Journal of Applied Geophysics 141 (2017) 1–12

Contents lists available at ScienceDirect

Journal of Applied Geophysics

journal homepage: www.elsevier.com/locate/jappgeo

Seismic scattering attribute for sedimentary classification of nearshore marine quarries for a major beach nourishment project: Case study of Adriatic coastline, Regione Abruzzo (Italy)

Luciana Orlando [a,*], Paolo Contini [b], Paolo De Girolamo [a]

[a] DICEA, Sapienza University of Rome, Italy
[b] MODIMAR s.r.l., Rome, Italy

ARTICLE INFO

Article history:
Received 4 November 2016
Received in revised form 13 February 2017
Accepted 8 April 2017
Available online 9 April 2017

Keywords:
Pinger seismic facies
Scattering
Sediment classification
Quarry marine sand
Beach nourishment
Multibeam
Boomer seismic data

ABSTRACT

Of fundamental importance for any major beach nourishment project using marine quarries is a correct sedimentary classification. The main purpose of such a classification is to identify sand with the appropriate features for beach nourishment. This task is more onerous when quarry sediments are heterogeneous and mixed with silt. This is typical of nearshore marine quarries. The presence of excess silt compromises the use of marine quarries because of the water turbidity that may be induced in the nourished beaches, especially when the beaches are protected by defense structures. Here we discuss the use of scattering amplitude of seismic data, acquired with a pinger source (2–10 kHz), to detect and classify the unconsolidated sediment of a marine quarry. A robust correlation was found between this seismic attribute and the silt content in the sediment. The scattering amplitude was numerically calculated from the seismic data and used to map slices of silt content at different depths. The results have been validated with sedimentary analysis of vibra- and rotary cores, and by the dredged material used for the beach nourishment. The marine quarry produced about 1.200.000 m^3 of sand used to nourish eight different beach sites along the Adriatic coasts of the Regione Abruzzo (Italy). The large-scale sedimentary assessment of the area was based on seismic boomer data and the evaluation of the volume of dredged sediments on multibeam data surveyed before and after the exploitation of the quarry. The study shows that this approach is effective in sites with high lateral and vertical variations in the percentage of sand in the sediments.

1. Introduction

Climate change and intensive urbanization (Komar, 1998; Nordstrom, 2000) reduce river sediment transport and destroy coastal sandy dunes, inducing shore erosion and regression (Bird, 1996). This affects not only private homes and commercial activities (Bird, 1996; Finkl and Walker, 2004) but also has a strong impact on the environment and the economy. In Italy beaches and their habitats as well as being an invaluable environmental resource, are also an economic source related to the tourism sector. Italian beaches attract not only domestic tourists, but also tourists from abroad, mainly from Central, North and East Europe. The flourishing seaside economy of the Adriatic Italian coast is threatened by strong coastal erosion processes. The Regione Abruzzo was, about two decades ago, one of the first Italian regions to understand that erosion processes may be tackled successfully only by using an integrated approach focusing on the environmental quality of the coastline (Capobianco et al., 2003, Orsini et al., 2003).

Beach nourishment is an example of "soft-engineering", aimed at counteracting coastal erosion by adding sediment to the beach system. This approach has the advantage of not substantially changing the landscape (Hanson et al., 2002; Thom, 2003; Finkl and Walker, 2004). However, it only delays rather than definitely solves the erosion process if not accompanied by appropriate coastal interventions, such as groins and/or detached breakwaters. In spite of its environmental and economic feasibility, beach nourishment can only be applied where there is a sedimentary quarry near the area to be nourished. A particular aspect to be tackled when nourishment projects are designed is the large amount of sediment volumes needed, which may reach the order of magnitude of hundreds of thousands or of millions of cubic meters. Hence, marine rather than land mining is in most cases the only sustainable technical and environmental choice. Reviews of artificial beach nourishment have been conducted for a number of European countries, USA and Australia (Silva and De Girolamo, 1993; Basco, 1999; De Girolamo et al., 1999; Hamm et al., 2002; Hanson et al., 2002; Franco et al., 2004, Campbell and Benedet, 2006; Di Risio et al., 2010, Cooke et al., 2012).

A correct beach nourishment must respect the environmental features of the original beach/native sand by using sand with similar

* Corresponding author.
E-mail address: luciana.orlando@uniroma1.it (L. Orlando).

http://dx.doi.org/10.1016/j.jappgeo.2017.04.004
0926-9851/

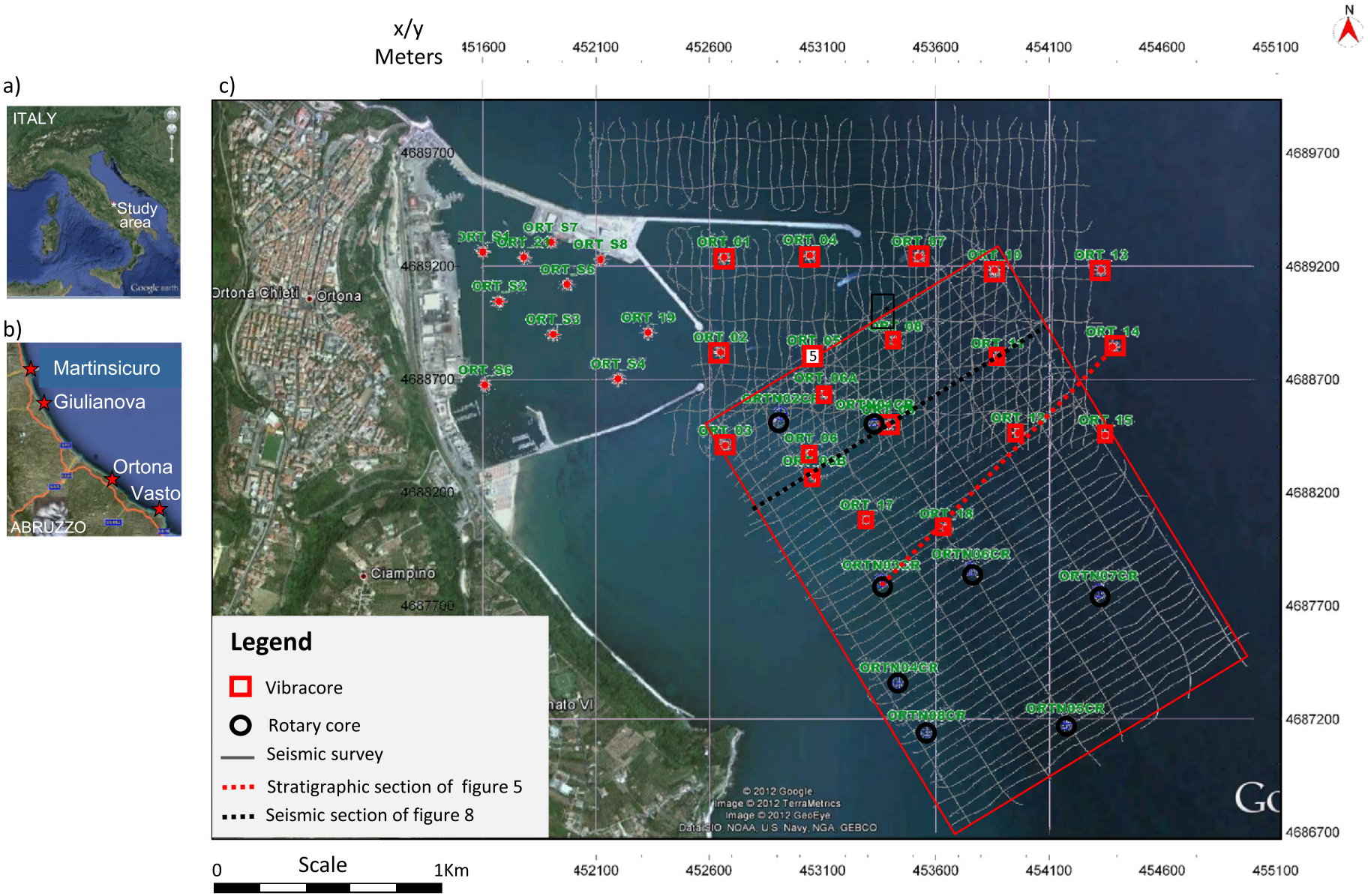

Fig. 1. Study area location (a), Investigated areas (b), Vibra and rotary cores, and seismic profiles location (c). The study is based on the seismic profiles located inside the red box. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)