

Giant Mudwaves in the NW Argentine Basin (South Atlantic)

Dmitry Borisov¹, Ivar Murdmaa¹, Elena Ivanova¹ and Oleg Levchenko¹

¹ P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russia. dborisov@ocean.ru

Abstract: A large field of giant mudwaves was mapped in the NW Argentine Basin for the first time. The field is subdivided into buried and surficial part affected by different circulation patterns. It is suggested that global changes in climate and bottom circulation resulted in formation and burial of several mudwave “generations” revealed in the study area.

Key words: contourites, bottom currents, Antarctic waters, continental rise, South Atlantic.

INTRODUCTION/BACKGROUND

Mudwaves are widespread on the Argentine Basin characterised by a highly dynamic oceanographic regime. The mudwave fields in the southern and central part of the Basin are well studied while those in the North remain poorly understood (Flood and Shor, 1988).

This work characterizes a new large field of giant mudwaves in the NW Argentine Basin. The field ranges from 3400 to 4000m water depth. It partly covers the Santa Catarina Plateau (SCP) and extends into the Santos Basin. Bottom circulation in the study area is generally controlled by water of Antarctic origin, the Lower Circumpolar water (LCPW) that extends below 3500m water depth. (Morozov et al., 2010) (Fig. 1). Above the LCPW the North Atlantic Deep Water (NADW) is identified.

DATA AND RESULTS

The mudwave field has been mapped on base of very high resolution seismic profiles (4kHz) and multibeam data. Seismic profiles revealed that mudwaves are not only confined to the seafloor, also buried (draped) mudwaves can be identified within the sediment column down to 60m below the seafloor, in the northern part of the field. The wave field covers about 42000km² of the sea-floor (~35000km² excluding buried area).

The surficial mudwaves represent roughly symmetric sediment mounds with wave heights of 10 to 60m, wavelengths of 2–5km and a crest length up to 30km. No migration evidence is observed. The crest lines of the waves are sinuous and often bifurcated. Mudwaves are oriented with their long axes in NW-SE direction at an angle of 5° to 45° respect to regional contours. The biggest waves are found on the SCP slopes (Fig 2.A). Wave height decreases toward the plateau summit and to the centre of the Santos Basin. Buried mudwaves are overlapped by acoustically stratified deposits with roughly horizontal parallel high-amplitude reflectors (Fig. 2B).

The base of the southern plateau slope is mostly characterized by chaotic seismic facies with hummocky relief (Fig. 2A).

Four sediment cores were retrieved (during cruises 33, 43, RV “Akademik Ioffe”; cruise M29/2, RV “Meteor”). They indicate that surface sediments are generally composed of muddy contourites. Cores from the buried area recovered in their upper parts a 26-cm thick turbidite sequence (GeoB2112-3, 4010m; Bleil et al., 1993) and a thick layer of homogenous muds interpreted as hemipelagites (AI-3153, 4030m). A core collected on the northern slope of the SCP (AI-3154, 3592m) contains numerous thin silt-enriched layers and that one retrieved from the plateau summit (AI-2443, 3410m) is characterized by muddier sediments. All the cores recovered Pleistocene deposits in their lower parts (as inferred from the planktic foraminiferal data). A preservation of foraminifera test varies along the cores with some intervals of strong test dissolution.

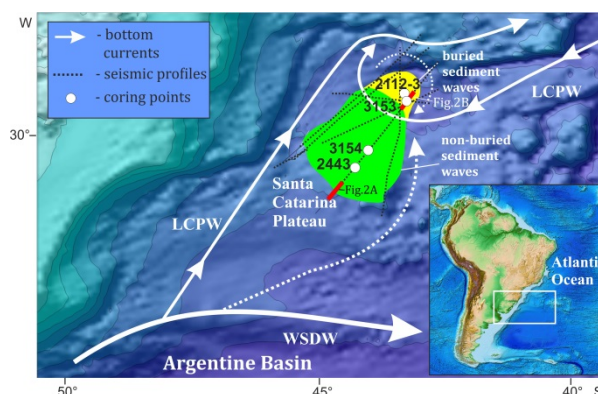


FIGURE 1. Bathymetric chart of the study area with sketched regional bottom circulation and location of mudwave field, coring points and seismic profiles. LCPW – Lower Circumpolar Water; WSDW – Weddell Sea Deep Water.

DISCUSSION

Symmetric shape of mudwaves suggests either low current velocities insufficient to produce migrating features or interplay between contour and internal tidal currents (which are internal waves with tidal periodicities (Dykstra et al., 2012)). Formation of giant mudwaves implies long-term quasi-persistent action of high-velocity flow (Flood and Shor, 1988). It means that

the first suggestion is incorrect. Internal waves occur on the density boundary between waters of Antarctic and North Atlantic origin. A transition zone between these waters affects the slopes of the SCP. Wave height and grain-size variations indicate also topographic control of flow velocity. The SCP as a large topographic obstacle causes turbulence and a flow velocity increase.

Bedding patterns typical for internal tide deposits were not observed in cores. Deposition of contourites in the study area is related to bottom currents of Antarctic waters and their interface with the waters of North Atlantic origin.

The buried part of the mudwave field is embraced by a large gyre formed by a return branch of the LCPW (Fig. 1). Mudwave burial is a result of increased deposition of contourites in the centre of the gyre. During the last deglaciation an intensity of the LCPW return branch decreased due to lower production of the Antarctic waters. It led to domination of hemipelagic settling and deposition of hemipelagites recovered by the core AI-3153. This suggestion does not contradict to planktic foraminiferal data.

Seismic profiles RC1605, RC1610 revealed several generations of buried mudwaves underlying the modern wave field. It means that evolution of the observed deposition system is a cyclic alternation of sediment wave formation and burial. Such alternation is considered to be related to global changes in bottom circulation and climate.

CONCLUSIONS

Formation of the giant non-migrating mudwaves is controlled by sea-floor topography, strong bottom and internal tidal currents.

Mudwave burial is a result of contourite deposition in the centre of the large gyre formed by the return branch of the LCPW. Global changes in bottom circulation and climate in the past could result in a cyclic alternation of mudwaves formation and burial.

ACKNOWLEDGEMENTS

Many thanks to J. Hernandez-Molina for critical comments. The study is partly supported by RFBR, research project No. 14-05-31357.

REFERENCES

- Bleil, U. et al. 1993. Report and Preliminary Results of METEOR Cruise 23/2, Rio de Janeiro – Recife, 27.02.–19.03.1993. Berichte, Fachbereich Geowissenschaften, Universität Bremen 43, pp. 133.
- Dykstra, M. 2012. Deep-Water Tidal Sedimentology. In Davis, R.A., Dalrymple, Jr. and R.W. (eds.), Principles of Tidal Sedimentology. Springer Science+Business Media B.V. 371-395.
- Flood, R.D., Shor A.N. 1988. Mudwaves in the Argentine Basin and their relationship to regional bottom circulation patterns. Deep-Sea Research I 35, 943-971.
- Morozov, E.G., Demidov, A.N., Tarakanov, R.Y. et al. 2010. Abyssal Channels in the Atlantic Ocean. Springer, Dordrecht, pp. 256.

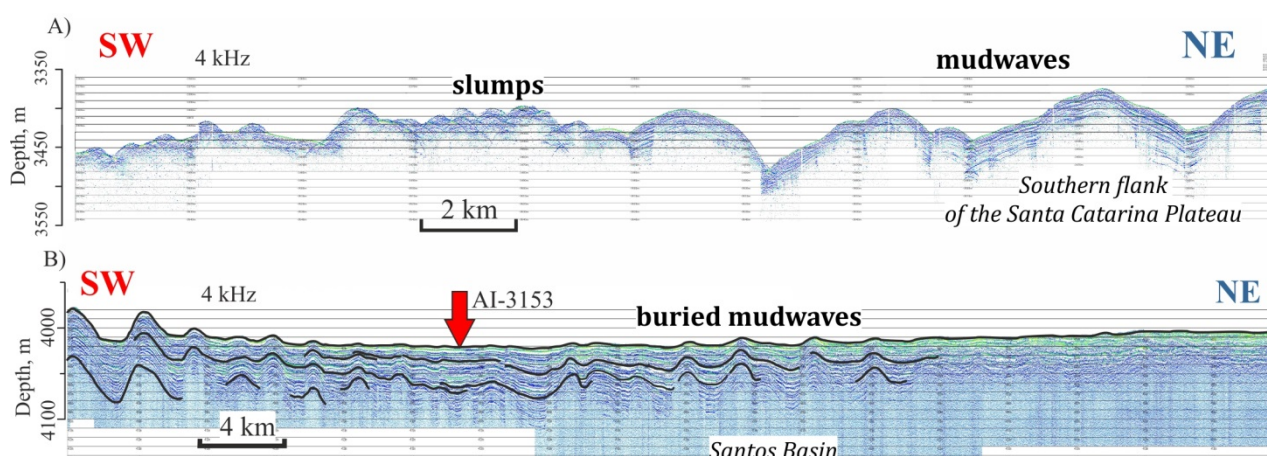


FIGURE 2. Fragments of very high resolution seismic profiles: A) sediment waves on the southern slope of the Santa Catarina Plateau; B) draped and buried mudwaves in the Santos Basin. Location of the seismic profiles shown on Fig. 1.