IODP Proposal Cover Sheet

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Mediterranean-Atlantic Gateway Exchange

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Title	Investigating Miocene Mediterranean-Atlantic Gateway Exchange (IMMAGE)
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Area	Either side of Gibraltar Strait

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Abstract

Marine gateways play a critical role in the exchange of water, heat, salt and nutrients between oceans and seas. The advection of dense waters helps drive global thermohaline circulation and, since the ocean is the largest of the rapidly exchanging CO2 reservoirs, this advection also affects atmospheric carbon concentration. Changes in gateway geometry can therefore significantly alter both the pattern of global ocean circulation and associated heat transport and climate, as well as having a profound local impact.

Today, the volume of dense water supplied by Atlantic-Mediterranean exchange through the Gibraltar Strait is amongst the largest in the global ocean. For the past five million years this overflow has generated a saline plume at intermediate depths in the Atlantic that deposits distinctive contouritic sediments in the Gulf of Cadiz and contributes to the formation of North Atlantic Deep Water. This single gateway configuration only developed in the early Pliocene, however. During the Miocene, a wide, open seaway linking the Mediterranean and Atlantic evolved into two narrow corridors: one in northern Morocco; the other in southern Spain. Formation of these corridors permitted Mediterranean salinity to rise and a new, distinct, dense water mass to form and overspill into the Atlantic for the first time. Further restriction and closure of these connections resulted in extreme salinity fluctuations in the Mediterranean, leading to the formation of the Messinian Salinity Crisis salt giant.

IMMAGE is an amphibious drilling proposal designed to recover a complete record of Atlantic-Mediterranean exchange from its Late Miocene inception to its current configuration. This will be achieved by targeting Miocene offshore sediments on either side of the Gibraltar Strait with IODP and recovering Miocene core from the two precursor connections now exposed on land with ICDP. The scientific aims of IMMAGE are to constrain quantitatively the consequences for ocean circulation and global climate of the inception of Atlantic-Mediterranean exchange; to explore the mechanisms for high amplitude environmental change in marginal marine systems and to test physical oceanographic hypotheses for extreme high-density overflow dynamics that do not exist in the world today on this scale.

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Scientific Objectives

The objectives of the IMMAGE research program are:

Objective 1: To document the time at which the Atlantic first started to receive a distinct overflow from the Mediterranean and to evaluate quantitatively its role in Late Miocene global climate and regional environmental change.

Objective 2: To recover a complete record of Atlantic-Mediterranean exchange before, during and after the Messinian Salinity Crisis and to evaluate the causes and consequences of this extreme oceanographic event, locally, regionally and globally.

Objective 3: To test our quantitative understanding of the behavior of ocean plumes during the most extreme exchange in Earth's history.

These objectives require sediments that can only be recovered by undertaking both onshore drilling in Morocco and Spain and offshore drilling in the Alborán Sea and on the Moroccan and Iberian Atlantic margin. The drilling strategy for IMMAGE is therefore amphibious.

IMMAGE's scientific objectives 1 and 2 fall under IODP's science plan for Climate and Ocean Change: Reading the Past, Informing the Future, addressing Challenges 1, 2, 3 and 4 specifically and ICDP's focus on Global Cycles and Environmental Change. Objective 3, however, goes beyond the remit of the science plans of both ICDP and IODP by providing an unparalleled opportunity to test physical oceanographic representations of extreme high-density overflow dynamics. This objective will provide key insights into the role and behavior of all marine gateways and their impact on global climate.

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

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Proposed Sites (Total proposed sites: 8; pri: 3; alt: 5; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
ALM-01A (Primary)	37.4317 -9.5767	1567	990	0	990	To recover a thick, shallow Late Miocene succession which contains distal Mediterranean overflow deposits. The main contribution of this site is that it captures the evolution of the equilibrium depth of the plume and hence tests quantitative constraints on the behavior of dense overflows (Objective 3). In addition, the high resolution (precessional) record we will recover at this site is a key component of the complete record of Mediterranean-Atlantic exchange during the Late Miocene-Pliocene (Objectives 1 and 2).
ALM-02A (Alternate)	36.8359 -9.7481	2265	1630	10	1640	To recover a thick, shallow Late Miocene succession which contains distal Mediterranean overflow deposits. The main contribution of this site is that it captures the evolution of the equilibrium depth of the plume and hence tests quantitative constraints on the behavior of dense overflows (Objective 3). In addition, the high resolution (precessional) record we will recover at this site is a key component of the complete record of Mediterranean-Atlantic exchange during the Late Miocene-Pliocene (Objectives 1 and 2).
MOM-01A (Primary)	35.240956 -6.747839	555	1460	10	1470	This site targets a complete late Miocene succession in the pathway of Mediterranean overflow linking the onshore record at RIF-01A with the distal site ALM-01A. The aim is to obtain a high-resolution (precessional) record of Miocene Mediterranean overflow. This record provides critical information for all three objectives.
MOM-02A (Alternate)	35.107278 -6.818264	712	997	10	1007	This site targets a complete late Miocene succession in the pathway of Mediterranean overflow linking the onshore record at RIF-01A with the distal site ALM-01A. The aim is to obtain a high-resolution (precessional) record of Miocene Mediterranean overflow. This record provides critical information for all three objectives.
GUB-01A (Alternate)	36.5256 -7.6059	637	911	10	921	This site targets a complete late Miocene succession in the pathway of Mediterranean overflow. The aim is to obtain a high-resolution (precessional) record of Miocene Mediterranean overflow at an intermediate site between the onshore records (RIF-01A and BET-01A) and the distal record (ALM-01A). This record makes a critical contribution to all three objectives
WAB-03A (Primary)	36.312544 -4.571213	800	1700	0	1700	This site targets one of the few thick late Messinian sedimentary successions in the Alboran Basin. The record recovered from this location will provide key constraints on the chemistry and physical properties of Mediterranean overflow during the Late Miocene. This is critical for all three objectives.
EAB-02A (Alternate)	35.75518251 -2.43956525	845	1277	0	1277	This site targets one of the few thick late Messinian sedimentary successions in the Alboran Basin. The record recovered from this location will provide key constraints on the chemistry and physical properties of Mediterranean overflow during the Late Miocene. This is critical for all three objectives. The site is located on the Spanish side of the Moroccan-Spanish territorial boundary, very close to the other alternate site EAB-03A.
EAB-03A (Alternate)	35.750427 -2.431305	838	1277	0	1277	This site targets one of the few thick late Messinian sedimentary successions in the Alboran Basin. The record recovered from this location will provide key constraints on the chemistry and physical properties of Mediterranean overflow during the Late Miocene. This is critical for all three objectives. The site is located on the Moroccan side of the Moroccan-Spanish territorial boundary, very close to the other alternate site EAB-02A.