

Ojos del Salado

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FOR the past two years there has been considerable speculation as to whether the Argentine peak, Aconcagua, was still to be considered the highest mountain in the western hemisphere. Reports persisted that it might have yielded its place to the Ojos del Salado, which lies in the Andean Cordillera that forms the frontier between northern Chile and Argentina some 400 miles north of Aconcagua.

The American Alpine Club Ojos del Salado Expedition succeeded in making an accurate survey of the Ojos del Salado during July and August of 1956. We determined that this peak has an altitude of 22,590 feet or 6885 meters. This is 244 feet lower than the new altitude for Aconcagua, of 22,834 feet or 6959.7 meters, a figure released by Dr. Eduardo E. Baglietto, Director of the Instituto de Geodesia in Buenos Aires, Argentina, and determined through surveys conducted in the past several years under his direction. (See Appendix III.)

It has not been easy to bring order out of the confusion that existed over the mountain's history. A little had been published on the subject in scattered articles in mountaineering journals, often of small circulation; the rest came from first-hand sources. Writing the history would have been impossible without the unstinting help of the Chileans: Captain René Gajardo, Sr. Juan Simken, Sr. Juan Soltof; and the Argentines: Prof. Enrique Würschmidt, Sr. Jaime Femenías, Sr. Rudolfo Benvenuti; and the Austrian, Herr Matthias Rebitsch. The expedition could never have been organized without the help of Mr. Robert P. Koenig of the Cerro de Pasco Corporation, Mr. Henry S. Hall, Mr. William Rudolph of the Chile Exploration Company, the Andes Copper Mining Company, Prof. Würschmidt, Captain Gajardo, the Instituto Geográfico Militar de Chile, Sres. Arturo Podestá and Boris Kraizel of the Federación de Andinismo de Chile, and Sr. Sergio Barros of the Sociedad Importadora Willys de Chile, and the American Geographical Society.

1. Historical Background of the Ojos del Salado

Nestled among other 20,000-foot peaks of the Andes which soar above the upland plateaus of the Atacama Desert, the Ojos del Salado, highest point in the range, remained for centuries unnoticed. The Spanish con-

quistadores on their 1500-mile overland journey south to conquer Chile, in 1536, crossed the Portezuelo de San Francisco to reach the wind-scoured, inhospitable 14,000-foot-high desert-pampa of Barrancas Blancas within twenty miles of the summit of the Ojos del Salado, but they made no mention of the peak. The Argentine-Chilean boundary commission surveyed the region in 1896 and 1897 and again in 1903. They placed on their maps *an* Ojos del Salado to which they gave the altitude of 6100 meters (20,013 feet).* I have not seen the records of the commission personally but I understand that they had bad weather when they were in the region. They did, however, from two survey stations also observe a very high mountain nearly hidden by intervening ridges; this they called Peak "e."† From one station the altitude of Peak "e" came out to 6878.3 meters and from the other, 6885.8 meters. They averaged 6880 meters.

The German, Walter Penck, systematically explored the area from 1912 to 1914, but in his writings I find no mention of the Ojos del Salado, though he passed by its base several times.

The Ojos del Salado burst momentarily into the limelight in 1937, but the peak in question appears to be not the one so-named by the boundary commission but rather their Peak "e." In that year a Polish expedition climbed six of its higher summits. They discovered that behind a maze of ridges there was a peak that rose higher than any of the other giants of the zone. To this peak they gave the name "Ojos del Salado" (Source of the Salty River), by which it has since been known. Much confusion has resulted from this transfer. From their base camp near the Salina de la Laguna Verde, southwest of the Ojos del Salado, all four Polish climbers headed north up the Río Salado, or Salty River. After a day's travel together, Dr. Witold Paryski and Stefan Osiecki continued northwest to make the first ascent of the two highest summits of Tres Cruces (21,719 feet), while J. Wojsznis and J. A. Szczepanski turned northeast on muleback. Despite fields of nieves penitentes, they crossed a pass to camp at about 19,000 feet. Unable to distinguish which was their peak, they continued upwards rather blindly on foot across sandy slopes and snowfields to the summit of a 21,000-foot peak, probably what is now called the "Cerro Volcán." There they camped beside a frozen lake. The next day

* This peak may be identified from its location. Jaime Femenías, of the Asociación Tucumana de Andinismo, who made a preliminary survey in the region south of the Ojos del Salado, believes that a mistake was made in its altitude and that it actually measures 5100 meters (16,733 feet). It is not the mountain now generally called the Ojos del Salado, which lies to the northwest.

† Since 1937 it has been to this peak rather than to the other that the name Ojos del Salado has been given.

was spent ascending and descending high ridges covered with unconsolidated volcanic gravel and fields of nieves penitentes. A second time they had to camp high on the slopes of the massif. On the third day, February 26, 1937, after traversing another summit to the west and some 500 feet lower, they reached the top of the main peak of the Ojos del Salado. They noticed volcanic action in the crater some 650 feet below the summit, probably the highest in the world.

For about twelve years the region appears to have been left unvisited. In April 1949 Alfredo E. Magnani, Horacio Granero, and Vicente V. Cicchitti, of Mendoza, Argentina, explored the southeastern approaches up the Río Cazadero to about 16,000 feet. A year later three more climbers from Mendoza, headed by Jorge W. Flores, reached the southwestern slopes but failed to attack the Ojos del Salado seriously.

In February 1950 the Chileans entered the picture. Oscar and Carlos Alvarez, Luis Alvarado, and Jorge Belastino camped at Barrancas Blancas, north of the mountain. They apparently had little knowledge of the topography of the region and their account is confused. Although they climbed what they claimed was the Ojos del Salado, their description of it differs from all others. They saw a much higher peak to the west of them, which they thought was Tres Cruces. Doubtless they climbed El Muerto (21,227 feet), the next mountain to the east of the Ojos del Salado. Their "Tres Cruces" was probably the real Ojos.

Guillermo Poma and Francisco Solano Quintana, of Jujuy, Argentina, were the next to claim an ascent of the Ojos del Salado, in November 1951. From their description of routes and times it seems obvious that they climbed a minor peak in the Tres Cruces group above the Río Salado, which despite its name does not spring from the slopes of the Ojos del Salado.

In April 1951 the Asociación Tucumana de Andinismo sent the first of its three expeditions into the region. It was based, as were the subsequent ones, just north of the Salina de la Laguna Verde. Enrique Würschmidt, Jesús Sarquis, Federico Vervoost, and Dr. Guillermo Chaica reached nearly 20,000 feet on the southwestern slopes.

It was, however, after the second Tucumán expedition, in 1955, that the mountaineering world was astounded by a press report of *the ascent of the highest mountain in the western hemisphere*. It announced that the Ojos del Salado rose to 7100 meters, or 23,294 feet, and was therefore higher than Aconcagua. Since I was helping edit the *American Alpine Journal*, I was anxious to get the true facts. Enrique Würschmidt, professor of physical geography at the University of Tucumán and president of the

Asociación Tucumana de Andinismo, was kind enough to send me an excellent report both of the region and of the expedition. It was unfortunately too late to be included in last year's *A.A.J.* After establishing three camps, on January 22, 1955, Prof. Orlando Bravo, Rudolfo Benvenuti, Jaime Femenías, Wilfred Cöppens, Manuel Luis Condomi, and Gerardo Türpe, thinking they were on the Ojos del Salado, climbed to the summit of an unnamed peak which turned out to be some six to eight miles south and about 800 feet lower than the main peak of the Ojos del Salado. *Their peak may at the time have been indeed the highest unclimbed mountain in the Americas.*

They stated that it was possible that the Ojos del Salado was higher than Aconcagua, although they had no proof. The newspapers took the hypothetical statement as fact and made their announcement.

Thanks to this press release, four different expeditions were attracted to three different sides of the Ojos del Salado in the southern midsummer (January and February) of 1956. The Asociación Tucumana de Andinismo returned to the field with a double purpose. Jaime Femenías, Susana Olmos, and Guillermo Muntaner made a preliminary survey of the region, but they lacked control to establish any definite altitudes. In the course of their work they climbed to within a thousand feet of the summit of the Cerro Solo (20,309 feet) and made the second ascent of the Cerro de los Arrieros (18,375 feet), which Femenías and Türpe had climbed the year before. The climbers of the group, Orlando Bravo, Alfredo Bolsi, Pedro Pérez Cherp, Flora Albornoz, and Wilfred Cöppens, joined forces with the expedition from the Agrupación Montañesa Calchaquí de Catamarca, made up of Julio César Díaz, René Peralta, and Enrique Carrazano. Together they reached about 21,000 feet on the Ojos del Salado's southwestern slopes.

At the same time the Austrian, Matthias Rebitsch, was making his ascent from the southeast and the Chileans theirs from the north at Barrancas Blancas. The Chilean group of 26 climbers, sponsored jointly by the Chilean Army and the Federación de Andinismo de Chile, was under the leadership of Captain René Gajardo. On their return they claimed an altitude of 7084 meters (23,241 feet), obtained by aneroid barometer, a statement which was seized by the press as an exact altitude. Considerable nonsense has appeared in print, which has cast doubts on the validity of both the Austrian and the Chilean ascents. I have seen the photographs and have talked with or communicated with most of the climbers of both groups. There is no doubt whatsoever that at this date, there have

been three ascents of the Ojos del Salado—the Polish, the Austrian, and the Chilean.‡ (For accounts of these ascents see appendices I and II.)

2. *The American Alpine Club Ojos del Salado Expedition*

While collecting data on the Ojos del Salado, some of which is found in the first section of this article, both information and misinformation seeped in, so that the picture became, instead of clearer, decidedly more confused. The mountain had been climbed by such and such a group; it had not been climbed by them. It lay here; no, it lay there! It had been recently triangulated; it had been measured only by aneroid barometer. A new much higher summit had been discovered; there was no such summit. Throughout all the articles and correspondence there ran either the speculation that the Ojos del Salado might be higher than Aconcagua or the definite statement that it was. It finally became clear that the only way to bring order out of this chaos was to go to the region and find out the facts for ourselves. Therefore, the American Alpine Club Ojos del Salado Expedition was born in May 1956. Since we had discovered that all the recent reports of altitude were indeed based on readings of aneroid barometers, a notoriously inaccurate method, we would triangulate the peak and settle the question whether it was the highest mountain in the western hemisphere or not. How much climbing we could do we should have to see after we had completed our main objective. We also knew that the weather would have a definite bearing on how much we could accomplish.

Little seemed to be known about weather conditions in the region during the southern hemisphere midwinter. We had reports of crippling blizzards that dropped many feet of snow. We knew, however, that the Ojos del Salado rose above the incredibly dry Puna de Atacama, possibly the most arid region in the world. The Argentinean, Dr. Würschmidt, sent us a description of what his somewhat scanty evidence indicated were probable weather conditions. He stated that there was less cloudy weather and precipitation in the winter than in the summer months and guessed that we might count on cloudless skies up to 85 percent of the time. What precipitation there was would not be great in quantity. Temperatures would depend much more on the sun than on the season, though it would be somewhat colder in the winter. In summer and winter we would have both subzero cloudy days and rather warmer sunny ones. In any case the

‡ I have just received word that the fourth ascent of the mountain was made on January 11, 1957 by Alfredo Bolsi and Wilfred Cöppens, members of the Argentine expedition of the Asociación Tucumana de Andinismo under the leadership of Jaime Femenías. They reached the Polish cairn but decided against climbing the rock tower, ascended by Captain Gajardo's party, which is about ten feet higher.

dry air would cause the temperature to plummet downwards in the course of a few minutes after sundown. The constant high winds would be our worst enemy at any time of the year. His description proved an accurate one.

How to enter the region and how to cover the great distances during our survey posed the next problem. Transportation seemed solved when the Chilean mapping service, the Instituto Geográfico Militar, offered to send a survey team of two officers and a half-dozen enlisted men with us and to provide two 2½-ton army trucks. The Chilean mountain troops loaned us Captain René Gajardo, who proved a tower of strength and a loyal companion. The knowledge he had gained of the region when he had led the Chilean expedition up the Ojos del Salado half a year before was of course invaluable.

We met in mid-July in the northern Chilean port of Antofagasta. Bob Bates and his wife, Gail, arrived by sea with the expedition equipment. Our chief surveyor, Peter Weaver, my wife, Ann, and I flew from the north. Harvard student John Wylde interrupted a skiing holiday in Central Chile to join us. Major Luis Correa flew north to make arrangements with us about meeting in the region. He would take his survey party in one truck directly east into the zone from Copiapó, while we, with Captain Gajardo and our driver, Corporal Alberto Soto, would approach it from the north in the other.

From Antofagasta it was a long trip south across mountainous desert to the Andes Copper Mining Company's mine and smelter at Potrerillos. About twenty-four hours after our departure we emerged from the top of the baggage in the back of the truck covered from head to foot with a full quarter-inch of dust.

We needed an established elevation from which to start our survey. In the length of time we had it would have been impossible to survey across the jumbled mass of ranges that lay in the 150 miles between the Pacific Ocean and the Ojos del Salado. The Chilean Instituto Geográfico Militar had its nearest station at Carrera Pinto still about 100 miles to the west and separated from the mountain by very rough terrain. We had reason to believe that the Andes Copper Mining Company had established accurate altitudes around Potrerillos. This proved to be the case. The elevation of Potrerillos had been determined to within inches by running lines of differential spirit levels when the railroad and transmission lines had been put in. Moreover, in the never-ending quest for water for the mine, other lines of levels had been run towards the Ojos del Salado above the

Salar (Salt Flat) de Maricunga. We were now assured of a highly accurate elevation about forty miles from the peak.#

The officials of the company were extremely helpful, but they were also very discouraging. Why were we entering this desolate, uninhabited, inhospitable region in the dead of winter? Why had two of us brought our wives into these mountains where even men did not penetrate at that season? Did we realize that a blizzard might immobilize us for weeks, or worse? Had we heard of the hurricane winds that were not the exception but the rule? It was therefore not without misgivings that on July 21 we drove away from the comforts of the mine into the cold as snow flurries seemed to foretell a full-dress blizzard. Around us barren, precipitous slopes, bare of all vegetation and brilliant with the reds, greens, purples, yellows, and browns of a heavily mineralized soil, rose upward into black clouds that now were whitening the upper slopes with a blanket of snow. We crossed a 12,000-foot pass to the salt flat of Pedernales. In improving weather but over several inches of snow, we crossed this huge basin to La Ola at its upper end, where three men from the mine were stationed to see that the small salt stream did not freeze as it entered the pipe to run fifty miles to process the ore at the mine. It was in the bright light of the moon, 30-odd miles beyond La Ola, that we camped at 12,500 feet on the northern edge of the Salar de Maricunga, where the road from Copiapó met ours. To our surprise Major Correa and his surveyors had not yet arrived.

The next morning with numbed fingers I pawed through the boxes in the back of the truck for the breakfast. The salt eluded me but the solution seemed easy. I could cook the cereal in salt water from the nearby salt lake that steamed unfrozen in the zero temperature. As the Bateses and Ann readied our four-man tent to accommodate eight for breakfast, I set off across the strangest frost formations I had ever seen. Only gradually did I realize that I was walking, not across frost and snow, but over white crystals of usable salt.

The truck had no antifreeze, and Soto, unaccustomed to such temperatures, had not known that he must run the motor as he drained the radiator. Consequently the water still remaining in the engine had frozen hard during the night. Leaving Soto to thaw the motor and Gail and Ann to melt enough snow to fill the radiator again, the rest of us climbed the 15,453-foot Cerro de la Sal that rose above camp. The mountain was easy technically, but we puffed and panted up the loose volcanic gravel in the rarefied air to which we were not yet acclimatized. Below us stretched the

For details on the survey itself, see Weaver's engineering report, Appendix IV.

Salar de Maricunga, typical of the many huge, barren salt-flats and pampas that form the backbone of the cordillera. Lying at altitudes as high as many of the summits of the Alps, these flat basins are hemmed in by 16,000-, 18,000-, or even 20,000-foot volcanos and ridges which in turn separate them from the next pampa. We had a magnificent view across Maricunga with its white of snow or salt, its browns, yellows, greens and reds of wind-cleared ground, and its turquoise of salt lakes, the remnants of an upland sea of a less arid era. After stretching out flat for twenty miles, the terrain suddenly rose abruptly in the slopes of the 19,947-foot volcano Copiapó. To the southeast, 21,719-foot Tres Cruces still blocked our view of the Ojos del Salado.

The next morning we set out to reconnoiter the snow- and ice-choked 15,000-foot Portezuelo Colorado, the pass that led to the next pampa, the Campo de Piedra Pómez, and to Barrancas Blancas at the foot of the Ojos del Salado. We entered the canyon of the Colorado to find the first water hole we had seen since we left the salt stream above La Ola, fifty miles behind. The water had spilled out over the valley floor, leaving the road blue ice dusted with snow. Since no chains had been available for our vehicle, for the first time in the experience of any of us we set about cutting steps with our ice axes for a truck. Higher up in the pass we shoveled a track through the drifts where the wind had heaped up the snow in the shelf scratched out of the steep slopes, the "International Highway" to the Argentine. We managed to advance only about three miles up the pass that day.

With still no news of the Chilean surveyors, on the morning of July 25 we bucked and shoveled our way across the whole of the Colorado Pass and down onto the snowy but flat Campo de Piedra Pómez. Cutting through the snow and hard crust of pumice soil, the wheels churned ineffectually in the loose pebbles below, making progress painfully slow. By early afternoon we had traveled twenty miles, half way to the base of the Ojos del Salado. Captain Gajardo excitedly pointed out the sharp summit cone of our peak rising above the shoulders of closer ridges. By sundown we had cajoled the truck to the top of the Portezuelo de Piedra Pómez. Trampling and shoveling the snow in front of the truck and with the determined Gajardo at the wheel, we arrived by midnight at our goal, Barrancas Blancas (White Banks).

It dawned clear and still, but the thermometer read -20° F. We set about moving the base camp to a more protected spot nearby. Before the last loads were thrown back into the truck, the wind came up with the speed of a squall. In a very few minutes it reached hurricane force, driving

head-high icy particles which cut our faces like sandpaper. The only sensible course was to retreat temporarily to the comparative protection of Colorado Pass to avoid the possibility of having the truck snowed-in till spring.

That twenty-mile retreat took us twenty hours. The radiator froze repeatedly as we bucked terrific winds. Moisture froze in the gas line; poor Soto, our driver, had to dismantle it and blow it clear, not an easy trick in a subzero hurricane. Our traction in the loose pumice gravel became even worse as the snowdrifts grew and hardened in the wind. Shoveling drifts helped keep us warm but at nearly 15,000 feet it was exhausting work. By nightfall the truck, driven by the tireless captain, had battled its way back only as far as the top of the Portezuelo de Piedra Pómez. We pushed on, seriously concerned whether the truck could get out or not. In the dark the ridges stood outlined with broad crystal ribbons where the rising moon struck the graceful plumes of powder snow that swirled above them. At about two A.M. we saw the unbelievable: headlights coming towards us. It was Major Correa's party, who, weary and half-frozen, had spent four days struggling over the snowy passes from Copiapó. Worried about us in the storm they had pushed on to find us. Together we all labored back up their tracks to the illusionary shelter of the Colorado Pass. There we tried to pitch our four-man tent. While the Bateses held the windward corners, Ann and I inside struggled to raise the pole. As a particularly strong gust of wind caught us, all four rolled some thirty feet end-over-end like a floppy package wrapped in canvas. We finally spent what was left of the night collapsed in exhausted sleep in the back of the truck on top of each other and the luggage.

When we awoke a few hours later, the wind had dropped. It was cold and sparkling clear. While the military worked to start the balky trucks, Pete Weaver and I climbed the 16,000-foot peak that rose immediately south of us to reconnoiter for the survey. Upon our return we discussed plans with Major Correa. Although we had looked on the retreat as temporary, he definitely did not. His enlisted men were poorly clothed. Their tentage could never have stood the high winds. We Americans might have stayed on alone and without transportation, 100 miles from the nearest habitation, as we had a month's food-supply and excellent equipment, but to remain under these conditions seemed hardly sensible. Thoroughly frustrated, we retreated with the Chileans 700 miles to Santiago. All that we had accomplished so far was a hurried reconnaissance of the region that convinced us that we really could do the job.

A hectic but delightful week in Santiago put the expedition back in the field again. We should never have managed it without the help of the



OJOS del SALADO—Surveying the baseline.



OJOS del SALADO—The survey-party.



OJOS del SALADO,



OJOS del SALADO,

Federación de Andinismo and the generosity of the Chilean Willys agency. John Oberlin arrived in Santiago just in time to share in a very successful "joint meeting" of the Federación and the American Alpine Club.

On August 7 a much abbreviated party rolled out of Santiago packed into a brilliant red Jeep and a bright green trailer. Of the original party only Peter Weaver, Ann, and I had time left to return. We were strengthened by the addition of a member of the Federación de Andinismo, the Chilean mountaineer Roberto Busquets. He is well known for his Andean ascents and had been a member of the first Argentine expedition to Dhaulagiri. At dawn on August 9 we headed east from Copiapó and by midafternoon had crossed the width of Chile to the Salar de Maricunga. We put our camp at 13,000 feet at the lower end of the Aguada (water hole) del Colorado on what the rather sketchy maps of the area call the Río Colorado. Only after comparatively warm days did the mighty "Colorado River" trickle a hundred feet or so past camp before being swallowed by the thirsty volcanic soil. Sundown always put an end to our water supply since temperatures could plummet to below zero in a very few minutes after the sun left the moistureless air.

Our previous reconnaissance enabled us to set to work at once with a good idea of what was involved. First of all we had to choose the final locations for our eighteen survey stations. These eventually extended from Base Camp ten miles north across Maricunga to tie in with one of the stations on the Andes Copper Mining Company's line of levels. They reached out east across the high ridge which is cut by the Portezuelo Colorado and out onto the Campo de Piedra Pómez for about fifteen miles. From five of the latter stations we could observe the sharp spire of the summit of the Ojos del Salado rising above its crater edge. Each carefully selected station was marked with a long pole held firm against the winds by a large rock-cairn big enough to be sighted through the theodolite from the neighboring stations. It is arduous work to be a stone mason at 15,000 and 16,000 feet. Once the cairns were built, we returned a second time with the theodolite to measure the horizontal and vertical angles between the stations, which would, by trigonometry, give us exact distances and altitudes. It was no mean trick to operate the instruments on the frequent days when icy winds numbed Pete's fingers and constantly filled his eyes with water as he crouched over to peer into the theodolite. Roberto would attempt to shield Pete from the wind. Meanwhile, Ann or I, huddled over the precious angle books with backs to the gale, would slip gloved hands out of bulky arctic mittens to record the figures. It took a long time to make the ten readings taken of each angle under conditions like these.

Whenever possible we approached our stations by jeep, a vehicle far better suited to the terrain than the 2½-ton army trucks. With chains and antifreeze and no longer so "road" bound, we could get to the base of the mountains where our stations had been placed and in some cases actually drive our mountain climbing jeep right to them. I had never before made "first ascents" with motor transport. We still had our transportation difficulties, however, caused by the water in the 100 gallons of gasoline which the enterprising filling station in Copiapó had added to stretch its profits. In order not to have to remove the gas line and melt it over a gasoline stove as we had to do the first morning, it was a nightly ritual to syphon all the gas out of the tank and to drain the carburetor and gas line.

We worked without interruption from sunrise to sunset except on two days on which it snowed. Mercifully the accumulation was small. It was after the second of these storms that we discovered to our horror that the ignition switch of the jeep had been left on. For thirty-six hours electricity had been draining out of the battery. No amount of pushing, cranking, or ingenuity during that desperate morning would start the vehicle. The nearest good battery was at Potrerillos, 100 miles away. Leaving Ann and Pete to continue the survey on foot, Busquets and I shouldered heavy packs, to trudge the fifty miles that separated us from the three men tending the dam at La Ola. Normally water would have been a problem, since none exists on the whole route between the fresh water at Base Camp and the salt stream at La Ola. Even there the men are dependent on water brought them from Potrerillos. However, we could melt the snow from the drifts of newly fallen snow. Bucking a wind so strong that we took turns breaking it, we reached the northern end of Maricunga by sundown. The next day we crossed the pass that leads to the Salar de Pedernales and descended towards the salt flat. It was not until the third day that we reached La Ola and help. On foot we began to appreciate the enormous scale of the country. Towards the end of this gruelling march, we saw more of the birds and animals that live in this inhospitable region. We had already seen herds of graceful guanacos (the llama's wild cousin), foxes, partridge, sparrows, and a single giant condor. In La Ola we saw numerous water birds, including sea gulls, pintails, teal, and lovely black and white geese known locally as *penquenes*. The strangest of all were the rheas, the American ostrich, which ran from us with lightning speed as we approached. A company truck drove us from La Ola to Potrerillos, where the company officials gave us immediate help. On the fifth day after our departure we were back at Maricunga with a new battery and a large piece of fresh beefsteak.

Together again, all four continued the survey with redoubled energy, for time was running out. Perhaps the loveliest day was the one when we occupied Station Roberto. (All the stations bore the names of members of the party or their offspring.) This station lay at 16,313 feet on one of the summits of the Cordillera Claudio Gay between Maricunga and Piedra Pómez. In order to make use of the usual comparative lulls early in the morning, we left camp several hours before dawn in the light of the nearly full moon. As we ascended the Colorado valley, the 40-foot cliffs that hem in the canyon on both sides looked like huge jagged peaks in the half light. The sun touched the 20,000-foot mountains around us with a gorgeous dawn-glow long before it reached us. We four were well acclimatized and reached the summit in about four hours. To the south rose the colossal masses of Tres Cruces and of the Ojos del Salado, while other 20,000-foot peaks hid the horizon to the east. On the other side we looked down on a lava flow which looked as if it had just descended from the very summit and cooled there. Beyond we saw the many colored Salar de Maricunga. No wind disturbed the beauty of the scene or slowed the observations.

After another week of comparatively kind weather, the surveying was done except for the measurement of the base line. Base lines are a finicky kind of thing that require the greatest precision; the slightest error would be magnified enormously, as its length is projected and expanded into the whole survey. It took us two days to place and drive the stakes, lined up to the millimeter with the theodolite and spaced at precise 25-meter intervals with a standardized steel tape pulled out to exactly 22 pounds of pressure. It took a morning to run a line of levels along the base line stakes and back again to determine the exact differences in altitude between them. After lunch, confident that in a few hours we would be finished, we unwound the tape to start the final measurements. As was so often the case, the wind had been increasing steadily all day. As I held the scales with which we stretched the extended tape, a terrific gust caught the thin steel ribbon. With a sharp snap and a gigantic leap, the tape whip-lashed the air, while Ann held tight to the other end 50 meters away. The same horrid thought struck us all: the tape had snapped. No tape meant no base line; no base line, no survey. Like possessed beings, Pete and I lunged for the whipping end. It was still intact! The gust had merely forced open the clip that held the tape to the scales. Since it would have been madness to continue working in that gale, we retired to camp determined to return the moment the wind fell, whether it were midnight or dawn.

While Ann nervously watched the canvas of our four-man tent strain and bellow against its swaying metal framework and listened to the cloth of Pete's and Roberto's nearby mountain tents snap in the wind like the crack of a rifle, we prepared our final banquet of crabmeat and noodles. Over the last of the fifteen bottles of excellent red wine that Roberto had insisted on bringing from his family's vineyards, we heard our nightly quota of tales, true, to be sure, but fantastic and losing nothing in the telling. Roberto transported us to remote parts of the Chilean cordillera or dynamited tent platforms on lofty Dhaulagiri. With Pete we dived for sunken treasure in the waters of the Pacific or ate monkeys' hands presented by naked head-hunters in the jungles of the Amazon. The wind still buffeted the tents as we crawled into our sleeping bags.

The hush of the now windless night awoke us an hour before dawn. We wasted no time. The first run of measurements along the length of the base line was done before the sun rose. We were a well-drilled team. While Ann held one end of the 50-meter tape on the pinpoint mark on one stake, I stretched it with the scales and Pete, at my side, marked a precise 50 meters on the second stake from her. Roberto guided the tape over a nail in the intermediate stake to eliminate sag and read the temperature each time on an attached thermometer. The sun struck us as we began the second run: twenty minutes later it was eighteen degrees less frigid. Towards the end of the third and last run the wind picked up; so suddenly and strong did it come that if we had started ten minutes later, we could never have finished the job that day. Scudding clouds foretold worse weather as we broke camp that morning of August 31, three weeks to a day after we had reached Maricunga for the second time. Violent sandstorms pockmarked the windshield as we turned the jeep back towards civilization. The weather worsened as we advanced. As we crossed the last pass before Potrerillos, the snow began to fall.

Appendix I

THE SECOND ASCENT OF THE OJOS DEL SALADO

By Matthias Rebitsch

On January 5, 1956, we left Buenos Aires. Our group consisted of Verena and Anders Bolinder, the Swedish couple with whom I had reconnoitered the southern Peruvian Cordilleras in 1952, the outstanding Argentine mountaineer, Sergio Domicelj, secretary of the Centro Andino Buenos Aires, and me. After overcoming an endless series of mishaps, we finally were able to head our 12 pack animals from Fiambalá in the Province of Catamarca

towards the Ojos del Salado. After days of riding across the high desert, on January 22 we reached our base camp near the Agua Calientes caves at 13,600 feet. Near the hot springs we found roots for fuel and grass for the mules. An ideal camp site!

To acclimate ourselves to the altitude, we made the first ascents of two nearby peaks of over 19,000 feet that lay to the east and west of the Tres Lagunas Negras Pass. From them, we could clearly see the route to and up the Ojos del Salado. After a two-day storm which transformed the brown, arid Puna into an icy winter landscape, Sergio Domicelj, the muleteer Santos Carrizo, and I started out to try the Ojos del Salado. We had chosen the shortest but as yet unattempted eastern route. After crossing the 17,400-foot Tres Lagunas Negras Pass, we pitched our Base Camp at 17,700 feet at the foot of the Ojos beside a broad field of nieves penitentes on a flat above the Lagunas Negras (black lakes). Carrizo turned back with instructions to return for us in six days. During continuous loathsome wind squalls, Sergio and I established, in the next three days, first Camp I at 18,400 feet and then Camp II on a saddle beside crags at 20,350 feet. The climb there with our 65-pound packs was tiring, but technically easy. The route led across lava slopes with loose debris, large boulders interspersed with fields of bizarre nieves penitentes. I had the feeling that I was suffering from mountain sickness more than in the Himalayas at similar altitudes. Thirst also plagued us much more.

Late on February 1, the steady wind rose to hurricane force and, despite the protection of the stone wall we built, our light-weight tent was torn to bits in the night. It was a bad night! At 6:30 on February 2, we left Camp II with high winds and low temperatures. There were no climbing difficulties and the sky was still clear, but banners of flying snow hung off the ridges which themselves had been blown clear. So sharply did the wind and biting cold attack us that soon hands and feet lost all feeling. Since Sergio, my ideal climbing companion, unfortunately did not have really first-class clothing, he had to turn back to save fingers and toes. He deserved to reach the top as much as I.

In deteriorating weather and gathering clouds, I had to summon all my willpower to climb on, although I was somewhat protected from the icy wind by my face mask. I had to brace myself against the fierce wind, propped on two ski poles, as I fought my way up the sliding scree slopes and snowfields that robbed me of my strength. It was a deadening, monotonous struggle up the frozen crater-landscape of almost oppressive monotony and lifelessness. Almost all the usual impulses were lacking that

drive us upward in other friendlier and more beautiful mountains. It was almost only an experiment of pure willpower simply to reach the goal that lay above. As I climbed on alone, mountain-sick and lonely, I had, for the first time in my life, the impression that I was not unaccompanied. Previously I had always been very skeptical towards this Himalayan "ghost companion."

At 1:30 P.M., I suddenly found myself on the flat, snowless summit ridge. On the highest point of this, I found the cairn the Poles had built in 1937. It contained a narrow round tin can (Ovomaltine, I believe) with a single calling-card with their names: J. Wojsznis and A. Szczepanski; one printed, the other in pencil. I added my calling card to theirs, but without writing the date, for I had no pencil. § Photography was difficult and in the few seconds I was without my gloves, I froze my fingers slightly. My Luft aneroid barometer read about 6870 meters (22,540 feet). Although recent reports had placed the Ojos del Salado higher than 7000 meters, I had the personal feeling at the time that my readings probably were not far wrong. I had brought a thermometer to determine the temperature and thus to eliminate that possible source of error, but while pulling it out of its case with my clumsy mittens, I broke it. I have been told that Gajardo's party found a maximum-minimum thermometer near the summit; it must have been mine.

The view through the broken clouds was very limited. From time to time, there loomed out of the gloomy murk a tower-like jagged point, separated from me by a deep gap. The mists distorted dimensions and made it hard to judge how far away it lay, but I assume it was 75 to 125 feet away and some 8 to 12 feet higher than the spot where I stood beside the Polish cairn. Although I considered the problem of the ascent solved, I did want to get closer to the jagged point, so climbed down into the gap. However, the wind was growing even stronger and threw me continually off balance while I climbed. I could not remove my mittens to grasp the rock. As the danger was too great, I turned back.

I descended snow and volcanic gravel slopes to Camp II and descended from there the same evening with Sergio to Camp I. He had been able, while wrapped in both sleeping bags, to massage his fingers and toes and thereby save them.

Meanwhile, the Bolinders and Santos Carrigo had made the first ascent of the Cerro Aguas Calientes (18,100 feet), which rose above our Base

§ This would explain why the Chileans did not realize that Rebitsch had made the ascent. They found two cards and must have assumed that Rebitsch, with his Slavic name, was one of the Poles. — H.A.C.

Camp, and had an excellent view of the unexplored volcanic area north of the Paso San Francisco. They carried out an extensive reconnaissance, during which Bolinder made the first ascent of Incahuasi Chico (about 19,650 feet).

Appendix II

THE THIRD ASCENT OF THE OJOS DEL SALADO

by Captain René Gajardo

On the morning of February 4, in Camp I (19,400 feet), our small group awoke in rather bad physical condition, suffering from mountain sickness. Two ropes (Capitán René Gajardo, Sargento Nemesio Zamora, Luis Alvarado, Vicente Chiaranda, and the American surveyor, Wayne Miller) headed south to establish Camp II. The slopes grew steeper and were mostly covered with large snowfields. The increased wind, carrying with it snow and ice particles, made climbing difficult. We ascended ice for a long time, since a large part of the terrain between the two high camps was covered by snowfields and nieves penitentes.

The only two real glaciers on the mountain lie on this northwestern slope. Both end in tongues that descend to the northwest and northeast to be absorbed in the thirsty gullies below. The steeper lower glacier probably was once an extension of the upper one. The penitentes rose to as much as six feet above the surface of the glaciers. The snow-covered crevasses of the lower glacier required care and finally, to avoid these difficulties, we traversed it from north to south.

The temperature, already low, kept dropping, exhausting us. Starting at 19,500 feet, we had to surmount the upper glacier which had a few deep crevasses. Finally, we established Camp II at 21,000 feet, on a bit of clear ground between the upper glacier and a large field of penitentes that descended from the southwest. From there, we could see the northern rim of the crater.

The night of February 4 was too cold. Fatigue let us sleep for a long time, but later sulphur fumes driven by the strong wind from the fumaroles of the Ojos del Salado nearly asphyxiated us. We suffered from headaches, all the more when it was cold.

Leaving the camp set up, we left for the summit at 7:30. After crossing fields of penitentes, an hour-and-a-half later we reached the northern rim of the crater. This is a dormant volcano with fumaroles that continually and with considerable rumbling expel clouds of sulphurous smoke. At times we were nearly suffocated, but when the wind changed direction

those of us who were somewhat bolder went close to look into these mysterious cavities. The crater of the volcano is about 1300 feet across and has badly eroded walls of volcanic gravel, pumice, and basalt, and others of scoria. This northern rim is considerably lower than other parts of the crater's edge. A number of fumaroles in the crater puff in unison, showing subterranean connection.

We continued along the rim towards its highest part. Again the strong wind, which carried with it fine sand, the low temperature, and the rarefied air began to exhaust us. We had to rest more and more frequently, sometimes after only a few steps. The slope became more difficult. We had to zigzag to avoid steep patches of loose volcanic gravel. Thinking that we should arrive momentarily at the summit, especially after we surmounted one rise after another, our nearly exhausted group finally caught sight of a jagged tooth rising some 300 feet above us on the northeast corner of the crater rim. Basalt blocks seemed to be heaped up one on the other, precariously balanced.

After a long rest, we began the ascent of a gulley of rotten rock, which became even looser as we ascended. Next we climbed a chimney full of loose rocks which got narrower towards the top. The final obstacle was a large wall of insecure rocks, which at this altitude and in this cold was difficult for us in our exhausted state. Above this wall, a precariously balanced rock momentarily delayed the final ascent. After we had surmounted this, we found ourselves on the roof-shaped summit. The flat part was about ten feet long and a foot or two wide. It fell off on each side, first gently, then steeply.

We stood on top at 2 P.M. and stayed there for about forty minutes, taking pictures and reading our aneroid barometer, which showed 7084 meters (23,241 feet). Despite the wind and our fatigue, we enjoyed the magnificent panorama. The sun shone brilliantly and everywhere we saw mirages and multicolored reflections where the sun's rays struck the highly mineralized peaks. Toward the west was the silver mirror of the Pacific, cut here and there by high summits. Towards the east, there was another distant horizon, yellowish in color, the Argentine pampa, also broken by closer big peaks.

We descended slowly and reached Camp II at 5 P.M., which others had already reached from below. We continued on to Camp I where we discovered that through a misunderstanding climbers had ascended from Base Camp, not leaving space for all of us. Half of us continued on to Base Camp, where we arrived at 10 P.M. On the day of the ascent, the maximum temperature was 48° F; the minimum, —18° F.

On February 6, the climbers left in Camp II started out at 8 A.M. The group (Juan Soltof, Juan Simken, Erick Segura, Raúl Araya) went east, following the northern rim to ascend the back side of the peak to reach the cairn. There they found the cards left by the Poles in 1937. The cairn lies about ten feet lower than the top of the jagged peak which we had climbed the day before. || Simken and Soltof climbed the other summits of the massif, which lie close together towards the west. They measure about 540 and 685 feet less than the main peak. On the same day they broke camp and all descended to the advance Base Camp.

On February 7 a group reached the summit of the Cerro Peñas Blancas (19,750 feet).

Appendix III

DETERMINATION OF THE ALTITUDE OF ACONCAGUA

Having in recent years reached the high mountain zone of the Andean Cordillera between Upsallata and the Chilean frontier in the course of our geodetic field work, we of the Instituto de Geodesia of the Engineering School of the University of Buenos Aires decided to determine the exact altitude of Aconcagua during our 1955 and 1956 geodetic field work. I was accompanied by other professors of geodesy from the Institute, by army officers, students of the Advanced Technical School of the Army (Escuela Superior del Ejército), and graduate students of the Engineering School.

The best method to follow to determine the altitude of the mountain above mean sea level would be to run a geodetic line of differential spirit levels to the summit of Aconcagua, but this would produce insuperable difficulties. It was therefore necessary to carry the line of levels as close to the region as possible and from there to compute the altitude of the summit by trigonometric leveling.

To help in our solution of the problem we already had the precise line of levels of the Instituto Geográfico Militar to the Nodal Point 63 in the Plaza Chile in Mendoza (about 1900 kilometers), the precise line of levels from Nodal Point 63 to Fixed Point 1 in Upsallata made by the Instituto de Geodesia (about 100 kilometers), and the line of levels from

|| Juan Soltof states the following. "The two summits lie about 65 feet apart but are divided by a deep gap about 260 feet deep, which it would be difficult to cross. The only practical route is to make the whole circuit of the crater, which would involve a whole day's trip. From the Polish cairn we could see that the rock tower was slightly higher." Soltof also spoke of the cards and the broken thermometer mentioned in Rebitsch's article. — H.A.C.

Fixed Point 1 in Upsallata to Puente del Inca made by the Instituto de Geodesia (about 100 kilometers).

In our first effort, following the Quebrada Horcones, we reached with geodetic leveling Plaza de Mulas from Puente del Inca (about 38 kilometers). From there, however, trigonometric leveling (triangulation) would have presented serious difficulties.

We decided to start the trigonometric leveling from the benchmark situated next to the Laguna (Lake) Horcones in the *quebrada* (deep valley) of the same name at about 8 kilometers from Puente del Inca. From that point, some 18 kilometers from the summit of Aconcagua, the peak may be very well observed.

We measured a base line of 1000 meters with an Invar stadia rod and an optical theodolite reading to .2" of arc. With an optical theodolite reading to 1" of arc we expanded the base to the 2000 meters diagonal of a quadrilateral bounded by two mountains that flanked the *quebrada*. From all these points the vertical and horizontal angles were observed on the summit of the mountain at different hours of the day.

With the data which we then had at our disposal we completed the necessary calculations to solve the problem, taking into account the corrections which affect the different types of leveling. We corrected the geodetic altitude to the geoid of the benchmark of the Laguna Horcones because of the lack of parallelism of the level surfaces of the terrestrial gravitational field, using values of gravity measured on the geodetic line of levels.

The components of the topographic-isostatic deviation from the vertical were calculated for the benchmark of the Laguna Horcones, the summit of Aconcagua and the two stations separated from them by 20 kilometers at each side. From these data there was determined a profile of the level surface which passes through the benchmark of the Laguna Horcones with respect to the tangent sphere to that surface of level at that point and with respect to which was calculated the trigonometric part of the altitude figure for Aconcagua.

One can therefore relate this part of the altitude figure to the level surface of the Laguna Horcones benchmark. The lack of parallelism between this level surface and the geoid which is related to the geodetic height of the benchmark of the Laguna Horcones was calculated theoretically.

The assembled measurements and corrections have given as the altitude of the summit of Aconcagua:

Height equals 6959.7 meters — 22,834 feet, with a maximum probable error of 1 meter.

Ing. Eduardo E. Baglietto, *Director, Instituto de Geodesia, Engineering Department, University of Buenos Aires, Buenos Aires, Argentina.*

October 27, 1956

Appendix IV

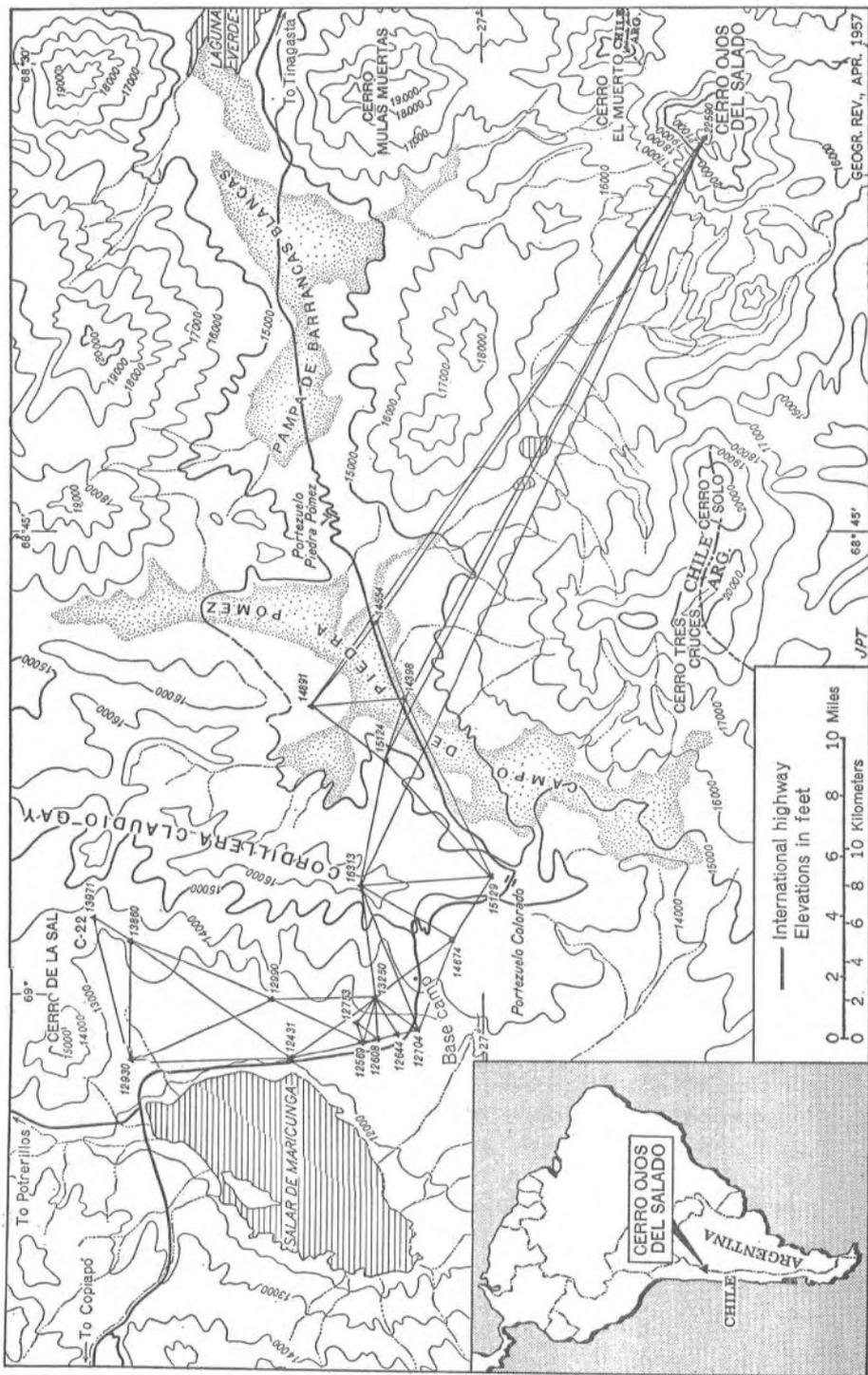
REPORT ON THE ENGINEERING IN CHILE OF AUGUST, 1956, DETERMINING THE ELEVATION OF THE OJOS DEL SALADO

Conclusion: The Ojos del Salado has an elevation of 6885 meters, or 22,590 feet, with a possible maximum error of no more than \pm three meters regarding the control connecting the difference in elevation between the established point C-22 and the summit of the Ojos del Salado.

Background: I was first approached in May 1956 for the purpose of establishing accurately the elevation of the Ojos del Salado which rises in the Andean Cordillera above northern Chile and Argentina. At the time there was a great deal of evidence pointing to the possibility of this mountain being higher than Aconcagua, which would result in the Ojos del Salado being the highest mountain in the western hemisphere. Almost nothing was known of the existing local geodetic control except that the nearest known stations were about 200 kilometers from the Ojos over extremely rugged terrain.

However, the large copper mine and smelter belonging to the Andes Copper Mining Company at Potrerillos was noted to be within about 120 linear kilometers of the Ojos. As it seemed quite feasible that an accurate elevation would be established there, the on-the-spot engineering research began at Potrerillos. It was discovered that the Andes Copper Mining Company had located various accurate elevations within about 60 kilometers of the Ojos; therefore, it was only logical that one of these stations be used as a base elevation.

The expedition proceeded to the Ojos region during the latter part of July but after several days was forced to withdraw to Copiapó and on to Santiago because of adverse weather conditions and transport difficulties. During that first trip into the region I was able to develop a reconnaissance plan and estimate that it would be possible, weather permitting, for four people to complete the field control within three weeks.



A jeep was secured in Santiago and a party of four—Mr. and Mrs. H. Adams Carter, Roberto Busquets, and myself—returned to the Ojos region and completed the field work within just three weeks during the month of August. The work was carried out over extremely rugged terrain at high altitudes under very adverse conditions. The successful completion was made possible only by the tremendous efforts and aid given by the Carters and Sr. Busquets.

Base Elevation: The station C-22 of the Andes Copper Mining Company with an established elevation of 4258.343 was selected as the base departure point.

In 1915 a line of differential spirit levels was run from the port of Barquito (Chañaral) to Potrerillos for the railroad survey. During 1925 the Andes Copper Mining Company also ran a spirit level line from Barquito to Potrerillos for a transmission line survey and rectified the previous Potrerillos elevation by 4 meters. Both level lines were based on mean sea level.

A well-checked spirit level line was carried about 80 kilometers to the water reservoir at La Ola for the engineering of the La Ola-Potrerillos water pipe line.

During late 1955 and early 1956 a further spirit level line was run from La Ola about 30 kilometers south towards the Maricunga salt flat for the purpose of additional water and drainage studies. It was one of these Maricunga level stakes—C-22—which was recovered and used as the base elevation.

Method: A 788.676-meter base line was measured on the Maricunga Salt Flat. From this base line a triangulation scheme of 18 stations was established extending about 15 kilometers north to connect with C-22 and about 22 kilometers south and east to establish five stations from which the summit of Ojos del Salado was visible. Reciprocal zenith observations were made from all stations to establish the individual differences in elevation and non-reciprocal observations from five stations to the summit of the Ojos to determine ultimately the difference in elevation between the Ojos and C-22 by trigonometric leveling and thus the elevation of the Ojos.

Accuracy: The majority of all field work was done under extremely unfavorable conditions, such as snow and ice and high velocity wind- and sand-storms. This, of course, affected the accuracy of the survey. However, the survey is more than sufficiently accurate for the purpose for which it is intended.

← Sketch map of the Ojos del Salado region, Chile,
showing triangulation network. (Courtesy of The
American Geographical Society of New York.)

A Wild T-1 repeating theodolite reading direct to one minute and with visual interpolation to six seconds was used. Five repetitions of direct and reverse were taken on all horizontal angles. Two or three repetitions of direct and reverse were read on all zenith distances. All zenith distances, with the exceptions of those to the Ojos del Salado, were reciprocally observed.

Magnetic north was observed from North Base with a Brunton compass and the result was used as the basis for calculating all bearings.

North Base was assigned the arbitrary coordinates of N 50,000 m., E 50,000 m., from which all other coordinates were derived.

The base line was measured three times backward and forward with a standardized steel tape and all corrections carried out for temperature; tape catenary and sag; set up, set back; inclination; and reduction to sea level. A probable maximum error of 8.8 millimeters exists in the base measurement.

Please note that the base line and, therefore, all other computed lines, is reduced to sea level datum.

A probable maximum error of three meters exists for the calculated difference in elevation between C-22 and the summit of the Ojos del Salado.

Data: All data—elevations, angles, distances, bearings, coordinates, etc.,—will be found on the accompanying plan showing the triangulation scheme and relative topography. The topography and road are drawn to sketch accuracy only. (See page 94.)

All detail information—field books, calculations, adjustments, and the original plan on tracing cloth—are in my files in Lima, Peru.

Relative Elevations: Most recent elevation as determined for

Aconcagua	6959.7 m.	22,834 ft.
Ojos del Salado	6885.5 m.	22,590 ft.
Difference	74.2 m.	244 ft.

Peter C. Weaver, Sanchez Carrión 331. Magdalena Nueva, Lima, Peru.