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Origin and chronology of the Augias deposit in the Ionian Sea (Central Mediterranean Sea), based on new regional sedimentological data

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ABSTRACT

In the Ionian Sea (Central Mediterranean Sea), several thick acoustically transparent layers are present including the Augias deposit. The Augias deposit is the most recent, thick layer covering the entire floor of the Ionian Abyssal Plain with an average thickness of 10–12 m and a maximum thickness of up to 24 m in the Sirte Abyssal Plain. This deposit has also been observed in several adjacent smaller basins in waters deeper than 3000 m. Its estimated volume is>65 km^3. There are multiple plausible hypotheses regarding its age and triggering event, which include the 1600 BC Santorini volcanic caldera collapse, the 365 AD Crete M 8.5 earthquake and other smaller earthquakes such as the 374 AD Calabria M 6.3 earthquake and the 361 AD Sicily M 6.6 earthquake. Understanding the cause of this mass-transport deposit is crucial for improving the natural hazard assessment of a vast area between southern Italy and western Greece. In this study, we propose a new interpretation of the Augias deposit in terms of sedimentary processes and origin, based on sediment cores collected in the NW Ionian Sea during the CIRCEE cruise onboard R/V Le Suroit in October 2013.

The sedimentological analysis of seven piston cores reveals three sedimentary facies corresponding to the Augias deposit: 1) “homogenite”, 2) “megaturbidite” and 3) “thick sandy turbidite”. These sedimentary facies are distributed within specific morpho-tectonic regions as defined by newly acquired bathymetric data, indicating a strong control by transport and depositional processes. Sixteen radiocarbon dates obtained above and below the Augias deposit indicate a possible time window of about 500 years. This means that we cannot definitively prove a link to the 365 AD Crete earthquake, but we regard it as the most likely trigger. Other depositional models may be plausible, but here we propose a sequence of events as follows: (1) earthquake shock and possible triggering of submarine mass flow in the eastern part of the Ionian Sea (western Hellenic subduction zone); (2) tsunami waves amplified by the confined morphology of the Sicily and Calabria continental shelves inducing an intense re-suspension of fine-grained sediment and massive destabilization at the heads of submarine canyons triggering turbidity currents; (3) gravity driven downslope transport of suspended sediment toward the deep basin and decantation; and (4) a final stage of decantation from seiche waves forming the majority of the homogenite facies in the Ionian Abyssal Plain.

1. Introduction

Several acoustically transparent layers are found in at least three different basins in the Mediterranean Sea: the Herodotus basin (in the eastern Mediterranean Sea) (Reeder et al., 2000); the Balearic Abyssal Plain (in the western Mediterranean Sea) (Rothwell et al., 1998); the Ionian Sea (in the central Mediterranean Sea) (Cita and Aloisi, 2000; Hieke and Werner, 2000; Polonia et al., 2013; Fig. 1). Several hypotheses have been proposed regarding their origin and triggering mechanisms, all associated to catastrophic events (volcanic activity, megathrust earthquakes, tsunamis …). Identifying the parameters that have influenced the deposition of such layers is crucial to strengthen our understanding of geohazard in the Mediterranean Sea region. The present paper focuses on the most recent acoustically transparent layer found in the Ionian Sea, named hereinafter the Augias deposit. This layer offers an excellent opportunity to disentangle at least part of the open questions concerning the origin of those acoustically transparent layers, because it is a relatively accessible deposit - buried only a few metres below the seafloor - and it is present in a sedimentary succession rich in stratigraphic markers (e.g. sapropels and tephras; Fig. 2). The Augias deposit was first described by Kastens and Cita (1981) in the Ionian Sea. Since then, several oceanographic campaigns across the central and eastern Mediterranean Sea have collected kilometres of echosounder profiles and more than 50 cores to unravel the distribution, properties, origin and triggering mechanisms of such sedimentary unit (Fig. 3). However, no definitive answers have been provided concerning its depositional process and origin. Additional data acquired

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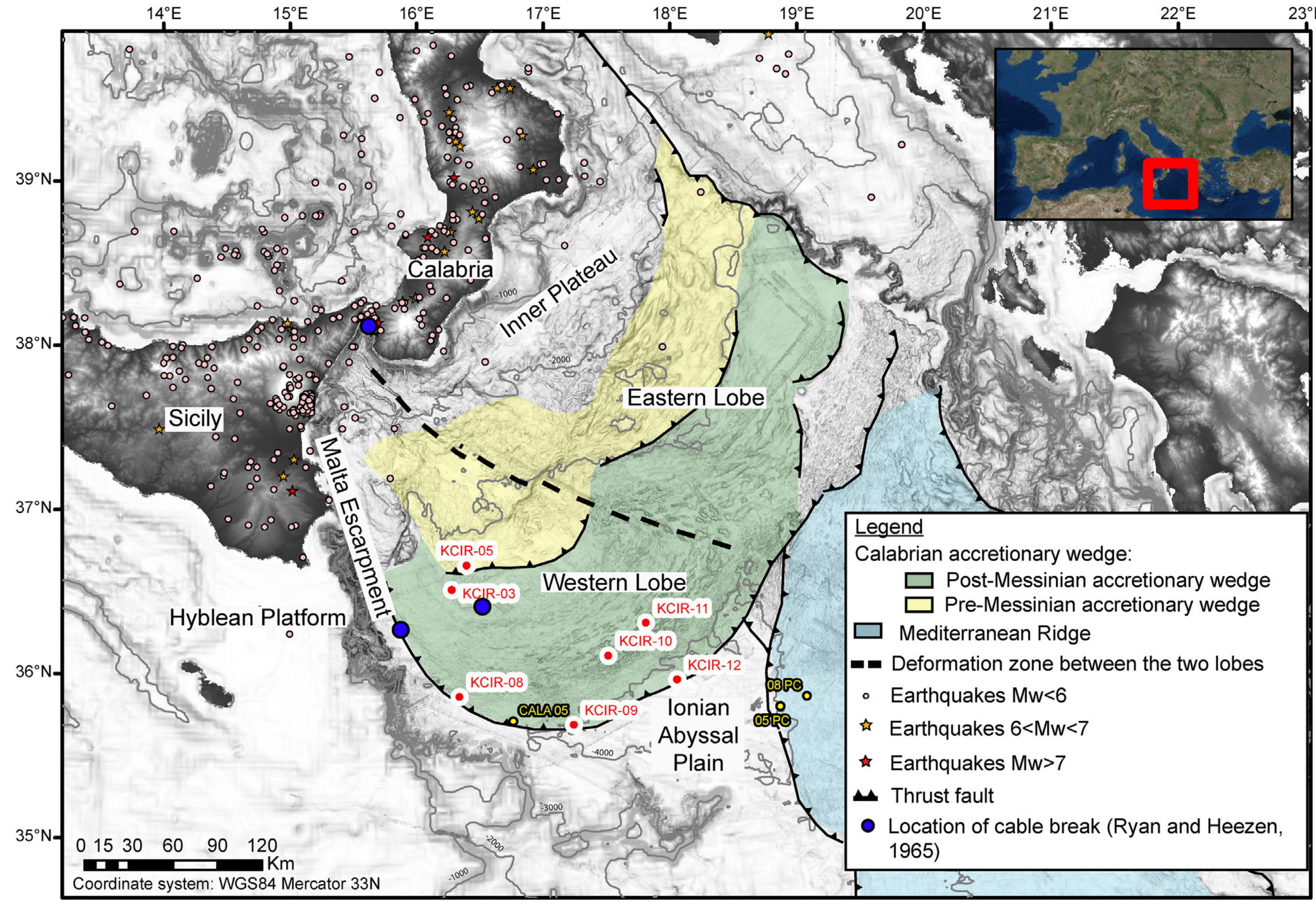

Fig. 1. Structural map of the Calabrian accretionary wedge derived from the interpretation of seismic data (Polonia et al., 2011; Gallais et al., 2012). Bathymetric data compiled from CIRCEE data, RV Meteor data (M86 and M111 - Dionysus), EMODnet data, SHOM data (French Hydrographic Service), MediMap data (Loubrieu et al., 2007) and GEBCO. Red points represent the CIRCEE sediment cores used in this study and yellow points are cores (Cita and Aloisi, 2000; Polonia et al., 2011) described in Fig. 2. Blue points correspond to the location of cable breaks after the 1908 Messina earthquake and tsunami (Ryan and Heezen, 1965). The earthquake epicentres are from the catalogue CPTI04 spanning the time period from 217 B.C. to 2002 AD (Gasperini et al., 2004).

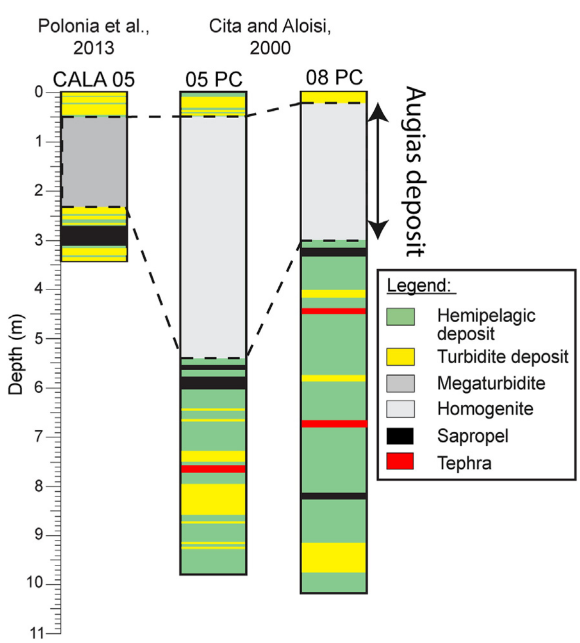

Fig. 2. Schematic stratigraphy of recent sedimentary deposits in the Ionian Sea showing the main turbidites, tephras, and sapropel layers as well as the Augias deposit (modified from Cita and Aloisi, 2000; Polonia et al., 2013). The location of these cores is shown in Fig. 1 (yellows points).

during the recent CIRCEE survey onboard R/V Le Suroit in October 2013 provide new evidence to understand the suite of processes, which formed the Augias deposit (Fig. 1).

This paper presents a high-resolution analysis of a set of piston cores collected across a wide range of geomorphological settings of the Ionian Sea that highlight the spatial variability in terms of thickness and sedimentary facies within the Augias deposit. The objectives are to estimate the age and origin of the Augias deposit, and to describe the sedimentary processes and the triggering mechanism that produced this type of thick deposit in the Mediterranean Sea region.

2. Geological setting

2.1. Seismotectonic setting of the Calabrian Arc

The Ionian Sea is a deep and narrow basin in the Central Mediterranean Sea. It is bounded by two accretionary wedges formed by the Calabrian and the Hellenic subduction zones, respectively to the northwest and to the east (Fig. 1).

The Calabrian accretionary wedge (Fig. 1) is caused in part by the convergence between the African and Eurasian plates (D'Agostino et al., 2008) as well as by the roll-back of the Ionian-Tyrrhenian slab toward the southeast. The Calabrian accretionary wedge is bounded to the west by the Sicily margin, characterized by the Malta escarpment, and to the north-east by the Apulian escarpment. The Malta escarpment is an extremely steep continental slope bordering the Ionian Sea and marks a transition between the Hyblean continental platform (with