Transient measurement with a silica long base tiltmeter

F. Boudin, mail: frederic.boudin@gm.univ-montp2.fr, F. Boudin, P. Bernard, L. Longuevergne, O. Bour

Observation of the tectonic loading and cosismics signals, North Chile area

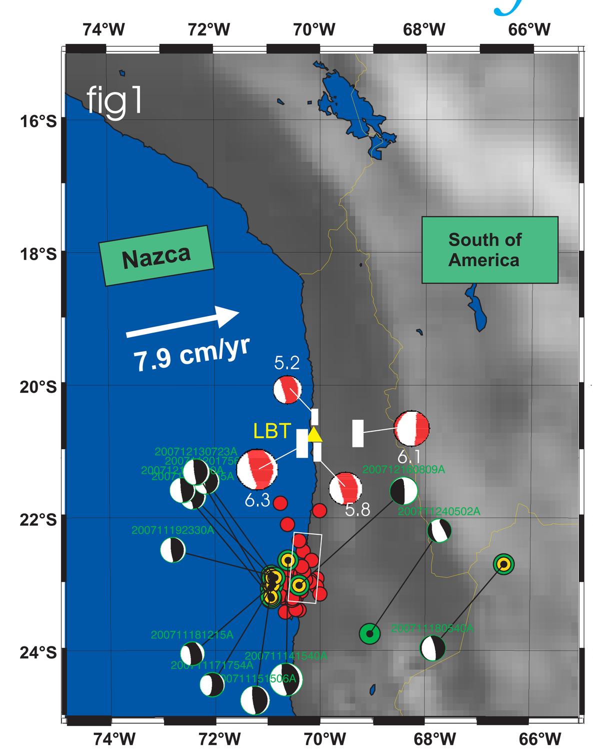


Fig 1: In the south, the last major earthquake of Tocopilla M7.7, on Nov 14, 2007 with its aftershocks. Between January and March 2008,at 250 km in the North, other events with a magnitude 5.2 M 6.3 occurred near the Iquique town and the tiltmeter.

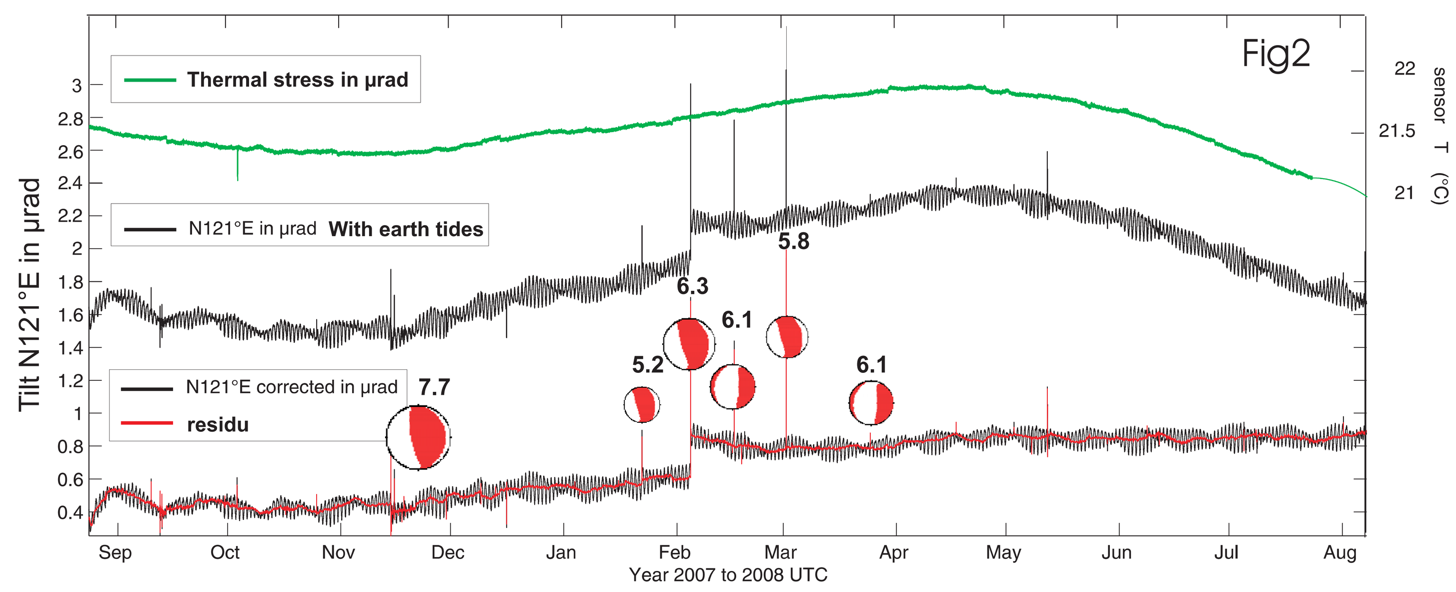


Fig2: continuous geophysical monitoring of the seismic gap of North Chile is done in the frame of the EPOC program. The Gap is long from 600 to 800 km. The last big event with a 8.9 magnitude occurred in 1877. With a convergence of 8 cm/year between Nasca and South America plates, it is possible to have a new event of ~M9. We have installed a long base tiltmeter, continuous tilt measurement started in august 2007. We observed a long term signal of 0.35 µrad/an (see fig 2)

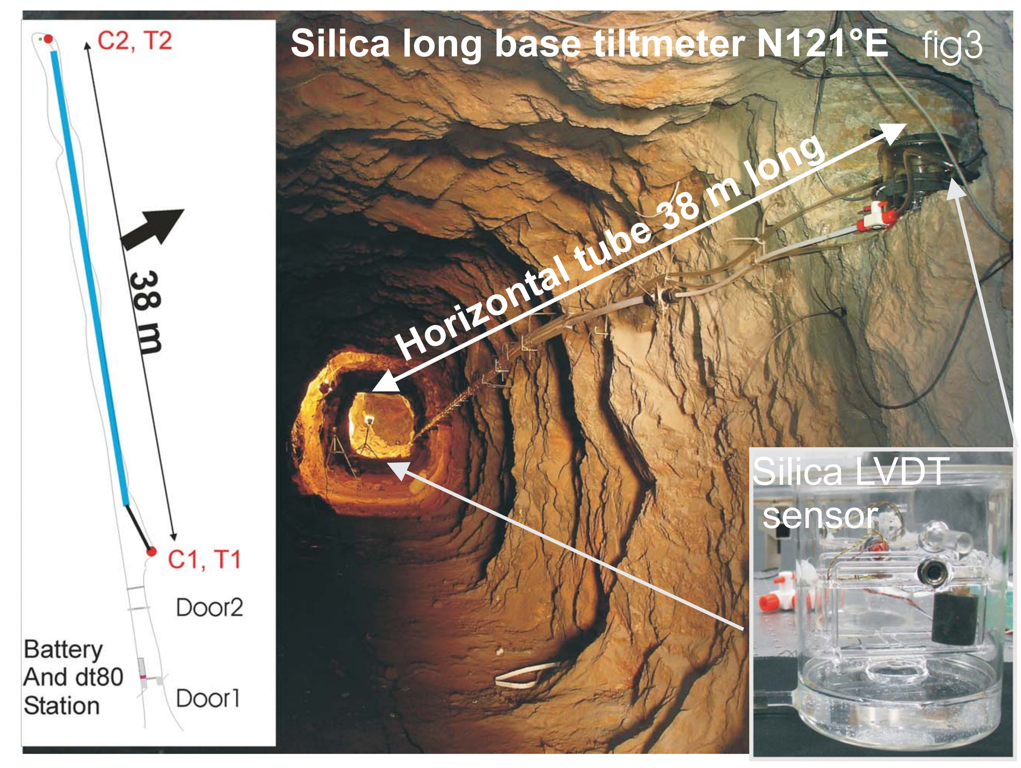
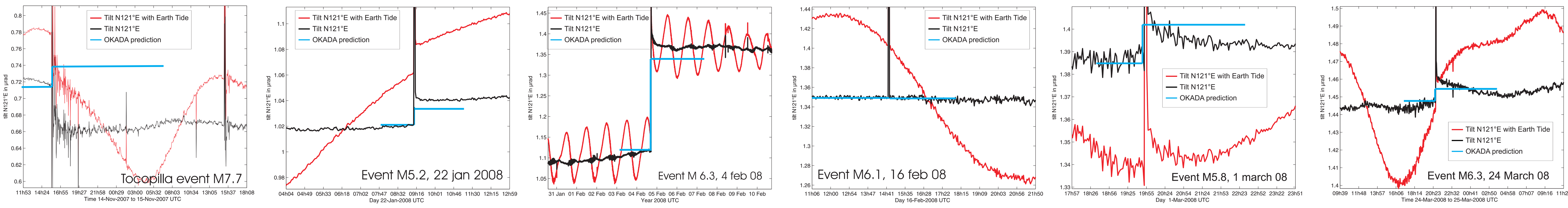
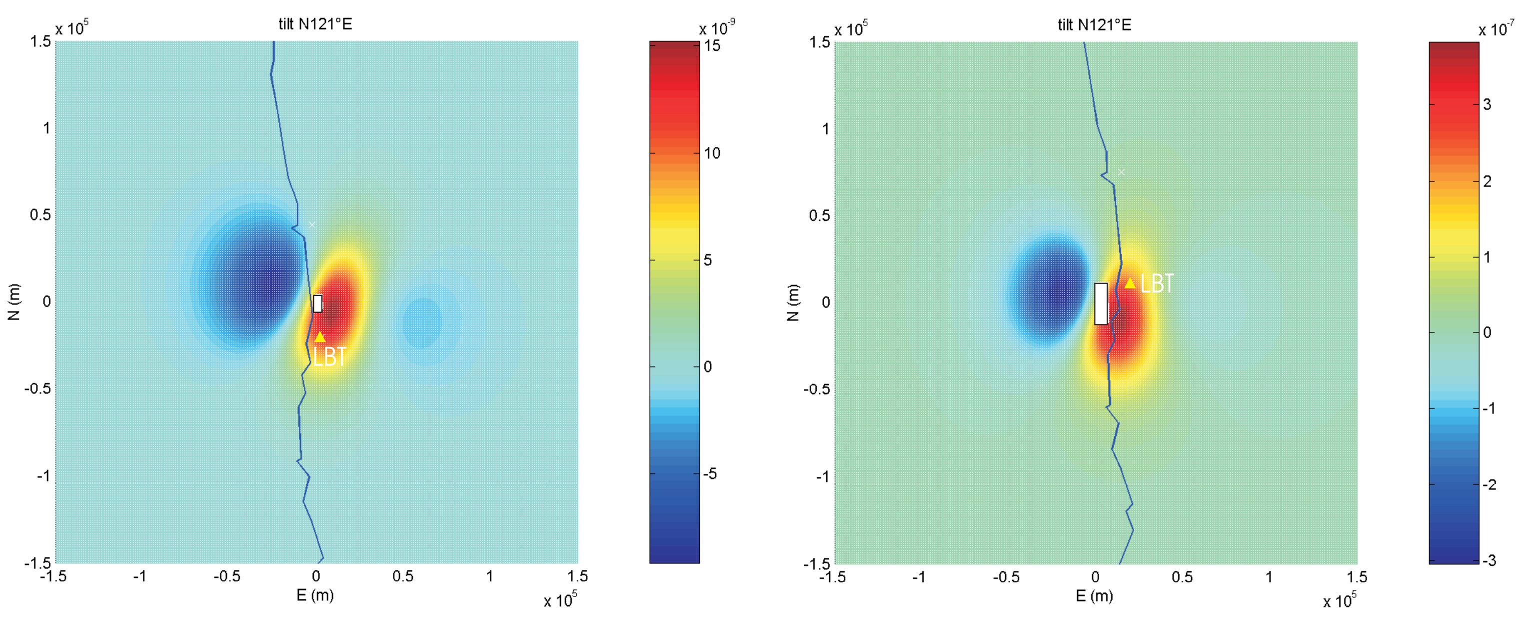


Fig 3: The instrument is installed on a 38 m long base in a Mine tunnel . It is perfectly horizontal to minimize the thermal impact on the signal.





figures 1 to 6: We present the coseismic observations in N121°E direction for each event between January and March 2008 (black curve). We present OKADA modeling (blue curve).
The localization is determined with the local network of seismic Chilien station. The sources used are Harvard mechanism. We calculated the static strain field with a OKADA modeling. All these events are at a distance between 10 and 100 km of the instrument, the observations are quite coherent with OKADA modeling. It is not the case for the big event of Tocopilla being 270 km from the instrument. Figures 7 and 8 represent the fields of coseismic strain for the event M5.2 on 22 January 2008 and the event M6.3 on 4 February 2008.
The nearest and strongest coseismic event is the M6.3 event. It is very well observed on the long base tiltmeter with an amplitude of 0.27 µrad. The Okada modeling gives a vertical movement of 3 mm. It thus seems difficult to observe with GPS. The other events produce smaller verticals movements < mm. They are impossible to observe with GPS.

Observation of the tsunamis wave loading produced by the Tocopilla event (M7.7).

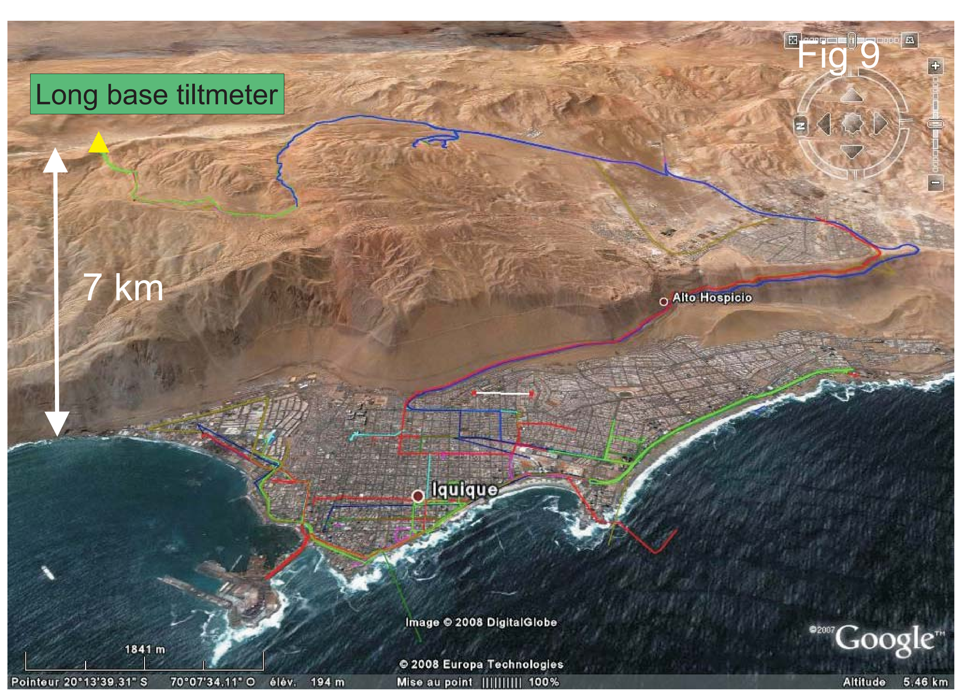


Fig 9: Localisation of the long base tiltmeter near the Iquique town and the Pacific ocean.

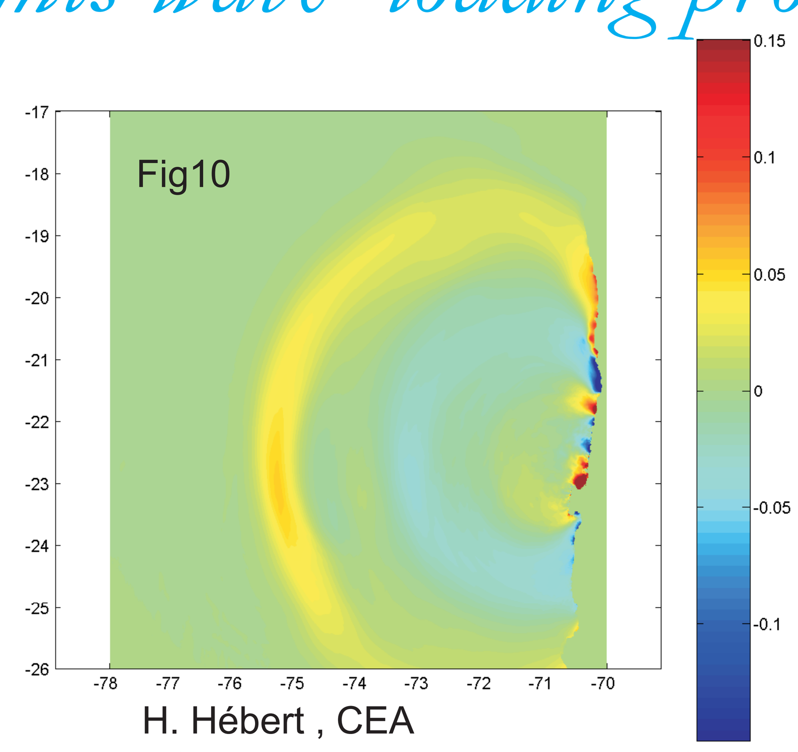


Fig10: modeling of the Tsunamis waves produced by Tocopilla M7.7 big earthquake , 40 minutes after the event.

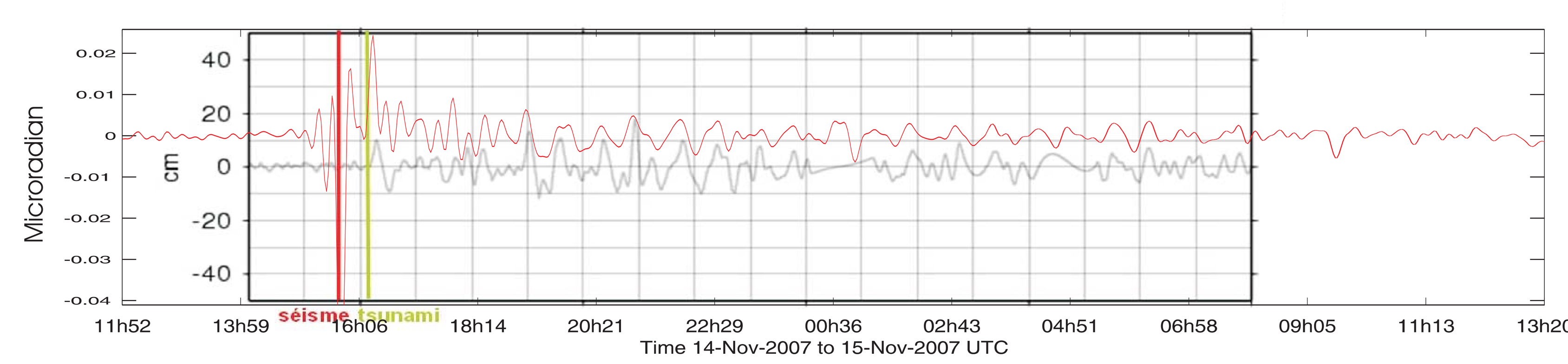
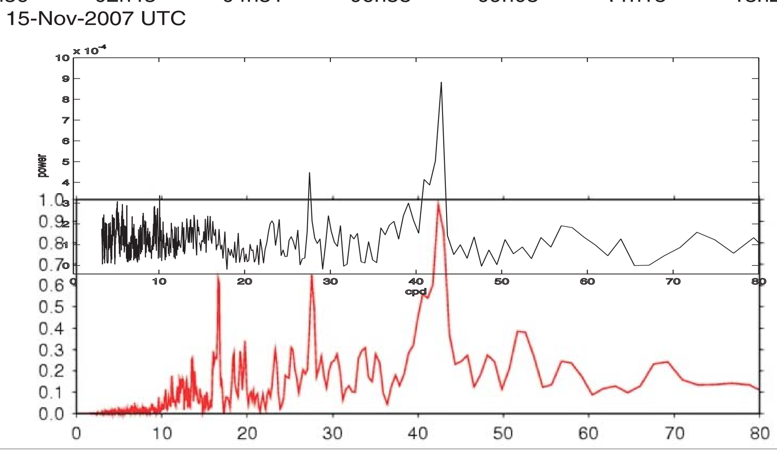
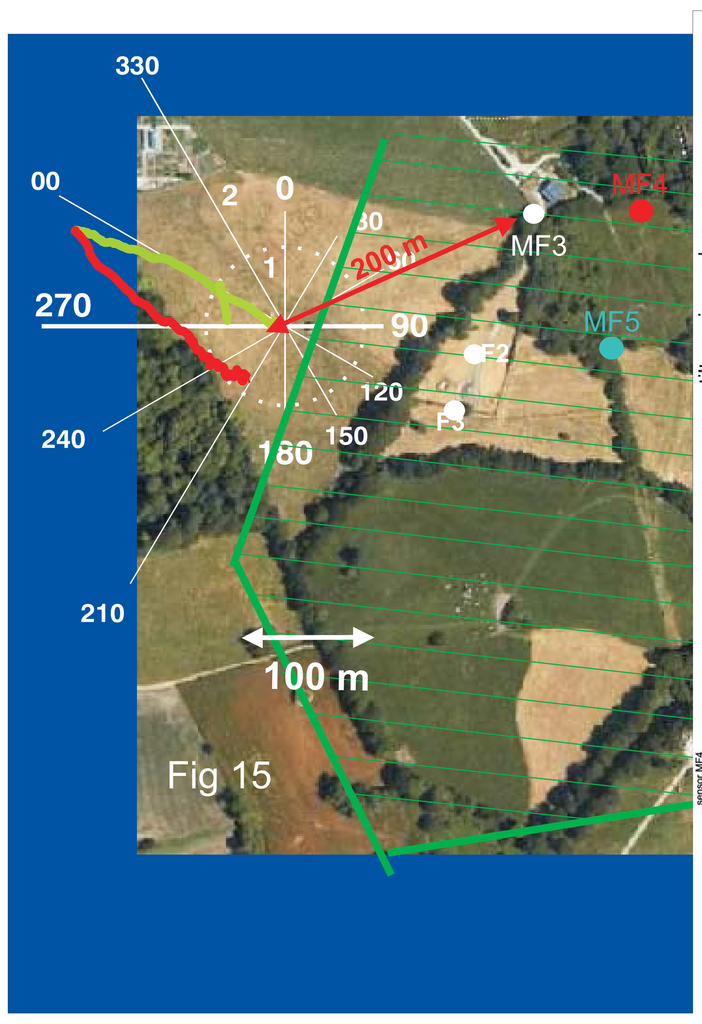
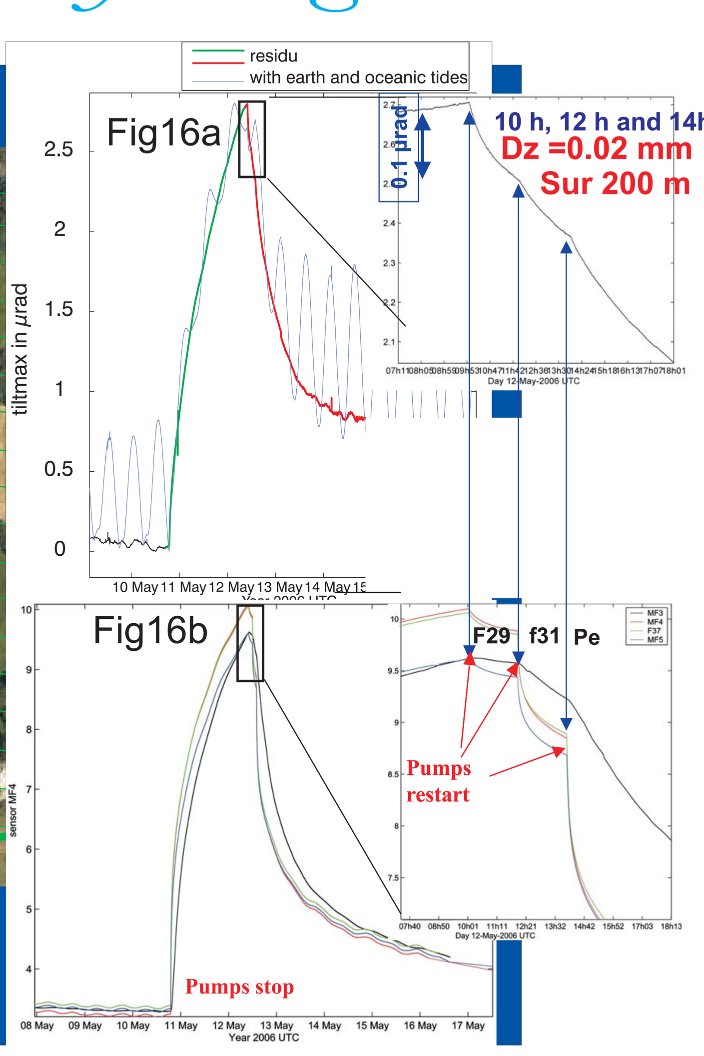


Fig 11 : tide gauge data from Iquique (black curve), we observe a first wave of 20 cm amplitude 30 minutes after the event of Tocopilla, then a succession of oscillation during several hours. Thanks to the very good resolution of the long base tiltmeter of 10^{-9} rad, we can observe the oceanic load of the waves produced by the small tsunamis at the same moments.
Fig 12: we observe 2 dominant periods of oscillation one at 27 minutes and the other at 43 minutes.



Observation of the hydrological loading





Our aim is to study the strain induced by the pressure of a confined Aquifer to find the hydrological properties. The site is near the town of Ploemeur (Morbihan). The town uses this site to pump the water.
Fig16a & b: We observe here the strain produced by the stop of pumpings. We can see the same signal when we restart the pumps. This tilt signal is very small. Among a lot of GPS and gravimeters, only long base tiltmeter has seen the induced strain.
Fig 15: the azimuth of the maximum tilt is calculated and shows very well the inflation of the confined aquifer.

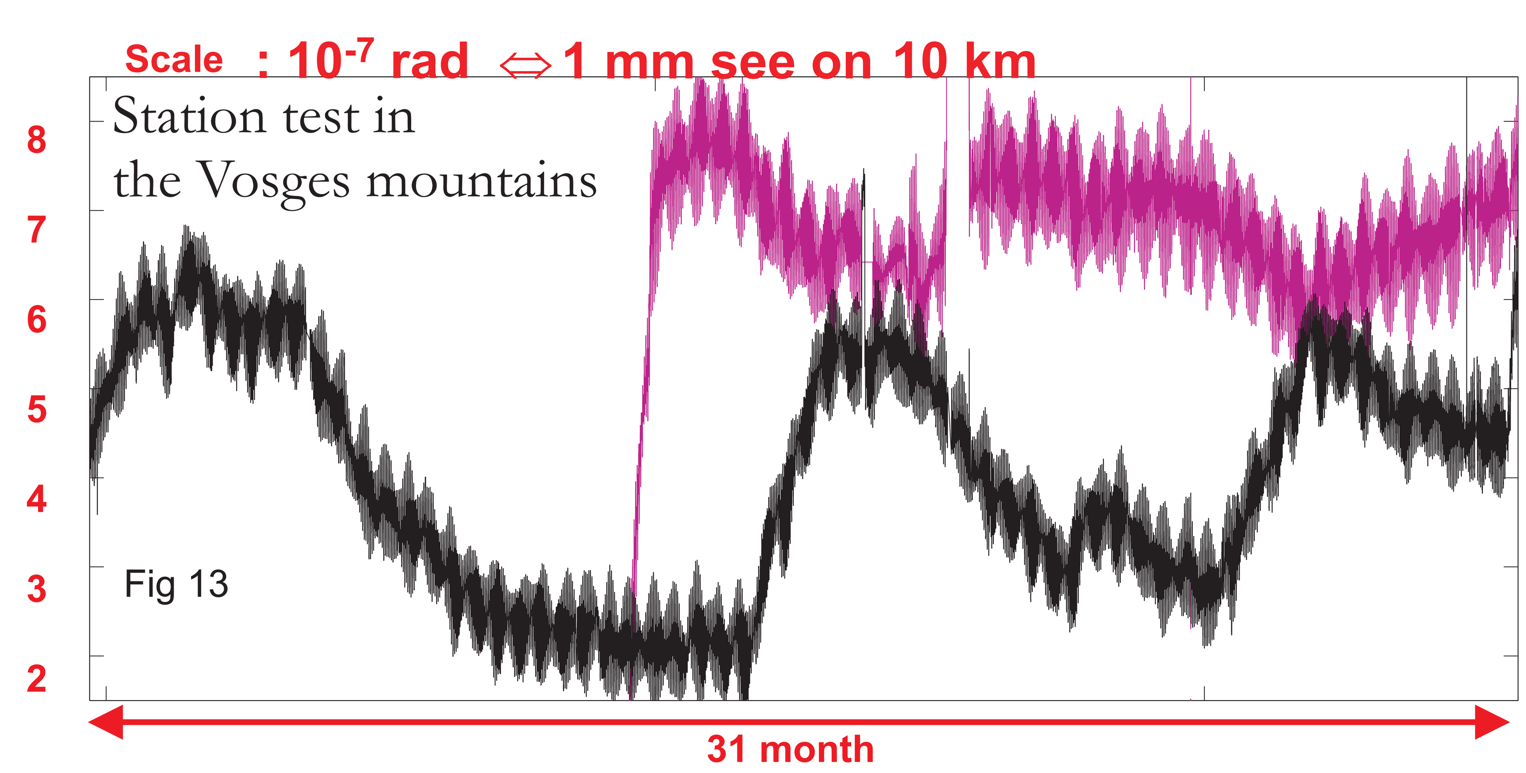


Fig 13: In order to be valuable for long term hydrological surveys, our instruments must display the smallest drift rate as possible. Over the last months, the data showed **a drift of only 6.5x10^{-9} rad/month** (moreover a part of this dritft might be due to a constant very long period external tilt signal). This long term stability which was displayed very shortly after the installation is one of the lowest drift rate reported in the worldwide scientific literature. This proves that **our long base tiltmeter** with similar installation conditions **is perfectly suitable for the monitoring of long term tiltmetric motions lower than 10^{-7} rad/year.** On volcanic or sismo-tectonic sites.

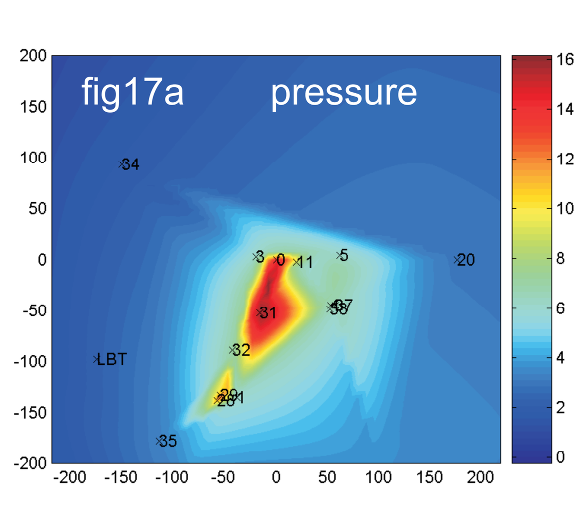
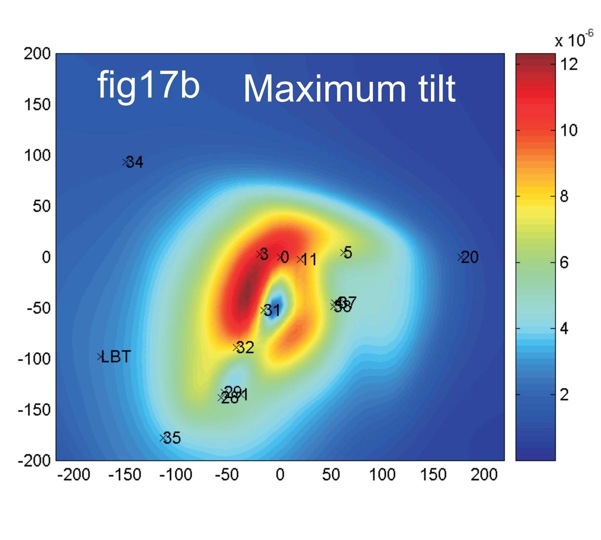


Fig17a & b: We modelize the tilt deformation from aquifer pressure.



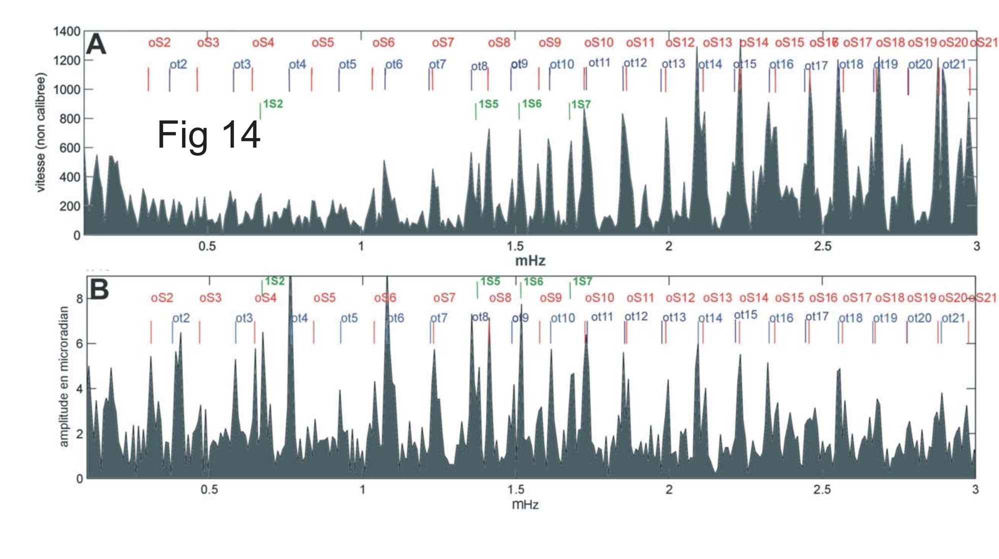


Fig14a: &b Observation of the spheroidal modes in red and toroidal modes in blue. Fig14a: recording of the 37°E speed component of the STS1. Fig14b: observation on the tiltmeter component.