

Plagioclase Ferrous/Ferric Correlation with Magma Oxygen Fugacity in a Volcanic Succession

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Beamline(s): X26A

$\text{Fe}^{3+}/\Sigma\text{Fe}$ was measured in plagioclase phenocrysts and groundmass from the uppermost two units of a ~24 Ma middle Tertiary volcanic succession in the Atascosa Mountains of south-central Arizona. Correlation of the oxidation state of iron in plagioclase and parent magma oxygen fugacity and mineral composition were explored. The Synchrotron microXANES (SmX) technique was used to measure % Fe^{3+} in plagioclase at Beamline X26A National Synchrotron Light Source (NSLS), Brookhaven National Lab. Fe absorption spectra were collected from 10 x 15 micron areas on thin sections.

The upper unit, a trachyandesitic lava flow, is a hybrid of more and less silicic magmas. Honeycomb-textured plagioclase phenocrysts, which crystallized in the lower-Si magma, show zoning of $\text{Fe}^{3+}/\Sigma\text{Fe}$ from 77% in the core to 100% in the rims. Some dusty plagioclase phenocrysts, which crystallized in the higher-Si magma, show total FeO varying from 0.11-0.59 wt%, but are unzoned in $\text{Fe}^{3+}/\Sigma\text{Fe}$ (82% +/- 5). $\text{Fe}^{3+}/\Sigma\text{Fe}$ variation may therefore reflect variation in magmatic oxygen fugacity. Large phenocrysts that formed after the hybridization event have 10um oscillatory Ca/Na zoning, and $\text{Fe}^{3+}/\Sigma\text{Fe}$ varies from 63-87% from core to rim. Latest stage groundmass plagioclase laths have lower $\text{Fe}^{3+}/\Sigma\text{Fe}$ (56-58%). Magmatic oxygen fugacity appears to have decreased as the lava evolved.

Phenocrysts in the underlying ignimbrite are unzoned in Ca/Na and total FeO%. Two phenocrysts show oscillatory zoning between 60% and 80% $\text{Fe}^{3+}/\Sigma\text{Fe}$, implying that oxygen content in the magma oscillated and that Fe^{3+} variations are not removed by diffusion. Two melt inclusions in one crystal have 75% $\text{Fe}^{3+}/\Sigma\text{Fe}$, lower Fe^{3+} than the matrix glass (86-100%), implying that oxygen fugacity increased as the magma evolved.

Magmatic oxygen fugacity effects can be detected in spite of possible crystal chemical complexities. Measurement of $\text{Fe}^{3+}/\Sigma\text{Fe}$ in plagioclase appears to monitor otherwise undetectable changes of oxygen fugacity of the magma in which they grew.

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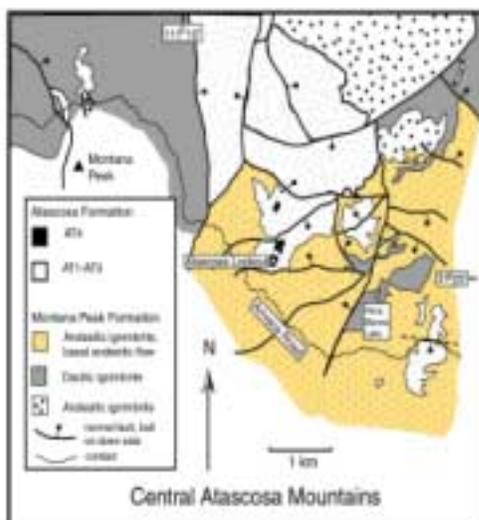


Figure 0: Map showing location of the Atascosa Mountains (from Seaman, 2000).