

Introduction :

Between April 2004 and June 2007 a network of 40 geodetic benchmarks has been installed. This network is periodically surveyed (usually 15 days twice a year, april/may and november/december) during GPS campaigns. The goal of those measurements is to precisely determined and quantify the crustal deformation in this area, i.e. the accumulation of elastic deformation which will be released during a future earthquake. The curvature and intensity of the deformation gradient will tell us more about the characteristics of the subduction geometry (dip angle, locking depth, friction coefficient) on this segment of the subduction.

Interleaved with those markers we also installed cGPS (continuous permanent GPS) stations to monitor time variation of the deformation pattern. Should they exist, they would most probably be related to active processes on the subduction interface at depth (episodic or transient slip, tremor) and possibly give a clue to the understanding of earthquake nucleation.

This area between 30° and 32°S was chosen because it is the locus of an abnormal seismicity since at least 1997 and the Punitaqui earthquake. Early GPS measurements in the area also seemed to indicate a possible decoupling of the subducting interface, at least partially and/or locally near the Coquimbo peninsula (Tongoy).

Network descriptions

Campaigns are made with dual frequency Ashtech ZX-treme receivers, each site being measured 24 hours a day during 3 to 5 days. The precision obtained on site positions is around 1-3 mm on horizontal coordinates and slightly less on vertical coordinates. Therefore, horizontal velocities characterizing the crustal deformation pattern are determined with an accuracy of about 1-3 mm/yr. The network is designed with a regular spacing between markers (as much as possible) of about 20-30 km.

With the exception of the 2 southernmost stations equipped with Ashtech micro-Z receivers, all cGPS stations (11 on 06/07) are equipped with Trimble NetRS receivers (with their Zephyr antenna). The receivers are set to acquire data at two different sampling rates simultaneously:

- the classical 30s sampling rate, allowing the computation of a daily position precise within a few mm
- 1s (or 1Hz) sampling rate to allow kinematic positioning of a station during an earthquake

In all cases, data are stored locally in the receiver memory, and then automatically transmitted to the main data archive at DGF at Universidad de Chile, Santiago, when possible. Some sites in remote areas are in standalone mode and need an occasional manual data download. Then, data are transmitted and processed at different processing centers, including ENS and IPGP (GPScope).

Network 1: Geodetic markers

code	Name	latitude (°)	longitude (°)	Latitude S.			longitude			altitude	marker type
		deg	deg	°	'	"	°	'	"	m	
AGUA	Agua Chica	-30,9824307	70,8066310	30	58	56,8	70	48	23,9	1359,182	Delmont
ANDA	Andacollo	-30,2776646	71,0699701	30	16	39,6	71	4	11,9	1238,341	Delmont
BSJL	BSJL aux	-30,6869688	71,3379923	30	41	13,1	71	20	16,8	281,024	tripod
CENT	Centinella	-30,9617727	71,2071901	30	57	42,4	71	12	25,9	647,185	Delmont
CHAN	Chanaral	-30,8974887	71,0279726	30	53	51,0	71	1	40,7	659,909	Delmont
CHAP	Chapilca	-29,8529127	70,4998717	29	51	10,5	70	29	59,5	1104,909	GEODYSSEA
CHIN	LasChinchilas	-31,4880611	71,1219901	31	29	17,0	71	7	19,2	673,836	Delmont
CHIP	Chipel	-31,1146035	71,2136320	31	6	52,6	71	12	49,1	875,555	Delmont
CMOR	Cerro Morales	-30,2053993	70,7963033	30	12	19,4	70	47	46,7	2175,099	GEODYSSEA
CNFL	Puente Confluencia	-31,6723687	71,2887886	31	40	20,5	71	17	19,6	243,2192	Delmont
COGO	Cogoti	-31,1534254	70,9752569	31	9	12,3	70	58	30,9	1186,119	tripod
CTAL	Caleta Talca	-30,9292637	71,6704320	30	55	45,3	71	40	13,6	41,193	GEODYSSEA (1)
EALM	El Almendro	-31,4132495	71,4303072	31	24	47,7	71	25	49,1	449,715	Delmont
EMAN	El Mansano	-30,1748785	71,1847940	30	10	29,6	71	11	5,3	324,588	Delmont
EMAT	Caletta El Maiten	-31,1466763	71,6626623	31	8	48,0	71	39	45,6	46,380	GEODYSSEA
ESAU	Caletta El Sauce	-30,5111367	71,6835850	30	30	40,1	71	41	0,9	70,222	GEODYSSEA
ESPI	Espirito Santo	-31,2201423	71,4549298	31	13	12,5	71	27	17,7	642,163	Delmont
FUND	Fundina	-30,3829717	70,8507787	30	22	58,7	70	51	2,8	816,159	GEODYSSEA
HERA	Herradura	-29,9981891	71,3794713	29	59	53,5	71	22	46,1	178,114	GEODYSSEA
LCAN	Los Canelos	-30,7889430	71,4404031	30	47	20,2	71	26	25,5	287,278	Delmont
LISL	La Isla	-31,0608564	71,0109512	31	3	39,1	71	0	39,4	829,198	GEODYSSEA
LMOL	Los Molles	-30,7420123	70,4577319	30	44	31,2	70	27	27,8	2274,719	GEODYSSEA
LPER	Las Perdices	-30,3646028	71,2506801	30	21	52,6	71	15	2,4	594,456	Delmont
MPAT	Monte Patria	-30,7023990	71,0130776	30	42	8,6	71	0	47,1	478,957	Delmont
NIPA	La Nipa	-30,4687790	71,4661107	30	28	7,6	71	27	58,0	329,490	Delmont
OVEJ	Puente Oveja 2	-31,2928575	71,1936564	31	17	34,3	71	11	37,2	721,314	Delmont
PACH	Pachingo	-30,4571100	71,5948600	30	27	25,6	71	35	41,5	218,000	Delmont
PIDN	Piden	-30,8146317	71,2137919	30	48	52,7	71	12	49,7	534,915	Delmont
POBR	Cerrillo Pobre	-30,5910222	71,5037244	30	35	27,7	71	30	13,4	325,585	tripod
PTOM	Caletta Puerto Manso	-31,5321227	71,5722644	31	31	55,6	71	34	20,2	32,448	tripod (2)
SGER	San Geronimo	-29,8924278	70,9133120	29	53	32,7	70	54	47,9	601,2745	Delmont
SPED	San Pedro	-31,0152434	71,3938103	31	0	54,9	71	23	37,7	363,979	Delmont (3)
TAHU	Tahuinco	-30,4767920	71,0422867	30	28	36,5	71	2	32,2	533,041	Delmont

TONG	Tongoy	-30,2494515	71,5023295	30	14	58,0	71	30	8,4	60,496	GEODYSSEA
VARI	Varillar	-30,7414826	70,7498080	30	44	29,3	70	44	59,3	1004,376	Delmont
OVL1	Ovalle Aux1	-30,59454696	71,17238056	30	35	40,4	71	10	20,6	263,817	tripod
BSJ1	BSJL aux	-30,68700496	71,33799259	30	41	13,2	71	20	16,8	281,036	tripod

(1) cap sealed. Need broken marker adaptor

(2) broken GEODYSSEA marker. Only hole remains

(3) slightly damaged thread. Need broken marker adaptor

Network 2: cGPS stations

code	Name	latitude (°)	longitude (°)	Latitude S.			longitude			altitude	marker type
		deg	deg	°	'	"	°	'	"	m	
BTON	Tongoy	-30,2632247	71,4872048	30	15	47,6	71	29	13,9	39,000	permanent
CMBA	Combarbala										permanent
CNBA	Canela Baja	-31,3982223	71,4579590	31	23	53,6	71	27	28,7	316,000	permanent
EMAT	Caletta El Maiten	-31,1466756	71,6626612	31	8	48,0	71	39	45,6	46,380	permanent
LSCH	La Serena	-29,9081920	71,2460391	29	54	29,5	71	14	45,7	77,000	permanent
LVIL	LosVilos	-31,9092399	71,5138463	31	54	33,3	71	30	49,8	29,302	permanent
OVL1	Ovalle	-30,6037465	71,2038965	30	36	13,5	71	12	14,0	248,758	permanent
PEDR	Pedregal	-30,8389697	70,6891289	30	50	20,3	70	41	20,9	881,000	permanent
PFRJ	Parc Fray Jorge	-30,6747473	71,6354344	30	40	29,1	71	38	7,6	206,000	permanent
SLMC	Salamanca	-31,7770217	70,9627940	31	46	37,3	70	57	46,1	547,638	permanent
TOLO	El Tololo	-30,1698922	70,8060515	30	10	11,6	70	48	21,8	2229,656	permanent

Tongoy (bibliotheca)

operationnal since 16/11/2006.

Site Code : B T O N

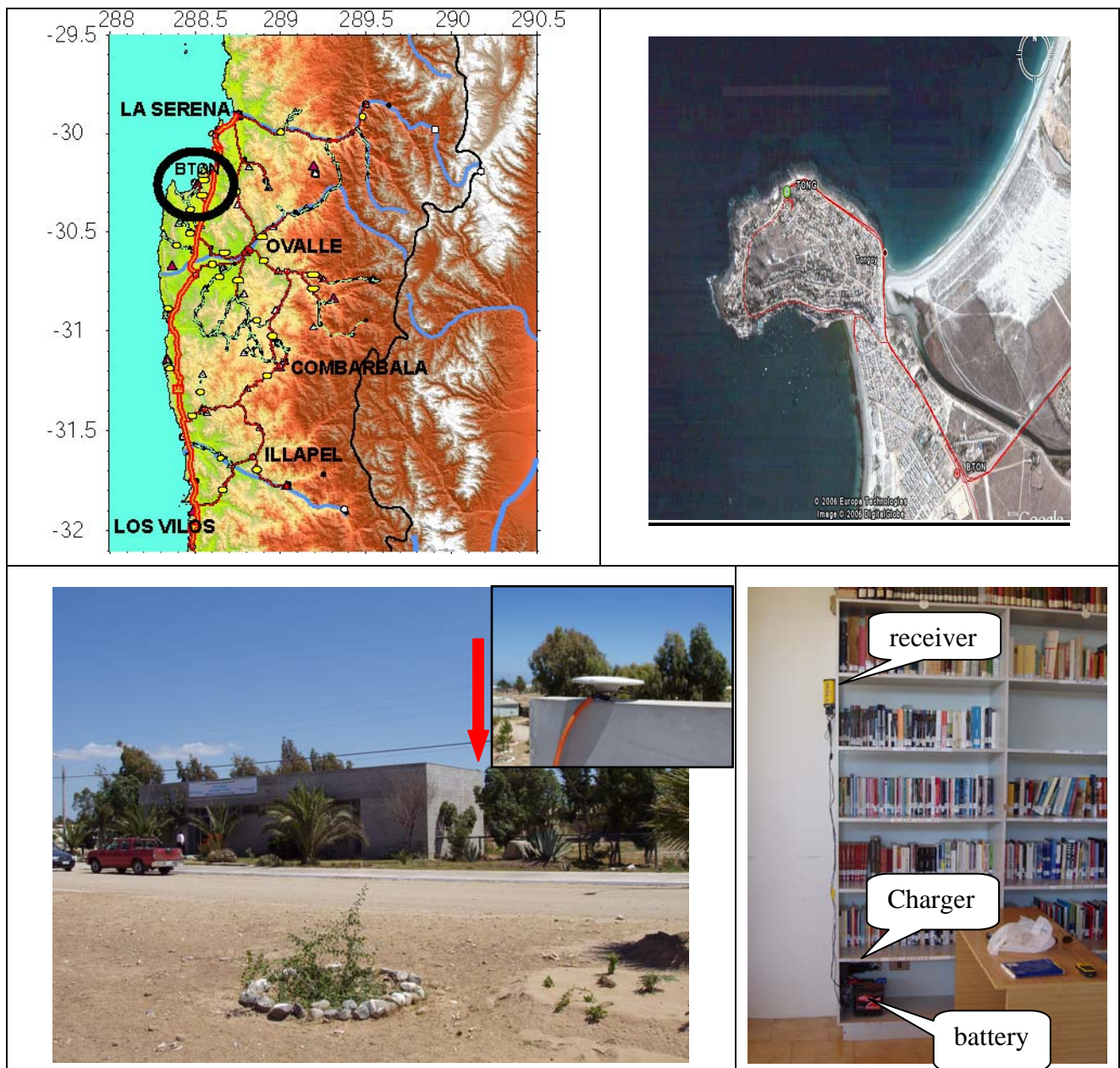
Coordinates : Lat. : S 30° 15' 47.6", Lon.:W 071° 29' 13.9", Alt. : 39 m.

Description : North Chili IV region, district of Limari, city of Tongoy, on top of the roof of the Biblioteca David Leon Tapia.

Monumentation : Brass 12 cm rod (Delmont type), scealed in concrete + Brass rotating adaptor, height 44 mm.

Alimentation : secteur 220v + batterie 12v Delphy Freedom 40A/h with Charger Mascot 5A. Antenna cable of 10m, small section.

Data transmission : using library internet access.



Combarbala (liceo agricola)

operationnal since since 08/05/2007

Site Code : C M B A

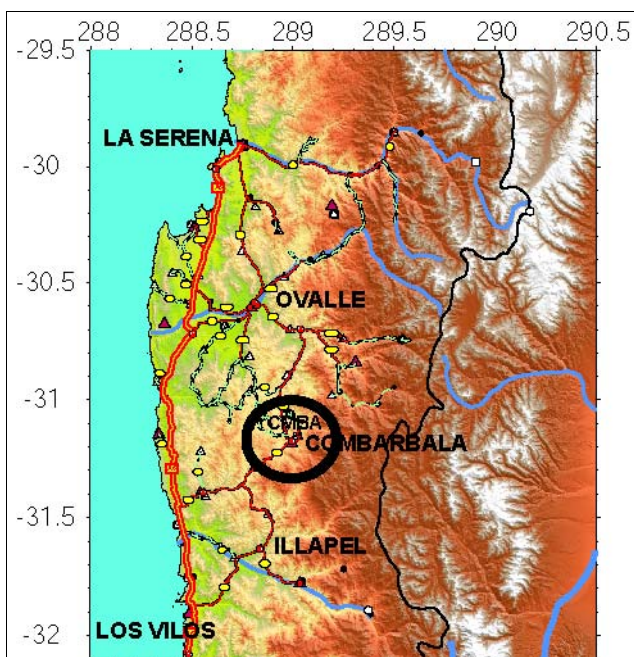
Coordinates : Lat. : S 30° 10' 33.10" Lon. : W 071° 00' 13.9" Alt. : 39 m

Description : North Chili IV region, district of Limari, city of Combarbala, in the field of agricol school 'Samuel Roman Rojas'.

Monumentation : Brass 12 cm rod (Delmont type), scealed in concrete pilar (3m deep) + Brass rotating adaptor, height 44 mm.

Alimentation : secteur 220v + batterie 12v Hankok 50Ah with Charger Mascot 5A. Antenna cable of 10m, small section.

Data transmission : none yet



Pillar and receiver shelter



System in meteo shelter

Canela Baja (municipalidad)

Operational since 21/11/2006

Site Code : C N B A

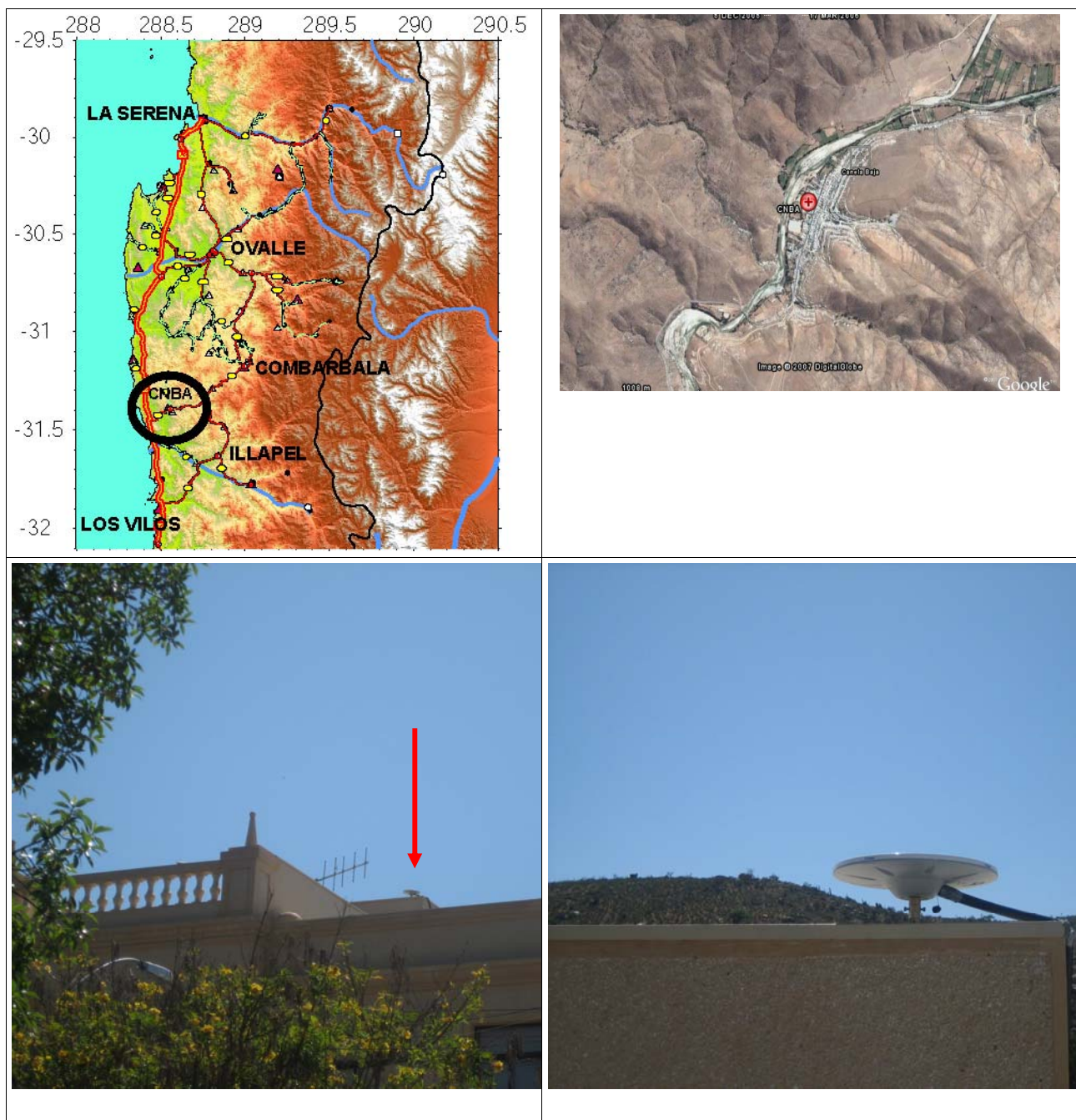
Coordinates : Lat. : S 31° 23' 53.65046", Lon. : W 071° 27' 28.70277", Alt.:316.181 m.

Description : North Chili IV region, district of Limari, city of Canela Baja. On the roof of the municipality.

Monumentation : Brass 12 cm rod (Delmont type) sealed in concrete + brass rotating adaptor , height 44 mm.

Alimentation : secteur 220v + batterie 12v Delphy Freedom 40A/h with Charger Mascot 5A. Antenna cable of 10m, small section.

Data transmission: with internet access of the municipality



Caletta El Maïten

operationnal since 08/05/2007.

Site Code : E M A T

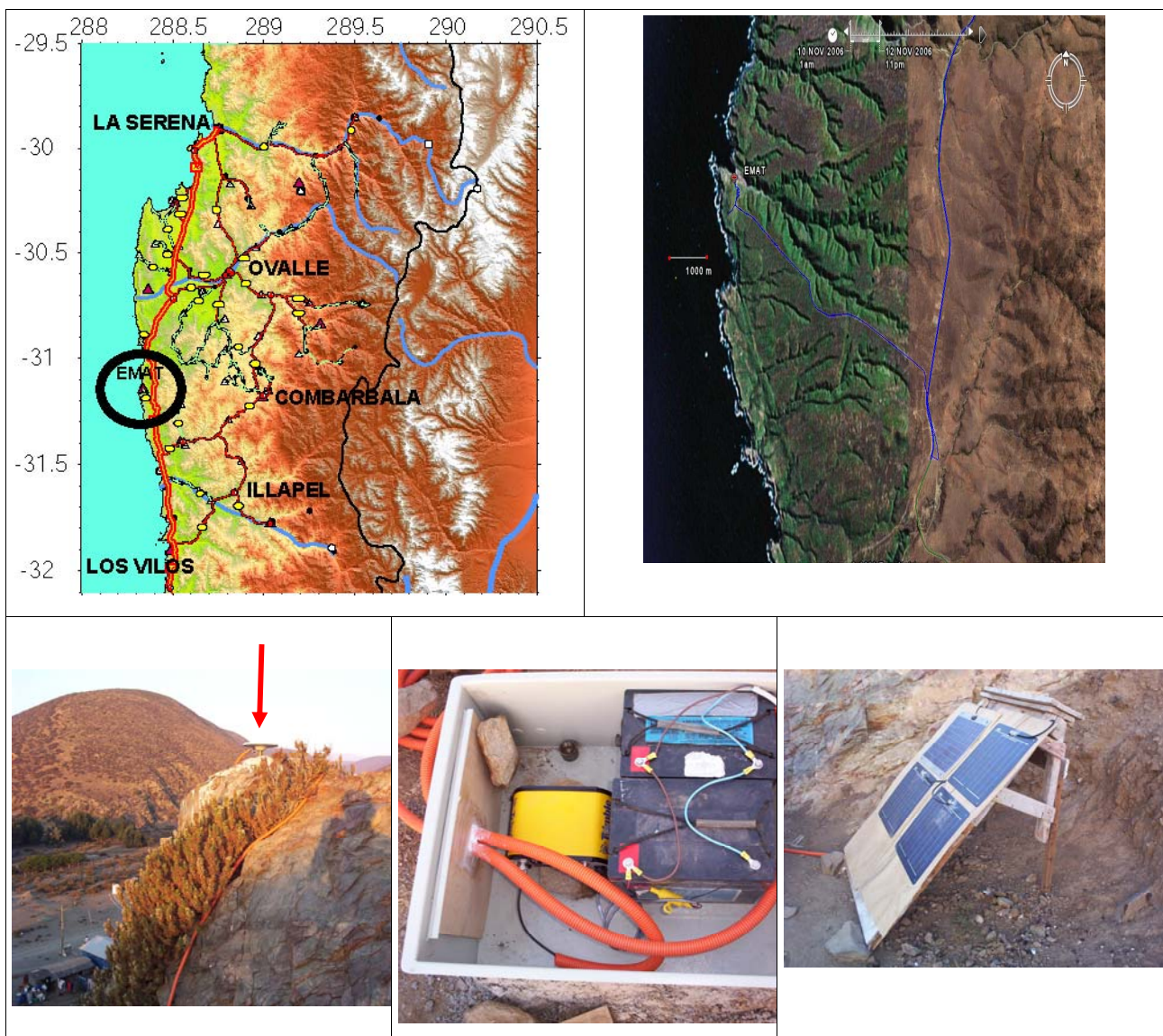
Coordinates : Lat. : S 31° 08' 48.6", Lon. : W 071° 39' 45.0", Alt.: 14 m.

Description : North Chili IV region, district of Limari, on the south side of Calleta el Maiten.

Monumentation : Geodyssea type marker, scealed in outcrop + rotating adaptator, height 28 mm.

Alimentation : 4 solar pannels 20w with 4 regulators 12v, 4.5A + 2 batteries 12v Gel Cellyte 100A/h. Antenna cable of 10m, small section.

Data transmission: none yet.



La Serena (universidad)

operationnal since 20/11/2006..

Site Code : L S C H

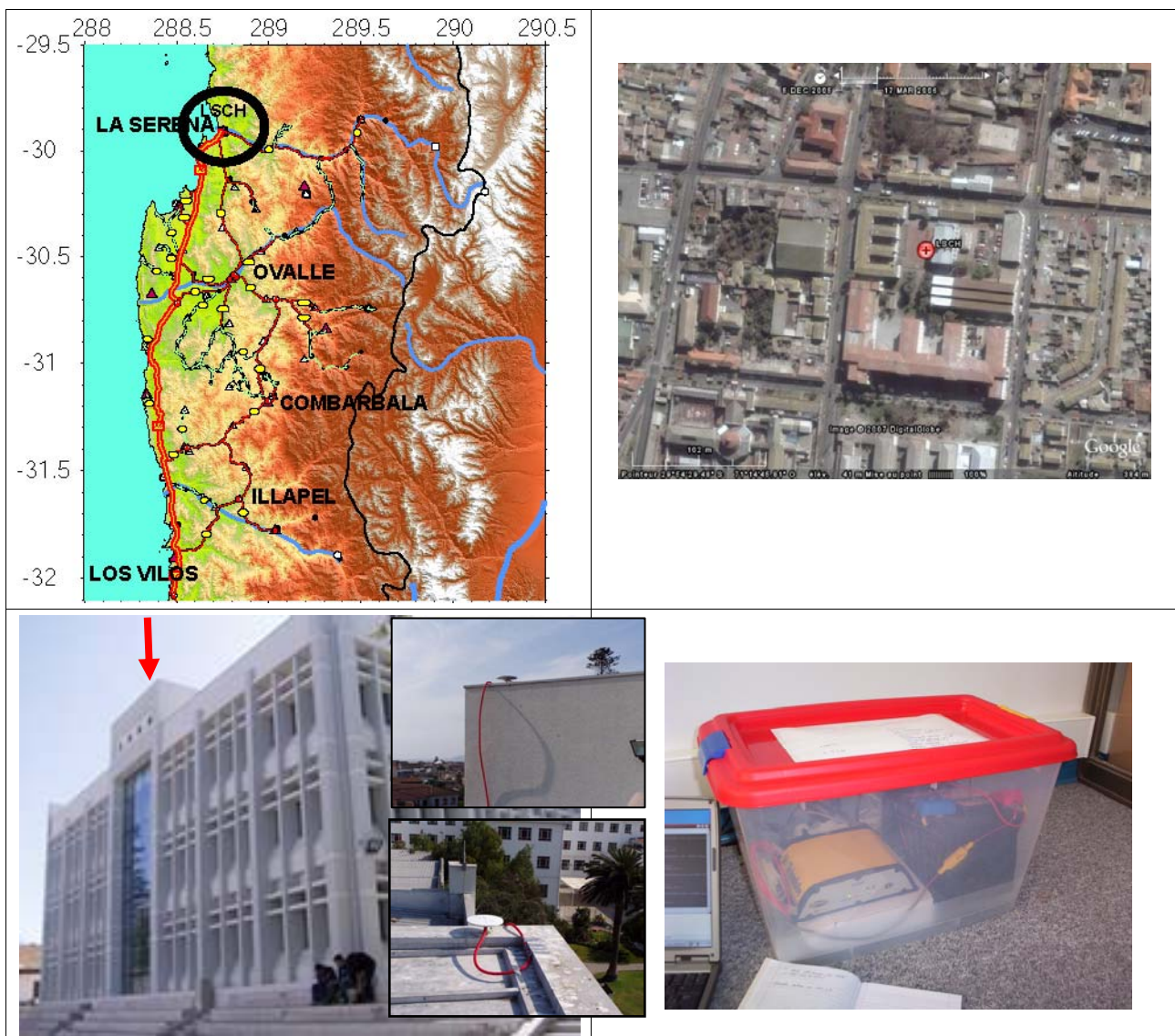
Coordinates : Lat. : S 29° 54' 29.52250", Lon. : W 071° 14' 45.78420", Alt.: 77.463 m

Description : North Chile IV region, district of Limari, University of la Serena. On the roof of CETECFI building (Moderno Centro Tecnológico para la facultad de ingeniera).

Monumentation : The station is on the roof of the CETECFI building of the University. Brass 12 cm rod (Delmont type) scealed in concrete + brass rotating adaptor, height 44 mm.

Alimentation : secteur 220v + batterie 12v Delphy Freedom 40A/h with Charger Mascot 5A. Antenna cable of 30m, big section.

Data transmission : with internet access of the university



Ovalle (Municipalidad)

operationnal since 26/04/2004 (updated with NetRs 30/04/2007)

Site Code : O V L L

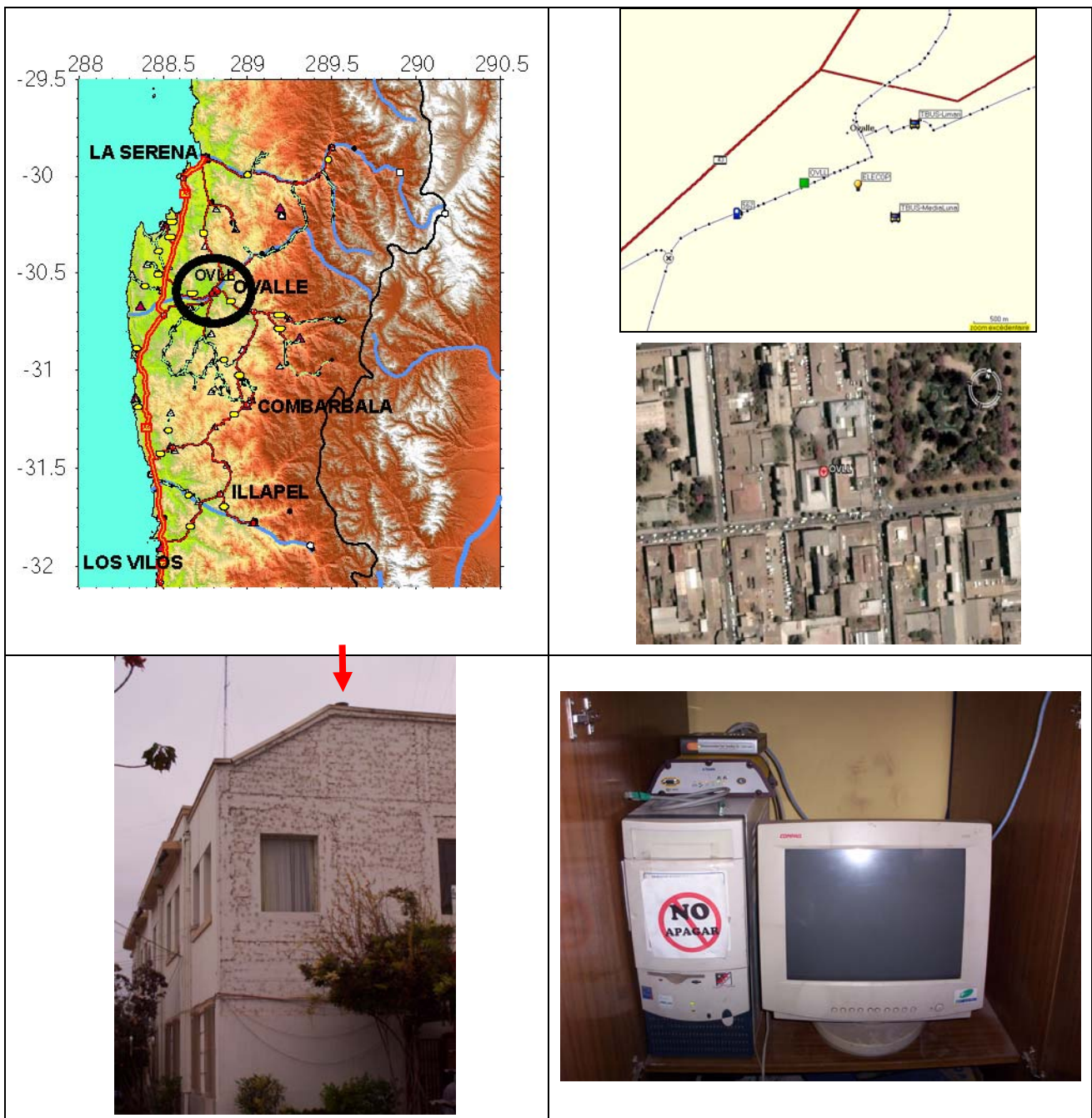
Coordinates : Lat. : S 30° 36' 13.51", Lon. : W 071° 12' 14.00", Alt. : 248 m.

Description : North Chili IV region, district of Limari, city of Ovalle, on the roof of the municipality.

Monumentation : Geodyssea marker type, sealed in concrete pillar + rotating adaptor, height 28 mm.

Alimentation : secteur 220v + batterie 12v Hankok 50A/h with Charger Mascot 5A. Antenna cable of 10m, small section.

Data transmission : with internet access of the municipality.



Pedregal (hacienda)

operationnal since 21/11/2006

Site Code : P E D R

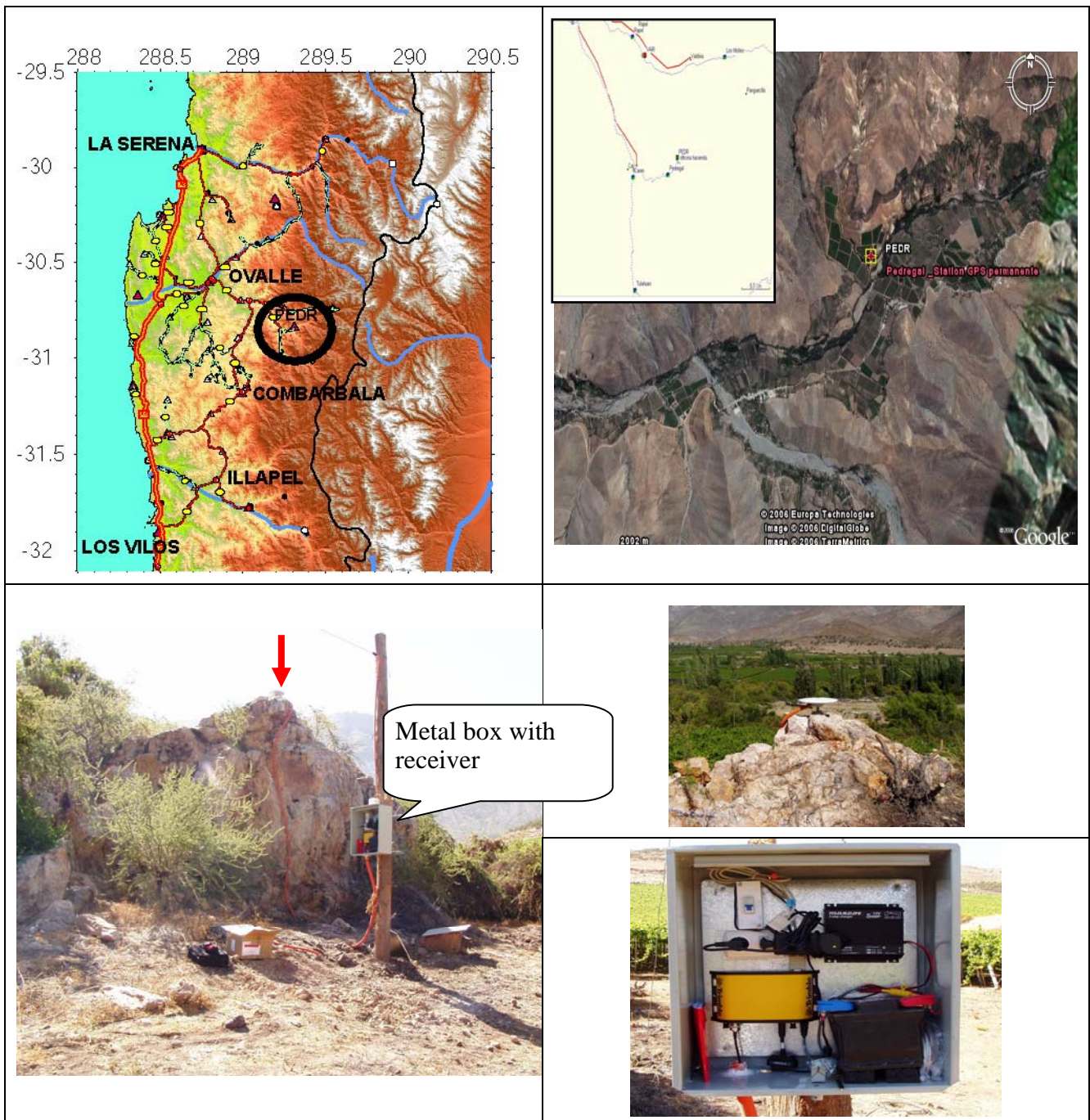
Coordinates : Lat. : S 30° 50' 20.4", Lon. : W 070° 41' 20.9", Alt. : 938 m.

Description : North Chili IV region, district of Limari, city of Pedregal, Hacienda Ivan Varilla Barros.

Monumentation : Outcrop near the water reservoir of the Hacienda. Brass 12 cm rod (Delmont type) scealed in bed rock (sandstone?) + Brass rotating adaptor, height 44 mm.

Alimentation : secteur 220v (2A fuse) + batterie 12v Delphy Freedom 40A/h with Charger Mascot 5A. Antenna cable of 10m, small section.

Data transmission : none yet.



Parc Fray Jorge (CONAF station)

operationnal since 18/11/2006

Site Code : P F R J

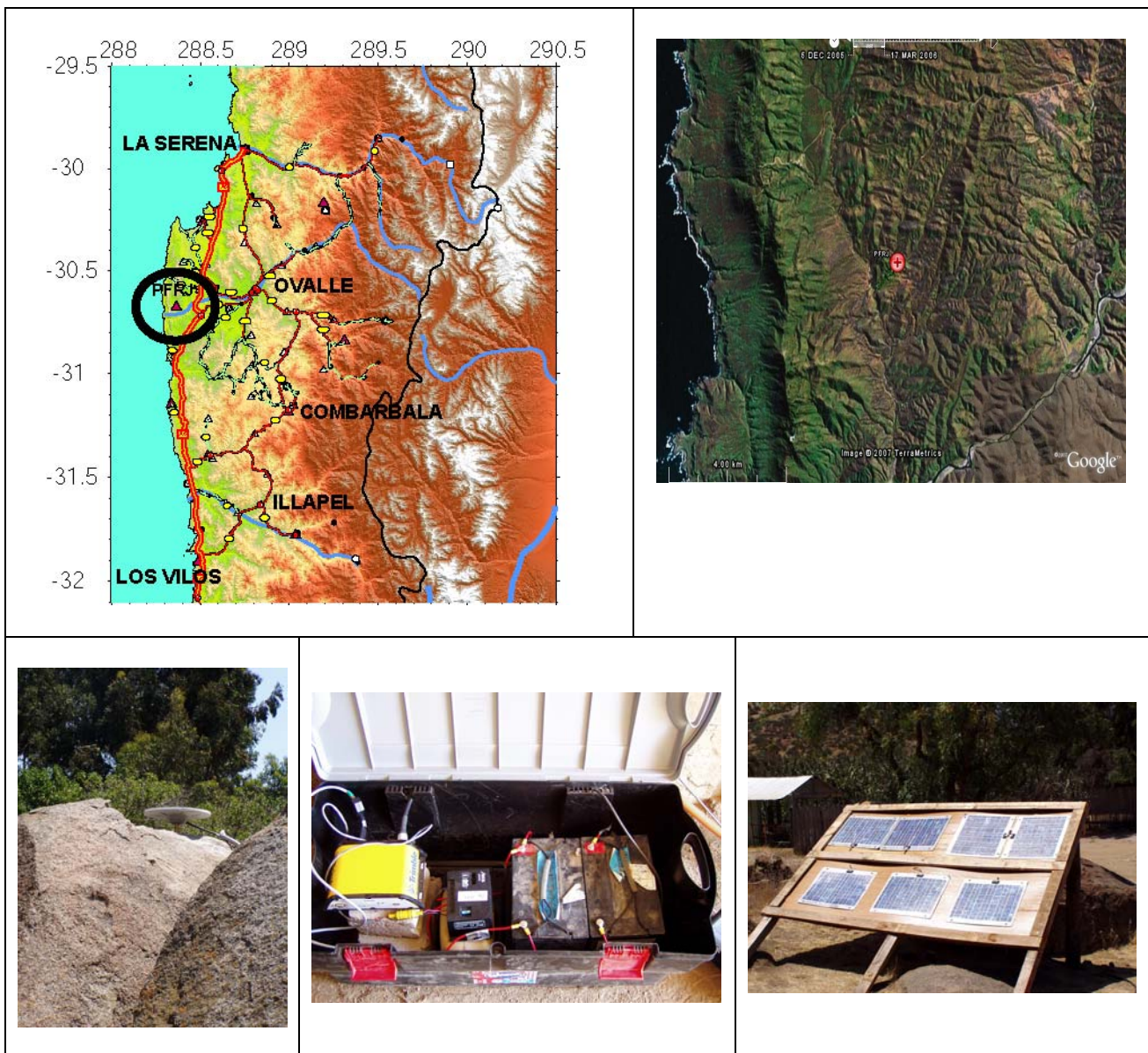
Coordinates : Lat. : S 30° 40' 29.11183", Lon. : W 071° 38' 07.60632", Alt.: 206.628 m.

Description : North Chili IV region, district of Limari, national park Fray Jorge (open 9-16h30), outcrop near the administration house.

Monumentation : Brass 12 cm rod (Delmont type) scealed in outcrop + brass rotating adaptor, height 44 mm.

Alimentation : 6 solar pannels 20w with a regulator + 2 batteries 12v Gel Cellyte 100A/h. Antenna cable of 30m, big section.

Data transmission : none yet.



El Tololo (observatorio astronomico)

operationnal since 21/11/2006

Site Code : T O L O

Coordinates : Lat. : S 30° 10' 11.73", Lon. : W 070° 48' 21.75", Alt.: 2228 m.

Description : North Chili IV region, district of Limari, area de Vicuna. On the roof of the Observatory of Cerro Tololo.

Monumentation : Geodyssea marker type, sealed in concrete pilar + rotating adaptor, height 28 mm.

Alimentation : secteur 220v + batterie 12v Delphy Freedom 40A/h with Charger Lian Long 12v. Antenna cable of 10m, small section.

Data transmission : with internet access of the Observatory.

