BEDFORMS ACROSS A SANDY-GRAVEL CONTINENTAL INNER SHELF, MARETTIMO ISLAND (EGADI ISLANDS; SOUTHERN-WESTERN TYRRHENIAN SEA)

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Abstract

Side scan sonar data were recorded across Marettimo island inner shelf (Egadi Islands; southern-western Tyrrhenian sea). The distribution and morphological characteristics of bedforms were analyzed across this sandy gravel inner shelf to examine possible forcing mechanisms. It is discussed that these morphological features could be produced by waves of period higher than 8 s and/or medium-high velocity bottom currents.

Keywords: gravel and sandy bedforms; inner shelf; waves and currents

Introduction

Inner shelf gravel bedforms have been observed in a number of shelves around the world (1, 2, 3). In the Mediterranean, few studies deal with bedforms on sandy gravel shelves: Kenyon and Belderson (4) described coarse sand sandwave across Spanish and Moroccan shelves and Lykousis (5) observed coarse megaripple in the Aegean Sea. The sedimentary processes able to generate gravel bedforms in moderate-energy environments like the Mediterranean are unclear from previous studies. However, it is relevant to know if these bedforms are relict features that correspond to episodic/catastrophic events occurred in the past or, in contrast, they can be generated by present day processes.

In this study, bed features have been recognized, measured, described and digitally mapped. The aim of this work is to reconstruct which are the forcing processes that could generate them.

Methods

Side scan sonar records range in water depths of 10-60 m and have been obtained during a cruise around the Egadi Island offshore. The instrument was a chirp technology side scan sonar, model SIS 1500 (Benthos-Datasonics), operating at 100 kHz.

Sea bed samples were recovered by mean a Van-Veen grab sampler. Calibration by dives was effectuated for collecting further sedimentological data and observing sedimentary structures dimensions.

Bedforms and their distribution

Data analysis revealed the presence across the inner shelf of symmetrical coarse grained subaqueous dunes and elongated small sand patches. Bed forms can be defined as small subaqueous dunes *sensu* Ashley (6). They are observed all over the inner shelf, from 15 to 50 m depth, and range from 1 to 2.2 m in wavelength and from 0.15 to 0.30 m in height. These bedforms are formed in sandy-gravel areas with modal grain sizes ranging from 2 to 11 mm. The biggest dunes appear at 25-35 m water depth, their orientation is almost parallel to the coast (35° E) and the sediment displays a medium grain size of 8-11 mm.

Sand patches have been observed in a small area of the north eastern sector of the inner shelf. They develop from 40 m to the maximum depth of the survey coverage (60 m approx.), in a main direction perpendicular to the coast. Their width varies from 50 to 150 m and the sediment corresponds to sinuous bands of medium sand over a gravel and sandy gravel area.

Discussion about forcing mechanisms for the formation of the subaqueous dunes

Theoretical estimation using different hydrodynamic conditions (waves and currents) have been effectuated to investigate over the forcing mechanisms that generated the observed small subaqueous dunes.

Starting from hypothetical waves conditions (height ranging from 3 to 6 m; period raging from 7 to 11 s), applied to different grain sizes sediments (2, 5, 10 mm), theoretical dune dimensions (7, 8) have been obtained (Fig. 1). For a depth interval of 10 - 70 m, bedform wavelength (λ) values range from a minimum of 0.5 m to a maximum of 4 m. No relevant differences were observed in the resulting dimensions of sedimentary structures using grain sizes from 2 to 10 mm.

Threshold conditions for sediment movement based on the critical Shields parameter (θcr) values (9) have been obtained for different grain sizes (1-10 mm),. The corresponding critical velocities values (uz cr) at 1 m above the bottom (10), reveal how the critical values for sediment moving ranges from 0.56 to 1.85 m/s for grain sizes of 1 to 10 mm respectively.

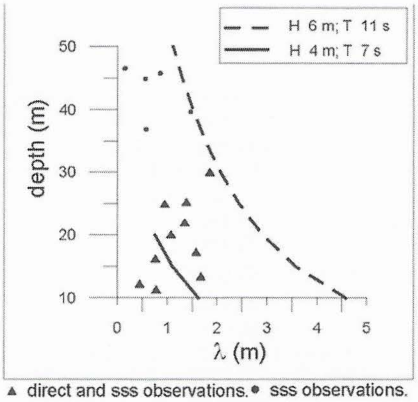

Fig. 1. Bedform spacing (λ) (8) for different waves conditions compared to Marettimo sub. dunes. Theoretical equations have been applied to 2 mm grain size sediments.

The wavelength of the Marettimo subaqueous dunes are comprised within interval obtained by theoretical formulas. Most of the observed dunes could have been formed with the presence of waves ranging from 4 to 6 m in height and 7 to 11 s in period. These conditions can be reached during strong NW storms that episodically occur on the north-western Sicilian continental shelf (11). Sand patches can develop with the presence of moderate velocity bottom currents (< 50 cm/s).

Conclusions

Comparison between observed dunes with theoretical estimations of bedform characteristics generated under different hydrodynamic conditions, suggests that most of bedforms observed on the Marettimo inner shelf can be caused by waves of 4-6 m in height and 7-11 s in period. Therefore, dunes are active morphological features only during major storms and are relict bedforms for most of the time.

References

1 - Langhorne D.N., Heathershaw A.D., Read A.A.,1986. Gravel bedforms in the West Solent, Southern England. *Geo Mar. Lett.*, 5: 225-230.
2 - Forbes D.L., Boyd R., 1987.Gravel Ripples on the inner Scotian Shelf. *Jour. Sed. Petrology*, Vol. 57, 1: 46-54.
3 - Anthony D., Leth J.O., 2002.Large-scale bedforms, sediment distribution and sand mobility in the eastern North Sea off the danish west coast. *Mar. Geol.*, 182: 247-263.
4 - Kenyon N.H., Belderson R.H., 1973. Bed-forms of the Mediterranean undercurrent observed with side-scan sonar. *Sedim. Geo.*, 9: 77-99. -172.
5 - Lykousis V., 2001. Subaqueous bedforms on the Cyclades Plateau (NE Mediterranean) – evidence of Cretan Deep Water Formation? *Cont. Shelf. Res.*, 21: 495-507.
6 - Ashley G.M., 1990. Classification of large scale subaqueous bedforms: a new look at an old problem. 1997 SEPM Bedforms and bedding structures research symposium, Austin, TX. *Jour. Sed. Petrology,* Vol. 60: 160-172.
7 - Grant W.D., Madsen, O.S., 1982. Moveable bed roughness in unsteady oscillatory flow. *J. Geophys. Res.*, 87: 469-481.
8 - Nielsen P., 1992. Coastal Bottom Boundary Layer and Sediment Transport. World Scientific Publishing, Singapore, Advanced Series on Ocean Engineering, vol. 4.
9 - Soulsby R. L. & Whitehouse R. J. S. W., 1997. Threshold of sediment motion in coastal environment. Proc Pacific Coasts and Ports '97 Conf. Christchurch, 1, pp 149-154. University of Canterbury, New Zealand.
10 - Soulsby R.L., 1997. Dynamics of marine sands. Thomas Telford editions. London.
11 - Istituto Idrografico della Marina, Genova, 1979. Il vento e lo stato del mare lungo le coste italiane e dell'Adriatico. Vol III, IIM editions.