

# Dacite Petrogenesis at Middle Sister in the Klah Klahnee/Three Sisters Volcanic Complex (TSVC), Central Oregon

<sup>1</sup>Alex E. Newsom and <sup>1</sup>May (Mai) Sas

<sup>1</sup>Geology Department, Western Washington University, \*newsoma3@wwu.edu

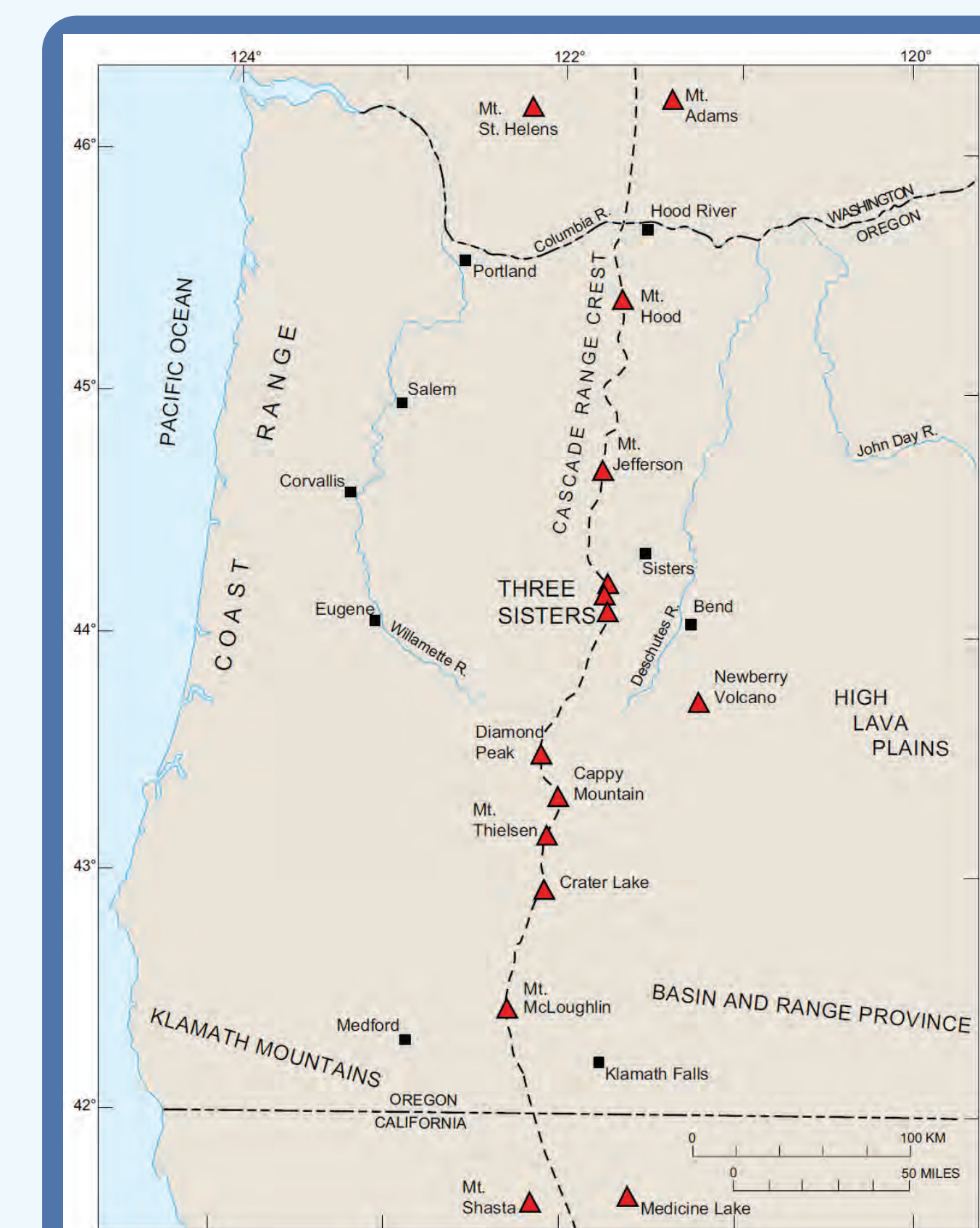


Fig. 1: Map focused on western Oregon with sections of Washington to the north and California to the south (US) taken from Calvert and others (2018). The top of the figure represents north.

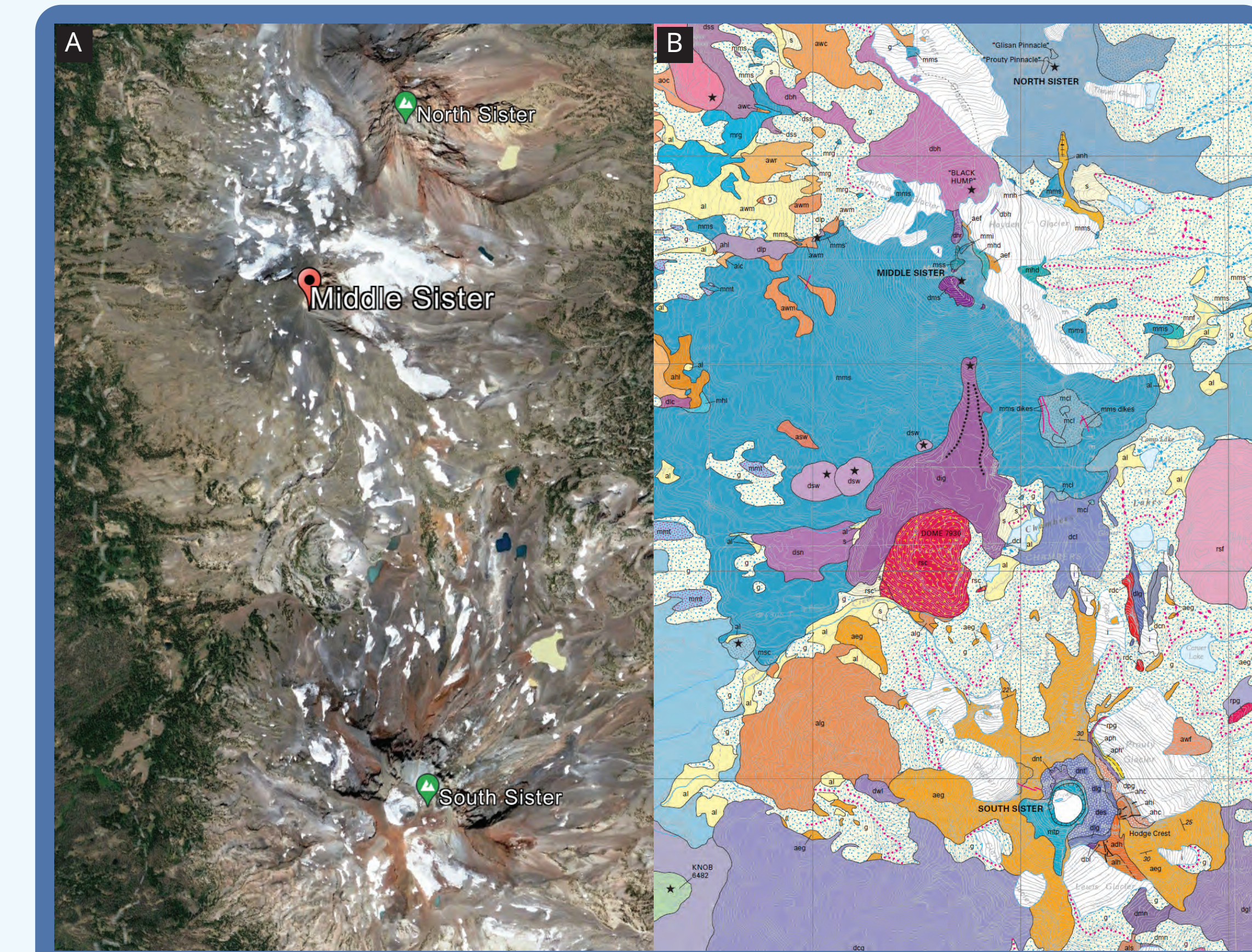


Fig. 2: (A) Aerial image of the Three Sisters taken from Google Earth; (B) geologic map of the TSVC taken from Hildreth and others (2012).

## 4. Middle Sister Eruptive History

**Pre-50 ka:** basaltic andesites from Middle Sister or a predecessor volcano

**48-37 ka:** basaltic-andesites, andesites, one known dacite, and one known rhyolite

**37-25 ka:** lull in Middle Sister volcanic activity while South Sister had a concentrated eruptive pulse

**25-14 ka:** concentrated eruptive pulse at Middle Sister began with andesites, then shifted to bimodalism of basaltic-andesites and dacites, while South Sister activity rapidly declined and ceased

## Acknowledgements

The TSVC is located on land historically tied to those of the Confederated Tribes of Warm Springs, including the Klamath and Molalla peoples. Research is possible through funding provided by Western Washington University. I will continue to apply for further funding.

## 1. Objectives

Using three intermediate-composition lavas erupted from Middle Sister, this research aims to better understand magmatic processes and origins in this recently active volcanic system. Data obtained from whole rock and mineral geochemistry as well as crystal textures will be utilized to decipher magma sources, crystallization conditions, and changes occurring in this system over time, offering improved inferences regarding future hazards at this volcano.

## 2. Research Questions

- Is dacite petrogenesis consistent or varied throughout the eruptive history of Middle Sister?
- What are the pressure and temperature storage conditions of Middle Sister dacites?
- Could recent uplift at the TSVC be associated with dacite generation and/or dacite storage?
- What is influencing the compositional shift at Middle Sister to strictly dacites and basaltic andesites?
- Is there evidence for connectivity between Middle Sister and South Sister?

## 3. Geologic Settings

The TSVC is influenced by various overlapping geologic provinces; these include the compositionally diverse Cascades continental volcanic arc that is driven by subduction of the Juan de Fuca plate, the extensional Basin and Range Province, and the compositionally bimodal High Lava Plains (Lawrence, 1976; Jordan et al., 2004; Hildreth, 2007). Like nearby volcanic centers (e.g., Tumalo and Newberry), the TSVC has a primarily mafic periphery surrounding the silicic centers of Middle and South Sister (Hildreth, 2007).

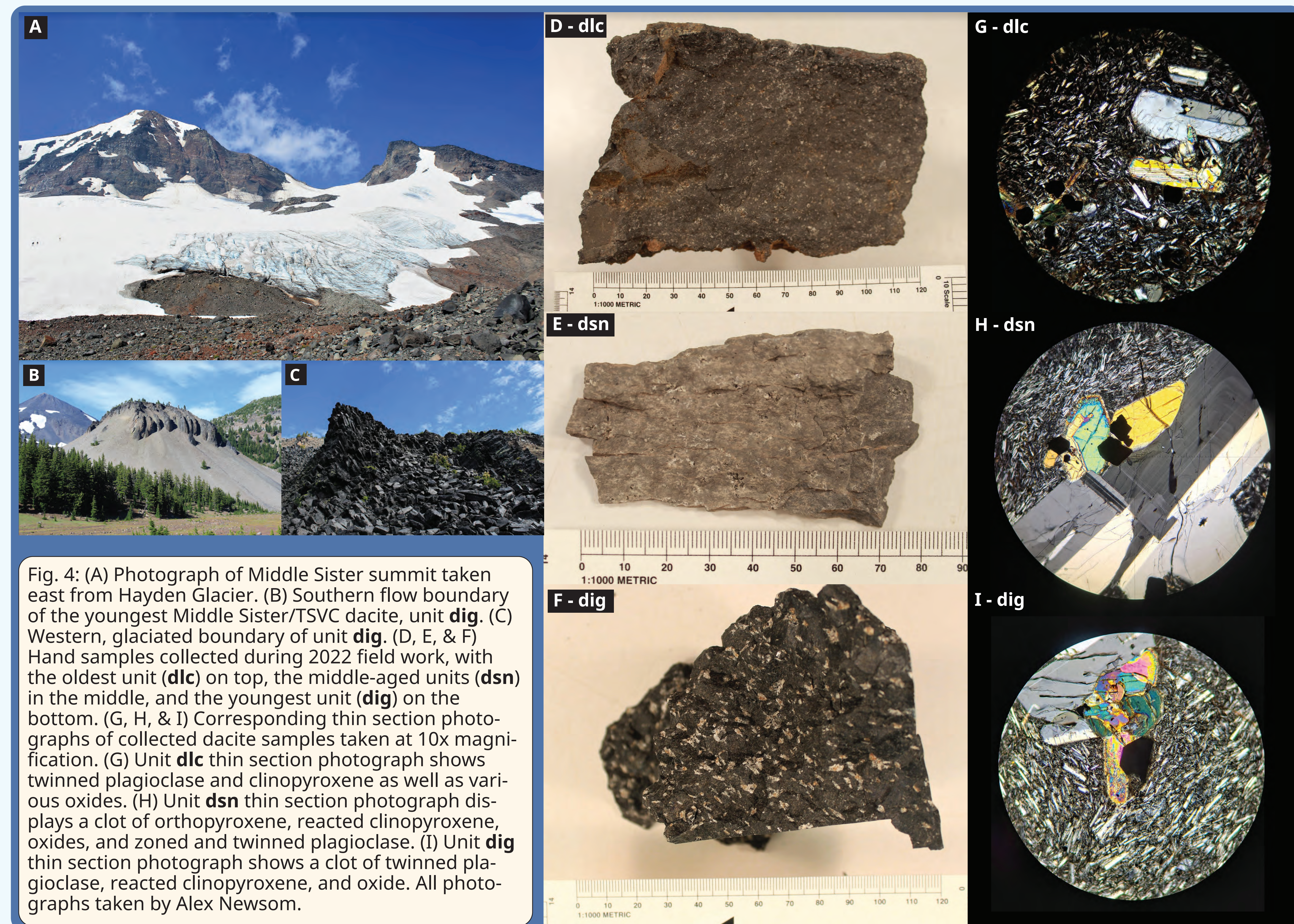


Fig. 4: (A) Photograph of Middle Sister summit taken east from Hayden Glacier. (B) Southern flow boundary of the youngest Middle Sister/TSVC dacite, unit **dig**. (C) Western, glaciated boundary of unit **dig**. (D, E, & F) Hand samples collected during 2022 field work, with the oldest unit (**dlc**) on top, the middle-aged units (**dsn**) in the middle, and the youngest unit (**dig**) on the bottom. (G, H, & I) Corresponding thin section photographs of collected dacite samples taken at 10x magnification. (G) Unit **dlc** thin section photograph shows twinned plagioclase and clinopyroxene as well as various oxides. (H) Unit **dsn** thin section photograph displays a clots of orthopyroxene, reacted clinopyroxene, oxides, and zoned and twinned plagioclase. (I) Unit **dig** thin section photograph shows a clots of twinned plagioclase, reacted clinopyroxene, and oxide. All photographs taken by Alex Newsom.

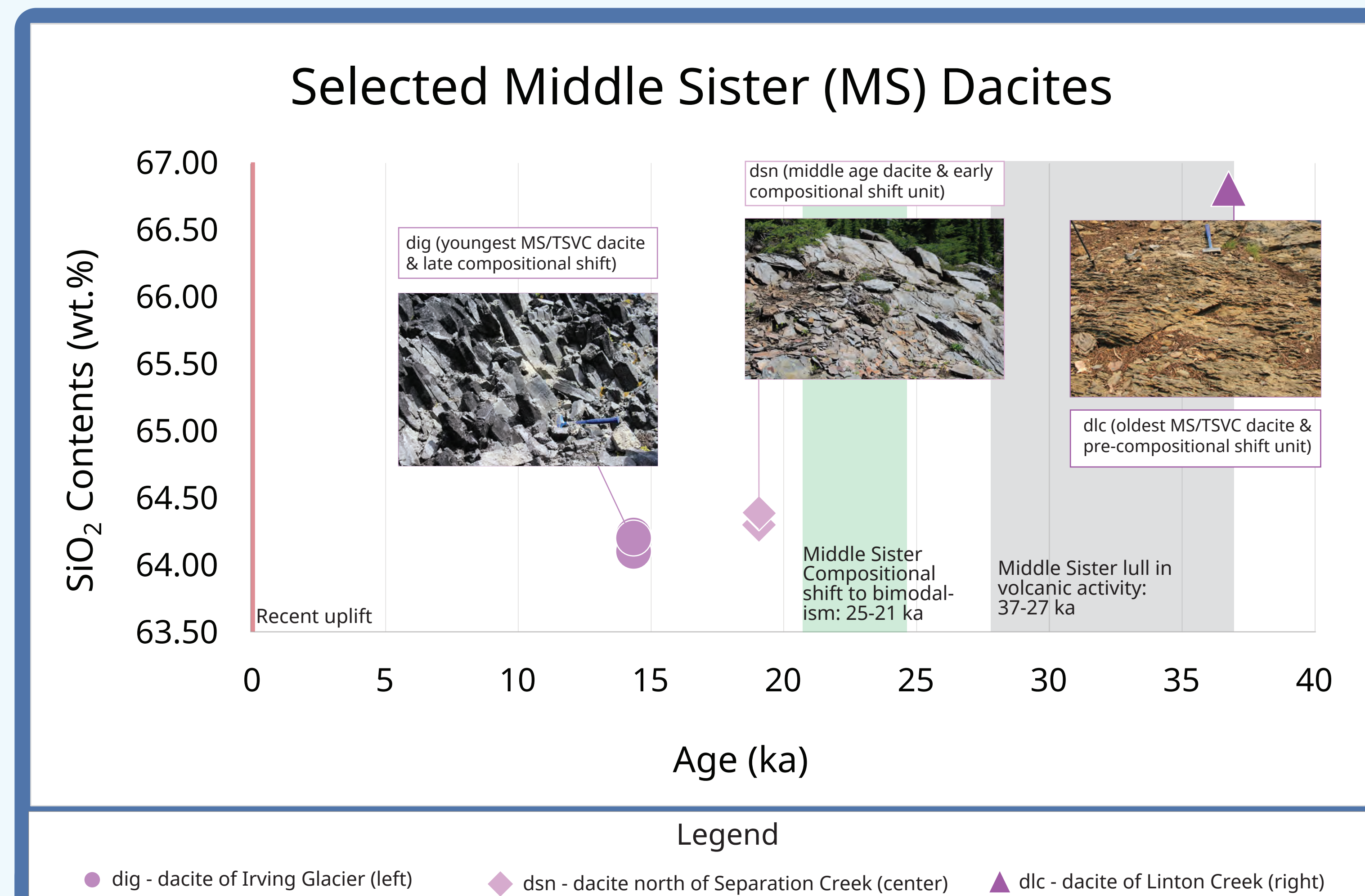


Fig. 3: Graph portraying silica content (wt. %) on the y-axis versus age (ka) along the x-axis for the selected three Middle Sister dacites. Background vertical rectangles portray significant events in the eruptive history of Middle Sister. Data from Hildreth et al., 2012. Outcrop photographs taken by Alex Newsom.

## 5. Methods

**Sampling:** Collected representative samples of three Middle Sister dacites in summer of 2022.

**Petrography and BSE imaging:** Characterizing thin and thick sections for sample description and mineral textures.

**Electron microprobe:** Major element data for determining mineral composition and populations, as well as for thermobarometry.

**LA-ICP-MS:** To determine trace elements and potential magma sources.

## Works Cited

- Calvert, A.T., Fierstein, J., and Hildreth, W., 2018, Eruptive history of Middle Sister, Oregon Cascades, USA—Product of a late Pleistocene eruptive episode. *Geosphere*, v. 14, no. 5, p. 2118–2139, <https://doi.org/10.1130/GES01638.1>.
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- Jordan, B.T., Grunder, A.L., Duncan, R.A., and Deino, A.L., 2004, Geochronology of age-progressive volcanism of the Oregon High Lava Plains—Implications for the plume interpretation of Yellowstone: *Journal of Geophysical Research*, v. 109, B10202, doi:10.1029/2003JB002776.
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## 6. Societal Significance

This research will be one of the first to perform comprehensive geochemical analysis, including trace elements, on minerals found in Middle Sister dacites. These data will contribute to the understanding of magma sources, magmatic transport history, and pre-eruption conditions of the TSVC. Results from this research will help improve geohazard assessment in this area.

## 7. Project Status

Work on this project began in September 2022. Petrography is currently under way; please look for future results.