

Sandra Underwood

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Education

Montana State University, Bozeman, MT 2000–2009
Started Ph.D. program: Fall 2003. Ph.D. Earth Sciences (Geology) August 7, 2009
Focus areas are igneous petrology, geochemistry, volcanology
Dissertation title: Stable Isotope ($^{18}\text{O}/^{16}\text{O}$ and D/H) Studies of Cascade Volcanic Arc Magmatism. Three areas of investigation include:
(1) Hydrogen isotope investigation of amphibole in dacites from 1980–1986 and 2004–2005 eruptions Mount St. Helens, Washington.
(2) Hydrogen isotope investigation of amphibole and biotite phenocrysts in degassed crystal-rich silicic magmas erupted at Lassen Volcanic Center, California.
(3) Oxygen isotope geochemistry of olivine, clinopyroxene, and plagioclase phenocrysts in primitive Quaternary mafic lavas of the southernmost Cascade Range.

University of California, Berkeley, CA 1978–1984
Ph.D. Chemical Engineering May 22, 1987
Dissertation title: Polyelectrolyte adsorption and flow characteristics (aqueous solutions) through porous silica

University of Wyoming, Laramie, WY 1974–1978
B.S. Chemical Engineering with Honor May 21, 1978

Employment

| <i>Period</i> | <i>Employer</i> | <i>Job Title / Brief Job Description</i> |
|---------------------------|---|--|
| Spring 2017 –Fall 2017 | Department of Earth Sciences, Montana State Univ., Bozeman | Non-Tenure Track Professor: Taught Igneous Petrology (GEO450) Spring and Metamorphic Petrology (GEO449) Fall |
| March 2011 to Present | John Childs / Childs Geoscience Inc. 1700 W. Koch Ste 6 Bozeman, MT 59715 (406) 404-1242 | Senior Research Geologist (Part Time): Research and evaluate industrial mineral occurrences for economic potential. Map preparation using GIS programs |

| <i>Period</i> | <i>Employer</i> | <i>Job Title / Brief Job Description</i> |
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| Fall 2003 – Summer 2004; Spring 2005 – Spring 2006 | Department of Earth Sciences, Montana State Univ., Bozeman | Doctoral Research/Research Assistant: Collected samples at Mt. St. Helens. Prepared amphibole, biotite and groundmass separates for D/H ratios and Fe ³⁺ /Fe ²⁺ microanalyses. Performed EMPA for mineral composition and geothermometry. Obtained ¹⁸ O/ ¹⁶ O analyses for olivine, cpx, and plagioclase phenocrysts by laser fluorination. |
| Fall 2004 and Spring 2006 | Department of Earth Sciences, Montana State Univ., Bozeman | Adjunct Assistant Professor: Taught Physical Geology (ESCI 111) Fall 2004, and Igneous Petrology (GEOL 306) as sabbatical replacement for T. Feeley Spring 2006. |
| 1990 – 1998 | Intel Corporation, 4100 Sara Road, Rio Rancho, NM | Sr. Process Integration Engineer, Quality and Reliability Engineer, and Process Engineer for high volume microprocessor manufacturing factories. |
| 1984 – 1990 | Intel Corporation, 2200 Mission College Blvd, Santa Clara, CA | Sr. Process Technology Development Engineer: Plasma etch process development for polysilicon, aluminum alloys and silicon-oxy-nitride thin films, post-etch clean procedural development and ultrapure water systems quality assurance. |
| 1978–1984 | Department of Chemical Engineering, Univ. of Calif., Berkeley, CA | Research Assistant. PhD program. Focus area = aqueous surface chemistry related to fluid flow in porous media. |
| Fall 1978 – Spring 1980 | Department of Chemical Engineering, Univ. of Calif., Berkeley, CA | Teaching Assistant: Chemical engineering intro. classes, and unit operations labs. |
| Summer 1978 | Lawrence Livermore National Laboratory, Livermore, CA | Engineer: Development of computer model describing plutonium recovery from radioactive waste. |
| Summer 1977 | Atlantic Richfield Company, North American Producing Division Research Center, Plano, TX | Engineer: Construction and operation of enhanced oil recovery (polymer flood) model. |

Research Interests

Geochemistry (including stable isotopes of hydrogen and oxygen) of igneous and metamorphic rocks. Igneous petrology. Timescales of volcanic processes. Structural geologic controls on magma migration in upper crust; low water:magma mass ratio hydrovolcanism at continental subaerial volcanoes. Hydrothermal mineralization (i.e. talc genesis) in greenschist facies (and lower) conditions.

Publications

Underwood, S.J., Clynne, M.A. Oxygen isotope geochemistry of mafic phenocrysts in primitive mafic lavas from the southernmost Cascade Range, California. *American Mineralogist*, <http://dx.doi.org/10.2138/am-2017-5588> (In a special collection: Geochemistry, Geology and Geobiology of Lassen Volcanic National Park).

Underwood, S.J., Childs, J.F., Walby, C.P., Lynn, H.B., Wall, Z.S., Cerino, M.T., and Bartlett, E., 2014, The Yellowstone and Regal talc mines and their geologic setting in southwestern Montana, in Shaw, C.A., and Tikoff, B., eds., *Exploring the Northern Rocky Mountains: Geological Society of America Field Guide 37*, p. 161–187, doi:10.1130/2014.0037(08).

Underwood, S.J., Feeley, T.C., Clynne, M.A. Hydrogen isotope investigation of amphibole and glass in dacite magmas erupted in 1980–1986 and 2005 at Mount St. Helens, Washington. *Journal of Petrology*. doi:10.1093/petrology/egt005.

Underwood, S.J., Feeley, T.C., Clynne, M.A. Hydrogen isotope investigation of amphibole and biotite phenocrysts in silicic magmas erupted at Lassen Volcanic Center, California. *Journal of Volcanology and Geothermal Research*. doi:10.1016/j.jvolgeores.2012.02.019.

Feeley, T.C., Wilson, L.F., Underwood, S.J. (2008) Distribution and compositions of magmatic inclusions in the Mount Helen dome, Lassen Volcanic Center, California: Insights into magma chamber processes. *Lithos*, doi:10.1016/j.lithos.2008.07.010

Abstracts

Underwood, S.J., (2016) SW Montana Talc Deposits: Growth Enhancement by Crack-sealing Processes in Basement Carbonates under the Proterozoic Belt Basin? GSA Annual Meeting, Sept. 25-28, 2016, Denver, Colorado. GSA Abstracts w/Programs Vol. 48, No.7, 280186)

Underwood, S.J., (2016) Hydrothermal Talc Deposits in Pre-Belt Carbonates of Southwest Montana: An Updated Model. SME Annual Conference & Expo, Feb. 21-24, 2016, Phoenix, Arizona

Underwood, S.J., (2015) Revised Model for Carbonate-Hosted Proterozoic Hydrothermal Talc Deposits in Southwest Montana. Mining and Mineral Symposium, May 8-10, 2015 Montana Bureau of Mines and Geology, Butte, Montana.

Underwood, S.J., Feeley, T.C. (2007) Complete Chemical Analyses of Amphibole and Biotite: Evidence for Thermal Input and Volatile Loss in Shallow Silicic Magma Chambers by Multiple Mafic Magma Recharge Events at Lassen Volcanic Center. *Eos Trans. AGU*, 88(52), Fall Meet. Suppl., Abstract V33C-1520.

Feeley, T.C., Cosca, M.A., Hamblock, J.M., Underwood, S.J. (2007) High-Precision $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology and Geology of St. George Island, Pribilof Islands, Alaska: Implications for Eruption Rates in the Bering Sea Basalt Province. *Eos Trans. AGU*, 88(52), Fall Meet. Suppl., Abstract V23B-1433.

- Underwood, S.J., Feeley, T.C. (2006) Chemical and Hydrogen Isotope Compositions of Amphibole Phenocrysts in 1980 - 1986 and 2005 Mount St. Helens Eruption Products. *Eos Trans. AGU*, 87(52), Fall Meet. Suppl., Abstract V23C-0623.
- Feeley, T.C., Ulianov, A., Underwood, S.J. (2006) Melting and Metasomatism in the Mantle Lithosphere beneath the Pribilof Islands: Petrology and ICP-MS Analyses of Spinel Peridotite Xenoliths from St. George Island, Bering Sea, Alaska. *Eos Trans. AGU*, 87(52), Fall Meet. Suppl., Abstract V31D-0606.
- DeRaps*, M.R., Feeley, T.C., Underwood, S.J., Winer, G.S. (2006) Petrology and Geochemistry of Plagioclase-Phyric Basaltic Lava Flows on St. George Island, Alaska: Evidence for a Genetic Link Between Magmatic Centers of the Pribilof Islands. *Eos Trans. AGU*, 87(52), Fall Meet. Suppl., Abstract V11A-0569.
- Pollard*, B., Feeley, T., Underwood, S., Wilson*, L., Abrahamson*, S., Fernandez, A. (2005) Johnston Ridge to Windy Ridge: A self-led geologic trail guide at Mount St. Helens National Volcanic Monument. *Geological Society of America Abstracts with Programs*; 37.
- Wilson*, L.F., Feeley, T.C., and Underwood, S.J. (2005) Spatial distribution and compositional variations of magmatic inclusions in the Mount Helen dome, Lassen Volcanic Center: implications for magma chamber dynamics. *Geological Society of America Abstracts with Programs*; 37.
- Detwiler*, J.A., Feeley, T.C., Underwood, S.J. (2004) Disaggregation of plutonic inclusions in Mount St. Helens dacitic rocks erupted from 1980 through 1986. *Geological Society of America Abstracts with Programs*; 36:77.
- Underwood, S.J., Feeley, T.C., Clynne, M.A. (2004) Oxygen isotope geochemistry of primitive calc-alkaline mafic lavas in the southernmost Cascades. *Geological Society of America Abstracts with Programs*, 36:359.
- Underwood, S.J., Feeley, T.C., Clynne, M.A. (2004) Oxygen Isotope Evidence for Subducted Water in the Source of Primitive Calc-alkaline Mafic Lavas in the Southernmost Cascades. *Proceedings of Geological Society of America Penrose Conference "Mass Redistribution in Continental Magmatic-Hydrothermal Systems", September 6-10, Yellowstone National Park and Butte, Montana.*

(* Undergraduate research project authors)

Oral Presentations

- Underwood, S.J.: SW Montana Talc Deposits: Growth Enhancement by Crack-sealing Processes in Basement Carbonates under the Proterozoic Belt Basin? GSA Annual Meeting, Sept. 26, 2016, Denver, Colorado.
- Underwood, S.J.: Hydrothermal Talc Deposits in Pre-Belt Carbonates of Southwest Montana: An Updated Model. SME Annual Conference & Expo, Feb. 24, 2016, Phoenix, Arizona.
- Underwood, S.J.: Revised Model for Carbonate-Hosted Proterozoic Hydrothermal Talc Deposits in Southwest Montana. Mining and Mineral Symposium, May 10, 2015 Montana Bureau of Mines and Geology, Butte, Montana.

Underwood, S., and Feeley T.C.: Chemical and hydrogen isotope compositions of amphibole phenocrysts in 1980 – 1986 Mount St. Helens eruption products (final). Mount St. Helens Petrology Workshop, Cascades Volcano Observatory, Vancouver, WA, August 29, 2006.

Underwood, S., and Feeley T.C.: Chemical and hydrogen isotope compositions of amphibole phenocrysts in 1980 – 1986 Mount St. Helens eruption products (preliminary). Mount St. Helens Petrology Workshop, Cascades Volcano Observatory, Vancouver, WA, July 28-30, 2005.

Teaching/Education Activities @ Montana State University

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| ESCI 111 | Physical Geology |
| GEOL 306 / GEO 450 | Igneous Petrology |
| GEO 449 | Metamorphic Petrology |

Other Professional Development

GSA Field Trip Leader (2014) for "The World-Class Talc Deposits of Southwestern Montana", May 22, 2014, Joint Mtg. of Rocky Mountain and Cordilleran Sections, Bozeman, Montana

Volunteer w/USGS Geophysical Unit of Menlo Park (C. Bouligand and J. Glen). Magnetic and gravity survey of selected hydrothermal areas in Yellowstone National Park (Sept. 16-28, 2008)

Field assistant (mapping) St. George Island, Alaska (July 2006)

Service (MSU)

2005-2006 Academic Year Graduate Student Representative for Graduate Council

Selected Employment (Intel) Awards

May 5, 1998 US Patent # 5,747,879. Patent Title: Interface between titanium and aluminum alloy in metal stack for integrated circuit
Co-Authors: R. Rastogi and H. Fujimoto

October 1992 Intel Achievement Award. Corporate recognition of Microprocessor Manufacturing Yield Improvement Program = Edge Die Recovery Team

Q2/1992 Instructor of the Quarter, New Mexico Site. Best instructor performance evaluations for site Intel University classes

Academic Awards

Fall 2004 MSU [College of] Letters and Science Research Enhancement Award

2004 Geological Society of America, Graduate Student Research Grant
(#7821-04). Project Title: Oxygen Isotope Geochemistry of Primitive
Calc-alkaline Mafic Lavas in the Southernmost Cascades

F 2003 – Sp 2004 MSU: Presidential Graduate Scholarship

F 1978 – Sp 1979 UCB: Stanley M. Tasheira Scholarship

1978 UW: Dept. of Mineral Engineering Chemical Engineering Honor Book

Professional Affiliations

American Geophysical Union
Geological Society of America
Tobacco Root Geological Society