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Reson SeaBat 8125 backscatter data as a tool for seabed characterization (Central Mediterranean, Southern Italy): Results from different processing approaches

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ABSTRACT

Acoustic methods for seafloor mapping have been widely developed over the last decades. In particular, the development of swath bathymetry has allowed the creation of detailed maps of seabed topography and acoustic backscatter data; these data have been used to infer sediment and habitat types. In this paper the capability of Multi-Beam Echo Sounder (MBES) system data to distinguish different seabed types in a site in the Tyrrhenian Sea (Mediterranean) is evaluated; dataset used includes bathymetric data and backscatter intensity, with the support of sediment samples and scuba investigations. The Reson SeaBat 8125 MBES system provides bathymetric and backscatter data. The backscatter data are stored both as Sidescan-like data (intensity values produced by an averaging process) and Snippet data (a time-series of intensity values for each beam). The processing of these acoustic data belongs to a relatively new field of research: the aim of this paper is to show two different processing approaches, and discuss the produced output. The mosaic of images from the Sidescan-like and Snippet data are statistically analyzed, in order to highlight the resolution of the Snippet when dealing with acoustic facies and the correlation existing between granulometric features and the recognized facies. In conclusion, even if no signal appears to be better than the other, it is evident that both Sidescan-like and Snippet data are complementary to a correct interpretation of the seafloor features and can produce a highly detailed acoustic mosaic useful for several scientific areas, including habitat mapping.

1. Introduction

The development of acoustic seafloor mapping methods over the last decades has allowed for the creation of detailed seabed morphology maps and acoustic backscatter data (e.g., [27,31,44,52,19,41,43]). Bathymetric data depict the relief of the seafloor whereas acoustic backscatter data variability can be related to the morphological and compositional characteristics of the seafloor surface [47]. Consequently, Multi-Beam Echo Sounder (MBES) systems have been used to infer physical, geological and biological properties of the seafloor, such as surface roughness (e.g., [59,22]), sediment grain size (e.g., [16,4,22,40,12]), substrate type (e.g., [17,39]), meadow distribution [18], and other biota [32]. MBES backscatter data are used to segment the seafloor into different classes, and ground-truth information is required to calibrate for each identified class to differentiate seafloor types (e.g., [30,13,52,4,53,35,26,43]). Seafloor backscatter intensity is the amount of acoustic energy, scattered back from the seafloor towards the echosounder receivers after interaction with the seafloor. It has been shown that backscatter intensity is related to sediment properties (e.g., [20,25,60]) and it depends on two components: volume scattering from sediment inhomogeneities and interface scattering from bottom roughness. The scattering from the sediment volume is created by fluctuations in sediment density or sound velocity; the scattering from the sediment surface is controlled by the impedance difference between the overlying water and the sediments [9,28]. Fine sediments generally exhibit low backscatter intensity due to low sediment bulk density and low acoustic impedance contrast at the water–sediment interface, whereas coarse sediments generally result in higher backscatter intensity due to higher bulk density, high acoustic impedance contrast and greater roughness of the sediment–water interface (e.g., [59,10,11,54]). According to the scattering theory, the rougher the surface, the less energy of acoustic waves will be reflected at the specular angle and the more energy will be scattered in the

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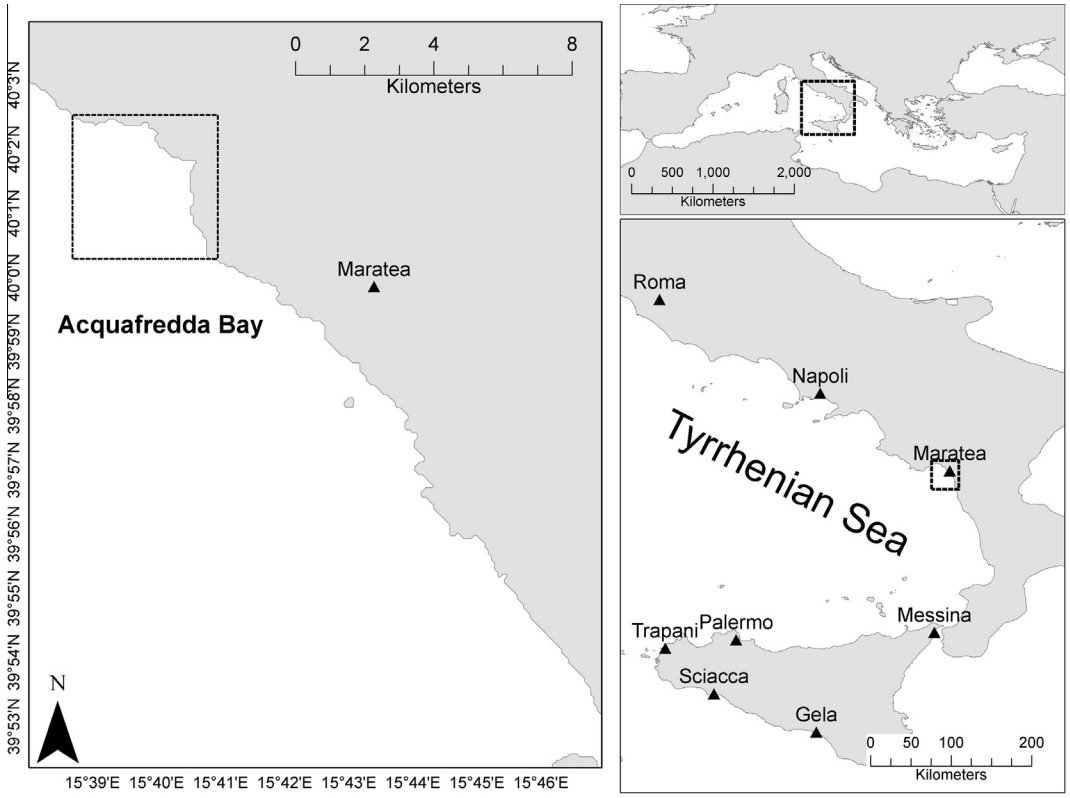

Fig. 1. Location map.

other directions [56]. Furthermore, it has been shown that, for sandy sediments, the backscatter intensity decreases with mean grain size [20]. The acoustic response from the seabed can also be related to the presence of benthic organisms (e.g., macroalgae, seagrasses, sessile invertebrates) [29]. Accordingly, multibeam bathymetry and related backscatter have been used to map benthic habitats [34]. For example, the analysis of backscatter intensity data collected with a Reson SeaBat 8125 (455 kHz) allowed an acoustic classification of different habitats along the Australian coastal zone [57]. This study focuses on a seafloor survey carried out in the Acquafredda Bay (Italy, Basilicata Region, Southern Tyrrhenian Sea) using a Reson SeaBat 8125. Backscatter data from MBES system are usually stored as Sidescan-like and/or Snippet data; in the first approach the backscatter information is completely separated from the bathymetric profile, while in the second case the backscatter information is associated with the bathymetric profile [3].

The aim of this paper is to present and discuss how integrating information derived from different instruments and processing methods (such as Snippet data and as Sidescan-like) could be used to produce more detailed seafloor maps, allowing a better seafloor characterization.

2. Study area

The area under study lies on the inner shelf of the Policastro Terrace, an embayment of the Tyrrhenian Sea off the coast of the Basilicata Region of Italy (Fig. 1). The coast portion of the study (Fig. 1) is an indented very steep up to vertical high coast with small promontories and bays, and with very few beaches [14]. Sandy-pebbly beaches develop in the small alluvial areas at the outflow of the main rivers (Fiumicello creek to the north and Noce river to the south). Structurally this coastal zone is characterized by a series of anticlines and monoclines, truncated by normal and reverse faults [45,49,8]. Acquafredda is a small city located in the most northern Tyrrhenian sector of Basilicata. The two largest gravel beaches of the Acquafredda Bay (Anginnara and Luppa) together form the most important shorelines of this sector of Basilicata. The area is characterized by different lithotypes, so it was selected as sample area to analyze the backscatter intensity.

The survey was carried out in a 4 km^2 wide sector, in a depth range of 5–50 m; coarse sand with gravel and rock blocks, fine and medium-fine sand were present. Benthic environments characterized by coralligenous concretions and well-developed *Posidonia oceanica* meadows on hard and soft substrata were also present. Coralligenous concretions, the unique calcareous formations of biogenic origin in the Mediterranean benthic environments, are produced by the accumulation of encrusting algae growing in dim light conditions [1]. There is no real consensus among scientists studying benthic communities in the Mediterranean Sea about what a coralligenous habitat is (e.g. [37,51,38,7,24,2]. In this review a coralligenous habitat is considered to be a hard substratum of biogenic origin that is mainly produced by the accumulation of calcareous encrusting algae growing in dim light conditions, i.e. in a depth between –20 and –120 m [1].

3. Material and methods

3.1. Acoustic data acquisition

In September 2007 a bathymetric survey was carried out in order to map the whole margin of the Basilicata region Tyrrhenian coast, in a depth range of −5 to −50 m. The survey was performed using a pole-mounted Reson SeaBat 8125, a 455 kHz MBES that provides sub-centimetric depth resolution data. The system insonifies a swath on the seafloor that is 120° across track by 1° along