Mt. Mazama Tephra Identification Using Microprobe Geochemical Analysis at Saltese Flats, Eastern Spokane County, Washington

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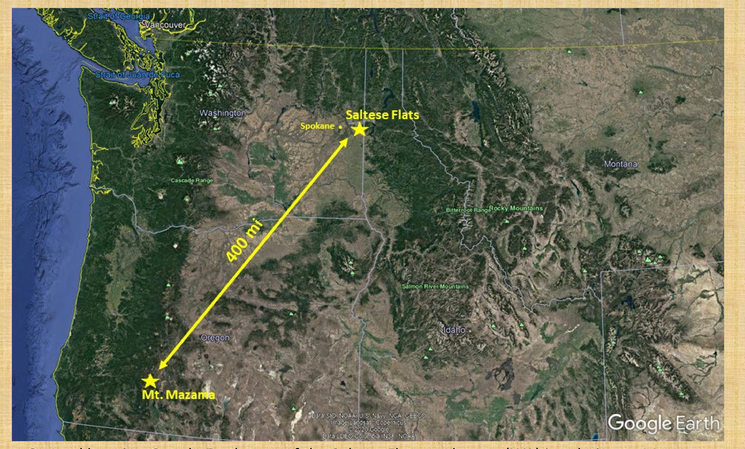
PROJECT OVERVIEW

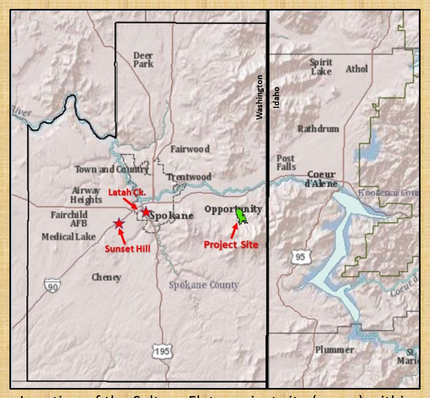
The purpose of this study was to use field and laboratory analysis to describe a recently exposed volcanic tephra (ash) layer, correlate it to other ash locations in the Pacific Northwest, and to ascertain the source eruption event.

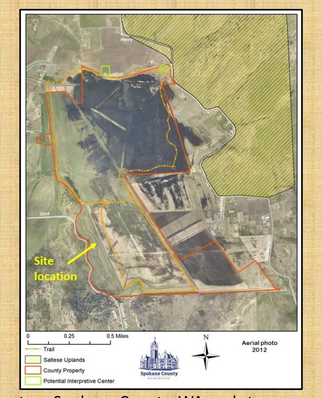
- A recent wetland restoration project in Saltese Flats of eastern Spokane County, Washington, exposed a previously recognized but undescribed ash horizon.
- Trench mapping, sampling, and ash characterization was performed using microscopy and glass shard geochemistry.
- The 71 cm layer of very fine (<150 µm), light-grey ash exhibits sharp upper and lower contacts, and occurs within a thick sequence of peat, suggesting a shallow, low-energy, lacustrine environment of deposition.
- SEM imaging and petrography reveals that the ash is dominated by glass shards (>85%), with accessory microlites of lath-shaped feldspar and possible amphibole, iron-titanium oxides, and pyroxene.
- Microprobe analysis of glass shard compositions (75 shards) correlate the Saltese Flats ash to the climactic 7700 cybp eruption of Mt. Mazama with a 0.98 similarity coefficient.

LOCATION



General location Google Earth map of the Saltese Flats study area (WA) in relation to Mt. Mazama (Crater Lake National Park) of the Oregon Cascades (**above**).





Location of the Saltese Flats project site (green) within eastern Spokane County, WA, red stars are other Spokane County Mazama ash locations (**left**); sample & trench site location at Saltese Flats wetland restoration area (**right**).

SPOKANE COUNTY MAZAMA OCCURRENCES

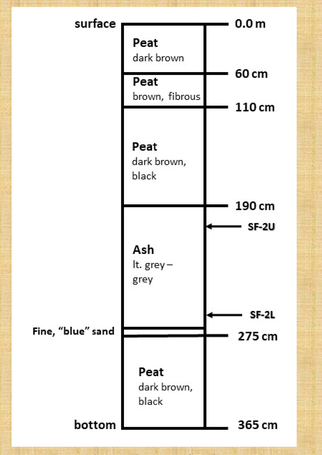
Sunset Hill (see **Location map**), Mazama ash exposure, westbound Interstate 90 (**left**). Sunset Hill, Mazama ash exposure, filling eroded channel in Wanapum Basalt (**center**). Latah Creek, Mazama ash exposure, US-195 south (**right**).

SALTESE FLATS PROJECT SITE

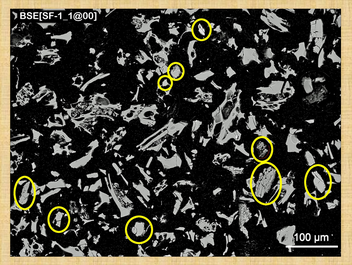
Left: Saltese Flats project site, and Spokane County wetlands restoration project: initial excavation and pre-exposure of Mazama ash deposit.

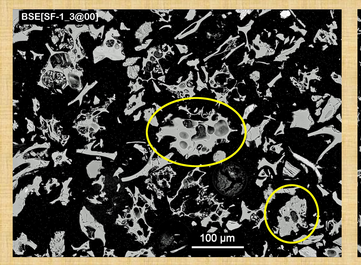
Right: Saltese Flats Mazama ash with initial exposure during excavation of wetland pond. The light gray ash exposed at approximately 1.9 m depth.

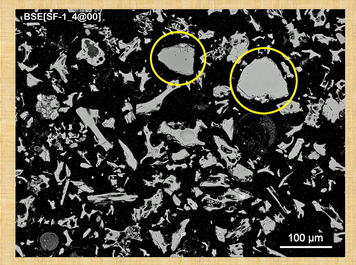
STRATIGRAPHY & SEM IMAGERY



Stratigraphic column of Saltese Flats trench with the ash samples indicated by SF-2U & SF-2L (**left**). Measurement of stratigraphic relations using a stadia rod (**center**). Close-up of ash layer showing sharp upper contact with peat; sharp lower ash contact not shown due to rapid groundwater infill (**right**).







SEM images of the Saltese Flats ash. **Left**: sample SF-1_1, showing vesicular glass shards with mineral and rock fragments (circled). **Center**: sample SF-1_3, large volcanic rock fragment (circled) containing ultra-fine microlites (lower right) and large vesicular glass fragment (center). **Right**: sample SF-1_4, showing two large mineral fragments (circled). In all samples, glass shards dominate (>85%).

ACKNOWLEDGMENTS

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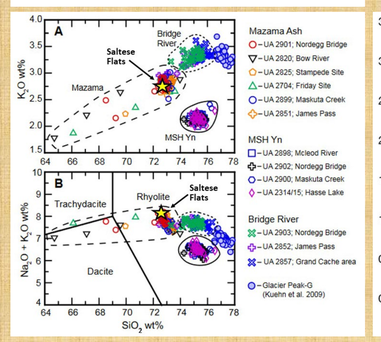
METHODS & RESULTS

- Three samples collected; SF-1 (grab), SF-2U & SF-2L, in situ upper & lower.
- Epoxy mounts for each sample were examined via petrographic microscopy.
- Dried samples were sent to the Peter Hooper Geoanalytical Laboratory at Washington State University for analysis.
- Microprobe analysis of glass shards (n=25 per sample) for major element compositions and SEM imagery was done using a JEOL JXA8500F field emission electron microprobe.
- Samples were run via the WSU Pacific Northwest tephra database for elemental correlation analysis and similarity coefficient determination using Borchardt et al., 1972.

Glass compositions in weight % oxides

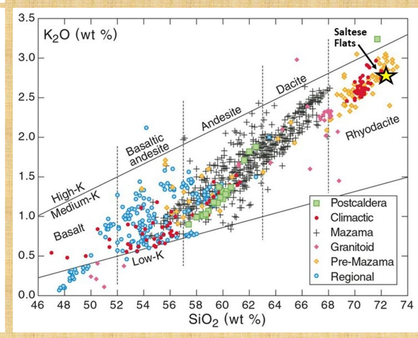
	SF-1		SF-2U		SF-2L	
	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
SiO_2	72.97	0.31	72.78	1.07	72.89	0.31
Al_2O_3	14.23	0.19	14.21	0.39	14.32	0.24
Fe_2O_3	2.04	0.07	2.08	0.46	2.03	0.06
TiO_2	0.4	0.04	0.4	0.08	0.4	0.04
Na_2O	5.44	0.21	5.53	0.17	5.39	0.2
K_2O	2.74	0.14	2.79	0.14	2.77	0.12
MgO	0.45	0.03	0.46	0.1	0.44	0.03
CaO	1.55	0.1	1.59	0.32	1.58	0.11
Cl	0.18	0.02	0.17	0.02	0.17	0.02
Total	100		100		100	
# shards	25		25		25	
Similarity Coefficient	0.98*		0.98*		0.98*	



Left: major element glass shard compositions from the three ash samples.

Below left: comparisons of Saltese Flats ash data to selected Cascade ashes (Jensen et al., 2019): wt.% K_2O vs. SiO_2 (**A**); wt.% K_2O + Na_2O vs. SiO_2 (**B**).

Below right: comparison of Saltese Flats ash data to Mazama rock compositions from the Crater Lake region (Bacon & Lanphere, 2006): wt.% K_2O vs. SiO_2.



CONCLUSIONS

This study analyzes a recently exposed, undescribed tephra layer at Saltese Flats. The fine tephra (ash) unit is homogeneous with sharp lower & upper contacts; no stratification was observed. Deposition of the tephra likely occurred in a low-energy, lacustrine environment. The amount of potential reworking and/or overthickening was not determined in this study.

The Saltese tephra correlates to the 7700 cybp climactic eruption of Mt. Mazama (Crater Lake, OR) based on the following:

- overlapping glass shard vs. rhyodacite chemistry of Mt. Mazama (Bacon & Lanphere, 2006).
- overlapping glass shard compositions with known Mt. Mazama exposures of the Pacific Northwest and southern Canada (Jensen et al., 2019).
- *similarity coefficient of 0.98 to 22 known Mt. Mazama samples within the WSU Pacific Northwest tephra database.

SOURCES

Bacon, C.R., Lanphere, M.A., 2006, Eruptive history and geochronology of Mount Mazama and the Crater Lake region, Oregon: GSA Bulletin, v. 118 (11-12), p. 1331–1359.

Borchardt, G.A., Aruscavage, P.J., Millard, H.T., 1972, Correlation of the Bishop Ash, a Pleistocene marker bed, using instrumental neutron activation analysis: Journal of Sedimentary Research, v. 42, p. 301–306.

Jensen, B.J.L., Beaudoin, A.B., Clynne, M.A., Harvey, J., Vallance, J.W., 2019, A re-examination of the three most prominent Holocene tephra deposits in western Canada: Bridge River, Mount St. Helens Yn and Mazama, Quaternary International, v. 500, p. 83-95.