IODP Proposal Cover Sheet

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Mediterranean - Black Sea Gateway Exchange

Received for: 2021-10-01

Title	BlackGate: Understanding the dynamic evolution of the Mediterranean-Black Sea gateway and its paleoenvironmental consequences
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Keywords	Gateways, Paleoenvironment, Anoxia, Biogeochemistry, Tectonics
Area	Northern Aegean, Sea of Marmara, Black Sea

Proponent Information

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Abstract

BlackGate aims to address fundamental questions concerning the dynamic evolution of the Mediterranean-Black Sea (MBS) gateway and its paleoenvironmental consequences. The importance of Mediterranean connectivity has been recognised, and several accepted IODP projects (IMMAGE, DEMISE) are currently directed at a better understanding of the Miocene gateway systems that led to the rise and demise of the Mediterranean Messinian Salinity Crisis, the youngest and largest salt giant in Earth history, and its consequences for global climate change. The missing link for a comprehensive understanding is the poor constraints on the hydrological fluxes through the Mediterranean-Black Sea gateway, derived from a huge catchment that at times drained much of Europe and Asia. This gateway also drives the Pliocene-Quaternary circulation patterns in the Black Sea and governs its status as the world's largest example of marine anoxia. The exchange history of the MBS gateway is poorly constrained because continuous Pliocene-Quaternary deposits are not exposed on land adjacent to the Black Sea or North Aegean. Gateway exchange is controlled by climatic (glacio-eustatic driven sea level fluctuations) and tectonic processes in the catchment (linking the Black and Caspian seas) as well as tectonic propagation of the North Anatolian Fault zone in the gateway area itself. Changes in MBS connectivity trigger dramatic paleoenvironmental and biotic turnovers. Drilling a Messinian to Recent transect in the Aegean, Marmara and Black seas will recover high-amplitude records of continent-scale hydrological changes during glacial-interglacial cycles, marine and fresh water fluxes, biological turnover events, patterns and processes of anoxia, chemical perturbations and carbon cycling, growth and propagation of the NAF, existence of land-bridges for Africa/Asia-Europe mammal migration and presence/ absence of water exchange during the Messinian salt giant. We propose to use a MSP to drill three sites, one on the Turkish margin of the Black Sea (Arkhangelsky Ridge 400mbsf), one on the southern margin of the Sea of Marmara (North Imrali Basin 750mbsf) and one in the Aegean (North Aegean Trough 650mbsf). All sites target Quaternary oxic-anoxic marl-sapropel cycles. Pliocene lacustrine sediments and mixed marine-brackish Miocene sediments will be recovered from the Black Sea and Aegean. MSP drilling is required because JOIDES Resolution cannot pass under the Bosporus bridges. The wider scientific objectives are in line with the aims and scope of the IODP overall Science Plan, Illuminating Earth's Past, Present, and Future, and relate specifically to the themes Earth's climate, deep life and geohazards.

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Scientific Objectives

1) To reconstruct the morphological evolution of the Mediterranean-Black Sea (MBS) gateway in Messinian-Quaternary times
2) To quantify the time-lag between the arrival of Atlantic waters in the Aegean, Marmara and Black seas at the onset of marine connectivity and evaluate its environmental consequences.
3) To constrain the linkage between the hydrological connection in the MBS gateway and widespread anoxia, biological turnover, and organic carbon burial in the gateway region.
4) To document environmental variability in the highly sensitive, restricted Black Sea on a variety of time scales ranging from years (varves) to glacial-interglacial (orbital) to millions of years as driven by the interplay of climate, local and global sea level, nutrient inputs, tectonics, macro- and micro-ecology, and the overall regional water balance.
5) To elucidate the effects of variations in bottom water oxygen, salinity, and input of organic carbon on microbial communities and biogeochemical processes in a deep biosphere environment that is strongly influence by organic-rich sedimentation and pronounced upward fluxes of methane.
6) To identify how growth and propagation of strike-slip faults in the continental domain affect gateway dynamics and geohazards.

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

The following sampling and measurement must take place on board the MSP vessel and be compliant with the Nagoya Protocol:
- Salinity, methane, ammonium, hydrogen sulphide, and alkalinity analyses;
- Porewater samples collected with rhizons, subsampled without exposure to the atmosphere and stored at 4°C or -20°C.
- Sediment samples for geochemical speciation require storage in an inert atmosphere (argon or nitrogen) at -20°C. Sterile sampling techniques are required for the geomicrobiology samples.
- Geomicrobiology requires sterile sampling should storage in an inert atmosphere at -20°C or -80°C.

Have you contacted the appropriate IODP Science Operator about this proposal to discuss drilling platform capabilities, the feasibility of your proposed drilling plan and strategies, and the required overall timetable for transiting, drilling, coring, logging, and other downhole measurements?

yes

Science Communications Plain Language Summary

Using simple terms, describe in 500 words or less your proposed research and its broader impacts in a way that can be understood by a general audience.

Over the past seven million years, the opening and closure of the aqueous connection between the Black Sea and Mediterranean has triggered numerous environmental crises that have had significant repercussions for the region's marine and terrestrial ecosystems. The current gateway configuration is controlled by the North Anatolian Fault, one of the most active strike slips in the world today. Tectonic activity along this fault has resulted in compartmentalized circulation systems in the North Aegean, Marmara and Black seas. This makes the region susceptible to rapid, basin-specific fluctuations in salinity, oxygen concentration and sea level. For example, today on the Mediterranean side of the gateway the environment is fully oxygenated, with salinity conditions slightly higher than the open ocean, while the much fresher Black Sea is the largest anoxic basin on Earth and a major carbon sink. Spatial and temporal changes in environmental conditions with profound impacts on local, regional and global biodiversity are governed by subtle changes in climate, sea level and tectonics. We have little understanding about the critical thresholds that force these basins and we lack fundamental insights into the causal mechanisms between basin connectivity/threshold evolution and environmental collapse. This is because there are no continuous Pliocene-Quaternary deposits on land adjacent to the Black Sea or North Aegean, no scientific drill cores from the Aegean or the Sea of Marmara and the available DSDP cores in the Black Sea are disturbed by core gaps, erosional events and the deposition of slumped material, making them unsuitable for high-resolution reconstruction of paleoenvironmental change.
The BlackGate project proposes to drill a transect of three sites across the gateway using a mission specific drilling platform (MSP) because the size of ship able to access the Black through the Bosphorus is limited. The aim is to recover continuous high-amplitude records of paleoenvironmental change over the last seven million years recovered from the Black Sea, Marmara and North Aegean. These cores will allow us to: understand the role of global climate in controlling exchange across the gateway; identify the mechanisms that link gateway exchange, anoxia, biological turnover, and organic carbon burial; reconstruct environmental variability in the Black Sea region and its extensive catchment which at times covers much of Europe and Asia; determine the effects of variable bottom water oxygen, salinity, and input of organic carbon on microbial communities and biogeochemical processes in the deep biosphere; understand how growth and propagation of strike-slip faults in the continental domain affect gateway dynamics and earthquakes.

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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	
AEG-01A (Primary)	39.5046 23.8769	1120	730	0	730	Key objective is to recover a complete sedimentary sequence down to the Messinian, including detailed records of the Pliocene and Quaternary. This site is located on seismic line 103 from the NAFAS expedition that was held in 2017. The site occupies a relative plateau in the southern, deepest part of the North Aegean Trough. We expect to drill Quaternary and Pliocene cemented sediments and Messinian clastic sediments with potential intercalation of thin evaporite layers. We will perform microbiological and geochemical analysis to 1) identify sea-level variations, 2) determine paleo-environment, 3) investigate strike-slip fault activity.
AEG-02A (Alternate)	39.7998 24.0763	960	650	0	650	Key objective is to recover a complete sedimentary sequence down to the Messinian, including detailed records of the Pliocene and Quaternary. This site is located on seismic line 13-14 acquired during the YPOTHER/ Aegean expeditions that were held in 2013-2015. The site occupies a relative plateau in the central, deep part of the North Aegean Trough, just south of the Sithonia peninsula. We expect to drill Quaternary and Pliocene cemented sediments and Messinian clastic sediments with potential intercalation of thin evaporite layers. We will perform microbiological and geochemical analysis to 1) identify sea-level variations, 2) determine paleo-environment, 3) investigate strike-slip fault activity.
MAR-01A (Primary)	40.6535 28.8465	346	400	0	400	Key objective is to obtain a complete record of Quaternary sea level fluctuations including the corresponding hydrological/geochemical transitions.
MAR-02A (Alternate)	40.7386 28.3505	399	400	0	400	Key objective is to obtain a complete record of Quaternary sea level fluctuations including the corresponding hydrological/geochemical transitions.
BSB-01A (Primary)	41.9603 36.6858	375	470	0	470	Key objective is to obtain a complete record of the Quaternary (3 holes) and late Miocene to Pliocene (2 holes) sediments of the Black Sea Basin. The site is located on the SE end of the NW-SE-extending Arkhangelsky Ridge. The sites have been selected because of the relatively undeformed sequence and the absence of turbidites and mass complex deposits. We expect to reach the Messinian unconformity. We aim to resolve 1) Quaternary paleoenvironmental change, 2) deep biosphere records, 3) marine incursions, 4) climate signals from Mio-Pliocene lacustrine deposits.
BSB-02A (Alternate)	41.9744 36.7307	370	370	0	370	Key objective is to obtain a complete record of late Miocene to Pliocene sediments of the Black Sea Basin, avoid of major mass transport complexes. The site is located on the SE end of the NW-SE-extending Arkhangelsky Ridge. The sites have been selected because of the relatively undeformed sequence between the seafloor and we expect to reach the Messinian unconformity. We aim to resolve 1) paleoenvironmental change, 2) marine incursions, 3) climate signals from lacustrine deposits.
BUL-01A (Alternate)	42.5215 28.8657	1595	650	0	650	Key objective is to obtain a complete record of late Miocene to Pliocene sediments of the Black Sea Basin, avoid of major mass transport complexes. The drill-line for this site is the BS-20 2D seismic reflection profile acquired during the “Geology Without Limits” project in 2011. The site is located in the southernmost part of the Bulgarian deepwater slope, very close to the Turkish maritime border. Bulg1 has been selected because of the relatively undeformed sequence between the seafloor and we expect to reach the Messinian unconformity. We aim to resolve 1) paleoenvironmental change, 2) marine incursions, 3) climate signals from lacustrine deposits.
BUL-02A (Alternate)	42.2385 29.0502	1724	670	0	670	Key objective is to obtain a complete record of late Miocene to Pliocene sediments of the Black Sea Basin, avoid of major mass transport complexes. The drill-line for this site is the BS-20 2D seismic reflection profile acquired during the “Geology Without Limits” project in 2011. The site is located in the southernmost part of the Bulgarian deepwater slope, very close to the Turkish maritime border. Bulg1 has been selected because of the relatively undeformed sequence between the seafloor and we expect to reach the Messinian unconformity. We aim to resolve 1) paleoenvironmental change, 2) marine incursions, 3) climate signals from lacustrine deposits.