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RUSSIAN AIRBORNE GEOPHYSICAL INVESTIGATIONS OF MAC. ROBERTSON, PRINCESS ELIZABETH AND WILHELM II LANDS, EAST ANTARCTICA

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This paper provides an overview of Russian geophysical studies of Mac. Robertson, Princess Elizabeth and Wilhelm II Lands, East Antarctica. The dedicated complex geological and geophysical investigations during the 17–19th SAE (1971–1974) austral summer field seasons paved the way for systematic research works. These included deep seismic sounding, ground-based gravity measurements with reflection seismic sounding over the 30 × 30 km survey grid, and combined aeromagnetic surveys on a scale of 1:2 000 000, and radio-echo sounding (RES). After a significant gap, a new phase of the investigations in this region has been underway since the 31st SAE (1985/86) field season. The airborne geophysical investigations include airborne magnetic and RES surveys along the traverse lines with the 5 km interval between the profiles, which have covered the area between 62° E and 88° E in East Antarctic, from the coastal line to the 2800 m ice surface elevations in the South.

East Antarctica, airborne geophysical investigations

INTRODUCTION

The region comprising the Lambert depression and its extension, the Prydz Bay, bounded by Mac. Robertson Land, Princess Elizabeth Land and Wilhelm II Land is critical in understanding both the subsurface structure and glaciation of East Antarctica. Given that the region's diversity is manifest in geological, geomorphological and glaciological aspects, it has been studied for many years with the involvement of eextensive geological and geomorphological studies, RES profiling, gravity andmagnetic surveying and seismic observations, as well as reflection seismic technique as deep seismic sounding (DSS) [*Soloviev et al., 1967; Fowler, 1971; Boyarskii and Shalygin, 1976; Soloviev, 1976; Ravich et al., 1978; Allison, 1979; Kolobov, 1980; Kurinin and Grikurov, 1980; Budd et al., 1982; Kurinin and Aleshkova, 1987; Mikhalsky et al., 2001; Lastochkin et al., 2006; Kamenev et al., 2009*]. Additionally, different seismic surveys and bottom sampling have been carried out in the adjacent offshore area of the Cooperation Sea [*Dubrovin and Korotkevich, 1977; Ravich et al., 1978*]. Today, this area, with the exception of the Antarctic Peninsula alone, appears one of the most explored regions of Antarctica. This paper aims at providing a possibly full account of the dedicated Soviet and Russian geophysical investigations.

A BRIEF OVERVIEW OF THE RUSSIAN GEOPHYSICAL STUDIES

The 1950s and 1960s surveys. Launching the Mirny station on February 13, 1956 on the Davis Sea coast is associated with the beginning of the USSR's active research of Antarctic. *Ground geophysical, glaciological (including drilling), air-borne geophysical, marine and special geologic investigations* have been conducted since the earliest expeditions. At the initial stage, the investigations were for the most part reconnaissance in nature, set out to obtain a basic, nevertheless sufficiently comprehensive understanding of the continent in its integrity. The extensive scientific works provided first-hand information about its climate, the ice sheet, sub-ice relief, tectonic structure and geology of the continent, which was reflected in early editions of The Atlas of Antarctica [*Atlas of Antarctica, 1966, 1969*].

Russia's geological, geophysical and glaciological research of Antarctica reached their peak in the 1970s and 1980s. At that time, the then novel and very promising *radio-echo sounding (RES)* geophysical technique was widely introduced into scientific investigations and offered for industrial applications. Among its advantages over seismic surveys were its agile parameters and principle possibility for airborne applications, which allowed mapping the sub-ice topography and internal structure of glaciers with maximum efficiency. The special RES tests were performed during the summer field season of 9th SAE (1963/64) by researchers from the Department of Physics of Ice and Ocean of the Arctic and Antarctic Research Institute (AARI) near Mirny station [*Bogorodskii et al., 1965*]. By the end of the 1960s, development of this technique had been fully completed and field measurements corroborated its practical applicability. The pioneering airborne RES technique

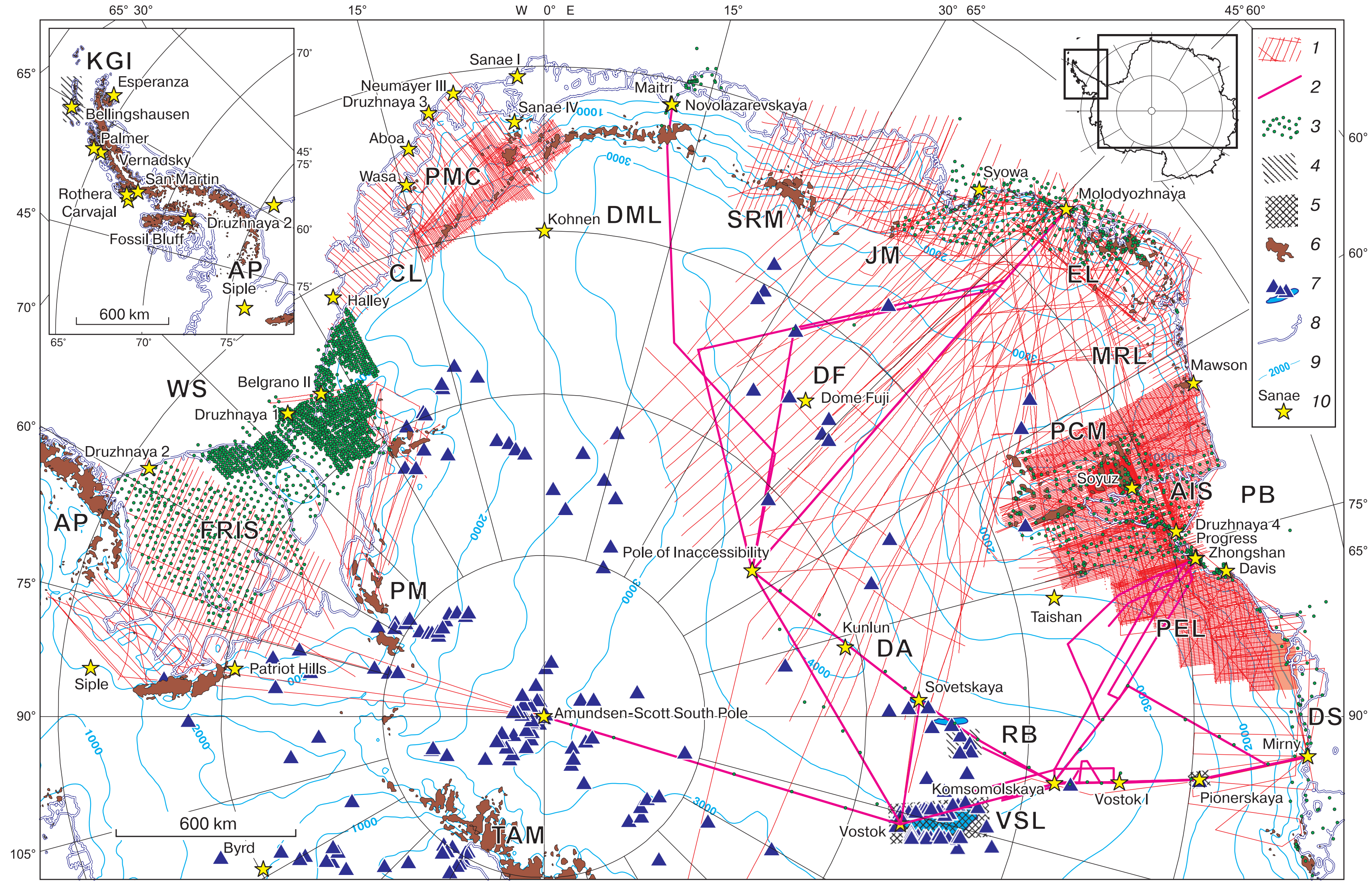

Fig. 1. Russian seismic and RES surveys in Antarctica.

1 – airborne geophysical flights; *2* – ground-based RES traverse lines; *3* – reflection seismic sounding points; *4* – areas of ground-based detailed RES surveys; *5* – areas of ground-based detailed reflection seismic and RES surveys; *6* – bedrock outcrops [*Antarctic..., 1998*]; *7* – subglacial water cavess after [*Popov and Chernoglazov, 2011; Wright and Siegert, 2011*], blue triangles show non-scale objects; *8* – coast line and grounding line of ice shelf according to [*Antarctic..., 1998*]; *9* – ice surface elevation contour lines, m; contour-line interval 500 m; *10* – major polar stations and field bases. AIS – Amery Ice Shelf, AP – Antarctic Peninsula, CL – Cotes Land, DA – Dome Argus, DF – Dome Fuji, DML – Queen Maud Land, DS – Davis Sea, EL – Enderby Land, FRIS – Filchner–Ronne Ice Shelf, JM – Mount Yamato, KGI – King George (Waterloo) Island, MRL – Mac. Robertson Land, PB – Prydz Bay, PCM – Prince Charles Mountains, PEL – Princess Elizabeth Land, PM – Pensacola Mountains, PMC – Princess Martha Coast, RB – Ice Ridge B, SRM – Mount Sør-Ronnane, TAM – Transantarctic Mountains, VSL – subglacial Lake Vostok, WS – Weddell Sea.

applications to the Antarctic studies were implemented in February 1966 (the 12th SAE), when the Il-14 aircraft-borne RES surveys were conducted in the vicinity of Mirny station, producing the first airborne measurements of the ice sheet thickness and sub-ice relief elevations in the history of Russian geophysical surveys [*Fedorov, 1967*]. In February 1968 (the 14th SAE), the AARI staff conducted first *general coverage RES survey* on Enderby Land along the regular network of traverse lines, also using Il-14 airplane as a carrier. The length of RES traverse lines totaled to about 11 000 km [*Kozlov and Fedorov, 1968; Fedorov, 1973*]. Since then, the RES technique has been actively applied to Russia's ground-based and airborne research in Antarctica. To date, RES surveys have covered an area of about 5 mln km^2, which is more than a third of the continent's area (Fig. 1).

At the initial stage, RES studies consisted for the most part of individual soundings. Usually the data acquisition was done by photographing reflections from the oscilloscope screen (Fig. 2, *a*). The method however proved unacceptable in the context of large-scale surveys, inasmuch as the nature of reflections proved so complicated that tracing the target boundaries in this case appeared all but impossible. The proposed method of recording luminous intensity on a film allowing continuous recording of RES data, consisted in the strobes forming on the oscilloscope display, i.e. the lobe of the sphere whose size depends on the antenna directional diagram; the strobe width corresponds to the spatial extent of the pulse, while its radius – to the delay of the reflected signal with the amplitude proportional to the intensity of marks. Given this method focuses on continued RES data registration, it is called *radar (or RES) profiling*. Fig. 2, *c* shows a fragment of the radar time section obtained in the Amery Ice Shelf area during the 1993/94 field season.

The 17–19th SAE field season (1971–1974) research. Investigations during the 17–19th SAE field seasons ("Operation Amery") laid the foundation for future systematic medium-scale airborne geophysical surveys of Mac. Robertson Land and Princess Elizabeth Land. They were carried out under the general guidance of D.S. Soloviev by a team of geologists and geophysicists headed by G.E. Grikurov. The dedicated field works during the three (1971–1974) seasons

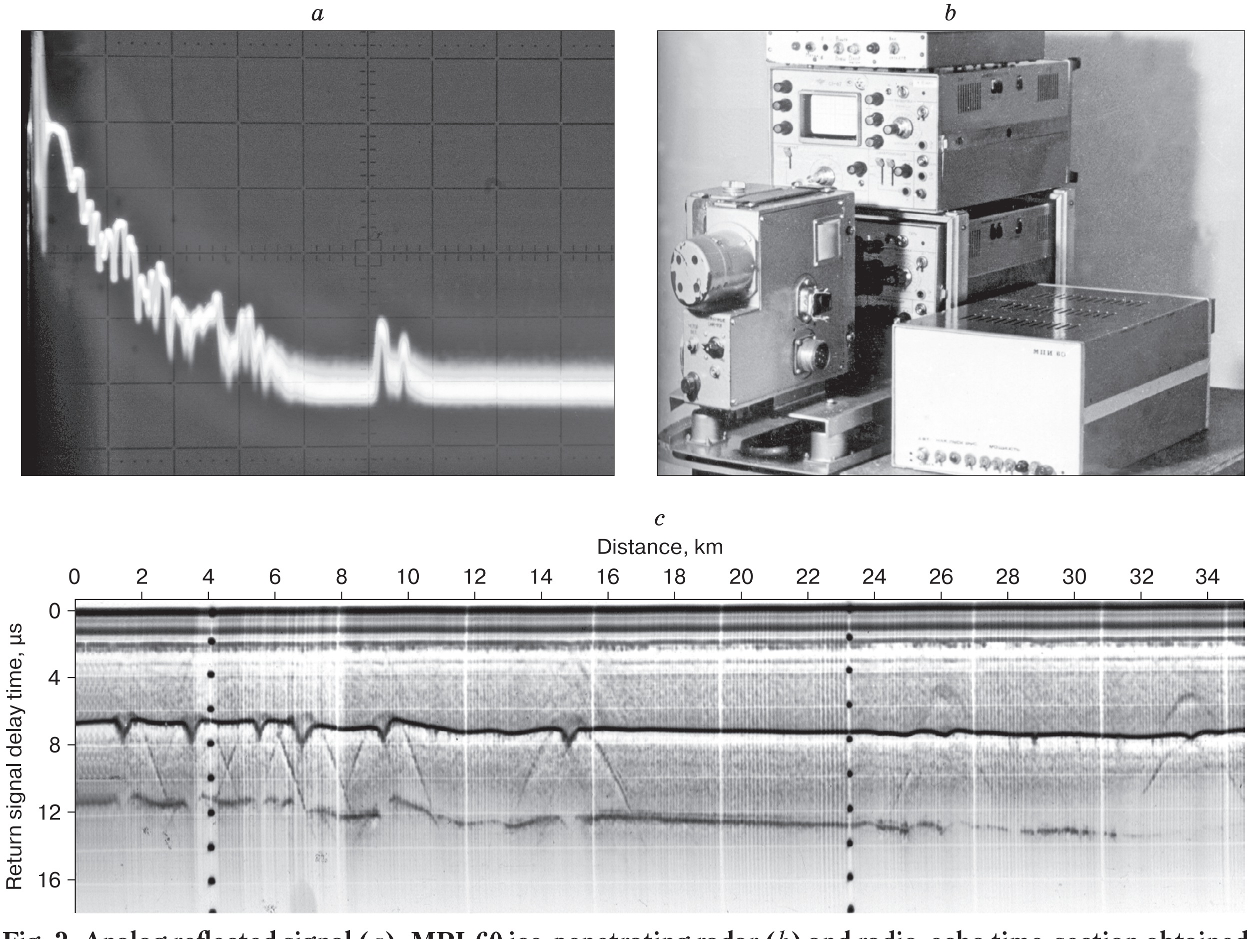

Fig. 2. Analog reflected signal (*a*), MPI-60 ice-penetrating radar (*b*) and radio-echo time-section obtained in the Amery Ice Shelf area (*c*).

Table 1. **Technical characteristics of MPI-60 ice-penetrating radar**

No.	Characteristics	Value
1	Transmitter main frequency	60 MHz
2	Transmitter pulse power	>5.7 kW
3	Pulse duration	<0.08 μs
4	Pulse repetition frequency	5 kHz
5	Receiver dynamic range	>82 dB
6	Receiver sensitivity	10 μV
7	Antenna beamwidth in horizontal plane of aircraft	100°
8	Antenna beamwidth in vertical plane of aircraft	50°
9	Radar energy potential	165 dB

included a wide range of geophysical surveys: *airborne gravity surveys*, accompanied by *reflection seismic sounding* over a regular network sized 30 × 30 km (on a 1:3 000 000 scale), *aeromagnetic surveys (AMS*) on a 1:2 000 000 scale combined with *RES surveys*, the then novel geophysical technique, and *deep seismic sounding (DSS)*.

Aeromagnetic and RES surveys, as an adequate geophysical method, were performed using Il-14 airplane as a carrier which would take off from airfields located either at the Amery research base or Mirny station, depending on the site of investigations. The surveys covered a total area of 932 000 km^2 and were conducted at a constant barometric height of 2000 m for the continental ice sheet, and 500 m for the shelf or off-shore area flowing or passing round individual summits. The airborne geophysical profiles from Amery base to the Pole of Inaccessibility and Vostok stations were accomplished early in 1974 (Fig. 1).

Navigation was carried out either with the use of *aerial positioning* or by *calculating the coordinates*. To this end, prior to the commencement of the works, continuous photography (backbone photography) was used for subsequent positioning on natural landmarks. Standard DISS-013 Doppler Navigation Set (measuring speed and deflection) coupled with the gyrocompass were used for the aircraft navigation along the traverse lines. The error in determining the spatial coordinates by this method tends to aggravate with increasing distance along the traverse and constitutes 2.0–3.5 km per 100 km. Ultimately, the accuracy of spatial positioning was 1–3 km. In most areas located far from the coastline or mountainous terrain, i.e. poor in natural landmarks, the error was 2–5 km and more. Analysis of electronic navigation and Doppler methods for determining the positioning is provided in [*Bochkovskii, 1980; Bochkovskii and Khmelevskii, 1980*].

The altitude positioning was carried out by *barometric leveling*. For this purpose, a barometric measurements were registered on stationary point was installed in the area of work, which was used for standard permanent meteorological observations. Relative flying height was determined by the RV-10 radio altimeter system which includes coincident photography. The magnetic field was measured using a fluxgate magnetometer whose readings can be traced simultaneously on the recorder's permanent strip chart paper. The variations in geomagnetic field were taken into account using the AARI three-component station data. The mean-square error of aeromagnetic surveys (AMS) was ±(25–40) nT in different seasons. RES profiling was carried out by the AARI team headed V.G. Trepov. They used the RLS-60 ice-penetrating radar with 60 MHz frequency of sounding pulses.

The results of the works enabled a better understanding of the subsurface structure of the largest rift zone in East Antarctica, confined to the Lambert Glacier-Amery ice shelf system; revealing the main features of the sub-ice relief and geological framework; and tectonic zoning [*Kolmakov et al., 1975; Ravich et al., 1978; Kurinin and Aleshkova, 1987*].

The successful applications of extensive RES surveys conducted in Arctic and Antarctica by Russian and foreign researchers and, most importantly, the results obtained during the Amery Operation, have led to the creation of a PMI-60 ice-penetrating radar system with signals recorded on photographic film. This device (Fig. 2, *b*) has been designed by and developed back in 1984 within the joint project Polar Marine Geosurvey Expedition (PMGE) with the A.M. Gorky Mari Polytechnic Institute (now Volga State University of Technology). Its main technical characteristics are listed in Table 1. For better performance while surveying the relatively low-mass balance arctic glaciers, the device could be readjusted for higher frequency 300 MHz.

Airborne geophysical studies during the 31–35th SAE (1985–1988). After a significant hiatus, the systematic study of the Lambert rift area was resumed in the 31st SAE field season (1985/86) through the implementation of complex airborne geophysical surveys first on a scale of 1:200 000 and then 1:500 000 [*Popov and Pozdeev, 2002; Kiselev and Leonov, 2012; Popov et al., 2014*], which marked the beginning of a new era of the Soviet scientific research of Antarctica. The works included aeromagnetic and RES measurements using Il-14 aircraft as a carrier that based at the Soyuz field base aerodrome and resulted in complex airborne geophysical surveys conducted on a scale of 1:200 000 and covering an area of about 16 000 km^2 (Fig. 3). The spatial positioning of the carrier was defined from the *aerial photography*, and also using the Doppler method with the use of the standard navigation equipment DISS-013 and the aviation gyrocompass GPK-2 [*Bochkovskii, 1980; Bochkovskii and Khmelevskii, 1980*]. Aerial positioning was carried out using an airborne camera AFATE 55. Preliminary compilation based on the obtained photographs allowed to identify natural landmarks.

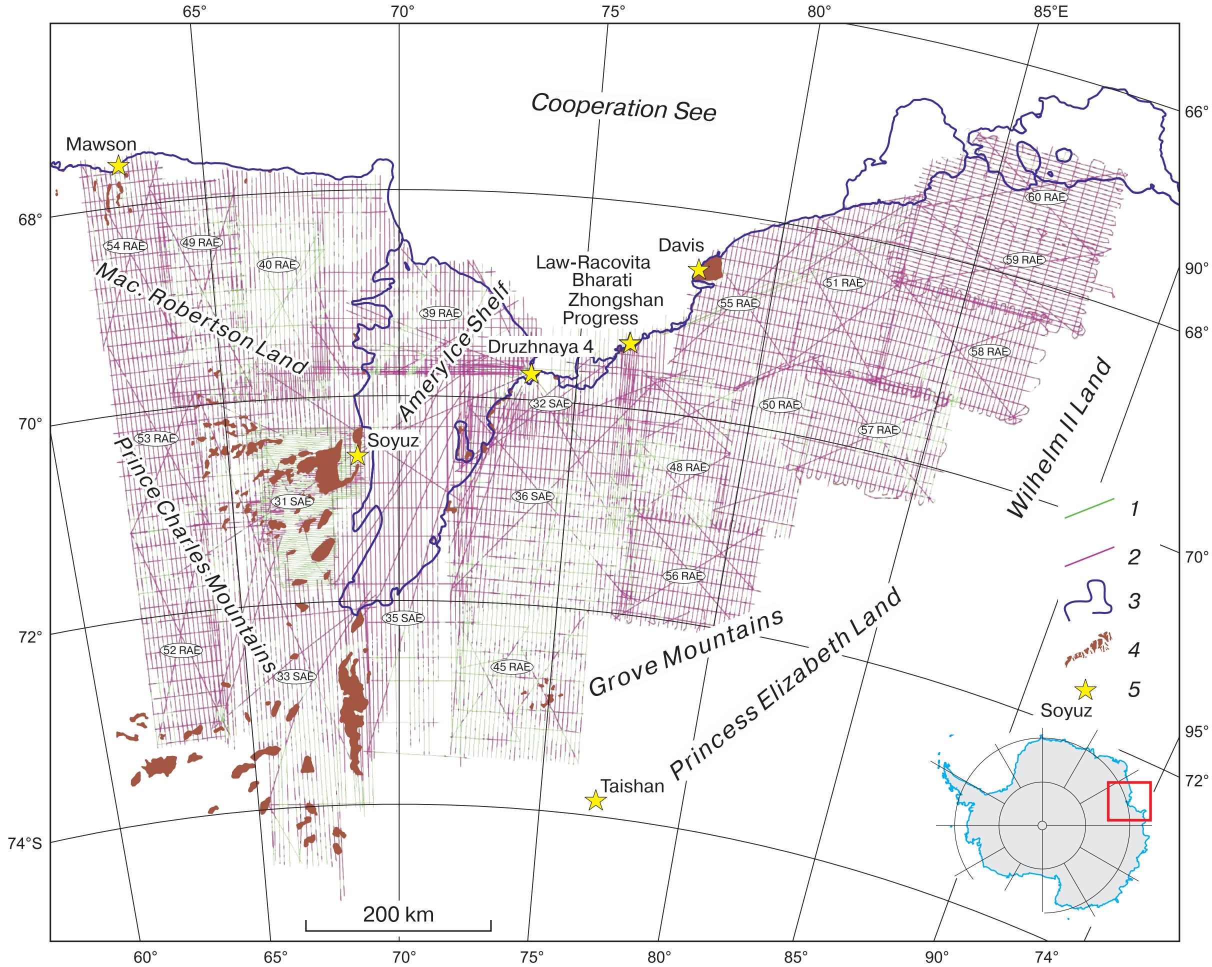

Fig. 3. Schematic representation of airborne geophysical flights on Mac. Robertson Land and Princess Elizabeth Land during the 31st SAE–60th RAE period.

1 – airborne geophysical flights; *2* – segments of flights with reflections from the glacier bed according to RES data; *3* – coast line and grounding line of ice shelf according to [*Antarctic…, 1998*]; *4* – bedrock outcrops according to [*Antarctic…, 1998*]; *5* – major polar station and field bases.

The flying height was determined by the RV-18G radio altimeter. The lateral coordinate positioning error was 175 m. The RES profiling was performed by the MPI-300 ice-penetrating radar (an MPI-60 radar with adjusted frequency) with sounding pulses frequency 300 MHz which were recorded on a 35 mm photographic film.

In subsequent years, the RES profiling was performed by an MPI-60 radar (Fig. 2, Table 1). Alternatively, the surveys were initiated on a smaller scale (1:500 000). In the 33rd SAE season (1986/87), the implementation of the satellite positioning method by using the SNS Transit receiver-indicator, and beginning from the 35th SAE (1988/89) season, the spatial positioning of airborne geophysical operations was performed using a satellite navigation system. Due to the resultant significant improvements in accuracy, specifically, during the 35th SAE works, the error in coordinate positioning was 30 m. The MX-4400 GPS NAVSTAR receiver was used in those and subsequent surveys. Absolute altitude and radio-altitude of the flight were determined using standard instruments: the BS-6 string barometer and the RV-21 radio altimeter, respectively.

Airborne geophysical surveys during the 36th SAE–61th RAE (1989–2016). Short-range Antonov aircraft An-2 has been used as a carrier in Russia's airborne geophysical surveys in Antarctica since the 36th SAE season (1989/90). In addition, renovating the MPI-60 ice-penetrating radar during the 39th RAE pre-field period (1993/94) allowed obtaining higher quality materials. The technical characteristics of the improved instrument are given in Table 2. The renovated MPI-60 ice-penetrating radar was ready-to-use beginning from the 40th RAE season (1994/95). The advancement of digital technologies

Table 2. **Technical characteristics of modernized MPI-60 ice-penetrating radar**

No.	Characteristics	Value
1	Transmitter main frequency	69 MHz
2	Transmitter pulse power	5 kW
3	Pulse duration	0.2 μs
4	Pulse repetition frequency	5 kHz
5	Radar energy potential	>140 dB

Table 3. **Technical characteristics of RLK-130 ice-penetrating radar**

No.	Characteristics	Value
1	Transmitter main frequency	130 MHz
2	Transmitter pulse power	200 W
3	Pulse duration	0.5–15 μs
4	Pulse repetition frequency	10 kHz
5	Bit capacity of ACD board	24
6	Discretization interval	38.46 ns

and lowered cost of its components prompted the creation of analog-digital converter (ADC) for RES data recording to a PC, which became a new reality in the 45th RAE season (1999/2000) for airborne geophysical studies in Antarctica. A six-bit ADC board was used for data sampling at an interval of 140 ns. The introduced digital registration completely changed the processing of the RES data and opened new opportunities and perspectives for the radar technique.

In the 45th RAE field season (1999/2000) the MPI-60 ice-penetrating radar was to some extent improved, which reduced the frequency of sounding pulses from 69 MHz to 65 MHz. In the 49th RAE season (2003/04) the ice-penetrating radar experienced further modernization, when the frequency of sounding pulses again became 60 MHz, while other parameters remained unchanged. The navigation equipment was also subject to alterations. The technologically obsolete MX-4400 GPS NAVSTAR was replaced by a more advanced SVeeEight Trimble, ensuring thereby a greater accuracy of the lateral and vertical positioning. The relative flying height was determined by the A-037 standard radio altimeter of An-2 airplane and connected to the aboard recording equipment, which resulted in accuracy of about 3 m for lateral positioning, and about 20 m for vertical positioning.

In the 50th RAE field season (2004/05), the ADC (Analog-to-Digital convertor) board was also modernized, giving way to a new device based on the TMS320 signal processor. In comparison with the previous one, the ADC bit value has increased from 6 to 8, however the sampling interval of 140 ns remained the same. A year later, beginning from the 51st RAE field season (2005/06), the sampling interval was halved to be 80 ns. In addition, compared with the previous radar modification, the pulse recurrence frequency increased to 4.1 kHz.

In attempt to increase the information content of the RES radargrams during the pre-field period of the 53rd RAE (2007/08), the introduced modification to the MPI-60M radar resulted in increased frequency of sounding pulses from 60 MHz to 62.5 MHz. and increased transmitter power from 6 kW to 10 kW. This made the radargrams more than 90 % informative.

The technological obsolescence of MPI-60 ice-penetrating radar urged the development of a new instrument, its successor. The prototype of a more advanced ice-penetrating radar RLK-130 was first tested in Antarctica during the 59th RAE field season (2013/14). Its main technical characteristics are listed in Table 3. Although already found to be applicable to the industry needs, the instrument has thus far not passed the final stage of its development.

The integrated aeromagnetic and RES surveys were carried out on the same system of traverse lines. During the 31st–36th SAE works, magnetometric studies were performed with a towed bird using the YMP-3 and MMS-214 proton aeromagnetometers. The registration interval was 1 second. The measurement error basically did not exceed 0.2 nT. The data were recorded in a digital form on the magnetic tape. In order to monitor the recording quality, the data acquisition was visualized on the instrument display.

The account of variability of the geomagnetic field was possible through setting up magnetovariation stations operating in an automatic mode, that include optically pumped magnetometer MMP-303 (M-33M) with a digital recording device and a five-minute measurement interval. MM-60 magnetometers with data registration in ROM with an interval of 1 minute were also applicable. The measurement accuracy in both cases was 1.0 nT. As a rule, magnetovariation stations were installed at the airfield where the aircraft was based. In case of the survey area was remoted from the airfield, the MV stations placement was chosen to be directly in the study area. The applied equipment and methods allowed to generate maps of anomalous magnetic field with a mean-square error not exceeding ±(10–15) nT.

Unfortunately, in the early 1990s, all the equipment reading information from magnetic tapes was disposed of, and their destruction shortly followed. This led to the irretrievable loss of all primary magnetometric information during this period. Only printed graphs and isolines maps of an anomalous magnetic field have been preserved as attachments to the PMGE Technical Reports.

After resuming aeromagnetic surveys during the 45th RAE season (1999/2000), the registration system was transferred to more reliable removable magnetic storage media – floppy disks, and subsequently, starting from the 48th RAE season (2002/03) – to hard disks of the onboard computers, inasmuch as the hardware was becoming increasingly advanced and its prices affordable, providing thereby a stepping stone for the creation of the appropriate bases of the primary aeromagnetic data, which integrated all basic flight information, including the flight duration, the aircraft's lateral and vertical positioning, relative flying height (radio altitude), as well as full-vector geomagnetic field records.

In the 48th RAE season, the gondola installation options changed from the towed type with fixed magnetometric sensor, to its hull-mounted version onto the outlying pole behind the tail part of An-2 aircraft, which allowed, on the one hand, to simplify the acquisition technology, and on the other hand, to improve the flight safety. This, however, largely fueled forces causing aircraft deviation and therefore required most careful attention to the flight deviation curve behavior.

The magnetic field was measured using optically pumped magnetometer MGM-04 whose measurement accuracy was 0.01 nT and recording interval – 0.5 s, which in the 49th and 50th RAE seasons (2004–2006) was replaced by optically pumped magnetometer MM-01 with similar technical characteristics, but with an auto-orientable magnetic system, providing thereby a higher reliability of measurements on all survey directions. The MM-60M optically pumped magnetometer served as a magnetovariation station, with a measurement accuracy of 0.1 nT and a 30 s recording interval. However, despite the high accuracy parameters of the equipment used, it failed to result in any significant improvements to the error in aeromagnetic surveying. The more so, because of organizational problems, the magnetovariational observations during that period were carried out only at stationary stations and field bases in remoted locations hundreds of kilometers away from the investigated areas. Therefore, even after introducing the well- proven in Russia's high latitude regions system of flights with high concentration of transects, the error in the aeromagnetic survey was about ±10 nT.

A new stage of the equipment modernization and improvements to the existing methods for aeromagnetic surveys began in the 51st RAE season (2006/07). Measurements were made using a four-chamber quantum sensor GMS-4B (manufactured by "Geologorazvedka" company) inasmuch as its performance of remained stable and reliable at temperatures down to −40 °C and at any survey directions; while the MINIMAG proton precession magnetometer (PPM) ("Geologorazvedka" company) capable of operating for a long time in an autonomous mode installed directly in the survey area for the entire period of works, served as a magnetovariation station. The resulting the accuracy of aeromagnetic surveys has increased to ±(4–5) nT. Given the GMS-4B sensor resource had been depleted and found irreparable due to lack of necessary spare parts (quantum sensors for aeromagnetometers were not produced in our country at that time) it was therefore replaced starting from the 57th RAE season (2011/12) by a CS-L quantum sensor (Scintrex, Canada) whose main characteristics are listed in Table 4. Owing to successful applications of integrated airborne geophysical surveying on a 1:500 000 scale, including aeromagnetic measurements and radar profiling, the southern sector of East Antarctica between 62° and 88° E from the coast to 2800 m elevation marks of the day surface (Fig. 3) has been most profoundly explored.

Table 4. **Technical characteristics of optically pumped magnetometer CS-L**

No.	Characteristics	Value
1	Magnetometer sensing unit	Caesium, single-chambered
2	Sensitivity	0.001 nT
3	Systematic error signals on the operating band	<2.5 nT
4	Random error	<0.002 nT
5	Sampling rate	1–10 Hz
6	Measurements range	15 000–105 000 nT

Russian ground-based investigations during the 41–58th RAE (1995–2013). The discovery of subglacial Lake Vostok in the central part of East Antarctica [*Ridley et al., 1993; Kapitsa et al., 1996*] in 1995 (41th RAE) was followed by the commencement of a systematic study of this natural phenomenon first by seismic reflection method and then by ground-based RES surveys.

During the 49–58th RAE summer field seasons (2004–2013), land-based radar profiling was carried out within the snow-cat traverse, composed of stretches first between Mirny and Vostok stations, and then between Progress and Vistok staions (Fig. 1). The investigations provided insights about the structural features of the sub-ice relief of poorly studied or unexplored regions of East Antarctica [*Popov, 2015; Popov and Lunev, 2016*], allowing, in particular, detection of new sub-ice water bodies [*Popov and Popkov, 2015*].

The materials of Russian aeromagnetic and RES surveys were used in the international projects ADMAP (the study of anomalies in the Antarctic magnetic field) [*Golynsky et al., 2006*], BEDMAP and BEDMAP2 (topography of the Antarctic bedrock) [*Lythe et al., 2001; Fretwell et al., 2013*].

Foreign geophysical research. Speaking of exploring the Antarctic areas by geophysical methods, the contribution made by foreign expeditions, primarily, by the ANARE staff (Australian National Antarctic Research Expedition) deserves a special mention. Beginning from the mid-fifties of the last century their team started to undertake regular sledge-caterpillar expeditions from their base at Mawson station (in Mac. Robertson Land in the west) southwards, into the inland areas of Antarctica.

In 1954, they discovered the Prince Charles Mountains and Lambert Glacier, the largest channel glacier on the globe. During the 1957–1959 summer field seasons they conducted land-based seismic-gravimetric observations south of Mawson station on the profiles striking submeridionally whose aggregate length totaled to more than 1000 km [*Fowler, 1971*]. In this context, the Australian map published in 1958 provided pioneering insights about the geography of the discovered areas, while the monograph authored by P. Crohn [*Crohn, 1959*] was, by itself, the first overview of information about the area's geologic structure, topography and glaciation. Concomitantly with the works carried out by the Soviet geophysicists, Australian researchers conducted airborne radar profiling during the 1971/72, 1973/74 and 1989–1995 summer field seasons, which resulted in a radial network of traverse lines with a total length of about 6900 km from a sub-base located in the Cresuel massif area and ground-based integrated geophysical surveys, including radar profiling along the traverse passing round the Lambert Glacier from Mawson Station to the Lowie Base [*Morgan and Budd, 1975; Allison, 1979; Budd et al., 1982; Higham et al., 1995*]. In addition, ANARE and the Japanese Expedition (JARE) carried out extensive seismoacoustic surveys in the offshore area of the Prydz Bay [*Nakao, 1990*].

In 2004, a complex airborne geophysical survey at a 1:500,000 scale was carried out in the southern part of the Prince Charles mountains within the area of 81,000 km^2 as part of the joint Australian–German PCMEGA project [*McLean et al., 2004*]. These studies were performed based on the Polar-2 airborne geophysical laboratory. The PCMEGA project works also included surface geophysical and glaciological studies conducted by the team of Australian scientists.

In recent years, the Chinese national expedition has been carrying out comprehensive ground-based research within a segment stretching from the Larsemann Hills (Zongshan Station) as far as Dome Argus (East Antarctica), in the area of a recently set up Kunlun Station. The works include glaciological and meteorological observations, as well as radar profiling [*Sun et al., 2009*].

Quite an ambitious AGAP project with participation of researchers from the United States, Britain, Australia, Germany, China and Japan, aiming at studying the region, which comprise the Gamburtsev Subglacial Mountains and the southern Prince Charles mountains. The project was implemented within the framework of the Third International Polar Year (IPY-3) during the 2009 field season and involved airborne geophysical surveys (laser altimetry, magnetometry, gravimetry and radar profiling), glaciological and seismological observations covering the area in excess of 1 mln km^2 [*Sun et al., 2009; Bell et al., 2011*].

CONCLUSION

In the course of the Soviet (succeeded by the Russian Federation) systematic comprehensive airborne geophysical research, albeit conducted intermittently in the period from 1971–2016 on Mac. Robertson, Princess Elizabeth and Wilhelm II Lands, provided titally new data on the ice sheet thickness, the of the sub-ice topographic elevations, and on the anomalous magnetic field. The materials of the investigations based on DSS and the reflection seismic sounding conducted in the area of the Aimery Ice Shelf in 1971–1974 still have not lost their relevance and topicality for the study of the Lambert trough and the rift system confined to it.

The materials on the ice sheet thickness and subice terrain as Russia's contribution to the study of Antarctica were included in databases of the BEDMAP and BEDMAP2 international projects and in the compiled maps [*Lythe et al., 2001; Fretwell et al., 2013*]. They also were reflected in the most recent Atlas of the Antarctic [*Kuroedov, 2005*], as well as in the first geomorphological atlas of Antarctica [*Antarctica: Geomorphological Atlas, 2011*]. The obtained aeromagnetic data, in turn, have become part of the ADMAP international project [*Golynsky et al., 2006*] as a contribution from our country.

The adopted on October 30, 2010 "*Strategy for the development of the Russian Federation's activities in the Antarctic for the period until 2020 and for longer-term perspective*" testify to the great importance the government of our country attaches to research in Antarctica. Specifically, it points out the connection between the international prestige of our country and the implementation of "*...large-scale ... scientific research and environmental protection measures relating to Russia's activities in the Antarctic.*" The concluding part of the document ascertains that "*the large-scale scientific research activities conducted by the Russian Federation in the Antarctic is a prerequisite for maintaining the status of the Consultative Party to the Antarctic Treaty for Russia that serves as a the basis for full participation in negotiations on and adoption of all decisions concerning the management of this region and the implementation of the existing special legal regime for international cooperation in Antarctica*". Besides, among the directions of scientific work, geological and geophysical research is given first priority to.

The complex airborne geophysical works in the considered area have not yet been completed. They will continue to be systematically conducted on the same scale, oriented eastwardly, on Queen Mary Land, Wilkes Land and Victoria Land, with Mirny station to be their base in the near future. This is consistent with the general plans set out in the "*Strategy for the development of the Russian Federation's activities in the Antarctic for the period until 2020 and for longer-term perspective*". The prospective applications of new Il-114 aircraft in Antarctica, which is expected in the near future, will allow to conduct the works in the inland areas of the continent, as far as the latitude of the Vostok station location.

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