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# Glacial pumping of a magma-charged crustal lithosphere

Alexander Wilson and Kelly Russell
University of British Columbia, Earth, Ocean and Atmospheric Sciences, Vancouver, Canada (awilson@eoas.ubc.ca)

For tectonic environment like Iceland where the lithosphere is thin, it is shown that glacial loading and unloading can affect rates and timing of magmatism. However, in continental arcs where the lithosphere is substantially thicker, the generation of subduction-related magmas is unlikely to be influenced by glacial loading and unloading events. Rather, inputs of magma to the crust are probably supplied at a steady, background rate. If causal linkages between volcanic eruptions and glaciers exist in these environments, they must relate to the processes that modulate transport and storage of magmas within the crustal lithosphere. Glacial loading and unloading of continental and mountain-scale ice sheets is well-known to lead to crustal depression and rebound on timescales of <10 ka. Over the last glacial cycle, the crust overlying the southwestern Canadian Cordillera, was flexed downward by ∼300 m. Isostatic rebound largely occurred over a period of ∼5 ka, following the demise of the last Cordilleran Ice Sheet. During this time, there was a significant increase in the frequency and volume of volcanic eruptions. We use a cylindrical, thin-plate bending approximation to calculate accumulated, horizontally-oriented fiber stresses of up to several 10's of MPa within the crust during loading. During isostatic depression, the fiber stresses are compressive in the upper half of the lithosphere and tensile in the lower half. These magnitudes of accumulated stresses have the potential to modulate magma transport and storage by hindering or enhancing dike propagation. To test this, we develop a Monte Carlo simulation that tracks the relative positions of magma-filled dikes in the crustal column during the various stages of depression and rebound. We find that ice loading causes an overall suppression in volcanism, while unloading acts to evacuate the crust of stored magmas and causes an eruption spike immediately following deglaciation. We suggest that, through repetitive glacial cycling, this process could act as a "glacial pump" that amplifies and supresses volcanism.