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Noto Canyon, Sicily: Terminal Spillway of the Zanclean Flood and Earth's Largest Fossil Waterfall Indicating a ~2200 m Sea-Level Drawdown

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The subsequent refilling of the Mediterranean Sea following the Messinian Salinity Crisis (~5.33 Ma) represents one of the most extreme flood events in Earth history.

The magnitude of the sea level drawdown during the Messinian Salinity Crisis is heavily debated since its discovery in the 70s. Previous studies utilized a diverse range of methods and proxies to quantify the drawdown. Estimates vary significantly, spanning from less than 500 metres to more than 2 km. This variability largely reflects the method-dependent nature of the reconstructions: flexural–isostatic models typically yield lower drawdowns (hundreds of metres), geomorphic canyon analyses suggest intermediate to large values (~500–1500 m), while evaporite mass-balance and isotopic approaches imply the highest drawdowns, consistent with kilometre-scale or greater drops in the Eastern Mediterranean.

New marine seismic reflection data reveal a prominent, amphitheatre-shaped, erosional scarp at the base of the Noto Canyon, whose morphology and dimensions are consistent with its interpretation as the terminal spillway of the Zanclean Flood. The feature represents the largest fossil waterfall identified to date. The morphology of the canyon and the geometry of its scarp, including its amphitheatre shape, relief, and lateral extent, are the products of the extraordinary hydraulic energy unleashed during the catastrophic Atlantic inflow.

The geological setting is challenging, featuring steep canyon flanks, out-of-plane reflections, and complex sedimentary layering. Notwithstanding, the geomorphology that has been preserved enables an estimation to be made of a sea-level drawdown of approximately 2200 m in the Eastern Mediterranean. Numerical hydrological and landscape-evolution models reproduce similarly large drawdowns, but emphasise temporal and local variability rather than a single static lowstand, suggesting that much of the published spread reflects methodological sensitivity, rather than fundamentally incompatible sea-level scenarios.

These findings demonstrate the substantial influence of gateway geomorphology in constraining past sea-level changes, and provide a more accurate understanding of both the magnitude and erosional impact of the Zanclean Flood and the associated ~2200 m sea-level drawdown in the

Eastern Mediterranean, with broader implications for Mediterranean palaeogeography and hydrodynamics during extreme paleo-flood events.