Programma Nazionale di Ricerche in Antartide (PNRA)

Final project report

Project ID:	2002/4.09
Title:	*Fueguian Orogen Tectonic Evolution*
Principal investigator:	Marco Menichetti
Institution:	Universita' di Urbino
Email:	*marco.menichetti@uniurb.it*
Duration:	2 years
Assigned funding:	€ 61.974,82

Activities and results

The aim of the FORTE project was to study the main tectonic and geophysical features along N-S geo-transects through the Andean Orogen in the Tierra del Fuego Island.
The main activities consisted of 8 geological and geophysical campaigns from 2002 to 2007, which was attended by about 25 researchers. The geological survey was focused on mapping and collecting structural data in several sectors of the Cordillera. The geophysical survey was mainly carried out through gravimetric and magnetic data acquisition and a bathymetric mapping of the Lago Fagnano.
The main results derive from the integration of geological and geophysical data and can be synthesized in several regional geological cross-sections through the Fueginan orogen. They permited to describe the geological evolution of the whole region. The main geological features developed during the Mesozoic-Cenozoic Andean orogenic cycle with the shortening and inversion of the back-arc margin through horizontal contraction and crustal thickening. The uplift of the Cordillera, the emplacement of plutonic rocks, and the intracontinental polyphase deformation resulted from thick-skinned tectonics. The thrust system developed from its deeper roots, where the Palaeozoic basement was involved in compressional deformation, and propagated to the shallower stratigraphic levels of the northward verging Magallanes fold-and-thrust belt. The Magallanes foreland basin developed in front of the orogenic wedge that records at least four syntectonic angular unconformities from Late Cretaceous to Lower Miocene. During the Late Cretaceous Andean compression, three distinct phases of penetrative ductile deformation defined by low-greenschist facies assemblages took place, both in the basement and in the cover units. From the Palaeogene to the present, E-W sinistral wrench tectonics affected the region as a component of the relative motion between South America and the Antarctic Peninsula. This strike-slip activity is well documented from the Carbajal valley to the Canal de Beagle region south of the Magallanes-Fagnano transform fault system. Restraining bends and overlapping step-over geometry characterize few sectors of the strike-slip faults with pop-ups, pressure ridges and uplifted slivers of crust. The Lago Fagnano represents the main morphotectonic expression of this structural setting with an asymmetric basin floor fault controlled. The orogenic shortening of the Fuegian Andes, including the Cordillera and the Magallanes fold-and-thrust belt, reaches few hundred kilometres with a left-lateral wrenching component of many tens of meters.
The Island is characterized by low magnitude (M<3.5) and shallow crustal earthquakes. The southern part presents strong morphological evidence of Quaternary activity, related to the E-W left-lateral strike-slip faults, while the northern sector is affected by extensional tectonics related to the normal fault systems of the eastern arms of the Magallanes Strait.

Products

A – papers in scientific magazines

1. Lodolo, E., M. Menichetti, A. Tassone, R. Geletti, P. Sterzai, H. Lippai and H-L. Hormaechea, 2002 - Researchers target a continental transform fault in Tierra del Fuego. *EOS, Trans., AGU*, 83, 1-5,

2. Lodolo, E., M. Menichetti, A. Tassone and P. Sterzai, 2002 - Morphostructure of the central-eastern Tierra del Fuego Island from geological data and remote-sensing images. *EGS Stephan Mueller Special Pub. Series*, vol. 2, 1-16.
3. Lodolo E., Menichetti M., Bartole R., Ben Avram Z., Tassone A. , Lippai H., 2003 - Magallanes-Fagnano continental transform fault (Tierra del Fuego, southernmost South America). *Tectonics,* 22, 6, 1076, doi:1029/2003TC0901500,2003.
4. Lippai H., Lodolo E., Tassone A., Hormachea J.L., Menichetti M., Vilas J.F., 2003 - Morpho-structure of Lago fagnano (Tierra del Fuego) and adjacent areas. *Bollettino di Geofisica Teorica e Applicata* vol. 45/2 pp. 142-144 ISSN: 0006-6729
5. Menichetti M., 2004 - Geological cross-section across the Fueginan Andes in the Tierra del Fuego Island. *Bollettino di Geofisica Teorica e Applicata vol.* 45/2 pp. 72-73 ISSN: 0006-6729
6. Menichetti M., Cenni M., Gattini D., Gaudio A., Mattioli M., 2004 - Geometries, deformation styles and kinematics of the Fueginan Andes and Magallanes fold-and-thrust belt (Tierra del Fuego Island). *Bollettino di Geofisica Teorica e Applicata* vol. 45/2 pp. 44-46 ISSN: 0006-6729
7. Yagupsky D., Tassone A., Lodolo E., Menichetti M., Vilas J.F., 2004 - Seismic imaging of the Magallanes-fagnano fault system (Tierra del Fuego Region) *Bollettino di Geofisica Teorica e Applicata* vol.45/2 pp. 47-49 ISSN: 0006-6729
8. Menichetti M., Acevedo R.D., Bujalesky G.G., Cenni M., Cerredo M.E., Coronato A., Hormachea J.L., Lippai, H., Lodolo E., Olivero E.B., Rabassa J., Tassone A., 2004 – Field Trip guide of the Tierra del Fuego. *Geosur 2004, meeting* - Buenos Aires-Ushuaia, 39 pp.
9. Tassone A., Lippai H., Lodolo E., Menichetti M., Comba A., Hormaechea J.L., Vilas J.F., 2005 – A geological and geophysical crustal section across the Magallanes-Fagnano fault in Tierra del Fuego. *Journal of South American Earth Sciences,* 19, 99-109, *ISSN: 0895-9811*
10. Menichetti M., 2005 - Structural and kinematic analysis in the Andes of the Tierra del Fuego Island. *Rendiconti della Societa' Geologica Italiana* vol. 1 pp. 127-129 ISSN: 0392-3037
11. Cenni M., Menichetti M., Mattioli M., Lodolo E., Tassone A., 2006 - Analisi meso- e microstrutturale lungo la faglia trascorrente Magellano-Fagnano nella Cordigliera delle Ande in Terra del Fuoco-Argentina . *Rendiconti della Societa' Geologica Italiana*, 2 ,Nuova Serie 121-124.
12. Lodolo E., Lippai H, Tassone E., Zanola C., Menichetti M., Hormachea J.L., 2007- Gravity map of the Isla Grande de Tierra del Fuego, and morphology of Lago Fagnano. *Geologica Acta* vol. 5,4, pp. 307-314 ISSN: 1695-6133.
13. Menichetti M., E. Lodolo, A. Tassone, 2008 - Structural geology of the Fuegian Andes and Magallanes fold-and-thrust belt – Tierra del Fuego Island . *Geologica Acta,* Vol.6, Nº 1 , 19-42.
14. Menichetti M., Lodolo E., Tassone A., Hormaechea J.L., Lippai H., 2007 - Geologia dell'area del Lago Fagnano in Terra del Fuoco (Sud America). *Rendiconti della Società Geologica Italiana* vol. 4, pp. 251-254 ISSN: 0392-3037.
15. Menichetti M., Tassone A., Peroni I.J, Gonzlez Guillot M. Cerredo M.E., 2007 - Assetto strutturale, petrografia e geofisica della Bahía Ushuaia - Argentina. *Rendiconti della Società Geologica Italiana* vol. 4, pp. 259-262 ISSN: 0392-3037.
16. Menichetti M. , Lodolo E. Tassone A., 2007 - Geology and geodynamics of the Tierra del Fuego region. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 97.
17. Menichetti M. , Tassone A., M.E. Cerredo, F. Esteban, 2007 - Geological cross-sections in the Fuegian Andes. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 99.
18. Menichetti M. , Lodolo E., Tassone A., Flores J., Cominguez A., 2007 - Structural evolution of the Magallanes and Malvinas basins southern margins in the Tierra del Fuego Atlantic offshore. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 98.
19. Menichetti M., Tassone A., Flores J., 2007 - Neotectonics an seismotectonics of the Tierra del Fuego. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 100.
20. Menichetti M. , Hervé F. - The geological perspective of Juan Ignacio Molina about Chile and Italy in the XVIII century. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 96.
21. Cerredo M.E., Remesan M.B., Tassone A., Menichetti M., Peroni J.I., 2007- The Ushuaia pluton, Tierra del Fuego, Andes: petrographic facies and geochemical signature. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 31.
22. Flores J., Cominguez A., Tassone A., Lodolo E., Menichetti M., 2007 - Depth seismic-migration modelling off-shore Tierra del Fuego by means of an interactive-approach with the inherent cristal-velocity profile. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 61.
23. Peroni J.I., Tassone A., Lippai H., Menichetti M., Lodolo E., Vilas J.F., 2007 – Geophysical modeling of the Kranck pluton , Tierra del Fuego, Argentina. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 122.
24. Santomauro M., Tassone E., Lippai H., Menichetti M., Lodolo E., Vilas J.F., 2007- Geophysical study on Lago Fagnano area, Tierra del Fuego. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 147.
25. Santomauro M., Tassone A., Lippai H., Menichetti M., Lodolo E., Vilas J.F., 2007 - Geophysical study in Bahia Ensenada, Tierra del Fuego. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 148.
26. Tassone A., Menichetti M., Lodolo E., 2007 - Paleogene pull-apart basino on Atlantic off-shore, Tierra del Fuego, Argentina. *Cong. Int. GEOSUR 2007- Santiago Chile, vol. abstracts,* 160.

27. Tassone A., E. Lodolo, M. Menichetti, D.Yagupsky, M. Caffau J.F. Vilas, 2008 - Seismostratigraphic and structural setting of the Malvinas Basin and its southern margin (Tierra del Fuego Atlantic offshore). *Geologica Acta,* Vol.6, Nº 1, 55-67.

B – book chapters

C - proceedings of international conferences

1. Menichetti M., Tassone A., (Eds) - 2007 - GEOSUR2004: Mesozoic to Quaternary evolution of Tierra del Fuego and neighboring austral region I. *Geologica Acta*, 5, 4, 283-286. ISSN 1695-6133.
2. Menichetti M., Tassone A., (Eds) - 2008 - GEOSUR2004: Mesozoic to Quaternary evolution of Tierra del Fuego and neighboring austral region II. *Geologica Acta*, 5, 4, 283-286. ISSN 1695-6133.

D – proceedings of national meetings and conferences

E – thematic maps

F – patents, prototypes and data bases

G – exhibits, organization of conferences, editing and similar

Sono stati organizzati congiuntamente con le U.O. i seguenti congressi sia durante la ricerca che nella fase di sintesi finale:
- GEOSUR 2004 - tenutosi a Buenos Aires nel mese di novembre 2004. Al congresso sono stati presentati i risultati delle ricerche svolte nell'ambito del progetto. I riassunti estesi delle comunicazioni presentate sono stati pubblicati sul *Bollettino di Geofisica Teorica e Applicata. vol. 45/2, 2004.* Dopo il congresso si è svolto un *field-trip* in Tierra del Fuego guidato dalle U.O. che hanno curato anche la redazione della guida all'escursione (Menichetti et alii, 2004), disponibile sul sito www.uniurb.it/forte.
- GEOSUR 2007 - tenutosi a Santiago del Cile nel mese di novembre 2007. A questo convegno (vedi www.geosur.org) hanno partecipato oltre 200 ricercatori di 18 diverse nazionalità, sono stati presentate 180 comunicazioni pubblicate su un volume degli Abstracts. Attraverso comunicazioni orali e posters sono stati presentati i risultati finali delle ricerche svolte nell'ambito del progetto FORTE.

H - formation (PhD thesis, research fellowships, etc.)

1. Yagupsky, D.L., 2003, Estudio sismoestratigráfi co y estructural del sector meridional de las cuencas de Magallanes y Malvinas. Trabajo final de Licenciatura. Dpto. de Geología. Facultad de Ciencias Exactas y Naturales. Universidad de Buenos Aires 111 p.
2. Cenni M., 2005 – Rilevamento geologico ed analisi strutturale del settore centrale della Cordigliera delle Ande nella Terra del Fuoco – Tesi di Laurea Università di Urbino, Corso di laurea in Scienze geologiche, AA 2004-2005, 88 p.
3. Peroni J.I. 2006 - Anomalía magnética en Bahía Ushuaia (Tierra del Fuego). Estudio Geofísico de la continuidad de las unidades geológicas en subsuelo. Trabajo final de Licenciatura. Dpto. de Geología. Facultad de Ciencias Exactas y Naturales. Universidad de Buenos Aires, 90 p.

Research units

1) Università di Urbino
Marco Menichetti
Mario Tramontana
Paolo Colantoni

2) Istituto Nazionale di Oceanografia e Geofisica Sperimentale OGS
Emanuele Lodolo
Riccardo Geletti

International collaborations

3) Universidad de Buenos Aires - Instituto de Geofisica "D. Valencio" Departamento de Geologia. Facultad de Ciencias Exactas y Naturales. Universidad de Buenos Aires.Ciudad Universitaria - Buenos Aires Argentina.
   Alejandro Tassone
   Juan Francisco Vilas

4) Estacion Astronomica Rio Grande – CONICET – Tierra del Fuego
   Josè Luis Hormachea
   Gherardo Condor

5) Centro Austral de Investigaciones Cientificas – Ushuaia
   Daniel Acevedo

Date: 23 ottobre 2008
