GEOHAZARD CORE LABORATORY: MULTIPROXY ANALYSES OF RESEDIMENTED DEPOSITS

GEO HAZARD CORE LAB

GEOHAZARD@ISMAR.CNR.IT

It is focused on geohazards in the submarine environment (seismic, landslides, tsunamis) and provide a collaboration environment to acquire geological, geophysical, geochemical and geotechnical data on sediment cores to assess geohazards and their impact.

GEOHAZARD CORE LAB HOUSING:

(i) Innovative multisensor core-logger, developed by ISMAR-CNR in collaboration with Proambiente with "open" hardware and software technology, able to carry out measurements on both open and closed sediment cores with great detail (less than a tenth of a mm) of some physical properties such as magnetic susceptibility, P-wave velocity, resistivity;
(ii) The Mastersizer 3000 laser diffraction particle size analyzer (0.01µm-3.5mm);
(iii) Optical microscopy;
(iv) Tracer 5i-5g* Portable XRF Spectrometer based on Silicon Drift Detector (SDD) technology.

AVAILABLE SOFTWARE

(i) ***ChirCor***, open software developed at ISMAR-CNR for acquisition of phisical parameters on Sediment cores and generation of synthetic seismograms. (Dal Forno Giulio and Luca Gasperini, 2008. ChirCor: a new tool for generating synthetic chirp-sonar seismograms, Computers & Geosciences, COMPUTERS & GEOSCIENCES, 34, 103-114

(ii) ***SeisPrho***, open software developed at ISMAR-CNR for seismic data processing and interpretation (Gasperini L., Stanghellini G., 2009. SEISPRHO: An interactive computer program for processing and interpretation of high-resolution seismic reflection profiles, COMPUTERS & GEOSCIENCES, 35, 1497-1507);

(iii) ***Corlog***: Core logger control software (ISMAR-Proambiente);

(iv) ***Barth***: software for magnetic susceptibility acquisition and calibration;

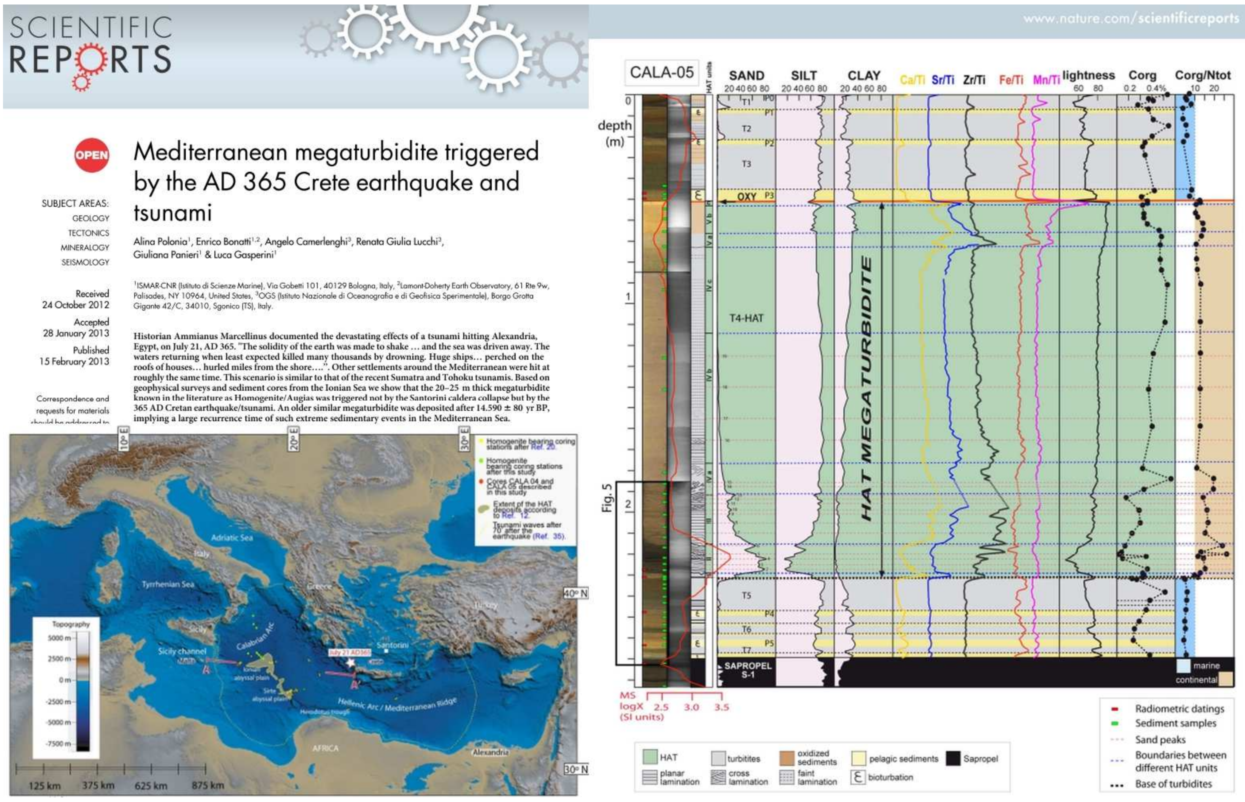
(v) ***Pico***: software for acquisition of Vp in sediment cores.

RESEARCH FOCUS AND EXAMPLES

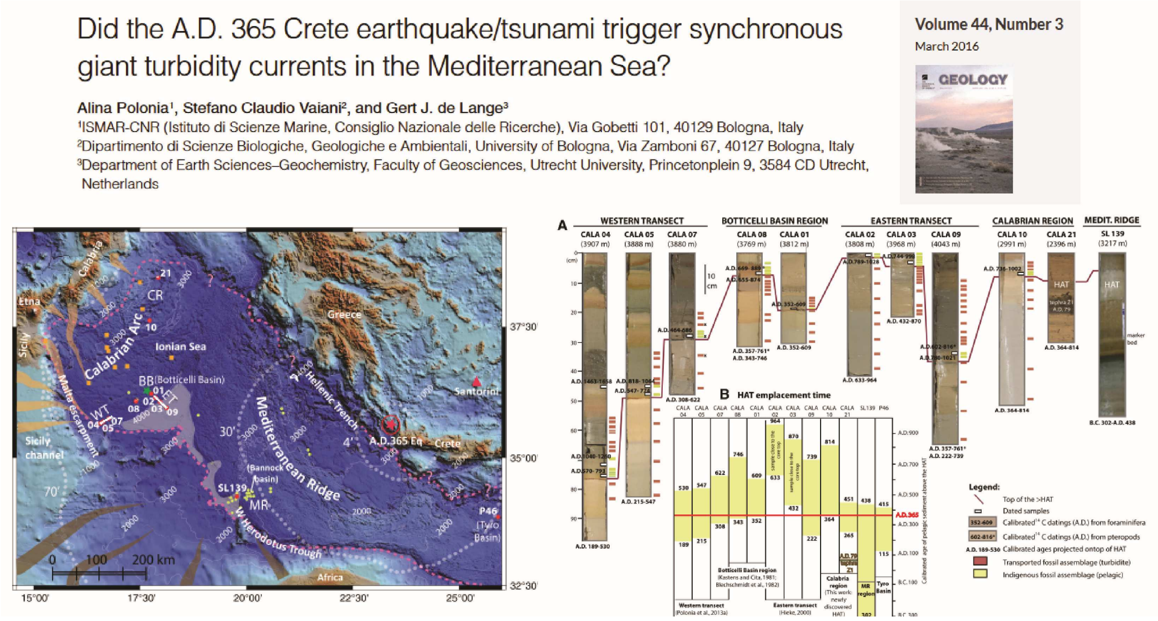
The main analytical activities are carried out in the frame of national and international research projects with the main objective to characterize marine sediments deposited during extreme events and to reconstruct sedimentary processes and triggering mechanisms responsible for sediment remobilization (seismic shaking, slope failures, tsunami wave propagation).

Here are some examples of main results obtained within these themes.

1) Mediterranean megaturbidite triggered by the AD 365 Crete earthquake and tsunami (**Polonia A.**, Bonatti E., Camerlenghi A., Lucchi R. G., Panieri G., Gasperini L., 2013. **Scientific Reports** 02/2013; 3:1285. doi:10.1038/srep01285



2) Did the AD 365 Crete earthquake/tsunami trigger synchronouss giant turbidity currents in the Mediterranean Sea? (Polonia A., Vaiani C.S. and de Lange G.J., 2016. **Geology**, DOI: 10.1130/G37486.1


Did the A.D. 365 Crete earthquake/tsunami trigger synchronous giant turbidity currents in the Mediterranean Sea?

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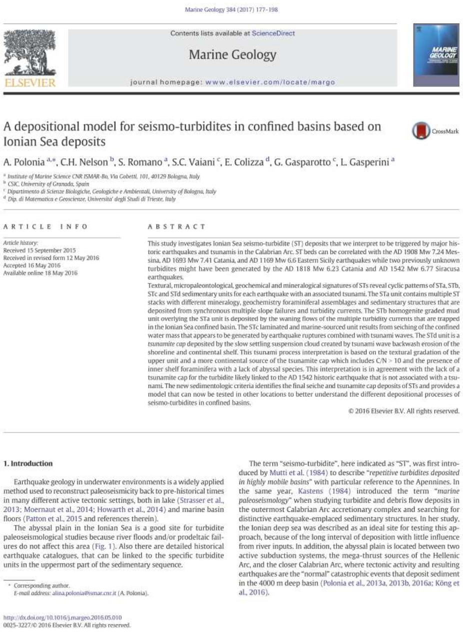
Volume 44, Number 3
March 2016
GEOLOGY

3) Turbidite paleoseismology in the Calabrian Arc Subduction Complex: the 1908 Messina, 1693 Catania and 1169 Sicili earthquakes (Polonia A, Panieri G, Gasperini L, Gasparotto G, Bellucci L.G, Torelli L., 2013.). **Geochemistry Geophysics Geosystems** 01/2013; 14(1):112-140. doi:10.1029/2012GC004402


Marine Geology 384 (2017) 177–198
Contents lists available at ScienceDirect
Marine Geology
journal homepage: www.elsevier.com/locate/margo

A depositional model for seismo-turbidites in confined basins based on Ionian Sea deposits

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ARTICLE INFO
Article history:
Received 15 September 2015
Received in revised form 12 May 2016
Accepted 16 May 2016
Available online 18 May 2016

ABSTRACT
This study investigates Ionian Sea seismo-turbidite (ST) deposits that we interpret to be triggered by major historic earthquakes and tsunamis in the Calabrian Arc. ST beds can be correlated with the AD 1908 Mw 7.24 Messina, AD 1693 Mw 7.41 Catania, and AD 1169 Mw 6.6 Eastern Sicily earthquakes while two previously unknown turbidites might have been generated by the AD 1818 Mw 6.23 Catania and AD 1542 Mw 6.77 Siracusa earthquakes.
Textural, micropaleontological, geochemical and mineralogical signatures of STs reveal cyclic patterns of STa, STb, STc and STd sedimentary units for each earthquake with an associated tsunami. The STa unit contains multiple ST stacks with different mineralogy, geochemistry foraminiferal assemblages and sedimentary structures that are deposited from synchronous multiple slope failures and turbidity currents. The STb homogenite graded mud unit overlying the STa unit is deposited by the waning flows of the multiple turbidity currents that are trapped in the Ionian Sea confined basin. The STc laminated and marine-sourced unit results from seiching of the confined water mass that appears to be generated by earthquake ruptures combined with tsunami waves. The STd unit is a *tsunamite cap* deposited by the slow settling suspension cloud created by tsunami wave backwash erosion of the shoreline and continental shelf. This tsunami process interpretation is based on the textural gradation of the upper unit and a more continental source of the tsunamite cap which includes C/N > 10 and the presence of inner shelf foraminifera with a lack of abyssal species. This interpretation is in agreement with the lack of a tsunamite cap for the turbidite likely linked to the AD 1542 historic earthquake that is not associated with a tsunami. The new sedimentologic criteria identifies the final seiche and tsunamite cap deposits of STs and provides a model that can now be tested in other locations to better understand the different depositional processes of seismo-turbidites in confined basins.

1. Introduction

Earthquake geology in underwater environments is a widely applied method used to reconstruct paleoseismicity back to pre-historical times in many different active tectonic settings, both in lake (Strasser et al., 2013; Moernaut et al., 2014; Howarth et al., 2014) and marine basin floors (Patton et al., 2015 and references therein).

The abyssal plain in the Ionian Sea is a good site for turbidite paleoseismological studies because river floods and/or prodeltaic failures do not affect this area (Fig. 1). Also there are detailed historical earthquake catalogues, that can be linked to the specific turbidite units in the uppermost part of the sedimentary sequence.

The term "seismo-turbidite", here indicated as "ST", was first introduced by Mutti et al. (1984) to describe "*repetitive turbidites deposited in highly mobile basins*" with particular reference to the Apennines. In the same year, Kastens (1984) introduced the term "*marine paleoseismology*" when studying turbidite and debris flow deposits in the outermost Calabrian Arc accretionary complex and searching for distinctive earthquake-emplaced sedimentary structures. In her study, the Ionian deep sea was described as an ideal site for testing this approach, because of the long interval of deposition with little influence from river inputs. In addition, the abyssal plain is located between two active subduction systems, the mega-thrust sources of the Hellenic Arc, and the closer Calabrian Arc, where tectonic activity and resulting earthquakes are the "normal" catastrophic events that deposit sediment in the 4000 m deep basin (Polonia et al., 2013a, 2013b, 2016a; Köng et al., 2016).

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http://dx.doi.org/10.1016/j.margeo.2016.05.010
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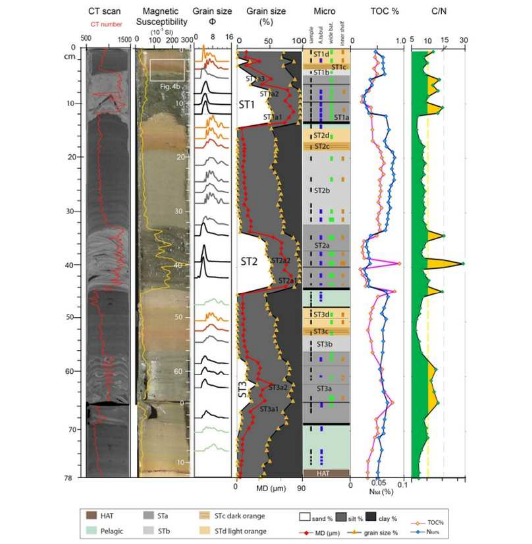
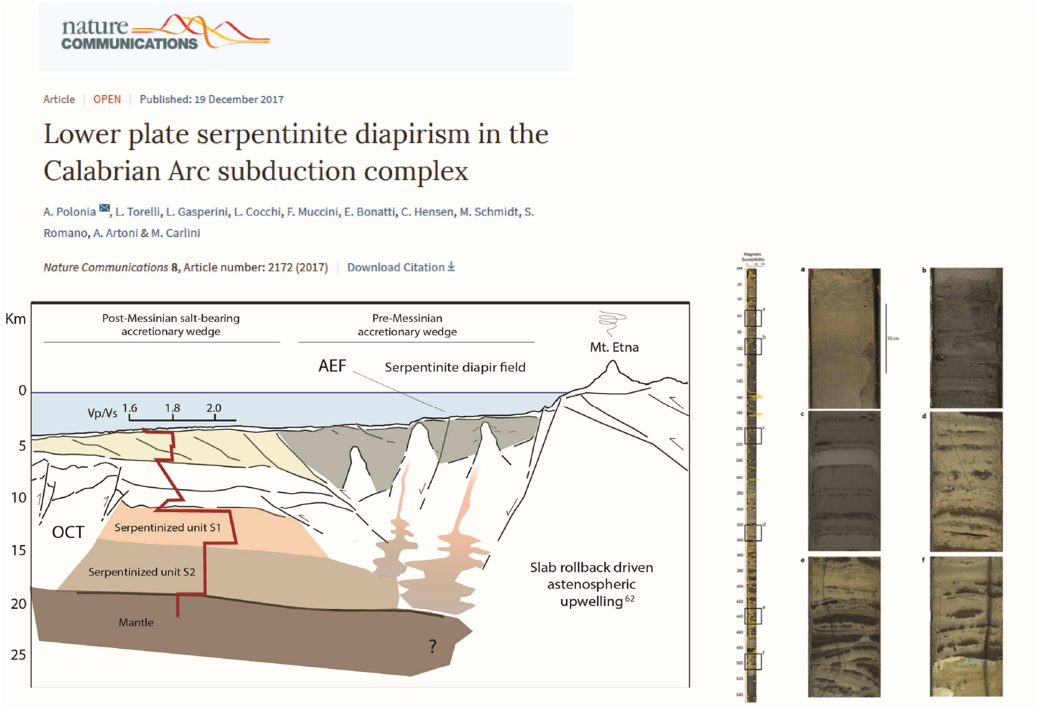
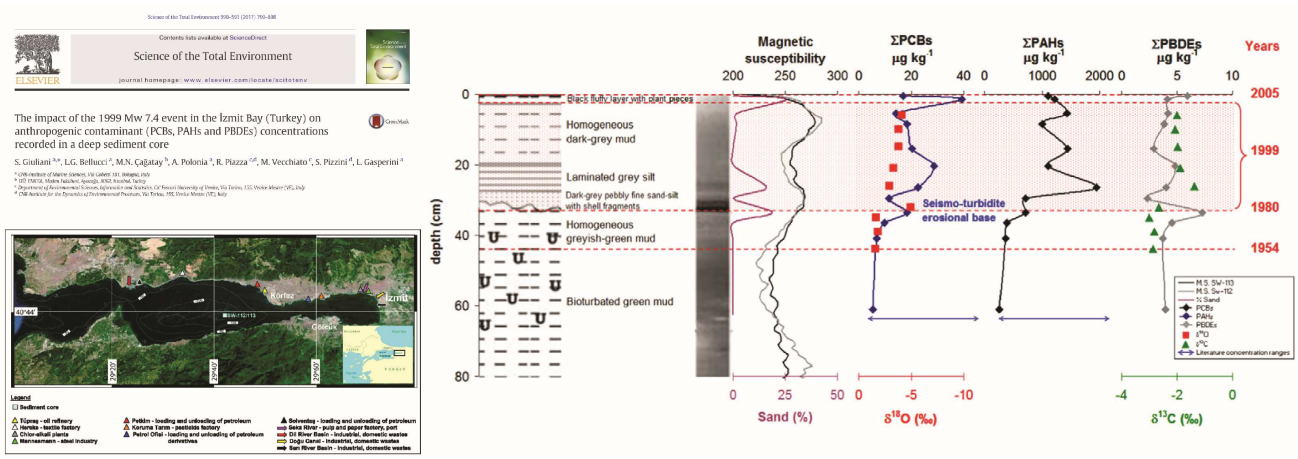


Fig. 3. Uppermost section of core CALA 04: CT scan with CT number in red, photograph with high resolution magnetic susceptibility in yellow, grain size modes in different colours, grain size % with mean diameter grain size (MD) in red, sedimentary facies STa, b, c, d with benthic foraminifera assemblages and organic carbon data (TOC%, N_{tot}, and C/N: green areas if C/N < 10, yellow areas if C/N > 10). Benthic foraminiferal assemblages are grouped in three different classes: blue = abyssal species (mainly *A. tubulosa*); green = wide bathymetric ranges; brown = inner shelf (see Table 2 for more details). Thin coloured line = rare specimens: <25 specimens in 0.03 g of sample; thick coloured line = common specimens: >25 specimens in 0.03 g of sample (see Table 2 for details on the bathymetric distribution). Identified seismo-turbidites (ST1, ST2 and ST3) with individual units (a, b, c and d) are indicated.

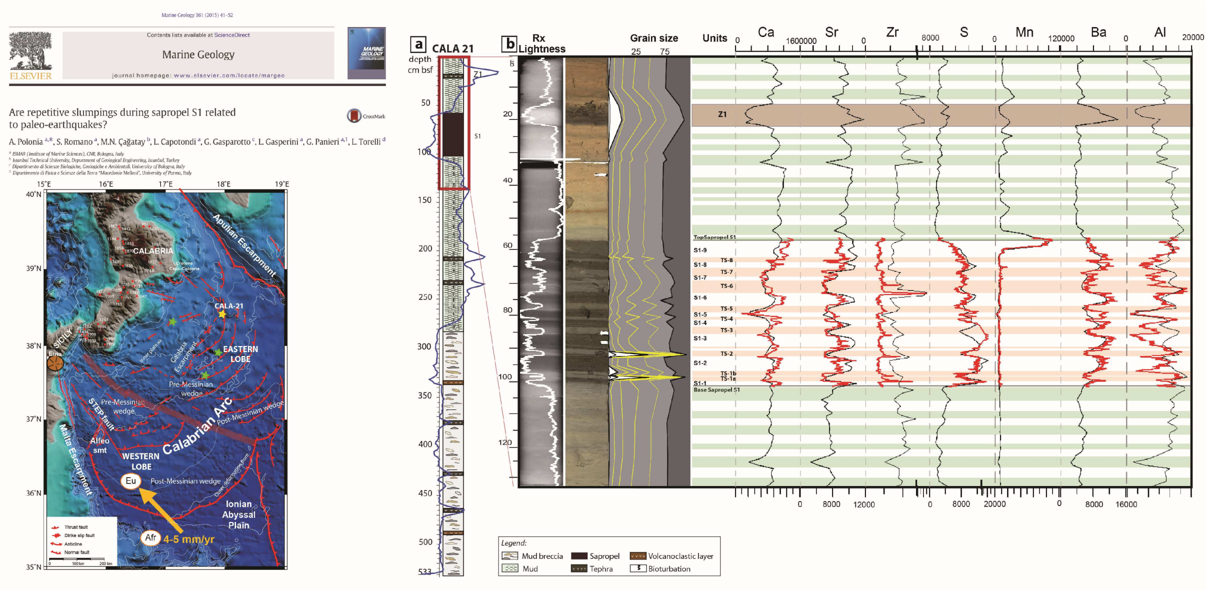
4) Lower plate serpentinite diapirism in the Calabrian Arc subduction complex triggered by transtensional lithospheric faults segmenting the subduction complex. (Polonia A., Torelli L., Gasperini L., Cocchi L., Muccini F., Bonatti E., Hensen C., Schmidt M., S Romano, Artoni A., Carlini M., 2017. **Nature Communications** 8 (1), 2172, DOI 10.1038/s41467-017-02273-x. http://rdcu.be/CGjQ



5) Risks of extensive industrialization in seismic areas: The impact of the 1999 Mw 7.4 event in the İzmit Bay (Turkey) on anthropogenic contaminant (PCBs, PAHs and PBDEs) concentrations recorded in a sediment core. (Giuliani S., Bellucci L.G., Cagatay N., Polonia A., Piazza R., Vecchiato M., Pizzini S., Gasperini L., 2017. **Science of the Total Environment**, 590-591, pp. 799-808.



6) Are repetitive slumpings during sapropel S1 related to paleo-earthquakes? (Polonia A., Romano S., Çağatay M.N., Capotondi L., Gasparotto G., Gasperini L., Panieri G., Torelli L., 2015. **Marine Geology** 361 (2015) 41–52.



7) A depositional model of seismo-turbidites in confined basins based on Ionian Sea deposits. (**Polonia A.,** Nelson H. C., Romano S., Vaiani S.C., Colizza E., Gasparotto G., Gasperini L., 2016. **Marine Geology,** Volume 384, 2017, Pages 177-198, ISSN 0025-3227, https://doi.org/10.1016/j.margeo.2016.05.010).