quantization levels are achieved, in the IDA instrument, with 9 bit and 12 bit D/A converters, respectively.

For broadband systems, such as the STS, an 18 bit D/A should be sufficient to span the range from earth noise up to an M_W 8.5 earthquake at 30°.

S51B-09

Earth Strain in the Period Range 0.1 - 10,000 Seconds at Six Borehole Sites Within the San Andreas Fault System, California

Johnston, M.J.S., and Borcherdt, R.D., U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025

To utilize the high sensitivity, the wide dynamic range and the broad bandwidth of deep borehole three-component and dilational strainmeters in the short period range (0.1 seconds to 10,000 seconds), 16-bit digital recorders (GEOS) have been used at six sites in California to record earth strain noise, nuclear explosions, and seismic events. Limited dynamic range and bandwidth of standard recorders have not permitted such recordings previously. The power spectral density estimates for earth noise are similar in general characteristics for each of the sites. With the exception of about 10 db of 6 second microseismic noise, they decrease from about -170 dB with increasing frequency at a rate of about 10 dB per decade. Peak power in strain seismograms of local earthquakes and nuclear explosions occurs between 0.1 and 1 Hz. Detection of possible pre-rupture strains at the 10^{-10} strain level appears feasible in this period range.

S51B-10

Strain and Creep Meter Observations (1983-1984) Near the Southern San Andreas Fault, California

BEN-ZION, Y., P. LEARY and E. HAUKSSON (all at Department of Geological Sciences, University of Southern California, Los Angeles, CA 90089-0741)

A creep meter located in a shallow trench across the San Andreas fault (approximately 15 km northwest of Pearblossom) that has been operated at an increased sensitivity since March 1984 can resolve changes in displacement of 10 microns. The data show no strain steps at this resolution during the time period March-September 1984, when filtering techniques are applied to remove thermal contamination of the data. Data from the pairs of carbon fiber strain meters that are installed in tunnels near Bouquet Reservoir (approximately 10 km south-west of the San Andreas fault) and near Dalton (close to the Sierra Madre fault) are analyzed to remove obvious temperature and rainfall effects. Multichannel Wiener filters are constructed using atmospheric temperature, rain and theoretical tides as input data. The results of applying the filters indicate that creep meter data from the shallow trench site are more contaminated by atmospheric temperature effects than the data from the strain meters installed in tunnels.

S51B-11

Hybrid Codes for Propagating Teleseismic Love and Lg Waves Across Lateral Inhomogeneities

JANICE REGAN and DAVID G. HARKRIDER (both at: Seismological Laboratory, California Institute of Technology, Pasadena, California 91125)

The propagation of surface waves crossing regional transition zones is modelled using a hybrid technique. Waves are propagated from their source through a plane layered media using a propagator matrix method. They are then coupled into a 2-D finite element grid spanning the transition zone using a discretized form of the Representation Theorum. After propagation through the grid they can be coupled into another layered structure for further propagator matrix propagation by again applying the Representation Theorum. This process can be repeated for any number of transition zones.

Examples showing the accuracy and limits of the above method will be presented. For SH waves propagating through a half space with the source 15 km from the grid edge, amplitudes of pulses recorded within the finite element grid vary from theoretically generated amplitudes by a few percent, and the pulse shapes agree very well. For Lg mode sums propagated through a layer over a half space the correspondence in phase between finite element results and direct calculation is excellent. The maximum amplitudes in each finite element trace agree reasonably well with direct calculations. Amplitudes of later peaks of the finite element calculation usually agree as well as the maximum values but a few peaks do not agree as well with the direct solution. Finally Lg mode sums were used as input into ocean continent transition grids, with the transition taking place over 10 and 20 km. The effects of the transition zones on the waveforms will be illustrated.

S51B-12

Elastic Surface Wave Solitons

ROBERT I. ODOM (Department of Geological and Geophysical Sciences, Princeton University, Princeton, New Jersey 08544)

We have shown that the propagation of nonlinear, weakly dispersive Love waves is described by the modified Korteweg-de Vries (mKdV) equation of the form

$$U_\tau - 6U^2U_\xi + \nu U_{\xi\xi\xi} = 0$$

where U is a non-dimensional component of either the displacement gradient or the velocity, τ and ξ are non-dimensional time and distance, ν is a coefficient that depends on the ratio of dispersive to nonlinear effects, and $\delta = \text{sign}(\gamma)$ where

$$\gamma = \frac{\lambda}{8} + \frac{\mu}{4} + \text{(3rd + 4th) order elastic constants}$$

The mKdV equation is derived by performing a uniformly valid perturbation analysis of the complete nonlinear equations of motion. The mKdV equation is exactly integrable, and can be solved by the inverse scattering method. For the case $\delta = -1$ it possesses two types of solitary pulse soliton solutions. For $\delta = +1$, the solution is a hyberbolic tangent, which has the appearance of a hydraulic jump, and connects two uniform states. In general the velocities will be slightly faster than the linear wave velocities. Elastic surface wave solitons might possibly be observed as precursor arrivals after a very large earthquake or explosion.

S51B-13

Radar Visibility of Subsurface Paleoseismic Features

R. BILHAM
Lamont Doherty Geological Observatory, Palisades, NY 10964 and at CIRES, University of Colorado, Boulder, CO 80309.

25 locations on active fault strands have been investigated using a ground-penetration radar system operating at 300MHz to 80MHz center frequencies. The system has a potential depth penetration of more than 10m and a resolution of 5-50cm dependent on subsurface electromagnetic velocity and antenna center frequency. Features associated with the Wasatch, Hebgen Lake, Borah Peak, Fairview Peak, Owens Valley, Concord, San Andreas and San Gabriel faults were investigated and additional studies were undertaken at Mammoth Lakes and Coalinga. In cases where there exist stratigraphic layers possessing contrasting electromagnetic velocities in the upper 3m it was possible to locate paleoseismic features related to recent fault activity. However, a near-absence of dielectric layering is found to be typical of the coarse colluvium of faulted range fronts in Nevada, Utah and California. Notable successes of radar imaging were the detection of colluvial wedges associated with former movements of the Lost River Fault, Idaho, and the identification of wide zones of fracturing on strands of the San Andreas fault system at Point Reyes, Hollister and the Salton Sea. It is concluded that impulse radar profiling can provide useful subsurface structural information in those locations where polymodal sedimentation is likely to be important in subsequent trench investigations but that many paleoseismic features may be invisible if insufficient dielectric layering exists.

S51B-14

Mapping of Near Surface Fault Zones with Shear (SH) Waves

MILKEREIT, B. (Institut für Geophysik, Universität Kiel, D-2300 Kiel)
RABBEL, W. (Institut für Geophysik, Universität Kiel, D-2300 Kiel)
(Sponsor: Prof.Dr. R. Meissner)

Lateral discontinuities of near surface geological structures are a matter of interest in pure science as well as in mineral exploration and mining.

Since shear wave velocities are not affected by the degree of water saturation a high resolution of shallow stratification can be achieved by applying a short wavelength (SH) source. This results in a good correlation between subsurface velocity distribution and lithology.

Both reflection and refraction experiments have been carried out for the detection of lateral inhomogeneities in different regions. Examples will be given for the lateral variation of shear wave velocities and frequency content of refracted signals in the presence of near surface fault zones. We compare the results from a SH-reflection survey with detailed borehole informations.

Intraplate Earthquakes and Tectonics

Larkin II Fri PM
Presider, P. Talwani, Univ of South Carolina
P. Sommerville, Woodward Clyde

S52A-01

A Global Study of Intermediate-Depth Earthquake Mechanisms

L. ASTIZ (Seismological Laboratory, California Institute of Technology, Pasadena CA 91125)
T. LAY (University of Michigan, Dept.of Geological Science, Ann Arbor MI 48109) and H. KANAMORI (same as first author)

We investigate the occurrence of intraplate intermediate-depth earthquakes with a global focal mechanism catalog. First, we review published focal mechanisms of earthquakes listed by the NOAA and ISC catalogs with mb>6 and depths between 40 and 200 km that occurred between 1963 and 1983. Then, we determine focal mechanism solutions from first motion data of long and short-period WWSSN records for the earthquakes with unknown source parameters. The final catalog includes only intraplate intermediate-depth earthquakes: 271 published focal mechanisms and 47 determined by this study. The larger events can be grouped into four types. 1) Normal-fault events (40%), and 2) reverse-fault events (30%), both with a strike nearly parallel to the trench axis. 3) Normal or reverse fault events with a strike significantly oblique to the trench axis (15%). 4) Others (15%). Type 1 events occur mainly along the South and Middle America trenches; they also occur in the Northwest Pacific, Alaska, Kamchatka, Solomon and Tonga trenches. Type 2 events occur mainly in the South Philippine, New Guinea, Solomon, New Hebrides and Kermadec trenches. Simple models of plate coupling and geometry suggest that type 1 events occur at strongly coupled plate boundaries where a down-dip extensional stress prevails in a gently dipping plate. Continental loading may be another important factor. Type 2 events occur by a similar mechanism, but a down-dip extensional stress is more vertical. Type 3 events occur where the trench axis bends sharply causing horizontal extensional or compressional intraplate stress. Type 4 events occur at plate boundaries with complex features such as an aseismic ridge.

S52A-02

Ground Deformation Modeling of the Southern Italy Earthquake of November 23, 1980

S.C. KEY
R.S. CROSSON (Both at: Geophysics Program, Univ. of Wash., Seattle, WA 98195)

Two leveling profiles which apparently reflect the coseismic ground deformation were reoccupied in the epicentral area shortly after the November 23, 1980 magnitude 6.9 earthquake in southern Italy. This destructive earthquake occurred in the southwest side of the Apennine chain in a region of block faulting and probable extensional tectonics. We have modeled the leveling profiles using a dislocation representation of two nearly orthogonal faults which are suggested by the aftershock hypocenter distribution and the character of the leveling lines. Preliminary results indicate that the leveling data can be fit to within approximately 10% with two high angle faults, intersecting at an angle slightly greater than 90 degrees and having primarily dip slip displacements. This model indicates the existence of a primary NW trending fault and a secondary NE trending fault. The magnitude of displacement on both faults appears to increase towards the intersection of the two faults, with the secondary fault terminating at this point. The primary fault probably extends slightly past the intersection with the magnitude of displacement decreasing rapidly beyond this point. The combined action of the two major faults resulted in a down-dropped structural "corner" block. This double-fault structure fits well with the strong motion seismic observations which clearly indicate that two major rupture episodes occurred within one minute. The mainshock rupture apparently triggered secondary displacement on the NE trending fault which is comparable to the initial event.

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