CONVERSE Eruption Dynamics Workshop 14 Dec 2019

OBSERVATIONAL VOLCANOLOGY BREAKOUT GROUP

1) Hardware issues

Choice of key items

- Because of the need for extremely rapid response at the onset of explosive eruptions there is a need for a central cache, or caches, of key hardware that can be deployed rapidly 'off a single shelf'.

- There is a tradeoff between (1) having bought hardware immediately available in a CONVERSE repository (but potentially becoming redundant quickly) and (2) buying the latest and newest items off-the-shelf immediately when a crisis starts.

- There is no single solution as some items fall under (1) and other (2).

- High speed cameras are very data-greedy. With future purchases we must look to much longer recording times (currently a single Strombolian explosion requires about 1GB per second of virtual memory).

- There is a growing inclination to use cheap, portable time lapse cameras.

- A future requirement are cameras that don't need a long time to transfer data: transfer times of 20-30 minutes are common with many devices.

-The final report should contain a list of hardware that can be bought immediately and a list of items where purchase can be delayed until the time of a deployment (ACTION ITEM).

- Our deployments of camcorders should be augmented by synchronized time lapse cameras, portable infrasound array, and portable seismometers.

Network Design and Execution

- Science response scales with the eruption: we must match observations and networks to style, intensity, and frequency.

- Most deployments will require multi-sensor stations, time-lapse cameras, high-definition remotely programmable, infrasound, thermal and high-speed cameras.

- There is a distinction between the response in periods of unrest and during the eruption. Separate elements will be needed.

Use of UAV/UAS

- Specifics of drones' use is very dependent on the event and also issues such as accessibility and permitting.

- We should explore the feasibility of access to longer range drones, currently not accessible to volcanology (in 2018 single drones could not cover the whole flow field, or estimate total volume).

- This brings with it the requirement to be certified to fly beyond line-of-sight. This time-consuming and ideally should be negotiated at high level in advance.

- The future will contain the option of a network of synchronized drones flying together.

- Drones greatly extend our options for night-time observation, which is currently possible only during a state of emergency.

2) Operational Issues

- A key requirement is GPS synchronization of all techniques.

- Integration of observational/geophysical data streams and gas data at 1 Hz or better, a major short-term goal and involves working cross CONVERSE discipline groups.

- Transportation of hardware to crisis volcanoes is a significant problem.

- A major issue is the restrictions on transportation of lithium polymer batteries on aircraft; this may necessitate stockpiling of batteries in multiple locations, each within driving distance of active or awakening volcanoes.

- Many short-lived eruptions offer a limited time window for close observation (i.e., a few hours), we must plan in advance for what we want to and can do in this window.

3) Organizational issues, including permissions

- USGS and university collaboration is vital with written 'recipes' for personnel and hardware roles.

-Partnerships with other agencies, such as the Forest Service, National Parks and State and other larger land agencies, who may be interested in longer term data series is a path to explore in advance of eruptions in the future.

-We must have the science equivalent of ‘call-down lists’ knowing (1) what hardware is out there, (2) who is available and (3) how to contact/call them.

- How to get around obstacles of land access, such as permitting is a major issue.

- USGS is a key with high levels of prior trust and contact with land managers and owners.

- There is already advanced discussion in the VO’s before eruptions about access etc.

- Separation of roles of the primary monitoring team, and secondary data-collecting teams are seen as highly desirable after the 2018 LERZ eruption.

4) Outreach, and Data Sharing

- There is clear recognition for science to speak with a single voice, through the established channels of the Volcano Hazards Program.

- A strategy of sharing/uploading raw data is needed especially in real time.

- Information transfer via social media is a key issue, the need is for professionals in this field again under the auspices of the Volcanic Hazards program.

- Access to the closed zones during an eruption (to monitor or make observations) carries special obligations in terms of the flow of information or opinions to land owners/managers.

TEPHRA BREAKOUT GROUP

1. Access to Hazard Zones for Sampling

- Permitting (who issues the permit, to how many, for how long, restrictions in terms of what can be achieved with the permit, etc.)

- In a crisis, the priority is to determine deposit locations and sample each
    - Mapping info to campaign/advisory committee leader
    - Coordination if several teams targeting different locations

2. Database of Institutions/Laboratories/Personnel

- Reiterate need for lists of:

- Institutions: Sampling instruments and capability
- People: who has expertise, who have proper training, and how fast can they arrive, how many can come and are needed

- Crucial for efficiently requesting and using access/funding (e.g., NSF RAPID) when a hazard arises

- We should have established skeleton plans based on location/eruption type/how many teams are allowed to work in the hazard area at a given time
- Work with sponsored projects offices at listed institutions to streamline their processes for submission and acceptance of RAPID funding

3. Document Science Needs, Goals, & Methods

- Identify: Science goals > Analyses required > Samples required (type and amount) > What/where to sample

-Many goals can be satisfied with a small (1–2 kg) sample volume

- Tephra sampling is strongly time-critical: which samples are required to be collected in what time window

    - If possible, preserve samples to do analysis later, away from sampling site

- Table of instructions or checklist with priority printed on waterproof paper

    - Min. sample volume, ideal sampling location, citation for best practices paper (see Kristi Wallace USGS documents and documents produced by Tephra group Marcus/Kristi)
    - Create videos to give example of typical procedure for sampling location quickly and efficiently (use opportunity with AVO?)
    -

- Standardization of sample naming scheme based on IGSN (see geosamples.org)

4. Sample Curation & Equity

- Sample Archivist

    - Coordinate sample curation and distribution
    - Bulk samples for multiple users should be distributed immediately

- Recommend all observatories adopt the AVO database model

    - Establish pipeline for sample data á la NASA Planetary Data System
    - Enter your samples into SESAR/IGSN!
    - Standardized sample naming scheme (as part of sampling procedure)

5. Hardware/Software

- Identify low-effort, low-tech sampling “instruments” and opportunities (e.g., collection bucket next to seismometers that can be retrieved every time the seismometer is checked during the summer)

- Readily available, bullet-proof

- Use Strabo during data gathering for rapidly linking and mapping tephra layers in real-time

- AVO sends out pre-stamped citizen science kits

    - Send thank you notes with SEM image of the sample
    - Need someone in charge of the logistics

- Development of passive, time-incremental sample collection system

    - e.g., Japanese carousel collector system

MODELLING BREAKOUT GROUP

1. Overall Needs

- High-quality observational data to initialize the models and improve scientific understanding of underlying processes
- Collaborative effort among academic and government modelers to support observatory response efforts in times of unrest
- Access to a semi-public web platform with subject matter experts to vet and discuss observations and scientific needs in near-real time
- Conduct modeling studies in advance of a crisis, over a wide parameter space to identify likely scenarios

2 Conduit Processes and Fragmentation Model Needs

(Not considered extensively)

- What TGSD gets generated at the onset? Can we predict it by modeling the subsurface dynamics? Or is it something that should/could be measured remotely (after instrument development/improvement)?

3. Plume Model Needs

Input needs

- We need improved characterization of:

- Mass eruption rate
- Atmospheric mass loading
- Total grain size distribution / fine ash fraction / particle shape and density
- Level(s) of injection / vertical distribution of mass
- Aggregation and other processes that enhance fallout

- Ash resuspension– emissivity of ash as a function of grain size, moisture content, and wind speeds

- If using 1D models like Plumeria, have colleagues with 3D models who can supplement the efforts offline

- Have 3d models running in the background all the time for high priority volcanoes (using USGS alert levels as a guide for the priorities)
- What can we get from 3D models that we can't get easily from other means:
    - Water development in the plume (external water + atmospheric)
    - Vertical distribution of mass
    - Convective instabilities and partial column collapse
    - Ascent of secondary or co-PDC plumes
    - Separation of ash and gas in the atmosphere
    - Links between plume height and MER in different atmospheres
    - Time varying source conditions to consider uncertainties – pulsatory eruptions, unsteady eruptions
    - Plume-atmosphere feedback

Hardware/Software Needs

- Improved characterization of volcanic plume dynamics would be aided by time-series of multiparametric data that capture key processes during pyroclast injection and transport. We emphasize the following:

- **Video observations** - web cams, game cams (used during the 2018 LERZ eruption), high speed, high-definition, IR and UV cameras (covered in some detail by breakout group on observations)
- **Weather radar** - existing NEXRAD network AND smaller, more sensitive mobile instruments
    - Mobile ground-based radar
    - AVO's c-band weather radar is "transportable not portable", future options with x-band polarimetric
    - NWS Nexrad polarimetric radar – high power but not mobile
- **Satellite detection** - for early plume detection, measuring umbrella spreading rates, plume heights, changes in MER, etc.
- **Infrasound/seismic data** - (to detect seismoacoustics associated with changes in mass eruption rate or vent conditions) - covered by Converse workshops on seismicity and infrasound?
- **Volcanic lightning** to detect plume electrification linked to MER and microphysics in the plume (facilitated by ground-based sensors and high-speed camera work)
- Ground-based lidar – what's the existing network in the USA? Partnerships with NASA and NOAA? Identify academics who have working systems, and can develop
- High-resolution WRF runs for wind data
- Ensemble model runs for ash clouds – a dashboard of different model types; probabilistic modeling
- A GUI that makes ashfall modeling easier– user interfaces for lava flows
    - Software development needs for making the ash dispersal model results more accessible

4. Lava Flow Model Needs

Input needs

- Real time effusion rates would be a game changer

- Footprint of the source area and lava flow thickness (InSAR) – map out where the lava is being effused to update real-time modeling

- DEMs could be provided and made public in a repository (OpenTopography)

- High resolution time series data… modeling is on the order of minutes
- Modeling levees – terrestrial radar interferometry to measure levee deformation fields… can also create DEMs
- Thermal data + deformation can allow characterization of failure processes (breakouts) in the models → useful for linking analogue models with observations

Physics based models

- Needed to characterize arrival times
- Provide the current lava channel geometry to the community
- Very challenging to predict inflation and toe breakouts – stacking vs. inflation. Is it possible to forecast based on thermal data (the hottest point) and thickness…..somewhere between thickest and hottest point; need combination of thermal and optical imaging (see James Farrell, Syracuse lava project, https://agu.confex.com/agu/fm19/meetingapp.cgi/Paper/628488)
- Map out the probability of certain processes (e.g., breakouts)
- Probabilistic models to constrain what you think your volume would be, and tie that into the deformation signal

Hardware/Software

- Drones
- SfM
- Rheology instrumentation
- Terrestrial radar interferometry

5. Lahars / Sector Collapse models (similar needs as lava flows)

- Lahar/PDC studies impacts – areas of mass loss/origin area
- Observations of rainfall – what's the existing network – crowdsourced sensors?
- Small, cheap met stations, particularly rainfall
- Topographic DEMs for all Holocene eruptive centers in the USA (or moderate- to high-threat volcanoes)

6. Personnel needs

- Have an index map of modeling community members and available codes (end-users)

- Who is available to help run these models 6. offline?

    - Links to other agencies, especially NOAA, as well as academics
    - The observatories want access to wider scientific guidance and recommendations for what to look for
        - Need for human hours dedicated to some specific problem or model runs
    - Ultra-rapid NSF proposals – ultra expedited scientific projects
        - USGS external grants program is potentially an option
        - University funding also has restrictions limiting timely ability to accept funding, etc.
    - Can there be an online public platform (like public Mattermost) to post observations and questions
    - A public operational dashboard? ("Twitterdeck")
    - Making a list of experts available ….provide the static list, maintain it, and provide some public questions
        - Spreadsheet of available researchers with information on time available and students available
        - List of lava flow, etc. modelers
        - List of gas dispersion people – University of Hawaii for SO_2 modeling, Vog modelers
    - Have an external board of experts – to vet the people and the responses
    - Computer scientists and software engineers writing NSF grants for volcanology to streamline code, create/maintain GUIs, etc.

- Access, sampling, and where does the output go?

    - Model outputs:
        - Need for a model output repository of past runs
        - Including metadata that goes with the model run
        - Possibly include a template of metadata needed for model archive
        - NSF requirements for data sharing and metadata should be exploited (including versioning)
        - USGS requirements for data/code publication could also be brought to the fore
        - Follow up with archived data: Systematic reanalysis of forecasts and observation.