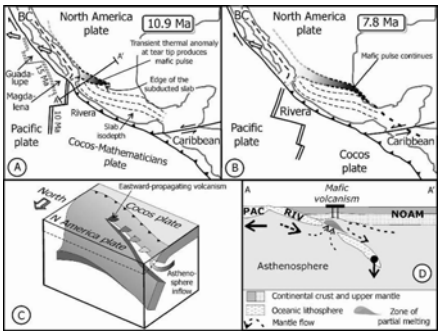
Design, Installation, and Performance of a Delay Tolerant Seismic Network in Mexico

Allen Husker, Igor Stubailo, Martin Lukac, Alma Quezada, Steven Skinner, Irving Flores, Paul Davis, Richard Guy, Deborah Estrin - Seismology – http://www.cens.ucla.edu/portal/seismic_monitoring/

Impetus: Seismological study in remote location – Where is plate tectonic subducted slab?

Question of slab position



Two possible models for flat slab subduction

- Geochemical model from Ferrari, 2004 (left)
- Geodynamical model from Billen and Hirth 2005 (below)
  - Young slab leads to flat-slab subduction

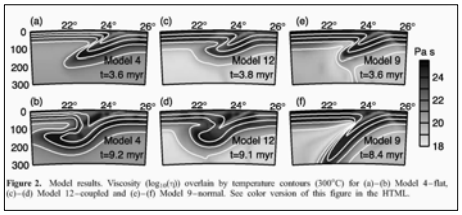
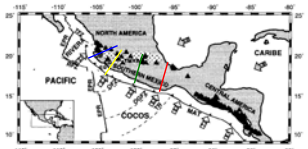
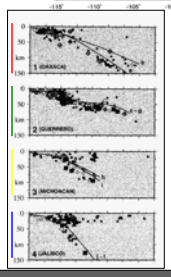


Figure 2. Model results. Viscosity ($\log_{10}(\eta)$) overlain by temperature contours (300°C) for (a)–(b) Model 4–flat, (c)–(d) Model 12–coupled and (e)–(f) Model 9–normal. See color version of this figure in the HTML.





Shape of the slab from seismicity

- No knowledge of slab beyond the Trans-Mexican Volcanic Belt (TMVB)

Solution: A dense seismometer network in Mexico

100 station seismic network measuring subduction from the coast across Mexico

Pachuca Line
Example of network topology

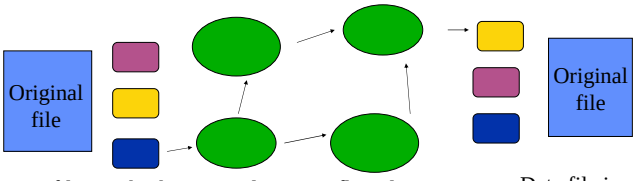
CDCC	Following CDCC	Lat	Lon	Name
MIMO	stand-alone	20°08.453'	98°40.894'	Mineral del Monte
PACH	SAPE	20°05.750'	98°42.032'	Pachuca
Pachuca-R	(200.57.61.5)	20°07.685'	98°44.102'	Pachuca UAEH Rectoria
Cubitos-R	Pachuca-R	20°06.357'	98°44.216'	Cubitos (repeater)
PASU	Cubitos-R	20°05.270'	98°47.485'	Pachuca Sur
SUPA	Zacualtipan-R	20°02.018'	98°48.422'	sur de Pachuca
SAPE	Zacualtipan-R	19°59.409'	98°51.818'	San Pedro
Zacualtipan-R	Cubitos-R	19°58.432'	98°51.703'	Zacualtipan (repeater)
KM67	Zacualtipan-R	19°57.061'	98°52.395'	tierra publico
PSIQ	KM67	19°54.061'	98°54.588'	Hospital Psiquiatrica
ECID	TIZA	19°51.996'	98°55.703'	El Cid
TIZA	KM67	19°49.053'	98°55.578'	Tizayuca
Banco-R	Cubitos-R	19°47.304'	98°58.732'	Banco de Material (repeater)
SNLU	Banco-R	19°47.060'	98°58.819'	San Lucas
SALU	Banco-R	19°45.039'	98°59.772'	Santa Lucia
TECA	COAC	19°41.975'	98°58.849'	Tecamac
TONN	COAC	19°41.166'	99°02.772'	Tonnanitla
COAC	Banco-R	19°37.128'	99°05.130'	Coacalco

- **What we have achieved that other networks have not in remote locations**
  - Near real-time knowledge of problems within the network
  - Dynamic network reconfiguration
  - Delays on the order of a few weeks can be tolerated within the network
- **Improvements still to be made**
  - Addition of in-network timing for those locations where GPS is not available (e.g. buildings, tunnels)
  - Add CENS suite of tools to see data using Google Earth in near real time and simplify software for field technicians.

- **Challenges**
  - Environment (see picture at right)
    - trees growing and blocking signals
    - flooding
    - strong wind changing antenna direction
  - Computer network and Internet connection reliability
  - Obtaining skilled technical assistance
  - Cultural and language differences

Preliminary Results: Disruption Tolerant Shell (DTS) & Possible Slab?

DTS has been developed to aid data flow for a system with weak or variable links



Data files are broken up and aggressively pushed through the system.

Data flow direction is decided separately for each file portion.

Data file is recompiled at the sink node.

Evidence of slab already seen in preliminary data