Elucidation of groundwater discharge mechanism after the Kumamoto earthquake in northwest Aso

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The Kumamoto earthquake that occurred on April 14 and 16, 2016, has had major impact on the groundwater environment. The influence of the earthquake was not only on the Kumamoto area, but also the Aso area which is far from the epicenters. It was reported that the flow rate of groundwater increased and some hot spring sources stopped flowing at the time. In the northwestern part of the Aso area, horizontal movement of the topography to the northwest which occurred locally after the main shock was accompanied by compression and extension fields resulting in many cracks and sinks. The appearance of new spring water was confirmed at several places. Previous studies have elucidated the structural changes in the northwestern part of Aso. No hydrological studies on the new spring waters has been carried out yet. This study therefore attempts to elucidate the occurrence of the new springs. General water quality data, isotope analysis, topographical changes and reports on underground structural changes after the earthquake in the northwestern part of Aso are used to decipher the flow and discharge mechanism of the new springs.

The new spring water was classified into two (2); the mountain spring water at the foot of the outer ring mountain, and the plain spring water confirmed at the plain spreading across paddy fields. These waters showed different quality compositions. The mountain spring water was of low concentration Ca-HCO_3 type (the water type of common mountain stream waters), originating from the Somma. On the other hand, the plain spring water showed a high concentration of Ca-SO_4 type originating from the central volcanic hill. It is speculated that this is underground water influenced by volcanic activity. Both waters were of the same quality as spring waters reported so far of the Aso caldera, as well as the distribution area.

Sulfur isotopic ratios were used as tracers to clarify the mechanism for the high concentrated water found only on the plain. The $\delta^{34}S$ value varied depending on the site. One point showed relatively high $\delta^{34}S$ value (10 ‰to 17 ‰) and another showed relatively low $\delta^{34}S$ value (2.5 ‰). The new spring water in the Kario area has the same isotopic composition as that of hot spring water in the surrounding area, and this may be due to the influence of a heat source similar to that of the hot spring water during the springing process. In a previous study, the $\delta^{34}S$ of spring water recharged from the Aso volcano, which is a typical heat source in the Aso caldera, was approximately 5 to 10 ‰. Relatively, spring water in the northwestern part in this study have higher $\delta^{34}S$ values, suggesting the possible presence of a heat source different from that of the central crater in the area.

In identifying reasons for the groundwater discharge after the earthquake, different factors were considered for both the mountain spring water and plain spring water based on flow system and water quality characteristics. The release of groundwater reserved beneath the mountain due to seismic motion and the possible formation of “water pathways” from the earthquake could be the reason for the occurrence of the new springs. New spring waters in the paddy fields of the plain whose discharge rate show no decreasing tendency even a year after the earthquake, taking into consideration seasonal variation, indicates that major underground structural changes have occurred. It can be inferred that new discharge route for groundwater has been created.

Keywords: Kumamoto earthquake, northwest Aso, new spring water