

## Bottlenecks

In our final blog we will re-capture our journey through the Mediterranean as it is not very often that one gets to travel from one end almost to the other. The Mediterranean is unique because of its numerous passages and straits. These maritime bottlenecks also characterized our journey, but luckily proved to be the only bottlenecks we had to break! So come along with us and take our tour again through Mare Nostrum, our sea, and learn about its rich cultural and geological inheritance while we are heading towards the port of Heraklion on our last transit, enjoying every glimpse of the sea that we get while packing our equipment, cleaning the labs and getting hooked on the data that we collected over the last weeks – just like scientists do!



See you all back home in a little while,

Heidrun Kopp  
*Chief Scientist MSM-71, at sea*

P.S. The narrow marine straits were the only bottlenecks we had to break during MSM71 – so a big THANK YOU to Sebastian M., Mario B. and Iris S. in the galley for three weeks of culinary treats and of course to Benjamin R. and his troops from the machine, who kept everything running.

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[From the Canary Islands to Crete: sailing the Mediterranean straits, Part I](#)  
[Marine straits and their and their place in geological history](#)

*By Anouk Beniest, UPMC*

The Maria S Merian left Las Palmas de Gran Canaria on the 7<sup>th</sup> of February 2018 at 4 in the afternoon. Our final destination is the harbour of Heraklion on the island of Crete. In 22 days at sea we have to recover 29 broadband Ocean Bottom Seismometers (OBS). In addition, we will deploy another 48 OBSes and Ocean Bottom Hydrophones (OBH) along two different

profiles. To do so, we need to cross the Atlantic and reach the Ligurian Sea through the strait of Gibraltar. Then, after recovery of all stations, we sail through the Strait of Bonifacius in between the islands of Corsica and Sardinia. Next we'll pass the Ionian Sea through the Strait of Messina. To reach Heraklion, the last strait to take would be the Strait of Kythira – Antikythera. Where do these narrow seaways come from? And what role did they play in recent geological history?

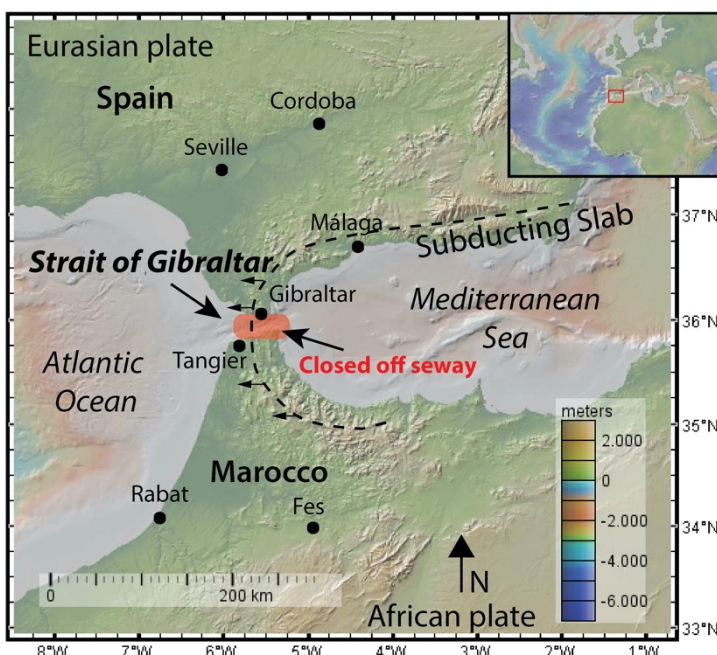


*The Maria S Merian in the harbour of Las Palmas de Gran Canaria, one day before departure.*

*Photo: D. Lange, GEOMAR*

### *Strait of Gibraltar*

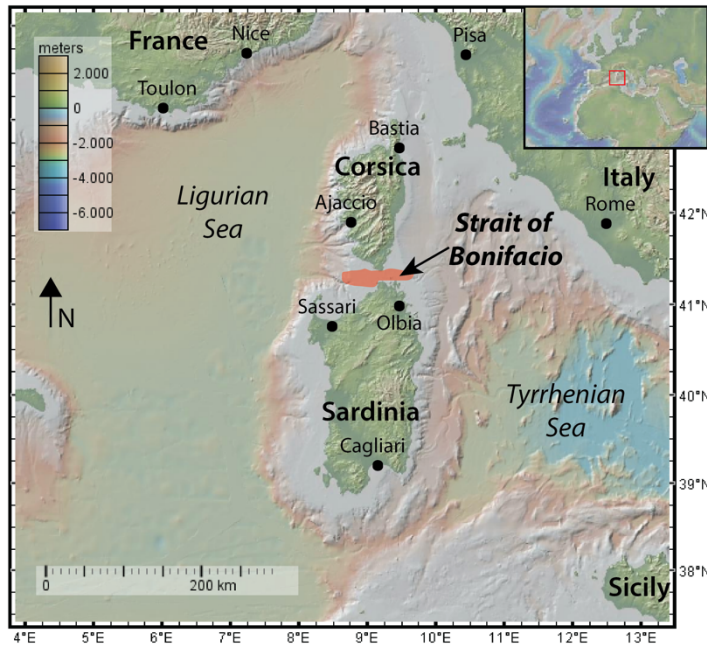
The Strait of Gibraltar separates the African and Eurasian plates by a 14.3 km stretch of water. Before Africa and Europe became located so closely together, the Tethys Sea separated the two continents. When subduction of the Tethys Ocean was initiated some 90 Ma the Strait of Gibraltar resulted from the northward moving African plate. The narrow seaway has played a major role during the late Miocene, when around 5.9 Ma when it caused a separation between the Mediterranean waters and the Atlantic Ocean. As a result, limited amounts of less salty and fresh waters entered the Mediterranean basin and it dried out, leaving a massive package of salt at the bottom of the basin. This crisis is now known as the Messinian Salinity Crisis. Only 600.000 years after the closure of the basin, around 5.3 Ma, the barrier at Gibraltar was breached and the so-called 'Zanclean flood' filled the basin with water. Over the last 5 myr, sediments have been deposited, covering the salt layers and the Mediterranean Sea as we know it nowadays is the result.



*Map of the Strait of Gibraltar, showing the retreating slab and the region that was closed off during the Messinian salinity crisis in 5.33 Ma.*

### *Strait of Bonifacio*

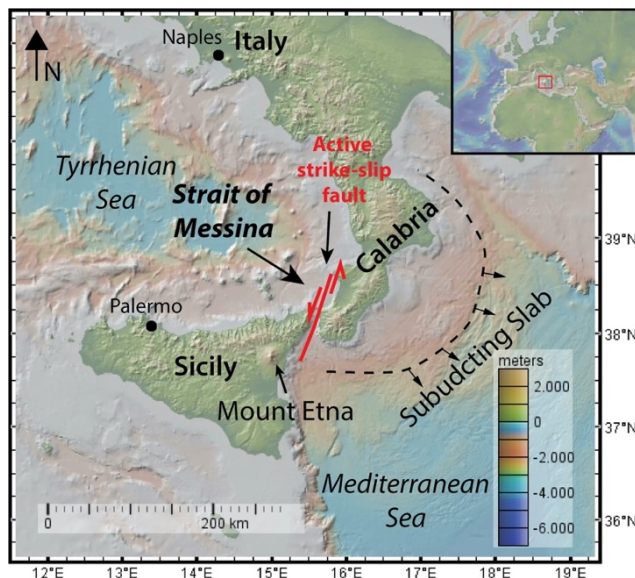
The islands of Corsica and Sardinia are separated by the 11 km wide Strait of Bonifacio. Both islands are made of granite and limestone and throughout a large part of their existence they behaved as one big crustal block. To the west and east of the islands the crust is under extension resulting in the Ligurian Sea and the Tyrrhenian Sea. The strait itself is rather shallow, not more than 100 meters deep. It is part of a deep ravine that would surface in prehistoric times when sea level was low. Then the passage would form a land bridge between the two islands.



*Map of the Strait of Bonifacio, showing the Ligurian and Tyrrhenian seas that are connected through the Strait of Bonifacio.*

### *Strait of Messina*

The Strait of Messina is only 3.1 km wide and separates the island of Sicily from mainland Italy. Currents are strong and in the old days the passage was feared by seafarers. But not only the currents make it a dangerous region. This strait is also one of the most seismic active regions in the Mediterranean realm. In 1908 an earthquake of 7.1 produced a 10 meter high tsunami-like wave and caused 60.000 casualties. Through the seaway a strike-slip fault runs NE-SW. Activity over the last 2.5 million years along this fault has been detected by marine terraces that are now above sea level on the island of Sicily. One of the reasons for the tectonic activity in the region is the retreating, subducting slab below Calabria, mainland Italy.

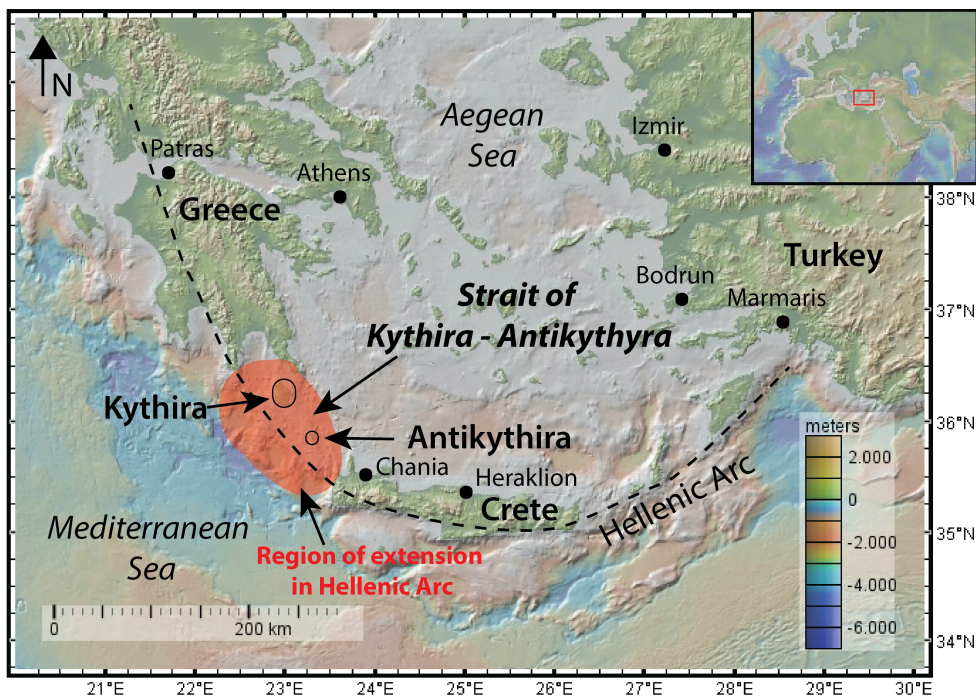


*Map of the Strait of Messina showing the retreating subducting slab southwest of Calabria and the active strike-slip fault that runs through the Strait of Messina.*



### *Strait of Kythira – Antikythera*

The Strait of Kythira – Antikythera is the widest seaway we will pass through on this mission. It measures roughly 100 km in width and the islands of Kythira and Antikythera are lying in the strait. South of Greece, the Mediterranean Sea is over 4000 meters deep. The passage is much shallower, only 150 meters deep or at some points even less. This is because the Strait of Kythira – Antikythera is a submerged part of the Hellenic Arc, which runs from south-west Greece, through Crete until western Turkey. Compared to the rest of the western Hellenic Arc, the submerged part is being extended faster than the onland parts over the last couple of million years. For that reason, the crust is thinner and submerged, creating a seaway from the Aegean Sea into the deeper Mediterranean Sea.



*Map of the Strait of Kythira – Antikythera showing the Hellenic Arc and the region of relative more extension and thinning that was eventually submerged and provided the seaway between mainland Greece and the island of Crete.*

## From the Canary Islands to Crete: sailing the Mediterranean straits, Part II In the steps of ancient traders

*Von Anouk Beniest, UPMC*

The Maria S Merian, bound for Heraklion, on the isle of Crete, needs three weeks to get there, including the deployment and recovery of some 50 OBS (Ocean Bottom Seismometers) and OBH (Ocean Bottom Hydrophone) systems. Like there are many ways that lead to Rome, there are many sea routes that lead from Gran Canaria to Crete. From the broad Atlantic waters (photo 1) to the narrow passages in the Mediterranean Sea (photo 2-5), on this journey, we encounter all. Most of the small straits we sail through have been explored and used to the advantage of lost cultivations. How did ancient seafarers use the straits? Who were the people that did all the exploration for us so we can now safely use these passages to cross the Mediterranean from west to east?



*A rainbow on the vast Atlantic Ocean after sailing out of Las Palmas de Gran Canaria. Photo: A. Beniést, IGP*

### *Strait of Gibraltar*

The Canary Islands are located in the middle of the Atlantic Ocean. Before the Maria S Merian reaches the western gateway of the Mediterranean Sea, the Strait of Gibraltar, the Atlantic Ocean has to be crossed. At its narrowest point, the strait measures only 14.3 km. This very short distance has been used by several cultivations through history. According to Wikipedia, Carthagians, Romans, Moors and Berbers all used the strait, mainly used for campaigning and travelling. It has not always been a cross-way though. By the end of the 15<sup>th</sup> century the Strait of Gibraltar functioned as a barrier, when the last Muslim governors were driven out by the Spanish. Ever since this event, both sides of the strait developed distinct cultures, languages and religions.



*Sunrise over the Strait of Gibraltar as seen from the Monkey Island of the Maria S Merian. Photo: A. Beniést, IGP*

### *Strait of Bonifacio*

After the recovery of the broadband stations that were deployed in the Ligurian Sea 8 months ago and the OBSs along the profiles, the Maria S Merian is headed for Heraklion. The Strait of Bonifacio is the second seaway we will sail through with the island of Sardinia the southern shores and Corsica to the north. Long before us, the Romans used this strait to ship western European goods, e.g. Spanish wines and olive oils to Italy. The route is known though as treacherous due to heavy currents, rocky parts and winds. One of the most famous shipwrecks in the area is the one of the *Sélimante*, a French ship that left Toulon with over 650 people on board and a load of gunpowder for the Crimea war. In February 1855 it was surprised by a heavy storm and the ship exploded on the islands along the southern shores of Corsica, leaving no survivors. In the 90's a tanker disaster occurred in the strait and ever since ships with dangerous goods are highly discouraged to take this seaway.



*Passage through the Strait of Bonifacio. La Maddalena Archipelago (Italy) is on the left, L'île Ratino (France) is to the right*

*Photo: A. Beniest, IPGP*

### *Strait of Messina*

The narrowest waterway on this journey is the Strait of Messina between the island of Sicily and mainland Italy. The passage measures only 3.1 km at its narrowest point. The currents in the strait are rough and alternate between south to north and north to south every 6-8 hours, thereby dropping the water level with 15-20 cm. The rocky coast and the heavy currents made it a seaway feared by sailors in the antiquity. The two settlements on Sicily (Melae in the north, Messene in the east) were founded as early as 750 BC to protect the passageway for unwelcome visitors. The cities were also used by merchants sailing goods, who were in need of a safe harbour when the strait could not be sailed in bad weather conditions.



*Tight throughway at the Strait of Messina* Photo: A. Beniest, IPGP

### *Strait of Kythira – Antikythera*

To reach the final harbour of this scientific mission, the Maria S Merian will sail through the Strait of Kythira-Antikythera, which connects the Mediterranean Sea with the Aegean Sea. Compared to the other straits, the Strait of Kythira – Antikythera is rather wide with a width of roughly 100 km. But don't take this as an easy crossable strait as many ships sank as a result of strong winds. Like the Strait of Messina, this passage was considered dangerous by the Greeks themselves, as many ships wrecked on the southern coast of the Peloponnese

peninsula. Still, traders from northern Greece, Istanbul and the Black Sea harbours used it to get their goods to the occidental civilisations.