

The real diameter of the Neugrund impact structure (Gulf of Finland, Estonia)

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Abstract

The Neugrund impact structure is located on the southern side of the entrance of the Gulf of Finland (59°20' N, 23°31' E), immediately eastward of the Osmussaar Island (in Swedish Odensholm, what means Odin's Grave in English). The Neugrund impact structure was formed in Early Cambrian (about 535 Ma) as the result of impacting a chondritic asteroid about 1 km in diameter.

The Neugrund impact structure is the world's best preserved meteorite crater in the sea, because almost all of its structures are preserved, exposed partly on seabed and they are easily accessible for the researchers. Neugrund is a complex meteorite crater about 19 km in diameter. In the center of the structure emerges the inner crater with quite narrow (ca 200 m) rim wall, which has about 6,5 km rim-to-rim diameter. The presence of central peak (uplift) in the crater, deep about 5,5 km diameter, is not proven. The 4–5 km wide terrace or zone of dislocations surrounds the inner crater.

The real diameter of the Neugrund impact structure has been under discussion since of revealing of the meteoritic origin of the structure in 1995. Several dimensions has been proposed, as 7 up to 20 km. Considering methodology used for determination of diameter of the quite similar impact structures (Gosses Bluff in Australia Ma 14,5 and Ries Nördlingen in Germany Ma 14,5), ratio of diameter of the structure to the inner crater is approximately 3 km (accordingly 22 to 6 km and 24 to 8 km). In both cases, as by the Neugrund case, the limit of the structure is not clearly developed. In the Neugrund case the outer limit of the impact structure is marked by the unclearly developed ring fault outer which the sedimentary target rocks of the structure are intact. It follows from the foregoing dimensions of the

Neugrund impact structure: rim-to-rim diameter of the inner crater – 6,5 km; diameter of the impact structure – 19 km, ratio of diameter of the structure to the diameter of the inner crater – 2,9.

Seismic reflection profiling (SRP) was one of the most commonly applied methods in investigation of the submarine Neugrund impact structure and it was the first method that cleared up the elements of the partially buried impact structure. The filtered bands 250–500 Hz were more suitable for revealing deeper buried bedrock layers and for surface of crystalline basement rocks, while filtered band 4 kHz was used for observing the buried bedrock surface under the Quaternary deposits and for revealing the details inside the latter. A disturbing circumstance was presence of thicker layers of Quaternary deposits containing gas (especially varved clays), which could not be penetrated by the wave of higher frequency bands (4 kHz).

Simultaneously with SRP the side-scan sonar (SSS) profiling was carried out for studding sea floor topography and a certain amount its sediment composition were surveyed within 100–400 m wide band. By the SSS profiling was established origin of the mega-blocks consisting of crystalline basement rocks and giant erratic boulders discovered in rather deep (more than 50 m) sea within the Osmussaar Deep westward of the Neugrund Bank and on other sites. The intensity of rebounded beam made possible deciphering lithological composition of a seabed.