15. An Ancient Japanese Opal Glass

By Kazuo YAMASAKI^{*)} and Yoshihiko SAITO^{**)}

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Opacifying agents used to produce opacity in ancient glasses have been studied by several workers,¹⁾ and compounds like reduced copper compounds (Cu_2O , Cu , $\text{Cu}_2\text{O} + \text{Cu}$), antimony compounds ($\text{Ca}_2\text{-Sb}_2\text{O}_7$ and $\text{Pb}_2\text{Sb}_2\text{O}_7$), stannic oxide and calcium fluorophosphate were found in the glasses ranging from the ancient Egypt to the last century. Further the presence of calcium fluoride in some Chinese glasses as the opacifying agent was reported,²⁾ but no study on ancient Japanese glasses has ever been made.

The present authors had an opportunity to examine some glass fragments of the 8th century preserved in the Shôshôin Repository in Nara.³⁾ Among the fragments studied which were all lead glasses of the high lead content a white opal glass bead was found. The chemical compositions of the glass bead as revealed by chemical analysis were as follows:

SiO_2	32.8%	MgO	trace
PbO	66.0	CuO	0.35
Al_2O_3	0.19	Na_2O	0.19
Fe_2O_3	trace	K_2O	0.19
CaO	trace	Sum	99.7%
Color of the bead = faintly green			
Diameter of the bead = ca. 6 mm			
Apparent density = 4.4			

To find the cause of the opacity the powdered glass was studied by x-ray diffraction method. Two peaks were found at $d=3.35\text{\AA}$ and $4.25\text{\AA}$ in the diffraction curve, the former being stronger than the latter. These peaks coincide well with those of quartz. Actually minute quartz crystals were detected in the glass under the polarizing microscope. Thus the presence of quartz was found to be responsible for the opacity of this glass bead. Small bubbles present in the glass also contributed to the opacity.

The site of a glass making factory in the 8th century in the Nara area is not found yet, and nothing definite about the method of glass melting is known. It may be reasonable, however, to presume that quartz was added intentionally during cooling of the

^{*)} Inorganic Chemistry Laboratory, Faculty of Science, Nagoya University.

^{**)} Institute for Solid State Physics, University of Tokyo.

melted glass, because, if added during heating, quartz crystals must have dissolved into the glass phase.

References

- 1) W. E. S. Turner and H. P. Rooksby: *Glastechn. Ber. Sonderband, V. Inter. Glaskongress*, **32kVIII/17** (1959). Full bibliography on this subject is given in this paper.
- 2) A. E. A. Werner and M. Bimson: *Techn. Papers, 6th Intern. Congress on Glass, Washington*, **2**, 303 (1962).
- 3) For the general description of the glasses preserved in the Shôsôin, see "The Glass Objects in the Shôsôin" published by the Nihon Keizai Shimbun in 1965. This is the report of the special investigation carried out by Y. Harada, Jo Okada, K. Yamasaki, and K. Kagami.