International Journal of GEOMATE, April, 2018 Vol.14, Issue 44, pp.15-19
Geotec., Const. Mat. & Env., DOI: https://doi.org/10.21660/2018.44.7183
ISSN: 2186-2982 (Print), 2186-2990 (Online), Japan

PRESENCE STATE OF TRACE ELEMENTS IN THE OHTAKIGAWA RIVER WATERSHED FROM THE FOOT OF Mt. ONTAKE

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*Corresponding Author, Received: 11 Oct. 2017, Revised: 24 Oct. 2017, Accepted: 22 Dec. 2017

ABSTRACT: This paper is aimed at understanding the influence of Mt. Ontake volcanic activity on the water quality of the Ohtakigawa River watershed. For this purpose, various properties of trace elements are obtained. The Ohtakigawa, which flows along the southern foot of Mt. Ontake, has several tributaries such as Nigorigawa River, Shirakawa River, Shimokurosawa River, and Uguigawa River. Seven sampling stations were selected in the four tributaries (four points) and the Ohtakigawa (three points). Filtration of samples was carried out with teflon filter paper (PTFE, 0.5μm, φ 47mm), and the samples were separated into dissolved and suspended matters. Trace elements contained in them were analyzed by using the ICPE. The concentrations of the trace elements were high in the following order: the Nigorigawa (Al: 6.16mg L^{-1}), the Ohtakigawa after the confluence of the Nigorigawa (Al: 1.92mg L^{-1} and 0.88mg L^{-1}), and the others (Al: 0.06-0.70mg L^{-1}). This result indicates that among the four tributaries, the Nigorigawa plays a predominant role in the change in the water quality of the Ohtakigawa.

Keywords: trace elements, Mt. Ontake, volcanic activity, Ontake Landslide, Ohtakigawa River watershed

1. INTRODUCTION

Mt. Ontake (altitude 3,076m) is located across Nagano Prefecture and Gifu Prefecture. Mt. Ontake often has shown large volcanic activities since the prehistoric age. Recently the Western Nagano Prefecture earthquake (M6.8) occurred on September 14, 1984, and the volcano erupted on September 27, 2014.

Volcanic activities affect surrounding rivers and change their water quality and biota. The Ohtakigawa River flows on the southern side of Mt. Ontake and is strongly influenced by volcanic eruptions. The river has many tributaries (Fig. 1). The Nigorigawa River, which is one of the tributaries of the Ohtakigawa, remarkably differs in pH, electric conductivity, and biota from other tributaries [1], [2]. The water quality of the

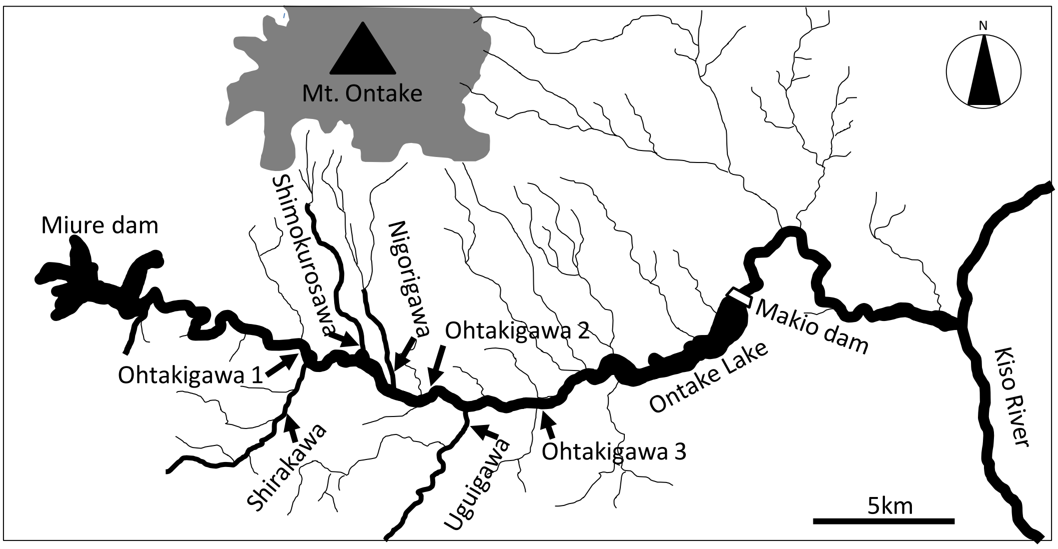

Fig. 1 Map of the locations of sampling stations in the Ohtakigawa watershed.

Ohtakigawa changes at the junction with the Nigorigawa [3], [4].

It is one of the most important topics to provide useful information to recover the river environment damaged owing to the influence of the volcanic eruption. In this paper, we observed trace elements in water of the Ohtakigawa and tributaries of the Ohtakigawa to clarify the formation process of water quality of the Ohtakigawa.

2. METHODS

2.1 Study site

Figure 1 shows a map of sampling stations. We select seven stations as the sampling stations. They consist of four stations for the tributaries of the Ohtakigawa (the Shirakawa, Shimokurosawa, Nigorigawa, and Uguigawa) and three stations for the Ohtakigawa. We call the three stations in the Ohtakigawa as the Ohtakigawa 1, Ohtakigawa 2, and Ohtakigawa 3 stations, respectively. The Ohtakigawa 1 station is located before the joining of the Shirakawa, the Ohtakigawa 2 station is located after the junction with the Nigorigawa, and the Ohtakigawa 3 station is located after the confluence of the Uguigawa.

Observations were conducted three times on October 10 in 2015, September 17, and October 29 in 2016.

2.2 Sampling and analysis

2.2.1 pH

The pH was measured by a pH meter (RISEPRO ph-900).

2.2.2 Dissolved oxygen (DO)

DO was measured by a DO meter (input electrode type, fluorescence method, HACL Inc., turned electrode type).

2.2.3 Trace elements

Samples were filtered. Filtration was carried out with a teflon filter paper (PTFE, 0.5μm, φ 47mm), and the samples were separated into dissolved and suspended matters.

The filtrate samples were added to aqua regia (HNO_3:HCl=1:3), and the suspended particle matter on the teflon filter was decomposed in aqua regia. Trace elements contained in them are analyzed and 21 element species (Na, Mg, Al, Si, P, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, Sn, Ba) are measured by using the ICPE. In this work, eight element species: Na, Mg, Al, Si, K, Ca, Mn, and Fe, which demonstrated high concentrations, are exhibited in detail.

3. RESULT

First of all, the change in pH is observed. The pH is low (5.4-6.0) at the Nigorigawa, the Ohtakigawa 2, and the Ohtakigawa 3 stations and is high (6.4-6.8) at the other stations. Therefore, it is confirmed that the lowering in pH in the Ohtakigawa is caused by the confluence of the Nigorigawa, as shown in [1].

Next, the concentrations of the eight element species are shown in Fig. 2. They have the similar tendency that the concentrations are high in the following order: at the Nigorigawa, at the Ohtakigawa 2, at the Ohtakigawa 3, and at the other stations. For example, the concentration of Al is 0.70mg L^{-1} at the Ohtakigawa 1 station, 1.92mg L^{-1} at the Ohtakigawa 2 station, 0.88mg L^{-1} at the Ohtakigawa 3 station. In the tributaries, it is 6.16mg L^{-1} at the Nigorigawa station and 0.06-0.10mg L^{-1} at the stations of the other tributaries.

Furthermore, the component compositions at the seven stations are investigated. Figure 3 shows the rates of the trace elements at the sampling stations. At the Ohtakigawa 1, the Shirakawa, the Shimokurosawa, and the Uguigawa stations, Si (37-47%), Ca (18-28%), and Na (13-23%) are the main components. As minor components, Al, Fe, and Mn account for 1-6%, 1-2%, and 0%, respectively. At the Nigorigawa, the Ohtakigawa 2, and the Ohtakigawa 3 stations, the rate of Si (23-32%) decreases compared with that at the above four stations. However the rates of Ca (25-27%) and Na (21-26%) show hardly change. By contrast, the rates of Al, Fe, and Mn increase to 4-7%, 3-4%, and 1%, respectively.

It is on the confluence point with Nigorigawa that the rates of Al, Fe, and Mn drastically increase. Therefore, it has been clarified that the water quality in the Ohtakigawa is affected dominantly by the Nigorigawa newly from analyzing the component compositions.

Finally, the dissolved oxygen level is observed at the three stations which show high concentrations in Fig. 2, namely, at the Nigorigawa, the Ohtakigawa 2, and the Ohtakigawa 3 stations. The dissolved oxygen level is 90-92%, quite high, and thus the reduction state does not play any roles in the maintenance process of dissolved matters.

4. CONCLUSION AND DISCUSSION

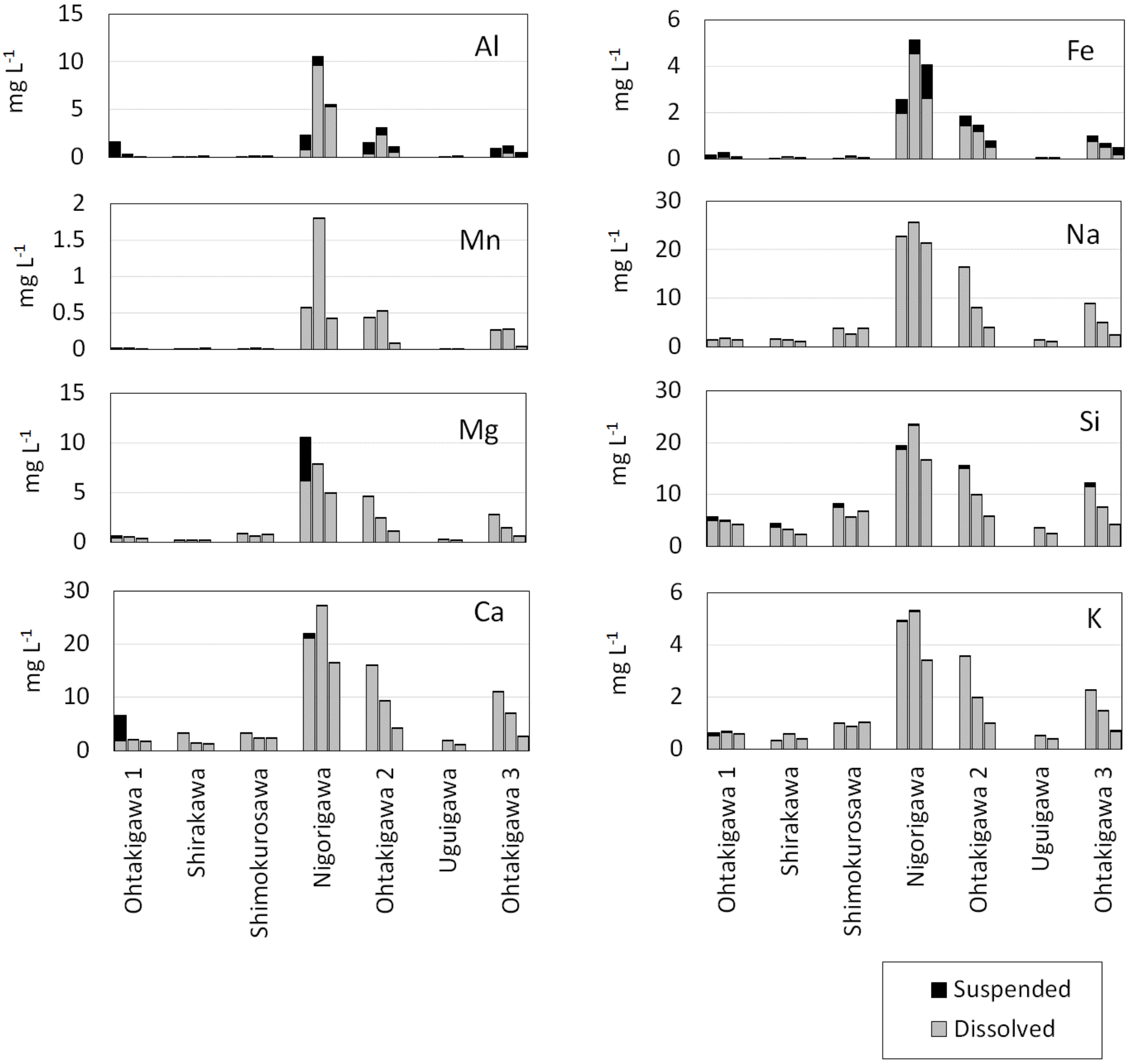

Fig. 2 Concentrations of suspended and dissolved trace elements at the sampling stations.

In this work, it has been found that the Nigorigawa and the Ohtakigawa after the junction of the Nigorigawa have the anomalous water quality that the water is acidified, and the concentrations of Al, Fe, and Mn as dissolved matters are high. Consequently, it has been confirmed that the water quality in the Ohtakigawa is significantly affected by the Nigorigawa.

Now it is discussed that how the anomalous water quality is formed in the Nigorigawa. There are enormous sediment of erupted materials in the Nigorigawa basin [5], and large amounts of Al and Fe are contained in the erupted materials [6]. Asami et al. reported that owing to the erupted materials injected into the river, pH was decreased to 2.5 [4]. This implies that the anomalous water quality in the Nigorigawa has been formed by the erupted materials.

Indeed it is confirmed that pH indicates low values (5.4-6.0), and thus the acidic environment is considered to be responsible for the maintenance process of dissolved matters for the trace elements. However, a comprehensively understanding of the maintenance process of dissolved matters will require that various factors such as sorption, ion exchange, and diffusion are taken into account [7], [8], [9].

It has been reported that the dissolved matters of trace elements have a harmful influence on algae and fishes [10], [11]. Such harmful effects definitely occur in the Ohtakigawa, too. However, investigation on the precipitation of the trace elements is also an important issue [12], [13], [14], if the influence of trace elements in the erupted materials on biota is comprehensively discussed. Trace elements are precipitated as pH recovers to the neutral state. Now it is predicted that the precipitation of the trace elements already has been

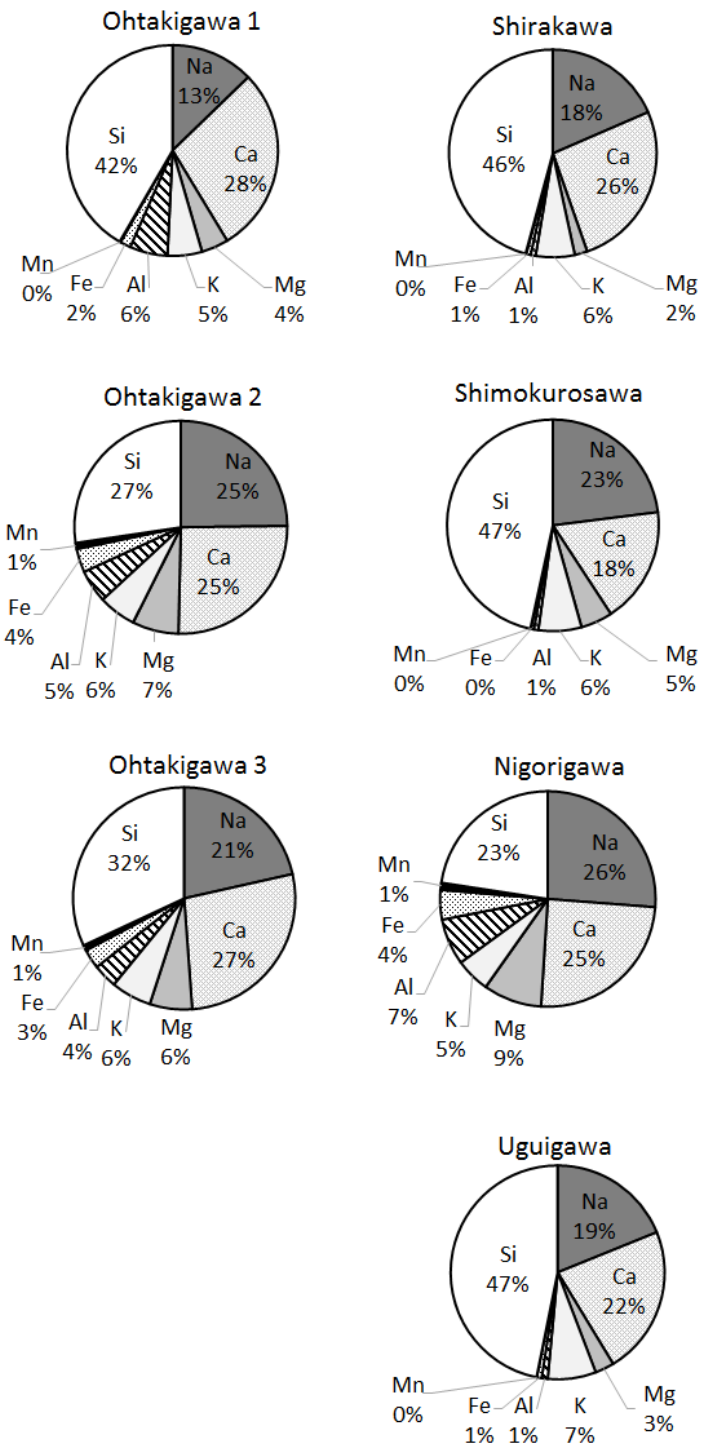

Fig. 3 Ratio of elements at the sampling stations.

accumulated in the Nigorigawa and Ohtakigawa. This prediction is based on the following two facts. The one is that pH in the Nigorigawa varies seasonally, as reported by Asami et al. [4], and the other is that the acid water in the Nigorigawa is clearly diluted by joining to the Ohtakigawa. It would be one of the most important research topics to investigate in what way the precipitation of the trace elements affects attached organism and organism feeding on it.

5. ACKNOWLEDGEMENTS

The authors thank Takashi TASHIRO of Nagoya University, Tomomasa TANIGUCHI of Mie University, Kentaro NOZAKI of Sugiyama Jogakuen University, Yoshitaka MATSUMOTO of National Institute of Technology, Toyota College, and Yukio ONODA of the Aqua Restoration Research Center for cooperation in the field survey and valuable suggestions. They thank students of Aichi Institute of Technology for their helping in this work. The analysis in this work is performed on “ICPE-9000” (SHIMADZU) which supported by 2012 Ministry of Education Private University Research Facilities Maintenance costs subsidies.

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