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A complex interplay of sediment erosion and deposition during the 18 March 2007 crater-lake breakout lahar at Mt. Ruapehu, New Zealand

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The long-anticipated 2007 Ruapehu Crater Lake breakout lahar provided a unique opportunity to capture a complete dataset of a single mass-flow event. On 18 March 2017, the tephra dam that had been blocking the lake outlet collapsed, releasing 1.3 million m3 of water into the Whangaehu River channel. The generated flow reached its maximum sediment-carrying capacity at 22 km from source and continued to travel as fully-bulked lahar for at least another 40 km along the Whangaehu River. We focus on medial reaches, following attainment of the highest sediment concentrations (25-40 km) to evaluate sedimentary processes during the lahar passage by combining the depositional record with high-precision, pre- and post-event LiDAR topographic data and detailed observations of flow height, velocity and seismic energy.

LiDAR data reveal a broad alternating pattern of erosion and deposition along this sinuous river stretch with net-erosion dominating in straight sections and deposition mainly occurring on outer channel bends. The deposits comprise several discrete units that differ in grainsize, texture, thickness and distribution depending on local channel conditions and time-variant flow rheology. The dynamic flow data show a rapidly rising watery bow-wave ahead of the lahar, which emplaced bedded, moderately-sorted medium sands on middle- to high-level banks. High flow velocity and turbulence promoted erosion in near-channel sites. Overlying massive, reversely graded, very poorly-sorted sandy gravels were deposited by the highly sediment-charged main lahar body. Decrease in stage height and retreat of the concentrated flow back into the channel ceased deposition on the upper banks and initiated near-channel accumulation of thick, normally graded gravelly units at channel bends and a thin coarse sandy layer

along straight sections. The final depositional stage was marked by bedded, moderately to poorly-sorted sandy deposits in near-channel sites and initially on middle slopes, with pulses in the waning flow producing alternating layers of coarse and medium sands. The step-wise drop in flow stage resulted in simultaneous erosion of the previously deposited sediments and successive cutting of terraces.

The 2007 lahar event has provided more specific constraints on erosion and deposition rates and processes in relation to tempo-spatial flow variations and local river channel morphology that could help mitigate future risks to communities and infrastructure from such events.