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# Trace element distribution, solid- and fluid inclusions in untreated Mong Hsu rubies

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Mong Hsu/Myanmar has been an important source for gem quality ruby since the early 1990's. White calcite-dolomite marbles are the host rock for well developed crystals that are thought to have formed at amphibolite facies conditions of 500-550C$^{\circ}$ and 2.0-2.5kbar (Peretti et al. 1995). The most apparent characteristic of untreated Mong Hsu rubies is a distinctive optical zoning whereby a dark blue to black sapphire core is surrounded by a red ruby rim. More complex zoning patterns such as oscillatory color zoning may also be present. The association of optical with chemical zoning has already been discussed in several studies (e.g. Achiwawanich et al. 2006) and was related to a zonal distribution of Cr, Ti and Fe. Nevertheless, additional knowledge of the trace element contents is fundamental to understanding the unique optical appearance of Mong Hsu rubies. Aside from minor/trace element patterns, solid and fluid inclusions are an additional important feature that can be used to identify specific corundum deposits and to distinguish between natural and synthetic corundum. In case of Mong Hsu rubies, liquid $CO_2$-inclusions and a suite of solid inclusions involving diaspore, white mica, rutile and dolomite are typical (Peretti et al. 1995).

The aim of this study is to gain better insight into the color zoning mechanisms of the Mong Hsu rubies by using electron microprobe (EMPA) and LA-ICP-MS analyses to investigate their minor and trace element zoning patterns and to compare these data with those already available from the literature. Three transparent samples (diameter

0.5cm) with sapphire cores und ruby rims and a number of smaller and less transparent specimens (diameter 0.1cm) were investigated. Optical zoning and the position of solid and fluid inclusions were located with optical microscopy. Chemical zoning was then investigated with cathodoluminescence imaging, EMPA analyses (spot analyses and Cr- and Ti-mapping) and LA-ICP-MS. This yields the following values: $Cr_2O_3$ 0.27-2.32wt%; $TiO_2$ 0.03-0.49wt%; V 280-1006ppm; Mg 16-89ppm; Fe 69-135ppm;Ga 69-79ppm; Nb $<$0.11-4.6ppm; Ta $<$0.02-2.0ppm. Additional WDX analyses are in excellent agreement with LA-ICP-MS data. In addition to the mineral chemical study, laser Raman spectroscopy was used to identify fluid inclusions and a suite of solid inclusions involving Cr-muscovite, paragonite-margarite solid solutions, phlogopite, Mg-rich chlorite, rutile, quartz, dolomite and diaspore. The latter four phases have also been identified in fluid inclusions containing $CO_2$ as only liquid, most likely representing daughter crystals that have formed from an originally mixed $CO_2$-$H_2O$ fluid

**References**

Achiwawanich S. et al. (2006) Applied Surface Science, Vol. 252, Issue 24, Pages 8646-8650

Peretti A. et al. (1995) Gems & Gemology, Vol. 31, No. 1, 2-26.