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The source and evolution of a magma chamber

A crystal forming in a magma chamber has a lot of parallels to tree rings forming as a tree grows. Just like how a tree ring develops from the centre outwards and reacts to the changing climate as it grows, a crystal might do something very similar. Plagioclase crystals found in rocks often form a profile that varies in both texture and chemistry, the changes in these features will tell a story about how the magma chamber developed.

Located just off the west coast of Sweden lies two islands: Älgön and Brattön. These islands are both recognized nature reserves and are visited frequently for their scenery; one attraction of these islands that most visitors might not be aware of is the presence of a peculiar and enigmatic type of rock: anorthosites. These types of rocks have been pondered upon regarding their formation, with many theories being suggested, debunked, and argued over since the early twentieth century.

By using microscopes and certain analytical equipment we can observe these rocks very closely to try determine their formation history. The tree ring-esque plagioclase crystals found in these rocks show very distinct features, namely a patchy band around the edge of the crystals which also coincide with some significant changes in their chemistry. These features are likely to be caused by a new batch of magma being injected into the magma chamber, causing changes to the system that the crystal then reacts to.

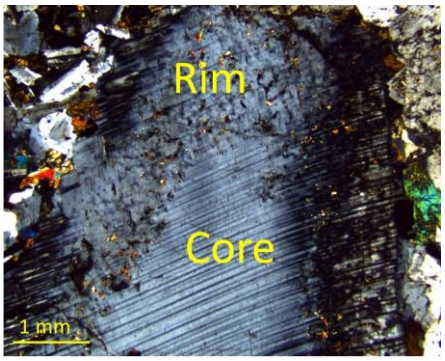

Figure 1. a plagioclase megacryst displaying the patchy rim texture

What is the significance of these magma injections?
These magma injections have direct implications on what type of source the magma came from and the setting in which it developed in. Previous studies have looked at other chemical signatures of these rocks and noted that it was indicative of a magma source coming from the Earth's crust rather than the mantle. It was inconclusive however because the argument could be made that the chemistry could still reflect a mantle source if it mixed with the Earth's crust as the magma chamber developed. This argument however is much less plausible now that magma injections must be considered. These prior studies showed very consistent chemical profiles, and if they were to be explained by mixing with the crust, they should have shown variation in the chemical profiles with each subsequent injection of magma, which was not present. A magma source coming from the Earth's crust also implies that these rocks formed in a continental collision zone at the time (the type of setting that forms mountains, e.g. the Himalayas).

To conclude, the type of rocks that can be found on the islands Älgön and Brattön have been long debated regarding their magma source and tectonic setting. By observing the features in plagioclase crystals found in these rocks we can find evidence for injections of new magma into the chamber as it is developing. The evidence of these injections in tandem with observations from prior studies suggest that the magma source is likely to come from the Earth's crust. By extension of this, it can also be suggested that these rocks formed in a continental collision zone.

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