Differentiating Transport Mechanism of Pumices in Hyperconcentrated-flows from Numazawa Volcano –Japan

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Introduction -The great majority of research on debris flows and the continuum of sediment processes associated with them in volcanic environment has been dominated by work in clastic material with density of 2.5 g/cm^3 to almost 2.8 g/cm^3. Within the continuum of processes occurring in them, Pierson (2005) recognized that hyperconcentrated flows have been too often overlooked and only seen as a transition phase, despite of the fact that they display particular characteristics.

Questions and Objectives - In the present contribution, the authors are looking at the role of pumice vesicular characteristics to understand how fast pumice sink in the liquid they are mixed with, in order to link the data to how it will affect the depositional characteristics.

Location - Numazawa volcano erupted last about 5,400 years ago and resulting in the emplacement of a 4 km^3 pumiceous pyroclastic flow deposit that temporarily impounded a large volume of water from the Tadami River. The failure of the ignimbrite dam, in turn, caused a breakout flood that reached down more than 150 km downstream the Niigata plain (Kataoka et al., 2008, 2009). The flood left mainly hyperconcentrated flow deposits several tens of meters thick, from which samples were collected. The flood deposits show bedding structures including sub-horizontal stratifications and low-angle, low-amplitude, long wavelength cross-stratifications. Individual bed sets are 5 cm to decimeters-thick, and they are commonly inversely graded. This suggests that traction carpet sedimentation occurred in the hyperconcentrated flow during the flood event.

Method - From a quarry site in the upstream part of the flood deposit, material ranging in size from >1cm long axis to <10 cm long axis was collected. At the laboratory, a first series of experiments investigated the role of capillarity absorption for flat cut surfaces, just put in contact with the water, using rectangular volumes cut from the pumice clasts. The change in weight by water absorption was measured using a Metler Toledo AG245 precision scale, with a measurement error in ideal condition of 0.001 mg A second set of experiments was the plunging of non-modified pumices in water for series of time periods ranging from 30 seconds to 3 weeks. The material was weighed before immersion in water, and in sequences of (1) minute scales, (2) day scales and (3) weeks using the same Metler Toledo AG245 precision scale. Similar experiments were repeated with a water mixer, and also with different levels of clay mixed with the fluid, as it is most likely that turbulence and clay content will modify the water integration in the pumice clasts.

Results - The results from the capillarity absorption, have shown a mass increase, changing rapidly from 6 g to 7 g in 10 seconds, and then following a power curve of $m=5.9t^{0.0711}$ (where m is the mass in gram and t the time in seconds) for a surface of absorption of 24mm x 10mm, providing an absorption rate per surface unit (ARS) decreasing in time following the power function $ARS = 0.109t^{-0.618}$. The results in turbulent fluid show that the mass first increases within the first minutes (it depends on the size of the pumice) before decreasing, showing that the pumice needs to increase its weight to gain sufficient mass, and then momentum to then start abrasion of its surface with other pumice clasts.

Discussion and Conclusion –Because small pumice clasts can double their mass within 5 seconds in water, and continue increasing at a lowering rate, this helps explain why the upper surface of the successions of traction carpets do not display erosional contacts, but rather undisturbed contacts. For two identical pumice clasts, the one located in a first deposited traction carpet will have a more important mass than the one arriving on top. This general rule however, should display some variations as a soaking process must have happened for the portion of the natural dam that was in contact with the impounded water.

Keywords: Numazawa Volcano, Hyperconcentrated flow, Breakout flood

