New emerald production from the Curlew Mine in Western Australia.

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Australian emeralds have been known for over a century but have always remained under the radar. Small volumes, low clarity and desaturated color were among the reasons for their low recognition in the global market.

One of Australia's emerald deposits is the Curlew mine in the East Pilbara Shire of Western Australia. This area has officially been worked since the mid 1970's but anecdotal evidence suggests that emeralds were known at least 50 years prior to that. During this first period of mining, the focus was on specimen collecting. Any gem-quality material was sold to Indian-based emerald manufacturers and they disappeared into the huge pool of emeralds with undetermined origin.

From the 1980s up to 2011 the mine was mostly abandoned, although a few (unsuccessful) attempts were made to revitalize the deposit. In 2011, a prospecting license was passed around between different groups with little success in emerald production. In the most recent years, the mining license was taken over by a small scale mining group. They successfully produced gem-quality material from the existing mining pit during the mining season in 2023.

GIA in Bangkok was able to study a suite of 69 emeralds from this recent production (figure 1).

Figure 1: Emeralds in matrix and various cut stones from the Curlew mine in Western Australia. All stones were mined in 2023. The cut stones are untreated and range from 0.45ct to 7.92ct.
Photo by L. Nillapat/GIA, stone courtesy of Matt Allen (The Gemstone Trading Company)

The rough emerald crystals showed a well-formed hexagonal outline, often coated with dark mica crystals. Other minerals associated with the emerald are feldspar and quartz. One of the matrix specimens also contained significant volumes of purple fluorite (confirmed by Raman spectroscopy).

This suggests that these stones are formed in the contact zone of a pegmatite intrusion into an (ultra-) mafic rock. Images from the emerald mineralization in the field confirmed this (figure2). Such geological environment is found at many other emerald deposits around the world. These are responsible for the majority of emeralds in the marketplace including Kafubu (Zambia), Urals(Russia), Shakiso(Ethiopia), Itabira(Brazil), etc

Figure 2: Emerald pocket at the reaction zone between the pale pegmatite intrusion (bottom right) and ultramafic, greenish rock (top left). The emeralds are encrusted in dark mica crystals. Field of view +-50cm. Photo by Matt Allen.

The refractive index of the stones is 1.580-1.586+-0.001 with a birefringence of 0.007. This is in the higher range for emerald which corresponds with other emeralds that form in a similar geological environment.

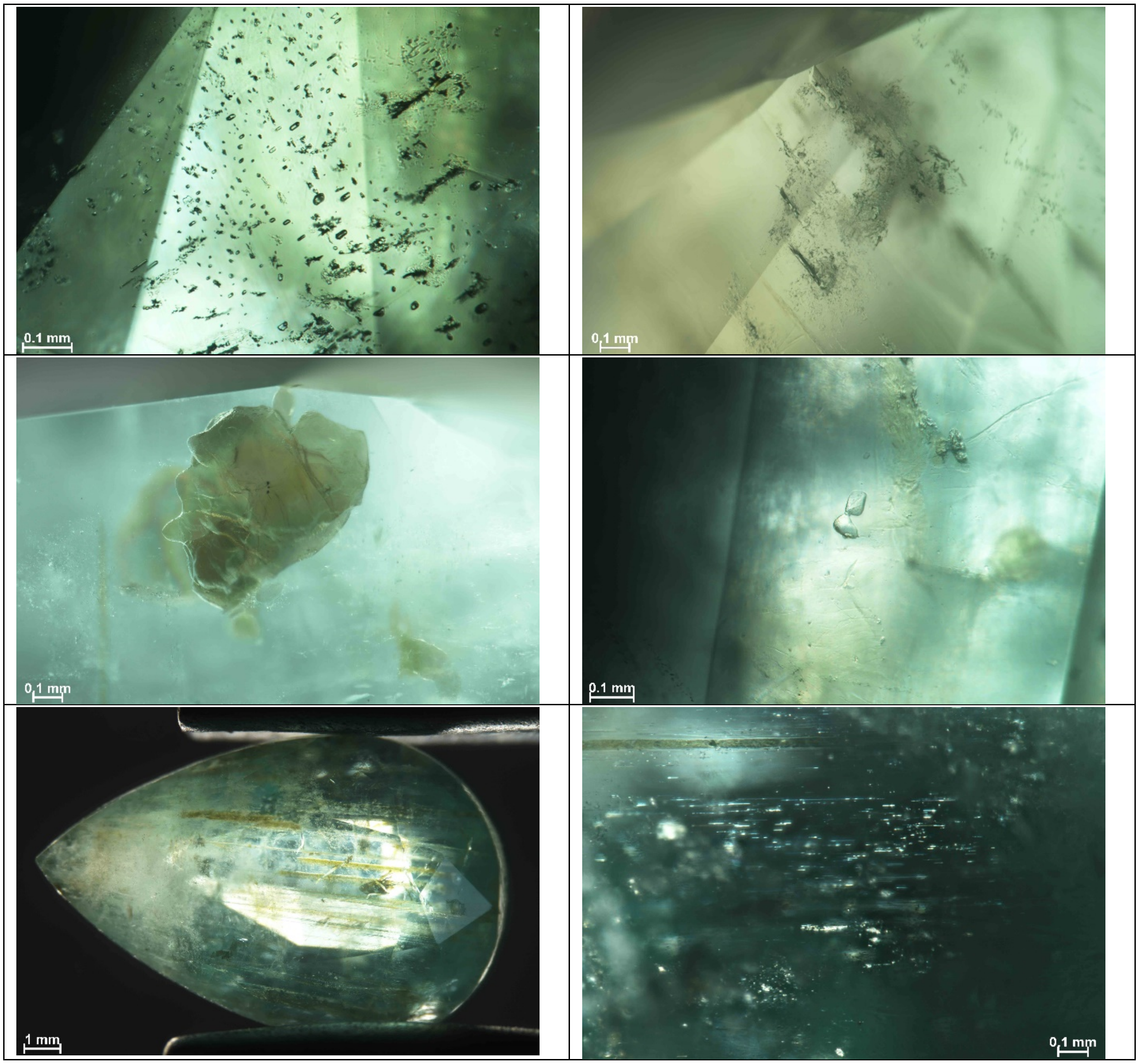
Chemical and spectroscopic analysis also confirmed that these emeralds are rich in iron. UV-Vis-NIR spectroscopy revealed Chromium-related absorption features as well as a strong band around 810nm which is attributed to the higher iron concentration. This band is used to separate high-iron, schist-hosted emeralds from hydrothermal, low-iron emeralds (Eg Colombia and Afghanistan).

Various inclusions were seen in the emeralds (Table 1). Very fine fluid inclusions had a blocky outline, sometimes elongated to tubes, with a single bubble in them. In many cases, they have a frosty rim around them which can be so large it obscures the fluid inclusion.
No color zoning was observed but some of the cleaner stones showed wavy to straight graining.
Two types of crystal inclusions were observed in the emeralds. The most common one are dark mica

platelets, the second one are small transparent colorless crystals. Some of these were identified as feldspar while others are fluorite using confocal Raman spectroscopy. Several of the stones also showed clusters of short needles which can be mixed with smaller reflective particles, sometimes forming fields of “dusty particles”.

A handful of the stones had large, wide tubes that were stained with orangey-brown iron mineralization.

Table 1: A) A field of blocky, two-phase fluid inclusions. B) Elongated two phase fluid inclusions with large frosty rims. C) An irregular shaped, platy mica crystal. D) Two small, transparent and colorless feldspar crystals. E) Large tubes filled with foreign orange-ish material. F) A cluster of short, parallel needles.
All images by S. Wongchacree/GIA



Overall, this inclusion scene shows many similarities with other high-iron emerald sources like Kafubu (Zambia) and Itabira (Brazil) (Saeseaw, renfro, Palke, Sun, & McClure, 2019)

Trace element analysis (LA-ICP-MS) was performed on 40 stones (3 spots per stone) following standard protocol at GIA.

Measurements in ppmw	7Li	23Na	24Mg	45Sc	51V	53Cr	57Fe	85Rb	133Cs
Average	377	4093	2345	89	156	1367	1903	38	718
Standard deviation	73	1446	1205	69	85	549	780	22	385
Minimum	260	2240	891	21	34	219	916	13	228
Maximum	603	9990	7710	325	444	2750	4700	133	2270

This trace element composition allows for separation from other high-iron emerald sources, although multiple elements should be taken into account to clearly separate the Australian emeralds from those found in Russia and Nigeria.

Emeralds from the Curlew mine in Australia have only started to enter the global emerald trade in the past months. Their appearance and characteristics are in line with other high-iron, schist-hosted emeralds like those from Zambia, Brazil and Russia. Inclusions offer limited clues for origin determination which relies heavily on trace element analysis and correct interpretation of these results. During the first season, production was limited to a few kilograms of gem-quality material but the owners are scaling up the production in 2024.

Saeseaw, S., renfro, N., Palke, A., Sun, Y., & McClure, S. (2019). Geographic origin determination of emerald. *Gems & Gemology, 55*(4).