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The erosive nature of pyroclastic density currents – A summary of findings from the 18 May 1980 Mt St Helens (USA) deposits with implications for future work

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Our understanding of the mechanisms and conditions that promote substrate erosion by pyroclastic density currents (PDCs) is evolving through the combination of field data and experiments. However, many questions remain as to how particle concentration, topography, and the nature of the substrate influence erosive capacity. PDC deposits from the afternoon of the 18 May 1980 eruption of Mount St Helens provide insight into the role of these parameters on erosive capacity of the parent currents. We combine depositional characteristics from PDC deposits across slopes of 5-30º with componentry and granulometry studies to elucidate (1) how topography influences current dynamics, and (2) where and into what substrate the PDCs eroded. Blocks up to 0.29-m in size, eroded from the underlying substrate, are found within the cross-stratified deposits along the steep flanks of the volcano. We interpret that acceleration, partial confinement and high surface roughness increased basal shear stress, resulting in substrate erosion. In the shallow-dipping pumice plain, blocks of 0.64-1.2-m in size were eroded from upstream debris avalanche (DA) hummocks. Eroded blocks are most prevalent just above the base of unit contacts, consistent with experimental findings that erosion occurs due to a pore pressure gradient at base of currents. Eroded blocks located high above unit contacts indicate entrainment occurs within currents whose deposits aggrade upwards. Stratification and grain fabric at the PDC-DA contact also suggest basal shear stress due to irregular topography is important. Finally, an extensive ground penetrating radar study tracks a 200-m-wide scour-and-fill channel from an exposure in the distal region toward source, providing evidence of self-channelization and insight into the consequences of channelization on later PDCs. Our work demonstrates that topography and the nature of the substrate strongly influence PDC dynamics and erosive capacity, and motivates the need to further understand the consequences of substrate erosion on runout.