ABRIS Project: new bedrock topography map for central Antarctica

S. V. Popov,[1] G. L. Leitchenkov,[2] M. Yu. Moskalevsky,[3] V. V. Kharitonov,[1] V. N. Masolov,[1] and the BEDMAP Consortium

[1]Polar Marine Geosurvey Expedition (PMGE), 24, Pobeda Str., St. Petersburg, Lomonosov, 188512, Russia (spopov67@yandex.ru)
[2]Institute of Geology and Mineral Resources of the World Ocean (VNIIOkeangeologia), 1, Angliysky Ave. 190121, St.-Petersburg, Russia (german_l@mail.ru)
[3]Institute of Geography, Russian Academy of Sciences (IGRAN), 29, Staromonetny lane, 119017, Moscow Russia (moskalevsky@mail.ru)

Summary A new bedrock topography map has been compiled for the central region of East Antarctica using ice thickness data available in the BEDMAP Project data base and new information obtained after 2000 by the Russian Antarctic Expedition (when the BEDMAP product finished). Moreover, airborne radio-echo sounding data acquired during the Soviet Antarctic Expeditions (before 1992) between Enderby Land and the Gamburtsev Subglacial Mountains and recorded on films have been revised and reinterpreted. This work allowed imaging of improved bedrock topography for this area. Unlike the previously published bedrock topography map produced by the BEDMAP Project, the new map shows real bathymetry of Lake Vostok and some earlier not recognized morphological features of the Gamburtsev Subglacial Mountains and area to the north of them.

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Introduction

Knowledge of subglacial topography of Antarctica is very important for geoscientists and glaciologists. The last version of bed topography of Antarctica compiled within the international Project BEDMAP has been published in 2000 (Lythe et al., 2000, 2001) and was not upgraded from that time. In 2006, PMGE, VNIIOkeangeologia and Institute of Geography initiated a new project ABRIS (Antarctic Bed Relief and Ice Sheet) aimed to: 1) upgrade the small-scale ice thickness and the bedrock topography map for East Antarctica; 2) compile relatively detailed ice thickness and the bedrock topography maps for Enderby Land and Prince Charles Mountain region using all available (mostly Soviet and Russian) radio-echo sounding (RES) and reflection seismic sounding (RSS) data; 3) determine position of Ice Sheet grounding line in the areas noted in point 2. This work was stimulated by the IPY Project of the Commission for the Geological Map of the World "Tectonic Maps of the Earth’s Polar Regions" and IPY Project "Antarctic Surface Accumulation and Ice Discharge" (ASAID) which called for new information on the subglacial topography and ice thickness for interpretation of tectonic provinces/features under the ice and present-day ice discharge. In this paper, results of first Project stage focus on central part of East Antarctica.

Data used and map compilation

On the first stage, all RES time sections collected during the Soviet Antarctic Expeditions from 1987 to 1991 (and recorded on films) were thoroughly analyzed and digitized. The first result of ABRIS project is the ice thickness and bedrock topography digital models of the central part of East Antarctica including Domes Fuji, Concordia and Argus, Ridge B and Vostok Subglacial Lake. For this map compilation we used the available BEDMAP data base including: 1) USA RSS data collected in 1960's (Beitzel, 1971; Crary and Robinson, 1962); 2) the joint UK/USA/Denmark airborne RES data acquired in 1971/72, 1974/75 and 1978 between 90°E and 160°E (Drewry, 1983a, b; Drewry and Meldrum, 1978); 3) Japanese ground-based RES data collected in 1992-94 within the Dome Fuji area (Fig. 1). Another set of data includes: 1) seismic data acquired during 1958-1964 along traverses crossing central Antarctica (Kapitsa, 1960; Kapitsa and Sorochtin, 1965; Kogan, 1968); 2) Airborne RES data with 50 km line spacing collected in 1966/67 field season using middle-range aircraft IL-14 on Enderby Land; 3) Airborne RES data with 50 km line spacing collected during 1987-1991 field seasons between the Gamburtsev Subglacial Mountains and Enderby Land using long-range aircraft IL-18; 4) ground-based RES data collected between 1998 and 2006 in the area of Vostok Subglacial Lake and along the traverses from the Mirny Station to the Vostok Station (Masolov et al., 2006; Popov et al., 2006); 5) ground-based RES and RSS data collected along numerous lines crossing Subglacial Lake Vostok (Fig. 1).

During data processing and map compilation we follow procedures similar those described by Lythe et al. (2001) for BEDMAP Project compilations but unlike the Kriging algorithm which was used by authors we applied the Inverse Distance technique. The bedrock topography map (Fig. 2) was produced by subtraction of the ice thickness (and water thickness data for Vostok Subglacial Lake collected from 1995 to 2005) from the ice sheet elevation data available from GTOPO30 Project (Gesch and Larson, 1996) with 5×5 km grid. Before contouring, the integrated grid was filtered by a moving average method with 15 km radius.

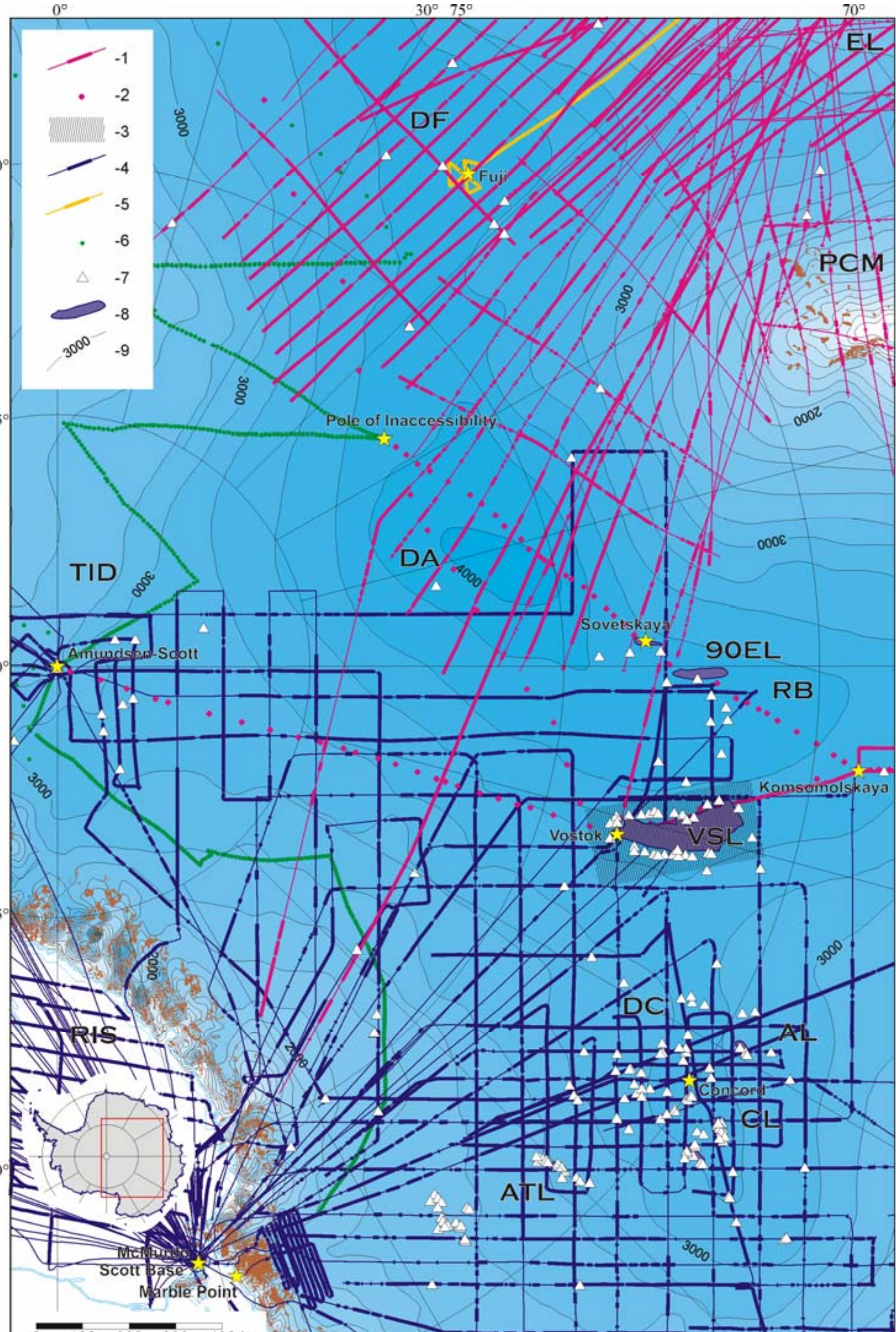

Figure 1. RES profiles and RSS points used for the bedrock topography map compilation. 1- Russian RES profiles; 2- SAE RSS points; 3- area of detailed RAE ground-based RES and RSS studies; 4- UK/USA/Denmark airborne RES profiles; 5- Japanese ground-based RES profiles; 6- USA RSS points; 7- subglacial lakes (Siegert et al., 2005; Popov et al., 2006); 8- large subglacial lakes identified from ERS dada (Siegert et al., 2005; Bell et al., 2006; Popov et al., 2006); 9- the 200 m ice surface elevation contours (Gesch and Larson, 1996). Outcrops and ice front are from ADD (BAS, 1998). Thicker parts of RES profiles show reliably observed reflections from the ice bottom. 90EL- 90E Subglacial Lake; AL- Aurora Subglacial Lake; ATL- Adventure Trench Subglacial Lake; CL- Concordia Lake; DA- Argus Dome; DC- Concordia Dome; DF- Fuji Dome; EL- Enderby Land; PCM- Prince Charles Mountains; RB- Ridge B; RIS- Ross Ice Shelf; TID- Titan Dome; VSL- Vostok Subglacial Lake.

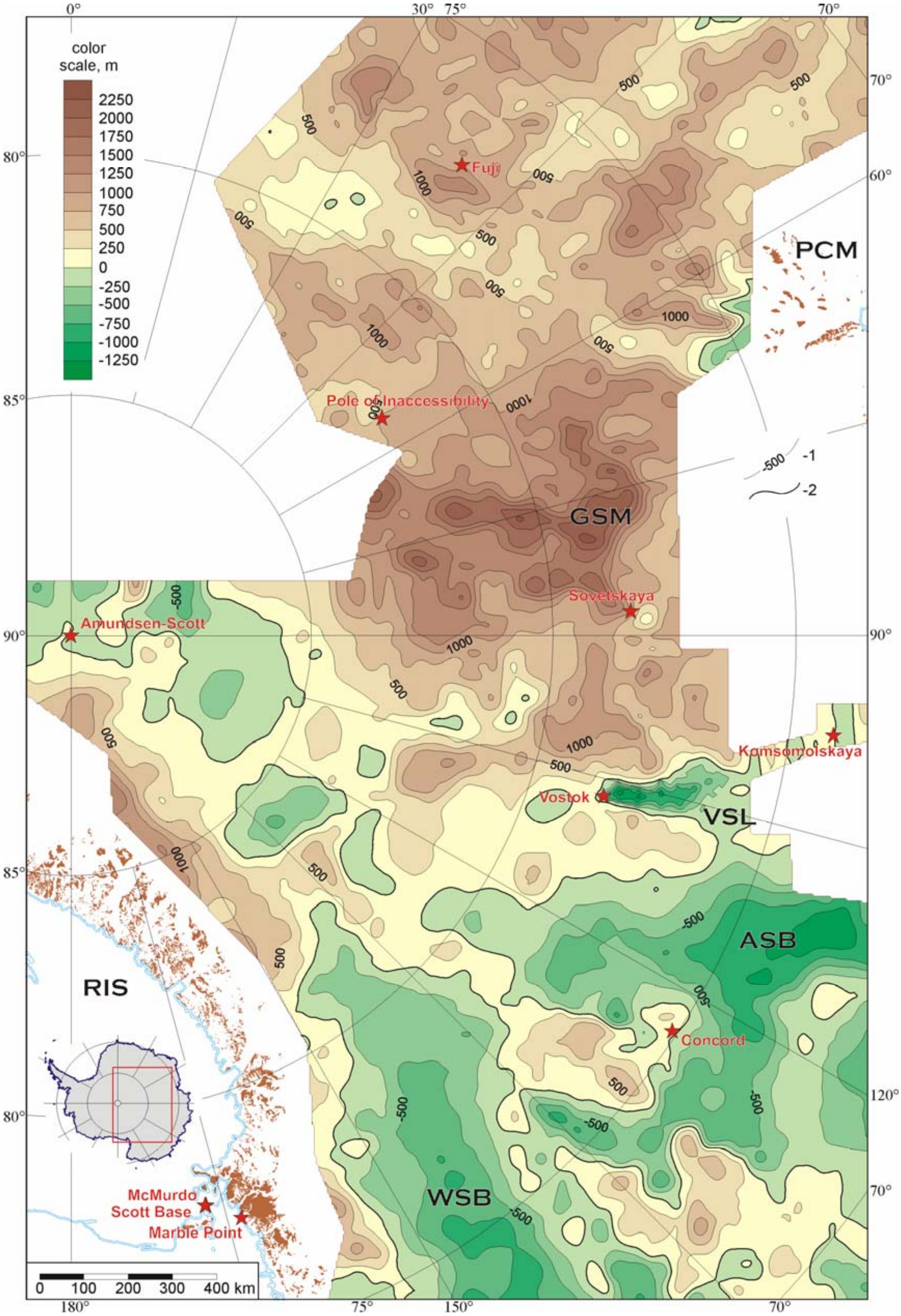

Figure 2. Bedrock topography map for central East Antarctica. 1- bedrock contours spaced with 250 m; 2- sea level. Outcrops and ice front are plotted on ADD (BAS, 1998). ASB- Aurora Subglacial Basin; GSM- Gamburtsev Subglacial Mountains; WSB- Wilkes Subglacial Basin.

Unlike the previously published bedrock topography map produced by the BEDMAP Project, the new map shows 1) bathymetry (bedrock relief) of Vostok Subglacial Lake, based on numerous RES data; 2) slightly different morphology of the Gamburtsev Subglacial Mountains with distinct NNW-SSE orientation of major ridge; 3) more ranked morphology of the Enderby Land with extensive N-S trending mountain ridge in the north-eastern part of the study region; 4) remarkable E-W trending valley between Enderby Land and the Gamburtsev Subglacial Mountains (Fig. 2).

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