

Final project report

<i>Project ID</i>	2004/4.05
<i>Title</i>	Interaction between the Antarctic and South American plates: the Tertiary and Quaternary back-arc basalts from Patagonia as tracers of ridge-trench collision processes
<i>Principal investigator</i>	Fabrizio Innocenti – Massimo D’Orazio (since 2009)
<i>Institution</i>	Dipartimento di Scienze della Terra - Università di Pisa
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<i>Duration</i>	3 years
<i>Assigned funding</i>	100.000,00 Euro

Activities and results

Field Activity

This research project did not involve field activities in the Antarctic continent but in the southernmost part of South America.

Back-arc magmatism of extra Andean Patagonia: the first part of the project was spent to complete the activities related to the study of three main occurrences of Cenozoic magmatism of the extra-Andean Patagonia: the “Camusú Aike Volcanic Field”, the “Meseta de las Vizcachas” and the “Sierra de San Bernardo –Rio Genoa-Senguer Valley”. During previous field campaigns more than 100 samples of these poorly studied volcanic areas have been collected.

Adakitic magmatism of the Austral Andes volcanoes: during January 2006 we performed an helicopter-assisted (Aerovías DAP, Punta Arenas, Chile) sampling of the hardly accessible Austral Andes volcanoes Reclus (50°58' S 73°35' W) and Burney (52°20' S 73°24' W). The long distance separating the two volcanoes (310 km and 200 km, respectively) from the nearest base (Punta Arenas) made necessary to do two separate flights. A total of 23 samples of lava and pyroclastic material from the two volcanoes have been collected.

Analytical work

During the project were produced about 120 major element analyses of whole rocks, 70 ICP-MS trace element analyses, 10 ⁴⁰Ar-³⁹Ar datings, 14 K-Ar datings, 25 Sr, 25 Nd, 15 Pb, 12 He isotopic analyses, and many SEM-EDX microanalytical data on mineral phases.

Results

The petrologic and geochemical studies of the three above-mentioned volcanic occurrences of extra-Andean Patagonia allowed us to improve our understanding of the origin of this widespread Cenozoic magmatism; in particular, the origin of the basalt magmas was related alternatively to the opening of a “slab window” under southern South America during Neogene (Camusú Aike and Meseta de las Vizcachas) or to the uprise of asthenospheric mantle in the wake left by the westward drift of the mantle wedge coupled with the South America lithosphere (Sierra de San Bernardo). In addition, the geochemical and isotopic data revealed a marked imprint of subduction related materials of the middle Miocene basalts from the Meseta de las Vizcachas; this contrast with the majority of Patagonian lavas which show a prevailing within-plate geochemical signature.

The study of the rocks from the Burney and Reclus volcanoes revealed that they are all porphyritic dacites showing marked geochemical differences with respect to the volcanic rocks from the Southern South Volcanic Zone of the Andes with the same evolution degree. These differences can be summarized in the following: 1) Reclus and Burney dacites have significantly higher Mg#’s, 2) basalts and basaltic andesites are totally lacking; 3) they show high Sr/Y (>50) ratios, low contents of HREE, high LREE/HREE fractionation (La/Yb=10-25) and positive Sr and Eu anomalies. These features are those typically observed in “adakitic” magmas, and testify to a major role played by garnet in the genesis of these magmas. As the continental crust beneath the Austral Andes has a normal or slightly reduced thickness (~ 35 km) it is unlikely that the “adakitic” features are due to garnet fractionation in a deep lower crust. More likely, due to the young age

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(24-12 Ma) of the subducting Antarctic Plate and its slow subduction rate (2 cm/yr), it is possible that "adakitic" magmas may be, at least partially, formed by slab melting.

Products

A – papers in scientific magazines

1. D'Orazio M., Innocenti F., Manetti P., Haller M.J., Di Vincenzo G., Tonarini S. (2005): The late Pliocene mafic lavas from the Camusú Aike Volcanic Field (~ 50°S, Argentina): evidences for geochemical variability in slab window magmatism. *Journal of South American Earth Sciences*, 18, 107-124.
2. Massafiero G.I., Haller M.J., D'Orazio M., Alric V.I. (2006): Sub-recent volcanism in Northern Patagonia: a tectonomagmatic approach. *Journal of Volcanology and Geothermal Research*, 155, 227-243.
3. Bruni S., D'Orazio M., Haller M.J., Innocenti F., Manetti P., Pécskay Z., Tonarini S. (2008): Time-evolution of magma sources in a continental back-arc setting: the Cenozoic basalts from Sierra de San Bernardo (Patagonia, Chubut, Argentina). *Geological Magazine*, 145, 714-732.

B – book chapters

1. Charlin, J., Franco, N., D'Orazio, M. (2010). El Campo Volcánico Pali Aike y las fuentes potenciales de aprovisionamiento lítico: primeros resultados geoquímicos. In: Borrero, L.A., Charlin, J. (Editors): *Arqueología de Pali Aike y Cabo Vírgenes* (Santa Cruz, Argentina). CONICET-IMHICIHU, Buenos Aires, 145 pp.

C - proceedings of international conferences

1. Tonarini S., Leeman W.P., Innocenti F., D'Orazio M., Leat P.T. (2006). The boron transfer from the Slab to the mantle wedge: a combined study in South Sandwich Island Arc and Southern Volcanic Zone in the Chile Andes. *Eos Trans. AGU*, 87(36), Jt. Assem. Suppl., Abstract V33A-06.

D – proceedings of national meetings and conferences

1. Bruni S., D'Orazio M., Haller M., Innocenti F., Manetti P., Pécskay Z., Stuart F., Tonarini S. (2005). Cenozoic back-arc basalts from Sierra San Bernardo and Río Genoa-Senguerr Valley (Central-southern Patagonia, 44.5-46° S): geochemistry, isotope evolution and geodynamic implications. *GeoItalia 2005*, 5° Forum Italiano di Scienze della Terra, Spoleto, 21-23 settembre.
2. Doglioni C., Innocenti F., Tonarini S. (2007). Supra-slab mantle wedge asymmetry and geodynamic constraints on mantle convection. *GeoItalia 2007*, 6° Forum Italiano di Scienze della Terra, Rimini, 12-14 settembre.

E – thematic maps

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F – patents, prototypes and data bases

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G – exhibits, organization of conferences, editing and similar

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

1. N° 1 contract research to Dr. Maurizio Gemelli (U.O. 1): "Petrologic and geochemical study of the Cenozoic volcanic rocks from the northern tip of Antarctic Peninsula"

Research units

U.O. 1 UNI Pisa: Innocenti Fabrizio, D'Orazio Massimo, Tamponi Marco, Bertoli Marco, Bruni Sandro

U.O. 2 IGG-CNR Pisa: Tonarini Sonia, Manetti Piero, Agostini Samuele, Dini Andrea, Giannotti Umberto

Date: April 6, 2010