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Raman spectroscopic investigation of graphite from the Gremyakha Vyrmes and Pogranichnoe carbonatites, Russia

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Unusual, graphite-bearing carbonatites were found in several localities, including Gremyakha-Vyrmes (Kola peninsula), Pogranichnoe (Transbaikalia), and Chernigovsky (Ukrain). Here we report first results of a study of graphite samples from the first two localities, which was undertaken to understand how carbon can be transported, and how a carbon phase can be formed, in carbonate-rich igneous rocks. The Gremiakha-Vyrmes massif is a large (130 km2) intrusive complex situated in the northwestern part of the Kola peninsula. Here, carbonatites are the youngest formation, occurring as up to 1 m thick veins, in zones of intensive tectonic disturbances of foidolite series rocks in the central part of the massif, along a submeridional fault. Graphite occurs in calcite carbonatite together with albite, in aegerine albitite, and in gabbro. Graphite forms spherulites with knobby surface, up to 1.5 mm in diameter. The Pogranichnoe carbonatite is located in a fault zone cutting the Precambrian crystalline basement. Graphite was found to occur in dolomite carbonatite, together with magnetite, fluorapatite, and aegerine; as well as strontianite, pyrite, hematite, biotite, and arfvedsonite as minor components. Graphite forms spherulites with hexagon-like shapes, 1-2 mm in diameter. Some of these spherulites contain carbonate or hematite inclusions (Doroshkevich et al., 2006). The carbon isotope distribution between carbonate and graphite allowed us to estimate the formation temperature of the graphite. Results indicate formation at 430-470 C (Gremiakha-Vyrmes) and 470-520 C (Pogranichnoe), respectively. In recent spectroscopic studies it was shown that the degree of order/disorder of graphite reflects the formation/transformation temperature and can thus be used to study the thermal history of the host rock. The degree of ordering of graphitic carbon, or similar carbonaceous material, can be determined in situ by micro-Raman spectroscopy. Beyssac et al. (2002) proposed a thermometer based on the observed correlation between the ratio of the band integral of the graphite G and D bands, and the height of these bands, and metamorphic temperature. This thermometer been modified by Rahl et al. (2005). Data presented in these two papers and by Guedes et al. (2005), show that both the position and the FWHM (full width at half band maximum) of the graphite G band decrease with temperature. The G band of high-temperature graphite (i.e., formed or recrystallized at >400 C) was found to have Raman shifts of 1571-1583 cm-1 and FWHMs in the range 13-30 cm-1. In the present study, Raman studies were done using a Renishaw RM1000 spectrometer with 632.8 nm He-Ne excitation. Raman spectra of graphite samples from the Pogranichnoe carbonatite are largely similar to published spectra of crystalline graphite. The G band exhibited generally low FWHM values of about 16-18 cm-1. Graphite from the Gremiakha Vymers carbonatite, in contrast, exhibited notable, but still moderate, band broadening, with G band FWHMs in the range 19-31 cm-1. Results indicate that graphite from Gremiakha-Vyrmes is somewhat less ordered than graphite from Pogranichnoe, in spite of the fact that both of them fall in the “high-temperature” area. These observations seem to indicate that the lattice order of primary carbonatitic graphite formed at a certain temperature can be notably different from that of metamorhphic graphite formed from biogenic carbonaceous material at the same temperature. This may question as to which degree the above graphite thermometer can be applied to carbonatitic or other graphite of non-biogenic origin.

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