

# Preliminary results from NSF Shared Platform R/V Maritime Maid 2015 Leg 3: Western Aleutians E. R. Grant<sup>1</sup>, K. A. Kelley<sup>2</sup>, E. Cottrell<sup>3</sup>, M. Coombs<sup>4</sup>, M. Pistone<sup>3</sup>, K. Sheppard<sup>5</sup>, M. Jackson<sup>5</sup>

<sup>2</sup>Graduate School of Oceanography, University of Rhode Island, Narragansett, RI USA <sup>1</sup>Department of Earth and Space Sciences, University of Washington, Seattle, WA, USA <sup>4</sup>Alaska Volcano Observatory, U.S. Geological Survey, Anchorage, AK, USA <sup>3</sup>National Museum of Natural History, Smithsonian Institution, Washington, DC, USA <sup>5</sup>University of California at Santa Barbara, Santa Barbara, CA, USA

## Abstract

Among the characteristics shared by arc magmas and continental crust is calc-alkaline affinity, an early decrease in magmatic Fe concentration. Our work aims to address how subduction zone magmas acquire calc-alkaline affinity, with particular focus on the roles of magmatic  $H_{\gamma}O$  and  $fO_{\gamma}$  in influencing magmatic phase equilibria and liquid lines of descent. Here we report on preliminary results from a field campaign aboard the R/V Maritime Maid, part of the NSF-funded Shared Platform for Aleutians research for the 2015 field season. Our cruise sampled the Western Aleutian islands of Buldir, Kiska, Segula, Little Sitkin, Semisopochnoi, Gareloi, Tanaga and Kanaga, which compositionally range from mildly tholeiitic to strongly calc-alkaline, providing an ideal suite of samples to constrain magmatic evolution as a function of  $H_2O$  and  $fO_2$ . We will use melt inclusions from collected tephra samples to assess mantle conditions, primary/parental magma compositions, and magmatic evolution as a function of water content and oxygen fugacity.



### Kiska

- Kiska was a major success for gas sampling (pictured below at the summit).
- Spatter collected at the summit was the most promising airfall sample.
- Kiska appears to erupt less explosively than neighboring Aleutian volcanoes.
- We collected the first samples of many young, intermediate composition lava flows, including the 1962 Sirius Point flow.

### Photo Credit: T. Lopez

### Buldir

Despite a pessimistic outlook for Buldir (no known Holocene eruptions), Cottrell, Coombs, and Sheppard found airfall deposits on very steep escarpments. These suggest:

- Buldir has erupted explosively in the past ( $\geq 0.3$  m bombs > 2 km from summit).
- Tephra records at Buldir have not been erased by glaciation.

• Promising samples were collected at two main localities, one proximal to Kittiwake Pond (below left), the other exposed along a gully in the NW (below right)..





### Motivation

Fe-depletion with the continental crust (i.e calc-alkaline affinity), which has been linked to the influence of magmatic H<sub>2</sub>O on equilibria and the liquid line of descent (Zimmer et al., 2010).

matic H<sub>2</sub>O contents and the "Tholeiitic Index" strongly correlate with oxidation

leutians, magmas range from mildly tholeiitic to strongly calc-alkal our goal is to evaluate the  $H_0O$  contents and redox conditions of these magmas, to test their effects on magmatic differentiation.



# **Synergies & Broader Impacts**

Scientific

funded 3 scientists and 5 additional days in the field, maximizing our chance of good weather window.s • AVO/USGS serviced 28 seismic stations on 5 islands that had not been serviced in 10 years. Good weather allowed AVO 30+ helicopter hours to achieve these successes for science and monitoring. • DCO funded 2 volcanic gas chemists to join our expedition. They sampled six new sites including three summit fumaroles. • Tephrachronology and eruptive histories will be available through AVO & Smithsonian's Global Volcanism Program. • 386 samples of tephra, lava, and soil from 8 volcanic islands will be curated at Smithsonian, GSO/URI, and AVO in perpetuity and made available for science.

### Education

• InReach satellite text devices sent 90 Tweets to 80 followers including school children, policy makers, funding agencies, academics, and members of the public. Retweets by the Smithsonian reached more than 2 million additional followers! • We collected thousands of still images and hours of videography that will be packaged for public distribution by the Smithsonian institution and the PIs.

• Two incoming graduate students and three postdocs were trained and made up half the scientific party.



Before our arrival, Segula (pictured at right approaching from the NW) had not been visited by geologists since the 1950's, and only three whole-rock samples have known analyses. Tephra fall on Segula was locally heterogeneous, but sections across the island yielded abundant, thick tephra deposits. We found: • A rich history of explosive and effusive volcanism, with many morphologically very young lava flows. Photo Credit: K. Sheppard • A series of thick scoria falls on the



• The north shore also has a thick sequence of unvisited pyroclastic deposits.

• Many young lavas are crystal-poor pyroxene andesites; one older lava is basalt.

## Little Sitkin

On Little Sitkin, we worked at two main tephra sections, guided by previous AVO field work.

• One (pictured at left) is in a gully on the southwest side of the island.

• The other (pictured at right) is northwest of the summit, in the island interior.

• Scoria fall deposits are yellowish and oxidized, and much of the output at this volcano is intermediate in composition, but some mafic-looking deposits were identified and sampled.



• Our team also collected olivine-bearing scoria from Mount Cerberus, the central vent on

saltic andesite.











ruise participants. from left to right. Back row: Adriar Bender (AVO), George Rains (Captain), Katherine Shepp Joe Schmitt (Engineer). Not pictured: Mike Cooper (Hel<sup>2</sup>)

### Gareloi

We were guided in our sampling of Gareloi Island by the 2012 Coombs et al. geologic map and hazard assessment, which included descriptions of previously-sampled tephra sections.

• We collected abundant mafic scoria at all compass points on the island including more distal coarse ashes and proximal coarse lapilli from the saddle between North and South Peaks.

• Flanks at low elevation contained units >1 m thick characterized by repetitive eruptive cycles oscillating between medium ash and fine lapilli. • Gas team sampled emissions from the summit fumarole at South Peak.



active fuma summi North photo at le thought to absent in 2005



• We may have found older tephra from Takawanga that is more mafic than crater lake and historical output from Tanaga.



# Semisopochnoi

Our work at Semisopochnoi built on AVO field work here in 2005. • We targeted Sugarloaf Peak, the most mafic volcanic center on the south side of the island. • We collected proximal and medial falls from several azimuths around the vent.









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- Christie Haupert and Polar Field Services
- Jenn Wade, Lina Patino, and Donna Blackman at NSF

## lanaga

At Tanaga, our field work built on AVO work here in 2003.

• We sampled mafic Sajaka scoria proximally and more distally.

• The island has an excellent tephra record preserved and we logged numerous sections at all azimuths around the Holocene cones.

• Many of the youngest falls appear to be basalitc (see photo below left), likely from Sajaka, but confirmation will await analysis.

• In combination with prior AVO work in 2003, our sampling provides suffi-

Kanaga Our work at Kanaga built on the geologic map of Waythomas et al. (2001), and AVO field work there in 1999-2000.

• Mafic Holocene deposits were scarce but we sampled several thick intemrediate fall deposits. No mafic tephra that we can definitively attribute to Kanaga were found.

• We sampled basalts from Round Head, a parasitic cone east of Mt. Kanaga, all Pleistocene, but stratigraphy exposed in the eastern sea cliff was inaccessible.

• We attempted to collect mafic inputs into the young magmatic system by sampling quenched mafic inlucisons from young andesite flows. These were described as "abundant" in the Waythomas et al. (2001) geologic map, but we found these rare to absent.

• Gas sampling at Kanaga was very successful, both by direct sampling (pictured below, T. Lopez) and airborne DOAS.



