RUBIES FROM MONG HSU

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Large quantities of rubies—both rough and faceted—from a commercially important new source in Myanmar (Burma) have been available on the Bangkok market since 1992. The ruby crystals from the Mong Hsu marble deposit have dipyramidal to barrel-shaped habits and reveal dark violet to almost black "cores" and red "rims." With heat treatment, which removes their blue color component, the cores become intense red. The rubies grew under varying conditions in complex growth sequences. The color distribution between cores and rims is related to a different incorporation of chromium and/or titanium during crystal growth. Gemological, microscopic, chemical, and spectroscopic properties presented here permit the separation of faceted Mong Hsu rubies from their synthetic and other natural counterparts. Problems arising from artificial fracture fillings are also addressed.

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Since 1992, Mong Hsu has been a primary source of ruby available in Thailand (figure 1). Mong Hsu is a small town situated in northeastern Myanmar (formerly Burma) in Shan State, which borders Thailand, Laos, and China. Untreated samples from this new source typically consist of bicolored corundum, with dark violet to almost black sapphire cores and ruby rims (figure 2). With heat treatment, the violet cores can be converted to red. Large quantities of untreated corundum crystals are brought into Thailand at Mae Sai and, to a lesser extent, at Mae Hong Son (see figure 3). In 1993, about 200 buyers from Chantaburi (Thailand) were spending several million U.S. dollars a month on Mong Hsu rough in Mae Sai ("Special report: Mong Hsu . . .," 1993). Thus, the Mong Hsu ruby has become an important source of supply to the world market.

In September 1992, one of the authors (AP) joined a group of gemologists who traveled to Myanmar and Vietnam at the invitation of the Asian Institute of Gemmological Sciences (AIGS), Bangkok, to learn about the occurrences of rubies and sapphires in these countries (see Jobbins, 1992; Kammerling et al., 1994). During this trip, at the mid-year Emporium in Yangon (Rangoon), Myanmar, the Myanma Gems Enterprise (MGE) announced a new ruby deposit in the region of Mong Hsu, and showed the group a series of rough samples with violet cores and red outer layers (called rims here for simplicity). Six samples were submitted for further study to one of the authors (AP), who also took the opportunity to test some cut stones (including heat-treated samples without violet cores) from this new source. The untreated rough and heat-treated cut rubies examined during that visit were essentially identical to the material examined later for this study. According to information subsequently obtained in Bangkok, many Thai dealers were already buying Mong Hsu rubies (see "Burma's Mong Hsu mine rediscovered . . .," 1993).

By October 1992, large quantities of faceted material approximately 0.5–1 ct in size and of high-quality color saturation and transparency had also begun to appear on the European market. One of the first lots of this material (obtained from a dealer in Munich) was studied in detail by

Surdez (1994) reported seven sharp bands of varying intensity at 3189 (weak), 3233 (medium), 3299 (very weak), 3310 (strong), 3368 (very weak), 3380 (very weak), and 3393 cm^{-1} (very weak) in the absorption spectra of Mong Hsu rubies. Similar features have been found in the infrared spectra of Verneuil-grown synthetic rubies and sapphires that were doped with various trace elements in different concentrations and, at least partly, annealed in a hydrogen atmosphere at high temperatures (Borer et al., 1970; Eigenmann and Günthard, 1971; Eigenmann et al., 1972; Blum et al., 1973; Volynets et al., 1972, 1974; Beran, 1991; Moon and Phillips, 1994). Consequently, the sharp absorption bands in the infrared spectra of Mong Hsu rubies are assigned to OH-stretching vibrations and indicate that hydroxyl groups have been incorporated in the crystal structure of some heat-treated samples.

Smith (1995) recorded an absorption spectrum in some untreated samples that consisted of several broad absorption bands. He assigned this spectrum to microscopic or submicroscopic inclusions of diaspore, AlO(OH).

OH-stretching vibrations were also measured previously in the infrared spectra of a few untreated ruby and sapphire samples from Sri Lanka (Schmetzer, unpublished), in a ruby from Sri Lanka and a blue sapphire from Montana (Beran, 1991), and in untreated blue Australian sapphires (Moon and Phillips, 1994). They were not found in the spectra of flux-grown synthetic rubies (Belt, 1967; Volynets et al., 1972; Peretti and Smith, 1994).

For practical gemology, the presence of OH-related absorption lines in the infrared spectrum of an unknown ruby indicates that the sample is not a flux-grown synthetic ruby, although it may be a Verneuil-grown or hydrothermally grown synthetic sample (either of which is more readily identifiable from natural rubies than the flux-grown material) or a natural stone. For discussion of the difference between Verneuil- and hydrothermally grown synthetic ruby, see Belt (1967), Beran (1991), and Peretti and Smith (1993, 1994).

SUMMARY AND CONCLUSION

Large quantities of rubies from the new deposit at Mong Hsu have been widely available since 1992. Most are heat-treated before they enter the jewelry trade. Mong Hsu rubies are easily recognized by their distinctive microscopic properties. They have a number of features that thus far have not been reported for rubies from other occurrences. These include:

- A distinct color zoning confined to specific growth structures, with one or two violet "cores" surrounded by a red "rim."
- Spectroscopic features in the red to yellow portion of the visible spectrum, with absorption bands that are removed during heat treatment to change the cores from violet to red.
- The presence of whitish particles in certain growth zones, formed as a result of heat treatment.

We found that the color zoning in our samples is closely related to a complex chemical zoning confined to growth layers formed parallel to the basal pinacoid, to the positive rhombohedron, and to two hexagonal dipyramids. We observed a distinct growth sequence whereby red and violet areas formed in various growth cycles, with a specific habit change between different growth zones. The variation in physical properties, such as refractive indices, is closely related to the chemical composition of the samples. Although those properties of the crystals that are related to different growth conditions during the formation of the rubies—that is, growth zoning, color zoning, and chemical zoning related to temperature and/or pressure and/or chemical composition of the environment—are well understood. Only preliminary models are presently available to provide a detailed explanation of the cause of successive growth cycles (Peretti and Mouawad, 1994).

Nor is there a comprehensive explanation for those properties of Mong Hsu rubies that change with heat treatment. Likewise, no model is available that can explain all features related to the change in UV-visible and IR spectroscopic properties, which are closely related to the color change and possibly also to the formation of the whitish particles.

The distinctive properties of Mong Hsu rubies are useful in separating faceted samples from their synthetic counterparts and also in establishing the locality of origin. The most prominent diagnostic properties of faceted, heat-treated Mong Hsu rubies require careful microscopic examination, using immersion techniques in conjunction with fiber-optic illumination. Key features include growth structures confined to a distinct color zoning between cores and rims; different types of whitish particles and whitish streamers are also of diagnostic value. Specialized laboratory techniques, such as XRF analysis and IR spectroscopy, provide additional diagnostic information. Problems for the trade arise, however, from the large numbers of stones with fractures that appear to have been filled with a foreign material, especially partially healed fractures with glassy and/or crystalline fillers.

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