UPPSALA UNIVERSITET

Safety regulations for field work at volcanoes

Department of Earth Sciences

Contents

1. Summary

The following compendium on safety regulations for work at volcanoes was compiled using a number of sources, but relying most heavily on Aramaki et al., (1994), which is the officially recommended set of guidelines by the IAVCEI (International Association of Volcanology and Chemistry of the Earth's Interior).

For advice on recommended conduct during volcanic crisis (i.e. interaction with other scientists and local authorities as well as the public), the reader is referred to the IAVCEI publications by Newhall et al., (1999) and Donoven et al., (2012).

2. Introduction and background

Research and monitoring the activity of a volcano often requires to approach dangerous sites, such as active vents and fumaroles. In such situations unexpected eruptive activity can jeopardize the lives of volcanologists as well as the lives of those attracted to volcanoes by simple curiosity. In recent decades there has been a large number of unfortunate accidents involving volcanologists. In 1991 three volcanologists together with 40 other people were killed when they were engulfed by a pyroclastic flow from the collapse of a lava dome at Unzen Volcano, Japan. In early 1993 six volcanologists and three other people were killed by

an explosive eruption at Galeras volcano, Colombia and in 1993 two volcanologists were killed by a phreatic explosion at the crater of Guagua Pichincha volcano, Ecuador. Because of these accidents IAVCEI (the International Association of Volcanology and Chemistry of the Earth's Interior) issued a set of safety recommendations that could prevent, or at least reduce, the number of casualties and fatalities at active volcanoes. These recommendations shall be used as mandatory when working at active volcanoes within an UU project and are summarized below. It is hoped that the regulations will help avoid unnecessary disasters involving volcanologists as well as the general public.

3. Planning and logistics

3.1 A research program on a volcano must include a comprehensive safety plan. Such a plan minimizes hazards and can save lives. Each volcano visit requires a targeted assessment as to transport, hiking routes and contact person(s) outside the danger zone. This information must be provided to each team member prior to work commencement, following the general regulations for field work at Uppsala University.

3.2 It is highly advisable that during the planning stage, local authorities responsible for civil defense, disaster mitigation, and rescue should be contacted by the volcanologists, and the procedures to be taken in case of an emergency should be discussed. In fact, there would have to be a very special reason for not doing so (e.g. National safety)!

3.3 The daily work schedule of the field party must be left with local authorities or colleagues who remain outside the hazardous area (see example §7).

3.4 It is highly advisable to contact local researchers, especially where a volcano observatory is in operation. Such contact would reduce possible confusion at the time of an accident and minimize the possible embarrassment of local colleagues who would be the target of media attention. In fact, there would have to be special reasons for not doing so (see above).

3.5 Working alone must be avoided! The size and composition of the field party must be optimised for the specific work plan. A large group would require a different action plan to that for a smaller group. Visits to hazardous areas by very large groups, such as field excursions connected to scientific meetings, must be avoided. Small and highly efficient (experienced) sampling teams should be used whenever possible.

3.6 Do not include inexperienced people like tourists, reporters, TV crews, and others, for travel with scientists into hazardous areas. Dissuade such people from entering hazardous areas on their own. If you invite them, they are your responsibility!

3.7 Participants must be trained in basic first aid and regular safety procedures. If working in special conditions (e.g. polar conditions in the Icelandic winter or desert-like conditions in

high altitude areas (e.g. Chile, Tenerife), dedicated climate-specific advise must be sought and weather-forecasts should be checked regularly!

3.8 In winter or at high altitude, cold, snow, and ice are to be expected and volcanic interaction phenomena like snow avalanches from tremors, phreatic explosions from snow melting, and collapse of snow bridges through creation of caves due to melting of snow and ice must be considered. A snowstorm may totally obstruct movement to and from the volcano and you must be prepared for the possibility of a longer stay!

3.9 An integral part of planning is to evaluate risks of fieldwork and to issue guidelines for safe conduct to all team members regularly. Common sense must always be foremost when planning fieldwork and discussion of alternatives must not be supressed (see e.g. Newhall, et al., 1999).

4. Intelligence on latest developments

4.1 Knowledge of precursory eruption phenomena must be acquired whenever possible. Precursors may differ from volcano to volcano and consultation with local specialists is essential.

4.2 It is highly advisable to keep in radio communication with the observatory or monitoring headquarters located outside the hazard area wherever possible, especially if seismographs and other monitoring equipment is available and under surveillance by the observatory staff.

4.3 Always be alert and avoid hasty action! Approach dangerous spots such as active craters, fumarole fields active, lava flows steep slopes as well as unstable, pyroclastic flow and debris flow deposits with care and only when absolutely essential. Always use the appropriate safety equipment (e.g. hard hat on slopes > 70°, gas mask when fumaroles are active, goggles and thermal protection when approaching geothermal and hydrothermal areas. etc., etc.). Note: usually gas masks used on volcanoes are protective of acid fumes (e.g. S-based fumes), but they do not protect from CO and CO_2! The risk of falling victim to eg. a CO gas-trap is hence not diminished by a standard gas mask!!!

4.4 Work efficiently and spend the minimum time necessary inside the danger area.

4.5 Exposure to noxious gases can be minimized by working upwind of active craters, solfataras, fumaroles, and so on. Avoid fumarole or vents in depressions!

4.6 Avoid difficult routes that may cause fatigue! Always maintain an energy and water reserve in the team (see 4.8) and avoid working at night an less you are fully equipped with headlamps, torches, maps, GPS, etc, etc.

4.7 Avoid valleys that could channel rock or snow avalanches, lava flows, or pyroclastic flows. Avoid depressions that could collect heavy gases or are at risk to rapid (re-) filling by water, sediment, or boulders. Avoid fresh lava surfaces which may conceal hot lava and gas bubbles.

4.8 Be prepared for possible alternative routes into and out of dangerous areas, especially in the event of sudden changes in conditions or if necessary, to evacuate injured team members until help arrives. This may include preparedness for night conditions (eg. A delayed return hike that is not completed before night fall due to unforeseen changes in conditions).

5. Specific recommendations: low level volcanic activity!

The Galeras and Guagua Pichincha accidents were from low-energy events – a blast from a glowing lava dome, and a phreatic eruption, respectively. Such minor events are possibly the most dangerous for volcanologists, as their precursors can be weak and may not be detected. Do avoid low-level activity situations whenever possible!

6. Equipment

6.1 Hand-held, two-way radios are the recommended form of communication! Do not rely on mobile telephones! Frequently these fail in mountainous areas, in deep valleys or within volcanic craters. Each team should have one radio per four people as a minimum. To exchange mobile numbers and to keep track of possible mobile reception is nevertheless recommended in order to provide backup communication opportunities.

6.2 Protective helmets (hard hats) with chin straps as well as knee and elbow protection if required (on slopes > 70°, during ash fall and ballistic eruptive episodes).

6.3 Full-face and half-face gas masks (respirators) should be carried always, especially when working in thick fumes or in areas of high gas concentrations. Use the correct type of absorbers! Bring an ample supply of spare filters!

6.4 Clothing should be suitable for harsh weather conditions and for protection from ash fall to dust storms. Brightly coloured clothing will increase visibility of team members and help to safe time during possible rescue operations!

6.5 Heavy-duty boots with good ankle support are strongly recommended.

6.6 Sturdy gloves provide protection from cuts, abrasions, and burns and are essential when working on fresh lava!

6.7 A first-aid kit for burns, cuts, and abrasions is essential and must be carried ideally by each individual on a team!

6.8 Adequate water and food supplies are mandatory! Water is critical for survival!

6.9 Topographic maps, compass, altimeter, knife, whistle, signal mirror, and so on, must be available to a team and ideally are carried by each member of a team. A GPS device must be available to each team, but ideally also to each individual member of a team (no less than one GPS devise per four people is recommended).

6.10 Identification tags or equivalent, with blood type, name and address, and person to contact, etc., will greatly help in case of serious accidents!

6.11 Please use checklists in §7b, c if required.

7. Appendix

7a. Example of route card:

FIELDWORK ITINERARY CARD

NAME:

HOME ADDRESS:

PHONE NO.:

FIELDWORK ADDRESS:

PHONE NO.:

DATE: DEPARTURE TIME:

DESTINATION/WORK AREA (Map co-ordinates):

ROUTE:

ESTIMATED TIME OF RETURN TO BASE:

7b. Equipment check list: Personal protection (alphabetical order)

✓	**Clothing and Personal gear**
	Backbag (approx. 40 liters)
	Emergency high calory food*
	Gloves
	Insect repellant
	Jumpers/Fleece**
	Lipbalm
	Mountain boots
	Painkillers
	Rain coat / gear
	Robust and sturdy long pants for fieldwork
	Sunglasses
	Sun hat
	T-Shirts/shirts
	Water bottle***
	Wooley hat

***** You should **always** have a reserve of fast acting high-energy food with you (e.g. glucose) to support those suffering from injuries or fatigue.

** Irrespective of cold or warm climate destination, one **must** be prepared for both, hot and cold weather at all times!

*** You should **always** have a reserve of clean water with you to wash out injuries and provide to those dehydrated. Water is critical for survival!

7c. Equipment check list: Health and safety (alphabetical order)

✓	**Safety Equipment**
	Astronaut blanket
	Batteries for GPS
	Compass
	Emergency whistle
	First-aid-kit
	Gas mask
	GPS
	Hard hat (if required)
	Maps/ route plans
	Name tags
	Pen knife/ tools
	Safety goggles/glasses
	Signal light/torch
	Signal vest
	Sticky tape
	Walki-talki/ radio

8. References

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Donovan A., Oppenheimer C., and Bravo M. (2012) Science at the policy interface: volcano-monitoring technologies and volcanic hazard management. *Bulletin of Volcanology*. 74, 1005-1022.

Newhall C., Aramaki S., Barberi F., Blong R., Calvache M., Cheminee J-L., Punongbayan R., Siebe C., Simkin T., Sparks S., and Tjetjep W. (1999) Professional conduct of scientists during volcanic crisis. *Bulletin of Volcanology.* 60, 323-334.