

Annual Project Summary

DEEP BOREHOLE TENSOR STRAIN MONITORING, SOUTHERN CALIFORNIA

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seismology, geodesy, borehole geophysics

Project Objectives and Approach

This project provides field observations critical to an understanding of fault processes associated with earthquakes along the San Andreas and Sierre Madre faults. Continuous high precision and high resolution borehole tensor strain data provide an essential complement to long baseline interferometry studies (limited to sampling intervals of weeks), GPS studies, and seismic characterisation of faults.

The project continues a program of maintenance and analysis of deep borehole tensor strain instrumentation initiated at Pinon Flat in late 1983, and a further deployment in the San Gabriel mountains region (Coldbrook) in 1996. These instruments consist of a three component plane strain module operating at strain sensitivity of 10^{-10} and support data logging systems. As deployed to date they provide data sampling at 30 minute intervals for transmission via satellite for permanent archive purposes. The instruments provided by this project are unique in the program in that they provide continuous tensor strain data of high quality and sensitivity not achievable by any other instrumentation. These data form a critical complement to GPS and geodetic studies in assessing strain rates and consequent earthquake risk, as well as investigating fault processes associated with earthquake preparation and postseismic relaxation. Archived long term baseline data are available from <http://www.cat.csiro.au/dem/msg/straincal/straincal.html>. Data are made available in near real time in the USGS Menlo Park computer system (*thecove:/home/mick/QUICKCHECK*). These data supplement long baseline survey data, and permit real time monitoring for short term strain phenomena.

The **immediate objectives** of the project are

- Maintenance of uphole system integrity at 2 Southern Californian sites, with repair or production of replacement uphole electronics if necessary.
- Manual preparation of raw instrument data for permanent archive.
- Analysis of continuous unique low frequency shear strain data (30 minute samples) and modelling studies based on the constraints of these data
- Near real time alert response to the earthquake studies community when necessary.

- Archive of processed data for access by the earthquake studies community, and provision of near-real time automatically processed data for inclusion in publically accessible web pages linked to the USGS web datasets.

The project is carried out in parallel with maintenance of five further sites (San Juan Bautista, along the Hayward fault and near Parkfield) in Northern California.

Investigations & Results

Long Term strain data

The Coldbrook site is situated in the San Gabriel mountains, and together with three USGS operated borehole dilatometers *puba* (20km NW), *cnts* (15 km SW) and *bdtis* (15 km SE) forms a 4 instrument array in the region between the Sierre Madre and San Andreas faults. The Coldbrook instrument was installed in late 1996, and borehole recovery processes evident in the data in the form of exponential signals have been removed. Figure 1 indicates a change in shear strains Gamma2 and Gamma1 gradient from July 1 to 10, 2000 which is not associated with rainfall. This change is also evident in the data from dilatometer *pubs* over the same period. A significant change in dilatometer records at *cnts* also shows from July13, indicating a possible propagation of strain across the array.

One of the three channels (gauge 2) in the Pinon Flat BTSM instrument has suffered significant degradation in gain from 1999 onwards, due to component aging in the downhole preamp (after 20 years of continuous operation). The internal gain compensation system ran out of dynamic range in mid-2000. In December 2000 an uphole gain compensating circuit was installed on this channel. Normal operations have resumed, allowing the 18 year dataset baseline to be continued.

Note that results from the borehole tensor strainmeters situated at Parkfield and in northern California are detailed in the companion Northern California report.

Data Availability

Archived strain data from the Californian sites is stored in both raw component form, and as processed areal and shear strains. A regularly updated archive of data has been maintained in the USGS Menlo Park computer system since 1988. This data is stored in binary files with appended header information (USGS “*bottle*” format).

Home page for access to data plots from all borehole tensor strain instruments is <http://www.cat.csiro.au/dem/msg/straincal/straincal.html>. ***This page also includes facilities for download of raw or processed data from our CSIRO archive.***

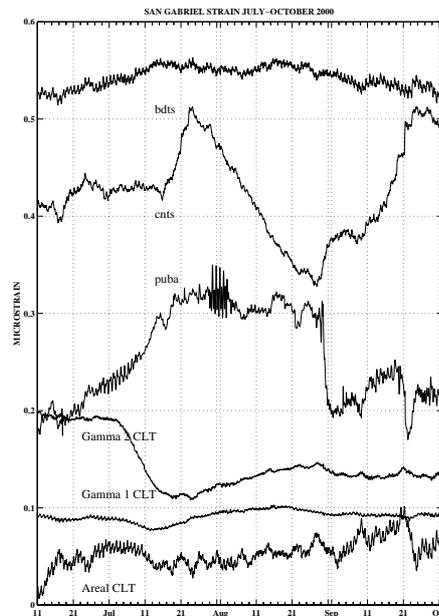


Figure 1 Data from Coldbrook tensor strainmeter during June-October 2000. Changes in Gamma2 shear strain from July1 – 10 are also evident in dilatometer records (*puba* and *cnts*).

Automatically processed near-realtime data is available in *thecove:/home/mick/QUICKCHECK* for users with access to USGS plotting software “xqp”, and via the USGS crustal deformation web pages in graphical form.

Scientists requiring other access to the archived data should contact Dr. R. Gwyther (+617 3212 4586, email: *r.gwyther@cat.csiro.au*) or Dr. M.T. Gladwin (+617 3212 4562, email *m.gladwin@cat.csiro.au*).

Publications

Publications 2000

Gwyther R.L., M.T. Gladwin, R.H. Hart & M.Mee Sharpening our Image of Fault Processes: what Borehole Tensor Strain Observations can add to Seismic and Geodetic Studies. *Seis. Res. Lett.* 70(1), 255, 2000.

Gladwin, M.T., R.L. Gwyther, R.H. Hart, & M.Mee Borehole Tensor Strainmeter Arrays to Enhance our Imaging of Crustal Processes *EOS. (Trans. Am. Geo. Un.)*,48(17), , 2000

Gwyther, R.L., C.H. Thurber, M.T.Gladwin &M. Mee Seismic and Aseismic Observations of the 12th August 1998 San Juan Bautista, California M 5.3 earthquake, *Proc. 3rd Conf. on Tectonic Problems of the San Andreas Fault*, 2000

Gwyther R.L., M.T. Gladwin, R.H. Hart & M.Mee Propagating Aseismic Fault Slip events at Parkfield: What they tell us about fault processes at depths of 1km to 5 km. *EOS. (Trans. Am. Geo. Un.)*,81(48), p F1125, 2000.

Gladwin, M.T., R.L. Gwyther, R.H. Hart, & M.Mee Are linear strain rates between major strain events characteristic of transition zone regions of the San Andreas Fault *EOS. (Trans. Am. Geo. Un.)*, 81(48), p F921, 2000

Gladwin,M.T., Gwyther,R.L., & Hart,R.H.G., Addition of Strain to Targeted GPS Clusters-New Issues for Large Scale Borehole Strainmeter Arrays, *Proc. 2nd Plate Boundary Observatory Workshop*,1.17a-1.17e, 2000

Langbein, J., Gladwin, M.T., & Gwyther,R.L., Extension of the Parkfield deformation array,*Proc. 2nd Plate Boundary Observatory Workshop*,2.45-2.49,2000

Thurber,C., Gladwin,M.T., Rubin,A., & DeMets,D.C., Focussed Observation of the San Andreas/Calaveras Fault intersection in the region of San Juan Bautista, California, *Proc. 2nd Plate Boundary Observatory Workshop*,2.75-2.79, 2000

Roeloffs,E., Gladwin,M.T., & Hart,R.H.G., Strain monitoring at the bend in the Cascadia Subduction Zone, *Proc. 2nd Plate Boundary Observatory Workshop*,4.36-4.40 2000

Steidl,J., Gladwin,M.T., Gwyther,R.L., & Vernon, F., Fault Processes on the Anza section of the San Jacinto Fault, *Proc. 2nd Plate Boundary Observatory Workshop*,2.70-2.74, 2000

Agnew,D., Wyatt, F., & Gladwin, M.T., Strainmeter Calibration, *Proc. 2nd Plate Boundary Observatory Workshop*, 11-15, 2000

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Selected Previous Journal Publications

Langbein, J., R.L. Gwyther, R.H.G.Hart and M.T. Gladwin Slip-rate increase at Parkfield in 1993 detected by high-precision EDM and borehole tensor strainmeters *Geophys. Res. Lett.* 26(16) pp 2529-2532, 1999

Gwyther R.L., M.T. Gladwin and R.H.G. Hart Anomalous Shear Strain at Parkfield During 1993-94 *Geophys. Res. Lett.* V 23 (18) p 2425-2428, 1996

Hart R.H.G., M.T. Gladwin, R.L. Gwyther, D.C. Agnew and F.K. Wyatt Tidal Calibration of Borehole strain meters: Removing the effects of small-scale inhomogeneity *J. Geophys. Res.*, *V101(B11)*, p25553-25571, 1996

Linde A. T., M.T.Gladwin, M.J.S.Johnston, R.L.Gwyther & R.G.Bilham A Slow Earthquake Sequence near San Juan Bautista, California in December 1992. *Nature V. 383* p. 65-69 1996

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Gwyther R.L., Gladwin M.T. and Hart R.H.G. (1992) A Shear Strain Anomaly Following the Loma Prieta Earthquake. *Nature* Vol 356 No.6365 pp 142-144.

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Non-Technical Summary

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