Multiple Magma Batches: Understanding the Pre-Eruptive Architecture and Magmatic Processes of Supereruptions Based on Textural, Mineralogical, and Geochemical Features of Fiamme from the Ora Ignimbrite (Permian, Italy)

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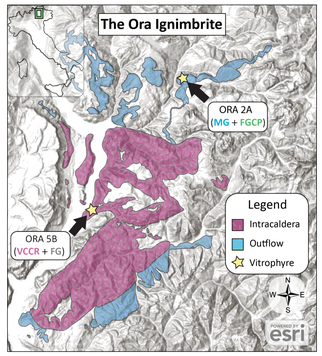
Motivations

- Understanding the structure and evolution of **large silicic magma systems** through time
- Investigating the pre-eruptive conditions of a **crystal-rich ignimbrite**
- Examining the plutonic-volcanic connections of a **supereruption-sized** magmatic system

The Ora Ignimbrite



- The Ora Ignimbrite (277 ± 2 Ma) has both **crystal-rich** and **crystal-poor fiamme** distributed throughout the >1,000 km^3 deposit
- **Vitrophyre** horizons contain well-preserved**, glass-bearing** juvenile material
- This study focuses on fiamme from two **vitrophyre** horizons:
  - **Early-erupted** intracaldera (ORA 5B)
    - **VCCR** + **FG**
  - **Late-erupted** outflow (ORA 2A)
    - **MG** + **FGCP**

Fiamma Type Classification

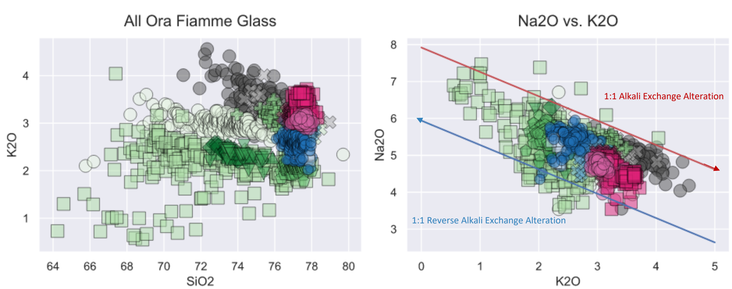
- Crystal content was calculated in ImageJ using **greyscale thresholding** on thin section scans

FIAMMA TYPES:	DESCRIPTION:	LOCATION	CRYSTAL CONTENT:	MAX PHENOCRYST SIZE:	MAFICS:
TYPE 1:	Very Coarse-Grained Crystal-Rich (VCCR)	Intracaldera	~40-50%	>5 mm	~2-3%
TYPE 2:	Medium-Grained (MG)	Outflow	~20-40%	1-3 mm	<0.5%
TYPE 3:	Fine-Grained (FG)	Intracaldera	~20%	≤1 mm	<0.1%
TYPE 4:	Fine-Grained Crystal-Poor (FGCP)	Outflow	~10%	≤1 mm	≤0.15%

- Fiamme were initially grouped into **four types** based on crystal content and biotite content

Glass Major Element Compositions

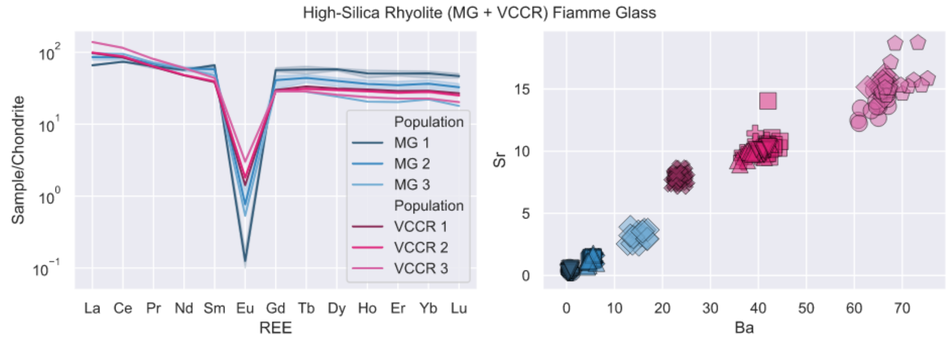
- **Glass** major elements were obtained using EDS analysis on an SEM at Vanderbilt University



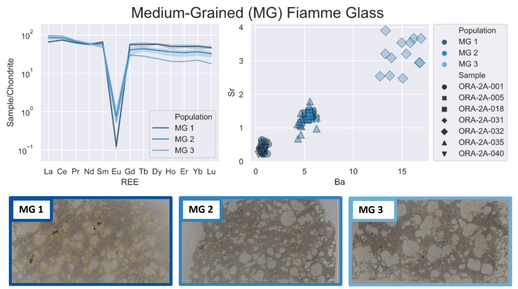
- Glass major elements verify the **four** different fiamma **types** from the textural-based classification
- The tight clustering of **VCCR** and **MG** fiamme suggests that these types have **unaltered** glasses

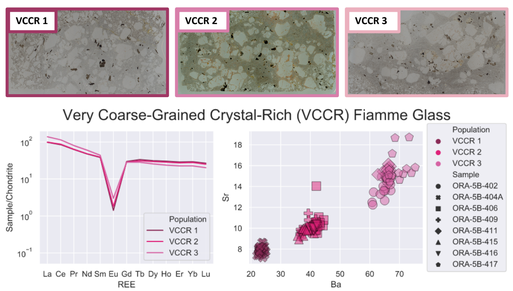
Glass Trace Element Compositions

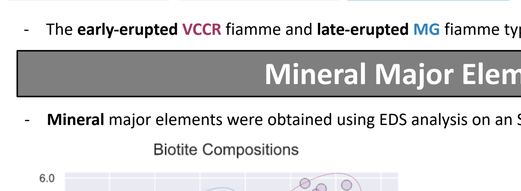
- **Glass** trace elements were obtained using a LA-ICPMS at Vanderbilt University and the data were processed with GLITTER



- Trace elements further **confirm** the fiamma type classification scheme and show **distinct populations** for the **intracaldera VCCR** fiamme and the **outflow MG** fiamme**,** suggesting the presence of **multiple magma batches** within the Ora system







- The **early-erupted VCCR** fiamme and **late-erupted MG** fiamme types each have **three** discrete glass populations

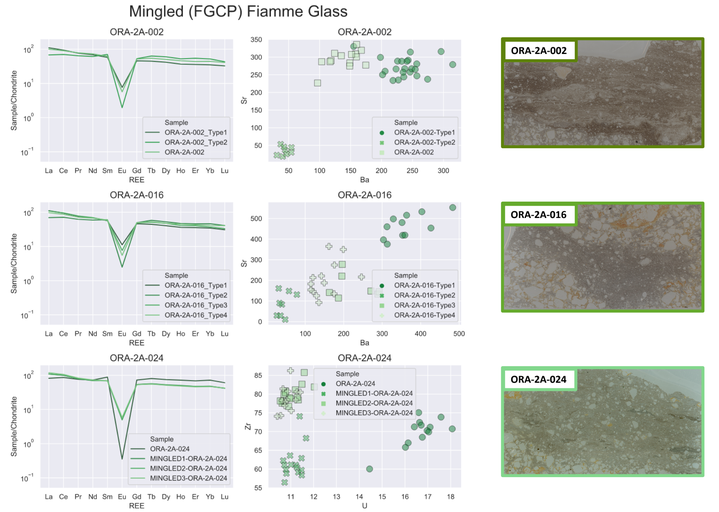
Mineral Major Element Compositions

- **Mineral** major elements were obtained using EDS analysis on an SEM at Vanderbilt University

- We observe variations in **biotite** and **plagioclase** major element compositions between the intracaldera and outflow units
- Biotite compositions can be used to infer both fiamme **type** and **population** in fiamme with no preserved glass

Mingled Glass Trace Element Compositions

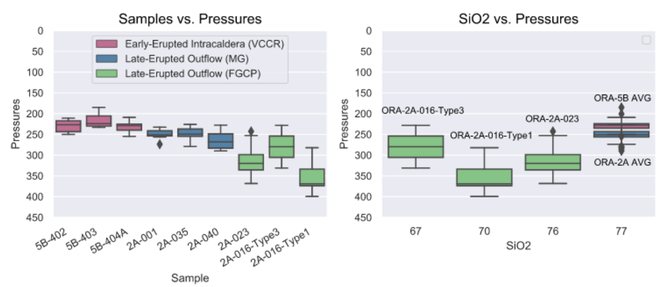
- **Mingled glasses** were identified **texturally** prior to major and trace element analysis



- The presence of **multiple different types** of glass in a **single fiamma** demonstrates magma mingling with limited mixing just prior to (days? weeks? years?) or during eruption

Rhyolite-MELTS Geobarometry

- **Pre-eruptive storage pressures** were calculated using the **rhyolite-MELTS (Q2F)** geobarometer



- The fiamme types return **different** storage pressures, suggesting (1) progressive withdrawal of **deeper magmas** or (2) the tapping of **separate** magma batches over the course of an eruption

Conclusions

- The variation in trace elements, biotite content, plagioclase and biotite major element compositions, and rhyolite-MELTS pressures reveals the tapping of either (1) **two distinct mush zones** or (2) **heterogeneous zones within a continuous crystal mush**
- Different fiamme **types** and **populations** can be identified with **biotite** and **plagioclase** major element compositions in samples with no preserved glass
- We would like to better constrain **timescales** of **magma mingling** for the Ora system