International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2026 Vol. 16, pp. 151-154/Usmanova
Research Article

MORPHOLOGY OF THE ANOMALOUS GRAVITATIONAL FIELD AS A CRITERION FOR IDENTIFYING A FRAGMENT OF AN OCEANIC PALEOSEAMOUNT (ZIRABULAK-ZIAETDIN REGION, SOUTHERN TIAN SHAN)

*** S.A. Usmanova**
Institute of Geology and Geophysics named after H.M. Abdullaev,
at the University of Geological Sciences, Tashkent, Uzbekistan,
Author for Correspondence: sab_us@mail.ru

ABSTRACT
Based on the results of a comprehensive interpretation of the anomalous gravitational field of the Zirabulak-Ziaetdin region, a large brachiform geophysical structure spatially coinciding with the occurrence of rocks of the Katarmay Formation was identified for the first time. An analysis of the anomalous field morphology, horizontal gravity gradients, and their relationship with the geological structure of the region was performed. It was established that the area of minimum horizontal gradients corresponds to the relatively homogeneous core of the paleovolcanic edifice.

Keywords: *gravitational field, brachiform geophysical structure, paleoseamount, Katarmay Formation, Zirabulak-Ziaetdin region, Turkestan paleo-ocean.*

INTRODUCTION

The Southern Tian Shan is one of the largest accretionary-collisional systems in Central Asia, where fragments of oceanic crust, island arcs, and intraplate volcanic constructs are widespread. Despite a significant amount of geological research, the origin of the Katarmay Formation has remained controversial until recently (Sadikova *et al*, 2022).

Most researchers considered it to be a Devonian volcanosedimentary sequence. However, a combination of geological, lithological, petrophysical, and geophysical data suggests that the Katarmay Formation represents a preserved fragment of an oceanic volcanic island (paleoseamount) formed in the Turkestan paleo-ocean (Sadikova *et al*, 2025)

Of particular interest is the gravitational field of the region, which reflects the depth-related density distribution of rocks and allows for the reconstruction of ancient volcanic morphostructures.

MATERIALS AND METHODS

Morphology of the gravitational field and identification of the brachiform geophysical structure.

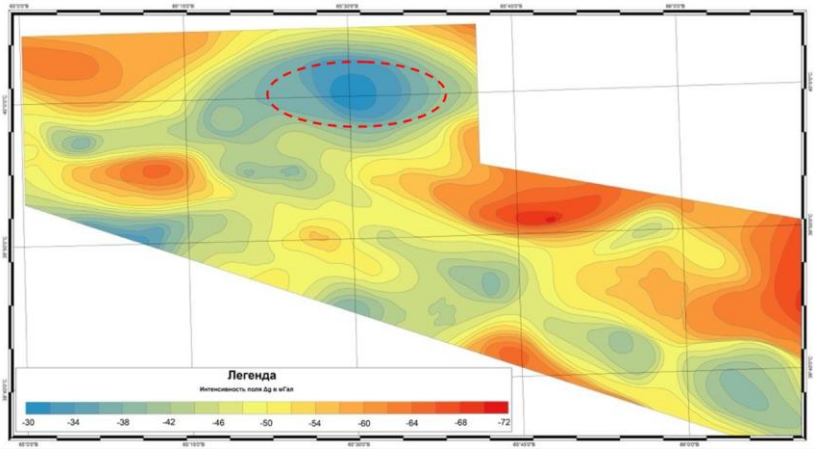

Figure 1: Digital gravity map of the Zirabulak-Ziaetdin region, scale 1:200 000

— — —	outline of the paleoseamount fragment (Katarmay Formation)

To analyze the deep structure of the Zirabulak-Ziaetdin region, a digital map of the anomalous gravity field at a scale of 1:200,000, combined with a digital geological map of the same scale, was generated in ArcGIS 10.5. The anomalous gravitational field is characterized by a complex heterogeneous structure, varying within approximately 42 mGal (from –30 to –72 mGal), which indicates a significant density heterogeneity in the upper crust of the study region (Figure 1).

Analysis of the map demonstrates that the territory is characterized by a pronounced block-zonal structure and high tectonic fragmentation. The gravity field exhibits a system of linear anomalies with predominantly sublatitudinal and northeast strikes, whose spatial orientation aligns well with the regional tectonic structures of the Southern Tian Shan and reflects the influence of deep fault zones.

In the northern part of the study area, there is a prominent zone of relatively high gravity field values ranging from -30 to -40 mGal, represented by a large isometric negative anomaly. The formation of this zone is associated with the development of low-density rocks caused by intense tectonic reworking, decompaction, and widespread occurrence of siliceous-carbonate, terrigenous, and volcanosedimentary sequences. Comparison of the gravitational and geological fields demonstrates that this anomaly spatially corresponds to the occurrence area of the Katarmay Formation rocks. The largest local minimum, situated in the north-central part of the area, likely reflects a deep-seated zone of prolonged fluid impact accompanied by hydrothermal and metasomatic rock transformations.

The central part of the region is characterized by intermediate gravity values ranging from -44 to -54 mGal. Alternating local positive and negative gradients are observed here, reflecting blocky structure and the presence of local density heterogeneities.

The most intense negative anomalies are confined to the eastern part of the study area, where an extensive sublatitudinal zone with values of -64 to -72 mGal stands out. Local minima reach -70 to -72 mGal. Such anomalies may be caused by a combination of deep decompaction zones, major tectonic disruptions, and intensely hydrothermally altered rocks.

The southern part of the region is characterized by alternating local gravity minima and relative maxima ranging from –40 to –68 mGal, which reflects a complex combination of lithological complexes of different ages and tectonic blocks.

Of particular interest is a large brachiform geophysical structure, identified for the first time within the Zirabulak-Ziaetdin region based on gravity data (Fig. 1). In this work, a brachiform geophysical structure is defined as a local geophysical anomaly of rounded or oval-isometric shape, characterized by a concentric distribution of physical fields.

In the anomalous gravitational field, the Katarmai Formation is expressed precisely by such an oval-isometric shape structure. Its morphology is characterized by a central region of relatively elevated values of the gravitational field (-30...-34 mGal), gradually moving to the periphery into zones of more negative values. Such a concentric distribution indicates the heterogeneous structure of the density model and reflects the internal architecture of the geological object.

A comparison of the gravitational field with geological data shows that this structure spatially coincides with the area of the Katarmai Formation.

Based on the results of lithological-stratigraphic, petrogeochemical, and geodynamic studies, it is interpreted as a geophysical reflection of an accreted fragment of an oceanic volcanic island (paleoseamount) formed under the conditions of intraplate oceanic magmatism of the Turkestan Paleocean.

The central part of the brachiform structure corresponds to the most intensively processed zone of the ancient volcanic structure, where the processes of tectonic crushing, hydrothermal-metasomatic transformations, calcification and local decompression of rocks are widely developed. The peripheral areas reflect the transition to the slopes of the paleoseamount, composed of alternating volcanogenic, siliceous-carbonate and terrigenous formations, characterized by more contrasting density characteristics.

The concentric morphology of the gravity anomaly aligns well with the reconstructed dome-like shape of the ancient volcanic structure and demonstrates the preservation of its main morphostructural elements, despite subsequent accretionary-collisional processes, regional metamorphism, and intense tectonic dislocation.

The Katarmay Formation is represented by a thick volcanosedimentary sequence over 3000 m thick, traceable for more than 20 km within the Ziaetdin Mountains and forming an elongated belt in the Zirabulak Mountains (Figure. 2).

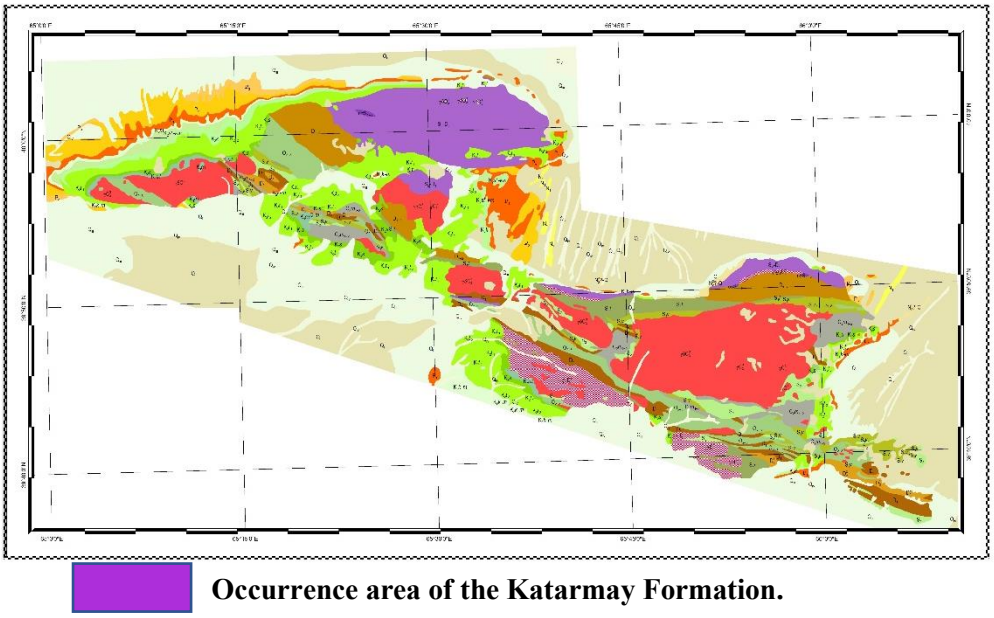

Figure 2: Digital geological map of the Zirabulak-Ziaetdin region, scale 1:200 000.

It is characterized by the predominance of pyroclastic rocks over effusive ones. The main volume of volcanites is represented by ash tuffs, whereas agglomerate tuffs, volcanic breccias, lavas and tufolaves are developed to a limited extent and are confined to paleovolcanic centers (Dalimov, Ganiev,2010). A distinctive feature of these centers is the increased content of magnetite (up to 3%). Basalts predominate among the effusive rocks, while ankaramites account for about 10% of the total thickness of the volcanogenic stratum (Mikhailov 2000; Korsakov, Mushkin,1971; Stratigraphic Dictionary of Uzbekistan,2001).

According to the petrochemical characteristics, the metabasalts of the Katarmai Formation belong to the tholeiitic series. The geochemical interpretation based on the La/Yb -Th/Nb and TbN/NbN diagrams indicates their formation under conditions of intraplate oceanic magmatism associated with the development of an OIB-type oceanic island. The analysis of the stratigraphic sequence of the sections and the established cyclicity of volcanogenic-sedimentary accumulation made it possible to reconstruct the structural model of the paleomorphostructure of an oceanic volcanic island (Sadikova *et al*, 2025)

The results of a comprehensive analysis of gravimetric and geological data make it possible for the first time to identify a large brachiform geophysical structure within the Zirabulak-Ziaetdin region, corresponding to the area of the Katarmai Formation. The combination of geophysical, lithological, stratigraphic, and geochemical features makes it possible to interpret it as an accreted fragment of an oceanic volcanic island (paleoseamount) of the OIB type, which retained the main elements of its primary morphology despite the subsequent accretion-collision evolution of the region.

RESULTS AND DISCUSSION

According to gravimetry data, for the first time, a large brachiform geophysical structure has been identified within the Zirabulak-Ziaetdin region, spatially coinciding with the area of the Katarmai Formation.

The morphology of the anomalous gravity field reflects the complex block-zonal structure of the region, controlled by a system of deep faults of the sublatitudinal and northeastern strike.

The combination of gravimetric, lithological-stratigraphic, petrogeochemical, and geodynamic data makes it possible to interpret the selected structure as an accreted fragment of an oceanic volcanic island (paleoseamount) of the OIB type formed in the Turkestan Paleocean.

The identified brachiform geophysical structure can be considered as a new geophysical criterion for the reconstruction of paleovolcanic structures and a promising prospecting feature in forecasting ore-bearing objects in the Zirabulak-Ziaetdin region.

REFERENCES

Sadikova LR, Rakhimov AD (2022). Historical review and current state of stratigraphic studies of the Zirabulak-Ziaetdin Mountains. *Geology and Mineral Resources*, **6**, 22-27.

Sadikova LR, Rakhimov AD, Usmanova SA (2025). Paleomorphostructure of the intraplate oceanic magmatism of the Zirabulak-Ziaetdin region. Geology and Mineral Resources, **5**, 3-11.

Dalimov TN, Ganiev IN (2010). Evolution and types of magmatism of the Western Tianshan. Tashkent: University, 227 pp.

Mikhailov VV (2000). Ankaramite–trachybasalt formation of the Ziaetdin Mountains and its ore potential. In Abstracts of the Conference "Petrology and Ore Formation of Magmatic Formations of Folded Regions". Tashkent: University, 96–98.

Korsakov VS, Mushkin IV (1971). Olivine–basalt association of volcanic rocks of the Zirabulak–Ziaetdin Mountains (Southern Tianshan). Reports of the Academy of Sciences of the USSR, **Vol. 197**, No. 5, pp. 1137–1140.

Stratigraphic Dictionary of Uzbekistan (2001). Edited by Z.M. Abduazimova. *Proceedings of the Institute of Mineral Resources. Tashkent: GIDROINGEO*, 580 pp.