

## **Studies of the nature of the molding mass from the bronze sculpture**

**St John the Baptist**

**Italy XV cent.**

**Donatello (c. 1386 - 1466)**

### **Methods:**

Investigations of a sample of material (item 1) were carried out by microscopic methods in reflected light (Hund wetzlar microscope).

The microstructure of the sample was studied using a scanning electron microscope (JSM-5910LV, JEOL) in reflected electrons in the Z-contrast regime. Analysis of the distribution of the elements (qualitative and quantitative composition of the samples) was carried out by the method of energy-dispersive microanalysis (analytical systems INCA and AZtecENERGY, Oxford Instruments). Electron microscopy studies were carried out at the Scientific Center for Fiber Optics (headed by Iskhakova, LD, the analytical centre).

X-ray examination of the sample was carried out using a Bruker D2 PHASER diffractometer on CuK $\alpha$ -radiation. The results were processed and the X-ray phase analysis of the samples was carried out using the DIFFRACplus (EVA and TOPAS 4.2.0.2) software complexes.

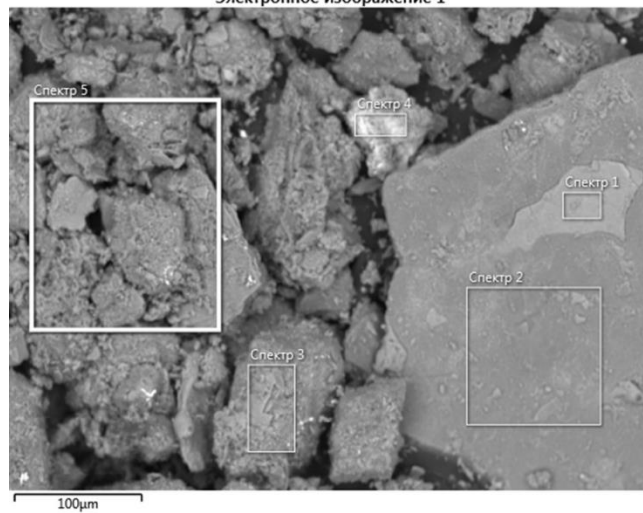
The method of IR spectrometry on the Simex instrument IR Fourier spectrometer FT-801 and microchemical analysis was also used.



Sampling site

Electronic image of the test sample of the molding mass

Электронное изображение 1



The photo shows the areas where the elemental composition was being identified.

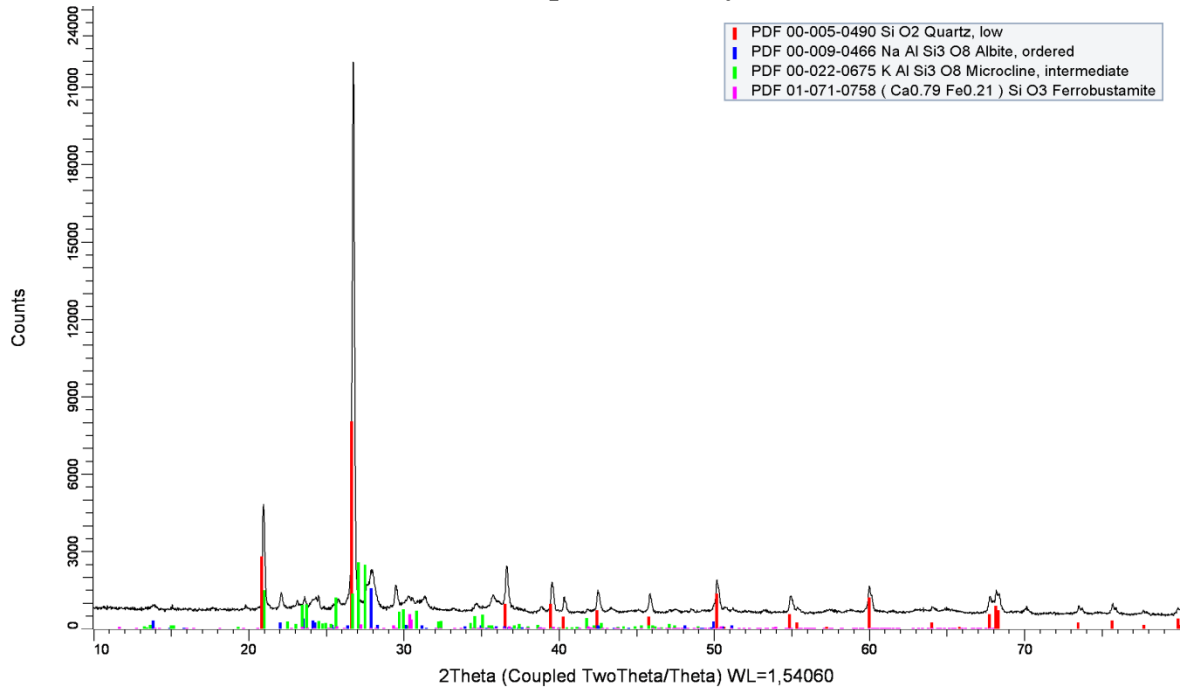
### Qualitative and quantitative composition of the white mass in the five samples

Element	Element content in 5 different sections									
	spectrum 1		spectrum 2		spectrum 3		spectrum 4		spectrum 5	
	% mass	% atomH	% mass.	% atomH	% mass.	% atomH	% mass.	% atom H	% mass.	% atom H
O	39,71	59,97	44,68	60,67	44,4 4	61,16	34,03	61,54	43,38	61,04
Na	1,25	1,31	0,92	0,87	2,37	2,27	0,69	0,87	1,67	1,63
Mg	4,06	4,03	0,76	0,68	1,94	1,76	1,84	2,19	2,17	2,01
Al	9,32	8,34	18,06	14,54	11,0 6	9,02	3,9	4,18	9,25	7,72
Si	14,84	12,76	21,1	16,33	24,0 2	18,83	10,52	10,84	22,04	17,67
K	2,14	1,32	8,83	4,91	3,22	1,81	2,69	1,99	2,98	1,72
Ca	3,13	1,89	0,9	0,49	4,26	2,34	5,79	4,18	6,36	3,57
Fe	16,4	7,1	1,96	0,76	4,67	1,84	3,18	1,65	7,72	3,11
Zn	5,48	2,03	0,88	0,29	1,52	0,51	0,68	0,3	2,33	0,8
Ba			0,29	0,05			29,81	6,28		
Pb	1,35	0,16	0,84	0,09	1,9	0,2			0,78	0,09

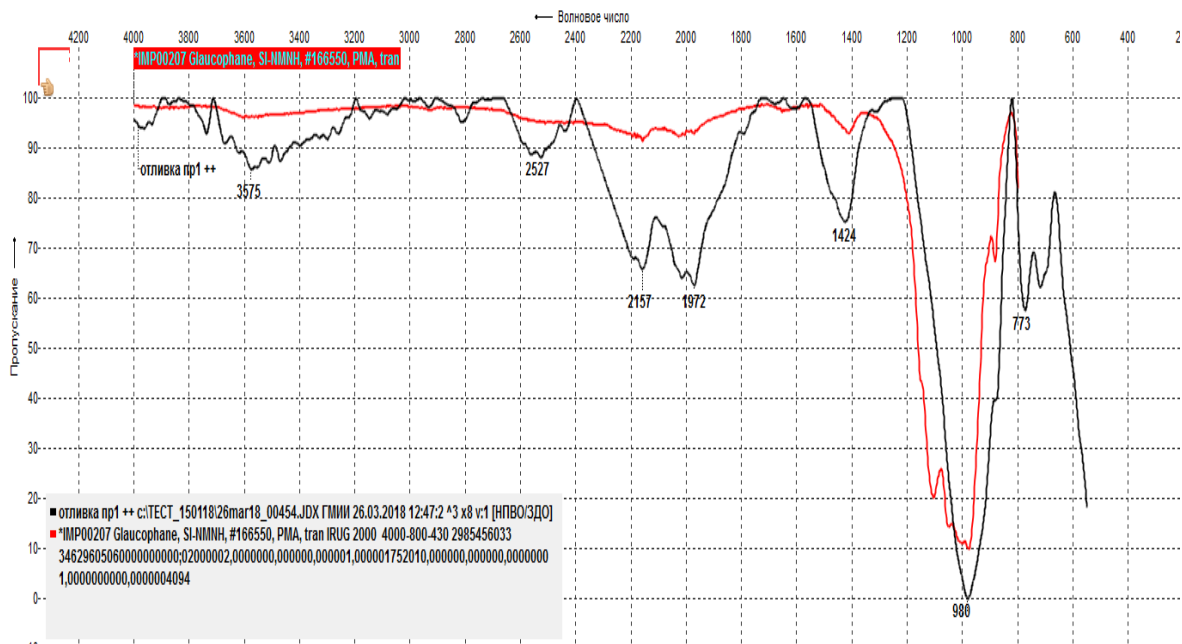
The conducted studies allow us to conclude the following:

1. The samples are a mixture of quartz (sand) and clay minerals.
2. The difference between the samples consists in a different ratio of clay minerals and quartz (sand).
3. The samples contain barium sulphate BaSO<sub>4</sub>
4. There are differences in the number of metallic inclusions

## Phase composition analysis.



The main phase is quartz  $\text{SiO}_2$ , then - albite, microcline, iron silicate. In addition to these phases, the sample contains barium sulfate  $\text{BaSO}_4$ , zinc oxides  $\text{ZnO}$  and lead. The remaining cations are most likely impurities in quartz and other silicates



IR spectra: sample 1 and the standard of soil (mixture of green earth and calcite).

The sample consists of a mixture of clay (soil) mineral with quartz and calcite.

IR spectra confirmed the results obtained by the energy dispersive and X-ray phase methods.

Energy dispersion spectra of the surface of one of the samples of the molding mass

