

Results of GPS, Ground Photogrammetry, Echosounding and ERS Interferometric Surveys During Ukrainian Antarctic Expeditions

Rudolf Greku⁽¹⁾, Gennady Milinevsky⁽²⁾,

Yuriy Ladanovsky⁽³⁾, Pavel Bahmach⁽³⁾, Tatyana Greku⁽¹⁾

⁽¹⁾Institute of Geological Sciences, National Academy of Sciences of Ukraine, Kiev, 55B, Gonchara st, 01054, Kyiv, Ukraine, e-mail: satmar@svitonline.com

⁽²⁾Ukrainian Antarctic Center, Kyiv/Ukraine; antar@carrier.kiev.ua

⁽³⁾ECOMM Co, 18/7, Kutuzov st., 01133, Kyiv, Ukraine, lada@ecomm.kiev.ua

Abstract

The region of ukrainian Antarctic geodetic and topographic surveys includes the Argentine Archipelago where the Vernadsky/Faraday Ukrainian Antarctic Station is located and an adjoining part of the Antarctic Peninsula. Following works in this area are carried out under the auspices of the Ukrainian Antarctic Center within the State Program of the Ukrainian Antarctic Research for the SCAR's GIANT, ANTEC and IBCSO Projects:

- Seasonal many days GPS observations at the "SCAR GPS 2002" site on Galindez Island;
- Restoration of coordinates of the British triangulation stations and creation of new network on islands;
- Large-scale topographic mapping of islands and ground photogrammetry survey;
- Echosounding of the Argentine archipelago's sea-bed in the shallow water unsurveyed areas;
- Mapping of the Galindez ice cap and ice streams of the Antarctic Peninsula with the ERS radar interferometry;
- Determination of the Bellingshausen sea geoid with the altimeter data for geological purposes.

The main goal of these works consists in following: creation with the GPS survey of a precision geodetic network and determination of geodynamic characteristics of the region, determination massbalans and dynamics of the ice cover by the satellite radar interferometry, modeling of a deep structure of the lithosphere with the altimeter data, creation of the "Vernadsky-Argentine Islands" GIS.

Seasonal continuous GPS observations

Observations with dual frequency Trimble 4700 receiver were carried out during two weeks in 2002 and 2003 to monitor the physical stability of the main station and for the estimation of the regional tectonic stability of the area. Four IGS GPS stations were used for processing of our measurements by the Space Geodesy Analysis Centre (AUSPOS), Australia. Differences between coordinates are: 3.1 mm in latitude, 6.4 mm in longitude, 5.0 mm in height. RMS were from 3 mm to 7 mm. Horizontal vector of the ground mark displacement during one year is 7.2 mm at azimuth 64.5°.

Coastal GPS survey

Local network of GPS sites was created in an approximate 10-15 km radius around the main observing station and relatively the “SCAR GPS 2002” site. More than 300 GPS points had determined for positioning of different geophysical measurements on islands. They are different objects on the Vernadsky station (meteorological and geophysical pavilions, masts and antennas), british triangulation stations, tidal gauge, fixed points for the stereophotogrammetric survey, and points of geomagnetic, geological and biological samples. 30 points are fixed in rock and can be used for repeated observations and expansion of a local geodetic network. One of results is shown in Fig. 1 as a topographic map of the Galindez Island by the GPS measurements.

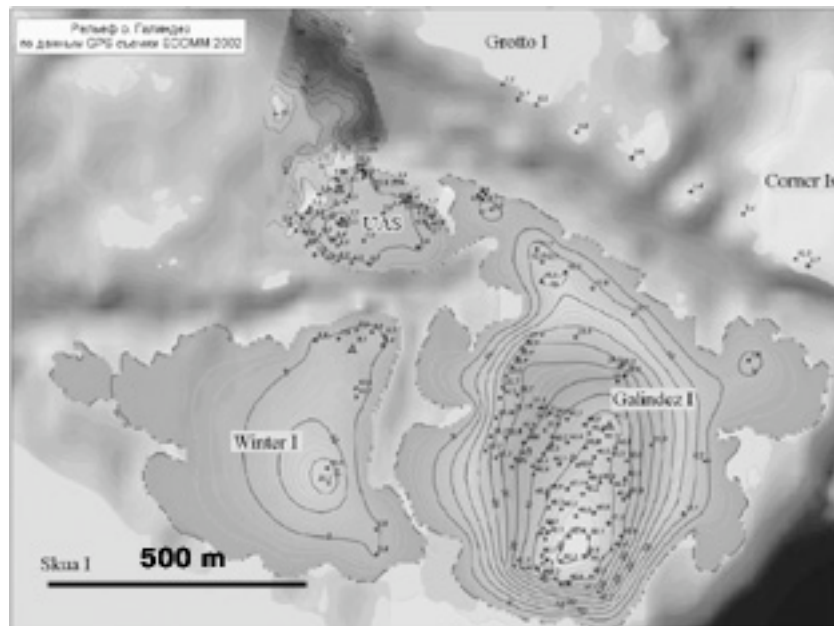


Figure 1. Topographic map of the Galindez (Ukrainian Antarctic Station) and Winter Islands by the GPS survey at geophysical polygons. Contour isoline: 5m

Ground Photogrammetry for mapping of the Galindez Island ice cliff

Stereophotogrammetric survey of the coastal line and ice cliff were carried out by a Sony DSC-F717 digital camera on a boat. 70 overlapping images were made for the Galindez and Winter Islands along length of 1000 m (Fig. 2). Coordinates of the reference marks (x) were determined by GPS. Comparison of the topographic data allows to estimate a seasonal changeability of the ice cap by layers with high accuracy.

Now the processing of stereopairs is implemented with the ERDAS software. These field works have been carried out in collaboration with the Lvov Polytechnic University



Figure 2. Fragment of a photomontage shows the southeast coast of the Galindez Island with the cliff of the island ice cap (height approximately 50 m).

Research of the Archipelago's bottom topography

The archipelago of the Argentine Islands is located on the western shelf of the Antarctic Peninsula. It is separated from the Peninsula by deep (more than 300 m) and wide (7 km) Penola strait. The archipelago is tectonic mesoblock, which is broken at smaller fragments by system of fractures.

Echo-sounding and geological sampling on the equipped boat were carried out in the internal water between islands of the archipelago during March - April 1998 and then added in 2002 and 2003 (Fig. 2). Total tracks extension is 400 km approximately. Depths and co-ordinates were recorded with two second period (or 5 m distance approximately). Depth accuracy is not worse than 0.1 %. Depths are corrected for the tidal level.

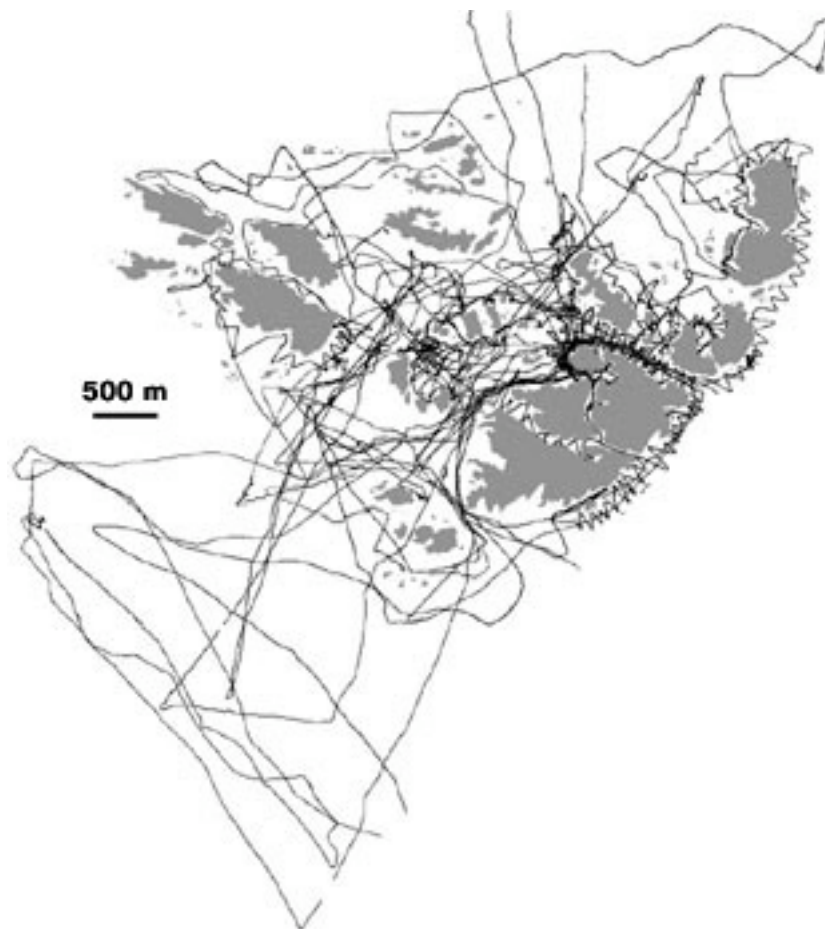


Figure 3. Boat echosounding survey during season expeditions 1998-2003.

DEM with 20 m resolution and an electronic map of the bottom topography were constructed (Fig. 3). On this base different morphometric and geomorphological maps (slope, aspect, curvature, ridge and channel directions) were created with the LandSerf software (Lester Univ., UK). Depths within the archipelago are not more than 70 m. The general nature of the bottom is rock with thin mud and sand sediments distributed in morphological traps.

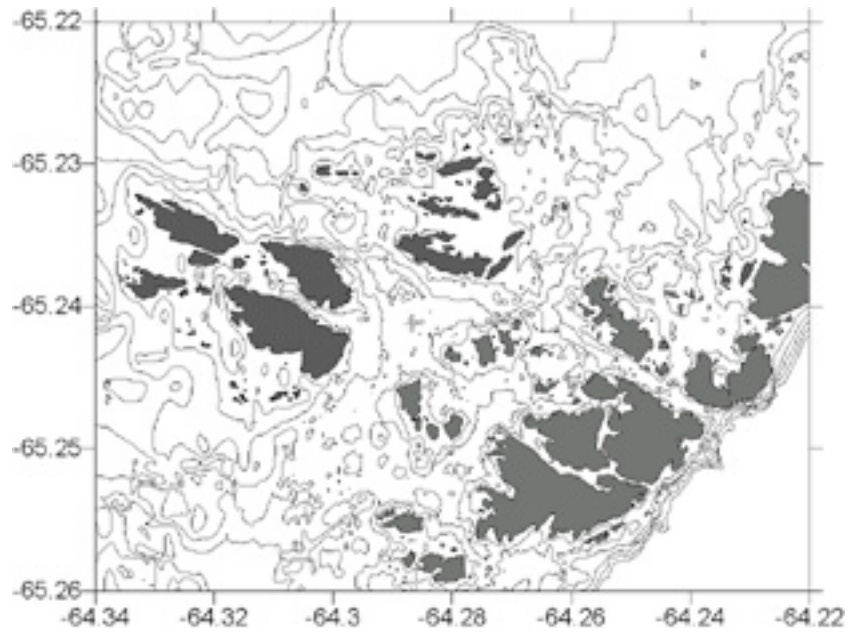


Figure 4. Bathymetric map of the Argentine Archipelago's sea-bed with the season Ukrainian expeditions (1998-2003). Contour interval is 10 m

**Topography of the Flask Glacier (Antarctic Peninsula)
with the interferometry technique by the ERS SAR images**

12 radar ERS1/2 images (including the Tandem mission) for the same area of the Graham Land on area 100_100 km are received. These images are used for investigation of variability of the ground and ice cover topography for period 1996-2003, and for geological, oceanological and ecological researches also.

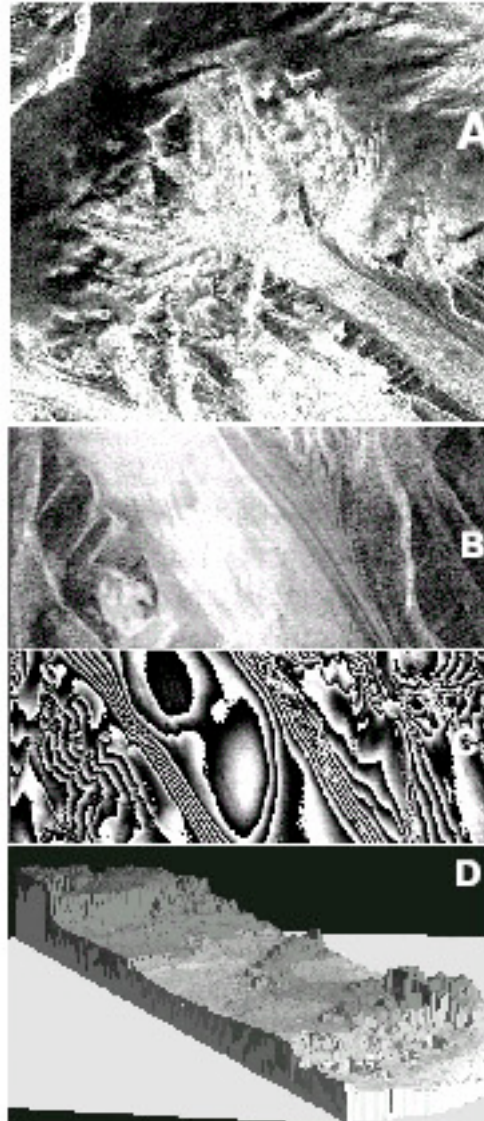


Figure 5. ERS-2 image of 27.02.96 for the Flask Glacier flowing from the Bruce Plateau (1700 m) to the Weddell Sea;

A – area of the fragment is 36km x 32km

B - amplitude image of the fragment distinguished from A for interferometry processing, area is 7 x 15 km

C - phase interferogram by two Tandem images

D - 3D image by DEM from the interferogram

Topographic-geodetic works in a complex with other researches at the Vernadsky station (seismology, geomagnetism...) will be an important contribution to a fundamental area of studying of geodynamic processes.