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Decoupling between fluvial aggradation-incision dynamics and paleo-denudation rates during the last glacial cycle, Crete, Greece

Richard Ott[1,2], Dirk Scherler[1], Karl Wegmann[3], Mitch D'Arcy[4], Susan Ivy-Ochs[5], Marcus Christl[5], and Christoph Vockenhuber[5]

[1]Earth Surface Geochemistry, German Research Centre for Geosciences, Potsdam, Germany (richard.ott@gfz-potsdam.de)
[2]Department of Earth Sciences, ETH Zürich, Zürich, Switzerland
[3]Department of Marine, Earth and Atmospheric Sciences & Center for Geospatial Analytics, North Carolina State University, Raleigh, U.S.A.
[4]Department of Earth, Ocean and Atmospheric Sciences, University of British Colombia, Vancouver, Canada
[5]Ion Beam Physics, ETH Zürich, Zürich, Switzerland

The impact of Quaternary climate cycles on denudation as well as fluvial aggradation and incision is debated, especially in regions that did not experience glaciation. Here we present a record of paleo-denudation rates, and geochronologic data constraining aggradation and incision from the Sfakia and Elafonisi alluvial sequences on the island of Crete, Greece. We report seven new optically stimulated luminescence (OSL) and ten new radiocarbon ages, as well as eight ^{10}Be and eight ^{36}Cl denudation rates from modern and terrace sediments. At the Elafonisi fan system, we identify four periods of aggradation, where marine isotope stages (MIS) 2, 4, and likely 6 correspond to aggradation periods, and MIS 1, 3, and likely 5e are characterized by incision. The dating of paleoshorelines indicates constant uplift over the past 71 ka, at rates of 1.2 mm/a. Aggradation occurred throughout the entire glacial cycle at the Sfakia fan, followed by up to 50 m of incision in the past 10 ka. Chronological constraints indicate that aggradation rates were particularly high during MIS 2 and 4, analogous to the Elafonisi fan system. However, our paleo-denudation rates indicate mostly constant denudation throughout the past 80 ka; with only two samples indicating an up to 50% increase in paleo-denudation rates compared to modern rates. Nearby climate and vegetation records show that MIS 2, 4, and 6 were characterized by cold and dry climate with sparse vegetation, whereas forest cover and wet conditions prevailed during MIS 1, 3, and 5. Our data suggest that variations in climate and vegetation cover were not sufficient to markedly alter landscape-wide denudation rates, but that changes in hydroclimate and vegetation exerted a strong control on the aggradation-incision behavior of the drainages. During relatively cold stages, low vegetation cover and river sediment transport capacity led to aggradation, whereas the increased river transport capacity during relatively warm stages caused subsequent incision. We therefore hypothesize that the studied catchments show a decoupling between transport-limited streams responding to climate forcing and near-steady hillslope denudation.