EMERALDS FROM ETHIOPIA

Roland Schluessel and Naryratha Heng Schuessel

Emeralds are a welcome business for Ethiopia. The recently discovered gemstone deposits in Ethiopia contribute to the utterly needed economic growth of this East African nation.

A few years ago, during an interview on international TV, a member of the Ethiopian government was asked about the repeated assistance supplied by the international community to overcome poverty and food shortage. His answer was as follows. "Ethiopia has all the resources to become self-sufficient; the best way to achieve it is by not begging for foreign aid." After quartz, feldspar, opal, garnet, peridot and sapphire, it is now mining and trading of emeralds that creates new jobs for thousands of Ethiopians. Figure 1.

FIGURE 1. *A selection of the new Ethiopian emeralds mined in 2017, ranging from 3.75 ct to 29.41 ct. The rough crystal weighs 18 grams. Photo by Roland Schluessel.*

GEOLOGY AND LOCATION

The emerald deposit discovered in 2016 is located in the south-central part of Ethiopia, 20 km south of Shakiso town. This whole region is situated within the northern portion of an orogenic belt known as the Mozambique Metamorphic Belt (MMB) extending from the Red Sea all the way to Mozambique and as far as eastern and southern Madagascar. The belt is a major suture that formed during the late Neoproterozoic, with main metamorphic events occurring between 500 and 650 million years ago; mafic and ultramafic rocks were compressed and uplifted as a result of the extensive Pan-African geologic event, where several continents and terranes amalgamated to form the supercontinent Gondwana.

In the uplift areas, relatively high pressure and temperatures re-organized the composition and texture of pre-existing rocks, which transformed into metamorphic rocks during cooling. The emerald mineralization occurred through metasomatism in and near the contact zone between the mica schist and silica-rich fluids from granitic batholiths and pegmatite veins.

The emeralds are mined in and near Kenticha (Seba Boru district), to be subsequently brought to Shakiso where gemstone dealers from Addis Ababa buy the rough. Kenticha is also known for its rare-element pegmatite which is the largest tantalum reserve in Ethiopia. This is not the first nor the only emerald deposit discovered in Ethiopia, but so far it is the most promising regarding both factors quality and quantity.

This region of southern Ethiopia is not particularly rugged, though some mountains cut through the water-poor savanna that extends at over 5,000 feet elevation. From the mine, the emeralds are transported by car on a dirt road to Shakiso; despite the presence of a small airport, most emerald dealers prefer to drive 10 hours to the capital city. Access to the mining area has been barred to anyone without a permit from the Ministry of Mines. Figures 2-6.

Refractive index, specific gravity and the absence of UV-fluorescence are characteristic of schist-hosted emeralds. Thus,

FIGURE 2. *Oromo girl in southern Ethiopia. The recently discovered emerald sources are located in the Borena Zone of the Oromia Region. Borena is named after the Borana tribe of the Oromo people. Photo by Roland Schluessel.*

FIGURES 3 & 4. *On the road between the capital city of Addis Ababa and Kenticha. Photos by Roland Schluessel.*

FIGURE 5. *The village near the emerald mines. Photo by B.N. Trading Ltd.*

FIGURE 6. *The Haloo mine is one among the several emerald mines that are worked the traditional way using hand tools. Photo by Teferi Gobezi.*

microscopic observation and "traditional" gemological properties enable us to identify the nature of Ethiopian emeralds but not to separate them from metamorphic-metasomatic emeralds of other origin. According to GIA, the origin of Ethiopian emeralds can be determined by LA-ICP-QMS quantitative chemical trace-element analysis, which enables a distinction of Ethiopian emeralds from the Brazilian and Zambian emeralds that formed in similar metamorphic schists. (Figure 1.)

ASPECT AND GEMOLOGICAL PROPERTIES

The Ethiopian emeralds possess optical and physical properties that are consistent with other schist-hosted emeralds, particularly those from Minas Gerais in Brazil and Zambia. The Shakiso area produces emeralds that weight up to 10 ct when faceted, but stones over 20 ct and even exceeding 30 ct have been recorded. Their color ranges from very pale green to very intense green, with the more saturated emeralds often showing a slight bluish secondary color. Figures 7 & 8.

Growth structures are quite frequent, especially in larger crystals; generally, growth zones are more pronounced in the more intensely colored emeralds and can reduce their transparency as a result, generating a turbid and blurred appearance.

Other inclusions consist of growth tubes oriented parallel to the c-axis, primary and secondary fluid inclusions both often with multiphase content, and biotite flakes. This interior landscape particularly resembles the one seen in emeralds from Zambia. Figure 9.

When cutting larger crystals, the loss is particularly substantial because of the many inclusions, especially dark-colored biotite, significant impurity concentrations in most parts of

FIGURE 7. *A 145-gram rough emerald prism recovered at Kenticha near Shakiso in 2016. Photo by Peter Jakobsson and Kristian Ståhl.*

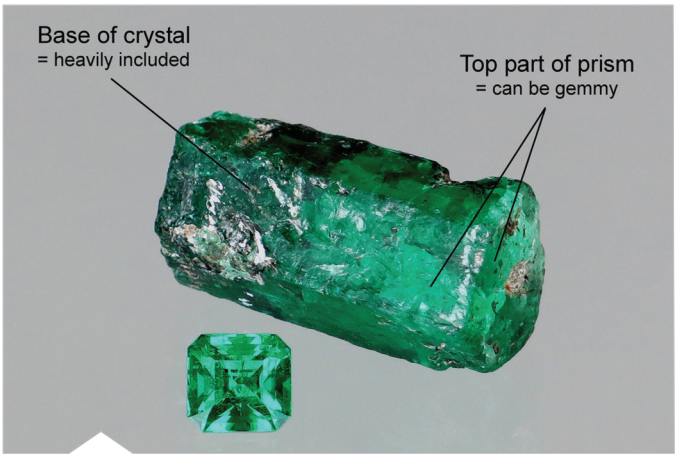

FIGURE 8. *Mostly, only a small portion of the top part of the emerald crystal is good enough to be fashioned into a gemstone. Here is an example with an 18 ct rough. Photos by Roland Schluessel.*

the crystal and inhomogeneous color spread. When cutting high-quality Ethiopian emeralds, the average yield is approximately 10%.

Once the most obvious inclusions are eliminated during the cutting process, the Ethiopian emeralds are beautiful gemstones that cover a wide range of color and clarity grades and that can be fashioned into various shapes. Some samples are so bright, that they remind us of the "electric" green of Paraiba type tourmalines, and which dramatically increase in brightness under direct sunlight, and particularly under direct incandescent light.

CLARITY ENHANCEMENT

In nature, the formation of emerald is related to dynamic tectonic events that affect both the rock environment and the emerald crystals. Tectonic movements produce mechanical strain that causes emerald crystals to break or generate fissures and fractures. These flaws can develop in any direction and in any part of the crystal, be isolated within the crystal's interior, or reach the crystal's surface; they also can vary in quantity and size. Fractures/fissures can simply re-crystallize, others may partially heal and trap fluids; but often, they do not heal. The higher the extent, meaning the larger and/or more numerous fractures/fissures present in the emerald, the more the transparency of the stone is reduced. This is particularly the case with surface-reaching fractures/fissures because they enable the surrounding gas, in normal conditions the air, to penetrate the fissure. Such a fissure develops into an easily visible flaw because of the difference of optical density (refractive index) between the emerald and air. Consequently, the clarity treatment enhances the transparency of the emerald, without improving its true clarity grade!

As with emeralds of any other origin, the clarity enhancement of Ethiopian emeralds depends upon three factors:

1) The absence, or presence and extent of surface-reaching fissures/fractures in the emerald(s).

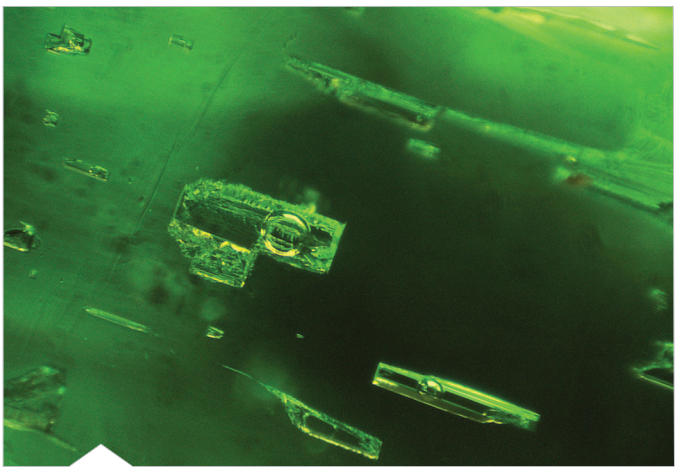

FIGURE 9. *Emerald from the Shakiso region with primary fluid inclusions. Magnification 56x. Photo by Roland Schluessel.*

2) The supplier's policy regarding the choice of the filler used for the clarity treatment of the emerald(s). A policy should apply to the whole inventory or type of inventory.

3) The supplier's policy regarding the choice of the gemological laboratory used to issue the gemological report for the analyzed emerald(s). *Note: It is understood that the author confines his explanations to colorless to near-colorless fillers.*

With emeralds containing surface-reaching fissures/fractures, the manufacturer/supplier has 4 choices:

1) Leave the emerald untreated and accept the conspicuousness of surface-reaching blemishes. If the crystal is of very good clarity, it is possible that no clarity treatment is needed. Further, if the emerald is devoid of surface-reaching fissures/fractures, no clarity treatment is possible.

2) Use a liquid filler such as cedar-wood oil. This offers the advantage of a filler that can be removed and re-

newed indefinitely, making the clarity enhancement reversible and repeatable at any time.
3) Use a hardening filler such as a mixture of polymer and oil. This type of filler is more resistant than liquid oil, but the polymer part has tendency to degrade over time. Emeralds treated with mixed fillers can often be cleaned by a careful cleaning process with acids, and subsequently clarity enhanced with liquid oil. The authors strongly advice anyone who is not familiar with this cleaning process to avoid doing it; it is a delicate procedure that should be carried out by specialists only. A new gemstone report should be issued after the alteration of the clarity enhancement.
4) Use a hardening filler such as polymer or a mixture of two or more different polymers. This type of mixed filler is the most resistant on a short-term; however,

SUMMARY CHART OF GENERAL PROPERTIES

- Color ranges from light bluish green to intense saturated pure green.

- Typically, medium to medium-light color intensity. A small portion of the production shows an intense saturated green, but the lighter color range is more common.

- Comparatively high brilliancy; fine qualities display an "electric" green, sometimes comparable to green Paraiba type tourmaline.

- Although some dark colored inclusions cannot always be eliminated through the cutting process, most Ethiopian emeralds are devoid of black and other dark inclusions. Obvious dark inclusions are usually confined to non-gemmy areas of the rough, especially in the peripheral and base zones.

- Good color and brightness in daylight and in incandescent light.

- Color zoning is often swirl to veil-like in combination with straight and angular (hexagonal) color and growth zoning.

- Cutters have recognized a comparatively good toughness.

- Dichroism shows clearly the bluish green perpendicular to the c-axis and a faint yellowish green parallel to the c-axis.

- Fluid inclusions are frequent both parallel to the c-axis and perpendicular to it.

- Unlike Zambian emeralds which owe their green color to vanadium, Ethiopian emeralds are colored by chromium, like most emeralds from Brazil and all emeralds from Colombia.

- Typically for mica schist-hosted emeralds, Ethiopian emeralds contain trace amounts of iron. However, their iron content is lower than in Zambian and most Brazilian emeralds.

- Ethiopian emeralds do not fluoresce when exposed to long-wave or short-wave ultraviolet light.

- Like all Colombian emeralds, most Ethiopian emeralds react red when struck by a blue laser light beam (e.g. laser pointer pen 450nm).

- The rough produces mainly faceted stones up to 8 carats. High-quality emeralds exceeding 10 ct are very rare.

- Can be cut in any shape and cutting style.

- Many Ethiopian emeralds do not require clarity enhancement. Even though "no oil" (e.g. Gübelin, SSEF, GRS) or "no clarity enhancement" (e.g. GIA, AGL) is rarely conceded by gemological laboratories, many stones are graded "insignificant" and "minor" clarity enhancement by the leading gemological laboratories. *Comment: One should be aware that it is the "clarity enhancement" that is graded, in opposition to "clarity grading" where the size, quantity and position of the inclusions is assessed. Since the assessment of the extent of the clarity extent is subjective, discrepancies between gemological laboratories are frequent; sometimes even between various scientists of a same laboratory.*

Altogether, the new Ethiopian emeralds can be compared to the emeralds originated from the other East African (e.g., Zambia, Madagascar, etc.) and East Brazilian (e.g., Minas Gerais, Bahia etc.) sources. They share a common color origin (chromium) with some Brazilian emeralds and the Colombian emeralds. Ethiopian emeralds cannot compete with the finest and largest Colombian emeralds, and to the naked eye, they resemble more fine emeralds from Itabira, Minas Gerais, Brazil, than Zambian emeralds.

Currently, prices of Ethiopian emeralds are below prices of Zambian emeralds in comparable quality, size and shape. However, this is expected to change as this attractive new material will be accepted in the marketplace, gain in popularity, and experience the habitual price increases at the source.

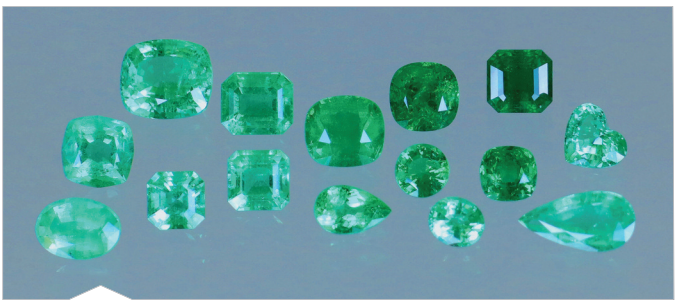

FIGURE 10. *A selection of Ethiopian emeralds ranging from 1.51 ct to 6.99 ct. The selection is representative for the range of color intensity produced at Kenticha. All are enhanced with oil only. Photo by Roland Schluessel.*

> when the polymer deteriorates over time, it is very difficult or even impossible to remove the filler and to renew the clarity enhancement.

Thus, the choice is significant because it is one of the factors that can influence the decision to which gemological laboratory the emeralds are sent for testing. Many gemological laboratories do not discriminate between the types of filler (liquid versus hardened; oil versus polymer) used for the clarity treatment. In fact, several laboratories use the code "O" on the front page of the report, only to explain the code on the back side of the report that "O" stands for clarity treatment with oil, wax, polymer/resin etc. The type and/or composition of the filler often remains undisclosed!

The future is brighter. There is an increasing number of gemological laboratories that have adapted their policy (e.g., AGL, Gübelin, etc.), or plan to adapt it by identifying and disclosing the type of filler used for the clarity enhancement of emeralds. SSEF (Schweizerische Stiftung für Edelsteinforschung) in Basel, Switzerland, has committed to a policy of full disclosure for many years. Several high-end jewelry brands unconditionally reject emeralds that have been submitted to a clarity enhancement with a "hard filler." Figure 10. ◆

The authors are thankful to Peter Jakobsson and Kristian Ståhl, both from Stockholm, Sweden, for their support in this project.

FIGURE 11. *Author Roland Schluessel with a chief of the Karo tribe in southwestern Ethiopia.*

About the authors: *Roland Schluessel and Naryratha Heng Schuessel are the owners of Pillar and Stone International, based in Tiburon, California. The company is a major importer of Ethiopian emeralds. Their policy is to exclusively use liquid cedar-wood oil for the clarity enhancement of their Ethiopian emeralds. Roland has visited Ethiopia on numerous occasions since the 1990s.*

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