THE CAPÃO TOPAZ DEPOSIT, OURO PRETO, MINAS GERAIS, BRAZIL

By Peter C. Keller

For over 200 years, the only known source of imperial topaz has been a small mining district near Ouro Preto. One of the oldest and most productive mines in the district is the Capão do Lana. This article examines the history of the Ouro Preto district as well as the geology of the area and occurrence of the topaz. Special attention is focused on the relatively sophisticated recovery methods used at the Capão do Lana mine. Also discussed is the gemology of this most prized color variety of topaz.

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Of all the colored varieties of topaz, the most sought after is the deep, rich sherry to red topaz most commonly known as "imperial" (figure 1). Imperial topaz comes from one small mining district just west of the colonial city of Ouro Preto, in Minas Gerais, Brazil (figure 2).

Today there are at least a dozen topaz mines in the Ouro Preto area. The most important of these are the Vermelhao mine, on the outskirts of the city, and the Boa Vista, Jose Correa, and Capão do Lana mines, near the village of Rodrigo Silva, about 15 km west of Ouro Preto.

This article focuses on the Capão do Lana mine, both because it has been recognized as the first to produce imperial topaz (Bastos, 1964) and because it has been one of the most prolific producers of this gem material. In addition, for the last several years, the Capão do Lana has been one of the most mechanically sophisticated gem mines in Brazil.

The author visited the mine on three occasions in 1978 and 1979 in conjunction with his participation in a documentary film entitled *Gems of the Americas*, which was coproduced in 1980 by the Natural History Museum of Los Angeles County and the Gemological Institute of America.

LOCATION AND ACCESS

Ouro Preto is located about 285 airline kilometers north of Rio de Janeiro, in the Serra do Espinhaço mountain range in the southwest corner of the state of Minas Gerais, Brazil. Once the capital of Minas Gerais, it is only 97 km by car from the modern-day capital, Belo Horizonte.

Figure 1. Rough and cut imperial topaz from the Ouro Preto area, Minas Gerais, Brazil. The crystal (6 cm high) and cut stones (19.21 and 17.78 ct, respectively) are courtesy of Pala International, Fallbrook, CA. Photo © 1982 Harold & Erica Van Pelt—Photographers, Los Angeles.

Figure 2. A view over the colonial city of Ouro Preto, Minas Gerais, Brazil.

Access to Ouro Preto from Belo Horizonte is very easy via BR-3, the modern highway that leads north from Rio de Janeiro. One takes BR-3 about 33 km south from Belo Horizonte to the famous iron-mining town of Itabira. From Itabira, another unnumbered, but paved, highway leads southeast about 64 km to Ouro Preto.

The Capão do Lana mine is located near the village of Rodrigo Silva, about 15 km west of Ouro Preto (figure 3). Access from Rodrigo Silva may be very difficult in the rainy season, which usually lasts from December through May, because of washouts of the dirt road.

HISTORY AND PREVIOUS WORK

The early history and production of topaz in the Ouro Preto area is known only through the early records of the Portuguese royal court. According to Rolff (1971), the earliest reference to the deposits was in 1751, when "Brazilian rubies" were reported found near Vila Rica, the original name for Ouro Preto. Currently, Brazilian ruby is the name occasionally applied to topaz from this locality that has taken on a red color as a result of heat treatment (which will be addressed later in this article). The official discovery of topaz in the Ouro Preto area is dated 1768, when the royal court in Lisbon marked the event with a splendid celebration (Rolff, 1971).

Not long thereafter, mineralogists began visiting and studying the topaz deposits. In the early 19th century, Mawe (1812) included the area in his pioneer travels of Brazil. Eschwege visited the deposits in 1811 and 1812, and published the first scientific description in 1833. Other important 19th century reports include von Spix and von Martius (1824) and Gorceix (1881).

There has always been a great deal of interest in the mode of occurrence of the topaz. The first detailed account was by Derby (1901). Because of the highly decomposed nature of the rock in the region, he called his study one in "mud geology"—"an attempt to reconstruct from earthy materials the original rock types from which they were derived." Derby observed that the topaz crystals were singly terminated and concluded that they originally grew in open cavities.

By the beginning of the 20th century, the deposits were no longer active; in fact, many thought that they had been exhausted (Bauer, 1904). In 1908, however, Atkinson reported that the old topaz mines of Boa Vista and Saramenha in the Ouro Preto district had been reopened. At that time, at least some of the mining was in alluvial deposits, for Atkinson reported that the topaz occurred in a gravel bed at a depth of about 5.5 m.

Bauer (1904) provided some of the only known early production figures for the area. He stated that at one time as much as 18 hundredweight (about 2,016 lbs, or 916 kg) of topaz per year was mined near Ouro Preto, but the average annual production was only 7 to 8 hundredweight. He went on to note that the Boa Vista and Capão do Lana mines were the most productive in the region, and that as many as 50 people were working in the mine at Capão.

Production figures for the 20th century remain very spotty, as accurate records are still not kept.

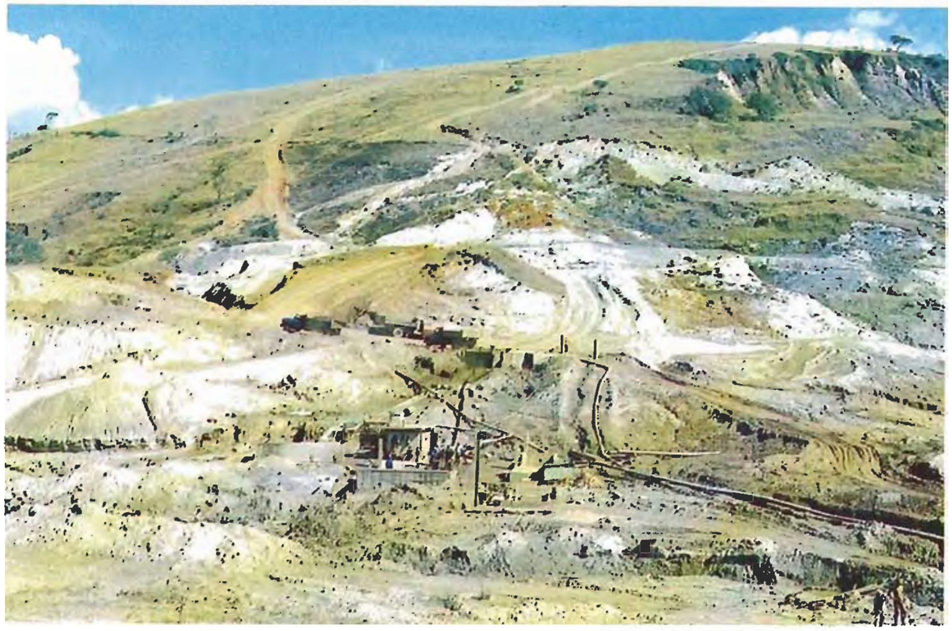

Figure 3. The Capão do Lana mine, near the village of Rodrigo Silva. This is one of the most mechanized gem mines in Brazil.

GEOLOGY AND OCCURRENCE

The mining district is situated in the Ouro Preto quadrangle of the Quadrilatero Ferrifero in southern Minas Gerais; this region is best known as one of the great iron-producing areas of the world. The region was mapped and studied in detail by a joint Brazilian-American effort just after World War II; the findings were published by Johnson (1962) and Dorr (1969).

All of the rocks in the region are strongly weathered, most to a depth of 50 m or more, thus producing thick lateritic horizons (Dorr, 1969). The region is underlain by granitic gneisses, granites, and similar coarsely crystalline rocks; as well as by three series of metasedimentary rocks of Precambrian age with a minimum aggregate thickness of about 14,000 m (Dorr, 1969).

The entire Ouro Preto quadrangle is underlain by rocks of the Precambrian metasediments belonging to the Minas series. The Minas series consists principally of a sericitic phyllite heavily charged with fine hematite and a ferruginous quartzite. The Minas series was intruded about 2700 million years ago by a granitic batholith that metamorphosed and domed and fractured the sediments; a second intrusion occurred about 1300 million years ago. One or both of these intrusions was probably responsible for the fluorine-rich hydrothermal solutions that invaded the rocks through fractures and gave rise to the distinctive topaz mineralization around Ouro Preto.

The topaz mineralization is limited to a chain of hills that forms a belt 20 km × 6 km running east-west, just west of the city of Ouro Preto. This belt extends from the Saramenha mine, about 4 km west of the city, to the Olaria mine, about 25 km to the west of Ouro Preto. The majority of the mines are clustered in the central area of the belt between the villages of Dom Bosco and Rodrigo Silva. The hills may be part of a large anticline (Rolff, 1971).

The topaz occurs in remnant hydrothermal quartz-potassium-feldspar veins in the highly decomposed country rock. The potassium feldspar is now totally altered to kaolinite. Other minerals found in the veins include euhedral quartz and euclase, and sub- to anhedral hematite and rutile.

The origin of the imperial topaz has been a subject of speculation and debate for over a century. The question asked most is whether the crystals are of pegmatitic origin. Gorceix (1881) noted the association of topaz with quartz as an indication that the deposits were pegmatitic, and was later supported in this view by Boa Nova (1929). The main argument against a pegmatitic origin is the fact that the topaz occurs only in a narrow stratigraphic horizon within the Minas series. Pegmatite dikes normally cut across stratigraphic units. Johnson (1962), however, points out that pegmatitic solutions could have been localized to one of the stratigraphic horizons by the differential competence of the beds during the emplacement of the dikes.

The most recent research into the origin of the topaz was done by Olsen (1971). Olsen concluded that fluorine-rich solutions that invaded the Minas series during one of the early intrusive episodes actually replaced the phyllites and that the topaz

Figure 4. Large earth-moving equipment initially strips away the deeply weathered country rock, which is now essentially a lateritic clay that contains remnant pockets of kaolinite and topaz.

Figure 5. High-pressure water cannons put the topaz-bearing clay into solution so that the "heavies" can be separated from the lighter clays. The slurry is then washed down a concrete sluice to a concrete apron below.

formed as a result of the replacement of preexisting kaolinite. Geochemically, this theory is plausible, and Olsen presents chemical equations to substantiate his conclusion. Such a complex hypothesis is not necessary, though. If, as the earlier researchers thought, there were fluorine-rich pegmatite-like fluids invading the Minas series, filling cracks formed when the rocks were domed by the granitic intrusions, quartz-feldspar veins with localized topaz pockets could have resulted. With the deep chemical weathering of all rock units in the region, the enclosed veins and pockets would also be weathered, leaving kaolinite and quartz "veins" in the lateritic clay soils and localized "nests" or pockets of topaz. These pockets of topaz in what appear to be pegmatite-like veins are exactly what we observe at the Capão do Lana workings today.

MINING METHODS AT CAPÃO DO LANA

The mining and recovery methods currently used at the Capão mine are among the most sophisticated of any gem mine in Brazil. The method is essentially hydraulic, with high-pressure water cannons used to separate the topaz and other "heavies" from the tons of laterite clay matrix. The water is supplied by a large reservoir constructed above the mine site.

Initially, large bulldozers and other heavy

Figure 6. Final washing of the "heavies" before they are sorted by hand. Photo by D. Vincent Manson.

earth-moving equipment strip the deeply weathered country rock (figure 4) and deposit it, along with any remnant topaz-bearing vein material, into large dump trucks. These dump trucks then transport their cargo to a large, concrete-lined washing pit. Here, over two tons of ore at a time are hit with a high-pressure water cannon. This action puts the entire load into a muddy solution which then runs down a long concrete sluice (figure 5), through a sieve, onto a concrete apron. The muddy slurry runs off into a stream below. The topaz, quartz, hematite, and any other "heavies" are left on the concrete apron where they are washed again with another high-pressure water cannon (figure 6). The remaining "heavies" are then shoveled into a sieve box about 2 m in diameter where they are rinsed one last time before about half a dozen sorters come in with small instruments to carefully pick through the remaining material for topaz (figure 7). After the hand-sorting is completed, the topaz is placed in a bag and the remaining residue is washed into the stream below, where a number of independent miners, or *garimpeiros,* wait to rework the material with simple sieves and shovels in hopes of finding topaz that has been overlooked (figure 8).

Each day approximately 900 tons of ore are processed, yielding an average of about 9 kg of topaz, of which only a small percentage is gem quality. The average yield at Capão is approximately 50 ct of topaz per ton of ore mined. It is important to note that all mining ceases during the rainy

Figure 7. Hand sorting the residual "heavies" for topaz.

season, which generally lasts from December through May.

Not all of the topaz is recovered using the highly sophisticated methods described above. Frequently, the bulldozers expose a kaolinite vein while scraping the surface. These veins are easily seen, as the pure white kaolinite contrasts with the dark, chocolate brown clay. It is the sole responsibility of one of the oldest and most trusted miners to follow the bulldozers and, when a vein is exposed, carefully search for any topaz pockets using only a knife. Working very slowly and carefully, he obtains yields that are often surprisingly large. These crystals also are usually in much better condition than the crystals subjected to the harsh treatment of the water cannon. Apparently, though, the high production that results from the mechanized mining compensates for the greater incidence of damage.

THE IMPERIAL TOPAZ FROM OURO PRETO

The topaz from the Ouro Preto district varies from pale yellow to a dark reddish sherry color (figure 9). In rare instances, dark red crystals, referred to in the early literature as "Brazilian ruby," are observed in nature. These reddish stones are, however, commonly produced artificially by a heating process called "pinking" (Webster, 1975). The pinking process involves the packing of yellow topaz in an inert material such as magnesite, or even sand, and then slowly heating the stones to 450°–500°C. The yellow fades at these elevated temperatures, but as the stone cools, a pink to red hue appears. The color has been considered permanent. In experiments at GIA, however, Dr. D. Vincent Manson has found that the color stability may be variable. Care must be taken not to apply too much heat, or to heat the topaz too rapidly,

Figure 8. Garimpeiros work with simple sieves below the main mining operation at Capão in hopes of recovering an overlooked topaz. Photo by D. Vincent Manson.

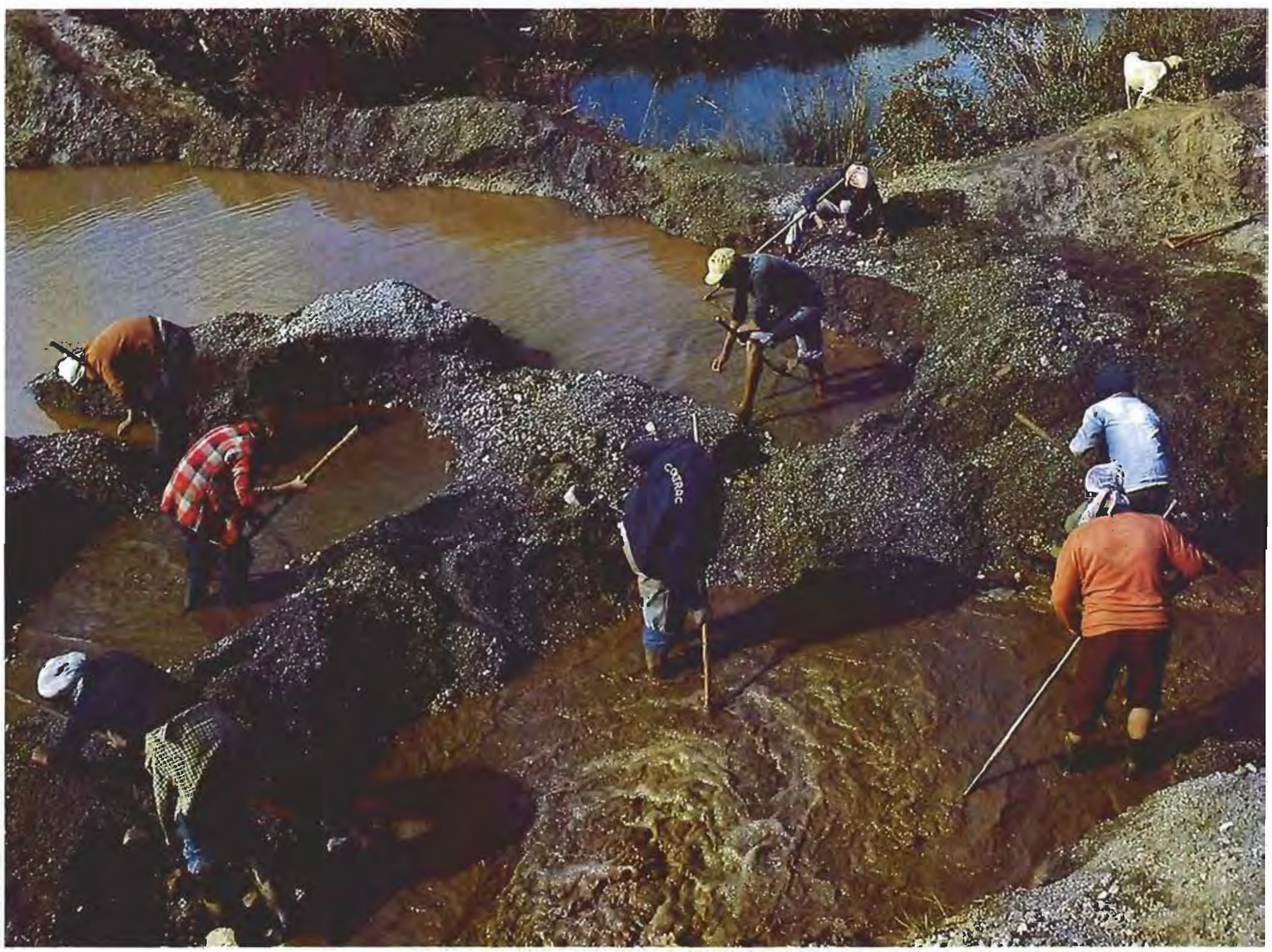

Figure 9. A representative sample of fine imperial topaz from Ouro Preto, 5.75–38.53 ct. Photo © 1982 Harold & Erica Van Pelt; courtesy of Jules R. Sauer, Brazil: Paradise of Gemstones, *Rio de Janeiro, 1982.*

Figure 10. Reputedly the largest imperial topaz crystal in existence today, this 27-cm long, 5-cm wide crystal is part of the collection of the Los Angeles County Museum of Natural History. Photo by Larry Reynolds.

to avoid fracture. It is interesting to note that a chromium absorption band on the spectroscope is usually not seen in a stone before it has undergone the "pinking" process, but will be quite apparent in the same stone following the process (Webster, 1975).

Recently, there has been a great deal of concern in the industry regarding artificial gamma irradiation of gemstones to induce color. Imperial topaz has been part of this concern. Nassau (1974) exposed 31 samples of pale to medium yellow topaz to gamma irradiation for 5 to 30 minutes and found that while 14 of the 31 samples did not change significantly, 17 did acquire a distinct brownish overtone which when combined with the original yellow color yielded a rich "imperial color." Nassau noted, however, that the irradiation-induced color was not stable and that the stones faded to their original color when heated gently at about 200°C for a few hours, or when exposed to daylight for one or two days. To protect against such unstable stones, many dealers in Rio de Janeiro routinely place a sample from a topaz parcel in a window for a day or two and then compare the exposed sample with the rest of the parcel before they buy it.

Gemologically, the imperial topaz from the Ouro Preto area differs significantly from topaz derived from granitic pegmatities elsewhere. In addition to its distinctive color, the Ouro Preto topaz generally exhibits a lower specific gravity (3.53 versus 3.56) and a higher refractive index (1.63–1.64 versus 1.61–1.62) than the more common topazes. According to Webster (1975), this is

Figure 11. A large (57.35 ct) imperial topaz from Ouro Preto. Stone courtesy of Geminas Ltda., Belo Horizonte, Brazil. Photo © 1983 Harold & Erica Van Pelt—Photographers, Los Angeles.

due to a richness in hydroxyl in the Ouro Preto material versus a relatively high fluorine content for topaz from elsewhere. The topaz from Ouro Preto also shows a weak absorption doublet at about 6820 Å. The Ouro Preto topaz commonly contains tube-like inclusions running the length of the c-axis of the crystal.

Imperial topaz crystals vary greatly in size. Most commonly they are less than 2 cm in length, although very large crystals have been reported. Atkinson (1908) noted that there was a specimen in the museum in Rio de Janeiro that "was of beautiful color, transparency, and was absolutely flawless." The specimen weighed nearly 2000 g. Rolff (1971) reported a crystal in the Mineral Museum of the School of Mines in Ouro Preto that was 20 cm long and 10 cm in diameter. He also reported seeing a crystal in Rodrigo Silva that was 30 cm long and 5 cm in diameter. The latter is probably the same crystal that is now housed in the gem collection of the Los Angeles County Museum of Natural History (figure 10). This crystal, considered the largest found in recent times, measures 27 cm × 5 cm and weighs approximately 1800 g.

Faceted imperial topaz of large size is exceedingly rare. The 129-ct stone at the Smithsonian Institution in Washington, DC, is one of the largest known. The American Museum of Natural History in New York has a red imperial topaz that weighs 71 ct. Figure 11 illustrates an attractive 57.35-ct imperial topaz seen at the 1983 Tucson show.

CONCLUSION

Ouro Preto has been the only source of imperial topaz for over 200 years. Of the many mines that have been active during this period, Capão do Lana stands out, for both the quantity and quality of production. Because of the relatively high degree of sophistication of the mining methods used today at Capão, production of imperial topaz there has never been greater. The apparently large extent of the deposit suggests that imperial topaz production has a very bright future.

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