

The Highest JMA-intensity-scale 7 Recorded in Mashiki Town Urges Rethinking of Groundwater Environments as a Responsible Factor

*Tsuyoshi Haraguchi¹

1. Department of Geosciences, Graduate School of Science, Osaka City University

Groundwater is commonly perceived as an important natural resource. For instance, more than one million people who live in Kumamoto City and the surrounding areas, including Mashiki Town, owes drinking water supplies to the groundwater that is recharged in a volcanic watershed, Aso Caldera 18 km by 25 km across. Notably, Aso Caldera is situated 40 to 60 km away from Shimabara Bay to the east, having altitudes of 400 to 500 m. The precipitation there amounts to 3000 mm or so per annum, maintaining the rich groundwater resources. The description up to this point, however, is only half a story regarding volcano-related legacies.

When coming to the site response to earthquake shaking (not directly related to volcanic activities herein), volcano-derived thick deposits of sediment can be a threat. The surveys conducted by the author (and other researchers) immediately following the Kumamoto earthquake reveal that the way in which Mashiki Town suffered from the quake varied in extent from one district to another, suggesting the importance of subsoil and groundwater conditions. Specifically, the damage in the form of the collapse of wooden houses concentrated in a district where layered deposits of volcanic soil extended from the ground surface to considerable depths. In contrast, the damage to wooden houses in Douen and Fukuhara areas remained minimal, even though the shaking-related fault(s) appeared in the ground surface with a permanent displacement being more than 1 m. It is likely that the thickness of the volcanic sediment or proximity to the basement rock exerted an influence on the linkage between the seismic amplification and structural resilience of wooden houses.

The hydrogeologic features of the most severely damaged district of Mashiki Town may be summarized as follows. First, the site is situated on a gently sloping terrace, facing south, that was formed approximately 90000 years B.P. as being a consequence (non-welded style) of the Aso-4 pyroclastic flow. Second, the site is so favorable in groundwater supply and storage, keeping the groundwater level high. Third, the underground flow system of the site's upper areas terminates in a form to enhance fluvial processes such as gully erosion and scarp sliding, thereby facilitating continued deposition of volcanic soil in the lower areas. Fourth, the sediment deposited in this manner over a prolonged period of time has transformed it into a "structured soil" that can support its self weight on a sloping terrain unless the skeleton structure of it is broken down due to mechanical disturbances such as earthquake shaking. What is the lesson learnt from the soil-related, severe hazard with Mashiki Town? It is important to recognize that pyroclastic flow deposits of non-welded style, which are relatively common in this country, are leaky in some cases but are not so in other cases. In order to promote preparedness for future earthquakes, it is advisable to explore groundwater environments as well in such settings in light of the Mashiki-Town case discussed in this paper.

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