MASE: Shallow Subduction in Central Mexico

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ABSTRACT

The objective of the MASE (Middle America Subduction Experiment) is to construct a geodynamical model of the subduction process. The Middle America Trench was chosen as the first example because of the relatively simple plate geometry (a linear margin with near normal subduction) and a significant along-strike slab-dip variation. The initial deployment along the Acapulco to Tampico transect in central Mexico is designed to investigate the case of shallow subduction.

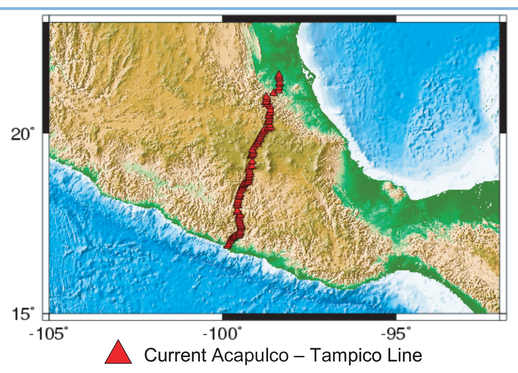
The main results to date are:

- The discovery that the slab underplates the continental crust to a distance of 200 km from the trench. This result is interesting because there is no geologic or geodetic indication of coupling in this zone – the coupling that is measured geodetically is confined to the initial 75 km near the coast where the slab is dipping down. There is also no fluid signature in the magnetotelluric (MT) data of the flat-slab portion of the line.
- The relative attenuation in the mantle under the Mexican Volcanic Belt (presumed location of the mantle wedge) is a factor of 2 higher than the surrounding mantle.
- Modeling studies indicates that a shrinking low-viscosity mantle wedge can lead to flat-slab subduction as observed.
- A slow earthquake appears to be in progress on the southern 200 km of the MASE line. The last slow event occurred in 2002. This one started in March, 2006.

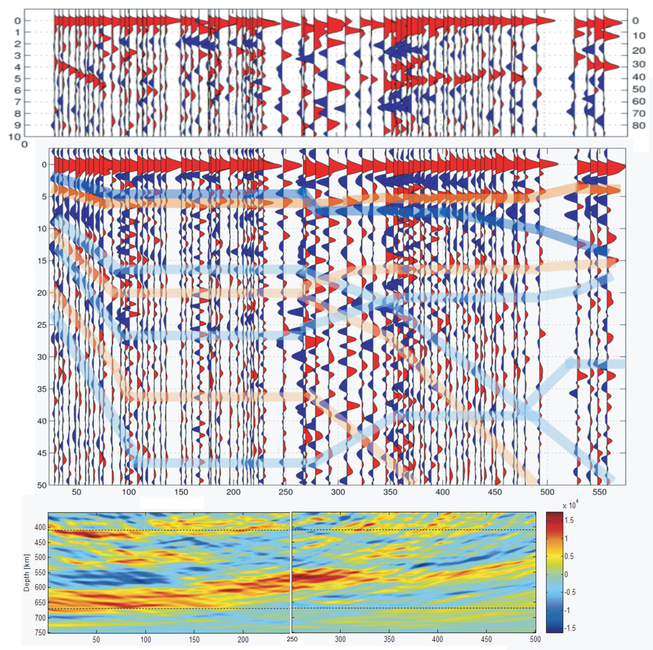
El objetivo del proyecto MASE (*Middle America Subduction Experiment*) es construir un modelo geodinámico que represente un proceso de subducción. Se ha escogido como primer ejemplo la Trinchera de América Central debido a que presenta una geometría relativamente simple (un margen con geometría lineal y con una dirección de convergencia cercana a la normal) y una variación significante del manteo de la placa a lo largo del rumbo. La fase inicial de este proyecto, que consiste en un experimento a lo largo de un transecto localizado en la región central de México entre Acapulco y Tampico, se ha diseñado para investigar este tipo de subducción sub-horizontal. Los principales resultados obtenidos hasta el momento son:

- El descubrimiento de que la placa se encuentra en contacto con la corteza continental hasta una distancia de 200 km de la trinchera. Este resultado es interesante dado que no se ha encontrado indicación geológica o geodésica de que exista acoplamiento en esta zona – el acoplamiento medido en forma geodésica esta confinado a los primeros 75 km cercanos a la costa, donde la placa se encuentra buzando. En la porción del transecto que pasa por la zona de subducción sub-horizontal, los datos magnetotelúricos (MT) no indican la presencia de fluidos.
- Bajo el cinturón volcánico Mexicano (donde se piensa que esta ubicada la cuña del manto) el manto tiene una atenuación relativa con el doble del valor de la del manto circundante.
- Estudios a través de modelos numéricos, indican que la existencia de una cuña de baja viscosidad en el manto puede ser la causa de la presencia de zonas de subducción sub-horizontal como la que se observa en este experimento.
- A partir de Marzo de 2006, se observa que un terremoto lento se esta desarrollando en los 200 km ubicados en la zona sur del transecto de MASE. El último evento de este tipo ocurrió el año 2002.

CURRENT MASE SEISMIC ARRAY



RECEIVER FUNCTION STUDY



1st panel: Stacked receiver function from 0 to 90 km including Moho and slab
2nd panel: Depth-expanded view with predicted multiples superimposed
3rd panel: Migrated section from 350 to 750 depth including 410, 520, and 660 km discontinuities

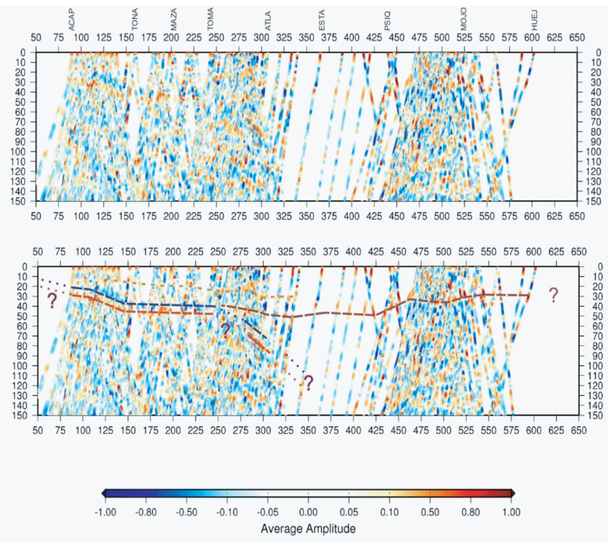
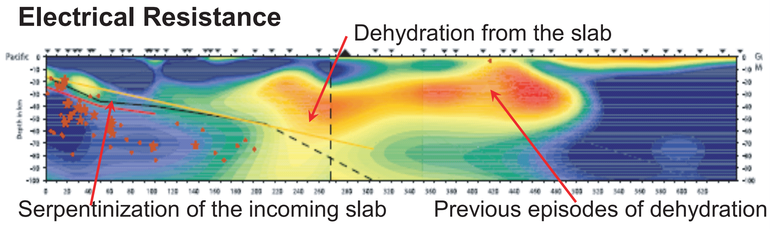


Image by back-projection and migration of receiver function. Top panel is the image and the bottom panel is current interpretation.

MAGNETOTELLURICS STUDY

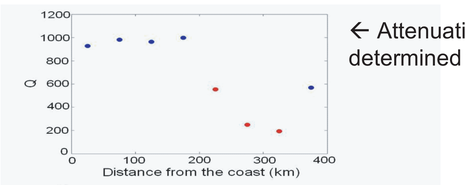
Electrical Resistance



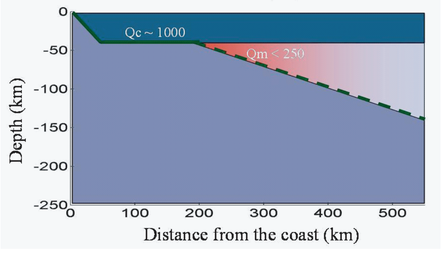
[*Jodicke H., Jording A., Ferrari L., Arzate J., Mezger K., Rupke L., 2006. Fluids release from the subducted Cocos plate and partial melting of the crust deduced fro magnetotelluric studies in Soutern Mexico: Implications for the generation of volcanism and subduction dynamics. Journal of Geophysical Research, v. 111, B08102, doi:10.1029/2005JB003739.*]

ATTENUATION STUDY

Attenuation Model



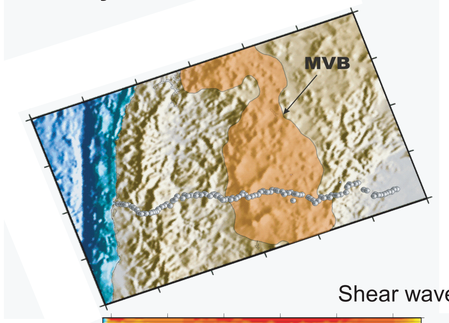
← Attenuation measurements determined from local earthquakes



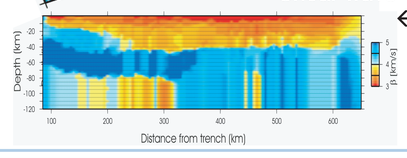
←Inferred model with a low-Q wedge

SURFACE WAVE STUDY

Velocity Model from Surface Waves



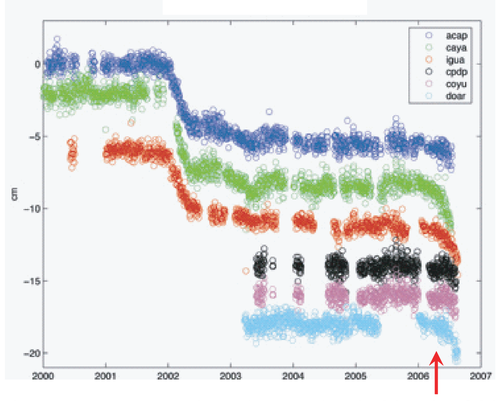
Shear wave velocity model derived ←from Rayleigh waves



GPS STUDY

GPS Transient

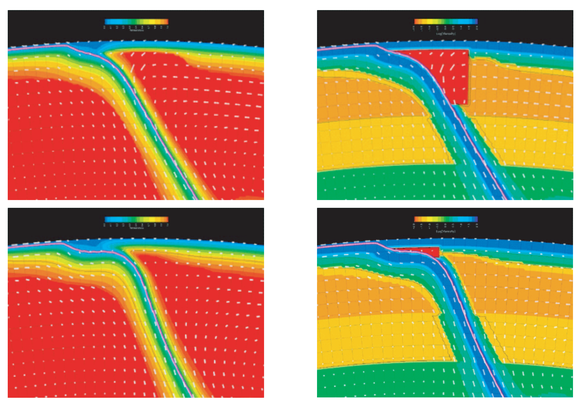
[From Kostroglodov's group]



Apparent slow earthquake starting in March of 2006

GEODYNAMICAL MODELING

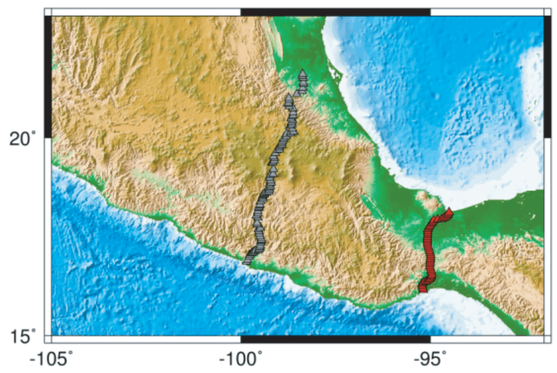
Simulation of Flat Slab Subduction



Temperature Viscosity

FUTURE MASE SEISMIC ARRAY

Proposed Oaxaca Line



Current Acapulco – Tampico Line
Next Oaxaca – Veracruz Line

OUTREACH

The pictures show engineering students from UNAM making presentations on earth science and earthquake hazard at a school that is hosting a MASE student