Petrological studies on the A.D.1909 lava dome of Tarumae volcano

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Tarumai volcano erupted in large scale Plinian style in A.D.1667 and A.D.1739. After those events, the eruption scaled down and the style changed from Plinian to lava dome effusion. This study focused on the latest 1909 lava dome eruption. The dome is 134 meters high with a basal diameter of ca.450 meters. The total volume of the dome is estimated to be 0.10 kmˆ3. We collected 26 samples from the dome and examined by petrographic methods and XRF analyses. Four types of texture are recognized by macroscopic observation. Three types are volcanic and one type is metamorphic. Type 1: dense blocks of gray andesite sporadically dispersed on the dome surface. Type 2, 3: vesiculated rock constituting dome surface. Type 3 is a more vesiculated and somewhat weathered than type 2. Type 2 has larger microlite size and abundant microlite content in the matrix compared with the type 3, but have similar phenocryst content and assemblage. Bulk composition of Type 1 and 2 indicate the same fractionation trends, however composition of type 3 shows different trends in some elements. Plagioclase phenocrysts in the type 3 samples are often completely altered, which may be responsible for the lower CaO and Al2O3 contents and higher SiO2 contents of the type 3 samples. The type 4 represent pyrometamorphosed sedimentary rocks, characteristically including cordierite and andalusite. The magma temperatures were calculated from either two pyroxenes or iron-titanium oxides compositions using QUILF and Ishibashi and Ikeda (2005, JMPS). Pyroxene compositions suggest two assemblages representing two end member magmas for magma mixing. The lower temperature pyroxene assemblages indicate 910-930C, whereas the high temperature assemblages gave 1000-1020C, independent of the rock types. We used glass composition and magma temperature for LSG (Liquidus temperature-SiO2 Geohygrometer) (Miyagi and Takahashi, 2007) and estimated the initial water contents of the mixed magma to be ca. 3.5-4.0 wt%. The roughly axisymmetric flat topped morphology of the Tarumae 1909 dome suggests it is transitional between the platy and axisymmetric types (psai = (timescale of advection) / (timescale of solidification) = ca. 15) according to Fink and Griffiths (1998, jgr). The duration of eruption was estimated from a document (Oinoue, 1909) to be ca. 48 hours, giving effusion rate of 60 mˆ3/s, and the yield stress of 10ˆ5 Pa. From the chemical composition of the glass and temperature, viscosity of melt is estimated to be 10ˆ(8.5-10.3) Pa s (Giordano et al.,2006, chem.geol.). Taking the crystal fraction (0.40-0.50) of the Tarumae lava into account, bulk viscosity is estimated in the range of 10ˆ(9.7-11.5) Pa s. Although there are no a priori relations between viscosity and yield strength, available experimental data of Lavallee et al.(2007,Geology) on crystal-rich silicic magmas, yield strength of the order of 10ˆ5 Pa is well expected at 900-1000 C for the Tarumae lava. It is suggested that the Tarumae dome represents one of the most rapidly emplaced dome with high psai parameter among volcanic domes on the terrestrial planet.