IODP Proposal Cover Sheet

857C - Full

DREAM: Lago-Mare Deposits

Received for: 2018-10-01

Title	The demise of a salt giant: climatic-environmental transition during the terminal Messinian Salinity Crisis
Proponents	Claudia Bertoni, Giovanni Aloisi, Angelo Camerlenghi, Johanna Lofi, Andrew Madof, Alice Marzocchi, Judith McKenzie, Aaron Micallef, Iuliana Vasiliev, Hugh Daigle, Nick Evans, Daniel Garcia-Castellanos, David Hodell, Christian Hübscher, Zohar Gvirtzman, Terry McGenity, Junichiro Kuroda, Jörn Peckmann, Tina Treude, Patrick Grunert
Keywords	Messinian, Evaporites, Mediterranean, Lago-Mare
Area	Eastern Mediterranean

Proponent Information

Proponent	Claudia Bertoni
Affiliation	University of Oxford
Country	United Kingdom

☐ Permission is granted to post the coversheet/site table on www.iodp.org

Abstract

Approximately 6 Myrs ago, during the Messinian Salinity Crisis (MSC), the Mediterranean was transformed into a giant saline basin. This geologically short-term event (~640 ka) deposited up to 2 km of salt in the deep basin, producing the largest, youngest, and least deformed salt giant on Earth. Drilling the upper reaches of the Mediterranean Salt Giant offers exceptional opportunities to understand: (1) dramatic environmental changes and salinity fluctuations experienced during terminal stages of the MSC and (2) development of an exceptionally active deep biosphere involved in extensive mineral transformations.

After salt emplacement, the Mediterranean underwent dramatic environmental changes: 1) its deep basins were presumably subaerially exposed and became host of huge fluvial depositional systems from surrounding land-masses, 2) it experienced rapid basin-wide salinity decreases from hypersaline into brackish water conditions resulting in enigmatic Lago-Mare sedimentary accumulations and 3) it underwent a rapid return to normal open marine conditions following the catastrophic refilling of the basin with Atlantic waters during the Zanclean megaflood event, interpreted as the largest known event of this kind. The drivers responsible for the rapid and dramatic basin-wide salinity fluctuations, from hypersaline to brackish to open marine conditions, are presently unknown. The Mediterranean's near land-locked physiography makes it highly sensitive to subtle changes in insolation and associated fluctuations in freshwater input. The central and eastern Mediterranean MSC deposits are ideally located for understanding how this hydrological evolution was forced by water exchanges between Mediterranean sub-basins and the Paratethys and Atlantic Ocean, and by the climatically-influenced input of freshwater from major circum-Mediterranean rivers.

The halite – gypsum – Lago Mare succession of the terminal MSC offers a means to test our hypothesis that the upper reaches of the Mediterranean Salt Giant contain one of the most active deep biosphere environments on Earth. We propose that microbes in this deep biosphere (1) use sulphate minerals as a source of oxidative power, (2) catalyse formation of massive amounts of mineral dolomite and (3) thrive within fluid inclusions of evaporite minerals over geological timescales. Recent observations in the Ionian Abyssal Plain suggest on-going microbially-mediated dolomitization over an area as large as the island of Sicily.

We propose to drill two sites in the Ionian Basin and two in the Levant Basin, penetrating the terminal MSC successions: open-marine Pliocene siliciclastic deposits hosting the hypothesized active dolomitization front; lacustrine Lago-Mare sulphate evaporites, carbonates, marls, and siliciclastic accumulations; and Upper Messinian salts.

857C - Full

Scientific Objectives

SCIENTIFIC OBJECTIVES

Theme 1: Deep basin records of the demise of the Mediterranean Salt Giant.
(1.1) to test the hypothesis that fluvial deposits exists above the deep basin halite of the Levant basin;
(1.2)to establish the role of climate in the evolution from hypersaline to brackish conditions;
(1.3) to test the hypothesis that the post-MSC marine restoration was a geologically-instantaneous event involving an unprecedented water discharge.

Theme 2: Deep biosphere and dolomite formation in the upper reaches of the Mediterranean Salt Giant.
(2.1) to identify microbial populations and quantify the metabolic activity of the deep biosphere thriving on the microbial reduction of anhydrite- and gypsum-derived sulphate;
(2.2) to understand if deep biosphere microorganisms are catalysing the ongoing formation of massive amounts of dolomite;
(2.3) to document life surviving within fluid inclusions of evaporite minerals, possibly over geological timescales.

Non-standard measurements technology needed to achieve the proposed scientific objectives

ODP/IODP contamination monitoring measurements, shipboard cultivation and radiotracer facilities, GC with H2 gas analyzer, ion chromatograph for measuring low molecular weight fatty acids and dissolved nitrate.

857C - Full

Proposed Sites (Total proposed sites: 12; pri: 6; alt: 6; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
ION-01A (Primary)	35.8478 18.1963	4013	1018	0	1018	Sampling the dolomitised sediments in the upper Messinian (Lago Mare?) and basal Pliocene oozes. Sampling the distal part of the Eo-Sahabi/Chad fluvial system (upper Messinian). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, K-Mg salts) and the upper part of the halite unit.
MAL-01A (Primary)	35.3594 16.9549	3696	563	0	563	Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, K-Mg salts) and the upper part of the halite unit. Sampling the distal part of the Eo-Sahabi/Chad fluvial system (upper Messinian).
LEB-01A (Primary)	34.2701 35.1461	1793	606	0	606	Sampling the proximal part of the Nahr Menashe fluvial system (upper Messinian, UU). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, UU) and the upper part of the halite unit (MU).
MAL-02A (Alternate)	36.2477 15.8149	3573	1294	0	1294	Sampling the Zanclean chaotic deposit. Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, K-Mg salts) and the upper part of the halite unit, only if problems have been encountered at SIte ION-01.
MAL-03A (Primary)	36.1312 15.9504	3645	1051	0	1051	Sampling the Zanclean chaotic deposit. Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, K-Mg salts) and the upper part of the halite unit, only if problems have been encountered at Site ION-01.
MAL-04A (Alternate)	36.3869 15.6523	3383	1236	0	1236	Sampling the Zanclean chaotic deposit. Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, K-Mg salts) and the upper part of the halite unit, only if problems were encountered at Site ION-01.
LEV-02A (Alternate)	33.5973 33.1919	2008	441	0	441	Sampling the distal part of the Nahr Menashe fluvio-deltaic system (upper Messinian, UU). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, UU) and the upper part of the halite unit (MU).
LEB-02A (Alternate)	34.3381 35.1516	1811	618	0	618	Sampling the proximal part of the Nahr Menashe fluvial system (upper Messinian, UU). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, UU) and the upper part of the halite unit (MU).
LEV-03A (Primary)	33.1196 33.4983	1669	564	0	564	Sampling the basin plain lateral equivalent of the distal part of the Nahr Menashe fluvial system (upper Messinian, UU). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, UU) and the upper part of the halite unit (MU).
LEV-04A (Alternate)	33.1802 33.5230	1704	561	0	561	Sampling the sediments that are laterally equivalent to the distal part of the Nahr Menashe fluvial system (upper Messinian, UU). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, UU) and the upper part of the halite unit (MU).
ION-02A (Alternate)	35.8480 18.1455	4013	1018	0	1018	Sampling the dolomitised sediments in the upper Messinian (Lago Mare?) and basal Pliocene oozes. Sampling the distal part of the Eo-Sahabi/Chad fluvial system (upper Messinian). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, K-Mg salts) and the upper part of the halite unit.
LEV-01B (Primary)	33.3284 33.1666	1733	648	0	648	Sampling the distal part of the Nahr Menashe fluvial system (upper Messinian, UU). Sampling the Upper Evaporites (gypsum-anhydrite, carbonates, UU) and the upper part of the halite unit (MU).