

**Italian Antarctic Research Programme
Geoscience activities 2001-2002**

SCAR Working Group Geosciences

In 2000-2001 and 2001-2002 two Italian expeditions in Antarctica were accomplished. The Geoscience activities were based on several projects which developed research in four main areas: Victoria Land/Ross Sea, Central Transantarctic Mountains, Dome C, and Antarctic Peninsula and surrounding seas.

Victoria Land and Ross Sea

Research activity was conducted in areas near the Italian station, Terra Nova Bay (TNB), reached by daily expeditions, and in remote localities where camps were installed. The geological research concerned the Proterozoic-Paleozoic evolution of the active margin of Gondwana and the Paleozoic accretion processes occurred at the margin in Paleozoic times. These investigations included structural observations and extensive sampling on both the Cambro-Ordovician granitoids and the low- to high-grade metamorphic basement.

The studies on the Meso-Cenozoic evolution of the Ross Sea area were focused to the structural and thermo-tectonic history of the Transantarctic Mountains (TAM). New structural data on the Meso-Cenozoic deformation patterns were collected in the area inland of Terra Nova Bay. In order to reconstruct the evolution of the Cenozoic volcanic activity in the area between Hallet and Adare peninsulas, a combined geological and aerogeophysical campaign has been conducted during the 2001-2002 season.

With the aim of reconstructing the glacial history of the area of Mt Joyce and Coulman Island quadrangles, samples for exposure age determination were collected in collaboration with the glaciological group and with ETH Zürich for dating key erosional and depositional surfaces.

In collaboration with a US research project, investigations on Holocene-raised beaches have been carried out in the Terra Nova Bay area and at Depot Island (Scott Coast). The principal aim was to reconstruct the curve of emersion of the coastal area after the last glacial maximum.

The Cape Roberts Project the field activities of which was concluded in 1999, produced new results on the cored material which were published in *Terra Antartica*. Information can also be found at <http://www.geo.vuw.ac.nz/croberts/>.

During a marine cruise in the Ross Sea, sediment cores were collected in the area between Coulman Island and Cape Adare for paleoclimatological and paleoceanographical research.

During the 2001-2002 campaign further 173 meteorites were collected at Frontier Mountain as well as dust bands in the ice; in the area between Frontier Mountain and Terra Nova Bay two new glaciological traps of meteorites have been discovered.

Activity of geophysical Observatories at TNB started at the very beginning of the Italian Program for several disciplines and have continued also in the last two years with some improved functionality of the equipment and with participation to national and international initiatives.

The geomagnetic Observatory has the purpose of monitoring the absolute level of the geomagnetic field and its time variations. Since the Earth's magnetic field can be approximated by a dipolar field, with the magnetic and geographical poles relatively close, the polar regions of the Earth are a very peculiar area from a geomagnetic point of view.

At the geomagnetic observatory a low power off line system is used to measure the components (D, H and Z) and the total magnetic field (F) while a twin system runs powered by the central Base power system. Instrumentation was partly updated in the last season and now consists of two fluxgates, a proton precession magnetometer, an Overhauser magnetometer and two independent data acquisition units. Absolute measurements are undertaken by means of a DI fluxgate theodolite. One minute interval absolute values of the three elements H, D and Z are published for summers only. Winter data are available on request.

The high quality seismic station installed close to the Base, equipped with sensors which comply with the Very Broad Band specifications, with an instrument response flat on ground velocity in the frequency band from 8Hz to 3mHz, was completely recalibrated and renewed in the data acquisition part. The digitizers allow a dynamic range of 140 dB. For such a sensitive instrumentation, the installation was made inside a 8-meter long tunnel in granite rocks. Improvements in the seismic station were also made with the installation of a SUN workstation for remote data acquisition in the Base and local data acquisition.

The observatory, seismic and magnetic, has been performing continuous unmanned operation. Central continuous power supply is now provided by a new automatic system installed in 1997/98 summer expedition (PAT), and data acquisition is performed also by a central computer. A satellite communication linked to the computer at the Base, allows the remote monitoring of the instrumentation, as well as viewing and transferring data of events of special interest.

Central Transantarctic Mountains

Within the framework of the US project *Geology and geochronology of the Byrd Glacier discontinuity – a pilot study*, lithostratigraphic and structural analysis and sampling of the outcrops along the southern slope of the lower part of the Byrd Glacier were carried out.

Dome C

Dome C is located on the Polar Plateau, at a height of 3 200 m, about 1 200 km from TNB. At the site, a French-Italian station - Concordia - is under construction. The site was selected for a series of experiments - with unique character on the Earth: a 3 000 m-deep ice coring, atmospheric, geophysical, and astrophysical observatories, and human adaptation to extreme conditions.

The drilling activity started during the 1996-97; the ice-coring continued during the following seasons and the drilling arrived at depth 2871 m in February 2002. The cored ice is under study in several European laboratories in the ambit of the European Project for Ice Coring in Antarctica (EPICA).

In the ongoing cooperation with French scientists instruments and shelters were tested in order to organize a permanent Geomagnetic observatory in Concordia Station. The results were good and some improvements were made. The observatory is constituted by two shelters: the variometer shelter, where the first three instruments were installed, and the absolute shelter, where a proton magnetometer is running every time the absolute measurements are taken. The shelters are far from the main Base about 300 m. Two variometers and one Overhauser proton magnetometer were installed in order to start the acquisition of the intensity and of the elements of the geomagnetic field. After some tests and checks, the observatory operated so far only on an experimental phase.

Seismographic stations are extremely sporadic in the Antarctic continent, and therefore provide very scanty data for the study of continental seismicity and lithospheric structure. To improve this situation, in the joint Italian-French team, also the installation of permanent seismographic instrumentation (a very broadband station) in the area of the new Base at Dome C was realized. A small aperture seismographic array is planned. We have conducted two field surveys to evaluate the properties of local seismic noise. Seismic noise characteristics have been analyzed as a function of different depth of instrument installation (down to 9 meters) and distance from the base. With its relatively moderate noise levels, also due to its location on the plateau 1,000 km away from the coast, Dome C is a particularly promising location, at critical distance from highly active seismic regions to allow optimal sampling of the deep mantle and the core in crucial geometries.

Antarctic Peninsula and surroundings seas

On the Spanish research vessel Hespérides, several Italian scientists participated in the study of the marine depositional system at the Pacific margin of the Antarctic Peninsula in order to correlate sedimentary evidence of advance and retreat of the ice sheet on the continental platform with deep-sea sedimentary sequences.

The International cooperation in the field of seismological study of the Scotia Sea region has been growing according to the recommendations of the SCAR Solid Earth Geophysics working group. OGS (Osservatorio Geofisico Sperimentale, Italy) and IAA (Istituto Antartico Argentino) have installed the Esperanza (ESPZ, 1992), Ushuaia (USHU, 1995) and Orcadas (ORCD, 1997) stations. At the same time in the frame of IRIS, BAS (British Antarctic Survey, Cambridge, UK) and USGS (USA Geological Survey) together installed three more stations, at Palmer (PMSA), on the Falkland Is. (EFI), and on the South Georgia Is. (HOPE). A coordination of all data acquisition and exchange activities has been recently realized, by means of a 'Memorandum of Understanding' among the research Institutions and Universities operating broadband seismographs in the Scotia Sea area: (in addition to mentioned institutions AWI, Germany, University of Bristol, UK, Universidad de Chile, Chile, Washington University of Saint Louis, USA). The seismological research activity is also a contribution to the International Lithosphere Program (ILP). The assembling of a data base which includes all the seismological information together and the compiling of some velocity models which can be used further for calculating source mechanism solutions, represent the short term aim of our project. The long term goal is an accurate tomographic image of the shear velocity structure in the Scotia Sea region in the framework of a new seismotectonic model by moment tensor waveform inversion.

Geoscience Maps

In the framework of the German-Italian programme for producing 1:250 000 geological map series of NVL, the surveys of the Sequence Hills, Freyberg Mountains, Mt Melbourne and Reeves Névé quadrangles were conducted.

Within the frame of the production of 1:250 000 geomorphological-glaciological map series, surveys were performed in the Mt Joyce and Coulman Island quadrangles.

Within the Antarctic Geomagnetic 1:250 000 Map Series, the Total Magnetic Anomaly Map of Marie Byrd Land (Edward VII Peninsula/Sulzberger Bay) has been published.

In the framework of the SCAR/IAGA project called ADMAP that aims to the compilation of a map of magnetic anomalies for all Antarctica, Italy contributes with one project (INTRAMAP) for the sector between 135° E and 105° W. The map was recently published as a joint effort of several Institutions including the Italian Programme at scale 1:10 000 000.

Activities in Italy

Many laboratories are involved in the studies of the material collected during the Antarctic expeditions. Claudio Ghezzo (ghezzo@unisi.it) of the University of Siena coordinates the research in the field of the Geology, Giuliano Brancolini (gbrancolini@ogs.trieste.it) of OGS Trieste the research in the field Geophysics, and Andrea Morelli of INGV Rome (morelli@ingrm.it) the research in the field of the Geophysical Observatories and Geodesy.

The *Museo Nazionale dell'Antartide, "Felice Ippolito"* Earth Science Section at the University of Siena (mna@unisi.it) has set up the Italian repository of Antarctic geological material collected during all the Italian Expeditions (more than 16 000 rock specimens, about 800 meteorites, fossils and ice-cores), and a data base of samples.

The *Museo* publishes the journal *Terra Antartica*, the bulletin *Terra Antartica Report*, scientific books and maps (*Antarctic Geological 1:250 000 Map Series; Antarctic Geomorphological and Glaciological 1:250 000 Map Series, Antarctic Geomagnetic 1:250 000 Map Series*).

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