Gem Glass of Chzhurchzhen in the Russian Far East

D.G. Fedoseev[1], V.A. Pakhomova[1], L.G. Filipas[2], B.L. Zalishchak[1], N.I. Ekimova[1], M.A. Ushkova[1], V.A. Kamynin[1], S.U. Buravleva[1]

1. Far East Geological Institute, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia

2. Teacher of history, leader of the school regional society

寶石玻璃函蓋各式及不同形態的人造玻璃和料材，本文作者對中古時期俄羅斯遠東區域之古Chzhurchzhen 考古出土的寶石玻璃及料材，作出寶石學的檢測，並簡略地對比現代人造玻璃及古代玻璃的製作技術。

There is a wide range of gem glasses, and the most popular are modern ceramicised glass, Swarovski type lead crystal glass, and Millefiori – from the Italian word meaning "a thousand colours". Millefiori is a mosaic glass composed of thin coloured glass plates alternating with optical samples/templates. Latticino is the name for a curved mosaic glass with a spiral pattern. Traditionally it is a white colour that is reflected in its name "latte", which, as most coffee drinkers nowadays know, means "milky". Murrhine is a mosaic glass produced as the result of placing pieces of hot glass one on top of the other or by the melting of preformed components, which are then strained. Finally, its cross-section reveals a pattern like letters, shapes, animals or faces.

Gem (art) glass, one of the first artificial materials produced by humankind, was invented in high antiquity in the Eastern Mediterranean. As a material for decorative applied art, this glass was used only in periods of economic success, thus the history of art glass is closely connected with social and economic history.

The first record of gem glass comes from Pliny the Elder. His XXXVIIth book of Natural History contains Murrhine glass among the long list of stones of which imitations could be produced by glass makers of the time (1st century A.D.).

Beads are among the earliest archeological finds ever made and bead-making instruments were among the first tools ever invented. When a new, attractive material was discovered that might be made into an article of adornment primitive people first did so by making beads out of it. Beads are so bound up with human cultural development that they can really be considered one of the foundations of human civilisation. These small items of varying shapes and materials, so diverse and unspecific one can perhaps best refer to them as "doodads", with bore or drill holes are one of the things that originally distinguished us from the other creatures inhabiting our Earth.

The subject of our study was some ornaments of the ancient Chzhurchzhen peoples found near the Ariadnoe settlement (in the Dal'nerechensky district of the Primorsky region) (Fig. 1). We examined blue and greenish-blue beads discovered by archeologists at the site of the Chzhurchzhen medieval settlement.

Fig. 1

The Chzhurchzhen settlement is located 1.5 km north-west of the Ariadnoe settlement on the right bank of the Malinovka River. It was discovered and investigated in 1967 by archeologist A.V. Garkovik and classified as a medieval settlement, Ariadnoe–III, which dates from the beginning of the XIth to the XIIth centuries. The settlement is situated on a cape-like spur with steep, scree covered slopes from which a beautiful view opens out onto the valley of the Malinovka River.

The gem glass beads of the study were examined with common gemmological equipment. Their glass composition was detected using a 4-channel JXA-8100 Microanalyzer for the examination of two analogous samples.

The gemmological features of the samples studied, N_1 and N_2 (Fig.s 2 and 3), are (according to the GIA System) as follows:

Colour: blue, tincture VstbG, hue vl, saturation mst,

Refractive index: n -1.52,

Thermal conductivity test - glass, isotropic, in UV rays (356 and 254 nm) soapy fluorescence typical of glass.

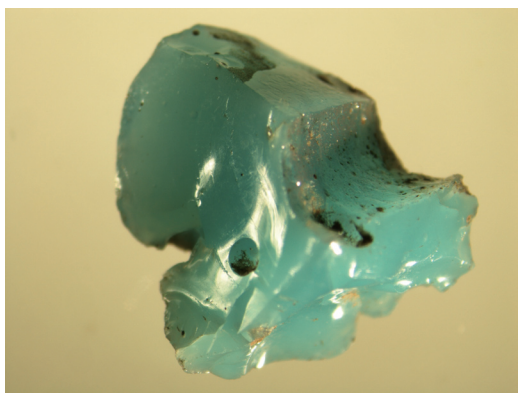

Fig. 2

Fig. 3

The results of the microanalyzer analysis of the samples are given in Tables 1 and 2.

Table 1 Microanalyzer analysis of sample 1, (Fig. 4 A), (Fig. 4 B)

Spectrum	F	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe	CuO	Total
Spectrum 1 d=0	6.74	4.5	2.15	2.04	61.12	0.87	10.65	14.98		0.36	0.64	104.05
Spectrum 2 d=0	8.49	3.11		23.44	47.74	0.71	14.7	1	0.91	0.81		100.91
Spectrum 3 d=0	3.13	2.73	0.97	11.1	64.47	0.39	12.18	5.1		0.56		100.63
Spectrum 4				21.86	53.54		20.07		1.4	0.87		97.74

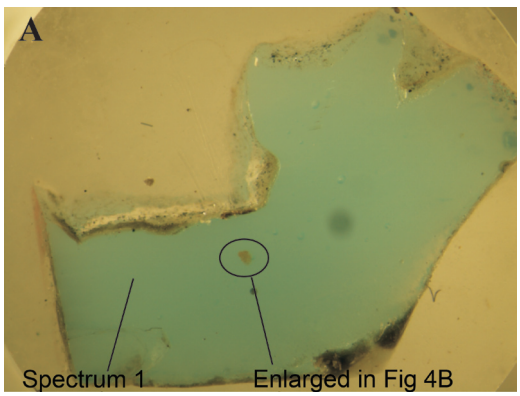

Fig. 4A

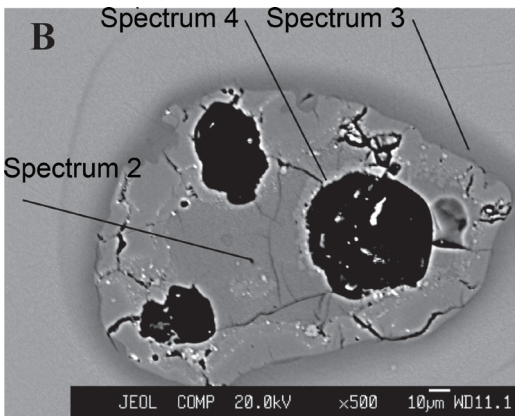

Fig. 4B

Table 2 Microanalyzer analysis of sample 2, (Fig. 5)

Spectrum	F	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	FeO	CuO	Total
Spectrum 1	6.36	2.96	3.93	0.78	59.46	0.83	8.81	19.15	0.57	0.76	103.61
Spectrum 2					101.33						101.33

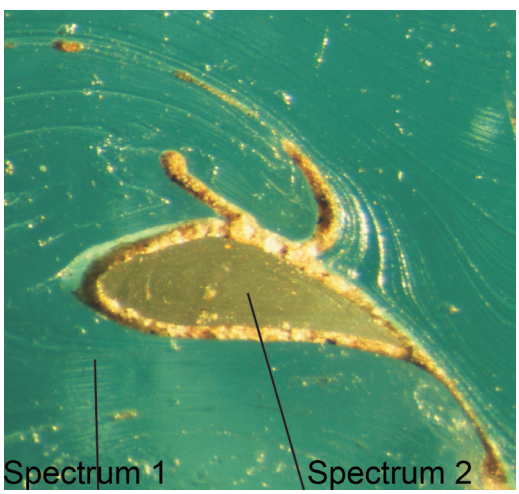

Fig. 5

Comparison of the test bead results with modern glass analyses known from the literature demonstrate that the test glass is similar in composition to that technically called *Calcium Crown*. The chemical composition of mineral inclusions in sample N_1 (spectra 2, 3, 4) confirms the presence of muscovite (spectrum 2) and orthoclase (spectra 3, 4).

Based on the results obtained from our tests we can associate them with modern ceramicized glass.

The gemmological features of samples of the latter (determined by testing on the basis of general methodology) are:

greenish-blue colour,

isotropic under microscope,

refractive index n -1.62,

thermal conductivity test - glass,

in UV rays (356 and 254 nm) soapy fluorescence typical for glass.

The results of our microanalyzer analysis of the ceramicised glass sample are given in Table 3.

Table 3 Microanalyzer analysis of the modern ceramicised glass sample.

Spectrum	Mg	Al	Si	Ti	Ni	Zn	Zr	Total
Mean	4.73	27.14	43.33	6.68	1.23	12.69	4.32	100.11

The composition of Gem glass is evidently changing over time. Modern samples show a more perfect structure. Innovative technology permits the use of chromophore elements (instead of those minerals used by earlier glassblowers) to colour modern gem glass, and oxygen-gas torches, with a flame temperature exceeding 2000-2500ºC, form glass that is free of bubbles as well as producing a dichroic surface; the result of rare elements evaporating in a vacuum.

The experiments of the early master glass blowers with unknown minerals in their search for the ideal colouring techniques are amazing as they apparently worked using only intuition and practice. For example, their knowledge of kiln construction or colour mixing techniques could only have been obtained through experiment. Glass polishing and cutting techniques on the other hand came from the art of stone processing. The Egyptian name for glass was "*iner en wedeh*" which literally means "the stone that flows".

Our present knowledge of glass forms and production clearly owes a considerable debt to the glassblowers of antiquity. It is therefore important for us to investigate historical ornament in order to understand glass production techniques even of today, as the history of glass, particularly that used for Art, is closely connected with the history of each civilisation.

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