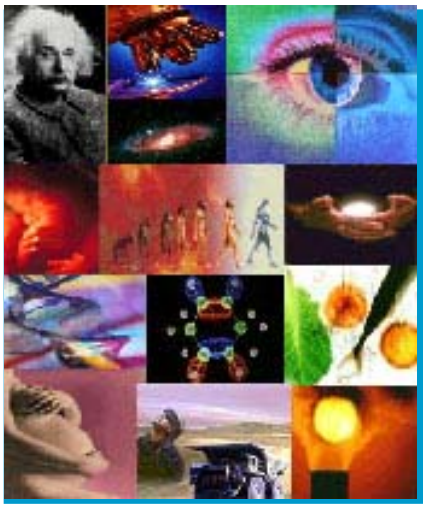

FONDECYT 2009

NATIONAL RESEARCH FUNDING COMPETITION

REGULAR COMPETITION

NATIONAL COMMISSION FOR SCIENTIFIC & TECHNOLOGICAL RESEARCH

PRINCIPAL INVESTIGATOR:

Sergio Barrientos Parra

NATIONAL FUND FOR SCIENTIFIC & TECHNOLOGICAL DEVELOPMENT (FONDECYT)
Bernarda Morín 551, Providencia - P.O. Box 297-V, Santiago 21
Telephone: (56-2) 365 4350 Fax (56-2) 372 0828
e-mail: postulacion.fondecyt@conicyt.cl
SANTIAGO – CHILE

FONDECYT NATIONAL RESEARCH FUNDING COMPETITION
2009 REGULAR COMPETITION

CHECKLIST

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I.2.	Principal Investigator Signature	X		
I.3.	Institutional Representative Signature of Sponsoring Institution(s)	**X**		
I.5.	Coinvestigators Signature	**X**		
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III.1.	Proposal Description, Theoretical Background and Literature Review	**X**		
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IV.	Prior Work on the Proposal Topic	**X**		
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FONDECYT NATIONAL RESEARCH FUNDING COMPETITION
2009 REGULAR COMPETITION

I. GENERAL INFORMATION

Proposal Type	1	FONDECYT Council	1	1.- Science 2.- Technology	Proposed length (2 to 4 years)	3

Proposal Title:	GPS measurement of crustal deformation associated to subduction and active faulting in central Chile

Proposal keywords

GPS	Faults	Earthquakes

Primary Field	64	Secondary Field	65	Application Sector		Application Region	

I.1. FUNDING REQUEST SUMMARY

BUDGET ITEMS	Thousand Chilean $ (1000 CHP)				
	Year 1	Year 2	Year 3	Year 4	Total
Staff	10500	10500	10500		31500
Travel	2600	3850	3850		10300
Operational Expenses	6270	7570	7570		21410
Equipment	22500	1352			23852
Annual Total	41870	23272	21920		87062

I.2. PRINCIPAL INVESTIGATOR

Barrientos	Parra	Sergio	5.782.949-4
FATHER'S SURNAME	**MOTHER'S MAIDEN SURNAME**	**NAMES**	**TAXPAYER ID NUMBER**

sbarrien@dgf.uchile.cl
MAILING ADDRESS

Santiago	2777	56-2-9784309	56-2-6968686
CITY	**P.O. BOX**	**TELEPHONE**	**FAX**

sbarrien@dgf.uchile.cl
E-MAIL ADDRESS

Depto. Geofísica, Fac. Cs. Fís. y Matemáticas, Universidad de Chile
INSTITUTION

PRINCIPAL INVESTIGATOR SIGNATURE

I.3. SPONSORING INSTITUTION(S): Performing Unit(s)

	INSTITUTION NAME (University/Faculty/Department)	Institutional Representative Signature	FONDECYT USE
1	U. de Chile / Fac. Cs.Fs. y Mat. / Dpto. Geofisica		
2	Laboratoire du Geologie, Ecole Nomale Superieure, CNRS Francia		
3			
4			

I.4. ADDITIONAL FUNDING COMMITTED FROM OTHER INSTITUTIONS/SOURCES. If applicable, indicate the amount contributed by other institutions/enterprises interested in the proposal results. Please attach certifying letters.

INSTITUTION(S)	CONTRIBUTION (1000 CHP$)	FONDECYT Uso
TOTAL		

I.5 COINVESTIGATORS.

REMINDER

In accordance with the terms of the 2009 competition, be aware that a researcher's signature as:

- **COINVESTIGATOR IN 2 PROPOSALS**
- **PRINCIPAL INVESTIGATOR IN 2 PROPOSALS**

will cause immediate elimination from all proposals in which he/she participates.

The CoInvestigators, whose signatures appear below, commit themselves to participate in this proposal until its full completion.

Use an asterisk **(*)** to identify the CoInvestigator who would act as Principal Investigator (PI) in case of a temporary absence of the latter. **Do not** include CoInvestigators without residence in Chile. Funding for these participants, if applicable, may be requested in the Travel Item (Travel International Cooperation**)**.

	TAXPAYER ID #	FATHER'S SURNAME	MOTHER'S MAIDEN SURNAME	NAMES	SIGNATURE
*					
	8.869.720-0	Campos	Muñoz	Jaime *	
	Institution Name	Dpto de Geofisica/Fac Cs Fis y Mat/Universidad de Chile			
	14.699.314-1	Perez	Franco	Adriana	
	Institution Name	Particular			

II. PROPOSAL ABSTRACT:

The Chilean subduction zone is extremely active with an average of one M=8 event every ten years and at least one M>8.7 per century. The largest earthquake of the past 100 years, the May 22 1960 Chilean earthquake of magnitude 9.5, occurred along the Chili subduction zone and generated a giant trans-Pacific tsunami that caused catastrophic damage along the coasts of Hawaï and Japan. These events are the consequence of subduction of the Nazca plate beneath South America at a convergence rate as high as 7 cm/yr. In Chile, several studies have shown an along strike variation in the dip angle of the slab, and possible segmentation of the subduction zone, well expressed at the surface geology and morphology. The fast convergence is accommodated by large inter- and intra-plate earthquakes, and by shallow earthquakes associated with intra-continental fault systems in the Andes cordillera and the Altiplano-Puna. The study of Chilean earthquakes has a long history and major seismic gaps, e.g. Central Chile (Constitución-Concepción) and North Chile (Antofagasta-Arica), are reaching the end of the seismic cycle with a high megathrust earthquake risk in the 21st century. Other areas, like the Coquimbo region, show strange patterns of deformation, possibly transient. Inter-plate earthquakes are not the only destructive earthquakes in Chile. Several observations suggest intra-plate earthquakes as potentially more destructive, e.g. slab-pull earthquakes of 2005 (Tarapacá), 1950 (Antofagasta), 1939 (Chillán) as well as slab-push earthquakes of 1997 (Punitaqui). Central Chile is also shaken by earthquakes at shallow depths. In the Metropolitan area, the earthquakes of Las Melosas (1958) and recently of Curicó (2004) may be the signature of active deformation and faulting associated with the building of the Andes. The seismic risk of these shallow earthquakes, pointed out by recent studies of active faulting along the western front of the Andes, is still poorly understood.

We propose to study in almost real time the crustal deformation representative of processes leading to future earthquakes in the Chilean subduction zone and/or the associated crustal faults and detect changes in deformation patterns using permanent and temporary GPS measurements. These measurements are necessary to quantify in details the present day deformation both spatially and temporally. In particular, along-strike variations of coupling and segmentation of the subduction, and the existence of shallow continental faults behind the subduction are still poorly known. They pose distinct level of seismic hazard depending on what the amount of coupling is, how much of the deformation is not occurring on the subduction (2-plates vs. 3-plates models), and whether transient deformations dissipate seismic energy in “silent” mode.

This project builds upon a long standing collaboration with French scientist from CNRS, under the framework of the internal laboratory (LIA) “Montessus de Ballore” and Argentinian scientists from San Juan University.

Among other realisations, our cooperation has led to the installation of ~20 cGPS stations and numerous campaign measurements in the central area of Chilli. These activities have been supported by a number of projects from INSU-CNRS, by the ECOS-Sud program, by the European Commission and, recently, by a PICS between CNRS and CONICYT in Chile.

III. PROPOSED RESEARCH.

III.1 PROPOSAL DESCRIPTION, THEORETICAL BACKGROUND AND LITERATURE REVIEW:

It has been almost two decades now that GPS has been used to measure plate tectonics and quantify plate deformation. In South America, the debate rapidly focused on the motion of the Nazca plate relative to the South America plate. Space geodesy allow to compares plate motions averaged over a few years to plate motion averaged over several million of years. Since the initial work of (*Larson et al., 1997*) which found similar rates, it is well known now (eg*: Norabuena et al, 1998; Norabuena et al, 1999; Angermann et al., 1999; Altamimi et al., 2002; Kendrick et al, 2003; Vigny et al, 2008*) that in fact the present day motion of the Nazca plate is around 15% slower than its Nuvel-1A estimate. This finding has the important consequence that along the South American margin, instead of nearing 8 cm/yr, today's subduction rate ranges from 5.5 cm/yr in Equator to 7 cm/yr in central Chile, before it decreases again to 6.5 cm/yr in southern Chile (figure 1 and table 1). Because of friction preventing free on the subduction interface (at least to a given depth), the upper plate (South America) accumulates elastic deformation. This deformation is released intermittently when earthquakes occur on the trench; it affects a very wide area including all Chile and penetrating deep into Argentina on the other side of the Andes. Relative to the South-America plate, CFAG (Coronel Fontana), 400 km from the trench, moves 7 mm/yr inland and TUCU (Tucuman), 550 km from the trench, moves 5 mm/yr also inland. CORD (Cordoba), 700 km from the trench, also has a non-zero residual velocity (4 mm/yr northward) but with a higher uncertainty due to its determination over 2 epochs spanning a small period of time, so we consider it non significant (Figure 5). Only LHCL (Lihue Calel), 800 km away from the trench, has a small and insignificant residual velocity (1 mm/yr) and can be located with certainty on the undeformed South-American plate. This pattern is representative of the very far reach of the deformation induced by locking on a low dipping subduction plane.

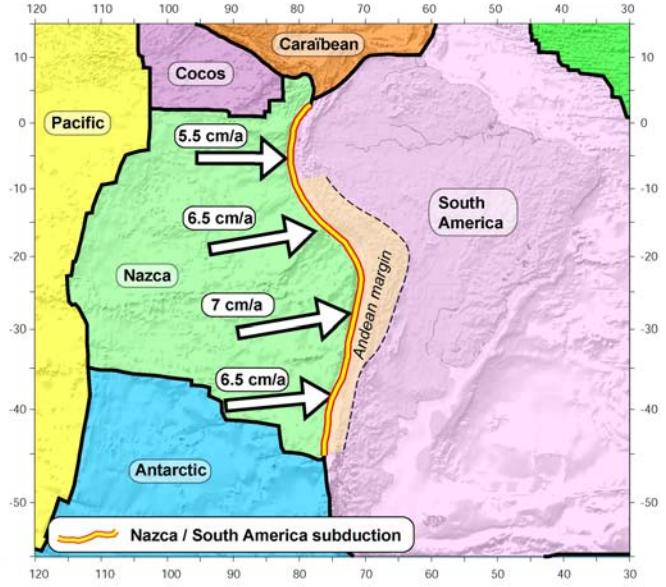
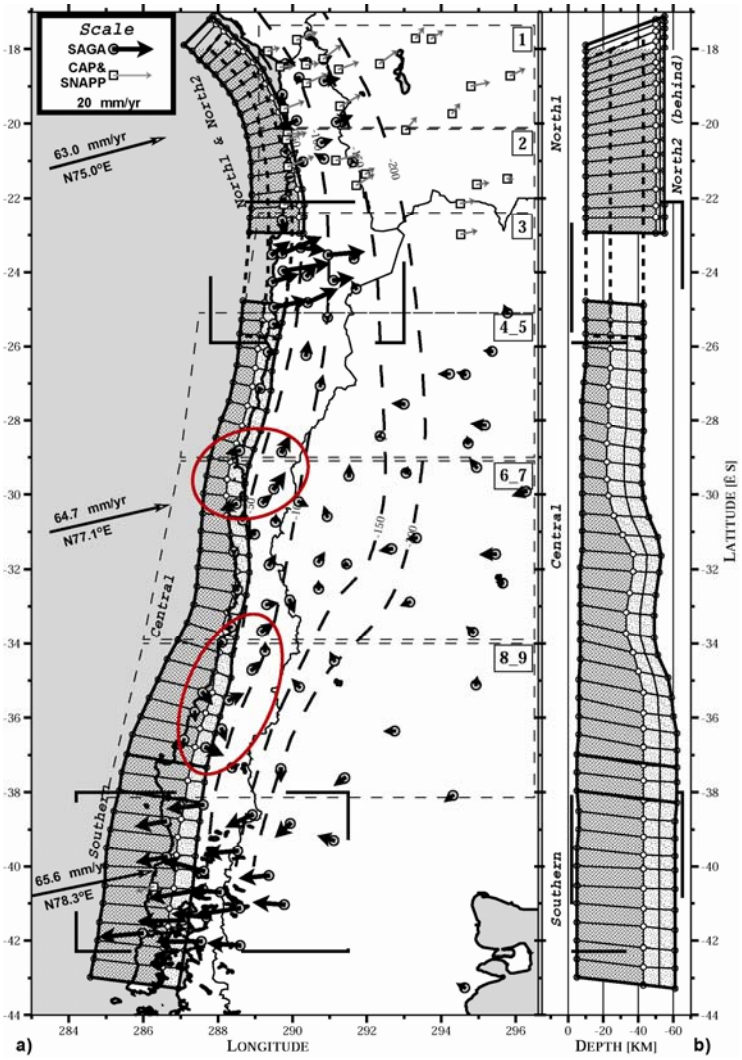


Fig 1. Nazca/South America relative motion and today's rate of subduction as measured by GPS.

Up to now, two different families of models have been presented. Based on campaign measurements over a network of hundreds of geodetic benchmarks spanning the whole continent (SAGA), Klotz and co-authors (*Klotz et al., 2001; Khazaradze et al., 2003*) use a 2-plate (Naza and South America) model, where the slab geometry varies with latitude and depth (figure 2). Kendrick and co-authors (*Kendrick et al., 2003; Brooks et al, 2003)* also use a comprehensive network of benchmarks (CAP)

	Angular velocity			Predicted velocities	
	latitude	longitude	rotation	convergence	Azimuth
Nuvel1A	56,0 °N	94,0 °W	0,720 °/Ma	80 mm/yr	78°N
Larson et al, 1997	43,8 °N	84,8 °W	0,740 °/Ma	80 mm/yr	81°N
Angermann et al, 1999	48,8 °N	91,7 °W	0,590 °/Ma	65 mm/yr	77°N
Norabuena et al., 1999	47,4 °N	93,7 °W	0,624 °/Ma	68 mm/yr	76°N
Kendrick et al., 2003	61,1°N	93,6°W	0,570 °/Ma	63 mm/yr	80°N
ITRF2005 (Altamimi et al., 2007)	53,9 °N	87,5 °W	0,605 °/Ma	67 mm/yr	81°N
Vigny et al., 2007	55,9 °N	95,2 °W	0,610 °/Ma	68 mm/yr	78°N

Table 1: Nazca/South America relative angular velocities and velocities predicted on the Chilean trench at 31°S using these poles.



Khazaradze and Klotz, 2003.
Two plates model with variable dip angle and locking depth. The red ellipses depict the areas where measurements don't fit well the model.

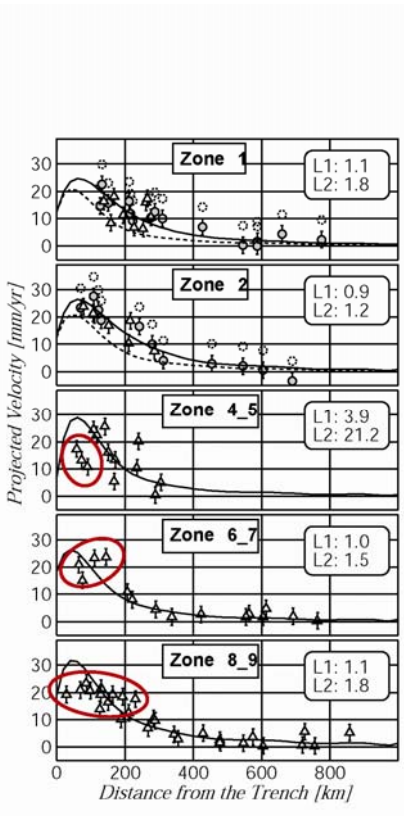


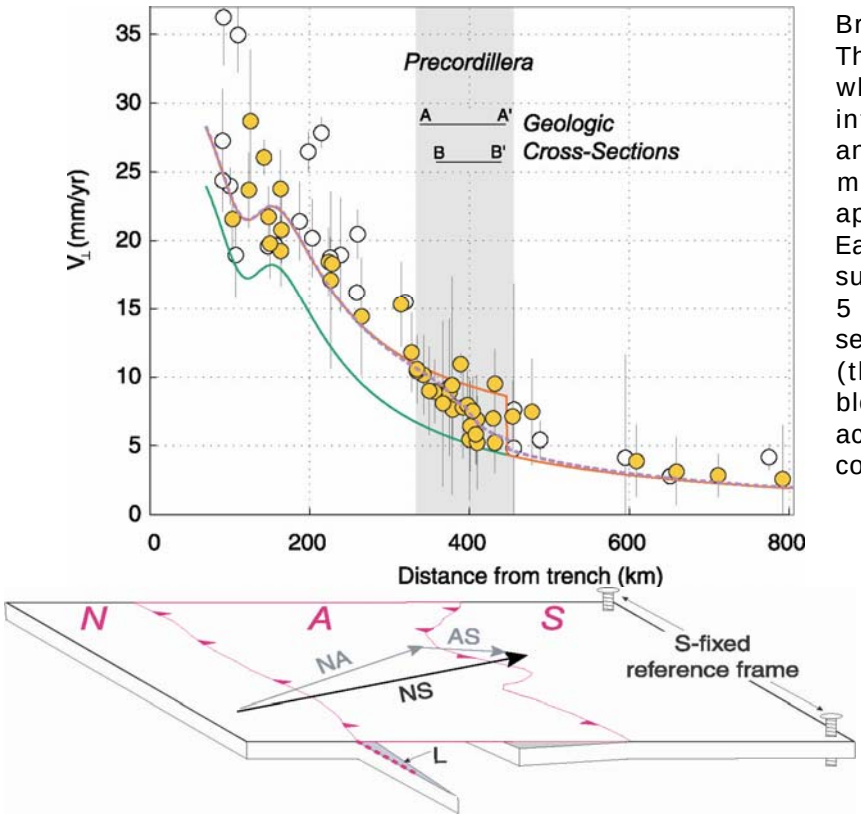
Fig 2. Residual velocities (a) based on the slab model presented in panel(b). Profiles at different latitudes show the point measurements (open and shade symbols) and the predicted deformation there (thin lines).

but reach a different conclusion: Claiming they have a better definition of the Nazca plate (thanks to measurements at San Felix and Robinson Crusöe islands), they find a motion reduced by 5 mm/yr for this plate, and then re-assign this motion to an Andean rigid block between Nazca and South America

(figure 3). The seismic hazards generated by the two mdels are somehow different: in the first case it is maximized on the subduction and essentially zero everywhere else; in the second case it is slightly reduced on the subduction, at the cost of generating a new at-risk area on the eastern margin of their Andean block. However, both models assume full coupling along the whole length of the subduction, which contradicts other studies (eg Norabuena et al., 1999; Vigny et al., 2008).

We attribute this difference to the fact that both studies (SAGA and CAP) use very large scale networks with hundreds of points but with very large spacing (100-200 km) between them. This has an important consequence: both studies model the subduction giving too much weight to far field data, by essence not very sensitive to details on the trench, and therefore miss to model accurately what's happening on the trench itself.

This is particularly obvious for SAGA, where important residuals (the difference between measured and modeled velocities reach 1.5 cm/yr at many points) show up precisely near the trench, whereas the fit is much better 400 km away from the trench (figure 2, right panel). Given the high quality of the measurements made by the SAGA teams, we think measured velocities cannot be in-error at so many points by so much, but rather indicate important patterns of deformation that the full coupling model cannot explain.



Brooks et al., 2003.

Three plates model, where an Andean block is introduced between Nazca and SouthAmerica. This micro-plate would move approximately 5 mm/yr Eastward. Thus, the subduction rate would be 5 mm/yr slower and a second tectonic structure (the boundary between blocks A and S) would accumulate 5 mm/yr of convergence.

Fig 3. Measured velocities (yellow dots between 30°s-33°S, white dots outside) and modeled velocities at 32°S (green and purple lines) based on a 2-plates model (green), or a 3-plates model (purple)

The 3-plate model obtained from the CAP data also suffers some problems. In particular between 30°S and 33°S, velocities measured in Chili vary by at least 50% (from 3 cm/yr to 2 cm/yr) at a given distance from the trench. The gradient of 5 mm/yr in the Argentinian precordillera is also poorly constrained: velocities at a given longitude vary between precisely 5 and 10 mm/yr. In this case, we think it is quite clear that the model neglects along-strike (latitudinal) variations.

Recent more detailed studies (*Ruegg et al., 2008, Vigny et al., 2008*) have shown that there is a clear change of trend in the Coquimbo region between 30°S and 32°S, and that this region is itself different from what is expected from the standard elastic modeling that works well further south or

further North.

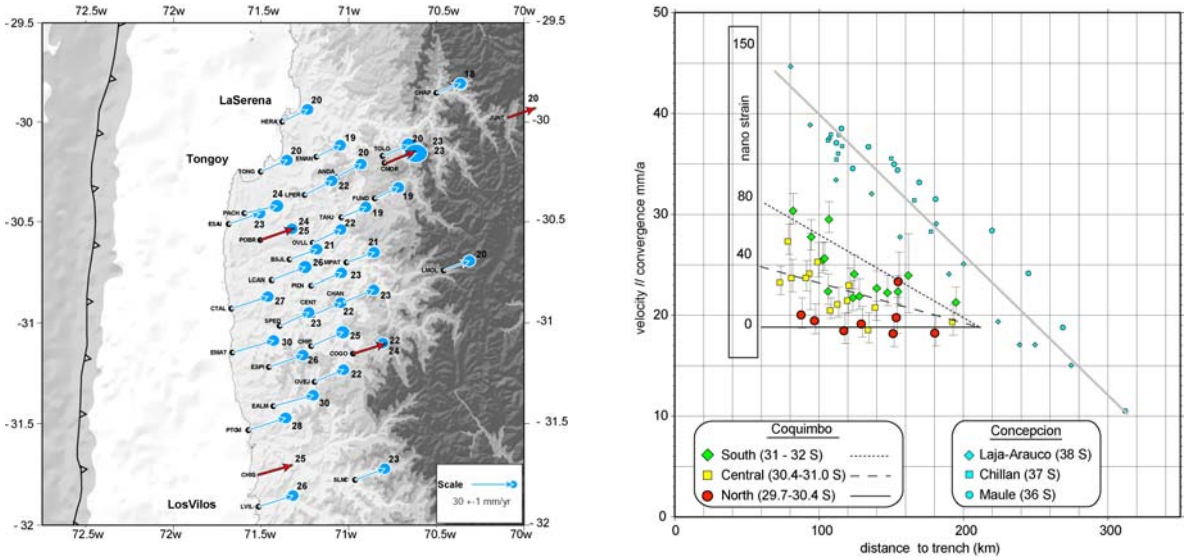


Fig 4. GPS velocities in Coquimbo region and profiles with distance to trench sorted by latitude.

First of all, and unlike in the Concepcion-Constitucion area (35°S-37°S) velocity arrows do not rotate as we move inland. They are aligned almost parallel to each other from the coast to the Andes, striking 70°N+/- 5° (Figure 4). Second, and although the trench is only roughly 100 km away from the coast in this area, the amount of compression is much less than in the south: While Andean stations in both segments have roughly the same velocity of 20mm/yr inland, coastal stations move at 25-30 mm/yr inland in Coquimbo, which should be compared with 40-45 mm/yr around the Arauco peninsula, immediately south of Concepcion (37°S) (*Ruegg et al., 2002; Ruegg et al., 2008*). Finally, there is also a clear change of pattern within the network itself. Coastal stations lying approximately at the same distance from the trench have decreasing velocities as their latitude increase: 30 mm/yr at EMAT (31.1°S), 27 mm/yr at CTAL (30.9°S), and 23 mm/yr at ESAU (30.5°S). In the Andes, stations at corresponding latitudes have approximately the same velocities: 20 mm/yr at LMOL (30.7°S), 20 mm/yr at TOLO (30.2°S) and 18 mm/yr at CHAP (29.9°S). Therefore, it is the amount of compression that is changing (decreasing) with latitude. This decrease is so intense, that North of 30.3°S (Tongoy – TONG) the compression is essentially zero. All stations in this area from the coast to the Andes (TONG, HERA, EMAN, ANDA, TOLO, CHAP) have roughly the same velocity of 18 to 20 mm/yr. Profiles of compression with distance to trench sorted by latitude depict this tendency very clearly: strain in the Coquimbo area is on average two-times lower than the average strain rate corresponding to the profiles measured between 36°S and 38°S. Moreover, a steady decrease of strain rates with latitude seems to emerge from the picture.

The last finding of these studies, and possibly the more important, is that to model these patterns with a full coupling on the trench is not possible. Following *Norabuena et al., 1999*, and contrary to *Khazaradze et al., 2003 and Brooks et al 2003*, we conclude that coupling must be varying on the interface, both with depth and along strike, and can reach value as low as 40° regionally and even less locally. Moreover, these cannot be steady state and should correspond to transient deformations. Therefore, the whole concept of 2-plate or 3-plate models and the corresponding seismic hazards, have to be re-evaluated with this new perspective.

Because these deformations are transient and small scale, we need a mix of continuous and small mesh campaign style GPS measurements to quantify them. Because we make the hypothesis that transient motions on the subduction interface originate at the intermediate depth of 30-50 km where the fragile/ductile transition is located, we conclude that the surface network should have this spacing at most. According to the elastic curves showed on figure 5, it is clear that a shallow dipping slab will generate significant deformation far inland, at least 500 km from the trench, and even in the case of reduced coupling on the interface. They also clearly show that horizontal measurements in the central area of Chile and the cordillera cannot distinguish between a 20° dip

angle and a 10° dip angle with

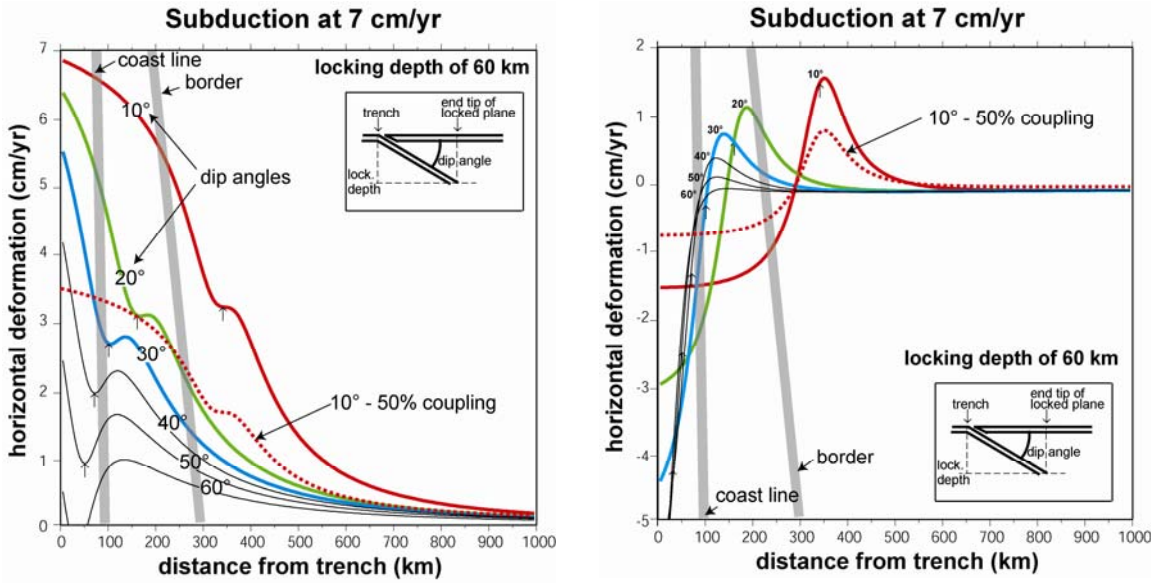


Fig 5. Elastic curves computed using Okada's equations for horizontal (left) and vertical (right) surface deformation, assuming 100% coupling, a convergence velocity of 7 cm/yr, a fixed locking depth of 60 km, and varying dip angles. Colour curves (red, green, blue) depict the models for "reasonable" Chilean trench values (10° to 30°)

50% coupling: between 200 and 300 km both models predict horizontal velocities which don't differ by more than 2 mm/yr and with very similar pattern. Therefore, measurements very near the subduction (on the coast) and where the plateau of the curve is to be found (in Argentina) are absolutely needed. Alternatively, vertical velocities do differ very significantly: the pick of elastic uplift can reach 1 cm/yr and can be shifted by 100 km depending on the dip angle.
However, GPS usually provides less precise vertical velocities because of tropospheric effects and because they are affected by noises from distinct non-tectonic origins. Frequently repeated campaigns (at least every year) or even continuous measurements may be needed to quantify them accurately. In any case, the elastic curves also show that the "plateau" of the horizontal deformation or the pick of the vertical deformation are narrow: 50km to 100km at most. Therefore, dense measurements (with points every 20km at least) are needed to "capture" them; and because trends change rapidly with latitude, profiles cannot be stacked to enhance general trends. Thus, we need many dense profiles to characterize the deformation. If made uniquely of permanent stations, such dense networks would be extremely costly and difficult to maintain. For this purpose, we advocate a mix of cGPS and campaign style measurements: the later give the needed spatial resolution when continuous stations interleaved with the markers allow to detect transient motions and seasonal cycles affecting the vertical deformation.

The main objective of this proposal is to achieve a complete understanding of the mode of deformation in the central section (between 28°s and 38°S) of the subduction. This section could produce several magnitude 8 earthquakes similar to those of Concepcion (1835), Valparaiso (1906, 1985) and La Serena (1730, 1880, 1943) or rupture in one larger magnitude 9 earthquake similarly to what happened on the Sumatra-Andaman trench in December 2004. It could also be that the more or less recent intraplate events (Chillan, Punitaqui, Tarapaca), associated to the abnormal coupling near La Serena-Tongoy and the high rate of seismicity in this area since 1997 (*Gardi et al., 2006; Vigny et al., 2008*) are an indication of the preparation of the interface for a major rupture. A second objective, for which the first one is a prerequisite, is to asses if enough shortening - not accommodated by the subduction - remains across the mountain ranges to generate seismic hazard on localized faults on both sides of the Andes. If such faults exist they could also accommodate strike-slip motion, similarly to the Liquine-Ofqui fault zone in the South of Chile. It should be noted that it will be very difficult, if not impossible, to characterize a motion of 1-5 mm/yr on these structures if the knowledge of the deformation generated by the subduction remains at this level of uncertainty. However, if these

shallow crustal faults exist and accommodate deformation, they clearly pose a serious problem in terms of seismic hazards for major cities like Santiago, built at the foot of the Andes,

precisely where they might be located. Therefore, assessing their existence and quantifying their motion could reveal
quite important, even if it is only at the mm/yr level. In this case, GPS measurements carried out during this project may not evidence this small signal, but precise geodetic measurements should start as early as possible anyways to provide the longer time span needed by future studies.

The third objective is to capture transient motions, possibly related to the nucleation of earthquakes.
To achieve these objectives, we first need to realize a comprehensive mapping of the pattern of deformation both in latitude and longitude with an extension of hundreds of km (1000 km along strike, 500 km perpendicular to trench), a spatial resolution of a few tens of km and precision of a few mm/yr both in horizontal and vertical motions. For this purpose we want to:

- Deploy permanent stations in the gap of the existing cGPS network, both north and south of the metropolitan area, and further east in Argentina (figure 6).
- Install a dense network of benchmarks for campaign style measurements where they are mostly needed: essentially along dense profiles in the metropolitan area, continuing in Argentina (figure 6).
- Frequently measure these networks, at least every year, to achieve a reasonably good precision in the duration of this project (3 years)

In a second step, we will model the pattern of deformation using both 3D-elastic models (following Okada's equations), with a full inversion of the slip deficit along the subduction interface. We also want to analyze the different role played by Coulomb, shear and normal stress increase, pore-pressure variation and post-seismic deformations on past and future earthquake triggering, taking into account the complex fault geometry in the area. Ultimately, 3D finite element models including visco-elastic effects should be developed. However, it should be noted that acquiring measurements is the sine-qua-non condition of this proposal.

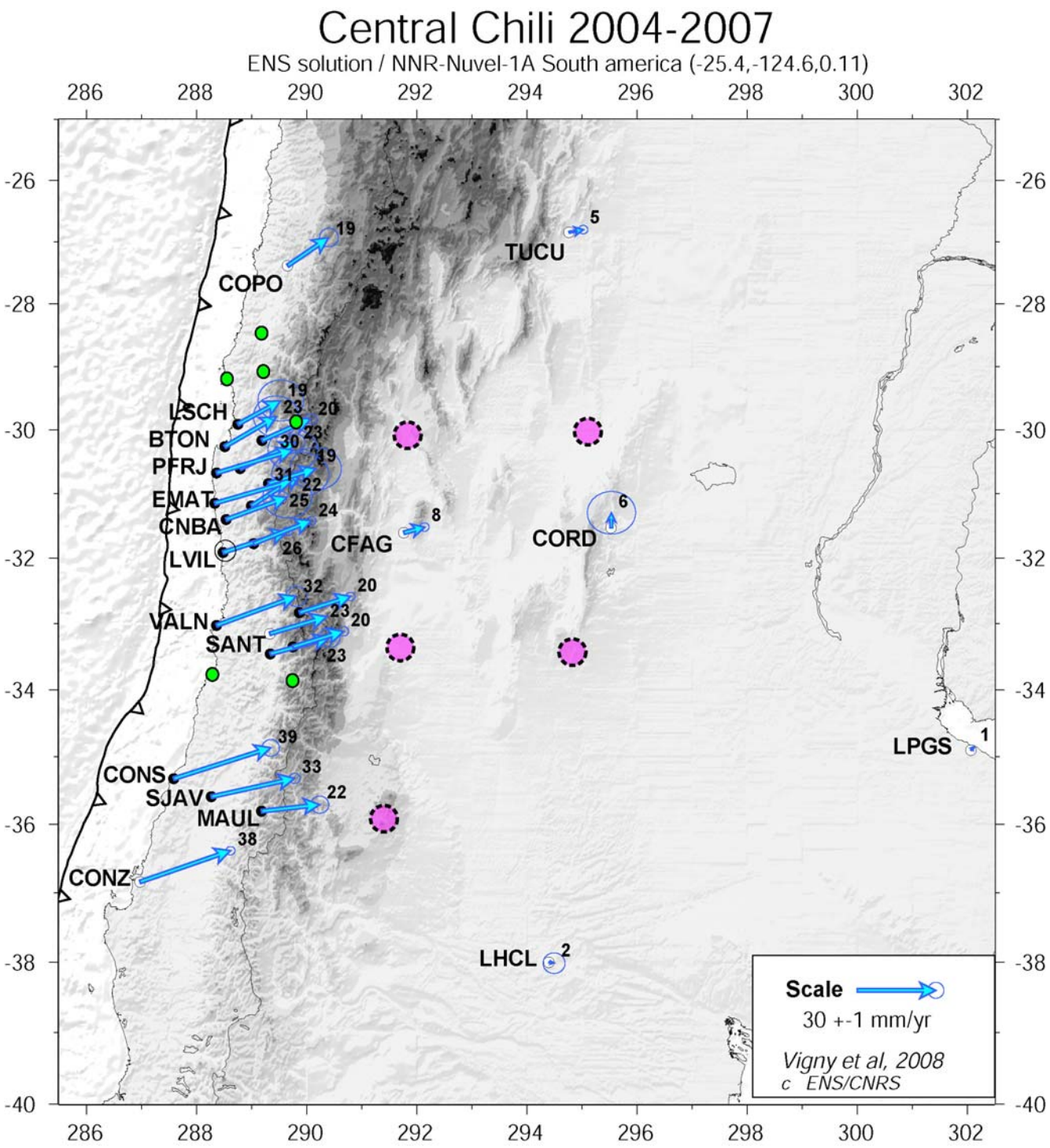


Fig 6. cGPS measurements in central Chile. Blue arrows depict velocities at stations already operated in the framework of the International Chilean-French laboratory (LIA) "Montessus de Ballore" (black dots) and other projects (IGS, CAP, TIGO: white dots). The green dots show the locations of future LIA cGPS stations and the purple circles show the places where additional stations in Argentina would be much usefull. The two black squares indicate the areas where dense campaign style networks already exist and are regularly measured in the framework of the LIA. The two red squares indicate when profiles of benchmarks need to be installed.

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Pardo, M., D. Comte and T. Monfret (2002a), Seismotectonic and stress distribution in the central Chile subduction zone, *J. S. Am. Earth Sci.*, 15, 11-22

Pardo, M., D. Comte, T. Monfret, R. Boroschek and M. Astroza (2002b), The October 15, 1997 Punitaqui Earthquake (Mw=7.1): a destructive event within the subducting Nazca plate in central Chile, *Tectonophysics*, 345, 199-210.

Ruegg, J.C., J. Campos, R. Madariaga, E. Kausel, J.B. DeChabalier , R. Armijo, D. Dimitrov, I. Georgiev, S. Barrientos (2002), Interseismic strain accumulation in south central Chile from GPS measurements, 1996-1999, Geophys. Res. Lett., 29, no 11, 10.1029/2001GL013438.

Savage J.C., (1983), A dislocation model of strain accumulation and release at a subduction zone, J. Geophys. Res. 88 pp. 4948-4996

III.2 HYPOTHESES: Specify your working hypotheses or questions that will guide your research. **The maximum length for this section is ½ page. (Arial or Verdana, font size 10)**.

Crustal deformation is representative of physical processes occurring at depth, on fault planes. It is possible to measure this deformation accurately with GPS, provided that these measurements are made on dense networks and repeated frequently.

- We want to test the 2-plates vs. the 3-plates model, and the existence of continental faults behind the subduction.

- We want to distinguish between full coupling on the subduction interface associated to large dip angles and reduced coupling with shallower dip angles.

- We want to test if the shallow seismicity in the central area of Chile and in the San Juan area in Argentina is associated with crustal faults with significant motions.

- We want to test whether the deformation pattern observed north of 30°S (almost no accumulation of deformation there) is steady state (not likely) or transient. If so, with what time scale.

III.3 GOALS: Specify your general and specific goals. **The maximum length for this section is ½ page. (Arial or Verdana, font size 10)**.

Understand the deformation process allows the is observed south and north of 30-31°S. At the same time, we would like to recognized the link between deformation and seismicity in the Cordilleran region of Central Chile.

Specific goals are:

Provide better estimates of seismic hazard in Central Chile

Capture pre-, co-, and post-seismic motion in case of a medium to large earthquake taking place during the time span of the project or afterward;

Develop the data base of geodetic measurements in the central area of Chile and Argentina. All acquired measurements will be archived and distributed by a centralized system at U-Chile, Santiago; and

Transfer to the DGF at U-Chile, Santiago the knowledge and capacity of GPS data processing. One of us (C. Vigny) is an internationally known expert in this field of research.

Publications in international research journals

III.4 METHODOLOGY: Describe the methods you plan to use to achieve the proposed goals. For example: experimental techniques, sampling procedures justification, statistical analysis of results, etc.. **The maximum length for this section is 3 pages. (Arial or Verdana, font size 10).**

GPS Equipment

- **cGPS**: Trimble Net-RS + Zephyr Antennas. These Geodetic dual-frequency receivers allow to acquire data at high sampling rate (up to 10Hz - useful in case of earthquake) and geodetic sampling rate (30s) simultaneously. Their capacity to internally store data up to 1 Gb is precious in case of local computer failure or data transmission rupture. The Net-Rs has also been chosen by the Caltech, CNRS and millenio (?) groups for their projects in Chile. We have accumulated a lot of experience with this equipment over the last 4 years.
- **Campaigns**: we use specially designed bolts sealed in bedrock outcrops. These sites enable direct antenna centering with sub-millimeter accuracy. One campaign is 2-3 teams deploying ~15 receivers simultaneously and moving them every 4-5 days from one site to the next ones. 2 to 3 weeks of measurements allow to survey 40 to 60 sites with the millimetric precision provided by 24 hours long sessions repeated at least 4 times on every site. We will use the Ashtech ZX-treme pool of receivers made available to us by the LIA "Montessus de Balore" (5 receivers) and the French INSU (30 receivers). We will repeat campaigns every year in order to get velocities constrained by 3 points over 2 years of time span at the end of the project duration.

Software

- **GPS data processing** : GAMIT
  We will implement the GAMIT/GLOBK package (*King and Bock*, 2000; *Herring et al.*, 1990) at DGF to process all acquired data. Standard procedure (repeated sessions of 24hours of measurements, the use of IGS precise orbits, the modeling of Ionosphere and troposphere effects using the GPS data themselves, the resolution of ambiguities, mapping in precise ITRF2005 reference frame using Helmert transformation) will allow to reach a precision of 2-3 mm/yr on most points surveyed with these methods in no more than 2 years of measurements.
- **Elastic modeling** : RNGCHN, DEFNODE
  In this project, we will use only "simple" elastic equations developed by Okada in the 1980's (*Okada*, 1985). In a first step we will do forward modelling using dislocations on simple rectangular planes with the RNGCHN software (*Feigl and Dupré,* 1999). In a second step, we will do a complete description of the slab and plausible continental faults geometry and a full inversion of slip deficit on these structures using the DEFNODE software (*McCaffrey*, 1995)

Some of us accumulated a lot of experience with those software and techniques over the last decade, as is attested by our list of publication. The project will be the occasion of knowledge transfer between us.

Technical references

Feigl, K., and E. Dupré, RNGCHN: A program to calculate displacement components from dislocations in an elastic haf-space […], *Computers and Geosciences, 25*, 695-704 (1999).

Herring, T. A., et al. (1990), Geodesy by radio astronomy: The application of Kalman filtering to very long baseline interferometry, *J. Geophys. Res.*, *95*, 12,561-512,581.

King, R. W., and Y. Bock (2000) Documentation for the GAMIT GPS software analysis version 9.9, *Mass. Inst. of Technol.*, Cambridge.

McCaffrey, R., DEFNODE users' guide, Rensselaer Polytechnic Institute, Try, NewYork (http://www.rpi.edu/~mccafr/defnode) (1995)

Okada, Y. (1985), Surface deformation due to shear and tensile faults in a half-space, *Bull. Seism. Soc. Am.*, *75*, 1135–1154.

III.5 WORK PLAN: On the basis of your stated goals, indicate the stages and describe the activities **to be carried out each year**. **The maximum length for this section is 1 page.** (Arial or Verdana, font size 10). **If appropriate, use a Gantt chart.**

1st Year

1. Acquire instruments (Net-Rs with Zephyr antennas) for the cGPS operations
2. Make reconnaissance for suitable sites for both cGPS stations and high density benchmark profiles.
3. Install the cGPS and the campaign style markers
4. First campaign of field measurements
5. Data processing

2nd year

6. Second campaign of field measurements
7. Data processing
8. Aggregation of new data to existing data set, first tests on preliminary velocity solutions
9. Construction of models (3D description of faults, software benchmarking,…)
10. participation to international workshops and meetings (AGU)

3rd year

11. Third campaign of field measurements
12. Data processing
13. Aggregation of new data to existing data set, generation of final velocity solutions
14. Modeling
15. publications

III.6 RESEARCHERS ACTIVITIES: Describe the job to be carried out annually by each **researcher. Attach additional sheets, if necessary.**

NAME: Sergio Barrientos

Activities
Coordinator, execution of the project. Obtain permits, and adjustments to install permanent and temporal GPS sites. Build monuments to the sites, , pin installation, data adquisition and later interpretacion report writhing and later publications. Peaches of equipment.

NAME: Christophe Vigny

Activities
I use space geodesy (GPS) to measure crustal deformation associated to active faulting. For this matter, I make GPS measurements over networks of benchmarks I regularly survey or using permanent stations I install. Then I process the acquired data to reduce them to point positions and velocities, or time series in the case of cGPS. In a final stage I analyse, interpret and model these data. My aim is to quantify plate tectonics and crustal deformation in the neighbourhood of active faults (continental, subduction or rifting) in order to characterize their geometry and velocity, and to asses the seismic hazard they generate. I also use GPS measurements to monitor crustal deformation immediately before, during and after earthquakes, in order to understand the friction and rheological laws that govern crustal failure and rupture propagation. For all these purposes, I have been active in different areas of the world, where these processes are actually occurring: South-East Asia in Myanmar (Sagaing fault) or Indonesia (Sumatran trench, Great Sumatran fault, Palu fault), Afar (the Asal rift in Djibouti), and Chile

NAME: Jaime Campos

Activities
Data adquisition and later interpretacion report writhing and later publications. Analysis, interpretation and model data.

NAME: Adriana Perez

Activities
Support in Build monuments to the sites, pin installation, data adquisition and later interpretacion report writhing and later publications Support in make GPS measurements over networks of benchmarks Support in process the acquired data to reduce them to point positions and velocities. Support in Analysis, interpretation and model data

III.7 TIME COMMITTMENT TO THE PROPOSAL: On the basis the above described activities, indicate the number of hours per week committed to the proposal by each researcher.

Taxpayer ID #	FULL NAME	Year 1	Year 2	Year 3	Year 4
5.782.949-4	Sergio Barrientos	15	15	15	
8.869.720-0	Jaime Campos	10	10	10	
14.699.314-1	Adriana Perez	25	25	25	

IV. PRIOR WORK ON THE PROPOSAL TOPIC: In the space below, if appropriate, summarize the main results of your previous work on the topic of this proposal. **The maximum length for this section is 1 page. (Arial or Verdana, font size 10)**.

- 15 years of making GPS measurements and 10+ papers on plate tectonics and fault motions in South East Asia: Sagaing fault in Myanmar, Palu fault in Sulawesi, Great Sumatran fault in Sumatra. We discovered the now well know motion of the Sundaland platelet. We studied (and still work on) the mega thrust earthquake of 24 december 2004 in Sumatra (for which we did the original work of following the rupture with high sampling rate GPS), and the following events since.
- 15 years of making GPS measurements and 5 papers in the Afar depression (Arabia, Yemen, Ethiopia, Djibouti). We revised the velocity of Arabia plate and monitor a multi-decade crisis in the Asal rift.
- 4 years and 2 papers on the Chilean subduction in two distinct areas: South Central (near Concepcion) and North Central (near La Serena). We also worked on the deformation prior and after the earthquake of 21 April 2007 in Aysen (not published).

V. ADDITIONAL INFORMATION: Include other information that you consider relevant, not included elsewhere, which would facilitate this proposal's review. **The maximum length for this section is 1 page. (Arial or Verdana, font size 10)**.

VI. RESEARCHERS CURRICULA

(Fill out one form for the Principal Investigator and for each CoInvestigator).

VI.1. BIOGRAPHICAL INFORMATION

5	7	8	2	9	4	9			4

TAXPAYER ID # (Do not include decimal point)

Barrientos	Parra	Sergio
FATHER 'S SURNAME	**MOTHER'S MAIDEN SURNAME**	**NAMES**

03	10	1953	M [X] F [ ]	Chileno	56-2-9784309	56-2-6968686
Day	**Mont**	**Year**				
DATE OF BIRTH			**SEX**	**NATIONALITY**	**TELEPHONE**	**FAX**

sbarrien@dgf.uchile.cl
MAILING ADDRESS

Metropolitana	Santiago	2777	sbarrien@dgf.uchile.cl
REGION	**CITY**	**P.O. BOX**	**E-MAIL ADDRESS**

Dpto Geofisica/Fc Cs Fisicas y Mat/Universidad de Chile
INSTITUTION

VI.2. ACADEMIC BACKGROUND

Professional Title(s)	UNIVERSITY	COUNTRY	YEAR
Bachiller en Ciencias, mención Geofísica	Universidad de Chile	CHILE	1979
Academic Degrees			
Magister en Ciencias, mención Geofísica	Universidad de Chile	CHILE	1980
Ph.D. (Ciencias de la Tierra)	Universidad de California	USA	1987
Other			

Main Lines of Research / Specialty Areas

1.-Geodesy
2.-Seismology
3.-Seismotectonic

CURRENT ACADEMIC APPOINTMENT(S)	INSTITUTION	HOURS PER WEEK
Director del Servicio Sismologico Nacional	Universidad de Chile	

VI.3. PARTICIPATION IN FONDECYT-APPROVED PROJECTS SINCE 1998.

YEAR		PROJECT NUMBER & TITLE	ROLE (PI, CoInvestigator)
Begin	End		

VI.4. PARTICIPATION IN OTHER PROJECTS OR RESEARCH PROGRAMS FUNDED BY NATIONAL OR FOREIGN SOURCES SINCE 2003. SPECIFY THEIR GOALS AND EXPLAIN THEIR DIFFERENCES WITH THE CURRENT PROPOSAL. (Attach as many pages as needed)
FONDECYT Councils, at their discretion, may request proper certification.

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2007	2010	MIDEPLAN. ICM	MILLENIUM SCIENCE NUCLEUS MONTESSUS DE BALLORE INTERNATIONAL RESEARCH EARTHQUAKE CENTER	Coinvestigator
SPECIFICATION:				

VI.5. PUBLICATIONS. Please provide full references (author(s), title, journal full name, volume, pages, year) for articles **accepted or published** over the last 5 years. If appropriate, specify the FONDECYT project number.

Please, be aware that female investigators who have given birth between 2003 to 2008, must report their scientific productivity since 2002.

a. Publications since 2003. Use additional sheets, if necessary. Use an "X" to check the appropriate box.

Identify the corresponding author by inserting an asterisk (*) to the left of his/her surname.

Author(s)	**Barrientos, S. E**., E. Vera, P. Alvarado and T. Monfret						
Article title	Intraplate seismicity in Central Chile						
Journal full name	*J. South American Earth Sciences*				FONDECYT Project Nº		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2004	16		759-768	Published x	In press ☐	Accepted ☐

Author(s)	**Barrientos, S**						
Article title	Giant returns in time						
Journal full name	*Nature*, News & Views				FONDECYT Project Nº		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2005	437		629	Published ☐	In press ☐	Accepted ☐

Author(s)	**Barrientos, S.** , L. Zerbo and G. Suárez						
Article title	CTBTO contribution to hazard mitigation						
Journal full name	IRIS Newsletter				FONDECYT Project Nº		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2006				Published x☐	In press ☐	Accepted ☐

Author(s)	Ruegg, J.C., Rudloff, C. Vigny, R. Madariaga, B. Dechabalier, J. Campos, E. Kausel, **S. Barrientos** and D. Dimitrov						
Article title	Interseismic strain accumulation measured by GPS in south central Chile seismic gap						
Journal full name	Submitted to Phys. Earth Plan. Int., 2007				FONDECYT Project Nº		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2007				Published x☐	In press ☐	Accepted ☐

Author(s)	Alvarado, P., **S. Barrrientos**, M. Astroza, M. Saez and S. Beck						
Article title	Source and Damage study of the historic 1958 Las Melosas, Chile, earthquake and its tectonic implications						
Journal full name	Submitted to Phys. Earth Plan. Int., 2007					FONDECYT Project Nº	
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2006				Published x☐	In press ☐	Accepted ☐

b. Books and Book Chapters since 2003: Please provide full references and use additional sheets if necessary. Use an "X" to check the appropriate box.

Author(s)	**Barrientos, S. E**.,		
Title of Book or Chapter	Earthquakes in Chile, in Geology of Chile		
Editor(s) Name(s)	ed. W. Gibbons and T. Moreno		
Editorial	published by Geological Society of London		
Publication Place & Date	2007		
Publication type			Pages
Book ☐	Book Chapter x	Monograph ☐	

c. Publications in Proceedings of Scientific Meetings since 2003. Include the publications relevant to this proposal topic.

Author(s)	**S. Barrientos**			
Abstract Title	Potential Civil and Scientific Applications of the IMS Seismic Networks			
Congress Title				
Place, Date & Pages	Country:Hungary	City:Sopron	Date:2003	Page(s):

Author(s)	**S. Barrientos**			
Abstract Title	Potencial scientific use of data produced by the Internacional Monitoring System of CTBTO			
Congress Title	III Internacional Conference on Earthquake Engineering and Seismology			
Place, Date & Pages	Country: Iran	City:Tehran	Date: mayo 2003	Page(s):

Author(s)	**S. E. Barrientos**			
Abstract Title	Development of the Seismic Networks of the International Monitoring System			
Congress Title	International Association of Seismology and Physics of the Earth's Interior			
Place, Date & Pages	Country: Chile	City: Santiago	Date:2005	Page(s):

Author(s)	**S. E. Barrientos**			
Abstract Title	Status of the Seismic Networks of the International Monitoring System			
Congress Title	XX Session of the ICG/ITSU			
Place, Date & Pages	Country: Chile	City: Viña del Mar	Date:2005	Page(s):

Author(s)	**S. E. Barrientos** and G. Suárez			
Abstract Title	The Seismic Networks of the International Monitoring System of the Comprehensive Nuclear-Test-Ban Treaty Organization			
Congress Title	Seismological Society of America			
Place, Date & Pages	Country: USA	City: San Francisco	Date:2006	Page(s):

Author(s)	**S. E. Barrientos**			
Abstract Title	Intermediate and Shallow Depth Earthquakes: Implications for the National Building Code			
Congress Title	Montessus de Ballore Conference			
Place, Date & Pages	Country: Chile	City: Santiago	Date:2006	Page(s):

Author(s)	**S. E. Barrientos**			
Abstract Title	Earthquakes in Fiordland, Southern Chile: Initiation and development of a magmatic process			
Congress Title	EOS Trans. 88(23) Joint. Assem. Suppl			
Place, Date & Pages	Country: Acapulco	City: Mexico	Date:2007	Page(s):

Author(s)	**S. E. Barrientos**			
Abstract Title	Estado actual de la preparación de Mapas de Peligro Sísmico en Chile and Geofísica en tiempo real: Temblores, Deslizamientos y Tsunami en Aysén			
Congress Title				
Place, Date & Pages	Country: Brazil	City: Itu	Date:2007	Page(s):

Author(s)	**S. E. Barrientos,** K. Bataille, C. Aranda, D. Legrand, L.C. Báez, H. Agurto, J. Genrich, C. Vigny, F. Bondoux			
Abstract Title	Complex sequence of Earthquakes in Fiordland, Southern Chile			
Congress Title	GEOSUR			
Place, Date & Pages	Country: Chile	City: Santiago	Date:2007	Page(s):

Author(s)	J Campos, S Peyrat, M Bejar, A Socquet, G Meneses, A Perez, R Madariaga, P Favreau, P Bernard, **S Barrientos**, R Armijo, G Asch, M Sobesiak, J Vilotte
Abstract Title	The Mw 7.7 Tocopilla, Chile, Earthquake of 14 November 2007: A Comprehensive Study Using Teleseismic, Local and InSAR data

Congress Title	AGU Joint. Assem			
Place, Date & Pages	Country: USA	City: Fort Lauderdale	Date:2008	Page(s):

Author(s)	M Béjar-Pizarro, D Carrizo, A Socquet, R Armijo, J B de Chabalier, A Nercessian, O Charade, J C Ruegg, **S Barrientos**, J Campos			
Abstract Title	Rupture Geometry and Slip Associated With the 2007 November 14 Mw = 7.7 Tocopilla (Chile) Earthquake, as Preliminary Determined by InSAR and GPS			
Congress Title	AGU Joint. Assem			
Place, Date & Pages	Country: USA	City: Fort Lauderdale	Date:2008	Page(s):

Author(s)	M Sobiesiak, S Eggert, H Woith, H Grosser, S Peyrat, J Vilotte, E Medina, J Ruch, T Walter, P Victor, **S Barrientos**, G Gonzalez			
Abstract Title	The M 7.7 Tocopilla earthquake and its aftershock sequence: deployment of a Task Force local network			
Congress Title	AGU Joint. Assem			
Place, Date & Pages	Country: USA	City: Fort Lauderdale	Date:2008	Page(s):

Author(s)	M A Astroza, **S E Barrientos**, R R Astroza			
Abstract Title	Damage, Vulnerability and Intensities Generated by the November 14, 2007, Tocopilla Earthquake			
Congress Title	AGU Joint. Assem			
Place, Date & Pages	Country: USA	City: Fort Lauderdale	Date:2008	Page(s):

d. Thesis Direction. List Doctoral and Master's theses directed since 2003.

Students Names	Thesis Title	Degree, Institution & Year Awarded
Patricia Alvarado	Sismicidad superficial de los Andes Centrales (33-35S; 69.5 - 70.5W)	Magister in Since, Mencion Geophysics. 1998 University of Chile

VI.1. **BIOGRAPHICAL INFORMATION**

	8	8	6	9	7	2	0	-	0

TAXPAYER ID # (Do not include decimal point)

Campos	Muñoz	Jaime
FATHER 'S SURNAME	MOTHER'S MAIDEN SURNAME	NAMES

28	1	1961	M	X	F		Chileno	978 4306	696 86 86
Day	Month	Year							
DATE OF BIRTH			SEX				NATIONALITY	TELEPHONE	FAX

Blanco Encalada 2007, Casilla 2777, Santiago
MAILING ADDRESS

RM	Santiago	2777	jaime@dgf.uchile.cl
REGION	CITY	P.O. BOX	E-MAIL ADDRESS

Depto. Geofísica, Fac. Cs. Fís. y Matemáticas, Universidad de Chile
INSTITUTION

VI.2. ACADEMIC BACKGROUND

Professional Title(s)	UNIVERSITY	COUNTRY	YEAR
Academic Degrees			
Magister Geofísica	University of Chile	Chile	1989
Graduate studies (DEA)	IPGP – University Paris 7, Paris	France	1991
Ph.D Geofísica	IPGP - University Paris 7, Paris	France	1995
Other			

Main Lines of Research/Specialty Areas

1.- Seismology / Seismotectonics / Physics of the Seismic Source
2.- Tectonism / Seismic Cycle and Lithospheric deformation
3.- Geodynamics / subduction

CURRENT ACADEMIC APPOINTMENT(S)	INSTITUTION	HOURS PER WEEK
Associate Professor	U. de Chile	44

VI.3. PARTICIPATION IN FONDECYT-APPROVED PROJECTS SINCE 1998.

YEAR		PROJECT NUMBER & TITLE	ROLE (PI, CoInvestigator)
Begin	End		
1999	2000	FONDECYT No 1990036; Title: Estimation and analysis of Strong Ground Motion of Intermediate Depth Earthqaukes In Constitución-Concepción Seismic Gap of Chile for Hazard;	PI
2004	2006	Fondecyt regular 1040808: Stress regimes induced by slab-pull, bending and unbending in subducting oceanic lithosphere associated with outer rise seismicity in the Central Chile region	Co-PI

VI.4. PARTICIPATION IN OTHER PROJECTS OR RESEARCH PROGRAMS FUNDED BY NATIONAL OR FOREIGN SOURCES SINCE 2003. SPECIFY THEIR GOALS AND EXPLAIN THEIR DIFFERENCES WITH THE CURRENT PROPOSAL. (Attach as many pages as needed)
FONDECYT Councils, at their discretion, may request proper certification.

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
1999	2003	ERS-A03 European Community	Survey of Large Surface Deformation in the Chile-Peru Seismic Gap using SAR Interferometry: the loading and triggering of giant earthquakes; No 362;	Co-PI
2001	2003	NSF (USA)	Slab Geometry and the Mountain Building Processes in South-Central Andes; EAR-9304949;	Co-PI
2001	2002	FNDR (Chile)	Broad Band Seismological Network for Metropiltain Region: Phase II;	PI
2000	2001	EXPLORA CONICYT (Chile)	Juvenil Academy of Earth Sciences in Internet. Phase I and II.	PI
1999	2000	CNRS/CONICYT (France-Chile)	New Seismotectonics Evidences for a Re-evaluation of the Seismic Hazard in the Hazard in the Metropilitan Region;	PI
1997	2000	ECOS/CONICYT (France-Chile)	Study of the Constitución-Concepción Seismic Gap.	PI
1996	1999	European Community Direction Générale XII	The Seismic Cycle in Chile: Evolution and Monitoring; Contract No CI1*-CT94-0109	Collaborator

1995	1999	PNRN-INSU (France)	Crustal Deformation and Seismic Cycle in Northern Chile.	Co-PI
1999	2003	ERS-A03 European Community	Survey of Large Surface Deformation in the Chile-Peru Seismic Gap using SAR Interferometry: the loading and triggering of giant earthquakes; / U. de Chile.	Co-PI
2002	2004	ECOS/CONICYT (France-Chile)	Estudio de la deformación actual en la laguna sísmica del Centro Sur de Chile. / U. de Chile	PI
2003	2005	ECOS/CONICYT (France-Chile)	Morphologie, tectonique, sismicité et couplage mécanique au Chili Central	Co-PI
2004	2007	ICM MIDEPLAN (Chile)	MILLENNIUM SCIENCE NUCLEUS OF SEISMOTECTONICS AND SEISMIC HAZARD	PI
2005	2007	FONDEF (Chile)	INCIDENCIA SISMICA EN OBRAS CIVILES Y HABITACIONALES DE LA CUENCA Y ZONA CORDILLERANA DE SANTIAGO	Co-PI
2007	2010	ICM MIDEPLAN (Chile)	MILLENIUM SCIENCE NUCLEUS MONTESSUS DE BALLORE INTERNATIONAL RESEARCH EARTHQUAKE CENTER.	PI

VI.5. PUBLICATIONS. Please provide full references (author(s), title, journal full name, volume, pages, year) for articles **accepted or published** over the last 5 years. If appropriate, specify the FONDECYT project number.

Please, be aware that female investigators who have given birth between 2003 to 2008, must report their scientific productivity since 2002.

a. Publications since 2003. Use additional sheets, if necessary. Use an "X" to check the appropriate box.
Identify the corresponding author by inserting an asterisk (*) to the left of his/her surname.

Author(s)	M. Chlieh, J. B. de Chabalier, J. C. Ruegg, R. Armijo, R. Dmowska, J. Campos, K. L. Feigl										
Article title	Crustal deformation and fault slip during the seismic cycle in the North Chile subduction zone, from GPS and InSAR observations										
Journal full name	*Geophysical Journal International*								FONDECYT Project		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date*						
	2004	158		doi:10.1111/j.1365	Published	X	In press		Accepted		

Author(s)	A. Gardi, A. Lemoine, R. Madariaga, and J. Campos										
Article title	Evidence of stress transfer in the Coquimbo region of Central Chile										
Journal full name	Journal of Geophysical Research								FONDECYT Project		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date*						
	2005				Published	X	In press		Accepted		

Author(s)	Clouard, V., Campos, J., Perez, A , Lemoine, A., and Kausel, E.										
Article title	Outer rise stress changes related to the subduction of the Juan Fernandez Ridge, Central Chile										
Journal full name	Journal of Geophysical Research				FONDECYT Project 1040808						
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date*						
	2006				Published	X	In press		Accepted		

Author(s)	Peyrat, S., **Campos, J.,** de Chabalier, J.B, Perez, A., Bonvalot, S., Bouin, M.P., Legrand, D., Nercessian, A., Charade, O., Patau, G., Clevede, E., Cisternas, A., Kausel, E., Bernard, P., Vilotte, J.P.										
Article title	"The Tarapaca Intermedia depth Earthquake. (MW=7.7, 2005, Northern Chile): a Slab-pull event with horizontal fault plane constrained from seismological and geodetic observations.										
Journal full name	Geophysical Reserch Letters, B05305 doi 10.1029/2005JB003999				FONDECYT Project						
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date*						
	2006	33			Published	X	In press		Accepted		

Author(s)	Sepulveda, S., Astroza, M., **Campos, J**., Kausel, J., Casas, E., Rebolledo, S., and Verdugo, R.,										
Article title	New Finding on the 1958 Las Melosas Earthquake sequence, Central Chile: Implications for Seismic Hazard Related to Shallow Crustal Earthquakes In Subduction Zones;										
Journal full name	*Journal of Earthquake Engineering, 12 (3), 432-455. DOI 10.180/13632460701512951.*				FONDECYT Project						
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date*						
	2007				Published	X	In press		Accepted		

Author(s)	Leyton, F., Pérez, A., **Campos, J.,** Rauld, R., and Kausel,							
Article title	Anomalous Seismicity in the Lower Crust of the Santiago Basin, Chile							
Journal full name	Accepted to *Physical of the Earth and Planetary Interior*, March 2008				FONDECYT Project Nº			
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date			
	2008				Published ☐	In press ☐	Accepted X☐	

Author(s)	Leyton, F., Ruiz, J., **Campos, J**., and Kausel, E.;							
Article title	Intraplate and Interplate Earthquakes in Chilean Subduction Zone: A Theoretical and Observational Comparison;							
Journal full name	Accepted to *Physical of the Earth and Planetary Interior*, March 2008.				FONDECYT Project Nº			
Bibliographic	Year	Vol.	Nº	Pages	Publication status to date			

Reference	2008				Published ☐	In press ☐	Accepted X☐

Author(s)	Vigny, Ch., Rudloff, A., Ruegg, J.C., Madarriaga, R., **Campos, J**., Alvarez, M						
Article title	Upper plate deformation measured by GPS im the Coquimbo Gap, Chile.						
Journal full name	Accepted to Physical of the Earth and Planetary Interior, March 2008.				FONDECYT Project Nº		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2008				Published ☐	In press ☐	Accepted X☐

b. Books and Book Chapters since 2003: Please provide full references and use additional sheets if necessary. Use an "X" to check the appropriate box.

Author(s)				
Title of Book or Chapter				
Editor(s) Name(s)				
Editorial				
Publication Place & Date				
Publication type				Pages
Book ☐	Book Chapter ☐	Monograph ☐		

c. Publications in Proceedings of Scientific Meetings since 2003. Include the publications relevant to this proposal topic.

Author(s)	Clouard, V., A. Flores, A. Perez, M. Gerbault and J. Campos,			
Abstract Title	The effect of seamount subduction on the stress field of the oceanic plate and the accretionary prism offshore Valparaiso, Central Chile			
Congress Title	EGU General Assembly			
Place, Date & Pages	Country: Austria	City: Vienna	Date: 04/2005	Page(s): 08641

Author(s)	Flores, A., V. Clouard, A. Pérez, M. Gerbault and J. Campos			
Abstract Title	Efecto de la subducción de una montaña marina sobre el campo de esfuerzos y el prisma de acreción frente a Chile central y su relación con la nucleación del			
Congress Title	Achisina, IX Jordanas			
Place, Date & Pages	Country: Chile	City: Concepción	Date: 11/2005	Page(s): A01-29

Author(s)	**Campos, J.,** Peyrat, S., Bejar, M., Socquet, A., Meneses, G., Perez, A., Madariaga, R., Favreau, P., Bernard, P., Barrientos, S., Armijo, R., Armijo,
Abstract Title	The Mw 7.7 Tocopilla, Chile, Earthquake of 14 November 2007: A Comprehensive Study Using

Congress Title	S24A-01**;** Joint Assembly,			
Place, Date & Pages	Fort Lauderdale, Florida,	27–30 May 2008.		

Author(s)	Béjar-Pizarro, M., Carrizo, D., Socquet, A., Armijo, R, de Chabalier, J B., Nercessian, A., Charade, O., Ruegg, J C., Barrientos, S., **Campos, J.;**			
Abstract Title	Rupture Geometry and Slip Associated With the 2007 November 14 Mw = 7.7 Tocopilla (Chile) Earthquake, as Preliminary Determined by InSAR and			
Congress Title	S24A-01**;** Joint Assembly,			
Place, Date & Pages	Fort Lauderdale, Florida,	27–30 May 2008.		

Author(s)	Peyrat, S., Madariaga, R., **Campos, J.,** Asch, G., Favreau, P., Bernard, P., Vilotte, J			
Abstract Title	Detailed source process of the 2007 Tocopilla earthquake;			
Congress Title	S24A-01**;** Joint Assembly			
Place, Date & Pages	Fort Lauderdale, Florida	27–30 May 2008.		

Author(s)	Kuge, K, **Campos, J**., Perez, A., and Ruiz, J.,			
Abstract Title	Source Characterization of the 13 June 2005 Tarapaca, Chile, Intermediate-depth Earthquake (Ms7.8),			
Congress Title	Eos Trans. AGU, 87(52), Fall Meet. Suppl., Abstract AGU-xx,			
Place, Date & Pages	San Francisco,	California.	Dic 11-15 2006	

d. Thesis Direction. List Doctoral and Master's theses directed since 2003.

Students Names	Thesis Title	Degree, Institution & Year Awarded
Marcela Villarroel	Modelo de Ciclo Sísmico en zonas de subducción	MsCs. 1998, Depto. Geofísica, Fac. Cs. Fís. y Matemáticas, Universidad de Chile
Robert Fromm	Parámetros focales para sismos de magnitud < 6.5 utilizando redes de cobertura regional	MsCs. 2001, Depto. Geofísica, Fac. Cs. Fís. y Matemáticas, Universidad de Chile
Felipe Leyton	Comparativo de Sismos interplaca e intraplaca desde el punto de vista sismológico en Chile	MsCs. 2001, Depto. Geofísica, Fac. Cs. Fís. y Matemáticas, Universidad de Chile
Javier Ruiz	Efectos sismogénicos en los movimientos fuertes del suelo para sismos chilenos: aspectos teóricos y observacionales.	MsCs. 2002, Depto. Geofísica, Fac. Cs. Fís. y Matemáticas, Universidad de Chile

VI.1. BIOGRAPHICAL INFORMATION

1	4	6	9	9	3	1	4		1

TAXPAYER ID # (Do not include decimal point)

Perez	Franco	Adriana
FATHER 'S SURNAME	**MOTHER'S MAIDEN SURNAME**	**NAMES**

18	09	1971	M ☐ F ☒	Colombiana	56-2-9784971	56-2-6968686
Day	**Mont**	**Year**				
DATE OF BIRTH			**SEX**	**NATIONALITY**	**TELEPHONE**	**FAX**

aperez@dgf.uchile.cl
MAILING ADDRESS

Metropolitana	Santiago	2777	aperez@dgf.uchile.cl
REGION	**CITY**	**P.O. BOX**	**E-MAIL ADDRESS**

Dpto Geofisica/Fc Cs Fisicas y Mat/Universidad de Chile
INSTITUTION

VI.2. ACADEMIC BACKGROUND

Professional Title(s)	UNIVERSITY	COUNTRY	YEAR
Ingeniera Geóloga	Universidad Nacional de Colombia. Sede Medellín.	Colombia	1996
Sismologa	Universidad de Chile	Chile	2002
Academic Degrees			
Magíster en Ciencias, Mención Geofísica, Área Física de la Tierra Sólida.	Universidad de Chile.	Chile	2002
Other			

Main Lines of Research / Specialty Areas

1.- Seismology: hypocentral determination, determination of velocity models, data bases construction and analysis, relocation hypocentral using different programs, seismic modeling.

2.-Geodesy
3.-Seismotectonics

CURRENT ACADEMIC APPOINTMENT(S)	INSTITUTION	HOURS PER WEEK
Resercher	Particular	45

VI.3. PARTICIPATION IN FONDECYT-APPROVED PROJECTS SINCE 1998.

YEAR		PROJECT NUMBER & TITLE	ROLE (PI, CoInvestigator)
Begin	End		

VI.4. PARTICIPATION IN OTHER PROJECTS OR RESEARCH PROGRAMS FUNDED BY NATIONAL OR FOREIGN SOURCES SINCE 2003. SPECIFY THEIR GOALS AND EXPLAIN THEIR DIFFERENCES WITH THE CURRENT PROPOSAL. (Attach as many pages as needed)
FONDECYT Councils, at their discretion, may request proper certification.

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2004	2007	**ICM** MIDEPLAN (Chile)	MILLENNIUM SCIENCE NUCLEUS OF SEISMOTECTONICS AND SEISMIC HAZARD	
SPECIFICATION:				

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2005	2008	**FONDEF**	INCIDENCIA SISMICA EN OBRAS CIVILES Y HABITACIONALES D ELA CUENCA Y ZONA CORDILLERANA DE SANTIAGO	
SPECIFICATION:				

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2007	2010	**ICM. MIDEPLAN**	MILLENIUM SCIENCE NUCLEUS MONTESSUS DE BALLORE INTERNATIONAL RESEARCH EARTHQUAKE CENTER.	
SPECIFICATION:				

VI.5. PUBLICATIONS. Please provide full references (author(s), title, journal full name, volume, pages, year) for articles **accepted or published** over the last 5 years. If appropriate, specify the FONDECYT project number.

Please, be aware that female investigators who have given birth between 2003 to 2008, must report their scientific productivity since 2002.

c. Publications since 2003. Use additional sheets, if necessary. Use an "X" to check the appropriate box.

Identify the corresponding author by inserting an asterisk (*) to the left of his/her surname.

Author(s)	**Clouard, V**., Campos, J., Perez, A , Lemoine, A., and Kausel, E									
Article title	Outer rise stress changes related to the subduction of the Juan Fernandez Ridge, Central Chile									
Journal full name	Journal of Geophysical Research B05305 doi 10.1029/2005JB003999				FONDECYT Project 1040808					
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date*					
	2007	112			Published	x	In press		Accepted	

Author(s)	Peyrat, S., Campos, J., de Chabalier, J.B, **Perez, A**., Bonvalot, S., Bouin, M.P., Legrand, D., Nercessian, A., Charade, O., Patau, G., Clevede, E., Cisternas, A., Kausel, E., Bernard, P., Vilotte, J.P.						
Article title	"The Tarapaca Intermedia depth Earthquake. (MW=7.7, 2005, Northern Chile): a Slab-pull event with horizontal fault plane constrained from seismological and geodetic observations.						
Journal full name	Geophysical Reserch Letters, L22308, doi:10.1029/2006GL027710				FONDECYT Project Nº		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2006	33			Published X☐	In press ☐	Accepted ☐

Author(s)	Leyton, F., **Pérez, A**., Campos, J**.,** Rauld, R., and Kausel,						
Article title	Anomalous Seismicity in the Lower Crust of the Santiago Basin, Chile						
Journal full name	Accepted to *Physical of the Earth and Planetary Interior*, March 2008				FONDECYT Project Nº		
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2008				Published ☐	In press ☐	Accepted X☐

d. Books and Book Chapters since 2003: Please provide full references and use additional sheets if necessary. Use an "X" to check the appropriate box.

Author(s)				
Title of Book or Chapter				
Editor(s) Name(s)				
Editorial				
Publication Place & Date				
Publication type				Pages
Book ☐	Book Chapter ☐	Monograph ☐		

c. Publications in Proceedings of Scientific Meetings since 2003. Include the publications relevant to this proposal topic.

Author(s)	Pardo, M., T. Monfret, E. Vera, A. Eisenberg, S. Gaffet and **A. Perez**			
Abstract Title	Flat-slab subduction zone in Central Chile-Argentina: Seismotectonic and body-wave tomography from local data			
Congress Title	5th International Symposium on Andean Geodynamics			
Place, Date & Pages	Country: TOLOUSE	City: FRANCIA	Date:2002	Page(s):469-472

Author(s)	Campos, J., Clouard, V., Lemoine, A., Kausel, E., and **Perez, A**.			
Abstract Title	Outer Rise Stress Changes in Central Chile related to the 1985 Mw 7.8 Valparaíso Earthquake			
Congress Title	APRU/AEARU Research Symposium of Earthquake Hazard around the Pacific Rim – Prediction and Disaster Prevention			
Place, Date & Pages	Country: JAPON	City: KYOTO	Date:AGOSTO 2005	Page(s):109

Author(s)	Clouard, V., A. Flores**, A. Perez**, M. Gerbault and J. Campos			
Abstract Title	The effect of seamount subduction on the stress field of the oceanic plate and the accretionary prism offshore Valparaiso, Central Chile			
Congress Title	EGU General Assembly			
Place, Date & Pages	Country: AUSTRIA	City:VIENNA	Date:04/2005	Page(s): 08641

Author(s)	Flores, A., V. Clouard, **A. Pérez**, M. Gerbault and J. Campos			
Abstract Title	Efecto de la subducción de una montaña marina sobre el campo de esfuerzos y el prisma de acreción frente a Chile central y su relación con la nucleación del			
Congress Title	Achisina, IX Jordanas			
Place, Date & Pages	Country: CHILE	City: CONCEPCION	Date:11/2005	Page(s): A01-29

Author(s)	Campos, J**., A. Perez**, Denis Legrand, Armando Cisternas, Valerie Clouard, Edgard Kausel, R. Dannot, Sylvain Bonvalot, Jean-Bernard de Chabalier, Anne Lemoine,			
Abstract Title	*Source parameters and GPS deformation of the Mw 7.8 Tarapaca intermediate depth earthquake (Northern Chile) of June 13, 2005*			
Congress Title	, AGU Fall Meeting			
Place, Date & Pages	Country: USA	City: SAN FRANCISCO	Date:12/2005	Page(s):

Author(s)	Clouard, V., **Perez, A**., Campos, J.,			
Abstract Title	Temporal Evolution of the outer rise stress offshore Valparaíso between 1906 and 2001			
Congress Title	International Conference Montessus de Ballore 2006, Valparaiso Earthquake Centennial			
Place, Date & Pages	Country: CHILE	City: SANTIAGO	Date:11/2006	Page(s):

Author(s)	Leyton, F., **Perez, A**., Campos, J., Rauld, R., Kausel, E			
Abstract Title	Anomalous Seismicity in the Lower Crust of the Santiago Basin.			
Congress Title	International Conference Montessus de Ballore 2006, Valparaiso Earthquake Centennial			
Place, Date & Pages	Country: CHILE	City: SANTIAGO	Date:11/2006	Page(s):

Author(s)	Kuge, K, Campos, J., **Perez, A**., and Ruiz, J.,			
Abstract Title	Source Characterization of the 13 June 2005 Tarapaca, Chile, Intermediate-depth Earthquake (Ms7.8),			
Congress Title	Eos Trans. AGU, 87(52), Fall Meet. Suppl., Abstract AGU-xx,			
Place, Date & Pages	San Francisco,	California.	Dic 11-15 2006	

Author(s)	J Campos, S Peyrat, M Bejar, A Socquet, G Meneses, A Perez, R Madariaga, P Favreau, P Bernard, **S Barrientos**, R Armijo, G Asch, M Sobesiak, J Vilotte			
Abstract Title	The Mw 7.7 Tocopilla, Chile, Earthquake of 14 November 2007: A Comprehensive Study Using Teleseismic, Local and InSAR data			
Congress Title	AGU Joint. Assem			
Place, Date & Pages	Country: USA	City: Fort Lauderdale	Date:2008	Page(s):

Author(s)	Campos, J**.,** Peyrat, S., Bejar, M., Socquet, A., Meneses, G., **Perez, A.,** Madariaga, R., Favreau, P., Bernard, P., Barrientos, S., Armijo, R., Armijo,			
Abstract Title	The Mw 7.7 Tocopilla, Chile, Earthquake of 14 November 2007: A Comprehensive Study Using			
Congress Title	S24A-01**;** Joint Assembly,			
Place, Date & Pages	Fort Lauderdale, Florida,	27–30 May 2008.		

d. Thesis Direction. List Doctoral and Master's theses directed since 2003.

Students Names	Thesis Title	Degree, Institution & Year Awarded

VII. AVAILABLE RESOURCES: If applicable, identify means and resources available at the sponsoring institution(s) to carry out this proposal. **The maximum length for this section is 1 page (Arial or Verdana font size 10).**

In France, at “laboratoire de Géologie” of Ecole Normale Supérieure

- 3 Linux workstations dedicated to GPS data processing
- Free access to a 32 nodes parallel cluster of CPUs.
- Access to the French pool of GPS receivers (30 Ashtech ZX-treme), available for campaign style measurements at no financial cost for French investigators.

In Chile, at DGF U-Chile

- 7 GPS receivers (Trimble Net-Rs) from Millenio (J. Campos)
- GPS data archive managed by servicio sismologico (40+ cGPS stations over all Chile)

In Argentina, at ?

- support for field operations
- support for installation of cGPS stations and data flow

VIII. AMOUNTS AND JUSTIFICATION OF FUNDS REQUESTED FROM FONDECYT.

VIII.1 FUNDS FOR EACH PERFORMING UNIT. (Please use one sheet for each University Department).

University of Chile / Faculty of Physics and Mathematics Sciences / Detp. Of Geophysics			
INSTITUTION (University / Faculty / Department)			
BLANCO ENCALADA 2002		60.910.000-1	
MAILING ADDRESS		INSTITUTION TAX ID	
2777	santiago	56-2-9784309	56-2-6968686
P.O. BOX	CITY	TELEPHONE	FAX
E-MAIL ADDRESS			

NAME OF INSTITUTIONAL REPRESENTATIVE

_____

The above named Institutional Representative certifies to know the terms and regulations of this FONDECYT

INSTITUTIONAL

Particular			
INSTITUTION (University / Faculty / Department)			
BLANCO ENCALADA 2002		14.699.314-1	
MAILING ADDRESS		INSTITUTION TAX ID	
2777	Santiago	56-2-9784971	56-2-6968686
P.O. BOX	CITY	TELEPHONE	FAX
aperez@dgf.uchile.cl			
E-MAIL ADDRESS			

NAME OF INSTITUTIONAL REPRESENTATIVE

_____

The above named Institutional Representative certifies to know the terms and regulations of this FONDECYT

INSTITUTIONAL

BUDGET ITEMS	ANNUAL AMOUNTS (1000 CLP$)				
	Year 1	Year 2	Year 3	Year 4	TOTAL
1. STAFF	10500	10500	10500		31500
2. TRAVEL					
2.1 PROPOSAL TRAVEL					
Domestic Per Diem		200	200		400
Domestic Fares		100	100		200
International Per Diem		890	890		1780
International Fares		1800	1800		3600
2.2 TRAVEL INTERNATIONAL COOPERATION					
International Per Diem	1000	1000	1000		3000
International Fares	1000	1000	1000		3000
Total Travel	**2000**	**4990**	**4990**		**11980**
3. OPERATIONAL EXPENSES	6270	7570	7570		21410
4. EQUIPMENT	22500	1352			23852
TOTAL REQUESTED (1+2+3+4)	**41870**	**23272**	**21920**		**88742**

VIII.2 HONORARIA REQUESTED FOR EACH PERFORMING UNIT RESEARCH STAFF. Please read Application Instructions. (Include data for all researchers, even if no honoraria are being requested).

RESEARCH UNIT (INSTITUTION / UNIVERSITY/ FACULTY/ DEPARTMENT)			ANNUAL AMOUNTS (1000 CHP)				
ROLE	TAXPAYER	FULL NAME	Year 1	Year 2	Year 3	Year 4	TOTAL
PI	5.782.949-4	Sergio Barrientos Parra	**3.200**	**3.200**	**3.200**		**9600**
CoInvestigator	8.869.720-0	Jaime Campos Muñoz	**2.500**	**2.500**	**2.500**		**7500**
CoInvestigator							
CoInvestigator							
Thesis/Doctoral Students			**1.300**	**1.300**	**1.300**		**3.900**
Technical & Support Staff			**1.200**	**1.200**	**1.200**		**3.600**
SUB-TOTAL HONORARIA (1000 CHP)			**8.200**	**8.200**	**8.200**		**24600**

PRIVATE (Include here staff personnel **not affiliated** with an institution/organization).			**ANNUAL AMOUNTS (1000 CHP)**				
ROLE	**TAXPAYER**	**FULL NAME**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**TOTAL**
CoInvestigator	14699314-1	Adriana Perez	**2.300**	**2.300**	**2.300**		**6.900**
TOTAL PERSONNEL (1000 CHP)			**2.300**	**2.300**	**2.300**		**6.900**

VIII.3. JUSTIFICATION OF REQUESTED AMOUNTS: Justify the annual amounts requested for each of the items above.

1.a. If applicable, fully describe the tasks of all **technical & support staff** for which honoraria are being requested. Make sure their inclusion is directly related to the proposed goals and work plan of the research.

1.b. Clearly specify if this proposal intends to fund **theses students/Doctoral students**. For theses students, include the names of prospective candidates, possible topics and degree objective. For Doctoral students, indicate the name of the program.

PhD in Seismology. University of Chile
Initiation: March 2009.
Funds: This Project
Duration: 3 years

2. TRAVEL

2.1. PROPOSAL TRAVEL: Funding may be requested for activities directly related to the proposal development and dissemination of results.

a. FOREIGN TRAVEL: All trips abroad require a **clear justification**. Indicate tentative destinations, number of days and amounts for each trip. Estimate annual international travel fares and per diem expenses. Remember that only coach fares are acceptable. Please read the **Application Instructions**.

	AMOUNTS (1000 CHP)		Purpose	No. Days
	Fares	Per Diem		
Year 1				
Year 2	1.200	540	AGU Meeting , San Francisco California, 2009	6
Year 3	1.200	540	AGU Meeting, San Francisco, California, 2010	6
Year 4				

Justification (for each year):

The AGU Assembly which takes place annually in San Francisco, is the ideal environment to make a presentation on the progress of the project, in addition to be the body to generate an atmosphere of discussion around the topic of the crustal deformation that is representative of processes leading to future earthquakes in the Chilean subduction zone and/or the associated crustal faults and detect changes in deformation patterns using permanent and temporary GPS measurements

b. **DOMESTIC TRAVEL & FIELD TRIPS**: Per Diem expenses related to domestics field trips must be justified. Provide a detailed schedule including transportation means to be used. Include a tentative calendar of national scientific meetings you plan to attend.

	AMOUNTS (1000 CHP)		Purpose	No. Days
	Fares	Per Diem		
Year 1				
Year 2	100 600	200 350	Congreso en Chile Congreso en America Latina	4 5
Year 3	100 600	200 350	Congreso en Chile Congreso en America Latina	4 5
Year 4				

Justification (for each year):

2.2. INTERNATIONAL COOPERATION FOREIGN TRAVEL ITEM: Please justify your request for international cooperation activities funding. Explain why the visit of a researcher residing abroad will benefit achievement of your proposal goals. Remember that only coach fares are acceptable. Please read the **Application Instructions**

	AMOUNTS (1000 CHP)		Justification	No. Days
	Fares	**Per Diem**		
Year 1	1400	1200	The researcher is an expert in GPS and is fundamentally for the project	15
Year 2	1400	1200		15
Year 3	1400	1200		15
Year 4				

3. **OPERATIONAL EXPENSES:** Specify and justify, for each proposal year the amounts requested, if applicable, for the following items: computing-related items, reagents and other laboratory non-durable materials, field trip related expenses (vehicle rental, shipping charges, gasoline, lubricants, highway tolls), books purchases, scientific journals and subscription fees (all of which must be registered with the performing unit), scientific meetings registration fees, payments for services, hiring of occasional auxiliary personnel, publishing costs of proposal-derived papers on ISI-indexed journals or equivalent depending on the nature of the field.

since 2004, we realized 2 GPS campaigns every year in the area of Illapel-Coquimbo. We are very much used to managing these campaigns and controlling field operations and expenses.
A campaign dedicated to measure a network of 30 points over an area of 400 km (North-South) and from the coast to the cordillera is:
- 15 receivers
- 20 batteries (re-usable for the whole duration of the project)
- 3 teams (of 2 people and 1 car -camionetta)
- 15 days of measurements
- 10,000 km in total (=> 1000l of gas)

and almost always costs 11-12 kUSD (depending on if we have to buy hardware like batteries, tools, etc.. Here they are on a separated line). We want 3 campaigns over the 3 years of the project duration

- 4x4 car rental (75.000 $ /day) x3x15daysx3camp => $10.000.000
- Food/lodging during camps. (40.000/day/pers) x3x15daysx3camp=> $5.400.000
- Combustible (750$/liter) x1000x3camp =>$2.250.000 USD
- **TOTAL gastos de terreno** **$17.650.000**

- **Scientific meetings registration fees (AGU: US$ 1500) $375.000 * 2 years= $750.000.-**
- **Non-durable materials, Fax, Tel, etc. = $200,000.- x 3 years = $ 600,000.-**
- **Material for computation (Toner): 185,000 .- x 3 years = $ 555,000**
- **Publishing costs of proposal-derived papers (3) = US$ 4,500.- = $2,250,000.-**

4. EQUIPMENT FOR EACH PERFORMING UNIT.

Indicate the quantity and cost of each piece of equipment being requested. This amount(s) specified must include transportation, insurance and applicable import taxes costs. Non-durable, expendable items, must be included under Operational Expenses. Include, if deemed relevant, one quotation/proforma invoice. **No equipment purchase is allowed during the last execution year.**

a. Equipment specifications

University of Chile / Fc Cs Fis y Mat / Department of Geophysics								
RESEARCH UNIT (INSTITUTION / UNIVERSITY/ FACULTY/ DEPARTMENT)							**FONDECYT USE**	
	Amounts (1000 CHP)							
	Year 1		**Year 2**		**Year 3**		**TOTAL**	
ITEM	**Qty.**	**1000 CHP**	**Qty.**	**1000 CHP**	**Qty.**	**1000 CHP**	**Qty.**	**1000 CHP**
1. Net-RS, UNAVCO	**4**	**20000**						
2. Specially designed marker.	**30**	**750**						
3. Batteries 70 Ah	**20**	**1000**						
4. Small hardware tools (drill bit, glue, …)		**750**						
5. Notebook			**2**	**1.350**				
TOTAL		**22500**		**1.350**				

b. **EQUIPMENT JUSTIFICATION**: Each piece of equipment requested must be clearly justified considering the proposal goals and intended work plan. Purchase of furniture or upgrading of physical spaces for the proper execution of the project is allowed.

- Net-RS, UNAVCO price list (10,000 USD)	x4	=>	40,000 USD
- Specially designed marker (50 USD)	x30	=>	1,500 USD
- Batteries 70 Ah (200 USD)	x20	=>	4,000 USD
- Small hardware tools (drill bit, glue, …)		=>	1,500 USD

- The additional 4 receivers are needed to install 4 last cGPS in Argentina (Check Unvaco price list for Chile at Trimble dealer in Chile ?)

- The specially designed marker are needed because we want stainless steel (so that the markers last for decades), long enough (12 cm) so that they are extremely difficult to destroy or remove, large enough (25 mm) so that we can directly screw the GPS antennas on them, avoiding tripods and optical tribrachs which are a source of errors and increase the level of measurements uncertainty. 50 USD a piece is an estimation based on what we usually pay at workshops equipped to tool stainless steel parts.

- 20 batteries is what we need to operate 15 receivers, and move them from one location to the next one while recharging 5 batteries everyday. We need 70 Ah because we want 4 to 5 days of continuous measurements and the receiver use 0.5 A (=12 Ah /day).

- The markers are large and long, so that drilling holes of this size in hard outcrops is not an easy task. We need the best (expensive) type of drill bits to do that. The life time of a drill bit depends essentially on the hardness of the rocks drilled….our experience is that we need to replace the 3 biggest (22,25,28) every 20-30 holes = 600 USD

- We use special 2 component glue to seal the markers. The quality of the glue is essential for the duration of the site (decades). We use 1 set of Fisher FIS-P-300-TP (~20USD) for each marker = 600 USD

- Finally, we always need boxes of small tools (screwdrivers, pliers, electric cables, etc etc etc) we evaluate this cost at ~300 USD over the duration of the project.

IX. ANEXOS

IX.1 REQUERIMIENTOS DE ETICA, BIOSEGURIDAD y OTROS:

Los(Las) investigadores(as) de proyectos FONDECYT deben cumplir con los estándares éticos y bioéticos que regulan la actividad científica, así como velar por la adecuada protección de especies protegidas y animales de experimentación, el adecuado manejo de materiales potencialmente dañinos para la salud y uso de archivos o documentos protegidos. En todos estos casos deben adjuntar a su postulación uno o más de los siguientes documentos:

Aquellos proyectos que involucren estudios en seres humanos, (biomédicos, pre-clínicos, clínicos, encuestas, entrevistas, focus groups, etc.) deberán contar con:

- certificación aprobatoria fundamentada del Comité de Ética/ Bioética de la **Institución Patrocinante Principal** (Institución del(de la) Investigador(a) Responsable). Además, debe adjuntar la autorización escrita **de la autoridad correspondiente** de cada una de las instituciones del proyecto **donde se realicen dichos estudios**, aceptando explícitamente la aprobación de la institución patrocinante principal o adjuntando la certificación aprobatoria de esa institución.

- un ejemplar del(de los) documento(s) de consentimiento informado "ad hoc" para el estudio, que considere los aspectos específicos del protocolo al que se incorporen los sujetos de estudio, cuyos principales contenidos se encuentran disponibles en la página web de FONDECYT **www.fondecyt.cl/bioetica**

Los proyectos que incluyan experimentación con animales deberán presentar certificación aprobatoria fundamentada del Comité de Bioética de la Institución Patrocinante **Principal y de la(las) institución(es) donde se realice la experimentación**.

Los Consejos se reservan el derecho a recabar directamente un pronunciamiento ético/bioético independiente en los casos que considere necesario, como asimismo, a auditar los aspectos éticos/bioéticos de los proyectos tomando las medidas que estime pertinentes de encontrar discrepancias o incumplimientos en relación al protocolo aprobado.

En aquellos proyectos que se manejen patógenos para humanos, animales o plantas, ADN recombinante y/o radioisótopos u otros elementos de riesgo, deberán contar con la certificación de un Comité Institucional de Bioseguridad (CIB) de cada Institución Patrocinante donde se realice experimentación de acuerdo a las especificaciones contenidas en el "Manual de Normas de Bioseguridad", de CONICYT edición 2008, disponible en la página web de FONDECYT www.fondecyt.cl. En su defecto, podrá adjuntar una carta fundamentada del (de la) Investigador(a) Responsable que indique las medidas de bioseguridad que se tomarán y facilidades que cuenta para realizar la investigación de acuerdo a las especificaciones del Manual. En caso que el proyecto no cuente con las medidas apropiadas, los Consejos podrán decidir su rechazo o aprobación condicionada a la adecuación de las instalaciones para los experimentos propuestos.

Los proyectos que involucren estudios en especies protegidas, sitios arqueológicos, áreas silvestres protegidas (SNASPE), utilización de archivos - información reservada -, internación de especies animales y/o vegetales y otras, deberán anexar las autorizaciones emitidas por los organismos correspondientes.

A continuación de esta hoja anexe, si es aplicable a su proyecto, todos los permisos, certificaciones y autorizaciones que corresponda.

En caso que las certificaciones estén en proceso y con el fin de evaluar su proyecto con la totalidad de los antecedentes, el(la) Investigador(a) Responsable deberá hacerlas llegar a FONDECYT hasta el lunes 18 de agosto de 2008. La falta de estos antecedentes, dejará fuera de bases al proyecto y, en consecuencia, no seguirá participando en el presente concurso.

Curriculum vitae from CHRISTOPHE VIGNY, INTERNATIONAL COOPERATION.

VI.1. BIOGRAPHICAL INFORMATION

0	7	A	L	3	9	0	2		1

TAXPAYER ID # (Do not include decimal point)

Vigny		Christophe
FATHER 'S SURNAME	**MOTHER'S MAIDEN SURNAME**	**NAMES**

02	03	1964	**M**	X	**F**		Frances		
Day	**Mont**	**Year**							
DATE OF BIRTH			**SEX**				**NATIONALITY**	**TELEPHONE**	**FAX**

vigny@mailhost.geologie.ens.fr

MAILING ADDRESS

	Paris	75231 cedex 05	vigny@mailhost.geologie.ens.fr
REGION	**CITY**	**P.O. BOX**	**E-MAIL ADDRESS**

Département **T**erre **A**tmosphère **O**céan
École Normale Supérieure

INSTITUTION

VI.2. ACADEMIC BACKGROUND

Professional Title(s)	UNIVERSITY	COUNTRY	YEAR
Licenciatura en Fisica	University Paris XI	Francia	1985
Academic Degrees			
Magister en Fisica	University Paris XI	Francia	1986
PhD Ciencias de la Tierra	University Paris XI	Francia	1989
Other			

Main Lines of Research / Specialty Areas

1.- crustal deformation measured by precise satellite positioning (GPS)
2.-
3.-

CURRENT ACADEMIC APPOINTMENT(S)	INSTITUTION	HOURS PER WEEK

VI.3. PARTICIPATION IN FONDECYT-APPROVED PROJECTS SINCE 1998.

YEAR		PROJECT NUMBER & TITLE	ROLE (PI, CoInvestigator)
Begin	End		
		NOT APLAY	

VI.4. PARTICIPATION IN OTHER PROJECTS OR RESEARCH PROGRAMS FUNDED BY NATIONAL OR FOREIGN SOURCES SINCE 2003. SPECIFY THEIR GOALS AND EXPLAIN THEIR DIFFERENCES WITH THE CURRENT PROPOSAL. (Attach as many pages as needed)

FONDECYT Councils, at their discretion, may request proper certification.

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2003	2005	French ministery of research (ACI)	Monitoring of Palu fault, Sulawesi, Indonesia	PI
SPECIFICATION:				

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2004	2006	European community	SEAMERGES (monitoring seismic hazards in SE-Asia)	Co-PI
SPECIFICATION:				

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2006	2008	French government (ANR)	SUBCHILE (Subduction in Chile)	Co-PI

SPECIFICATION:

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2006	2008	French Embassy in Indonesia	Geodesy in Indonesia	PI
SPECIFICATION:				

YEAR		FUNDING SOURCE	PROJECT TITLE	ROLE (PI, Coinvestigator)
Begin	End			
2007	2009	French Government (ANR)	OPOSSUM (Observation and modelisation on Sumatra)	PI
SPECIFICATION:				

VI.5. PUBLICATIONS. Please provide full references (author(s), title, journal full name, volume, pages, year) for articles **accepted or published** over the last 5 years. If appropriate, specify the FONDECYT project number.

Please, be aware that female investigators who have given birth between 2003 to 2008, must report their scientific productivity since 2002.

e. Publications since 2003. Use additional sheets, if necessary. Use an "X" to check the appropriate box.

Identify the corresponding author by inserting an asterisk (*) to the left of his/her surname.

Author(s)	Nilforoushan, F., P. Vernant, F. Masson, **C. Vigny**, J. Martinod, M. Abbasi, H. Nankali, D. Hatzfeld, R. Bayer, F. Tavakoli, A. Ashtiani, E. Doerflinger, M. Daignières, P. Collard, J. Chéry						
Article title	GPS network monitors the Arabia-Eurasia collision deformation in Iran						
Journal full name	*Journal of Geodesy* doi:10.1007/s00190-003-0326-S						FONDECYT Project Nº
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2003	77		422-441	Published x	In press ☐	Accepted ☐

Author(s)	**Vigny, C.**, A. Socquet, C. Rangin, N. Chamot-Rooke, M. Pubellier, M.N. Bouin, G. Bertrand, M. Becker

Article title	Present day crustal deformation around Sagaing fault, Myanmar						
Journal full name	*J. Geophys. Res,* doi:101029/2002JB001999					FONDECYT Project Nº	
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2003	108			Published X	In press ☐	Accepted ☐

Author(s)	Present day crustal deformation and plate kinematics in Middle East constrained by GPS measurements in Iran and northern Oman						
Article title	Vernant, P., F. Nilforoushan, D. Hatzfeld, M. Abbasi, **C. Vigny**, F. Masson, H. Nankali, J. Martinod, A. Ashtiani, R. Bayer, F. Tavakoli, J. Chéry						
Journal full name	*Geophysical Journal International*					FONDECYT Project Nº	
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
		157	2004	381-398	Published X	In press ☐	Accepted ☐

Author(s)	Insight into the 2004 Sumatra-Andaman earthquake from GPS measurements in southeast Asia						
Article title	**Vigny, C.**, W. Simons, S. Abu, R. Bamphenyu, C. Satirapod, N. Choosakul, C. Subarya, A. Socquet, K. Omar, H. Abidin and B.A.C. Ambrosius						
Journal full name	*Nature*					FONDECYT Project Nº	
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2005	*vol 436,*		*pp201-206*	Published x☐	In press ☐	Accepted ☐

Author(s)	GPS determination of the relative motion between India ands Sunda, and its accomodation in Myanmar						
Article title	Socquet, A., **C. Vigny**, W. Simons, N. Chamot-Rooke, C. Rangin, B. Ambrosius						
Journal full name	*J. Geophys. Res* B05406, doi:10.1029/2005JB003877					FONDECYT Project Nº	
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2006	111			Published x☐	In press ☐	Accepted ☐

Author(s)	Kinematic behaviour, crustal block rotations and plate coupling in the triple junction area in SE Asia from inversion of GPS and slip vector data (Sulawesi, Indonesia						
Article title	Socquet, A., W. Simons, **C. Vigny**, R. McCaffrey, B. Ambrosius, W. Spakman, C. Subarya and D. Sarsito						
Journal full name	*J. Geophys. Res* , B08409, doi:10.1029/2005JB003963					FONDECYT Project Nº	
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2006	111			Published x☐	In press ☐	Accepted ☐

Author(s)	A decade of GPS in SE Asia: Resolving Sundaland motion and boundaries

Article title	Simons, W., A. Socquet, **C. Vigny**, B. Ambrosius, S. Haji Abu, Chaiwat Promthong, C. Subarya, D. Sarsito, S. Matheussen, P. Morgan, ,and W. Spakman						
Journal full name	*J. Geophys. Res* B06420, doi:10.1029/2005JB003868						FONDECYT Project Nº
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2007	112			Published x☐	In press ☐	Accepted ☐

Author(s)	Defining the source region of the Indian Ocean Tsunami from GPS, altimeters, tide gauges and Tsunami models						
Article title	Pietrzak, J., A. Socquet, D. Ham, W. Simons, **C. Vigny**, R. J. Labeur, E. Schrama, G. Stelling, and D. Vatvani						
Journal full name	*EPSL* doi:10.1016/j.epsl.2007.06.002						FONDECYT Project Nº
Bibliographic Reference	Year	Vol.	Nº	Pages	Publication status to date		
	2007	261		49-64	Published x☐	In press ☐	Accepted ☐

f. Books and Book Chapters since 2003: Please provide full references and use additional sheets if necessary. Use an "X" to check the appropriate box.

Author(s)				
Title of Book or Chapter				
Editor(s) Name(s)				
Editorial				
Publication Place & Date				
Publication type				Pages
Book ☐	Book Chapter ☐	Monograph ☐		

c. Publications in Proceedings of Scientific Meetings since 2003. Include the publications relevant to this proposal topic.

Author(s)	**Vigny, C.**, W. Simons, S. Abu, R. Bamphenyu, C. Satirapod, M. Hashizume, C. Subarya, P. Tregoning, B. Ambrosius			
Abstract Title	Monitoring of the December 26th 2004 mega-thrust earthquake in SE Asias by GPS			
Congress Title	*trans. EGU, EGU05-A-10732 Geophysical Research abstracts,*			
Place, Date & Pages	Country: USA	City:San Francisco	Date:2005	Page(s):

Author(s)	**Vigny, C.**, W. Simons, S. Abu, R. Bamphenyu, C. Satirapod, M. Hashizume, C. Subarya, A. Socquet, K. Omar, H.Z. Abidin, and B. Ambrosius			
Abstract Title	Banda Aceh 26 december 2004 earthquake monitored by GPS			
Congress Title	*7th surveyor congress, Institution of Surveyors Malaysia (ISM),*			
Place, Date & Pages	Country: Malasia	City:Kuala-Lumpur	Date: June 2005	Page(s):

Author(s)	**Vigny, C.**, W. Simons, A. Socquet, and B. Ambrosius			
Abstract Title	GPS unveils Actual Impact of the Mega-thrust Earthquake in SE-Asia			
Congress Title	*SEAMERGES final meeting,*			
Place, Date & Pages	Country:	City: *Bangkok*	Date: Nov 2005	Page(s):

Author(s)	**Vigny, C.**, W. Simons, S. Abu, , Chaiwat Promthong, C. Satirapod, A. Socquet, R. Cattin, J. Pietrzak, Kee Tuan Chew, D. Sarsito, B. Ambrosius			
Abstract Title	Status of GPS based investigations on the 26 December 2004 mega-thrust earthquak			
Congress Title	*Geophysical Research abstracts, trans, . EGU, EGU06-A-*			
Place, Date & Pages	Country: USA	City: *San Francisco*	Date: 2006	Page(s):

Author(s)	**Vigny, C.**, W. Simons, S. Abu, , Chaiwat Promthong, C. Satirapod, A. Socquet, R. Cattin, J. Pietrzak, Kee Tuan Chew, D. Sarsito, B. Ambrosius			
Abstract Title	Geohasards: the example of Dec. 2004 mega thrust earthquake			
Congress Title	Nederlands .Aardwetenschappelijk Congress (NAC)			
Place, Date & Pages	Country: Netherlands	City:	Date: April 2006	Page(s):

Author(s)	**Vigny, C.**, J.C. Ruegg, R. Madariaga, J. Campos, A. Rudloff, J.B. de Chabalier			
Abstract Title	Transient motions on subduction zones, Coquimbo "gap" example			
Congress Title	International colloquium "Montessus de Ballore			
Place, Date & Pages	Country: Chile	City: *Santiago*	Date: Nov 2006	Page(s):

Author(s)	Simons, W., **C. Vigny**, A. Socquet, B. Ambrosius and M. Naeije			
Abstract Title	The Sundaland Block in SE Asia: A Tectonic Entity Surrounded by Earthquake Hazards			
Congress Title	*EOS, trans. AGU Fall meeting*			
Place, Date & Pages	Country:	City:	Date: 2007	Page(s):

Author(s)	Socquet, A., **C. Vigny**, W. Simons, J. Pietrzack, Ham, and R. Cattin,			
Abstract Title	Relative plates Motions and associated deformation across the Sunda-Sumatra-Arakan trenches			
Congress Title	*EOS, trans. AGU Fall meeting*,			
Place, Date & Pages	Country:	City:	Date: 2007	Page(s):

Author(s)	Hermawan, I., **C. Vigny**, R. Cattin, and N. Chamot-Rooke
Abstract Title	Status of GPS Based Investigations on the Recent Sequence of Earthquakes on the Sumatran Trench

Congress Title	*EOS, trans. AGU Fall meeting*,			
Place, Date & Pages	Country:	City:	Date: 2007	Page(s):

d. Thesis Direction. List Doctoral and Master's theses directed since 2003.

Students Names	Thesis Title	Degree, Institution & Year Awarded
Alain Rudloff	Monitoring faults with GPS	PhD, Univ.Paris-XI, 2002-2007
Iwan Hermawan	GPS in Indonesia	PhD, Univ. Paris VI, 2006-
Rana Charara	GPS in Grece and methodology	PhD, Univ. Paris VI, 2007-
Nadaya Cubas	Measurements and processing of GPS in Chile	Mgs, ENS, 2006-
Romain Jolivet	Processing and Modelisation of GPS in Chile	Mgs, ENS, 2008