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Quantifying chemical dissolution and mechanical weathering in carbonates and clastic rocks using multiple cosmogenic nuclides and water chemistry Crete, Greece

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Quantifying chemical versus mechanical weathering in carbonate catchments has proven problematic due to the difficulties estimating the long-term total or mechanical denudation in carbonates. On Crete similarly to other Mediterranean regions, carbonate massifs form high mountain ranges whereas topography is lower in areas with clastic-metamorphic rocks. This observation suggests that differences in denudation among more carbonate rich rocks and more quartzofeldspathic units imparts a fundamental control on topographic form. Here we present 16 new cosmogenic 10Be and 4 cosmogenic 36Cl basin average denudation rate measurements from clastic and carbonate bedrock catchments. This data is used to quantify the differences in substrate erodibility between carbonate and clastic-metamorphic bedrock and compared to dissolution rates calculated from 70 new and published water samples from Crete to quantify the amount of dissolution responsible for the long-term denudation in carbonate catchments. Water cation concentrations are then used to calculate modern carbonate dissolution rates in all catchments from river, spring and groundwater data. Basin average denudation rates of clastic-metamorphic units in western Crete are $\sim$ 0.1 mm/a, which is a magnitude lower than coastal uplift rates measured in southwestern Crete. Basin average denudation rates derived from 36Cl in the 4 carbonate catchments were slightly higher than catchments draining clastic-metamorphic rocks. These differences in erosion rate are possibly a result of the higher total relief at the margins of carbonate massifs. Average dissolution rates measured from all different water sources in carbonate areas yield a mean dissolution rate of $\sim$ 0.06 mm/a, suggesting that only about half of the mass-loss is attributable to dissolution processes and mechanical weathering plays an important role at the catchment scale weathering of carbonates. Carbonate dissolution in clastic-metamorphic units is negligible. The prominence of carbonate massifs on the island of Crete likely does not solely reflect a difference in erodibility compared to clastic-metamorphic units, but might also be related to a tectonics and/or isostatic rebound.