USE OF RAMAN SPECTROMETRY TO DETERMINE THE COMPOSITION OF PRIMARY INCLUSIONS IN SAPPHIRES.
S. Y. Buravleva1, V. A. Pakhomova1, and D. G. Fedoseev1, 1Far East Geological Institute, Russian Academy of Sciences, 159 Prospekt 100-letiya, 690022 Vladivostok city, Russia; e-mail: s_buravleva@yahoo.com.

Introduction: In the Russian Far East Nezamnetnoye deposit is the only placer deposits of jewelry grade corundum (sapphire) and zircon (jacinth) [1]. A new type of sapphire material was investigated by authors in the Jewish Autonomous Oblast in the Russian Far East. At the outer limits of the Sutara goldmine district sapphire crystals and their fragments were discovered.

The mining region consists of sedimentary, metamorphic and intrusive rocks. The bedrock of mining region consists of early Cambrian aleurolites, sandstones, marbleized limestones, crystal slates which are interstratifying with clay slates, carbonate and graphitic rocks. As a result of regional metamorphism carbonate rocks became marble. Intrusive rocks are presented by biotite gneissoid granites, biotite and tourmaline leucogranites, veins of granitic pegmatites, and migmatites. The alluvial corundum occurrences were discovered in the basin of the Sutara River.

Materials and methods: Sapphires is represented by euhedral dipyramidal crystals or broken pieces up to 3 cm in size. They are mostly blue and gray. The color is often zonal and spotty.

To determine the genesis of corundums, authors investigated mineral and fluid inclusions. Research of primary inclusions makes it possible to obtain accurate information on the condition of mineral crystallization.

Thermometric experiments with use of TS 1500 Stage, Linkam showed that primary inclusions are not homogenized even at the 1200 degrees Celsius. The composition of primary inclusions was not determined.

Use of Raman spectrometry allows one to solve this problem. Inclusions in sapphire samples were analyzed by Raman spectrometry using a Horiba LABRAM HR 800 spectrometer, a Si-based CCD detector and an Ar+ (or green) laser at an excitation wavelength of 514 nm of Melles Girot at the Sobolev Institute of Geology and Mineralogy, Siberian Branch of the Russian Academy of Sciences (Novosibirsk, Russia).

Primary inclusions consist of diaspore (AlO(OH)) with a very strong peak at 447 cm⁻¹, carbon dioxide with peaks 1284 and 1385 cm⁻¹, and methane with peak 2914 cm⁻¹. Molecular ratios of carbon dioxide and methane are 0.989 and 0.011 respectively.

Secondary fluid inclusions presented by carbon dioxide have peaks 1284 and 1385 cm⁻¹.

We also measured the spectra of various mineral inclusions such as rutile, zircon, monazite, xenotime, ilmenite, spinel, pyrite, biotite, and plagioclase.

To determine the composition of plagioclase, authors applied quantitative chemical analyses at the JEOL JXA-8100 electron microprobe (Laboratory of X-Ray Methods, Far East Geological Institute, Vladivostok.). As a result of research it was established that the plagioclase corresponds to andesine in composition.

Results: The use of Raman spectrometry allows one to determine the composition of primary inclusions in sapphires of the Sutara goldmine district. They consist of diaspore, carbon dioxide, and methane.

The carbon dioxide low-density fluid took part in formation of sapphires. This fluid formed as a result of thermal impact of magma on carbonate rocks.

Plagioclase is often present in sapphires. Primary mica inclusions are rare. We believe original paragenesis was mostly plagioclase and mica played a minor role in it.

When alumina-rich magmatic rocks (in our case the anatectic granites, and then veins of pegmatite) is introduced to the limestones and dolomites, there is a reaction between a magmatic material (fluid) and host rock.

As a result, metasilicon acid (H₂SiO₃) and alkalis which are present at magmatic fluid react with host rocks. Mica, chlorite, and sometimes talc crystallize. Magmatic material, while losing alkalis and metasilicon acid, is enriched with alumina. This alumina can be enough for corundum crystallization.

Acknowledgement: The authors express their gratitude to the Far Eastern Branch of Russian Academy of Sciences for financial support (grant 14-3-B-08-172). The authors thank Mr. Kurnosov for the permission to enter the Sutara gold mine. They are also grateful to Mr. S.Z. Smirnov for his kind advice and assistance during the Raman analysis.