Chemical composition analysis of Human Face Mosaic Glass Beads excavated from Silla tomb using portable XRF

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The Silla kingdom (1st century BC-10th century AD) was a kingdom located in the southeastern part of the Korean Peninsula. Gyeongju, was the capital of the Silla kingdom, has a lot of tombs dating to the 4-6th century. Various grave goods, including gold crowns, jade ornaments, glass vessels and glass beads, were excavated from the tombs. It is supposed that the Silla kingdom imported these grave goods from West Asia or Central Asia. Especially in glass beads, some mosaic glass beads produced using multiple colors of glass were unearthed from these tombs in addition to thousands of monochrome-colored glass beads. This study focused on the Human Face Mosaic Glass Beads (National Treasure No.634) excavated from King Michu District Tomb No. 4 (5-6th century AD), its diameter is 1.8 cm.

In this mosaic glass bead, five human faces, six white birds, and flowering branches are decorated with four colored glasses of blue, white, yellow, and red. Each human face is represented by a white glass for skin, a blue glass for the eyes and nose, and a red glass for the mouth. The birds are represented by a white glass for body, a blue glass for the eyes, and a yellow and red glass for the legs. The flowering branches is represented by a white glass for branch, and a yellow and red glass for the flowers. The bead has been thought to be produced at the Mediterranean region because similar mosaic glass beads were found at the region. On the other hand, recent archaeological investigation, found similar beads in Indonesia (East Java), and it is indicated that the mosaic glass bead excavated from Silla tomb was transported via the area or produced at the area¹.

In this study, we analyzed this mosaic glass bead to reveal its production area by non-destructive XRF. Glass artifacts excavated from the Eurasia at the ancient times can be divided into several various types based on their chemical composition. It is important that the chemical compositions of glass to reveal its production area and distribution. We brought potable XRF analyzer OURSTEX100FA-IV to the National Gyeongju Museum, and we analyzed the mosaic glass bead using it. This analyzer has Pd target as an X-ray source and a silicon drift detector and the weight is approximately 20 kg. It has two measurement modes (monochromatic X-ray mode: 40 kV 1.0 mA, white X-ray mode: 40 kV 0.25 mA) for 200s (live time). Its irradiation diameter is approximately 2 mm.

Our XRF analysis demonstrated that the dark blue part was soda lime glass, and that it was a plant ash type (v-Na-Ca) from the contents of MgO and K₂O. It has been thought that this composition type was produced in West Asia or Central Asia during the first Millennium AD. In addition, it is revealed that their colorant is cobalt and copper. The white part and yellow part contain tin and the yellow part contain lead also. It is thought that the white part contains crystalline cassiterite (SnO_2) and the yellow part contains lead tin yellow (PbSnO₃). In the red part, the Cu content is higher than in the other color parts and it is thought to be colored by metallic copper nanoparticles or microcrystals of cuprite (Cu₂O).

It is known that South Asia and Southeast Asia were primary production area of high alumina soda lime glass (m-Na-Al) containing high Al content²⁾. However, the base glass (dark blue part) of this mosaic glass bead revealed to be soda lime glass (plant ash type) produced in West Asia or Central Asia. So far, it was considered that this mosaic glass bead was produced in Eastern Java. However, our result indicated it was

produced by glass from West Asia or Central Asia. It is an important achievement to reveal the chemical characteristics of this bead in this study.

Several various mosaic glass beads were excavated from Silla tombs. Further Archaeological and scientific researches for other mosaic glass beads may provide understanding about trade among ancient Asia region.

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