2014

Basalt Ring Formations of the Columbia River Plateau

Skye Schillhammer
Eastern Washington University

Carly Sorensen
Eastern Washington University

Ted Uecker
Eastern Washington University

Natasha Garland
Eastern Washington University

Basalt Ring Formations of the Columbia River Plateau

Skye Schillhammer, Carly Sorensen, Ted Uecker, Natasha Garland and Dr. Chad Pritchard

Department of Geology, Eastern Washington University

ABSTRACT

Unusual basalt ring formations are located about 6 miles north of Odessa, WA (Fig. 1) as part of the expansive Columbia River Basalt Group. There are over 100 crater-like structures that range in size from 50-500 meters in diameter and span a 60 kilometer area of the channeled scablands. These structures are enigmatic due to the erosion of surficial features by the Missoula Floods, and due to their association with a magnetic anomaly as evidenced by an aerial geophysical survey. Since the 1970s, multiple geologists have proposed conflicting formational mechanisms for the rings, including hydrothermal explosions and sag flows. Over the past decade many more data sets and studies have been published on the CRBGs and we use these data to re-evaluate past hypotheses for these unique structural features. Our research team measured the orientation of stratigraphy of the craters and the surrounding rock using Brunton Compasses and collected samples for XRF analysis at the WSU Peter Hooper Memorial Geoanalytical Laboratory. The data suggests that these structures formed by auto-intrusions of the Roza member of the Wanapum Formation.

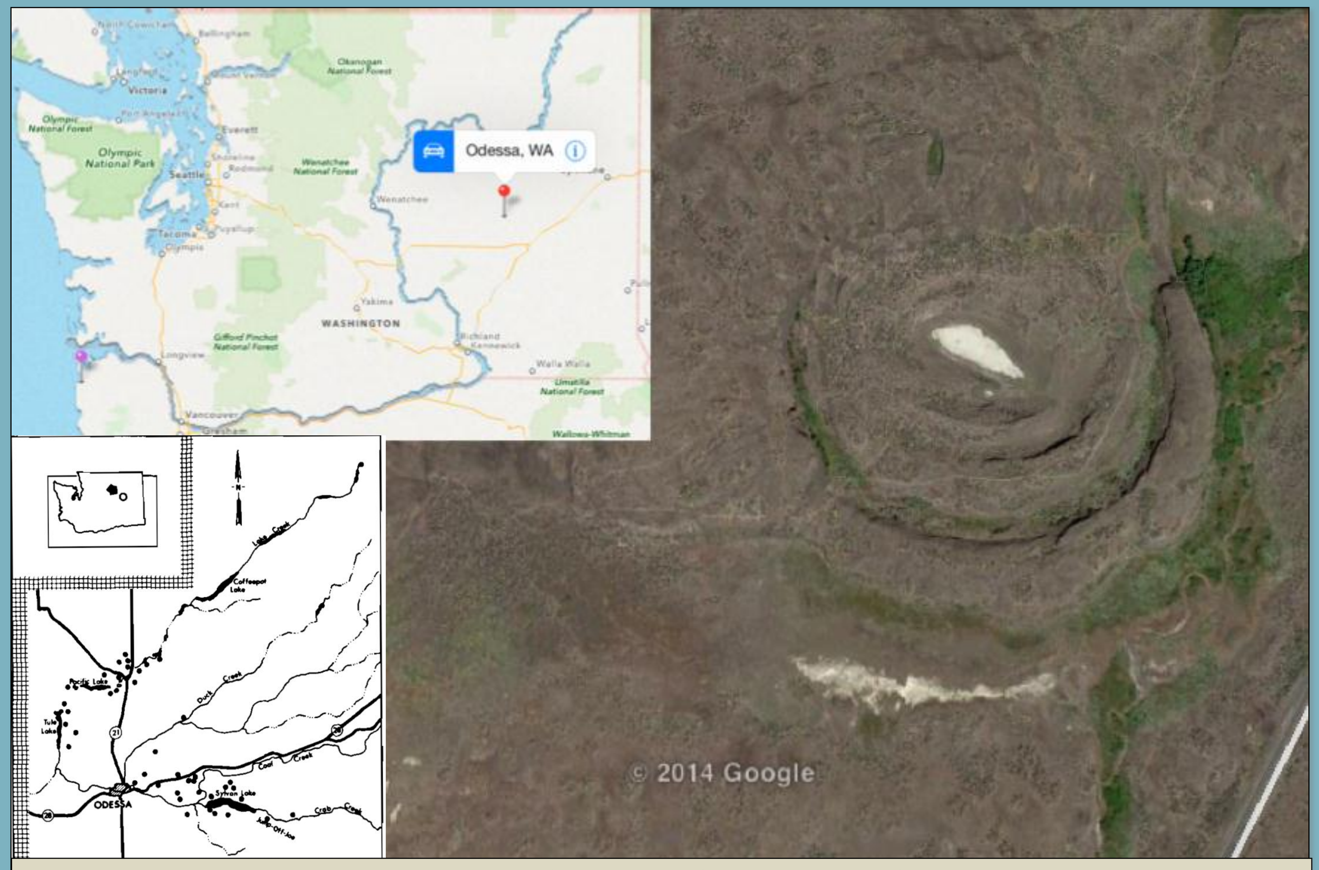


FIG. 1. Map of Washington state in upper left corner along with the selected Odessa basalt ring that was studied. Distribution of rings from McKee and Stradling(1970). Aerial photo from Google Earth.

PREVIOUS RESEARCH

McKee & Stradling (1970) attributed the rings to sag flowout. This is the swelling and subsequent collapse of the magma chamber as it cools and solidifies. Hodges (1978) proposed that the rings were caused by hydrothermal explosions during groundwater infiltrating the cooling basalts. Jaeger et al. (2003) proposed that the structures were formed by inflation pits, or as fanning joints and fracture zones caused by water influx.

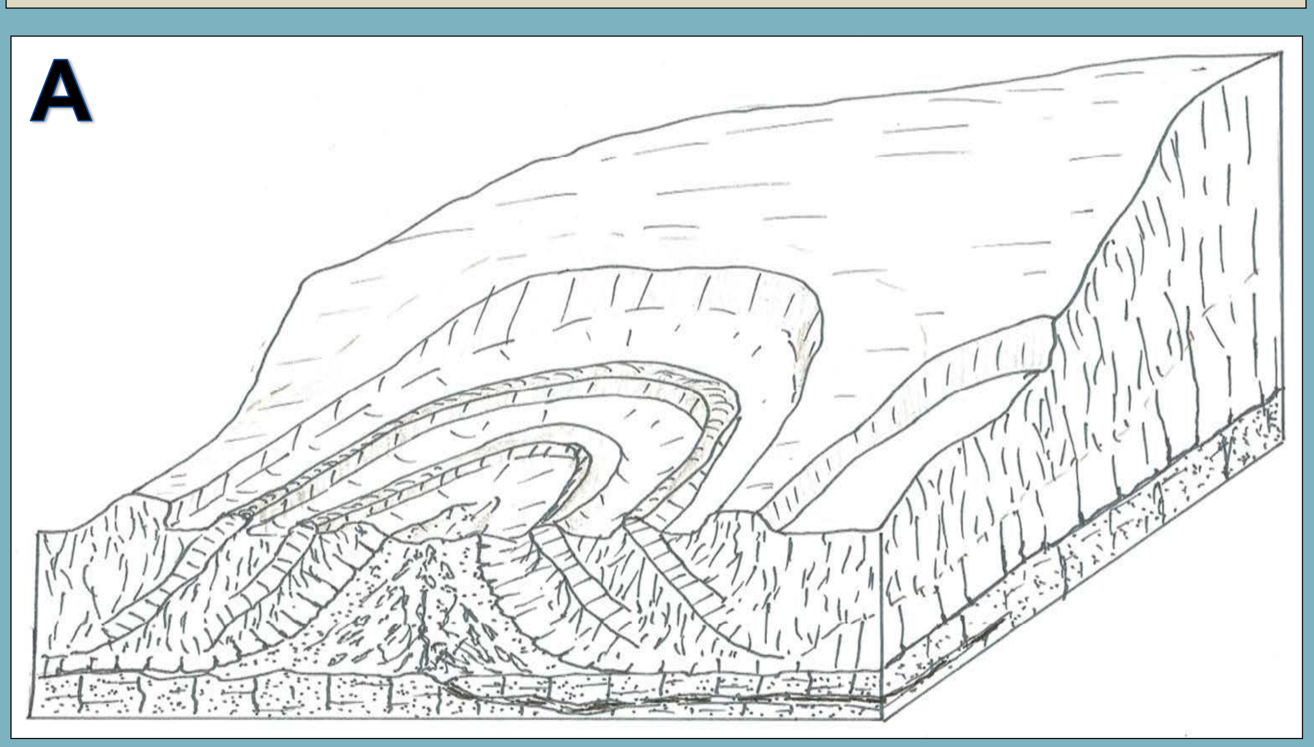


FIG. 2. A. Schematic of a typical ring structure. Diagram courtesy of the Ice Age Floods Institute.

METHODS

Our research team analyzed two ring structures in the field in the fall of 2013. With the permission of the Bureau of Land Management, six basalt samples were collected, three from the craters and three from the country rock. The samples were taken to Washington State University's Geoanalytical Laboratory where they were mechanically disintegrated, combined with flux (dilithium tetraborate) to lower the melting temperature, and melted into fused disks. This process was repeated to increase homogeneity of the samples. The disks were analyzed for chemical composition using an X-ray fluorescence spectrometer (Fig. 3).

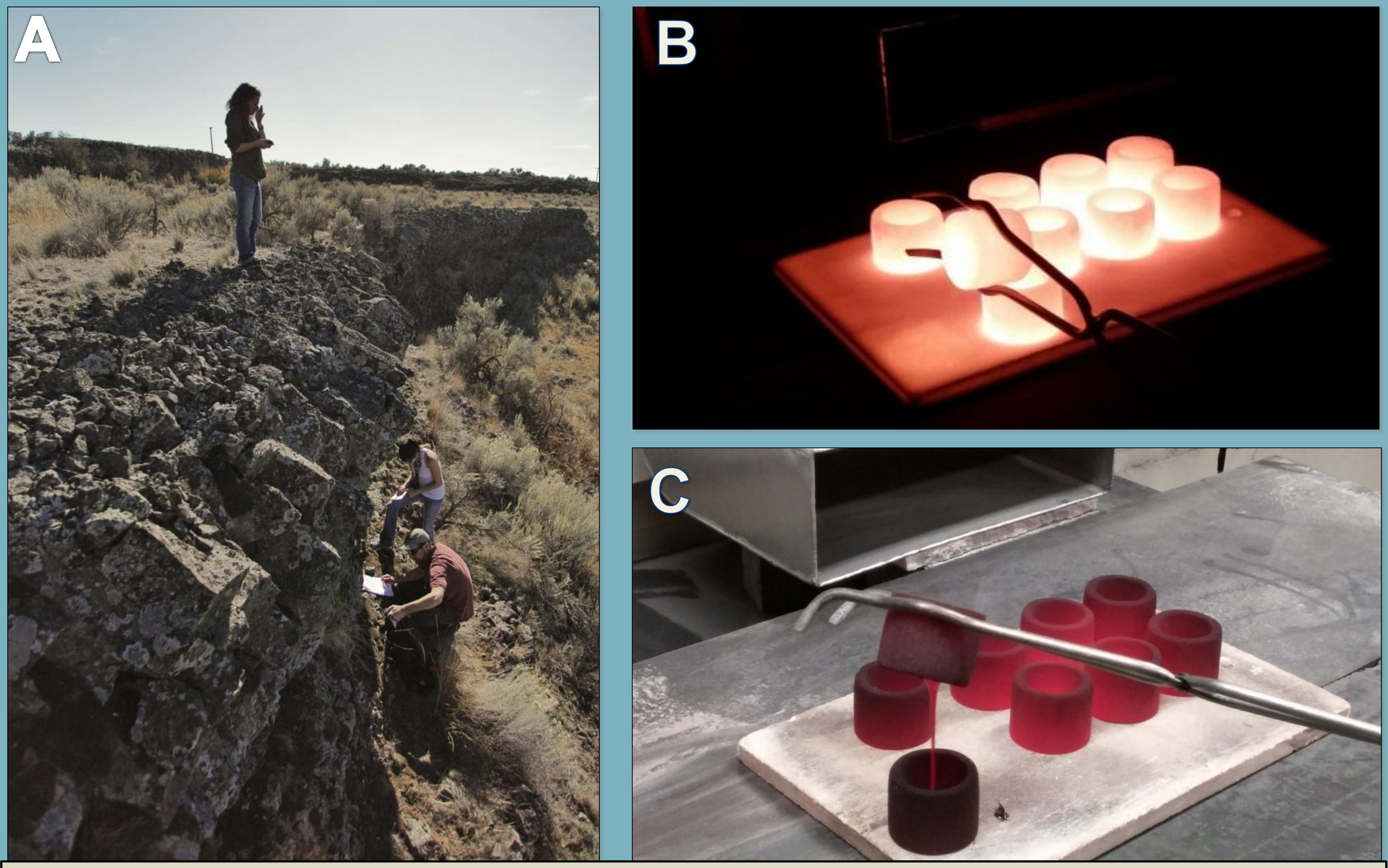


FIG. 3.
A. Dr. Pritchard, Carly and Natasha taking measurements and making observations at the crater. B. Heating the powdered basalt into a homogenous glass. C. Pouring the sample in the crucible for analysis. Below are more pictures from the field.

DISCUSSION

A stereonet was made using representative Brunton compass measurements and Stereonet 9 software by Rick Allmendinger of Cornell University (Fig. 4). The stereonet shows that the craters dip away from the center (Fig. 5). The basalt samples were found to be of Roza Member composition using the chemical discrimination data from Hooper (2000). Fig. 6 shows the plot of phosphorous oxide versus titanium oxide occurring in the range specified by Hooper with titanium ranging from 3.0-3.5% and phosphorous ranging from 0.6-0.8% for all of the samples. This implies that these structures are a form of auto-intrusion; and they are similar in composition to the country rock.

FIG. 4.
A. Stereonet of the average strike and dip measurements indicating that the dip orientation is away from the crater center.
B. Photo of typical basalt ring.

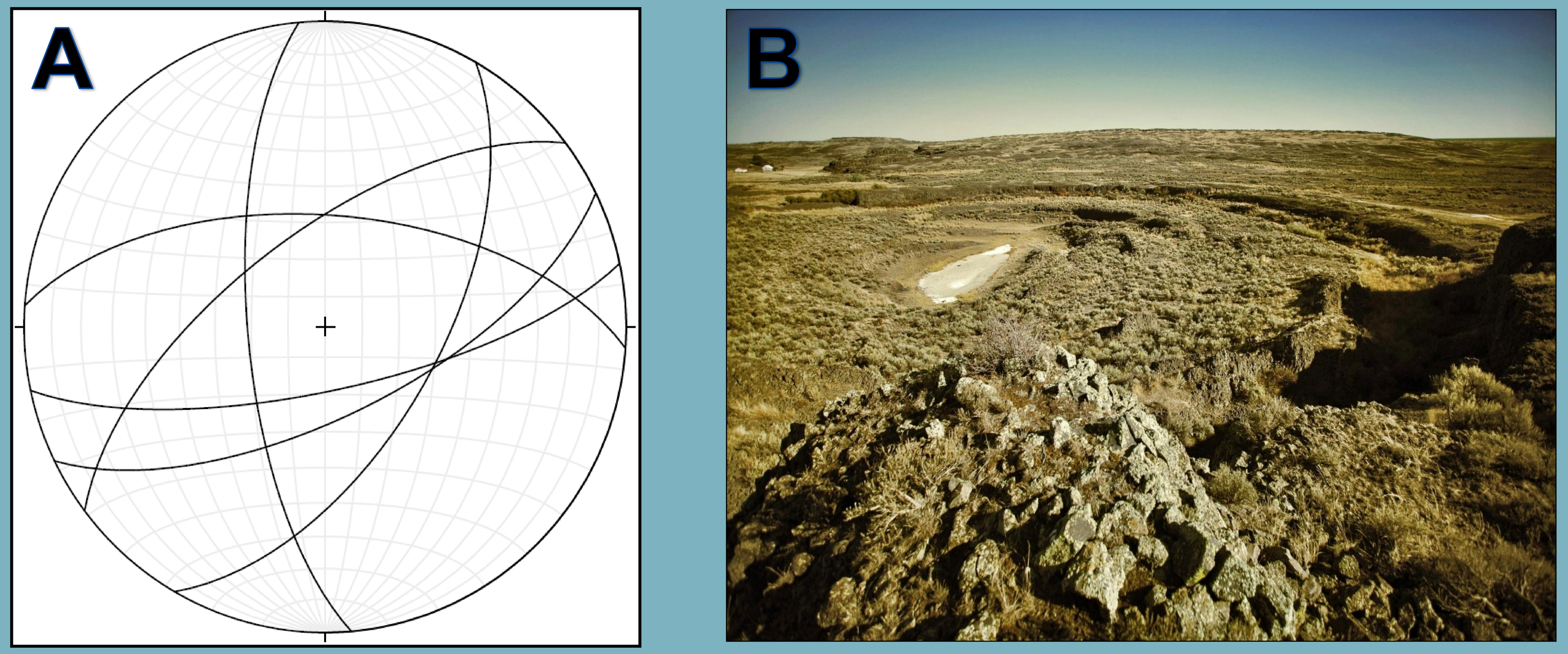
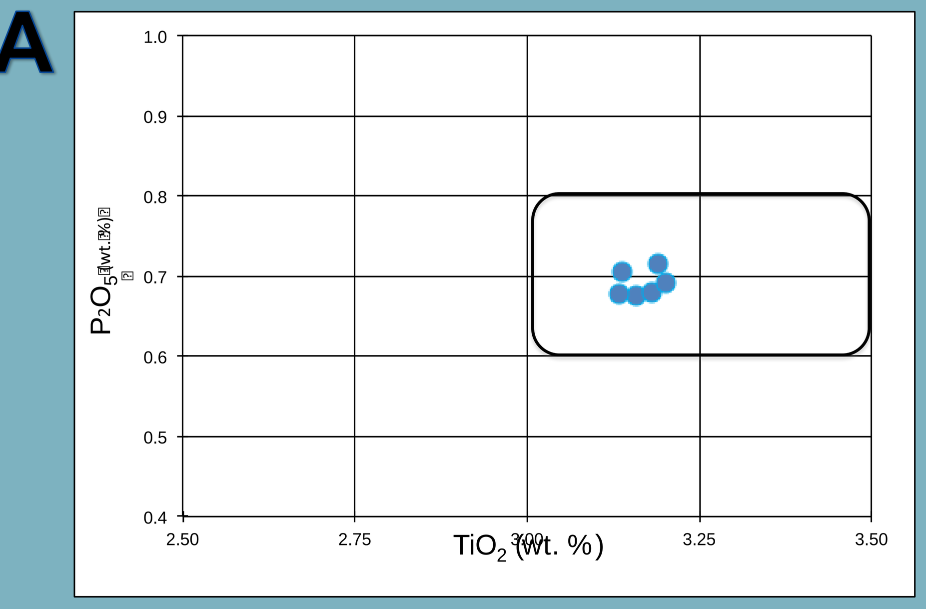


FIG. 5. Picture of the crater wall dipping away from the center of the crater.



B

Normalized Major Elements (Weight %):

SiO2	50.70	50.40	50.40
TiO2	3.18	3.19	3.20
Al2O3	13.48	13.78	13.70
FeO*	14.22	14.49	14.58
MnO	0.22	0.22	0.22
MgO	4.53	4.28	4.42
CaO	8.71	8.87	8.83
Na2O	2.76	2.72	2.70
K2O	1.52	1.33	1.26
P2O5	0.68	0.71	0.69
Total	100	100	100

FIG. 6. A. The phosphorus oxide vs. titanium oxide graph showing the basalt is of Roza Member composition, indicated by the outline. B. The table listing the normalized oxide values of the basalt samples.

CONCLUSIONS

- Brunton measurements show the strata is dipping away from the ring structures.
- XRF data confirms that the rings are of the same composition as the surrounding country rock.
- We hypothesize that the ring formation is due to auto-intrusions of magma from the Roza member, and the occurrence of glass is due to the presence of surface water.

BIBLIOGRAPHY

Hodges, C.A., 1978, Basaltic ring structures of the Columbia Plateau: Geological Society of America Bulletin, v. 89, p. 1281-1289.

Hooper. R.P., 2000, Chemical discrimination of Columbia river basalt flows: Journal of Earth Sciences, v. 1, p. 1-14.

Jaeger, W.L., Keszthelyi, L.P., Burr, D.M., McEwen, A.S., Baker, V.R., Miyamoto, H., and Beyer, R.A., 2003, Ring dike structures in the Channeled Scabland as analogs for circular features in Athabasca Valles, Mars: Abstracts of Papers Submitted to the Lunar and Planetary Science Conference, v. 34, p. @abstr.no.2045- @abstr.no.2045.

McKee, B. and Stradling, D., 1970, The Sag Flowout: A Newly Described Volcanic Structure: Geological Society of America Bulletin, v. 81, p. 2034-2044.