Giant Subaqueous Dunes on a Tideless Sea Bottom, Rozewie Bank, Southern Baltic

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ABSTRACT: A series of giant sand waves, upwards of 1000 m in wavelength and 10 m in height, have been observed on a 30–40 m deep bottom located approx. 20 km north of Cape Rozewie. Waves of this size have not been previously noted in the Baltic Sea. Their morphology and structure indicate that they were formed under a constant deposition from a flow with a speed of up to 1.0 m/s and with a rich supply of sandy bed load. Such conditions may be related to bottom currents caused by undulations during very strong storms. A multibeam echosounder, side-scan sonar, and bottom profiler were used, and scoop and core samples were also collected. The aim of the study was to indicate that sand waves can also appear on tideless sea bottoms, and to underline the scientific and practical importance for research on the structure and morpholithodynamics of the bottom and of water body hydrodynamics.

1. GENERAL INFORMATION

The morphology and structure of well-developed giant sand waves were analysed based on data collected between 2006 and 2012 from a 5x10 km research site. The site (Figure 1) is located in the sandy Rozewie Bank, which constitutes the eastern part of a vast erosion – aggradation platform stretching from the Słupsk Bank to the Gdańsk Basin.

The obtained results, together with general knowledge of the studied area (e.g. Mojski 1995, Uścinowicz 2012), allowed for initial conclusions regarding the origin and the dating of these forms (Questions included: Were they extant or contemporary forms? And were they the result of marine, fluvoglacial, or river processes?).

The study used integrated systems for non-invasive registering, primarily with a multi-beam echosounder (Reson Seabed 8101), a side-scan sonar (EdgeTech 4200), and a seismic bottom profiler (SIG Energy boomer). Also used were the results of granulation analyses of the sediments from samples obtained using a scoop and a vibration probe. A DGPS integrated with a specialised system for underwater navigation enabled precise positioning.

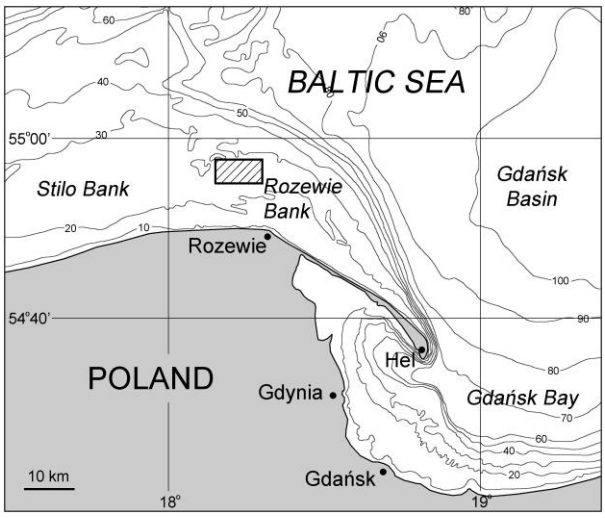

Figure 1. Location of the study area.

2. RESULTS

The studied forms showed a surprisingly recent morphology (Figure 2). Their crests were asymmetric in the cross-section: with longer, mild western slopes; and shorter, steep eastern slopes. The crest lines were slightly curved in a wave-like manner. Similarly shaped but smaller forms with a wavelength of up to 100 m and a height of up to 2 m were also present on the proximal slopes. The structure of the waves showed a two-part series of diagonally stratified, unimodal, sorted, and mostly undifferentiated medium sands. The series was divided by a surface of unconformity, with coarse sands and pebbles. A similar layer of pavement was also present in the bedrock of the sandy series, on the erosion surface that sheared the marginal wetland sediments (loams and silts) and/or tills.

Similar subaqueous dunes from the bottom of the North Sea are known to be formed by strong tidal currents (vide Ashley 1994, Berne et al. 1994, Brew 1996). However, the Baltic is a tideless sea, and thus the sand waves present in the area must occur due to other causes. The morphology and structure of these waves indicate that they were formed (after Einsele 2000) under a constant redeposition, related to a relatively constant flow at between 0.5 to 1.0 m/s, with a rich supply of sandy bed load and a generally weak erosion of the bottom. Model-based research indicates the possibility that bottom currents with a speed of 0.5–1 m/s, related to storm waves over 40 m in length, may be occurring in the area. The recentness of the morphology and the generally unimodal (except for the erosion pavements) granulation constitute primary evidence against the hypothesis that the studied forms may be relics (e.g. the extant fragments of a former riverbed, an outwash plain, or berms).

3. CONCLUSIONS

Giant sand waves may occur on the bottom of tideless seas. They may be formed not only by tide currents, but also by currents related to undulation. Determining the state of the sand waves has a scientific and a practical importance for research on the structure and morpholithodynamics of the bottom and for the hydrodynamics of a water body, as well as for the assessment of environmental conditions (e.g. during the exploitation of resources or the installation and use of hydrotechnical equipment, cables, pipelines, etc.).

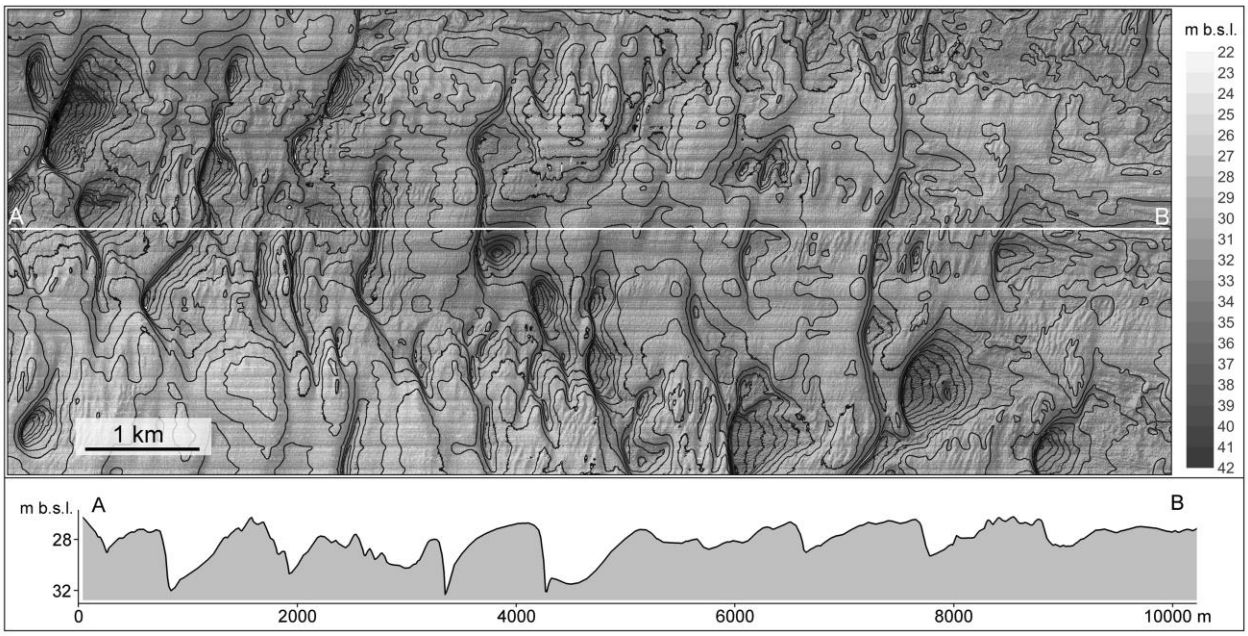

Figure 2. Bathymetric map of the research area and its bathymetric profile.

4. REFERENCES

Ashley, G.M. 1989. Classification of large-scale subaqueous bedforms a new look at an old problem. J. Sed. Petrol. 69: 160—172.

Berne, S., Trentesaux A., Missiaen T., de Batist M. 1994. Architecture and long term evolution of a tidal sandbank: the Middelkerke Bank (Southern North Sea). Marine Geology, 121: 57-72.

Brew, D.S. 1996. Late Weiselian to early Holocene subaqueous dune formation and burial off the North Sea Northumberland coast. Marine Geology134: 203-211.

Einsele, G. 2000. Sedimentary Basins. Springer, Berlin, 792 pp.

Mojski, J.E. 1995. Geological Atlas of the Southern Baltic. Polish Geological Institute, Warszawa.

Uścinowicz, S. 2012. Continental Shelf of Baltic Sea. (in) Chiocci F. & Chivas A. (eds) Continental Shelves.