Pyroclastic Density Currents from the May 18th, 1980 Eruption of Mt St Helens (Washington, USA) - Uncovering the influence of surface roughness, substrate erosion and self-channelization

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Detailed measurements of recently exposed strata from the May 18, 1980 eruption of Mt St Helens, Washington, provide substantial insight into the influence of surface roughness, substrate erosion, self-channelization and varying mass flux on the dynamics of pyroclastic density currents (PDCs). The infamous eruption began with the debris avalanche and lateral blast that swept across the north side of the volcano, leaving behind a modified, deforested terrain of variable slopes and irregular topography. The afternoon PDC phase occurred several hours into the Plinian eruption and was dominated by column collapse and boil-over PDC behavior. Debris avalanche hummocks scattered across the pumice plain, north of the volcano, provided meters to 10s of meters of vertical relief for later PDCs to interact with. The first PDCs to traverse the hummocky topography left behind the fines-depleted, stratified to diffusely-stratified deposits of Units 1 and 2. Vertically in the sequence, or as the terrain filled in, the deposits become more massive and the degree of fines depletion diminishes. This observation suggests bed shear stress, transport mechanisms and elutriation are strongly controlled by the degree of surface roughness. The climactic phase of the eruption produced the most voluminous and wide-spread PDCs (Units 3 and 4) which are characteristically massive and rich in lithic blocks. Lithic levee deposits in Unit 3 transition downstream into a 10 m deep, 130 m wide channel scour, which cuts into the earlier PDC deposits. This occurs in an area where debris avalanche relief is limited, suggesting self-channelization was important during the transport and deposition of Unit 3. The channel scour is filled with two lithic breccias of Units 3 and 4. The average size and percent of lithic blocks within Units 3 and 4 increase with distance from source, suggesting that self-channelization increases the carrying capacity of the flows. This counterintuitive trend of increased lithic size in more distal locations is also observed downstream from debris avalanche hummocks. Componentry analysis of the blocks downstream from hummocks demonstrates that many were eroded from the debris avalanche deposits (see abstract by Nicholas Pollock). However, as the hummocks were progressively filled in the percent of blocks derived from the hummocks approaches zero. Thus, while many interesting findings are associated with this work, the most important include our ability to understand the influence of self-channelization on carrying capacity of the currents and the influence of surface roughness on elutriation and substrate erosion. These observations have critical consequences for understanding the flow dynamics and hazard potential of PDCs.