Subduction Zone Observatory Discussion – Chile Workshop 2015

Latin America has over 10,000 km of subduction and convergent margin with associated earthquakes and volcanic arcs. Increasing populations are living in the vicinity of subduction zones and are at risk for earthquakes, tsunamis, volcanic eruptions, and landslides. A coordinated approach to the concept of a Subduction Zone Observatory (SZO) was generally thought to be a good idea in Latin America. The Chile example shows that building geophysical observatories is not purely a scientific development, but requires major support from hazard mitigation agencies (ONEMI). Hazards must be a major part of a SZO.

Human Capacity Building, Education and Training

Education and training is key to promote and improve our understanding of earthquakes and subduction zones in the broadest sense and must be part of an SZO. There was the general feeling that there is enough instrumentation at the moment but not enough people trained to use the data and make progress understanding earthquakes, volcanic processes, and plate boundary and cratonic processes. We need improvement in the following areas of training:

1. Webinars in Spanish. Topics might include:
    a. Instrumentation and construction and installation of instruments
    b. Data processing and archiving along with quality control
    c. Research methods (modeling, inversions, earthquake locations, and interpretation)
2. On line courses for credit or non-credit – basic seismology, geophysics, marine science etc.
3. Workshops on a regular basis (every year)
    a. Summer courses with US students & Latin American students working jointly on topics that could continue well beyond the workshop
    b. IT training for Latin America geophysical network operators
4. USGS training on shake map and other tools.
5. Promote formal graduate studies in US. Find ways to recruit graduate students that have an interest in returning after their degree.
6. Focus on specific research projects that have long-term follow up and interaction. Training with a goal and objective to deliver a product with responsibility.
7. Summer internships for Latin American students. Open up UNAVCO and IRIS summer schools to Latin Americans.
8. Send more US students abroad for long term visits to geophysical labs.
9. PASSCAL training for the region not just the immediate collaborators.

Key Science Questions to Address with a Subduction Zone Observatory

1. How do we define subduction zone segments & interplate coupling along strike and up and down dip in the seismogenic zone? What is the role of subducted ridges? What controls the coupling and maximum size earthquake in a subduction zone and what controls the variations (asperities and barriers)? Is there paleoseismic evidence of megathrusts in the geologic record that could extend our earthquake record beyond the historic record?
2. What are the physical and chemical processes in the subduction channel including the role of fluids and sediments?
3. What is the fate of the subducting slabs in the mantle? What is the role of slab tears and the deformation in the slab?
4. What is the roll of silent slip events and non-volcanic tremors in the earthquake cycle?
5. Where and why are there intraplate earthquakes associated with the subduction zone (outer-rise, slab and upper plate)? What faults are likely to be dangerous in the upper plate

especially near population centers? Are there unmapped faults that are hazardous? Is there a relationship between water loading and seismicity?
6. How can we better understand tsunamigenic earthquakes and identify regions where tsunamis are likely to be large and damaging?
7. Are there links or triggering between the megathrust earthquakes and the volcanic arc response?
8. How does subduction drive orogeny in the Andes and Latin America? What is the role of the craton in the convergent margin process and mountain building? What do the earthquakes in the craton tell us? What is the role of dynamic topography? What is the seismic structure of the over-riding plate? Can we relate mantle processes with surface uplift?
9. What are the forearc mechanisms for accretion, basin development, and forearc sliver deformation?
10. What is the plumbing of volcanic arcs and how does it work over short and long time spans?
11. What is the water budget in the subduction process?
12. What is the origin and formation of the Caribbean Plate?
13. What is the thermal structure of subduction zones and how does it impact the deformation in the over-riding plate?
14. What is the role of subduction in ore deposit formation?

What facilities/equipment/data do we need?

1. More offshore observations that will require more and improved technology for both seismic and GPS data collection. Are cables the answer? What would we put on a cable? GPS, seismometer, acceleration, OBS, pressure gages, temperature. What did we learn from Neptune?
2. Ocean drilling in subduction zones
3. More detailed subsurface imaging
4. Continuous GPS data
5. Improved and higher resolution bathymetry off-shore, and on the continental shelf, and improved topography on continental areas with LIDAR measurements and in the Amazon region
6. Improved mapping of landslides and faults
7. MT across the upper plate including the crust and mantle wedge
8. Improved geochemistry of subducting fluid
9. Data on aquifer recharge and water loading
10. Satellite Grace data
11. Uplift data from thermochronology and paleoaltimetry
12. InSAR & SAR data (8 day repeat mapping of planet is now possible?)
13. Strainmeters – boreholes
14. Heat flow measurements in a systematic way
15. Atmospheric data

Other ideas

1. Can subduction zones generate energy?
2. Create a Master table of instrumentation and metadata for Latin America geophysical instrumentation.
3. Create a combined earthquake catalogue for Latin America by relocating all the earthquakes in a systematic way for research purposes (not in real time).

Funding

- Distributed funding sources
- International Inter-agency MOUs and agreements showing collaboration and coordination already in place would help funding potential SZO activities.

Institutional framework

Collaborative models to consider –

- Facilities
- Science themes
- Hazard themes
- Steering committees
- GeoPRISMS model – community based office to follow science plan and coordinate activities
- Topical institutes – to access science questions
- Every country needs to be involved – who is interested, what is the situation in each country – letter of intent from each country, what are the possibilities for funding (what agencies) needed to start the project?
- Form follows function – define the function and goals first
- Science has to be closely coupled to development of facilities

Action Items

1. Establish a Data sharing metadata working group to be led by Marcelo Bianchi.
    a. Encourage everyone use an FDS Network code and ISC registered station names.
    b. Start by putting together all the network metadata in a database for everyone so we know what instrumentation we have. Start with seismic instrumentation and then expand. Build a dynamic master database that is updatable as new or corrected metadata is available. This would provide a temporal, spatial and frequency band evolution of seismic instrumentation in Latin America. It could help identify future instrument needs.

2. Establish an offshore cable working group to investigate possibilities, technology, and needs.
3. Establish an educational and training working group to coordinate and identify training ideas and coordinate with existing training opportunities.
4. Establish collaborative working group to focus on a research topic of interest Latin America wide. Start with a community project to do ambient noise tomography across Latin America (Beck, Perez-Campos, Russo, Pulliam, Julia volunteered to coordinate). Ideas for community projects are:
    a. Ambient noise
    b. Earthquake location catalogue – relocations done in a systematic way with all the data using double difference or other methods.
    c. Tremor catalogue