INTERNATIONAL GEOLOGICAL NATURAL HAZARDS PROGRAMS AT MICHIGAN TECH: Examples and motivation for international collaboration

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Michigan Technological University

Houghton, MI USA


Houghton is a *long* way from Latin America
Lake-effect snow bands

Objectives

- Offer ideas for collaborative funding
- Offer ideas about effective collaboration
- Provide motivation for going after these kinds of projects

NSF PIRE Program

The primary goal of PIRE is to support high quality projects in which advances in research and education *could not occur without* international collaboration.

PIRE seeks to catalyze a higher level of international engagement in the U.S. science and engineering community.

NSF PIRE Program

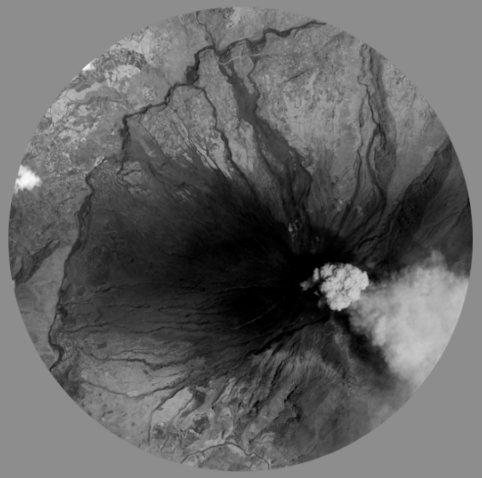
Grants are typically for 5 years

$3-6 million

Must effectively integrate research and education activities in the US and at partner institutions

PIRE projects may include multiple US institutions as well as multiple collaborative partners

Michigan Tech PIRE: Remote Sensing for Hazard Mitigation and Natural Resource Protection in Pacific Latin America



Advance remote sensing techniques and their application in Pacific Latin America.

Develop a collaborative arrangement among researchers in Central and S. America.

Create scientists better prepared for global workplace.

PROGRAM GOALS

Michigan Tech PIRE: Remote Sensing for Hazard Mitigation and Natural Resource Protection in Pacific Latin America

Goals of our project:

1) develop a formal linkage among geoscientists in four countries, focusing on the collaborative development of remote sensing tools for hazard mitigation and water resource development

Goals of our project:

2) build on newly developed educational systems that emphasize applied research and engineering

- The undergraduate Enterprise program

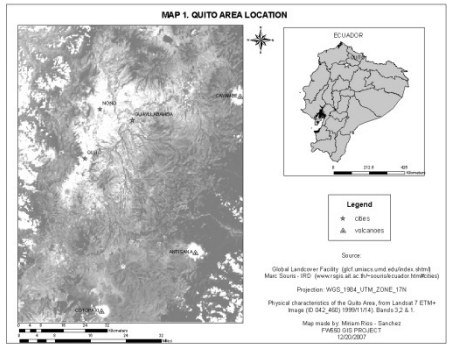
- The Peace Corps Masters Int'l

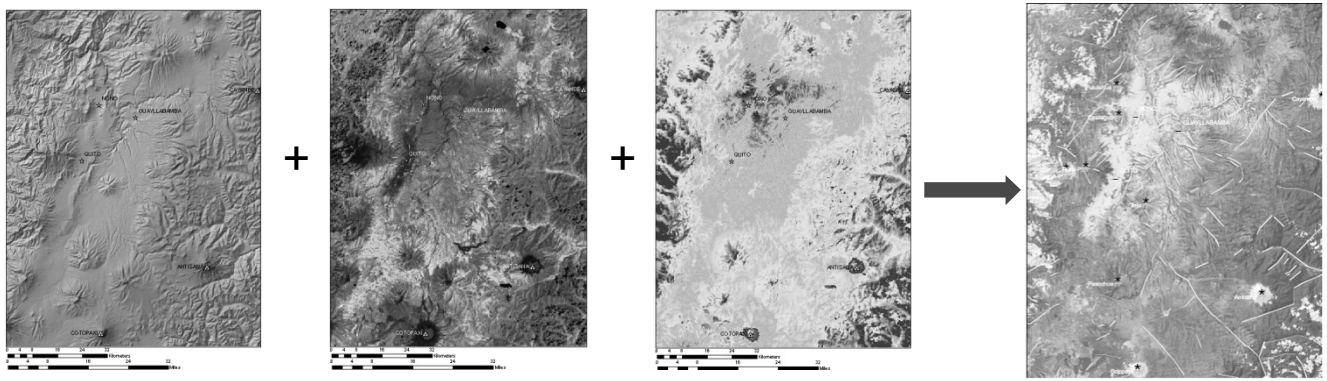

PIRE
0530109
Michigan Tech
Partner Countries and Organizations fo
Remote Sensing for Hazard Mitigation and Natura
Resource Protection in Pacific Latin America
Ecuador EPN
EMAAP-Q CLIRSEN
Philippine
Tanzania
Peru
Benin
Central America
El Salvador: SNET, LA Geo, GTZ, CEPRODE
Guatemala: INSIVUMEH, CONRED, UDVG, USCG, GTZ
Nicaragua: INETER, SNV, CIRA/UNAN, OBS
Costa Rica: OVSICORI, ICE, UCR
Panama: IGC

Research Areas: Water resources

Variety of tools are used to assess ground water availability

- Lineament mapping in igneous rocks
  - Processing of satellite images to identify lineaments that may promote water flow
  - Validation through
    - mapping of wells
    - geophysical surveys

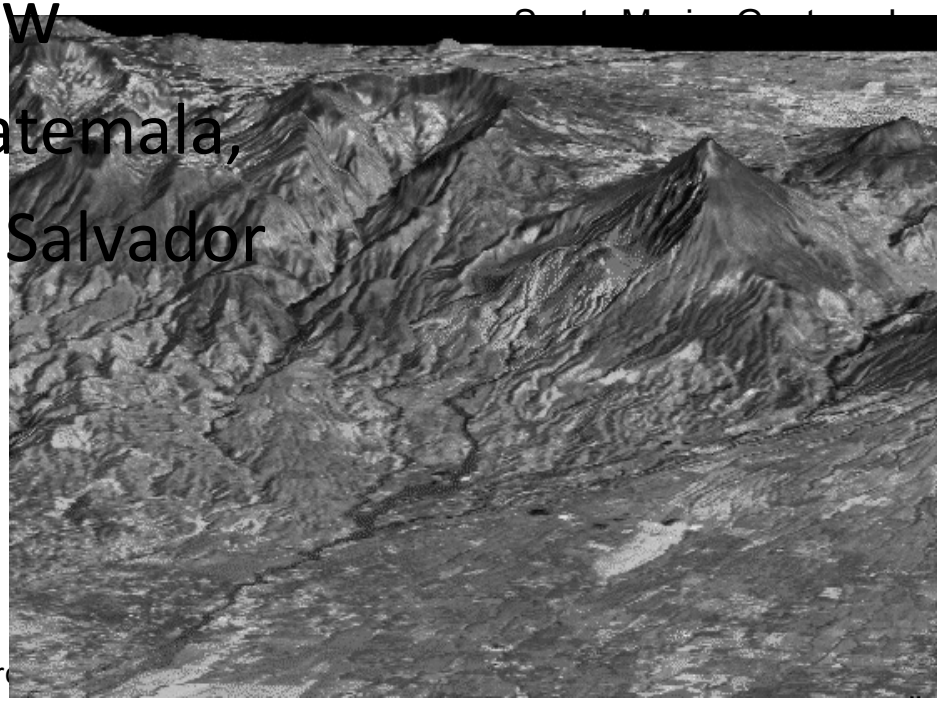




Research Areas: Landslide Hazards

Monitoring and modeling of mass movement

- volcanic flank collapse
  - Modeling past flank collapses, e.g., Pacaya Volcano, Guatemala
- Rotational or debris flow
  - Lake Atitlan region, Guatemala,
  - San Vicente volcano, El Salvador
- Lahars
  - Multiple field sites



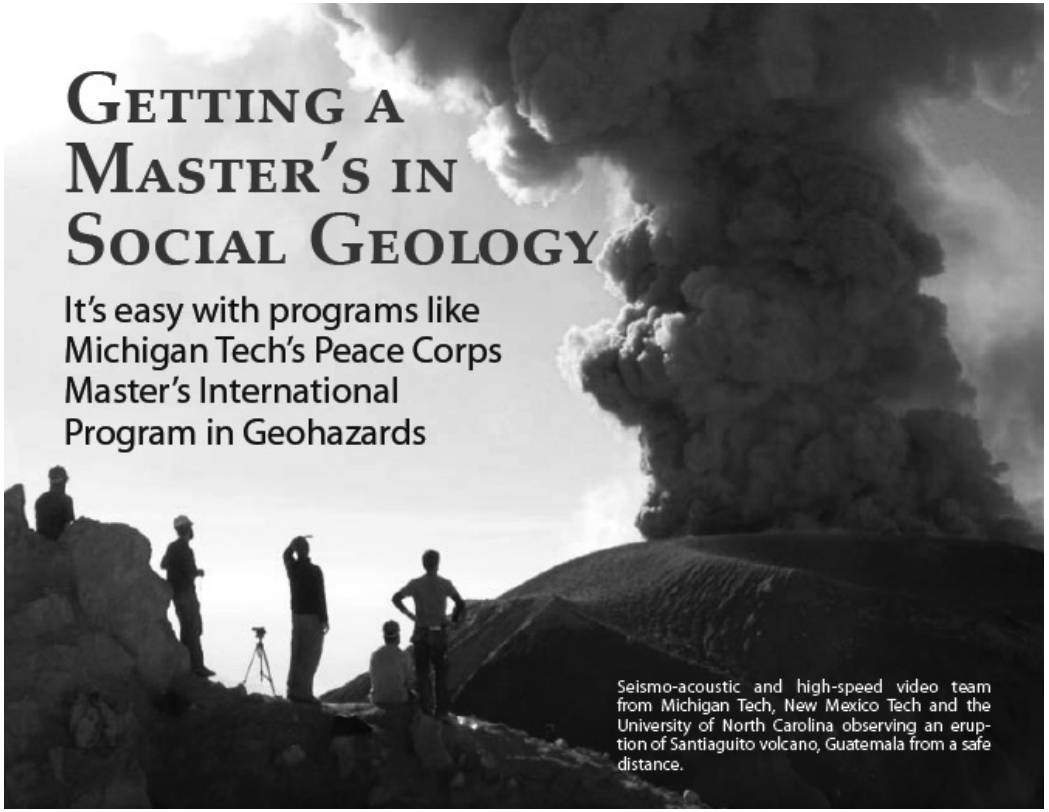
Research Areas: Volcanic Hazards

- Monitoring and modeling active volcanoes
- Satellite remote sensing of ash, sulfur dioxide
- Ground-base measurements of sulfur dioxide, heat output
- Infrasound and seismic measurements of volcanic fluid transport
- Assessment of eruption hazards (PF, lahar)
- Risk assessment
- Social aspects of risk assessment (perception)

Research Areas: Social Geology

Research focused on human factors of natural hazards and hazards mitigation

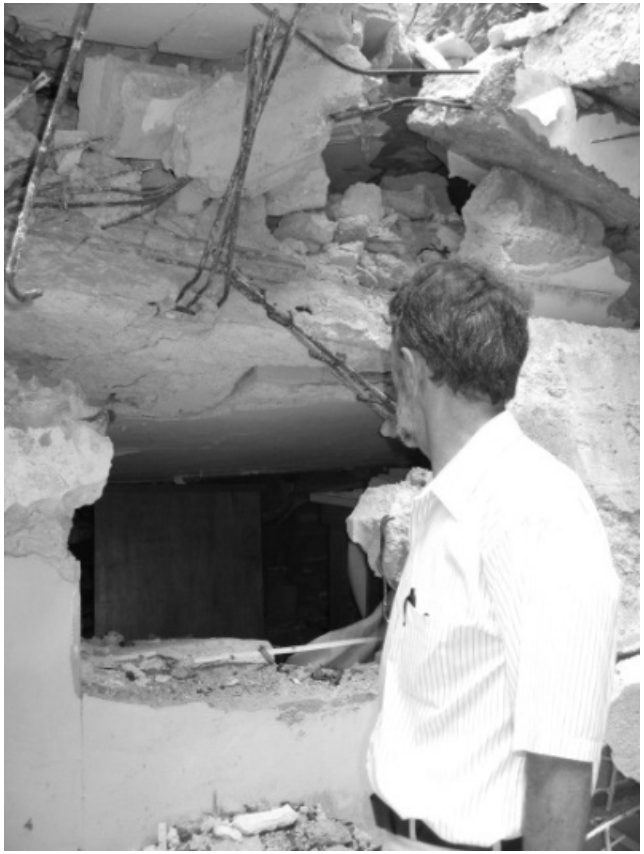
- Risk perception
- Effective mitigation
- Improving communication between

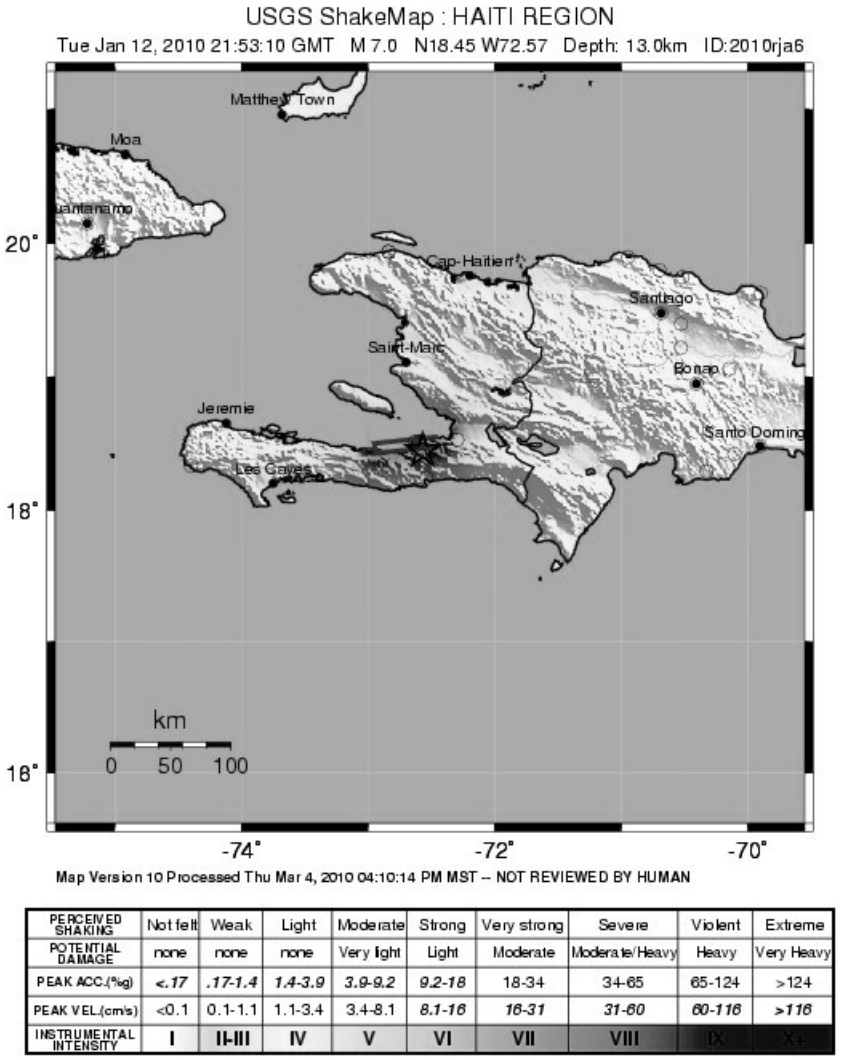


Scientists <-> managers <-> public

Research Areas: Earthquake Hazards

Developing research





PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Research Areas: Earthquake Hazards

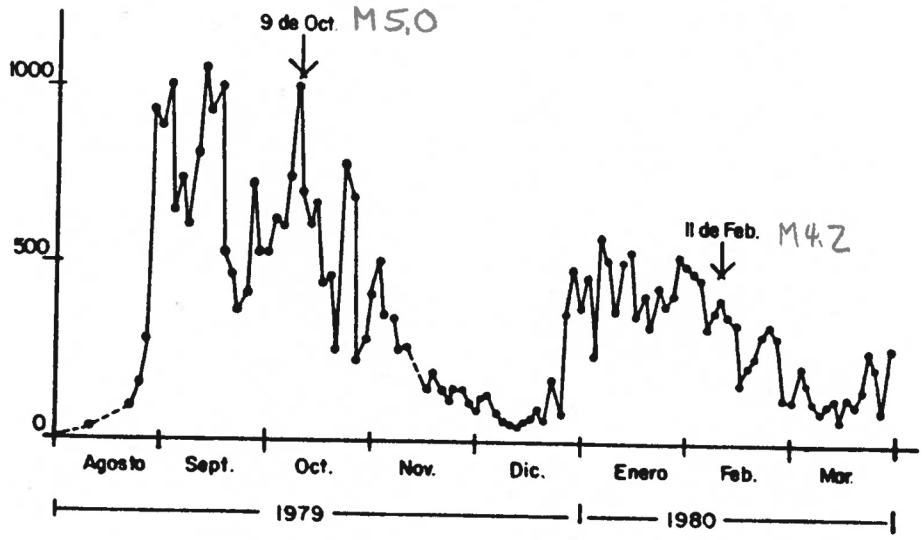
Santa Rosa (Chiquimulilla) Swarm, Guatemala

- New study with Omar Flores of U. San Carlos, Gustavo Chigna & Luis Arriola, INSIVUMEH
- Normal faulting(?) (1979 & 2011)
- Volcanic or tectonic origin?
- Relationship to Jalpatagua right-lateral fault?

Research Areas: Eart

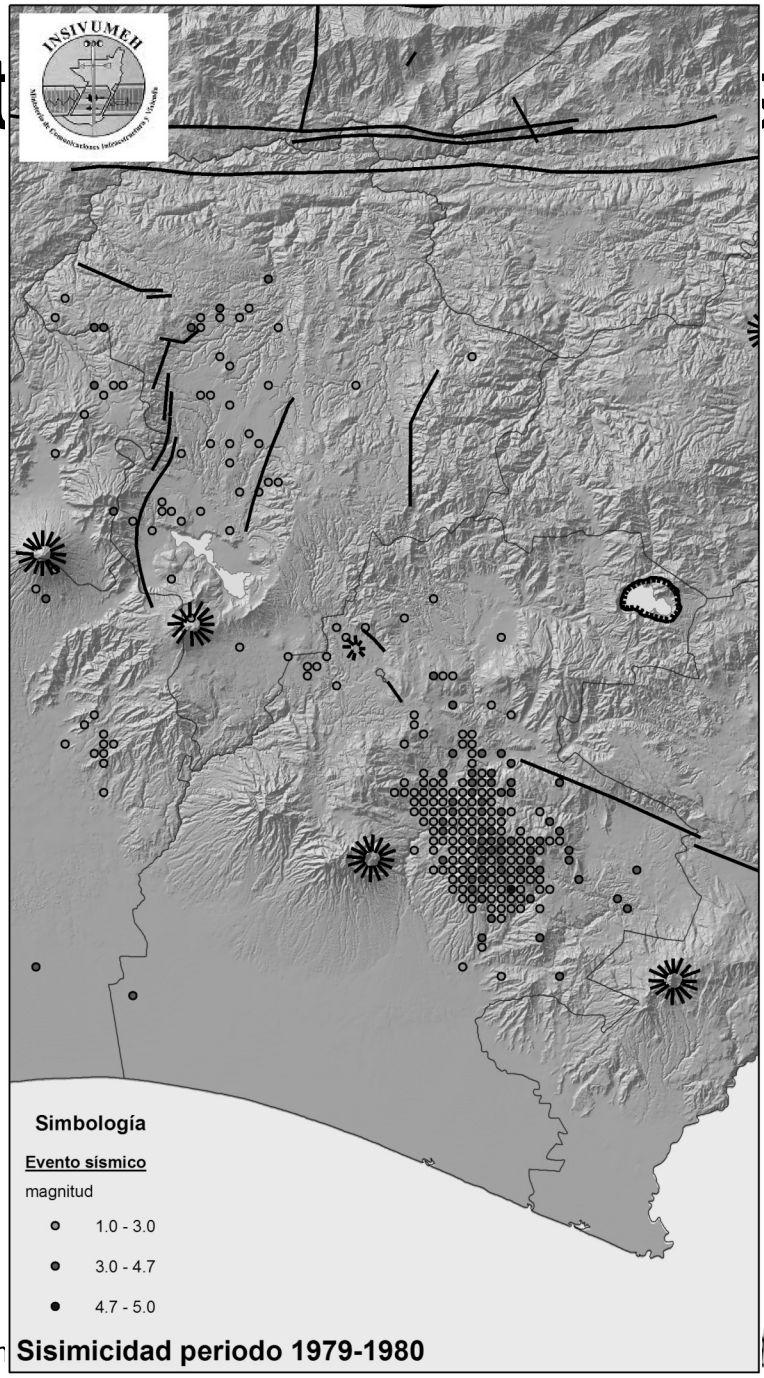
Santa Rosa Swarm

- 1979-1980 swarm



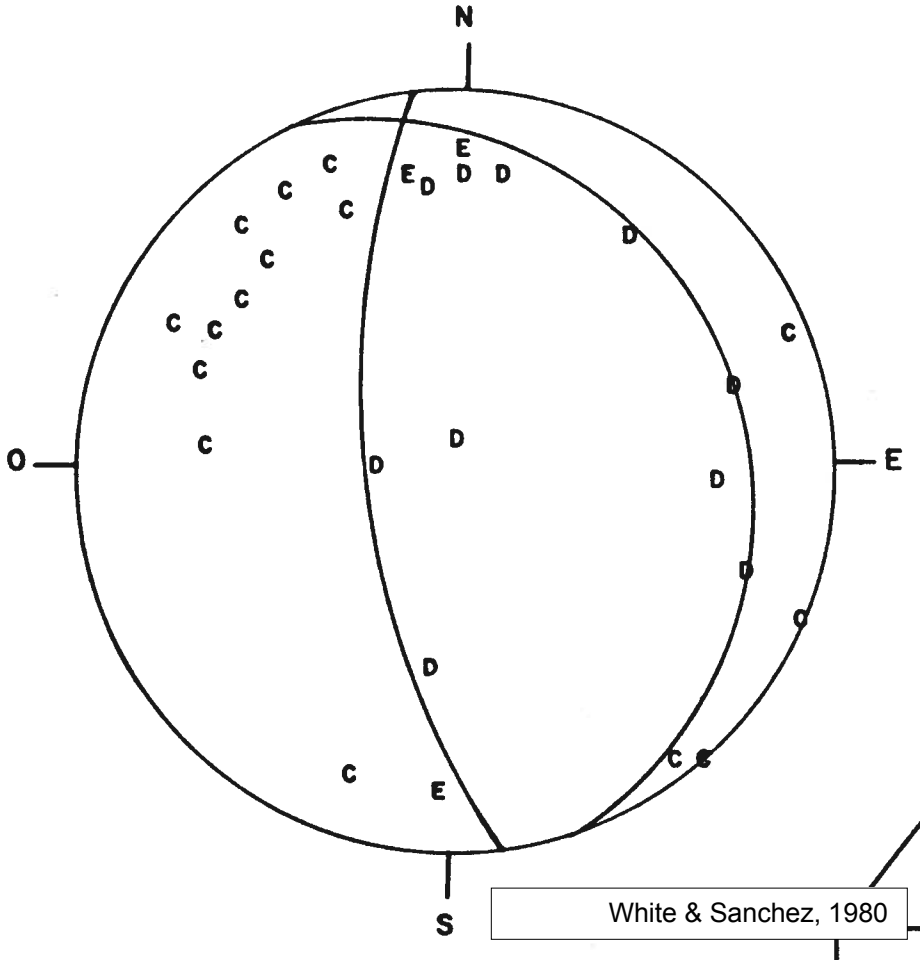
FRECUENCIA POR CADA DOS DIAS DE LOS SISMOS DE CRUZ QUEMADA (1979-80)
NUMBER OF EVENTS EVERY TWO DAYS

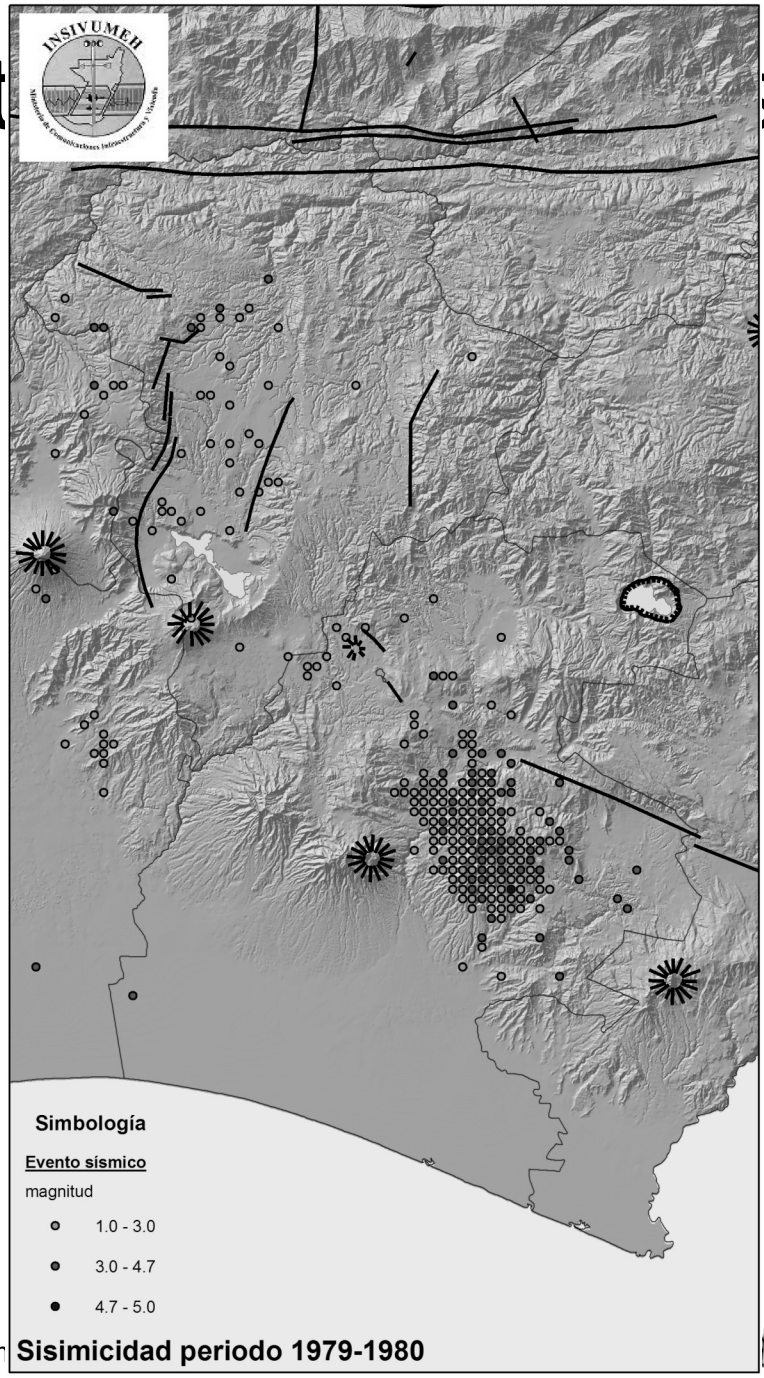
White & Sanchez, 1980



Research Areas: Eart

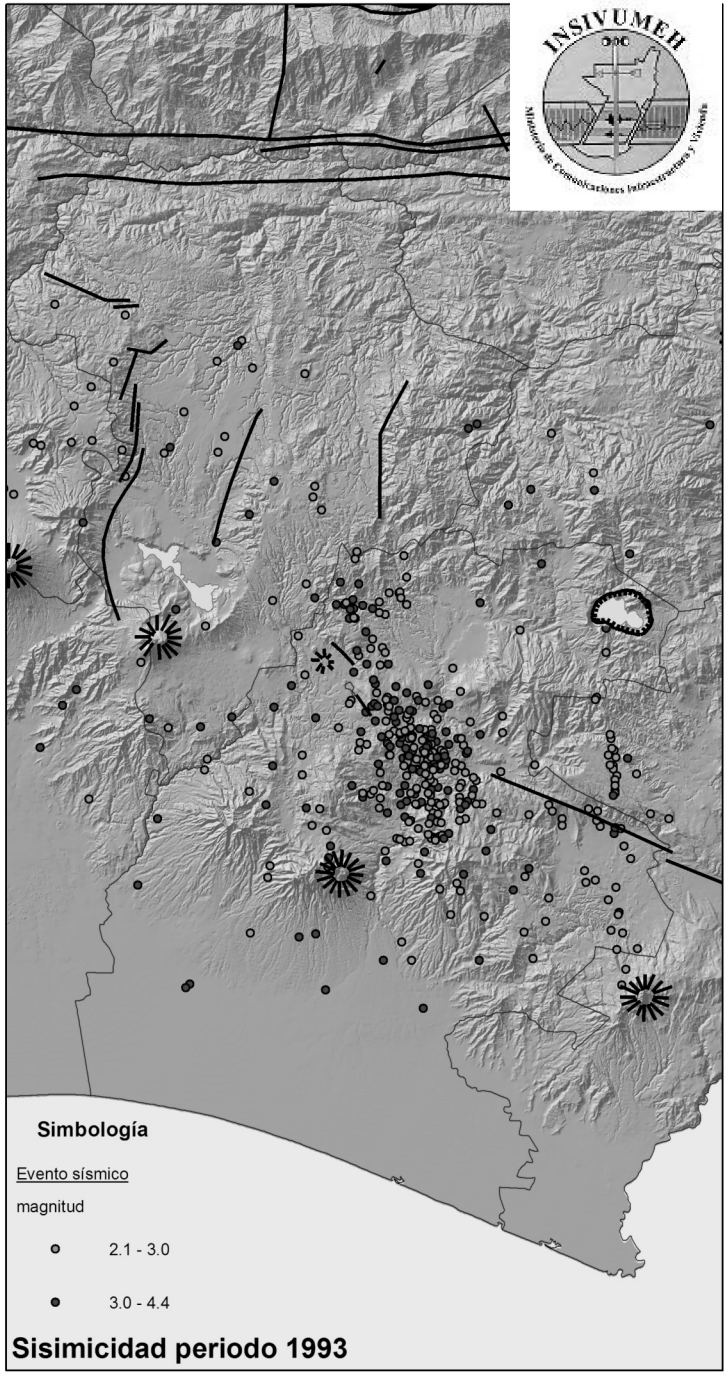
Santa Rosa Swarm





Research Areas: Eart s

1993 swarm



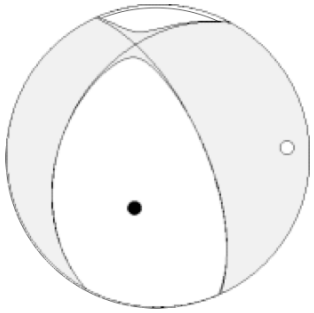
Research Areas: Earth

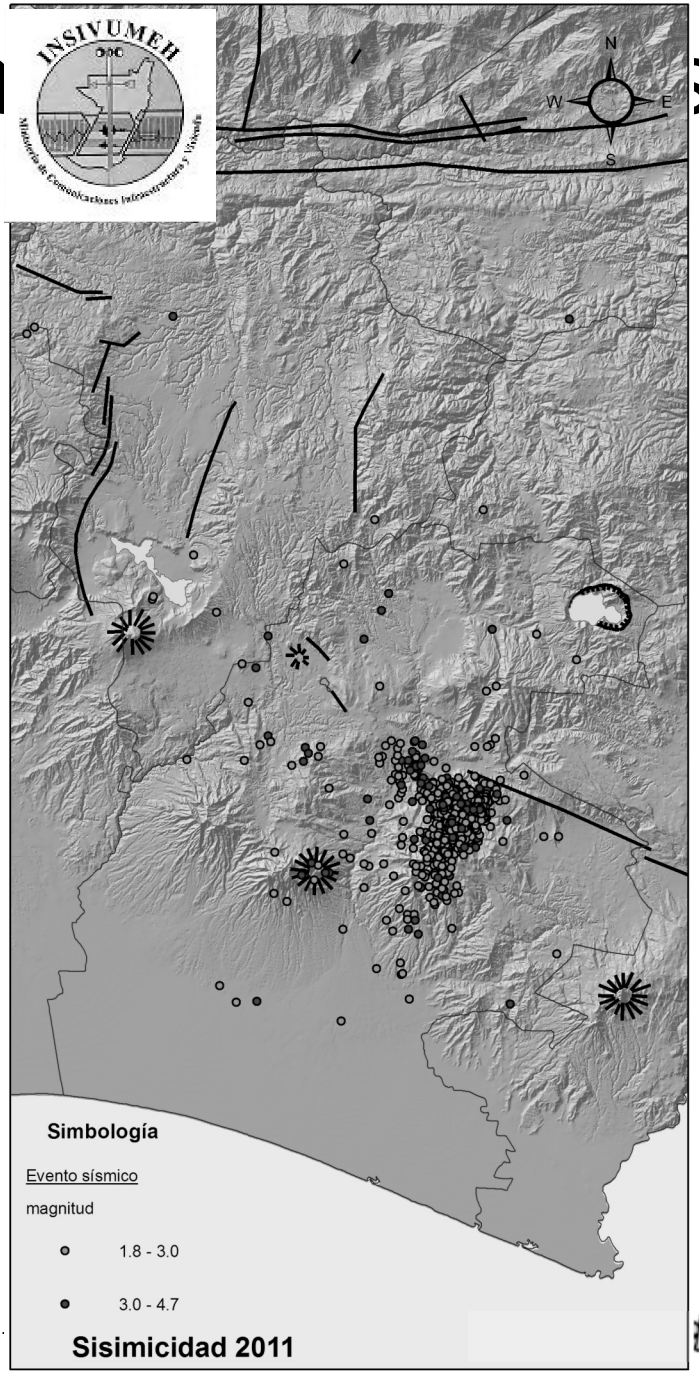
Current swarm

July (18) 19 to present

gCMT M_W 5.6

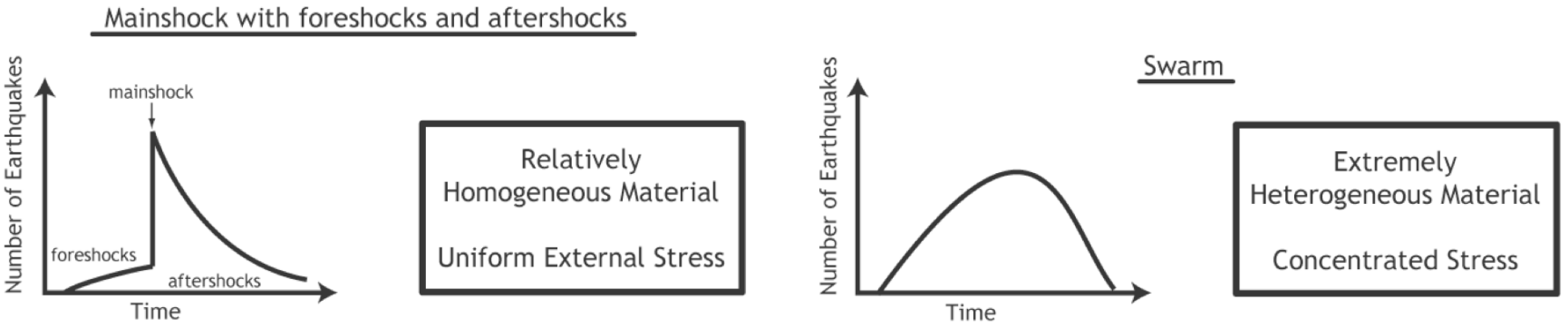
USGS/SLU M_W 5.6





Should we worry about seismic swarms?

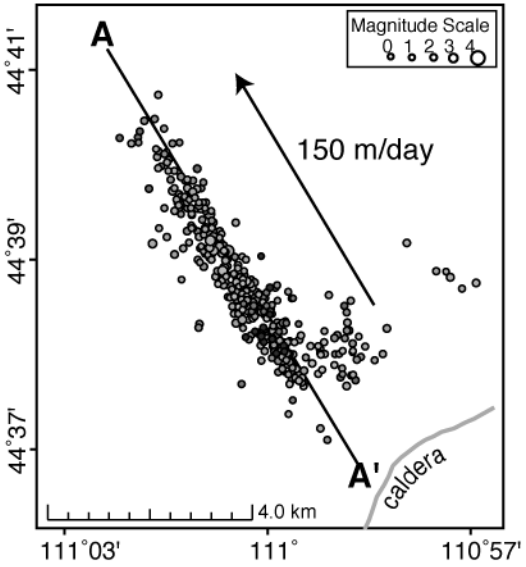
- Generally small magnitude events with little damage
  - 2009 Mw 6.3 L'Aquila earthquake was part of a swarm?
- Tectonic or volcanic, earthquake swarms are not well understood

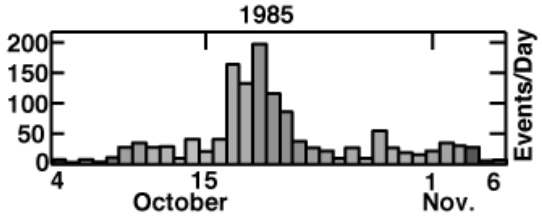


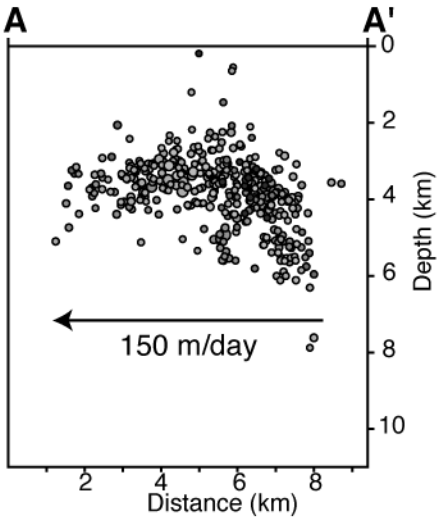
From Mogi, 1963

1985 Yellowstone Swarm

- At the edge of the Yellowstone caldera
- Coincident with initiation of caldera subsidence
- Activity migrated ~150 m/day
- It was a tectonic swarm



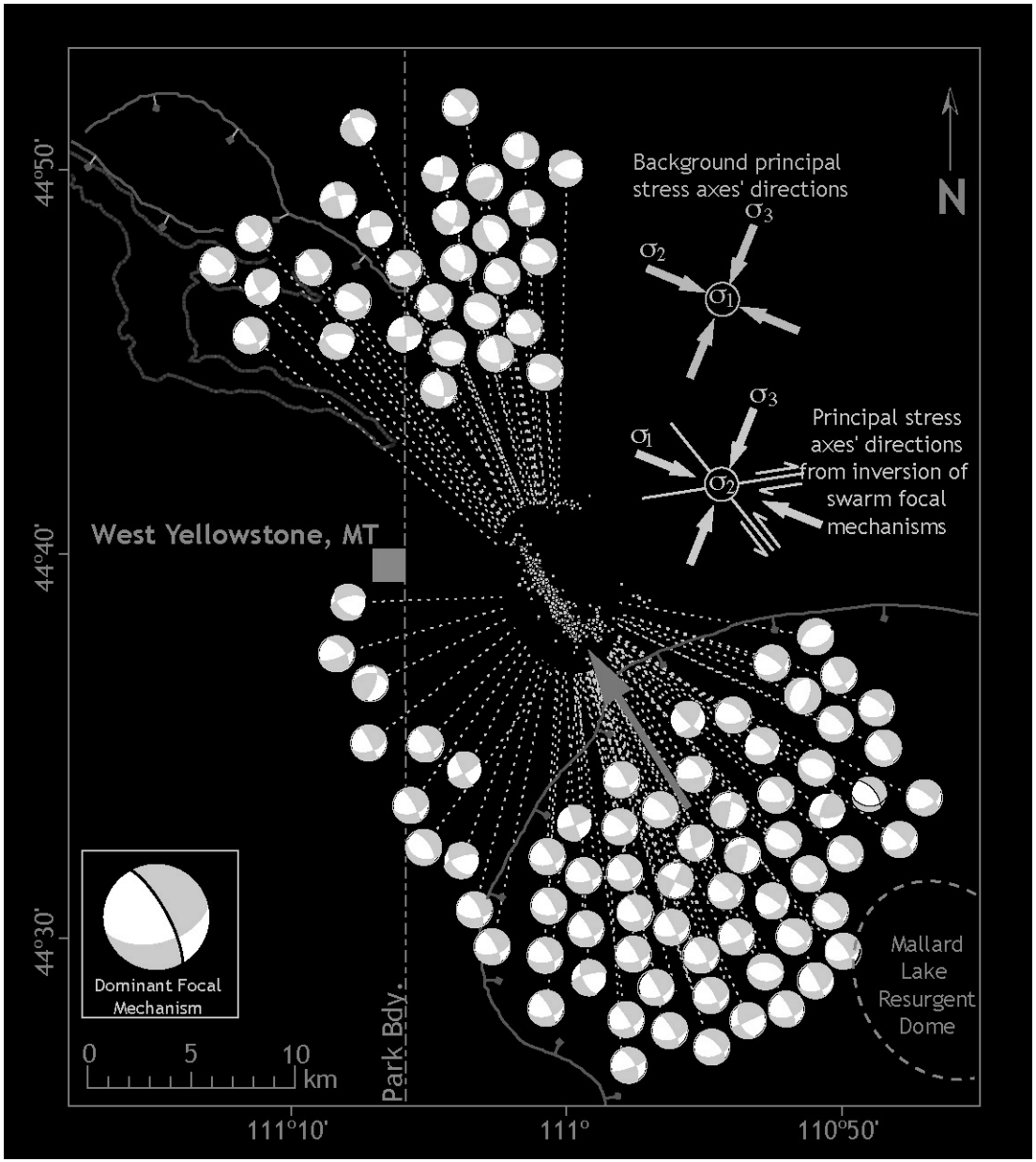




Waite & Smith, JGR, 2002

1985 Yellowstone Swarm

- Repetitive DC events
- Plane of events consistent with a nodal plane
- Migration due to pore pressure migration

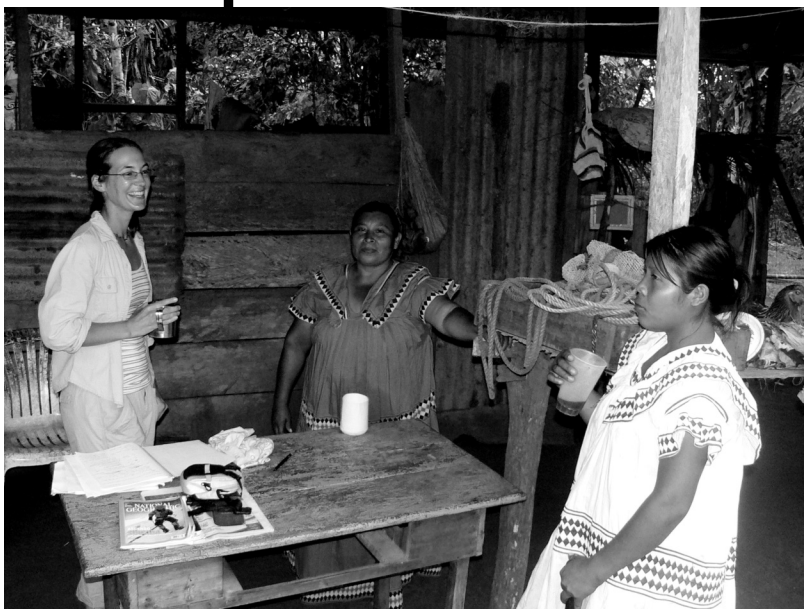


Waite & Smith, JGR, 2002

Peace Corps Masters International

3 year Master of Sciences geosciences degree program, with Peace Corps association -- develops strong international social awareness that seem to address student professional needs

U.S. Peace Corps



- Volunteer program begun in 1961
- 27 month service in one of 76 countries (Africa, Asia, Central & S. America, Pacific Islands, Middle East, Indonesia)
- Provide technical assistance and education
- Improve cross-cultural understanding
- Only open to US citizens

Peace Corps Masters International

- Students in our program receive degrees in
  - Geology
  - Geophysics
  - Geological Engineering
- Attend classes 1st year
- Volunteer in years 2 & 3
  - Collect and analyze data while also performin PC responsibilities (teaching English, or hazard mitigation, improving water or sanitation)
- Defend thesis upon return to US

- Geological Hazards PCMI is unique to Michigan Tech
- Many schools offer programs in other fields

www.geohazards.mtu.edu


Remote Sensing for Hazard Mitigation
and Natural Resource Protection
NSF
PIRE 0530109
Guatemala
Kenya
Philippin
Benin
?
Panama
Madagascar
Nicaragua
Tanzania
Indonesia
Peru
Honduras
El Salvador
60 Student participants (Undergrad, Masters, & Ph.D.)
8 Faculty
3 Post-doctoral researchers
2 Nd
Worksho
Michigan Tech

Importance of PCMI program for research

- Site conditions and logistics sometimes necessitate low cost, low tech research projects
- PC volunteers provide logistical support for visiting scientists
- Widespread availability if mobile-phone internet access is changing

Collaborators visit students in field

John Stix, McGill Univ

Jeff Johnson, New Mexico Tech

Nick Varley, Universidad de Colima

Jonathan Lees, North Carolina

Jim Walker, N Illinois Univ

Guillermo Alvarado, Univ Costa Rica

Chris Newhall, USGS

Andy Harris, Univ Hawaii

Alan Whittington, Univ Missouri

Importance of PCMI program for establishing/maintaining collaboration

- Many US & European scientists do research in areas for short durations
- 2+ year PC commitment allows relationship to build
- PC volunteers learn language and culture
- Passed on from volunteer to volunteer and collaboration builds over time

What is Social Geology?

Community-based hazard mitigation in Tecitan, Guatemala

- Landslide hazard mitigation using lessons learned from Hurricane Stan (2005)
- CoIREDs (community organizations for the reduction of disasters)
  - First aid, shelters, information collection, security

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What is Social Geology?

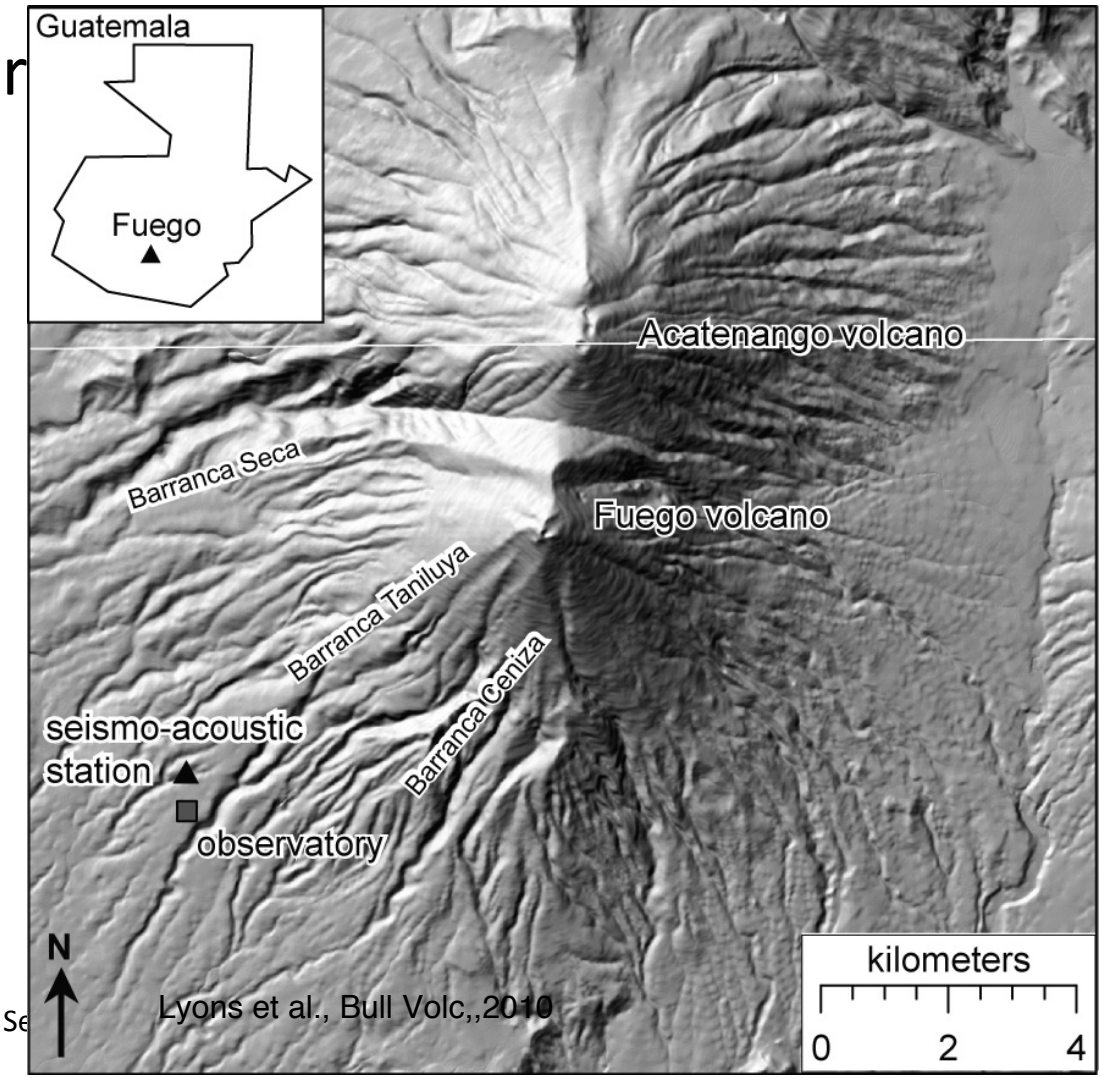
Community-based hazard maps:

hazard mapping based on community needs and resources

A Peace Corps student project

John Lyons

- Began as PC volunteer in Guatemala



A Peace Corps student project

- Began as PC volunteer

A Peace Corps student project

- Began as PC volunteer
- Low tech observations
  - Working with INSIVUMEH observers
  - Daily observations of activity
  - Tracked length of all lava flows
  - Led to definition of 3 eruption styles

- B
- L

Passive effusion and strombolian explosions

Paroxysmal eruptions

Degassing explosions

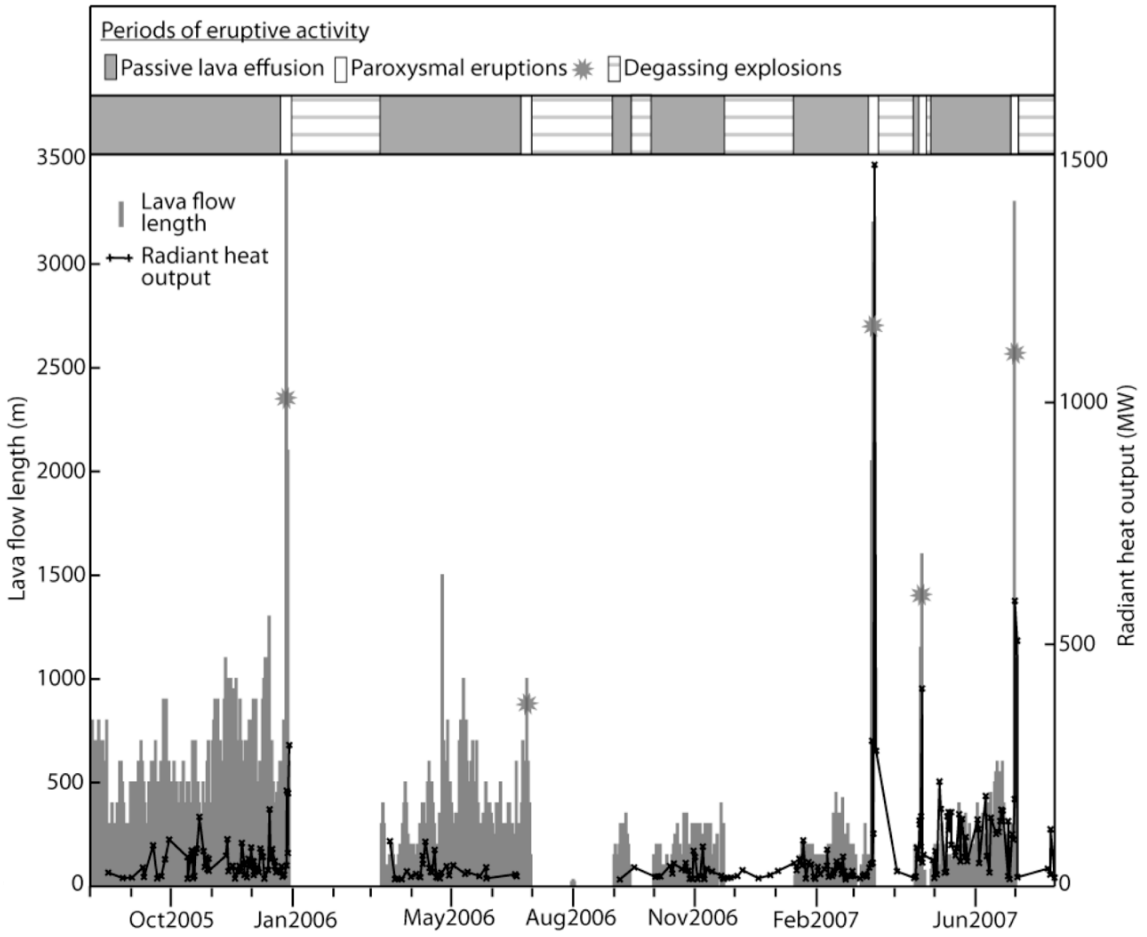
 Lyons et al., Bull Volc,,2010

Visual observations revealed repeating pattern of three types of activity

1) passive lava effusion and small explosions

2) paroxysmal, eruptions lasting 24-48 hours

3) discrete, often pyroclastic explosions with no lava flow



Lyons et al., Bull Volc,,2010

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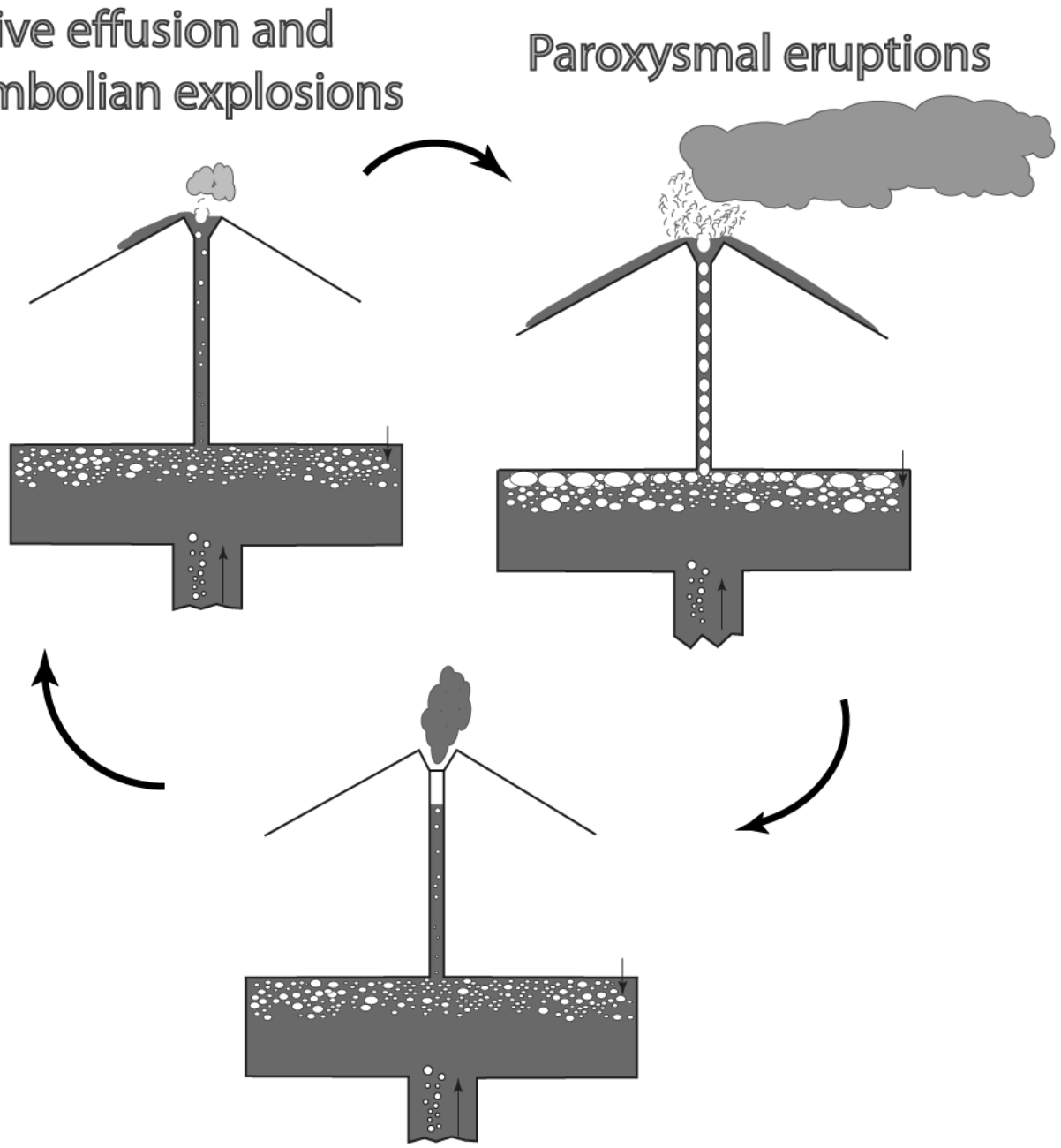

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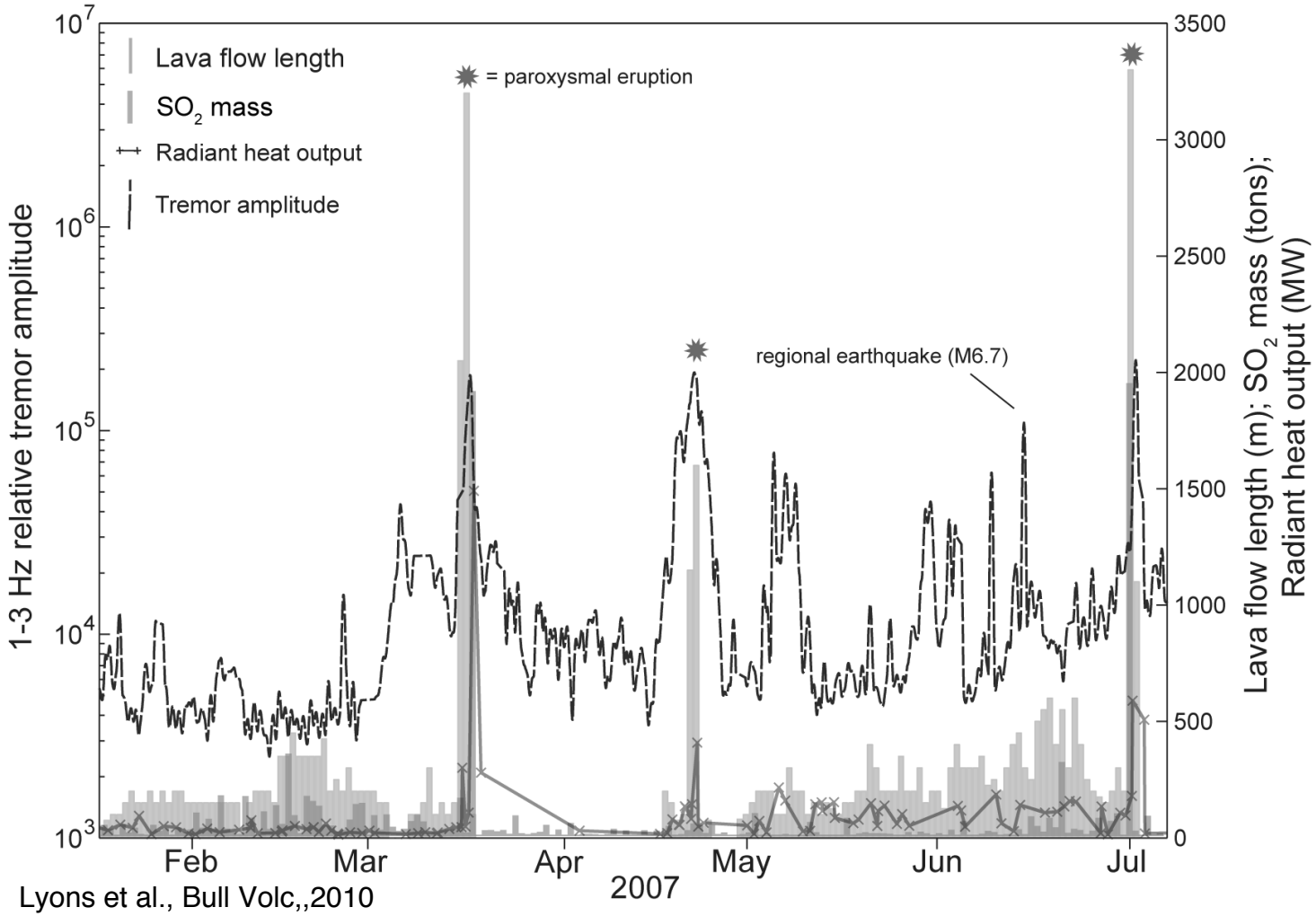
A Peace Corps student project

- Added seismic and infrasound

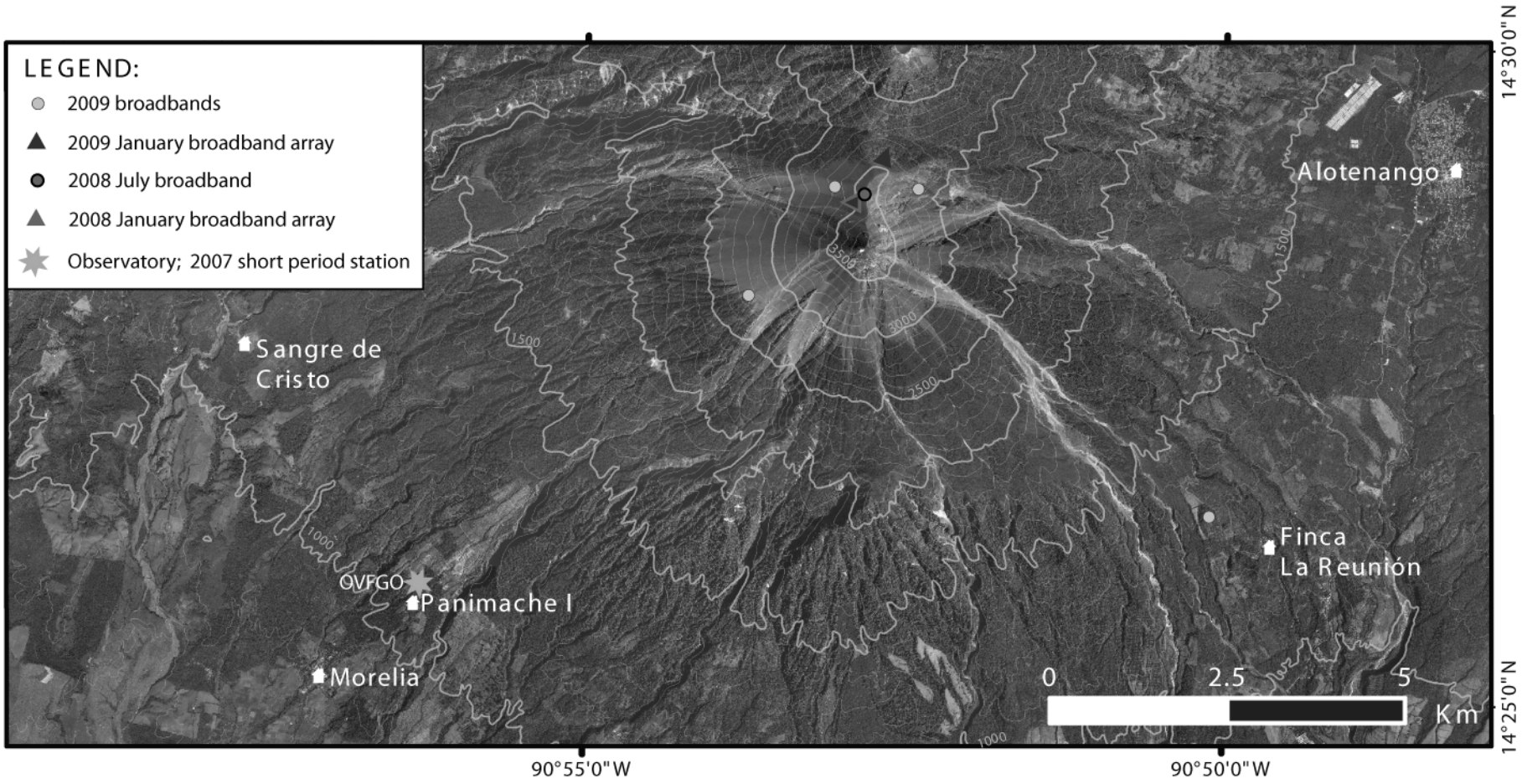


Lyons et al., Bull Volc,,2010

Example of a Peace Corps student

- Began as PC volunteer
- Low tech observation
- Added seismic and infrasound
- Helped lead field deployments

2008 & 2009 campaigns



UV Camera for SO_2 imaging

- UV absorbance is proportional to SO_2 concentration
- Comparison with calibration cells of known concentration
- Measure absorbance in a profile perpendicular to plume
- Plume speed estimate from image sequences
- Yields emissions at high temporal resolution

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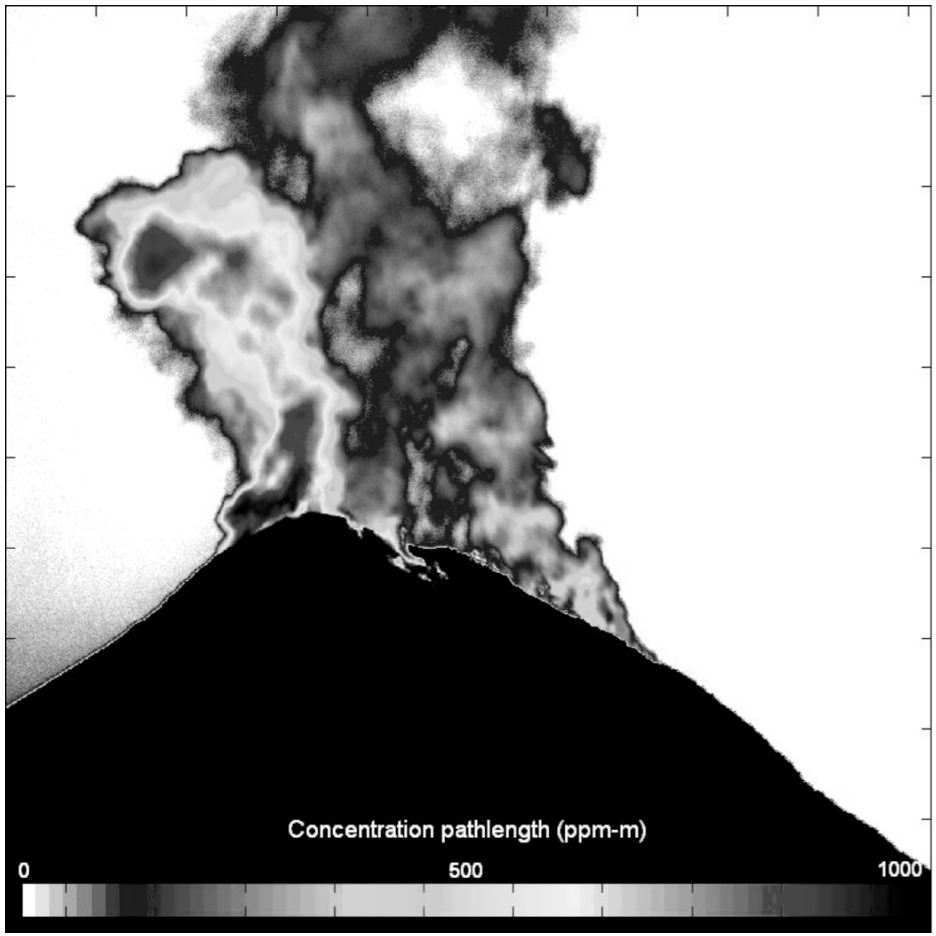
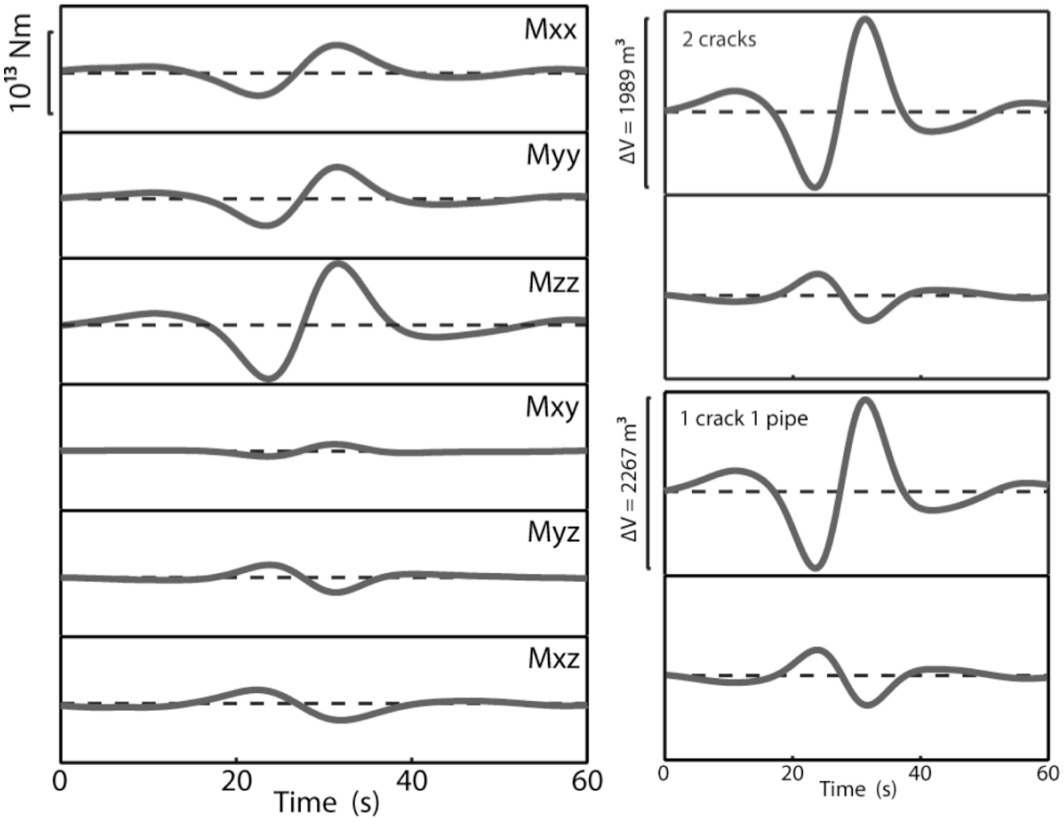


Nadeau et al, GRL, ,2011

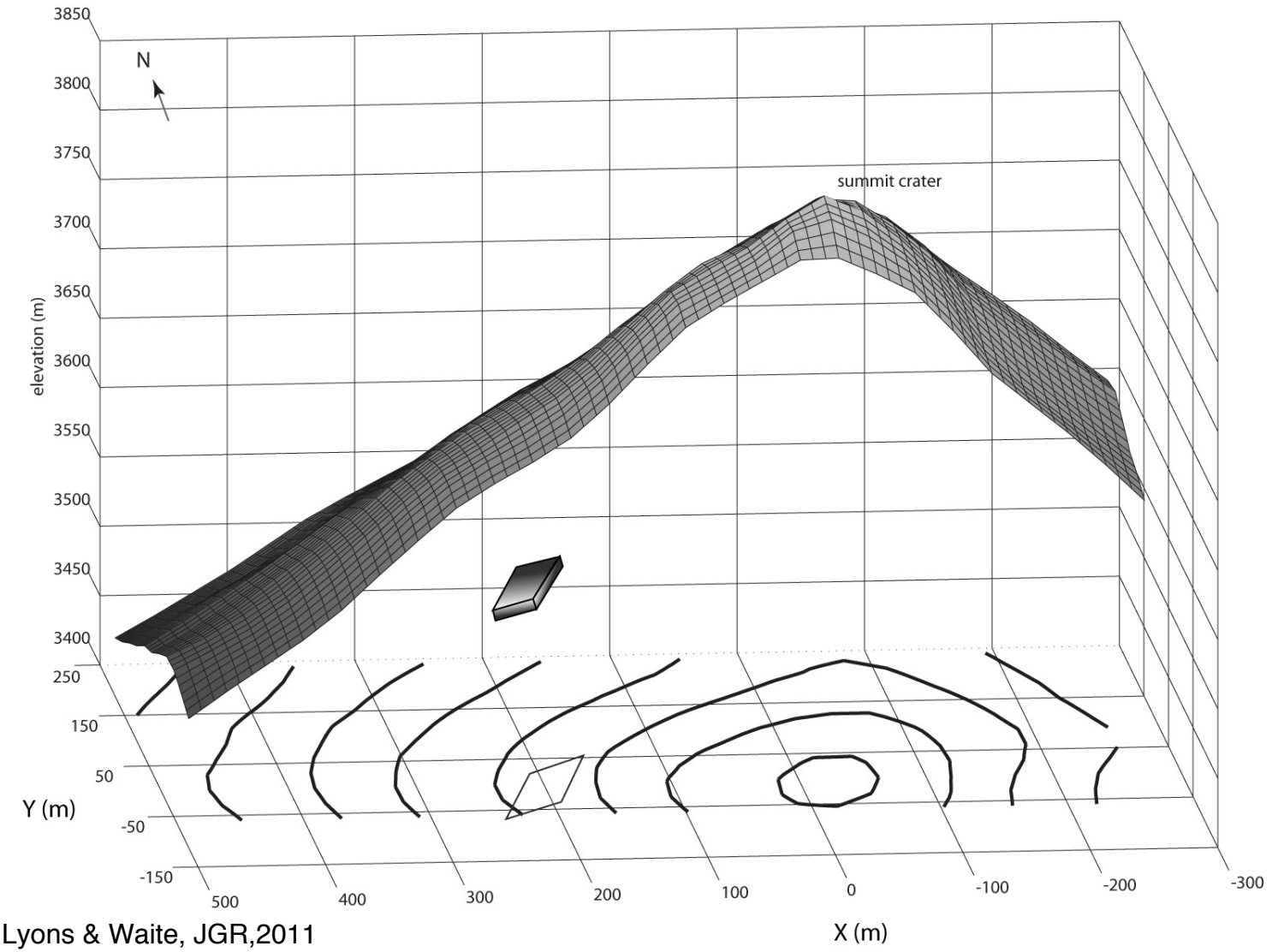
Example of a Peace Corps student

- Allowed us to do full waveform MT modeling of explosion VLPs



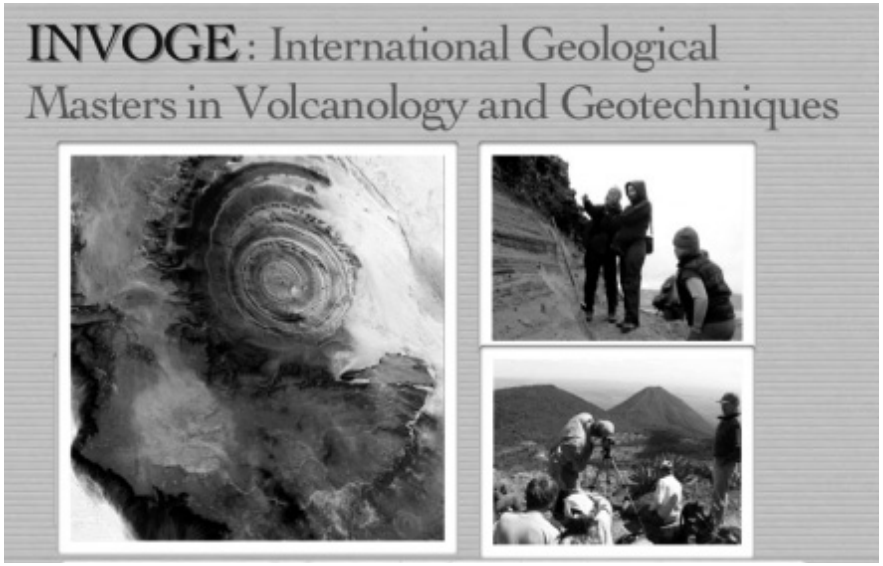
Lyons & Waite, JGR,2011

Dominant VLP source



Lyons & Waite, JGR,2011

Other Multinational Graduate Study Opportunities



Dual M.S. in Hazards Engineering and Water Resources (program in development)

Examples of International Impacts

Advising the Vice President of Guatemala and the Director of CONRED and the Guatemalan National Science Foundation on Research Needs for Volcanological and Landslide Hazards

Advising the International Atomic Energy Agency on Remote Sensing for Water Resource Assessment in the Dominican Republic

Outgrowth Activities at Michigan Tech

Teaching PC Style

Eduardo Cabret
at a local school

Lara Kapelanczik
PCV-Nicaragua

Survey Methods Colloquium

Benefits of PIRE project

- Helps us to place students in international positions
- It has improved international collaborations - not just with partner countries
- Improved student diversity - students from many different backgrounds make a more interesting and better department

Lessons we have learned: partnerships

- Universities AND government hazard agencies
  - Both have strengths, partnerships are more effective when they include both
  - Understanding of differences in priorities/economies
- Memorada of understanding (MOUs)
  - Critical for some partner organizations, but often unnecessary or difficult to obtain for US institutions
- Maintain communication
  - Internet is OK
  - Face-to-face is better
  - Must be frequent
  - Workshops

Other challenges: assessment

- US agencies increasingly want to see evidence of project effectiveness
- Could actually be meaningful if done correctly from the outset

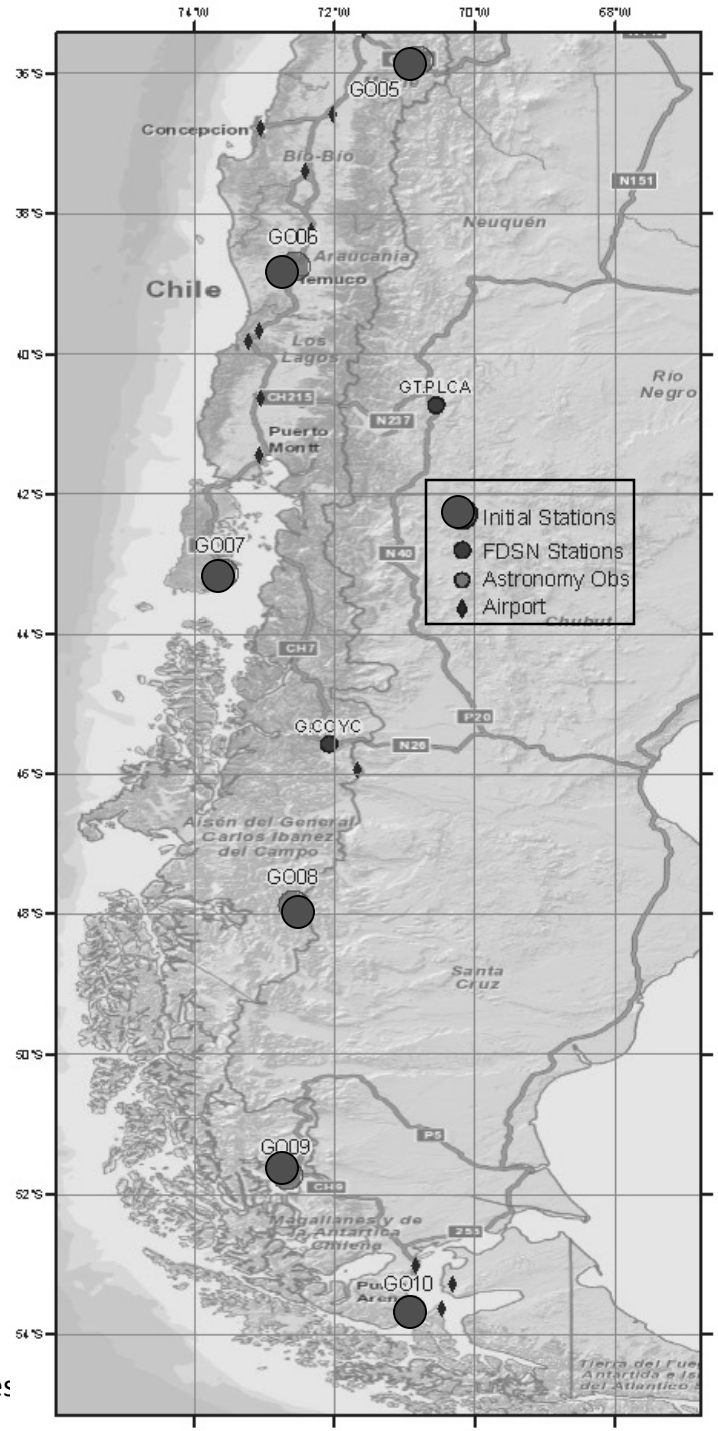
Other related programs

- Peace Corps Response - program for returned PC volunteers who want or are needed for additional service
- Fulbright - funding for US researchers to work with partners or non-US researches to work in US
- Partnerships for Enhanced Engagement of Research (PEER)
  - NSF and USAID funding
  - Provides funding directly to collaborators (not USA PIs)
  - One focus area is *disaster mitigation*
- Pan-American Studies Institutes (PASI) - funds for focused workshops

focused workshops

Related projects

- Major Research Instrumentation (MRI)
  - Chile "backbone" broadband seismic network
  - IRIS is the PI
  - 3 year installation and initial servicing project
  - U. de Chile will operate the network



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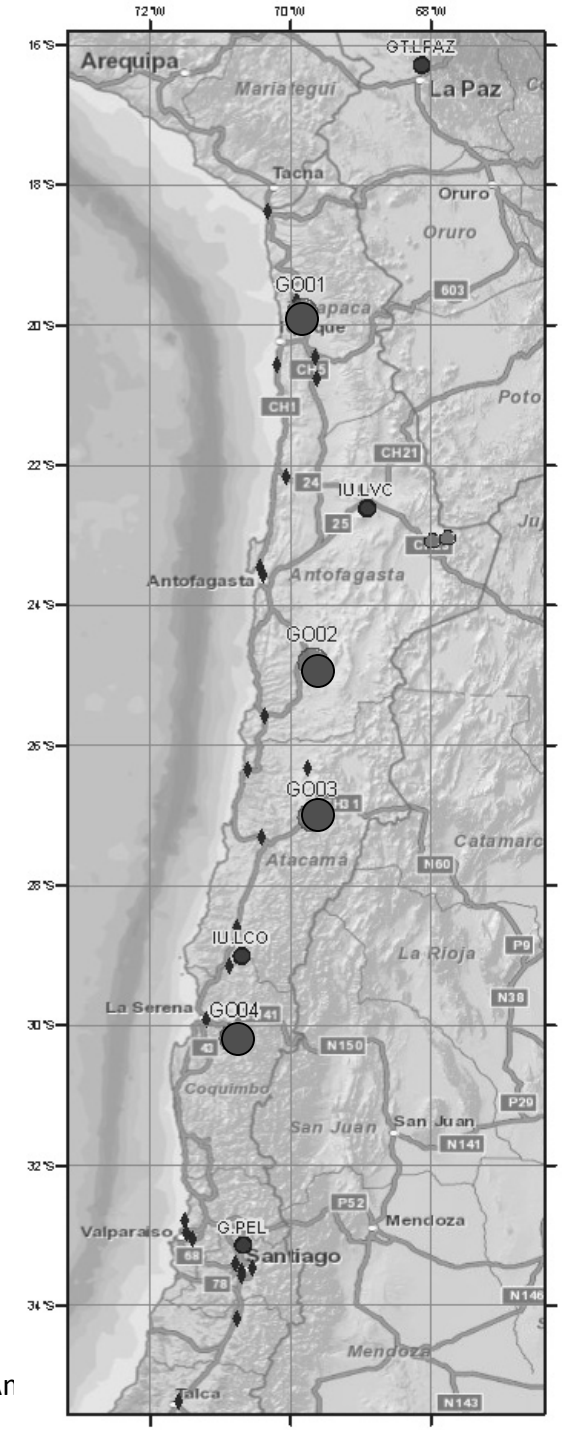
www.iris.edu/gmap/C



Does this make sense for CA?