VOLCANIC ERUPTION RESPONSE: CLEVELAND, SHISHALDIN, AND PAVLOF VOLCANOES

In 2014, volcanic eruptions occurred at Cleveland and Shishaldin volcanoes in the Aleutians, and Pavlof volcano on the Alaska Peninsula. During volcanic eruptions and unrest, DGGS Volcanology Section staff spend a significant amount of time responding to the events. Responsibilities include responding to emails from the public, ensuring the public website contains the most up-to-date volcanic information releases and photographs, keeping the internal data flow manageable through the internal website and communications log, participating in daily seismic and remote sensing data monitoring checks, contributing to eruption scenario forecasts, and keeping a detailed record of ash fall, eruption chronology, and the eruption's impact on air traffic and infrastructure.

Eruptions at Cleveland volcano have been ongoing throughout historic time, with only brief cessations in activity. A renewed phase of unrest began in late December 2013, with minor ash plumes detected in satellite data and cloud heights less than ~15,000 feet above sea level. After three months of no detected activity another explosion occurred on June 5, 2014. During the summer of 2014, the Alaska Volcano Observatory (AVO) added seismic, infrasound, and web-camera monitoring equipment on Chuginadak Island (fig. 1). To our knowledge, these are the first-ever geophysical monitoring stations on or near highly-active Cleveland volcano. The work was made possible in part by logistical support from a three-year, multidisciplinary National Science Foundation project on Geological Hazards, Climate Change, and Human/Ecosystems Resilience in the Islands of the Four Mountains, Alaska.

On January 30, 2014, AVO raised the Aviation Color Code at Shishaldin Volcano to yellow after increased surface temperatures were detected in the summit crater. In March, analysis of elevated temperatures detected in satellite imagery indicated that lava was erupting in the summit crater and the color code was increased to orange. An overflight on August 10, 2014, confirmed incandescence in the crater (fig. 2). Due to continued thermal anomalies in satellite imagery and above-background seismic activity, Shishaldin remains at Aviation Color Code orange and we continue to monitor the volcano closely.

The most recent eruption of Pavlof volcano, which began November 12, 2014, intensified on November 15, sending an ash cloud to 25,000 feet above sea level (fig. 3). Lava fountaining and ash clouds could be seen from Cold Bay, and residents reported hearing rumbling during the more intense phases of the eruption. Pavlof, arguably the most active volcano in Alaska, also erupted earlier this year (May 31 through early June), repeating the eruptive style of the 2013 eruption with elevated seismic activity, lava fountaining, and occasional steam, gas, and ash plumes to 22,000 feet above sea level.

For a complete record of these eruptions and others, visit the Alaska Volcano Observatory website at www.avo.alaska.edu.

Figure 1. Steam rises from the summit of Cleveland volcano as viewed on November 19, 2014, from the newly installed web camera on Chuginadak Island, about 15 km (9 mi) east of the volcano's summit.

Figure 2. Incandescence in the summit crater of Shishaldin Volcano on August 10, 2014. Photo by Cyrus Read, USGS.

Figure 3. Satellite image from the NASA/USGS Landsat-8 satellite showing the eruption cloud at Pavlof volcano on November 15, 2014, at 12:46 pm AKST (21:46 UTC). This is just a portion of the eruption cloud, which extended for more than 250 miles to the northwest at the time this image was collected. In this image, the distance from the erupting vent (lower right) to the upper left corner of the image is 45 miles (70 km).

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ALASKA TEPHRA DATABASE

In 2014, DGGS Volcanology Section staff began Phase I of the Alaska Tephra Database development plan. The end result will be the first-ever comprehensive database of Alaska tephra (volcanic ash). This database will house all pertinent information on Alaska tephras necessary for sample processing, archiving, and scientific research. Developing correlations of tephra records across Alaska and the northern hemisphere requires an understanding of the age, chemistry, and character of tephra deposits. Tephra studies are a key component in understanding the magnitude and frequency of volcanic eruptions and help improve volcanic ashfall hazard assessments (fig. 1). In addition, tephrostratigraphy is an integral part of linking marine, lacustrine, and terrestrial records to aid research in paleoclimate studies and archaeology (fig. 2). Currently, Alaska tephra chemical, stratigraphic, and age data are dispersed in hundreds of publications and unpublished lab results, making efficient querying of data for specific research purposes impossible. Creating and populating a single, comprehensive tephra database and developing web portals for easy access will alleviate this difficulty, and open up Alaska tephra data to geoscientists everywhere.

Phase I accomplishments include: (1) loading of test datasets; (2) ability to query glass geochemical data by sample ID, source volcano, and glass chemistry; and (3) computation of glass chemistry similarity coefficients for multiple tephra samples. Phase II, to begin in 2015, will consist of: (1) sorting tephra datasets in preparation for geochemical and sample metadata upload; (2) developing a streamlined upload process for new data; (3) developing a database schema to store age data; and (4) developing a database schema to hold sample fraction information. Phase III project goals include expanding the database to store sample preparation details and individual grain-point and mineral analyses, and creating a laboratory database interface for post-field sample preparation.

All members of Volcanology Section are involved in this project, combining their expertise in a concerted effort to create and maintain a scientifically relevant and user-friendly database of Alaska tephras: Janet Schaefer, tephrochronology; Cheryl Cameron, database development; and Seth Snedigar, programming. This is a multi-year effort and the group is working closely with USGS geologist Kristi Wallace and the USGS Alaska Tephra Lab, housed at the Alaska Volcano Observatory office in Anchorage.

Figure 1. (left) DGGS geologist Janet Schaefer inspects layers of volcanic ash (tephra) erupted from Makushin volcano, near Dutch Harbor/Unalaska. Photo by USGS geologist Christina Neal, August 9, 2013.
Figure 2. (far left) Photo of 1 meter of lake core extracted from Mother Goose Lake near Chiginagak volcano. More than 50 tephras are preserved in cores like this from Mother Goose Lake, recording more than 3,000 years of volcanic activity at Chiginagak volcano and nearby volcanoes on the Alaska Peninsula. Photo by Chris Kassel, former graduate student at Northern Arizona University.

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GEOLOGIC DATABASE OF INFORMATION ON VOLCANOES OF ALASKA (GEODIVA)

DGGS Volcanology Section staff design, populate, maintain, and distribute the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA). GeoDIVA maintains complete, flexible, timely, and accurate geologic and geographic information on Quaternary (Pleistocene and younger) volcanoes in Alaska. This data supports scientific investigation, crisis response, and public information in a dynamic, digital format. GeoDIVA is the most comprehensive and up-to-date source of information for Alaska volcanoes available. This database is also the back-end of the public and internal websites of AVO.

GeoDIVA has been developed in modules, and currently uses more than 300 MySQL tables. GeoDIVA grows by continual feeding of new data into existing modules and by episodic surges of growth as new modules come on line. See the table below for completed, in progress, and planned modules.

Module	Status	Notes
Bibliography	Maintenance mode	Contains ~4,800 references
Basic volcano information	Maintenance mode	145 major volcanoes, 178 sub-features; descriptive text update in progress
Eruption history information	Maintenance mode	Information and references for 627 historical eruptions and non-eruptive events
Images	Updated in 2014	More than 22,000 images
Geologic sample information	Maintenance mode	11,797 samples and metadata
Geochemistry	Maintenance mode	Published in 2014
Petrology	Data created and loaded intermittently	Intent is to build an Aleutian-Arc-wide collection of thin section descriptions and images
GIS data	Flexible holding database built, not populated	Awaits personnel time to inventory existing GIS data
Hand-sample storage	Update planned for 2014-2015	More than 8,200 archived samples have been moved to improved storage; see separate briefing paper
Ash—Is it falling?	Maintenance mode	Website and database for citizen ashfall reporting
Internal logs and contacts	Updated in 2014	Supports internal AVO communications
Vent Inventory	Merging separate database with GeoDIVA	Published in 2014; nearly 1,200 known Quaternary volcanic vents in Alaska
Satellite observations	Planning and test construction	Scheduled for 2015
Tephra data	Planning and test construction	See separate briefing paper
Geochronology	Schema built	Lesser priority than satellite obs and tephra

Our recently-published geochemical database module is available at https://www.avo.alaska.edu/geochem/ and contains more than 5,200 published whole-rock analyses on Quaternary volcanic rocks in Alaska. This database is searchable by map location, volcano, eruption, citation, sample metadata information, or specific geochemical values and analysis types. Users can query the database and retrieve fully-documented .html or .csv tables. This database is a valuable research tool for geoscientists with interests ranging from volcano-specific processes to whole-arc data synthesis.

As part of our in-progress tephra database (see separate briefing paper), we are expanding the sample metadata and analysis abilities of this whole-rock geochemical database to hold electron microprobe analyses of glass grains.

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ALASKA VOLCANO OBSERVATORY (AVO) HAZARD COMMUNICATIONS

One of AVO's primary responsibilities is to provide timely and accurate information on volcanic hazards, and warnings of impending dangerous volcanic activity to local, state, and federal officials and the public. AVO issues event-driven messages that require immediate action (such as warnings of immediate or ongoing eruptions), as well as less time-sensitive scientific publications and information about non-eruptive volcanic phenomena. In all cases, AVO wants information delivered to all interested persons in their most useful format. Code development and programming maintenance for all AVO web-driven communication pathways is a primary responsibility of DGGS Volcanology Section staff.

Time-sensitive, immediate-action messages are crafted in our Hazard Notification System (HANS, developed and maintained by DGGS–AVO staff) and then distributed via HANS to our website (www.avo.alaska.edu); our Volcano Notification Service (VNS, developed and maintained by DGGS–AVO staff) email list; a fax list; our Twitter feed (@alaska_avo); and our Facebook page (http://facebook.com/alaska.avo). During a significant volcanic event or Aviation Color Code change, AVO also makes phone calls to other agencies, in accordance with the Alaska Interagency Operating Plan for Volcanic Ash Episodes. Depending on the volcano and eruption, AVO staff in Anchorage typically call the Federal Aviation Administration (FAA), National Weather Service (NWS), Center Weather Service Unit (CWSU), Joint Base Elmendorf/Richardson, U.S. Air Force Weather Agency (AFWA), Canadian Meteorological Centre, the U.S. Coast Guard, and the Alaska Division of Environmental Conservation. AVO staff in Fairbanks call the Alaska Division of Homeland Security and Emergency Management, the Governor's Office, Eielson Air Force Base, and Fort Wainwright.

AVO also has message products that are less time-sensitive, such as formal scientific publications, updates on current investigations, eruption anniversary science nuggets, selected scenic or informative images, and talks and presentations given to the public. These items are highlighted on our website in our "News" area on the home page, and often posted to Facebook.

Communicating science results and hazard information is a critical responsibility of everyone at AVO. We strive to share timely, accurate, helpful, and consistent information that reaches our many audiences and reflects well on the AVO organization and mission. As an AVO partner, the DGGS Volcanology Section is responsible for delivering AVO's messages via the website, the VNS, Facebook, and Twitter.

Most of our audience is reached via the website, which sees about 80,000 unique visitors per month, even during times of no eruption. About 8,000 people have signed up for color code change emails via VNS, and about 13,300 receive our updates on Twitter. The Facebook page has a modest 2,500 likes, but some images and updates on Facebook reach more than 100,000 people within hours. Facebook also provides a unique form of two-way communication between citizen observers of eruptions and AVO, especially for eruption photos and information about eruption impacts. AVO's foray into social media is relatively new, and DGGS–AVO staff recently crafted a communications policy document to help guide our agency's interactions on social media, as we want to continue to present the highest-quality and most helpful information via all of our media channels.

Pavlof Volcano in eruption on June 2, 2014. Photo courtesy of William Yi, U.S. Coast Guard, submitted to AVO via Facebook.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

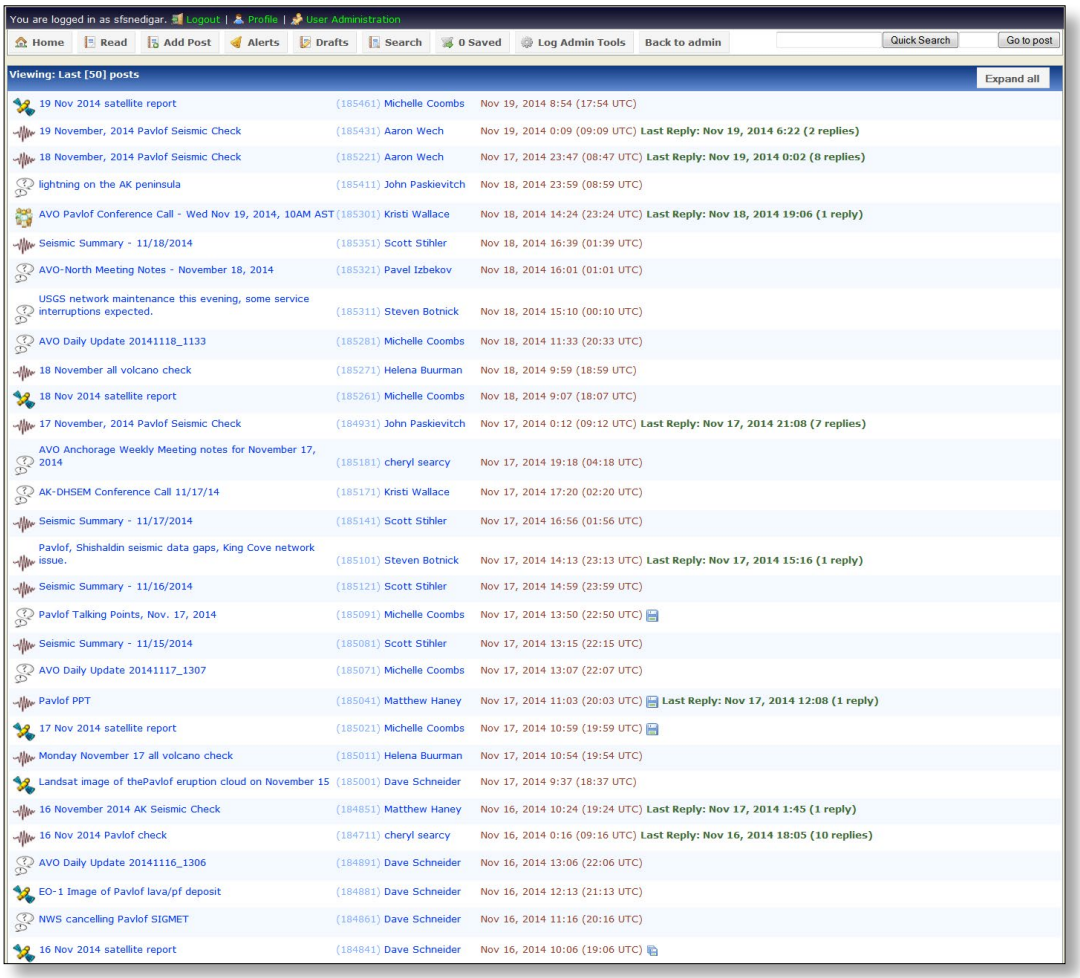
ALASKA VOLCANO OBSERVATORY (AVO) INTERNAL COMMUNICATIONS

The AVO internal website is home to several tools used by AVO scientists to monitor volcanoes as well as share information among Observatory staff. One of the most frequently accessed tools is the communication and observation logging system. All of the daily workings of the Observatory are stored in these searchable logs: daily seismic checks, satellite reports, infrasound observations, GPS observations, formal information products, geologic interpretations, and fieldwork flight following. The logs are accessible by all AVO staff and allow for discussion strings that can include photographs, interpretative graphs, and data files. Code development and programming maintenance for these web-driven communication tools is a primary responsibility of DGGS Volcanology Section staff.

Applications on the internal site are continually refined with software updates and user-requested features and capabilities. Newly added log system features include allowing uploaded images to be displayed in-line with text and emails, auto-recognition of keywords and volcanoes, easy uploading of files and images by url or from the user's computer, and the ability to email a log post to selected addresses.

The user management system that drives access to the logs and other internal applications received a much-needed upgrade this year. Previously, a basic username and password allowed users to access any part of the internal website—much of the website could be viewed without a username at all. Now the site requires individual logins and each user can be assigned specific permissions. For example, individual user accounts can be given permission to only read the logs, or post to the logs, or be restricted to various other sections of the internal site. Accounts can be given an expiration date—useful for managing the access of interns and graduate students.

DGGS Volcanology Section staff are currently upgrading the mobile logs software. This upgrade aims to reproduce most of the functionality of the desktop version of the logs while being easily useable on any mobile device.



During times of heightened volcanic unrest and activity, such as the November 2014 eruption of Pavlof Volcano, the logs are heavily used. This is the main reading page of the logs, showing three days of posts.

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ALASKA VOLCANO OBSERVATORY (AVO) ROCK SAMPLE ARCHIVE

AVO collects rock, tephra, soil, water, and other material samples in support of our scientific objectives to monitor and study Alaska's volcanoes. These materials are currently stored in separate facilities in Anchorage and Fairbanks. AVO's Anchorage-based samples will be moved to the new DGGS Geologic Materials Center facility in 2015, and we plan to also move AVO's Fairbanks-based collection there sometime in future years. DGGS Volcanology Section staff manage and archive the samples stored in Fairbanks.

Figure 1: Hand sample specimen of the post-April 4, 2009, Redoubt lava dome, collected by Kate Bull, DGGS-AVO.

Several years ago, DGGS–AVO inventoried and cataloged all of the hand samples, analysis powders, thin sections, and thin section offcuts held in AVO Fairbanks' "cold storage" building—about 8,200 samples in all. Physical sample locations are tied to sample metadata in our geologic database wherever possible. For some samples, we now can see all of the sample's descriptive information, references, hand sample storage location, analysis results, and images (e.g., photomicrographs, hand sample photos) on one page. DGGS Volcanology Section staff also conduct quality assurance/quality control of AVO whole-rock samples sent to Washington State University GeoAnalytical lab for XRF and ICPMS analysis. We ensure sample and station information are in the database, verify which samples are sent, check the analysis results for accuracy, enter the geochemistry in the database, and distribute the information to AVO geoscientists.

During summer 2014, the University of Alaska Fairbanks Geophysical Institute offered AVO the opportunity to move these samples from an unheated and dimly lit building in the back parking lot of the Geophysical Institute to the repurposed University Park school building—featuring light, heat, plumbing, and cellphone access. Samples were physically moved during fall 2014, but we no longer have a current inventory of which shelves contain which boxes.

Figure 2: AVO/University of Alaska Fairbanks geologist Jess Larsen and graduate student Mariah Tilman carry Augustine samples back to the helicopter for analysis and archiving in Fairbanks. Photo by Michelle Coombs, AVO–USGS.

Beginning in December, 2014, we will reorganize these boxes and shelving, as well as catalog newly arrived samples. We will also populate spreadsheets of sample metadata for the eventual move of these samples to the GMC facility in Anchorage.

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ALASKA VOLCANO OBSERVATORY (AVO) WEBSITE

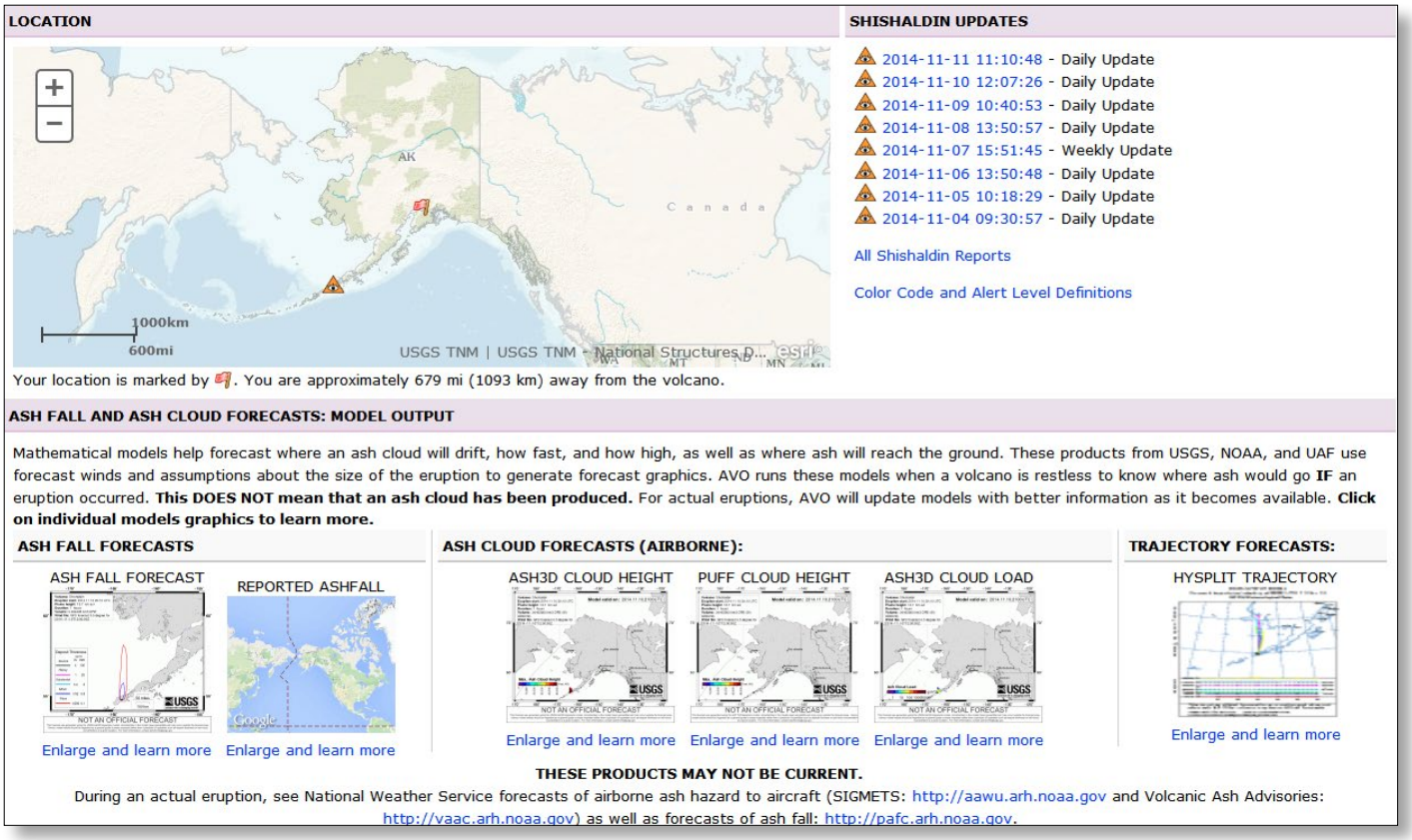
The AVO public website (http://www.avo.alaska.edu) serves about 2,800,000 pages to more than 80,000 unique visitors per month, and is among the top ten most-visited USGS and USGS-affiliated websites in the country. It continues to be the most complete single resource on Quaternary volcanism in Alaska. The Alaska Division of Geological & Geophysical Surveys (DGGS) was the original creator of the AVO website in 1994, and the Volcanology Section continues to design, build, and manage the site. The website is dynamically driven by the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA).

This year saw the first graphical change to the website in several years. While the layout of items on the pages remained relatively stable, the colors and section borders have become less bold, making the pages appear more open and uncluttered.

Pages showing current activity at an individual volcano have received some important updates, including improved ashfall information and the ability for users to determine how far away they are from an active volcano. Images displaying modeled ash cloud and ashfall information are generated twice a day by the USGS Ash3d tephra modeling system. These images are then copied to the AVO webserver for public use. Also, users can now click a button that (with permission) retrieves their approximate location, plots that location on a map, and returns a distance measurement to the volcano of interest.

In addition to housing thousands of Alaska volcano references contained in the online library (https://www.avo.alaska.edu/downloads/index.php), the website is also home to AVO's recently published geochemical database (https://www.avo.alaska.edu/geochem/index.php) and serves as the primary portal to access that information. All searches and data displays or downloads reside within this portal on the AVO website.

DGGS–AVO is on the leading edge of web and database development for volcano observatories nationwide, and portions of DGGS-written database software have been installed at other U.S. volcano observatories. DGGS is monitoring new and emerging technologies that will allow us to further improve AVO's web presence and data dissemination methods. We continually refine and enhance the applications that AVO and other observatories use regularly. We will maintain our focus on continued improvements to the site, and serving new database modules as they become available (see briefing paper on the Geologic Database of Information on Volcanoes of Alaska for additional information on the database modules).



Shishaldin volcano's activity page, showing Ash3d model images and a map displaying the user's approximate location and distance from the volcano.

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