

HEIGHTS OF INTEREST

Text and photos by Johan Reinhard

Strange that in this age of high-tech computers and space probes, we still lack accurate heights for some of the mountains in our own hemisphere. In the more distant and less accessible Himalaya, we have accurate figures for the altitudes of the major peaks, although even there a controversy arose a couple of years ago about Everest. In South America, where the highest mountains in the Western Hemisphere are found, we are not even sure which peaks to consider.

In this article, I will attempt an overview of the current situation based largely on my research, which has led me to climb some of the highest South American mountains and provided a few surprises about some of the lesser known peaks, as well. Please note that these are my personal views and not to be taken as final answers. Further technical studies are needed to make order out of the curious chaos that now reigns.

Huscaran (6,769m) as seen from the Cordillera Negra while climbing a prehispanic wall.

To begin this discussion, let us look at a small area of Chile and Argentina which has what appear to be five of the ten highest mountains in South America. All these peaks are over 6,500m (21,325 ft), and all are within 100 kilometers (62 miles) of each other, making this the densest concentration of 6,000m (19,685 ft.) mountains outside of Asia. It has been rather difficult to reach these mountains, but roads have recently been improved. At the base of Ojos del Salado there is now even a hotel. Ojos del Salado is generally considered the second highest peak in the Western Hemisphere.

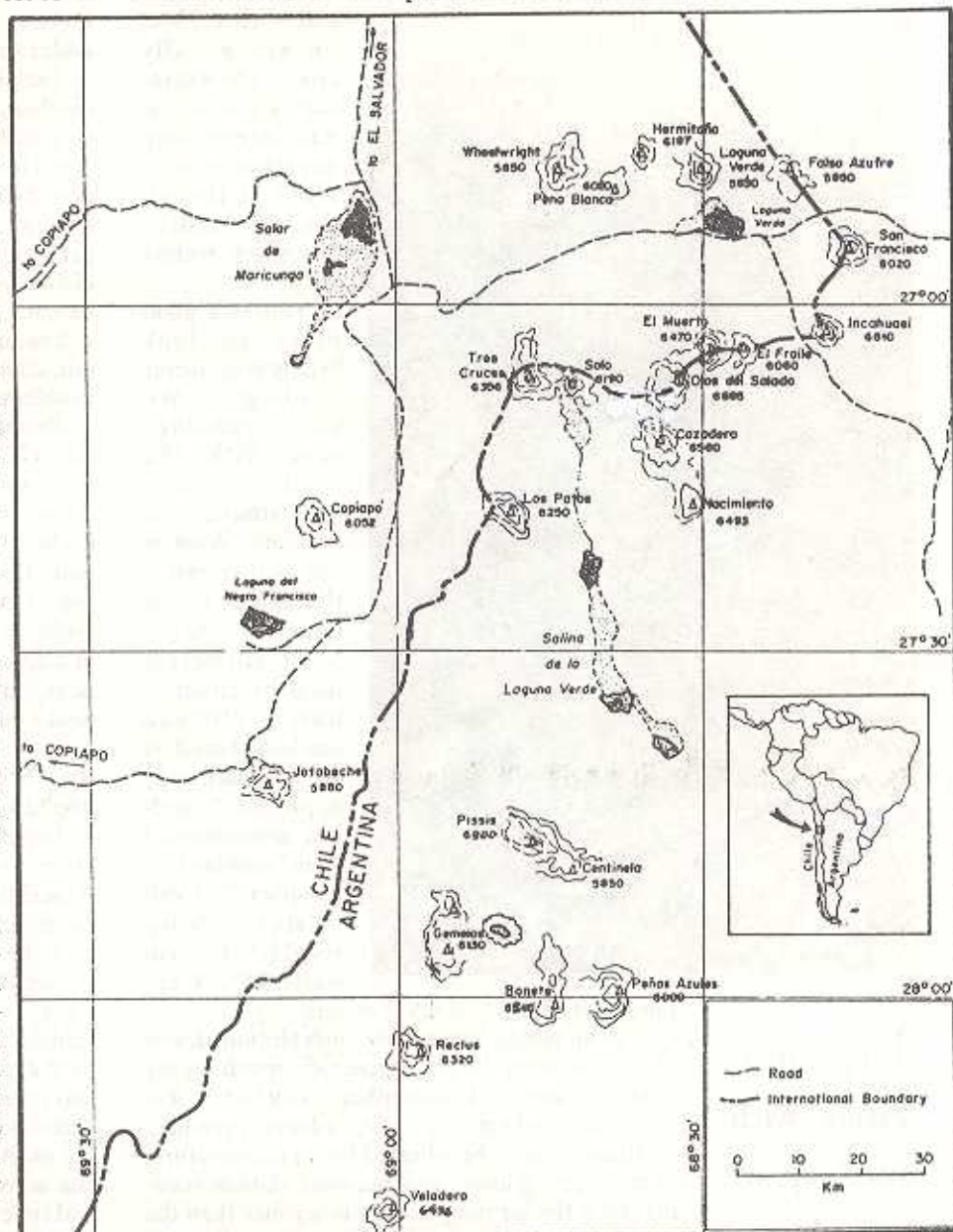
I said "generally" because several maps still erroneously list the height of Ojos del Salado as 7,084m (23,241ft), which, if true, would make it the highest mountain in the Americas. This error is based on an incorrect altimeter reading. The actual height of this mountain is 6,885m (22,998ft), an altitude established over 30 years ago. (See "Ojos del Salado," by Adams Carter, *American Alpine Journal*, 1957.) Other maps give 7,010m (22,998) as the height for Aconcagua/Il-lampu, but this, too, has proven to be in error.

With altitudes of 6,960m (22,834ft) for Aconcagua and 6,885m for Ojos del Salado well-established, it would seem that the altitudes of the two highest mountains have been definitively resolved once and for all. Well, the heights may be correct, but are these peaks definitely the highest?

In 1985, Louis Glauser, Martin Erb, Alexander von Bergen and I climbed Pissis, to the south of Ojos del Salado. With an altitude of 6,779m (22,241ft), it is considered the third highest peak. Without adjusting my altimeter, I found it read 69m (220ft) higher on Pissis than it had on Ojos in similar, clear weather. Louis Glauser climbed Ojos two months later, and his altimeter read 20m (66ft) higher on Ojos but in storm conditions.

It is now well known that altimeters are fickle. If it were simply a case of two altimeters giving relatively higher readings for Pissis (the bad weather certainly raised Louis' reading more than 20m while on Ojos), I wouldn't think much about it, assuming there existed a well-established height for Pissis, that is. However, thanks to Evelio Echeverría and his bottomless well of information on the Andes, we know that this is not the case. (See his "Survey of Andean Ascents," *American Alpine Journal*, 1973 and 1974; and Jill Neate's *Mountaineering in the Andes*, 1987, for heights and additional information on the Andes.)

Evelio sent me several maps of the Ojos del Salado region. The 6,779m figure for Pissis comes from a survey conducted by Riso Patron and published in 1902. Although many of the heights provided by Riso Patron are indeed accurate, some of those on his map are incorrect. For ex-



ample, he gives 6,769m as the altitude of Tres Cruces. As we shall see, this is likely to be far off the mark. The Polish team that climbed Pissis in the 1930s retained the same figure, although they did sort out which of Pissis' summits is highest. After the Poles, there was an Argentine ascent in the 1950s, but it is unclear if they reached the highest summit. More recently, an Argentine team climbed Pissis' second highest summit in 1983. As far as I am aware, neither of the Argentine expeditions came up with a new figure for Pissis' altitude. Only Hans Stegmann apparently recorded a read-

The summit of Lullailuca (6,739m) with the world's highest archaeological site.



To get in [to Pissis] with our Jeep, we had to rebuild part of an old mining road, and then hike two more days

ing close to my own when he gave the height as 6,875m, but that was in the early 1900s.

So the true height of Pissis is still up in the air (so to speak). But let us suppose for a moment that my altimeter reading was correct, and Pissis is actually 69m higher than Ojos. Add 69m to 6,885m and with 6,954m we are awfully close to Aconcagua's 6,960m. An interesting question arises: What if the altimeter reading was seven meters low?

This is a good place to look briefly at altimeter readings. We know readings vary with the weather, changing with atmospheric pressure. What is less well-known is the effect of air temperature. Most altimeters used by climbers have altitude markings based on an internationally approved "standard atmosphere." This "standard atmosphere" is calculated as being roughly 5° Fahrenheit/-15° Cen-

tigrade at 15,000 feet/4,572 meters.

The air temperature in the high altitude desert of the southern Andes is generally much higher than this standard atmosphere. Hot air is less dense than cold air. To obtain a correct reading, an altimeter must be adjusted for air temperature, or it will give a lower and incorrect altitude reading when the air temperature is warmer than the standard atmosphere, and vice versa. According to a chart that deals with these differences, if the temperature is 50°F higher than the "standard," the altimeter will read 550ft (168m) low for a 5,000ft (1,524m) altitude gain. This explains why we consistently had low readings on high peaks such as Ojos del Salado.

Although readings vary considerably with pronounced temperature differences and altitudes of several thousand feet, they are not so dramatically affected by small increases in elevation. If Pissis' altitude is 6,779m, this is only some

100m lower than Ojos. Even a significant temperature change, therefore, (and it was maybe 20° F colder on Pissis) would not account for my reading of 6954m for Pissis. The chart indicates a 20°F temperature difference will show up as a 5m difference per 100m of altitude. My reading on Pissis, however, was 175m (574ft) higher than 6,779m under similar weather conditions.

Despite its height, Pissis has been ignored by climbers. This is not surprising since it is not challenging for serious (i.e. technical) climbers, is located in a barren, rarely visited region and cannot even be seen from any easily accessible location. Even getting close is somewhat problematical. To get in with our Jeep, we had to rebuild part of an old mining road, and then hike two more days to its base. This road has since been improved, but still requires a 4-wheel drive vehicle. As it turned out, climbing Pissis turned up yet another height problem; that of Bonete.

Bonete is even less accessible than Pissis and the subject of even greater misinformation. On some maps its altitude is listed as 6,850m while others list it as 6,380m. To make things worse, some people distinguish between a Bonete Chico and a Bonete Grande with the Bonete Chico being higher on some maps and lower on others. In addition, there are maps that show the two peaks in a north-south line, while others show only one peak, and some climbers insist there are two peaks, but east and west of each other!

In 1986, we organized an expedition which we hoped would establish once and for all the heights of Bonete and Pissis. Robert Lyall, Director of Operations for the mining company Anglo American Chile (which supported our work), came up with a clever system to get accurate altitudes using two base points and a reflecting device. We felt prepared to the point of overkill once we were outfitted with 4-wheel drive vehicles, radio gear, excellent equipment donated by Patagonia and REI plus 25 horses and mules and desert bikes, and were assured that renowned Scottish climber Hamish MacInnes would be joining us. As things turned out, what with Hamish's late arrival and some other problems, we barely had time to accomplish our goals, some of which were a bit unusual to be sure. On a satellite photo we could see that Bonete and Pissis make up part of a ring of volcanos enclosing a high (ca. 5,550m, 18,044ft) plateau. Near the middle of the plateau is a crater roughly 5km (3mi) wide, nearly 400m deep containing a lake some 2km wide. As far as we knew, no one had investigated the crater or climbed the peaks along the western side of the plateau. During our expedition, we boated on the lake in the crater, dove at 5,200m in another lake at the foot of Pissis, and had the unusual experience of climbing a mountain *inside* the crater. (All of us noticed that climbing inside the crater

was rather tiring. Hamish was later told that the high concentration of sulphur accounted for our fatigue and has roughly the same effect on the body as climbing at an additional 2,000m [6,562ft] of altitude!

Louis Glauser and I climbed Bonete first. On the summit just after a bit of bad weather that doubtless raised the reading somewhat, my altimeter read 30m (100ft) lower than it had on Ojos. We paid a price for underestimating Bonete's height (and the distance) and didn't get back to camp until just before daylight.

Unless Bonete Grande refers to one of Bonete's lower summits on its long north ridge, there is no separate mountain of any respectable height in that direction. If it refers to the peak to the east, then Bonete "Grande" cannot be much over 6,100m and is probably less. It seems obvious that only the main peak should be called Bonete, and a separate name be given to the much lower peak to the east. Since it is close to a place marked Peñas Azules, I would recommend that it be called Cerro de Peñas Azules. The Bonete name problem is not the only one in this region.

Depending on which map you look at, there are mountains with different heights and names to the west and southwest of Bonete, as well. For example, Reclus is a name given to a peak west of Bonete. Riso Patron gives it a height of 6,316m. The Poles give its height as 6,320m (20,735ft), but call it Veladero and locate Reclus to the north with a height of 6,130m. Since on most maps Veladero is the name given to a mountain further south, it seems best to keep the name Reclus for the 6,320m peak. Glauser and I climbed this Reclus, finding Inca ruins in the process, and we did get a reading which, adjusted, comes close to the 6,320m height. To the north of it is a low, flat massif followed by two volcanic cones which we called Los Gemelos (The Twins). On the higher northern cone we got a reading close to 6,130m (20,111ft). The Veladero to the south of Reclus is usually given a height of 5,357m (17,575ft), this having been provided by Riso Patron. Antonio Beorchia made the first modern day ascent in 1986 and estimated its altitude at around 6,300m (20,669ft). Patrick Tierney and I climbed it in 1988

and found its height to be 6,436m (21,115ft), or the same as that listed on a revised Argentine map.

I noted earlier that one of the expedition's goals was to firmly establish heights for Pissis and Bonete. In the case of Bonete, the two base points could not be set up in time. While Louis and I were

The view to the southwest from the summit of Incahuasi (6,610m). The arrow points to Ojos del Salado (6,885m).



climbing to the south, Chilean members of our team made the ascent of Pissis' second (eastern) summit. There they waited two days to send the signals to the base stations. Alas, bad weather on both days made this impossible.

At the beginning of this article, I mentioned there were five peaks over 6,500m (21,325ft) in the Ojos del Salado region. The two remaining ones are Incahuasi and "Cazadero." Before dealing with them, however, I should explain why I have selected 6,500m as the cutoff for the "highest mountains."

Most mountaineering journals (not to mention most of the world), prefer to list heights in meters rather than feet. The "Top Ten" mountains, a convenient grouping, nearly equals the number of mountains over 6,500m in the Western Hemisphere. Were we to include peaks over 6,400m, the list would get a bit cumbersome. Also, the grouping of a dozen 6,500m mountains provides something of a parallel to the classic grouping of the fourteen 8,000m peaks in the Himalaya. (Wonder if anyone has climbed all dozen of the highest Andean peaks? I am aware of only two men who are close to having done so.)

To return to the remaining two mountains, Incahuasi is usually given a height of 6,610m

Depending on which map you look at, there are mountains with different heights and names to the west and southwest of Bonete

An aerial view towards Pissis (left) (ca. 6,900m) and Bonete (ca. 6,800m) (right) from just above Copiapo (6,052m) (lower center).



(21,686ft). My adjusted altimeter produced a reading close to this figure.

Many question marks still surround Cazadero. Wrongly shown on some maps (e.g. the Chilean 1:500,000 one) as west and southwest from Ojos and close to it, it is in fact, more south by south-

true altitude. This is, therefore, one mountain that clearly needs to have its height accurately established, and when this is done, it conceivably could be included among the other 6,500m-plus peaks.

Just for the record, the altitude for most of the other 6,000m mountains in this region are close to those found on the Chilean maps, i.e. El Muerto (6,470m), El Fraile (6,060m), Los Patos (6,250m), Copiapo (6,052m), Peña Blanca (6,020m), Ermitaño (6,187m), San Francisco (6,020m), etc. We verified most of these heights ourselves.

Before leaving this area, and in keeping with our theme of "highest," I might add that Ojos del Salado is the world's highest "active" volcano, its fumaroles being a couple of hundred meters below the summit. The area has some of the world's highest unfrozen bodies of water (we saw one some 50m in diameter at about 5,900m/19,357ft on Bonete and several larger lakes above 5,500m), one of the world's highest hotels (Murray Lodge at 4,500m/14,764ft), and one of the most spectacular high altitude desert views I have seen: it is from the summit of Pabellon de la Laguna Verde (5,815m/19,078ft) looking out over the Salina de la Laguna Verde with different colored lakes, sand and rocks, and with the peaks of Ojos del Salado,

Tres Cruces, Cazadero, etc., in the background.

Now we can turn to the other 6,500m (21,325ft) mountains. Those with altitudes well established include Huascarán (6,769m/22,208ft) and Yerupajá (6,617m/21,709ft) in Peru, and Llullail-laco (6,739m/22,109ft) on the border between Chile and Argentina. (The latter peak has the world's highest archaeological site.) The altitudes of Mercedario (6,770m/22,211ft) in Argentina, Sajama (6,542m/21,463ft) in Bolivia, and Tupungato (6,550m/21,489ft) in Chile are also widely accepted, listed as they are on fairly accurate maps issued by military geographical institutes in the respective countries. Riso Patron has Sajama at 6,520m (an often used figure) and Mercedario at 6,670m.

Several other mountains occasionally listed with altitudes above 6,500m are, in fact, definitely lower, e.g. Ancohuma and its close neighbor Ill-lampu (generally acknowledged to be 6,427m/21,086ft and 6,362m/20,872ft, respectively), Illimani (widely accepted to be 6,462m/21,201ft, but listed as 6,402m on the Bolivian Instituto Geográfico Militar's 1:50,000 map) and Coropuna (generally credited to be the 6,377m/20,922ft on the Peruvian Instituto Geográfico Militar's 1:100,000 map, but also given

west. The Chilean map shows a 6,493m peak at Cazadero's true location and another 6,493m mountain, Nacimiento, to the south of it. Clearly there was an error and the 6,493m figure was used twice. The Poles and Riso Patron locate Cazadero correctly and give its altitude as 6,669m and 6,637m respectively, although calling it by different names. "Cazadero" was the name proposed by Evelio Echevarria and accepted by those who made its first ascent. Riso Patron called the 6,493m peak (6,552m on his map) Nacimiento del Cazadero. I climbed both the 6,669m (21,850ft) peak ("Cazadero") and the 6,493m (21,302ft "Nacimiento") and found my adjusted altimeter readings to be at least 100m (328ft) lower for both.

The height of Tres Cruces to the west of Ojos del Salado is often listed as over 6,500m. The Poles give its height as 6,630m, and Riso Patron in 1902 lists its height as 6,769m. In 1924 Riso Patron gives another height, this time listing it as 6,620m (21,719ft). To complicate matters, two climbers I asked who have separately ascended the central and highest summit of Tres Cruces, agree that the Chilean 1:500,000 map and Mario Fantin's estimate, which give the height of this mountain as 6,330m and 6,356m respectively, are closer to the

Ojos del Salado is the world's highest "active" volcano, its fumaroles being a couple of hundred meters below the summit

as 6,425m on some maps). Because of an old error, Tocorpuri still can be found listed as 6,755m (22,162ft). It is actually only 5,755m (18,881ft). Cachi or Libertador is often noted as having an altitude of 6,720m. Riso Patron gave it 6,310m, and one Argentine map listed 6,380m as did the U.S. Operational Navigation Chart of 1:100,000, which, unfortunately, is often inaccurate, and this figure was close to what we measured with an adjusted altimeter. Antofalla was noted on one occasion as over 6,500m, but many maps list it at 6,100m or 6,440m. My adjusted reading was close to the latter figure. Galan occurs on some maps with a height of 6,600m, but Mathias Rebitsch, who climbed it, came up with 6,000m, and the U.S. Operational Navigation Chart has it at 6,116m. Echevarria informs me that it is actually about 5,550m (18,208ft).

This covers most of the mountains that have been listed with altitudes higher than 6,500m. Obviously, the actual height of several of these peaks is still in doubt. Nonetheless, a discussion of their altitudes does focus attention on where information is lacking and what future work needs to be done.

The question of heights is of little interest to many climbers, especially as several of the 6,500m mountains are volcanos offering no challenging routes. Some of these were climbed by the Incas 500 years ago. However, a fair number of people

in the countries concerned do care about heights, and some of them care passionately.

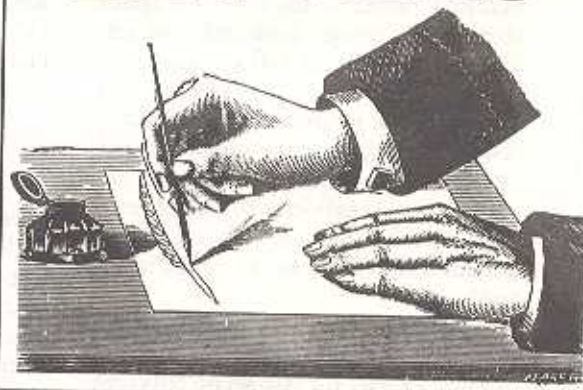
My list of the highest peaks does not take into account separate summits of the same massif. For example, some sources list the north (6,654m) and south (6,769m) summits of Huascarán as two separate mountains. Still, if this approach were followed with any consistency, we would have quite a mess, indeed. Pissis, Aconcagua, Bonete and Ojos del Salado all have other summits, albeit most are not as dramatically distinct as those of Huascarán.

1. Aconcagua	6,960m/22,834ft
2. Pissis	6,900m/22,638ft
3. Ojos del Salado	6,885m/22,588ft
4. Bonete	6,800m/22,309ft
5. Mercedario	6,770m/22,211ft
6. Huascarán	6,769m/22,208ft
7. Llullaillaco	6,739m/22,109ft
8. Yerupajá	6,617m/21,709ft
9. Incahuasi	6,610m/21,686ft
10. Cazadero	6,560m/21,522ft
11. Tupungato	6,550m/21,489ft
12. Sajama	6,542m/21,463ft

It should be obvious from the above article that I have occasionally had to estimate altitude. It will be interesting to see how my list compares to accurate readings once they become known. □



LETTERS



of responses that I hoped the article would elicit.

I agree with Mr. Gallop that the maps generally available for Mercedario and Tupungato are not completely accurate (hence the reason I wrote they were *fairly* accurate). One reason that I kept the altitudes they listed is because I have not read or heard of any serious discrepancy in this regard by people who climbed those mountains. I noted in my article that Riso Patron lists Mercedario as 6,670 m (instead of the 6,770 m found on most maps). I have seen detailed maps of the Mercedario range (e.g., one by the Club Andino Mercedario) and they maintain that altitude (6,770 m) despite its members having climbed it many times.

The Federación de Andinismo in Chile has kept the 6,550 m altitude for Tupungato after numerous ascents by its members. Of course, this does not *prove* that these altitudes are exactly correct, but it would seem unlikely that radical changes would arise about their heights ... unless a hundred meters or so is considered radical.

I agree with Mr. Gallop that better surveys need to be done, and I wrote the article precisely to make that point. I've the feeling (based on my increased respect for Riso Patron and on Evelio Echevarria's statement that the Argentinians never substantiated the altitude of 6,770 m) that Mercedario will drop to 6,670 m.

I was very pleased to receive Mr. O'Brien's correction of Tres Cruces' altitude (6,758 m) based on his ability to view the Chilean IGM 1:50,000 map. I had tried unsuccessfully on three occa-

sions (including May 1990 after my article was in press) to obtain this map from the IGM in Santiago. As Mr. O'Brien mentioned, the area from Tres Cruces to Ojos del Salado is classified "For Military Use Only." In April I had been told by a climber that he had had an altimeter reading of over 6,700 m on its main summit.

Compared to Mercedario and Tupungato, few ascents have been made of this peak. It was for this reason that I noted in my article that this was one mountain that clearly needed to have its height accurately established. I should add that Riso Patron once again

proved fairly accurate, having given its altitude as 6,769 m in 1902 and then for some unknown reasons (perhaps confusing it with one of its adjacent summits) changing it to 6,620 m in 1924.

This might be a good place to update the list of heights of South America's 6,500 m mountains based on what I wrote in a previous letter (regarding recent revised altitudes by IGM of Ojos de Salado, Pissis, and Bonete), on Riso Patron's altitude for Mercedario, and on Mr. O'Brien's information.

1. Aconcagua 6,960 m/22,834 ft
2. Pissis 6,882 m/22,578 ft
3. Ojos del Salado 6,862 m/22,513 ft
4. Huascarán 6,769 m/22,208 ft
5. Bonete 6,759 m/22,175 ft
6. Tres Cruces 6,758 m/22,172 ft
7. Lullailaco 6,739 m/22,109 ft
8. Mercedario 6,670 m/21,883 ft
9. Yerupajá 6,617 m/21,709 ft
10. Incahuasi 6,610 m/21,686 ft
11. Cazadero 6,560 m/21,522 ft
12. Tupungato 6,550 m/21,489 ft
13. Sagama 6,542 m/21,463 ft

As for ascents made in the Sierra Nevada north of Paso San Francisco, I am not aware of any in that precise range. By coincidence, I had planned to go there myself some years ago, mainly as I'd been told that it had the highest unclimbed peak in South America, i.e., Laudo at 6,400 m. However, when I obtained the IGM 1:50,000 maps of the area, I couldn't find any summit above 6,141 m. Views from mountains not far to the south left me with the same impression.

Sincerely,

Johan Reinhard

Dear Club:

I would like to thank Nigel Gallop and Liam O'Brien for writing with regard to my article "Heights of Interest" in Number 26, and for their helpful comments. They were exactly the kind