PhD Proposal

This manuscript (permalink) was automatically generated from gennachiaro/phd_proposal@a8bd5ba on January 16, 2020.

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Motivation

Background

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The Ora Ignimbrite (277 +/- 2 Ma) is a welded crystal-rich supereruption-
sized deposit located in the southern Alps of northern Italy.  Ora
represents the final eruptive pulse of the Athesian Volcanic Group (285-274
Ma), a slab-rollback ignimbrite flareup resulting from the oblique
subduction of the Paleo-Tethys ocean under Eurasia in the Permian (Marocchi
et al., 2008; Best et al., 2016).  This volcanic terrain escaped alpine
deformation and has been scoured by glacial incision, exposing intracaldera
deposits reaching thicknesses of 1350 m.  Outflow deposits are less than 250
m thick and are stratigraphically similar to the late-erupted deposits
(Willcock et al., 2013) (Fig 1).  The Ora eruption is interpreted to have
had an early caldera collapse, based on the large amount of intracaldera
fill and the fact that the outflow correlates with the late-erupted units of
the intracaldera deposit (Willcock et al., 2013).  Furthermore, Willcock et
al. (2015) identify two discrete collapse calderas (northern and southern)
and variations in bulk rock compositions and biotite content between the two
calderas suggest that multiple magma chambers were evacuated to form the Ora
Ignimbrite.
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Figure 1: A map of the field location. The four fiamme types identified in Chiaro et al. (in prep) are listed with their corresponding vitrophyre locations.

Table 1: Samples collected in Fall 2017 and Spring 2019. Sample locations are shown in Fig. 1. The number of bulk tuff samples and fiamme are listed.

Samples: Location: Type: Bulk Tuff: Fiamme: ORA 2 Outflow Vitrophyre Vitrophyre 1 x ORA 3 Northern Intracaldera Bulk Tuff 1 1 ORA 4 Odorizzi Quarry Bulk Tuff 2 50 ORA 5 Intracaldera Vitrophyre Vitrophyre 1 x ORA 6 Northern Intracaldera Rhyolite Dike 4
ORA 7 Base of Northern Intracaldera Bulk Tuff 1
ORA 8 Northern Intracaldera Bulk Tuff 1
ORA 9 NW Outflow 1 Biotite-Rich Fiamme x ORA 10 NW Outflow 2 Medium-Grained Fiamme x ORA 11 Castel Firmiano Ash/Ignimbrite Contact 3
ORA 12 Rhyolite Dike Granite Dike 4
ORA 13 Rhyolite Dike Potential Fiamma 1 ORA 14 Caldera Rim Cutting Dike Porphyritic Coarse-Grained Dike 1
ORA 15 Caldera Rim Cutting Dike Medium-Grained Dike 1
ORA 16 Cava Flor Quarry Fine and Coarse-Grained Fiamme 4 ORA 17 NW Outflow 3 Fine to Medium-Grained Fiamme x ORA 18 Magdalena Hike Pseudotachylite 1
ORA 19 Magdalena Hike @ Sculpture Fine and Coarse-Grained Dikes 1

Recent work has attempted to understand the pre-eruptive architecture of the Ora system by using textural, mineralogical, and geochemical features of fiamme (Chiaro et al., in prep). Fiamme were collected from two vitrophyre horizons: an early-erupted intracaldera deposit and a late-erupted outflow deposit in order to find well-preserved glass. These fiamme were initially grouped into four types based on crystal content and biotite content (Table 2). Glass major elements further verified the categorization scheme.

Table 2: The four fiamme types and their location, crystal content, maximum phenocryst size, and mafic content (Chiaro et al., in prep).

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Glass trace elements illuminate at least three distinct populations for both
the VCCR and MG fiamme, suggesting the presence of multiple magma batches
within the Ora system (Fig. 2).
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Figure 2: Rare earth element diagrams and a plot of strontium vs. barium illustrate the six discrete glass populations in the Medium-Grained (MG) and Very Coarse-Grained Crystal-Rich (VCCR) fiamme.

Pre-eruptive storage pressures were calculated using the Rhyolite-MELTS (Q2F) geobarometer.

Different fiamme types were stored at different pressures in the crust, with a progression of erupting shallower to deeper magmas through time.

Silica content vs. pressure shows variable storage depths for the fine-grained crystal-poor melt, suggesting that there were multiple, small melt bodies located at different depths throughout the magma chamber.

Figure 3: (from Chiaro et al., in prep)

This work suggests that there were two potential scenarios for the pre-eruptive architecture of the Ora magma system. There were either two distinct mush zones that were at slightly different depths within the crust, or a continuous crystal mush with multiple heterogeneous zones located throughout.

References