DEEP BOREHOLE PLANE STRAIN MONITORING
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ACTIVITIES

1. An investigation of both the long term strain anomalies and details of short term changes of level in the strain data from San Juan Bautista has been carried out. These data have been compared with long term and short term creepmeter data from sites along the San Andreas fault in the region of San Juan (provided by K. Breckenridge). Models of possible common source regions for similar creep and strain signals have been investigated. Papers reporting the results of these investigations (including collaborative work undertaken during a visit by Kate Breckenridge of the U.S.G.S., Menlo Park in July, 1991) have been prepared for the Fall, 1991 AGU and have also been submitted for publication.

2. Valuable collaborative work was undertaken during an extended visit by Dr. Alan Linde (D.T.M., Carnegie Inst. of Washington) in 1991. Investigations were completed of amplitude of tidal components of the strain record for the periods before and after Loma Prieta earthquake. A paper reporting the results of this work has been submitted. Comparison of a number of different methods of tidal analysis for use in investigating strain data was also undertaken during this visit.

3. Data from the three tensor strain sites at Parkfield has been processed regularly, and monthly reports of strain provided to the Parkfield group meetings. A number of short term (hours to days) signals evident on both a strain data record and on a nearby creepmeter in the Parkfield region have been investigated to determine the possibility of a common source region.

4. A procedure involving a plot of the two primary shear strain components γ_1 and γ_2 against each other has been developed, and a paper giving the details is in preparation. This procedure provides a useful means for physical interpretation of shear strain and strain changes over time.

RESULTS

For the period 1985 - September 1991 we examined the San Juan Bautista strain (SJT) and creep (XSJ2) records independently for steps. Apart from coseismic steps which are generally seen only on the strainmeter, the most frequent event is one involving both strain and creep steps. Individual strain steps at SJT are remarkably similar and have duration of about an hour. They are followed within hours to days by right lateral creep events at XSJ2 of several mm. The creep events are much slower than the strain events, with the major offset occurring over a few days. A representative selection of the events as recorded on the strainmeter and the creepmeter at XSJ2 are shown in Figure 1.

Investigation of a wide range of dislocation models in the region of San Juan Bautista led to our conclusion that the source is a small region below XSJ2 at a very shallow depth of about .5 to 1km, and a few km at most in extent. Location of this source so close to XSJ2 by processing of totally independent strain data , suggests a causal relationship between the strain and creep events.

The long term data for these two sites was examined in the light of these conclusions (see Figure 2). Data from other creepmeters further to the south on the San Andreas was also considered. The XSJ2 creep record is seen to be dominated by the event steps, which account for 80-85% of the total creep. In the strain record the shear strain γ_1 (approximately fault parallel) is dominated by a change of strain rate, relative to the 1987 rate, of +1 microstrain/year before Loma Prieta, and +2 microstrain/year following the earthquake. The onset time of the latter change coincided with an increased creep event frequency which began some 3 to 5 months after Loma Prieta.

The linearly increasing elastic shear strain seen by the SJT strainmeter can be explained by the dislocation stress arising from a slip deficit on a locked patch in the region. Consideration of possible source regions to account for this anomaly resulted in a model with a locked patch at least 5 kilometers long, centred south-east of San Juan Bautista, the upper boundary of which is within 1-2 km of the surface, beneath the regularly failing small region discussed above. Such a model is shallower than locked regions postulated in the literature, suggesting that either the coseismic slip propagates closer to the surface than indicated in the literature, or that the region 3 to 1 km depth is locked but fails aseismically probably as afterslip, due to a velocity strengthening mechanism.

RELEVANT PUBLICATIONS

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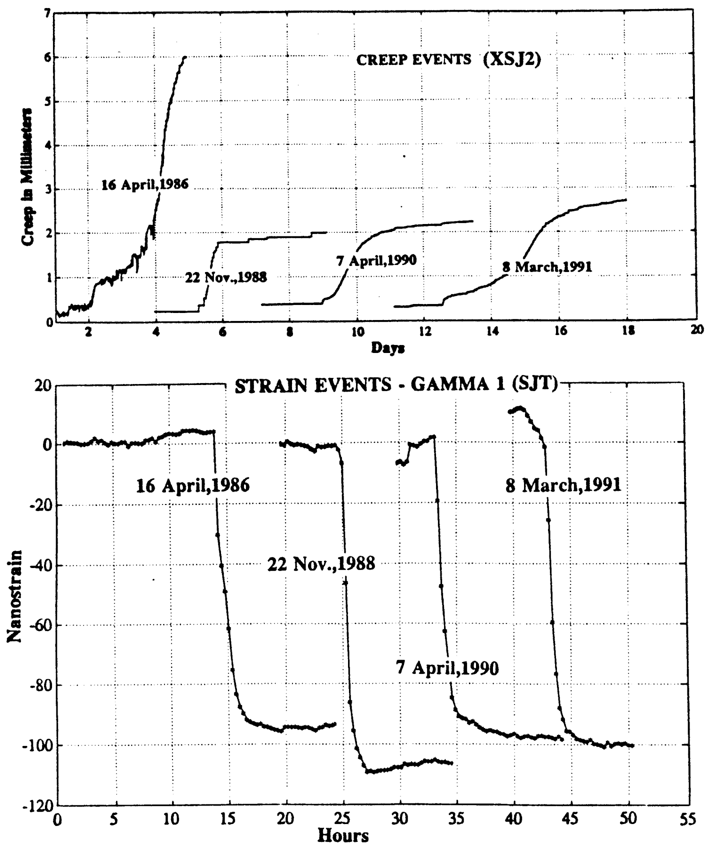

Figure 1. A Some representative samples of creep/strain events observed in the data from creepmeter XSJ2 (located on the San Andreas Fault on the southern outskirts of San Juan Bautista) and tensor strainmeter SJT (located 2 km to the west of XSJ2). Note the striking similarity of events over a 5 year timespan.

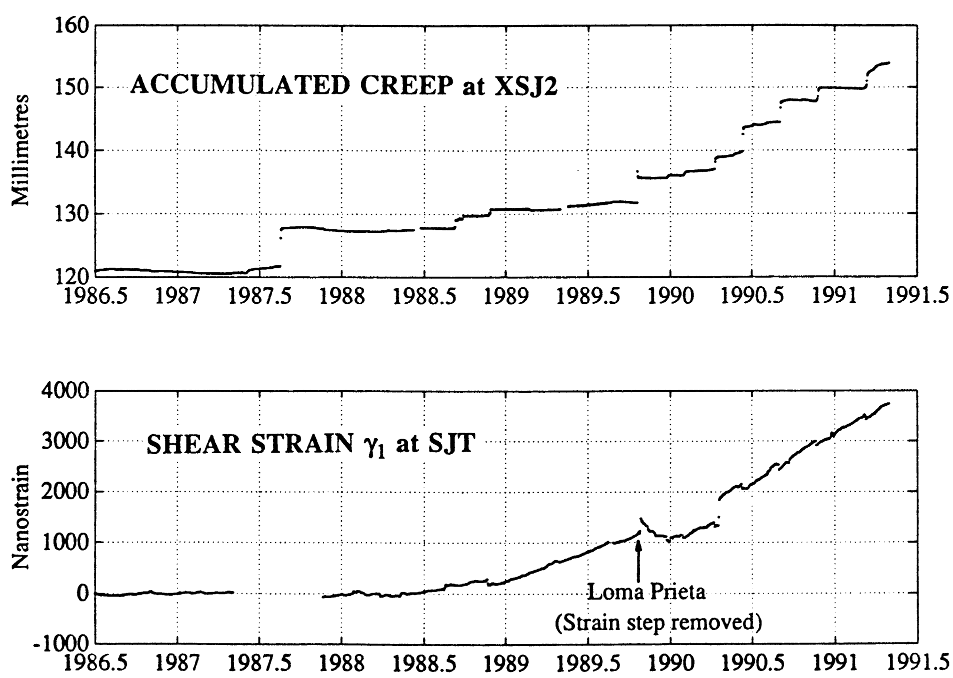

Figure 2. A comparison of the shear strain anomaly before and following the Loma Prieta event with the creep at XSJ2 (data courtesy of Ms K. Breckenridge, USGS). The creep retardation characteristic of the pre Loma period has changed to an above average creep rate with similar time signature to the observed shear strains at the San Juan tensor strain instrument.