Long-term erosion and exhumation rates in the Romagna Apennines, north-central Italy

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The Romagna Apennines, Italy, are part of a recently uplifted mountain range that exposes a uniform sequence of Miocene turbidites exhumed from beneath a heterogeneous Ligurian nappe. Fission-track thermochronometry shows that: 1) the Ligurian nappe was thicker in the hinterland, and; 2) exhumation of the Miocene rocks was rapid, from 0.2 mm/yr at the toe of the range to 1.2 mm/yr at the crest. Cosmogenic nuclides can better quantify recent erosion rates across this tectonically active range. We use cosmogenic ^{10}Be to determine both modern erosion rates from river sediment and paleo-erosion rates from Pleistocene nearshore sands, and compare these with existing thermochronometry.

Catchment-averaged erosion rates were determined both near the crest and at the toe of the Romagna Apennines, at thirteen sites across five drainage basins. Erosion rates are nearly uniform, from 0.3 to 0.5 mm/yr, in contrast to variable long-term exhumation rates. Paleo-erosion rates were determined at three other sites in the northern and central Apennines: 1) Middle Pleistocene nearshore sands to the north, near Imola; 2) Lower Pleistocene nearshore sands to the south, near Ancona, and; 3) a cave containing river sands in the Frasassi Gorge to the south. At all of these sites, paleo-erosion rates range from 0.2-0.3 mm/yr at 1 Ma. Moreover, the river incision rate determined at the Frassassi gorge is 0.15-0.30 mm/yr. Together, these data suggest uniform erosion rates in the Romagna Apennines.

Because exhumation rates are controlled, at least in part, by erosion rates, we would expect cosmogenically-derived erosion rates and long-term exhumation rates from thermochronometry to be similar. Yet the patterns and rates of erosion are significantly different. It is not likely that erosion rates have changed over different timescales, because our paleo-erosion rates and published fission-track ages are determined from rocks that are similar in age. Instead, the difference may reflect lithologic control on erosion rates. Thermochronometry records the erosion rate of the overlying Ligurian nappe, composed of quartz-poor lithologies. Cosmogenic nuclide data from both modern stream sands and paleo-shore deposits record erosion rates of underlying, quartz-rich sandstones. The data can be reconciled if the sandstone erodes more slowly than the Ligurian cover. Existing models show that erosionally resistant sandstone in a tectonically active wedge can drive wedge growth and stimulate topographic uplift.