Distal Exposures of the Miocene Peach Spring Tuff in the Marble and Ship Mountains, CA

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ABSTRACT

The Peach Springs Tuff (PST) is a uniquely identifiable ignimbrite deposit formed by a large caldera-forming volcanic eruption during the early Miocene era. Previous investigations (e.g., Miller et al., 1986; Neilson et al., 1990) have suggested that distal ignimbrite deposits located within the Mojave region of southern California belong to the PST eruptive event. To address this hypothesis, this study investigates ignimbrite samples collected from outcrops within the Marble Mountains (n = 6) and Ship Mountains (n = 8) of southern California. Petrographic analysis reveals the abundance of quartz, sanidine, titanite, hornblende, and biotite in most ignimbrite samples. These mineral phases agree well with previous heavy mineral studies of the PST (Gusa, 1986). Electron Probe Micro-Analysis (EPMA) reveals average biotite, hornblende, and sanidine compositions that closely match PST values. Our data suggests that the ignimbrite deposits in the Marble and Ship mountains are distal exposures of the PST.

METHODS

Fourteen samples were collected from outcrops located within the Marble (n = 6) and Ship Mountains (n = 8) of Southern California (Fig. 2). Thin sections of samples KB022-6WR, KB022-8WR, KB022-11WR, KB022-12WR, KB022-16WR, and KB022-17WR were examined using a standard polarizing microscope in plain polarized light (PPL) and cross polarized light (XPL) to determine the modal mineralogy. Two samples were selected for detailed analyses: KB022-8WR and KB022-12WR (Fig. 5). Mineral phases from these samples were analyzed by Electron Probe Micro-Analysis (EPMA) at Louisiana State University, using a JOEL JXA-8230 EPMA (Fig. 7).

Petrographic Methods


Fig. 4: Outcrop

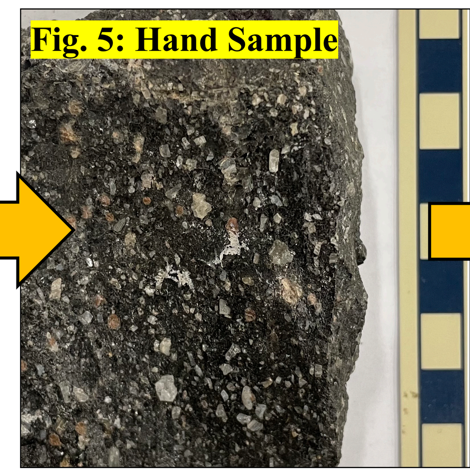
Fig. 5: Hand Sample

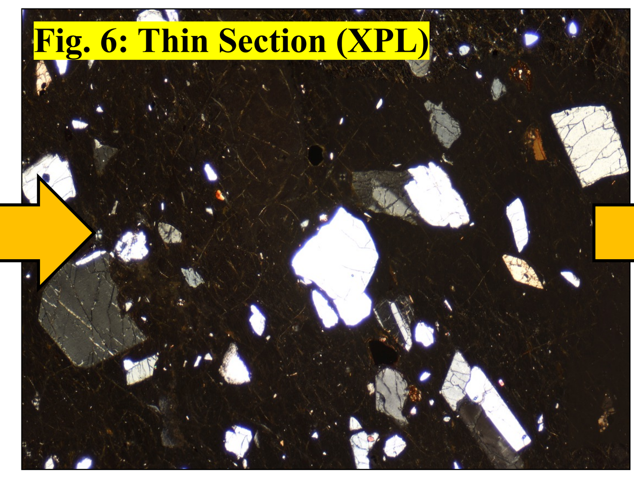
Fig. 6: Thin Section (XPL)

Geochemical Methods

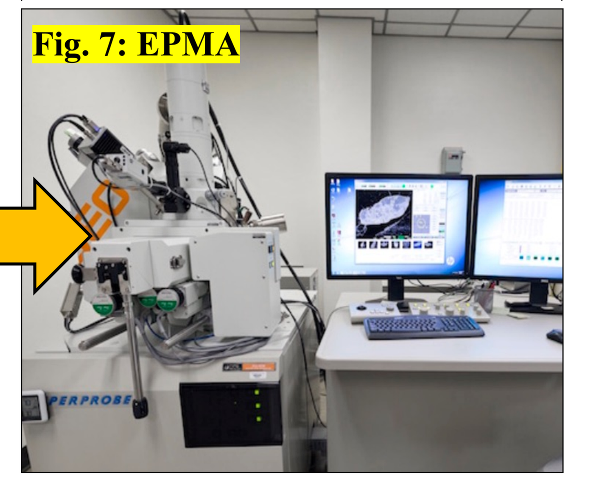
Fig. 7: EPMA

Macro- Scale → Micro- Scale

INTRODUCTION

Eruption of the Silver Creek caldera (west of Kingman, Arizona) 19 million years ago produced the laterally extensive PST. Its pyroclastic flows consolidated pumice fragments and volcanic material, forming distal exposures of Miocene ignimbrites across Arizona and the Mojave region of California (Fig. 1).

Miller et al. (1986) first identified the strong correlation between the PST and the ignimbrites of the central Mojave Desert. Relatively few studies, however, have examined the distal deposits in detail, resulting in only a tenuous connection to the PST.

This project will be characterized a suite of 16 ignimbrite samples collected from outcrops in the Marble and Ship Mountains of Southern California to evaluate this hypothesis. This project aims to characterize the mineralogy and textural features of these rocks to reconfirm the correlation.

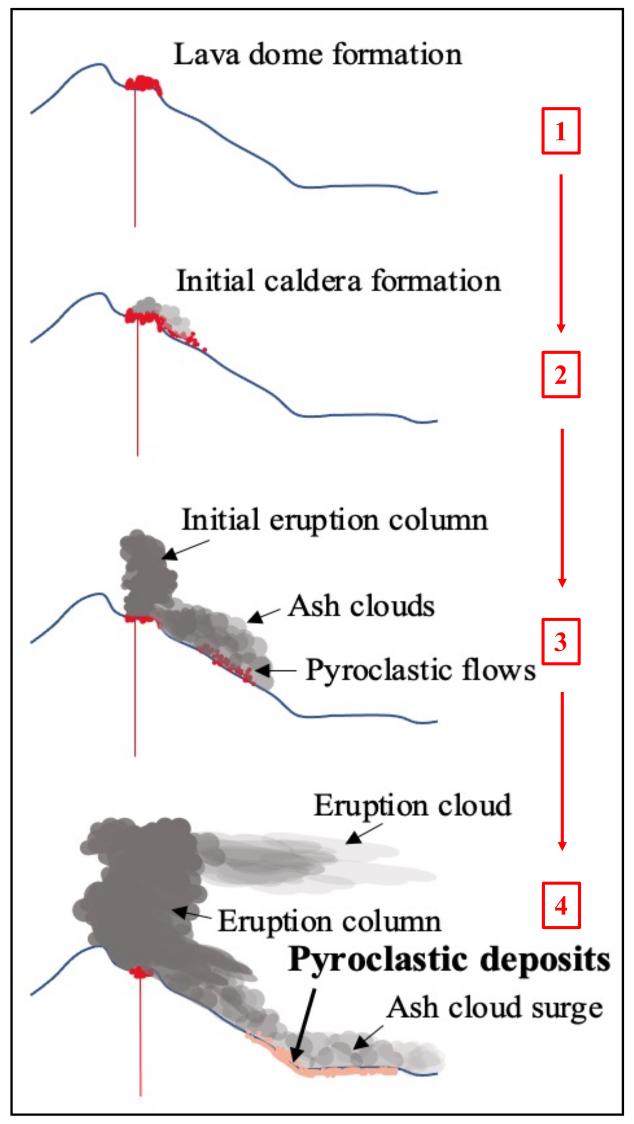

Fig. 1: Sequential formation of ignimbrites – deposits of pyroclastic flow formed from the cooling of pyroclastic ash clouds and material ejected from an explosive volcanic eruption (Carleton College, 2009).

BACKGROUND

This study examines ignimbrite samples from the southern Marble Mountains and the northern Ship Mountains, located within the Mojave region of southern California (Fig. 2). Ignimbrite exposures found within these mountains are hypothesized to be distal deposits of the Peach Spring Tuff (Miller et al., 1986).

Although few studies have examined these exposures in detail, previous work suggests a tentative correlation (e.g., Roche et al., 2016; Ferguson et al., 2013; Nielson, 1990, Glazner, 1989). These studies have shown that phenocryst compositions, e.g., sanidine, plagioclase, biotite, and hornblende, (Glazner et al., 1986) and heavy mineral populations (Gusa, 1986) can be successfully used to correlate distal ignimbrite exposures to the Peach Spring Tuff.

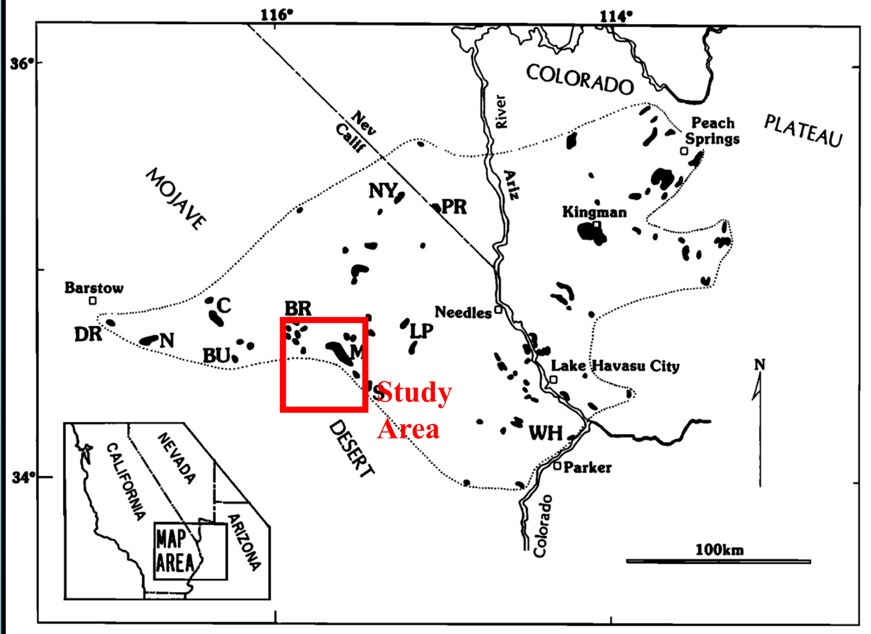

Fig. 2: Lateral extent of the PST (Nielson et al., 1990).

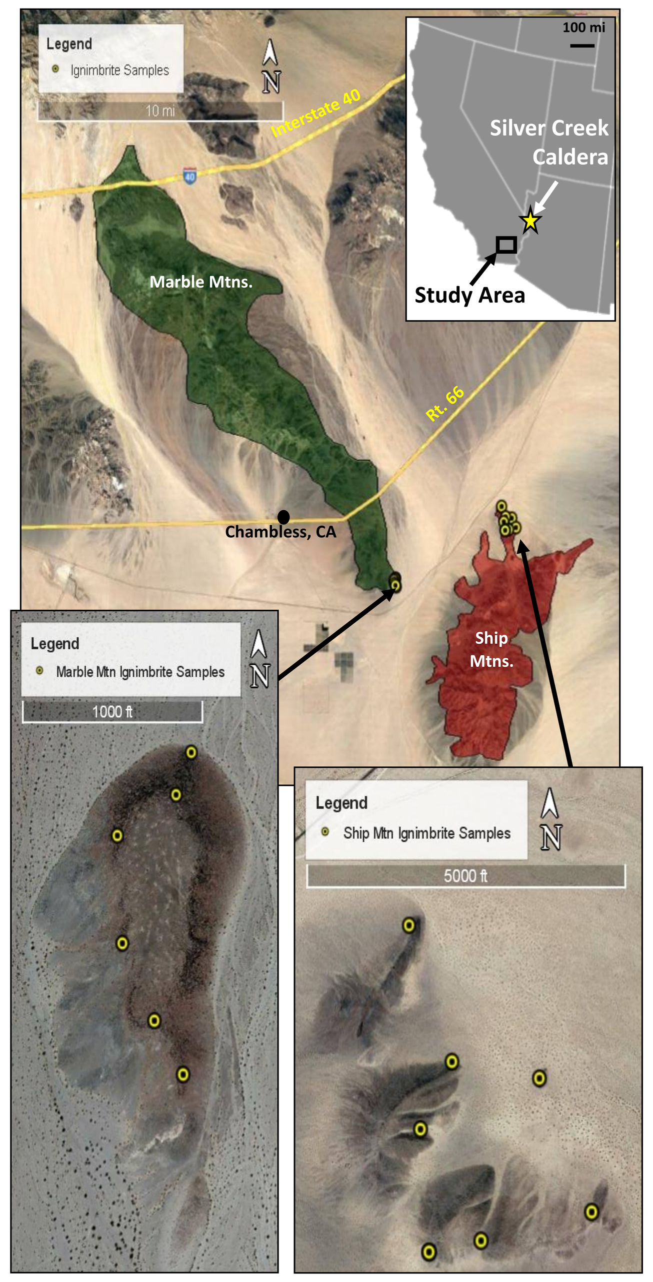

Fig. 3: Annotated aerial photograph maps showing the sampling locations of the Marble and Ship Mountains and the distribution of ignimbrite samples collected.

PETROGRAPHIC RESULTS

Sample	Quartz	Sanidine	Titanite	Hornblende
KB022-6WR	✓	✓		✓
KB022-8WR	✓	✓	✓	✓
KB022-11WR	✓	✓		
KB022-12WR	✓	✓	✓	✓
KB022-16WR	✓	✓		✓
KB022-17WR	✓	✓	✓	✓

Table 1: Common minerals phases identified through petrographic analysis. The recurring presence of heavy minerals like Hornblende and Titanite (or Sphene) in the collected samples provide evidence for a correlation to the Peach Spring Tuff petrography.

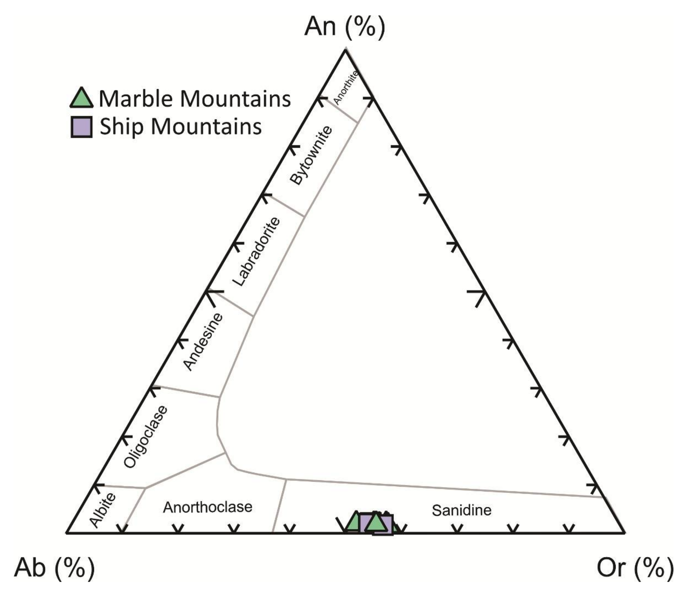

Fig. 11: EPMA results of the alkali feldspar phenocrysts yielded Sanidine for MM and SM samples, unique to the Peach Springs Tuff.

GEOCHEMICAL RESULTS

Table 2: Comparison of Biotite Compositions

	CM	CR	PST	MM	SM
SiO_2	38	38.6	39.1	38.2	38.2
Al_2O_3	12.6	12.7	12.8	12.9	13.1
FeO	14	14.9	14.3	15.3	14.4
MnO	0.6	0.6	0.6	0.5	0.6
MgO	16	16.2	16.7	15.1	15.6
CaO	-	-	-	-	-
Na_2O	0.6	0.6	0.6	0.6	0.6
K_2O	9.2	9.7	9.6	9.2	9.2
n	9	2	1	2	2

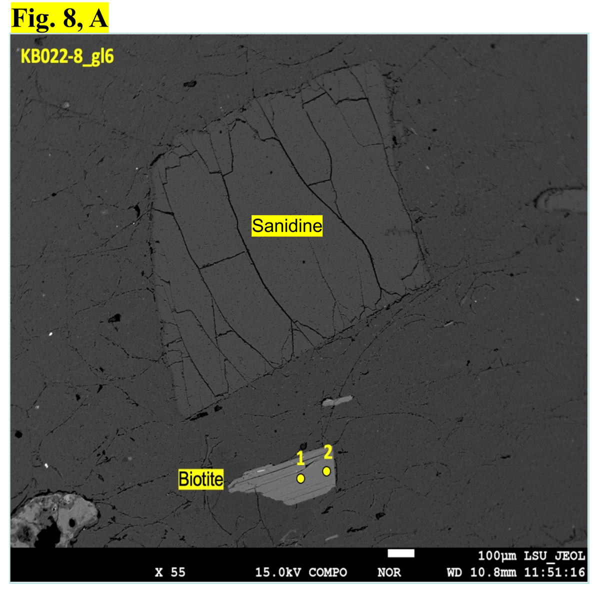
Fig. 8, A

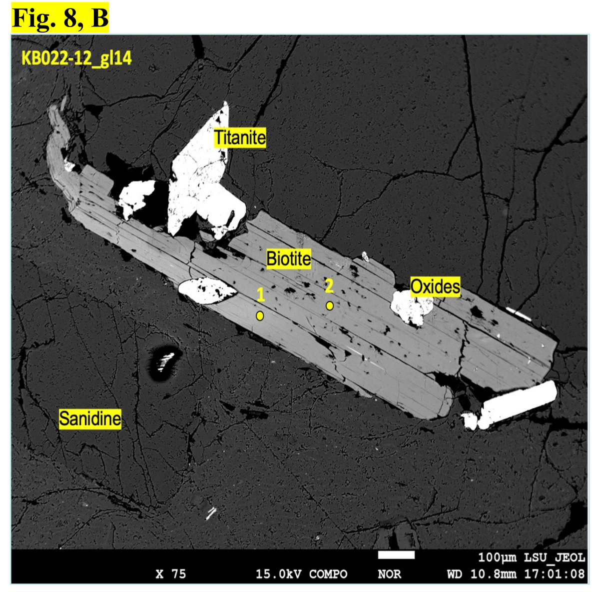
Fig. 8, B

Table 3: Comparison of Hornblende Compositions

	CM	CR	PST	MM	SM
SiO_2	47.4	46.7	47.4	47.2	47.0
Al_2O_3	6.5	7.0	6.9	6.5	6.7
FeO	12.7	13.0	13.1	13.3	13.3
MnO	1.1	1.0	1.1	1.2	1.1
MgO	14.9	14.7	15.0	14.4	14.4
CaO	10.9	10.8	11.3	10.9	10.9
Na_2O	2.2	2.2	2.2	2.1	2.1
K_2O	0.9	1.0	1.0	0.9	0.9
n	3	3	2	2	2

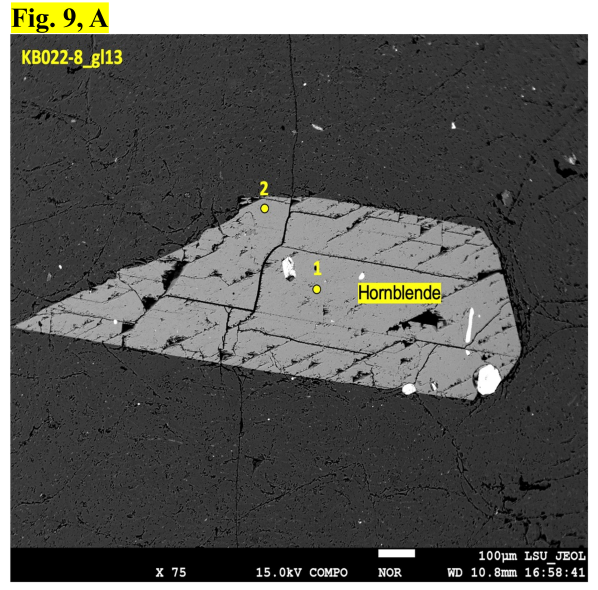
Fig. 9, A

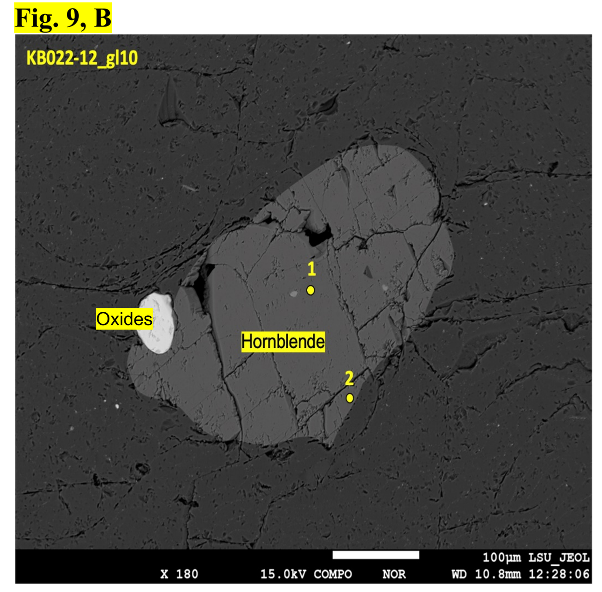
Fig. 9, B

Table 4: Comparison of Sanidine Compositions

	CM	CR	PST	MM	SM
SiO_2	65.7	65.4	65.4	65.8	65.7
Al_2O_3	18.8	18.9	18.5	18.7	18.7
FeO	-	-	-	0.2	0.2
MnO	-	-	-	-	-
MgO	-	-	-	-	-
CaO	0.4	0.5	0.4	0.4	0.4
Na_2O	5.3	5.1	5.1	4.9	5.0
K_2O	9.2	9.0	9.4	9.4	9.4
n	19	11	4	6	4

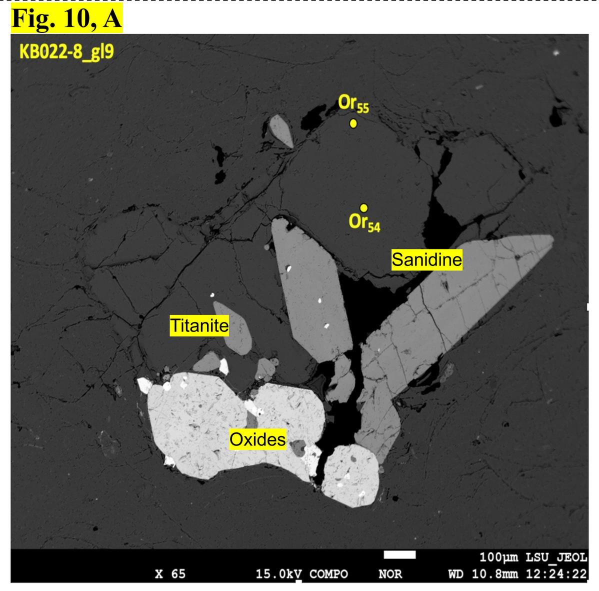
Fig. 10, A

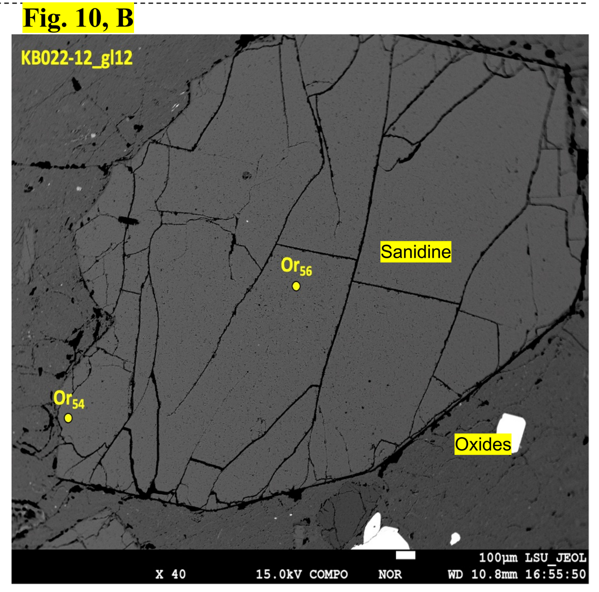
Fig. 10, B

Note: CM = Central Mojave; CR = Colorado River; PS = Peach Springs Tuff; MM = Marble Mountain (this study); SM = Ship Mountain (this study); n = number of point analyses. These are average analyses of n samples. CM, CR, and PST analyses by A. F. Glazner at UCLA, January 1985; MM and SM analyses conducted by M. Loocke at LSU, April 2022.

Fig. 8 (A, B): Backscatter images of biotite (A – Marble Mtn.; B – Ship Mtn.)

Fig. 9 (A, B): Backscatter images of Hornblende (A – Marble Mtn.; B – Ship Mtn.)

Fig. 10 (A, B): Backscatter images of Sanidine (A – Marble Mtn.; B – Ship Mtn.)

CONCLUSION & FUTURE WORK

The presence of heavy minerals such as titanite and hornblende in the Marble and Ship Mountains ignimbrite samples (Table 1) are consistent with PST samples described by Gusa (1986). Sanidine phenocrysts also exhibit a blue iridescence, which is a key feature of PST outcrops described by Glazner et al. (1986). Average sanidine (Table 4, Figs. 10 & 11), biotite (Table 2, Fig. 8), and hornblende compositions (Table 3, Fig. 9) within our samples closely match the average compositions found in other PST locations within the Mojave region, validating our hypothesis.

Because the pyroclastic deposits are so widely distributed, accounting for crustal extensions and paleomagnetic rotations (Glazner, 1989; Wells, 1989), analyzing a greater diversity of samples with more EPMA point analyses can determine compositional variations with greater accuracy.

ACKNOWLEDGEMENTS & REFERENCES

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