

(5) Southeast region

This region occupies primarily the southeastern part of the area. Main geological components are the Paleozoic schist, intrusives and the Tertiary volcanic rocks widely distributed over the east. Lineaments trending toward the NW-SE and the N-S are dominant in this region. The length is mostly 5 to 6 km, but they are scattered without any significant concentration.

[Folding and circular structures]

(1) Folding structure

Many beddings have developed in the Cretaceous sedimentary rocks (Kis1) distributed in the northeast of this area. By pursuing these beddings, anticlinal and synclinal structures were recognized to have axes of the NNW-SSE or the NNE-SSW orientations and develop repeatedly (Fig. II-2-12). The wavelength, in general, is 4 to 6 km. No folding structures were found except for this region.

(2) Circular structure

No circular structures were found in this area.

5) The San Carlos de Bariloche area

[Geological unit]

Rocks and sediments distributed in this area were classified into 23 geological units in total (Fig. II-2-15 and Table II-2-6). Seven of them were comparable to the Jurassic to Tertiary sedimentary rocks, and another seven were to the Jurassic to Quaternary volcanic rocks. Four geological units can be compared to the unconsolidated or semi-consolidated rocks of the Quaternary. In addition, one geological unit is comparable mainly to the Paleozoic schist while three units are compared to the intrusives generated from the Paleozoic to the Tertiary. One unit was judged to be an alteration zone.

[Alteration zone]

A total of 88 alteration zones (SB001 to SB088) were interpreted and extracted in this area (Fig. II-2-15 and Table II-2-19). The largest one in scale is SB039 (3.6 km by 2.4 km) located in the north, followed by SB045, SB050, SB051 and SB060 each with an area of 3 to 5 km². A majority of the zones are around 2 km². Morphology of the alteration zone is generally massive.

This area is divided by four lineaments with the N-S and NW-SE orientations of good continuity into four zones, that is Zone I to IV trending toward the N-S from west to east. All the extracted alteration zones are distributed in Zone I, II and III and no alteration zones are

found in Zone IV. Alterations of Zone I, II and III can be summarized as follows:

(Zone I) This zone extends from the west of Lago Nahuel Huapi to the south of this area via Puerto Las Rayes with the N-S lineaments of good continuity forming the eastern limit. Geology of this zone is primarily made up of basement of the Paleozoic schist rock distributed in the north, the Cretaceous and Tertiary intrusive rocks and the Cretaceous to Quaternary volcanic rocks that intruded the Paleozoic schist. 34 alteration zones, that is SB001 to SB034, were observed in this zone. Size of most of the alteration zones is about 2 km². Many alteration zones are found in the Paleozoic schist, the Cretaceous intrusive rocks and the Cretaceous volcanic rocks. Relatively concentrated distribution of alteration zones is seen generally in the north to the south with an interval of 15 km from each other. No significant orientation of the alteration zones is observed throughout this zone.

(Zone II) This is a zone extending to the east of Zone I, and has a width of 20 km with the N-S orientation. The northeastern limit is bordered by the NW-SE trending lineament of good continuity, and the eastern limit is also bordered by the N-S trending lineament of good continuity (somewhat intermittent in the south). Geology within this scope primarily comprises basement of the Paleozoic schist, the Cretaceous intrusives and volcanics, and the Jurassic sedimentary rocks. There are 29 alteration zones recognized in this zone, that is SB035 to SB063. The largest one is SB039 (3.6 km by 2.4 km) found in the north. Many of the alteration zones are observed within the Cretaceous intrusive rocks and its periphery. There is one area in the north and two areas in the south where alteration zones are concentrated, and between them no alteration zones are observed due to cover of the Quaternary unconsolidated sediments. No appreciable orientation of the alteration zones is recognized throughout this zone.

(Zone III) This zone is located to the east of Zone II, with the N-S trend and width of 35 km. The northeastern limit is bordered by the NW-SE trending lineament of good continuity, and the eastern limit is also bordered by the N-S trending lineament of good continuity (somewhat ambiguous in the south). Geology within this scope primarily comprises basement of the Paleozoic schist in the central area, the Cretaceous intrusive rocks, the Cretaceous to Tertiary volcanic rocks, and the Jurassic sedimentary rocks. There are 25 alteration zones, that is SB064 to SB088, mostly in a range of 2 to 3 km². Most of the alteration zones occurs in the north and south, and an area between the north and south is covered by the Quaternary unconsolidated sediments where no alteration zones are observed. The alteration zones in the north are located in the NW-SE orientation that is the same as that of lineaments extracted nearby. No prominent orientation of the alteration zones is observed in the south.

Table II -2-6 Characteristics of photogeologic units of the San Carlos de Bariloche area

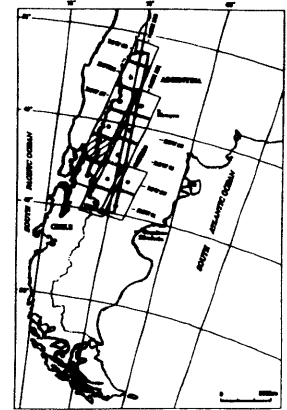
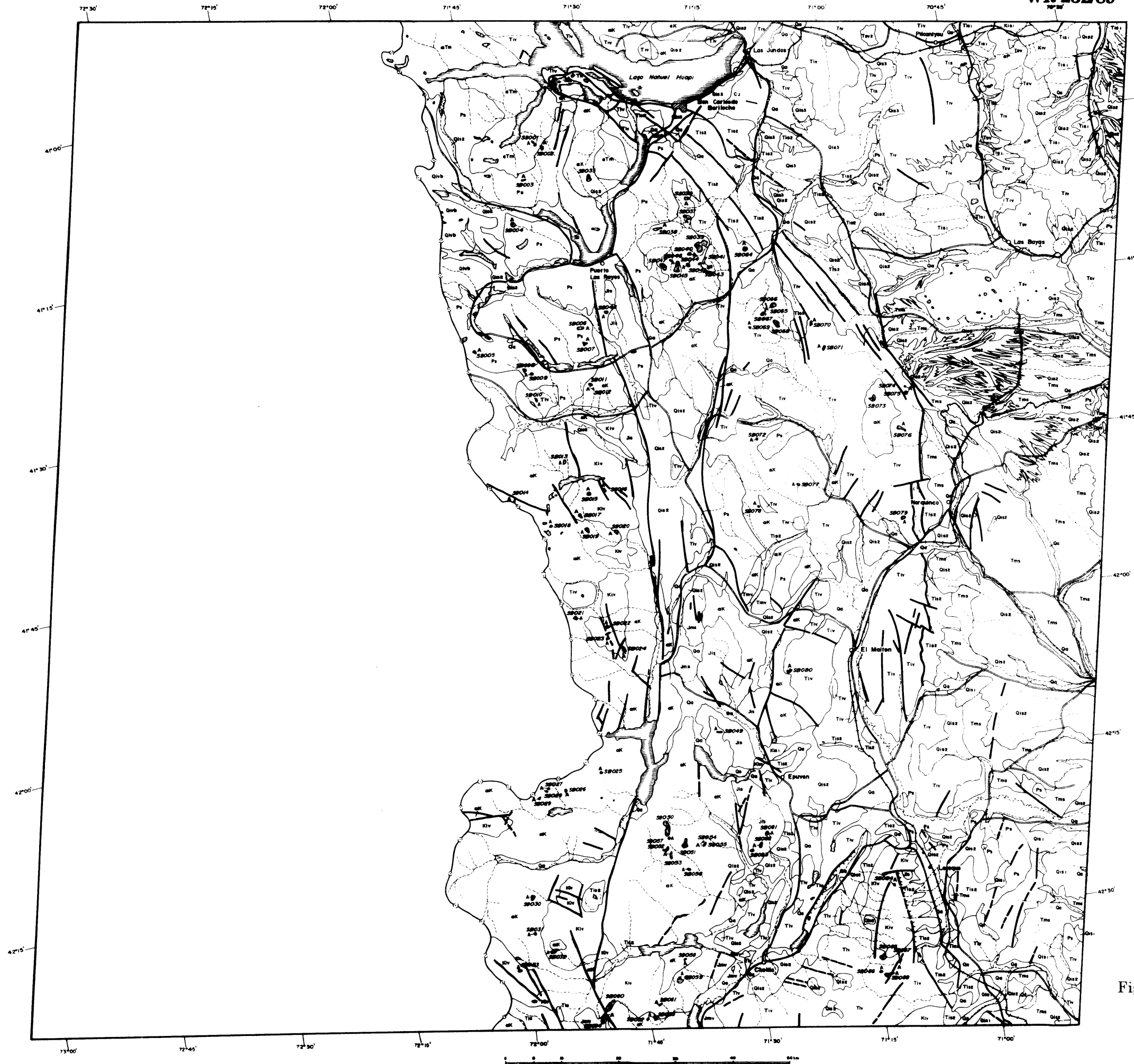
Unit	Photo-Characteristics			Morphologic Expression						Superficial Cover		Probable Lithology (Correlation with available Geologic Map)
	Tone	Texture	Bedding	Drainage		Section	Rock		Vegetation	Cultivation		
				Pattern	Density		Resistance					
Qa	gray, purplish red, green	very fine	none	meandering	very low		very low		partly dense	partly intense	Unconsolidated sediments composed of gravel, sand, silt and clay (Holocene : Recent alluvial deposits)	
Qis3	brown	fine	none	sub-parallel	low		low		partly	partly	Glacial deposits (Pleistocene : Gracial deposits)	
Qis2	light gray	medium	none	sub-parallel	low		low		none	none	Glacial deposits (Pleistocene : Gracial deposits)	
Qis1	purplish	fine	very gentle	sub-parallel	low		low		rare	none	Unconsolidated sediments composed of gravel, sand, silt and clay (Pleistocene : Fluvial, talus deposits)	
Qivb	reddish brown	rough	none	radial	medium		low		none	none	Basic volcanic rocks (Pleistocene : Basalt, pyroclastic rocks)	
Tsv2	brown	fine	massive	radial, sub-parallel	low		high		partly	partly	Volcanic rocks (Pliocene : Andesite, basaltic andesite, basalt and pyroclastic rocks)	
Tsv	brown	rough	none	sub-parallel	low		medium		none	none	Volcanic rocks (Pliocene: Basalt and pyroclastic rocks)	
Tms	grayish purple	coarse-fine	rare	sub-dendritic	low		low		none	partly	Sedimentary rocks (Miocene : Continental sedimentary rocks, Collon Cura, Pedregoso Formations etc.)	
Tmv	brown	coarse	massive	sub-dendritic	medium		medium-high		partly	rare	Mainly pyroclastic rocks (Miocene : Basaltic rocks, El Mirador Formation)	
Tiv	dark brown	coarse	massive	sub-dendritic	medium		medium-high		dense	partly	Andesitic volcanic rocks (Eocene-Oligocene : Andesite, basalt and pyroclastic rocks)	
Tis2	brown, dark purple	coarse	partly	sub-dendritic	high		medium		medium	rare	Sedimentary rocks (Oligocene : Marine and continental sedimentary rocks Nirihua Formation etc.)	
Tis1	brown, dark purple	coarse	partly	sub-dendritic	medium		low		none	none	Sedimentary rocks (Eocene-Oligocene : Continental sedimentary rocks, Sarmiento Formation etc.)	
Tis	brown	coarse	partly	sub-dendritic	high		medium		medium	partly	Coarse grained sedimentary rocks (Paleocene : Sandstone conglomerate, mudstone, limestone and Lutite, limestone, fanglomerate, mudstone, sandstone)	
Kis1	brown	medium	well bedded	sub-parallel	medium-high		medium-high		none	none	Volcanic rocks (Upper Cretaceous: Intermediate volcanic rocks (Devisadero Formation etc.)	
Kiv	brown	medium	well bedded	sub-parallel	medium-high		medium-high		none	none	Volcanic rocks (Middle-Upper Jurassic: Intermediate volcanic rocks, Lago La Plata, Lonco Trapia Formation	
Jmv	brown	medium	massive	sub-parallel	medium-high		medium-high		partly dense	none	Medium grained sedimentary rocks (Middle Jurassic : Conglomerate, sandstone, limestone, shale, tuff etc.)	
Jms	brown	medium	well bedded	sub-parallel	medium-high		medium-high		partly	none	Sedimentary rocks (Lower Jurassic: Marine and continental sedimentary rocks, Pitritron Formation	
Jis	brown	medium	partly	sub-parallel	low-medium		medium		partly	none	Schistose rocks (Paleozoic : Phyllite, schist, gneiss and migmatite)	
Ps	dark gray	rough	schistose	sub-dendritic	high		high		none	none		

Table II -2-6 Characteristics of photogeologic units of the San Carlos de Bariloche area

Unit	Photo-Characteristics		Morphologic Expression						Superficial Cover		Probable Lithology (Correlation with available Geologic Map)	
	Tone	Texture	Drainage		Density	Rock Resistance		Section	Bedding	Vegetation		Cultivation
			Pattern									
α Tm	brown	coarse	sub-dendritic		medium	high	high		massive	rare	none	Igneous rocks (Middle Tertiary? : Granitic rocks)
α K	brown	coarse	sub-dendritic.		medium	high	high		massive	partly	none	Igneous rocks (Cretaceous-Tertiary : Plutonic rocks and hypabyssal rocks)
α P	gray	coarse	sub-dendritic.		medium	medium-high	medium-high		massive	partly	none	Igneous rocks (Paleozoic : Plutonic rocks and hypabyssal rocks)
A	light gray	fine	none		low	low	low		none	none	none	Alteration Zone(Hydrothermal alteration zone)

San Carlos de Bariloche

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Symbol	Description
(Symbol)	Boundary of photogeologic unit
(Symbol)	Abandonment zone
(Symbol)	L. (uncertain)
(Symbol)	L. (uncertain)
(Symbol)	Angular structure
(Symbol)	Bedding trace
(Symbol)	Antiformal axis and its plunging direction
(Symbol)	Synclinal axis and its plunging direction
(Symbol)	Crease and its slope
(Symbol)	Drainage system
(Symbol)	Lake or dam
(Symbol)	Road
(Symbol)	Highway
(Symbol)	City and city area
(Symbol)	International boundary

LEGEND

- Geological Structure**
- (Symbol) Boundary of photogeologic unit
- (Symbol) Abandonment zone
- (Symbol) L. (uncertain)
- (Symbol) L. (uncertain)
- (Symbol) Angular structure
- (Symbol) Bedding trace
- (Symbol) Antiformal axis and its plunging direction
- (Symbol) Synclinal axis and its plunging direction
- (Symbol) Crease and its slope
- Geographic Features**
- (Symbol) Drainage system
- (Symbol) Lake or dam
- (Symbol) Road
- (Symbol) Highway
- (Symbol) City and city area
- (Symbol) International boundary

Fig. II -2-15 The San Carlos de Bariloche area: Photogeologic interpretation map

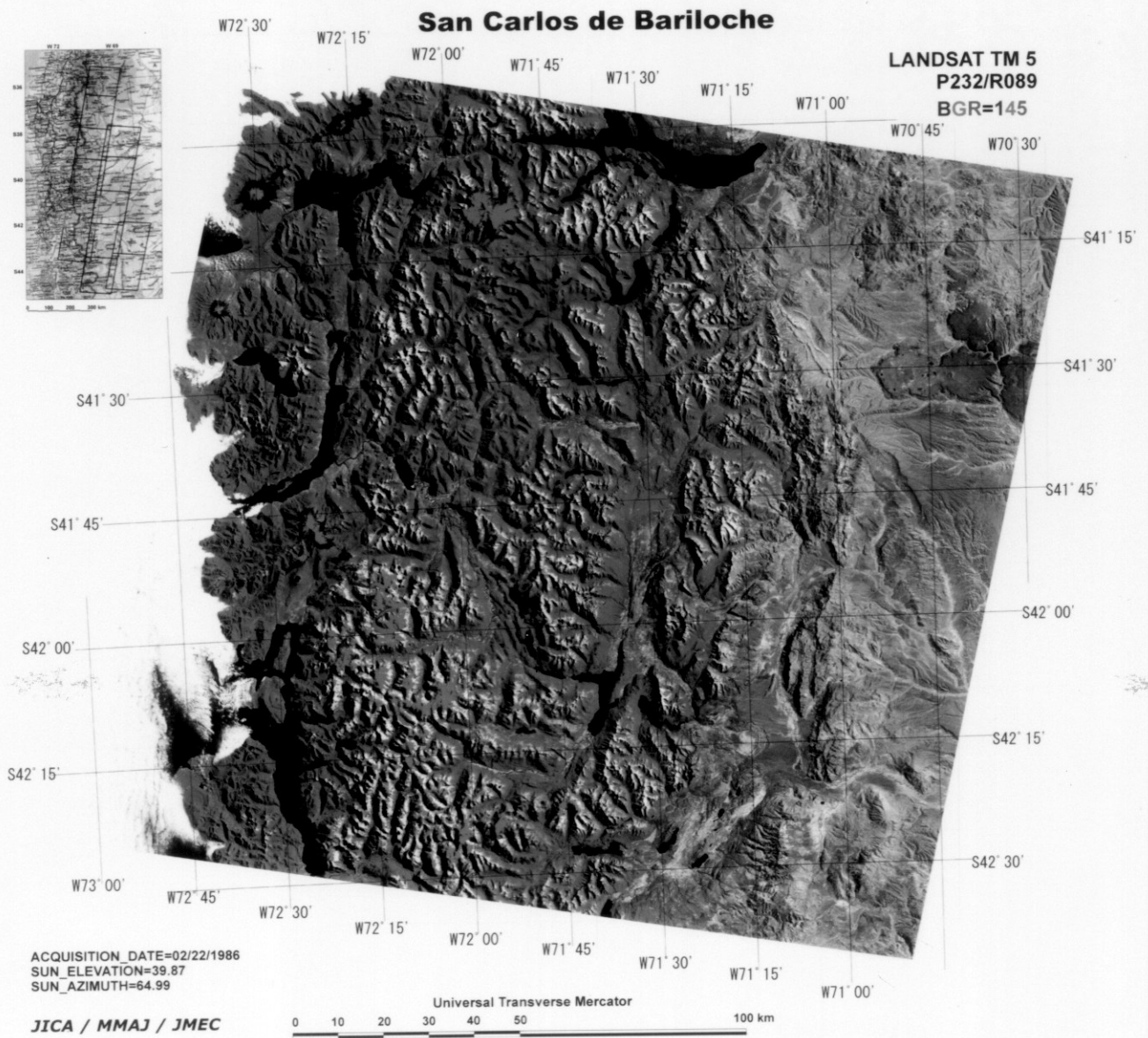


Fig. II -2-16 The San Carlos de Bariloche area: Landsat TM false color image



Fig. II -2-17 The San Carlos de Bariloche area: Landsat TM ratio image

[Lineament]

Lineaments in this area are represented by one in the N-S orientation with good continuity bordering each alteration zone and one to three parallel lineaments which develop toward the NW-SE direction from the southeast of Lago Nahuel Huapi. Number of areas where lineaments occur densely in the alteration zones are summarized as follows:

Zone I: Two in the Cretaceous intrusive volcanic rocks in the central area and three in the Cretaceous intrusive and volcanic rocks in the south.

Zone II: One in the Jurassic sedimentary rock and the Cretaceous intrusive rock in the central area.

Zone III: No prominent areas are observed.

[Folding and circular structures]

No folding and circular structures are observed in this area.

6) The Lago Menendez area

[Geological unit]

Rocks and sediments distributed in this area were classified into 12 geological units in total (Fig. II-2-18 and Table II-2-7). Three of them were comparable to the sedimentary rocks of the Jurassic to the Tertiary, and three units to the sedimentary rocks of the Jurassic to the Quaternary. Three units correspond to the unconsolidated or semi-consolidated sediments of the Quaternary. One geological unit can be compared mainly to the Paleozoic schist and one unit to the intrusive rocks generated in the Cretaceous. Another geological unit was judged to be an alteration zone.

[Alteration zone]

In total, 33 alteration zones (LM001 to LM033) were extracted in this area (Fig. II-2-18 and Table II-2-20). There are three large zones, that is LM015 (3.5 km by 2.5 km), LM026 (2.0 km by 3.5 km) and LM031 (4.5 km by 4.0 km). Almost all the others are less than 1 km² in size. Morphology is irregularly massive in general.

Many of the alteration zones are distributed in Tertiary volcanic rocks (geological unit: Tiv), Cretaceous volcanic rocks (geological unit: Kiv) and Cretaceous intrusive rocks (geological unit: α K). Three sites where alteration zones are concentrated and scattered alteration zones are observed. Three sites of concentration of alteration zones are as follows:

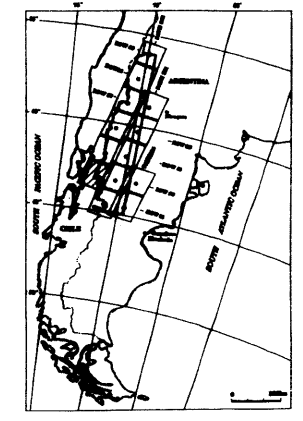
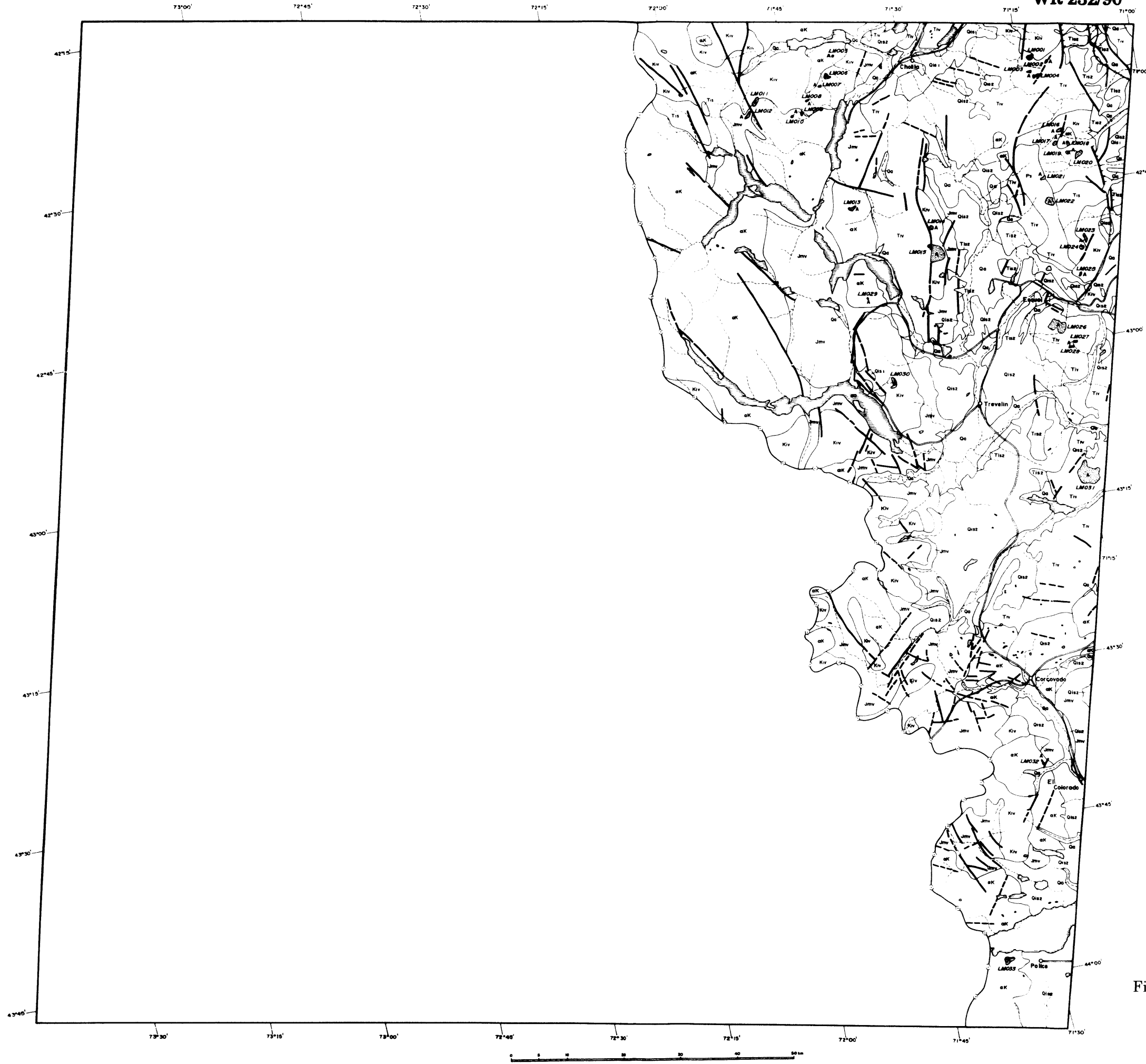
- (1) Group of alteration zones (LM001 to LM004 and LM016 to LM028) enclosed by lineaments in the N-S or NNW-SSE direction in the northeast end

Table II -2-7 characteristics of photogeologic units of the Lago Menendez area

Unit	Photo-Characteristics		Morphologic Expression					Superficial Cover		Probable Lithology (Correlation with available Geologic Map)
	Tone	Texture	Drainage		Rock Resistance	Section	Bedding	Vegetation	Cultivation	
			Pattern	Density						
Qa	gray, purplish red, green	very fine	meandering	very low	very low		none	partly dense	partly intense	Unconsolidated sediments composed of gravel, sand, silt and clay (Holocene : Recent alluvial deposits)
Qis2	light gray	medium	sub-parallel	low	low		none	none	none	Glacial deposits (Pleistocene : Gracial deposits)
Qis1	purplish	fine	sub-parallel	low	low		very gentle	rare	none	Unconsolidated sediments composed of gravel, sand, silt and clay (Pleistocene : Fluvial, talus deposits)
Tiv	dark brown	coarse	sub-dendritic	medium	medium-high		massive	dense	partly	Andesitic volcanic rocks(Eocene-Oligocene : Andesite, basalt and pyroclastic rocks)
Tis2	brown, dark purple	coarse	sub-dendritic	high	medium		partly	medium	rare	Sedimentary rocks (Oligocene : Marine and continental sedimentary rocks ,Nirihau Formation etc.)
Tis	brown	coarse	sub-dendritic	high	medium		partly	medium	partly	Coarse grained sedimentary rocks (Paleocene : Sandstone conglomerate, mudstone, limestone and gypsum)
Kiv	brown	medium	sub-parallel	medium-high	medium-high		well bedded	none	none	Volcanic rocks (Upper Cretaceous: Intermediate volcanic rocks (Devisadero Formation etc.)
Jmv	brown	medium	sub-parallel	medium-high	medium-high		massive	partly dense	none	Volcanic rocks (Middle-Upper Jurassic : Intermediate volcanic rocks, Lago La Plata, Lonco Trapia Formations etc.)
Jis	brown	medium	sub-parallel	low-medium	medium		partly	partly	none	Sedimentary rocks (Lower Jurassic : Marine and continental sedimentary rocks , Piltriquitron Formation etc.)
Ps	dark gray	rough	sub-dendritic	high	high		schistose	none	none	Schistose rocks (Paleozoic : Phyllite, schist, gneiss and migmatite)
αK	brown	coarse	sub-dendritic	medium	high		massive	partly dense	none	Igneous rocks (Upper Cretaceous : Granitic rocks)
A	light gray	fine	none	low	low		none	none	none	Alteration Zone (Hydrothermal alteration zone)

Lago Menendez

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Unit	Symbol	Stratigraphic Position	Age	Thickness	Composition	Remarks
LMO01	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO02	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO03	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO04	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO05	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO06	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO07	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO08	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO09	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO10	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO11	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO12	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO13	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO14	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO15	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO16	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO17	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO18	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO19	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO20	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO21	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO22	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO23	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO24	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO25	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO26	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO27	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
LMO28	ak	Upper	Quaternary	Thin	Clay, silt, sand	Recent alluvium
Qs1	ak	Lower	Quaternary	Thin	Clay, silt, sand	Recent alluvium
Qs2	ak	Lower	Quaternary	Thin	Clay, silt, sand	Recent alluvium
Jmv	ak	Lower	Quaternary	Thin	Clay, silt, sand	Recent alluvium
Kiv	ak	Lower	Quaternary	Thin	Clay, silt, sand	Recent alluvium
Tiv	ak	Lower	Quaternary	Thin	Clay, silt, sand	Recent alluvium

- LEGEND**
- Boundary structure
 - Boundary of photogeologic unit
 - Alteration zone
 - Lineament (certain)
 - Lineament (uncertain)
 - Anticline structure
 - Bedding trace
 - Antiformal axis and its plunging direction
 - Synformal axis and its plunging direction
 - Crater and its steps
- Geography/Infrastructure**
- Drainage system
 - Lake or dam
 - Road
 - Railway
 - City and city area
 - International boundary

Fig. II -2-18 The Lago Menendez area: Photogeologic interpretation map

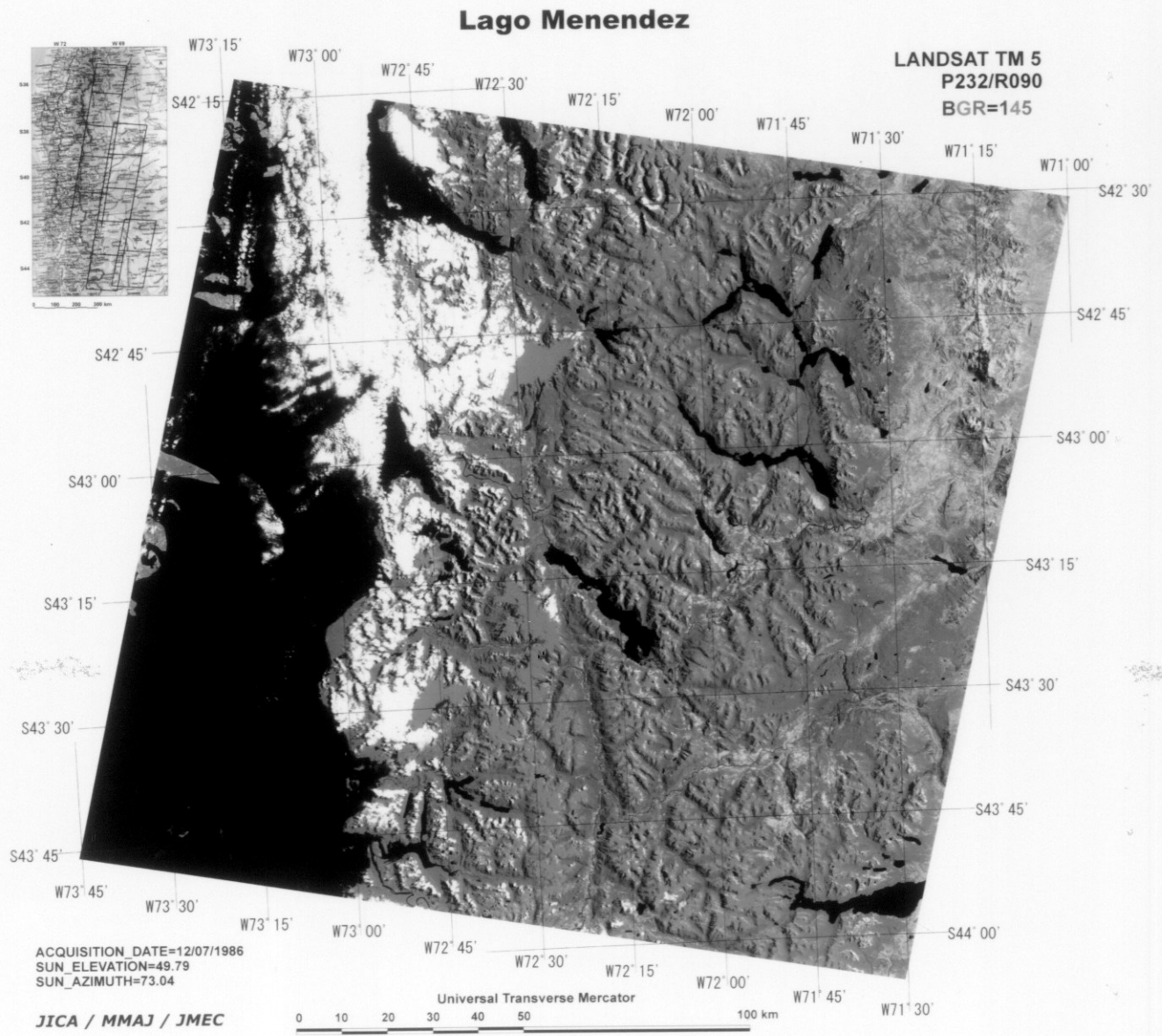


Fig. II -2-19 The Lago Menendez area: Landsat TM false color image

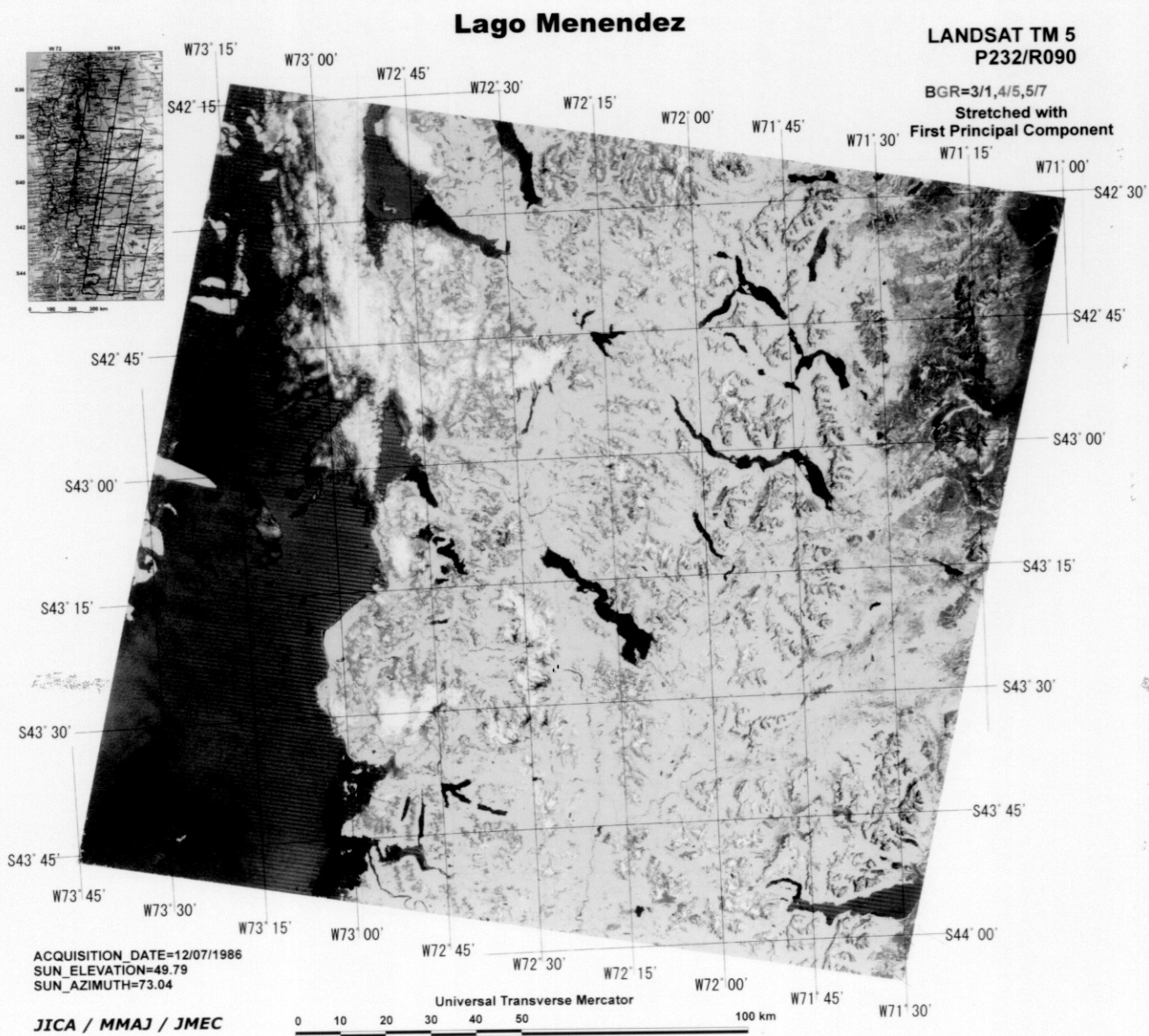


Fig. II -2-20 The Lago Menendez area: Landsat TM ratio image

- (2) Group of alteration zones (LM014 and LM015) enclosed by two parallel lineaments in the N-S direction in the central north
- (3) Group of alteration zones (LM005 to LM012) which are scattered a little in the northwest

[Lineament]

Lineaments interpreted and extracted in this area are roughly classified into six zones. Each zone has the following characteristics in general (Fig. II-2-18).

(1) Northeast end

There are two trends of lineaments which continue intermitently, one in the N-S orientation and the other in the NNW-SSE to NNE-SSE orientation, in an area of 15 km wide in the E-W direction. Alteration zones of LM001 to LM004 and LM016 to LM028 are observed in this area.

(2) South of Cholila

In this zone, two or three N-S lineaments whose lengths are less than is 36 km and several WNW-ESE lineaments that cross the N-S lineaments almost at right angles are recognized. This area includes alteration zones of LM014 and LM015.

(3) Northern border zone

In this zone, lineaments in the N-S or NNW-SSE direction with good continuity whose lengths are less 25 km are dominant. Particularly, there is an area where four or five lineaments develop in parallel along the border with Chile in the northwest end. At the east of these lineaments, alteration zones of LM005 to LM012 are found.

(4) Central west border zone

In this zone, there is an area where lineaments in the NNW-SSE, NNE-SSW and E-W directions are densely entangled. At the east of this area, alteration zone of LM030 is recognized.

(5) South border zone

This zone has an area where lineaments in the NNE-SSW, E-W, and NNW-SSE directions are densely entangled. Four parallel NNE-SSW lineaments have good continuity, and it is interpreted that they reflect the characteristics of normal faults. No alteration zones are observed around this zone.

(6) South-end border zone

In this zone, there is an area where lineaments in the NW-SE, E-W and NE-SW directions are densely entangled. Only an alteration zone of LB032 is found in the north. From regional point of view, it is judged that this zone and the Central west border zone, that is Item (4), are divided into the northern and southern parts by the lineaments in the NNE-SSW direction of the South border zone, that is Item (5).