ENGLISH

Topic/Title

Seismic facies and petrophysical properties of the Messinian deposits in the Tyrrhenian Sea (IODP Exp. 402)

Proposer (Tutor)

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PhD Research Project Overview

The main objective of this PhD research project is to deliver a comprehensive characterization of the evaporitic deposits in the Tyrrhenian Basin formed during the Messinian Salinity Crisis (MSC). This investigation will adopt a multi-scale, multidisciplinary approach—petrophysical, structural, lithological, and seismic stratigraphic—using deep-penetration seismic datasets, including:

- CROP data acquired in the 1990s,
- CS and MS data from the 1980s,
- MEDOC data collected in 2010 by the Spanish CSIC in collaboration with CNR.

These high-penetration datasets will be integrated with a broad archive of high-resolution seismic data (30 kJ and 1 kJ Sparker systems) collected in the 1980s and 1990s. All data are available through the Institute of Marine Sciences (CNR-ISMAR, Bologna).

This geophysical framework will be further enriched with information obtained from the IODP Expedition 402 (2024, Tyrrhenian Sea, JOIDES Resolution), as well as from earlier ODP Leg 107 and DSDP Leg 13 expeditions. These provide lithological, petrophysical, and geochemical datasets that are crucial for interpretation.

In the initial phase, the project will define and map seismic facies across the basin and correlate them with petrophysical and lithological properties at drilled sites. The primary aim is to reconstruct depositional environments and paleo-bathymetries of the Messinian units, with particular attention to syn-depositional tectonic processes. A 2D/3D distribution of the Messinian deposits will be developed through numerical modelling based on an integrated geological model.

Additionally, a detailed study of salt tectonics will be undertaken, focusing on the sealing capacity of evaporites and their role in reservoir formation. Finally, the interpretive stage will include comparative analysis with other Mediterranean basins affected by the MSC, both in the Western and Eastern sectors.

Research Plan

Given that all datasets are property of ISMAR-CNR, seismic and petrophysical analyses will be conducted primarily at the CNR-ISMAR laboratories in Bologna. A dedicated interpretation project will be built using software such as Kingdom, Petrel, and NORSAR, to integrate geophysical, geological, petrophysical, and geochemical (e.g., XRF) datasets and support georeferenced interpretation.

Year 1

- Initial work will be based at CNR-ISMAR Bologna, involving the collection, integration, and interpretation of all available seismic datasets within a dedicated Kingdom or Petrel project.
- Compilation, plotting, and analysis of IODP, ODP, and DSDP data from online repositories.
- Literature review on the MSC and related topics such as salt tectonics,

evaporite physical properties, and depositional environments.

- Construction of a preliminary geological model from interpreted seismic data.

Year 2

- The second year will include activities at the University of Naples (Department of Earth Sciences), focusing on the integration of the geological model with lithological, geochemical, and physical properties from IODP, ODP, and DSDP data.

- Access to core samples stored in the Bremen Core Repository will be sought through ISMAR's ongoing IODP collaborations.

- Seismic forward modeling using NORSAR software (training required), aiming to calibrate seismic facies with physical properties of the Messinian units.

- Comparison of synthetic seismic responses with actual survey data.

- Presentation of preliminary results at conferences such as SGI, EGU, CGMI, or thematic workshops.

Year 3

- The third year will include an international research stay. One option is the University of Nebraska under the supervision of Prof. Irina Filina, focusing on numerical modeling of the Messinian base using free-air gravity anomalies and seismic data to construct a constrained 3D geological model.

- Alternatively, a research stay at Sorbonne University with Prof. Christian Gorini could focus on comparative analysis between Tyrrhenian data and those from the Rhône and offshore Corsica basins.

- Final thesis writing and manuscript preparation for publication.

- Participation in conferences (SGI, EGU, GNGTS, etc.) to present the final outcomes and modeling result