PART I : GENERAL DISCUSSIONS

Chapter 1 Introduction

1-1 Circumstances of the survey

For mining in the Argentine Republic, while petroleum, natural gas and limestone had been developed until 1991, large-scale development of nonferrous metal resources had not been carried out. In 1992, the policy to promote investment from foreign countries in the mining field was started, and laws related to mining (such as the Mining Investment Act and the Mining Reconstruction Act) were amended in 1993. As a result, exploration and development by overseas companies became active, reaching a peak in 1997 when about 80 companies carried out mining operations. Since then exploration and development activities have been on the decline partly because prices of copper and gold have remained low, though substantial exploration activity has been continuing from the global standard.

Basic surveys for cooperation in resource development in the Argentine Republic were started by the Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ) in fiscal year 1977. Their surveys had been made in the following 7 areas from that time to fiscal year 1998 (Fig. I-1-1).

Northern area (surveys for resource development)	Fiscal 1977 - 1980
Famatina area (surveys for regional development planning)	Fiscal 1980
Patagonia area (surveys for resource development)	Fiscal 1981 - 1983
Alto de la Blenda area (surveys for resource development)	Fiscal 1986 - 1989
Falajon Negro area (surveys for regional development planning)	Fiscal 1990 – 1991
Western area (surveys for resource development)	Fiscal 1992 - 1994
Eastern Andes area (mineral resource surveys over a wide area)	Fiscal 1997- 1998

Under such conditions, Subsecretaria de Mineria, Secretaria de Industria, Comercio y Mineria of the Argentine Republic highly appreciated the surveys for cooperation in resource development carried out in the preceding fiscal years, and on November 30, 1998 (by Official Letter No. 350) asked Japan for basic surveys in the Southern Andes area, where potential of copper, gold, etc. was expected. The Argentine side wants to utilize the results of these surveys as basic data to promote exploration and development of the area through introduction of foreign currencies.

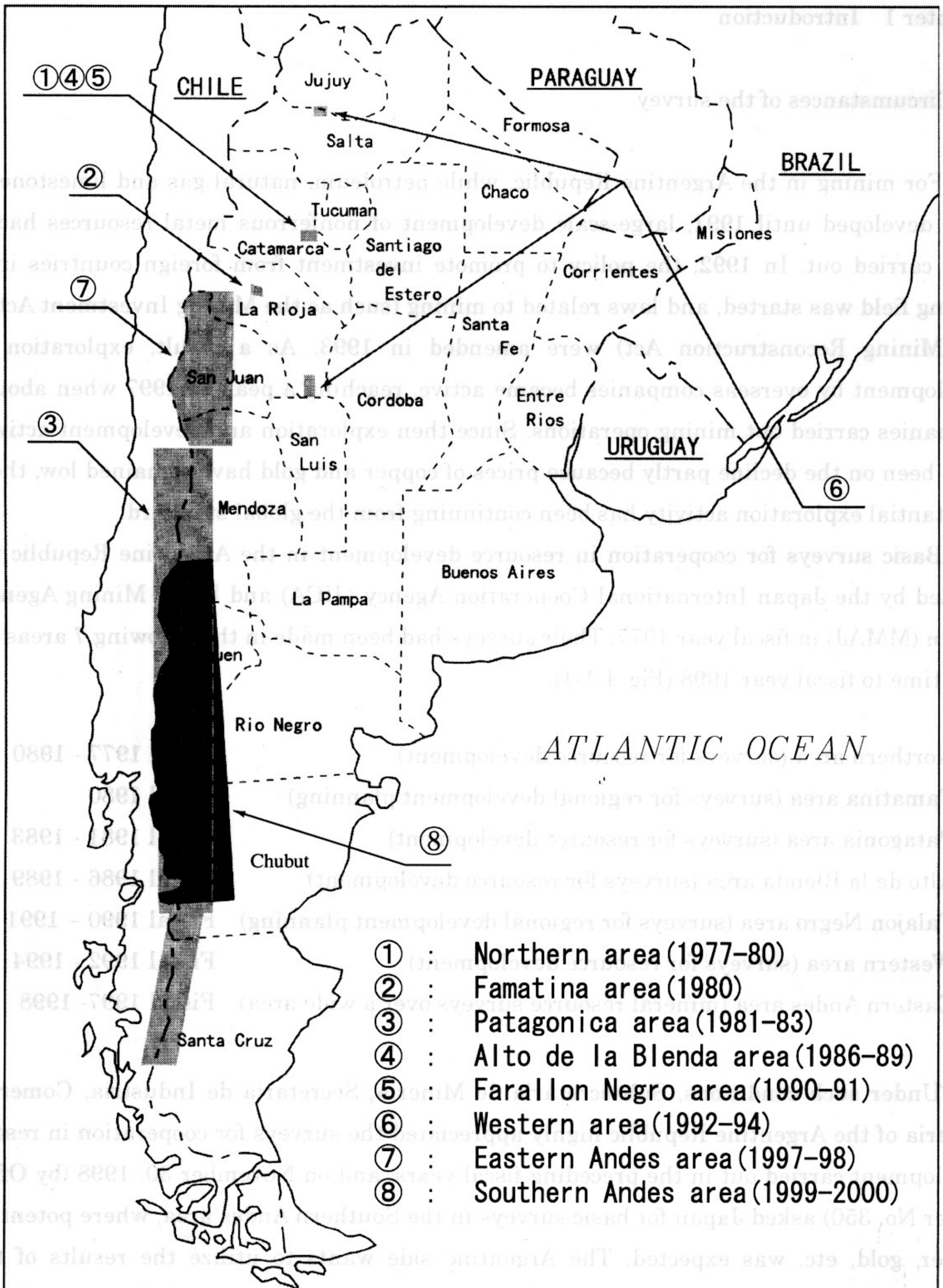


Figure I-1-1 Location map of the past projects

1-2 Outline of the survey

1-2-1 Objective of the surveys

The objective of the surveys is to efficiently extract highly potential areas for ore deposits from a vast area of the Southern Andes. This will be conducted by carrying out analysis of existing data, analysis of satellite images, and the ground truth survey (field survey) and then by comprehensively analyzing the obtained results. This fiscal year is the first year of the two-year plan.

1-2-2 Survey area

The survey area is located in the southwest of the Argentine Republic. It has an area of approximately 162,000 km^2, extending in the North-South direction from Lat. 36° 00' S at the north end to Lat. 45° 00' S at the south end, and in the east-west direction from the border line between Argentina and the Republic of Chile at the west end to Long. 69° 30' W at the east end. The survey area stretches over Mendoza, Neuquen, Rio Negro and Chubut Provinces (Fig. I-1-2). Geographically the area is roughly divided into the mountainous zone in the western side and the lowland zone in the eastern side.

1-2-3 Survey methods

(1) Existing data analysis

Data, drawings and maps obtained from geological surveys and mineral resource investigations, which have been carried out so far in this area by Servicio Geologico Minero Argentino (SEGEMAR) belonging to Subsecretaria de Mineria and Mining Direction (Direccion de Mineria) of Provincial Governments, are listed. Then, mineral occurrences that are considered to be important are selected.

(2) Satellite image analysis

False color synthetic image scenes and color ratio image are drawn up from Landsat TM data. They then are geologically interpreted together with existing data. Geological structures related to genesis of ore deposit, such as lineament and circular structure, are grasped, and alteration zones are extracted, in order to contribute to selecting areas highly potential for ore deposits.

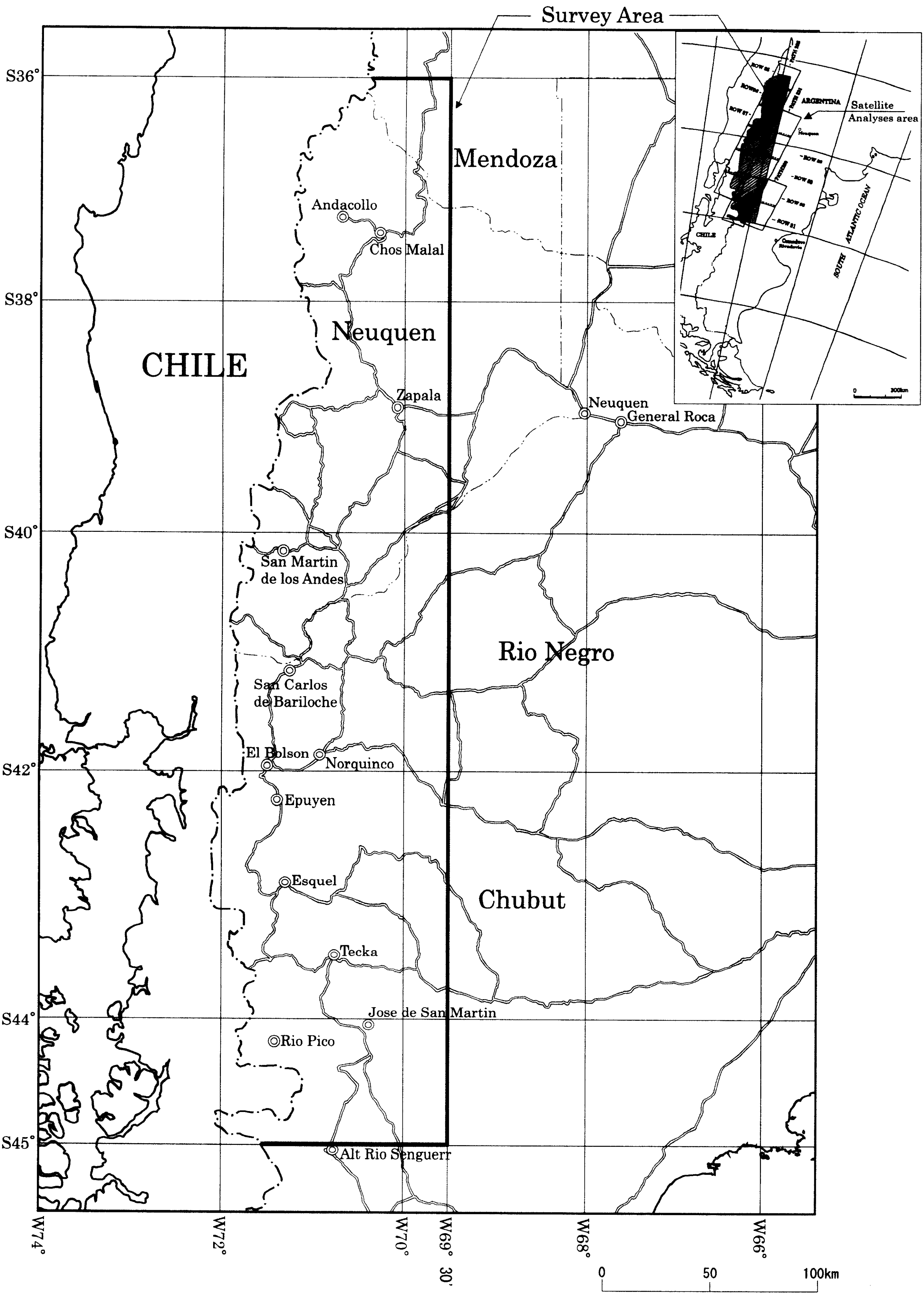


Figure I-1-2 Geographic map of the survey area

(3) Ground truth survey

Based on the results of analysis of existing data and satellite images, geological surveys (ground truth) are conducted in order to ascertain local geological conditions, alteration zones, mineral occurrences, etc. In addition, collected rocks and ores will be used for laboratory tests, and the results are used for comprehensive analysis together with results of ground truth.

1-2-4 Survey team

(1) Existing data analysis and ground truth survey

a) Japanese side

Ken Nakayama:	Japan Mining Engineering Center for International Cooperation (JMEC)
Hajime Hishida:	JMEC
Haruhisa Morozumi:	JMEC
Takayoshi Murakami:	JMEC
Ryuta Okubo:	JMEC

b) Argentine side

Mario Alberto Zubia:	Servicio Geologico Minero Argentino (SEGEMAR) Comodoro Rivadavia-Chubut
Juan Carlos Zanettini:	SEGEMAR, Mendoza
Rafael Alberto Gonzalez:	SEGEMAR, General Roca-Rio Negro
Roberto L.M. Viera:	SEGEMAR, Comodoro Rivadavia-Chubut
Marcelo J. Marquez:	SEGEMAR, Comodoro Rivadavia-Chubut

(2) Satellite images analysis (conducted in Japan)

Yoneharu Matano (analysis and reports):	JMEC
Masataka Ochi (production of images, analysis, and reports):	JMEC
Hiroshi Kanbara (data processing and production of images):	JMEC

(3) Interpretation and report making (conducted in Japan)

Ken Nakayama:	Japan Mining Engineering Center for International Cooperation (JMEC)
Hajime Hishida:	JMEC
Haruhisa Morozumi:	JMEC
Takayoshi Murakami:	JMEC
Ryuta Okubo:	JMEC

1-2-5 Period and amount of the survey

(1) Existing data analysis and ground truth survey

From January 12 (Wed.), 2000 to February 21 (Mon.), 2000

Table 1-1-1. Record of the Ground Truth

tem	Performance
Visiting sites	31
Samples obtained : Rocks and ores	314

(2) Satellite image analysis

From December 22 (Wed.), 1999 to March 17 (Fri.), 2000

Data processing, mosaic image preparation and analysis of Landsat TM images

(3) Laboratory works, interpretation and report making

From February 22 (Tue.), 2000 to March 23 (Thu.), 2000

Table 1-1-2. Laboratory test

Item	Number of samples
Microscopic observation	
Thin section	29
Polished thin section	16
Powdery X-ray diffraction	71
Bulk chemical analysis	
Geochemical analysis (28 elements)	128
Geochemical analysis (31 elements with PGM)	5
Petrochemical analysis (47 elements)	13
Ore grade assay (23 elements)	24
Fluid inclusion (Homo. Temp., Salinity)	13
K-Ar dating	3
Stable isotope	
$\delta^{18}O$	9
$\delta^{34}S$	7

Chapter 2 Geography of the survey area

2-1 Location and accessibility

The survey area is in the north of a district called Patagonian Andes located in the southwest of the Argentine Republic. It is an expanse with an area of 162,000 km^2 stretching long and narrow from north to south, with its northern end limited by Lat. 36°00' S, the southern end limited by Lat. 45°00' S, the western end limited by the Chilean border, and the eastern end limited by Long. 69°30' W (Fig. I-1-2). The area covers the three Provinces of Neuquen, Rio Negro and Chubut (and geographically small part of the southern tip of Mendoza Province). The list of major cities and towns of the survey area from north to south includes such names as Chos Malal, Zapala, San Martin de los Andes (of Neuquen Province), San Carlos de Bariloche, El Bolson (of Rio Negro Province), Esquel, Tecka and Alto Rio Sengual (of Chubut Province).

For access to the survey area regular flights are generally used from Buenos Aires to Neuquen, the central city of Neuquen Province (four to five 2-hour flights per day), to San Carlos de Bariloche, the tourist city of Rio Negro Province (four to five 2-hour-and-20-minute flights per day) or to Comodoro Rivadavia, the central city of Chubut Province (six to seven 2-hour-and-15-minute flights per day). From these local cities to the survey area, travelling by car on trunk roads is a common means of access. Although Esquel of Chubut Province has an airfield, no regular flights are in service now.

Most of main roads in the survey area are paved and well maintained. Among them, National Road No. 40 runs from north to south through practically the entire survey area, connecting Chos Malal, Zapala, Esquel and Alto Rio Senguer. National Road No. 237 connects Neuquen and San Carlos de Bariloche, and is partly used for travel between Zapala and San Carlos de Bariloche. National Road No. 258 connects San Carlos de Bariloche and Leleque located to the south, and is used for travelling between San Carlos de Bariloche and Esquel. Besides national roads, provincial roads are also well developed for traffic to connect major cities and towns. Although paved provincial roads are not as many as national roads, they are also well maintained for high-speed driving.

Distance between major cities and towns, and time required for travelling there are as follows;

General Roca - Zapala:	234 km, 3 hours.
Zapala - Chos Malal:	211 km, 3 hours.
Zapala - San Carlos de Bariloche:	363 km, 5 hours.
San Carlos de Bariloche - El Bolson :	132 km, 2 hours 30 minutes.
El Bolson - Esquel:	165 km, 2 hours.

Esquel - Alto Rio Senguerr: 351 km, 4 hours.
Alto Rio Senguerr - Comodoro Rivadavia: 354 km, 4 hours.

Access to mineral occurrences or alteration zones is mostly in a bad condition. Passing through streams, travelling on snow roads in winter and muddy roads in summer necessitate the use of four-wheel drive vehicles. When exploring deep into mountains, it is desirable to use two four-wheel drive vehicles or the combination of one four-wheel drive vehicle and one truck for transportation. For access to mountain areas where no roads are available, travelling on horseback may be necessary, though horses were not employed in this survey.

Gas stations operate in every major city and town from early in the morning until evening, so there is no problem of fueling. The fuel price as of February 2000 is US$0.972/l for regular gasoline and US$0.464/l for gas oil at General Roca of Neuquen Province.

2-2 Topography and drainage

The topography of the survey area changes its feature from west to east into three zones; i.e., the mountain zone at an elevation of 1,500 to 2,000 m near the Chilean border in the west, the hilly zone at an elevation of about 1,000 m in the central area, and the plains in the east. Expanses of high plateaus characteristic of the Andes to the north of the survey area are not observed. The elevation gradually becomes lower, and the width of mountains (Cordillera) becomes narrower toward the south until it averages not more than 100 km. The mountains of highest elevation are Mt. Volcan Domuyo (4,709 m: Neuquen Province) and Mt. Volcan Lanin (3,776 m), which are located on the border between Argentina and Chile, and make part of the divide of the Pacific and the Atlantic Oceans. The rest of the mountains, however, for the most part are obstructed everywhere by rivers running westward or eastward and do not function as the continental divide. A majority of volcanic activity centers are present on the western side of the mountains, i.e., on the Chilean side.

In the western mountain area, rivers trending to the E-W or NW-SE are prominent, and the flow of these rivers is interrupted in the south of Lat. 39° S to build up lakes. Especially, San Carlos de Bariloche and its surroundings have so many lakes that the area is named Lake District and designated as a national park. The lakes are very deep at high elevation and some of them, such as Lake Nauel Huapi, have glacial topography similar to fjords.

These rivers run toward the east for a while and then flow into the N-S trending rivers (Rio Alumine, Rio Agrio, A Picum Leufu, Rio Colon, etc.). In the plains, numerous branch rivers from various directions run into these rivers, change the flow to the northwest or to the northeast according to the topography of low land, and on the whole flow to the east.

2-3 Climate

The climate of Patagonian Andes is strongly affected by the Pacific Ocean extending to the west and south of the South American Continent and exposed to the strong wind spiraling around the Antarctic. In Argentina, mountains trending from north to south serve as a barrier to this westerly wind but, at the same time, they bring abundant rainfall and snowfall. The westerly wind, after rainfall, brings a dry climate to the area on the eastern side. Due to strong oceanic influence, unforeseeable climate changes frequently occur. In spring and early summer, it is not uncommon to see good weather suddenly change to bad one, accompanied by strong rain and storm from the Pacific. In such a case, snowfall can occur except in low land even in the middle of summer.

In general, the climate becomes harsher toward the south. This is reflected by the vegetation limit (upper limit) of alpine plants and also by the drop of accumulated snow level in the summertime. For example, alpine plants can be seen at an elevation above 2,000 m in the north of Neuquen Province, but lichen can grow at an elevation above 400 m in Cape Horn in the south. In the north, perpetual snow can be seen only at an elevation above 2,400 m but that elevation drops to 450 m in islands around the Antarctic at the Chilean southern tip.

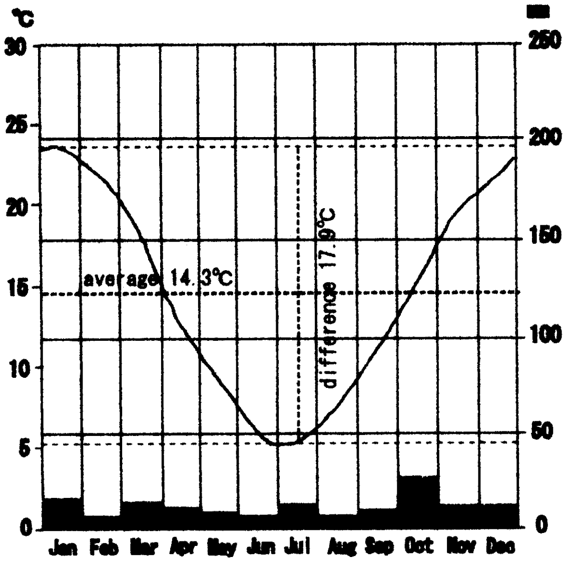
Storms are caused by low pressure in the steppe area in Argentina. This low pressure grows as air is heated in the summertime and a humid air block is drawn in from the Pacific Ocean. In general, winds escalate as they advance to the south and might, in some cases, cause danger in high places where there are no mountains to stand in their way. Westerly winds become the strongest between November and January, and continue until the end of April. In wintertime there is little wind and the calm season continues for a long time.

Of Patagonian Andes, the north is generally more stable than the south and has a long and hot summers without much of a breeze. In the area from Lake District to Aisen, the weather may break after a humid and uncomfortably warm breeze blows from the north. In the mountain area, thunder showers frequently occur in a hot summer.

2-4 Vegetation

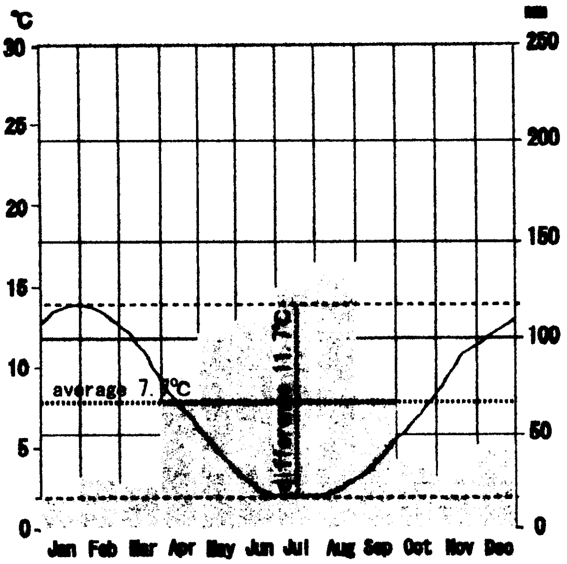
The vegetation in Southern Cordillera is divided into three zones from west to east; the humid lowland, the colder and dry mountain zone and the semi-dry steppe zone, reflecting the climate change. Towards the south, the climate becomes harsher with the temperate rainforests and deciduous forests occupying lower elevations.

The evergreen temperate rainforests comprise plural kinds of evergreen trees and cover the entire area in the west of Cordillera. Of the three zones, this zone is wide and the most thickly grown area and has all the important plant species in it. The north of Patagonian



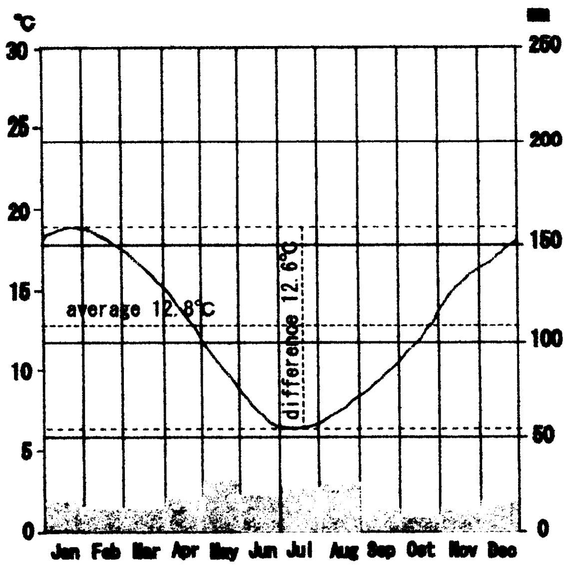
Latitude: 38° 57′ S
Longitude: 68° 08′ W
Altitude: 270 m
Total precipitation: 139mm
Major wind: West, East & Southeast
Average velocity: 13 km/h

(a) Climate at Neuquen, Neuquen Province



Latitude: 41° 09′ S
Longitude: 71° 10′ W
Altitude: 836 m
Total precipitation: 782 mm
Major wind: West
Average velocity: 24 km/h

(b) Climate at San Carlos de Bariloche, Rio Negro Province



Latitude: 45° 47′ S
Longitude: 67° 30′ W
Altitude: 61 m
Total precipitation: 187 mm
Major wind: West, Northwest & Southwest
Average velocity: 32 km/h

(c) Climate at Comodoro Rivadavia, Chubut Province

Fig. I-2-1 Data of climate of the survey area (Mining Secretary, 1993)