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" L I C A N C A B U R : M O U N T A I N O F T H E A T A C A M E Ñ O S "

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The Geographical Review

VOLUME XLV April, 1955 NUMBER 2

LICANCABUR: MOUNTAIN OF THE ATACAMEÑOS

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LICANCÁBUR, another of the few spots on the surface of the earth believed to be beyond man's attainment, has been ascended and some of its secrets bared. This conical volcano at the southwest corner of the Chile-Bolivia boundary was climbed by a group of six on November 22, 1953, after a challenging statement regarding its inaccessibility had been made in an article in the *Geographical Review* two years earlier.[1] The climbers confirmed all that had been previously recounted on the great and unique difficulties of the ascent. They also reported three unexpected discoveries: the mountain had been not only ascended but occupied in times past, for stone walls and remains of wood were found on the eastern rim; within the crater was an unfrozen lake, probably the highest (19,300 feet) liquid body of water on earth; chinchillas, thought to have been exterminated in the region, were seen among the rocks far up the mountainsides.

A Unique Mountain

Licancábur stands (Fig. 1) at the southern extremity of the long line of volcanoes approximating the 68th meridian that marks the Chile-Bolivia boundary. The Chilean government's official map[2] shows the height of the mountain as 5930 meters (19,455 feet). This is lower than the height of many other peaks in the vicinity, yet Licancábur dominates the landscape. Its lone, perfect cone commands respect[3] (Figs. 2 and 3). And well it may. Adjacent

[1] W. E. Rudolph: Chuquicamata Twenty Years Later, *Geogr. Rev.*, Vol. 41, 1951, pp. 88–113; reference on p. 113.

[2] Carta Nacional, 1945 edition of the Instituto Geográfico Militar, Santiago.

[3] Geographers who have written about the Atacama Desert region mention Licancábur frequently though they omit the names of higher peaks; it heads numerous tabulations and lists of mountains of the region.

MR. RUDOLPH, chief engineer at Chuquicamata for the Chile Exploration Company, has written frequently for the *Geographical Review*. His most recent contribution was "Sulphur in Chile" in the issue for October, 1952.

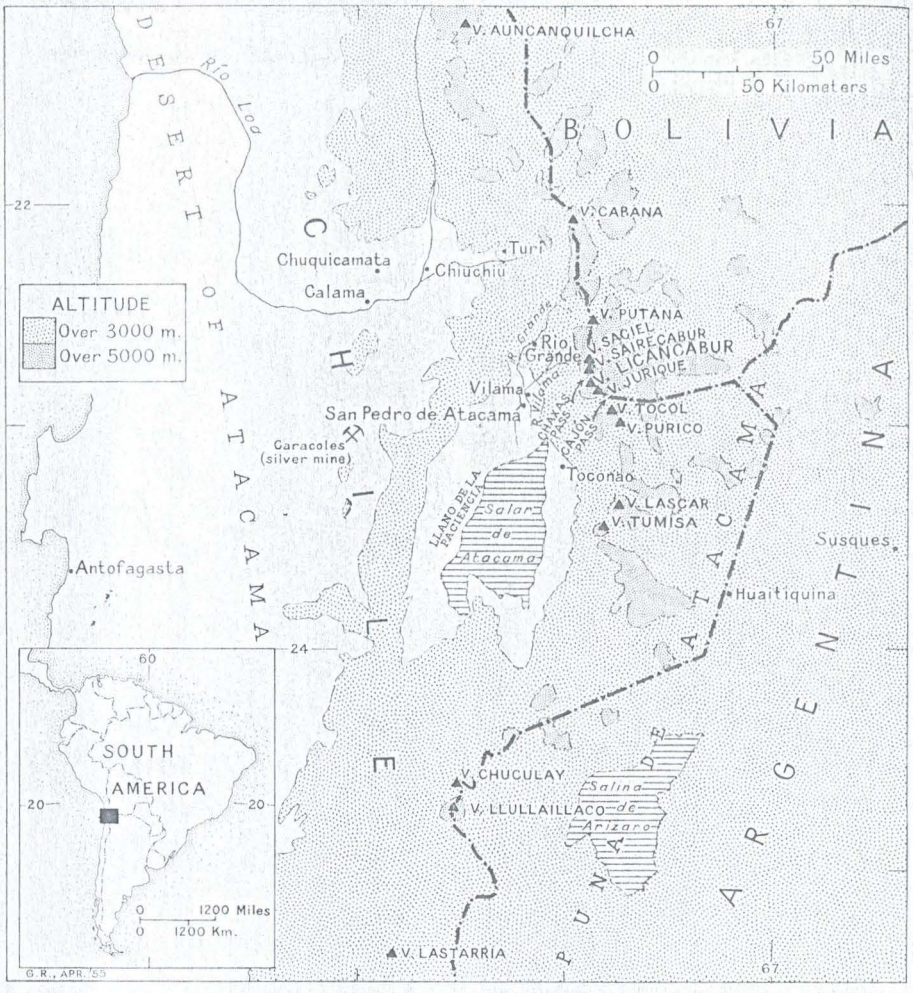


FIG. 1—The region surrounding Licancábur.

peaks, though higher, have been ascended scores of times in the present century; on some, sulphur is mined near the very top. These other mountains present no serious difficulties of ascent except for shortness of breath for those unaccustomed to high altitudes; even mules and jeeps have gone above 19,000 feet. But Licancábur is different. Above 15,000 feet, where the steeper slopes begin, the ground, unlike the firm rock surfaces and cliffs of other volcanoes, is totally unstable. Rocks shudder or move or start slides where one touches or steps, or sometimes for no visible reason. This unrest is manifested especially at night, when campers at the foot or sides of the mountain are ever aware of the sounds of sliding rock; at times the noise becomes so loud and ominous that fear of burial beneath an avalanche of rock makes sleep impossible.

Licancábur is also distinguished by the scantiness or even complete absence of snow except immediately after a severe storm. In the Andean cordillera at this latitude the first snows of late June or early July generally cover mountains and passes above about 15,000 feet with a mantle of white that remains until mid-September or later. Not so with Licancábur. The unbroken whiteness of its cone as the storm clouds disappear is transient. A day or two later dark lines appear; within a week or two the white remains only in streaks. Thus Licancábur stands out among its white compeers as the dark mountain—a reddish black that becomes purple at sunset.

And, again, in a region where every volcano higher than 18,000 feet has large deposits of sulphur Licancábur seems to have none. Saciel, only seven miles to the north, has 600,000 tons of proven sulphur ore reserves assaying 55 to 60 per cent sulphur; Tocol, 11 miles to the southeast, has 600,000 tons of ores averaging 54 per cent proven and 1,400,000 tons between 45 and 50 per cent probable and possible.[4] The prospector's clue that a bleached appearance of the normally dark-hued volcanic rock may betoken the presence of sulphur but lack of it definitely indicates absence[5] rules out sulphur on Licancábur—its surface is entirely dark.

History and tradition add to the lure of the mountain. The high plateaus to the north, east, and south are uninhabited and little explored, but 20 miles to the west is the ancient pueblo of San Pedro de Atacama,[6] a group of oases irrigated by the waters of the Grande and Vilama Rivers. Probably the first humans who appeared in the Atacama Desert saw the possibility of utilizing the waters of these two streams, which, emerging from their deep canyons, transform a brown plain to green before they disappear within the great white Salar de Atacama. By how long these first people antedated the Atacameños we do not know; only the Atacameños of the older people have left remnants of culture and language. At some time in the early part of the fourteenth century the region was subjugated by the Inca Yahuar-huaccac.[7] The Spaniards arrived in the early sixteenth century—a bell in the church tower at San Pedro de Atacama carries the date 1607. To the Incas and the Spaniards, to the Chileans and the Bolivians, Licancábur was a source of worldly goods—chinchilla skins and yareta—but to the Atacameños the mountain was an object of worship. Thus came its name, from the Cunza

[4] Tomás Vila: Recursos minerales no-metálicos de Chile (Santiago, 1953), p. 82.

[5] W. E. Rudolph: Sulphur in Chile, *Geogr. Rev.*, Vol. 42, 1952, pp. 562–590; reference on p. 568.

[6] See Isaiah Bowman: Desert Trails of Atacama, *Amer. Geogr. Soc. Special Publ.* No. 5, 1924, p. 251.

[7] Stig Rydén: Contributions to the Archaeology of the Rio Loa Region (Göteborg, 1944), pp. 19 ff. Garcilasso de la Vega: First Part of the Royal Commentaries of the Yncas, translated and edited by C. R. Markham, 2 vols., *Hakluyt Soc.* [*Publs.*], Ser. 1, Vols. 41 and 45, 1869 and 1871, reference in Vol. 1, p. 339.

language of the Atacameños: *lican,* meaning "pueblo" or "people"; *cábur,* "mountain."[8] An Indian of Toconao told me some years ago of the traditions of his Atacameño forefathers. Licancábur, the Mountain of the Pueblo, was god indeed. There is a legend of a golden guanaco head within the crater, taken there by the ancient people as a tribute to their god. Others differed with him as to the nature of the object, but all agreed that it was of gold. The feeling among the Indians, which persists to the present day, is that the high mountains are sacred. Calamities follow when a mountain is climbed, and the older people had been wont to use persuasion or force to prevent violation of the sanctity of their mountains.[9] Although a large sum was offered two Indian youths to accompany the 1953 expedition to the top of Licancábur, both refused and when asked why gave evasive replies.

The Ascent

Some 30 to 35 years ago, during the earlier days of operation of the Chuquicamata copper mine, considerable impetus was given to mountain climbing. At that time it was believed that Licancábur never had been climbed and never could be. A few adventurers who came to San Pedro de Atacama for the purpose found their ardor dampened by tales of chinchilla hunters who had gone to the mountain and failed to return. There was one who refused to be turned back. He spent two weeks trying to climb the mountain and admitted failure only after suffering severe cuts and bruises. Not until 1953 was a further attempt made. A group of engineers from Chuquicamata, headed by Henning Kristensen and Martin Madden, began a serious study of approach by way of a buttress on the northwest face, where the rock appeared to be more stable. They were aided by a road just completed by yareta cutters to a point above 14,000 feet, which permitted a base reconnaissance by truck and jeep instead of by mule or afoot. Three unsuccessful attempts demonstrated that ropes and conventional climbing techniques were impracticable. Enough was learned, however, to plan an assault at full moon in November. Base camp was made at 17,000 feet on the afternoon of the 21st, and early on the morning of the 22nd two parties of three

[8] Francisco Solano Asta-Buruaga, in his "Diccionario geográfico de la República de Chile" (New York, 1899, p. 366), refers to the records of 1870 of the boundary commissioners of Chile and Bolivia, in which it is stated that the name Licancáur or Licancáguar signifies in the Cunza or Atacameño language "proud mountain of the people." The word *lican* was also applied to the Atacameños themselves, according to Luis Riso Patrón (Diccionario jeográfico de Chile [Santiago, 1924], p. 53), these people sometimes being known as *lickantai* or *lican-antai.*

[9] Sir [W.] Martin Conway wrote at some length of the passive, and even active, resistance by the Aymaras to his expedition's attempt to climb Illampu in Bolivia, which, as a result, ended in failure.

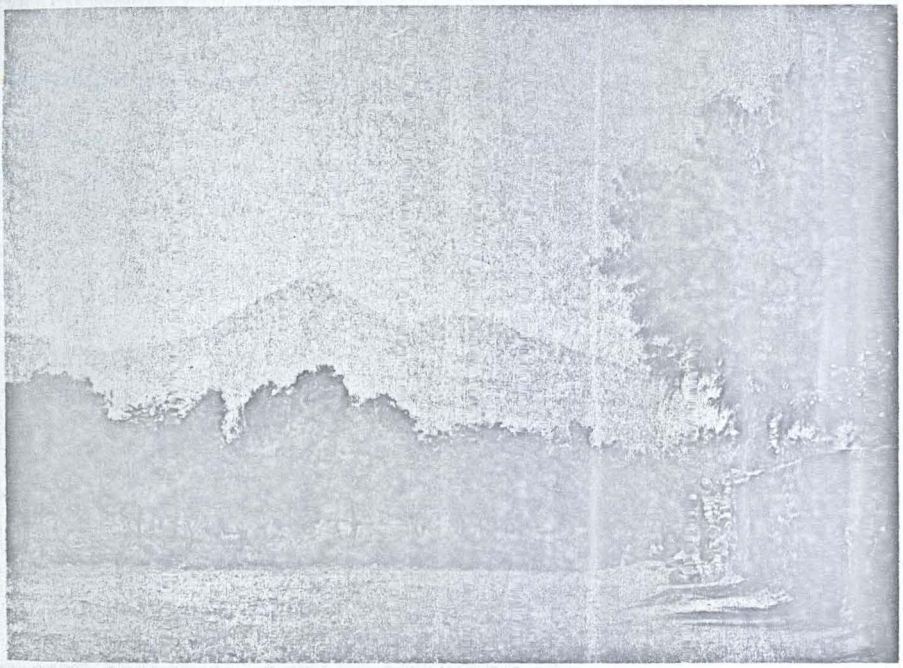


FIG. 2—Licancábur as seen from San Pedro de Atacama.

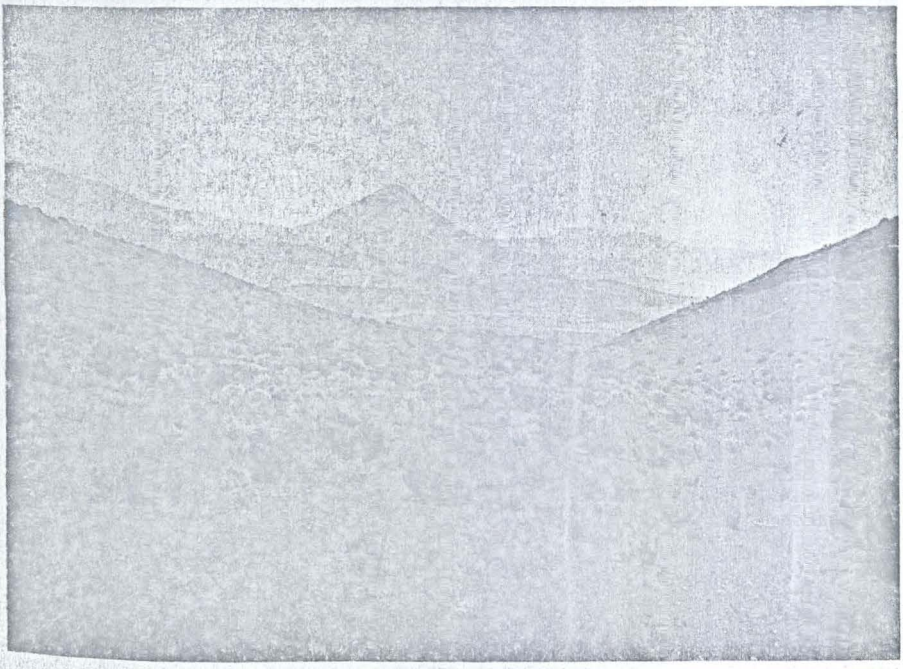


FIG. 3—Licancábur as seen from the Llano de la Paciencia.

men each set out for the top. Kristensen and Madden now knew their way around the loose cliffs and other barriers. They had discovered how to circumvent unstable rock masses without touching them. At some places they crawled beneath rock fragments or through crevices in the rocks. By climbing in the early morning they avoided the cutting *viento blanco,* the white wind that would have been a merciless opponent in the afternoon. Both parties reached the summit about an hour after sunrise.

The climbers discovered at once that they were not the first to reach the goal. On the eastern rim of the crater they found stone walls that were the remains of three old houses or shelters, the largest about 15 feet long by 5 or 6 feet wide (Fig. 5). Each structure was open on the east side for its full length. The walls were a little more than 4 feet high, though caved in at places. Construction was of the *pirca* type, in which unworked pieces are fitted snugly together without mortar but with all joints completely filled with fines. Beside one of the ruins was a pile of wood about 10 feet across, much weathered and fragmented. One straight stick about 8 feet long, in fair condition, was off to one side of the pile.

Kristensen descended into the crater, a depth of about 150 feet, to the shore of a body of water some 5 to 10 feet deep, roughly elliptical in shape and measuring about 280 feet at its longer axis (Fig. 6). He found no golden guanaco head, though it would probably be hidden at the bottom of the lake if the legend is true. Fragments of wood as much as a foot in length, bleached and weathered, were scattered about the crater. There were two small patches of penitent snow, *nieve penitente,* barely a foot or two in height, one at the northern slope leading from the lake, the other at the eastern. Save for a thin border of ice less than six inches in width at the north shore, the lake showed no indications of freezing.

Retribution of the Gods

The feat of Licancábur's conquerors was not a subject for open discussion in San Pedro de Atacama. Enough that a sacrilege had been committed and that the gods would retaliate. Two weeks later, on December 6, the province of Antofagasta was shaken by the worst earthquake in the memory of the present dwellers. One-third of the houses in Calama were heavily damaged, many destroyed. Buildings in Chuquicamata resisted the shaking only because of their sturdier construction, but here, too, many houses had to be repaired. One of three houses in Chuquicamata which were so badly damaged as to have to be vacated at once was that of Paul Hodges, first of the six climbers to reach the top of the mountain. Frequent shakes continued each day for more than a week.

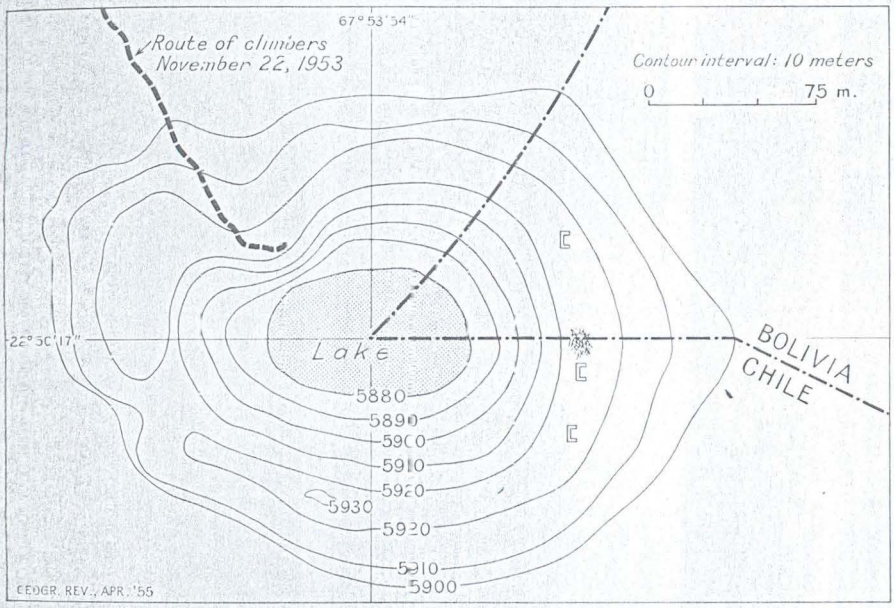


FIG. 4—Sketch map showing approximate contours at the crater of Licancábur, from observations made by Henning Kristensen.

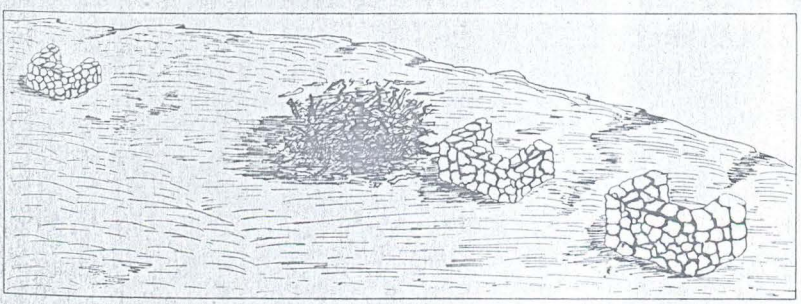


FIG. 5—Sketch of ruins and wood found on the east side of the crater rim, from observations made by Henning Kristensen.

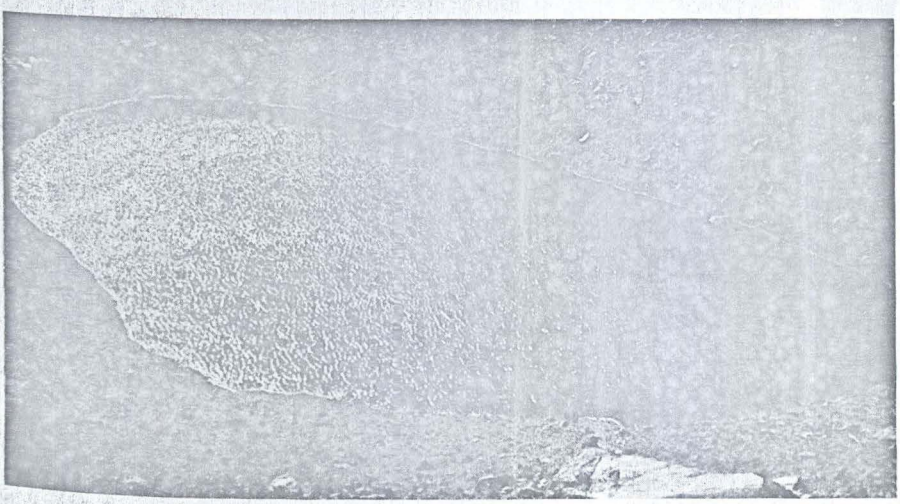


FIG. 6—Lake within the crater, as viewed from the north rim. (Photograph by Martin Madden.)

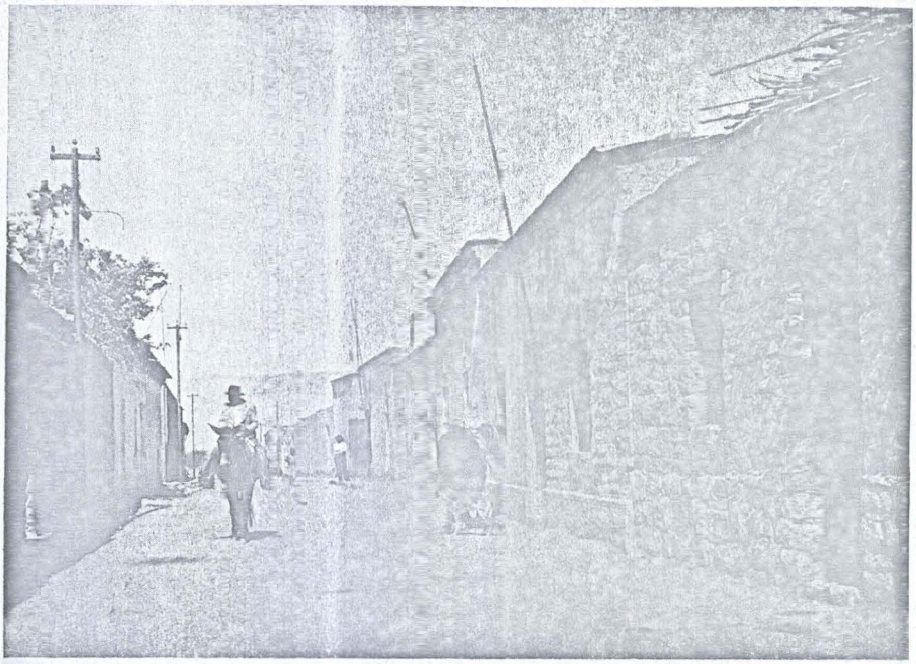


FIG. 7—A street in San Pedro de Atacama.

FIG. 8—Santiago de Rio Grande, a typical Atacameño pueblo.

The simple people of the hills were confirmed in their belief of retribution. Significant to them was the fact that the major calamity had fallen, not upon themselves as innocent bystanders, but upon the locality from which the trespassers had come!

Two Earlier Ascents

In view of the discovery that the Chuquicamata climbers were not the first to reach the top of Licancábur, I attempted to find out what might be known of earlier ascents. The search went back to reports of the exploring expeditions sent out by the Chilean government under decree of April 17, 1883, to obtain information on the new territory acquired as a result of the War of the Pacific. The records of Francisco J. San Román,[10] in charge of the investigations, disclosed that the mountain had been climbed twice during the course of his work in the eighties. He set out to place triangulation markers upon certain of the most conspicuous peaks of the region, with Licancábur heading the list. Although two of his assistants failed in their efforts, the mountain was climbed in November, 1884, by a San Pedro de Atacama Indian named Severo Titichoca and, again, on March 19, 1886, by Juan Santelices accompanied by Titichoca.[11] Santelices was *subdelegado* of the Chilean government in the Atacama region and apparently a great help to San Román.[12] He recorded that the crater had a diameter of 150 to 160 meters; on Kristensen's map (Fig. 4) the rim scales at about 600 by 500 feet. According to San Román, Severo Titichoca brought back from his climbs various household and working tools, which were exhibited in the National Museum at Santiago at the time.[13]

The next step was to seek out the Titichoca family in San Pedro de Atacama. Leaning against his house wall in the warming morning sunshine was Teofilo Titichoca. To judge from his appearance, he must have been born about the time Severo Titichoca climbed the mountain. Severo, he affirmed, was his grandfather. At first he showed little inclination to discuss the ascents, a hesitation easily understood in view of the resentment of the older people of the pueblo toward the outsiders who had desecrated their

[10] Desierto i cordilleras de Atacama (3 vols., Santiago de Chile, 1896–1902), Vol. 1, pp. 36–37.

[11] Luis Riso Patrón: La línea de frontera con la República de Bolivia (Santiago, 1910), p. 108.

[12] San Román, *op. cit.*, [see footnote 10, above] Vol., 1, p. 37.

[13] Roberto Montandon undertook to investigate the objects from the summit of Licancábur that had been placed in the National Museum at Santiago some 70 years ago. According to the catalogue at Quinta Normal in Santiago, there were many donations from San Román, mostly of prehistoric origin, and found by him in the Atacama Desert. Unfortunately, the name Licancábur does not appear in connection with any of these objects.

sanctuary. His grandfather had told him, when a boy, of his climbs to the crater and how he had found algarrobo wood there. Severo had approached the mountain from the east, and Teofilo recalled his mention of a sort of staircase built out of rock at the upper part of the slope. He himself had never been on the mountain, he said in a voice that told its story of dire warnings since early childhood.

Other members of the Titichoca family were consulted, and older people of the town. They confirmed that Severo Titichoca had known the mountain well, having hunted chinchillas, his means of livelihood, on Licancábur until his death at an advanced age. The belief concerning a stone staircase approaching the eastern rim of the mountaintop was repeated. Yet Kristensen, who had made a point of looking for some sort of trail on the eastern slope, saw nothing there resembling a feasible climbing approach.

Thus the search for information ended; to the length of the interval between Severo Titichoca's climbs and those of his remote ancestors there was not a clue.

The Setting of Licancábur

Brüggen[14] describes the region of the Puna de Atacama, in which Licancábur is situated, as having a foundation of immense flows of liparitic and dacitic lavas and rhyolitic tuffs of middle-Tertiary age upon which the volcanic peaks were built up, beginning in the Pliocene. The *meseta,* which forms the subsurface of the entire Puna de Atacama, dips sharply toward the west. Along the line of superimposed volcanoes the surface is generally at 11,000 to 12,000 feet. The comparatively recent eruptions here appear to have been centered about the Saciel group, just north of Licancábur, where towering peaks in close formation rise above 19,000 feet. The lavas of this late volcanism are of dark basaltic character, containing biotite and olivine, in sharp contrast with the light-colored rhyolitic base. The line of volcanoes ends abruptly at Licancábur, which stands apart with its small companion peak, Jurique. Some 12 miles to the southeast another chain of volcanoes begins, starting with Tocol and Purico and including various high peaks in irregular arrangement, among them Llullaillaco, 6723 meters, or 22,057 feet, believed to be the highest volcano in the world.

Whereas Licancábur has had no recorded eruption in modern times, some

[14] Juan Brüggen: Geología y morfología de la Puna de Atacama, *Rev. Chilena de Hist. y Geogr.,* No. 107, 1946, pp. 272–295; No. 108, 1946, pp. 157–203; and No. 109, 1947, pp. 275–333. (Also published separately, Santiago, 1947.)

of the volcanoes to the north and south are still active and have long records of activity. Putana, about 19 miles to the north, had a major eruption at the beginning of the nineteenth century. Its two craters and adjacent slopes are characterized by more than 30 fumaroles, which constantly emit sulphur gases. Lascar, some 38 miles to the south, has been intermittently active since its first recorded eruption, in 1848. It erupted violently several times in November and December, 1951, and again in June and July, 1954. Llullaillaco was active in 1868 and also emitted fumes at the time of the Iquique earthquake in 1877.

Chile's Instituto Geográfico Militar has mapped the region surrounding Licancábur by aerial photography on the 1 : 100,000 scale, with contours at 100-meter intervals. Despite the difficulty of photography because of the dangerous downdrafts, the map checks well with ground observations. According to the map, the 35-kilometer horizontal distance between San Pedro de Atacama and Licancábur is divided into three distinct types of sloping surface: first 12 kilometers, to the 2500-meter contour, alluvial plain averaging less than 1 per 100 rise; next 20 kilometers, to the 4000-meter contour, light-colored rhyolitic rock formation averaging 7½ per 100 rise, though steeper where invaded by lava flows; last 3 kilometers, to the rim of the crater at 5930 meters, dark-colored basaltic lava formation, averaging about 65 per 100 rise, though actually the part above the 5000-meter contour is mostly on slopes at or exceeding 100 per 100.

A short distance east-southeast of Licancábur is Jurique, 5710 meters (18,734 feet). It has the appearance of a parasitic cone with truncated top. The climbers of Licancábur were impressed by the great area and depth of the Jurique crater as they looked down upon it, in sharp contrast with the small area and depth of that of Licancábur.

Instability of the Mountain

The evenness of Licancábur's slopes as viewed from the distance is deceptive, for the surface is extremely rough. Everywhere are indications of rock fracture and movement. Matching faces of fragments may be a foot or more apart. Rocks forming an apparently solid cliff are loose and shudder under the touch or even in the wind. Rocks under foot need only the slightest impulse to change position. Dislodging a loose rock starts a general movement down the steeper slopes.

Wind and snow undoubtedly account for some of the instability. Occasional heavier earthquakes might have a similar effect. But none of these

causes would appear sufficient to produce the continuous downward movement of fragments. Some other powerful force must be acting upon the rock mass. Such a force might be found in the shearing stress created by the combination of expansion due to an interior source of heat below and contraction due to very low temperatures above. The interior source of heat is surely there—only this can explain the unfrozen lake of salt-free water at so great an elevation. The hypothesis is strengthened by the fact that most of the noise of moving rock is heard at night, when air temperatures are lowest.

What will be the ultimate effect of this combination of thermal stresses? So long as the action continues, slopes are being made less abrupt, with a tendency toward formation of a wider base and lower summit. Such action has probably been taking place ever since the last lava flows ran to the foot of the volcano. This would appear to explain the smallness of the crater and the mountain's uniform conical appearance; for initial irregularities would have been smoothed out as disintegration and filling proceeded. By the same token Licancábur could eventually lose its crater entirely.

The Crater Lake

The lake in the crater, at 19,300 feet, is fed by the snows that fall upon the peak. On nearby volcanoes, in contrast, snow does not melt but evaporates to the state of penitent snow. Other lakes exist high up on the slopes of Chile's volcanoes, their waters confined by lava flows, but nearly all of them are below the level of the penitent snows and most of them are perpetually frozen; for instance, the lake of black ice at 17,000 feet on Tocol (Fig. 9).

Average daily temperatures at 19,300 feet at this latitude in the Andes are always far below the freezing point, and below zero Fahrenheit during the winter. San Román recorded −11° F. on Lastarria in midsummer (February). At the sulphur mining base on Aucanquilcha, slightly above 17,000 feet, the foundations for a warehouse were built by pouring water from drums into pits in which wooden columns had been propped up, and the footings thus provided were fully as strong and lasting as concrete. At openings beneath the overburden high up on certain volcanoes, pillars of moist sulphur ore, hard because perpetually frozen, support large roof spans.

Above 17,000 feet in this section of the Andes water in liquid state does not normally exist, except that brought up in drums for sulphur mining. Even the damp wind off the interior lakes of the Puna is converted into the "white wind" of the cordillera that contains fine particles of ice.

The water in the Licancábur crater is apparently low in saline content; for no characteristic white line from salt deposition was seen on its shores.

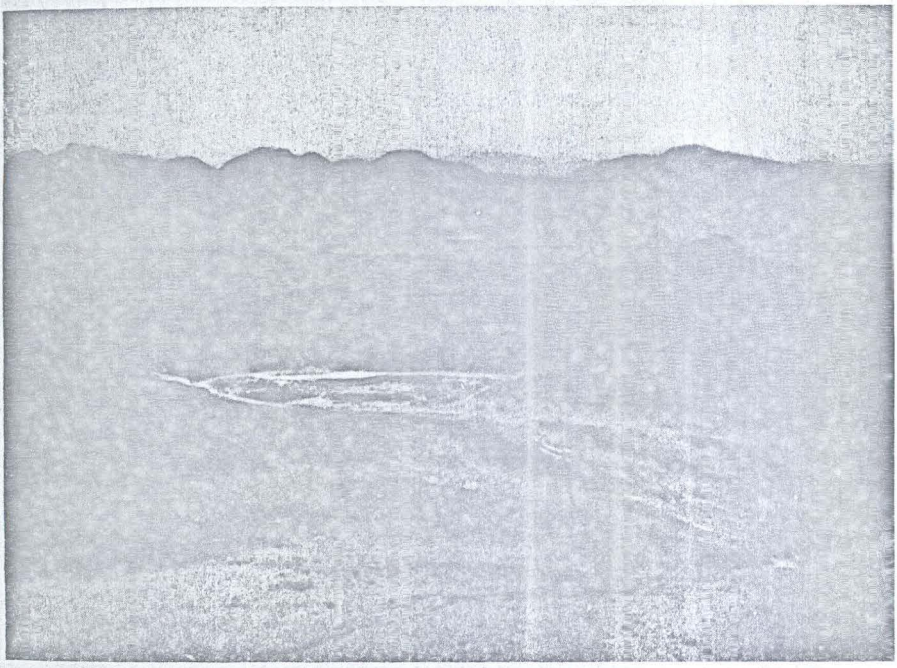


FIG. 9—Lake of black ice at about 7,000 feet on Tocol.

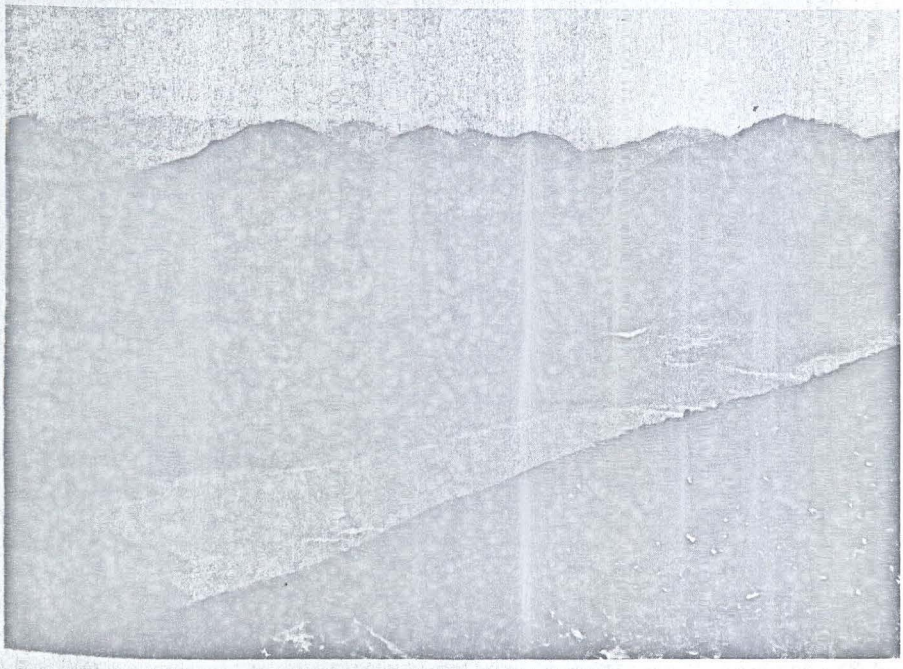


FIG. 10—Laguna Verde and the mountains of Bolivia, as seen from the top of Licancábur.

To be sure, its origin from melting snows would preclude salt entrance at the source; on the other hand, wind-blown dust of the desert, always high in solubles, has been entering the lake over many centuries. Evaporation from the surface would tend to build up any possible source of salts to sizable proportions unless there was an outlet by which water was bled off from the lake, either periodically or continuously. Such bleeding would be likely to occur at an overflow spillway, which actually does exist at the southwest side of the crater. There are indications that overflowing waters eroded the channel shown on the map (Fig. 4) at this point, to a depth of about 30 feet below the crater rim. Thus we know that the lake once had a depth of about 130 feet at high water, when it overflowed at this spillway. This must have occurred at a time in the remote past when precipitation was far greater than today.[15] At this time, after the last of the great volcanic outbursts that produced the lava flows that extend to the foot of the mountain, the crater had not been worn down to its present dimensions, and the catchment area of the lake must have been greater.

The only way now for water to leave the lake is by evaporation or seepage. The annual snowfall at Licancábur is probably not less than 14 inches, which for a crater area of about 240,000 square feet would produce not less than 280,000 cubic feet of water. Not all of this water would enter the lake, for some of it would be lost by evaporation from snow at the sides of the crater—not a large amount, since practically no penitent snow was observed within the crater on November 22, 1953, though there were extensive areas of it on nearby Saciel. Evaporation from the lake surface probably does not exceed 36 inches a year. This estimate, low as compared with rates of 90 to 135 inches a year observed at and around Chuquicamata, is based on such factors as low air temperatures, the rarefied condition of the air, and shelter within the crater both from the sun's rays and high winds. Not more than 126,000 cubic feet of water a year would seem to be evaporated from this lake surface of about 42,000 square feet.

If we allow about 14,000 cubic feet as evaporation from snow before it melts and enters the lake, it would seem that not less than 140,000 cubic feet of water annually, half of that which enters, leaves the crater as filtration through the volcanic rock. This seepage keeps down whatever small salt content may be present in the lake. Low or no salt content in the water also indicates that the rock crust enclosing the lake is strong and stable, with no

[15] Éric Boman: Antiquités de la région andine de la République Argentine et du Désert d'Atacama (2 vols., Paris, 1908), Vol. 2, pp. 714–715, points to a diminution of vegetation, which he attributes to a progressively drier climate in the Atacama Desert.

fumarole gases escaping. That fumaroles carry salts of many elements in large amounts is attested at the Tatio geysers to the north, where some of the outlets eject 14,000 to 16,000 parts per million of solids in solution.

The Archeological Finds

The archeological finds on the top of Licancábur give rise to some interesting speculations. What were the origin and the purpose of the wood? Not that the discovery was the first of its kind; for it appears to have been an ancient custom among Indians throughout the region to climb mountains and to leave something at the top. San Román found a copper knife at the summit of Chuculay, about 120 miles south of Licancábur. Climbers Bion Gonzalez and Juan Harseim, who in December, 1952, ascended Llullaillaco for what was believed to be the first time, found remains of stonework characteristic of the older Indians.[16] The custom of leaving a metal object on a high mountain as a tribute to the god it represented is easily understood, but the walls and the wood must have served a more practical purpose. Did the Indians once maintain a watchtower on Licancábur, with the walls for shelter and the wood for beacon fires? Did the walls on Llullaillaco once serve in the same way? Both peaks have an unfailing supply of drinking water, Licancábur in its lake, Llullaillaco in its eternal snows.

Indians of the Atacameño race use signal fires to the present day. The shepherd who at times takes his animals far from the communal pueblo for pasture sees a fire with much smoke on a certain high point. He knows that this is the signal to him to bring in the animals—the community lacks meat. Bowman[17] wrote of the villagers of Susques, on the Argentine side of the boundary, who came to San Pedro de Atacama for baptisms: "The Indians of Susques signal each other at night by lighting a fire upon a high mountain just north of the village; in the daytime columns of smoke serve the same purpose. A certain number of fires indicates that the Indians are to assemble in the village; a different number may signify 'Danger; hide yourself.' "

The theory that Licancábur served as a watchtower is supported by its commanding position. From the top the entire world of the northern Atacameños was visible (Fig. 10). From all that we know of these people, they were peaceful farmers, more concerned with defense against attack than with molesting others. A sentry atop Licancábur could look north and northwest to the valleys of the Vilama and Grande Rivers. The trails from the

[16] *Revista Andina*, No. 79, Santiago de Chile, 1953, pp. 15–16.

[17] *Op. cit.* [see footnote 6, above], p. 305. Based on Boman, *op. cit.* [see footnote 15, above], Vol. 2, p. 434.

north which the Indians use today, which the Incas used for conquest, cross passes plainly visible from the summit of Licancábur. An attacking force would have been under scrutiny, its every movement reported to the defenders, for at least two days before it reached San Pedro de Atacama. To the northeast and east the sentry could view a great number of passes providing access from the high plateaus and fertile valleys of northern Argentina. To the south-southeast the pass between volcanoes Lascar and Tumisa is easily seen, on one of the oldest trade routes in South America, that connecting Salta with San Pedro de Atacama via Huaitiquina; and here the watchtower might have been used to advise of the approach of friends as well as of enemies.

FIG. 11—The ruins of Lasana, one of the ancient fortresses that may have been controlled from Licancábur's "watchtower."

To the southwest was the Salar de Atacama, with a dozen communities or more, ranging in size from 300 persons down to a single family, at the little canyons on its eastern fringe all the way to the south end of the closed depression. To the west was the Bordo range, watershed barrier between the interior drainage of the Salar de Atacama and the Pacific. But the sentry could see far beyond this—to the cultivated areas of Calama, Chiuchiu, and Lasana in the Loa River Valley; to the hills of Chuquicamata, where findings of old stone hammers tell of mining activity before the Spanish conquest. View to the Pacific was blocked by foothills along the 69th meridian, but all

approaches to San Pedro de Atacama from the west, including the early trail past the Caracoles silver mine, were visible.

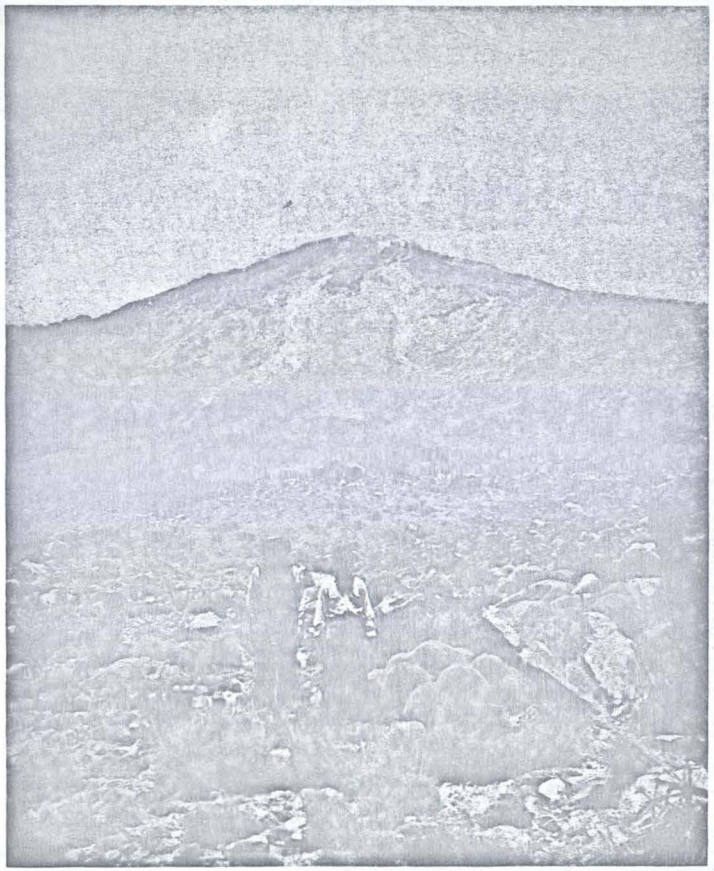
It would appear plausible that the operation of various fortresses now more or less in ruins throughout the Atacameño region might have been interlocked with signals sent out from the Licancábur lookout. Roberto Montandon, who recently completed restoration of the Lasana ruins (Fig. 11) as a national monument, Grete Mostny, Stig Rydén, and others have written of these *pucaras*, at Lasana, at Turi, and both north and south of San Pedro de Atacama, all at points to which information could have been flashed from Licancábur. How many other fortresses existed in the region is difficult to say. Recently I was shown the remains of a well-preserved watch and defense station on the eastern slope of the Vilama River canyon about five miles upstream from San Pedro de Atacama. A low stone wall, which looks like part of the rhyolitic rock formation from 250 feet below, affords protection or concealment; behind it are small piles of round stones about the size of an egg, such as the Indians still use in slings; in the rear are ruins of a house. That the site has been left undisturbed probably for centuries, close to a mule trail, may seem surprising; but the indigenous folk disturb nothing left by their forefathers, nor do they tell outsiders of such remains.

How long ago the Licancábur station might have been manned can perhaps be ascertained by radiocarbon dating of the fragments of the wood. The climbers of November, 1953, brought back no samples of the wood, feeling that only archeologists of standing had the right to disturb this monument of an ancient people, which had for so long a time withstood gale winds and driving snows atop an unsheltered mountain peak.

Licancábur may have served additionally to provide refuge for special persons—tribal chiefs, for instance, whom the Indians wished to protect from capture. It is narrated that the women of Toconao were hidden from the first Spanish conquerors in a *quebrada* that had but a single entrance until the secret was forcibly extracted. Such an asylum on Licancábur is possible but not probable; for members of a royal or favored family, accustomed to a sheltered existence, could hardly have lived long in the wind and cold of the mountaintop, even though acclimated to the high altitude.

Recent finding of the mummified body of a 12-year-old boy not far below the top of 18,000-foot Cerro Plomo, northeast of Santiago, believed to have been preserved there for 400 years or more,[18] suggests that primitive religious ceremonies might also have been carried on at Licancábur's summit.

[18] *Revista Andina*, No. 80, 1954, pp. 5–7.



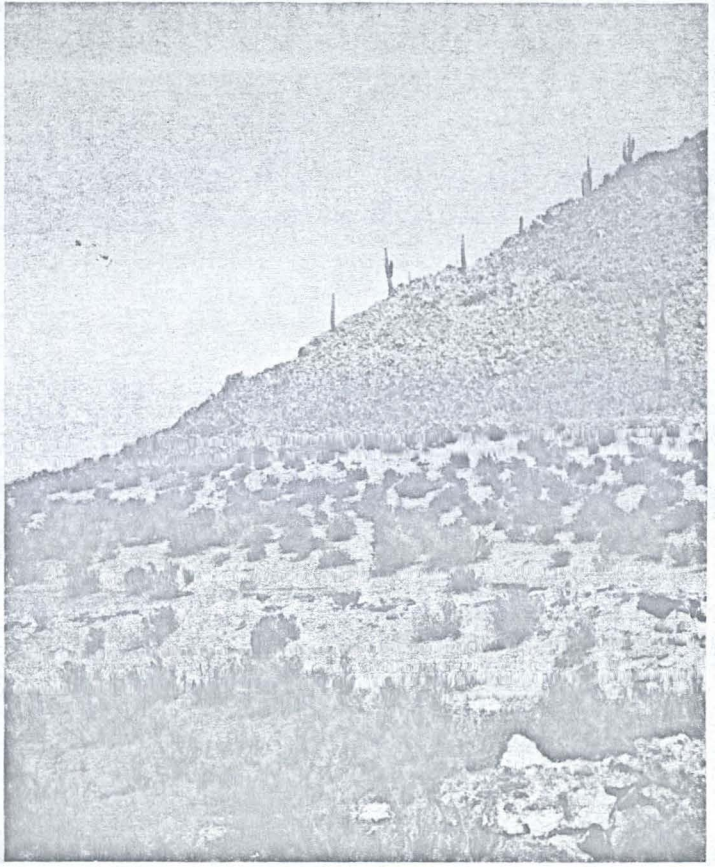


FIG. 12—Yareta and other plants at 15,000 feet. The two Indians shown could not be persuaded or bribed to climb the peak.

FIG. 13—Cactus and other vegetation at 11,000 feet on the northwestern slope of Licancábur.

Animal and Plant Life

An important finding of the expedition was that the chinchilla in the wild has not been exterminated in Chile, as had been generally believed; for chinchillas were seen at about 16,000 feet upon the slopes of Licancábur.

The chinchilla has been hunted in the Andean cordillera since the earliest times of record. It is written that when subjects of the Incas were unable to offer gold to their masters, the tribute consisted of skins of the royal chinchilla (*Chinchilla realis*), which were used by the Incas in their ceremonial robes. Naturally, exportation of these skins to Europe followed the coming of the Spaniards, and by the end of the nineteenth century such an increasing world-wide demand had been created that extermination of the animal was under way. Trained dogs were used to scent chinchillas high up on the mountain slopes; sulphur was burned to drive them out of their caves.

In the Atacama region chinchilla skins were sold at first by the hundred, later by the dozen. After 1911 they were offered only one by one; for a party of 15 experienced hunters had swept over the cordillera and killed most of the remaining animals. A few *chinchilleros* were offering one or two skins a month for sale in San Pedro de Atacama as late as 1925, but the zest for this sort of life had passed. The chinchilleros of the twenties had to do most of their hunting high upon the slopes of Licancábur, where earlier hunters had been reluctant to go. The natural caves of the mountain provide an ideal home for the chinchilla, whose feet are too weak to excavate a shelter. Apparently the little animal is too light and nimble to be injured by rockslides, but not so his pursuer! Thus the last of the chinchilleros disappeared in the twenties: one or two failed to return from the cordillera; others went to Chuquicamata, where expanding copper operations offered a more lucrative and less precarious living; and a few died natural deaths. The laws that Chile, Bolivia, and Argentina had passed to protect the chinchilla, never possible of enforcement, were no longer needed.[19] Licancábur has provided a natural, and probably a permanent, refuge for the chinchilla. It may be that the royal chinchilla, which Osgood[20] states has not been seen in Chile since about 1918, still survives on this mountain.

Plant life and other animal life are far more abundant upon Licancábur than under similar conditions of altitude and exposure elsewhere in the

[19] Chinchillas are now being raised in captivity at two farms in the Atacama region, one at Conchi Viejo and the other at Calama.

[20] W. H. Osgood: The Mammals of Chile, *Field Museum of Nat. Hist. Zoological Ser.*, Vol. 30, Chicago, 1943, p. 135. Osgood lists three other varieties recognized in the fur trade: *Chinchilla boliviana*, *C. cordillerana*, and *C. costina*.

region. Apparently water in liquid state is available at higher elevations and in greater quantity here, though precipitation is about the same as upon neighboring mountains. The snow at the higher levels, lost to evaporation in the slow transformation to penitent snow elsewhere, is saved for vegetation on Licancábur because it melts quickly and percolates into the ground. The upper level of vegetation and of the insects and small birds that go with it is fully 500 feet higher than upon corresponding neighboring slopes. Normally all animal life save for an occasional condor is absent in the Atacama cordillera above 15,000 feet, and the plants persisting to that level are few indeed. At Licancábur, on the contrary, yareta has been cut to 15,000 feet and higher (Fig. 12), and grasses and *tola* bushes appear all the way to 16,000 feet; and one finds lizards, large and small flies, and butterflies at these heights as well.

Farther down on the mountain the usual cactus growth characteristic of the 11,000–12,000-foot levels appears (Fig. 13), surrounded by more varieties and larger numbers of small flowering plants than are usually seen, which attract a great profusion of small birds. It is likely that the volcanic rock dust resulting from continual breakage and movement high up on the mountain also provides elements on which the relatively exuberant plant life thrives.

International Frontier

An interesting question arises as to exactly where upon Licancábur the Chile-Bolivia boundary corner should be located. For obvious reasons no marker has so far been placed at this angle, nor did members of the Chilean and Bolivian military engaged in boundary marking whom I met a few years ago expect to set an *hito* upon the peak.

The treaty of October 20, 1904, defines the boundary northwest of the Cajón Pass as the watershed divide of the *cordón* that runs north through the peaks Jurique, Licancábur, Sairecábur, and so on. Accordingly, the Chilean Instituto Geográfico Militar maps on the 1 : 100,000 scale show the boundary as a nearly straight line bearing about 26° north of west from the western extremity of the crater of Jurique to a slight prolongation of the eastern extremity of the summit of Licancábur. From here it runs due west to the center of the crater. It then turns at an abrupt angle to the northeast, to follow a buttress on the northern face of Licancábur that curves toward the north as it descends to the iron frontier marker set up in 1908 at the Chaxas Pass.

Future Exploration

The successful ascent of Licancábur opens a field for exploration that might unearth interesting facts regarding the Atacameños or, possibly, the

people who antedated them. The pirca technique used in the walls found at the summit appeared to the climbers to be similar to that used elsewhere in the San Pedro de Atacama region. Regarding the wood there are conflicting opinions. Whereas Severo Titichoca, after his trips to the mountain 70 years ago, described this wood as algarrobo, Henning Kristensen noted its close resemblance to trunks of the dwarf tree queñoa, which grows to five or six feet in height at a few places in the cordillera. This plant, described as "ckehuiña" (*Polylepis incana,* family Rosaceae),[21] is far commoner on the Bolivian Altiplano than in the Licancábur region, the nearest examples found at this time being near the volcano Cabana, some 50 miles north of Licancábur. During earlier times of less arid climate the twisted little queñoa trees probably grew on all the slopes and foothills frequented by the ancient climbers of Licancábur, and the Indians would have found them handier for firewood than algarrobo branches from San Pedro de Atacama. It remains to identify and determine the age of this wood.

Thus it may be possible to establish the date of occupation of the summit of Licancábur, but how was it reached? Certainly not by the route of the 1953 climbers. Surely the early Indians did something to ease the path for the numbers climbing the mountain; the rumors regarding the "staircase" would seem to bear this out. But whatever they did could not have lasted long, under the constant disintegration and movement at the higher surfaces of the volcano.

An old settlement in the northwestern environs of Licancábur has been mentioned by archeologists in connection with their studies of the Atacameños. This must have been at the Quebrada de Chaxas, about six miles west of the Chaxas Pass, where small springs of good drinking water issue from the rocks and disappear into the sands a short distance below. Indian shepherds still live at the site. This settlement might well have been the starting point of the climbs to the top of the mountain and could have sent signals as well as received them from the garrison above.

[21] J. T. del Granado: Plantas bolivianas (La Paz, 1931), p. 40.