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The influence of rock mass strength on the erosion rate of alpine cliffs in the Sierra Nevada, California, USA

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Collapse of cliff faces by rockfall is a primary mode of bedrock erosion in alpine terrain and exerts a first-order control on the morphologic development of these landscapes. In this work, we investigate the influence of rock mass strength on the retreat rate of alpine cliffs. To quantify rockwall competence we employed the Slope Mass Rating (SMR) geomechanical strength index, a metric that combines numerous factors contributing to the strength of a rock mass. The magnitude of normal cliff retreat was calculated by estimating the volume of talus at the toe of each rockwall and projecting that material back on to the cliff face, while accounting for the loss of production area as talus buries the wall. Selecting sites within basins swept clean by advancing LGM glaciers allowed us to estimate the duration of talus accumulation and calculate rockwall erosion rates. Our study area included a portion of the Sierra Nevada between Yosemite NP and Lake Tahoe. Rockwall erosion rates determined for 40 alpine cliffs in this region range from 0.02 to 1.22 mm/year, with an average value of 0.28 mm/year. We found good correlation between rockwall recession rate and SMR that is best characterized by an exponential decrease in erosion rate with increasing rock mass strength. Analysis of the individual components of the SMR reveals that joint orientation is the most important parameter affecting the rockwall erosion rate. The complete SMR score, however, best synthesizes the lithologic variables that contribute to the strength and erodibility of these rock slopes. Our data reveal no independent correlations between rockwall retreat rates and environmental attributes (e.g. elevation, aspect, slope length, and slope angle), suggesting that rock mass strength is the

dominant parameter controlling the rate of cliff erosion in our study area.