, augite, plagioclase and magnetite and includes such metamorphic minerals as talc, chlorite, epidote, carbonate minerals and serpentinite.

(5) Chemical composition

The Total alkalis (Na_2O+K_2O) vs Silica (SiO_2) diagram (TAS) and the Harker variation diagrams for granitic intrusive rocks (pCCG and pCC) are shown in Fig. II-3-5 and 6, respectively. The SiO_2 contents of the granitic intrusive rocks is within a range of about 47～78wt.%. Based on the TAS diagram, most of the samples are classified as subalkalic series, and plotted on the fields of granite, granodiorite, diorite and gabbro. Based on the Harker variation diagrams, the samples that contain more than 60% SiO_2 show negative correlations of SiO_2 vs TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO and CaO. In contrast, the samples that contain lower than 60% SiO_2 are scattered on the diagrams, and clear trends are unrecognized. Positive correlation is observed for the K_2O vs SiO_2 diagram.

(6) Radiometric age

Ancient granite intrusive rocks (pCCG) were dated from the biotite granite (BR001) corresponding to the host rock of the Mahoma mine in the middle west part of the main part of the San Jose area, and the age was obtained as 1960±140Ma by K-Ar method. This age is significantly young, when compared with the age before 2200Ma described in the existing information. It is considered that the ancient granite intrusive rocks are under the influence of rejuvenation, due to recrystallization by mylonitization as well as mineralization and alteration of the Mahoma mine.

Younger granite intrusive rocks (pCC) were dated from different samples. The age was indicated 1690±120Ma from the two mica granite (AR125) of the western part of the San Jose area, while 1240±10Ma and 1750±120Ma from the muscovite granite (AR128 : Mal abrigo granite) and the biotite granite (AR129 : Mahoma granite) respectively, both of which are distributed in the middle west part of the main part of the San Jose area. It was indicated 1980±130Ma from the leucogranite (AR127) of the Arroyo Grande area. Based on the existing information, younger granite intrusive rocks (pCC) were formed in about 1800 to 2000Ma and correlated with the igneous activity in the Transamazonian orogenesis.

The age obtained from the two mica granite (AR125) of the western part of the San Jose area, the biotite granite (AR129) of the main part of the San Jose area and the leucogranite (AR127) of the Arroyo Grande area, are consistent with the age described in the existing information, within the error range. The younger indicated age of muscovite granite (AR128) of the main part of the San Jose area is subjected to a strong mylonitization, based on the microscopic examination. Consequently it is considered that the younger age is under the influence of rejuvenation due to recrystallization.

As for the amphibolite (AR126) of the east part of the main part of the San Jose area, the age was obtained as 2000±280Ma. This rock is set down as the basement complex rocks in the geological map on a scale of 1:500,000 within the existing information, while it has been set down as younger intrusive rocks by the JMEC (2001).

3-4-3 Metamorphism

All of the San Jose (pCCsjo), the Paso Severino (pCCps), the Cerros de San Juan (pCCsj) and the Arroyo Grande (pCCag) formations which are constituent of greenstone, are subjected to metamorphism, and the lithologic facies are mainly metasedimentary rocks and metavolcanic rocks. Based on the result of the microscopic examination, the metasedimentary rocks consist of muscovite quartz rock and pelitic schist, and includes such metamorphic minerals as quartz, plagioclase, muscovite, carbonate minerals, apatite, titanite, limonite and opaque minerals.

The original rock of the metavolcanic rocks varies from acidic to basic rocks. However, basic metamorphic rocks such as metabasalt and metagabbro are predominant in the survey area, except the Arroyo Grande area. The basic metamorphic rocks show metamorphic facies mainly as greenschist facies, epidote amphibolite facies and amphibolite facies. The greenschist (AR026, BR029, BR039 and GR017) is characterized by the mineral assemblage of actnolite, chlorite and epidote, accompanying quartz, albite, carbonate minerals, titanite and limonite. The epidote amphibolite (AR033 and CR009) is characterized by the mineral assemblage of albite, hornblende and epidote. The amphibolite (CR018) consists of hornblende, plagioclase and quartz as its main mineral component, and does not include chlorite and epidote. The greenstone of the survey area, which shows such metamorphic facies composed of the above-mentioned greenshist, epidote amphibolite and amphibolite, is determined to be formed by metamorphism under a low- to middle-grade pressure.

3-4-4 Geological structure

The geological structure of the survey area is characterized by the faults general trends of E-W and NW-SE. The E-W fault forms the boundary between the San Jose formation on the south side and the Paso Severino formation on the north side, in the south part of the main part of the San Jose area. In the central part of the main part of the San Jose area, the boundary between the San Jose formation and the Paso Severino formation concordant with the E-W fault, is observed in parallel. The schistosity direction of metamorphic rock is almost concordant with the E-W fault. In the Arroyo Grande area, the well continued E-W fault forms the boundary between the basement complex on the south side and the Arroyo Grande formation in the north.

The NW-SE fault controls the distribution of ancient granite intrusive rocks, basement complex and the Cerros de San Juan formation, in the western part of the San Jose area. In the middle west part of the main part of the San Jose area, the schistosity close to the fault is controlled in a NW-SE direction, and younger granite intrusive rocks (pCC) are strongly subjected to mylonitization. Displacement of fracture is not

recognized at each outcrop. However, considering the geological distribution of the surrounding area, it is determined that the NW-SE fracture has a right lateral slip component.

3-4-5 Ore deposit

As the result of the field survey, the following 13 mineral showings were found as a zone where the quartz vein had been developed (Fig. II-3-7). Descriptions about each mineral showing are resumed in Tab. I-5-1.

The main part of the San Jose area (10 mineral showings)

A: surrounding area of the Mahoma mine (20km EW × 15km NS)

B: Nueva Helvecia (the western extremity of the area : 10km × 18km)

C: Arroyo del Medio (6km × 15km)

D: Canada de Cabrera (8km × 4km)

E: Arroyo charruzo (10km × 12km)

F: Tala I (3km × 4km)

G: Tla II (9km × 14km)

H: West of 25 de Mayo (6km × 8km)

I: South of 25 de Mayo (10km × 10km)

J: San Ramon (the eastern extremity of the area : 10km × 5km)

The western part of the San Jose area (1 mineral showing)

K: San Carlos (21km × 13km)

The Arroyo Grande area (2 mineral showings)

L: Rio Negro I (10km × 15km)

M: Rio Negro II (25km × 10km)

The gold-bearing quartz vein is impregnated with the basement complex (pCCcb and pCCanf), ancient granite intrusive rocks (pCCG) and greenstone (pCCps, pCCsj, pCCag and pCCsjo).

Wall rock alteration : The wall rock alteration was analogized as follows, based on the observation result of restricted outcrops including the open cuts of the Mahoma mine, because the outcrops were poorly developed in the survey area. It is megascopically recognized that both granites and greenstone of the wall rock are subjected to silicification at the edge of the quartz vein. The silicification range is in proportion to the vein width, and the silicification area tends to cover a wider range, the wider the vein width is. Chloritization and epidotization are also recognized in most of greenrocks and some of granites. The result of X-ray diffractive analysis is shown in Tab. II-3-4. The mineral assemblages consisting of quartz – sericite – (pyrite) and chlorite – epidote – (albite), are estimated from the edge of the quartz vein outwards.

Occurring appearance of quartz veins : The vein width comes to several to dozens of meters in basement rocks, greenstone and ancient granitic rocks, while it declines extremely to several centimeters to millimeters in younger granite intrusive rocks (pCC). It is considered that pCC somehow contributed to the gold mineralization. In the wall rock around the pCC body, quartz veins are well developed.

However the geological information of pCC as directly associated igneous rocks, is not obtained. Assuming a series of ore-forming processes, the following causes are estimated as reasons for diminution of the quartz vein width in pCC.

The lithologic character of pCC is inhomogeneous, when compared with pCCG. Large fissures were not formed because creeping deformation occurred due to its high ductility. Conversely, fractures with a moderate width could not be formed because brittle deformation occurred due to its low ductility.

Disposition pattern of the quartz vein : Two preferred directions of the quartz veins are observed; the NE-SW to E-W and the NW-SE. The former is approximately concordant with the geological structure as typified by faults and schistosity plane. Based on existing information, there is a description about a large-scale fracture zone displaying left lateral slip as the predominant E-W trending geological structure in this survey area. Regarding the latter NW-SE direction, NW-SE quartz vein shows the echelon disposition, at the mineral showing M (Rio Negro II) in the Arroyo Grande area, and the disposition pattern is "left echelon". Consequently the NW-SE trending vein displays right lateral slip sense, and accompanies faults developed in the same sense in the main part of the San Jose area and the western part of the San Jose area. It is considered that the NW-SE faults, which are the most recent structure in this survey area, can be a conjugate set with the NE-SW to E-W veins.

Mineralization : Based on the result of the polished section observation for both samples of quartz vein and wall rock, ore mineral was hardly found in the quartz vein except a little limonite and partially an infinitesimal amount of pyrite (Tab. II-3-5). A small amount of pyrite – (chalcopyrite) dissemination was recognized in green rocks and some part of the quartz vein. Based on the assay result, as described in Chapter 5, the maximum assay value was 19,890ppb (Appendix 4).

From the lithologic character of the quartz vein, it was classified into three types, milky sugar-like translucent quartz, colorless to white transparent quartz and gun metal transparent quartz. Considering the zonal distribution, which is locally recognized, and their appearance of interpenetration, it is estimated that these different stages of each quartz type become recent in this order in a chronological relationship. However it is difficult to determine each mineralization stage because the outcrop condition was generally bad and these types of quartz occurred together.

2, 1, 5, 4 and 2 samples were taken from the mineral showing A, C, E, G and M respectively, in order to subject them to the fluid inclusion analysis. As a result, the homogenization temperature was estimated to be 447.7°C at the highest and 85.6°C at the lowest, and the histogram usually had three peaks at around 300°C, 250°C and 200 to 150°C, which could be considered to correspond to milky translucent quartz, colorless to white transparent quartz and gun metal transparent quartz, respectively. Based on the result of measurement, the salinity was 4.2 to 35% (NaCl % equivalent), which indicates a coexistence of both quartz formed under high and low pressure.

Considering which type of quartz is accompanied by Au, no characteristic depending on the mineral showing is recognized. It seems that Au is apt to accompany colorless to white transparent quartz and gun metal transparent quartz. In addition to these types, black quartz also occurs which contains clay minerals

(phyllosilicate) difficult to identify. Consequently it is necessary to carefully analyze in more detail to be able to discuss the ore-forming stage of quartz accompanied by Au.

Next regarding the representative Mahoma mine in the survey area. The Mahoma mine is located in and belongs to the mineral showing A, slightly west of the center of the main part of the San Jose area, about 30km northwest of San Jose, a 35 minute drive. According to existing information, the prospecting was carried out from 1986 to 1990, and the digging was worked from 1992 to 1995. 2~3 kg of gold was produced. The wall rock is chloritized diorite to granodiorite.

Among the three open cuts remaining now, the western side of one of the outcrops, can be observed. The detailed ore deposit survey was implemented on this. The open cut is about 350m long in an EW direction, about 30 to 50m wide in the NS direction and about 10m deep, and the deeper part is now submerged. At that time, it was described as a trench dug 100m in length.

As shown in the Fig. II-3-9, the white transparent quartz vein 15 to 70cm wide and the reddish-blown limonite – quartz vein 2 to 5cm wide are recognized, showing the strike of 80° E and the dip of 87° N. According to existing information, only limonite is recognized as ore mineral, while there are descriptions about native gold of 20 to 40 μm occurring interstitially at a spot in the quartz grains in the quartz vein, and native gold of 1520 to 40 μm occurring in pyrite.

Based on the assay result, the assay values were Au: 1,520ppb for the sample of vein quartz, and Au: 291 to 111ppb for the wall rock sample. The assay value declines with the distance from the vein. Based on the result of X-ray diffractive analysis, it was found that sericite is included in the limonite – quartz vein.

At the east part of the mineral showing K in the western part of the San Jose area, a dump remains of the Cerro San Carlos mine vestige is found in a distribution area of granites (pCCG), although the details are unknown. Based on the assay result, the assay values were Au: 1,548ppb for the float of quartz vein, and Au: 115ppb for the float of wall rock.

The working Naranjio talc mine is located in the west part of the same mineral showing K. This mine was opened in 1904 for open-pit mining and from 1972 onward the mining method was changed to underground mining. Now the digging goes down approximate 70m below ground and the monthly production is 50 tons. It is said that the white part is used for ceramics and the green part for pigment.

This is a vein ore deposit, having a strike of N10° E to N45° E and a dip of 80° E to 85° NW. The wall rock is white dolomite (which does not appear on the surface) borne in the dark gray mafic rocks included in the greenstone (pCCsj). The vein width is 2 to 20m.

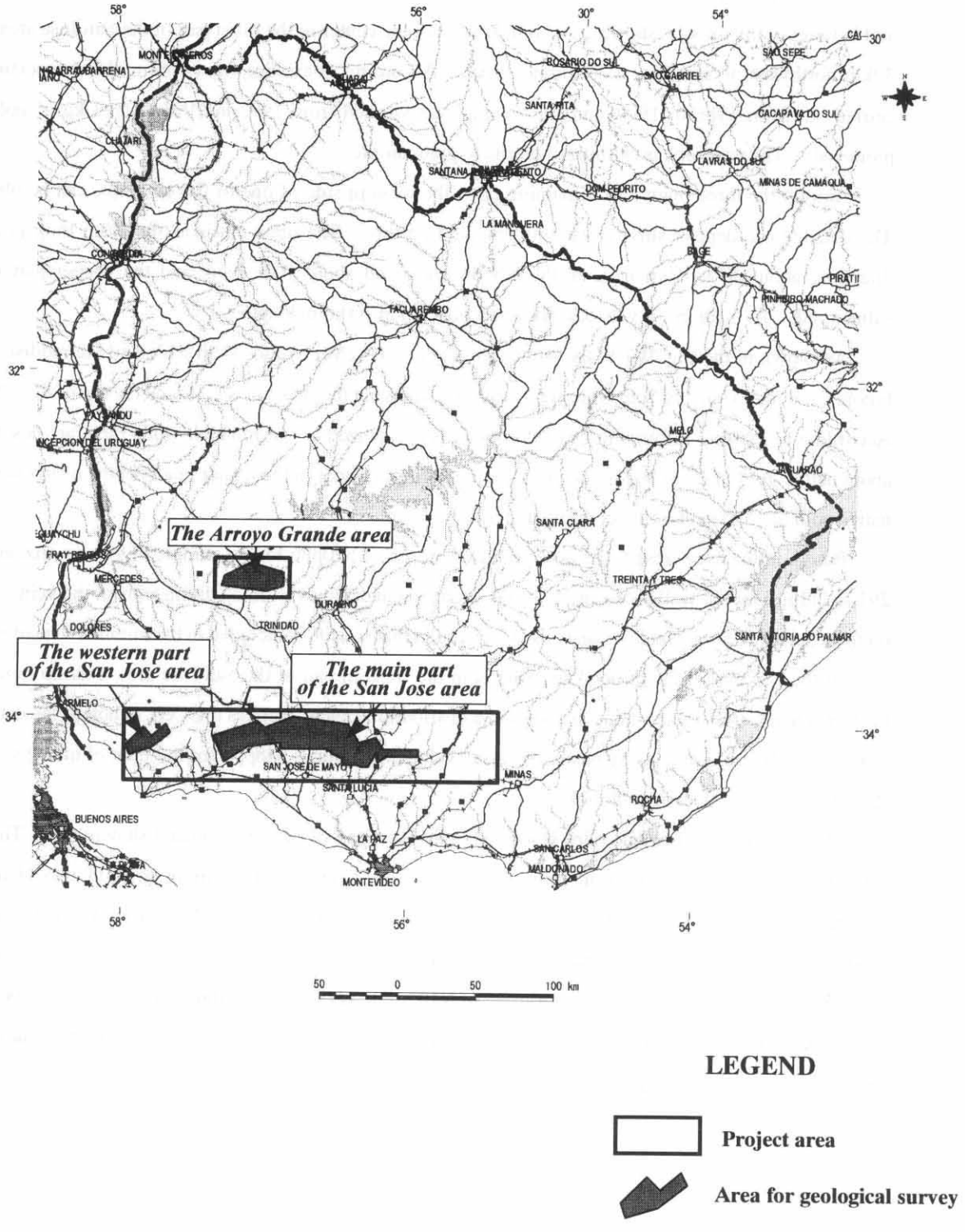
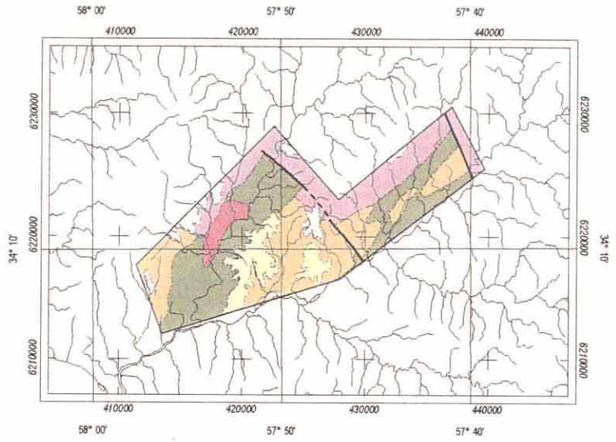
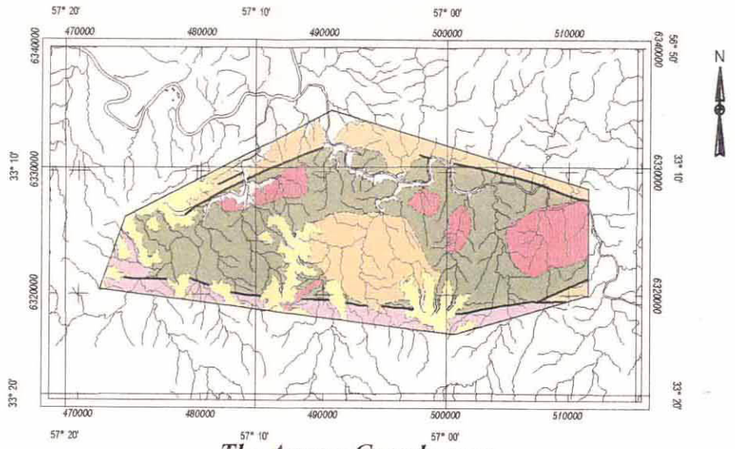


Fig.II-3-1 Location of the area for geological survey



The western part of the San Jose area



The Arroyo Grande area

LEGEND

Geology

Quaternary
Q

Tertiary
Tr

Cretaceous
KSa

Greenstone
pCCag
pCCsj
pCCps
pCCsjo

Basement complex
pCCcb
pCCanf

Granite intrusive rock(Transamazonian and Pre-transamazonian)
pCC

Granite intrusive rock(Pre-transamazonian)
pCCG

Dyke rock
dd
gb

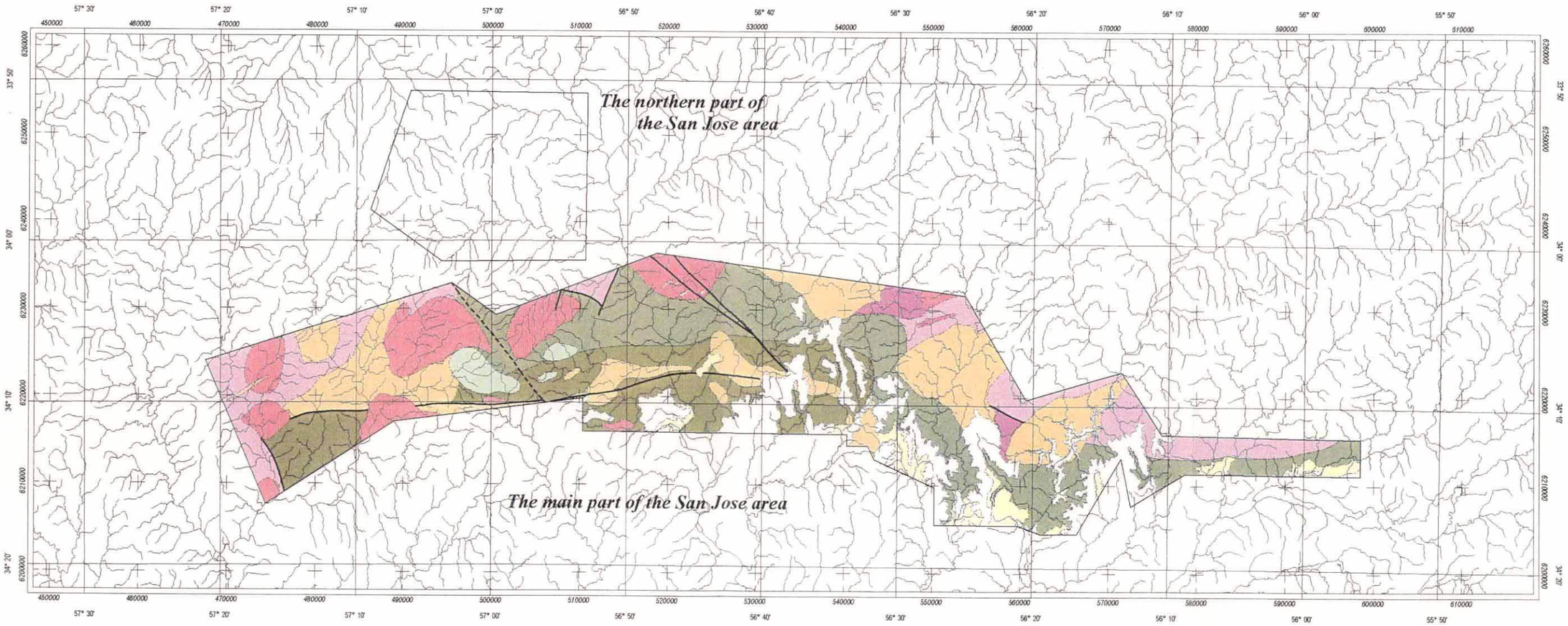
Geology and geochemical surveyed area

River

Fault

5 0 5 10 15 km

Projection : UTM
Zone 21
Spheroid WGS84



The northern part of the San Jose area

The main part of the San Jose area

Fig.II-3-2 Geological map

AGE (Ma)		UNITS	EVENTS	DOMAIN
1400? - 1800		Doleritic dykes	Distensive enviroments	
			CRATONIZATION	
1894 - 1925		Pintos granite (1845 Ma) Aplites and granitic dykes of A° de la Virgen		
2000		Mahoma granite (1930 Ma) Conchillas granite (1970 Ma) Granite - Gneissic Complex Minuano granite (2000 Ma) Carmelo granite (2015 Ma) Florida granite (2030 Ma)		*TRANSAMAZONIAN OROGENESIS*
2040	***pCC (pECy)****	Granitic dyke of Isla Mala Gabbroic Complex Mahoma - Guaycurú		
2070 - 2100			Metamorphism migmatization, granititation and folding	
2225		A° de la Virgen leucogranite	Late - orogenic	*PRE TRANSAMAZONIAN*
			MILONITIZATION	
2290		Isla Mala leucogranite		
2450		Isla Mala Granodiorite		
2500	***pCCps (pECps)**** ***pCCsjo (pECsjo)****	San José metamorphism belt with first big deformation phase older than 2500 Ma		*ARCHEAN*
?	***pCCcb (pECps)****	Complejo Basal		

* nomenclature used in the Carta Geológica del Uruguay. Escala 1:500,000 (1985)
Modified from Preciozzi, F.(1999). Petrography and Geochemistry of five Granitic Plutons from South - Central Uruguay: Contribution to the knowledge of the Piedra alta Terrane. Thesis, Universidad Quebec - Canadá.

Fig.II-3-3 Schematic stratigraphic column of the San Jose are

AGE (Ma)		UNITS	EVENTS	DOMAIN
1969		Leucogranite dykes		
2067		Leucogranite	III Deformational phase	*TRANSAMAZONIAN*
2180	***pCC (pECy)****	South Granite	Contemporaneous with Paso del Lugo Fault	*PRE TRANSAMAZONIAN*
2275 - 2386		Marincho main Granodiorite	II Deformational Phase	
2501 - 2557	***pCCag (pECag)****	Alkaline - Granite Blocks Arroyo Grande Belt Metamorphic Rocks	I Deformation Phase	*ARCHEAN*

* nomenclature used in the Carta Geológica del Uruguay. Escala 1:500,000 (1985)
Modified from Preciozzi, F.(1999). Petrography and Geochemistry of five Granitic Plutons from South - Central Uruguay: Contribution to the knowledge of the Piedra alta Terrane. Thesis, Universidad Quebec - Canadá.

Fig.II-3-4 Schematic stratigraphic column of the Arroyo Grande are

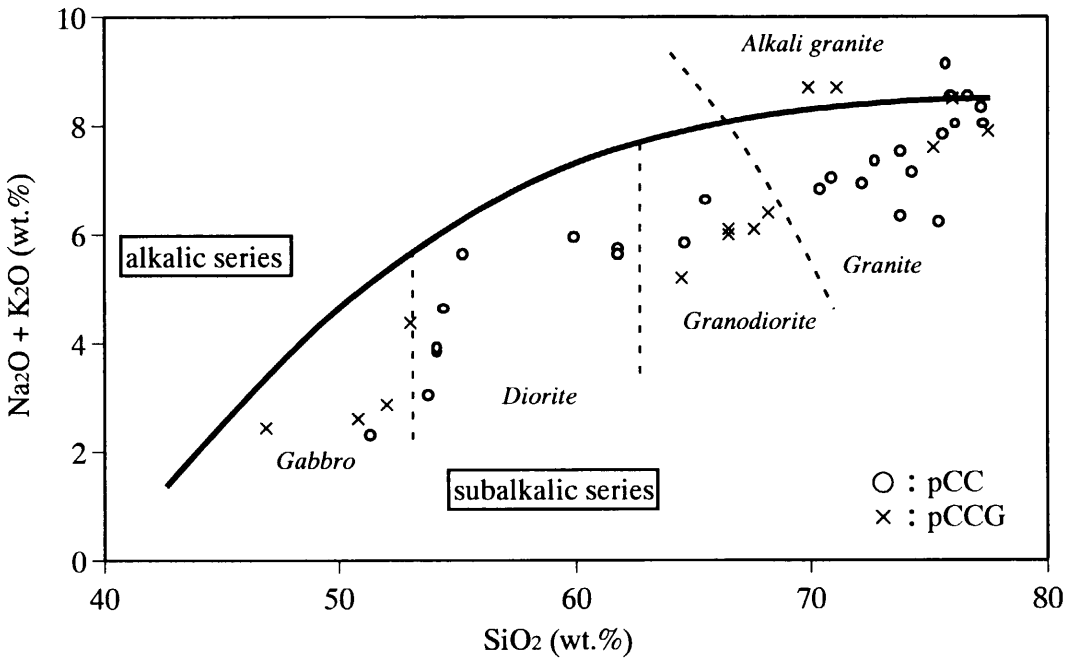


Fig.II-3-5 TAS diagram for granitic rocks

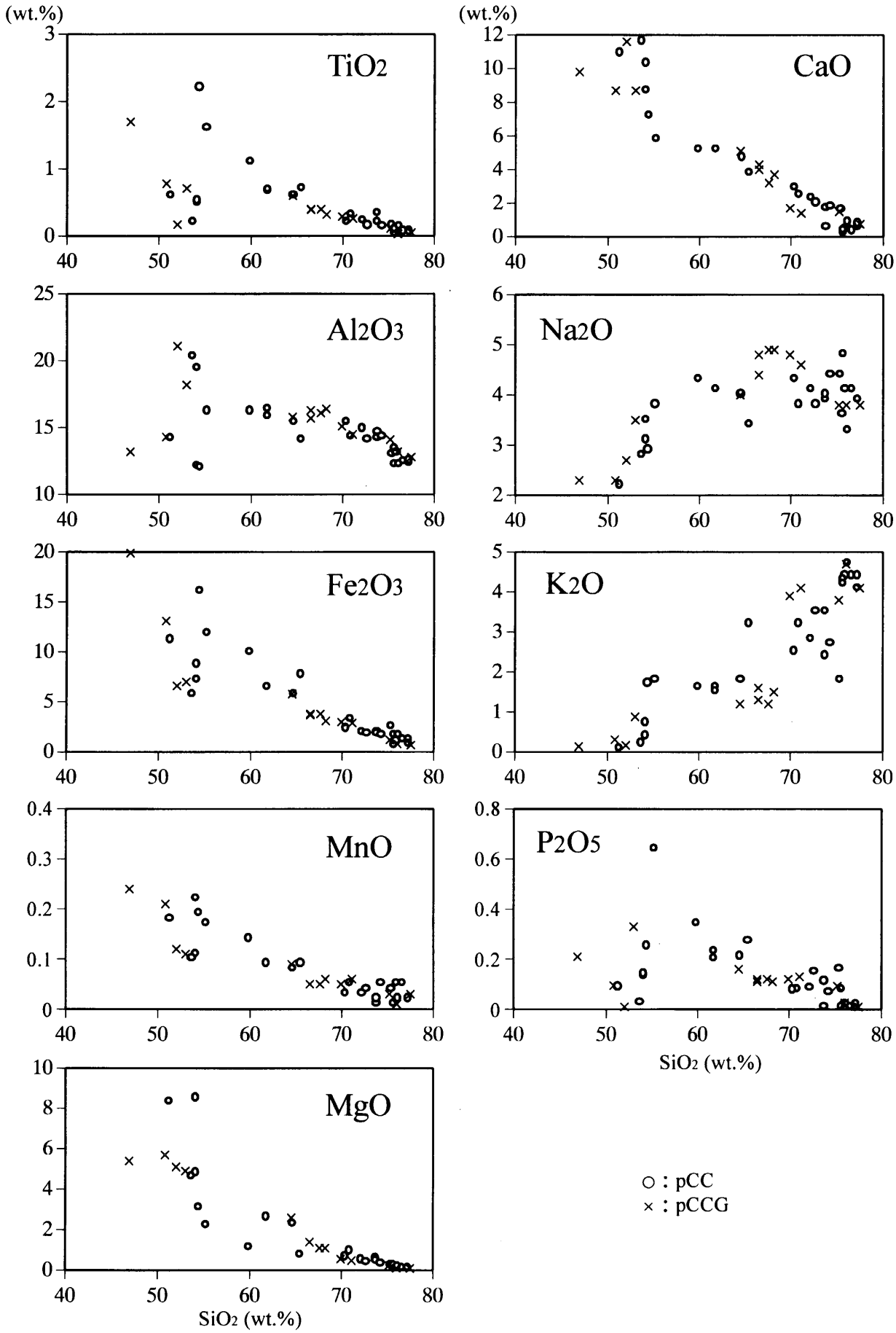
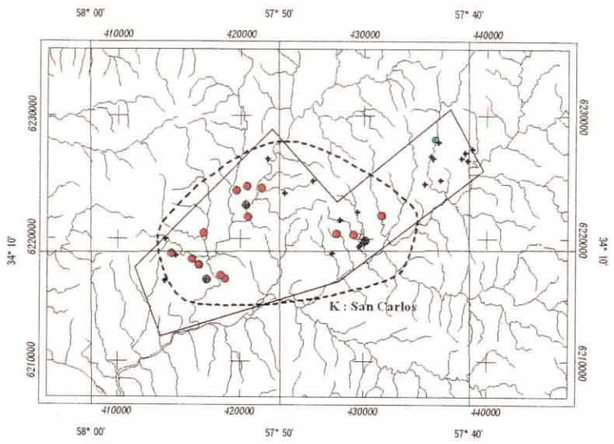
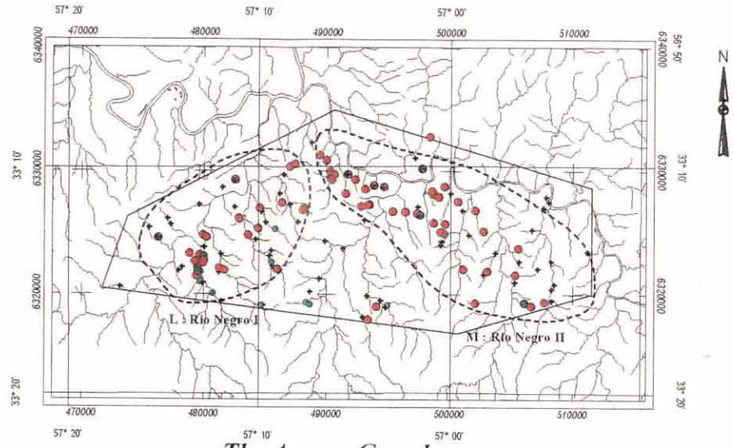


Fig.II-3-6 Harker variation diagrams for granitic rocks



The western part of the San Jose area



The Arroyo Grande area

LEGEND

- Quartz vein
- Green rock
- Others
- Quartz vein zone
- Geology and geochemical surveyed area
- River

5 0 5 10 15 km

Projection : UTM
Zone : 21
Spheroid : WGS84

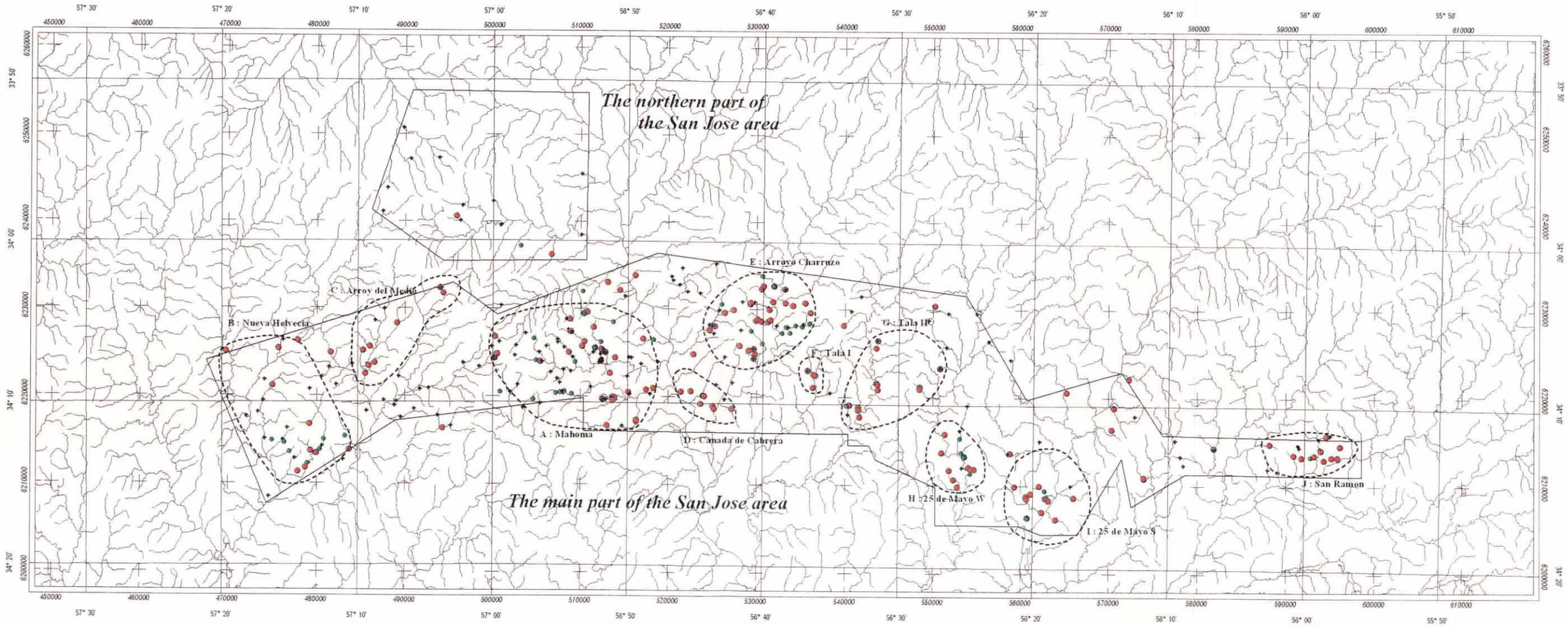


Fig.II-3-7 Location map of the quartz vein zones with location of geochemical rock samples

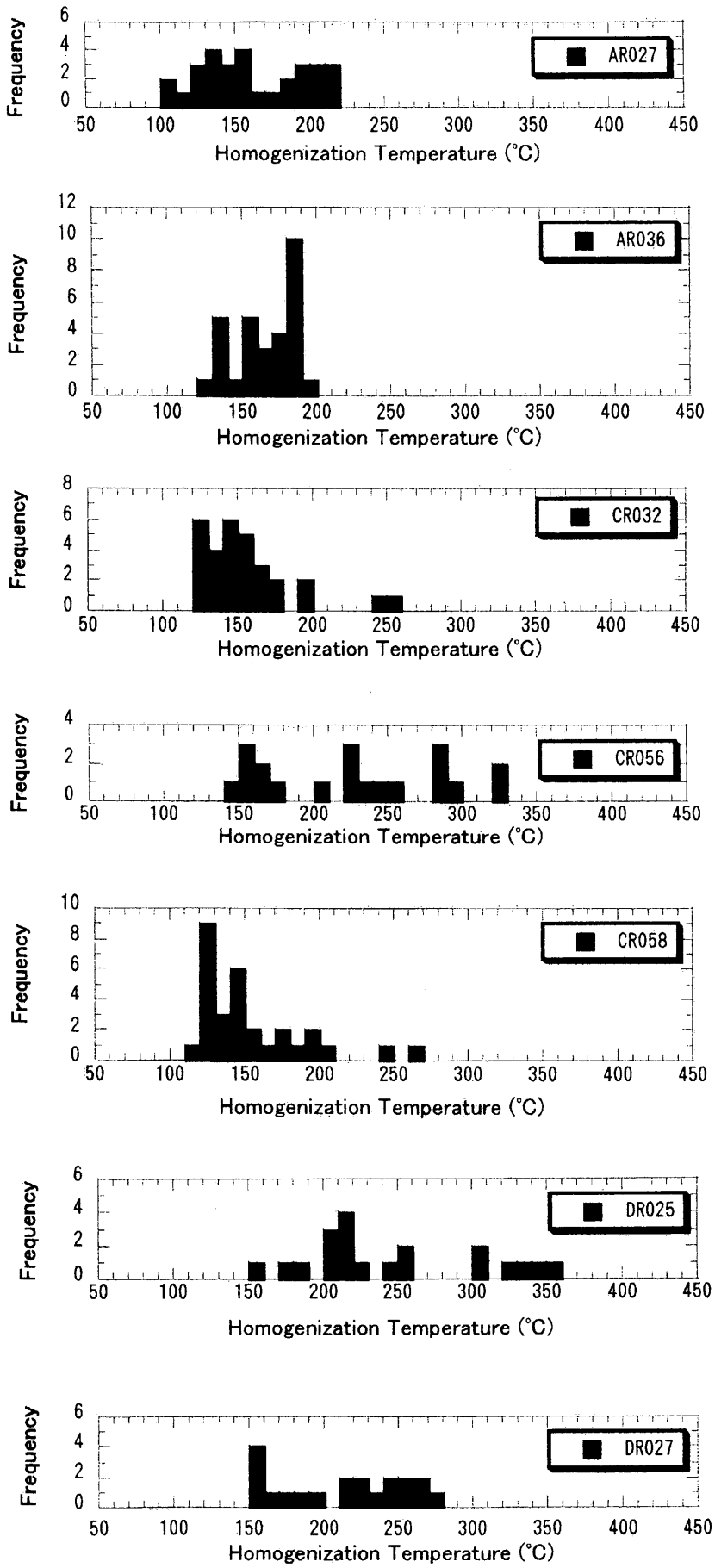


Fig.II-3-8 Histogram of fluid inclusions of quartz veins (1)

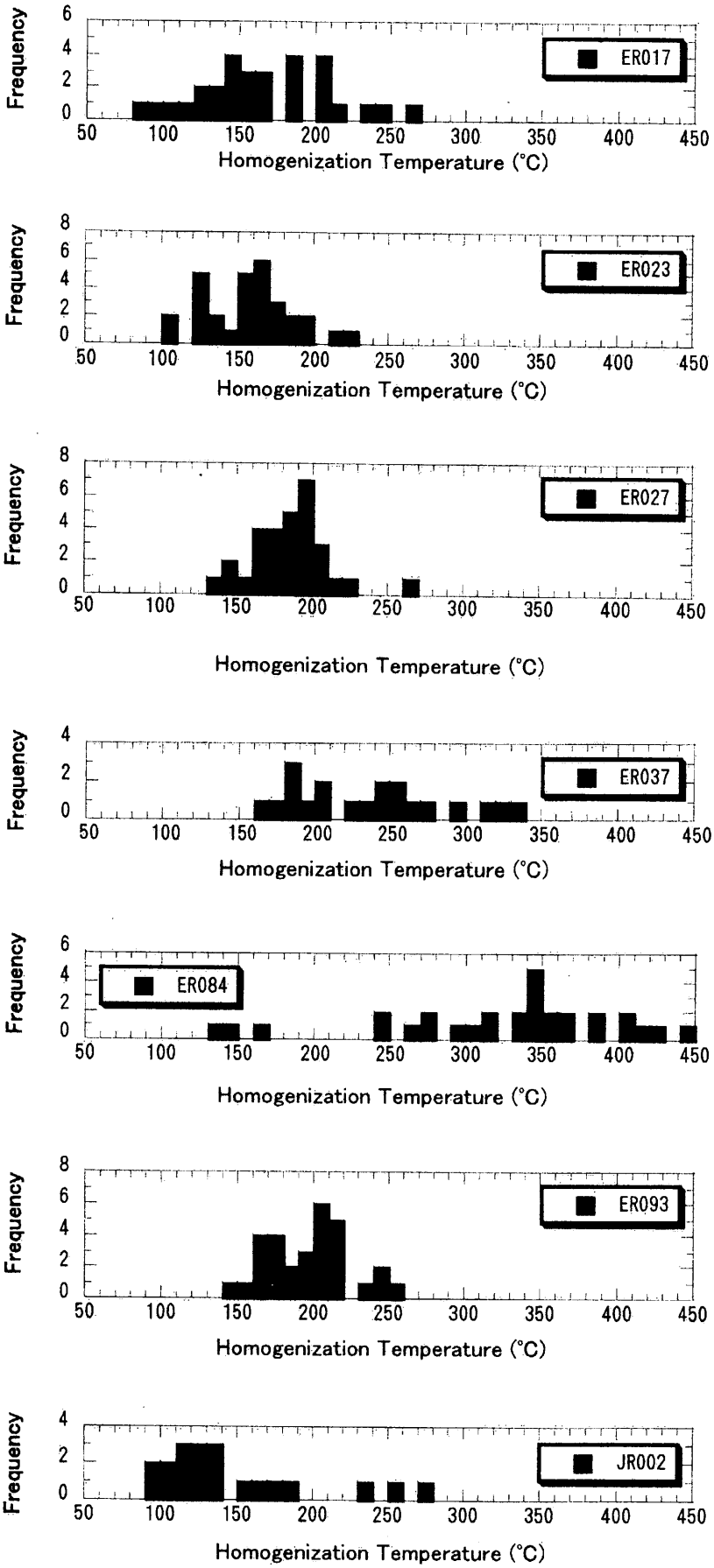
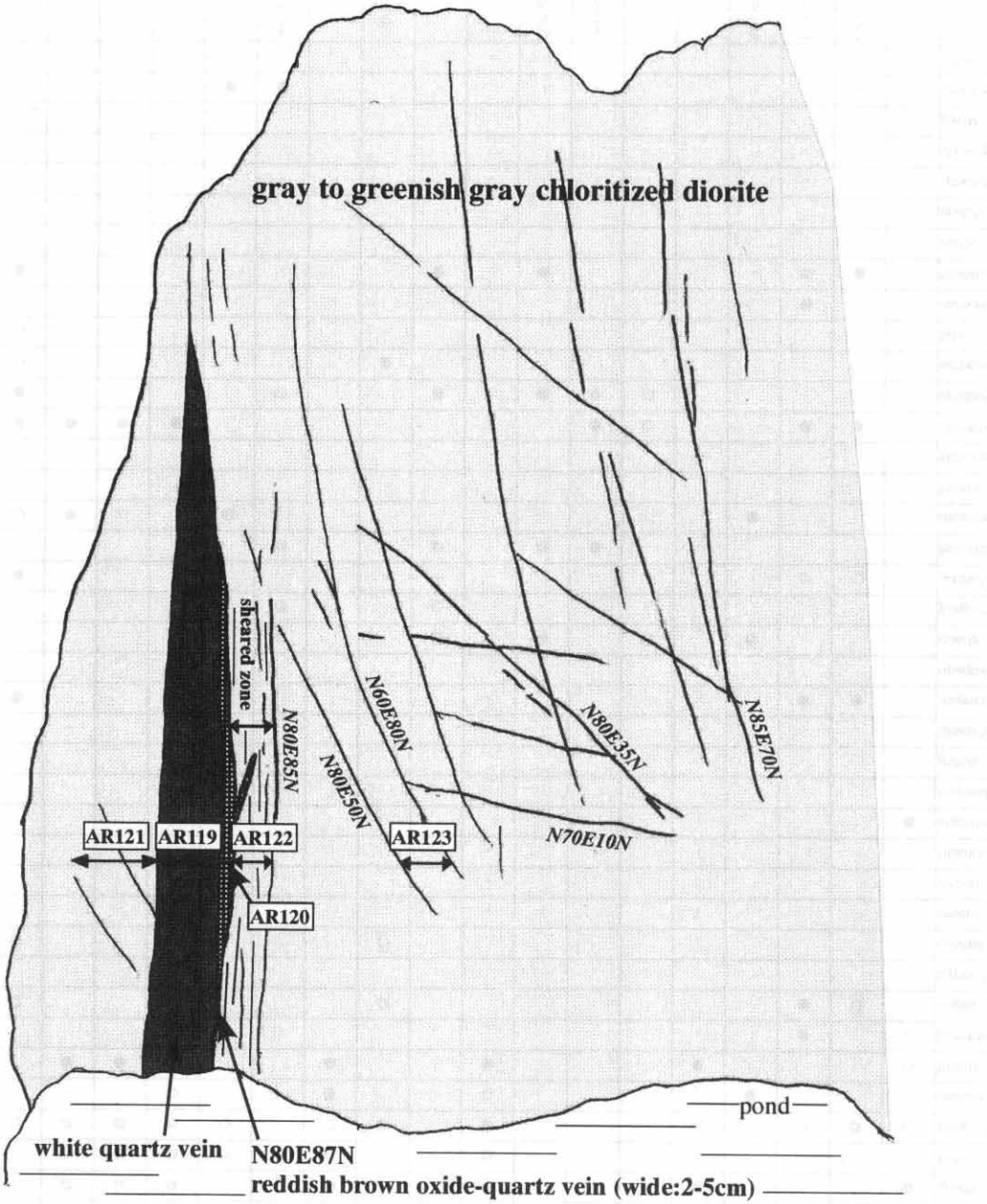


Fig.II-3-8 Histogram of fluid inclusions of quartz veins (2)



Sample No.	Au (ppb)
AR119	1520
AR120	1550
AR121	143
AR122	291
AR123	111

Fig.II-3-9 Geological sketch of quartz vein of the Mahoma mine

Tab. Ⅱ-3-1 Descriptions of thin sections (1)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Texture	Igneous Minerals and Phenocrysts																		Secondary and Metamorphic Minerals																				Remarks
						quartz	K-feldspar	plagioclase	muscovite	biotite	hornblende	augite	hypersthene	olivine	apatite	zircon	titanite	allanite	tourmaline	garnet	ilmenite	magnetite	opaque minerals	quartz	plagioclase	actinolite	hornblende	muscovite	biotite	sericite	chlorite	epidote	serpentine	talc	carbonate	titanite	rutile	apatite	limonite	chalcopyrite	pyrite	opaque minerals	others	
1	AR014	MS	quartz diorite	gb	porphyroclastic	◎		○		○	○					·		●				·								·				·				·					
2	AR016	MSJ	gabbro	gb	equigranular			◎				(○)										●				○				●				·	●						·		cataclastic
3	AR019	MSJ	diorite	pCCG	equigranular			◎			◎	●			·							●				○				●	·			●	●			·					poikilitic structure
4	AR022	MSJ	quartz schist	pCCcb	porphyroclastic				●	·						·								◎		·		●	·						·						·		schistose
5	AR023	MSJ	quartz diorite	pCCG	inequigranular	◎		○		●	·				·	·	·					·																					
6	AR026	MSJ	green schist	pCCps	inequigranular																			◎	·	·				○	○				·			·			·		
7	AR033	MSJ	epidote amphibolite	pCCps	equigranular																				·		◎			●	◎							·			·		completely recrystallized
8	AR043	MSJ	epidote amphibolite (metadolerite)	dd	equigranular																			◎	·	·	◎				●				●			·			·		fine grained
9	AR056	MSJ	biotite-muscovite granite	pCCG	inequant mosaic	◎	◎	◎	○	●					·	·	·					·																·				·	
10	AR059	MSJ	epidote amphibolite	pCCcb	porphyroblastic																			○	○	·	◎				●				●			·			·		
11	AR106	WSJ	olivine dolerite	pCCsj	subophitic			◎				◎		(○)							·	·				·				·		●	·										olivine occurs as phenocrysts
12	AR125	WSJ	mylonite (biotite-muscovite granite)	pCC	mylonitic, porphyroclastic	◎	◎	○	●	●										·	·													·				·					
13	AR126	MSJ	epidote amphibolite	pCCanf	inequigranular, porphyroclastic																			◎	◎		◎					○				·		·	·			●		weak schistose
14	AR127	AG	leucogranite	pCC	inequigranular	◎	◎	○																				○	·										·			●		
15	AR128	MSJ	mylonite(muscovite granite)	pCC	mylonitic, porphyroclastic	◎	◎	◎	○													·								●								·					
16	AR129	MSJ	biotite granite	pCC	inequigranular	◎	◎	◎	·	●					·	·						·								●								·					
17	BR001	MSJ	mylonite(biotite granite)	pCCG	mylonitic, porohyroclastic	◎	◎	◎	·	●					·						·	·						●			●				·	·			·					
18	BR006	MSJ	olivine gabbro	gb	inequigranular			○				◎		(◎)								●	·			●		○			●	●	○	○	·	●			·					
19	BR012	MSJ	mylonite(biotite granite)	pCCG	mylonitic, porohyroclastic	◎	◎	◎	○	(·)												·						○			○	○			·	○			·					
20	BR014	MSJ	muscovite granite	pCCG	porphyroclastic	◎	◎	◎	○	·																		●								·			·				strongly sheared

AG:The Arroyo Grande area, WSJ:The western part of the San Jose area, MSJ:The main part of the San Jose area

◎: abundant, ○: commonn, ●: a little, ·: rare, ( ): pseudomorph

Tab. Ⅱ-3-1 Descriptions of thin sections (2)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Texture	Igneous Minerals and Phenocrysts																		Secondary and Metamorphic Minerals																				Remarks
						quartz	K-feldspar	plagioclase	muscovite	biotite	hornblende	augite	hypersthene	olivine	apatite	zircon	titanite	allanite	tourmaline	garnet	ilmenite	magnetite	opaque minerals	quartz	plagioclase	actinolite	hornblende	muscovite	biotite	sericite	chlorite	epidote	serpentine	talc	carbonate	titanite	rutile	apatite	limonite	chalcopyrite	pyrite	opaque minerals	others	
21	BR015	MSJ	olivine gabbro	gb	inequigranular			◎				◎		(◎)								○									●	·	○	◎	●	●			·			·		
22	BR020	MSJ	biotite granite	pCC	mosaic	◎	◎	○	·	○					·	·	·																	·								·	clay mineral
23	BR029	MSJ	green rock	pCCsjo	equigranular																			○	○							◎			◎	◎						○		greenschist facies
24	BR035	MSJ	muscovite-biotite granite	pCC	inequigranular	◎	○	◎	●	○					·	·	·					·																						slightly deformed
25	BR039	MSJ	greenschist (metabasalt)	pCCps	blastoporphyritic											·									◎	◎				●	●			·	·		·	·					greenschist facies
26	BR041	MSJ	biotite-albite-quartz-cordierite schist (metasedimentary rock)	pCCps	porphyroblastic																			◎				◎									·				○	◎	cordierite porphyroblasts
27	BR042	MSJ	hornblende granodiorite	pCC	inequigranular	◎	○	◎			◎				·							●						·			●	○			·								poikilitic structure
28	BR043	MSJ	leucogranite	pCC	inequigranular	◎	◎	◎	·	·					·							●						·			·	·			·				·				slightly deformed
29	CR001	MSJ	granodiorite	pCCG	inequant mosaic	◎		◎		·	◎				·							●																						slightly deformed
30	CR005	MSJ	pelitic schist	pCCsjo	porphyroclastic	◎			·						·								◎																						
31	CR009	MSJ	epidote amphibolite	pCCsjo	porphyroblastic, nematoblastic																			◎	◎	●	○	·				◎				·			·			·		
32	CR010	MSJ	metagabbro	pCCps	blastoporphyritic																					●					◎	◎			◎	○		·	·				○	
33	CR016	MSJ	mylonite (biotite-muscovite granite)	pCC	mylonitic, porpyroclastic	◎	◎	○	○	●						·						·												·				·					
34	CR017	MSJ	biotite granite	pCC	inequigranular	◎	◎	◎	·	○												·												·				·	·				
35	CR018	MSJ	amphibolite	pCCps	nematoblastic																			◎	○		◎										·				○		weak foliation
36	CR024	MSJ	olivine gabbronortie	gb	inequigranular			◎			●	◎	●	○								·																·				·	weakly deformed
37	CR025	MSJ	gabbro	gb	inequigranular			◎				◎										·				◎					●			·	·			·					well laminated
38	CR026	MSJ	gabbro	gb	inequigranular			◎				◎										·				◎					●			·	·			·					well laminated
39	CR027	MSJ	hornblende-bearing olivine gabbronorite	gb	inequigranular, poikilitic			◎			●	◎	○	◎	·							●				·							●	●	·					·		weakly laminated
40	CR029	MSJ	biotite granodiorite	pCC	inequigranular	◎	◎	◎	·	○	·				·	·		·				●								·	●			·				·					slightly deformed

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Tab. Ⅱ-3-1 Descriptions of thin sections (3)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Texture	Igneous Minerals and Phenocrysts																		Secondary and Metamorphic Minerals																				Remarks
						quartz	K-feldspar	plagioclase	muscovite	biotite	hornblende	augite	hypersthene	olivine	apatite	zircon	titanite	allanite	tourmaline	garnet	ilmenite	magnetite	opaque minerals	quartz	plagioclase	actinolite	hornblende	muscovite	biotite	sericite	chlorite	epidote	serpentine	talc	carbonate	titanite	rutile	apatite	limonite	chalcopyrite	pyrite	opaque minerals	others	
41	CR030	MSJ	biotite microgranite	pCCG	inequant mosaic	◎	○	◎	·	◎					·	·	·													·	·			·				·						
42	CR036	MSJ	biotite granite	pCC	inequant mosaic	◎	◎	◎	·	◎					·	·	·					·									●											·	·	biotite altered to clay mineral
43	CR037	MSJ	hornblende-biotite-quartz diorite	pCC	inequigranular	○		◎		◎	○				·	·	·				·	●									·										·		clay mineral after biotite
44	CR040	MSJ	gabbro	dd	granophyric	●	●	◎		·	●	◎			·							◎																					ferroaugite bearing
45	CR046	MSJ	biotite tonalite	pCC	inequigranular	●	○	◎		◎	●				·	·						·												·									poikilitic structure
46	CR048	MSJ	epidote amphibolite (metadolerite)	dd	blastoporphyritic																			·	◎		◎				○			·	·			·			●		recrystallized groundmass
47	CR059	MSJ	mylonitic leucogranite or aplite	pCC	mylonitic, porphyroclastic	◎	◎	●	·	·					·		·					·																·				·	clay mineral after biotite
48	CR061	MSJ	mylonite (granite)	pCCcb	mylonitic, porphyroclastic	◎	●	○	·						·						·	·									·				·				·				
49	CR099	AG	olivine gabbronorite	pCCcb	inequigranular			◎				◎	○	◎	·							·														·				·				
50	CR126	WSJ	gabbro (gabbronorite)	pCCG	inequigranular	·		◎			·	◎	○									●				·		·				·				·				·				
51	DR001	MSJ	coarse dolerite or gabbro	pCCps	doleritic, blastoporphyritic			(◎)				◎										·			◎	◎					○	○			●	○			●				
52	DR004	MSJ	muscovite-quartz schist	pCCsjo	porphyroblastic																			◎				◎							○	●		·	◎			(◎)		schistose
53	DR006	MSJ	metadolerite	gb	intersertal			(◎)				(◎)										●		●	◎	◎					●	◎				○			●				●	greenschist facies
54	DR009	MSJ	muscovite-quartz schist	pCCps	lepidoblastic	●		○																◎	◎			◎	○										●		○		schistose
55	DR028	MSJ	quartz-plagioclase porphyry	pCCps	porphyritic																			◎	◎			◎							·	●			●				aphanitic groundmass
56	DR034	MSJ	muscovite-quartz schist	pCCsjo	porpyroclastic																			◎	◎				·		·				●	·		·	○			○		schistose
57	ER003	MSJ	muscovite-calcite-quartz schist (metasedimentary rock)	pCCps	mosaic																			◎	◎			●			●				◎	·	●	·	·			·		calcareous
58	ER025	MSJ	mylonite(granodiorite)	pCCG	porphyroclastic																			◎	◎			●			●	·			●	●		·	·					
59	ER058	MSJ	garnet-biotite-hornblende gabbro	pCCsjo	equigranular		○	◎	·	◎	◎				·	·				◎	·	●						·				·				·				·				
60	ER076	AG	muscovite-biotite granite	pCC	inequant mosaic	◎	◎	◎	●	○					·	·						·																						

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◎: abundant, ○: commonn, ●: a little, ·: rare, ( ): pseudomorph

Tab. Ⅱ-3-1 Descriptions of thin sections (4)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Texture	Igneous Minerals and Phenocrysts																	Secondary and Metamorphic Minerals																		Remarks
						quartz	K-feldspar	plagioclase	muscovite	biotite	hornblende	augite	hypersthene	olivine	apatite	zircon	titanite	allanite	tourmaline	garnet	ilmenite	magnetite	opaque minerals	quartz	plagioclase	actinolite	hornblende	muscovite	biotite	sericite	chlorite	epidote	serpentine	talc	carbonate	titanite	rutile	apatite	limonite	chalcopyrite	pyrite	opaque minerals	others	
61	ER077	AG	muscovite-quartz schist (metarhyolite)	pCCag	porphyroclastic																			◎	●			○								·		·	·			·	●	schistose
62	FR008	MSJ	biotite-hornblende granite	pCC	inequigranular	◎	◎	◎		○	○				·		·					·								·	●							·					
63	FR010	MSJ	biotite granite	pCCbc	inequigranular	◎	◎	○	·	○					·							●									·	●				●			·					weak foliation
64	FR011	MSJ	mylonite (muscovite-biotite granite)	pCC	mylonitic, porphyroclastic	◎	◎	○	·	○					·							·									·				·	·			·					
65	GR 004	MSJ	muscovite-biotite granite	pCCG	blastoporphyritic	◎	◎	○	·	○							●					·									·	●							·					
66	GR 017	MSJ	chlorite-epidote schist (metabasalt)	pCCps	equigranular																			◎		·					◎	◎			·	◎			·					greenschist facies
67	GR 021	MSJ	quartz-hornblende gabbro	pCCG	inequigranular	◎		(◎)		(●)	◎				·							·				●		◎			●	◎				●			·					poikilitic structure

AG:The Arroyo Grande area, WSJ:The western part of the San Jose area, MSJ:The main part of the San Jose area

◎: abundant, ○: commonn, ●: a little, ·: rare, ( ): pseudomorph

Tab. Ⅱ-3-2 Results of whole rock analysis (1)

Ser. No.	Sample No.	Area	Rock Name	Geol.Unit	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	P_2O_5	LOI	Total
1	AR014	MSJ	diorite	gb	65.40	0.36	16.80	3.80	0.05	1.50	4.70	4.50	1.40	< 0.01	0.130	0.78	99.42
2	AR019	MSJ	diorite	pCCG	46.90	1.70	13.20	19.90	0.24	5.40	9.80	2.30	0.14	< 0.01	0.210	0.26	100.05
3	AR026	MSJ	green schist	pCCps	53.80	1.30	16.00	11.60	0.17	5.30	5.50	3.60	0.03	0.02	0.400	3.17	100.89
4	AR033	MSJ	amphibolite	pCCps	49.20	0.94	14.00	13.20	0.19	6.90	11.40	1.80	0.10	0.03	0.083	2.36	100.20
5	AR042	MSJ	granodiorite	pCC	75.50	0.15	13.00	2.50	0.04	0.22	1.60	4.40	1.80	< 0.01	0.160	0.87	100.24
6	AR043	MSJ	amphibolite	dd	61.50	0.82	10.30	11.80	0.11	3.20	11.30	0.46	0.04	0.05	0.310	0.37	100.26
7	AR045	MSJ	granodiorite	pCC	61.90	0.66	15.80	6.40	0.09	2.60	5.20	4.10	1.60	0.03	0.230	0.61	99.22
8	AR055	MSJ	leucocratic granite	pCCG	77.50	0.05	12.80	0.69	0.03	< 0.10	0.75	3.80	4.10	< 0.01	< 0.010	0.22	99.94
9	AR056	MSJ	leucocratic granite	pCCG	76.00	0.03	13.20	0.81	0.01	0.11	0.47	3.80	4.70	< 0.01	0.026	0.36	99.52
10	AR059	MSJ	amphibolite	pCCcb	48.90	0.78	16.20	12.40	0.21	5.50	13.60	1.50	0.12	0.01	0.094	0.45	99.76
11	AR080	AG	granodiorite	pCC	65.60	0.71	14.10	7.70	0.09	0.76	3.80	3.40	3.20	0.03	0.270	0.37	100.03
12	AR125	WSJ	granite(mylonite)	pCC	76.70	0.06	12.40	1.20	0.05	< 0.10	0.33	4.10	4.40	< 0.01	< 0.010	0.40	99.64
13	AR126	MSJ	amphibolite	pCCanf	57.10	0.81	16.60	8.00	0.13	2.70	9.90	3.10	0.25	< 0.01	0.240	0.39	99.22
14	AR127	AG	granite	pCC	73.90	0.34	14.60	1.90	0.01	0.56	0.53	3.90	2.40	< 0.01	< 0.010	1.65	99.79
15	AR128	MSJ	granite(mylonite)	pCC	76.00	0.04	13.10	0.98	0.05	0.10	0.49	4.10	4.40	< 0.01	0.018	0.58	99.86
16	AR129	MSJ	granite	pCC	77.30	0.06	12.30	1.20	0.02	< 0.10	0.52	3.90	4.40	< 0.01	< 0.010	0.48	100.18
17	BR001	MSJ	granite(mylonite)	pCCG	66.50	0.39	15.70	3.70	0.05	1.40	4.00	4.40	1.60	0.02	0.110	1.85	99.72
18	BR012	MSJ	granite(mylonite)	pCCG	67.60	0.40	16.10	3.80	0.05	1.10	3.20	4.90	1.20	0.01	0.120	1.51	99.99
19	BR015	MSJ	gabbro	gb	50.00	0.51	13.00	11.10	0.18	9.80	10.40	1.40	1.20	0.12	0.066	2.20	99.98
20	BR020	MSJ	granite	pCC	71.00	0.31	14.30	3.20	0.05	0.93	2.50	3.80	3.20	0.03	0.080	0.34	99.74
21	BR029	MSJ	green rock	pCCsjo	49.00	1.30	14.80	13.20	0.18	5.20	8.60	2.00	0.03	0.01	0.200	5.10	99.62
22	BR035	MSJ	granite	pCC	73.90	0.21	14.20	1.80	0.02	0.44	1.70	4.00	3.50	< 0.01	0.110	0.24	100.12
23	BR042	MSJ	granodiorite	pCC	54.20	0.49	12.10	8.70	0.22	8.50	10.30	3.10	0.72	0.05	0.130	1.31	99.82
24	BR043	MSJ	granite	pCC	75.80	0.04	13.40	0.67	0.01	< 0.10	0.22	4.80	4.30	< 0.01	< 0.010	0.28	99.52
25	CR001	MSJ	granodiorite	pCCG	50.80	0.78	14.30	13.10	0.21	5.70	8.70	2.30	0.31	< 0.01	0.095	2.99	99.29
26	CR010	MSJ	metagabbro	pCCps	49.90	0.83	14.20	12.00	0.18	7.50	5.20	2.10	0.12	0.06	0.093	7.54	99.72
27	CR016	MSJ	granite(mylonite)	pCC	51.40	0.60	14.20	11.20	0.18	8.30	10.90	2.20	0.08	0.04	0.087	0.33	99.52
28	CR017	MSJ	granite	pCC	75.70	0.10	12.20	1.60	0.01	0.23	0.39	3.60	4.20	< 0.01	0.080	0.56	98.67
29	CR018	MSJ	amphibolite	pCCps	57.30	1.40	11.70	16.70	0.22	2.00	7.00	2.00	0.51	0.01	0.550	0.33	99.72
30	CR024	MSJ	gabbro	gb	49.30	0.19	20.30	8.40	0.11	8.40	10.00	2.80	0.13	0.02	0.017	0.02	99.69

AG:The Arroyo Grande area, WSJ:The western part of the San Jose area, MSJ:The main part of the San Jose area, NSJ: The northern part of the San Jose area

(wt. %)

Tab. Ⅱ-3-2 Results of whole rock analysis (2)

Ser. No.	Sample No.	Area	Rock Name	Geol.Unit	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	P_2O_5	LOI	Total
31	CR026	MSJ	gabbro	gb	51.10	0.24	17.10	5.50	0.11	7.60	14.60	2.30	0.12	0.05	< 0.010	1.23	99.95
32	CR027	MSJ	gabbro	gb	75.70	0.03	12.90	1.10	0.06	< 0.10	0.50	4.10	4.50	0.02	0.023	0.47	99.40
33	CR029	MSJ	granodiorite	pCC	70.50	0.21	15.40	2.30	0.03	0.65	2.90	4.30	2.50	0.02	0.075	0.39	99.28
34	CR036	MSJ	granite	pCC	76.20	0.14	12.20	1.60	0.02	0.16	0.86	3.30	4.70	< 0.01	0.020	0.22	99.42
35	CR037	MSJ	diorite	pCC	55.30	1.60	16.20	11.80	0.17	2.20	5.80	3.80	1.80	< 0.01	0.640	0.41	99.72
36	CR040	MSJ	micro gabbro	dd	53.10	2.20	12.10	17.00	0.20	3.10	7.30	2.60	1.60	< 0.01	0.240	< 0.01	99.44
37	CR045	MSJ	gabbro	pCC	54.50	2.20	12.00	16.10	0.19	3.10	7.20	2.90	1.70	0.01	0.250	< 0.01	100.15
38	CR046	MSJ	granite(tonalite)	pCC	60.00	1.10	16.20	9.90	0.14	1.10	5.20	4.30	1.60	< 0.01	0.340	0.02	99.90
39	CR047	MSJ	granite	pCC	64.70	0.60	15.40	5.70	0.08	2.30	4.70	4.00	1.80	< 0.01	0.210	0.72	100.21
40	CR048	MSJ	amphibolite	dd	49.70	0.94	14.80	14.00	0.20	7.60	11.20	1.00	0.04	0.03	0.070	0.63	100.21
41	CR051	MSJ	granite	pCC	54.20	0.52	19.40	7.20	0.11	4.80	8.70	3.50	0.39	0.01	0.140	1.00	99.97
42	CR055	MSJ	granite	pCCG	71.10	0.26	14.50	2.90	0.06	0.48	1.40	4.60	4.10	< 0.01	0.130	0.49	100.02
43	CR057	MSJ	granite	pCCG	69.90	0.29	15.10	3.00	0.05	0.56	1.70	4.80	3.90	< 0.01	0.120	0.44	99.86
44	CR059	MSJ	granite	pCC	77.40	0.05	12.50	0.80	0.02	< 0.10	0.77	3.90	4.10	< 0.01	0.021	0.23	99.79
45	CR060	MSJ	granite	pCCG	75.20	0.11	14.10	1.20	0.03	0.25	1.50	3.80	3.80	< 0.01	0.093	0.43	100.51
46	CR061	MSJ	granite(mylonite)	pCCcb	77.30	0.06	12.90	0.68	0.02	< 0.10	0.61	4.10	4.00	< 0.01	0.018	0.20	99.89
47	CR125	WSJ	granodiorite	pCC	53.80	0.21	20.30	5.70	0.10	4.60	11.60	2.80	0.21	< 0.01	0.025	0.80	100.15
48	CR126	WSJ	gabbro	pCCG	52.00	0.17	21.10	6.60	0.12	5.10	11.60	2.70	0.17	< 0.01	< 0.010	0.29	99.85
49	DR028	MSJ	porphyry	pCCps	76.30	0.02	13.90	0.87	0.01	< 0.10	0.10	3.70	4.40	< 0.01	0.026	0.73	100.06
50	ER003	MSJ	quartz schhist	pCCps	57.70	0.61	14.80	6.30	0.08	3.20	5.90	0.97	1.80	< 0.01	0.150	7.77	99.28
51	ER030	MSJ	granite	pCCG	64.50	0.60	15.80	5.80	0.09	2.60	5.10	4.00	1.20	< 0.01	0.160	0.53	100.38
52	ER051	MSJ	granodiorite	pCCG	66.50	0.40	16.30	3.80	0.05	1.40	4.30	4.80	1.30	< 0.01	0.120	1.20	100.17
53	ER058	MSJ	gabbro	pCCsjo	41.70	2.60	17.30	18.90	0.23	7.00	8.10	1.50	2.30	0.07	0.490	0.50	100.69
54	ER076	AG	granite	pCC	72.30	0.22	14.90	1.90	0.03	0.49	2.30	4.10	2.80	0.03	0.083	0.39	99.54
55	ER077	AG	meta rhyolite	pCCag	75.50	0.03	13.50	1.50	0.06	0.10	0.70	4.10	3.60	0.02	0.048	0.39	99.55
56	FR008	MSJ	granite	pCC	61.90	0.69	16.40	6.40	0.09	2.60	5.20	4.10	1.50	< 0.01	0.200	0.67	99.75
57	FR010	MSJ	granite	pCCbc	67.00	0.56	15.60	5.90	0.26	2.40	1.60	2.10	2.20	0.03	0.140	1.71	99.50
58	FR011	MSJ	granite(mylonite)	pCC	72.80	0.15	14.10	1.80	0.04	0.37	2.00	3.80	3.50	< 0.01	0.150	0.52	99.23
59	FR012	MSJ	granite	pCC	74.40	0.14	14.30	1.60	0.05	0.31	1.80	4.40	2.70	< 0.01	0.066	0.72	100.49
60	GR021	MSJ	gabbro	pCCG	53.00	0.71	18.20	7.00	0.11	4.90	8.70	3.50	0.88	0.03	0.330	1.87	99.23
61	GR055	NSJ	granodiorite	pCCG	68.20	0.32	16.40	3.10	0.06	1.10	3.70	4.90	1.50	0.03	0.110	0.56	99.98

AG:The Arroyo Grande area, WSJ:The western part of the San Jose area, MSJ:The main part of the San Jose area, NSJ: The northern part of the San Jose area (wt. %)

Tab. Ⅱ-3-3 Results of radiometric dating

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Sample Type	Potassium (K wt%)	Rad. ^{40}Ar (10^{-8}cc/g)	K-Ar age (Ma)	Air Cont. (%)
1	AR125	The western part of the San Jose area	granite	pCC	whole rock	3.12 ± 2	34000 ± 1700	1690 ± 120	1.4
2	AR126	The main part of the San Jose area	amphibolite	pCCanf	whole rock	0.17 ± 10	2420 ± 120	2000 ± 280	1.8
3	AR127	The Arroyo Grande area	granite	pCC	whole rock	1.76 ± 2	24700 ± 1200	1980 ± 130	1.9
4	AR128	The main part of the San Jose area	granite	pCC	whole rock	4.09 ± 2	28200 ± 1400	1240 ± 100	0.9
5	AR129	The main part of the San Jose area	granite	pCC	whole rock	3.41 ± 2	3900 ± 2000	1750 ± 120	0.9
6	BR001	The main part of the San Jose area	granite	pCCG	whole rock	1.16 ± 2	16000 ± 800	1960 ± 140	1.0

$\lambda\varepsilon = 0.581\times10^{-10}$ /year, $\lambda\beta = 4.962\times10^{-10}$ /year

$^{40}K/K = 0.01167$ atom%

Tab. Ⅱ-3-4 Results of X-ray diffractive analysis (1)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Detected Minerals												
					quartz	K-feldspar	albite	chlorite/smectite	chlorite	sericite	calcite	muscovite	hornblende	epidote	pyrite	hematite	goethite
1	AR026	The main part of the San Jose area	green schist	pCCps	◎		◎		◎					△			
2	AR032	The main part of the San Jose area	green schist	pCCps	◎		◎		◎	tr							
3	AR039	The main part of the San Jose area	green schist	pCCps	◎		◎		◎	tr	▲			▲			
4	AR041	The main part of the San Jose area	green rock	pCCps	◎		◎		◎		▲						
5	AR047	The main part of the San Jose area	metabasalt	pCCps	◎		○		◎				◎	△			
6	AR054	The main part of the San Jose area	metabasalt	pCCps	○		○		◎				◎	○			
7	AR120	The main part of the San Jose area	quartz vein	pCCG	◎		△		△	◎							
8	BR030	The main part of the San Jose area	green rock	pCCsjo	◎		◎		◎	○							
9	BR031	The main part of the San Jose area	quartz schist	pCCsjo	◎		◎			◎							
10	BR032	The main part of the San Jose area	green rock	pCCsjo	◎		○		◎		△						
11	BR033	The main part of the San Jose area	black schist	pCCsjo	◎		○	◎				◎					
12	BR034	The main part of the San Jose area	green rock	pCCsjo	◎		◎		◎	▲	◎						
13	BR036	The main part of the San Jose area	green schist	pCCsjo	◎	◎							◎				
14	BR037	The main part of the San Jose area	green schist	pCCsjo	◎		◎		△	◎	△						
15	BR038	The main part of the San Jose area	green schist	pCCps	◎		◎		◎	○					○		
16	BR039	The main part of the San Jose area	green schist	pCCps			◎		△				◎				
17	BR040	The main part of the San Jose area	green schist	pCCps	◎		◎		◎	○					○		
18	BR041	The main part of the San Jose area	green schist	pCCps	◎		△		△	◎					△		
19	BR055	The Arroyo Grande area	green schist	pCCag	◎		○			◎							
20	CR019	The main part of the San Jose area	black chert	pCCps	◎											△	tr

◎: >1000 cps, ○: 500-1000 cps, △: 200-500 cps, ▲: 100-200 cps , tr: <100 cps

Tab. Ⅱ-3-4 Results of X-ray diffractive analysis (2)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Detected Minerals												
					quartz	K-feldspar	albite	chlorite/smectite	chlorite	sericite	calcite	muscovite	hornblende	epidote	pyrite	hematite	goethite
21	CR048	The main part of the San Jose area	metadiorite	pCC	△		○		tr				◎				
22	CR123	The western part of the San Jose area	granite	pCCG			◎		△				◎				
23	DR037	The main part of the San Jose area	quartz vein	pCCsjo	◎											△	tr
24	DR041	The main part of the San Jose area	slate	pCCps	◎		○		○	○					▲		
25	ER029	The main part of the San Jose area	green schist	pCCsjo	◎		△		◎					◎			
26	GR013	The main part of the San Jose area	green schist	pCCsjo	◎		◎		◎	○							
27	GR015	The main part of the San Jose area	green schist	pCCps	◎		○		◎				◎	○			
28	GR016	The main part of the San Jose area	metabasalt	pCCps	◎		◎			◎							
29	GR018	The main part of the San Jose area	green schist	pCCps	◎		◎		◎						▲		
30	GR038	The Arroyo Grande area	quartz vein	pCCag	◎		◎						◎				
31	JR025	The Arroyo Grande area	green schist	pCCag	◎		◎		◎		△			○			

◎: >1000 cps, ○: 500-1000 cps, △: 200-500 cps, ▲: 100-200 cps , tr: <100 cps

Tab. Ⅱ-3-5 Description of polished sections (1)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Description	Phenocrysts, crystals											Gangue Minerals				Ilmenite
						pyrite	goethite	hematite	limonite	magnetite	chalcopyrite	chalcocite	covellite	shalerite	galena	rutile/anatase	quartz	zircon	phyllosilicates	titanite	
1	AR006	MSJ	quartz vein	pCCsjo	qz:200-1000 μm φ				・								◎		?・		
2	AR027	MSJ	quartz vein	pCCps	limonite along fracture				●								◎				
3	AR038	MSJ	quartz vein	pCCps	dark colored, fiber-like minerals												◎		●?		
4	AR046	MSJ	quartz vein	pCCps	limonite rich				○								○				
5	BR003	MSJ	siliceous rock	pCCsjo	py:5-25 μm φ , fractures with limonite	・			●								◎				
6	BR011	MSJ	siliceous rock	pCCsjo	py: 5-75 μm φ	・											◎				
7	BR013	MSJ	green rock	pCCsjo	feldspar(?) rich, fracture with limonite				・								○				
8	BR031	MSJ	quartzose schist	pCCsjo	py: 2-15 μm φ	・											○				
9	BR034	MSJ	green rock	pCCsjo	with sericite, chlorite	・											○		?・		
10	BR036	MSJ	green schist	pCCsjo	fractures with limonite				●								○				
11	BR038	MSJ	green schist	pCCps	py: 2-15 μm φ	・											○				
12	BR044	MSJ	quartz vein	pCCps	py: 5×40 μm φ												◎				
13	CR007	MSJ	quartz vein	pCCsjo	py: 3-6 μm φ	・			●								◎				
14	CR018	MSJ	basalt	pCCps	py: 5-15 μm φ , ilmenite: 3-8 μm φ	・			●								●				・
15	CR019	MSJ	black chart	pCCps	py:40×75 μm φ , ilmenite:45×75 μm φ	・			●								○				・
16	CR027	MSJ	granitoid granit	pCCps	py: 50-85 μm φ	・											○				
17	CR044	MSJ	quartz vein	pCC	fractures with limonite				・								◎				
18	CR052	MSJ	quartz vein	pCCps	py: 10-30 μm φ	・			●								◎				
19	CR054	MSJ	quartz vein	pCCG	with limonite				・								◎				
20	CR078	MSJ	green schist	pCCps	py:50-250 μm φ , ilmenite:5-8 μm φ	●															・

AG:The Arroyo Grande area, WSJ:The western part of the San Jose area, MSJ:The main part of the San Jose area

◎: abundant, ○: common, ●: a little, ・: rare

Tab. Ⅱ-3-5 Description of polished sections (2)

Ser. No.	Sample No.	Area	Rock Name	Geol. Unit	Description	Phenocrysts, crystals											Gangue Minerals				Ilmenite
						pyrite	goethite	hematite	limonite	magnetite	chalcopyrite	chalcocite	covellite	shalcrite	galena	rutile/anatase	quartz	zircon	phyllosilicates	titanite	
21	DR004	MSJ	green schist	pCCsjo	qz: 20-1000 μm φ, py: 200-900 μm φ	●			▪								○		?		
22	DR006	MSJ	microgabbro	gb	py: 20-140 μm φ, cp: 25-90 μm φ	●					●										
23	DR027	MSJ	quartz vein	pCCcb	py: 5-10 μm φ	▪											◎				
24	DR031	MSJ	quartz-sericitic schist	pCCG	py: 10-20 μm φ	▪											◎				
25	DR037	MSJ	quartz vein	pCCsjo	py: 5-20 μm φ within siliceous part	▪											●				
26	DR040	MSJ	quartz vein	pCCps	py: 2-5 μm φ	▪											◎				
27	ER005	MSJ	quartz vein	pCCps	with limonite				▪								◎				
28	ER013	MSJ	quartz vein	pCCcb	py: a few mm φ	●											◎		?		
29	ER039	MSJ	magnetite	pCCcb	magnetite, hematite, Imenite			●		○											○
30	ER040	MSJ	quartz vein	pCCcb	py: 1-5 μm φ	▪											◎				
31	ER087	AG	quartz vein	pCC	limonite along fracture				▪								◎				
32	FR006	MSJ	quartz vein	pCCps	py: 5-8 μm φ	▪		▪									○				
33	GR 008	MSJ	quartz vein	pCCsjo	py: 2-5 μm φ	▪											○				
34	GR 012	MSJ	green schist	pCC	magnetite & hematite: 100-500 μm φ			●		●							●				
35	GR 018	MSJ	green schist	pCCps	porphyroblast of qz & magnetite:100-700 μm φ					●							●				
36	GR 019	MSJ	metabasalt	pCCps	hematite: 10-45 μm φ			▪	○								○				
37	JR001	MSJ	quartz vein	pCCps	fracture without sulfide												◎				
38	JR028	AG	quartz vein	pCCag	py within qt: 5-10 μm φ	▪			▪								◎		▪		

AG:The Arroyo Grande area, WSJ:The western part of the San Jose area, MSJ:The main part of the San Jose area

◎: abundant, ○: common, ●: a little, ▪: rare

Tab. Ⅱ-3-6 Homogenization temperature and salinity of fluid inclusions

Ser. No.	Sample No.	Area	Mineral Showings	Rock Name	Geol. Unit	Temperature (℃)			Salinity (%)
						Number	Range	Average	NaCl eq.
1	AR027	The main part of the San Jose area	Arroyo Charruzo	quartz vein	pCCps	30	102.3 - 216.6	162.1	13.6
2	AR036	The main part of the San Jose area	Arroyo Charruzo	quartz vein	pCCps	30	129.0 - 192.6	165.2	4.8
3	CR032	The main part of the San Jose area	Arroy del Medio	quartz vein	pCCps	30	122.6 - 250.5	155.8	>23
4	CR056	The main part of the San Jose area	Tala Ⅱ	quartz vein	pCCG	20	141.7 - 321.3	227.0	4.3
5	CR058	The main part of the San Jose area	Tala Ⅱ	quartz vein	pCCG	30	115.8 - 267.4	154.3	18.0
6	DR025	The main part of the San Jose area	Mahoma	quartz vein	pCCps	20	157.1 - 357.5	247.5	20.0
7	DR027	The main part of the San Jose area	Mahoma	quartz vein	pCCcb	20	150.9 - 270.3	211.5	21.2
8	ER017	The main part of the San Jose area	Arroyo Charruzo	quartz vein	pCCsjo	30	85.6 - 263.2	166.0	31
9	ER023	The main part of the San Jose area	Arroyo Charruzo	quartz vein	pCCsjo	30	100.2 - 223.2	157.7	32
10	ER027	The main part of the San Jose area	Arroyo Charruzo	quartz vein	pCCsjo	30	133.6 - 223.1	184.3	7.2
11	ER037	The main part of the San Jose area	Tala Ⅱ	quartz vein	pCCG	20	164.5 - 334.2	237.1	16.9
12	ER084	The Arroyo Grande area	Rio Negro Ⅱ	quartz vein	pCC	30	141.7 - 447.7	322.2	35
13	ER093	The Arroyo Grande area	Rio Negro Ⅱ	quartz vein	pCCag	30	140.2 - 258.0	196.7	4.2
14	JR002	The main part of the San Jose area	Tala Ⅱ	quartz vein	pCCps	20	99.2 - 278.5	148.7	20.1