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Crustal structure of the Bunger Oasis and Highjump Archipelago (East Antarctica) based on magnetic data acquired by using fixed-wing UAV

Alexander V. Golynsky[1]✉, Dmitry A. Golynsky[1], German L. Leitchenkov[1], Nikita V. Borovkov[1], Vasiliy G. Antsev[2], Fedor G. Gutorov[2], Alexander E. Simakov[2]

[1] *All-Russia Scientific Research Institute for Geology and Mineral Resources of the World Ocean (VNIIOkeangeologia), St. Petersburg, Russia*

[2] *Radar mms JSC, Unmanned Aerial and Marine Systems Division, St. Petersburg, Russia*

✉*sasha@vniio.nw.ru*

AVG, 0000-0003-2546-4082; DAG, 0000-0001-8717-0894; GLL, 0000-0001-6316-8511; NVB, 0000-0003-2568-2039; VGA, 0009-0007-4472-7139; FGG, 0009-0009-6720-2997; AES, 0000-0002-2006-3071

Abstract. This study seeks to demonstrate the relationship between magnetic anomalies and geological structure of Precambrian complexes of the Bunger Oasis and Highjump Archipelago, East Antarctica. Aeromagnetic data effectively maps geological units, revealing distinct magnetic signatures for Neoarchean and Palaeo-Mesoproterozoic terrains. This provides the possibility of significantly improving existing geological maps, particularly in poorly mapped areas like the Highjump Archipelago. Magnetic anomaly intensity and strike correlate with rock composition and regional structural trends, enabling better differentiation of lithological units like magnetic metapelites and non-magnetic metapsammites. Tilt derivative calculations enhance structural mapping by linking magnetic sources to specific rock suites. As an example, a prominent northeast-striking belt of positive magnetic anomalies marks a key boundary between Archean and Mesoproterozoic complexes. Variations in the belt's strike suggest complex tectonic history, including potential fault contacts. Intrusive bodies exhibit complex magnetic characteristics. The Paz Cove intrusion displays a negative anomaly likely due to reversed remanent magnetization, while the Algae Lake intrusion has both positive and negative anomalies reflecting varying rock compositions. The Gabbro intrusions in the northeastern part of the Highjump Archipelago correlate with positive anomalies, while the intense negative anomaly over the Kashalot Island gabbroic intrusion suggests reversed magnetization. This study aims to produce a structural (tectonic) map of the Bunger Oasis and Highjump Archipelago by analyzing magnetic anomaly data collected by an unmanned aerial vehicle during the 69th RAE, combined with existing geological information for the area. The study highlights the value of UAV aeromagnetic surveys for detailed geological mapping in challenging environments, providing crucial insights into East Antarctica's Precambrian history.

Keywords: aeromagnetic survey, magnetic anomalies, magnetic properties, Bunger Oasis, Highjump Archipelago, Precambrian suites, intrusions

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Introduction

From the tectonic and geodynamic point of view, the Bunger Oasis and Highjump archipelago area plays a crucial role in the architecture of the Indo-Australo-Antarctic junction within Gondwana and Rodinia supercontinents [1, and references therein]. According to the studies that have been published, the Bunger Oasis area records the Mesoproterozoic assembly of Australo-Antarctica during the process of Rodinia supercontinent amalgamation. In particular, the region under study is considered as part of a wide Mesoproterozoic orogeny (1300–1150 Ma), extending from South-West Australia (Albany-Fraser Orogeny) towards its Antarctic counterparts in Wilkes Land: Windmill Islands, Bunger Hills, Obruchev Hills and some outcrops on the Denman glacier [1, and references therein]. But the effect of the Neoproterozoic–Cambrian amalgamation of Gondwana on the Indo-Australo-Antarctica subcontinents remains debatable. Aeromagnetic data obtained enables one to constrain the tectonic units, terrains, their relationships and structural features. Integration of aeromagnetic data with the geological map and tectonic model may clarify the geological history of the Bunger Hills Proterozoic province within the context of the Mesoproterozoic orogeny, including its relationship to its Australian counterparts.

The Bunger Oasis and Highjump Archipelago were previously surveyed aeromagnetically during the First Soviet Antarctic Expedition in 1956 and since that time the area has not been surveyed in detail. Several recently acquired aerogeophysical profiles by international programs conducted in this region mainly aimed to study only the structure of Denman and Scott Glaciers [2]. To fill the gap in the knowledge of the geologically complex Precambrian Province the VNIIOkeangeologia and Radar-mms undertook a high resolution aeromagnetic survey using a fixed-wing unmanned aerial vehicle (UAV) in January of 2023/24 field season, a world first [3]. The aeromagnetic survey was primarily conducted to expand the magnetic dataset for East Antarctica. This was necessary to refine our understanding of the crustal structure of the Bunger Oasis and Highjump Archipelago, and to better establish the geological connections between Antarctica and the formerly adjacent Gondwana and Rodinia supercontinents. The survey was accomplished with a profile spacing of 250 m and tie-line spacing of 1250 m. It was flown draped at ~120–150 m above the relief surface (Fig. 1). The airborne magnetometer system allowed a rapid acquisition of data covering 2940 linear kilometers over an area

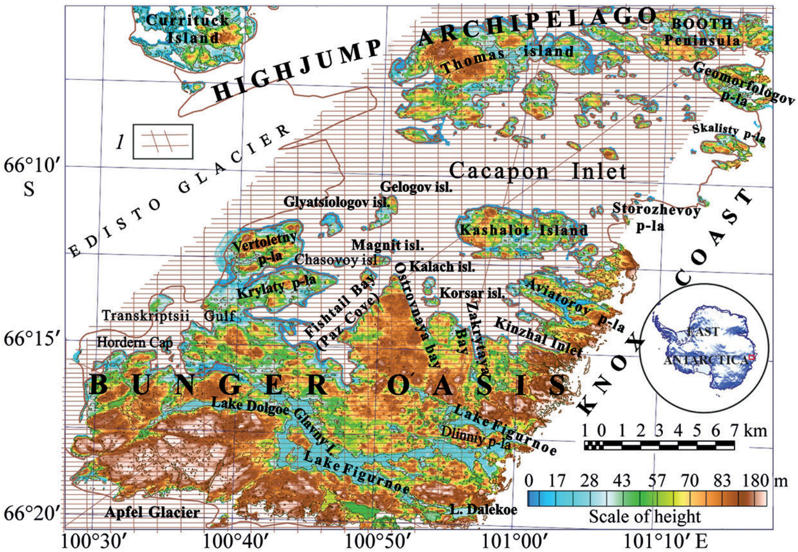

Fig. 1. Aeromagnetic survey flight lines in the Bunger Oasis and the Highjump Archipelago against a background of surface topography from SPOT-5 satellite data. The inset (red square) shows the survey area within Antarctica. *1* — survey lines

Рис. 1. Схема маршрутов аэромагнитной съемки в оазисе Бангера и архипелаге Хайджамп на фоне рельефа поверхности по данным спутника SPOT-5. На врезке красный квадрат показывает район работ в пределах Антарктиды. *1* — маршруты съемки

of 601 km². The onboard magnetometric system was equipped with a high-precision two-frequency satellite positioning system for accounting differential corrections using a ground base station in Post Processing Kinematic mode. The data underwent rigorous processing including several corrections: magnetic compensation for the aircraft's maneuvers, de-spiking, application of the International Geomagnetic Reference Field, adjustment for diurnals measured by a temporary base station and full levelling [3].

The survey results were used to compile a magnetic anomaly map at 1:25,000 scale, which clearly demonstrates the variability of morphological and amplitude characteristics of deeply metamorphosed Precambrian complexes (Fig. 2). The map shows significant variations not only in the strike but also in the shapes of anomalies ranging from individual features to complex systems. Areas of a sharply differentiated field are presented alongside the relatively quiet sections. Geological features of diverse scales, from several hundred meters up to the regional scale of the survey area, were identified through analysis of the aeromagnetic data, highlighting its comprehensive coverage. This includes the tectonic contact between Neoarchean and Mesoproterozoic terranes and abundant mafic to felsic intrusions [1, 4, 5]. However, it is broadly accepted that, when the distance between the magnetic sensor and the geological source exceeds the assumed size and internal dimensions of the magnetic rock body, interpretations of these parameters become inherently uncertain.

The primary objective of this work is to create a structural (tectonic) map of the Bunger Oasis and Highjump Archipelago based on the analysis of the magnetic anomaly data gathered during the 69th Russian Antarctic Expedition (RAE) using UAV, combined with existing geological information for the area.

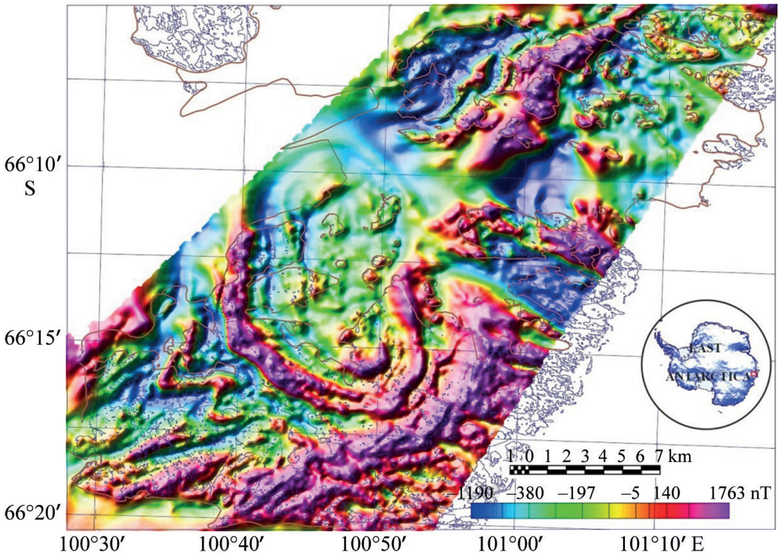

Fig. 2. Magnetic anomaly map of the Bunger Oasis and Highjump Archipelago. The blue lines indicate the location of lakes and islands. The thick brown line represents the coastline and the grounding line of the ice shelf

Рис. 2. Карта аномального магнитного поля оазиса Бангера и архипелага Хайджамп. Синие линии показывают местоположение озер и островов. Толстая коричневая линия отвечает береговой черте и линии налегания шельфового ледника

Geological Overview of the Bunger Oasis and Highjump Archipelago

According to [1], the Bunger Oasis and Highjump Archipelago comprise three or possibly four main structural-lithological complexes (tectonic units), defined by their structural and lithological characteristics: 1) an Archean terrane composing the eastern and southeastern parts of the Bunger Oasis and represented mainly by the orthogneissic complex of tonalite–trondhjemite–granodiorite (TTG) composition with protolith crystallization ages ranging between 2800 and 2600 Ma. This terrane, interpreted as part of an Archean basement reworked during the Mesoproterozoic orogeny, is juxtaposed against the Proterozoic metamorphic terrane by a blind thrust fault. It is thought to be located on the margin of the Mawson protocraton; 2) a Paleo- to Mesoproterozoic volcano-sedimentary metamorphic terrane; 3) a Mesoproterozoic magmatic complex represented by several gabbro-monzonite-granite plutons (Paz Cove intrusion in the center; Algae Lake intrusion in the south; Booth Peninsula batholith in the north-east) and 4) Dyke swarm complex represented by late Mesoproterozoic mafic dikes (1130 Ma, continental tholeiites) and, presumably, late Neoproterosoic, alkaline dykes (basanites-trachybasaltes-phonotephrites and lamproites) [6].

Russian geologists further subdivided the main tectonic units into lithological suites during the surveys of the Bunger Oasis conducted between the 62nd and 69th Russian Antarctic Expeditions (RAE, 2017–2024). The resulting geological map from the studies has not been published yet, but it was presented at the SCAR scientific conference in Chile [7]. Many suites on this map have small horizontal dimensions (tens to hundreds of meters) but extend for hundreds of meters to kilometers [Egorov, pers. communication].

This means that many geological features are undetectable in the magnetic anomaly field. Magnetic sources in this area range from weakly to strongly magnetic and are often closely spaced [Egorov, pers. communication]. The resulting superposition effects make it difficult to definitively correlate specific suites with individual anomalies.

The lack of modern geological surveys in the Highjump Archipelago necessitated the use of two existing maps: the Soviet map [4] and an Australian Geological survey map (Fig. 3 [1, 5]). However, the geological information on both maps is too generalized and lacks too much detail to be a match for the geophysical information obtained. In particular, the complexity of interpreting the magnetic anomaly map arises from the necessity of identifying several metamorphic suites characterized by homogeneous magnetic properties. These suites are tentatively correlated with rocks found in the Bunger Oasis.

The Archean terrane occupies the southern and the southeastern parts of the Bunger Oasis and comprises interlayered felsic and mafic orthogneisses of TTG compositions. The magmatic protoliths of Archean orthogneisses were formed between 2800 and 2700 Ma and inherited zircons from Bunger metasedimentary suites [1]. The Archean orthogneissic complex is represented by interlaying mafic schists, felsic orthogneisses, tonalitic to granodioritic orthogneisses (overlaying with schists, 2,685±25 Ma and 2,705±15 Ma, protolith crystallization) and orthogneisses of alkaline granite composition (2,618±34 Ma and 2,602±35 Ma, protolith crystallization) [1]. In general, more felsic orthogneisses are represented by orthopyroxene-bearing tonalites and granodiorites whereas the mafic ones are represented by quartz-rich dioritic gneisses, as defined by [1]. Migmatization is evident as orthopyroxene-(±) hornblende leucosome. Locally, the Archean orthogneissic complex contains lenses of pelitic metasedimentary rocks. Metamorphic zircon rims yield lower intercept and concordant ages of ca. 1,250–1,200 Ma [1]; there is no evidence of Archean metamorphism (ca. 2700 Ma). Zircons from the orthogneisses and paragneisses exhibit morphological and isotopic similarities, as well as similar geochemical characteristics, suggesting their formation through fractionation from a single magmatic source. This allows the association of these rocks to be interpreted as a syngenetic sedimentary-volcanic series formed in an extensional basin setting [1].

At the Neoarchean-Paleoproterozoic time, a newly formed crust began to develop with the formation of the primarily sedimentary suite being deposited on the Archean basement. The protoliths of these rocks were predominantly argillaceous sediments and basic graywackes. The metapelites of this suite contain an inherited zircon population providing ages of around 2700 Ma [1], suggesting that the sediments were derived mainly from the local Neoarchean rocks. Sm-Nd data from the primary sedimentary rocks also indicate a significant contribution of the Archean crust to their protolith.

The paleoproterozoic metamorphic complex is composed of variably migmatized orthopyroxene plagiogneisses corresponding to quartz diorites, tonalites or granodiorites. The largest bodies of this suite occur in the central part of the Bunger Oasis, where the outcrop widths approach 1 km [Egorov, pers. communication]. They extend from the northern shore of Lake Figurnoye northeastward and northward to Zakrytaya and Ostrovnaya Bays. In the western and eastern parts of the oasis, the rocks of this suite form smaller discontinuous, lenticular bodies with outcrop widths not exceeding 300 m.

The mesoproterozoic rocks in the Bunger Oasis are most prevalent around Transkriptsii Gulf, the northwestern and northern shores of Lake Figurnoye, and along the coast between Ostrovnaya Bay and Kinzhal Inlet. They are subdivided into

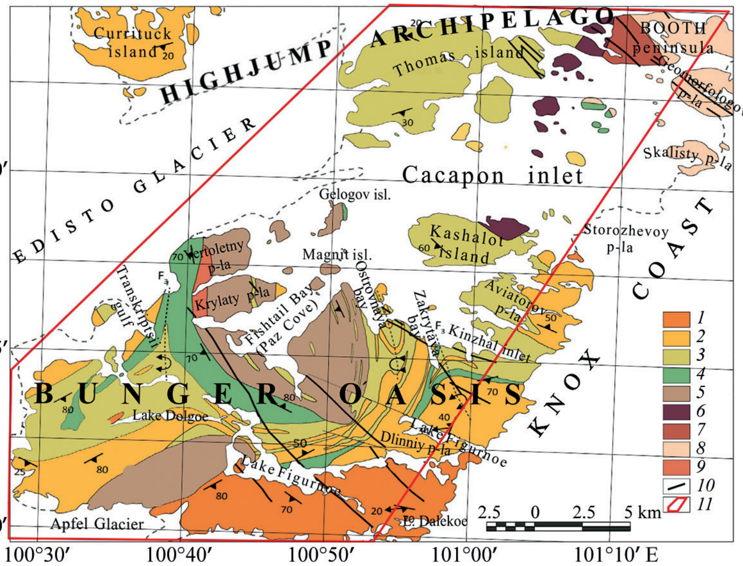

Fig. 3. Simplified regional geological map of the Bunger Hills and Highjump Archipelago (figure modified after [1]). *1* — composite mafic-felsic orthogneiss; *2* — tonalitic-granitic orthogneiss; *3* — interlayered pelite-orthogneiss; *4* — migmatitic metapelitic gneiss; *5* — pyroxene-bearing quartz monzogabbro; *6* — gabbro; *7* — quartz monzonite-monzodiorite; *8* — hornblende-pyroxene granite; *9* — garnet-pyroxene granite; *10* — mafic dyke; *11* — aeromagnetic survey area boundary

Рис. 3. Упрощенная региональная геологическая карта холмов Бангера и архипелага Хайджамп (рисунок изменен по [1]). *1* — комплекс расслоенных ортогнейсов (от мафических до фельзических); *2* — тоналит-гранитовый ортогнейс; *3* — переслаивающиеся пелитовые гнейсы и ортогнейсы; *4* — мигматитовый метапелитовый гнейс; *5* — пироксен-содержащий кварцевый монцогаббро; *6* — габбро; *7* — кварцевый монцонит-монцодиорит; *8* — пироксен-содержащий роговообманковый гранит; *9* — гранат-пироксеновый гранит; *10* — мафические дайки; *11* — контур площади аэромагнитной съемки

primary volcano-sedimentary and sedimentary sequences. The Mesoproterozoic stage of the crustal formation in this area is thought to have begun with active volcanism, leading to the formation of predominantly tholeiitic effusive rocks. Subsequently, volcanic activity transitioned to a sedimentation regime, resulting in thick sedimentary sequences dominated by metapsammites and metapelites. The maximum depositional age for metapsammites is estimated at 1368±22 Ma, and for metapelites at 1490±27 Ma [5].

Primarily tholeiitic, metaeffusive rocks are overlaid or embedded as lenses and boudins within aluminous metasedimentary gneisses. The metaeffusive rocks are represented by variably migmatized ortho- and clinopyroxene schists of mafic to intermediate composition. The metasedimentary gneisses, represented by garnet and sillimanite-garnet gneisses, quartzite gneisses, and calc-silicate rocks, also include the subordinate suite of migmatized schists [4, 5]. In most cases, the schists form elongated lenticular bodies (up to 8.5 km), reaching thicknesses of several hundred meters. Fragments of this migmatized schist suite, as lenticular xenoliths of varying thickness and length, are also mapped within the Paz Cove intrusion.

Among the metapsammite rocks, variably migmatized garnet and sillimanite-garnet gneisses, quartzite gneisses and quartzites dominate. The protoliths of this formation were most likely represented by sedimentary rocks with a subordinate amount of volcanic material. The metapsammite suite rocks are found in close spatial association with the schists of mafic to intermediate composition, forming continuous lenticular bodies that are 30–380 m thick. They are also observed within the Paz Cove intrusion as small and thin lenticular xenoliths [4, 5].

The metapelitic sequence is represented by cordierite-garnet, garnet-cordierite, and orthopyroxene-cordierite felsic gneisses. Subordinate components of the metapelitic sequence are sillimanite-biotite-garnet gneisses with embedded schists and garnet-biotite-orthopyroxene plagiogneisses. Even less common are garnet and biotite-cordierite-orthopyroxene schists and quartzite gneisses. The protolith of this suite is assumed to be argillaceous rocks [1]. The overall composition of the formation can be characterized as an alternation of predominantly intensely migmatized, highly aluminous rocks with a distinctly subordinate proportion of quartzose rocks (metapsammites). The maximum depositional age of the sedimentary protolith of biotite-garnet-cordierite gneiss is 1490±27 Ma [1].

The metapelitic sequence is widespread in the western and eastern parts of the Bunger Oasis (on the Vertoletny and Krylaty Peninsulas, along the northern shore of Lake Figurnoye, and east of Kinzhal Inlet) where it forms relatively large bodies with apparent outcrop widths of up to 1100–1700 m [4, 5]. Fragments of lenticular xenoliths of this suite are found within the Paz Cove intrusion. These fragments do not exceed 100 m in thickness, and their maximum observed length is about 900 m.

The next stage in the region's development is associated with intense tectonothermal activity, leading to deformation and high-grade metamorphism. This process was accompanied by the emplacement of intrusions ranging in composition from mafic to felsic, approximately between 1200 and 1170 Ma. Mesoproterozoic metamorphism reached peak conditions at granulite facies at interval between 1190±15 Ma [8] and 1183±8 Ma [9]. U-Pb LA-ICP MS (Laser ablation-inductively coupled plasma-mass spectrometry) geochronology for monazite from metamorphic rocks provided retrograde (isobaric cooling) metamorphic ages ranging between 1177±12 and 1164±5 Ma [10]. Prograde metamorphism may have begun earlier, at 1250 Ma, coinciding with pluton emplacement, according to [1]. Peak conditions reached 5.5–7.2 kbar and 800–960 °C and persisted between 1220 and 1180 Ma. The evolution of the endogenous regime followed a near-isobaric cooling path. The metamorphism corresponds to stage II of the Albany-Fraser Orogen and reflects the extension potentially associated with unloading and uplift (exhumation) during the development of a collisional orogen that arose after tectonic stage I in the Albany-Fraser Province [1].

The Mesoproterozoic intrusive complex is represented by three large intrusions: Charnockitic Peninsula (Booth Peninsula) batholith in the north, the Algae Lake pluton in the South, and the Paz Cove batholith (hypabyssal intrusion) in the central part [5]. The rocks exhibit a compositional range from mafic orthopyroxene-bearing gabbro to intermediate quartz monzogabbro and monzodiorite, and ultimately to felsic monzonite and charnockitic/orthopyroxene-bearing granites. The Algae Lake pluton and Paz Cove batholith are petrographically very similar [5]. The Paz Cove batholith forms a complex intrusive body, with interfingering relationships observed along its contacts with the host gneissic complex. It also contains sheet-like xenoliths hundreds of meters long, such as those near the southeastern contact. The presence of numerous sheet-like xenoliths, conforming to the contact of the Paz Cove intrusion, may be explained by the formation of a multiphase lopolith. In some areas, the rocks of the intrusion are foliated and even described as migmatitic [1].

The Algae Lake pluton predominantly consists of quartz gabbro and quartz monzogabbro while the Paz Cove pluton varies in composition from gabbro-diorite to granodiorite. U-Pb zircon geochronology for quartz gabbro collected both from the Algae Lake and Paz Cove plutons provided statistically indistinguishable magmatic crystallization ages of 1171±3 Ma and 1170±4 Ma, respectively [11].

The Booth Peninsula batholith (Charnockitic Peninsula pluton, [4, 5]) is the largest and most compositionally diverse intrusion of the Bunger Oasis region. Ravich et al. [4] estimated the exposed area of the intrusion to be 300 km², though a significant portion remains hidden beneath ice and fjord waters. The Booth Peninsula batholith outcrops across most of the Charnockitic, Geomorfologov, and Skalisty peninsulas, as well as nearby islands and part of Miles Island. The eastern part of the Charnockitic Peninsula batholith, including small nunataks 5 km east and 20 km east-northeast of Miles Island, is generally more felsic than the other two large intrusions and contains a variety of intrusive rocks ranging from orthopyroxene-bearing quartz monzodiorites to quartz monzonites and granites (i. e., charnockites *sensu stricto*). According to [11], the batholith is predominantly charnockitic but transitioning locally to quartz monzonitic. However, contacts between the different plutonic rock types within the batholith are difficult to map because they are gradational and most exhibit the characteristic dark reddish-brown weathering of charnockites. Generally, more felsic varieties intrude later than the more mafic ones, though locally they transit into one another [11]. U-Pb zircon geochronology for quartz monzogabbro from Booth Peninsula yields a crystallization age at 1151±4 Ma, which is younger than the crystallization age obtained for the Paz Cove and the Algae Lake samples [11].

To the west, the Booth Peninsula batholith is bounded by a linear intrusion composed of gabbro and quartz gabbro. This sill-like intrusion extends as a sub-meridional belt for 15 km from Kashalot (Fuller) Island to Miles Island. Sheraton et al. [5] noted that these rocks are petrographically similar to the more mafic rocks of the Algae Lake and Paz Cove intrusions. However, the age of this intrusion is unknown and, therefore, its genetic relationship, if any, to the Booth Peninsula batholith or other intrusion still remains an open question.

Northwest-southeast trending dolerite dikes swarm is widespread in the Bunger Oasis and the Highjump Archipelago. Dyke swarm is represented by continental tholeiites and has a crystallization age at 1130±10 Ma (U-Pb zircon, baddeleyite; [6]). The lack of metamorphic overprinting in these dikes indicates that the area has not undergone significant thermal reworking. The dikes were emplaced approximately 20 million years after the last known phase of plutonism in the Bunger Oasis. They were intruded at the end of the second stage of the Albany-Fraser Orogeny, signaling the termination of a protracted period of lithospheric thermal weakening that may have been caused by prolonged underplating of basic mantle material during orogenic collapse.

Magnetic properties of rocks

Over 15,000 magnetic susceptibility measurements were performed on a comprehensive collection of Bunger Oasis rock samples spanning from the Neoarchean to the Mesoproterozoic [Egorov, pers. communication]. The sample collection was gathered during recent Russian geological, which included ground magnetic measurements as well. For example, [16] based on ground magnetic data from the 64th Russian Antarctic Expedition (RAE), reported that a negative magnetic anomaly with an intensity of –500 to –700 nT corresponds to the porphyritic quartz monzodiorite and granodiorite sequence of the Paz Cove intrusion. These intrusive rocks are characterized by a unimodal distribution of magnetic susceptibility (27.1×10^{-3} SI units), indicating they are magnetic rocks. Therefore, reverse magnetization is a likely possibility for these rocks.

Golynsky et al. [2019] also note that the Paz Cove metagabbroids correspond to a low-gradient negative magnetic anomaly field with anomaly intensities of –(400–700 nT) and exhibit a bimodal distribution of magnetic susceptibility with modes corresponding to 2.92×10^{-3} SI units and 24.2×10^{-3} SI units. The discrepancy between the magnetic properties of the rocks and the sign of the magnetic field intensity is most likely explained by the reverse direction of the magnetization vector. The gabbro-dolerites forming the largest dike of the Bunger Oasis exhibit a unimodal distribution of magnetic susceptibility (48.0×10^{-3} SI units), which enables one to classify them as magnetic rocks [7].

Among the geological suites identified in the Bunger Oasis only two exhibit low magnetic susceptibility values: the Mesoproterozoic metapsammite sequence and the Neoarchean-Paleoproterozoic sedimentary sequence, primarily argillaceous sediments and basic graywackes [Egorov, pers. communication]. The magnetic properties of the metapsammite sequence remain invariable throughout the Bunger Oasis. They are attributed to the variably migmatized garnet and sillimanite-garnet gneisses, quartzite gneisses and quartzites [7]. At the same time, very weakly and weakly magnetic varieties predominate, therefore, these rock types collectively influence the overall magnetic properties of this suite. All the remaining metamorphic and igneous lithologies within the Bunger Hills oasis demonstrate variable magnetic properties classified as weakly to strongly magnetic [7].

A collection of samples gathered by N.V. Borovkov and V.A. Maslov of VNIIOkeangeologia from the western part of the Charnockitic Peninsula enabled them to measure the magnetic susceptibility in a series of intrusive rocks. Specifically, Opx-, Bt-, and Gt-bearing monzodiorites, as well as Opx-bearing diorites and monzonites were measured. These rocks exhibit high magnetic susceptibility values ranging from 20×10^{-3} to 36×10^{-3} SI units. It was also noted that stringers of fine-grained Opx-monzodiorites possess even higher magnetic susceptibility values — up to 110×10^{-3} SI units, whereas Q-bearing monzodiorites show significantly lower values, in the range of 4.3×10^{-3} to 5.6×10^{-3} SI units.

Even with a limited sample collection, the results suggest that granitic (i. e., charnockites *sensu stricto*) rocks play a primary role in the structure of the Charnockitic batholith while most intermediate rocks have a restricted distribution. Among others, Q-bearing monzodiorites exhibit significantly lower magnetic susceptibility compared to other rock types. This assumption is based on the fact that despite their high magnetic susceptibility values intermediate rocks do not produce intense magnetic anomalies across the entire batholith area.

Summarizing the magnetic properties of the Bunger Oasis rocks, it's clear that the significant variability in magnetization poses challenges for the interpretation of the magnetic anomalies [7]. Determining the specific source suite for a given local magnetic field component is not always straightforward.

Results

The geological structure map of the Bunger Oasis and Highjump Archipelago was constructed using calculations of the first vertical derivative of the magnetic anomaly field derived from aeromagnetic survey data. This derivative is most effective for highlighting local features of magnetic anomalies, such as the axes and lines of disruption in the magnetic field structure, which are particularly important in analyzing areas with

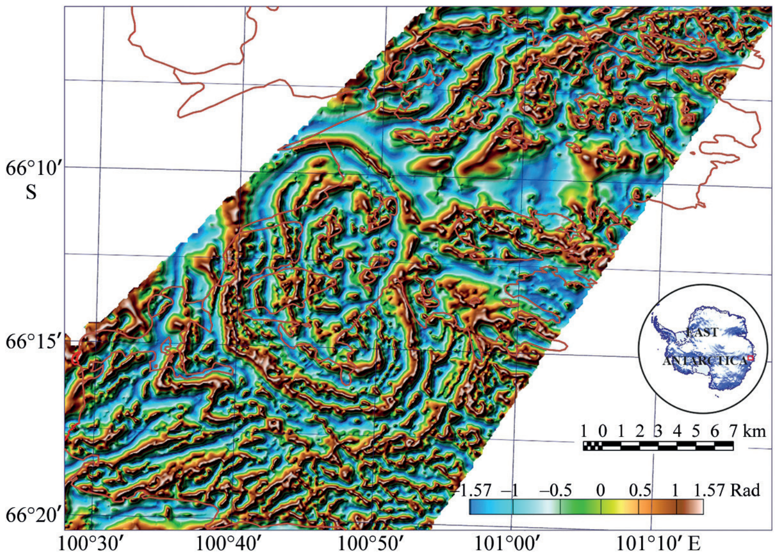

Fig. 4. Shaded relief map of tilt derivative of the Bunger Oasis and Highjump Archipelago aeromagnetic data

Рис. 4. Карта теневого рельефа производной наклона аэромагнитных данных оазиса Бангера и архипелага Хайджамп

sharply differentiated fields. Additionally, calculations of the horizontal derivative and the tilt derivative (Fig. 4) were performed. The tilt derivative provides the most accurate delineation of magnetic sources as, according to theory, the zero contour line of the tilt derivative corresponds to the location of the edge anomaly source [12].

All the aforementioned transformations were generated as colored shaded relief maps. This visualization method provides a clearer picture of the magnetic anomaly distribution, revealing the underlying geological bodies. It also facilitates more confident identification of the magnetic field's key morphological features when each is distinguished by unique attributes. In constructing the geological structure map (Fig. 5) we primarily relied on the tilt derivative calculations which allowed identifying the main magnetic sources and areas devoid of them throughout the study area. These were then correlated with geological suites and intrusive bodies. These bodies were examined, and if they were found to correspond to the rocks of a specific formation, they were then assigned the index of that formation. Areas lacking magnetic sources generally correspond to the non-magnetic metapsammite suite, part of the Mesoproterozoic Wilkes Land orogen [1].

For the protocraton region, the correlation between magnetic sources and the identified formations is ambiguous. Nevertheless, the primary magnetic sources were associated with the felsic orthogneisses which are most widespread in this area. We interpret the remaining protocraton rocks as interlayered suites, including metaintrusive gabbroids. The predominantly mafic crystalline suite is the exception, sometimes correlating with high-amplitude anomalies (see Figs. 2, 5).

The magnetic anomalies in the Bunger Oasis and Highjump Archipelago region are characterized by a complex structure. The principal geological features of the region are effectively revealed in the complete set of amplitude, morphological and structural characteristics of the magnetic anomaly field. The intensity of the magnetic anomalies is determined by the lithology of the geological sequences while the strike of the magnetic anomalies corresponds to the prevailing geostructural framework. The magnetic field is relatively calm in some areas, while others show sharply contrasting fields with high-intensity anomalies. These anomalies have significant horizontal gradients and amplitudes up to 1800 nT. This is characteristic, for example, for regions composed of layered migmatites associated with metapelitic paragneisses. The high horizontal gradients of magnetic anomalies in zones where paragneisses occur are caused by several

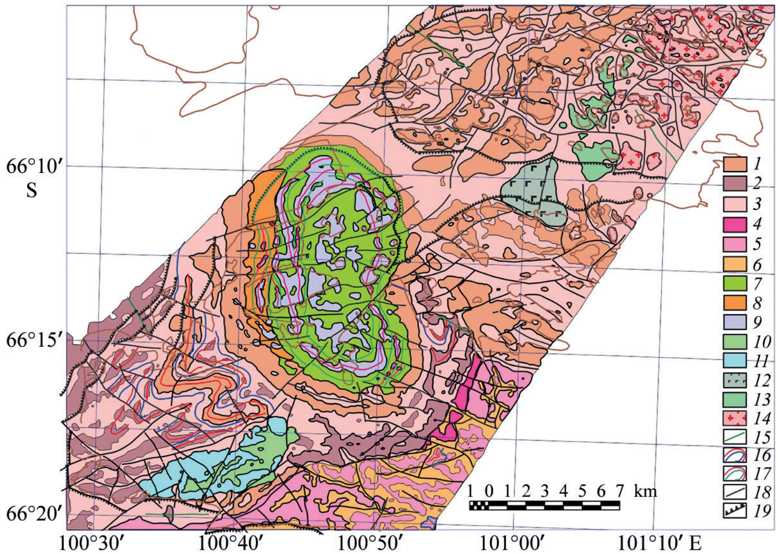

Fig. 5. The geological structure map of the Banger Oasis and the Highjump Archipelago, based on aeromagnetic survey data.
Mesoproterozoic Wilkes Land orogen: *1* — predominantly layered migmatites with a substrate of cordierite-garnet and garnet-cordierite, orthopyroxene-cordierite schists and gneisses; *2* — predominantly migmatized ortho- and clinopyroxene schists of basic to intermediate composition; *3* — predominantly migmatized garnet and sillimanite-garnet gneisses, quartzite gneisses, and quartzites.
Neoarchean-Paleoproterozoic Mawson protocraton: *4* — migmatized pyroxene schists and metagneisses; *5* — orthopyroxene orthogneisses of plagiogranite-tonalite-granodiorite-granite composition; *6* — interlayering metamorphic rocks of various compositions with meta-intrusive rocks.
Intrusive rocks: Paz Cove intrusion: *7* — predominantly biotite- and orthopyroxene-metamorphosed gabbro, gabbrodiorite, diorite, and quartz diorite porphyrites, less commonly granodiorite porphyries; *8* — bodies of porphyritic orthopyroxene granodiorites; *9* — interlayering of orogenic and intrusive rocks.
Algae Lake intrusion: *10* — metadiorites-quartz metamonzodiorite; *11* — gabbro and gabbro-diorite porphyrites with subordinate diorite porphyrites.
Mesoproterozoic plutons: *12* — gabbro and quartz gabbro pluton associated with a magnetic low; *13* — gabbro and quartz gabbro plutons; *14* — plutons of quartz monzodiorites, quartz monzonites, and granites.
Other elements: *15* — dolerite and gabbrodolerite dykes; *16* — large folds expressed in magnetic field; *17* — axes of local positive and negative anomalies highlighting the concentric zoning of the Paz Cove intrusion and surrounding country rocks; *18* — faults, structural discontinuities, lineaments; *19* — normal faults

factors including the heterogeneous composition of the formation, varying degrees of migmatization, the presence of schistosity and blastomylonitization zones, the occurrence of metagabbro and schists with high titanomagnetite content.

The aeromagnetic data results reveal a complex pattern over the areas where both metapelites and metapsammite sequences occur. In several instances, across extensive areas (Thomas and Kashalot Islands), where literature sources suggest the predominance of rocks we associate with the metapelitic suite, the intense negative anomalies are also observed, potentially, originating from different rock types (see Fig. 2). The presence of intense negative anomalies on the Aviatorov Peninsula indicates predominantly non-magnetic rocks, compositionally similar to the metapsammite suite. However, published maps from previous studies (see Fig. 3) indicated the presence of both aforementioned formations in this area characterized by roughly equal distribution [4, 5], which, we believe, is inaccurate. However, no recent detailed geological investigations have been conducted in these areas.

Areas dominated by intense negative magnetic anomalies (up to –1200 nT) correlate with the metapsammite sequence, which primarily consists of variably migmatized garnet and sillimanite-garnet gneisses, quartzite gneisses and quartzites, also characterized by extremely low modal magnetic susceptibility values.

The boundary between Paleoproterozoic-Neoarchean and Mesoproterozoic terranes in the southeastern Bunger Oasis is clearly delineated by an extensive linear zone (belt) of positive magnetic anomalies. This zone strikes northeast and is characterized by variations in the shape and amplitude of the anomalies (see Figs. 2–4). This belt exhibits an en-echelon arrangement of anomalies comprising the most intense anomalies (up to 900–1000 nT) concentrated within the Mesoproterozoic part of the metamorphic complex.

Рис. 5. Схема геологического строения оазиса Бангера и архипелага Хайджамп, по материалам аэромагнитной съемки.
Мезопротерозойский ороген Земли Уилкса: *1* — преимущественно послойные мигматиты с субстратом кордиерит-гранатовых и гранат-кордиеритовых, ортопироксен-кордиеритовых сланцев и гнейсов; *2* — преимущественно мигматизированные орто- и двупироксеновые кристаллические сланцы основного-среднего состава; *3* — преимущественно мигматизированные гранатовые и силлиманит-гранатовые гнейсы, кварцитогнейсы и кварциты.
Неоархейско-палепротерозойский протократон Моусона: *4* — мигматизированные пироксеновые кристаллические сланцы и меланогнейсы; *5* — ортопироксеновые ортогнейсы плагиогранит-тоналит-гранодиорит-гранитного состава; *6* — переслаивающиеся метаморфические породы различного состава с метаинтрузивными породами.
Интрузивные породы: Интрузия Паз-Коув: *7* — преобладающие дву- и ортопироксеновые метаморфизованные габбро-габбродиорит-, диорит- и кварцевые диорит-порфириты, реже гранодиорит-порфиры; *8* — тела порфировидных ортопироксеновых гранодиоритов; *9* — переслаивание пород орогена и интрузивных пород.
Интрузия Алго-Лэйк: *10* — метадиориты-кварцевые метамонцодиориты; *11* — габбро- и габбродиорит-порфириты с подчиненными диорит-порфиритами.
Мезопротерозойские плутоны: *12* — плутон габбро и кварцевых габбро, ассоциированный с магнитным минимумом; *13* — плутоны габбро и кварцевых габбро; *14* — плутоны кварцевых монцодиоритов, кварцевых монцонитов и гранитов.
Прочие элементы: *15* — долеритовые и габбродолеритовые дайки; *16* — крупные складки, выраженные в магнитном поле; *17* — оси локальных положительных и отрицательных аномалий, подчеркивающих концентрическую зональность пород интрузии Паз-Коув и вмещающих пород; *18* — разломы, линии нарушения структуры поля, линеаменты; *19* — сбросы

The foreland of the Mawson paleocraton [13], which we hypothesize is exposed in the southeastern part of the Bunger Oasis (see Fig. 5), lacks such intense anomalies. In some cases, they only reach 500–700 nT. Furthermore, the anomaly trends in this area are predominantly sub-latitudinal and characterized by short-wavelength anomalies unlike the boundary zone where the superposition effect from various sources results in a regional-scale anomaly.

The strike of the intense anomaly belt changes noticeably from west to east, trending northeast east of the Algae-Lake intrusion. The central segment extends sub-latitudinally along Lake Figurnoye suggesting that the lake is located at the contact between two major tectonic elements, the paleocraton and the mobile belt. The eastern segment strikes north, and it is orthogonally juxtaposed to the east by predominantly intense anomalies associated with relatively thick units with felsic orthogneisses, along with minor layers of intermediate orthogneisses and schists, despite both formations possessing only moderate magnetic susceptibility values. In contrast, alkaline orthogneisses mapped in this area strikes concordantly with the aforementioned magnetic belt and/or the boundary between the two metamorphic complexes.

The overall magnetic anomaly pattern over the paleocratonic block is quite complex lacking a clear correlation with the identified metamorphic suites, whose layers often exhibit limited horizontal extent. A wide range of relationships between main rock types and the magnetic anomalies has been established. However, since felsic orthogneisses are predominant, their distribution largely determines the magnetic anomaly pattern in this area, with other formations contributing additional elements. Numerous dikes of metagabbro, metabasites, and gabbro-dolerites, possessing strong magnetic properties, further complicate the magnetic anomaly pattern.

It should be noted that the Neoarchean rocks of protocratonic region are characterized by a striking prevalence of positive magnetic anomalies, varying significantly in intensity, wavelength, form, and orientation. Negative anomalies are extremely rare, largely corresponding to areas of low relief, such as Lake Figurnoye with its branches and Lake Dalekoe, suggesting their tectonic nature.

Gabbro and orthopyroxene granite intrusions, mapped in the northeastern part of the Highjump Archipelago (see Figs. 2, 5), correlate well with local, low-intensity magnetic anomalies occurring against a background regional negative minimum. While anomalies associated with gabbro intrusions can exceed 800 nT, those above the orthopyroxene granite intrusions of the Charnockitic batholith rarely exceed 50 nT. It is important to note that these low-amplitude anomalies correspond to all bedrock outcrops in the Highjump Archipelago region and should be attributed to granitic intrusions. The high concentration of local anomalies further supports the existence of a large batholith intruding into the metasedimentary sequence.

Westwards from the batholith, a linear chain of islands trending sub-meridionally and composed of gabbro intrusions, also correlates primarily with short-wavelength magnetic anomalies with intensity varying from 150–300 to 600–800 nT (see Fig. 2). These anomalies also occur against a negative background, but here the amplitude of the minima is significantly higher in comparison with the area of quartz-monzodiorite and granite intrusions, reaching –700 to –900 nT. One of the gabbro intrusions, according to literature sources, is mapped in the northern part of Kashalot Island [4, 5]. However, in this case, it corresponds to a deep minimum exceeding –1000 nT in amplitude. At this stage of research, such an unusual magnetic field anomaly distribution over this gabbro intrusion remains an enigma without a definitive explanation. Several hypotheses do exist, but they are still speculative, and it is crucial to verify the actual composition of the intrusion. If it is indeed gabbro, it is most likely that it intruded during a period of reversed magnetic polarity, and its remanent magnetization exceeds the induced magnetization. This suggests that all the other gabbro intrusions within the 15-km belt differ in their emplacement age. Determining their relative ages will require geochronological studies. However, it is noteworthy that a strong minimum is also observed over the Paz Cove intrusion, which may indirectly indicate a synchronous emplacement of these two intrusions.

Regarding the two other largest intrusions of the Bunger Oasis, Paz Cove and Algae Lake, both are clearly discernible in the magnetic anomaly pattern, but in distinctly different ways (see Figs. 2, 4, 5). All rock varieties of the Paz Cove intrusion, despite some variations, are most often characterized as moderately magnetic (27.1×10^{-3} SI units). The overall magnetic susceptibility distribution is primarily influenced by quartz diorite porphyrites and granodiorite porphyrites, to a lesser extent by diorite porphyrites, and even less by gabbro and gabbro-diorite porphyrites [16]. Given this, the presence of a broad minimum over the intrusion can only be explained by assuming the rocks possess reversed remanent magnetization.

The Paz Cove hypabyssal intrusion (see Fig. 5) is primarily associated with a region of predominantly negative anomalies shaped like a sub-meridionally elongated, deformed oval. The periphery of the oval is marked by a belt of intense positive anomalies flanking the intrusion from the west, south, and east. Only in the north is a relatively low-amplitude maximum recorded, likely representing the northern limit of the intrusion (see Figs. 2, 4, 5). The decrease in anomaly intensity in this case is explained by the deepening of magnetic sources beneath the Edisto Glacier along a system of normal faults. The most intense negative anomalies (over –700 nT) are registered in the west of the intrusion, where they correlate with the area of porphyritic orthopyroxene granodiorites.

There is every reason to believe that within the main oval of the magnetic anomaly field distribution, an inner oval exists, formed by local anomalies of low intensity (50–150 nT) interspersed with relatively deep minima (–300 to –700 nT), which is clearly captured by all magnetic anomaly field derivatives (see Figs. 4, 5). In the north, west, and south, it is formed mainly by linear anomalies, while in the eastern part, diversely shaped anomalies prevail, but in all cases, they are conformal to the outer boundary of the intrusion. Moreover, in the western part of the intrusion, there is another branch of the oval that gradually fades as it moves from north to south, suggesting asymmetry in the intrusion's structure. The central part of this structure is associated with a mosaic magnetic anomaly field pattern. This can likely be explained by the fractionation of the magmatic melt and the presence of interlayers of host rocks, as documented by geological observations [4, 5].

Almost all islands in Fishtail Bay (Paz Cove) are composed mainly of gabbro and gabbro-diorites, and in some cases, they are interspersed with thin lenticular layers of basement rocks. A majority of them coincide with local positive anomalies, contradicting the earlier suggestion about the nature of the magnetic minimum being related to the reversed remanent magnetization of the rocks composing the Paz Cove batholith and the low magnetic properties of metapsammite rocks. The reason for this phenomenon is not entirely clear, and it is possible that it is caused by more magnetic basement rocks buried at shallow depths.

It should also be noted that the contact between the Paz Cove intrusive rocks and the host rocks in the western part of the area is more or less clearly traced in the magnetic field as a linear gradient zone with a sub-meridional trend. Conversely, a zone of strong positive magnetic anomalies appears over the intrusion in the south and east, contradicting existing geological maps. This is likely due to the basement rocks occurring at a relatively shallow depth. These basement rocks are presumably the primary source of the magnetic anomaly field in the eastern and southern parts of the intense magnetic anomaly belt. Here, the superposition effects from different sources are most pronounced. In addition, there is a significant difference in the anomaly gradients on either side of the eastern branch of the belt. High gradients are characteristic of the east of the belt and they noticeably decrease to the west, which serves as an additional argument in favor of the assumption of buried anomaly sources beneath the igneous rocks of the intrusion.

Establishing the spatial boundaries of the hypabyssal intrusion is further complicated by the observations of Stüwe and Wilson [14], who noted that the contacts generally conform to the layering within the surrounding gneisses, whose mineralogy is also similar to that of the batholith rocks, and the contact relationships are gradational. Only in some places the contacts are intruded by coarse-grained, non-foliated charnockites.

In the magnetic anomaly field, the Algae Lake intrusion is also characterized in a unique way with areas of both positive and negative anomalies, primarily developed over gabbroic rocks. The predominance of hemo-ilmenite over titanomagnetite in the gabbroic rocks may indicate the presence of lamellar magnetism and the occurrence of anomalies due to reversed remanent magnetization [15]. Positive anomalies correlate more with areas dominated by diorite-quartz monzodiorite compositions, characteristic of the southwestern part of the intrusion. It's important to note that only the northwestern boundary is reliably determined. This boundary coincides with a minimum in the tilt derivative and extends northeastward to Lake Figurnoye. The most ambiguous magnetic anomaly distribution pattern is observed in the south and east of the intrusion, where anomalies may be caused by buried rocks of the Mesoproterozoic orogen, particularly rocks of the metapelite sequences suite, mapped in close proximity to and as small interlayers within the intrusion.

According to geological data, the thickness of dolerite and gabbro-dolerite dikes varies widely, from a few meters to 50–80 meters, as in the case of the region's largest dike, which crosses Bunger Oasis from northwest to southeast. Due to their small size, almost all known dikes cannot be discerned in the magnetic anomaly pattern, despite their high magnetic susceptibility values ($41.5 \cdot 10^{-3}$ SI units). As for the largest dike in Bunger Oasis, it also lacks a clear expression and correlates fragmentarily with both negative and positive anomalies, primarily residing within areas of low magnetic values. This is clearly visible in the area south of Lake Figurnoye, where the southern segment of the dike lies almost entirely within a region of positive anomalies. However, the local components do not show a clear correlation with the dike's location. A similar anomaly distribution was observed in ground survey data [16]. This situation may indicate that the dike, due to its dimensions, is not reflected in the magnetic field, but it is also possible that they intruded during a period of reversed polarity. One of the oasis's extensive and thick dikes, intruding along the coastal zone on both sides of Zakrytaya Bay, exhibits a similar pattern when local anomalies along its strike are randomly distributed.

Among the most striking geological structures clearly revealed in the aeromagnetic data of Bunger Oasis are folds mapped in several locations (see Figs. 2, 4, 5). For example, on the southern coast of Izvilistaya Bay and Lake Dolgoe, as well as the south of Ostrovnaya Bay. Existing literature on well-studied regions of the world indicates that fold geometry, including the dip, strike, and plunge of the axial plane, as well as the dip angles of the limbs, all influence the magnetic response [17]. Aeromagnetic data are most effective for visualizing upright and inclined folds (with vertical or steeply dipping axial planes) and less effective for visualizing recumbent folds (with horizontal axial planes). The folds in the southwestern part of the oasis are characterized by near-vertical axial planes, which allowed the detection of a system of positive and negative anomalies caused by the combined effect of interlayered strata, including those with low magnetic susceptibility values. The most contrasting folds relate to the D_2 deformation episode, belonging to the class of tight to isoclinal F_2 folds with subvertical or steeply dipping axial surfaces (dipping towards recumbency and having shallow, generally south-southwest plunging axial planes). The strike of the axial planes of the F_2 folds varies from sublatitudinal to northeasterly [4].

It is noteworthy that the observed increased intensity of the anomalies in the fold hinges may be related to the superposition of magnetic responses from the two limbs. However, such higher-amplitude anomalies could also develop due to localized increases in magnetic mineral content resulting from structural focusing of fluids in hinge zones during deformation or from limb attenuation and hinge thickening during intense fold tightening.

Most of the faults identified on the interpreted map, with rare exceptions, do not directly correspond to observed magnetic maxima and are mostly associated with minima that contrast with the surrounding field pattern. Additionally, faults were identified by the displacement and bending of anomaly axes, as well as their attenuation or termination. Normal faults were recognized by abrupt changes in the spectral composition of magnetic anomalies and by the appearance of regional anomalies with diffuse outlines, and also by a significant decrease in amplitude.

Thus, the analysis of the magnetic anomaly pattern of Bunger Oasis and Highjump Archipelago, combined with geological information, has identified two fragments of major geological provinces within the region. These are the structural-material Mawson Neoarchean-Paleoproterozoic cratonic complex and the Paleo-Mesoproterozoic volcano-sedimentary complex of the Mesoproterozoic orogen (mobile belt) of Wilkes Land, as a westward continuation of the Albany-Fraser Orogen in southwestern Australia, which are further subdivided into a number of smaller units identified by researchers. The Mesoproterozoic intrusive complex is represented by three large plutons: Paz Cove, Algae Lake, and Charnockitic, in which the main rock varieties are gabbro, tonalites, quartz monzogabbro, granites, and quartz monzodiorites.

Conclusions

The magnetic anomaly map reveals distinct patterns correlating with specific geological units: a Neoarchean terrane, and a Palaeo-Mesoproterozoic complex of orthogneiss, pelite gneiss, migmatitic pelite gneiss, and Mesoproterozoic plutonic rocks. This data provides valuable insights into the regional geological evolution and the Precambrian history of East Antarctica. The observed magnetic anomaly patterns, and the resulting spatial distribution of the source bodies, offer a significantly more effective tool for detailed geological mapping than existing published maps, particularly for the Highjump Archipelago (e. g., Thomas Island), Kashalot Island, and the Aviatorov Peninsula, where current maps demonstrate a clear lack of detail.

Within the Bunger Oasis and Highjump Archipelago, magnetic anomalies reflect the underlying geological structure, with anomaly intensity linked to rock composition and anomaly strike aligning with the regional structural framework. Tilt derivative calculations aided in mapping this structure, associating magnetic sources with specific rock suites and non-magnetic areas with metapsammite rocks.

Although widespread felsic orthogneisses are likely to be the primary magnetic source within the protocraton, correlating specific anomalies remains challenging due to the potential contribution of other sources, including numerous dikes, which further complicate the magnetic anomaly pattern. High-intensity positive anomalies (up to 1800 nT) are associated with magnetic, layered migmatitic metapelites, while strong negative anomalies (down to –1200 nT) correspond to non-magnetic metapsammite rocks.

A prominent northeast-striking linear belt of positive magnetic anomalies (see Fig. 2) demarcates the boundary between the Paleo/Neoarchean and Mesoproterozoic complexes in the southeastern Bunger Oasis. This zone, characterized by an en-echelon arrangement, hosts the most intense anomalies (up to 900–1000 nT) within the Mesoproterozoic complex. Conversely, the hypothesized Mawson paleocraton foreland (see Figs. 2, 5) exhibits weaker, sub-latitudinal anomalies (maximum 500–700 nT) with shorter wavelengths, indicating a distinct geological setting. The strike of the intense anomaly belt varies: (1) northeast east of the Algae Lake intrusion; (2) sub-latitudinal along Lake Figurnoye, potentially marking a tectonic contact; and (3) north-trending in the east, orthogonally juxtaposed against intense anomalies associated with felsic and intermediate rocks.

Aeromagnetic data reveal a complex relationship between magnetic anomalies and intrusive bodies. The Paz Cove and Algae Lake intrusions exhibit contrasting magnetic signatures (see Figs. 2, 4, 5). The moderately magnetic (27.1×10^{-3} SI units) Paz Cove intrusion [7] is associated with a broad negative anomaly, likely due to reversed remanent magnetization. This sub-meridionally elongated, deformed oval is bounded by intense positive anomalies (west, south, and east), with a low-amplitude northern maximum marking the intrusion's limit (see Figs. 2, 4, 5). The northward decrease in anomaly amplitude suggests deepening magnetic sources beneath the Edisto Glacier along normal faults. The strongest negative anomalies (>–700 nT) correlate with porphyritic orthopyroxene granodiorites to the west. High magnetic gradients along the eastern edge of this anomaly belt, decreasing significantly westward, further support the presence of buried sources beneath the Paz Cove intrusion.

Within the main negative magnetic oval of the Paz Cove intrusion, a lower-intensity inner oval (50–150 nT with minima of –300 to –700 nT) is apparent in magnetic field derivatives. This inner structure, defined by linear anomalies to the north, west, and south, and more complex anomalies to the east, conforms to the outer intrusion boundary. A westward-trending branch fades southward, suggesting structural asymmetry. The central mosaic anomaly pattern likely reflects magmatic melt fractionation and interlayered host rocks [4, 5].

The Algae Lake intrusion displays a distinct magnetic signature characterized by both positive and negative anomalies. Negative anomalies predominantly correspond to gabbroic rocks, where the prevalence of hemo-ilmenite over titanomagnetite suggests lamellar magnetism and the possibility of reversed remanent magnetization as the anomaly source. Positive anomalies are most confidently correlated with areas dominated by diorite-quartz monzonite-diorite rocks, particularly in the southwestern portion of the intrusion. Only the northwestern intrusion boundary is reliably defined, coinciding with a tilt derivative minimum extending northeast towards Lake Figurnoye. The southern and eastern boundaries exhibit a more ambiguous magnetic signature. Here, positive anomalies may originate from underlying Mesoproterozoic orogenic rocks, particularly metapelites mapped near and within the intrusion as enclaves.

In the northeastern Highjump Archipelago, gabbro and orthopyroxene granite intrusions correlate with localized, low-intensity magnetic anomalies (150–800 nT for gabbro, <50 nT for granite) superimposed on a regional negative minimum (see Figs. 2, 5). Low-amplitude anomalies over bedrock outcrops correspond to granitic intrusions, supporting the interpretation of a large batholith within the metasedimentary sequence. A sub-meridionally trending chain of gabbro intrusions west of the batholith exhibits short-wavelength anomalies (150–800 nT) against a strong negative background (–700 to –900 nT), significantly more negative than that observed near quartz-monzodiorite and granite intrusions [see Fig. 2]. The gabbro intrusion on Kashalot Island is associated with an exceptionally deep magnetic minimum (up to –1000 nT), requiring further investigation. A leading hypothesis attributes this, and potentially the reversed magnetization observed in the Paz Cove intrusion, to emplacement during a period of reversed magnetic polarity, exceeding the induced magnetization. This hypothesis necessitates further analysis, including compositional and geochronological studies of intrusions within a 15-km belt to determine relative ages.

Magnetic susceptibility measurements of Bunger Oasis rocks reveal a wide range of values, from very weakly magnetic psammitic rocks and granitic veins ($<0.3\times10^{-3}$ SI units) to strongly magnetic mafic schists, metagabbroids, metabasites, and dolerites/gabbro-dolerites ($>47.8\times10^{-3}$ SI units), with intermediate values observed in other suites [7]. The presence of magnetite-rich rocks within the metapelite suite likely explains the significant positive magnetic anomaly (4600–6190 nT; [16]). Thin dikes of magnetic rocks (e. g., metagabbroids) produce only localized positive anomalies.

In conclusion, this study demonstrates the effectiveness of fixed-wing UAV aeromagnetic surveys for mapping complex geological structures in areas like the Bunger Oasis and Highjump Archipelago, highlighting a strong correlation between magnetic anomaly characteristics and the composition and distribution of geological units.

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Строение земной коры оазиса Бангера и архипелага Хайджамп (Восточная Антарктида) на основе магнитных данных, полученных с помощью беспилотного летательного аппарата самолетного типа

А.В. Голынский[1]✉, Д.А. Голынский[1], Г.Л. Лейченков[1], Н.В. Боровков[1], В.Г. Анцев[2], Ф.Г. Гуторов[2], А.Е. Симаков[2]

[1] *Всероссийский научно-исследовательский институт геологии и минеральных ресурсов Мирового океана (ФГБУ «ВНИИОкеангеология»), Санкт-Петербург, Россия*

[2] *НПК Беспилотные авиационные и морские системы, АО Научно-производственное предприятие «Радар ммс», Санкт-Петербург, Россия*

✉*sasha@vniio.nw.ru*

АВГ, 0000-0003-2546-4082; ДАГ, 0000-0001-8717-0894; ГЛЛ, 0000-0001-6316-8511
НВБ, 0000-0003-2568-2039; ВГА, 0009-0007-4472-7139; ФГГ, 0009-0009-6720-2997;
АЕС, 0000-0002-2006-3071

Расширенный реферат

Наше исследование демонстрирует взаимосвязь между магнитными аномалиями и геологической структурой докембрийских комплексов оазиса Бангера и архипелага Хайджамп в Восточной Антарктиде. Аэромагнитные данные эффективно картируют геологические подразделения, выявляя отчетливые магнитные черты для неоархейских и палео-мезопротерозойских толщ. Это дает возможность значительно улучшить существующие геологические карты, особенно в слабоизученных районах, таких как архипелаг Хайджамп. Интенсивность и простирание магнитных аномалий коррелируют с составом пород и региональными структурными трендами, что позволяет лучше дифференцировать литологические подразделения, такие как магнитные метапелиты и немагнитные метапсаммиты. Расчеты производной магнитного наклона улучшают структурное картирование, связывая магнитные источники с конкретными комплексами пород. Так, например, выраженный пояс положительных магнитных аномалий северо-восточного простирания отмечает ключевую границу между архейскими и мезопротерозойскими комплексами. Изменения в простирании пояса указывают на сложную тектоническую историю, включая возможные разломные контакты. Интрузивные тела демонстрируют сложные магнитные характеристики. Интрузия Паз-Коув проявляется в виде отрицательной аномалии, вероятно, из-за обратной остаточной намагниченности, в то время как интрузия озера Алги имеет как положительные, так и отрицательные аномалии, отражающие различный состав пород. Интрузии габбро в северо-восточной части архипелага Хайджамп коррелируют с положительными аномалиями, тогда как интенсивная отрицательная аномалия над интрузией острова Кашалот предполагает обратную намагниченность.

Основная цель данной работы заключается в создании структурной (тектонической) схемы оазиса Бангера и архипелага Хайджамп на основе анализа аномального магнитного поля, полученного в ходе работ 69-й РАЭ с применением беспилотника самолетного типа, и существующей геологической информации по данной территории. Исследование подчеркивает ценность аэромагнитных съемок с использованием БПЛА для детального геологического картирования в сложных условиях, предоставляя важную информацию о докембрийской истории Восточной Антарктиды.

Ключевые слова: аэромагнитная съемка, магнитные аномалии, магнитные свойства, оазис Бангера, архипелаг Хайджамп, докембрийские толщи, интрузии

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