The mantle and basalt-crust interaction below the Mount Taylor Volcanic Field, New Mexico

Christian M. Schrader, Larry Crumpler, and Mariek E. Schmidt

The Mount Taylor Volcanic Field (MTVF) lies on the Jemez Lineament on the southeastern margin of the Colorado Plateau. The field is centered on the Mt. Taylor composite volcano and includes Mesa Chivato to the NE and Grants Ridge to the WSW. MTVF magmatism spans ~3.8-1.5 Ma (K-Ar, Perry et al., 1990). Magmas are dominantly alkaline with mafic compositions ranging from basanite to hy-basalt and felsic compositions ranging from ne-trachyte to rhyolite. We are investigating the state of the mantle and the spatial and temporal variation in basalt-crustal interaction below the MTVF by examining mantle xenoliths and basalts in the context of new mapping and future Ar-Ar dating.

The earliest dated magmatism in the field is a basanite flow south of Mt. Taylor (Perry et al., 1990). Mantle xenolith-bearing alkali basalts and basanites occur on Mesa Chivato (Crumpler, 1980) and in the region of Mt. Taylor, though most basalts are peripheral to the main cone. Xenolith-bearing magmatism persists at least into the early stages of cone-building. Preliminary examination of the mantle xenolith suite suggests it is dominantly lherzolitic but contains likely examples of both melt-depleted (harzburgitic) and melt-enriched (clinopyroxenitic) mantle.

There are aphyric and crystal-poor hawaiites, some of which are hy-normative (Perry et al., 1990), on and near Mt. Taylor, but many of the more evolved MTVF basalts show evidence of complex histories. Mt. Taylor basalts higher in the cone-building sequence contain >40% zoned plagioclase pheno- and megacrysts. Other basalts peripheral to Mt. Taylor and at Grants Ridge contain clinopyroxene and plagioclase megacrysts and cumulate-textured xenoliths, suggesting they interacted with lower crustal cumulates.

Among the questions we are addressing: What was the chemical and thermal state of the mantle recorded by the basaltic suites and xenoliths and how did it change with time? Are multiple parental basalts (Si-saturated vs. undersaturated) represented and, if so, what changes in the mantle or in the tectonic regime allowed their coexistence or caused the transition?

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Introduction

The Mount Taylor Volcanic Field (MTVF) lies on the Jemez Lineament on the southeastern margin of the Colorado Plateau. The field is centered on the Mount Taylor (MT) composite volcano and includes Grants Ridge to the WSW, Mesa Chivato (MC) and the Rio Puerco (RP) volcanic necks to the NE. MTVF magmatism spans ~3.8-1.5 Ma (K-Ar, Perry et al., 1990). Mafic magmas are variably alkaline with compositions ranging from basanite to hy-basalt. We are investigating the state of the mantle and the spatial and temporal variation in basalt-crustal interaction below the MTVF by examining mantle xenoliths and basalts in the context of new mapping and geochemical analysis.

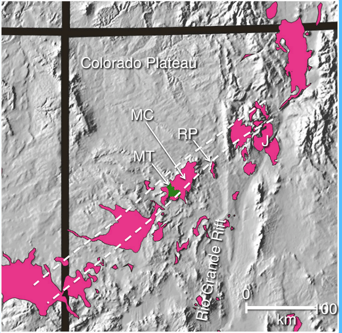
The earliest dated MTVF magmatism is a basanite flow south of Mt. Taylor (Perry et al., 1990). Mantle xenolith-bearing alkali basalts and basanites occur on Mesa Chivato (Crumpler, 1980) and in the region of Mt. Taylor. Xenolith-bearing magmatism persisted at least into the early stages of cone-building. The MT xenoliths are spinel lherzolites, clinopyroxene-rich websterites, wherlites, and rare dunites. Some xenoliths show metasomatic reactions of olivine to clinopyroxene or, more rarely, to orthopyroxene + clinopyroxene.

In addition to xenolith-bearing flows, there are aphyric and crystal-poor hawaiites on and near Mt. Taylor, and more evolved basalts that show evidence of complex histories, such as zoned plagioclase and clinopyroxene pheno- and megacrysts.

Among the questions we are addressing:

•What was the chemical and thermal state of the mantle recorded by the basaltic suites and xenoliths and how did it change with time and space?

•Are multiple parental basalts (Si-saturated vs. undersaturated) represented and, if so, what changes in the mantle or in the tectonic regime allowed their coexistence or caused the transition?

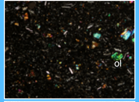


Regional map: The MTVF includes Mount Taylor volcano (MT), Mesa Chivato (MC), and the Rio Puerco volcanic necks (RP). Also shown are the Jemez Lineament (dashed lines) and Jemez Volcanic Field (J).

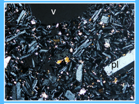
Basalts

- **Mantle melts:** Xenolith-bearing aphyric to crystal-poor basanites and alkali basalts (MT, MC, and RP)
- **Moderately differentiated basalts:** Ne- and Hy-normative crystal-poor alkali basalts and hawaiites (MT and MC)
- **Basalts with textural evidence of crustal residence:** Hy- and Q-normative basalts with plagioclase ± clinopyroxene megacrysts (MT and late at MC)

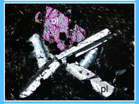
MT-7: aphyric, xenolithic-bearing basanite



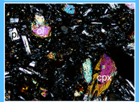
MT-12: crystal-poor hawaiite



MT-17: plagioclase basalt with glomerocrysts

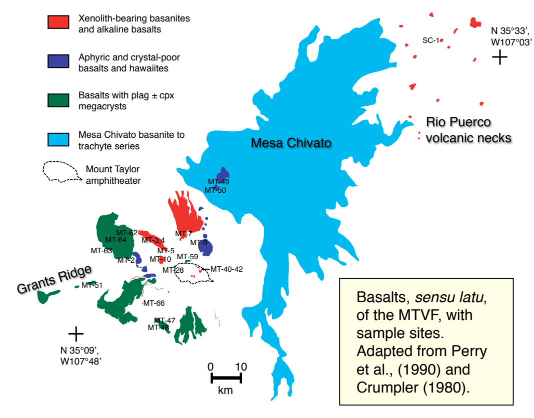


MT-66: clinopyroxene-plagioclase basalt



Above: Bisected volcanic neck on Grants Ridge.

Right: Thin section photos of MTVF basalts. All XPL, field of view = ~1200 µm across. Abbreviations: cpx = clinopyroxene; ol = olivine; pl = plagioclase; v = vesicle.



Basalts, *sensu latu*, of the MTVF, with sample sites. Adapted from Perry et al., (1990) and Crumpler (1980).

Xenoliths

We sampled xenoliths from Mount Taylor flows and from the Santa Clara volcanic neck in the Rio Puerco volcanic field.

Mount Taylor

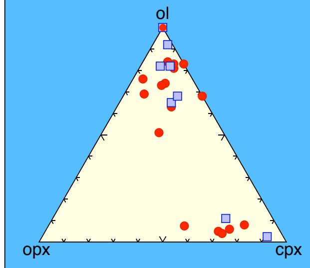
Spinel lherzolites have variably strained and granoblastic textures, often in the same sample. Some lherzolites contain rounded olivine grains, often optically continuous, in a matrix of clinopyroxene. This texture is also common in **wherlites** (see slide scan, below) and in **websterites.**

Websterites also show intergrown clino- and orthopyroxene and one **lherzolite** contains orthopyroxene replacing olivine.

Rio Puerco (Santa Clara)

The RP xenoliths span the same lithologies and show textures similar to the Mount Taylor samples. The differences are that spinel/opaques in some RP xenoliths show textures possibly representing depressurization reactions from garnet.

Some MT and RP xenoliths contain clinopyroxene replacing olivine. Previous studies of RP xenoliths (Porreca et al., 2006) found primary carbonate, which contributed to their model of reaction of lherzolite with a Ca-rich melt with low *a*(SiO_2) (i.e., some carbonatitic component). It is not clear if CO_2- or other volatile-rich melts played a role in the mantle below MT.

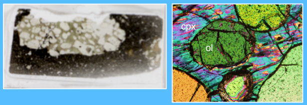


Modal compositions of Mount Taylor (●) and Rio Puerco (▢) mantle xenoliths.

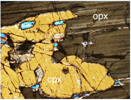
Above: Lherzolite xenolith in alkali basalt.

Right: Thin section scans and photos of xenoliths. Field of view = ~1200 µm across. Mineral abbreviations: cpx = clinopyroxene; ol = olivine; opx = orthopyroxene; sp = spinel.

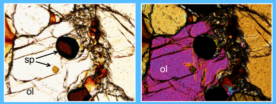
MT-42: rounded olivine in clinopyroxene matrix in wherlite (scanned section and XPL)



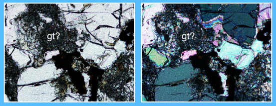
MT-3: intergrown clino- and orthopyroxene in websterite (XPL)



MT-11: intact spinel and rimmed spinel in lherzolite (PPL and XPL)



SC-1b (Rio Peurco): possible garnet replacement by pyroxene + spinel in lherzolite (PPL and XPL)



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References: Crumpler, L.S., 1980, *GSA Bull.*, 91:5, p.1293-1331; Perry, F.V., et al., 1990, *JGR*, 95:B12, p. 19327-19348; Porreca, C., et al., 2006, *Geosph.*, 2:7, p. 333-351.