Identifying the Decorative Stone Samples from the Mining Museum's Collection: First Results

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Abstract. The report presents the primary results of a study of a unique collection of polished decorative stone samples belonging to Empress Catherine the Great. Primary macroscopic analysis of 83 plates, divided into 13 groups according to similar features, was performed. The bulk chemical composition of rocks was estimated on the basis of XRF- analysis data, performed using a Delta Olympus XRF portable analyzer. Preliminary studies allowed to outline the characteristic fields of the studied samples of decorative rocks on the ternary plots of their bulk composition. In the future, it is planned to perform Raman spectral imaging to generate detailed maps of the mineralogical composition of the decorative stone samples.

Keywords: Polished decorative stones ·
Collections of Empress Catherine the great · Handheld XRF analyzer ·
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1 Introduction

Natural stone serves as a unique raw material for the objects of decorative and applied arts, as well as architectural monuments. Museums and monuments of St. Petersburg store rare objects made of natural stone. The problems of their preservation are increasingly forcing restorers and art researchers to turn to geologists to identify various types of gemstone materials needed for restoration. This raises a number of problems, primarily related to the lack of reliable information about the origin of various types of such materials, as well as their accurate identification in art objects. Their study is complicated by the need to use exclusively non-destructive analytical techniques, which greatly complicates the task. Unlike European museums, in Russia, there is no complex reference collection of natural decorative (ornamental) stone, supported by current results of laboratory research, reliable information on the location, and a complete catalog of art object made of such materials. Obviously, the need for such data is highly in demand not only among restorers and art historians but also among geologists, whose research interests include the preservation of the diversity of gemstone raw materials and objects of cultural heritage.

The object of this study was one of the oldest collections of polished flat samples of natural decorative (ornamental) stone of the XVIII century, previously owned by Empress Catherine the Great (Borovkova 2017). The research contributes to the development of a methodology for evaluating historical gemstone materials of considerable cultural, museum and scientific value. In 1816, a collection was transferred from the Imperial Hermitage to the Museum of the Mining Cadet Corps (now the Mining Museum), which included collections of marbles and «rock sampled as polished plates». In the inventory of this collection, which is stored in the archives of the State Hermitage Museum, there is the following note: «Jasper and solid rocks found in the Ural Mountains, starting from Tura River by noon over the rivers Uyu and Ural» [State Hermitage archives. F. 1. O. 6l. D. 1 a-c]. The total number of such samples is not indicated, but in the catalog (1798) they are recorded from №1525 to №1725; and in the next catalog (1811), there are a number of additional samples. Thus, with the same description, samples from № 2052 to 2330 are recorded in a later catalog.

2 Methods and Approaches

Currently, more than 100 items of such decorative rocks are found in the Mining Museum. The primary macroscopic evaluation of the samples suggested wider geography of their origin. The need for reliable authentication of historical samples necessitated their thorough review.

As the first phase of the study, 83 plates were selected and broadly classified into 13 groups. The groups were formed on the basis of visual estimation of similar characteristics: the rocks structure, texture, and color. Eight of the thirteen selected groups were pre-diagnosed as known geo-referenced decorative rock types that received code names corresponding to their regional and historical affiliation, namely: Korgon porphyry; Tigiretsky breccia; Tigiretsky quartz; Kalkan, Kushkuldinskaya, Nikolaevskaya, Urazovskaya, and Surguchnaya jasper. The remaining groups require further diagnostics and are pre-defined as andesite, hornfels, marble, and green marble.

The planned research method involves the use of known geo-referenced samples. Comparative analysis of the studied samples and reference rocks will be divided into three steps: visual comparison, comparison of chemical and mineral compositions.

As mentioned above, the study of museum objects requires a special approach and the use of non-destructive techniques. In this regard, the samples chemical composition analysis was performed using a Delta Olympus XRF handheld analyzer. The measurements were carried out in the Mining mode with preliminary calibration. There was threefold spectra collection from each point with a 30 s acquisition time. In general, 50 bulk chemical composition analysis of rocks belonging to seven previously selected groups (Korgon porphyry, Tigiretsky quartz, Urazovskaya jasper, green marble, marble, andesite, and hornfels) were made.

3 Results and Discussion

The absence of reference samples let us consider the obtained results as preliminary. Nevertheless, on the ternary plots of the rock samples bulk composition, it is possible to outline the characteristic fields corresponding to certain samples groups.

The Ca-Fe-Si diagram illustrates obvious trends: visible outlining of marble, Urazovskaya jasper, and andesite characteristic fields. The bimodal distribution of points corresponding to green marble possibly occurred due to the presence of large calcite phenocrysts, the content of which varies not only during the transition from sample to sample, but also unevenly distributed over the analyzed area of the sample. On the Ca-Fe-K triangular plot, the characteristic field of Urazovskaya jasper shows that it is ferruginous which is also expressed in its characteristic purple-red color (Fig. 1). The field corresponding to the decorative andesites and the bimodality of the green marble analysis distribution are presented on all charts and can later serve as a diagnostic feature.

Fig. 1. Ternary plots of the bulk chemical composition of polished decorative stones from the collection of Empress Catherine the Great, plotted according to the data acquired by handheld XRF analyzer Delta Olympus. Rock types and characteristic fields: 1 - Korogon porphyry; 2 - Tigiretsky quartz; 3, I - Urazovskaya jasper; 4, II - green marble; 5, III - marble; 6 - andesite; 7 - hornfels

4 Conclusions

Thus, preliminary studies allowed us to outline the characteristic fields of the studied decorative rocks samples on their bulk composition plots. To obtain accurate results, it is necessary to expand the number of samples under study and add reference samples to the diagram. The lack of variation in the petrogenic elements content level in decorative rocks of different types and geographic reference also requires the analysis of not only chemical but also mineralogical composition of rocks. Driven by the need in non-destructive techniques, it is planned to use Raman spectroscopy to make mineralogical composition maps of the samples.

Reference

Borovkova NV (2017) Personal mineralogical collection of Empress Catherine the great in the mining museum collection. Bulletin of St. Petersburg State University of Technology and Design, № 1, Series 2. Arts Philology 8–15

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