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Theoretical Analysis on the Conditions for Generating Pyroclastic Density Current during 2014 Eruption of Ontake Volcano

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I will present a preliminary result on the theoretical analysis on the condition that causes the collapse of an eruption column and generates pyroclastic density currents during the 2014 phreatic eruption of Ontake volcano, Japan by applying an integral model of buoyancy-generating turbulent plume. A video camera recorded the eruption column that was generated soon after the phreatic eruption of Ontake on September 27 has begun collapsed and flew down along the flank of the mountain as pyroclastic density currents. The behavior is significantly different from that of the eruption column spread high in the atmosphere as ash clouds during the 1979 phreatic eruption of Ontake. This implies that there are some differences in the source conditions at the vents among the two eruptions. Therefore, we discussed the physical conditions for the collapse of an eruption columns by applying a steady-state one-dimensional integral model of a turbulent plume that were modified to include the effect of the significant thermal expansion of entrained air to increase the buoyancy flux in an eruption column for properly describing the characteristic feature of a volcanic eruption column. The theoretical analysis based on the integral model yields that an eruption column collapses when a value of a constant that is directly proportional to the radius of a volcanic vent and the third root of the initial density of a gas-particle mixture in an eruption column and inversely proportional to the two-thirds root of the ejection speed of a gas-particle mixture at a vent and the two-thirds root of the temperature difference between inside and outside of the eruption column at the vent height is large. This implies that the pyroclastic density currents occurs during the 2014 eruption because the initial density of a gas-particle mixture in the eruption column is larger than that in 1979 eruption column because fields surveys indicate that there are no significant difference in the size of the vents and the temperature of the ejected materials among the 1979 and 2014 eruptions. The field surveys also indicate that the density of a gas-particle mixture of the 2014 eruption should have been significantly larger than that of the 1979 eruption because the former generated the largest eruption at the initial stage when the steam conduit under the ground was not yet completely established and the eruption involved a large amount of surrounding rocks.

Keywords: Ontake volcano, eruption column collapse, pyroclastic density current, integral model