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Imprints of the Messinian Salinity Crisis on the geomorphology of the Malta Escarpment (Mediterranean Sea)

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During the Messinian salinity crisis (MSC), between 5.97 and 5.33 Ma, the Mediterranean Sea became disconnected from the world's oceans and a fast and continuous evaporation generated its partial desiccation, resulting in the deposition of more than one million cubic kilometres of salt. The extent of the evaporative drawdown phases associated to the MSC remain poorly constrained, particularly in the central Mediterranean. In this study we investigate the geomorphology of the Malta Escarpment to provide answers to these questions. We use multibeam echosounder, seismic reflection data, and gravity cores to identify more than two hundred linear to arcuate scars and more than two hundred canyons. The largest of the canyons – Noto, Cumecs, and Heron Canyons – are up to 100 km long and 39 km wide. We also identify concave breaks of slopes and terraces, the most extensive of which are located in the northern Malta Escarpment, and which are 70 km long and 2478 m deep, and 25 km long and 2545 m deep. Along most of the base of the northern Malta Escarpment, the western Ionian Basin seafloor is characterised by a series of ridges that are up to 8 km long, have an average height of 30 m and are spaced 2-3 km apart. Seismic reflection profiles from the western Ionian Basin show the occurrence of lenses of intermediate amplitude and sub-parallel reflectors, which are up to 0.2 s (TWTT) thick and 8 km wide, downslope of the large canyon mouths and beneath the evaporite sequence. Gravity cores from the large submarine canyons feature sandy turbidites and debrites.

We propose that during the MSC, base level fall, fluvial erosion formed a dense network of canyons across the Malta Escarpment whilst coastal erosion developed extensive palaeoshorelines and shore platforms. We carry out an isostatic restoration of the palaeoshorelines and shore platforms on the northern Malta Escarpment to infer an evaporative drawdown of 1800 – 2000 m in the eastern Mediterranean Sea during the MSC. We interpret the occurrence of pre-evaporite sedimentary lobes in the western Ionian Basin as suggesting that either evaporative drawdown and canyon formation occurred predominantly before salt deposition, or that only the latest salt deposition at the basin margin occurred after the formation of the sedimentary lobes. After the MSC, the drivers of geomorphic evolution of the Malta Escarpment included: (i) canyon erosion by submarine gravity flows, with the most recent activity taking place <2600 cal BP; (ii) deposition by bottom currents across the entire depth range of the Malta Escarpment; (iii) widespread, small-scale sedimentary slope failures triggered by oversteepening and loss of support due to canyon erosion.