Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

HGM005-15 Room: Exibition hall 7 subroom 3 Time: May 25 14:11-14:24

Volcaniclastic apron formation and implications for a catastrophic outburst flood, Aso caldera, southwest Japan

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Syn- and post-eruptive volcaniclastic resedimentation by water process (i.e. lahar as Indonesian term) can be induced by heavy rain, snow and ice melt resulted from heat of pyroclasts, lava, or geothermal, direct draining of crater- or caldera-lake water by an eruption, and dam failure of crater- or intracaldera-lakes and volcanically dammed impoundments. Among them, catastrophic outburst floods by a breach of volcanic dam or caldera rim can cause large-magnitude ones with large volume of impounded water with sediments. The extreme floods can travel long distance from the source volcano that ultimately affect onto landform and hydrology further downstream areas and threaten human life and economy eventually. Many countries hosting active volcanoes have a potential to occur such a catastrophic flood by dam break.
This study focuses on geomorphic and sedimentary features in the Shira River catchment implying a volcanogenic catastrophic flood from Aso caldera southwest Japan, after the 90 ka Aso-4 ignimbrite eruption. A fan-shaped morphology spreading in west of the caldera rim of Aso volcano, namely Takuma gravel bed, is composed of 5-6 m thick, lithic rich hyperconcentrated flow facies including boulders with 1s m in diameter as outsized clasts. The deposits are totally aggradational with no channels and scours, indicating at least one single gigantic flood event occurred. Previous studies (e.g., Watanabe, 1998; 2001) showed the presence of three discrete horizons of lacustrine deposits in the intracaldera area after the 90 ka eruption and discussed possibility of draining of caldera lake water from the outlet in relation with active faults nearby the caldera rim. The boulderly sedimentary facies of the Takuma gravel bed does not match with the capability deduced by the present Shira River and its limited catchment size. Therefore, the Takuma gravel bed constituting the volcaniclastic apron is most probably derived from a gigantic outburst flood event with large volume and magnitude occurred by a breach of the caldera rim rather than from normal floods by meteorological triggers.