

Final project report

Project ID	2004/2.3
Title	MONITORAGGIO GEODETICO DELLA TERRA VITTORIA SETTENTRIONALE
Principal investigator	Alessandro Capra
Institution	DIMeC- University of Modena and Reggio Emilia
Email	alessandro.capra@unimore.it
Duration	3 years
Assigned funding	330 000,00 Euro

Activities and results

Periodical and permanent measurements of Geodetic Observatory, following more than ten years history of data recording, allowed to the surveying and monitoring of northern Victoria land. The determination of surface kinematic of northern Victoria Land has been obtained from GPS permanent observatories and from GPS periodical observations on VLNDEF (Victoria Land network for DEformation control) network (see at attached figure 1).

The activity has been done within international research programs in Antarctica like GIANT (Geodetic Infrastructure in Antarctica) and ANTEC (Antarctic Neo-Tectonics) group, there has been a geodesy program with the following objectives:

- 1) Creation of a common geodetic reference frame for all of the scientists in Antarctica;
- 2) Global geodetic contributions based on the definition of the terrestrial-geodetic reference frame;
- 3) Monitoring services for the crustal deformations, in terms of horizontal and vertical movements.

The scientific activities had good visibility even through Italian sub-project GOIA (Geodetic Observations In Antarctica) of POLENET (POLAR Earth observing NETWORK) of IPY (International Polar Year), which is particularly interested in dynamic knowledge of the polar areas, and installation of permanent observatories.

The main purpose of the VLNDEF is to detect neo-tectonic phenomena within the area of NVL, and to provide metric parameters for the definition of GIA (Glacial Isostatic Adjustment) models. A new definition of the Euler pole for Antarctica was computed and used to remove the inherently rigid rotation of the plate, so that intra-plate velocities can be estimated for use as input observations for the tectonic interpretation of the NVL area. Our results show that some of the main regional faults that characterized NVL had significant movement along their segments over this observation period (see at attached figures 2 and 3), and thus the kinematics found fully confirm that the reorganization of the plate tectonics that started in the late Oligocene period (approximately 40 Ma) in the Australia–Southern Ocean–East Antarctica system is still ruling the tectonics in NVL, with right-lateral, strike-slip, intraplate faulting with velocities comparable to those predicted at plate boundaries by plate tectonic theory.

A new sea bottom sensor for tidal observation has been installed. The sea tidal observations with geodetic and gravimetric data allowed to determine high accuracy geod of the area and permitted to make an estimation of local and regional effects of for PGR (Post Glacial Rebound).

Moreover GPS data processing permitted to obtain interesting results on the field of atmospheric physical parameters determination and weather now casting and forecasting.

Products

A – papers in scientific magazines

1. Negusini M., Mancini F., Gandolfi S., Capra A. (2005). *Terra Nova Bay GPS permanent station (Antarctica): data quality and first attempt in the evaluation of regional displacement*. JOURNAL OF GEODYNAMICS. Special issue:

- Glacial Isostasy and Neotectonics. Edited by G. Kaufmann and B. Vermeersen Vol 39/2 pp 81-90, 2005 vol. 39/2 pp. 81-90 ISSN: 0264-3707.
2. Negusini M., Mancini F., Gandolfi S., Capra A. *Terra nova bay gps permanent station (Antarctica): data quality and first attempt in the evaluation of regional displacement*. Journal of Geodynamics
 3. Capra A., Mancini F., Negusini M. (2007) "GPS as a geodetic tool for geodynamic in the Northern Victoria Land, Antarctica" Antarctic Science 19 (1), 107-114 . 2007
 4. Capra A. Mancini F., Negusini M.(2007) GPS as a geodetic tool for geodynamics in Northern Victoria land, Antarctica. Antarctic Science 19 (1), 107-114 . 2007. ISSN 0954-1020
 5. Zanutta A., Vittuari L., Gandolfi S.(2008)"Geodetic GPS-based analysis of recent crustal motions in Victoria Land (Antarctica)". Global and Planetary Change, vol. 62, pp. 115 - 131 ISSN: 0921-8181.
 6. Gandolfi S., Gusella L., Milano M., Vittuari L.(2008) "Precise Point Positioning, an alternative approach for GPS data processing in Antarctica". Terra Antarctica Reports, vol. 14, pp. 27 - 30 ISSN: 1723-7211.
 7. Capra A., Dietrich R. (Eds) (2008) Geodetic and Geophysical Observations in Antarctica ISBN 978-3-540-74881-6, Springer-Verlag Berlin, 2008
 8. Dubbini M., Cianfarra P., Casula G., Capra A. and Salvini F.(2010) Active tectonics in northern Victoria Land (Antarctica) inferred from the integration of GPS data and geologic setting, Journal of Geophysical Research, Vol. 115,17 pp, B12421, doi:10.1029/2009JB007123

B – book chapters

1. Capra A., Dubbini M., Galeandro A., Gusella L., Zanutta A., Casula G., Negusini M., Vittuari L., Sartoi P., Mancini F., Gandolfi S., Montaguti S. and Bitelli G. (2008)VLNDEF project for geodetic infrastructure definition of northern Victoria Land, Antarctica. On "Geodetic and Geophysical observations in Antarctica- an overview in the IPY perspective", pp. 37-72, Springer, 2008.
2. Sarti P, Negusini M, Lanconelli C, Lupi A, Tomasi C, Cacciari A (2008) "GPS and Radiosonde Derived Precipitable Water Vapour Content and its Relationship with 5 Years of Long-Wave Radiation Measurements at Mario Zucchelli Station, Terra Nova Bay, Antarctica" In: Geodetic and Geophysical Observations in Antarctica, BERLIN HEIDELBERG: Springer, ISBN 978-3-540-74881-6, doi: 10.1007/978-3-540-74882-3_9, 145-177

C - proceedings of international conferences

1. Sarti P, Negusini M., Cacciari A. (2004). Water vapour content at Terra Nova Bay retrieved by radiosonde and GPS. Terra Nostra. Schriften der Alfred Wegener Stiftung, 4: 287. 28th SCAR Open Science Conference "Antarctica and the Southern Ocean in the global system", Bremen (Germany), 26-28 July 2004
2. Capra A. (2006). "Overview of Geodetic Reference Frame and Related Activities in Antarctica". Proceedings of the workshop "Frontiers and Opportunities in Antarctica Geosciences". Siena, 2004. Terra Antarctica Reports, n.12, pp.21-28, MNA Siena (ISBN 978-88-88395-04-3).
3. Gandolfi S., Negusini M., Zanutta A., Milano M, Montaguti S., Dubbini M., Sarti P, Vittuari L.(in press) *Static GPS observations on the Antarctic Plateau for movement detection and meteorological purposes*. Proceedings of V Conga 2005 in Terra Antarctica Reports, in press.
4. Mancini F, Negusini M., Zanutta A., Capra A. (2007) Vertical motions in Northern Victoria Land inferred from GPS.: a comparison with the glacial isostatic adjustment models. On Antarctica : a keystone in a changing world- online proceedings for X ISAES, Santa Barbara , Cal, USA august 2007. Ed. By A.Cooper, C.Raymond and the ISAES editorial team- 2007, ISSN: 0196-1497 DOI:10.3133/of2007-1047 ISBN: 1.411-31788-2(for Cd-ROM version).
5. Capra A., Casula G., Dubbini M., Negusini M. (2010) The italian geodetic observatory in Antarctica. SCAR XXI Open Science Conference. Buenos Aires, Argentina, 3-6 August 2010
6. Dubbini M., Casula G., Cianfarra P., Salvini F., Capra A. (2010) Active tectonics in the northern Victoria Land (antarctica) inferred from the integration of GPS data and geological settings. SCAR XXI Open Science Conference. Buenos Aires, Argentina, 3-6 August 2010

D – proceedings of national meetings and conferences

1. Capra A., Galeandro A., Negusini M., Vittuari L. (2007) Inquadramento delle reti regionali VLNDEF e TAMDEF (Antartide) nel sistema di riferimento globale. Atti Convegno SIFET 2007 "Dal rilevamento fotogrammetrico ai data base topografici", Arezzo, Giugno 2007, pp.66-73, 2007, ISBN 88-901939-4-8.

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. Dr. Angelo Galenadro- PhD Thesis in Environmental and Territory Engineering- XIX Cycle- Polytechnic of Bari .
Title "Superficial kinematics study with GNSS measurement technique application in Victoria land (Antarctica)-
Final Discussion on 2007.

Research units

1) Principal investigator: Alessandro Capra

DIMeC Dept. - University of Modena and Reggio Emilia e-mail:

Research task: GPS data processing. Analysis and interpretation of crustal deformations and study of regional and continental geodynamics.

2) Principal investigator: Gabriele Bitelli

DISTART Dept. - Università di Bologna

Research task: Data acquisition, processing and analysis of GPS permanent trackers, VLNDEF network and Mt.Melbourne network.

Study of local, regional and continental geodynamics.

Data acquisition and processing and maintenance of tide gauge observatory. High resolution geoid computation. LIDAR observations processing.

3) Principal investigator: Franco Coren

Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)

Research task: LIDAR data acquisition and processing. Gravimetric data acquisition and processing for the high accuracy geoid computation. Geoid surface computation based on gravity measurements

4) Principal investigator: Pierguido Sarti

Istituto di Radioastronomia, INAF-Bologna

Research task: This research is organized in three different phases. First and second phases have a strong analytical content and are going to rationally select among the wide amount of data acquired, during previous expeditions, by the Geodesia e Osservatori sector. Data acquired at other Antarctic observatories will also be selected and used in order to create an homogeneous working dataset. Third phase has a stronger operative character and will take advantage of the results obtained in the first and second phases. The first phase of the work will be especially devoted to the computation of the Zenith Total Delay (ZTD) and Zenith Wet Delay at Terra Nova Bay and in the wider area of Eastern Pacific, using the experience that has been developed processing the data of the Italian GPS network with the same purposes (Al-bayari et al., 2000). This will imply a selection of a subset of data acquired by TNB1 and other Antarctic stations. The data acquired during the episodic surveys of VLNDEF and TAMDEF networks will also be used with the purpose of extending the area of investigation towards McMurdo and Dumont D'Urville. GPS data will be selected cross-checking the availability of meteorological data simultaneously acquired. Temperature, pressure and humidity values, if lacking at GPS sites, will be interpolated using adequate meteorological models in order to retrieve the values at place and time of GPS observation. ZTD and ZWD will be compared with external sources of information wherever available. This will allow a first check of the quality and reliability of the results obtained with our analysis. The following phase will be necessarily developed in deep cooperation with other OO.UU. of PNRA. GPS derived results will be tested in NWPM for short time, a posteriori forecasts at mesoscale level. The analysis of TNB1 data will allow historical series of ZWD contents that will be useful for determining long time variations in the area and for climatological studies. We are going to evaluate the reliability of the results concerning ZWD and optimise the methodology used for its computation. The reliability of the meteorological model used for extrapolating the meteorological values at GPS sites not co-located with met sensors will be verified. The last phase of the research concerns the upgrade of TNB1 for meteorological studies, similarly to several GPS stations already employed within MAGIC project (<http://kreiz.unice.fr/magic/>). This will require to set up an automatic and remote downloading of the data with automatic processing. The softwares that can be implemented and configured are GIPSY-OASIS II and Bernese V.4.2. In order to complete this last phase of the project, a permanent Internet link is required. Another part of the research will focus on VLBI data processing for ZWD estimate, comparing the results with those obtained processing simultaneously acquired, GPS data at co-located sites (O'Higgins and Syowa).

Date: 14/03/2011

Notes - Attached figures 1,2 and 3

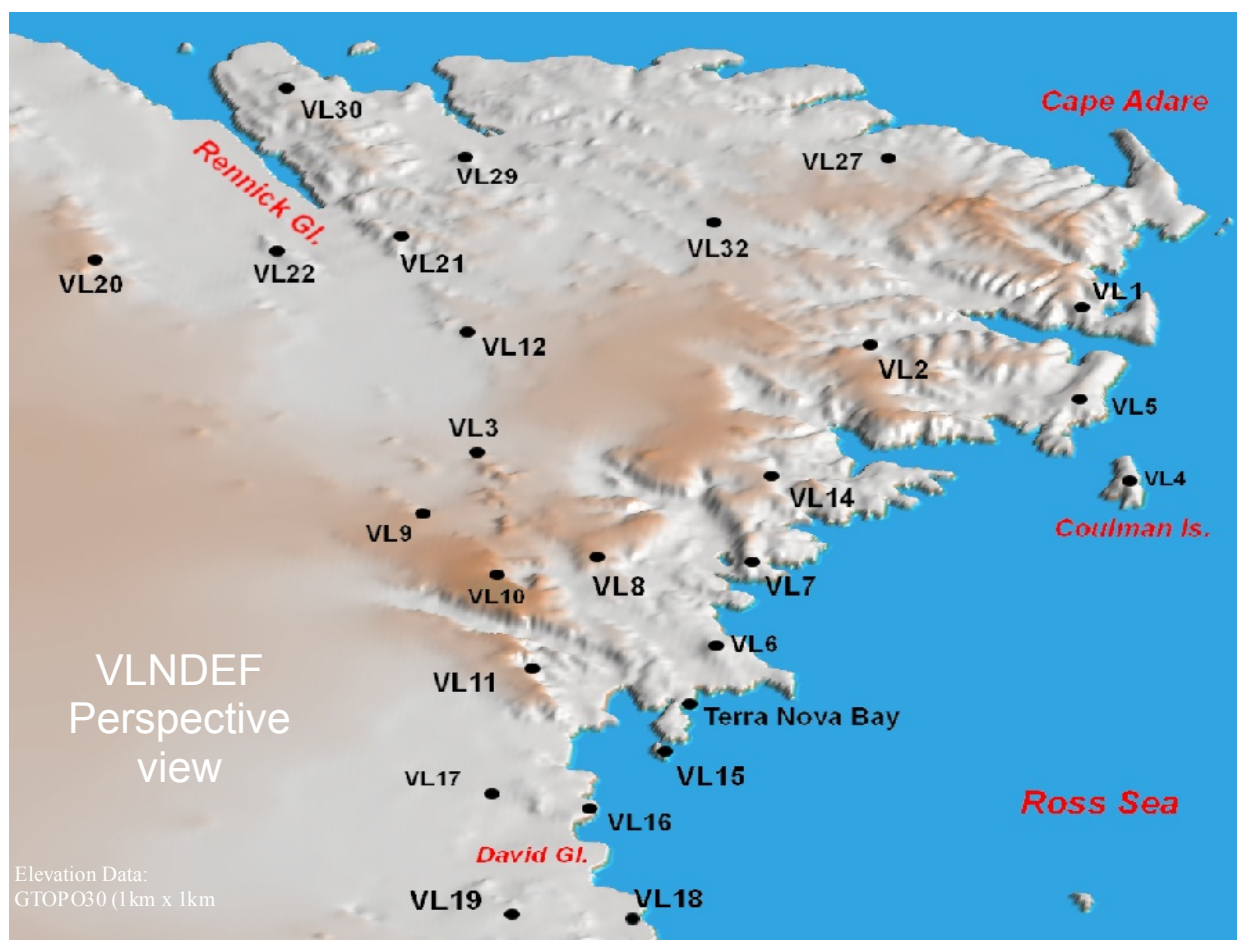


Figure 1 - VLNDEF network stations

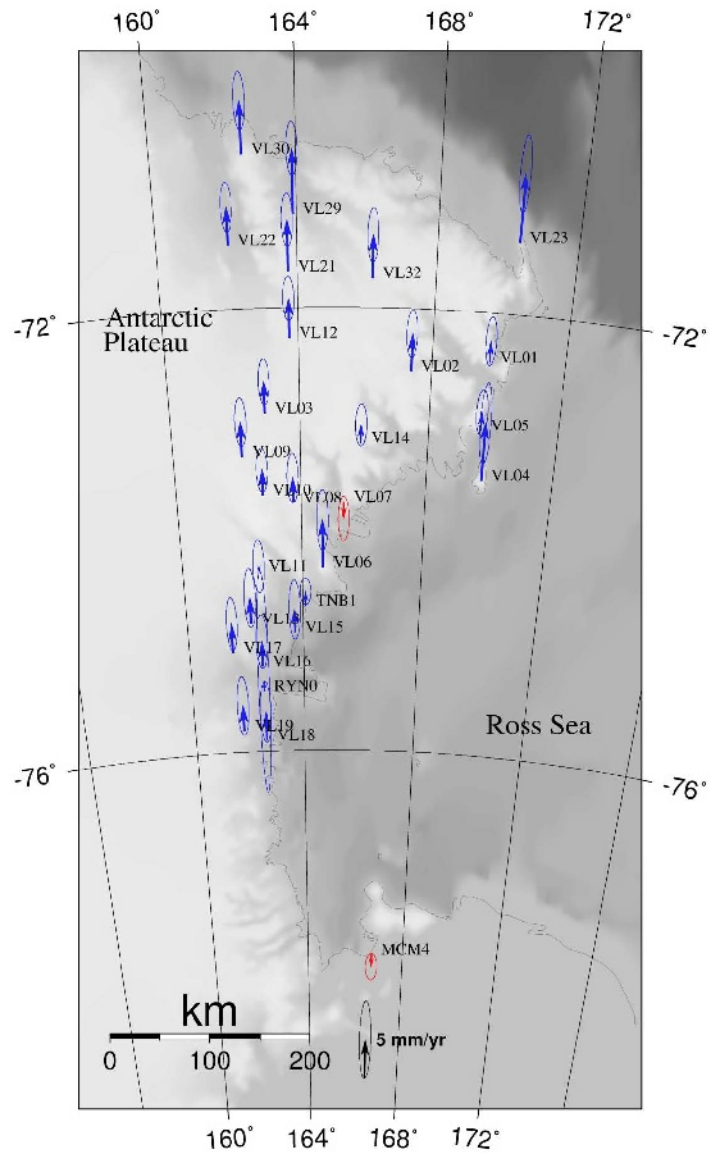


Figure 2 - Vertical velocity vectors (in mm/yr) calculated at each site of the VLNDEF, with their associated error ellipses: 95% confidence level, 2sigma (Dubini et al., 2010)

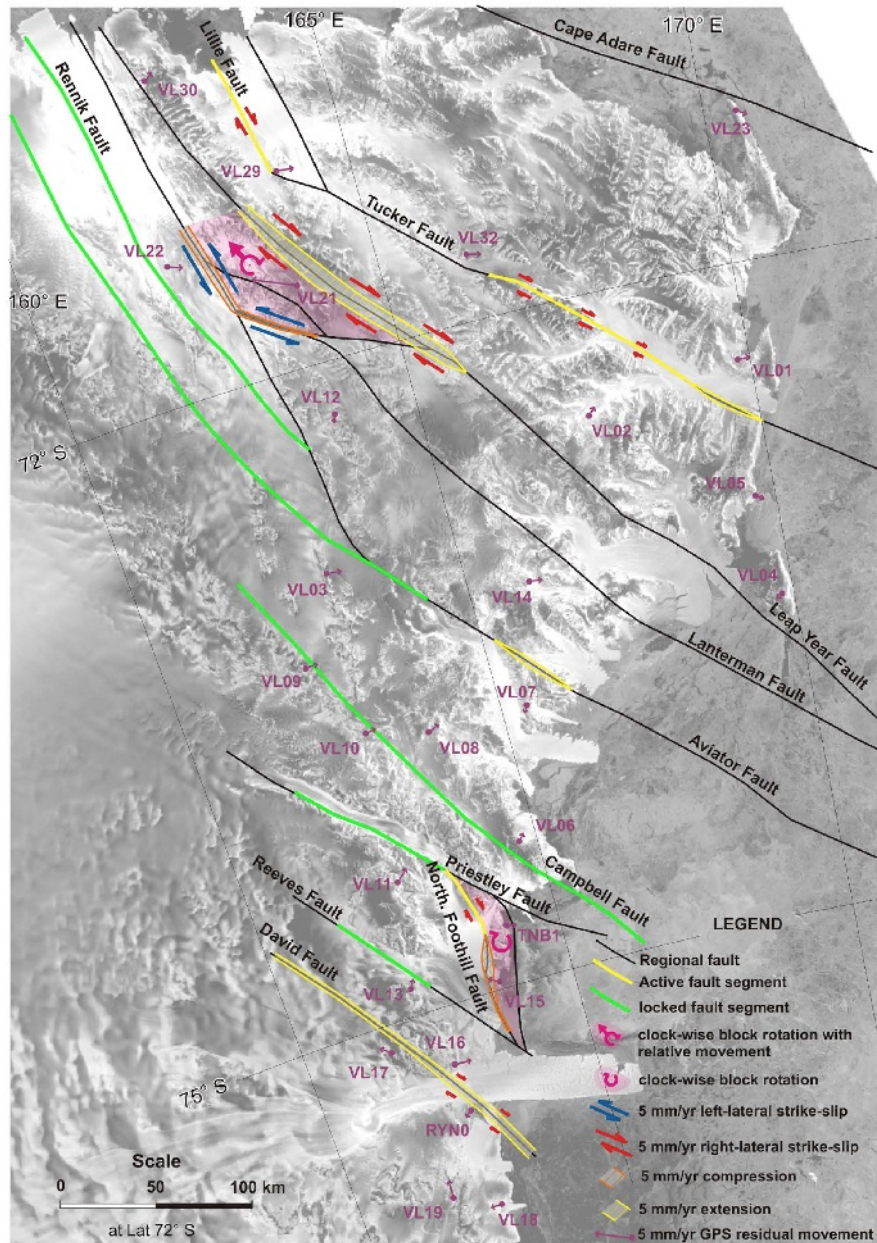


Figure 3 - Horizontal residual velocities projected along the main Cenozoic faults in NVL assuming block tectonic kinematics