EHAZ Questions - Jeff Johnson Infrasound Session - 29 Mar. 2007

General Stuff to start:

Terminology clarification:

- pyroclastic explosion
- Nyquist frequency

- filtering - low & high bandpass, bandpass, significance of model filtering

First Round

Colima:
1) Santiaguito (SLIDE 46): What is the source of the gas? Is itsupplied by bursting of vesicles in the conduit or trapping and eventual catastrophic release of gas rising from below? What is the proportion of juvenile material in the ash expelled?

MTU:
1) SLIDES 32 36. How are infrasound waves generated by mechanisms different than the ideal strombolian bursting bubble ? E. g. by the apparently non-coherent gas venting along a set of fractures and cracks at Santiaguito, or an even more extreme case for plinian or subplinian eruptions (i. e. continuos gas emission jets), could these also generate infrasound waves?, and in that case, how would the generation mechanism be (e. g. unsteady flow)? How would this other infrasound generated waves be different than the ideal strombolian case (e. g. would it have a more richer spectrum, besides being noisier)?

McGill:
1) In a viscous volcano, what is the mechanism of pressure buildup (gas exsolution, foam, collapse or subsidence of lava)? Can infrasound tell us anything about this process, if so, what?

UNAM
1)(Ana) If the infrasonic microphones aren t localized at intermediate epicentral distances (within 5 km of vent), what is the procedure to filter the influenced by time-varying atmospheric conditions? How is frequency dependence considered when evaluating the site response of a microphone?

ASU:
1) Frequency Spectra SLIDES 22 and 23 show plots of frequency spectra for seismic and acoustic signals. Is the convergence of frequency spectra diagnostic of acoustic signals, and if so, is it purely a function of the limited frequencies under examination or is it caused by a change in the signal with time (i.e. attenuation due to temperature changes)?

SFU/UBC:
1) (Chris) SLIDES 21-26 What kind of information can we get from frequency data? Can we discriminate a variety of volcanic characteristics from one edifice to another.

Buffalo:
1) **Mount St. Helens (slides 49-53, EPSL paper).** (Marc) Controversy about origin of second explosion. Is the location based upon the photograph or is it also constrained by infrasound triangulation? How accurate is triangulation at distances of hundreds of km? Which frequencies are most likely to be attenuated at regional distances?

Second Round

Colima:
2) What are the pros and cons of estimating bubble size from the frequency of their vibration vs. the pressure change when they burst?

MTU:
2) SLIDE 45. **Infrasound (and sound) waves generation without mass transfer (at least above the surface).** It has been observed that in many cases there are audible noises (sometimes called ***retumbos*** in many place in Latin America) related to volcanic processes but that may happen without an eruption or at closed vent volcanoes (even volcanoes that have been dormant for a long period), and this is sometimes a precursor to volcanic activity (at the reawakening of the volcano). **Has something similar been observed in the infrasound range?** What could the cause of these phenomena be? Coupling of seismic waves with the atmosphere? How could this kind of waves be studied with infrasound techniques?

McGill:
2) In the GRL paper: Though debate remains as to whether some volcanic infrasound can be generated internally (e.g., within a volcano s magma conduit)
What does this debate consist of? Could it be possible to

see/monitor bubbles as they rise through the conduit of a bubble-producing volcano ? Is bubble growth or vibrations reflected in the infrasound or seismic data?

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2)Victor and Ana
From: Johnson 2003, JVGR
Why generally have infrasonic data collected at volcanoes with VEI 1 and 2? In the case of a plinian activity, what kind of methods could we apply for study the explosion sources? Considering that in this cases the infrasonic study are not really useful; using for this case the seismic data.

ASU:
2) Mass Flux: Has anyone been able to compare mass flux calculations from acoustic data to those calculated from models of plume dynamics (height and velocity) for the same eruption?

SFU/UBC:
2) (RE) Can we discuss the webcam image on SLIDE 33? What is the physical response of "complex ringing of the edifice ?

Buffalo:
2) **Locating sources (slides 40 and 41, GRL Volcanic eruptions, lightning and a waterfall) (Sarah).** Could you explain more about how sources are located using the correlation (and more about the corelogram on pg. 40 itself)?

Third Round

Colima:
3) Bubble size is measured by Vergniolle using frequency of vibrations of the bubble at the surface and by Johnson using Lighthill's method which calculates the pressure difference when the bubble bursts. What are the pros and cons of each method?

MTU:
3) SLIDE 48. **Generation by air displacement: can large and fast (but at infrasonic velocity) moving masses cause an infrasound wave?** Can a volcanic edifice collapse and the related debris avalanche cause an infrasound wave by displacing air? Could this be produced by a fast moving pyroclastic flow? Could it be produced by an eruptive column collapse?

McGill:

3) What is the approximate minimum size of a bubble whose bursting may be detected by infrasound?

UNAM
3)(Natalia Pardo)
The understanding of the generation and propagation of infrasonic airwaves is also concerning phreatomagmatic eruptions? Does the magma/water interaction play a significant role on these kinds of signals and in their interpretation?

ASU:
3) Shock/Pressure Waves: For situations in which there is shock wave generation at eruptions, is it thought that a conjoint seismo-acoustic source is possible/probable? If it is, would there be a ~2 second delay between the seismic signal and acoustic arrival for the shock wave? Would other acoustic waves be generated behind the shock? Have the velocities of the pressure waves been estimated? What is involved in estimating the velocities of the pressure waves?

SFU/UBC:
3) (Heather) I was wondering about the assumption about homogeneity on SLIDE 34. Could you compare and contrast homogeneity for solids vs. the atmosphere in terms of the modelling parameters? How far can we assume the "homogenous" area stretches?

3) **Other Applications (Sarah).** What other applications can you envisage using infrasound for at volcanoes? How big are the hurdles of nonlinearity when it comes to diffuse sources? Could you tell anything about dome collapse or rockfalls for instance? Even though these are not ideal subjects for infrasound, would it be an easier tool to use than seismic signals?

Fourth Round - time permitting

MTU:
4) **Application to silent earthquake detection?** In 2000 a silent earthquake occurred at Kilauea; Paul Segall had discussed this event with us and explained that no seismicity was recorded, only GPS data indicated large displacement. Could infrasound have recorded this event?

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4)Hugo Murcia
From: J.B. Johnson, 2003
How the infrasound signals can be affected by possible

rainfall in the area at the moment of an eruption?

SFU/UBC
4) SLIDE 9 (Terry) Have you come upon a better microphone more suited to the data being collected? Are you constructing anything of this sort?

Buffalo:
4) Mount St. Helens (slides 49-53, EPSL paper)(Marc). Does the infrasound data rule out any of the possible mechanisms for the second explosion? - impact of cryptodome material in debris avalanche with Johnston Ridge resulting in a magmatic blast - phreatomagmatic explosion from interaction of cryptodome or lateral blast or hot debris avalanche with Toutle River (any associated deposits?) - lifting of blast front by atmospheric inflow (unlikely to be explosive) - inflation of leading edge of pyroclastic surge as it flowed over Johnston Ridge incorporating air beyond the ridge (unlikely to be explosive).

SFU/UBC
5) JVJR Fig. 2 & SLIDE 35(Terry) walk us thru the sequence from the acoustic pressure trace to the cumulative mass flux and the mass flux. Is this sequence illustrating actual data/calculations and is it widely applicable?

UNAM
Victor
Theme: VEI cases, noise of the signal
From: Johnson 2003, JVGR
How could we understand the explosions with VEI higher than II? Even when these are frequent and repetitive? i.e. explosion phases of Volcan Arenal, Volcán de Colima, etc.? How could you separate the explosions lower than VEI II from other kind of waves produced in the environment?