Tectonics and shore platform development: Rates and patterns of erosion on recently uplifted mudstone and limestone rocks at Kaikōura Peninsula, New Zealand

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On tectonically active rock coasts, there is a dearth of erosion data documenting how rocks adjust (either fast or slow) in response to marine and subaerial processes immediately after coseismic uplift. Here we report erosion rates and evidence of reshaping of shore platform morphology on intertidal- and previously subtidal- rocks at Kaikōura Peninsula, South Island New Zealand. As a result of the November 2016 Kaikōura 7.8 (Mw) earthquake, platforms around the peninsula were uplifted by ~1.01 m, extended in width, and a 43-year active erosion monitoring campaign was abruptly halted but an opportunity to record how rocks respond to sudden environmental change like tectonics was presented. High-resolution topographic data obtained from quarterly surveys over four years using the micro-erosion meters (MEM) and Structure-from-Motion Multi View Stereo (SfM-MVS) surveys have provided accurate quantitative rates of erosion and visual representation of surface morphologies. MEM erosion data revealed variations in erosion, weathering and deposition rates across lithology, seasons, tidal positions, and platform elevation after the uplift. Four-years post-uplift erosion data shows a resetting of erosion rates and faster rock breakdown on both mudstone and limestone lithologies compared to pre-uplift rates. Over the 4-year period, surface downwearing rates for all platforms was 2.19 mm/yr, a 99.9% increase from a pre-uplift rate of 1.10 mm/yr. Average lowering rates on limestone, hard mudstone and soft mudstone platforms are 1.31 mm/yr, 2.13 mm/yr and 3.60 mm/yr, respectively. Seasonal trends in erosion rates remain unchanged as higher rates are still experienced during summer than winter seasons due to greater periods of higher temperatures and increased wetting and drying cycles. A year after uplift, previously reported across shore variations where erosion rates decreased from inner/landward margins of the platform to the outer/seaward sections disappeared with higher erosion rates fluctuating across all platform sections. Increased lowering rates on limestone rocks at the inner and outer sections were attributed to greater periods of wetting and drying, and loss of biological cover. These initially rapid rates decreased on the seaward sections after 3 years as a result of bioprotection and increased tidal wetting. On one of the harder mudstone rocks, a dramatic increase from a pre-uplift erosion rate of 0.43 mm/yr to 19.23 mm/yr (1-year after uplift) and subsequent decline to 1.54 mm/yr after four years is suggestive of isolated incidents of block detachment and erosion. For the first time, we
complement MEM data with available SfM-MVS derived orthomosaics to provide evidence of changing rock morphology and processes such as intense granular disintegration, flaking, algal growth, and boring. On tectonically active rock coasts, the strong fluctuations in erosion rates and platform morphological expressions indicate the actions of not only waves, tides, and weathering processes but also tectonics in shore platform development.