Analyzing the origin of surface water in the Saijo Plain, Japan, based on the antimony concentration in the water

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1. Introduction

The flow of river water in many medium and small rivers is managed for water use and flood control. However, it is almost impossible to understand how the water taken from the rivers circulates throughout a basin. The source of water in the Saijo Plain in Ehime Prefecture is from the Kamo River surface water flow, shallow groundwater (unconfined ground water), and deep groundwater (confined ground water). Therefore, it is necessary to quantitatively clarify the source of water for sustainable water use. In this study, we tried to quantify the origin of river water in the plain based on the concentration of some chemical elements. In particular, antimony (Sb) was used as the main trace element because of large differences in its concentration between the water sources.

2. Materials and Methods

On November 25 and 26, 2017, during the non-irrigation period and on the 27th and 28th of July, 2018, during the irrigation period, surface water was collected at a total of 43 sites on small and medium rivers and waterways in the Saijo Plain. Multi-element analysis was carried out on the collected water using ICP-MS 7500 cx.

3. Results and Discussion

There was a large difference in the concentration of Sb among the sites. The highest concentration was found in the water from the Ichino River (Stn. 2) at 113 (2017) and 158 μg/L (2018). There was once an antimony mine in the Ichino River basin, so high concentrations of the element in the river water can be regarded as reflecting the influence of the geology. In the main stream of the Kamo River before joining the Ichinose River (Stn. 1), the Sb concentration was as low as 0.2 μg/L, and after the junction of the two rivers (Stn. 3), the concentration increased to 4.3 (2017) and 7.2 μg/L (2018). The concentration was 4.2 (2017) and 7.2 μg/L (2018) at Stn. 4 of the Kamo River, 11.6 (2017) and 11.7 μg/L (2018) in the unconfined ground water (average of Stns. 13, 14, 15), and 0.4 (2017) and 0.5 μg/L (2018) in the confined ground water (average of Stns. 28, 29, 40, 41, 43). The concentration of Si was 2.7 (2017) and 3.2 mg/L (2018) at Stn. 4 of the Kamo River, 3.4 (2017) and 2.9 mg/L (2018) in the unconfined ground water (average of Stns. 13, 14, 15), and 4.1 (2017) and 3.9 mg/L (2018) in the confined ground water (average of Stns. 28, 29, 40, 41, 43).
The ratio of water origin at each survey site was estimated using the above three sources as end members. In the upstream area, the irrigation water taken from the Kamo River occupied most of the surface water. In the middlestream area, the ratio of water taken from the rivers was smaller, and the contribution of

unconfined ground water exceeded 80%. In the downstream area, the confined ground water contribution exceeded 40% at many sites. In the Saijo Plain, the water origins are different in the upstream, middlestream, and downstream areas, where the contribution of irrigation water is small overall, and the contribution of the confined ground water is large.

