POLSKIE TOWARZYSTWO MINERALOGICZNE – PRACE SPECJALNE
MINERALOGICAL SOCIETY OF POLAND – SPECIAL PAPERS
Zeszyt 22, 2003; Volume 22, 2003

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PRELIMINARY STUDIES OF THE SOLID INCLUSIONS IN NATURAL AND SYNTHETIC RUBIES IN TERMS OF RAMAN MICROPROBE SPECTROSCOPY.

The work aimed at the identification of solid inclusions in synthetic and natural rubies using Raman microspectroscopy. An attempt was made to define typical parageneses of the inclusions in rubies from chosen localities or from synthetics produced by Verneuil method.

Raman microspectra were obtained on Jobin-Yvon T-64000 spectrometer, using Argon laser (λ=514,5 nm) at the Department of Molecular Physics, Technical University Lodz. The method is particularly useful in mineralogical and gemmological investigations as it does not require destruction or special preparation of samples (Pinet et al., 1998).

The analyses were conducted on the rubies from the Khitostrov locality of North Karelia and two occurences in Madagascar (Ambatofotsy Poassin district d'Anivorano and Vatomandry). Synthetic products used for the investigations comprised crystals manufactured by the Verneuil method in the Experimental Laboratory of the former Huta Aluminium in Skawina and a historical synthesis carried out by R. Fremy in 1903. This specimen is the property of the Mineralogical Museum of the Wroclaw University. As it is generally known, inclusions are especially useful in defining physical and chemical conditions of mineral formation and may be indicators for distinguishing natural crystals from synthetics (Gübelin 1983). Over 54 mineral inclusions have been identified in rubies so far, apart from gaseous and fluid ones. Over many years much effort in gemmological research has been put to describe inclusions characteristic of certain ruby deposits and of various methods of synthesis (Henn 1995). With reference to those investigations the authors carried out the Raman spectroscopy analyses for the following ruby types.

NATURAL RUBIES

Rubies from the Khitostrov locality of North Karelia were discovered in 1968. The corundum mineralisation of Khitostrov is confined to the zones of corundum-

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kyanite-bearing basifications of plagiomigmatisation stage. The zones are about 30-90m long and 6 to 30m thick and bed conformably with the country rock layering.

The corundum is basically concentrated in second zone from the centre except single uncommon crystals in the central plagioclastic zone. It attracts the collectors attention due to the presence of well developed, large crystals – from millimetres to 5-6 cm long and up to 2-3 cm in diameter. Many crystals are up to 10 cm long. Finer crystals are, as a rule, more transparent and display more complex and perfectly developed faces. The majority of the Khitostrov corundum, especially larger specimens, contains numerous solid inclusions represented first of all by rock forming minerals of the country basificates, such as garnet, plagioclase, biotite, hornblende, magnetite, rutile, ilmenite, wustite and diaspore (Gromov 1993).

Raman microspectroscopy, performed in several points in the Khitostrov rubies (Table 1 and Fig. 1) confirms the occurrence of almandine, high-T plagioclase, biotite, rutile, ilmenite, diaspore as inclusion phases and documents also zircon and poorly disordered graphite not noted before. The graphite is present in rutile inclusions.

Rubies occurring in granite pegmatites from Ambatofotsa (Madagascar) are poorer in inclusions (Table 1 and Fig. 2). Raman spectroscopy allowed to define microcline, turmaline, sillimanite, and gaseous inclusions of CO_2. Lowest amount of inclusions identified with this method was found in the rubies from Vatomandry (Madagascar), in which only plagioclase, rutile and garnet were noted (Table 1 and Fig. 2).

SYNTHETIC RUBY VERNEUIL CRYSTALS

The analysed synthetic rubies were produced in the Experimental Laboratory in Skawina. Raman spectroscopy investigations allowed to define cryolite and silicon as characteristic inclusions in Verneuil rubies from Skawina (Table 2 and Fig. 3)
No inclusions were detected using the Raman method in the synthetic Fremy's rubies produced in 1903 (Table 2 and Fig. 3).

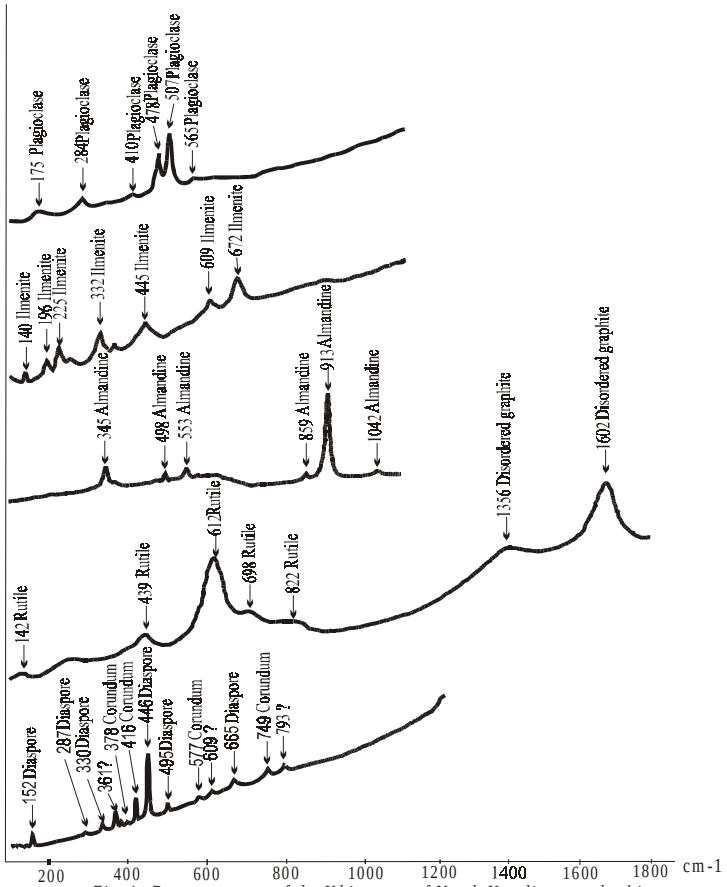

Fig. 1. Raman spectra of the Khitostrov of North Karelia natural rubies.

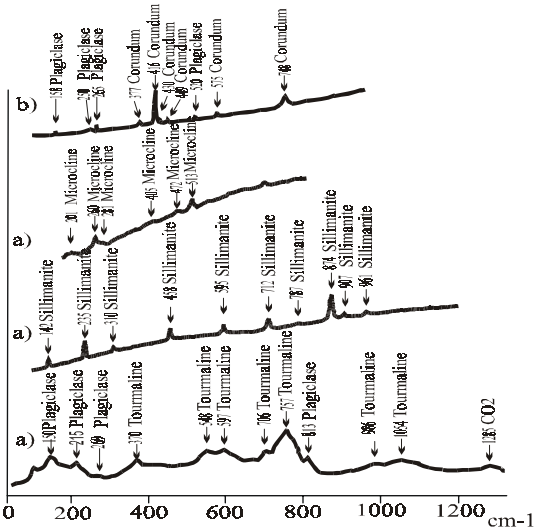

Fig. 2. Raman spectra of Madagascar natural rubies,
a) Ambatofotsy, b) Vatomandry

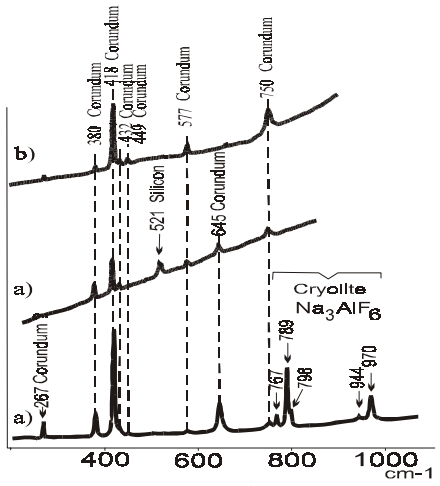

Fig. 3. Raman spectra of synthetic rubies.
a) Skawina, b) Fremy

Table 1 Inclusions in natural rubies.

Locality	Inclusions described in literature	Raman microspectroscopy (Jobin - Yvon T-64000 laser Ar =514.5 nm)
The Khitostrov of North Karelia	Gromov (1993) Garnet Plagioclase Biotite Hornblende Magnetite Rutile Ilmenite Wustite Diaspore	Almandine Biotite Rutile Zircon Ilmenite Diaspore High- T plagioclase Disordered graphite
Granitic pegmatite Ambatofotsy Poassin de Iaroka district d'Anivorano (Madagascar)	No date	Sillimanite Microcline Turmaline CO_2
Vatomandry (Madagascar)	Hänni (2001) Apatite Rutile Ore mineral grains (not yet identified)	Plagioclase Garnet Rutile

Table 2 Inclusions in synthetic rubies.

Verneuil synthesis	Inclusions described in literature	Raman microspectroscopy (Jobin - Yvon T-64000 laser Ar =514.5 nm)
Experimental laboratory of the former Huta Aluminium in Skawina	Gas bubbles Platinum Cryolite	Cryolite Silicon
R. Fremy (1903)	No date	Not found

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