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# ICE SHEET DYNAMICS AND STRUCTURE IN THE AREA OF ICE RUNWAY AT MIRNY STATION, EAST ANTARCTICA (BASED ON THE DATA COLLECTED DURING THE 2016/17 SUMMER AND WINTER SEASONS)

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Comprehensive glaciological and geophysical applied investigations were performed during the austral winter of the 61st RAE (2016) and austral summer field season of the 62nd RAE (2016/17) in the area of Russian Mirny Station (East Antarctica). The visual and instrumental observations have revealed that the landing strip site is completely safe for aviation operations. The ice surface elevation chart with the accuracy of 15 cm has been compiled based on collected geodetic data. The height varies from 37 m in the northern part to 71 m in the southwest. The monitoring results have demonstrated that the glacier flow velocity varies from approximately 6 to 80 m/year. Multi-offset soundings allowed improving the dielectric permittivity model of the ice sheet and estimating its moisture content to the depth of about 25 m in two points.

*East Antarctica, Mirny Station, GPR sounding, multi-offset soundings, ice dynamics, ice sheet structure*

## INTRODUCTION

Mirny station (lat. 66°33′ S, long. 93°01′ E), the first Russian station in East Antarctica located on the Davis Sea coast was opened on February 13, 1956. From the earliest days of its existence until the 1990/91 summer field season of the 36th Soviet Antarctic expedition (SAE), the employed air service ceased its operations due to the increasingly worsening economic situation in Russia [*Savatyugin, 2001*]. As the situation stabilized, the logistics of the Russian Antarctic expedition (RAE) has improved, creating thereby prerequisites for expansion of scientific research works in Antarctica. This is reflected in the "Strategy for the development of the activities of the Russian Federation in Antarctica for the period until 2020 and beyond", approved by the Russian Federation government resolution No. 1926-r dated 30.10.2010.

The research activities outlined in the Program involve *inter alia* comprehensive geological and geophysical studies on Wilhelm II Land, Queen Mary Land and Wilkes Land. There is therefore a stringent need for a landing strip at Mirny station both in terms of implementing such operations and from a logistics point of view.

Besides, its availability will significantly simplify flight connections between the polar stations and field bases located both east of Casey (Australia) and to the west of Davis (Australia). Given a long distance between these destination points (about one and a half thousand kilometers), an intermediate airport is critical for ensuring the flights safety in the challenging conditions of Antarctica.

Rehabilitation of the previously existing aviation infrastructure at Mirny station was thus commenced and encompassed the 2013–2016 summer field seasons (the 59–61st RAE), which involved primarily reconnaissance operations and subsequent large-scale glaciological and geophysical investigations, with GPR (ground-penetrating radar) used as the main research method [*Popov and Eberlein, 2014*]. These studies are discussed in detail in [*Pryakhin et al., 2015; Popov and Polyakov, 2016; Popov et al., 2016, 2017*].

Results of the studies were made the basis for construction of a landing strip site, on which a medium-range utility aircraft Basler Turbo 67 (DC-3T) by ALCI (Cape Town, South Africa) successfully landed on February 10, 2016 [*Popov et al., 2016*]. Thus, the activities of the 2016/17 summer field season (the 62nd RAE) in regard to landing strip site were focused on its visual and instrumental examination, compilation of high accuracy schematics of ice-sheet surface heights, multi-offset sounding for modeling dielectric permittivity and ice-flow velocities from analysis of the position of previously installed marker stakes.

Besides, a series of observations made during the 2016/17 wintering period (the 61st RAE) included GPR profiling along the runway, as well as determinations of position of the marker stakes and their elevations to calculate glacier flow velocities.

### Investigations at the landing-strip site

By the beginning of the 62nd RAE summer field season, the Mirny landing strip had been marked and rolled by the wintering crew. The completed signage included basic visual marking (runway centerline, runway shoulders, threshold), flight operator deck, and a wind cone. The landing strip was thus fully prepared for further operation. Its safety check was carried out both visually and instrumentally at the beginning of the field season by GPR sounding along three profiles in its middle, as well as in the marginal parts (both left and right).

The visual inspection revealed a total of 10 crevasses with a width varying between 10 and 20 cm appeared in the intercept straddling from point 787 m to the end (1300 m) of the landing strip. The crevasses characterized by smooth walls with no brow and are localized dominantly in the runway shoulder. The GPR profiling revealed several objects of the kind differing in width, while the thickness of snow-firn bridging over them is at least 1.5 m, which practically doesn't breach the landing strip safety. The identified crevasses, including the open ones, generally pose little or no threat, given precaution measures are observed. This basically means that the three-year work, which resulted in the construction of the landing-strip site, was underlain by appropriate methodology and scientific substantiation.

Moreover, the RAE employees have acquired good practical experience in healing small crevasses restoring thereby the runway surface integrity. The accomplished work permitted to actively use the landing-strip site throughout the field season to perform complex airborne geophysical studies of the Polar Marine Geological Research Expedition (PMGE).

### The glacier surface characterization

The ice surface elevations chart was compiled using results of the geodetic measurements based on GLONASS and GPS navigation satellite systems. High accuracy was achieved by using a static differential positioning technique for determining plane coordinates and RTK elevations (Real Time Kinematic).

It consisted in recording the GPS carrier phase and code measurements in each observation session at measuring points and the location of the base station. The method is distinguished by the observation data processing on a mobile (aka rover) receiver.

The accuracy may be increased considerably through the use of a reference station (a receiver at a location with known coordinates). As the observations of the mobile receiver (rover) are then adjusted so it, depending on the type of receiver, higher accuracies can be attained. This differential method may also be carried out in real time. It requires a communication link between the reference station and the rover. Depending on the type of observation (code or carrier phase), the method is referred to as differential, or real-time kinematics (RTK).

With the latter, the data processing is carried out on-line of the phase measurement, taking into account the corrections. The Leica GX1220 GG (*LEICA Geosystems AG, Switzerland*) and Leica GX 1230 GG (*LEICA Geosystems AG, Switzerland*) satellite receivers were used at the mobile and reference stations, respectively.

A snowmobile was used as a major transportation means. The data were recorded in automatic mode (spacing: 5 m). In the case of rugged terrain or areas of hard access by transport, the determinations were performed while walking. The geodetic routes totaled 34 km in length in the area of the existing landing strip site. Their position is shown in Fig. 1. The data were processed using specialized software package Topcon Pinnacle (*Topcon Positioning Systems Inc., USA*).

In addition to these measurements, tachometry was carried out in the area with the Trimble M3 DR 5′ (*Trimble Navigation Ltd, USA*). To increase the range and accuracy of measurements, 1P prism was used as a reflector, which allows surveying at a distance of up to 5000 m from the device. The measurements from a total of 115 points were post-processed (Fig. 1).

Comparison of the data showed that they are quite comparable in the quality of measurements. Given that both data sets can be considered equal, they were combined to serve as the basis for generating common schematics of the ice-sheet surface heights (Fig. 1). The griding was carried out with the Civil AutoCAD 3D 2012 software (*Autodesk Inc., USA*) by the Delaunay triangulation algorithm followed by a slight mesh smoothing.

The data quality was assessed by the statistical processing, which showed a 15 cm standard deviation for all 6290 measurements from the constructed grid. A 2 m section was used in the schematics, to enhance the contour detection.

The investigated segment of ice-sheet has surface heights ranging from 37 m (northern part) to 71 m (south-west) and in the general scheme represents a crescent-shaped valley with slopes, whose profound mapping is largely hindered by the zone of crevasses. These surround the valley on the southern, eastern and western sides, which is distinctly manifest on the orthophoto [*Pryakhin et al., 2015*].

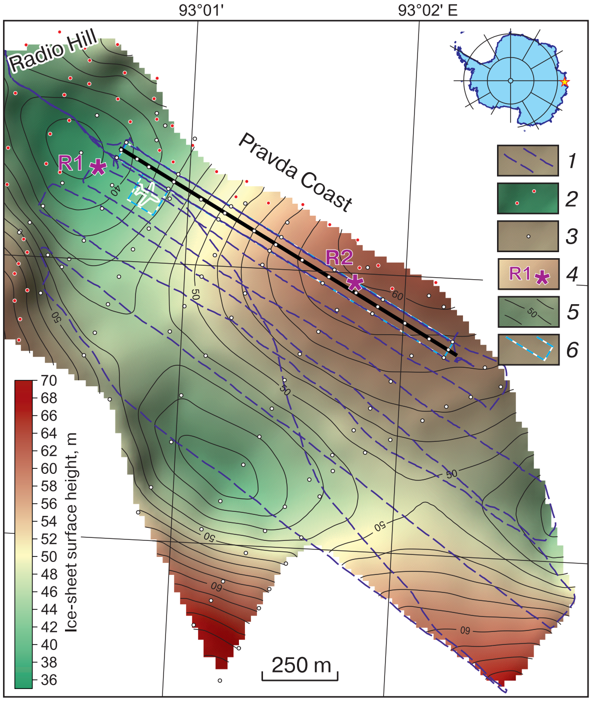


**Fig. 1. Ice surface elevations and location of measurements in the vicinity of Mirny station.**

*1* – geodetic routes; *2* – points of measurements while walking; *3* – points of tachometric measurements; *4* – points of multi-offset soundings and their numbering; *5* – contour lines of the ice surface, m; contour interval is 2 m; *6* – landing strip site, constructed during the 62nd RAE.

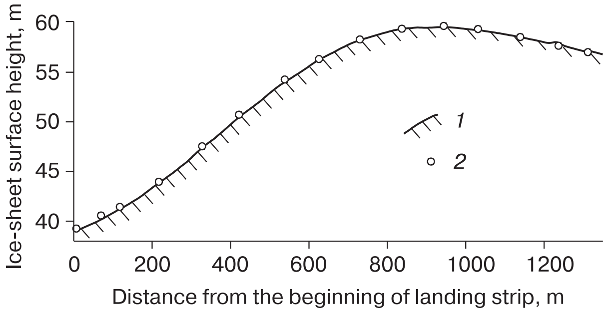


**Fig. 2. Longitudinal profile of the ice surface along the axis of the landing strip at Mirny station.**

*1* – ice surface profile according to the geodetic satellite data; *2* – results of tachometric surveying.

The main practical interest in regard to safety of aviation operations is associated with the landing strip site and its longitudinal profile (Fig. 2), showing almost full conformity between the tachometric and GNSS geodetic data.

The ice-sheet surface heights along the longitudinal profile of the runway site vary from 38 m at its beginning to 59 m at a distance of 873 m. The 120–680 m interval represents the steepest segment of the site with average slope of about 1.66° (29 m/km), while side slopes are almost totally absent. As such, the runway parameters meet the aviation requirements set forth in the normative documents of the Ministry of Civil Aviation (VSN37-76, REGA-94, NGEA-92 and FAP-69) [*MGA USSR, 1976; Mintrans RF, 1993, 1999, 2011*], although they are close to the limit values.

### Ice flow processes

Due to some circumstances, the landing strip has been constructed on a poorly investigated dynamically active glacier at the Mirny station area. The presence of crevasses in this area required long-term systematic observations of its dynamics and accumulation of solid precipitation for the construction of their prognostic development schemes.

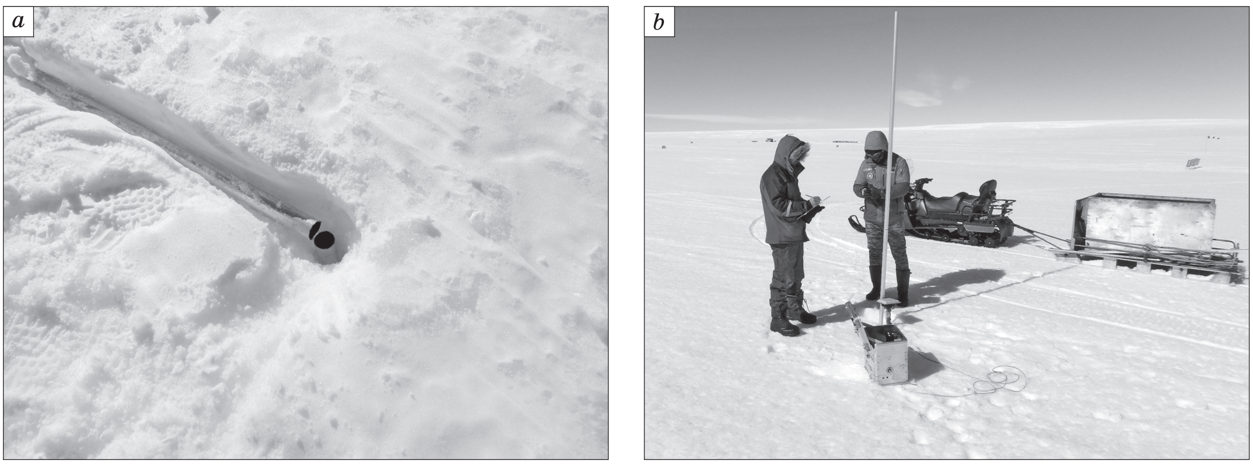


**Fig. 3. Photograph of the damaged marker stake (*a*) and measuring procedure for the position and height of maker stakes (*b*).**

Photographs by S.V. Popov (*a*) and A.L. Novikov (*b*), February 2017.

To this end, a total of 41 reference points (6-meter aluminum pipes 40 mm in diameter, with a 3 mm-thick wall), or marker stakes, were drilled into the ice sheet to a depth of at least 1 m during the summer field seasons of the 59th, 60th and 61st RAE. As such, this depth precludes the stakes' settling or tilting and allows to determine both the snow accumulation rate and surface velocity field in the area of works [*Popov et al., 2016*].

During the winter, two marker stakes were broken at their base (Fig. 3, *a*) owing to the strong wind, and four had their top broken off, which was an unpleasant surprise. The snow accumulation data from the damaged marker stakes were preserved only because the stakes had marking allowing to measure the distance from the pipe end, for better convenience of measurements. Four other marker stakes were lost in the zone of crevasses, being therefore inaccessible for measurements. Thus, 35 marker stakes are currently available to continue the ice flow dynamics monitoring.

During the 61st RAE wintering, the height of marker stakes and their in-plan position were measured once a quarter, using the GARMIN GPSmap 60 satellite transceiver with a GA 25MCX remote antenna. Although the device was non-geodesic class, its use is justified by the expected ice flow rates, which according to preliminary estimates are approximately 18 to 65 m/year for various sites [*Popov et al., 2016*]. Despite the relatively low accuracy of the measuring instrument, even quarterly variations in the position of the marker stakes were visible and subject to recording (Fig. 4).

The geographic coordinates of the first and last series were taken for each marker stake to estimate the ice flow velocity. The parameters were counted by inverse geodesic transformation the WGS-84 ellipsoid. Inasmuch as the interval between the series is 381 days, their values should be decreased by 4.4 % (i.e. multiplied by 0.958), to reduce the measurements to one year.

The resulting value was related to the position of the marker stakes in May 2016, which corresponds to the average position of the known section of its path. The exception is four marker stakes N11, N12, N40, and N41 (Fig. 4), which were last visited in November 2016. Their measurement interval constituted

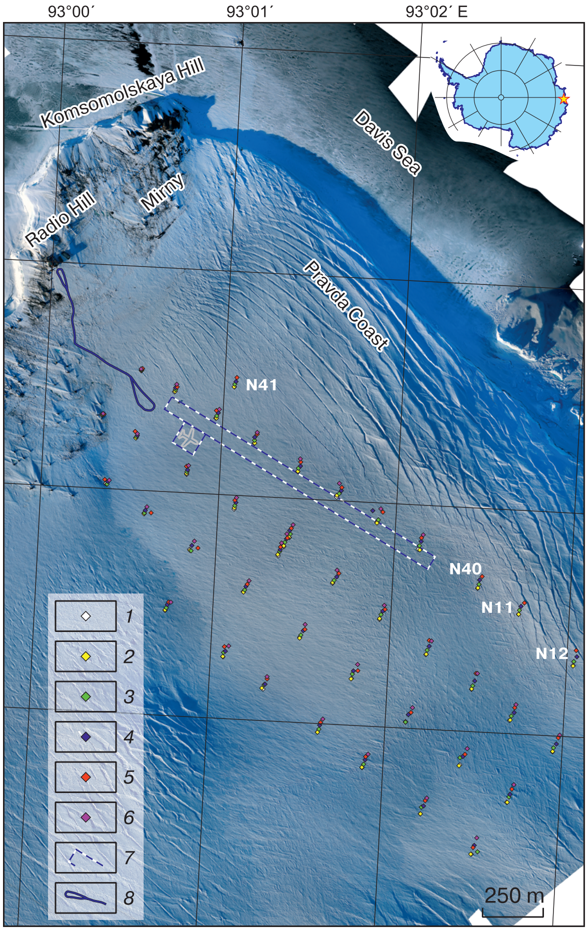


**Fig. 4. Movements of marker stakes near the landing stripe site of Mirny station.**

Position of marker stakes: *1* – Juanuary 2016, *2* – February 2016, *3* – May 2016, *4* – August 2016, *5* – November 2016, *6* – February 2017; *7* – contour of landing strip site; *8* – snow road connecting the station and landing strip site. Airborne photograph as of January 11, 2015.

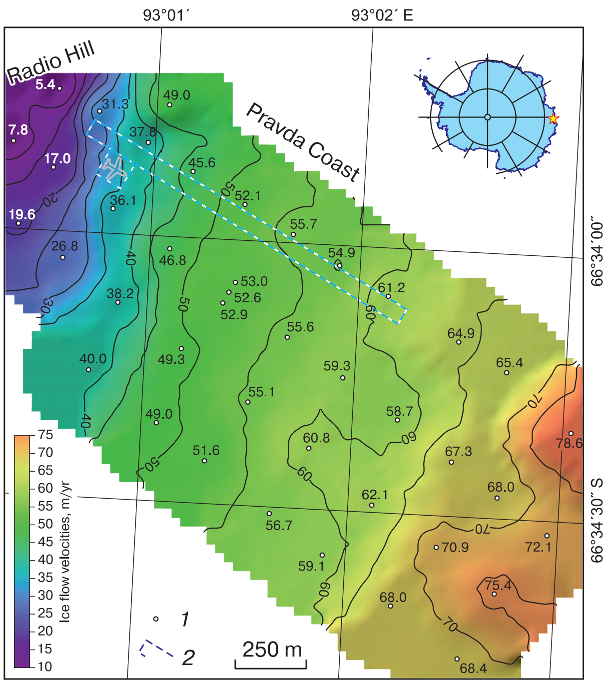


**Fig. 5. Glacier flow velocities chart for the area of active landing strip.**

*1* – marker stakes positions in May 2016 and the average annual velocity value; *2* – landing strip. Contour interval is 5 m/yr.

297 days. To reduce these values to one year, the measured difference should be increased by 1.23. To plot the glacier flow rate, the specified data reduced to one year were grided by the Inverse Distance method as part of the 13.6 Surfer software (*Golden Software Inc., USA*). The resulting schematics is shown in Fig. 5.

At this stage of the research, the authors abstain from analyzing the scheme and limit themselves to general comments that the ice flow rate in the area of work varies from about 6 to 80 m/year. During the 2016/17 summer field season ($62^{nd}$ RAE), triple measurements of the position of the marker stakes were made using the Trimble 4700 GNSS receivers (*Trimble Navigation Ltd, USA*).

The base station was installed in MIR3 point, near Komsomolskaya hill, where the observations were carried out throughout the field season. The authors believe that this will allow to achieve the accuracy of determining the position of marker stakes of the order of first centimeters.

Measurements were performed in about 10 days' intervals, which, based on the expected ice flow velocity, will determine the area-wide flow velocity field with high accuracy. The geodetic surveying equipment was courtesy of the Institute of Planetary Geodesy, TU Dresden, Germany where the data are presently being processed.

**Ice-sheet dielectric permittivity model**

As already noted above, for the correct time to depth conversion, it is necessary to choose a model of the dielectric permittivity of the studied medium. The three main available approaches depending on the tasks and the required accuracy are: 1) the use of tabular values based on a priori concept of the nature of the studied media; 2) application of travel-times of waves diffracted from inhomogeneities [*Glazovsky and Macheret, 2014; Popov, 2017*]; 3) specialized measurements, in particular multi-offset GPR soundings [*Popov et al., 2003; Vladov and Starovoitov, 2004; Macheret, 2006; Glazovsky and Macheret, 2014*]. Given its simplicity and effectiveness the second approach is the most widespread.

However, it can not always be applied in practice, since it requires the presence of a diffracted wave with extended branches, so that they can be calculated with sufficient accuracy. Besides, high-precision georeferencing of each sounding point is required to obtain qualitative results, which is not always the case in practice.

Multi-offset sounding is an advantageous technique because it can be performed anywhere. High accuracy is achieved by the profile marking. Thus, only multi-offset sounding performed by the CDP system (common depth point) or CSP (common source point) [*Boganik and Gurvich, 2006*], can claim to build the most accurate model of dielectric permittivity of the medium, and therefore the electromagnetic waves propagation velocity in it.

Earlier, during the field seasons of the $60^{th}$ and $61^{st}$ RAE, the travel-times of waves diffracted from the revealed crevasses were calculated. The obtained data allowed to construct a model of a two-layer medium, according to which the near-surface part of the glacier is composed of both snow-firn strata and meteoric ice with dielectric permittivity ranging from 1.6 to 3.2 [*Popov et al., 2016, 2017*].

Such a large scatter is associated with different conditions of the snow cover formation and the processes of firnization. The effective value of permittivity in this layer is 2.43 [*Popov et al., 2016*]. According to the drill core data [*Popov et al., 2017*], the underlying layer is ice with firn intelayers. Its effective permittivity is 3.0 [*Popov et al., 2016*].

The OKO-2 georadar (*Logic Systems LLC, Russia*) with two separated antennas and a 150 MHz frequency of sounding pulses was used to perform multi-offset GPR sounding (Fig. 6). Its specific design feature is fiber optic cable connecting both antennas. To perform the work, a 10 m long cable was used, which determined the maximum length of antennas array.

GPR profiling was first carried out in order to select the most suitable places for performing multi-offset soundings. The preferred areas were to have subhorizontal, low- relief and rough borders. The last two circumstances were of the greatest importance, since the post-processing was carried out within the dipping-layer model [*Popov, 2017*].

At the same time, significant deviations of the boundary configuration from the model ones could lead to calculation errors. After selecting the location, multi-offset-soundings were carried out according to the standard technique described in [*Boganik and Gurvich, 2006; Popov et al., 2018*].

During the $62^{nd}$ RAE summer field, CDP and CSP multi-offset soundings were performed to clarify the structure of the near-surface part of the ice-sheet in the area of landing strip operations.

In point R1 (Fig. 1), both types of multi-offset soundings (CDP and CSP) were carried out on January 17, 2017. The CDP method involves implementation of successive measurements when extending the receiving and transmitting antennas at the same distance from the center of the array [*Boganik and Gurvich, 2006*]. The GPR data are shown in Fig. 7, *a*, along with theoretical hodograph (travel-time). The corresponding dielectric permittivity model is represented in Fig. 7, *b*. The ray path is shown in Fig. 7, *c*.

The GPR imagery revealed five fairly contrasting reflections (Fig. 7, *a*). The GPR profiling along the marker stakes proved the boundaries position to be horizontal. The GPR data were calculated within frames of the horizontally layered medium model [*Popov, 2017*], which simplified the task initially solved in a general view for dipping boundaries,


**Fig. 6. Performing CDP multi-offset soundings.**
Photographs by I.G. Savchenko (*a*) and S.V. Popov (*b*, *c*), January–February 2017.

which required developing new software within frames of this study.

The thickness (5 m) and effective permittivity (2.35) of *the first (uppermost) layer* allowed to equate it with a dense snow-firn stratum. As was mentioned above, the travel-times calculation of waves diffracted from the crevasses allowed to reconstruct distribution of permittivity for this layer.

In point R1 it was 2.34 [*Popov et al., 2016*], which was within the error with the value derived from the multi-offset sounding data. A significant intensity of the lower boundary of this layer indicates the presence of moisture. This is consistent with the results of visual observations made in the field seasons of the 60$^{th}$ and 61$^{st}$ RAE [*Popov and Polyakov, 2016*].

*The second layer* has a thickness of 0.4 m. Its lower boundary occurs at a depth of 5.4 m. This thin layer is characterized by effective permittivity of 5.6. Such a high value indicates that it can only be *wet ice*, *i.e.* ice located near the phase transition temperature. This is quite consistent with the results obtained earlier [*Popov et al., 2016, 2017*].

Given that ice is far less permeable to moisture than the overlying snow-firn stratum [*Glazovsky and Macheret, 2014*], melt water accumulates at the interface between these layers, contributing to an increase in moisture content of ice, and causing thereby an increase in its permittivity $(\tilde{\varepsilon})$.

In his work, *H. Looyenga* [*1965*] uses a relation relating the parameter $\tilde{\varepsilon}$ to the volume moisture content $w$ for a two-component ice–water mixture with each of them having permittivity $\varepsilon_i$ and $\varepsilon_w$:

$$\tilde{\varepsilon} = \left[\varepsilon_i^{1/3} + w\left(\varepsilon_w^{1/3} - \varepsilon_i^{1/3}\right)\right]^3. \qquad (1)$$

Assumingly, water inclusions have a spherical shape. Graphic representation of the ratio (1) is shown in Fig. 4 in [*Popov et al., 2018*]. The ratio (1) shows the value corresponding to ice with a moisture content of 15 %. As such, its large amount is associated with the presence of melt water in the free form.

*The third layer* is characterized by: 0.7 m thickness; 6.1 m occurrence depth of the lower boundary; a lower effective permittivity 4.8, which, according to (1), corresponds to ice with volumetric moisture con-

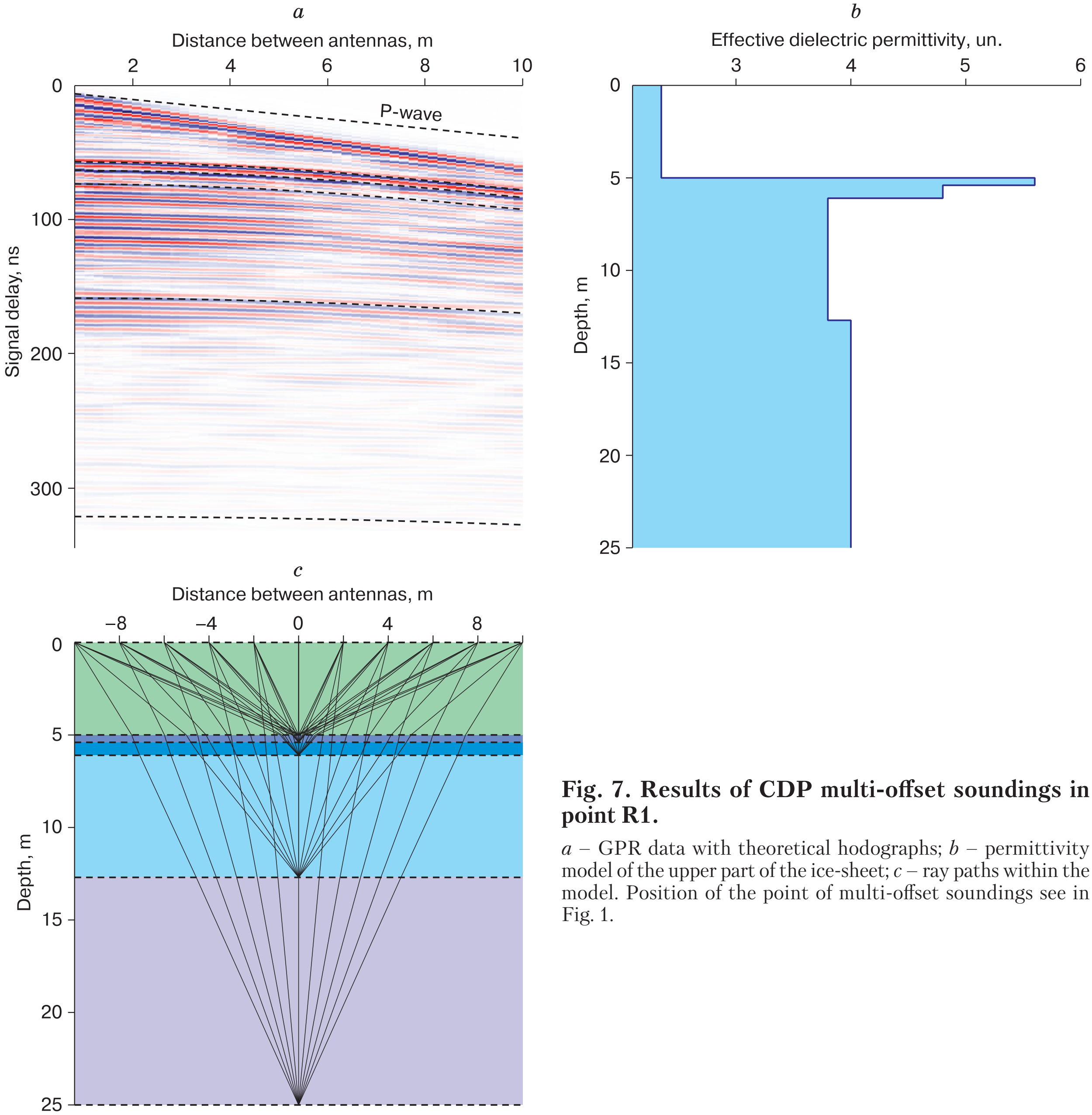


**Fig. 7. Results of CDP multi-offset soundings in point R1.**

*a* – GPR data with theoretical hodographs; *b* – permittivity model of the upper part of the ice-sheet; *c* – ray paths within the model. Position of the point of multi-offset soundings see in Fig. 1.

tent of 7.5 %. A decrease in the moisture content of ice indicates that most of melt water is drained through the overlying layer.

The *fourth layer* is 6.6 m in thickness, its lower boundary occurs at a depth of 12.7 m; its effective permittivity is even less and equals 3.8. The obtained value, according to (1), corresponds to ice with volumetric moisture content of 3.5 %. A consistent decrease in the amount of moisture indicates its far lower penetration into the glacier body.

*The fifth layer* is characterized by: 12.3 m thickness, its lower boundary occurs at a depth of 25.0 m; its effective permittivity is 4.0. The growth of this parameter and affiliated increase in ice moisture to 4.1 % may be associated with an increase in glacier temperature caused by the proximity of the rock base.

The CSP multi-offset soundings were performed at R2 point (Fig. 1) on January 31, 2017. These involved successive measurements at a fixed position of the transmitting antenna while the receiving antenna is moved at equal distances [*Boganik and Gurvich, 2006*].

Results of the previously obtained GPR data coupled with the core drilling results, the structure of the glacier, and hence the process of its formation, differ from the area at point R1 [*Popov et al., 2016,* *2017*]. This suggests application of multi-offset soundings in this place.

The three most contrasting reflections derived from multi-offset sounding were associated with three lower boundaries of layers in the glacier body.

*The first layer* is characterized by a thickness of 4.6 m and effective permittivity of 2.8, which enabled identification of a dense snow-firn layer. According to earlier works, the permittivity of this near-surface layer, determined by the travel-times of diffracted waves, was 2.1 [*Popov et al., 2016*]. It appears difficult to explain what caused such a significant discrepancy in numbers.

It is unlikely to have been caused by errors while the works were performed, inasmuch as waves diffracted from four cracks detected within a radius of 80 m from R2 were taken for post-processing. The obtained permittivity values are 2.02, 2.06, 2.12 and 2.12 [*Popov et al., 2016*]. Alternatively, this can be explained by the fact that geophysical surveys of the 60$^{th}$ and 61$^{st}$ RAE were conducted at the beginning of the field season (after December and January snowfalls), which significantly reduced permittivity in the near-surface layer.

Multi-offset sounding was carried out at the very end of the abnormally warm field season with no single snowfall and only a few cloudy days during the field season. Thus, the near-surface could be saturated with moisture due to the intense melting, which accelerated its firnization.

The identified parameters of *the second layer* are: thickness: 3.3 m; occurrence depth of the lower boundary: 9.9 m; effective permittivity: 3.5; volume moisture content: about 1.5 % (according to the relation (1)).

*The third layer* has a thickness of 14.9 m; its lower boundary occurs at a depth of 22.8 m; its effective permittivity is 3.2, which basically corresponds to the classical value of 3.17 for cold pure ice [*Macheret, 2006*].

The basically explicable apparent difference between the velocity models of points R1 and R2 reflecting the difference in glaciers structure is confirmed by all obtained to date GPR data, as well as core drilling results [*Popov et al., 2016, 2017*]. As early as the reconnaissance work of the 59$^{th}$ RAE, it was noted that, according to the GPR data, an aquifer identified in this area later disappears (unpublished data).

Subsequent works confirmed the correctness of this assumption [*Popov and Polyakov, 2016; Popov et al., 2016, 2017*]. This boundary, which separates the areas with different ice formation processes, is located approximately 360 m from the beginning of the runway, and points R1 and R2 are located at both its sides.

We should also discuss the errors of permittivity determinations according to soundings by the CDP or CSP methods. The problem is solved by the method of parameters selection within the model of inclined-layered medium. In this case, the surfaces are approximated by planes whose parameters are determined by the method of least squares [*Popov, 2017*].

However, real surfaces are sometimes characterized by significant roughness, and the layers themselves are characterized by local inhomogeneities. All this leads to the inference that the observed travel-time differs from the theoretical hodograph and the differences increase with the growth of roughness and heterogeneity. This was indicated, in particular, in [*Popov et al., 2018*], when an abnormally low value of the permittivity of sea water equal to 75 was obtained (about 15 % less than expected), according to the travel-time of waves reflected from the lower edge of sea ice.

Note that such significant inhomogeneities are not typical of the intraglacial boundaries, and the accuracy should therefore be appreciably higher. The advantage is that multi-offset sounding performed in the area of Vostok station (East Antarctica), with ice sheet being almost 4 km thick, gave an error of less than 0.5 % [*Popov et al., 2003*], which was confirmed by results of core drilling with subsequent penetration into Lake Vostok [*Popov et al., 2012*].

In our case, the error analysis was estimated by the degree of convergence of theoretical and observed travel-times, which were chosen on the basis of their best fit. The error analysis allowed to estimate the obtained values of permittivity to be at least 5 %.

## INFERENCES

The work carried out is a logical continuation of the earlier research. During the field season, a visual and instrumental (by GPR sounding) survey of the landing strip site showed that it is suitable for operation. Crevasses formed after the 787 meter point are characterized by small size and can be eliminated by their filling with subsequent compaction.

A wide range of comprehensive glaciological and geophysical works enabled determinations of the glacier flow velocity on the basis of year-round monitoring of glacier motions with marker stakes. The disadvantage is the use of non-geodesic class devices, which is compensated by the duration of observations and high flow rate of ice. Besides, high-accuracy satellite measurements by specialized equipment have been performed and the data obtained are being processed.

Another advantage of the work is the application of multi-offset soundings, which allows to independently obtain vertical models of the ice-sheet permittivity.

In the course of previous works, similar models were constructed on the basis of the calculation of waves diffracted from near-surface crevasses [*Popov et al., 2016, 2017*]. The results obtained by the two independent methods generally do not contradict each other.

At this, multi-offset soundings allowed to obtain a more complex model of the ice-sheet structure, largely complementing and clarifying the previous results.

## CONCLUSION

Results of the applied research serve to solve one of the tasks set out in the "Strategy for the development of the Russian Federation activities in Antarctic for the period until 2020 and longer-term perspective", approved by the decree of the Russian Federation Government No. 1926-r dated 30.10.2010.

This involves the construction of an airfield and infrastructure at Mirny station. This task was accomplished during the previous field season, and on February 10, 2016, the landing strip received a medium-range utility aircraft Basler Turbo 67 (DC-3T) by ALCI (Cape Town, South Africa) piloted by a Canadian crew from Kenn Borek Air Ltd. However, finding a suitable place and arranging an airfield and landing site is not enough, since they need to be maintained, to ensure safe operations. This means that the marker stakes monitoring and the observation of crevasses should be continued, particularly because of the rapidly changing coastal glaciers driven by the global warming effects.

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