Magellan Plus Workshop
September 22-24, 2021, (Frankfurt)

BlackGate

Black Sea – Mediterranean Gateway Exchange

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Final Report for ECORD/IODP

BlackGate: Black Sea-Mediterranean Gateway Exchange

Introduction:

Marine gateways are the lifelines for restricted basins like the Mediterranean and Black Sea, as they govern the regional and global expressions of first-order hydrologic, climatic, and environmental change. They play a critical role in the exchange of water, heat, salt, and nutrients between oceans and seas and hence impact regional and global climate and marine and terrestrial biodiversity (e.g. Flecker et al., 2015). The complex evolution of the Mediterranean gateways over the past 7 million years caused environmental challenges that severely impacted marine and terrestrial biota in Eurasia. During the Messinian, the Black Sea gateway opened, and the Atlantic gateway progressively closed as the Mediterranean developed into a largely desiccated saline giant and later into a brackish water lake-sea (Lago Mare) during the Messinian Salinity Crisis (MSC; 5.97-5.33 Ma) (Roveri et al., 2014; Andreetto et al., 2021). Two-way exchange with the Black Sea probably persisted (Vasiliev et al., 2013; Grothe et al., 2020), and its brackish water faunas expanded over the entire Mediterranean as far west as the Malaga Basin adjacent to Gibraltar (Guerra-Merchán et al., 2010). The exact hydrologic fluxes remain uncertain because the dimensions of the Black Sea gateway are poorly constrained (Fig. 1). A recent re-evaluation of the late Miocene faunal evolution in the Northern Aegean basins exposed new paleogeographic scenarios strikingly different from conventional views, illustrating the need to improve our understanding of the timing and location of critical gateways (Krijgsman et al., 2020).

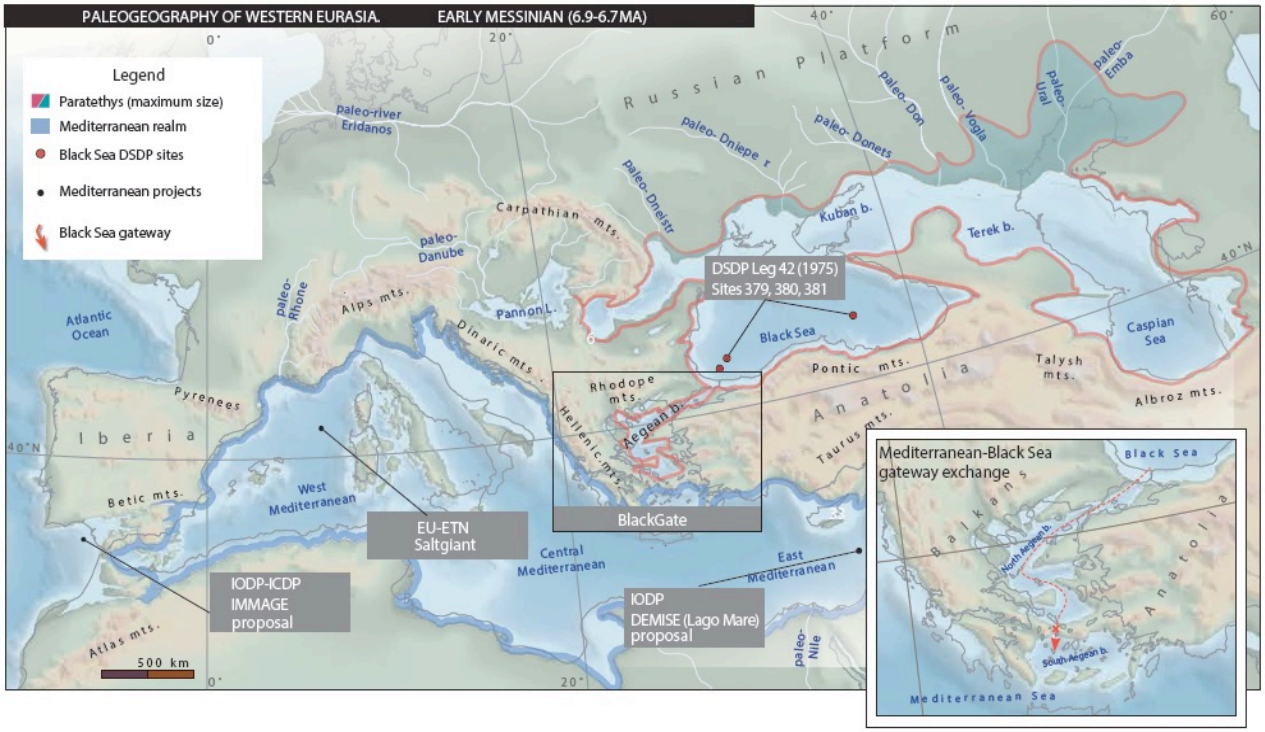

Fig.1 Late Miocene paleogeography of Eurasia showing context of BlackGate. Inset shows the hypothetical Miocene Black Sea-Mediterranean gateway through the Aegean and Marmara seas.

The global importance of dynamic Mediterranean connectivity is realized by the scientific community, and several projects are currently directed at a better understanding of the Mediterranean gateway system: the EU-funded ETN Saltgiant initiative focuses on the formation of thick evaporite units in the Mediterranean, the IODP-ICDP amphibious IMMAGE project will be directed at the evolution of the Mediterranean-Atlantic connection, and the IODP project "DEMISE of a salt giant: climatic-environmental transitions during the terminal Messinian Salinity Crisis" aims to unravel halite deformation of the eastern Mediterranean saltgiant. The missing link for comprehensive understanding of the Mediterranean hydrologic and environmental evolution is the poor understanding of the hydrological fluxes from the Black Sea domain. At the same time, these gaps limit our understanding of Black Sea evolution and its broader value in studies of abrupt marine-nonmarine transitions and widespread anoxia through history. For example, the Mediterranean-Black Sea gateway determines the fresh water flux for continental Eurasia (from the Alps in Germany to the Himalayas in western China), which may significantly influence salinity, temperature, and stratification in the Mediterranean. The gateway also influences circulation patterns in the Black Sea ($\leq$ 2000 m deep) and its status as the world's largest example of marine anoxia. This condition dominated the global ocean for the first 90% of Earth history and intermittently over the last 500 million years (Lyons et al., 2014), including ocean-scale anoxic events (OAEs) that are often marked by mass extinction.

Objectives and outcome:

The exchange history of the Black Sea-Mediterranean gateway is poorly constrained because continuous Pliocene-Quaternary deposits are not exposed on land adjacent to the Black Sea or northern Aegean. Gateway exchange is controlled by climatic and tectonic processes and changes in Black Sea-Mediterranean 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 and allow us to reconstruct marine and fresh water fluxes, biological turnover events, patterns and processes controlling anoxia, chemical perturbations and carbon cycling, growth and propagation of the North Anatolian Fault Zone, the timing of land-bridges for Africa/Asia-Europe mammal migration and presence/absence of water exchange during the Messinian salt giant. The Black-Gate workshop was so successful that we directly wrote and submitted a preliminary proposal for the IODP October 1, 2021 deadline with the following three themes:

- Generation of high-resolution integrated continental-scale climate, sea surface temperature, salinity, anoxia and thermohaline circulations records
- Impact of Black Sea-Aegean gateway connectivity on biogeochemical processes and subseafloor microbial communities,
- Reconstruction of the detrital provenance and tectonic history of the gateway basins and the surrounding mountains.

To achieve these scientific goals, we propose to use an MSP to drill three sites, one on the Turkish margin of the Black Sea, one on the southern margin of the Sea of Marmara and one in the northern Aegean. 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.

References

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Vasiliev, I., et al. (2013). Impact of the Messinian Salinity Crisis on Black Sea hydrology - Insights from hydrogen isotopes analysis on biomarkers, *Earth Planet. Sci. Lett.*, **362**, 272-282, doi: 10.1016/j.epsl.2012.11.038

Workshop Structure:

The MagellanPlus workshop "Black Sea-Mediterranean gateway exchange: BlackGate" was hosted by the Senckenberg Biodiversity & Climate Research Centre in Frankfurt, Germany. The BlackGate workshop was sponsored by MagellanPlus, and co-sponsored by USSAC (5 scientists from the USA) and Saltgiant (4 Early Stage Researchers from the EU). It took place on September 21-24. The aim of the workshop was to frame scientific objectives and to select suitable drilling sites to MSP-drill a transect to recover the Messinian to Recent (~7 Myr) sedimentary sequences in the Northern Aegean, Marmara and Black seas. In order to achieve this, the workshop brought together 30 scientists in attendance (plus 7 participating online) from 12 different countries, and from multiple disciplines, ranging from geology, paleoclimatology, paleontology, biogeochemistry, tectonics and reflection seismics, including 11 Early Career Scientists. The workshop involved numerous scientists with expertise in the Black Sea-Mediterranean geology-tectonics-paleoclimatiology-paleoenvironment and fundamental bio-geochemical processes characterising the domain (anoxia and hypersalinity). The more experienced core of researchers was backed up by early career scientists (* in schedule) and subdivided into 5 Working Groups (WG).

- WG1 (Drilling & Logging, Johanna Lofi & Gabor Tari) will be responsible for drilling engineering, downhole logging and monitoring. A comprehensive dataset will be provided to characterize the lithostratigraphy of the borehole and to correlate petrophysical properties with stratigraphy in the Black Sea, Marmara and Aegean basins.

- WG2 (Paleoclimate/Paleoenvironment, Iuliana Vasiliev, Maria Triantaphyllou) will coordinate and optimize paleoclimate-related analytical programs to be performed at the different partner institutions. This group will also oversee the sampling requests and the production plan of the datasets and set out publication goals and timelines.
- WG3 (Geomicrobiology/Biogeochemistry, Timothy Lyons, Caroline Slomp) will be responsible for efforts to explore the deep biosphere, including subsurface microbiological hotspots resulting, for example, from abrupt variations of salinity and organic content (e.g., juxtaposed organic-rich sapropels and organic-lean lake deposits) on century and millennial times scales. The first-order goal is to identify how ecologies shifted and life responded to paleoenvironmental change, including major transitions and resulting patterns in carbon cycling and burial.
- WG4 (Tectonics/Sedimentology/Stratigraphy, Anouk Beniest, Namik Cagatay) will be responsible for reconstruction of the detrital provenance, low-temperature geochronology, tectonic history of the gateway basins and the surrounding mountains and for addressing how the North Anatolian Fault affects gateway exchange.
- WG5 (Synthesis, Wout Krijgsman, Rachel Flecker) will be responsible for correlating the borehole results with other drilling results from the Black Sea and Mediterranean, and assessing how gateway exchange affected the Mediterranean saltgiant.

The workshop followed the standard format of concurrent topical breakout sessions on scientific, technical, and funding themes that subsequently reported back to the main group. Breakouts were designed to include individual and complementary disciplines and broadly mixed expertise, with reporting back to the entire group for discussion.

Fig. 2: Participants of the BlackGate workshop in the garden of the Senckenberg Biodiversity & Climate Research Centre

Workshop Programme:

Tuesday September 21st

17:00 – 22:00 *Icebreaker with running BBQ to welcome all at the Senckenberg Institute garden*

Wednesday September 22nd

09:00 – 09:20: Welcome & introduction of the Workshop aims (Andreas Mulch & Wout Krijgsman)
09:20 – 09:40: Keynote talk (Dan Palcu*)
09:40 – 10:00: Keynote talk (Namik Cagatay)
10:00 – 10:20: Keynote talk (Maria Triantaphyllou)
10:20 – 11:00: PICO presentations ECR participants (2 min/person)

11:00 – 11:30: Coffee break

11:30 – 11:50: Keynote talk (Iuliana Vasiliev)
11:50 – 12:10: Keynote talk (Timothy Lyons)
12:10 – 12:30: Keynote talk (Caroline Slomp)
12:30 – 13:00: Discussion to identify key overarching research topics

13:00 – 14:00: Lunch break

14:00 – 15:00: Break-out session 1: define key-questions in interdisciplinary working groups (per age interval)
15:00 – 15:30: Reconvening for summary break-out results

15:30 – 16:00: Coffee break

16:00 – 17:00: Break-out session 2: elaborating overarching key questions (mixed communities)
17:00 – 18:00: Synthesize the two break-out sessions and list the most important research questions.

18:30 *Dinner at the Senckenberg Institute, followed by optional drinks in the garden*

Thursday September 23rd

09:00 – 09:20: Keynote talk (Rachel Flecker)
09:20 – 09:40: Keynote talk (Fadl Raad*)
09:40 – 10:00: Keynote talk (Johanna Lofi, online).

10:00 – 10:30: Coffee break

10:30 – 10:50: Keynote talk (Anouk Beniest*)
10:50 – 11:10: Keynote talk (Gunay Cifci)
11:10 – 11:30: Keynote talk (Gabor Tari & Özgür Sipahioglu)
11:30 – 12:30: Discussion to identify key suitable drilling locations

12:30 – 13:30 Lunch break

13:30 – 14:30: Break-out session 3: define best drilling locations in interdisciplinary working groups (per region)
14:30 – 15:00: Reconvening for brief group discussions

15:00 – 15:30: Coffee break

15:30 – 17:00: Break-out session 4: elaborating overarching drilling sites (mixed communities)
17:00 – 18:00: Synthesize the break-out session results and list the most important outcomes. How to best combine the different research questions? The main topics? What is are the key overarching goals?

18:30 *Dinner at the Senckenberg Institute, followed by optional drinks in the garden*

Friday September 24th

09:00 – 11:00: Metrics discussion with the whole group: high-risk/low-cross, colour-coding, what seems the most successful? Discussion and decision about how many cores we want to drill and how many basins.

11:00 – 11:30: Coffee Break

11:30 – 13:00: Identifying the crucial points for the proposal; wrap up with future planning/follow up activities

13:00 – 14:00: Lunch break

BlackGate Workshop: participant list

In person	Surname	Name	M/F	ECS	Country	Affiliation
1	Agiadi	Konstantina	F		AU	Vienna
2	Andreetto	Federico	M	*	NL	Utrecht
3	Arz	Helge	M		DE	Leipniz
4	Beniest	Anouk	F	*	NL	Amsterdam
5	Bulian	Francesca	F	*	ES	Salamanca
6	Butiseaca	Geanina	F	*	DE	Frankfurt
7	Cagatay	Namik	M		TR	Istanbul
8	Cifci	Gunay	M		TR	Istanbul
9	Flecker	Rachel	F		UK	Bristol
10	Giosan	Liviu	M		USA	Woods Hole
11	Gorini	Christian	M		FR	Paris
12	Gulyuz	Erhan	M		TR	Van
13	Henry	Pierre	M		FR	Aix
14	Huang	Yongsong	M		USA	Brown
15	Kaymakci	Nuri	M		TR	Ankara
16	Krijgsman	Wout	M		NL	Utrecht
17	Lazarev	Sergei	M	*	SW	Fribourg
18	Lourens	Lucas	M		NL	ECORD
18	Lyons	Timothy	M		USA	Riverside
19	Mandic	Oleg	M		AU	Vienna
20	McHugh	Cecilia	F		USA	New York
21	Moneron	Jimmy	M	*	IS	Jerusalem
22	Palcu	Dan	M	*	BR	SaoPaolo
23	Raad	Fadl	M	*	FR	Montpellier
24	Sakellariou	Dimitris	M		GR	Athens
25	Skampa	Elisabeth	F	*	GR	Athens
26	Slomp	Caroline	F		NL	Utrecht
27	Tari	Gabor	M		AU	OMV
28	Triantaphyllou	Maria	F		GR	Athens
29	Vasiliev	Iuliana	F		DE	Frankfurt
30	Wegwerth	Antje	F		DE	Leipniz
31	Wesselingh	Frank	M		NL	Leiden
32	Yanchilina	Anastasia	F	*	USA	St. Louis
online						
33	Bista	Diksha	F	*	UK	Bristol
34	Gasperini	Luca	M		IT	Bologna
35	Hoyle	Thomas	M	*	UK	Cambridge
36	Lofi	Johanna	F		FR	Montpellier
37	McInroy	David	M		UK	ESO
38	Molina-Hernandez	Javier	M		UK	London
39	Sipahioglu	Özgür	M		TR	Ankara