Studying magmatic systems through chemical analyses on clinopyroxene – a look into the history of the Teno ankaramites, Tenerife

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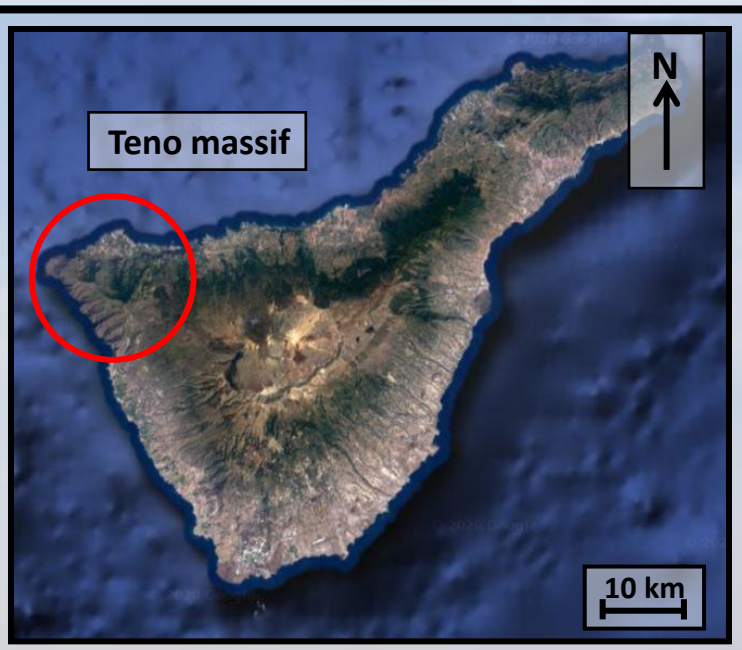
Background

The Teno massif is part of Tenerife, one of the islands in the Canary Islands archipelago. The massif has experienced at least two events of mass wasting that is thought to have affected the deep plumbing system of the volcano, resulting in eruption of dense ankaramite magmas rich with clinopyroxene phenocrysts. Clinopyroxenes can crystallize over a large range of temperatures, pressures and chemical composition, and are therefore ideal for analyses regarding past magma chamber processes.

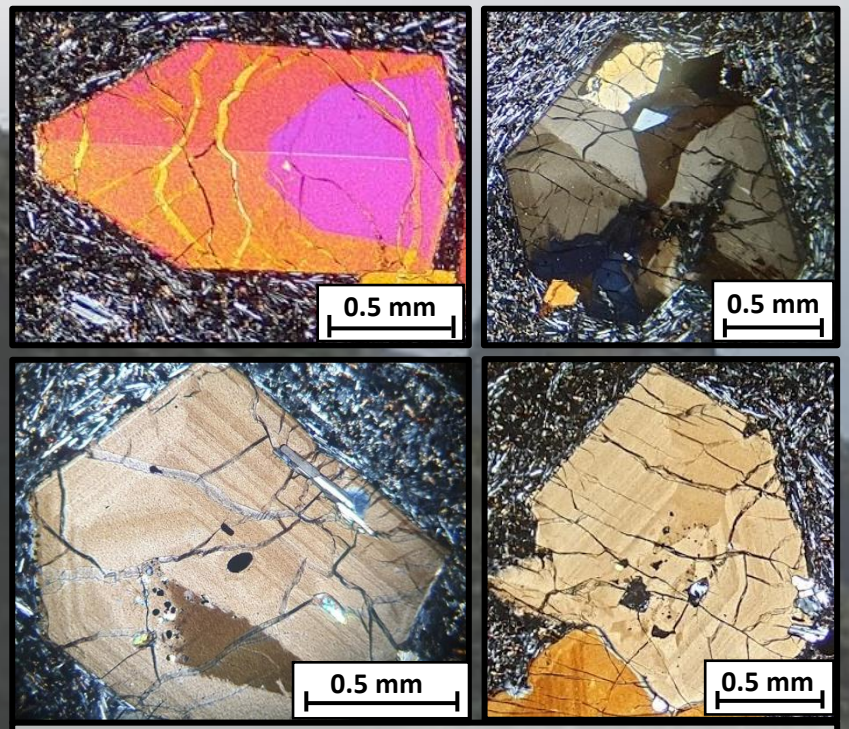
The aim of the study was to perform chemical analyses on clinopyroxene crystals in an ankaramite sample and link the results to possible processes affecting the magmatic system during their growth, including open system processes and eruption triggers related to the mass wasting events.

Methods

Four clinopyroxene crystals from two thin sections of the same ankaramite sample were analysed using optical microscopy, scanning electron microscopy (SEM) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Special interest was taken to chemical changes related to zoning, potential signs of open system processes and possible eruption triggers.



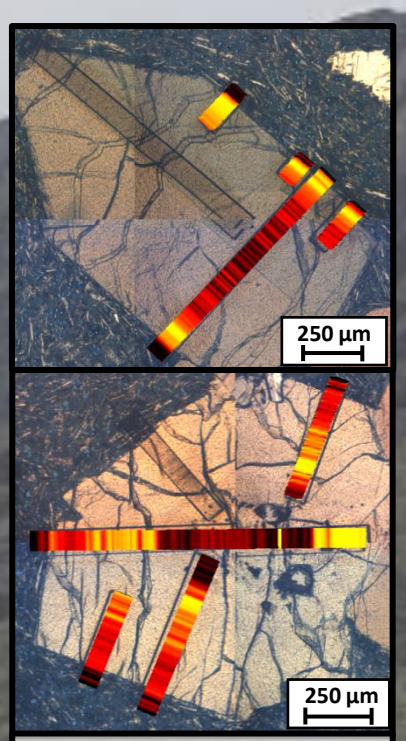
Tenerife. Image from Google maps, Imagery ©2020 TerraMetrics, Map data ©2020



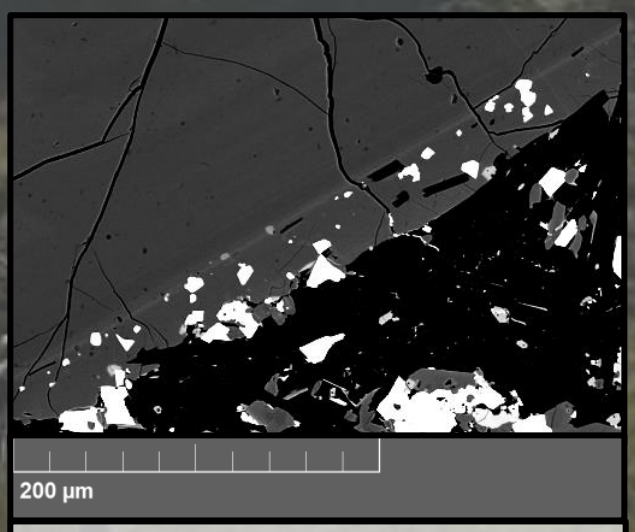
The four clinopyroxene crystals analysed, two of which are sector zoned (upper) and two of which are concentrically zoned (lower)

Results

The results show that the four clinopyroxene crystals display widely different types of zoning and can be divided into two groups: sector zoned crystals and concentrically zoned crystals. The concentrically zoned crystals are interpreted to have experienced a longer and more complex growth history, including stages of resorption, than the sector zoned crystals. The rims of all crystals likely grew simultaneously in the same eruption event. Additionally, a band of deviant chemical composition – in some instances higher Al concentration - is observed inside of the rims in all crystals. Cr spikes are recorded in all crystals, reflecting the addition of new primitive magma. The spikes are located in the rims of the sector zoned phenocrysts and in the interior of the concentrically zoned crystals.



Cr concentrations measured in lines analysed with LA-ICP-MS, higher concentrations are marked yellow, lower in red and lowest in black.



A backscatter electron image of the rim in one of the concentrically zoned crystals (lower left crystal in the figure above), displaying the band with deviant chemical composition (lighter contrast) inside of the rim.

Conclusions

- The concentrically zoned crystals are interpreted to either belong to another generation of clinopyroxenes, originate from a different part of the magmatic system or originate from an entirely different system than the sector zoned crystals.
- The band inside of the rims, if the observed increase of Al in some sites are to be regarded as a sign of a pressure decrease, might be related to the mass wasting event occurring before the eruption. However, more analyses are required to know this for certain.
- The differing locations of the Cr spikes in the two groups of crystals indicate that two separate magma recharge events are recorded. The proximity of the Cr spikes to the rims in the sector zoned phenocrysts might point towards system destabilization caused by the magma recharge, in turn causing the mass wasting event.
- Further analyses are required to confirm the hypotheses presented above. This includes analyses on a larger number of samples to further constrain the occurrence and nature of the band inside of the rims. Additionally, geothermobarometry would be beneficial to constrain the crystallization depth and temperature of the crystals and evaluate their respective origins.

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Background: Outlook in the Teno massif, Tenerife. Photo: Vendela Haag