CARATTERIZZAZIONE GEOLOGICA, GEOFISICA, GEOCHIMICA E GEOTECNICA DI SEDIMENTI PER L'ANALISI DELLA PERICOLOSITA' GEOLOGICA SOTTOMARINA E I PROCESSI DI RISEDIMENTAZINE

GEOHAZARD@ISMAR.CNR.IT

Il laboratorio utilizza e sviluppa metodologie analitiche finalizzate allo studio della ***pericolosità geologica*** in ambiente sottomarino (*terremoti, frane, tsunami*) e fornisce un ambiente di collaborazione per acquisire dati geologici, geofisici, geochimici e geotecnici sui campioni di sedimento allo scopo di ottenere elementi utili per una corretta valutazione della pericolosità geologica in diversi contesti oceanografici, dalla piattaforma continentale ai bacini profondi. Il laboratorio sviluppa metodologie operative per la correlazione di livelli stratigrafici dalle carote di sedimento ai riflettori sismici.

STRUMENTI PRESENTI

(i) ***core-logger* multisensoriale** di nuovissima concezione, sviluppato da ISMAR-CNR in collaborazione con Proambiente, con tecnologia hardware e software "open", in grado di effettuare misure sia su carote aperte che chiuse con grandissimo dettaglio (inferiore al decimo di mm) di alcune proprietà fisiche come suscettività magnetica, velocità delle onde P, resistività;

(ii) **granulometro laser** Malvern, modello Mastersizer 3000 (0.01µm-3.5mm);

(iii) **strumenti *per l'imaging* microscopico**, microscopio ottico;

(iv) ***XRF* portatile** per la caratterizzazione geochimica dei sedimenti (Tracer 5i-5g* Portable XRF Spectrometer based on Silicon Drift Detector (SDD) technology.).

SOFTWARE DISPONIBILI

(i) ***ChirCor*** un programma per la gestione di log fisici di carote e la generazione di sismogrammi sintetici. (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***, un software "open", per l'elaborazione e l'interpretazione di profili sismici a riflessione (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***: software di controllo del Core logger ISMAR-Proambiente ;

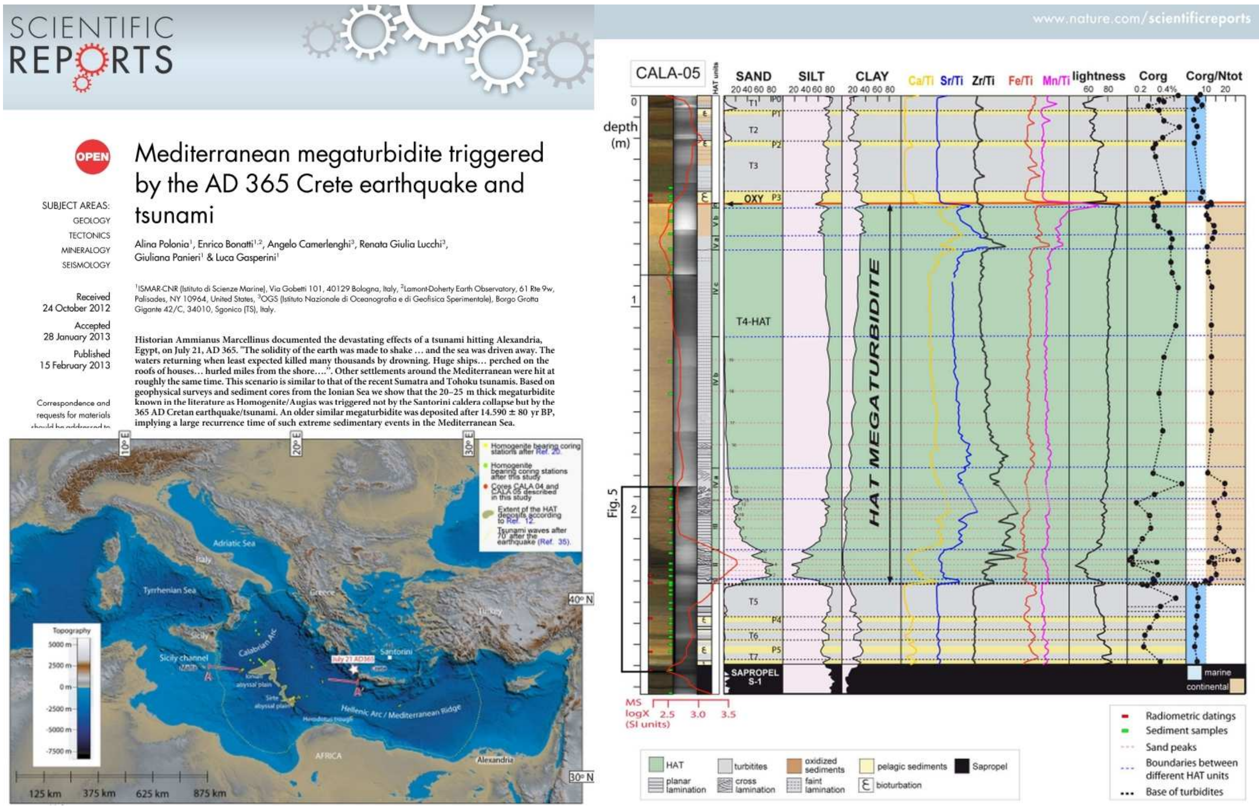
(iv) ***Barth***: software di acquisizione e calibrazione dati di suscettività magnetica;

(v) ***Pico***: software di acquisizione velocità delle onde P in sezioni di carote di sedimento.

ESEMPI DI RISULTATI NEL CAMPO DEI GEOHAZARD OTTENUTI ATTRAVERSO L'ANALISI MULTIDISCIPLINARE DI CAROTE DI SEDIMENTO

Le principali attività analitiche sono eseguite nell'ambito di progetti di ricerca nazionali ed internazionali che hanno come finalità la caratterizzazione dei sedimenti marini in relazione ai processi di ri-sedimentazione durante eventi estremi. Ecco alcuni esempi dei risultati ottenuti nell'ambito di questi temi.

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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Mediterranean megaturbidite triggered by the AD 365 Crete earthquake and tsunami

SUBJECT AREAS: GEOLOGY TECTONICS MINERALOGY SEISMOLOGY

Alina Polonia[1], Enrico Bonatti[1,2], Angelo Camerlenghi[3], Renata Giulia Lucchi[3], Giuliana Panieri[1] & Luca Gasperini[1]

[1]ISMAR-CNR (Istituto di Scienze Marine), Via Gobetti 101, 40129 Bologna, Italy, [2]Lamont-Doherty Earth Observatory, 61 Rte 9w, Palisades, NY 10964, United States, [3]OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), Borgo Grotta Gigante 42/C, 34010, Sgonico (TS), Italy.

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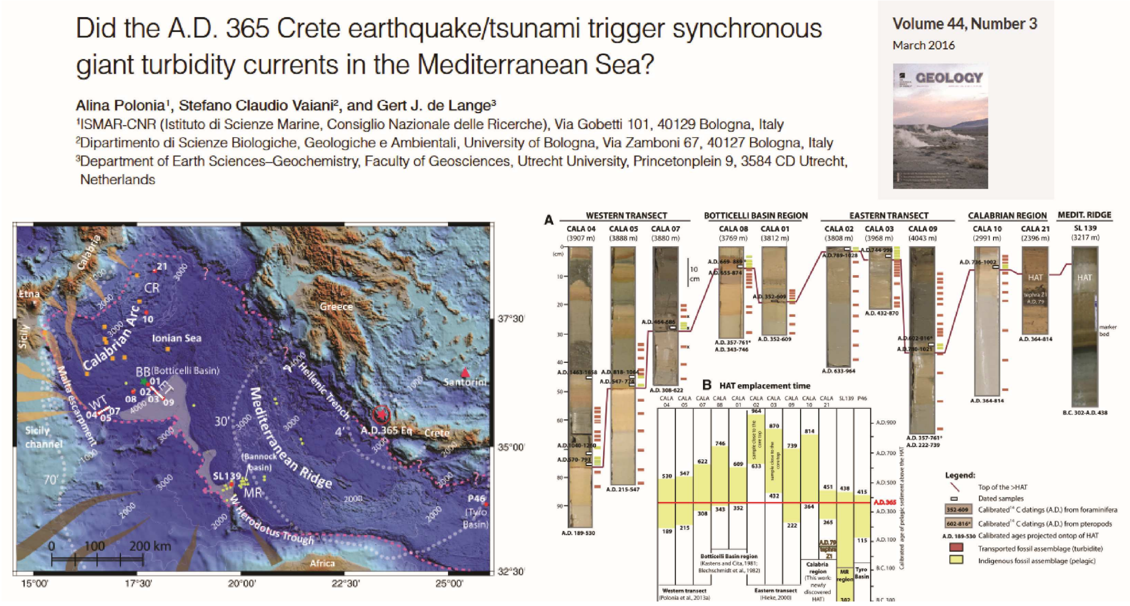
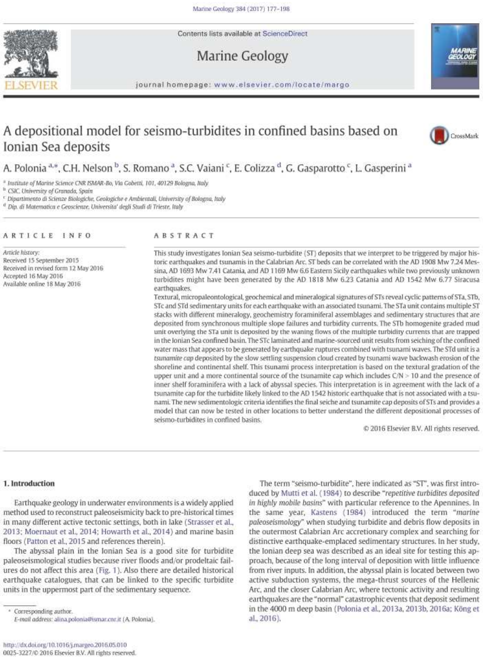
Correspondence and requests for materials

Historian Ammianus Marcellinus documented the devastating effects of a tsunami hitting Alexandria, Egypt, on July 21, AD 365. "The solidity of the earth was made to shake … and the sea was driven away. The waters returning when least expected killed many thousands by drowning. Huge ships… perched on the roofs of houses… hurled miles from the shore….". Other settlements around the Mediterranean were hit at roughly the same time. This scenario is similar to that of the recent Sumatra and Tohoku tsunamis. Based on geophysical surveys and sediment cores from the Ionian Sea we show that the 20–25 m thick megaturbidite known in the literature as Homogenite/Augias was triggered not by the Santorini caldera collapse but by the 365 AD Cretan earthquake/tsunami. An older similar megaturbidite was deposited after 14.590 ± 80 yr BP, implying a large recurrence time of such extreme sedimentary events in the Mediterranean Sea.

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



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

A. Polonia a,*, C.H. Nelson b, S. Romano a, S.C. Vaiani c, E. Colizza d, G. Gasparotto c, L. Gasperini a

a Institute of Marine Science CNR ISMAR-Bo, Via Gobetti, 101, 40129 Bologna, Italy
b CSIC, University of Granada, Spain
c Dipartimento di Scienze Biologiche, Geologiche e Ambientali, University of Bologna, Italy
d Dip. di Matematica e Geoscienze, Università degli Studi di Trieste, Italy

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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.

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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).

* Corresponding author.
E-mail address: alina.polonia@ismar.cnr.it (A. Polonia).

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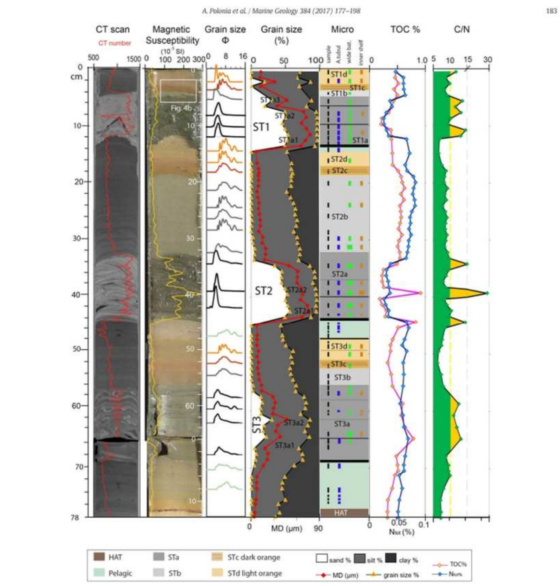
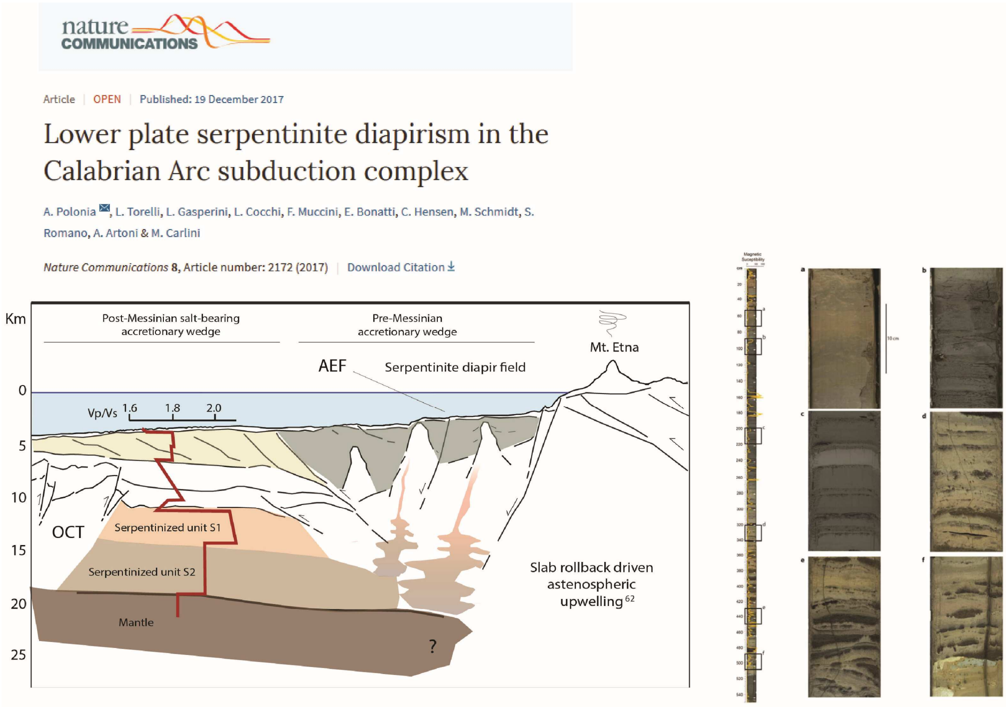
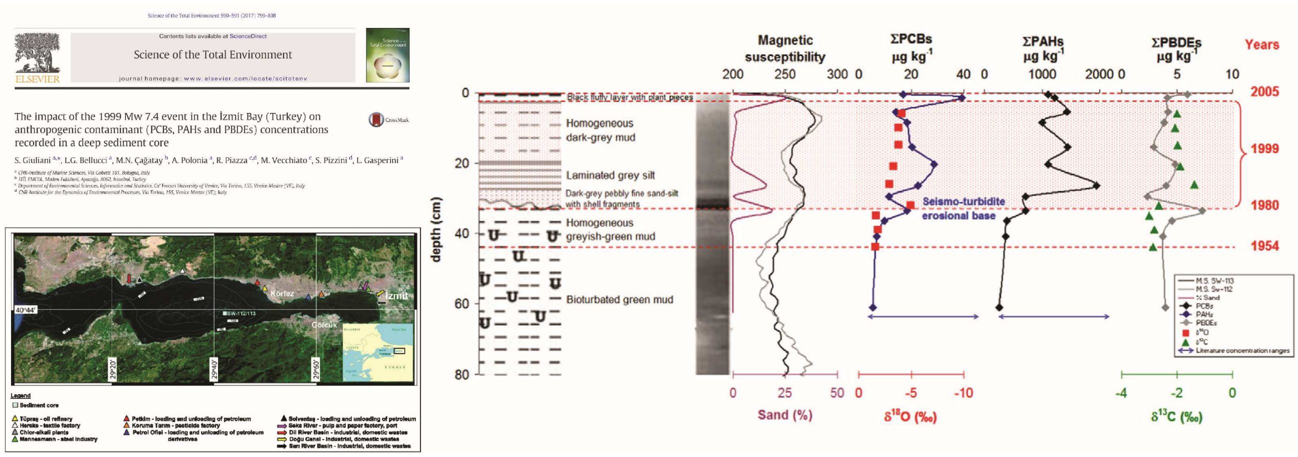


Fig. 3. Uppermost section of core CALA 04: CT scan with CT number in red, photograph with high resolution magnetic susceptibility in yellow, grain size modes in different colours, grain size % with mean diameter grain size (MD) in red, sedimentary facies STa, b, c, d with benthic foraminifera assemblages 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.

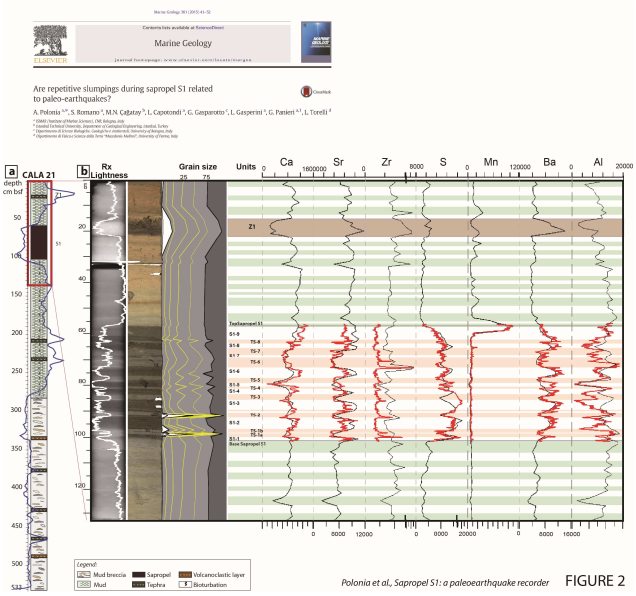
4) [Lower plate serpentinite diapirism in the Calabrian Arc subduction complex](http://rdcu.be/CGjQ) triggered by transtensional lithospheric faults segmenting the subduction complex. (Polonia A., Torelli L., Gasperini L., Cocchi L., Muccini F., Bonatti E., Hensen C., Schmidt M., S Romano, Artoni A., 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. http://dx.doi.org/10.1016/j.scitotenv.2017.03.051.



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).