Module B. Colour from the Cosmos

Lesson 15: Beryl Geology and Geography

*Magmatic*

Two general modes for the magmatically-related production of beryl are considered here: one where beryl grows *in situ* (from Latin meaning "in the place") from granitic magma and a second where Be is transported via magmatically-driven hot hydrothermal fluids (e.g., in what are later represented as "frozen" quartz veins).

Beryl can crystallize *in situ* within an intrusive body without being concentrated in any one place. When beryl is found in this type of environment, it is called interstitial or accessory beryl and is tightly surrounded by other minerals. Miarolitic cavities (open spaces resembling mini-pegmatites) within an intrusion can also host beryl, and crystals can be free standing in these pockets. Gem beryl from these types of *in situ* environments are mostly aquamarine, but goshenite and morganite can occur as well.

A hypothetical magma and some of the mechanisms by which beryl (black hexagons) can crystallize within it. Light grey areas near beryl indicate interaction of igneous material with the host rock. Not all mechanisms will be possible in every intrusive body, but it is common to see more than one mode of occurrence (e.g., interstitial and isolated quartz veins) at one deposit.

Hydrothermal fluids are very hot waters with large amounts of dissolved elements and compounds, such as sodium (Na), chlorine (Cl), silicon (Si), and carbon dioxide (CO2). The source of hydrothermal fluids will define their composition; fluids sourced from granite can contain rare elements, such as Be, boron (B), lithium (Li), and fluorine (F). Parent magmas that contain dissolved elements such as Be are often termed "fertile". The hydrothermal fluid and dissolved elements can then be transported significant distances from their original source. Veins of predominantly quartz will remain where these hydrothermal fluids once circulated through the rocks. This is the most important of the magmatic models for gem beryl formation and is especially important when the hydrothermal fluids interact with the host rocks.

Typically, hydrothermal fluids are corrosive to their surrounding host rocks and cause a number of chemical reactions that change the minerals that come into contact with the hot fluids. This can release elements that were originally tightly bound in those minerals, allowing them to become part of the hydrothermal solution. If the released elements include chromophores, then different varieties of gem beryl can form. Specifically, if Cr+3 is present in the corroded minerals, beryl can then incorporate it into its crystal structure, forming emerald! Many emerald deposits can be explained by this geological model.

The interaction of hot magmatically-derived hydrothermal fluids containing beryllium with a Cr- and V-bearing host rock. These types of quartz veins are normally up to ~30 cm thick, but can reach several metres. Colour coding as follows: pink=fertile granite, purple=Cr- and V-bearing host rock, white=quartz vein, yellow=zone of interaction. Gem beryl formation is indicated by the hexagons: green=emerald (Cr/V is available), blue=aquamarine (no Cr/V available). Grey crystal "fans"=tourmaline (commonly form throughout the system).

Green emerald crystals hosted in white quartz vein from Tsa Da Glisza Emerald Occurrence, Yukon, Canada. The black crystals are the mineral tourmaline, and are commonly found alongside beryl. Photo courtesy of [True North Gems](http://www.truenorthgems.com/).

A glimmer of green! Quartz vein with emerald exposed at the surface in rusty weathering schist. A prospector's delight! Photo courtesy of [True North Gems](http://www.truenorthgems.com/).

Tracing the quartz vein with emerald deeper into the rusty weathering schist. Crystals can sometimes be better quality just below the surface where less freezing and thawing cycles of water contribute to less fracturing of the gemstones. Photo courtesy of [True North Gems](http://www.truenorthgems.com/).

An unusual geological setting in the Wah Wah Mountains of Utah, USA, has produced the only known location of a saturated red beryl. There, rhyolite (a volcanic rock) hosts beryl found in vesicles (volcanic gas bubbles). The rocks are essentially an extrusive equivalent of a highly evolved granite with abundant Be and, uniquely, manganese (Mn). In one sense, the vesicles in the rhyolite are sort of like the equivalent of miarolitic cavities in granite. The red beryl crystals of the Wah Wah Mountains are typically only a few centimetres long and rarely produce material big enough for sizeable-cut stones, making them quite rare and very expensive!

Examples of red beryl crystals still within their rhyolite host rock. Note the central regions of the two larger crystals that show some transparency. These regions might be able to produce faceted gems. Photo by A. Borelli.

This specimen of red beryl was fractured at some point in its geologic history only to have the fracture filled in by a white mineral, likely albite. The transparency of this stone is very good, allowing what sits behind it to be seen! Note the vertical striations along the crystal, characteristic of beryl. Photo by A. Borelli.