A Study of 2020-2021 Mount. Etna Paroxsyms: Geochemical and Morphological Analysis

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Introduction and Methodology

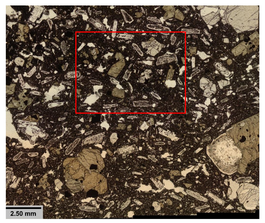
Mount Etna is one of the most active modern volcanos, located in Sicily, Italy. It has been active over the past 15k years and most notably is responsible for nearby town desecration of Mascali in 1928 and Catania in 1669 (Duncan, et al. 1996). Recent activity from December 2020 to September 2021, has been characterized by eruptive episodes of short duration (<1 day) and a maximum of 37 days separating each episode (Andronico, et al. 2021). Eruptions at Mt. Etna are of strombolian nature, characterized by explosive activity ejecting ash into the air. Strombolian eruptions also result in the ejection of lapilli and lava bombs from the magma chamber which then accumulate around the surface of the eruptive chamber. Due to this eruptive character, this particular volcanic activity is classified as paroxysms. Most recent eruptions produce K-trachybasalt paroxysms. In this work we studied products from paroxysms occurred in 2020-2021 C.E. The methods used to study these paroxysms include morphological analysis (using microscopy, crystal size differentiation and 3D microtomography) and geochemical analysis (SEM, ICP-OES, ICP-MS).

Paroxysm Date	Lava	Lapilli	Ash
13/12/20	X	-	-
16/02/21	X	X	X
02/03/21	-	-	X
07/03/21	-	X	X
23/03/21	-	-	X
01/04/21	X	-	-
19/06/21	-	X	X
29/08/21	-	X	X
21/09/21	X	X	
Total	4	5	6

Results: Petrographic Data

Dec, 13, 2020

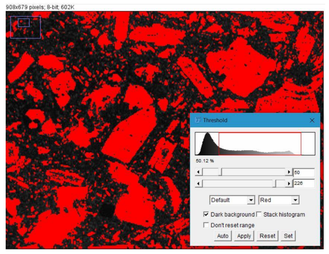
April, 1, 2021



These petrographic images were produced through imaging under PPL, accompanied by stitching using FIJI. A total of 25 images were taken and stitched together for each sample, in hopes of facilitating morphological analysis. Bubble and crystal size distribution (CSD) were to be done once high quality images were produced.

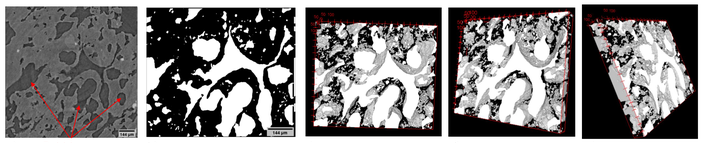
Observations from Sample 131220F:
- Large incidence of plagioclase grains
- Large size and high number of bubbles
- Overall smaller phenocrysts size

Observations from 010421F
- Significantly less plagioclase grains
- Overall larger phenocrysts
- Multiple occurrence of aggregated grains (ol±px)
- Bubbles are smaller in size and less frequent



Upon completion of image production, it was found that CSD was a challenge in the flow samples, as FIJI was not able to properly segment the differing crystal species. As seen to the right, thresholding of the image to begin CSD would require days of manual manipulation to produce a viable sample for analysis.

Results: 3D MicroTomography

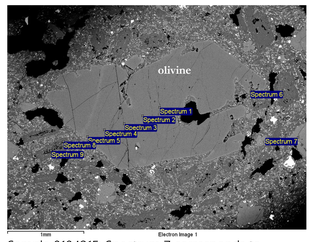


Sample 210821A: Preparation and final visualization of tomography images. a) shows a selected axial slice in its initial form; b) shows the same slice in 8-bit and with the segmentation of the bubbles. c), d), and e) show 3D visualizations of these bubbles. In a), the bubbles are labelled, while in b), the bubbles are white. In 3D visualizations (c-e), a sub-volume of the imaged sample is shown, where the white content are the bubbles within the ash sample.

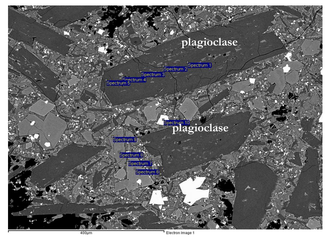
As tomographic data was received in March, preliminary visualizations have been completed, however data collection from bubble analysis is in progress.

Results: Scanning Electron Microprobe

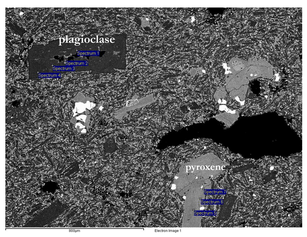
- Analysed plagioclase, pyroxene and olivine grains in each sample.



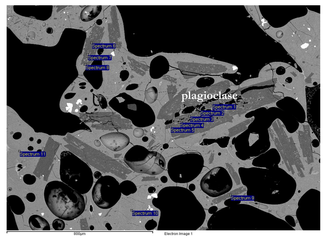
Sample 010421F: Spectrum 7 corresponds to a pyroxene grain, while Spectrum 6,8-9 correspond to plagioclase grains.



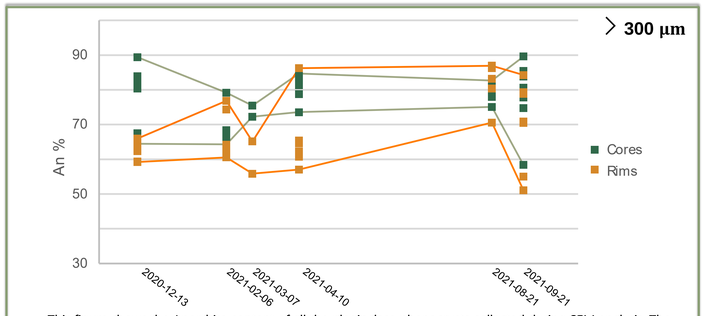
Sample 160221F: Spectrum 6-9 corresponds to pyroxene groundmass, while spectrum 10 corresponds to titanomagnetite oxide.



Sample 210921F: Spectrum 5-7 corresponds to pyroxene grains.



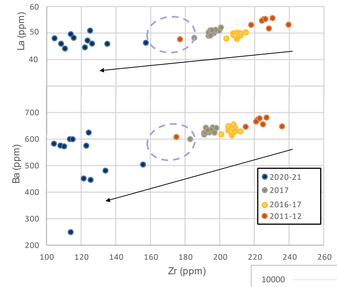
Sample 160221L: Spectrum 1-9 corresponds to plagioclase phenocrysts, while Spectrum 10,11 capture the matrix.



This figure shows the Anorthite content of all the plagioclase phenocrysts collected during SEM analysis. The lines plot the maximum and the minimums of the Anorthite content for both plagioclase cores and rims.

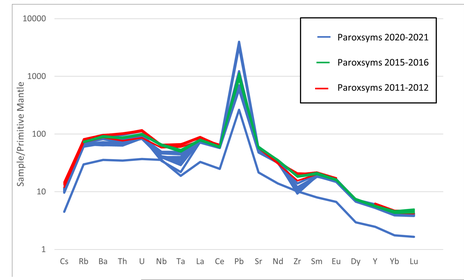
- Higher An content is indicative of crystallization from a more primitive melt
- Cyclicity of An content (Dec – April) shows that Etna's plumbing system is being exhausted, then recharged

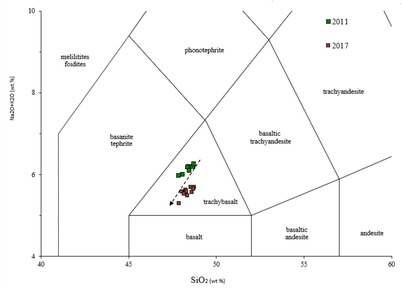
Results: Bulk Rock Geochemistry



Preliminary geochemical data tentatively shows that incompatible trace elements are more depleted over the last ten years. Trends are shown with arrows. Due to suspected challenges during sample digestion, Zr and other trace elements concentrations are likely underreported. The expected concentration fields would likely plot in the encircled areas. Correction of geochemical data in ongoing.

This spider diagram shows how 2020-2021 paroxysms follow the same relative trend as previous samples. It is likely that the pronounced negative anomalies may be due in part to challenges during geochemical analysis.





Major elements were not available for 2020-2021 Mt. Etna Paroxysms. However, major element data from 2011 and 2017 samples are plotted along with an arrow outlining the tentative trend.

All figures were created using data adapted from Di Renzo *et al.* (2019) and Giacomoni *et al.* (2021). Paroxysmal geochemical data from 2011 was obtained from Di Renzo *et. al* while 2016-2017 data was obtained from Giacomoni *et. al.*

Conclusion

- Mount Etna's magma reservoirs are likely being recharged with new magma, as supported by the gradual depletion of incompatible trace elements and SiO_2.
- The cyclicity of An content seen from September 2020 – April 2021 also points to recharge of the magma reservoir
- Further morphological analysis using 3D microtomography data will be conducted, in addition to a refinement of the geochemical data available for the samples.
- The continuation of this study will investigate if the recharge of Mt. Etna's plumbing system is caused by nearby extensional stress in the Sicilian region.

References

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Di Renzo, V, R A Corsaro, L Miraglia, M Pompilio, and L Civetta. 2019. "Long and short-term magma differentiation at Mt. Etna as revealed by Sr-Nd isotopes and geochemical data." *Earth-Science Reviews* 112-130.

Duncan, A M, C Dibben, D K Chester, and J E Guest. 1996. "The 1928 eruption of Mount Etna volcano, Sicily, and the destruction of the town of Mascali." *Disasters.*

Giacomoni, P P, F Casetta, V Valenti, V Ferlito, G Lanzafame, M Nazzari, and M Coltorti. 2021. "Thermo-barometric constraints on the Mt. Etna 2015 eruptive event." *Contributions to Mineralogy and Petrology.*

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