New Data on the Morphology and Geological Structure of the Gramberg Guyot (Magellan Seamounts, Pacific Ocean)

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Abstract—The geological–geophysical studies carried out in the western part of the Pacific Ocean by the State Research Center “Yuzhmorgeologiya” during cruises of the R/V “Gelendzhik” in 2002–2004 yielded new data on the relief of the Gramberg Guyot and its constituting rocks, which appeared to be Early Cretaceous to Pleistocene in age. The analysis of macro- and microfaunal remains in sedimentary rocks made it possible to define the transgressive phases in the development of seamounts (the Cenomanian–Turonian, Late Campanian–Maastrichtian, and Late Cenozoic). The geological development of the Gramberg Guyot is compared with that of other similar structures of the Magellan Seamounts.

Key words: guyots, Cretaceous, Cenozoic, Magellan Seamounts, West Pacific.

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INTRODUCTION

The Gramberg Guyot occupying the easternmost position in the Magellan Seamounts chain (Fig. 1) is one of the best studied structures in this system. Its knowledge degree is inferior only to that of the Fedorov, Ita Mai Tai, and Alba guyots.

Prior to its official naming after I.S. Gramberg in 2004, this structure was mentioned in publications as MZH-36 and the Roskomnedra Guyot [12, 13, 17–19].

The study of the guyot was conducted by vessels of the Marine Geological Survey of Russia during the terminal 20th–initial 21st centuries. In 1991, complex geophysical studies, including single-beam echo sounding, continuous seismoacoustic and hydromagnetic profiling, were performed during the cruise of R/V Sevmorgeologiya. In 1995, the same research vessel renamed the Dal’morgeologiya accomplished complex geological–geophysical works, which included hydroacoustic and phototelevision profiling and geological sampling of the bottom by dredges. These works were accompanied for the first time by drilling operations on seamounts using a special submersible drilling rig. They yielded general information on the geological structure and ferromanganese and phosphate mineralization of the guyot. The results of these studies have never been completely published, but some of them were considered in several publications [4, 11–13, 17–19].

During the cruises of R/V Gelendzhik carried out in 2002–2004, the scientists from the State Research Center Yuzhmorgeologiya accomplished a multibeam bathymetric survey of the guyot, its phototelevision profiling, geological sampling by dredges, and drilling several shallow boreholes. The results of these studies served as the basis for this paper.

METHODS

The works were conducted during two cruises: Cruise 6-02, which consisted of two phases (August–September of 2002, chief of expedition B.A. Shirokozhukhov; January–March of 2003, chief of the expedition D.D. Tugolesov), and Cruise 6-03 (September–December of 2004, chief of the expedition D.D. Tugolesov). Captain B.V. Petropavlovskii headed the crew in both cruises. An EM12 S120 Simrad multibeam echo sounder was used for the bathymetric survey. The phototelevision profiling was performed using Neptun-D equipment. The geological works included bottom sampling with box-shaped dredges and drilling shallow boreholes using a special submersible rig (GBU-1/4000-2).

In total, the complex geophysical and phototelevision observations in the guyot area were conducted along profiles >1400 and >350 km long, respectively. The geological bottom sampling included dredging at 69 stations and drilling shallow holes at seven sites. These works were accompanied by the lithological and petrographic description of hundreds samples of sedimentary and volcanogenic–sedimentary rocks. For 43 samples, a complex biostratigraphic study was performed with the analysis of planktonic and benthic for-
aminifers, calcareous nannoplankton, corals, and mollusks.

BOTTOM TOPOGRAPHY

Reliable information on the bathymetry and bottom topography is important for geological studies in the ocean. The survey performed with the multibeam echo sounder yielded the data necessary for compiling a detailed bathymetric chart (scale of 1: 200000).

The Gramberg Guyot is an isolated edifice that terminates the Magellan Seamounts chain. The guyot is contoured by the 5800 m isobath and surrounded on all sides by isolated compensated depressions with the position of the basis surfaces at depths of 6000–6050 m (Fig. 2). In the above-mentioned contour, the guyot base is almost isometric (66 × 58 km or approximately 3500 km$^2$ in size). Its structure is complicated by four radial spurs 30.5, 19.5, 29.0, and 29.5 km long oriented in the northeastern, eastern, southeastern, and southwestern directions. The spurs are distinguishable in the marginal parts of the guyot summit, being traceable to depths of 5000–5600 m, except for the southwestern one, which is traceable to a depth of 6000 m. In the near-summit areas in the depth interval of 1550 to 1875 m, the surfaces of the spurs are complicated by terraces.

The minimal water depth of the guyot (1215 m) is registered in the central part of its summit. The seamount towers above the bottom for 4600 m. Its plateau, which repeats the plane configuration of the base, is located at depths of 1225–1575 m, being 31 × 19 km or approximately 410 km$^2$ in size. The edge of the plateau is readily traceable owing to a sharp bend at the transition between the near-horizontal surface of its summit and the steep upper part of the slope. The areas where the spurs join the plateau are characterized by the gradual transition of the latter into wide terraces, which are traceable further to the ridge surfaces of all the spurs. The central part of the plateau is inclined at angles of 0–2°, while the surfaces of the remaining areas of the guyot are characterized by dip angles of 2–4°. In the southeastern part of the plateau, the base of the southeastern spur hosts a gentle dome-shaped structure with a maximal size of 2.0 × 1.3 km and approximately 50 m high.

The guyot slopes demonstrate a convex–concave profile with deep angles ranging from 4 to >25°. They are convex in the upper part between the edge of the plateau and depths of 2600–4200 m. The dip angle decreases gradually from >25 to 15–20°. In the central part of the slope at depths of 3000–4500 m, the dip angles amount to 10–12°. In the lower concave part of the slope located at depths of 4500 to 5500 m, the slope surface is inclined at <10°.

The slopes are complicated by various relief mesoforms such as volcanic cones and domes, ridges, terraces, steps, and scarps. Unlike the other guyots of the Magellan Seamounts [9, 10], the cones, domes, and ter-