

Exploration history of the Northern Patagonia Icefield

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Abstract

The exploration history of Northern Patagonia Icefield (NPI) is described, starting with a brief mention of the native inhabitants and the discovery by Magellan in 1520. The paper continues with a summary of the early explorations around NPI between the 17th and 19th centuries which took place mainly from the western side, and the subsequent reconnaissance of the Patagonian Andes and colonization from the eastern side in the early 1900's. The project on Istmo de Ofqui is also reviewed, because of its proximity to San Rafael Glacier. Dr. F. Reichert was the first one to make an expedition to a glacier of NPI in 1921. Since that year, 30 scientific and mountaineering expeditions have been reported to NPI, their main achievements being described here. Relevant scientific study on NPI is also mentioned.

1. Introduction

NPI lies within the Aisén Region (113,957 km²; Horvath, 1980), one of the 13 political divisions of Chile, of which the capital city is Coihaique. Due to the difficulty of access and inclement weather conditions, it was the last region in Chile to be settled. The channels on the western side of NPI have been explored by generations of sailors since the 14th century, but they never penetrated inland. Only at the end of the last century the eastern side (pampa) was reached through a transverse valley far north of NPI, and shortly afterward explorers and settlers began approaching the mountains from the pampa.

2. Native inhabitants

Nomadic Indians lived along all the western coast of Patagonia and were adapted to the rigorous conditions, relying mainly on seafood. They were known as the Chonos and were very similar to their neighbours the Alacalufes, who lived on the coast south of the Golfo de Penas. These two groups had frequent contact through the Istmo de Ofqui, which separates Laguna San Rafael from Golfo de Penas, avoiding the

dangerous open ocean of the Peninsula de Taitao, which cuts the continuity of the channels. However, they did not travel inland, into the "pampa" (plain), where skillful pedestrian hunters known as Tehuelches lived. There is no evidence of contact between the former two groups and the Tehuelches (Araya, 1985) and most probably none of them ventured into the outlet glaciers of NPI.

Our main source of information about the Chonos comes from the descriptions of John Byron in 1741 (Byron, 1955) and Jesuit Father Jose García in 1766/67 (García, 1889). These native Indians had great respect toward the supernatural forces which drove the strong westerly winds, the rain, the fire and the night. In spite of their primitiveness, they adapted extremely well to a hostile environment where many European settlers failed dramatically.

3. Discovery by Europeans

Some people regard Ferdinand Magellan as the discoverer of Aisén. In fact he viewed this territory "of rough topography and high mountains" from the sea at the 48th parallel south in December 1520, naming it "December Lands". Later, all the region ext-

ending south of Chiloé and west of the Patagonian pampa received the Spanish name "Trapananda".

In 1553 the first one of successive Spanish sailing expeditions which came from the north to explore the coast down to the Straits of Magellan and to prevent Dutch or English settlement in the area took place. During that expedition, native people were reported for the first time by the Spaniard Francisco de Ulloa (Mena, 1985), when his ships were violently driven away by many Indians "in big canoes with fire inside" at the *Península de Taitao*. This violent attitude was not strange, because Indians from further north (namely Chiloé) frequently visited the coasts of Aisén to capture Chonos and employed them for their own service, later also selling them to the Spanish.

4. Early explorations: 17-19th centuries

In 1675 Spanish Lt. Bartolomé Díaz Gallardo, together with Navy Capt. Antonio de Vea led a sailing expedition which made a reconnaissance of the channels. They sailed through a river (*Témpanos River*) up to a lake which they named *San Rafael* and crossed the *Istmo de Ofqui*, reaching the *Golfo de Penas*, being the first Europeans to do so (Araya, 1985; Balmelli, 1980). De Vea wrote: "... I discovered a gap(in the mountains, where).... a snow glacier was seen running from the beach inland. From the gap this lagoon is formed...." (Brüggen, 1950). However, they did not report any icebergs floating on the lagoon. In a different part of his description de Vea reported seeing a glacier from a great distance, before arriving at *San Rafael Lagoon*. Historians have interpreted this description in several ways. Steffen (1947) believes that de Vea saw *San Quintín* glacier, but Brüggen (1950) states that it actually was *San Rafael Glacier*. Brüggen supports this by saying that *San Rafael Glacier* can be seen from as far away as *Punta Leopardo*, and even farther away, even if the glacier has retreated a few kilometers. This explanation seems quite reasonable and anyway, from across the lagoon the first description of de Vea fits *San Rafael Glacier* very well, having at that time a non calving glacier tongue. In 1741, the survivors of the shipwreck of the English frigate "Wager" crossed the *Istmo de Ofqui*, guided by local Indians, and J. Byron gave a very interesting description (Byron, 1955) in which there is also no mention of icebergs on *Laguna San Rafael*.

The Spanish established some small colonies

along the coast on Aisén, exploring the channels and converting the native people to christianity. In fact they tried to eradicate the Chonos, sometimes brutally, resulting in a very quick extinction and assimilation of this unique culture. In 1766-68 J. García crossed the Isthmus and gave a very detailed description of the Lagoon and the Glacier, noting the presence of some icebergs (García, 1889). In 1872 Chilean Navy Commander Enrique Simpson finally penetrated inland from the channels, reaching the edge of the pampa in the area *Los Baguales*, northeast of Puerto Aisén. Later, during the same expedition (February 1873), photographs of *Glaciar San Rafael* were taken for the first time.

From the eastern side no one had approached the mountain ranges. In fact, *Lago General Carrera* (or *Buenos Aires* in Argentina) was first reported by Carlos Moyano in 1881, during an exploration on behalf of the Argentine Boundary Commission. That same year a treaty was signed between Chile and Argentina which fixed the border line along the "high summits" and the "water divide" (which has caused a double interpretation ever since). Between 1892 and 1902 the Boundary Commissions of both countries, concerning about the determination of the borderline, reconnoitered the Patagonian Andes for the first time, and they found that it consisted of a series of ranges separated by transverse valleys.

5. Exploration of the Patagonian Andes and colonization

The main descriptions around our area of interest were published by German geographer Hans Steffen (Steffen, 1909, 1914, 1947), working for the Chilean Commission which was directed by Luis Risopatrón (Risopatrón, 1902, 1905). Steffen made several expeditions to the area and was the first one to describe "two vast mountain sections.....covered under snow and ice... into which no one has yet managed to penetrate", now known as NPI and SPI (the Southern Patagonia Icefield). He explored the *Pascua* and *Baker Rivers*, thus determining the wide gap between both icefields and the southern and eastern limits of NPI. The Argentine Commission proposed in 1898 and 1900 two slightly different boundary lines passing through Mt. *San Valentín* (Risopatrón, 1902) and dividing NPI between Argentina and Chile. In 1902 a treaty dictated by His British Majesty Edward VII fixed the border

line "crossing Lakes Buenos Aires (General Carrera), Pueyrredón (Cochrane) and San Martín (O'Higgins)... and the high peaks named San Lorenzo and Fitz Roy". This way NPI lies completely in Chilean territory, whereas SPI is shared by both countries, the Argentine part being smaller.

It was in these years that the first settlers ("pobladores") began coming from the eastern side, most of them from south central Chile. The way of life in this rough country resembled a real "Far West", of which many remnants still remain today. In 1907 the first estimate of Aisén's population was made, divided into three areas: 54 people in Puerto Aisén, 62 in Coihaique and 81 in Río Baker. In 1920 the population increased to 1660 and by 1930 reached 8886 inhabitants in the whole region (Araya, 1985). Around this period the first adventurous "pobladores" began to settle within the eastern valleys of NPI, looking for new land in which to raise their cattle. Unfortunately, with this settling successive fires destroyed millions of hectares of native forest, remnants of which can be found sometimes up to the glacier fronts. By 1982 the total population of Aisén was 65,478 (XV National Population Census, 1982).

Still, the very few families who live in these valleys are mostly original pobladores themselves or their descendants. They are very hospitable people who are strongly influenced by regional traditions prevailing all over Argentine and Chilean Patagonia. Mate, asado criollo (barbecue) and the typical gaucho (Argentine cowboy) clothing are part of daily life. Even though the pobladores live near and sometimes wander up to the glacier fronts, they rarely venture onto the ice surface. A very appropriate name has been developed by them, naming the glaciers as "pampa de nieve" (snow pampa).

6. Project of Istmo de Ofqui and variations of San Rafael Glacier

Because of its proximity to San Rafael Glacier, it is interesting to review the history of the project of Istmo de Ofqui, before describing the expeditions into NPI. This isthmus is about 22 km wide, and joins the continent with the large Península de Taitao, being the main interruption of the inner channels between Puerto Montt and Punta Arenas. Shipping, therefore, most follow the dangerous open waters west of this Península and the Golfo de Penas, where many ship-

wrecks have occurred.

The idea of constructing a channel for small ships across the Istmo de Ofqui began to develop during the early Spanish explorations of the area, and since then has been a matter of controversy. The Indians (Chonos and Alacalufes) had a trail across the isthmus where they transported canoes, partly navigating through small rivers which flow into the Golfo de Penas.

Several reconnaissances were made of the area, the most relevant one made by Navy Commander Guillermo García Huidobro in 1905 (Balmelli, 1980). On board the "Pilcomayo" he made a sounding of Laguna San Rafael and an exact topographical survey of the glacier front. Based on this survey, the Chilean Government decided to make a complete study, thus sending in October of 1908 an expedition led by Engineer Emilio De Vidts. De Vidts published a report in 1910 (reprinted in 1980), proposing the construction of a 5 m deep channel joining the lagoon with Río Negro, which flows into the Golfo de Penas. It was not until 1937 when the construction of the channel finally started, only to be interrupted just a few years later, with only 200 m of the proposed 2 km finished. At that time a big hotel was constructed, in anticipation of future sailing traffic in the area (constituting now the park rangers house of Parque Nacional San Rafael). The project has been revived several times ever since, but never to the extent of restarting the channel construction.

Dr. Juan Brügger, who studied the geology of the area, published a geological report (Brügger, 1936), including a map of advances and retreats of San Rafael Glacier from 1905 to 1935, which he reprinted in his book *Geología de Chile* (Brügger, 1950). Brügger also studied the early descriptions of explorers to the area, and believes that between 1741 (Byron, 1955) and 1766 (García, 1889) San Rafael Glacier advanced, calving into the lagoon. Thus a valuable historical record of advances and retreats of San Rafael Glacier has been kept.

7. Explorations into NPI and scientific studies

The first reported expedition to a glacier of NPI was made by Dr. Friedrich Reichert in 1921, ascending Glaciér San Rafael to a point midway across the icefield. Compared with SPI, very few explorations into NPI have taken place since. This difference may be caused by the easy access of SPI through Argen-

tina, in spite of its larger size compared to NPI (11,302 km² vs. 3,105 km² of NPI-Tanaka, 1980).

The first explorations attempted the ascent of Monte San Valentín, as well as scientific study. Dr. Reichert, both a climber and a scientist, contributed largely to the knowledge of NPI, making 3 expeditions from both sides (San Rafael and Lago Leones) between 1921 and 1940. Although failing in his attempts to climb San Valentín, he published interesting descriptions of the glaciers (Reichert, 1922, 1924, 1946). Late in 1921 the famous Swedish explorer Otto Nordenskjöld attempted to access into the icefield from San Quintín Bay, making a triangulation to San Valentín (Nordenskjöld, 1922 ; Pallin, 1933). In 1939/40 and 1945/46 the Swiss geologist Dr. Arnold Heim attempted Mount San Valentín from Lago Leones and studied the geology of the area (Heim, 1940a, 1940b, 1946, 1959).

In 1944/45 the US Air Force (USAF) made a complete aerial survey of Chile by trimetrogon photographs, publishing maps at 1 : 250,000 scale which were translated into Spanish and completed by the Instituto Geográfico Militar de Chile (IGM : Carta Preliminar, 1953). With this survey, the areal extension of NPI was determined, but, as Dr. Louis Lliboutry (1956) pointed out, in the Carta Preliminar the glaciers of Patagonia are poorly portrayed. The northern limit of NPI was established in the field by Augusto Grosse in 1947, when he made the first exploration of Río Exploradores from Lago General Carrera to the channels (Grosse, 1974).

During his stay at the Universidad de Chile in Santiago, Dr. Lliboutry made a very important contribution to the knowledge of Southern Andean glaciers. He introduced the names Hielo Patagónico Norte and Hielo Patagónico Sur (in English NPI and SPI respectively), replacing the erroneous name of Hielo Continental, which nevertheless is still used to date. He studied the trimetrogon photographs and the Carta Preliminar, and produced a sketch map at 1 : 500,000 scale (Lliboutry, 1956 ; revised in 1981) correcting the toponymy and some features of NPI. He also described some advances and retreats of glaciers, and general characteristics of Patagonian icefields.

In 1958 Kaoru Tanaka, the leader of a Chilean-Japanese joint expedition, made a periglacial study in the Colonia Glacier area (Tanaka, 1980) in relation to glacial outburst. In 1959, the American Geographical Society made an expedition to San Rafael Glacier, studying the periphery of the glacier, including a

detail study of the glacial geology of the area (Heusser, 1960, 1961a ; Muller, 1959 ; Lawrence and Lawrence, 1959). Later Calvin Heusser analysed this information and compared the Quaternary climatic change between North America and Patagonia (Heusser, 1961b). Mercer (1962, 1967) studied the trimetrogon photographs and described the NPI glaciers and their variations by incorporating existing information. Until 1962, as Mercer (1962) pointed out, San Rafael Glacier was the only one to be scientifically studied in NPI.

In 1963/64 Eric Shipton led a strong party which carried out the first W-E traverse of NPI, and gave descriptions of the icefield (Shipton, 1964, 1985). In 1967 Hironao Yoshida led a Japanese expedition that carried out preliminary researches in glaciology (Naruse and Endo, 1967 ; Naruse, 1983), geology and botany on the following glaciers of the northern part of NPI : Soler, Nef, Mt. San Valentín East, Circo (Grosse) and San Rafael. In 1972/73 a Joint Services Expedition (1973) from Great Britain did general studies of glaciology, geology, natural history and cartography in the area of San Quintín Glacier. They set a high camp up on the edge of the icefield, attempting San Valentín and making a north-south icefield crossing (Agnew, 1974).

In 1974 the USAF made a new aerial photogrammetric survey of NPI, from which IGM has compiled a complete set of maps at 1 : 50,000 scale (IGM : Carta Regular, 1982). Based on these photographs, Pedro Valdivia published a Glacier Inventory of the whole NPI (Valdivia, 1979), while he was studying at the Swiss Federal Institute of Technology.

The geology of the eastern part of NPI, including some outlet glaciers, was studied by Tsuyoshi Nishimura (1977), a member of the 1967 Japanese expedition, who made several other expeditions to the area, many of them with Katsuhito Yoshida. Yoshida (1981) carried out a detailed study of the geology of the upper basin of the Baker River as part of his Ph. D. program at Universidad de Chile, collecting information from many field trips including several outlet glaciers.

In 1981-82 a Japanese expedition led by Tadashi Koyama carried out preliminary observations of glacier flow, glacial flood and meteorology on Steffen Glacier (Enomoto and Abe, 1983), as well as fish and zooplankton studies in the fjords.

The first systematic scientific study team penetrating into the glaciers was a Japanese Expedition in

1983/84 (Nakajima, ed. 1985). This first part of Glaciological Research Project in Patagonia (GRPP) Northern Icefield carried out the following studies in the ablation area of San Rafael, Soler and Nef glaciers and the San Rafael Lagoon area : meteorology, climatology, glaciology, hidrology, glacial landforms, aerial survey, biology and limnology studies. Particularly interesting was the high velocity of 17 m/d measured at the calving front of San Rafael Glacier and the study of the east-west contrast in meteorological conditions related to glacier ablation. The second GRPP expedition took place in 1985/86, extending the field study to the accumulation area of the icefield as well. In general, more detailed studies were made, carrying out the following investigations for the first time : the 38 m deep ice boring on the icefield, the radio sounding measurements around San Rafael Glacier snout and the gravity measurements for the estimate of ice thickness in Nef Glacier, Soler Glacier and the icefield. Using aerial photographs taken in GRPP 1983/84 and the previous USAF flights, Aniya and Enomoto (1986a, 1986b) described recent glacier variations in NPI, and Aniya and Naruse (1986) mapped the structure and morphology of Soler Glacier.

8. Mountaineering in NPI

Even though it is located north of SPI, NPI has similar weather conditions as SPI, governed by the westerlies: high precipitation and very strong winds. Contrary to SPI, where distinctive rock massifs emerge on the eastern edge of the icefield and can be easily accessed from the pampa (Fitz Roy and Paine for example), most of the main mountains in NPI are located within the icefield. Only a few can be reached from the eastern side, without penetrating into the icefield, but often requiring long approach marches as the case of Mt. San Valentín, and also they present steep eastern slopes difficult to climb. On the other hand, the access into the icefield is complicated due to heavily crevassed outlet glaciers. Thus the climbing activity has been reduced to one expedition every 2.5 years to the whole NPI (average from 1921 to 1985, Table 1). Nevertheless, quite a few peaks have been climbed, some of them by technically difficult routes, as well as two complete icefield traverses.

8. 1. Climbing expeditions

Most of the first explorations to NPI attempted

the ascent of Monte San Valentín, the highest mountain in Patagonia. In the early maps published by the Chilean Boundary Commission (Risopatrón, 1902) it appeared with an elevation of 3,870 m. Later its elevation was quoted as 4,058 m (Risopatrón, 1924 ; IGM : Carta Preliminar, 1953), even though an earlier and reliable triangulation by Nordenskjöld in 1921 from San Quintín Bay gave an elevation of 3,876 m (Nordenskjöld, 1922 ; Pallin, 1933). In the new maps at 1 : 50,000 scale it appears with an elevation of 3,910 m (IGM : Carta Regular, 1982). After 6 unsuccessful attempts from both sides of the icefield since 1921, the elusive summit of Monte San Valentín was finally conquered by a Club Andino Bariloche Argentine expedition from San Rafael Glacier in 1953 (Club Andino Bariloche, 1954 ; Dudzinski, 1960).

The conquest of Mt. San Valentín put an end to the early exploration period. The subsequent expeditions were interested in conquering some of the many unclimbed peaks of NPI, smaller than San Valentín but in many cases technically more difficult, and at the same time attempting the challenging traverse of the icefield.

In 1958 a joint Chilean-Japanese expedition led by Kaoru Tanaka made the first ascent of Mt. Arenales (3,365 m), the third highest peak of NPI (García, 1958).

In 1963/64 Eric Shipton, together with Chileans Cedomir Marangunić and Eduardo García and Spanish Miguel Gomez made the first and only complete W-E traverse of NPI, from San Rafael Glacier to Colonia Glacier, ascending Cerro Arenales and Cerro Arco (1st ascent) on the way. It was Shipton's last great venture on the Patagonian icefields (Shipton, 1964, 1985 ; Arko, 1979). At the same time they made a N-S traverse, in total 120 km. In Patagonian Icefields "complete traverse" means from "water to water" ; *i.e.*, if it is W-E, from the ocean channels to the eastern lakes. This feat marked the beginning of a new period of exploration in which modern polar tactics and climbing techniques were applied to the rigorous conditions of NPI.

New Zealand climbers have been perhaps the most active in the area. Inspired by Shipton's description of a corridor of peaks within the icefield, they made three expeditions from 1969 to 1973 from the eastern side. The most successful took place in 1969/70, and in total New Zealanders completed 16 first ascents of peaks both within the icefield and separated from it, many of them requiring hard technical climbing. The ascents included the second ascent of Mt. San

Valentín by a new route on the upper slopes and the first ascent of the second highest peak of NPI, Mt. Cuerno de Plata or Tararua (3,725 m), located southeast of Mt. San Valentín. After these expeditions many reports were published in mountaineering journals, including a sketch map at 1 : 100,000 scale (Nankervis, 1970 ; Vickers, 1970a, 1970b ; Lucero, 1972 ; Barrera, 1970 ; Clark, 1972 ; Gunn, 1973 ; Tarsetti, 1972 ; Clarkson, 1973).

In 1972-73 a British Scientific Joint Services Expedition set up Base Camp in Kelly Inlet, south of San Quintín Glacier. Having reached the icefield, they traversed NE attempting San Valentín, but failed on the upper slopes. Later they successfully made the first N-S traverse of NPI from San Quintín Glacier to the snout of Steffen Glacier, and back to their Base Camp via a different route down Benito Glacier (Agnew, 1974).

In 1979 a New Zealand expedition, including Chilean Sergio Saldivia, explored a route to San Valentín from the north (Circo Glacier). Based on this exploration, Saldivia returned in 1981 leading a Chilean expedition from Coihaique, climbing a new route on Mt. San Valentín from Circo Glacier (Saldivia, personal communication). In 1981/82 a scientific Japanese expedition climbed an unnamed peak (1,597 m), located 30 km from the snout of Steffen Glacier. Mt. San Valentín was attempted unsuccessfully by Chilean C. Hopperdietzel in 1983 from San Rafael Glacier, but a minor peak named Mt. Norte was climbed, 15 km east of the lagoon (Hopperdietzel, personal communication).

Lastly, at the end of 1985 three expeditions visited the area. Clive Ward (Ward, personal communication)

led a South African expedition which attempted a north-south icefield crossing from San Rafael Glacier, reaching only the edge of the icefield. During the Japanese expedition GRPP 1985/86 the north peak of Mt. Largo (unnamed on official maps) located on Nef Glacier was ascended for the first time and named Pico Naranja, and a 30 km long traverse of the upper icefield from Nef to San Quintín Glacier and back (in total 60 km) was completed in one day with telemark (heavy cross-country) skis. In late December, Mt. San Valentín was climbed very fast from the normal San Rafael route by a French couple, being the fourth ascent and first woman on the top (Ward, personal communication).

9. List of expeditions and peaks climbed in NPI

Following is a list, by no means exhaustive, of scientific and mountaineering expeditions (Table 1) and peaks climbed in NPI (Table 2). Various scientific and climbing journals, as well as personal communications have been the source of information, and reference has been made to them.* Some discrepancies have existed in the names of the peaks ; here, in general the names given by the first climbers have been respected. As suggested by Prof. E. Echevarría, who has kept an excellent record of Andean ascents (Echevarría, 1963, 1974), the names have been translated into Spanish, although in brackets other names are also given. Based on Dr. Lliboutry's map (1956) and information provided by a map of Iwata (1976), a sketch map of NPI is presented (Fig. 1).

Table 1. List of climbing and scientific expeditions to NPI.

YEAR	EXPEDITION	RESULTS
1921	Dr. F. Reichert <i>et al.</i>	Scientific and climbing exploration attempting Mt. San Valentín from San Rafael Glacier, penetrating to a nunatak about 18 km from the lagoon. (Reichert, 1922, 1924, 1946)
1921	O. Nordenskjöld, leading a Swedish expedition.	From San Quintín Bay they attempt to access unsuccessfully into the icefield. A triangulation to Mt. San Valentín is made, determining the height to be 3,876 m. (Nordenskjöld, 1922 ; Pallin, 1933)
1939	Dr. F. Reichert, Prof. H. Barrera, Capt. P. Ihl <i>et al.</i> (Joint expedition Club Andino de Chile-Instituto Geográfico Militar)	From the eastern side they explore Leones Lake area, looking for an access to climb San Valentín, but they are not able to mount into the icefield. Botanical and glaciological observations are carried out. (Ihl, 1939 ; Reichert, 1946)

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| 1939/40 | Dr. A. Heim, H. Hess and W. Schmitt. | From Leones Lake they reach a col overlooking the icefield, and return because of bad weather. Geologic observations are made. (Heim, 1940a, 1940b, 1959) |
| 1940 | Dr. F. Reichert, A. Grosse, Capt. P. Ihl, E. Hoffmann, W. Ihl <i>et al.</i> | From San Rafael Glacier Hoffmann and W. Ihl traverse the icefield on skis, reaching a depression west of Fiero Lake (ice divide), failing to climb San Valentín, but making general observations of the icefield. (Reichert, 1946) |
| 1941/42 | H. Hess <i>et al.</i>
(Club Andino Osorno Expedition) | From San Rafael Glacier they reach the col between Mt. Cuerno de Plata (Titlis) and San Valentín, returning because of bad weather. (Hess, 1942) |
| 1945/46 | Dr. A. Heim, H. Hess <i>et al.</i>
(Club Andino Bariloche Expedition) | First ascent of Mt. Tronco from Leones Lake, reaching a col which leads into the icefield, but failing to approach closer to San Valentín. (Heim, 1946, 1959) |
| 1952/53 | Club Andino Bariloche. | First ascent of Mt. San Valentín from San Rafael Glacier (same route as Hess 1941/42). (Club Andino Bariloche, 1954 ; Dudzinski, 1960) |
| 1958 | Joint Expedition from Kobe University and Federación de Andinismo de Chile. | First ascent of Mt. Arenales, from Colonia Lake. Attempt of crossing the icefield. Periglacial study around Colonia Glacier. (Tanaka, 1980 ; García, 1958) |
| 1959 | American Geographical Society. | Scientific study around San Rafael Lagoon, including glacial geology. (Heusser, 1960a, 1960b, 1961 ; Muller, 1959 ; Lawrence and Lawrence, 1959) |
| 1959 | Centro Andino Buenos Aires. | From Fiero Lake, first ascent of Mt. Helbling, located east of NPI, and unsuccessful attempt to mount into the icefield. (Joos, 1959) |
| 1959 | Federación Argentina de Campinismo. | Exploration of Fiero Lake and Fiero Glacier. (Joos, 1960) |
| 1960 | Centro Andino Buenos Aires. | Exploration of Leones Glacier and Leones Lake. (Joos, 1960) |
| 1963/64 | E. Shipton,
C. Marangunić,
E. García and M. Gomez. | First traverse of NPI, from San Rafael Glacier to Colonia Glacier, climbing Mt. Arco (1st. ascent) and Mt. Arenales (3rd. ascent). (Shipton, 1964, 1985) |
| 1967 | Japanese expedition from Hokkaido and Hiroshima Universities. | Preliminary glaciological investigation in the area of Soler, Nef, San Valentín Este (Exploradores), Circo (Grosse) and San Rafael glaciers. (Naruse and Endo, 1967 ; Naruse, 1983) |
| 1968 | T. Nishimura, F. Hervé and 4 Japanese members. | Geological expedition to Tranquilo River and Circo Glacier. |
| 1969/70 | Tararua Tramping Club Expedition (New Zealand) led by G. Vickers, including Chilean C. Lucero. | From León Lake they mounted into the icefield, where with the help of skis made many first ascents and also the second ascent of San Valentín. (Nankervis, 1970 ; Vickers, 1970a, 1970b ; Lucero, 1972 ; Barrera, 1970) |
| 1971/72 | New Zealand Expedition including Chilean R. Tarsetti. | From Nef Glacier they attempted Mt. Largo and Mt. Cachet, climbing one of the summits of the former and succeeding in the latter peak. (Clark, 1972 ; Gunn, 1973 ; Tarsetti, 1972) |
| 1972/73 | New Zealand Expedition. | From Soler Glacier, new route on Mt. Hyades, 2nd ascent of Aguja Aguda and two first ascents east of the icefield. (Clarkson, 1973) |
| 1972/73 | Joint Services Expedition Trust, Ministry of Defense, London. | Scientific investigations and penetration into the icefield from San Quintín Glacier. Attempt to climb San Valentín, reaching the upper slopes of the mountain. First NS traverse of the icefield, from San Quintín Glacier to the snout of Steffen Glacier. (Joint Services Expedition Trust, 1973 ; Agnew, 1974) |

1975	Universidad de Chile Expedition, T. Nishimura, K. Yoshida and M. Rojo.	Geological investigations in the area of Leones, Soler and Nef glaciers. (Nishimura, 1977 ; Yoshida, 1981)
1976	Universidad de Chile Expedition, T. Nishimura, K. Yoshida and E. García.	Geological investigations in the area of Colonia, Soler and Nef glaciers ; Ventisqueros River and Lake Cristal. (Nishimura, 1977 ; Yoshida, 1981)
1979	New Zealand Expedition with Chilean S. Saldívar.	Reconnaissance route to Mt. San Valentín from Exploradores River and Circo (Grosse) Glacier, climbing a small peak near the confluence of both valleys.
1981	Club Cóndores Australes (Coihaique).	3rd ascent to San Valentín, new route from Exploradores River and Circo (Grosse) Glacier.
1981/82	Hokkaido University Expedition, led by T. Koyama.	Meteorological and glaciological preliminary observations. From Steffen Glacier they penetrated into the icefield, making the first ascent of P1597, located 30 km from the glacier front. (Enomoto and Abe, 1983)
1983	Chilean C. Hopperdietzel with another climber.	Attempt to climb San Valentín from San Rafael Glacier, making the first ascent of Mt. Norte, located 15 km from the Lagoon.
1983/84	Japanese Glaciological Research Project in Patagonia (GRPP), led by C. Nakajima.	Meteorological, glaciological, hidrological and entomological investigations at San Rafael, Soler and Nef glaciers. (Nakajima, ed., 1985 ; Aniya and Enomoto, 1986a, 1986b ; Aniya and Naruse, 1986 ; Casassa, 1985)
1985	South African Expedition led by C. Ward, including Chilean R. Muñoz.	Traverse attempt of NPI from San Rafael Glacier, reaching a point on the edge of the icefield.
1985	2-person French Expedition.	4th ascent of Monte San Valentín, from San Rafael Glacier (first woman on the top).
1985/86	2nd Japanese GRPP, led by C. Nakajima.	Detailed continuation of previous investigations on San Rafael, Soler, Nef and San Quintín Glaciers, this time covering the accumulation area as well. On the icefield ice boring down to 38 m was carried out at 1296 m, about 25 km east of Laguna San Rafael, as well as a 30 km long gravity traverse from Nef to San Quintín Glaciers. First ascent of Mt. Pico Naranja (2645 m), one of the summits of Mt. Largo.

Table 2. Ascents on NPI

AGUJA AGUDA (2641 m) (erroneously named Mt. Hyades in the Carta Regular, 1982)	1st ascent (January 8, 1970) : P. Gresham, G. Vickers, R. Vickers (South Ridge). 2nd ascent (January 1973) : T. Clarkson, D. Bamford (South Ridge).
ARCO (2992 m)	1st ascent (December 25, 1963) : E. Shipton, C. Marangunić, M. Gomez, E. García.
ARENALES (3365 m)	1st ascent (March 6, 1958) : G. Mills, Maeda, C. Píderit. 2nd ascent (March 8, 1958) : Takagi, K. Claussen, M. Emmanji. 3rd ascent (December 27, 1963) : E. Shipton, C. Marangunić, E. García, M. Gomez.
CACHET (2632)	1st ascent (December 1971) R. Molineux, D. Clark, R. Tarsetti, R. Gunn.
CONO HELADO (2500 m(A))	1st ascent (January 6, 1970) : R. Gunn, J. Nankervis, C. Bibby, D. Launder (West Ridge).
CRISTAL (2745 m(A))	1st ascent (January 2, 1970) : R. Gunn, D. Launder, C. Bibby, J. Nankervis (West Ridge).
CUERNO DE PLATA (3725 m(A)) (Tararua, Titlis or Silberhorn)	1st ascent (December 20, 1969) : D. Launder, P. Gresham (South Ridge).

FIERO (3415 m(A))	1st ascent (December 20, 1969) : R. Gunn, J. Nankervis (North Ridge).
HELBLING (2500 m(A))	1st ascent (January 30, 1959) : H. Joos, P. Bruchhausen.
HYADES (3078 m(C)) (unnamed in Carta Regular, 1982)	1st ascent (January 7, 1970) : C. Bibby, R. Gunn, D. Launder, J. Nankervis (North Face). 2nd ascent (January 1973) : T. Clarkson, P. Milsom, G. Spearpoint, I. Thorne, D. Bamford (Southwest Ridge).
LA TORRE (2768 m) (Torre Tobler)	1st ascent (December 23, 1969) : C. Bibby, R. Gunn, D. Launder, J. Nankervis (East Ridge).
MOCHO (2440 m(A)) (beside Lago León)	1st ascent (January 5, 1970) : A. Bibby, D., Launder, J. Nankervis (Southwest Ridge).
PCW (2710 m(A)) (west of Mt. Cachet)	1st ascent (December 30, 1971) : D. Launder, N. Palmer, R. Gunn.
PICO NARANJA ¹ (2645 m(A)) (north summit of Mt. Largo, Nef Glacier)	1st ascent (December 1, 1985) : B. Schwahn, R. Mujica, G. Casassa.
PL4 ¹ (2710 m(A)) (one of the south summits of Mt. Largo)	1st ascent (December 31, 1971) : D. Launder, N. Palmer.
P1597 (1597 m) (North of Steffen Gl.)	1st ascent (January 1982) : T. Koyama, M. Tsutsumi, H. Enomoto, S. Nakatani (South-west Ridge).
P2000 (2000 m(C))	1st ascent (February 1973) : D. Bamford, I. Thorne, T. Clarkson.
P2545 (2545 m(C)) (P2000 and P2545 are located North of Rfo Soler, separated from the icefield)	1st ascent (February 1973) : D. Bamford, I. Thorne, T. Clarkson.
PICO SUR (Pamir)(3198 m)	1st ascent (December 24, 1969) : R. Vickers, C. Lucero (East Ridge).
SAN VALENTIN (3910 m)	1st ascent (December 18, 1952) : O. Meiling, C. Neumayer, T. Pangerc, C. Sonntag, D. Bertoncelj, G. Ezquerro, B. Lantschner (San Rafael route). 2nd ascent (December 23, 1959) : G. and R. Vickers, P. Gresham, C. Lucero (from Leones Glacier they joined the San Rafael route, with a new route on the upper slopes). 3rd ascent (1981) : S. Saldivia, J. Vargas, W. Millar and D. Vidal-the last died on the descent-new route from Circo Glacier (Grosse). 4th ascent (December 1985) : P. Modère and N. Mazoir (first woman) (San Rafael route).
SINIOLCHU ² (2470 m(A))	1st ascent (January 8, 1970) : C. Bibby, R. Gunn (North face and West Ridge).
TRONCO (2410 m(A))	1st ascent (1945) : H. Hess, H. Schmoll, J. Studer.
TORRECILLA (2285 m(A)) (Turret)	1st ascent (January 1970) : J. Nankervis, D. Launder (East face).

- NOTES:**
- 1) Both Pico Naranja and PL4 are part of Mt. Largo, located in Nef Glacier. The official maps name Mt. Largo a peak on the right margin of Soler Glacier. In fact Mt. Largo is an internationally accepted name among climbers for a magnificent ice covered mountain in the upper section of Nef Glacier, which, as its name correctly indicates, has a long ridge including several peaks, the highest one still unclimbed.
 - 2) Siniolchu is a Himalayan name, unacceptable for the Instituto Geográfico Militar de Chile.
 - 3) The elevations have been taken from the map (Carta Regular, 1982) at 1 : 50,000 scale published by the Instituto

Geográfico Militar de Chile (IGM), except in the following cases :

(A) : Altimetric reading by first climbers

(as they are based on the Carta Preliminar elevations, they have been corrected to fit the Carta Regular elevations)

(C) : Elevation from Carta Preliminar, 1953 (IGM) at 1 : 250,000 scale

10. Concluding remarks

Only in 1983/84 the first systematic study of NPI glaciers was carried out by a Japanese expedition (GRPP), continued in 1985/86. These expeditions have produced an important contribution to the scientific knowledge of the area, but still many scientific problems remain unsolved and it is hoped that the results of GRPP expeditions will be incentive for further studies on Patagonian glaciers, in order to achieve a scientific knowledge comparable to other glaciated areas of the world.

With respect to mountaineering, both the light French expedition to San Valentín and the east-west traverse of the upper icefield by a GRPP team in 1985 show the great possibilities of applying fast, alpine style techniques in Patagonian icefields. To date many areas of NPI are still unexplored, with a great number of challenging peaks unclimbed, most of which are incredibly sheer granitic spires (nunataks) emerging from the ice surface.

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Resumen

Historia de exploración del Hielo Patagónico Norte (HPN)

En este trabajo se describe la historia de exploración del HPN, empezando con una breve mención de los habitantes nativos y el descubrimiento por Magallanes en 1520. Luego se resumen las primeras expediciones a la zona alrededor del HPN entre los

Siglos 17 y 19, las cuales se efectuaron principalmente por la costa, continuando con el reconocimiento de los Andes Patagónicos y la colonización desde el lado oriental a principios de este siglo. Debido a su cercanía con el Glaciar San Rafael se describe también el proyecto del Istmo de Ofqui. En 1921 tuvo lugar la primera expedición a un glaciar del HPN, guiada por el Dr. F. Reichert. Desde entonces 30 expediciones científicas y deportivas han sido registradas al HPN (Tabla 1), describiéndose sus logros principales. También se hace mención de estudios científicos importantes sobre el HPN. En la Tabla 2 se presenta una lista de cumbres ascendidas en el HPN, las cuales se muestran en la Fig. 1.