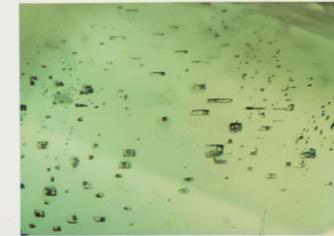


Alex Goodsohm<sup>1</sup>, Aaron Palke<sup>1</sup>, Wim Vertriest<sup>2</sup>  
<sup>1</sup>GIA Carlsbad & <sup>2</sup>GIA Thailand

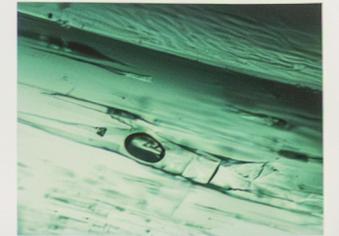
## Introduction

For a stone to be called an emerald, it must be beryl mainly colored by chromium and/or vanadium showing a medium to strong green saturation. Emeralds almost always contain fractures. Because air has a very different refractive index (RI) than emerald, fractures stand out as obvious clarity features. To make fractures less apparent, fractures are filled with a material (typically oils or resins) closer to emerald's refractive index.

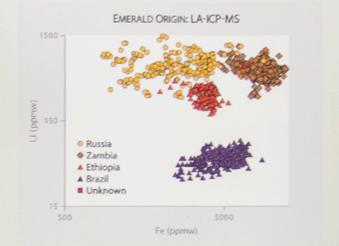
Blocky fluid inclusions indicate a schist-hosted deposit. Photomicrograph by Aaron Palke; FOV 1.72 mm.



Large jagged multiphase inclusion in Colombian emerald. Photomicrograph by Charuwan Khawpong; FOV 1.0 mm.



Rod-like amphibole inclusions in Zambian emerald. Photomicrograph by Nattida Ng-Pooresatien; FOV 1.6 mm.



LA-ICP-MS chemical data of an unknown stone (red squares) plotted against potential sources, indicating Zambian origin.

### EMERALD ORIGIN REPORT

DETAILS	RESULTS
Shape..... Octagonal	Species..... Natural Beryl
Cutting Style..... Step Cut	Variety..... Emerald
Transparency..... Transparent	Geographic Origin..... Colombia
Color..... Green	

TREATMENT (Scan QR code for more information)  
 Clarity Enhanced (F1)  
 Filler Type: A (may include oil or other naturally occurring materials)

Item Description: One loose stone  
 Weight: 8.78 carats  
 Measurements: 12.17 x 11.98 x 8.88 mm  
 Comments: \*\*SAMPLE\*\*  
 Any statement on geographic origin is an expert opinion based on a collection of observations and analytical data. Due to their growth conditions in nature and recovery methods, most emeralds contain surface reaching features. For this reason, clarity enhancement is a common trade practice.

NO FISSURES PRESENT	NO OR INSIGNIFICANT CLARITY ENHANCEMENT	QUANTIFICATION OF CLARITY ENHANCEMENT		
		F1	F2	F3
NONE	NO INDICATIONS OF CLARITY ENHANCEMENT	MINOR CLARITY ENHANCEMENT	MODERATE CLARITY ENHANCEMENT	SIGNIFICANT CLARITY ENHANCEMENT

To learn more about how GIA determines and classifies gemstone origin, as well as maps describing localities, go to [reportcheck.gia.edu](http://reportcheck.gia.edu) to view this report.



## Origin Determination

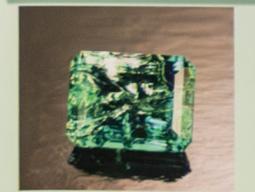
Emeralds come from various mines around the world: major producers include Colombia, Zambia, Brazil, Russia, and Afghanistan. GIA's field gemology team collects reference stones from important localities as close to the source as possible, to ensure sample reliability. When a stone is submitted, experienced gemologists use a combination of microscopic observations and more advanced techniques to determine origin. In particular, UV-Vis-NIR spectroscopy and geochemical data (collected by XRF or LA-ICP-MS) provide further evidence.

## Clarity Enhancement Classification

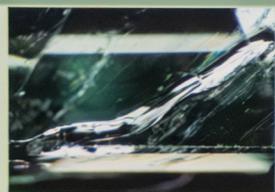
No fissures present	No or insignificant clarity enhancement	Quantification of clarity enhancement		
		F1	F2	F3
None	No / Insignificant indications of clarity enhancement	Indications of minor clarity enhancement	Indications of moderate clarity enhancement	Indications of significant clarity enhancement

To quantify clarity enhancement, the number of filled fractures, their prominence, and their placement is considered. The classification scheme is stated on GIA emerald reports. Filling substances can be detected using microscopic observation. Clues for detecting clarity enhancement include: an orange or blue flash as the stone is rotated under darkfield illumination (flash effect), low-relief fractures, bubbles in filled fractures, incomplete filling, leaking filler or yellowish-white appearance, and difference in fluorescence.

**Filler Added**



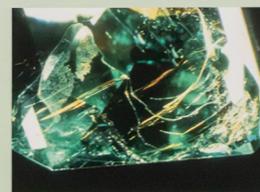
Emerald without clarity enhancement.



Unfilled fractures in emeralds stand out with high relief.



Emerald after clarity enhancement.



Orange "flash effect" in filled fractures under darkfield lighting.

## Filler Identification

Identifying the filling substance is helpful because:

- Some fillers are easier to clean out and refill.
- Some customers prefer natural oils, while some prefer the durability of modern resins.

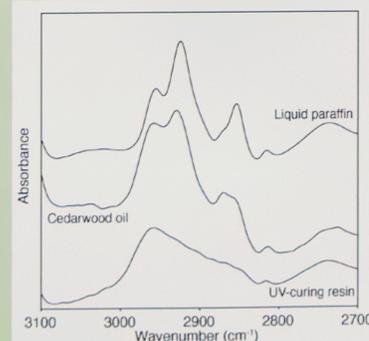
Peaks related to the filling material can be detected using advanced techniques, especially FTIR and Raman. Certain peaks are characteristic of certain filling materials.

**Filler Type: A (may include oil or other naturally occurring materials)**

**Filler Type: B (artificial resin)**

**Filler Type: Mixed (artificial resin and additional materials)**

FTIR spectra of 3 filling materials: Differences in the spectra allow for differentiation between Type A and Type B fillers.



Type A	Type B
Oils and other naturally occurring materials	Artificial resins
Canada Balsam, cedarwood oil, paraffin, etc.	Opticon, Permasafe, Araldite, etc.