

f. DE MONTESSUS DE BALLORE

1906 • 2006

**International Conference Montessus de Ballore 2006
Valparaíso Earthquake Centennial**

SANTIAGO 6th to 8th NOVEMBER 2006

Anniversary of the 1906 Valparaíso Earthquake and
the Development of the Chilean Seismic Network
created by Fernand Montessus de Ballore

100 F. DE MONTESSUS DE BALLORE

www.dgf.uchile.cl/montessus/

Department of Geophysics, University of Chile • Blanco Encalada 2002, Santiago, Chile

Introduction and welcoming

Dear Colleague,

On behalf of the whole organizing committee, I would like to welcome all participants to the Conference celebrating the centennial of the 1906 Valparaíso earthquake and the contribution of Fernand Montessus de Ballore to the Chilean Seismology.

It was decided to launch this conference more than 2 years ago, before the Sumatra-Andaman catastrophe, of December 2004. This dramatic event shows us that earthquakes are still unpredictable and that their human impact can be incredibly large. The whole geophysical community realized that it is necessary to better understand such earthquakes in order to mitigate casualties. Chileans are particularly sensitive to earthquakes, since the biggest ever recorded event occurred here in 1960. The awareness of the problem is not new since, in 1906, the same sudden awareness induced the start of Seismology as a scientific field.

Three very large earthquakes took place in the Americas in 1906, the first one, on 31 January in the Colombia-Ecuador region, the second on 18 April in San Francisco, California, and the third, on 16 August in Valparaíso, Chile. In all three cases, earthquakes resulted into the massive destruction of cities and large number of casualties. Chile, one of the most seismic countries in the world, decided to install a seismic network which is operating since that time. Its implementation and the associated investigations were entrusted to Fernand Montessus de Ballore, a French seismologist. Since these pioneering times, Chile has developed a strong scientific tradition in Seismology and a close relationship with France and Europe.

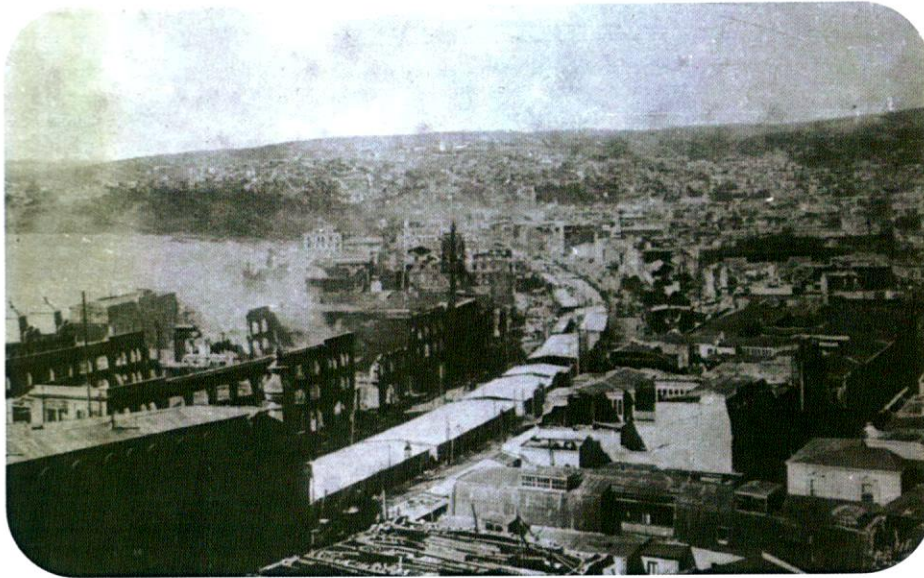
During the last century, seismic source investigations have revealed much of the intimacy of earthquakes, still escaping though an accurate prediction. This conference will be devoted to the state-of-the art in different aspects of Earthquake Seismology. The investigation of earthquakes needs by itself a multidisciplinary approach. That is the reason why this conference is also open to tectonics, geodesy and more generally to all geological fields. Some of the best specialists in the world will contribute to this conference, allowing an overview of the knowledge of seismic source mechanics and subduction process. Naturally there will be not only general sessions on seismic sources but also some focus on the Chilean subduction zone and the associated seismic risks. This conference is also the opportunity to reinforce the links between Chilean scientists and scientists from all over the world. And it is the opportunity to celebrate the creation of a joint laboratory between University of Chile and CNRS.

Finally, I would like to thank all sponsors in Chile and France which makes this conference possible, CONICYT, CNRS, Univ. de Chile, Núcleo Científico Milenio, MESR, MAE, Centre Culturel Français, IRD, IPGP.

On behalf of the whole organizing committee, I expect that you will enjoy this conference taking place in the wonderful city of Santiago as well as the field trip at the end of the conference.

Jean-Paul Montagner
Chairman of the Conference

Centennial of the Valparaíso 1906 earthquake



Valparaíso 1906 earthquake: view of the port

San Francisco, California and Valparaíso, Chile, both harbor cities facing the Pacific Ocean, commemorate this year the centennial of their destruction due to two large magnitude earthquakes. The strong surpassing spirit of their inhabitants also deserves a special mention because they rebuilt their cities in a record time of three years.

1906 is a very particular year for the world seismology; there has been no other year in which three large magnitude earthquake have struck the Earth within such a time span. In fact, during 1906 three earthquakes took place along the Pacific Coast of the American continent. The first, in Tumaco on January 31, affected the coast of Ecuador-Colombia, the second of April 18, 1906 destroyed San Francisco, California and the third one in Valparaíso, took place on August 16, 1906.

The first one generated a tsunami, which drowned most of the 400 casualties. The other two have the sorrowful privilege to have destroyed the corresponding cities by shaking and their following devastating fires. The largest number of casualties, among these three earthquakes, is the Valparaíso one with 3764 victims, San Francisco had only 500.

After the 1906 San Francisco earthquake, the 1908 Lawson report had a strong impact on earth sciences, including the proposal of the first earthquake theory: Reid's elastic rebound. As consequence of this earthquake the Seismological Society of America was founded the same year.

On 18 April at 5:12 a.m., San Francisco commemorated the centennial anniversary of the earthquake and fire, with a citizen gathering in Market Street. The commemoration continued with the largest Conference ever held among seismologists, earthquake engineers, risk managers and other experts from different disciplines with more than 4000 participants from 64 countries.

The history of Valparaíso records earthquakes of large magnitude in 1647, 1730, 1822, 1906 and 1985. From this earthquake family of large earthquakes, one of the most destructive is 1906 one, which devastated El Almendral neighborhood, the most wealthy and commercial area of Valparaíso. The destruction of Valparaíso was due to site effects -sandy soils- and claimed land. Most houses placed in rocky hills did not show significant damage.

Valparaíso also commemorated the centennial of 1906 quake on August with a citizen gathering led by the city major on August 16 at 19.55 p.m. at Sotomayor Square, an earthquake exhibition at the Navy Museum and two seminars. In this regard, the International Conference Montessus de Ballore is the closing event of the 1906 Valparaíso Earthquake Centennial.

Montessus de Ballore's experience established "while the Valparaíso 1906 earthquake had intensity I, the Messina earthquake of December 28, 1908 and India June 12, 1897 had respectively intensities II and III. In other words the Chilean earthquake was rather moderated in the observed damage". [1]. This comment shows his astonishing capacity of observation of earthquakes around the world at beginning of XX century.



[1] Montessus de Ballore, F. "Historia Sísmica de los Andes Meridionales al Sur del Paralelo XVI. Quinta parte: El terremoto del 16 de Agosto de 1906", 1915. Page 10.



Creation of the LIA Montessus de Ballore

The International Associated Laboratory CNRS - University of Chile: A Scientific Chilean-French Program in Seismology Montessus de Ballore International Earthquake Research Centre

Comte Ferdinand de Montessus de Ballore, a French seismologist, was called by the Chilean government during Pedro Montt's presidency in 1908 after the tragedy of the great 1906 Valparaíso earthquake to establish the National Seismological Service. He not only established it, but also he initiated the Chilean-French collaboration in seismology that extends until present times.

The International Associated Laboratory (LIA), the last evidence of this scientific Chilean-French collaboration, is a four years Program in Earthquake Science under the sponsorship of the Centre Nationale de Recherche Scientifique (CNRS) of France and University of Chile. The major elements of this program, on which the LIA are based, consist of: (a) the Agence Nationale pour la Recherche (ANR) program that coordinates scientific programs of both Institut de Physique du Globe de Paris (IPGP) as well as Ecole Normale Supérieure de Paris (ENS), and (b) the Millennium Nucleus project in Seismotectonics and Seismic Hazard (ICM-MIDEPLAN) that coordinates a multidisciplinary scientific program of Departments of Geophysics, Geology and Civil Engineering of the University of Chile. The LIA is an effort of continuation of the Chilean-French collaboration towards the establishment of the Montessus de Ballore International Earthquake Research Centre (MB-IERC), a new structure that increases the contribution to the scientific knowledge ensuring at the same time the coordination and articulation of the national and international collaboration in this field. The LIA will promote and expand the possibilities of formation of new national experts as well as develop new opportunities to young researchers.

The main objective of LIA is to consolidate the major lines of research already in progress under the ANR and Millennium programs, among them, Seismotectonics, Seismic Hazard and Risk, Physics of the Seismic Source, Seismic Tomography, Crustal Deformation (seismic/aseismic), Tsunami Earthquakes, Near Field Seismology, main thrust and intermediate depth earthquakes, and Paleoseismology. During the next four years we also expect to create the basic elements for the establishment of a high level Chilean scientific structure for earth science studies.

As for the national level, two other major groups in Chile, at Universidad de Concepción and Universidad Católica del Norte in Antofagasta, will contribute and participate in this LIA and the MB-IERC.

Chile is one of the best natural environments in the world to observe, quantify, model and understand the tectonic deformation phenomena which result in a diversity of earthquake behavior: seismic, aseismic and transient processes. The exceptional conditions existing in Chile at this moment, in terms of the number of PhD's in seismology and a large number of students involved in postgraduate studies, make the creation of a new research structure such the LIA and MB-IERC a timely decision.

Organization Committee

Jean Paul Montagner	IPGP	jpmp@ipgp.jussieu.fr
Edgar Kausel	U. de Chile	ekausel@ddgf.uchile.cl
Jaime Campos	U. de Chile	jaime@ddgf.uchile.cl
Valérie Clouard	U. de Chile (secr.)	valerie@ddgf.uchile.cl
Jean Claude Ruegg	IPGP (secr.)	ruegg@ipgp.jussieu.fr
Armando Cisternas	EOST, Strasbourg	armando@eost.u-strasbg.fr
Rodolfo Saragoni	U. de Chile	rsaragon@ing.uchile.cl
Adriana Pérez Franco	U. de Chile	aperez@ddgf.uchile.cl
Sofía Rebolledo	U. de Chile	srebolle@ddgf.uchile.cl
Ramón Verdugo	U. de Chile	rverdugo@ing.uchile.cl
Denis Legrand	U. de Chile	denis@ddgf.uchile.cl
Sylvain Bonvalot	IRD/U. de Chile	bonvalot@ddgf.uchile.cl

The president of the Organization Committee is Jean Paul Montagner, the secretaries are Jean-Claude Ruegg and Valérie Clouard.

Scientific Committee

Barbara Romanowicz	(Univ. Berkeley)	barbara@seismo.berkeley.edu
Hiroo Kanamori	(CalTech)	hiroo@qps.caltech.edu
Domenico Giardini	(ETH Zurich)	giardini@seismo.ifg.ethz.ch
Cinna Lomnitz	(Univ de Mexico)	cinna@ollin.igeofcu.unam.mx
Hitoshi Kawakatsu	(ERI, Tokyo)	hitosi@eri.u-tokyo.ac.jp
Pascal Bernard	(IPGP)	bernard@ipgp.jussieu.fr
Sergio Barrientos	(CTBTO, Vienne)	sergio.barrientos@ctbto.org
Tony Montfret	(IRD, Nice)	montfret@geoazur.unice.fr
Aldo Zollo	(Univ. Napoli)	aldo@na.infn.it
Jean Pierre Vilotte	(IPGP)	vilotte@ipgp.jussieu.fr
Jesus Berrocal	(Univ. Sao Paulo)	berrocal@iaq.usp.br
Raul Madariaga	(ENS, Paris)	madariag@geologie.ens.fr
Rolando Armijo	(IPGP)	armijo@ipgp.jussieu.fr
Shri Krishna Singh	(Univ. de Mexico)	krishna@ollin.igeofcu.unam.mx
Agustin Udias	(Univ de Madrid)	audiasva@fis.ucm.es
Emile Okal	(North Western Univ.)	emile@earth.northwestern.edu

Ice-breaking: November 5th, 2006

On Sunday afternoon, an ice-breaking will take place at the Instituto Chileno-Francés de Cultura at 7 p.m. It will be the opportunity for the registrants to the Conference to meet each other around a cup of Chilean wine, after getting their badge.

Presentation of the LIA Montessus de Ballore: November 6th, 2006

At 5 p.m., in the Gorbea Auditorium, it will be proceed to the signature of the creation of the International Associated Laboratory (LIA) Montessus de Ballore. This seismological lab is the result of a convention between the French CNRS and the Department of Geophysics of the University of Chile.

It will be followed at 6 p.m. by a cocktail. It takes place in the basement (Zócalo) of the South Hall, in the main building of the Faculty.

Scientific "café": November 6th, 2006

On Monday night, a scientific café is organized at the "Café Torres" at 8 p.m. The subject is "Is Science able to forecast earthquakes?". It could be the opportunity to see how our job is understood by the general public, drinking a pisco sour or a coffee.

Geological Trip- Excursion: November 9th, 2006

On Thursday, after the Conference, two field trips are planned, one to the Cajón del Maipo and the other to Valparaíso. Participation fee for any of these field trips will depend on the number of participants.

Cajón del Maipo trip: The excursion will be centered on the morphology and the tectonics of the west-vergent front of the Andes at Santiago. The most frontal San Ramón Fault reaches the surface at the foot of Cerro San Ramón, across the eastern districts of Santiago. Some significant outcrops and Pleistocene scarps of variable size and along the fault trace will be visited, including a young scarp that may be associated with the last seismic rupture of the San Ramón Fault. The large-scale, west-vergent fold-thrust structure (parallel to the subduction zone) and its associated morphology will be discussed along with observations of the eastward down-flexed Coastal Range block, the uplifted Farellones Plateau and the deformed terraces in the Maipo valley. Sofia Rebolledo and Rolando Armijo will be your guides.

Valparaíso trip: The excursion will be centered on a conference at the Universidad Católica de Valparaíso.

Para la conmemoración del Centenario del terremoto de Valparaíso 1906, se designó una Comisión presidida por el Alcalde de Valparaíso, el Director de El Mercurio de Valparaíso, el Rector de la Universidad Católica de Valparaíso, el Director del Museo Naval y R. Saragoni. Se realizó una exposición en el museo naval sobre el terremoto, se editó un número especial de El Mercurio de Valparaíso, se hicieron 2 conferencias en Valparaíso y los bomberos y los barcos de la armada tocaron las sirenas a las 19:55 del 16 de agosto de 2006.

El acto final de esta conmemoración es una conferencia de clausura asociada con la Conferencia Internacional Montessus de Ballore, en Valparaíso en la sede de la Universidad Católica de Valparaíso el día 9 de noviembre a las 11 AM para público general.

A touristic visit of the city of Valparaíso can be added after.

Exposition Montessus de Ballore and history of seismology in Chile:

Before its presentation in Chilean college and French Universities, an exposition about Fernand de Montessus de Ballore and its relation to the initiation of seismological studies in Chile will be presented in the Hall of the Gorbea Auditorium during all the Conference.

Conference

is held in the auditorium Gorbea of the Faculty of Mathematic and Phisic Sciences
Monday 6th at 9 a.m. to Wednesday 8th at 5 p.m.

Auditorium Gorbea
3rd floor Facultad de Ciencias Físicas y Matemáticas
Beauchef 850, Santiago, Chile
Phone (Secretary DGF): (56-2) 978 45 62

Posters

They will be installed in the entrance hall of the auditorium.
The only poster session is Tuesday 7th at 5 p.m.

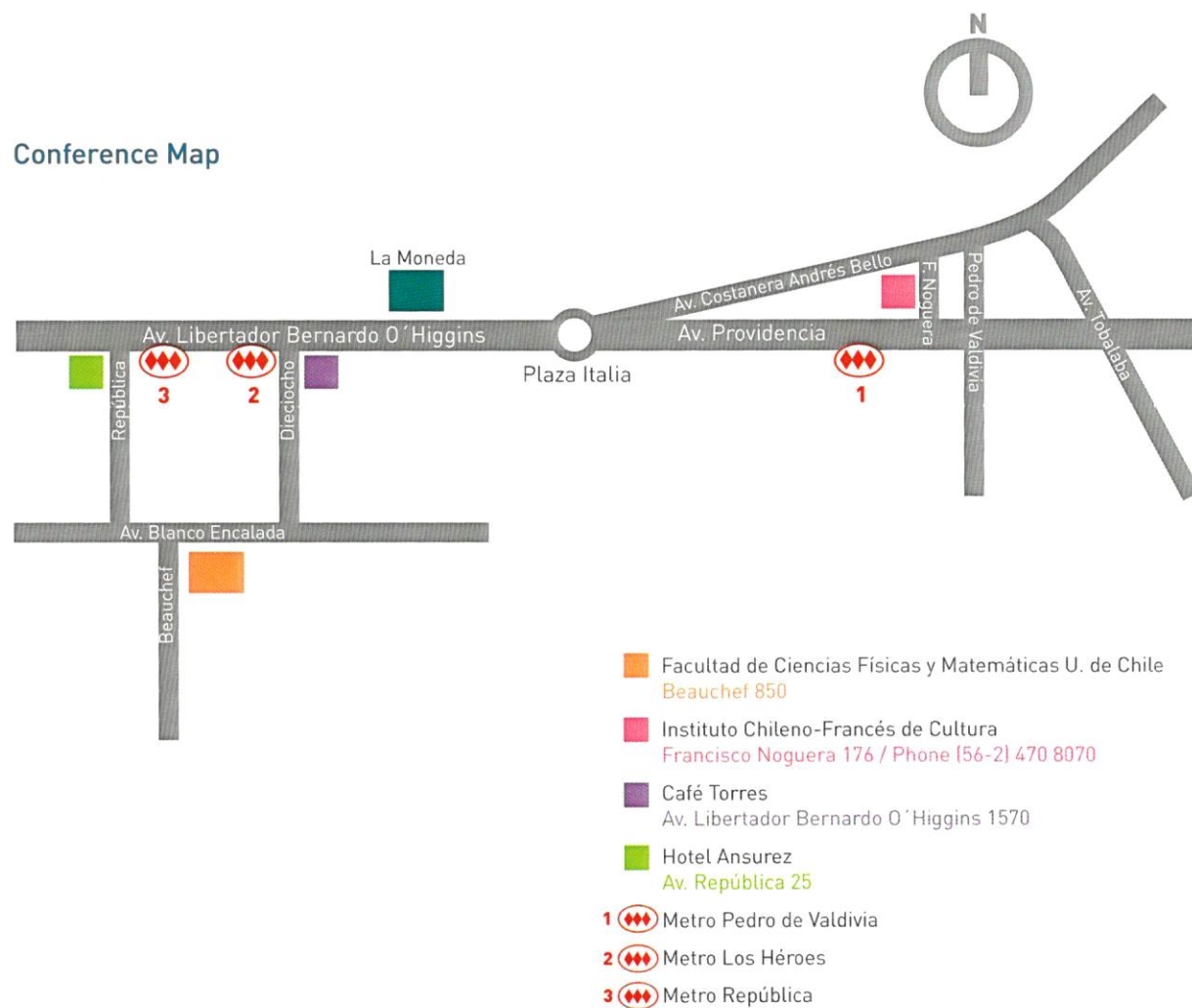
Internet

The auditorium is equipped with WiFi system.
A professor room is devoted to the participant of the Conference at the 1st floor of the Faculty.
You will find a PC connected to Internet and a color printer.

Coffee break

The morning, at 10h45, and the afternoon at 16h15.
Is proposed in the entrance hall of the auditorium.

Conference Map



Monday 6th

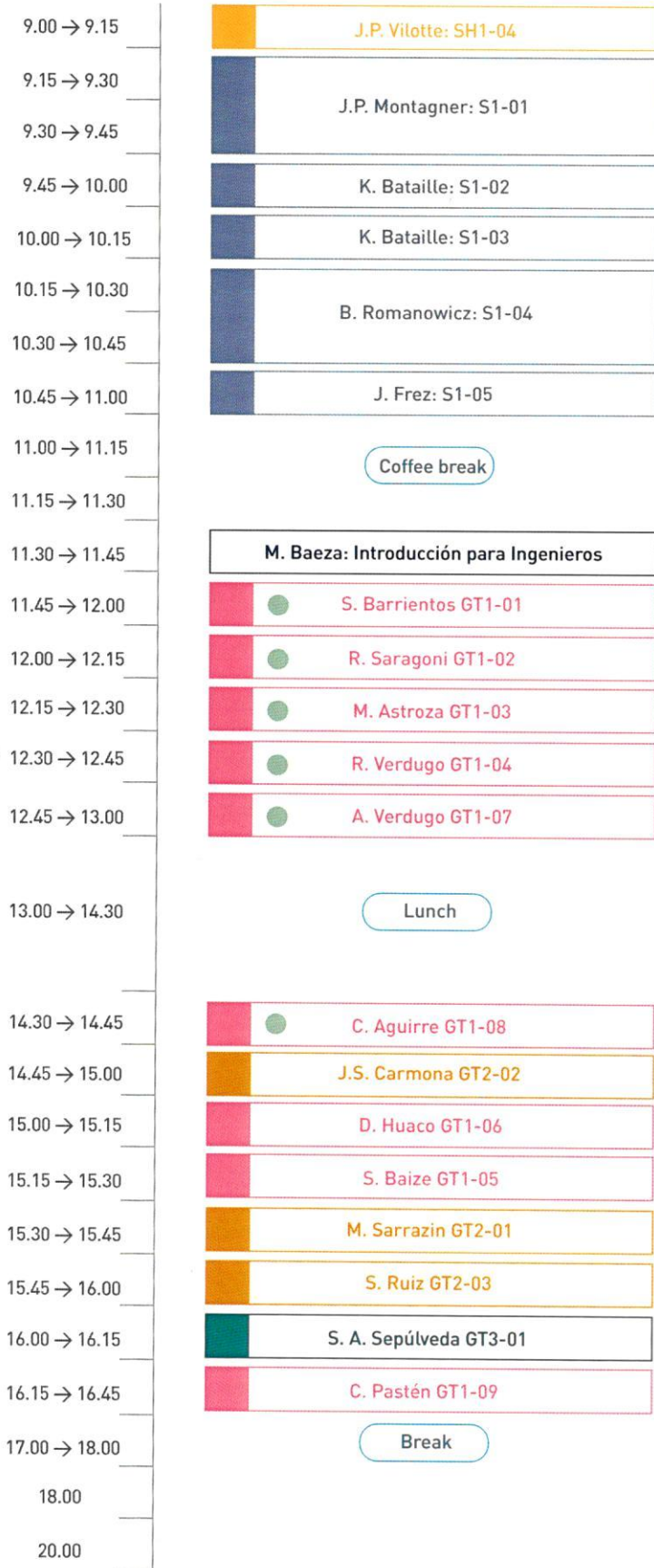
9.00 → 9.15	Opening Session
9.15 → 9.30	
9.30 → 9.45	
9.45 → 10.00	A. Cisternas: M. de Ballore
10.00 → 10.15	E. Okal: SH1-01
10.15 → 10.30	
10.30 → 10.45	Coffee break
10.45 → 11.00	
11.00 → 11.15	R. Madariaga: SH1-03
11.15 → 11.30	
11.30 → 11.45	P. Alvarado: ST1-07
11.45 → 12.00	
12.00 → 12.15	M. Pardo: ST1-01
12.15 → 12.30	T. Monfret: ST1-02
12.30 → 12.45	R. Armijo: ST1-03
12.45 → 13.00	M. Gerbault: ST1-04
13.00 → 14.30	Lunch
14.30 → 14.45	V. Clouard: ST1-05
14.45 → 15.00	A. Tassara: ST1-06
15.00 → 15.15	F. Leyton: S2-01
15.15 → 15.30	J.P. Vilotte: S2-03
15.30 → 15.45	
15.45 → 16.00	S. Peyrat: S2-02
16.00 → 16.15	B. Delouis: S2-04
16.15 → 16.45	Break
17.00 → 18.00	LIA: sign in U. Chile
18.00	Cocktail in U. Chile
20.00	Scientific café

Tuesday 7th

G. González: SH1-02
L. Audin: ST1-08
H. Tavera: ST1-09
G. Vargas: ST1-10
E. Okal: ST1-11
H. Kawakatsu: S3-01
Coffee break
M. Simons: GD1-01
J. B. De Chabalier: GD1-02
S. Bonvalot: GD1-03
J.C. Ruegg: GD1-04
C. Vigny: GD1-05
Lunch
Round Tables
Break
posters

Wednesday 8th

Thursday 9th



Field trip

- Historical Seismicity of Chile and the Valparaíso Earthquake (SH1)
- Importance of Montessus de Ballore in the Advancement of Seismology in Chile and in the World (SH2)
- General Seismological Contributions (S1)
- Seismotectonics in the Andean Subduction Environment (ST1)
- Site Effects and Geotechnical Engineering (GT1)
- Seismic Source Advances (S2)
- Geodesy and Transient Relaxation at the Source (GD1)
- Strong Ground Motion (GT2)
- Seismic Hazards in Subduction Environments (GT3)
- Seismic Structure and Sources (S3)
- The 1906 Valparaíso Earthquake: An Earthquake Engineering Retrospective 100 Years Later.

* E: Education S: Seismology
 GD: Geodesy SH: Science History
 GT: Geotechnics ST: Seismotectonics

KAWAKATSU H. and WATADA S.

Migrating the Japanese Subduction Zone.

LEYTON F., PÉREZ A., CAMPOS J., RAULD R. and KAUSEL E.

Anomalous Seismicity in the Lower Crust of the Santiago Basin.

LEYTON F., CAMPOS J., RUIZ J. and KAUSEL E.

Intraplate and interplate earthquakes in Chilean subduction zone.

MADARIAGA R. and GARDI A.

Central Chile seismicity: observing the preparation of a future earthquake.

MONTAGNER J.P., LARMAT C., FINK M., CAPDEVILLE Y., TOURIN A.

Time-Reversal Imaging of seismic sources and application to large Earthquakes.

MORONI O., SARRAZIN M., TRIGO T., TAYLOR D.

Caracterización del sitio donde se ubica el puente Marga-Marga.

OCHOA F. AND LEYTON F.

Site characterization with surface waves recorded from explosions records.

OKAL E.

17 August 1906: The False Twins.

PARDO M., MONFRET T., VERA E.

Seismotectonic of Central Chile–Western Argentina:

Body waves tomography and state of stress from local seismological data.

PEYRAT S., CAMPOS J., De CHABALIER J.B. et al.

The Tarapacá intermediate-depth earthquake (Mw 7.7, 2005, Northern Chile): A slab-pull event with horizontal fault plane constrained from seismologic and geodetic observations.

PEYRAT S., FAVREAU P., MADARIAGA R., VILOTTE J.P.

Kinematic inversion and dynamic modeling of the 2005 Tarapacá earthquake in Northern Chile.

RAULD R., VARGAS G., REBOLLEDO S., ARMIJO R., SEPÚLVEDA S.A., CAMPOS J.

San Ramón fault system: geomorphological antecedents of fault activity in the eastern boundary of Santiago basin.

ROMANOWICZ B., DREGER D., HELLWEG P., HOULIE N., KARAVAS W., NADEAU R., NEUHAUSER D.

Earthquake monitoring and research at U.C. Berkeley.

RUDLOFF A., VIGNY C., MADARIAGA R., RUEGG J.C., De CHABALIER J.B., ARMIJO R., CAMPOS J., KAUSEL E., BARRIENTOS S., DIMITROV D.
Interseismic strain accumulation in south central Chile seismic gap from GPS measurements.

RUIZ S., SARAGONI R., and KAUSEL E.
Asperidades de la zona central de Chile

SARAGONI R.
Estudio comparativo de los efectos de los terremotos de Valparaíso de 1906 y 1985 en el barrio El Almendral.

SIMONS M.
Constraints on slip behavior of the megathrust in subduction zones.

STEIN S. AND OKAL E.
Lessons in Plate Tectonics from the 2004 Sumatra Earthquake; applications to South America.

TASSARA A. AND LEGRAND D.
Structure of the Chilean seismogenic zone is partially controlled by the long-term, three-dimensional geological configuration of the forearc.

TAVERA H.
Seismicity and Seismotectonics of Perú.

VARGAS G., GUTIÉRREZ D., ORTLIEB L.
Dating strong earthquakes in northern Chile and Perú: the potential for paleoseismic inferences from marine laminated sediments in the forearc of the Central Andes.

VERDUGO A.
Amplificación sísmica en los sectores planos de Viña del Mar y Valparaíso.

VERDUGO R.
Caracterización geotécnica de Valparaíso y su efecto en el Terremoto de 1906.

VERDUGO R., PASTÉN C., BAIZE S., BONILLA F., VOLANT P., BERGE-THIERRY C. and CAMPOS J.
H/V Spectral ratio measurements on Santiago Basin

VIGNY CH., RUDLOFF A., RUEGG J.C., De CHABALIER J.C., CAMPOS J., MADARIAGA R.
Investigation for transient deformation on the Coquimbo-Illapel segment of the Chilean subduction.



Centre National de la Recherche Scientifique (CNRS)



Universidad de Chile

Universidad de Chile



Institut National des Sciences de l'Univers (INSU)



Departamento de Geofísica,
Facultad de Ciencias Físicas y Matemáticas U. de Chile



Núcleo Científico Milenio Sismotectónica y Peligro Sísmico
ICM-MIDEPLAN



Ministère de l'Éducation Nationale, de l'Enseignement Supérieur
et de la Recherche français (MENESR)



Ministère des Affaires Extérieures français (MAE)



Instituto Chileno-Francés



Institut pour la Recherche et le Développement (IRD Chile)



Institut de Physique du Globe de Paris (IPGP)

