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The functioning of polar rocky coast systems under warming climate

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Recent years have brought major advances in our understanding of cold region coastal processes operating in longer ice-free periods and adapting to accelerated sediment supply from rapidly transforming polar landscapes. However, the major progress in cold region coastal research was achieved along Arctic ice-rich permafrost coasts with only limited progress in rocky coastal environments typical of numerous still glaciated Arctic and Antarctic islands. This is a significant research gap as cold region coastlines are dominated by rocky types and it is expected that future infrastructure development in high latitudes will concentrate on rocky coasts recognised as more stable than unlithified permafrost shores.

This paper presents the results of an investigation into the processes controlling development of polar rock coast systems in Svalbard and South Shetland Islands. A mosaic of geomorphological and geophysical techniques have been applied to characterize the functioning of rocky cliffs and shore platforms and stacks influenced by lithological control and geomorphic processes driven by periglacial climate. Rock hardness, quantified by SHRT, demonstrate strong spatial control on the degree of rock weathering along studied rock coasts. Elevation controlled geomorphic zones are identified and linked to distinct processes, transitioning from peak hardness values at the icefoot zone through the wave-dominated scour zones to the lowest values on the cliff tops, where the effects of periglacial weathering dominate [1]. Observations of rock surface change using a TMEM indicate that significant changes in erosion rates occur at the junction between shore platform and the cliff toe, where rock erosion is facilitated by frequent wetting and drying and operation of nivation and sea ice processes [2]. ERT surveys have been used to investigate frozen ground control on rock coast dynamics and reveal the strong interaction with marine processes [3].

In our Svalbard key site, contrary to an expected acceleration in erosion rates, associated with the extension of ice-free period, we observed a reduction in rock cliff retreat over the 60 year timeframe. We think that this reduction is an indication of a shift from periglacial to marine domain, more akin to mid-latitude environments. We noted rock surface sensitivity to both global and local influences and exploring regional variations in coastal process zones of Svalbard, an area of unique climate sensitivity within the region.

The results are synthesised to propose a new conceptual model of polar rock coast systems.

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