Geodetic Observatory TIGO - Broadband Seismometer

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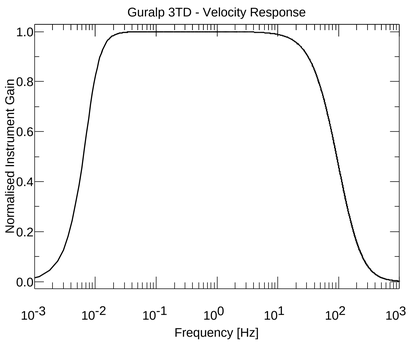
The Güralp 3TD Seismometer

The Güralp 3TD seismometer is a three-component, broadband sensor with built-in digitizer. The instrument at TIGO records the ground velocity in the vertical, north-south and east-west directions at 100 samples per second. The sprung masses respond to extremely gentle movements and quickly saturate for stronger ground motion.

Instrument Gain

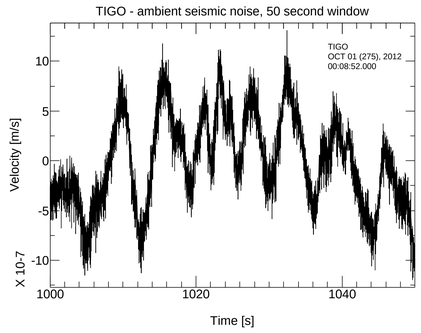


The above figure illustrates the amplitude part of the instrument response to an impulse function. The seismometer has a flat velocity response and is designed to operate in the frequency band of 120 s to 50 Hz, although it is sufficiently sensitive to record longer-period signals. The operational frequency ranges from that of small-magnitude local events to long-period surface waves from teleseisms, and even to Earth tides.

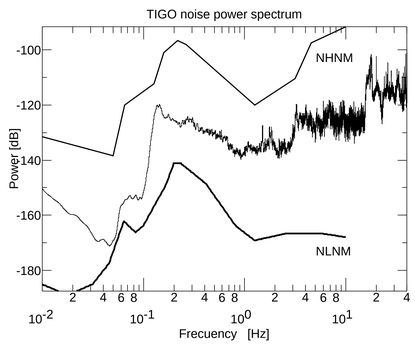
Güralp Systems Ltd.

A leading designer and manufacturer of seismological instruments based in the UK.

TIGO Noise Spectrum

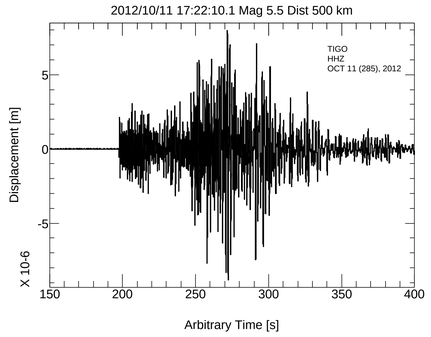


A 50 second-long recording, on the vertical component, during which no seismic event takes place - representative of the ambient noise recorded by the sensor. The oscillation at a period of around 6 seconds is microseismic noise, produced by standing waves in the oceans. Higher-frequency noise is attributed to local site effects. Finally there is a very long-period/low-frequency noise at around 400 s period (a quarter of this cycle can be seen on the above trace).

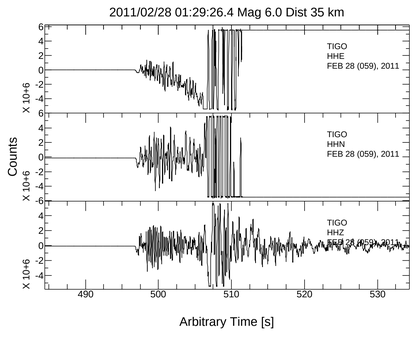


The noise power spectrum for the TIGO seismometer calculated for three hours of ambient noise on the vertical component. The units are the USGS convention for seismic noise levels, measured in Decibels [$10\log_{10}(\mathrm{m}^2/\mathrm{s}^4/\mathrm{Hz})$]; the spectrum is compared to the USGS New Low/High Noise Models (NLNM and NHNM) - the typical limits of seismic site performance [Peterson, 1993]. The sensor at TIGO shows good performance in the frequency range of 25 seconds to 10 Hz (note that the Nyquist frequency of this instrument is 50 Hz).

Example Data

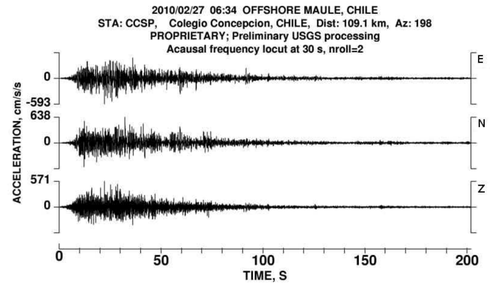


The seismogram registered at TIGO (vertical component) for a magnitude 5.5 earthquake on 11 October, 2012, near Santiago. The event is at a depth of 80 km and a distance of 500 km from TIGO, with a magnitude of 5.5. The record shows a seismic signal approximately 200 seconds long, with distinct P and S arrivals and a maximum displacement of $\sim$8 μm. This event was not powerful enough to be felt by the general public in Concepción, only sensitive seismic instrumentation.

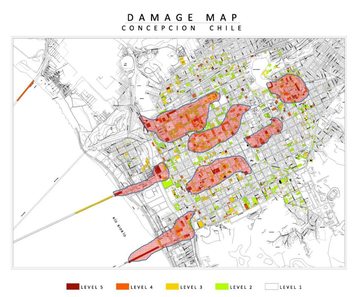


The seismogram registered at TIGO for a magnitude 6.0 earthquake on 28 February, 2011, near Concepción. The event is at a depth of 17 km and a distance of 35 km from TIGO, with a magnitude of 6.0. The record shows saturation of the North (HHN) and East (HHE) components, finally the seismometer horizontal component masses stick at their endpoints. After removal of the instrument response, the maximum acceleration, velocity and displacement of the oscillations are approximately 0.1 m/s^2, 1 mm/s and 1 mm, respectively.

The Maule, 2010, Earthquake



The Maule, 2010, Earthquake produced peak ground accelerations of around 0.6 g in Concepción. Beyond the saturation limit of a seismometer, the above trace was recorded on a three-component strong-motion accelerometer (CCSP, components east-west, north-south, vertical). The strong shaking lasted for around two minutes causing significant damage in the city, and moderate shaking lasted for several minutes beyond this. The following damage map was produced by the Geotechnical Extreme Events Reconnaissance (GEER) organisation.



Sources of Information

[1] Observatorio Geodésico TIGO, Universidad de Concepción: http://www.tigo.cl/

[2] Güralp Systems Ltd: http://www.guralp.com/

[3] J. Peterson, 1993. Observations and modeling of seismic background noise. USGS Open-File Report 93-322

[4] USGS National Earthquake Information Center: http://neic.usgs.gov

[5] GEER Geo-Engineering Reconnaissance of the February 27, 2010 Maule, Chile Earthquake

[6] IRIS - Incorporated Research Institutions for Seismology: http://www.iris.edu

[7] SSN - National Seismological Service, Chile: http://sismologia.cl/