

## Boiling as a mechanism for emerald colouration from the Emmaville and Torrington emerald deposits, Australia.

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The Emmaville emeralds were the first emeralds discovered in Australia during the late nineteenth century. The nearby Torrington emerald deposit was discovered a century later. Both deposits appear to be typical granitoid-related emerald deposits and are associated with the nearby Moule Granite of the New South Wales Fold Belt.

The emeralds are zoned (Fig. 1) and display alternating bands of emerald green and clear growth zones within individual crystals at the millimetre scale. The zoning is seen optically but can also be observed via other imaging techniques such as backscattered electron, cathode luminescence, and chemically via electron microprobe analyses. Additionally, there is a correlation between the presence of a population of primary vapour-rich fluid inclusions within the clear growth zones (Fig. 2) and a second population of highly saline three-phase (liquid + vapour + halite) fluid inclusions in the darker or coloured growth zones.



Fig. 1. Photomicrograph of a zoned emerald crystal from the Emmaville-Torrington deposit.

The two fluid inclusion populations appear to represent conjugate sets of a boiling system with the three-phase highly saline fluid inclusions having an average salinity of approximately 33 eq mass% NaCl. This population undergoes total

homogenisation into the liquid and probably represents fluids trapped in the liquid system of a two-phase (boiling) system. The vapour-rich population of fluid inclusions (Fig. 2) have an average salinity of approximately 6 eq mass% NaCl and homogenise into the vapour phase at higher temperatures.



Fig. 2. Enlarged area of the photomicrograph of primary fluid inclusions Figure 1 showing alternating coloured and clear areas in the zoned emerald crystal. The clear zones correspond to growth zones dominated by primary vapour rich fluid inclusions.

The correlation of colour versus clear growth zones corresponding to highly-salinity liquid-dominant and vapour-dominant low-salinity primary fluid inclusions, respectively, indicates that the colour banding within the Emmaville and Torrington emerald is related to emerald precipitation in the liquid or vapour portion of a boiling fluid system. Although other emerald deposits worldwide display similar growth banding this is the first time it has been documented as a consequence of boiling during emerald formation.

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