SPECTROSCOPY OF FULGURITE GLASSES

Lysiuk, A.Y.

Pervomaiskaja 54, 167982 Syktyvkar, Russia
e-mail: rmin@geo.komisc.ru.

Fulgurites are glassy tubular bodies, which formed after the melting of rocks by the stroke of a lightning. They are relatively rare and not sufficiently enough studied geological objects. In our investigations we use several methods such as X-ray analysis, Mössbauer spectroscopy, infra-red spectroscopy, and electronic microscopy. We studied fulgurite from the area of Nigoziro in Karelia, Russia, which formed on carbon-containing aleurolits. The main component of fulgurite is alumosilicate glass; its chemical composition roughly corresponds with the composition of carbon-bearing aleurolits.

With the help of X-ray analysis we found that fulgurite glasses have quartzo-felsphatic composition. We also exposed the heterogeneity of the glasses which consist in combined presence of an amorphous glassy matrix and of crystalline formations differing in composition: orthoclase, hematite, chlorite, pyrite.

The state of iron in fulgurite was studied with the help of Mössbauer spectroscopy. In the spectrum four double-peaks of iron can be distinguished. One double-peak of trivalent iron in tetrahedral position (δ = 0.32) which contains 4.1 % of all iron, and three double-peaks of divalent iron in octahedral positions. The latter differ by the extent of distortion of the octahedra (δ = 1.1; 1.13; 1.05). Accordingly, the content of iron at these positions amounts to 33.9, 30.4, and 31.6 from total iron.

The infra-red spectra of fulgurites consists of absorption bands which are typical for silicate glasses and which are related to the silicon-oxygen vibrations of the glassy fulgurite matrix. We also found several narrow bands of crystalline quartz giving evidence for the presence of crystalline quartz.

Using micro-probe analysis we determined that the main mass of the glassy fulgurite substance consists of a Si-Al-Fe melt. In main parts of the melt areas of almost pure glasses are distinguished. The simultaneous appearance of fragments such as residual quartz tells that the temperature of the melt in that zone was near the temperature of quartz melting, this is about 1700 °C.

We also often found inclusions of hematite Fe_2O_3. Its grains have straight borders. The appearance of these inclusions allows us to estimate the temperature of the fusion which did not reach the temperature of hematite melting. Besides, in the glass we found inclusions of hematite with tracks of partial melting.

Appearance of a great amount of skeleton formations with the composition such as FeO (wüstite) gives evidence for a high cooling speed. Such structures form because of dissociation in the cooling stage.