

GEOP572 - Volcano Geophysics Field Course in Ecuador

Instructors:

Jeffrey Johnson (jeff.johnson@ees.nmt.edu; 593 8 9452322)

Mario Ruiz (mruiz@igeqn.edu.ec; Cell: 593 8 4524695)

TA:

Omar Marcillo (omar.marcillo@ees.nmt.edu)

Guest instructors:

Pete Hall, Patty Mothes, Jorge Bustillos, Claude Robin, Julia Bourquin, and Patricio Ramon

Emergency Contacts:

Jonathan Hall (logistical coordinator at 099-800-438 and junzec@yahoo.com)

Instituto Geofisico (593 2 2225655)

Website:

information and .pdfs of papers will be posted at <http://nmtgeop.net/geop572> (continually under construction)

Overview:

This course provides hands-on instruction in volcano seismology and infrasound instrument deployment at an active volcano (Tungurahua, Ecuador) followed by data retrieval, processing, and analysis. Course is equally divided between field work, lectures, physical volcanology field trips, and hands-on data analysis. Focus of the 2009 course will be on array seismic deployments and infrasound networks. Weeks one and three will be based in Baños and students will be responsible for doing data analysis with PASSCAL software and in MATLAB. Enough computers will be provided such that students will need to work together in groups of three.

Text:

Required reading will be the journal articles that are listed below in References.

Discussion of these papers will be lead by both students and instructors. Additional highly recommended readings include the Ecuador Volcano Field Gudes for Cotopaxi, Tungurahua, Guagua Pichincha, and Reventador (downloadable at <http://www.ecuadorvolcanofieldguide.com/>)

Grading:

Letter grades will be assigned for students registered through New Mexico Tech. Grades are based upon student participation, demonstration of understanding of concepts in assigned exercises, and an oral presentation at the end.

Schedule and Syllabus (subject to modification/change)

Sunday June 7:

- everyone arrives Hotel Alcala, Quito

Monday June 8:

- early morning bus to El Trapiche, Banos (3.5 hours)
- fundamentals of seismology and volcano seismology lectures (Johnson / Ruiz) - reading of *McNutt (2005)* volcano seismicity review paper
- instrumentation overview lecture (Johnson)
- huddle test of instruments at El Trapiche
- (optional) basics of Unix lecture (Marcillo)

Tuesday June 9:

- Overview of Tungurahua current activity (Ruiz/ Bustillos)
- early morning array instrument deployment on 2006 Juive pfs
- filtering and digital signal processing lecture (Johnson)
- hands-on PQL tutorial with 2008 Kilauea data (Johnson / Ruiz / Marcillo) - exercise handout
- (optional) MATLAB primer (Marcillo)

Wednesday June 10:

- divide into two teams - one team does early morning infrasound network deployment at Pondo, Runtun, and Bilbao another team does early morning verification of Juive network stations
- lecture on data download, conversion, organization, and manipulation of data with PASSCAL software tools
- student hands-on time for quality control of Tungurahua data using PQL
- (optional) MATLAB primer part 2 (Marcillo)

Thursday June 11:

- (optional) field visit and verification of working stations at Pondo, Runtun, and Bilbao
- earthquake magnitude, focal mechanism, and moment lecture (Johnson / Ruiz)
- tutorial of importation of data into Matlab and viewing using Kilauea 2008 dataset (Johnson / Marcillo)
- student hands-on time for data viewing in Matlab
- student-led discussion of Tungurahua overview paper by *Hall et al. (1999)*

Friday June 12:

- Matlab DEM and station mapping lecture (Marcillo)
- earthquake localization lecture (Ruiz)
- all about volcano infrasound lecture (Johnson)
- visit to OVT in shifts (Bourquin)
- student hands-on time for mapping station locations in Matlab / Google Earth

Saturday June 13

- revisit of all stations to verify operation prior to field trip
- introduction to seismic array processing (Johnson) - readings assigned (for road trip) are *Almendros et al., 2002* and *Chouet et al., 1998*
- student hands-on time for doing array processing of Kilauea data
- student-led discussion of Ecuador volcanism overview paper by *Hall et al. (2008)*

Sunday June 14

- early morning departure to Quilotoa (Mothes and Hall)
- student-led discussion of Quilotoa papers by *Hall and Mothes (2008)* and *Mothes and Hall (2008)*
- night spent at Posada de Tigua at Quilotoa

Monday June 15

- early morning departure for Cotopaxi with stops at Limpiopungo, refugio, and Sangolquí (guest leaders Mothes and Hall)
- student-led discussion of Cotopaxi seismic lahar paper by *Kumagai et al. (2009)* and general Cotopaxi background paper (tbd)
- night spent at Casa y Campo in Lloa

Tuesday June 16

- early morning vehicle transfer and hike to Guagua Pichincha rim (Claude Robin)
- student-led discussion of *Garcia-Aristizabal et al (2007)* paper of 1999 eruption overview and *Robin et al (2008)* paper on Pichincha Holocene activity
- night spent in Quito at Alcala

Wednesday June 17

- tour of IG-EPN, meeting and presentations by Yepes and others
- drive to Reventador with stops at Chacana Caldera sites
- lodging at Coturpa and hot springs in Papallacta

Thursday June 18

- drive to Reventador with stops at Quijos pf's and San Rafael Falls (guest leader Patricio Ramón)
- student-led discussion of *Hall et al. (2004)* synopsis of 2002 Reventador eruption
- lodging at Hotelito

Friday June 19

- excursion into Reventador caldera
- student-led discussion of *Lees et al. (2008)* Reventador seismo-acoustic signals
- lodging at Hotelito

Saturday June 20

- bus back to Banos and El Trapiche

Sunday June 21

- pull all stations, download, backup, and process all data
- readings assigned from *Chouet et al (1998)*
- reading assigned from *Jones et al. (2008)*

Monday June 22

- lecture on earthquake classification and clustering
- all students work independently to catalogue data and produce graphics
- student-led discussion of *Ruiz et al (2005)* Tungurahua explosion dynamics paper

Tuesday June 23

- divide into groups focused either on earthquake localization OR seismic wavefield analysis (more advanced)
- student-led discussion of *Molina et al (2005)* Tungurahua tomography paper

Wednesday June 24

- student independent work on projects and oral presentation preparation
- student-led discussion of *Johnson et al (2005)* Tungurahua seismo-acoustic paper

Thursday June 25

- (optional and time/hazards permitting) hike up to refugio at treeline
- student independent work on presentations

Friday June 26

- morning student presentations
- afternoon return to Quito and Alacala and end of formal course

Saturday June 27

- students fly out or engage in independent travel

References:

- Almendros J, Chouet B, Dawson PB, Huber C (2002) Mapping the sources of the seismic wave field at Kilauea volcano, Hawaii, using data recorded on multiple seismic antennas. *Bull. Seismol. Soc. Am.* 92(6):2333-2351
- Chouet BA, Dawson PB, De Luca G, Martini M, Milana G, Saccorotti G, Scarpa R (1998) Array analyses of seismic sources at Stromboli. *Acta Vulcanologica* 10(2):367-382
- Garcia-Aristizabal A, Kumagai H, Samaniego P, Mothes P, Yepes H, Monzier M (2007) Seismic, petrologic, and geodetic analyses of the 1999 dome-forming eruption of Guagua Pichincha volcano, Ecuador. *J. Volc. Geotherm. Res.* 161(4):333-351
- Hall M, Ramon P, Mothes P, Le Pennec JL, Garcia A, Samaniego P, Yepes H (2004) Volcanic eruptions with little warning: the case of Volcán Reventador's Surprise November 3, 2002 Eruption. *Rev. Geol. de Chile* 31(2)
- Hall M, Samaniego P, Le Pennec JL, Johnson JB (2008) Ecuadorian Andes volcanism: A review of Late Pliocene to present activity. *J. Volc. Geotherm. Res.* 176:1-6
- Hall ML, Mothes PA (2008) Quilotoa volcano - Ecuador: An overview of young dacitic volcanism in a lake-filled caldera. *J. Volc. Geotherm. Res.* 176(1):44-55
- Hall ML, Robin C, Beate B, Mothes P, Monzier M (1999) Tungurahua Volcano, Ecuador: structure, eruptive history, and hazards. *J. Volc. Geotherm. Res.* 91(1):1-21
- Johnson JB, Ruiz MC, Lees JM, Ramon P (2005) Poor scaling between elastic energy release and eruption intensity at Tungurahua Volcano, Ecuador. *Geophys. Res. Lett.* 32(doi:10.1029/2005GL022847):L15304
- Jones K, Johnson JB, Aster R, Kyle P, McIntosh W (2008) Infrasonic tracking of large bubble bursts and ash venting at Erebus volcano, Antarctica. *J. Volc. Geotherm. Res.* 177:661-672
- Kumagai H, Palacios P, Maeda T, Castillo DB, Nakano M (2009) Seismic tracking of lahars using tremor signals. *J. Volc. Geotherm. Res.* 183:112-121
- Lees JM, Johnson JB, Ruiz M (2008) Reventador Volcano 2005: Explosion activity via Seismo-acoustic observation. *J. Volc. Geotherm. Res.* 176:179-190
- McNutt SR (2005) Volcanic Seismology. *Annu. Rev. Earth Planet. Sci.* 32:461-491
- Molina I, Kumagai H, Le Pennec JL, Hall M (2005) Three-dimensional P-wave velocity structure of Tungurahua Volcano, Ecuador. *J. Volc. Geotherm. Res.* 147:144-156
- Mothes P, Hall M (2008) The plinian fallout associated with Quilotoa's 800 yr BP eruption, Ecuadorian Andes. *J. Volc. Geotherm. Res.* 176:56-69
- Robin C, Samaniego P, Le Pennec JL, Mothes P, van der Plicht J (2008) Late Holocene phases of dome growth and Plinian activity at Guagua Pichincha volcano (Ecuador). *J. Volc. Geotherm. Res.* 176:7-15
- Ruiz MC, Lees JM, Johnson JB (2005) Source constraints of Tungurahua volcano explosion events. *Bull. Volcan.*:DOI 10.1007/s00445-00005-00023-00448