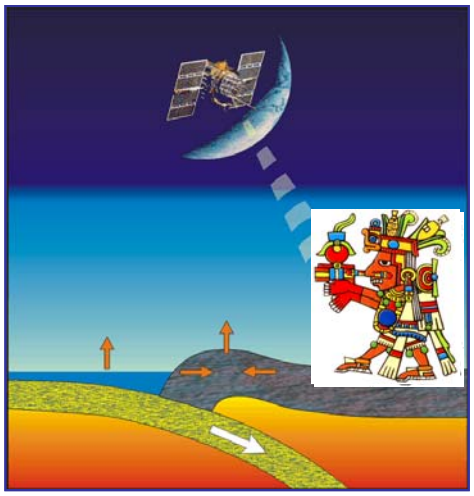
Seismotectonics of Mexico
Silent earthquakes in subduction zone



Interaction between the subducting oceanic and overriding continental plates produces a surface crustal deformation which can be measured and monitored by permanent GPS stations.

Networks of GPS reference stations permit direct study of coseismic static and dynamic deformations as well as interseismic, long term deformations during the earthquake preparation process.

Sismologia-UNAM GPS network

by Sara Ivonne Franco Sánchez, Jose Antonio Santiago, and Vladimir Kostoglodov

Sismologia-UNAM GPS network has recorded an astonishing change in the North American plate crustal motion from the interseismic phase to the slow silent earthquake active phase at the end of 2001 over the entire Guerrero State of Mexico.

The main purpose of the permanent GPS network of the Geophysical Institute, UNAM is to monitor the surface deformation on the Pacific coast of Mexico in order to study a cycle of large subduction thrust earthquakes.

Sismologia-UNAM GPS network is in continuous developing with a perspective to cover all southern Mexico coast where large destructive subduction zone earthquakes are a common natural phenomenon. At the present time the network consists of 19 continuously recording GPS stations.

The main cluster of GPS stations is installed in the NW of the Guerrero state where a large earthquake is expected in future. A study of crustal deformation during the interseismic period and before great earthquakes provides an advanced insight on the structure of the seismogenic zone and physical processes of earthquakes generation.

Continuous GPS records revealed in 1998 and 2001 two slow slip transients or silent earthquakes (SQ) in the subduction zone of Mexico. The silent earthquakes is an absolutely new type of elastic rebound events,

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- **Company**
  Instituto de Geofísica, Universidad Nacional Autónoma de México
- **Challenge**
  Discovery and study of silent earthquakes in Mexican subduction zone
- **Date**
  First permanent GPS station, 1997
- **Project Summary**
  Instruments:
  15 Leica GRX1200 and RS500 receivers. Leica AT504 Choke Ring antennas. Spider software.

  WEB page:
  http://tlacaelel.igeofcu.unam.mx/~vladimir/gpsred/gpsred.html

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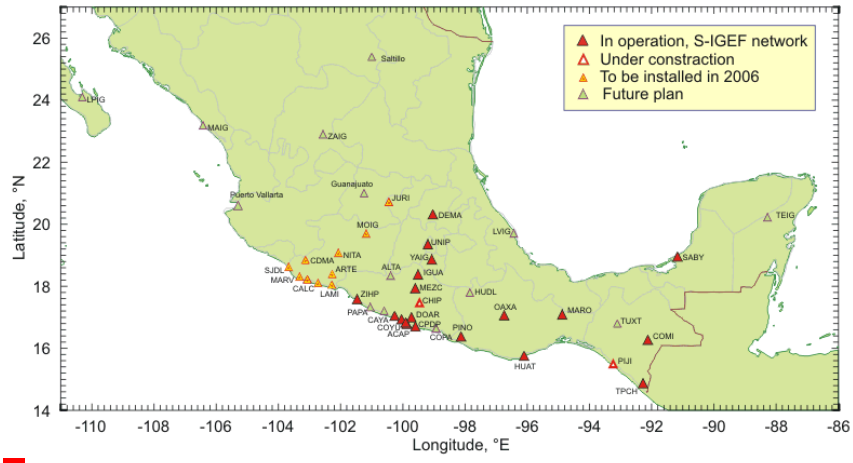


Permanent GPS network Sismologia-UNAM accounts for 19 stations (15 stations are equipped with Leica GRX1200 and SR500 receivers and AT504 antenas). Ten more RGX1200 receivers will be installed in 2006.

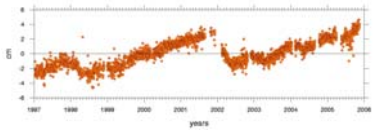
Benefits

Permanent GPS network permits almost real time monitoring of crustal deformation in tectonically active areas.

Continuous GPS records provide a highly consistent and reliable data in comparison with the measurements from campaign occupation networks.

Long term investments in the permanent GPS network is comparable with the expences for the campaign networks.

which has been discovered recently in Japan, Alaska, Cascadia, New Zealand and Mexico. The SQs last from several days up to several years and it is believed that they may trigger large subduction earthquakes in mature seismic gaps like the Guerrero seismic gap.

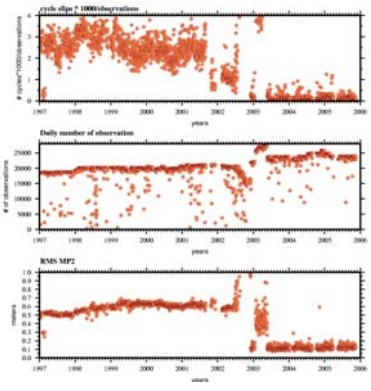


NS position component of the CAYA GPS station. Silent earthquakes of 1998 and 2001 lasted several months.

GPS data quality control is an important part of our project. A precision of several mm should be achieved in many cases for the seismotectonic studies. Furthermore some variation in the GPS equipment health and response may be misinterpreted as tectonic processes without a reliable data quality analysis. The Figure above shows a NS component of the time series at CAYA permanent GPS station. Trimble receiver (4000SSi) at this station has been replaced with Leica RS500 receiver in 2003. The quality of data is significantly better for the Leica receiver (see bottom Figure) while the antenna is kept the same (TRM22020.00+GP). Annual variations in the position of this station seen after 2003 would be deemed as real silent earthquakes of smaller magnitude if the quality data analysis was not done for all GPS stations.

Conclusions

Sismologia-UNAM GPS network project will advance to cover the entire subduction zone of Mexico. Leica Geosystems GPS reference station equipment (GRX1200) and



2001-2002 Silent Earthquake (red vectors) was the largest one (Mw ~ 7.5) ever recorded with GPS. Yellow vectors show interseismic steady state GPS stations velocities.

Spider software will be basic for our network at least for the next several years as the most reliable in our conditions. We are considering employing a rigorous and real time data quality control in our GPS processing procedure (GIPSY or GAMIT).

References:

Franco Sánchez, S.I., V. Kostoglodov, K.M. Larson, V.C. Manea, M. Manea, and J.A. Santiago, Propagation of the 2001-2002 silent earthquake and interplate coupling in the Oaxaca subduction zone, Mexico, *Earth Planets Space, 57*, 973-985, 2005.

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