CONVERSE Volcanic Gas and Remote Sensing Meeting Report

CVO September 12 and 13, 2019

Conveners: Tobias Fischer (University of New Mexico); Simon Carn (Michigan Tech); Peter Kelly (USGS – CVO)

Participants:

Deborah	Bergfeld,	USGS-CalVO
Laura	Clor	USGS-CVO
Dennis	Geist	NSF
Christoph	Kern	USGS-CVO
Peter	La Femina	Penn State
Allan	Lerner	U. Oregon
Taryn	Lopez	UAF
Jacob	Lowenstern	USGS-VDAP
Paul	Lundgren	NASA-JPL
Patricia	Nadeau	USGS-HVO
Sarah	Peek	USGS-CalVO
Vincent	Realmuto	NASA-JPL
Kevin	Reath	Cornell
Florian	Schwandner	NASA-Ames
Jean-Paul	Vernier	NASA-Langley

Agenda and speakers:

Thursday (September 12):

8:45 Introduction (Fischer)
9:00-10:30 Science motivations for volcanic eruption response
Talks by: Carn, Schwandner (15 min each)

coffee break

11:00- 12:30 Response to Kilauea eruption: the gas perspective and academia involvement
Kelly, Nadeau, Kern 11:00 – 11:50 Talks plus discussion
Lundgren, Realmuto 11:50 – 12:10 Talks
Further discussion 12:10 – 12:30

12:30 - 2:00 Lunch

2:00 - 3:30 Remote sensing approaches to early detection, response, precursory signals
Carn, Realmuto, Lopez, Reath (15 min each) followed by discussion

coffee break

4:00 - 6:00 The role of USGS, VDAP, observatories in eruption response and how to manage precursory activity, site access, data collection, sample distribution etc. with academic community
Lowenstern, Moran (15 min each) followed by discussion

7:00 Group Dinner.

Friday (September 13)

9:00 - 10:30 Discussion: Opportunities for agency-academia collaboration in eruption response. Includes short presentation by Dennis Geist on NSF possible funding mechanisms for such responses.

coffee break

11:00 - 12:30 Discussion: technology, data sharing
split into groups: remote sensing, automation, drones, data, others as needed.

12:30 - 2:00 lunch

2:00 - 3:00 Discussion of summary, action items.

The meeting and discussion resulted in the following main outcomes:

1. Science motivations for volcanic eruption response from a gas and remote sensing perspective

    - What processes makes a system move from quiescence to unrest to eruption and how can we distinguish between the potential processes related to:
        - magma injection
        - conduit sealing
        - water-magma interaction
        - earthquake triggering
    - Can we predict the type of eruption and its climate and environmental impacts?
        - excess sulfur – aerosols
        - gas impacts on the region
    - How variable is transfer of volatiles from earth's interior to surface through volcanoes in space and time?

    - All data needs to be open and accessible (treat eruption response like a community experiment)

- Other, more practical science goals for an eruption response:
    - Collect information for hazard response
    - Recording of transient data

2. Key capacities from academic science community related to gas remote sensing and gas geochemistry

   The USGS currently lacks substantial expertise in satellite remote sensing of volcanic gases. The academic community can contribute capacity in satellite remote sensing during or preceding eruptions, providing data products (e.g., SO_2 loading or emission rate) and interpretation on a 'best-effort' (i.e., probably not 24/7) basis.

   NASA is interested in targeting eruptions that release ≥ 5 Tg SO_2 (i.e., with potential climate impacts) and is prepared to send aircraft, balloons, drones to make critical measurements quickly. Note that this is not restricted to eruptions of US volcanoes.

   NASA has a major volcanic eruption response plan (https://acd-ext.gsfc.nasa.gov/Documents/NASA_reports/Docs/VolcanoWorkshopReport_v12.pdf). Hence, in the event of a major eruption (≥ 5 Tg SO_2) at a US volcano (including US territories such as the Commonwealth of the Northern Mariana Islands [CNMI]),), significant NASA observational assets could be made available.

   Plant stress and die back is a known consequence of high upflows of volcanic CO_2. Greening of plants may be an indicator of changes in CO_2 flux on flanks of volcanoes – there may be a geo-bio connection and NASA has the ability to detect via satellite, and is working with academic and USGS partners to learn how to interpret these changes.

   Gas geochemistry bridges the gap between petrology and geophysical observations such as seismology and geodesy.

   Plume velocity can be determined with remote sensing capabilities.

3. Some lessons learned from 2018 Kilauea eruption

    - Real-time petrology of samples by XRF at U of Hilo was extremely informative of the state of the magma system.
    - Assistance from a University intern already onsite was crucial for the operational response. Additional USGS staff from other parts of the Volcano Science Center rotated through to facilitate field work throughout the eruption. Other USGS staff provided remote support (instrumentation, data analysis & interpretation, contributing to forecasting) full-time.
    - Additional gas expertise was identified and then solicited by targeting individuals from the academic community to provide: FTIR – Simon Carn; Aerosol sampling – University of Leeds.

- Many academic groups wanted to come to Kilauea during eruption and collect samples, not all were granted access.
- An ad-hoc committee that included academic and USGS representatives identified knowledge/technique gaps, invited proposals and then evaluated these proposals by internal evaluation and by external reviews to decide which projects should go forward. All non-USGS collaborators came with their own funding for travel and analyses. Proposed work needed to be mutually beneficial.
- Ph.D. student Allan Lerner was an example of how students can become involved with USGS during an eruption/crisis. He has worked with USGS in the past, was trained in field instruments and techniques, had all necessary administrative training, and had volunteered at HVO previously.

4. <u>Some key aspects of a response to next Cascade volcano eruption</u>
   - Emergency managers need accurate information in a near real-time.
   - Teams need to be at several (probably 7) places around the volcano and communication between them is critical like through an Incident Command System (ICS).
   - ICS will allow access to volcano for scientists.
   - Access will be to people they know and trust.
   - Debate internally but speak with one voice

   Scientific advisory panel for CVO
   - Representatives from greater scientific community.
   - Its primary role during crisis is to be interface between CVO and science community.
   - Evaluate and prioritize scientific proposals requiring access to the volcano.

5. <u>Plan for what is available and what is needed in terms of forecasting the eruption and the end of the eruption</u>
   - Are we ready for the volcano scientifically? – answer is most likely no.
     - Subject matter focused workshop for each volcano or volcano group.
     - Adequate volcano models.
     - Probability tree.
     - Monitoring aspects (gas, seismic, deformation, petrology).

   - Establish the roles and rules of engagement for outside people
     - Information is needed in terms of what can be done ahead of time, establish links between researchers.
     - Need organized lists of pools of people and capabilities.
     - Gas people, drone people, labs, equipment and instruments that can be mobilized.
     - What are the critical things we can measure and detect?

6. <u>Important outcomes</u>

a) <u>Communication, organization</u>

- Establish early communication between NASA and observatories, with some limitations (NASA doesn't have an operational monitoring mission). See also NASA eruption response plan, Fig. 1.
- NASA Ames Research Center (airborne and UAS center of NASA, with strong gas & aerosols groups) and USGS Menlo Park are in the process of co-locating at Moffett Field, CA – to be exploited more.
- USGS is very interested in scientific aspects of volcanic eruptions and eruption forecasts.
- USGS does not want to be a gatekeeper of data or access during eruptions but has pre-defined role during eruptions.
- Set up academia-USGS collaborations during non-crisis times, ideally through smaller but key joint projects.
- Prepare during non-crisis for eruption.
- VDAP provides an example of how to manage volcano crises in other countries and what lessons can be learned from involving numerous scientists in eruption responses.

b) <u>Techniques, Data</u>

- If there are specific tools/techniques that academia can offer during a crisis, a memorandum of understanding (MOU) (or some kind of agreement) should be established so that this capacity can be added when needed.
    - It would be very beneficial if non-USGS partner agencies (i.e., NASA) would allow for some scientists to work full-time on eruptions when increased capacity is needed for a response. This could be part of an MOU.
- Train people in commonly used tools and techniques.
- Establish synergies between satellite and ground-based techniques.
- Establish plan about how to share data and samples.
- USGS often has lots of data but sometimes not enough people to look critically at this data – this could be good opportunity for student involvement or even student projects for a class.
- Better plume speed modeling is needed for gas flux determinations.

c) <u>Training the next generation</u>

- USGS and NASA have started a new joint postdoc program; first two are on board at Moffett Field CA. To be developed further.
- Suggestion to consider an informally coordinated internship stream between and from NASA and/to USGS.
- Ensuring good coding skills and cross-agency awareness, knowledge, and skills. There are training opportunities for this at NASA
- Workshops on Volcanoes (WOV) training program.
- Temporal graduate student and postdoc residency at USGS observatories:
    - On-site training/mentoring is a critical aspect of gaining field/lab experience and building trust between USGS and students, which may

be highly beneficial in the event of an eruption response and/or in subsequent data analysis and interpretation.
  - One promising mechanism for graduate student involvement with USGS is through the NSF-GRIP (Graduate Research Internship Program), which provides funding for students working on NSF-grants to spend time on-site with federal departments (including USGS +/- NASA) for collaborative work.

c) Some generally applicable lessons

- Know what a new data stream requires in terms of field support from observatory.
- Satellite data can be very useful for eruption response.
- Need for coordinated satellite response and communication between satellite people and observatories.
- Successful collaborations during crises are generally established before the crisis.

7. Funding opportunities

RAPID awards are most suited for eruption response. Funds mainly travel and some preliminary analyses or measurements. Not for full science investigation, not for salaries. Can be turned around within 24 hours. Key is to have approval from observatory to be allowed on the volcano to collect the data or samples, data and samples needs to be completely open to science community. If several groups want to go to eruption, groups need to self-organize and submit one proposal. Need good science question that can be addressed by timely/transient data. Contact program director in advance before submitting proposal.

8. *Proposed Sequence and Process for Academic Involvement in Volcanic Eruption Response*

1. Academic community needs to have a well-documented pool of capabilities.
2. USGS and Advisory Group needs to be aware of these capabilities.
3. USGS and Advisory Group requests academia support from this pool.
4. Academic scientists submit a proposal to USGS.
5. Proposal is evaluated by Advisory Group, changes are suggested and discussed.
6. Academic scientist contacts NSF PO and writes RAPID with USGS letter in hand.
7. Work is done at volcano and data and samples are shared if possible in real time and to entire science community.