

## Ancient glassware that traveled the Silk Road

The Niizawa Senzuka Tumulus Cluster is one of the most famous large tumulus clusters consisting of over 600 burial mounds located at Kashihara City, Nara Prefecture, Japan [1]. The burial mounds were constructed from the end of the 4th century through to the 7th century AD. In 1963, two pieces of glassware, comprising a transparent pale green facet-cut glass bowl (Fig. 1(a)) and a deep blue glass dish, were excavated as grave goods from Tumulus No.126 in the cluster. The burial date of Tumulus No.126 is considered to be in the late 5th century AD based on the structural features and associated artifacts of the tumulus. Because no evidence of primary glass production from raw materials in Japan dating prior to the late 7th century AD has previously been found, it is believed that all earlier glass products were imports produced overseas. Based on the typological features of these two pieces of glassware, it is considered that they were derived from two huge empires prospered a far distance to the west of Japan: the Sasanian Empire (ca. 3rd–7th century AD) in West Asia and the Roman/Byzantine Empire (ca. 1st–6th century AD) in the Mediterranean region. Although the specific provenances of these glasses have not yet been identified, they can provide important evidence demonstrating how varied cultures were introduced to and accepted by ancient Japan. This study thus aims to reveal the specific provenances of the glassware based on their chemical compositions. However, it is not easy to chemically investigate the glassware as they are designated as important national cultural properties in Japan and are now stored in the Tokyo National Museum.

Therefore, in this study, the author focused on the rest of the fragments from the glassware excavated from Niizawa Senzuka Tumulus No.126 in the previous scientific research conducted by the National Museum of Nature and Science [1]. The author decided to analyze not the real bodies of the glassware but rather fragments believed to be sampled from them. Two small glass fragments, specimens A and B, were collected from the rest of the previous scientific research. Specimen A (Fig. 1(b)) is a transparent pale-green glass fragment believed to be sampled from the facet-cut glass bowl (Fig. 1(a)). Meanwhile, specimen B is a tiny blue platelike fragment possibly sampled from the blue glass dish. Several X-ray fluorescence (XRF) analytical techniques – a laboratorial XRF analysis using custom-made spectrometers and a highly sensitive XRF analysis excited by synchrotron radiation – were applied to these specimens to establish their detailed chemical composition nondestructively. The specific provenances of these specimens were verified by a comparison between our analytical results and the literature data of Roman and Sasanian glass artifacts. Note that only part of the analytical results obtained for specimen A, the glass fragment believed to be sampled from the facet-cut glass bowl, are given in this article. Please refer to author's original paper [2] for further discussion including the results for specimen B.

The principal chemical composition of specimens A and B was quantified using two XRF spectrometers, 100FA-IIL and 100FA-V, in a laboratory. These spectrometers were developed by Ourstex Co. Ltd. in collaboration with the author. To analyze the trace

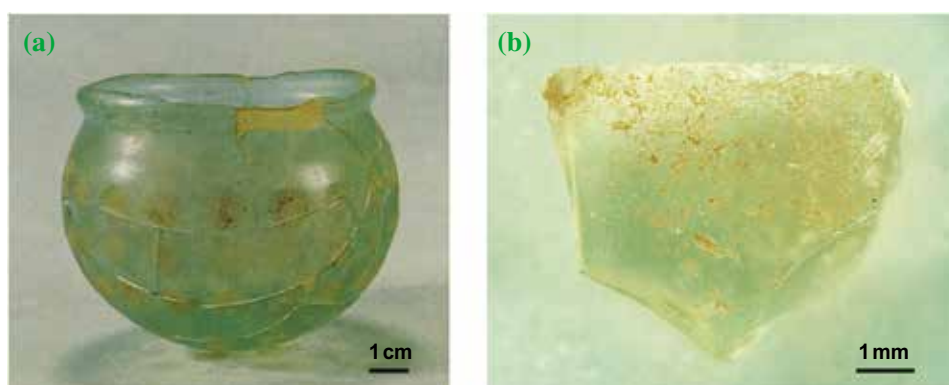


Fig. 1. (a) Facet-cut glass bowl excavated from Niizawa Senzuka Tumulus No.126. Reprinted from the excavation report by Archaeological Institute of Kashihara [1]. (b) Microscope photograph of specimen A, a piece of glass fragment believed to be sampled from the facet-cut glass bowl.

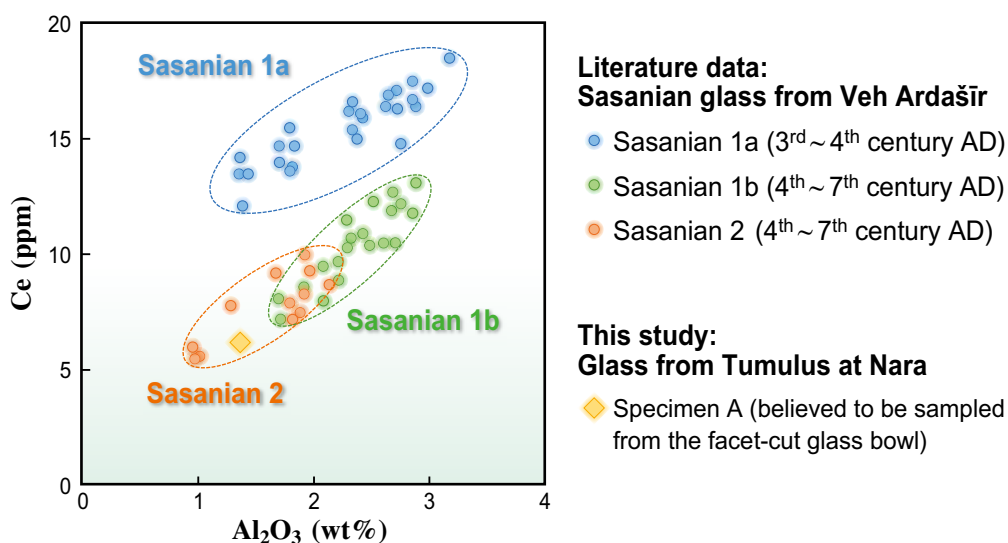


Fig. 2. Comparison of chemical composition between specimen A and Sasanian glass from Veh Ardašīr, Iraq [3].

heavy elemental composition, including rare earth elements (REEs), a high-energy synchrotron radiation (SR) XRF analysis was applied to specimens A and B in a nondestructive manner. The SR experiment was conducted at SPring-8 BL08W, the only wiggler beamline and the highest X-ray energy beamline in SPring-8. The use of its 116 keV monochromated X-ray enables the excitation of *K*-edges of all heavy elements up to uranium (*K*-edge: 115.6 keV). All measurements were carried out in a nondestructive manner.

From the principal chemical composition obtained by the laboratorial XRF, it is suggested that specimen A has a similar chemical composition to Sasanian glass, characterized by the use of a plant ash soda flux containing highly concentrated Mg and K. Through a series of recent scientific investigations of Sasanian glasses excavated from the royal town of Veh Ardašīr in Iraq, detailed chemical compositional features of Sasanian glass have become well understood in relation to their raw materials. The Sasanian glass excavated at Veh Ardašīr can be classified into three compositional groups – named Sasanian 1a, Sasanian 1b and Sasanian 2 – according to the use of different raw materials (plant ashes and silica sources) and the principal production period. Figure 2 shows a bi-plot focusing on elements derived from the silica source (aluminum and cerium) for comparison of the chemical composition between specimen A and the three compositional groups in the Sasanian glass from Veh Ardašīr [3]. As evidenced by Fig. 2, the chemical composition of specimen A is characterized by the use of a highly pure silica source; the chemical compositional feature of specimen A closely matches

that of Sasanian 2 glass. This indicates that the glass bowl found in Japan was originally manufactured using glass produced in the Sasanian Empire. Considering the discovery of similar facet-cut glass bowls in the Sasanian region, it is also possible that both the primary and secondary glass production of the glass bowl were conducted at workshop(s) in the Sasanian region. Even if it took several decades for the bowl to be transferred from the Sasanian glass workshop to Nara, the possible production period of Sasanian 2 glass (4th–7th century AD) corresponds to the burial date of Tumulus No.126 (late 5th century AD).

In conclusion, on the basis of nondestructive X-ray analysis of a small fragment using the highly brilliant and high-energy X-rays of SPring-8, this study demonstrated the possibility that the precious glass bowl discovered at a tumulus in Japan was glassware manufactured in the Sasanian Empire and transported to Japan along the Silk Road around the same time.

Yoshinari Abe

Department of Applied Chemistry,  
Tokyo University of Science

Email: y.abe@rs.tus.ac.jp

**References**

[1] Archaeological Institute of Kashihara: Tomb No. 126 of Niizawa (1977).  
[2] Y. Abe, R. Shikaku, I. Nakai: *J. Archaeol. Sci. Rep.* **17** (2018) 212.  
[3] P. Mirti *et al.*: *J. Archaeol. Sci.* **36** (2009) 1061.