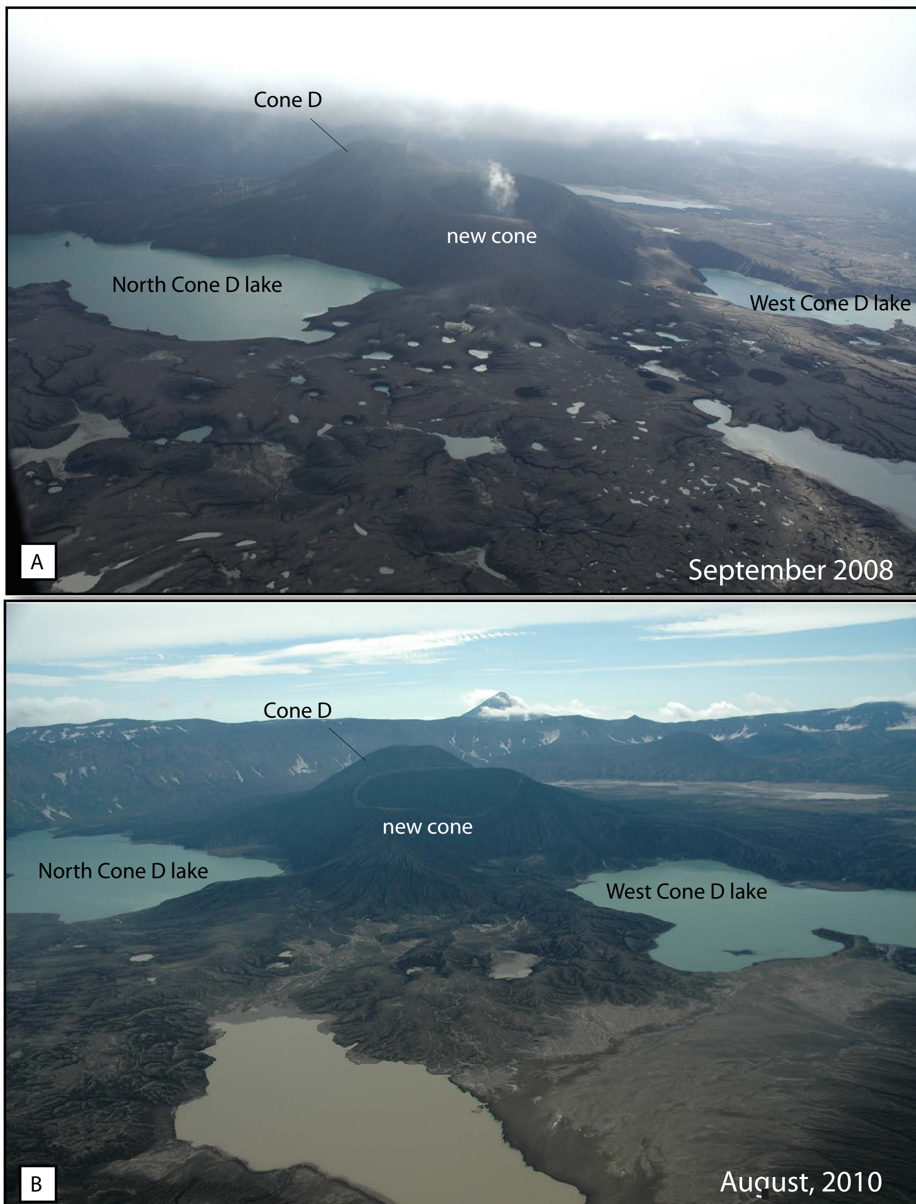
OKMOK VOLCANO: GEOMORPHOLOGY AND HYDROGEOLOGY OF THE 2008 PHREATOMAGMATIC ERUPTION

On July 12, 2008, with less than 5 hours of precursory seismic activity, the central Aleutian volcano Okmok erupted explosively, marking the beginning of a 5-week-long eruption that dramatically changed the morphology and groundwater system in the ten-km-wide caldera. The initial explosion sent an ash- and gas-rich column to 15 km above sea level. Early in the eruption, heavy rain mixed with new tephra on the flanks of the volcano, generating lahars (volcanic mudflows) that traveled across the upper slopes of the volcano and down all major drainages, creating large new deltas along the shoreline. For the next 5 weeks, eruption intensity waxed and waned with explosions occurring from multiple vents on the caldera floor as rising magma interacted with shallow groundwater. One crater formed next to, and eventually captured and drained, the largest pre-existing caldera lake (total volume drained was 13.6 million cubic meters). As the eruption subsided, coalescing maar and collapse craters eventually filled with water, forming a new lake west of cone D and dramatically changing the morphology and volume of the old lake. The longest-lived vent formed a new tuff cone about ~275 m tall and ~1.5 km wide on the western flank of pre-existing cone D. This new tuff cone, the new lakes and collapse pits, and the accumulation of many tens of meters of fine-grained tephra have significantly altered the Okmok landscape. This eruption was substantially larger than any Okmok eruption since that of 1817 (which destroyed the then-unoccupied village of Egorkovskoe on the north coast of Umnak) and far larger than the eruptions of 1945, 1958, or 1997.



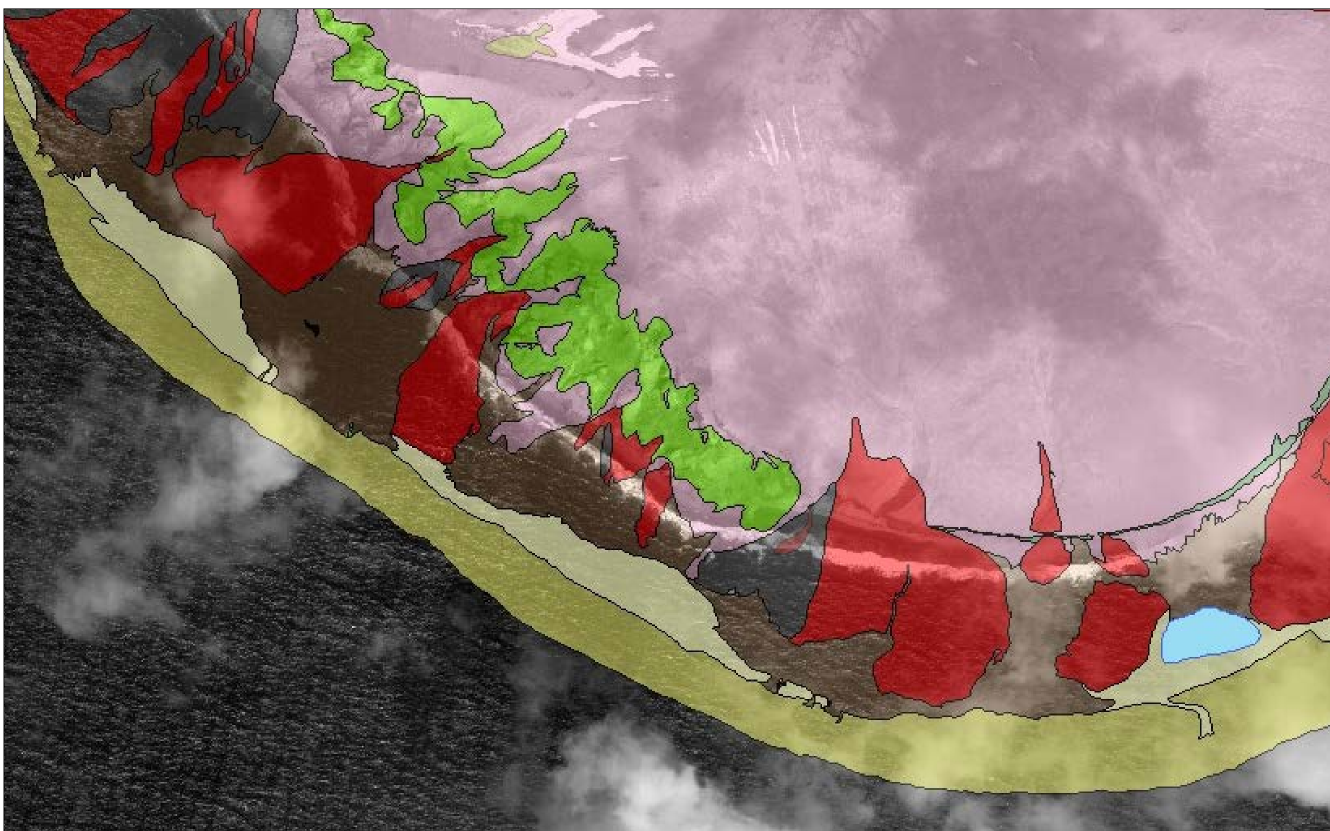
Division of Geological & Geophysical Surveys (DGGS) geologist Janet Schaefer, along with Alaska Volcano Observatory (AVO) lead author Jessica Larsen (University of Alaska Fairbanks Geophysical Institute) and colleague Tina Neal (U.S. Geological Survey), are writing a DGGS Report of Investigations documenting this fascinating eruption. Fieldwork focused on the stratigraphy and sedimentology of the tephra deposits from the 2008 eruption, documentation and description of vent evolution, a revision of the hazard assessment, creation of a post-eruptive geologic map, and acquisition of surveyed GPS points for digital elevation model (DEM) creation. The new post-eruption DEM of the caldera was published in 2011 (DGGS RDF 2011-6) and has aided significantly in quantifying the geomorphic changes in the caldera (fig. 1). Anticipated release of the Report of Investigations detailing the eruption is spring 2013.

Figure 1. Oblique aerial photographs of the newly expanded north Cone D lake, the new cone, and a new lake west of cone D; region of collapse pits in the middle ground. A) Photograph from September 2008 looking south. B) Photograph from August 2010 showing enlarged lakes and subdued field of collapse craters. Photographs by J. Larsen (UAF/GI).

Contact: Janet Schaefer, 907-451-5005, janet.schaefer@alaska.gov

KASATOCHI VOLCANO: GEOLOGIC MAPPING AND VOLCANOLOGICAL STUDIES

Kasatochi is a 2.7-square-mile island volcano midway between Atka and Adak, in the Aleutian Islands. It provides nesting territory for several hundred thousand seabirds, is one of the largest sea lion rookeries in the Aleutians, and has been closely studied by the U.S. Fish and Wildlife Service (USFWS) and other biologists for decades. In August of 2008 Kasatochi erupted for the first time in written history. The eruption was about a thousand times more energetic than any other Alaska eruption in nearly a century. During the day-long eruption, the area of the island increased by 40 percent, the area enclosed by the crater rim increased by 30 percent, the crater lake grew by 70 percent, and pyroclastic deposits completely covered seabird nesting crevices. A multi-agency and multi-disciplinary group quickly assembled, attracted to the rare opportunity to study the regrowth of an ecosystem that had been nearly obliterated. The study has been funded by the North Pacific Research Board, USGS, USFWS, and the Alaska Volcano Observatory (AVO). Prior to the eruption, the geology was virtually unknown. As an AVO partner organization, the Division of Geological & Geophysical Surveys (DGGS) is leading the effort to produce the first-ever geologic map of Kasatochi as part of the ecosystem recovery project, and as a lead-in to volcanologic and petrologic studies. Fieldwork has been based off the USFWS refuge ship Tiglax on 2- to 3-day trips twice each summer starting in 2009, although winds and waves that precluded landing a skiff on the island have resulted in dramatically reduced on-island time on some of the trips. To date, roughly 100 rock samples have been collected and analyzed chemically and petrographically. These data and field mapping serve to distinguish several major pre-2008 rock units. Additionally, 3,500 mineral analyses have been collected from a stratigraphically and compositionally representative subset of samples. The mineral analyses provide important information about complex petrogenetic (rock-forming) processes. The 2008 eruption, probably because it was so energetic, brought to the surface many nodules of cumulate, zero-age, gabbroic "crystal mush". Such nodules are unusual (though not unique) and, as the solid residue of petrogenesis, provide important additional constraints on processes governing the genesis of magmas. DGGS expects to publish the new geologic map of Kasatochi in late 2013.



The southwest portion of Kasatochi Island. Major units identified in current mapping are shown on top of a pre-eruption satellite image. The green units are pre-2008 deposits. Yellows are new beaches, and pink, red, tan and gray are unmodified or reworked 2008 deposits. The pre-eruption shoreline is marked by a line of white surf, which approximately underlies the seaward edge of the pink unit. The entire scene is about 1 km from east to west.

Contact: Christopher Nye, 907-474-7430, chris.nye@alaska.gov

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY13 Project Description

CHIGINAGAK VOLCANO: GEOLOGIC MAPPING AND HAZARD ASSESSMENT

Mount Chiginagak is a hydrothermally active volcano on the Alaska Peninsula, approximately 170 km south–southwest of King Salmon. This small stratovolcano, approximately 8 km in diameter, has erupted through Tertiary to Permian sedimentary and igneous rocks. Intermittent geologic fieldwork since 2005 has consisted of lava-sample collection for radiometric dating and geochemical analysis, mapping of Holocene lava flows, lahars, and debris avalanches, and the collection and stratigraphic description of tephra deposits.

Pleistocene pyroclastic flows and block-and-ash flows, interlayered with andesitic lava flows, dominate the edifice rocks on the northern and western flanks (fig. 1, Unit Pba). The oldest rocks dated (~250,000 years old) are lava bombs in a cliff-forming pyroclastic flow deposit on the northwestern flank. Pleistocene porphyritic lava flows range in composition from 54.2 to 62.7 weight percent silica (SiO_2) and contain variable proportions of plagioclase, hypersthene, and augite.

Our mapping indicates that Holocene activity consists primarily of debris avalanches, lahars, and lava flows; explosive activity resulting in proximal tephra fall is less prevalent. Terrace deposits of lahars and debris avalanches appear along a creek draining the southeastern flank toward the Pacific Ocean (fig. 1, Unit Hdl) and in upper Indecision Creek below the toe of the south flank glacier. Holocene lava flows (Unit Hl, fig. 1) cover Pleistocene lavas on the northeastern flank and range in composition between 55.9 and 57.5 weight percent SiO_2. Holocene block-and-ash flow and pyroclastic flow deposits extend almost 8 km from the summit, down a valley on the southeastern flank (fig. 1, Units Hba and Hp; and fig. 2). Proximal tephra collected during recent fieldwork suggests there may have been limited Holocene explosive activity that resulted in localized ash fall. Lake sediment from Mother Goose Lake has preserved as many as 50 tephras deposited within the last ~3800 years, some presumably from Chiginagak volcano (fig. 2). Samples of these tephras are currently being prepared for microprobe analysis to determine source vents.

A geologic map is scheduled to be published in 2013, followed by a hazard assessment report in 2014.

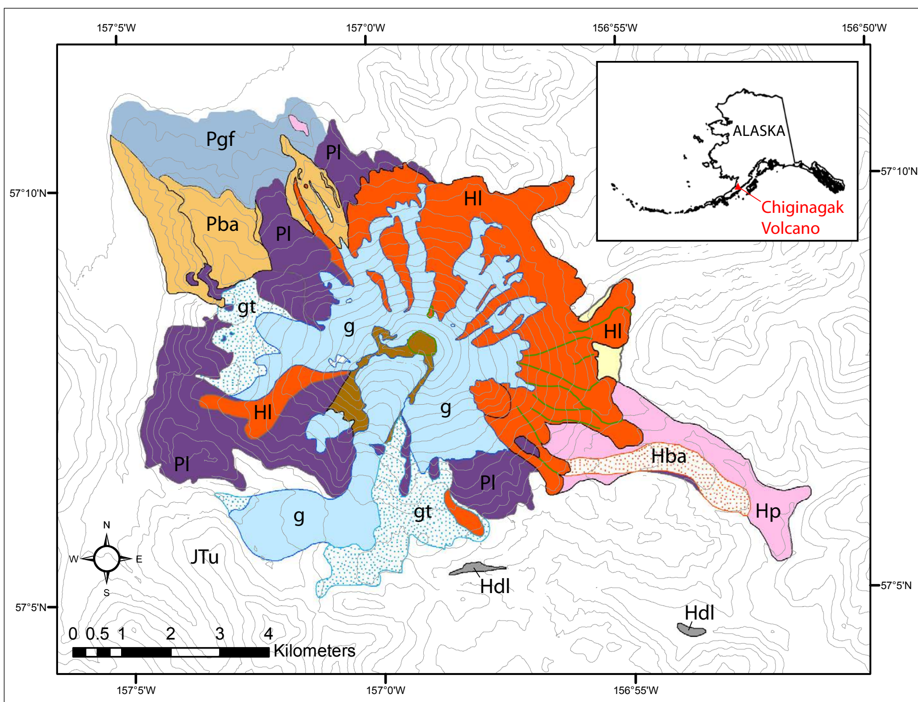


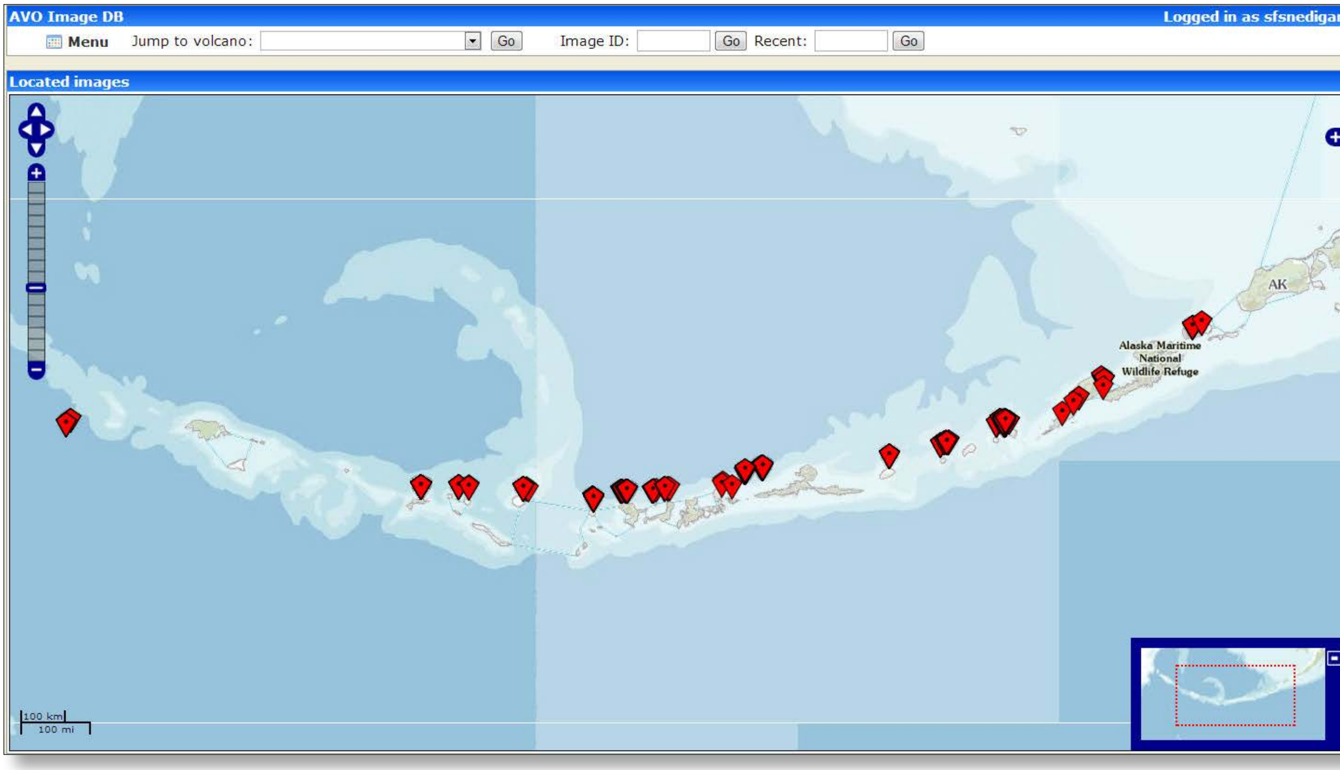
Figure 1. Generalized geologic map of Chiginagak volcano showing major undifferentiated deposits of Pleistocene lavas (Pl), Pleistocene block-and-ash flow deposits interlayered with andesite lavas (Pba), undifferentiated glaciofluvial and glaciolacustrine deposits (Pgf), Holocene lavas (Hl), Holocene block-and-ash flow deposits (Hba), Holocene pyroclastic flow deposits (Hp), Holocene debris avalanche and lahar deposits (Hdl), glaciers and perennial snow fields (g), and glacial till (gt). Pending $^{40}Ar/^{39}Ar$ age determinations and geochemical analyses will help differentiate these major depositional units. Unit JTu refers to undifferentiated bedrock (Tertiary to Permian rocks mapped by Detterman and others, 1987).

Figure 2. Photo of a section of Mother Goose Lake sediment core. Tephra layers appear as

Contact: Janet Schaefer, 907-451-5005, janet.schaefer@alaska.gov

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY13 Project Description

ALASKA VOLCANO OBSERVATORY (AVO) WEBSITE AND DATABASE



The image database contains this map, which shows the location of images that have been tagged with latitude and longitude coordinates.

The AVO public website (http://www.avo.alaska.edu) serves about 6,000,000 pages and approximately 300 gigabytes of data to well over 100,000 unique visitors per month, and is among the top ten most-visited U.S. Geological Survey (USGS) and USGS-affiliated websites in the country. It continues to be the most complete single resource on Quaternary volcanism in Alaska. The Division of Geological & Geophysical Surveys (DGGS) was the original creator of the AVO website in 1994, and continues to be the site designer, builder, and manager. The website is dynamically driven by the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA).

Images are a major part of the content on the AVO website. The image module within GeoDIVA currently stores about 20,000 images, ~6,000 of which are publicly viewable. This year, we are re-writing the image database software. The new version will take advantage of the metadata provided by digital cameras – such as date and time, latitude, longitude, elevation, and zoom level. These data are automatically read from the image file, and inserted into queryable fields of the database, enabling faster and more accurate image upload.

The image database also provides an interface where administrators review images for content and captions before they are accessible from the public web page. Administrators can also upload pictures to AVO's Twitter account and, eventually, to an AVO Facebook page.

In other continued database maintenance and development, the database now also holds ~10,700 sample records, ~5,600 of which have geochemical analyses, and about 4,700 references. Eruption histories are also continually updated.

DGGS/AVO is on the leading edge of web and database development for volcano observatories, and portions of DGGS-written database software have been installed at other U.S. volcano observatories. DGGS is following new and emerging technologies that will allow us to further enhance AVO's web presence and data dissemination abilities. DGGS continually refines and enhances the applications that AVO and other observatories use on a regular basis. We will maintain our focus on continual incremental improvements to the site, and serving new database modules as they become available.

Contacts: Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov
Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov

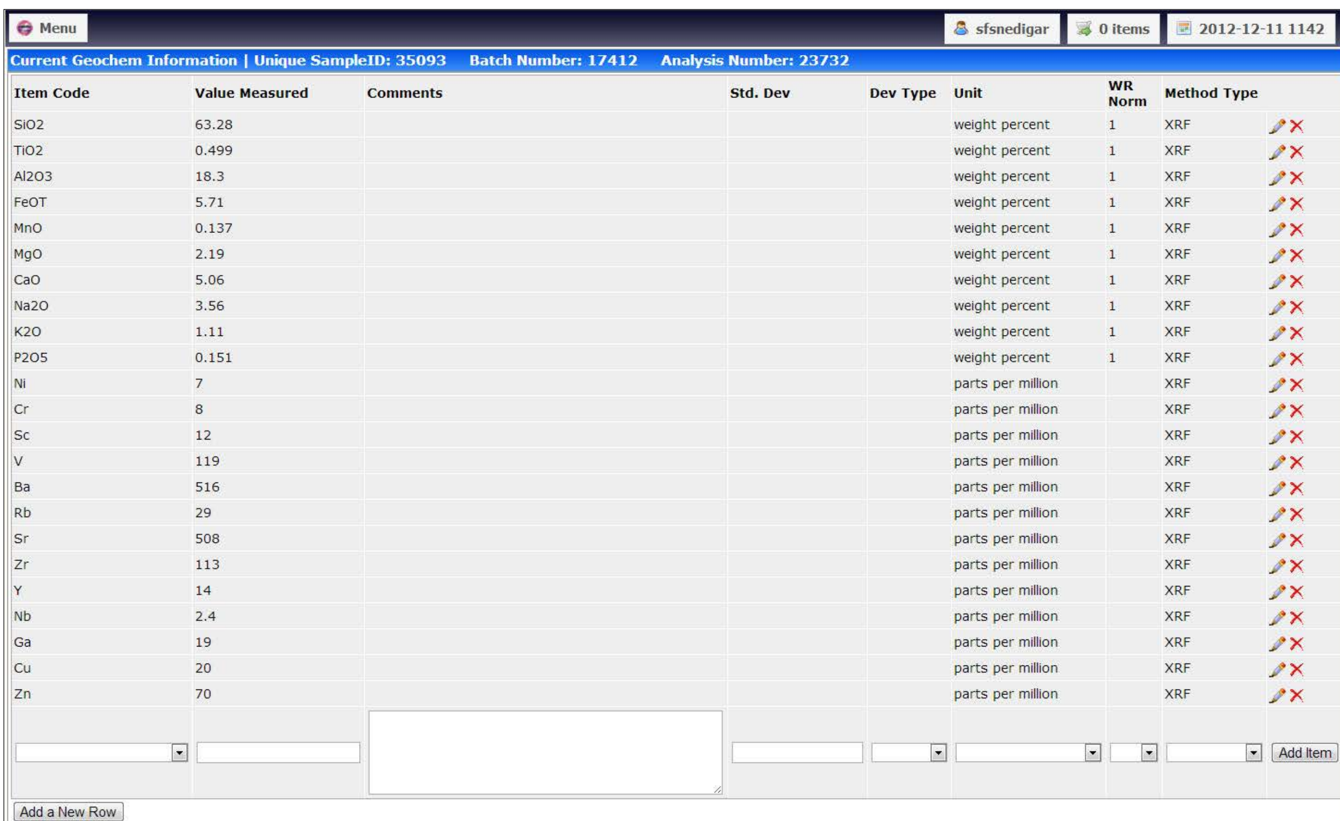
QUATERNARY VOLCANO GEOCHEMICAL DATABASE

As part of the Division of Geological & Geophysical Survey's (DGGS) ongoing development of the Geological Database of Information on Volcanoes in Alaska (GeoDIVA), DGGS/AVO staff have created a database structure to hold geochemical data on Quaternary volcanic rocks in Alaska. Published data is available to the public through AVO website (http://www.avo.alaska.edu), and searchable by map, volcano, sample metadata information, or analysis types. Unpublished data will also be available internally to AVO users, if the data owner has granted explicit permission.

Currently, only whole-rock major- and trace-element values and metadata are being uploaded to the database, although the system is designed to accommodate other types of data such as mineral, glass, or fluid geochemistry, and intended to be compatible with other major geochemical database efforts such as EarthChem. We are making every effort to provide the best data possible for each sample and analysis, which often entails additional actions such as tracking down obscure references and untangling multiple sample numbers for the same sample. In addition, DGGS and Washington State University (WSU) GeoAnalytical Laboratory staff have re-reduced the thousands of samples analyzed by WSU over the past 25 years using the same inductively coupled plasma mass spectrometry (ICP-MS) calibration in order to maximize internal consistency of the data.

This database will be a valuable research tool for geoscientists with interests ranging from volcano-specific processes to whole-arc data synthesis. Because the database is an intrinsic part of GeoDIVA, it will also help consolidate all of Alaska's volcano information in one place. The database currently holds about 10,900 sample records, and 5,853 have geochemical data entered. All known published whole-rock major- and trace-element analyses for Quaternary volcanic rock samples in Alaska have been uploaded to the database. We are nearly finished with a quality-assurance check of the data, and the published analyses are available on the public website via the individual volcano pages.

In this next year, we plan to refine our search and output tools. We are determining the best way to query and display our multi-dimensional data (sample, value, analyte, method, citation, etc.) in a two-dimensional spreadsheet that preserves the user's ability to manipulate numeric values. As with all GeoDIVA modules, geochemical data will be updated as the AVO community produces more data.



Item Code	Value Measured	Comments	Std. Dev	Dev Type	Unit	WR Norm	Method Type
SiO2	63.28				weight percent	1	XRF
TiO2	0.499				weight percent	1	XRF
Al2O3	18.3				weight percent	1	XRF
FeOT	5.71				weight percent	1	XRF
MnO	0.137				weight percent	1	XRF
MgO	2.19				weight percent	1	XRF
CaO	5.06				weight percent	1	XRF
Na2O	3.56				weight percent	1	XRF
K2O	1.11				weight percent	1	XRF
P2O5	0.151				weight percent	1	XRF
Ni	7				parts per million		XRF
Cr	8				parts per million		XRF
Sc	12				parts per million		XRF
V	119				parts per million		XRF
Ba	516				parts per million		XRF
Rb	29				parts per million		XRF
Sr	508				parts per million		XRF
Zr	113				parts per million		XRF
Y	14				parts per million		XRF
Nb	2.4				parts per million		XRF
Ga	19				parts per million		XRF
Cu	20				parts per million		XRF
Zn	70				parts per million		XRF

Web-based tool for adjusting individual analytes or values for an existing analysis in the database - an essential ability for quality control.

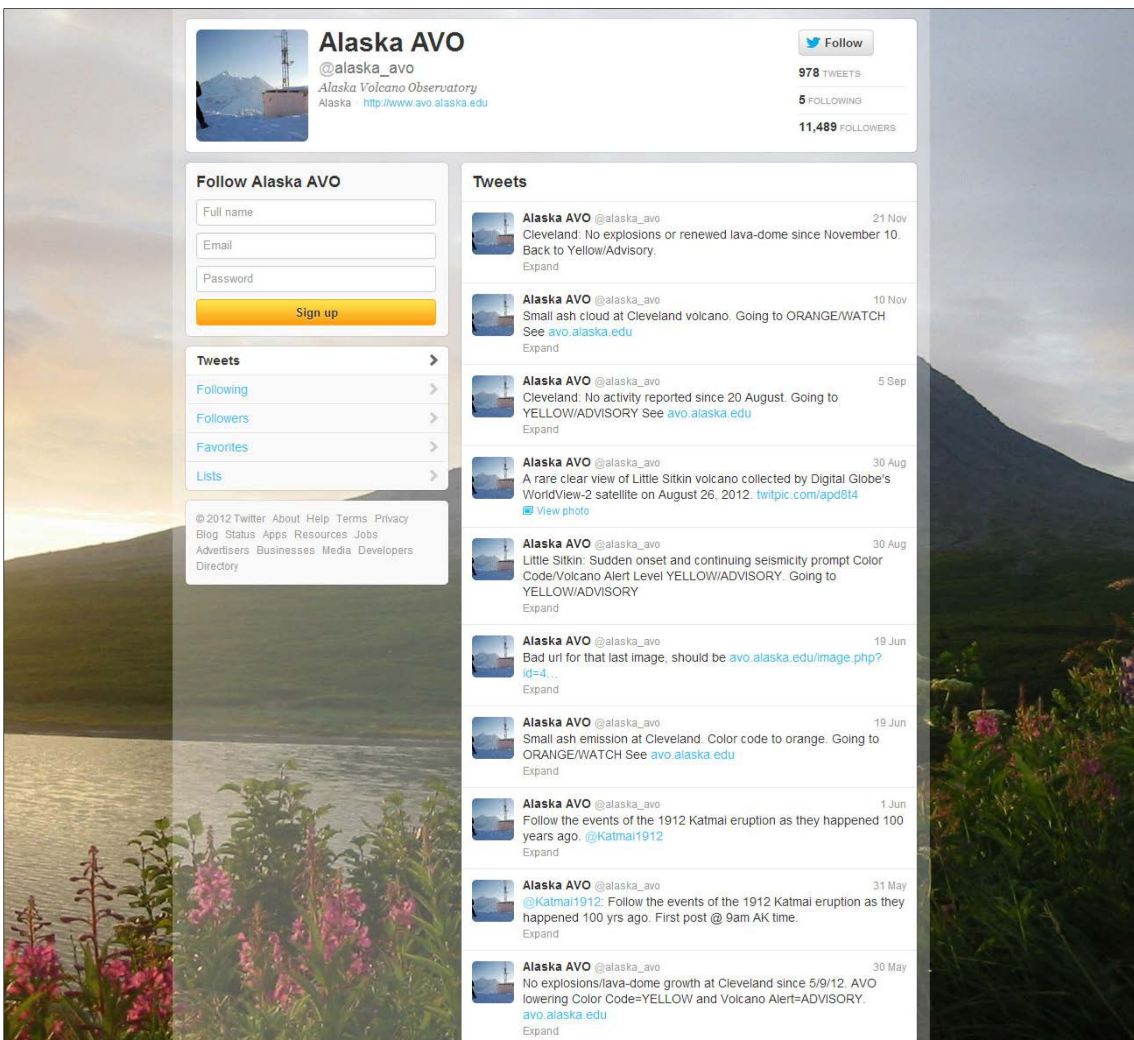
Contacts: Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov
Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov

ALASKA VOLCANO OBSERVATORY (AVO) SOCIAL MEDIA

AVO has three primary objectives: (1) to conduct monitoring and other scientific investigations in order to assess the nature, timing, and likelihood of volcanic activity; (2) to assess volcanic hazards associated with anticipated activity, including kinds of events, their effects, and areas at risk; and (3) to provide timely and accurate information on volcanic hazards and warnings of impending dangerous activity to local, state, and federal officials and the public. As an AVO partner, and in support of the third primary objective, the Division of Geological & Geophysical Surveys' (DGGS) Volcanology Section is working toward using social media such as Twitter and Facebook to reach a larger and more diverse audience than our current website, fax, and email protocols provide.

Since the 2009 eruption of Redoubt, AVO has had a presence on Twitter. This account has evolved over the past couple of years and now entails our use of Twitter's application programming interface (API). The Hazard Alert Notification System (HANS) automatically "tweets" a portion of any Volcanic Activity Notification, with a link to the full text. We have received very positive feedback from our use of Twitter, and have been reviewing other hazard-monitoring agencies' uses of social media (e.g., the National Weather Service). Because of the Twitter success, and with encouragement from members of the public and emergency managers, we plan to create a Facebook account that also uses an API, to auto-publish our updates. In addition, both APIs could be automated to easily post administrator-reviewed images to the accounts.

We believe social media can be an excellent tool to provide rapid communication to our diverse user base, as long as the information we post to social media (1) is not different from what we post in our formal notices, (2) continues to provide a link to full and complete information (rather than being an informational dead end), and (3) does not require unreasonable staff time for monitoring and maintenance.



AVO's Twitter page (http://twitter.com/alaska_avo) displays bits of information from the latest information releases as well as figures and images of note. Currently there are more than 11,000 individual users following the account.

Contacts: Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov
Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov