Depositional and welding processes of dilute pyroclastic density currents

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[Introduction]

Welding is more commonly observed in massive ignimbrite than it is in tractionally stratified lithofacies. Viewed simplistically, this may be taken to suggest either that fully dilute currents tend to be colder than and so rarely produce welded deposits, or that evidence for hot, low-concentration transport is missing because agglutination (rapid welding within the base of current) widely prevents traction (e. g. Branney and Kokelaar, 2002). However, in contrast with the general tendency, we found welded deposits with tractionally stratified lithofacies in the pyroclastic deposits of 6.5 ka caldera-forming eruption, Kikai caldera. In a presentation, we will talk about depositional and welding processes of dilute currents during this eruption.

[Description]

We analyzed the stratigraphy, component, and lithology of the intraplinian current deposits on two islands of Kikai caldera. The maximum thickness of the deposit is about 20 m at the topographic depression in Satsuma Iwo-jima, and is about 3 m in Takeshima. In Satsuma Iwo-jima, the deposits show both cross-stratified facies (weakly welded) and stratified facies (weakly-densely welded), which change transitionally each other in vertical and horizontal in the same crop. Non-welded deposits in lower to middle units are characterized by fine-depleted (sorting=2~3, Md=-2~0), crystal-rich (CCF=5~8), and a drastic increase of obsidian clasts (8~25 wt%) and glass shards with thick bubble-wall. Non-welded deposits in middle to upper units are characterized by some lenticular breccias composed of lithic including submarine boulders. Welded deposits in lower to upper units are basically composed of vitric ash and deformed pumice. Fiamme occur in densely welded part. In Take-shima, the deposits are only weakly welded (no-fiamme) with stratified facies, keeping connecting sinter necks of vitric ash.

[Interpretation and Discussion]

Results of geological analyses indicate that the deposits were produced by Plinian column collapse with magma/water interaction near Satsuma Iwo-jima. The heterogeneous facies could be derived from the unsteady nature of currents. It is interpreted that dense coarse materials with boulders were segregated within the base of a current and elutriated fine materials deposited, progressively. Theoretically, if a large amount of seawater mixed with magma clasts in column, a current could be dilute and cold, resulted in non-welded, wet pyroclastic surge. On the other hand, if little amount of seawater mixed, a current could be dense and hot, resulted in welded, pyroclastic flow or ignimbrite. Studied current deposits were probably produced between above two extreme modes, in that, on condition that a little amount of seawater mixed. Entrained seawater could have promoted a fluidization of currents and a segregation of dense materials efficiently, resulted in currents being dilute and keeping hot (more than glass transition temperature). We conclude that dilute currents, produced by column collapse with a small m/w interaction, caused high shear rate within flow boundary and produced tractionally cross-stratified or stratified facies in Satsuma Iwo-jima. Only thin stratified deposits with connecting sinter necks of vitric ash, in Take-shima, show that current velocity was lower than in proximal area, and that agglutination was dominant process for welding rather than post-emplacement load compaction.