THE SAPPHIRES OF MINGXI, FUJIAN PROVINCE, CHINA

By Alice S. Keller and Peter C. Keller

Blue sapphires are currently being mined on an exploratory basis from alluvial deposits at the Lindi mine, near the town of Mingxi in Fujian Province. The geology and occurrence of the sapphires appears to be similar to that of the gem corundum from Australia, Thailand, and Kampuchea (Cambodia). For the most part, the rough sapphires are greenish blue to dark blue in color and average approximately 2 ct; their gemological properties are also similar to those of sapphires from comparable geologic environments.

One of the greatest potential gem resources in China today is sapphire. Currently, there are two major areas producing gem-quality material: Hainan Island and Fujian Province. Because weather conditions on Hainan Island are so severe, these deposits have been largely inaccessible to Westerners for study. Recently, however, the Bureau of Geology and Mineral Resources of the People's Republic of China opened their operation at the Lindi mine, near the city of Mingxi in Fujian Province, to the authors. Although the current operation is solely for purposes of research and exploration, local officials hope to develop an economic facility and to begin marketing and distribution in the near future.

It is interesting to note that although large, crudely cut sapphires (as well as rubies and cat's-eye chrysoberyls) can be seen in the imperial regalia of the Ming (14th–17th centuries) and later dynasties, virtually all of these stones appear to have been obtained from Sri Lanka. There is little evidence of the use of native Chinese sapphires in historical pieces in China (Dr. Hu Chengzhi, pers. comm., 1985).

Sapphires were first discovered near the town of Mingxi in 1980, during the course of exploration for diamonds in the area. Since 1980, exploratory mining for sapphires has yielded 5,000–7,000 ct of largely blue rough from river gravels near the town. The geologic setting from which the sapphires have been recovered is similar to that of many alluvial corundum deposits elsewhere in the world: Kampuchea (Jobbins and Berrangé, 1981), Thailand (Keller, 1982), and Australia (Coldham, 1985). Most of the blue sapphires found to date are similar in appearance to the very dark stones (figure 1) commonly associated with the Australian deposits (Coldham, 1985).

The current review of the Mingxi sapphire fields and the gemstones found there is based on the authors' October 1985 visit to Mingxi.

LOCATION AND ACCESS

The Lindi mine is located 10 km northwest of the town of Mingxi in Fujian Province (see map in figure 1, Keller and Wang, 1986). The most direct access requires a seven-hour train ride from Fuzhou, the capital of Fujian, approximately 170 air kilometers northeast to the town of Sanming, and then approximately two hours by field vehicle over 80 km of winding, but mostly paved, mountain road to Mingxi. On their visit, the authors encountered several places where rock slides from a recent rain had blocked part of the road; access could be greatly impeded during heavy rains.

The town of Mingxi, although quite a distance from other population centers, has more than 50,000 inhabitants. The climate in this area of China is largely tropical, and rice paddies represent the dominant agriculture. Water buffalo are still seen pulling the ploughs as they have for centuries, although modern tractors are now far more common on the contryside.

All mining is controlled by the national Bureau of Geology and Mineral Resources; the headquarters of the Fujian branch of the bureau is in

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Figure 1. This 9.5-ct sapphire crystal was found at the Lindi mine, near the town of Mingxi, in Fujian Province. Photo © Tino Hammid.

Fuzhou. Access to the sapphire mine is by government invitation only, since it is not open to the general public.

GEOLOGY AND OCCURRENCE

Detailed geologic field mapping has only recently been initiated in the Mingxi area, and what information is available is a result of a widespread stream-gravel sampling project undertaken by geologists from the Fujian Bureau of Geology and Mineral Resources. Understanding the geology of the area is further complicated by the fact that the region's subtropical climate has led to deep chemical weathering and massive erosion. Rock outcrops of any type are very rare, and the sapphires are limited to alluvial stream gravels.

In the Mingxi area, sapphires have been detected over a distance of 50 km in Ginxi Stream, a tributary of the Minh River. Alkali basalt flows with mantle xenoliths (foreign rock fragments) have been mapped locally by Chinese geologists. They reported that some small crystals of sapphire have been found in these basalts. The authors were taken to a small, heavily weathered outcrop of what appeared to be an alkali basalt containing large weathered nodules, typical of mantle material. Furthermore, a detailed examination of the stream gravels revealed abundant black spinel, pyroxene, enstatite, and roughly equal amounts of pyrope garnet, zircon, and olivine (peridot) as detrital minerals along with the corundum.

Preliminary investigations into the geology of the area suggest that this sapphire occurrence may be very similar to the sapphire occurrences in the New England district of New South Wales, Australia (Coldham, 1985) and the ruby occurrences in Chanthaburi-Trat, Thailand (Keller, 1982) and Pailin, Kampuchea (Jobbins and Berrangé, 1981). These areas are also deeply weathered and the corundum is either alluvial or eluvial. In all instances, there appears to be an association between the presence of alkali basalt flows and the distribution of corundum. Furthermore, the minerals associated with the corundum in the alluvium are consistent with those found in an alkali basalt, particularly the type of alkali basalt that contains mantle xenoliths.

MINING AND PROCESSING

Mining. At the current time, mining is restricted to the Ginxi streambed itself. During the authors' visit, approximately 10 miners were working the deposit (figure 2), with active mining in only one small area of the stream. To retrieve the gem materials, the miners dam up various parts of the stream, thus shutting off the flow of water, and then shovel gravel from the drained stream bottom onto the adjacent bank (figure 3).

The gravel is trucked to a processing plant 5 km southeast of the mining area, halfway between the deposit and the town of Mingxi. In this fashion, the miners remove approximately 7–8 cubic meters of gravel per day.

Processing. To retrieve and sort the gem rough, the mine operators use a five-step recovery process:

First, the gem gravel is placed in a pulsator and washed. The larger pieces are removed by hand, while the smaller gravels are passed through a mesh 2.5 cm (1 in.) in diameter (figure 4).

Next, these smaller pieces are sent through a second pulsator, where they are sorted into five different groups via four different meshes: less than 1 mm, 1–2 mm, 2–4 mm, 4–8 mm, and 8–16

Figure 2. Several miners leave the small area of Ginxi Stream that they have been working for sapphire.

Figure 3. Various sections of this small portion of Ginxi Stream have been dammed up so that the miners can retrieve the gem gravel from the drained stream bottom.

mm. A final machine sort uses gravity to remove the lighter rock particles so that only the gem concentrate—approximately one-third garnet, one-third zircon, and one-third sapphire—remains (figure 5).

In the fourth step, the gem concentrate is taken to the local office of the Bureau of Geology and Mineral Resources. Here the gem crystals are sorted out on a glass table top that is lit from below so that the gem materials can be more readily identified by virtue of their translucency (figure 6). Lastly, the gems are sorted according to color and gem quality.

Since 1980, this small operation has produced 5,000–7,000 ct of predominantly blue sapphire, approximately one-third of which is gem quality. Equal amounts of dark red garnet and colorless zircon have also been found, but the Chinese have not yet investigated the commercial potential of these two materials.

Figure 4. In the first of a five-step recovery process, the smaller gravels are passed through a 2.5-cm mesh; the larger material that remains on top is removed by hand.

DESCRIPTION OF THE MATERIAL

Color. The sapphires from Mingxi occur in yellow-green, green, greenish blue, and blue. No ruby has yet been found at this deposit. The blue stones typically are very dark; some are heavily included with rutile silk.

The rough sapphire averages 2 ct per piece. The largest nongem sapphire crystal found to date at the deposit is 89.5 ct (15 × 30 mm). Gem-quality sapphires as large as 9.5 ct have been reported (again, see figure 1). The largest faceted stone produced thus far is 2.1 ct. It should be emphasized, however, that since the deposit was first discovered in 1980, only a small segment of the known gem-producing region has been examined. Therefore, these stones represent a very small sample of the potential gem product in this area.

Gemological Properties. The authors were able to obtain only one gem-quality sample of greenish blue sapphire from the Lindi mine (figure 1). Tests on this crystal revealed gemological properties very similar to gem corundum found in Australia, Thailand, and Kampuchea: refractive index 1.762-1.770, specific gravity (by the hydrostatic method) 4.01, inert to long-wave and short-wave ultraviolet radiation.

HEAT TREATMENT

Since early summer, 1985, geological engineers in the Bureau of Geology and Mineral Resources in Mingxi have been experimenting with heating the sapphires. For this procedure, they have been using a Choy industrial oven (an electric oven manufactured in Shanghai). As of October 1985, they had processed several hundred carats at temperatures up to 1600°C (the upper limit of the oven is 1800°C) in an oxidizing environment for a maximum of 10 hours. The rough crystals are placed in the oven as loose gems. Crucibles are not used; nor are the gems coated with any chemicals.

Thus far, the Chinese geologists with whom the authors spoke do not feel that the results are conclusive. The sample stones (a group of eight different types—i.e., different colors and intensities of color—with each treated sample accompanied by an untreated control sample) observed by the authors indicated little if any lightening of the dark blue stones. Those stones with significant amounts of oriented rutile show po-

Figure 5. A preliminary sort of a random concentration of gem gravels produced equal amounts of blue and blue-green sapphire, garnet, and zircon, in agreement with production information provided by local geologists.

Figure 6. A glass table top lit from below is used to sort the gem crystals from the rest of the concentrate.

tential to produce asterism with heat treatment (see Nassau, 1981, 1984). Tests are currently being conducted at the California Institute of Technology to treat a dark greenish blue gem-quality sample of blue sapphire from the Lindi mine in a high-temperature reducing environment (as is commonly used on Australian sapphires, per Coldham, 1985) to see if any improvement in color can be achieved. The results will be reported in a future issue of *Gems & Gemology*.

DISTRIBUTION AND FUTURE POTENTIAL

As mentioned above, the current operation at the Lindi mine is for research and exploration only. However, the bureau does hope to establish an economic operation, including treatment and faceting, in the near future.

While the yield of sapphire to date is too small to justify a major marketing effort, the authors feel that a full-scale mining effort along the entire distance (50 km) of the stream that has been found to produce sapphire should increase the production significantly. More efficient mining methods, such as a mechanical dredging operation for the streambed and the use of a high-power water cannon to break up the alluvial material along the banks, are currently under consideration and should also help to improve the yield. The future prospects for sapphire production in this area appear to be quite good.

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