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New constraints on the kinematics of the western Sinai Microplate: geodynamic implications

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The tectonic nature of the Sinai Microplate's western boundary is clouded with uncertainties. Early studies suggested that the western edge of Sinai is fully connected to the African Plate, thus concluding that Sinai is a sub-plate. Later, bathymetric analyses of prominent lineated faults straddling across the western edge of the Levant Basin have suggested that, in fact, this area is a plate boundary that accommodates dextral motion between the African Plate and the Sinai Microplate. However, this inference contradicts geological and geophysical observations across the Gulf of Suez, the southern continuation of the same plate boundary. Here we present preliminary results from a recent geophysical cruise aboard the R/V Bat Galim. We focused our investigation on one of the major faults, oriented in an NW-SE direction (located ~80 km southwest of the Eratosthenes Seamount), creating the plate boundary. We collected high-resolution shallow multichannel seismic reflection data complemented with multibeam bathymetry data. We also acquired two piston cores near the trace of the fault. These observations unravel the shallow three-dimensional structure of the fault system whereby several curved and steeply dipping normal fault segments are splayed from the main fault trace in a westerly direction. These secondary faults display a back-tilted and step-like morphology. This structure is best explained by a sinistral motion acting along the master fault. Independently, we present an updated Africa-Sinai Euler pole based on the motion of GPS stations recorded between 1996 and 2019. The results suggest that Sinai is moving in a northwesterly direction with respect to Africa (1.7-1.9±0.9 mm/yr). Focal mechanism solutions calculated for recent earthquakes occurring in this region (Mw>4.5) agree with the geodetic constraints of a sinistral relative motion.

Overall, these observations suggest that the western boundary of Sinai has been, and still is, accommodated sinistral motion relative to Africa. This conclusion implies that the Sinai Microplate is moving faster with respect to Eurasia relative to the motion of Africa with respect to Eurasia. This, in turn, seems to be in conflict with the notion that subduction of the oceanic lithosphere north of the Sinai Microplate (i.e., east of Cyprus) has recently ceased. We speculate that the downgoing slab might still promote the relatively fast northward motion of Sinai and/or a northward drag force induced by large-scale mantle flow related to the Afar plume could also contribute to the motion of the Sinai Microplate.