

GPS IN COLOMBIA

The GeoRED Project

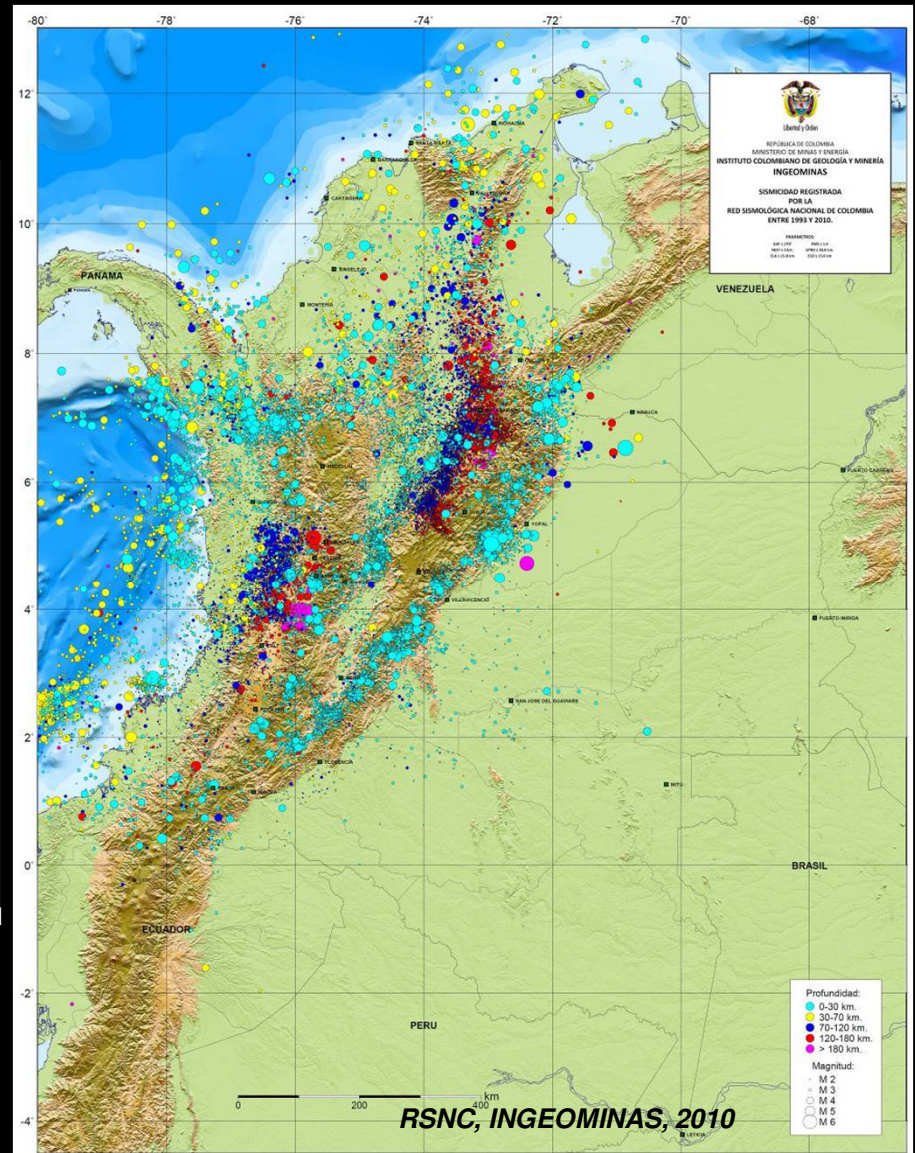
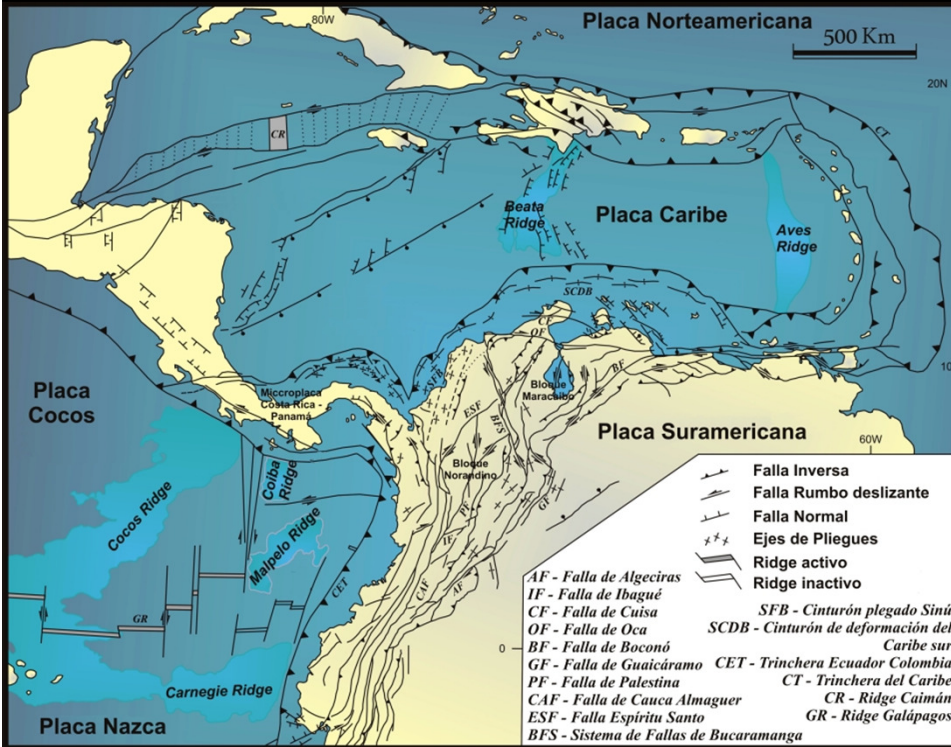
Héctor Mora-Páez



INGEOMINAS
Colombian Institute of Geology and Mining

Joint ICTP/TWAS Workshop
Seismic Sources in Central America: What is the largest earthquake each can produce
October 30 – November 5, 2011
Heredia, Costa Rica

TECTONIC FRAME AND SEISMICITY



GPS AND GEODYNAMICS IN COLOMBIA

CASA Project

Central And South America GPS Project

1988-1998

Kellogg et al

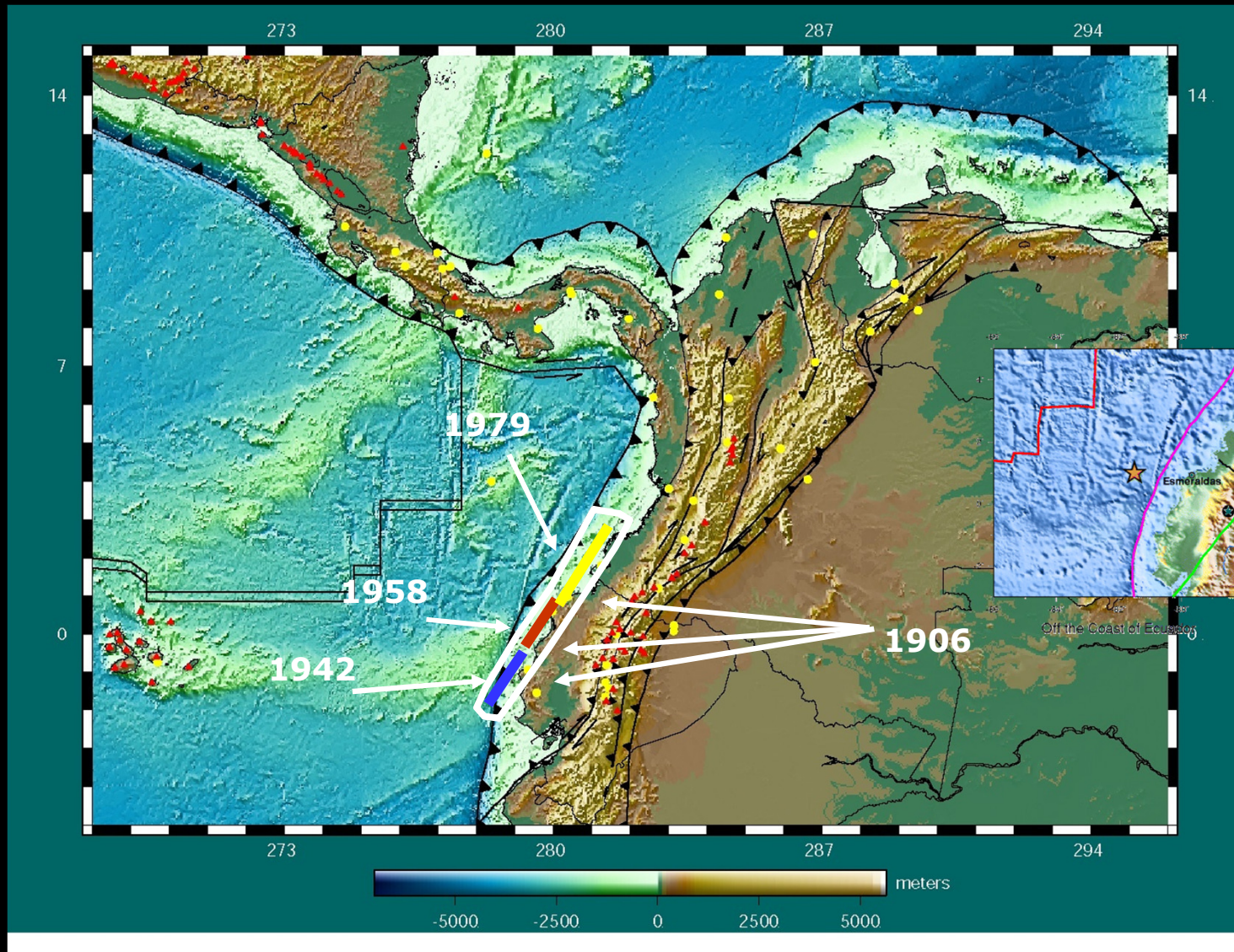
PRE-GEORED

1998-2006

GEORED

2007

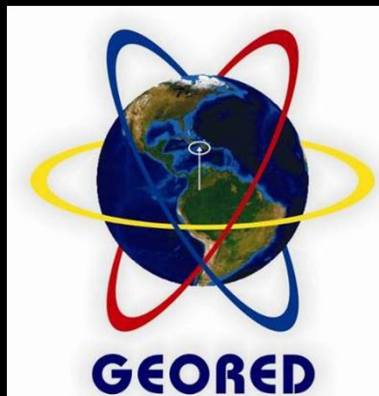
Earthquakes, (1900-1980)



WHAT IS GeoRED?

GEORED is a research and development project based on GNSS instrumentation proposed and initiated by the Colombian Institute of Geology and Mining - INGEOMINAS in 2007 (Mora, 2006)

This project takes into consideration political relevance, economic importance, social bearing, along with scientific, and technical pertinence, as an appropriate approach to cataloging, understanding and defining the geodynamics of northwestern South America in a multi-focused endeavor to study the crustal deformation in Colombia.



GEORED is the pseudonym adopted for the project "Implementation of the National GNSS Network for geodynamics" and the acronym for "Geodesia: Red de Estudios de Deformación" as the specific field application for the study and analysis of crustal deformation in Colombia.

It is a research and development project financed by the Colombian Government and executed by INGEOMINAS under the BPIN code 0043000220000 of the National Planning Department

OBJECTIVES AND SCOPE

The general purpose of the GEORED Project is to “*Improve the technical, scientific and operational capabilities in Colombia for analysis, interpretation and policy formulation regarding phenomena related to crustal deformation in Colombia, using GNSS satellite technology*”.

GEORED is also designed to meet the following specific objectives:

To implement an Active National GNSS Permanent Network for geodynamics with data transmission to an information-gathering center.

To create GNSS mobile teams for campaign style data acquisition (passive network) - (active faults studies, post-seismic assistance, volcanic crisis assistance, mass movements monitoring, etc).

To generate information about horizontal and vertical displacements as an essential input for the studies of crustal deformation.

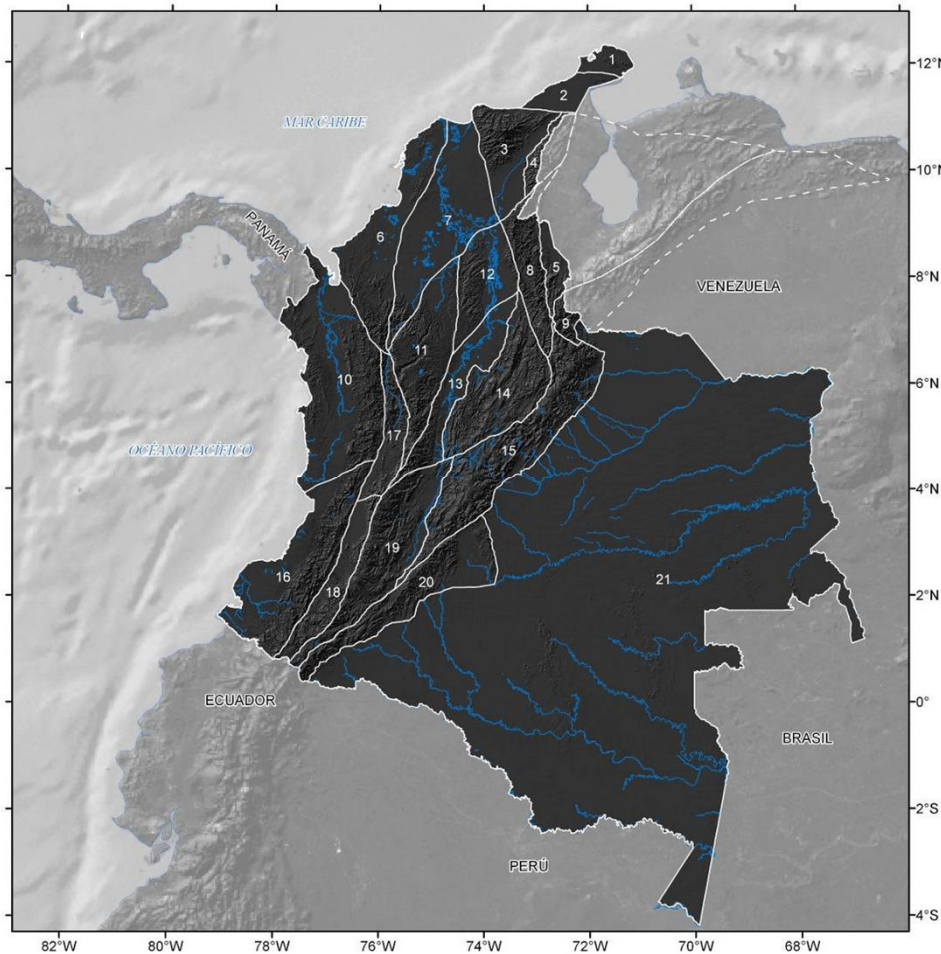
To establish a high precision geodetic reference frame for the multipurpose activities within INGEOMINAS.

To provide information within INGEOMINAS as well as to other government institutions toward the execution of research and development projects using GNSS data.



CRUSTAL SEGMENTATION OF THE NORTH ANDES WITHIN COLOMBIA

Beginning in 2007, discussions within the GEORED group led to a master plan for the distribution of the base permanent GPS station array and specific areas of interest for campaign site construction. The use of previously identified active faults as preferred structures along which stresses are transferred through the deformational area led to the idea of segmentation of the North Andes within Colombia into 20 tectonic sub-blocks.



These sub-blocks were determined taking into account some generalizations:

- *A tectonic sub-block represents a homogeneous crustal entity limited by the main active faults, and it is thought to possess a characteristic pattern of internal deformation;*
- *At some fault segments, current kinematics, rupture dimensions and terminations remains unclear; moreover, detailed palaeoseismological and neotectonic studies are yet scarce. Due to this, it has been necessary to make some general assumptions about fault extension, geometry and sense of slip from geophysical interpretation, geological maps and reports;*
- *Some regions at plate interfaces are expected to be more heterogeneous and to have higher sub-block segmentation. But, owing to the fact that some of those places have not been studied in depth and are difficult to access, the polygons of the sub-blocks are only approximately outlined.*



GEORED NETWORK IMPLEMENTATION

Each of the 20 sub-blocks is expected to have, at least, 2-3 permanent GNSS stations within the block along with construction of campaign sites along the boundaries.

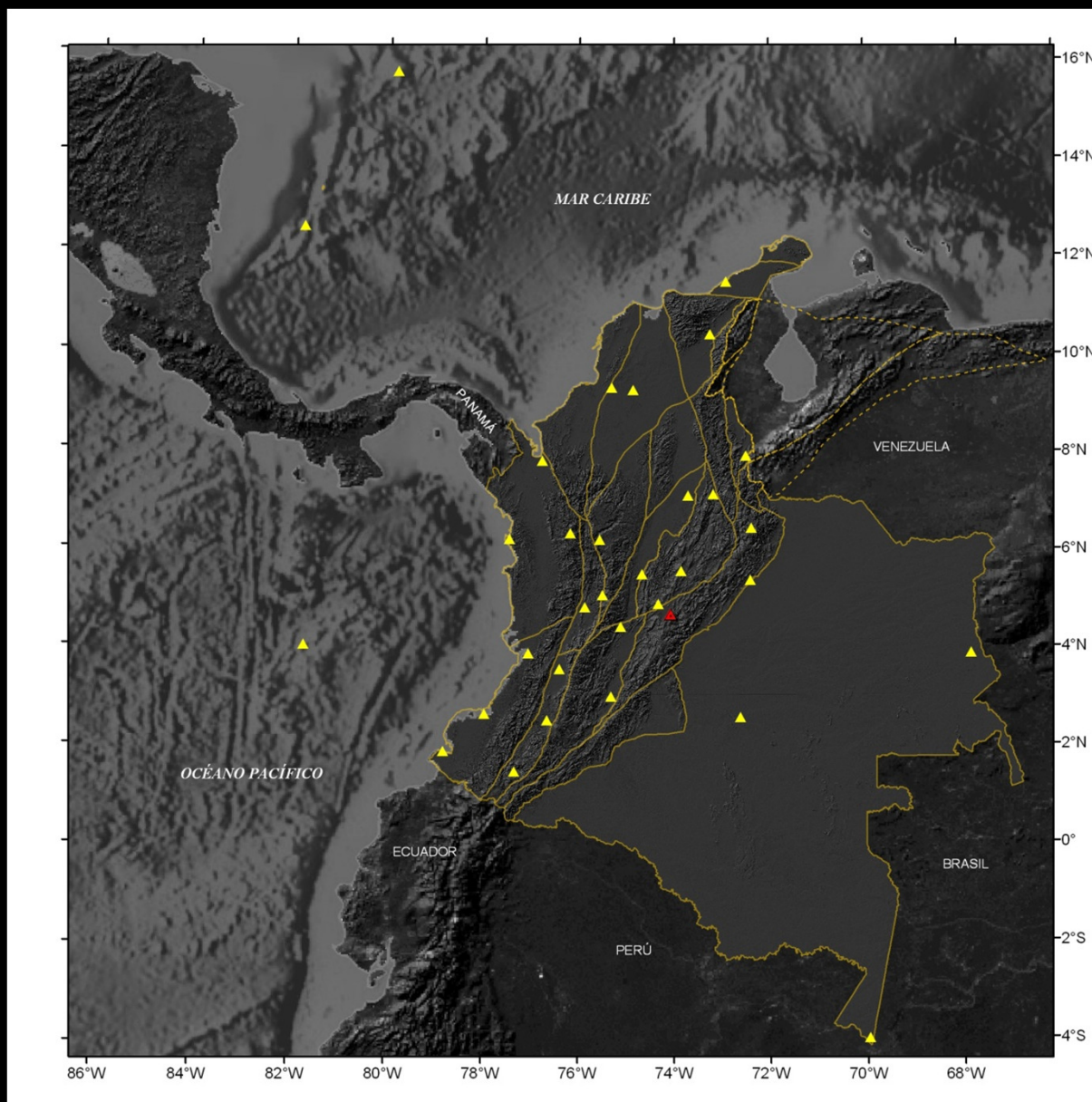
33 permanent installations and ~ 200 campaign style site constructions have been funded through October 2011.

Full implementation of ~ 60 permanent installations and 250 campaign site constructions should be completed by 2013.

The GEORED has several types of GPS and GNSS receivers for permanent and field campaigns occupation

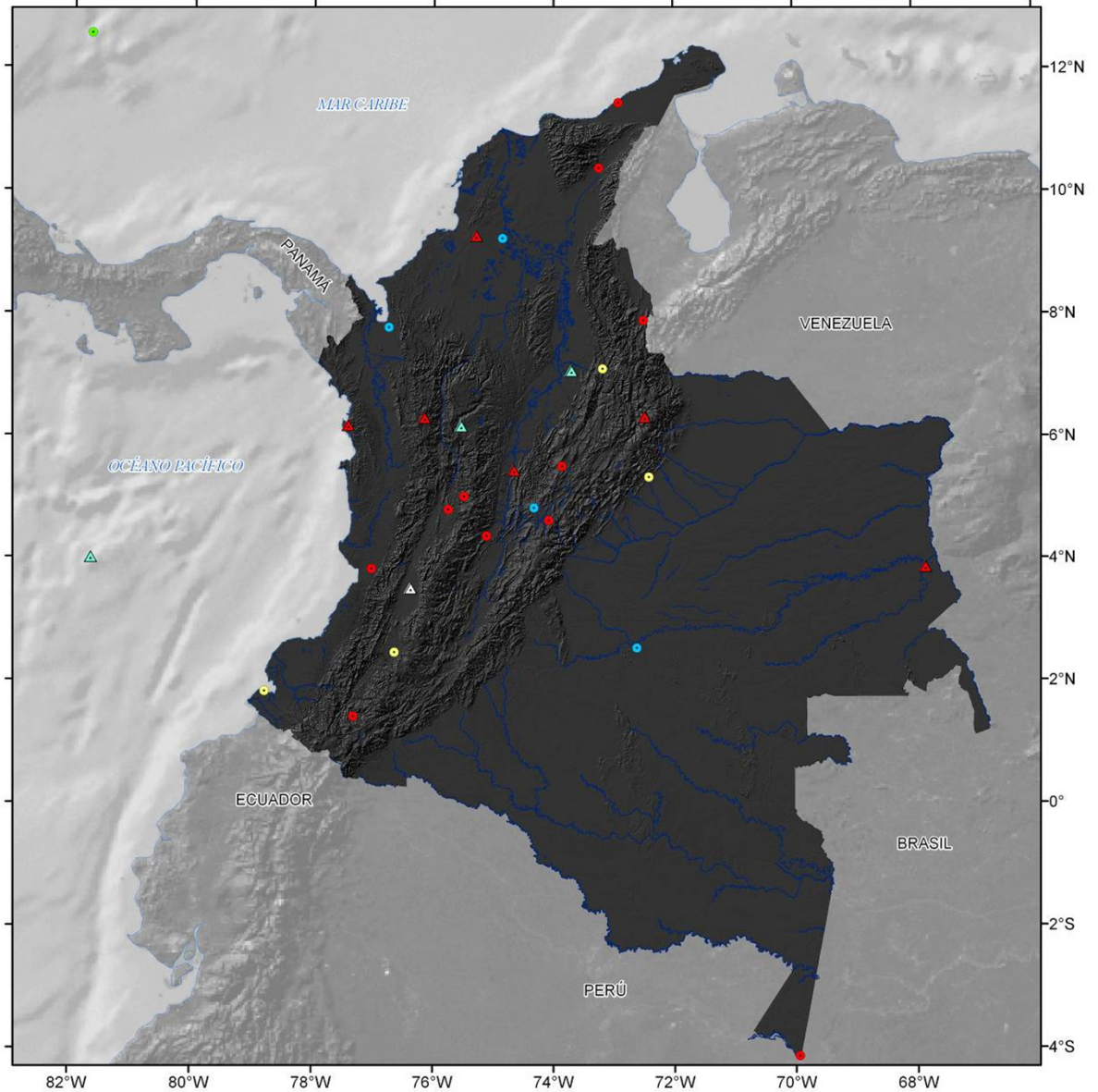
GEORED NETWORK IMPLEMENTATION

GPS Permanent Stations - Status October 2011

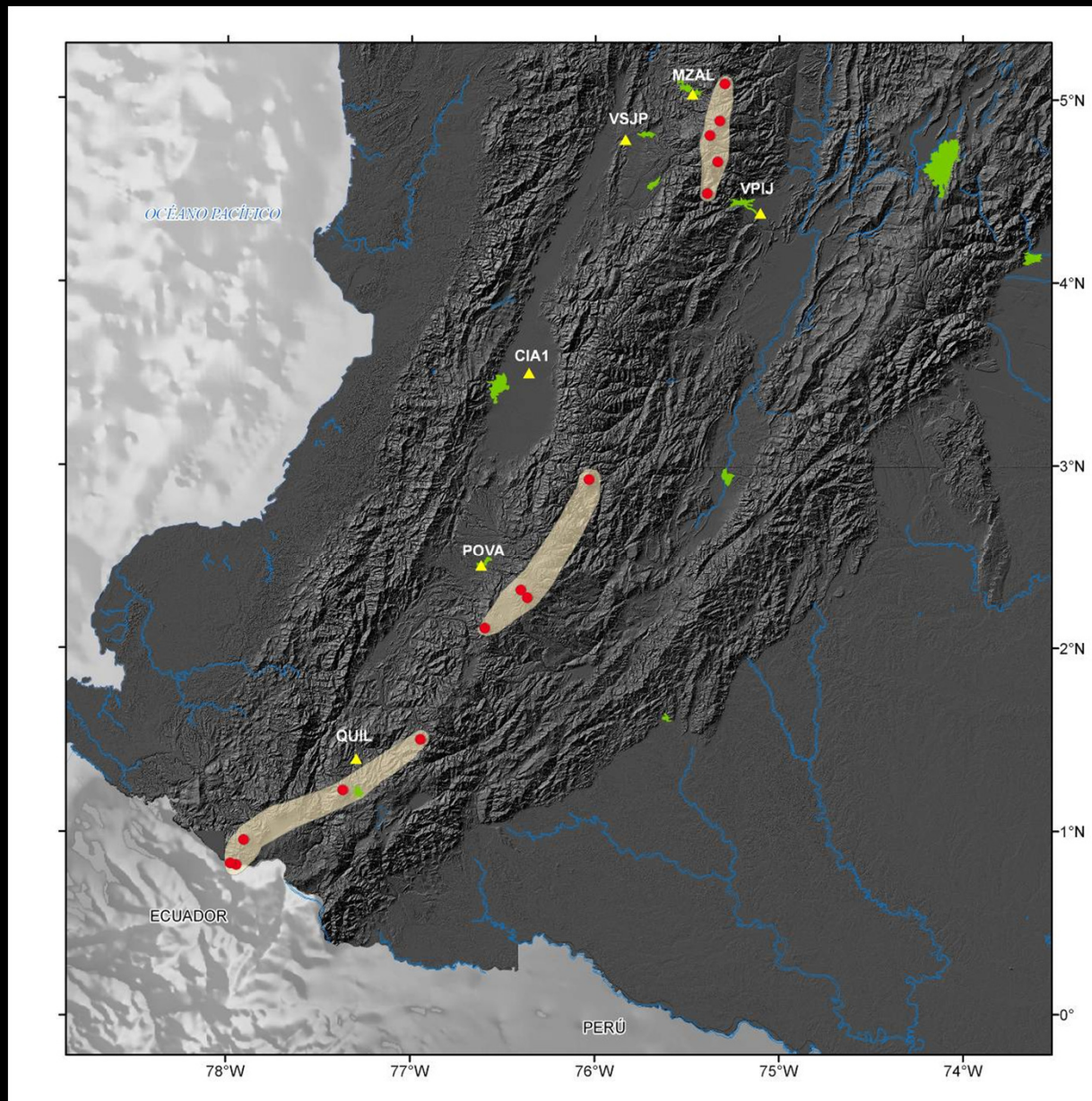


DATA TRANSMISSION

- ▲ GPRS modem
- ▲ Optical fiber + internet
- Radio-link + internet
- Radio-link + sat. internet
- Radio-link + satellital link
- ▲ Satellital link
- No data transmission

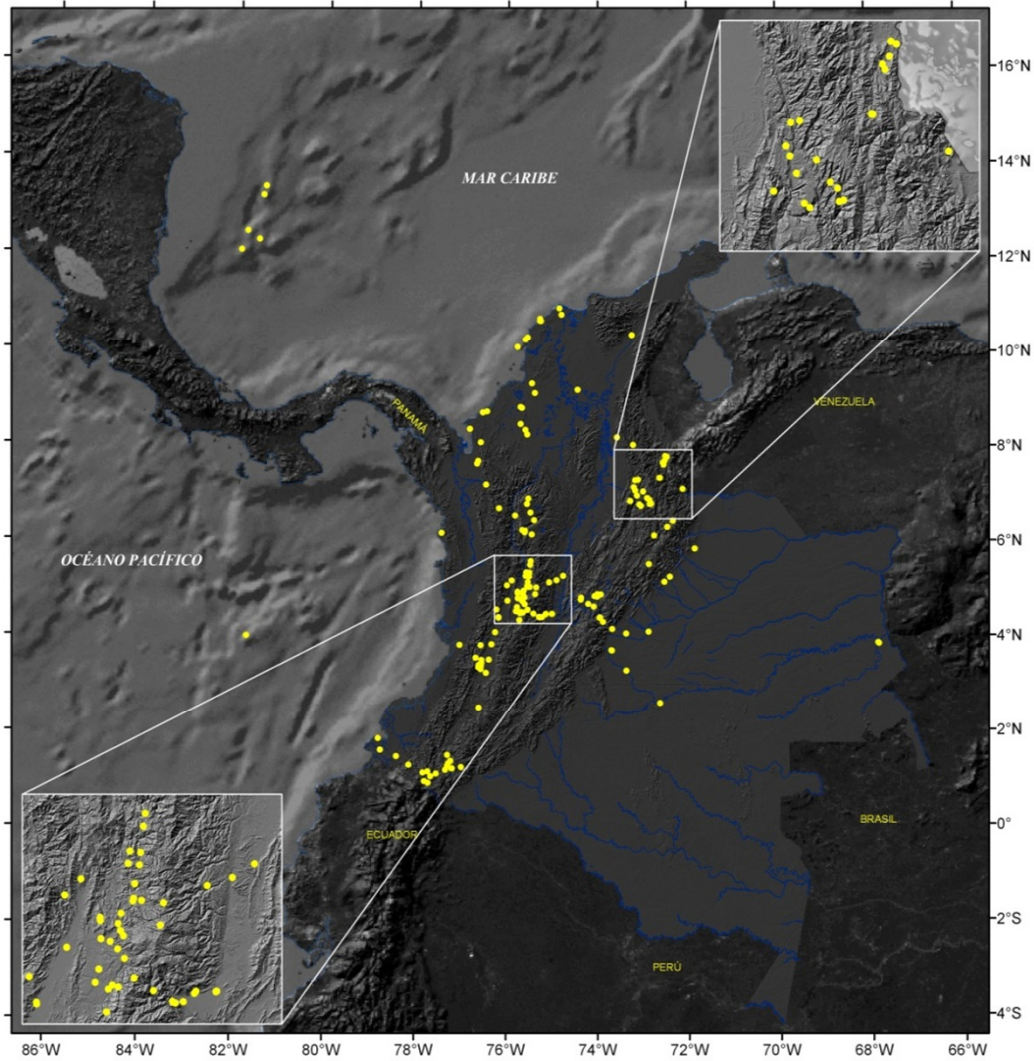


GNSS REFERENCE STATIONS FOR VOLCANIC DEFORMATION



GEORED NETWORK IMPLEMENTATION

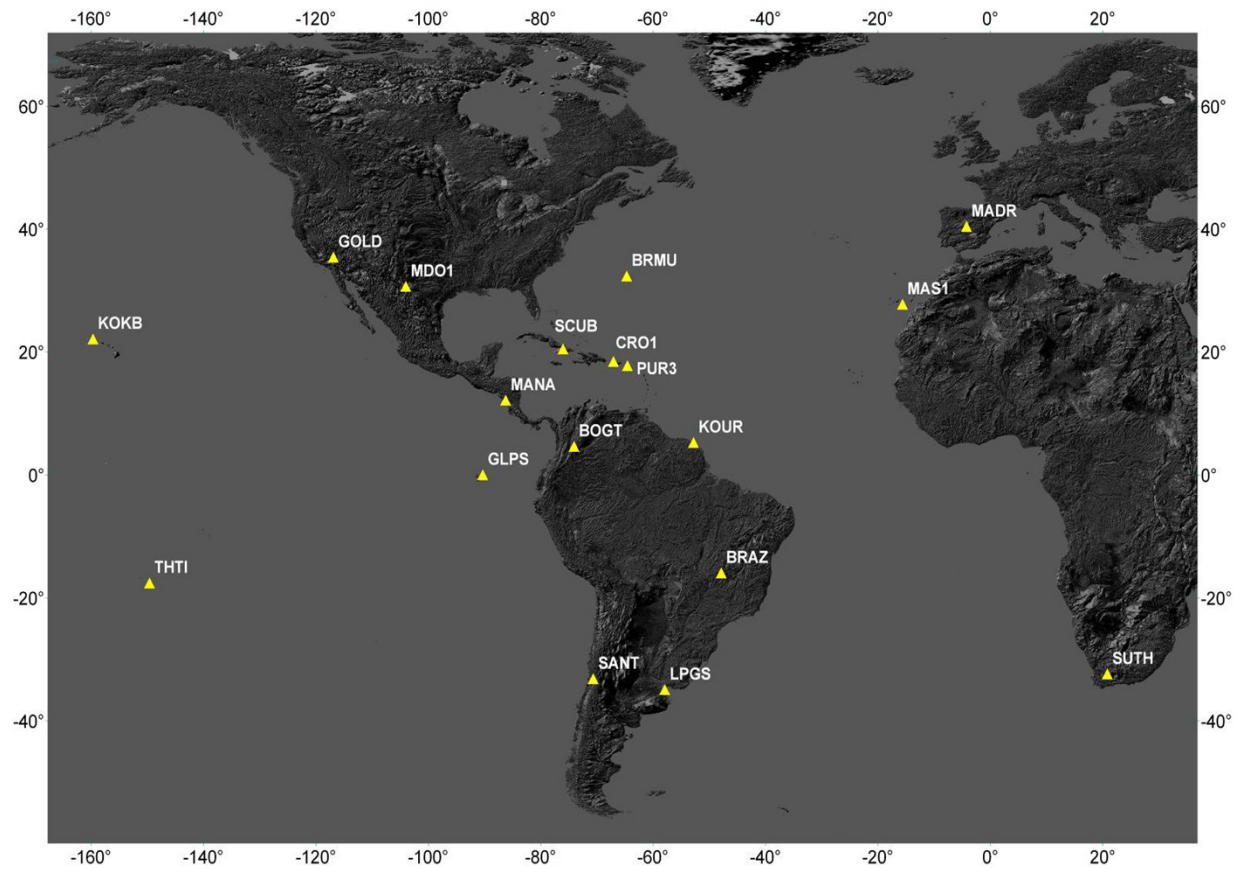
GPS Field Stations - Status October 2011



DATA PROCESSING

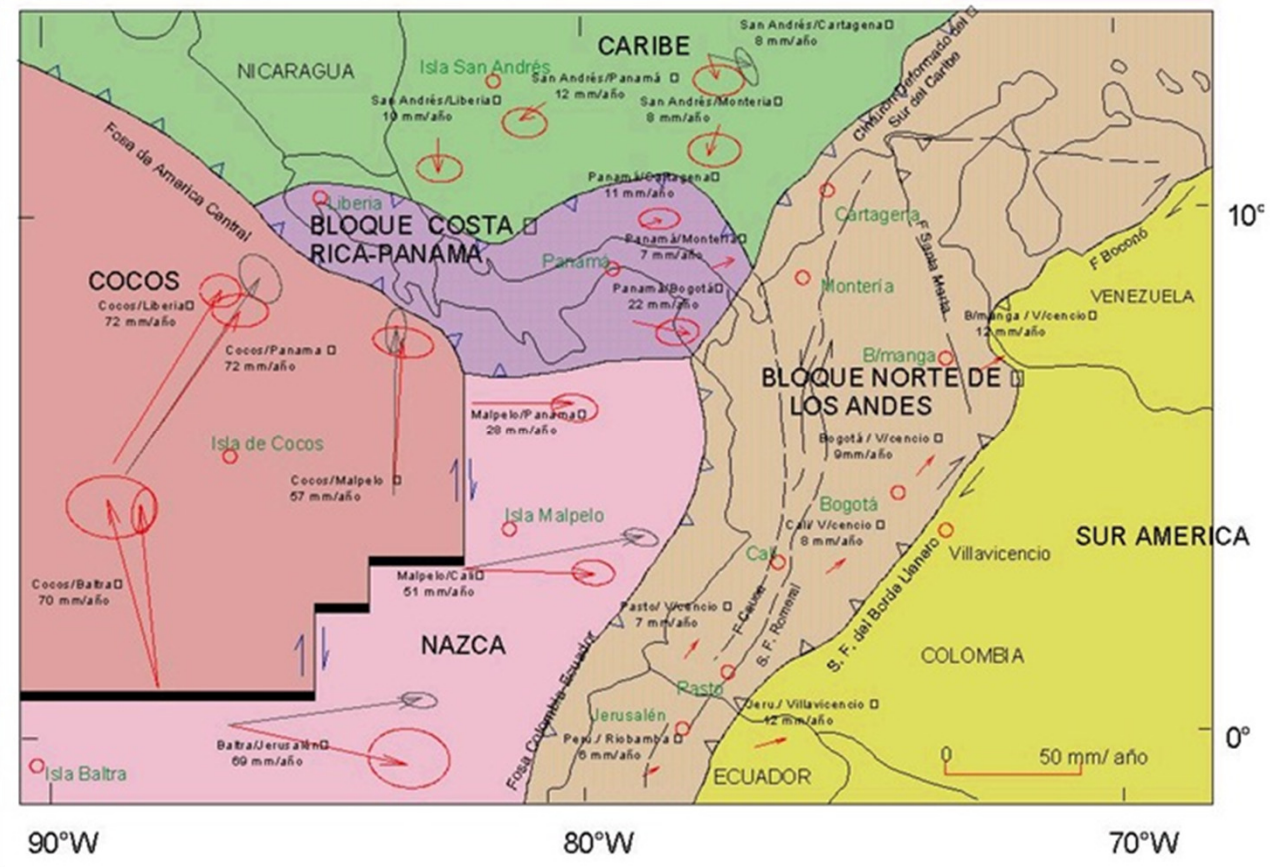
GIPSY-OASIS II
JPL-NASA

TEQC - UNAVCO
GMT - U. Hawaii
RZEBU - U. Colorado



GPS VELOCITIES

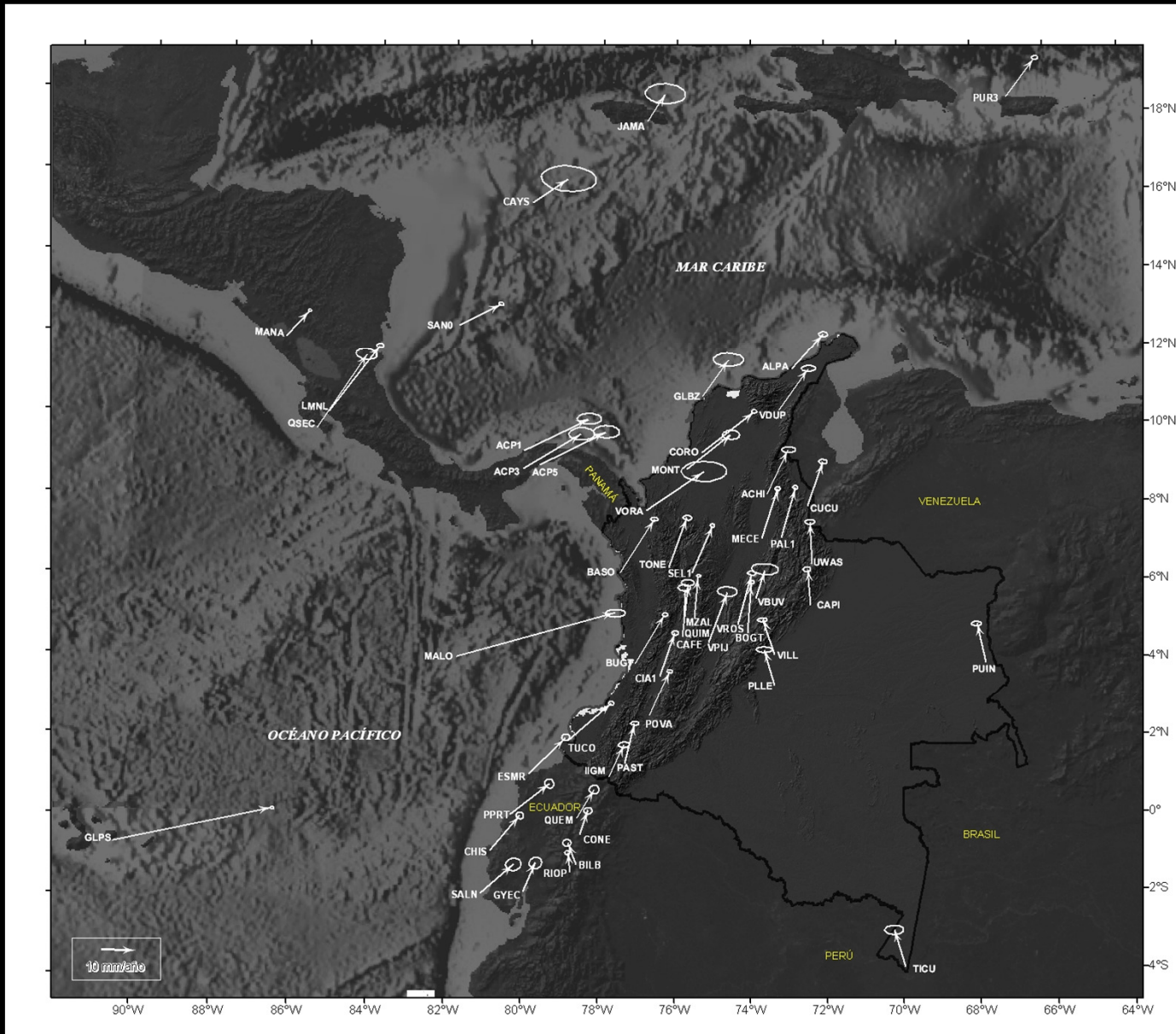
CASA RESULTS



Modified from:
Frey Mueller y Kellogg, (1991)
Mora (1995)
Vega y Kellogg, (1995)

Baselines

GPS VELOCITIES



ITRF2005

Mora et al, 2011



CHALLENGES



The final objective of the GEORED project is to increase the knowledge of the current crustal deformation stage at Colombia.

Specifically:

To obtain geodetic rates of fault displacements, as well as to characterize the kinematics of active faults and their seismogenic potential;

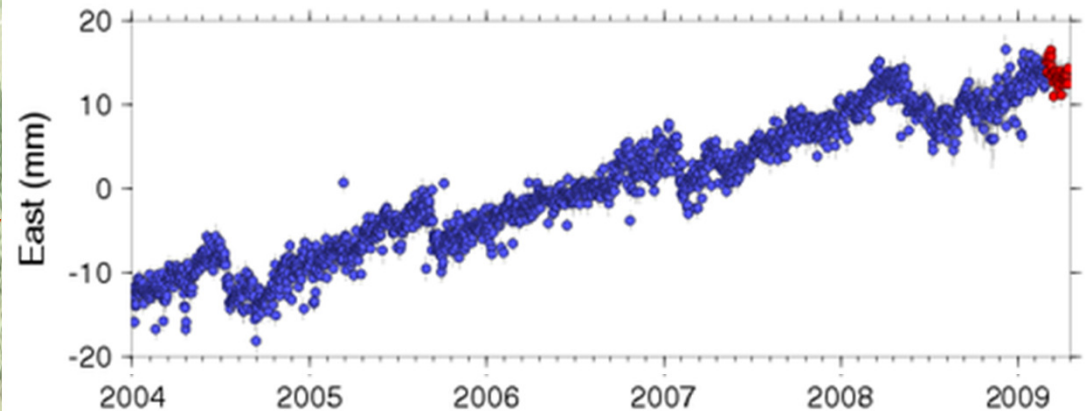
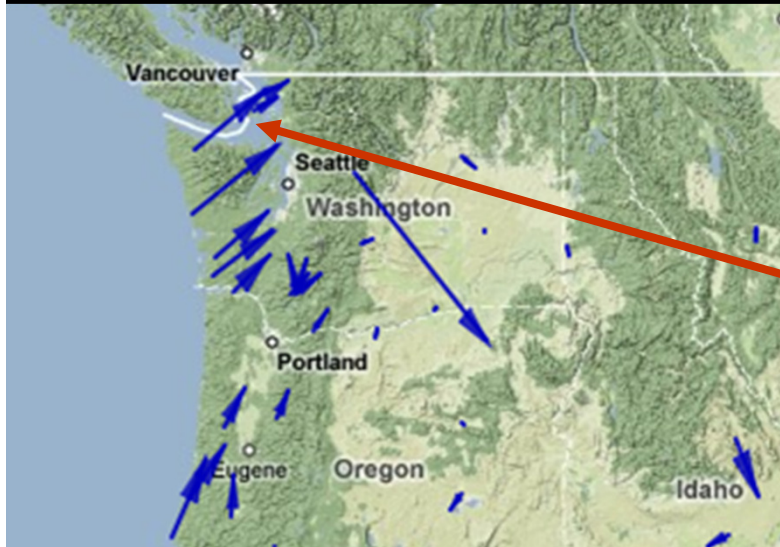
To generate crustal sub-block and regional deformation models to the Colombian territory, through the integration of geodetic, geological and geophysical data;

To establish an operative and dense geodetic network with geodynamic purposes.

In addition:

To provide support to atmospheric, ionosphere, subsidence and mass movement studies

EPISODIC TREMOR SLIP - ETS



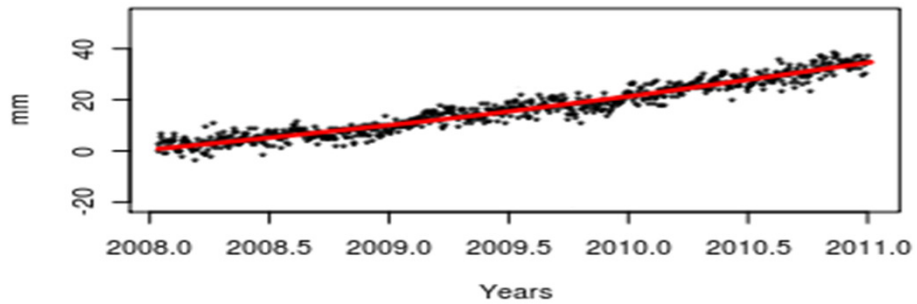
The top inset depicts the most exciting new discovery of GPS--show slip at depth on the interface between the subducting Juan de Fuca plate and the North American plate in Cascadia, potentially the region of the US (excepting Alaska) most vulnerable to a devastating earthquake.

After the slip, a 1-2 weeks long, was first noticed in recent measurements, geodesists looked at older data and found that it had occurred many times and was, in fact periodic! They later looked at seismic from the period and found a low-frequency tremor associated with the slip, hence the term "episodic tremor and slip" (ETS).

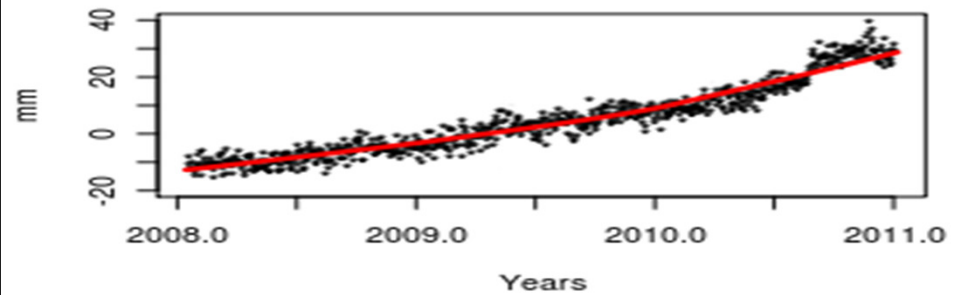
Tremor and slip have now been seen in other subduction zones (northern California, western Mexico, and Japan), but without periodicity. Explaining this behavior and accessing its impact on the recurrence time of earthquakes is a active area of research.

GPS TIME SERIES

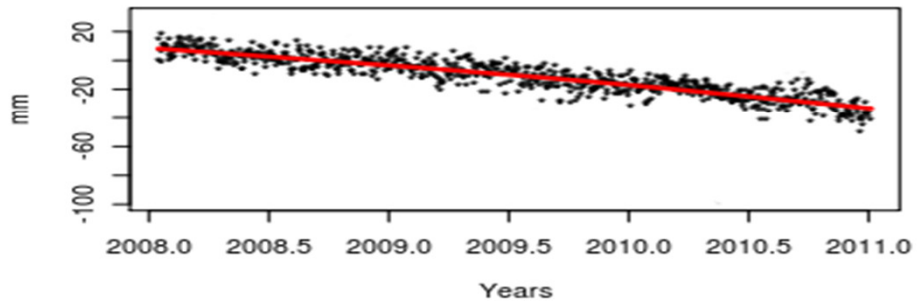
TUCO - Latitude



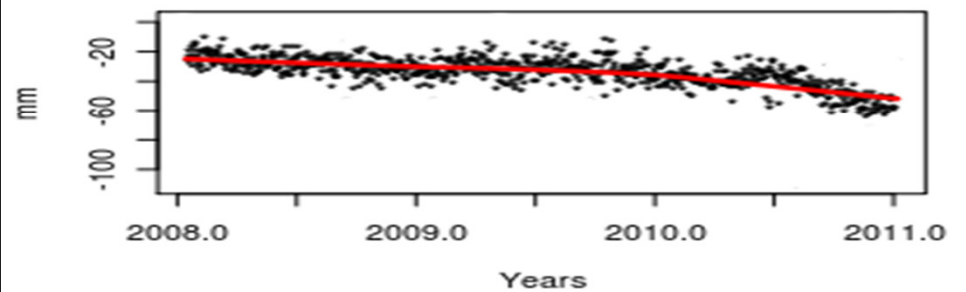
BUGT - Latitude



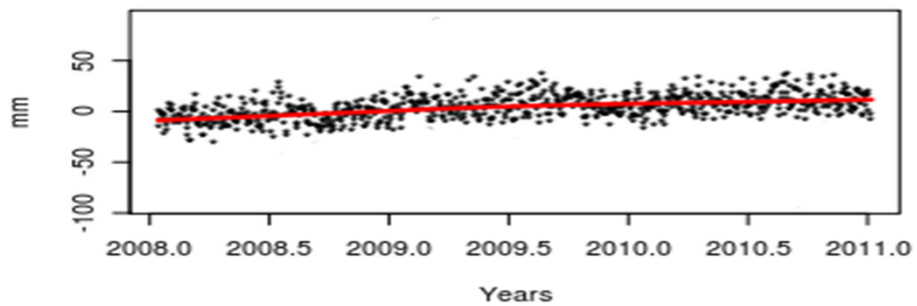
TUCO - Longitude



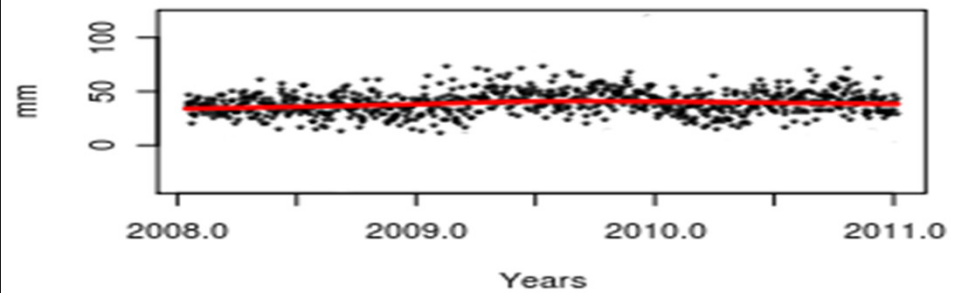
BUGT - Longitude



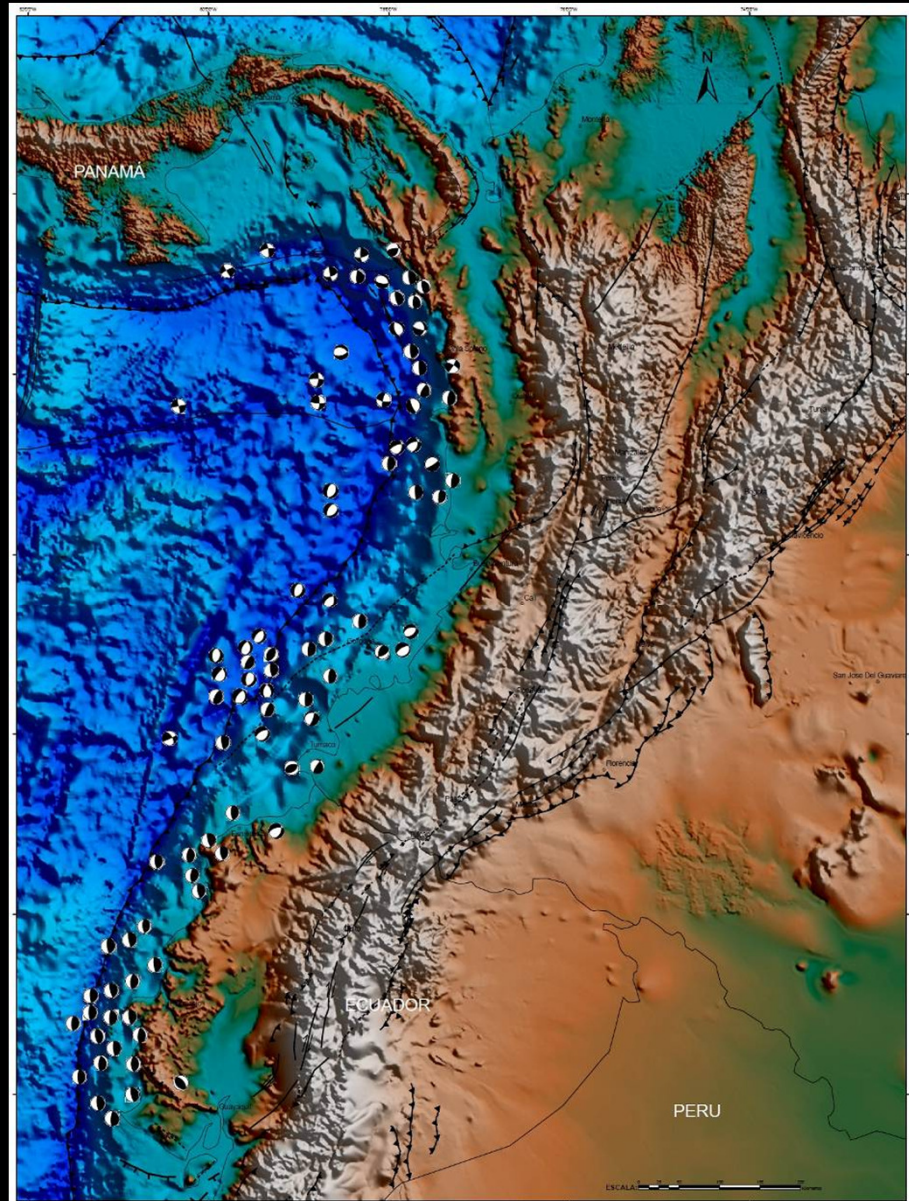
TUCO - Height



BUGT - Height

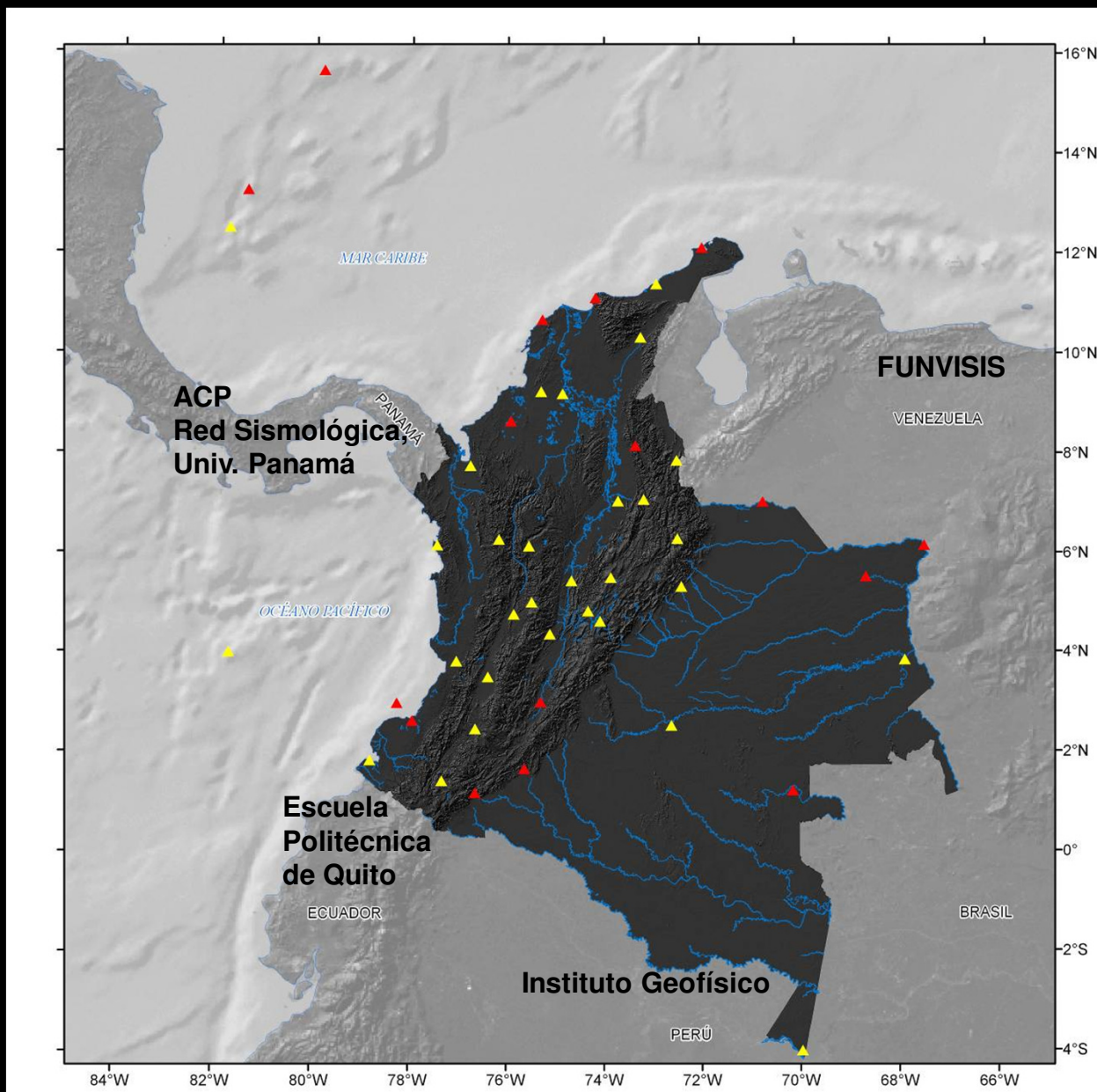


FOCAL MECHANISMS COLOMBIA-ECUADOR SUBDUCTION ZONE

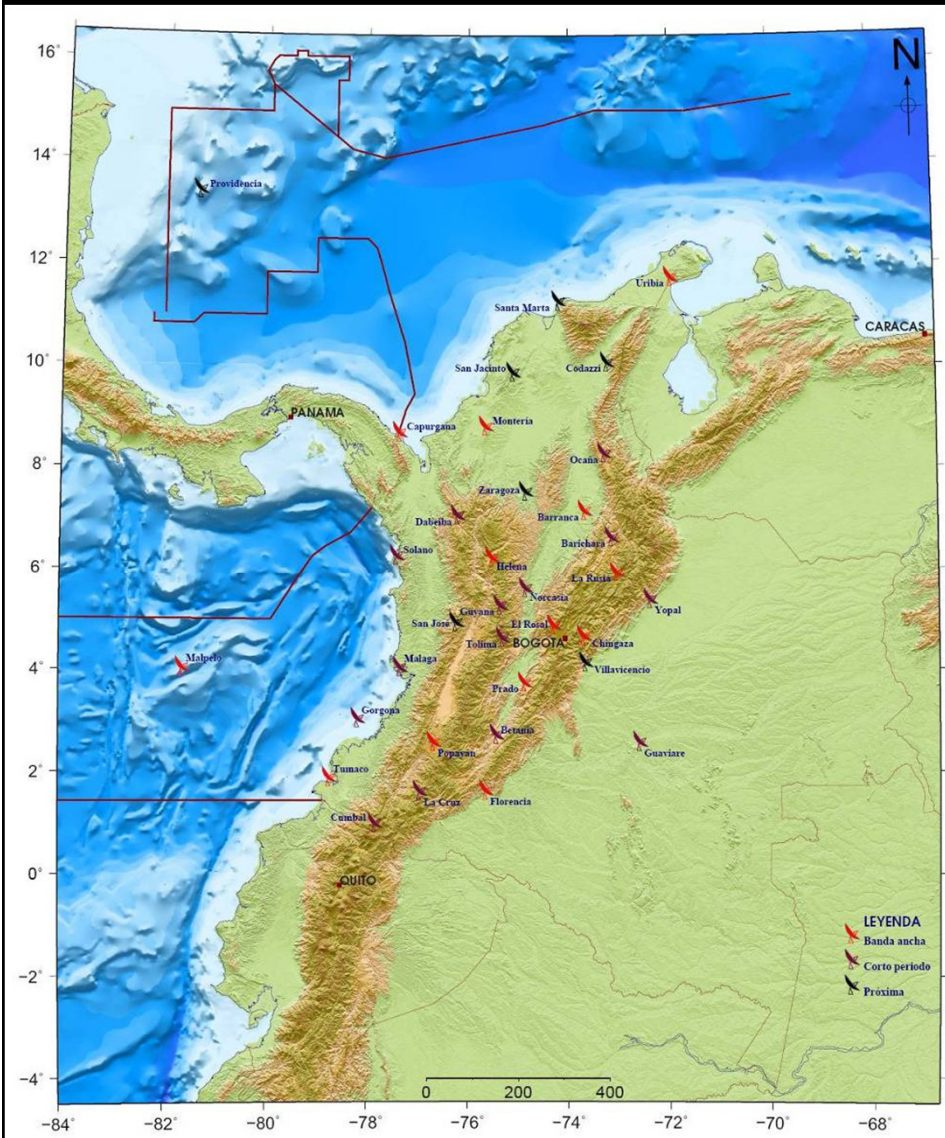


GEORED NETWORK

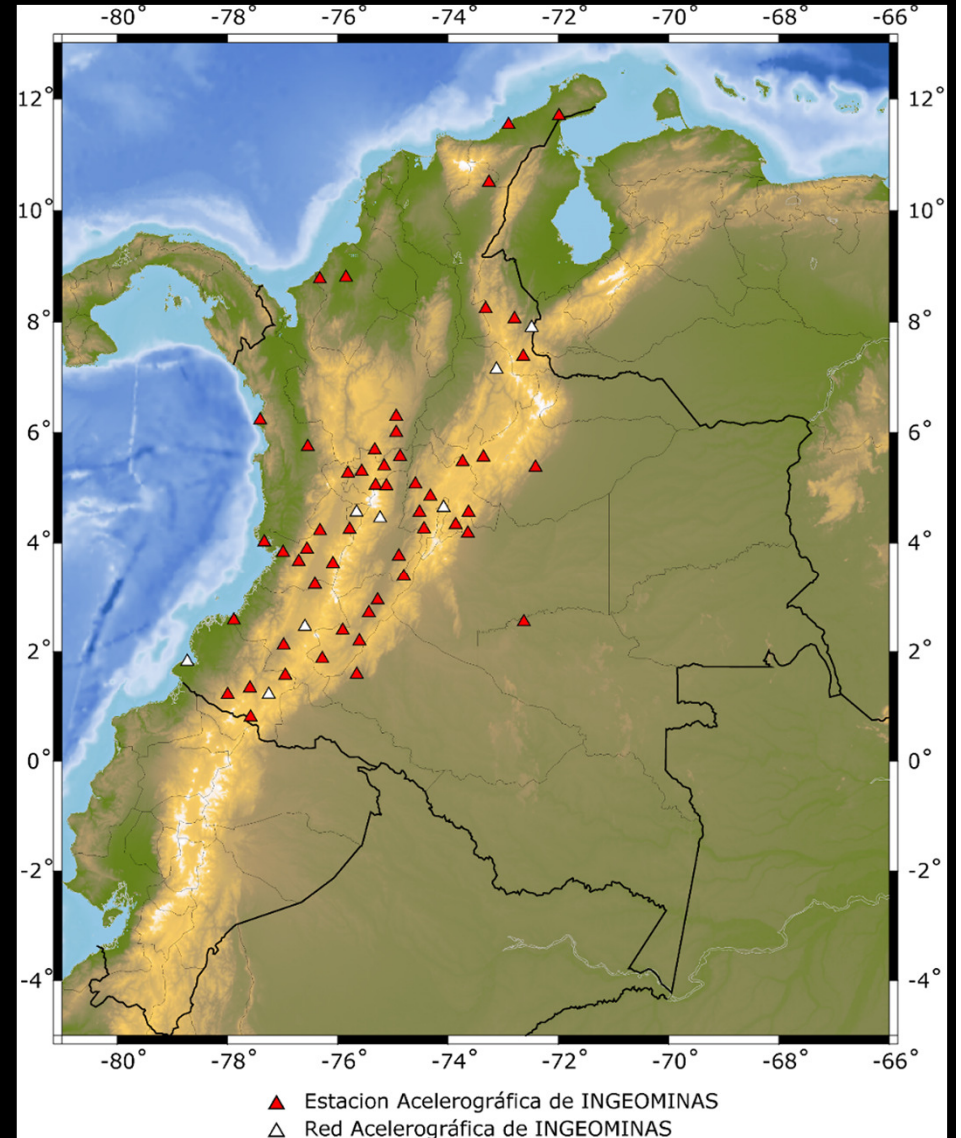
Current stations + next stations



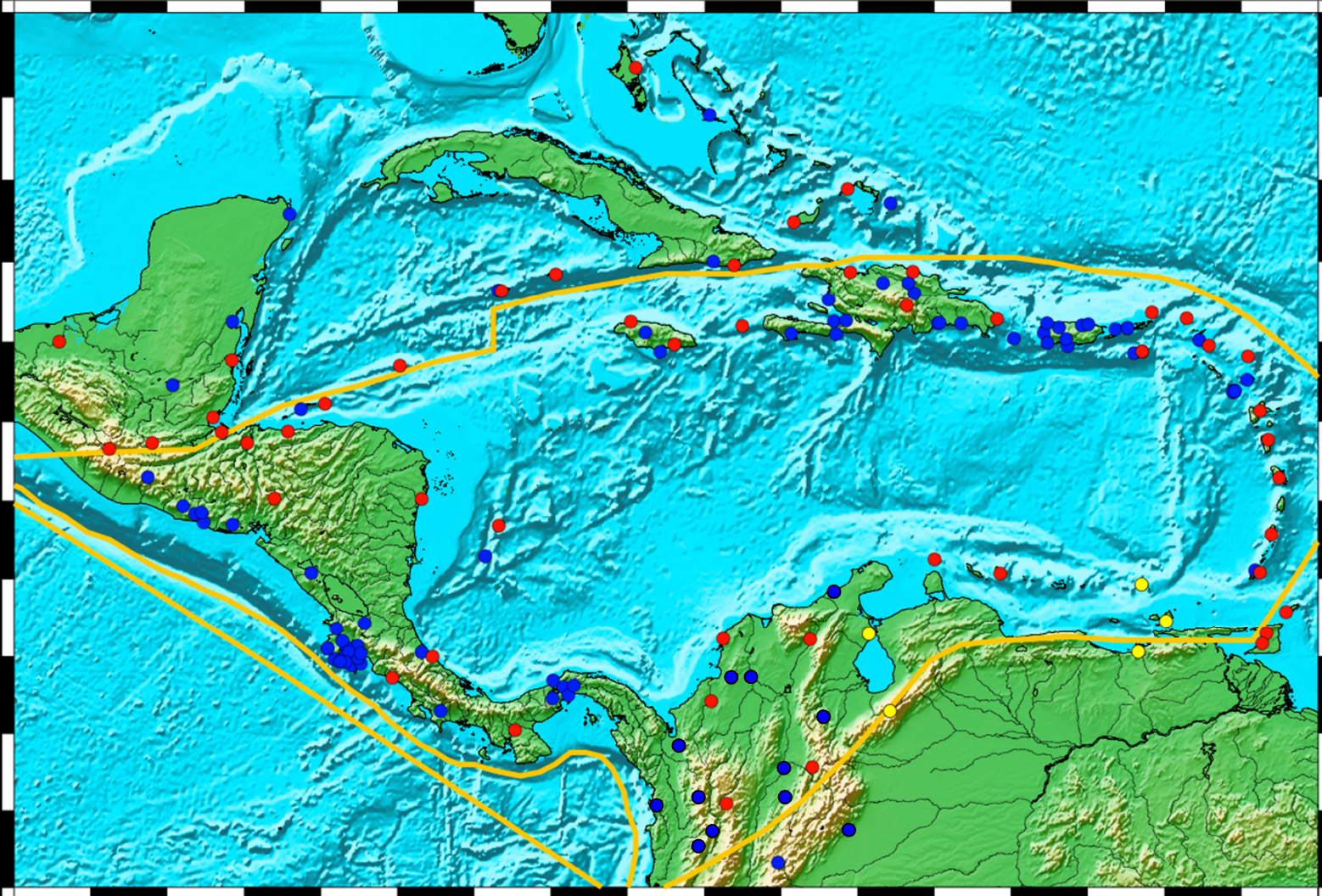
SEISMOLOGICAL NETWORK



STRONG MOTION NETWORK



COCONET Project



NEXT !!!!

More work has to be done

**More GPS permanent stations
More GPS field stations**

PROCESSING

GAMIT GLOBK
MIT

MODELING

Data integration
TDEFNODE
QOCA

*Thank you very much for your attention
Gracias por su atención*

<http://geored.ingeminas.gov.co>

