Unraveling shallow conduit processes

Integrating multiple data sets to evaluate volcanic hazards in Guatemala
Objectives

- Low-frequency seismicity (tremor, LP, VLP) is nearly always associated with eruptions
  - tremor (especially harmonic tremor) related to fluid movement or resonance of fluid-filled body
  - tremor amplitude correlated with eruption intensity
  - seismic monitoring in place
- Understanding the source of tremor and other low-frequency (fluid-related) seismicity is a key to hazard
- Use detailed temporary deployments to learn about activity
  - apply to short-period network data
Objectives

• LF seismicity must be interpreted in the presence of other data
  - infrasound
  - gas emission

• Field campaigns:
  - collect complementary data sets for joint evaluation
  - long-term data sets collected by PC/MI students
2008 Field Campaigns

- **Pacaya**
  - 5 day deployment
  - 5 station seismic network
  - 5 infrasound-sensitive microphones
  - UV-camera
  - FLIR

- **Fuego**
  - 5 day deployment
  - 6 station seismic antenna array
  - 5 infrasound-sensitive microphones
  - UV-camera

- **Santiaguito**
  - short period permanent seismic network
  - UV-camera (3 days)
2009 Field Campaigns

- Pacaya
  - 1st stage of GPS-gravity campaign - install GPS monuments
- Fuego
  - 20 days on La Meseta
  - 5 station seismic antenna array
  - 5 additional, azimuthally distributed seismometers
  - 12 infrasound sensitive microphones
  - UV-camera
  - visual video
- Santiaguito
  - 5 station broadband deployment
  - 12 infrasound sensitive microphones
2008 Pacaya

- weak explosions from summit vent
- secondary vent with passive lava effusion
- Constant non-harmonic tremor
• Publications

  - Analysis of gas, infrasound and seismicity by M. Dalton et al. as part of PhD, paper in progress

  - Analysis of FLIR by L. Kapelanczyk, W. Rose et al., paper submitted (?)
Santiaguito

• Publications
  - Analysis of seismicity, time-lapse visual by K. Brill (PC/MI) - collecting data for M.S.
  - Analysis of gas and seismicity (2007, 2008, 2009) by M. Dalton et al. as part of PhD, paper in progress
  - Analysis of plume ascent visual video by A. Blankenbicker (PC/MI) - writing M.S., defend summer 2009
  - Analysis of explosion with video, infrasound, seismic data by J. Johnson (NMT) et al. - paper submitted to GRL
2008 Fuego

- Intermittent ash-rich explosions from summit vent
- Constant harmonic tremor
- Obvious correlation between tremor and gas emissions
- Small LF events
2009 Fuego

- Larger explosions from summit vent
- Constant harmonic tremor
  - visible in the infrasound
  - lots of gliding 2-4 Hz
- LF events are different

- Multiple arrays will give us a better estimate of sources of tremor and LF seismicity
2008 - 2009
Fuego

- Publications and research plans
  - Analysis of gas, infrasound and seismicity by P. Nadeau et al. as part of PhD, paper in progress
  - Analysis of tremor (2008, 2009) by Lyons et al. as part of PhD, paper in progress
  - Analysis of explosions in long-term broadband record by J. Erdem as part of M.S. in progress
  - Analysis of LF events by Waite et al., paper in progress
  - Moment tensor analysis of various LF events in 2009 data by J. Richardson et al., beginning fall 2009
Example LF event

- Strong waveform distortion
  - stations are only 30 m apart
- Poor correlation across array
- Large uncertainties in event locations
The LF events have no airborne acoustic component and do not correlate with gas emission variations.
LF events at Fuego

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LF events at Fuego

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LF events at Fuego are repetitive

- Array analysis provides poor location estimates
- Use stacked data to locate a master event
LF events at Fuego are repetitive

- Use stacked data to locate a master event
- Locate all others relative to the master
  - relative errors are much smaller
- source is very stable through time
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Location of LF events

- Sum of all slowness vectors gives an average (best) vector for all LF events
- Forward model simple sources to find best location
- 150 m below the vent
Don’t have the data (2008) for full moment tensor inversion

Forward modeling can tell us what they are not

New data will help constrain seismic sources