Module B. Colour from the Cosmos

Lesson 14: Beryl Mineralogy and Gemology

What Colours can Beryl Have? How are those Colours Generated? What Gem Varieties Result?

The resulting colour of a beryl crystal is usually closely tied to substitution into the octahedral sites of the mineral structure normally occupied by Al. As with most cation substitutions, the chromophores that typically take the place of Al need to be similar in charge and ionic radius. This effectively reduces the number of possibilities for elements that may be able to enter into the crystal structure. Deviations at the channel site and Be-site from the ideal base formula are sometimes the cause of colours, too.

The most familiar example of coloured beryl occurs when Cr+3 substitutes for Al+3, imparting a vibrant green colouration and generating the variety of beryl known as emerald. It is generally agreed upon that the light blue colour of aquamarine is a result of Fe in the Al site, but there are some nitty-gritty complications once you start digging deeper. Research has shown that the "Maxixe-type" (often pronounced Ma-Sheesh-Ay) beryl, which has been found only in Minas Gerais, Brazil, shows a dark saturated velvety blue and owes its blue colour to irradiation and the presence of the radical nitrate (NO3-) in the channels. Unfortunately, its colour fades upon exposure to light, eventually rendering the crystal to a pale blue.

The table below shows the gem varieties of beryl, along with the dominant deviations from the ideal formula of beryl that generate the different colours and the most common geologic environment. Gem varieties in **bold**are those we will be focusing on in this course.

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| --- | --- | --- | --- | --- |
| **Mineral** | **Common Name** | **Colour** | **Chromophores and Common Deviations from Be3Al2Si6O18** | **Common Geologic Environment** |
| Beryl | **Beryl** | colourless, opaque | None | Pegmatite |
| Beryl | **Emerald** | green | Cr+3, V+3 for Al+3 | Metasomatic zones |
| Beryl | **Aquamarine** | light to dark blue-green | Fe+2, Fe+3for Al+3, and often Na+ in the channel | Pegmatite |
| Beryl | Goshenite | colourless, transparent | None | Pegmatite |
| Beryl | Morganite | pink | Mn+2, Mn+3 for Al+3,  Cs+ in the channel,  and Li+2 for Be+2 | Pegmatite |
| Beryl | Heliodor | yellow/gold | Fe3+ for Al3+ | Pegmatite |
| Beryl | Red Beryl | red | Mn+3 for Al+3, no H2O in the channel | Rhyolitic ejecta |
| Beryl | Maxixe | dark blue, fading to pale blue | (NO3-) in the channel | Pegmatite |

The finest colours are not only the result of elements substituting into the crystal structure, but also due to some elements **not** substituting into the crystal structure. Emeralds of the finest quality require Cr+3, but also typically have very low to no Fe since this element has a broad absorption range that conflicts with subtle red fluorescence imparted by Cr (optional reading [here](http://www.minsocam.org/msa/collectors_corner/arc/color.htm) and [here](http://www.flickr.com/photos/bob_81667/5661249480/)). This means that the environment of emerald formation must have either low Fe or another mineral that crystallizes first and sequesters Fe before beryl can incorporate it into its own crystal structure. Examples of minerals that have been known to do this include pyrite (FeS) and siderite (FeCO3).

Emeralds of the *finest* quality are given the descriptive term *Gota de Aceite*, which translates from Spanish as "Drop of Oil". An excellent description of this term is found in the article by Ronald Ringsrud cited below. Download a copy of the paper from the UBC Library and read it. Be sure to use the [guide provided here](https://connect.ubc.ca/bbcswebdav/pid-2559788-dt-content-rid-10494297_1/courses/SIS.UBC.EOSC.118.99C.2014WC.44220/Course_Files/moduleB/lesson14/download/Gota-de-Aciete-Guide.pdf), to help you through the article.

Ringsrud, R. (2008). "Gota De Aceite: Nomenclature for the Finest Colombian Emeralds". *Gems and Gemology*, Vol. 44, No. 3, p242-245.

To download and read the article listed above, read the instructions on how to:

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