Pyroclastic Andesite Tile Melting during the First Two Seconds after the Explosion of the A-bomb at 8:15 a.m. on August 6, 1945 in Hiroshima

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The extreme effect of the heat rays of the A-bomb explosion on August 6, 1945 at 8:15 a.m. in Hiroshima was studied on two tile fragments that had been excavated during the period from 1977 to 1982 from the west bank of Motoyasu River, about 100 m down the river from the Motoyasu bridge. A number of very hot and melted fragments, which the shock wave brought from buildings that were smashed at the hypocenter 1.318 s after the explosion, were deposited on the west bank of the river. The pieces of tile possibly came from the destroyed stone wall of the Sei Hospital, the Saikoji Temple, and/or the Sairenji Temple, and were quickly cooled by the river water.

The tile fragments were composed of andesitic pyroclastic rock and their surfaces were melted to a depth of 3.18 mm (Fig. 1). The glass crust had a variable andesite and basalt-andesite composition (Fig. 2), which are the melt products of cristobalite and/or tridymite, pigeonite (X_{Fe} = Fe/(Fe + Mg) = 0.37–0.44), hornblende (X_{Fe} = 0.33–0.42), labradorite ($Ab_{48.2–40.6}An_{51.8–55.5}Or_{0–3.9}$), and K-feldspar ($Ab_{8.2}Or_{91.8}$). The temperature of 6287°C was calculated on the surface of an object at the hypocenter after the explosion, according to the depth of 3.18 mm of the melt and different depths and melting points of above-mentioned minerals (Radvanec, 2009). This surface temperature was deduced by the extrapolating of the depth–temperature relationship obtained by the mineral-relicts between 2.68 and 3.18 mm of depth. According to the regression line $T = -1715.1d + 6287$ (d is the depth) with $R^2 = 0.989$, the temperature gradient in the andesite tile was 1715°C/mm, reaching a depth from 2.86 to 3.18 mm, where the volume of glass and volume of primary minerals (rock) are equal. For a depth of more than 3.64 mm, the structure and mineral assemblage of pyroclastic andesite rock has an initial composition (Fig. 3).

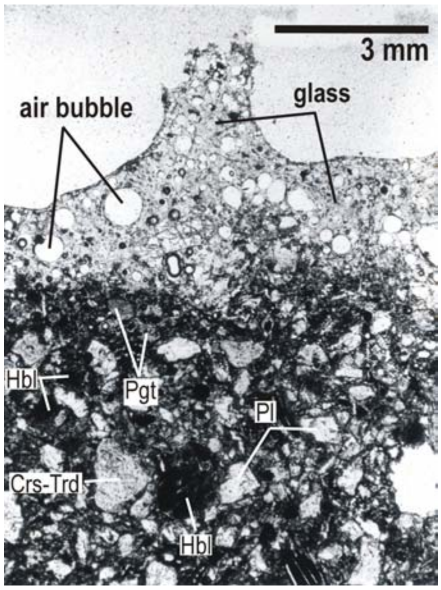

Fig. 1 Relationship between andesitic glass and mineral assemblage of the pyroclastic andesite tile in polarization microscope. Hbl – hornblende, Pgt – pigeonite, Pl – labradorite, Crs-Trd – cristobalite-tridymite.

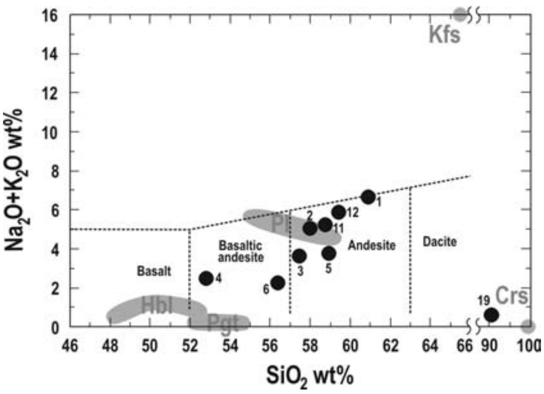

Fig. 2 Glass composition and hornblende (Hbl), pigeonite (Pgt), labradorite (Pl), K-feldspar (Kfs) and cristobalite-tridymite (Crs) and their compared compositions in diagram $Na_2O + K_2O$ versus SiO_2. Andesite, basalt-andesite, and dacite fields are after the classification of volcanic rocks (Le Bas *et al.*, 1986). Analyses 1–6, 11–12, and 19 and their exact depths of positions are in Fig. 3.

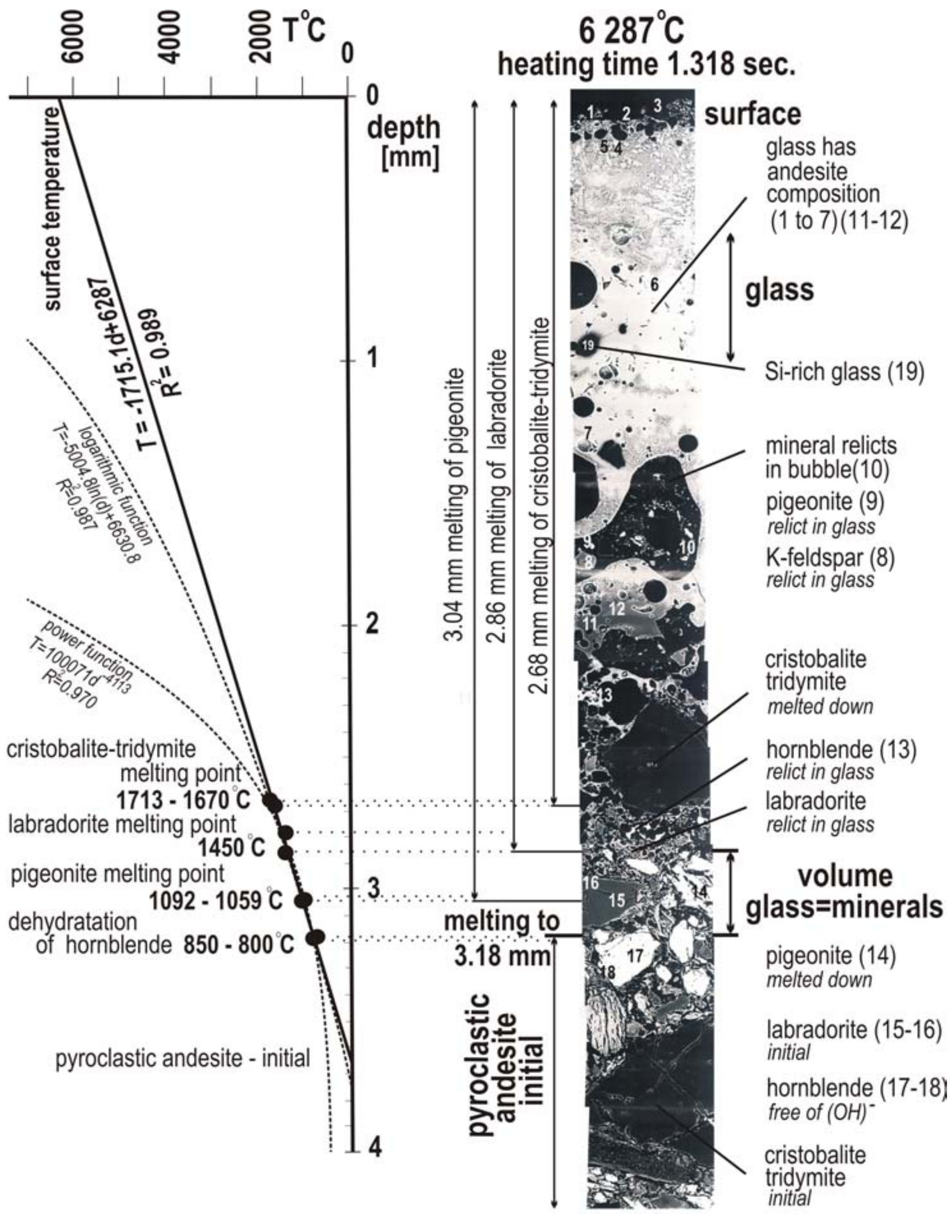

Fig. 3 Cross-section through melted pyroclastic andesite tile. The relations of average reached thickness of glass and original mineral assemblage. Backscattered electron image. The calculation of temperature 6287 °C on the tile surface was derived by the individual mineral relicts and surrounding melt, where temperature in the melt was falling by continual proportion in dependence of depth. 1 – 19 are the points of analyses.

References:

Le Bas, M.J., Le Maitre, R.W., Streckeise, A. and Zanettin, B. 1986: A chemical classification of volcanic rocks based on the total alkali-silica diagram. Journal of Petrology, 27, 745-750.

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