

An approach to understanding the factors in the emerald enhancement clarity grading system used at CDTECGemlab

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Emerald is the green variety of beryl, with its distinctive color resulting from trace amounts of chromium, vanadium, and iron. These elements replace aluminum in the octahedral positions of its crystal structure. The clarity of an emerald depends on the presence of internal characteristics such as inclusions (solid and/or fluid) and fissures. Since ancient times, the clarity of emeralds has been improved through various treatments (Nassau K. 1984). Among these, fissure filling is the most common procedure, where substances with

optical properties like the host material are used to enhance clarity by improving light transmission within the gemstone. Emeralds may undergo treatments and/or enhancements before, during, and after the cutting process (Fig.1). Sometimes, the application of specific substances helps increase the material's stability, making it more resistant to damage during cutting, especially when large fissures or voids are present (Scarratt K. 2015). In most cases, fissures are filled after the cutting process to improve the gem's appearance.



Figure 1. Possible stages during which the enhancement of the stone can occur throughout its transformation.

Sometimes, an untreated gemstone with visible fissures can undergo treatments or enhancements that lead to a significant improvement in appearance changes that may not be apparent to the final consumer (Fig.2). For this reason, certification is essential, as it provides detailed information about any enhancement treatments, including the extent of the improvement and, in some cases, the type of substances used. Such certification serves as a reliable disclosure to the consumer, offering transparency regarding the gemstone's condition and the nature of any treatments at the time the report was issued.



Figure. 2 Emerald before enhancement (left) and after enhancement (right).

Gemlabs face the challenge of identifying both the type and quantity of substances used in clarity enhancement. This task involves considering various factors, such as identify-

ing the diversity of substances—including vegetable oils, hydrocarbon-derived oils, resins, balsams, and waxes—which can be of natural or artificial origin (Johnson M. *et al*,

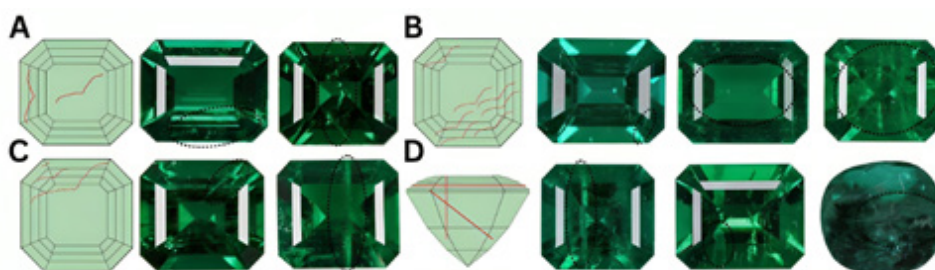


Figure 3. Primary factors used in grading emerald enhancement include, Location (A), quantity of fissures (B), length (C), and tilt (D)

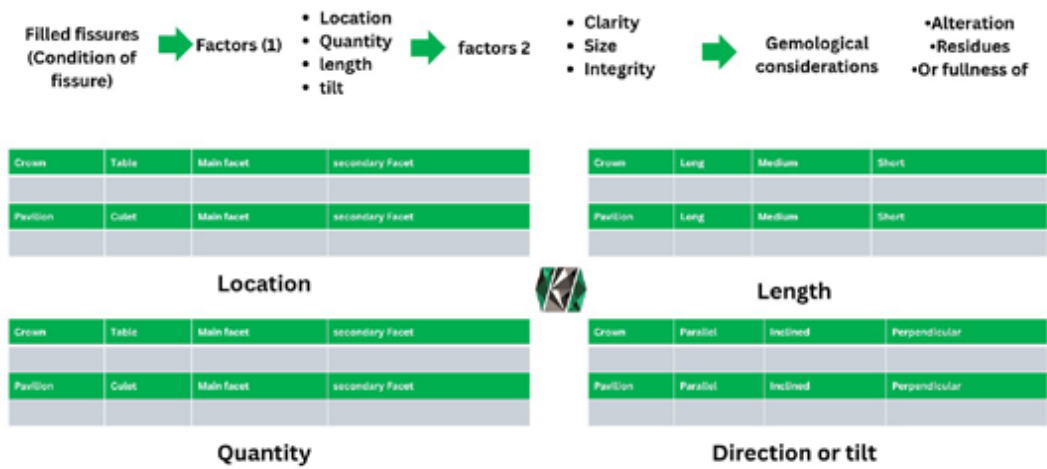
1990; Kammerling R. et al, 1991; Hanni H. 1992; Kiefert L. et al, 1999; Hainschwang & Notari. 2022), as well as the mixtures employed. Although cedar oil was historically a commonly used product, it is now less prevalent. Currently, substances such as natural hydrocarbon-derived oils—commonly known as mineral oil (e.g., baby oil)—and liquid or hardened artificial resins are predominantly used.

Additionally, it requires developing an assessment as objective as possible of the extent of clarity modification by fissure filling through qualitative analysis. The assessment of the extent or intensity of clarity improvement has been addressed by Shane McClure *et al.*, 1999, who classified the enhancement into three main categories: minor, moderate, and significant. This classification is based on factors such as the size, extent, or length of the treated areas; the number of fissures; the amount of treatment within fissures; and the location of filled fissures. The description of emerald enhancement is provided in Sheet # 5 (LMHC, 2014), which outlines a guide for determining the amount of filled fissures. This serves as the basis for quantifying the enhancement and assigning a corresponding quality grade.

However, one of the most important aspects of classification is the ability to identify fissures or voids containing substances. To achieve this, various methodologies have been developed that utilize different instruments and illumination techniques, along with careful inspection of various parts of the stone. These include transmitted light (bright field - dark field), reflected light, and UV light. Regarding UV illumination, caution should be exercised with certain UV ranges, as they may cause harmful effects on substances, such as polymerization. Additionally, it is important to remember that not all substances fluoresce, for example, some oils (Notari F. *et al.*, 2022). This comprehensive approach ensures the collection of complete information necessary for an accurate and reliable classification process.

The purpose of grading is to assess the extent of improvement in the clarity of the stone. While the number of fissures present may be important, it does not necessarily determine the degree of improvement. For example, a single fissure that is oriented parallel to the table and covers a large portion of the stone can result in a moderate grade because it significantly affects the stone's clarity. Conversely, several small fissures that are perpendicular to the table, located on the crown facets (not the table), and aligned with the edges of the crown facets, especially if they are small relative to the stone's dimensions—may warrant a minor grade.

Fissures typically behave as three-dimensional features, either resembling a plane or acting as pores or hollows within the stone, such as in emeralds. This means they possess volume. Factors such as their location, length, quantity, and inclination are highly important for determinate improve clarity. In certain areas of the stone, the presence and arrangement of fissures may have a greater impact on clarity than in other regions. Additionally, if a wide fissure is in a region that could affect the stone's integrity—such as on the pavilion, girdle, or crown—its significance increases. For example, a fissure that crosses the stone completely or is blunt can lead to chipping or even a fracture that splits the stone into two nearly equal parts (integrity factor). Another important consideration is size. It is rare to find stones over 5 carats—or even over 10 or 15 carats—that are free of fissures. However, a stone with several fissures that appear dense relative to its small volume does not necessarily indicate a similar density in a much larger stone (size factor). The clarity factor provides a general measure of the impact of fissures on the stone's overall appearance. If a stone has high clarity, filled fissures will be more visible. In such cases, the presence of fissures may be more significant in an untreated stone with high clarity than in one with lower clarity, where the abundance of inclusions makes fissures less noticeable (clarity factor). Other factors may also influence



Not indication – Insignificant - Minor (F1) - Minor to moderate (F1 - F2) - Moderate - Significant (F3)

Figure 4. Grading emerald enhancement system by CDTEC

the grading based on gemological considerations. These include residues, alterations of substances, or any other features within the stone that could impact its clarity. Such features should be identified, described, and evaluated to determine their effect on the stone's overall clarity.

To define the factors that enable the improvement of quality grade assignments related to enhancement and/or

treatment is an ongoing task for gemological laboratories, which helps foster consumer confidence. However, one of the objectives of this work is to contribute to the enhancement of methods that promote consistency in laboratory procedures. This includes supporting aspects such as record-keeping, traceability, and repeatability, all within the framework of international standards—not only for the gemstone industry but also for testing and analysis laboratories.

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