Mineralogical and Geochemical Characterization of Cook Canyon Tuff near Kingman, AZ with Implications for Magmatic Processes

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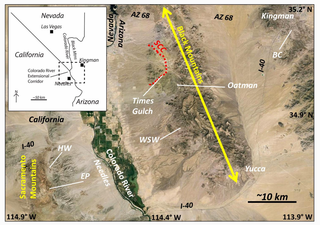
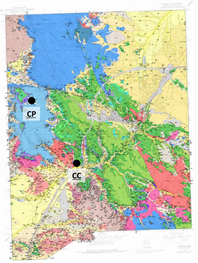
Introduction

• The Cook Canyon Tuff (CCT) is a major, ~18.9 Ma (Lidzbarski 2014) ignimbrite exposed in the Cerbat and Black Mountains and adjacent areas of NW Arizona and SE California.
• It's characterized by abundant plagioclase and biotite phenocrysts (Buesch and Valentine 1986).
• It underlies the supereruption-produced Peach Spring Tuff (PST) in many localities (Ferguson et al. 2013).
• AMS data indicates that the CCT may be sourced from the same vicinity as the PST (R. Varga, unpub), which suggests that they may be products of the same magmatic system.

Purpose

• Further characterize the eruptive/pre-eruptive conditions surrounding the CCT
• Compare new CCT data with previous findings
• Investigate possible geochemical difference between light- and dark-colored pumice



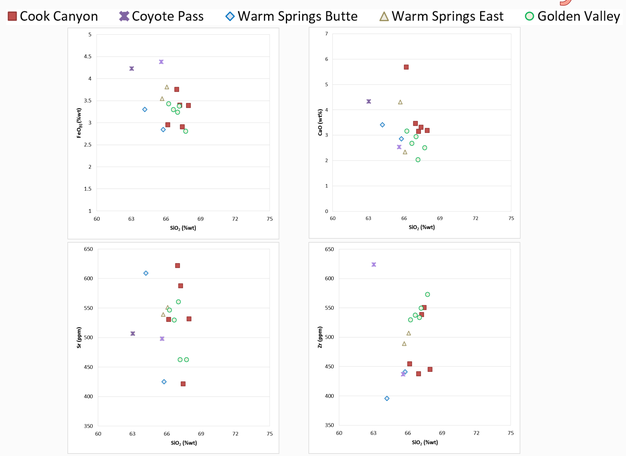


Left: Aerial map showing locations of CCT and PST (Nick Lang). Samples were taken near Kingman, AZ. **Right:** Kingman Quad Map (Ferguson 1980) with sample locations at Coyote Pass (CP) and Cook Canyon (CC) highlighted. The locations of samples from previous studies are not shown. *TCC (light purple) = CCT; PSx (greens) = PST*

Methods

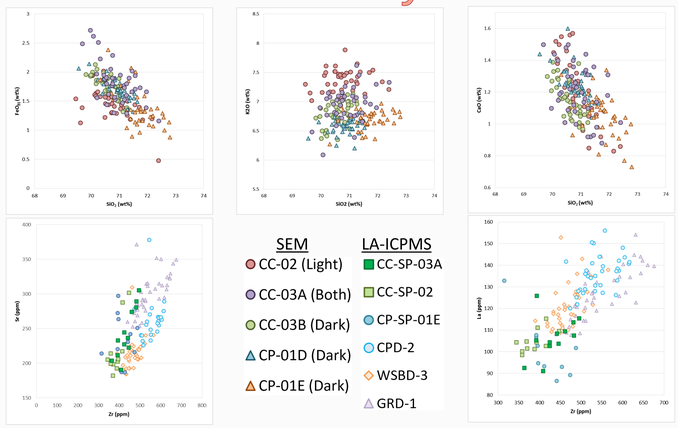
• **Field**: Samples were collected in-situ from Cook Canyon and Coyote Pass near Kingman, AZ.
• **SEM with EDS**: Glass, plag, biotite, and accessory mineral compositions were determined in pumice samples.
• **XRF**: Major and minor element compositions were determined (in bulk rock pumice samples).
• **LA-ICPMS**: Trace elements in glass were determined.
• **Petrology**: Thin sections were examined, specifically for any notable textures.
• **MELTs Modeling**: SEM data was plugged into Rhyolite-MELTS to determine possible pre-eruption temperatures
• **Saturation Thermometry**: Bulk rock and glass zircon data was used to determine possible pre-eruption temperatures (method by Boehnke et al. 2013)

Bulk Rock Geochemistry



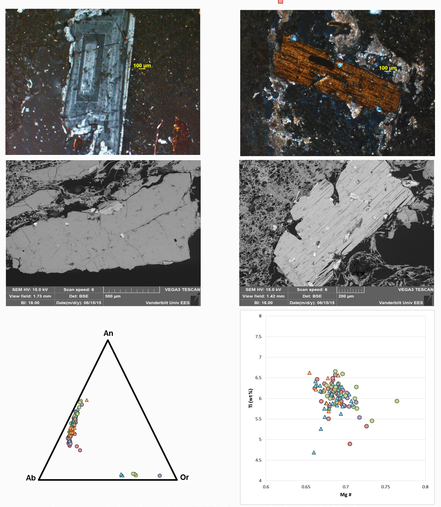
XRF data for (**top**) major and (**bottom**) minor elements. Series represent different sample locations. Data from previous studies is shown as faded points [1]. The data indicates heterogeneity in elemental composition between samples, but SiO_2 is relatively consistent. Outliers due to suspected alteration are not shown.

Glass Analyses



(**Top**) SEM data and (**bottom**) LA-ICPMS data on glass within pumice samples. Data collected in previous studies is shown as faded points [2]. Ca, Fe, and LA-ICPMS results indicate heterogeneity on a sample-level and SEM results suggest no geochemical difference between light- and dark-colored pumices. K is shown since it has distinctively high values.

Mineral Compositions

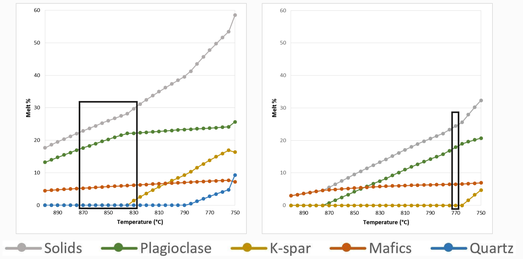


Photos taken with (**top**) SEM and (**middle**) a petrographic microscope of plagioclase and biotite (left and right, respectively). Zoning was visible in several plag grains under the microscope but not in SEM imagery. **Bottom** is compositional data. Plag composition is varied and there are a few sanidine; biotite is tightly clustered.

Temperature Modeling

Zircon (Bulk Rx)	
Sample	T,°C
CC-SP-02	740
CC-SP-03A	863
CC-SP-03B	840
CC-CS-01	858
CC-CS-02	834
52107-9	837
52107-7	830
52107-8	839
52107-10	853
52107-11	867
WSE-3A	833
WSE-4	790
WSBD-3	818
WSBD-9	834
CPD-SR-3	889
Average	**835**

Zircon (Glass)	
Sample	T,°C
CC-SP-02	816
CC-SP-03A	845
Average:	**831**



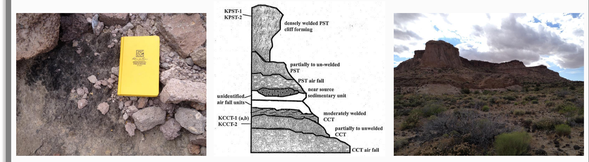
Left: Zircon saturation thermometry using method from Boehnke et al. 2013 [3]. Temperatures are estimated using bulk rock compositions (roughly approximating melt) and glass analyses (melt compositions, but because glasses are heterogeneous, these estimates are also approximate). Best estimate of T: ~830°C (CC-SP–02 is a clear outlier; anomalously low Al and high Ca results in high M value which may reflect alteration). **Top**: Rhyolite-MELTs modeling (Gualda et al. 2012) for CC-SP-03A, a trachytic rock, at 2 wt% and 4 wt% H_2O (left and right, respectively), 200MPa, oxygen fugacity NNO. Model assumes equilibrium conditions. T is estimated by comparing model proportions of melt and phenocrysts to those in CCT (see legend) and finding the T that best represents these proportions. Boxes indicate which temperatures are most likely (830-870°C at 2 wt% H_2O, 770 at 4 wt%).

Discussion

• The mineral assemblages and glass compositions in pumice are strong indicators of magma composition shortly before eruption. The variable but coherent intrasample major and trace element compositions of CCT pumice glass suggests incomplete magma mixing.
• Zircon saturation thermometry and MELTS modeling suggest relatively high T (~830°C). MELTs assumes equilibrium conditions, which may not have been achieved due to heterogeneous glass compositions (though the model still provides useful constraints).
• Plagioclase compositions were highly variable, but biotite was tightly clustered at a high Mg # and very high Ti compared with typical igneous biotite.

Conclusions

• Variable intrasample glass compositions indicate incomplete magma mixing.
• Temperature modeling constrains the CCT's pre-eruption temperature between 820-850°C.
• Sanidine crystals, which were not previously confirmed in CCT, are shown to exist.
• No geochemical difference between light and dark pumice.



Left: Picture of large, mutli-colored pumice at Cook Canyon [4]. **Right**: CCT outcrop at Coyote Pass [4]. **Center**: The relative stratigraphy of CCT and PST near Kingman, AZ (Gaudio 2003).

Acknowledgements

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References

1) WSB, WSE, and GV data from previous studies by Daniel Pratt (WSB, WSE) and R. Varga (GV).
2) Collected by Pratt.
3) Samples from previous studies by Varga (52107-) and Pratt (WSE, WSBD, CPD).
4) Photos by Briana Vidal.