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Tectonic activity and fluid flow along WNW-ESE trending lineaments in the Gulf of Cadiz: Preliminary results of Expedition M149

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In the Gulf of Cadiz off SW Iberia and W Morocco a 600 km wide WNW-ESE trending band of dextral strike-slip faults connects two segments of the plate boundary between Eurasia and Africa: the Gloria fault to the west and the Riff-Tell fault zone to the east. The band has important implications on the understanding of the plate tectonic framework and the generation of earthquakes and tsunamis in this region, such as the well-known Lisbon earthquake of 1755 (8.5–9.0 Mw). This is why Expedition M149 with the German research vessel Meteor set out in July 2018 to study the tectonic activity and fluid flow associated with those oceanic transform faults. During the expedition a comprehensive program of seafloor mapping, in situ heat flow measurements, short and long core sampling of mud volcanoes and fault zones was conducted. A special focus was also reserved to mud volcanoes, which in the Gulf of Cadiz are acting as windows to depth given their hydraulic connection to deeper (potentially seismogenic) levels of fault zones.

Here, we report on preliminary results from three faults located within the WNW-ESE band of transform faults: the Lineament Center, the Hermes fault, which is an east-west trending strike-slip fault branching from the Lineament Center, and the Lineament South. The faults are cutting through the Gulf of Cadiz accretionary wedge, where water depths of <2000 m allowed the deployment of the seafloor drill rig MeBo. At the Lineament Center and on the summit of the nearby Ginsburg mud volcano, the MeBo drilled two 20 m deep boreholes, which were successfully closed with long-term observatories that will measure pore pressure and temperature over the next few years. Another 50 m long sediment core was recovered in a small pull-apart basin along the Hermes fault and a fourth core was retrieved along the Lineament South (40 m long). The lithostratigraphic records show several turbidites (in fining-upward sequences) throughout the recovered sediment succession probably representing seafloor gravitational movements (Mass Transport Deposits, MTDs) due to faults slip activity in the past. The cores also show sharp contacts, tectonically displaced layers and abundant fluid seepage structures at different depths. In a preliminary assessment of the obtained heat flow and pore water profiles, our data corroborate the notion of active fault systems. Further gravity cores recovered from the fault zones will provide insight into the tectonic activity and fluid flow in the Gulf of Cadiz region during post-expedition analyses of the lithostratigraphic record.