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Horizontal and low-angle cross-stratifications from volcaniclastic sedimentary sequences: Outburst flood deposits, Numazawa and Ontake volcanoes, Japan

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This talk focuses on the formation and preservation of sedimentary structures such as horizontal and low-angle cross-stratifications in volcaniclastic sedimentary (lahar) sequences. The 5 ka outburst flood deposits in the Tadami river catchment, Numazawa volcano, Japan is presented as a first example. The flood, with a peak discharge of > 37,000–58,000 m3/s from ignimbrite-dammed valley left pumiceous gravelly sediments with meter-sized boulders in the flow path (Kataoka et al., 2008). Up to 30 m thick sequence attributed to the flood formed a low gradient fan of 10 km long and 1.5-3 km wide, covering an area of 18 km2 with a total volume of > 0.5 km3 at the downstream end of the Tadami River. Outcrop observations accompanied with extensive surveys of Ground Penetrating Radar (GPR) along 200 to 500 m lateral and longitudinal transects over the flood fan revealed bedforms of the deposits. The profiles show large internal cross structures with 2-5 m amplitude and 10s m wavelength indicating lateral/downstream accretion in flood fan deposits. Some of them are slightly inclined towards upstream (backsets) which may suggest upstream migration of bedforms. These cross stratifications in the GPR profiles correspond to low-angle cross-stratifications or horizontal stratifications observed in outcrops. In outcrops, the stratified flood deposits mainly comprises rounded pumice pebble and cobble gravel and sand sized mineral grains. Bedding structures include horizontal stratifications and low-angle, low-amplitude, long wavelength cross-stratifications that occasionally climb. Individual 5 cm to decimeters-thick bed sets are commonly inversely graded. The deposits imply 1) high sediment concentration within a flow and 2) aggradation and bedform migration occurred in relation with traction carpet sedimentation. Especially thick traction carpets were probably formed because of 1) high stream power to drive near bed layer deeper and 2) a density contrast among volcaniclastic particles (pumice, glass shards, and mineral grains) that may have enhanced hindered settling and persisted in traction carpet sedimentation. The paleohydrological estimation suggests that the flow continued for 18-30 hrs and resulted in the aggradational and thick sequence. Most of the flood deposits are well preserved since reworking of deposits occurred along the axis of the main channel as the flow waned, confined, and cut terraces.
The second example is a well-preserved flood deposit of a-rain-on-snow (ROS) event of April 20th, 2015 that-triggered lahar in the aftermath of 2014 eruption at Ontake volcano, Japan. The event resulted in sandy and gravelly hyperconcentrated flow deposits upstream, and well-sorted sandy normal streamflow deposits with parallel laminations downstream. Well-preserved downstream deposits indicate deposition under upper-flow regime conditions. The ROS-lahar deposits along the valley correspond to a single ROS event of 2015, even though the ROS conditions occasionally occurred before and after the 2014-15 season. This suggests that a lahar and resulting deposits form due to both the overloaded volcanic (eruptive) materials and ROS conditions.