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# DYNAMICS OF CHEMICAL COMPOSITION VARIATION OF 18th – 19th CENTURY RUSSIAN GLASS

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The chemical and isotopic compositions of glass fragments found on the site of a former 18th – 19th glass plant in Kazan are studied. The finds are divided into three basic groups in terms of three types of glass from which they are fabricated: Ca–K, Ca–K–Na, and Ca–Na–K. The data on the chemical and isotopic composition show difference between the glasses in terms of recipe and raw material source. Comparison of the analytical and historical data suggested that each group of glasses corresponds to a definite time period of production. The composition of one group indicates the possibility that soda ash was added to the recipe.

***Key words:*** archeological glass, late Russian glass production, recipe, chemical composition, isotopic analysis.

The glass industry in Russia developed rapidly in the 18th – 19th centuries. Numerous small and large glass plants were striving to meet the demand for container, window, and artistic glass. By 1800 about 50 glass producers operated in Russia. In the first quarter of the 18th century the Russian government supported the development the glass industry with the participation of Russian merchants.

The importance of this industry is demonstrated by the publication in 1864 of a separate volume of the *Technical Encyclopedia* edited by D. I. Mendeleev, which was completely devoted to questions concerning glass [1]. As commercial glassmaking developed, the technology and mixes changed.

However, there are very few publications devoted to studying the elemental composition of historical glass, being the evidence of these changes. The analytical data on the chemical components of archaeological and museum glass, including also the 17th – 19th centuries, are presented in [2]. In [3, 4] the authors studied the chemical composition of 17th – 19th century glass artifacts from excavations at the Dmitrov Kremlin and the Kazan Kremlin. Foreign investigators devote more attention to this question. D. Dungworth, S. Payter, M. Spring, R. B. Scott, L. Dussubieux, H. Wilmot, and others are actively studying late 17th – 19th century glass [5 – 9]. Many authors are studying not only glass production but also glass recipes [10, 11].

The present work is devoted to studying the chemical composition of the products manufactured at one of the plants, which was built in Kazan at the end of the 18th and beginning of the 19th century for the production of glass containers [12]. Archaeological studies in the region of the former of glass plant were conducted in 1929 by M. G. Khudyakov and the Kazan archaeologist N. F. Kalinin. In the course of the excavations remnants of glass melting furnaces, fragments of boilers for melting glass, and samples of production were found. The investigators were able to identify 16 boilers, attesting quite large production [13]. The archaeological material studied in this work was collected in the spring during the exposure of the 'glass' region of the peninsula, which was flooded as a result of the filling of the Kuibyshev water reservoir in 1957.

The chemical and isotopic compositions of the artifacts were studied in order to determine the recipes and composition of the glass.

## MATERIALS AND METHODS

The glass collection consists of 50 fragments of container glass of different thickness, size, and color. Some artifacts have separate letters or words (Fig. 1).

In terms of quality the glass falls visually into three groups. One group corresponds to a large portion of the ma-

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