

気泡を含む珪長質マグマの濡れと微細構造

中村美千彦^{*1}・中田笑美子¹・中野司²・土山明³・上杉健太郎⁴・大内智博¹
¹東北大・理・地球物質科学 ²: 産総研 ³: 大阪大・理・宇宙地球科学 ⁴: SPring-8

Wetting behavior and microstructure of bubble-bearing silicic magmas

M. Nakamura¹, E. Nakata¹, T. Nakano², A. Tsuchiyama³, K. Uesugi⁴, T. Ouchi¹

¹ Inst. Mineralogy, Petrology and Economic Geology, Tohoku Univ.

²Geological Survey of Japan, ³Dept. Earth and Space Science, Osaka Univ., ⁴SPring-8

Upon cooling and crystallization of hydrous magmas, residual melt becomes saturated with volatiles and vesiculated. Behavior of bubbles in solidifying magma chambers is a key to understand the triggering mechanism of volcanic eruption, flow and emplacement of granitic plutons and incipient processes of ore formation. Rheology and degassing efficiency of bubble-bearing magma, which are essential to the geological consequences, are controlled by its microstructure such as volume fraction, spatial distribution and connectivity of the bubbles. Clarifying the wetting behavior of the magmatic system involving phenocryst minerals (“crystal”), silicate melt (“melt”) and supercritical aqueous fluid (“vapor”) is a place to start. In contrast to the fluid-bearing and partially-molten rocks with one fluid phase, little is known about the interfacial energy relationships of the three-phase system involving two fluid-phases.

Theoretical consideration of wetting behaviour: The wettability among crystal, melt and vapor can be classified into four types according to the relative magnitude of interfacial energies among the three phases. (a) Adhesion increases the interfacial energy (γ), namely, $g_{sm} + g_{mv} < g_{vs}$ (b) Adhesion decreases the interfacial energy, but crystal is not “wet” with vapor; $g_{sm} = g_{vs} + g_{mv} \cos f$, $f > 90^\circ$ (f , contact angle) (c) crystal is “wet” with vapor; $f < 90^\circ$, (d) vapor covers the crystal surface and contact angle cannot be defined; $g_{sm} > g_{vs} + g_{mv}$. An important conclusion here is that the melt-vapor interfacial tension force may produce both attractive and repulsive force between the crystals, according to the host / guest relationship of the fluids. When crystals have type (b) wettability, repulsive force will work to prevent the coagulation of the crystals if melt is the continuous matrix phase and vapor is the isolated phase (right fig.). On the contrary, isolated interstitial melt will work as a glue for crystals to expel the vapor (left). This effect may cause the separation of crystal mush into crystal-melt

aggregates and vapor-filled crystal framework with little amount of melt.

Experiments: To investigate the wetting behavior of hydrous silicic magmas, we have carried out a series of piston-cylinder experiments. Granodiorite and pegmatite powders with various grain sizes were partially melted at 680°C and 0.8GPa to retain the relict crystals. The run products were observed by SEM and also with high-resolution X-ray CT using BL47XU at SPring-8# to obtain plucking-free, 3D bubble images. We found wide variety of wetting properties as follows; (1) Bubbles scarcely adhere to quartz and feldspars despite of their large abundances, showing these minerals have (a)-type wettability, or have f close to 180° . (2) Spessartine-rich garnet, magnetite, zircon and //c planes of biotite and muscovite have $f < 90^\circ$. (3) (001) cleavage plane of biotite and muscovite has $f < 90^\circ$. As predicted from the theory, crystals other than micas are coagulated with melt in the fluid-dominant region, accelerating the fluid segregation. This effect results in the separation of crystal+melt and crystal+vapor parts in the magma chambers. Formation of the vapor-filled crystal framework in the scales larger than phenocrysts may increase the permeability of crystal mush and facilitate the large-scale vapor migration in the magma chambers. Common occurrence of isolated crystals in volcanic ashes may be indicative of crystal+vapor parts in magma chambers. # With approval of JASRI (Proposal No. 2002B0159-ND2-np).

Aq. fluid = continuous *Melt = continuous*
Melt = isolated *Aq. fluid = isolated*

$$P_{MELT} = P_{AQ,FLUID} + 2g_m \cos f / d$$

