REPORT OF THE EXPLORATION TRIPS TO THE REGION OF ANTOFAGASTA DE LA SIERRAS IN THE NORTH-WEST OF ARGENTINA

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INTRODUCTION

Following with the project that aims to characterize the region of the north-west of Argentina potentially suitable for astronomical facilities (see previous reports: Recabarren et al. 2002 and Muriel et al. 2003), this report concentrates on one of the most promising regions as emerge from the analysis of GOES images (Recabarren et al. 2001,Mosconi et al 2002).

The area was explored in two complementary trips both starting from Cordoba city.

FIRST TRIP

From 03/15/2003 to 03/19/2003
Team: Diego G. Lambas, Hernan Muriel, Pablo Recabarren & Marc Sarazan.
Logistic: by the team.
Financial support: ESO.

SECOND TRIP

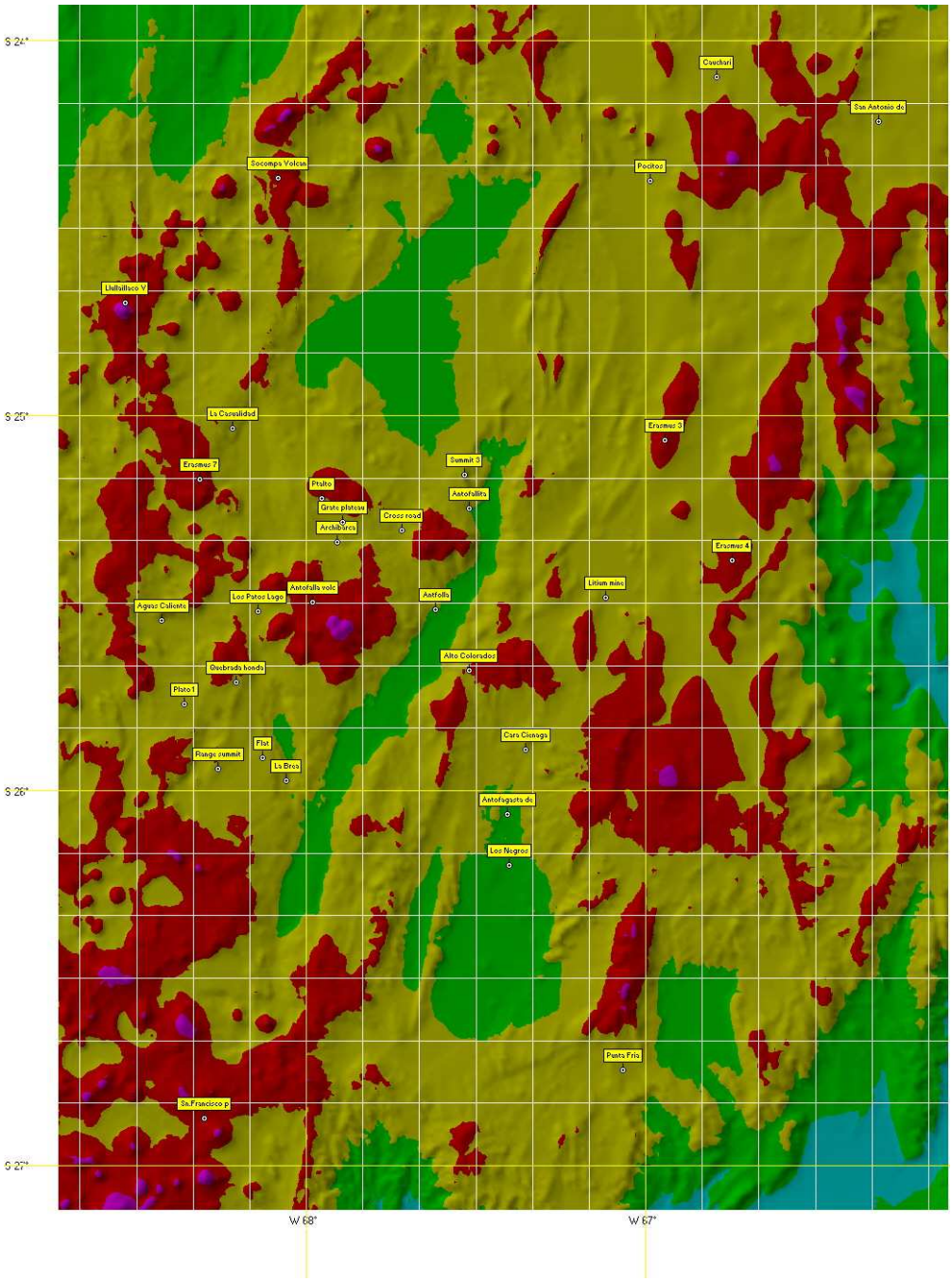
From 05/09/2003 to 05/17/2003
Logistic: We contracted the services of "Andes 4X4" (www.andes4x4.com), an experienced adventure agency, of Henry and Nicole Barret, who provided 4WD vehicles (Land Rover Defender), drivers, hosting and meals. The knowledge and experience of Ing. H. Barret and Mrs. Nicole Barret was an important aid and provided the opportunity to explore the region efficiently.
Team: Ruben Vrech, Hernan Muriel, Pablo Recabarren & Victor Renzi.
Financial support: ESO.

GENERAL DESCRIPTION OF THE REGION

The explored region is between 23 º and 28 º of latitude south and 66 º 30 ' and 69 º of longitude west, limited with the chilean border toward the west , mostly corresponds to the province of Catamarca and a small portion to the province of Salta. The region is known as "La Puna" and it is a great table shaped of more than 3000 m of altitud with several mountain ranges in a preferable North-South layout.

The altitudes in this area goes from 3000 m (over the see level) and more than 6000 m. There are more than two hundred volcanoes and non of them are in activity. There are several great salts flats and a lot of high plains of different sizes. On average, we estimate that 50% of the region corresponds to salts flats or plains and 50% to mountains and volcanoes in a wide range of altitude.

Figure 1. Digital Elevation Model map of the explored region.


S 24°
S 25°
S 26°
S 27°
W 68°
W 67°
Cauchari
San Antonio de
Socompa Volcan
Pocitos
Llullaillaco V
La Casualidad
Erasmus 3
Erasmus 7
Summit 2
Ptolto
Antofallita
Grute plateau
Cross road
Archibarca
Erasmus 4
Litium mine
Antofalla volc
Los Patos Lago
Antofalla
Aguas Calientes
Alto Colorados
Quebrada bonds
Plato 1
Cara Cienaga
Flat
Range summit
La Brea
Antofagasta de
Los Negros
Punta Fria
San Francisco p

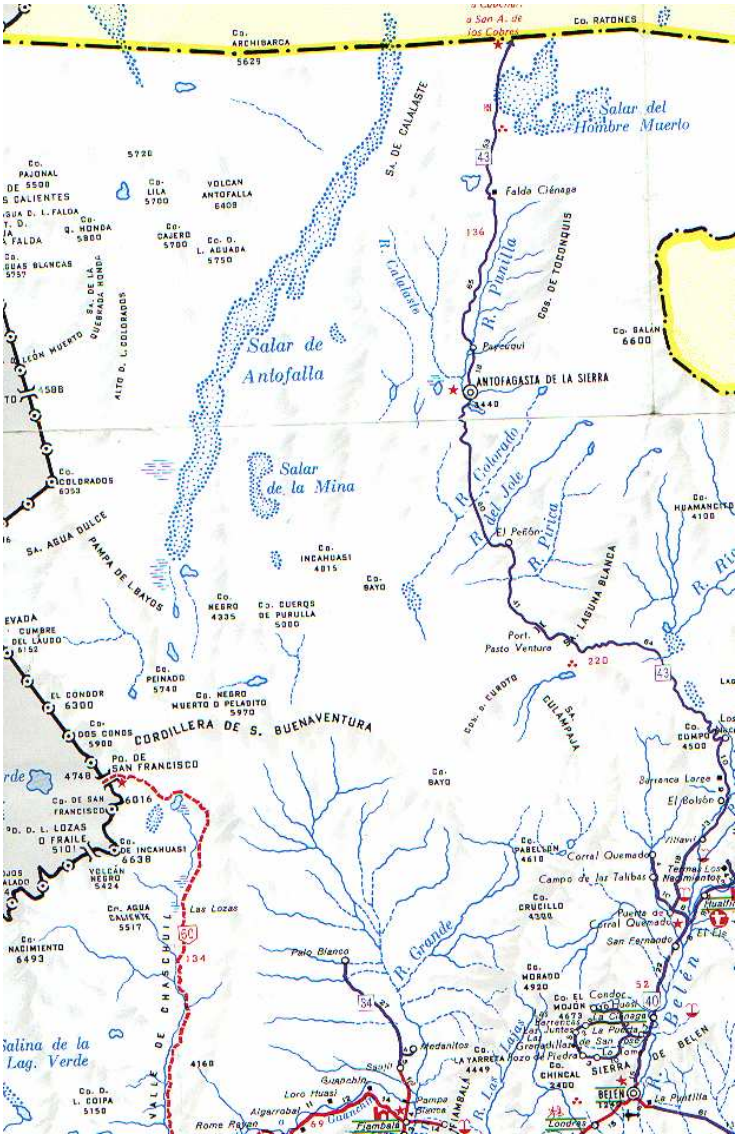
These characteristics result in a variety of potentially interesting places that will be described in the following sections. The Salar de Antofalla goes nearly south-north along one hundred km and naturally split in two half the region. In the following sections these two regions are analyzed separately.

ACCESIBILITY

The easyest way to access the region is from the south. Nevertheless, the northern area can also be reached from Salta. From Cordoba to Belen there is a paved road (620 kms) and then 270 kms of a good quality non-paved provincial road n. 43 to Antofagasta de la Sierras.

Exists another access from the North, a good condition non-paved road, from the Salar de Pocitos town, crossing thorugh the Arizaro Salt Flat, in the province of Salta. This road could be reached from Salta City (450 Km), and it goes trough the towns of San Antonio de los Cobres, Olacapato and Salar de Pocitos, in the Pocitos Salt Flat.

Figure 2. Road map.



MAIN CITIES AND TOWNS

Refering to the Figure 2, there are several towns in the area, which provide logistical facilities;

1) **Belen** is the main city in the region with 8000 inhabitants and provides services of different complexity. This city can be easily reached by bus and there is an airport. The distance between Córdoba and Belen is 620 km.

2) **Antofagasta de la Sierras**: It has approximately 800 inhabitants and provides basic services including hosting (the best is Hosteria Antofagasta, hosteriaantofagasta@yahoo.com.ar , tel. +54-3835-471001/002), telephone, internet connection and combustibles. Twice a week there is a bus service from Belen and there was a flight service presently suspended. There is also a gendarmerie post. In terms of location, this city is very important because it is close to many interesting places.

3) **El Peñón**: Small town between Belen and Antofagasta de la Sierras. This is a a town that is growing very fast, nevertheless, it only provides very basic facilities.

4) **Antofalla**: this is a very small town with approximately 60 inhabitants close to the west border of the Salar de Antofalla. It is possible to obtain basic lodging facilities or rent a house. There is a school with a new building. No transportation facilities. This is the western town in the region, therefore, is is also very important in terms of location. All the towns and cities mentioned can by reached by normal vehicles.

Figure 3. Antofagasta Townhall guest house.

Figure 4. Small catholic church in Antofalla village.

DEVELOPED ACTITIVITIES

EAST OF THE ANTOFALLA SALT FLAT

Starting from Belen (1267 m), the road starts to go up reaching ~4000 m and then descents moving on average at 3500m . There are several interesting plains and mountains. The track goes through the provincial road number 43 reaching Barranca Larga, El Peñón and finally Antofagasta de la Sierras (270 kms away from Belen). The first point to be mentioned is at 26º 44' 37" S 67º 06' 17" after crossing the Sierra de la Laguna Blanca where it is possible to see a large valley to the north and west.

Figure 5. Dr.M.Sarazin & Dr. D.Garcia Lambas and a great flat toward the North-West.

One of the most interesting places is called Pasto Ventura, consisting in a very big plain open to the west (see figure 6, taken from 26º 40' 38 S 67º 13' 01 W, at 4003 m). In this plain there are some mountains. Probably the most interesting is one close to the onyx mine El Quirquincho. It is at approximately one hour from road 43 and can be easily reach thought the old path to the mine . The old mine can be used as a shelter or base camp. The crossroads is at 26º 41' 56.5" S 67º 10' 48.8" at 3782 m. The top of this mountain is between 4500 and 5000 m and probably it can be reached by 4WD vehicles.

Figure 5.

Another interesting valley is close to El Peñón at 26º 35’ 15” S 67º 14’ 32” (3900 m, see Figure 5). North to El Peñón there is another plain that goes at lower altitude (~3000 m) and finally the city of Antofagasta de la Sierras is reached (270 km away from Belen).

Figure 6.

The same road continues to the north, nevertheless this is not traveled very often and therefore it is not as good as the stretch Belen-Antofagasta de la Sierras. The track goes directly to the north and reaches 4100 m at 25º 50’ 18” S 67º 18’ 19” W (see Figure 7 showing a view to the E-NE including the Concha Argolla range or Cordon Real range). The maximum altitude of 4450 m is reached at Falda Ciénaga 25º 37’ 06” S 67º 13’ 50” W. This place gives the possibility to easily reach high altitudes, see for instance close mountains to the east with tops around 5000 m (figure 8). After this point the road starts to descent to the Hombre Muerto Salt Flat (SHM, see figure 9), 96 km away from Antofagasta de la Sierras. Around the SHM there are several mountains that can be particularly interesting. From the SHM it is possible to see two of the points selected by A. Erasmus. Picture 8 shows sites Erasmus 3 and 4 respectively. Close to SHM is the very small village of Incahuasi that has a small elementary school. Also close to the salt flat is an active mine of lithium operates by Minera del Altiplano, FMC. This mine includes a daily flight to the City of Salta and operates a meteorological whether station. For more information the person to be contacted is Daniel Chaves Dias, Ejercito del Norte 20, Salta, tel. +54-387-4322100.

Figure 7.

Figure 8.

Figure 9. Hombre Muerto Salt Flat and Erasmus 3 site.

Figure 10. Hombre Muerto Salt Flat and Erasmus 4 site.

Starting from Antofagasta de la Sierras it is possible to explore the region between road 43 and the Salar de Antofalla. The most interesting points are located close to the salt flat and can be reached by different roads. The orography corresponds to a chain of mountains that goes parallel to the Antofalla Salt Flat (nearly south-north) reaching altitudes of more than 5000 m. Some of this points have mountains of similar or higher altitudes close to the opposite border of the salt flat. Nevertheless, there are places with an open west. In any case, it should be taken into account that the particular orography of the Salar de Antofalla can induces winds along the salt flat (it has more than 100 km long) that can interact with the typical wind of the region coming from the west and introducing the risk of turbulence.

i) The northernmost point is at 27º 35’ 21” S 67º 24’ 30” W at 4500 m. This site is reached through Caro Lagoon (crossroads at 29º 39’ 33” S 67º 14’ 01” W) and does not show an open view to the west.

ii) The following point to the south corresponds to the track to Antofalla through Los Colorados. The highest point (Alto del Colorado that corresponds to Sierra del Calalaste) is at 25º 40’ 43” S 67º 31’ 09” W and has an altitude of 4660 m and presents nearby summits of more than 5000 m that can be easily reached by 4WD vehicles (see figure 11).

Figure 11. Eng.P.Recabarren, Dr.M.Sarazin, Dr.H.Muriel & Dr.D.Garcia Lambas on the Los Colorados high flat.

iii) Continuing to the south, the third point, and probably the most interesting, corresponds to another road to Antofalla call Quebrada del Diablo. The advantage of this point stems from an open west in comparison to the other points . There are at least one top with an altitude of approximately 4800 m that should be easily reached by 4WD vehicles from 25º 52’ 36” S 67º 43’ 13” W (60 km away from Antofagasta de la Sierras).

iv) The southerner point 26º 18’ 55.5” S 67º 55’ 56.3” W at 4070 m is close to el Salar de la Mina.

Finally, there are other places east to the Antofalla Salt Flat that should be mentioned: i) A big plain very close to Antofagasta de la Sierras (~ 20 km) in the road to Sierra del Calalaste. Nevertheless, this region is surrounded by mountains. ii) A chain of mountains east of Antofagasta de la Sierras that goes approximately south-north. This mountain presents problems of accessibility.

WEST OF THE ANTOFALLA SALT FLAT

Starting from Antofalla (25º 31’ 34” S 67º 36’ 44” W, 3398 m) the road goes up to the north-west. At km 16 there is a pass at 4173 m that is the beginning of a large valley dominated by the Antofalla Volcano (to the south, 6409 m) and Tebenquicho. Figure 12 shows part of this valley and the Tebenquicho.

Figure 12. Mount Tebenquicho.

This valley (figure 13 shows a view to the north that also includes part of the small range of mountains that ends the plain to the west) goes south-north and is growing to the north where ends in to the great Arizaro Salt Flat in the province of Salta, 50 km away from Antofalla (see Figure 14) . The Salar de Arizaro is longer than 60 km.

Figure 13.

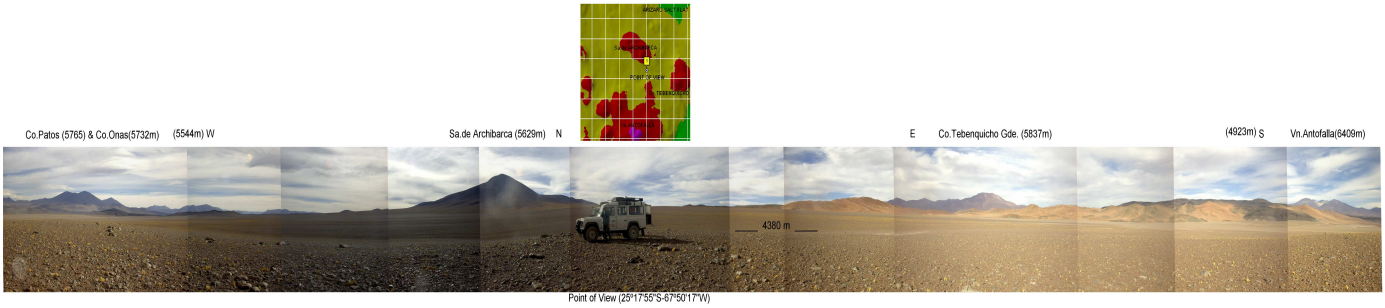
This report only analyzes the southern region of the Arizaro Salt Flat, the north of it was explored during the first recognition trip. Close to the SE border of the salt flat there is a very interesting soft shaped range with a flat top (see Figure 15). These mountain has several summits, and it was possible to reach three of the them (using a 4WD vehicle) from the south through the road to Antofallita (a very small village 9 km away close to Antofalla Salt Flat, that can be used as a base camp). The main summit can be reached by car from the west. The three visited summits have altitudes of 4256 m, 4315 m and 4474 m respectively. The main summit is around 4600 m . This region can also be visited from the north through Salta-San Antonio de los Cobres-Tolar Grande through the Arizaro Salt Flat road.

Figure 14. Arizaro Salt Flat.

Figure 15.

In the middle of the large valley described in previous paragraphs, there is a crossroads (36 km away from Antofalla village, 25º 18’ 20” S 67º 43’ 11” W). From this point, there is a road that goes to the west. 12 km away from the crossroads begins an interesting flat. Figure 16 shows from 25º 17’ 55” S 67º 50’ 17” W 4380 m a panoramic view of 360 degrees. The flat is limited to the north by the Archibarca range. The flat is called Archibarca Valley and continues to Mina la Casualidad located approximately 40 km away to the N-W. North-West of this valley is the interesting Sierra de Archibarca (Archibarca range) that offers multiple possibilities. By means of 4WD vehicles it was possible to reach the top of one of this mountains: 25º 13’ 19” S 67º 57’ 15” W 4580 m. Figure 16 shows this area of the Sierra de Archibarca from the south. This region is close to Archibarca, a place with water and a shelter that can be used as a elementary base camp. It is two hours away from Antofalla. The elevation map corresponding to the region around the south of the Salar de Arizaro and the area of Archibarca is presented in the same figure.

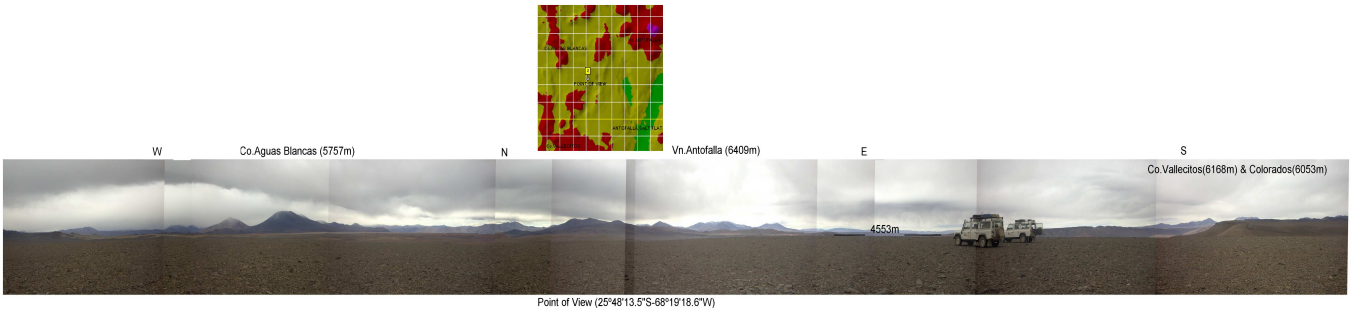
Figure 16. Panoramic 360 º view of the Archibarca plateau.



Aguas calientes is the western point visited during these expeditions. It is at least 5 hs away from Antofalla and does not offers a place suitable for astronomical facilities.

East-South of Aguas Calientes there is a plain at 4050 but still very inaccessible 25º 40’ 34” S 68º 19’ 13” W). South of this point there is another important high flat (25º 43’ 21” S 68º 18’ 53” W, 4200m) . In this plain we found a very interesting elevation (25º 48’ 13.5” S 68º 19’ 18.6” W, 4553m) with an open view that can clearly appreciated in the panoramic view shown in figure 17. The best way to access this area is coming from the south-east and it should be taken into account that this region is still difficult to access.

Figure 17.



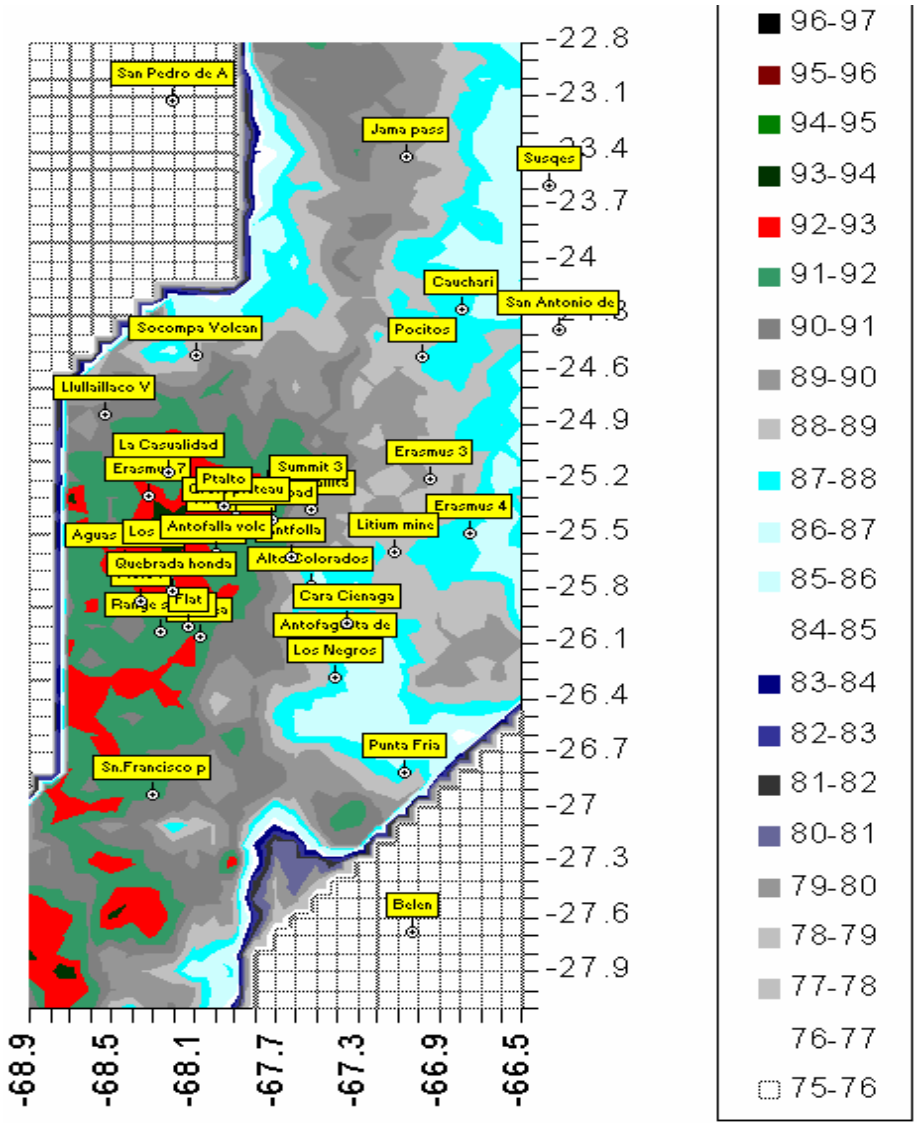
The east border of this plain corresponds to the mountain range of Sierra de la Quebrada Honda (SQH) that goes nearly south-north through more than 20 km . This range offers several interesting possibilities. It is possible to reach many of their tops either from the west or from the east (using 4WD vehicles). We reached one top at 25º 56’ 29” S 68º 15’ 34” W, 4539 m (figure 17 shows a N-NE view from this top). This region can be study using Quebrada Honda (a place with one or two houses) as a base camp. Nevertheless, presently the path is only a one way.

Figure 17. Quebrada Honda range summits.

East of SQH there is one of the larger high flat in the region. It is more than 30 km long and shows altitudes going from 4000 to 4500 m. This plain also offers very interesting possibilities. Close to the east border there are some elevations (close to 5000 m) that presents interesting conditions and good accessibility. This region is close to the west border of the Antofalla Salt Flat and is less than 20 km away from La Brea, a farm that includes a house, that can be used as a base camp. In La Brea there is a source of thermal fresh water.

Miscellany: Figure 18 shows a map of the cloud cover corresponding to three years of analysis of GOES images (Recabarren et al, 2002) superimposed to the way points of the most interesting points of the region explored in this report.

Figure 18. Clear sky distribution.



CONCLUSIONS

The reported area offers a large variety of places potentially suitable for astronomical facilities. There are several places between 4000 and 5000 m. Some of them are difficult to access and many others can be reached with moderate facility. The most interesting summits can by reached by 4WD vehicles.

Results from GOES images are very promising, nevertheless, there are no enough information about weather conditions, then, the installation of an authomatic weather station in the area is necessary.

It is important to develop a very good program of seeing measurements to detect areas not afected by turbulence.

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