NOAA's National Geophysical Data Center (NGDC) is developing and using an integrated system of Web-based tools for receipt, ingest, quality review, and dissemination of metadata and data. These tools are being used to improve the quality and content of gravity data as part of the North American Gravity Database. Using these tools, scientists will be able to submit data and metadata information on-line. After verification and ingest, these and other data can be compared and viewed with other data This poster describes the metadata component of the integrated system and introduces the Web-based tools for browse, subset, overlay, and delivery of data on-line using Oracle spatially enabled database, ArcIMS, and Web browsers.

URL: http://www.ngdc.noaa.gov/seg/potfld/gravity/welcome.shtml

G32A-0743 1330h POSTER

Earth-model discrimination via gravimetric terrestrial spectroscopy

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We devised a method for Earth-model discrimination, of potentially general interest to geophysics. Based on Jeffreys's rule of thumb, it is claimed that the last decade's mean-diurnal free oscillation magnitudes (MDOM) of the Earth's gravity field linearly correlate with seismic energies and seismic magnitudes of 381 earthquakes larger than M = 6.3 found in the record. Here the oscillation of the gravity field is caused by the seismic waves generated by these medium-to-large earthquakes. Oscillation magnitudes are taken at the discrete values predicted by the individual model's long eigen-periods; we take all modes between 12 min - 2 hrs. Using the correlation coefficients computed from variance-spectra between the MDOM and $M > 6.3$ global seismicity, which in some cases reach up to 0.97, we subsequently propose a general method for Earth-model discrimination: if a model yields high correlations of the MDOM with Earth's seismicity on the day of the large earthquake, that model is to be considered successful. Various criteria for model discrimination could then be derived from this observation. Gaps are normally present in the record of temporal gravity variations obtained by a seismically excited gravimeter. We thus start the data processing for our technique by applying a non-equidistant Gaussian filter with 4sigma-width, to the last decade's one second step record collected by the Canadian superconducting gravimeter (SG) that operates at Cantley, Quebec. Thus the original one-second data are transformed to records with steps 8 and 32 sec. The non-equidistancy feature of our filter means that one-second gaps in the record are properly accounted for and gaps larger than the filtering steps set at 8 and 32 sec remain in the series. We then perform the least squares spectral analysis (LSSA) of so filtered a record, without any further preprocessing of the data so as to satisfy the rigour requirement. The LSSA seems suitable for our purpose due to its ability to handle gaps in data, unlike other spectral analyses. We obtain power- and variance-spectra of the record (including noise), and using three different geophysical models we look into the free oscillation of the Earth at the periods predicted by these models; we compute respectively the mean-diurnal and mean-weekly gravity oscillation magnitudes (MWOM). For all three models the correlations are higher when seismic energies are used rather than seismic magnitudes, as well as when variance-spectra are used rather than power-spectra. As deduced from the variance-spectra (but not the power spectra) of gravity, the correlation is maximum for eigen-periods of around 821 sec. When a depth-of-earthquake separation is performed, the best correlation between the MDOM series and the deep ($d > 400$ km) earthquakes shows a curious delay of three days, for all the models. For this we have no physical explanation. Finally, the series of MDOM values of the Earth's gravity field appears periodic over the studied decade: a synodic semi-monthly and solar semi-annual periods show up as the only two significant periods from the one-day to ten-years period interval. Various researchers in the area of earthquake prediction and "tidal triggering" have in the past pointed their finger at the same periods. We know where these periods come from but we have no physical explanation as to why they should trigger the characteristic oscillations.

URL: http://einstein.gge.unb.ca

G32B MCC: 2010 Wednesday 1340h

Before PBO: What Do We Know? II
(joint with S, T)

Presiding: **R A Bennett,** Harvard-Smithsonian Center for Astrophysics**; K W Hudnut,** U.S. Geological Survey

G32B-01 1340h

The Plate Boundary Observatory Component of the EarthScope Facility

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The Plate Boundary Observatory (PBO), one of the core components of EarthScope, is a geodetic observatory designed to study the three-dimensional strain field resulting from plate boundary deformation in the western US including Alaska. The science goals of PBO require that plate boundary deformation be adequately characterized over the wide range of temporal and spatial scales common to active continental tectonic processes. To meet these goals, PBO will install a core of geodetic instruments that possess excellent sensitivity over this broad temporal spectrum, with a deployment configuration that will dramatically increases the spatial scale and density of stations. The PBO Facility will consist of 891 permanently-installed GPS stations, 175 borehole strainmeters, five laser strainmeters, and a pool of 100 portable GPS receivers for temporary deployment and rapid response for volcanic and seismic crises. PBO will provide a range of data and data products for scientific investigations and for education and outreach activities. Congress has provided funding for EarthScope to the National Science Foundation and a proposal to construct EarthScope has received approval from the National Science Board. Construction is expected to commence in September or October 2003.

URL: http://www.unavco.org/PBO/PBO.html

G32B-02 1355h INVITED

A Reference Frame for PBO: What do we Have; What do we Need?

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By definition, the Plate Boundary Observatory (PBO) will investigate the mechanics associated with the boundary between the North America and Pacific plates. A natural frame of reference to describe crustal deformation between these two plates would be one in which the far field appears to be stationary, which leads to two possibilities: the "stable North America frame" or the "stable Pacific frame." The theory of plate tectonics pre-supposes the existence of such entities. Within such a framework the sum of deformations across contiguous regions of the plate boundary zone are constrained by the known relative far-field plate motion. However both theory and observation complicate this simplified framework. Are "stable plate interiors" a meaningful concept at the level of anticipated geodetic accuracy? Observational evidence suggests that most of the North America and Pacific Plates appear to be horizontally stable at the level of 1–2 mm/yr over plate-wide distance scales, which is not a very stringent constraint given current and anticipated station velocity accuracies at <1 mm/yr. Where do these stable plate interiors end, and the plate boundary zones begin? The Pacific-North America plate boundary zone is so broad that gravitational potential energy and mantle dynamics must play an important role - how deep into the plates do these dynamics have a measurable effect? How should we account for glacial isostatic adjustment in the definition of a plate-fixed frame? How should we define a "vertical datum" that is theoretically useful and can be realized in practice? In this presentation I review the current status of reference frame theory and actual practice, and I outline current thinking on the reference frame needs for PBO that derives from the working group on the "Stable North America Reference Frame" (SNARF), recently formed under the auspices of UNAVCO and the IAG sub-commission on the North America Reference Frame (NAREF).

G32B-03 1410h

GPS Lessons Learned

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Global geodesy has improved dramatically over the past decade starting with the GPS for IERS and Geodynamics demonstration compaign in 1991 (GIG 91). At that time it took over a week of CPU time to process a network solution based on 21 global receivers and orbit overlaps were in the 40 cm range. Today it is possible to process a network solution based on 80 global receivers in less than one day of CPU time and orbit overlaps are in the 4 cm range. Special methods are under development for efficient processing of increasingly large regional networks which may contain hundreds or thousands of GPS receivers. Along the way there have been many lessons learned about GPS satellites, receivers, monuments, antennas, radomes, analysis, reference frames, error sources, and interpretation. A wide range of scientific disciplines have been impacted including studies of plate motion, post-glacial rebound, seasonal loading, deformation in plate boundary zones, coseismic displacements due to major earthquakes, postseismic relaxation, and interseismic strain accumulation related to assessment of seismic hazards. Lessons learned will be presented in the context of new dense networks such as the Plate Boundary Observatory (PBO).

G32B-04 1425h INVITED

Results and Comparisions from the Southern California Integrated and other arrays

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The Southern California Integrated GPS Network (SCIGN) was established after the 1994 Northridge Earthquake near Los Angeles, California. The SCIGN array is the largest integrated array in North America and was largely completed in July 2001. Currently the array has about 250 continuously operating GPS receivers. The current operation of SCIGN shares many of the characteristics sought for the operation of the plate boundary observatory. All of the data from SCIGN are freely available. SCIGN operates three analysis centers, one for near-real time processing and two for final post processing. There is also an analysis committee that compares and combines the results from the two post processing centers. This analysis committee makes available results in the form of time series, 3-dimensional velocity vectors, and postseismic deformation parameters from a uniform analysis of loosely constrained solution vectors with full covariance matrix information and from analyses preformed at the two post processing centers at Jet Propulsion Laboratory (JPL) and the Scripps Institution of Oceanography (SIO). (http://chandler.mit.edu/ tah/SCIGN). We present here comparisons of uniform processing of the solutions from JPL and SIO with the processing results presented by the two centers (http://sideshow.jpl.nasa.gov/mbh/series.html and http://sopac.ucsd.edu/cgi-bin/dbShowArraySitesMap .cgi?array=SCIGN). From these comparisons, the robustness of signals seen in strain field in the region and non-linear temporal variations in the time series can be assessed. The RMS difference of the 3-D velocities from the uniform analysis is 0.6 mm/yr, and for horizontal 2-D velocities 0.5 mm/yr. We will examine those sites where the two analysis centers do not agree well. In these cases, the differences arise from site characteristics such as the effects of snow, multipath, subtle instrument failures, and loading processes when different lengths of data are used. We will also examine results from other networks around the world where some of the effects discussed above are even more pronounced.

URL: http://chandler.mit.edu/~tah/SCIGN

G32B-05 1440h

Broadband Deformation in the San Francisco Bay Area

Measured at Mini-PBO Stations: Implications for PBO

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We report on 5 borehole stations installed in the San Francisco Bay area with strainmeters, seismometers, pore pressure monitors, tilt sensors, GPS, and high-frequency 24-bit recording systems. These "Mini-PBO" stations are part of an NSF-funded project to develop a pilot system for the study of transient plate boundary deformation from fractions of seconds to years in central California. We are currently resolving interaction problems, such as electical grounding, that are typically encountered during the hookup of such complex systems, and are in the initial stages of assessing the data quality of the instrumentation. The tensor strainmeters use the CIW hydraulic system to measure the volume change in 3 sensing volumes that form 120-degree sectors of an annulus, allowing the 3-component horizontal strain tensor to be determined. The tensor strainmeters, pore pressure monitors, and tiltmeters appear to reliably measure tidal strain, and local and teleseismic earthquake deformation. We will present studies of noise spectra and tidal calibration to better assess the performance of the strainmeters. We plan to add pre-amplifiers to the 3-component 2-Hz velocity borehole seismic packages to improve the signal at some of the stations where the microseismic noise peak around 0.1 Hz currently is not evident. The GPS antennas are mounted at the top of the borehole casings in an experimental approach to achieve inexpensive yet stable monuments. We will present noise studies that compare their stability with more conventional monuments. The lessons learned from the analysis and integration of the different data types produced by the Mini-PBO project should pave the way for users of the more extensive data sets that will be acquired through the dense instrumentation deployments planned under PBO.

G32B-06 1455h

Crustal Deformation in the Basin and Range: Recent Results from the BARGEN Network and Questions for the Future

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As late as the mid-1990's, our state of understanding of crustal deformation within the northern Basin and Range was quite poor. Prior space geodetic studies indicated that the integrated deformation across this ∼1000-km-wide zone was 10–12 mm yr^{-1}, with only one site (ELY) near the center of the province. By 1998, however, continuous GPS had described the major features of the horizontal velocity deformation field near lat. 40° N, and by 2002 detailed horizontal velocity fields from both continuous and campaign GPS were available for both northern and central Basin and Range. Studies now focus on the physical mechanisms for both the broad-scale and detailed studies of deformation patterns as they relate to individual faults. These studies have highlighted a number of problems to be addressed by PBO, including: whether or not strain is localized along a small number of individual faults, versus evenly distributed across most Quaternary faults; the relationship between past and present strain and seismicity; the role of plate boundary forces versus gravitational forces in controlling the deformation field; and the contribution of historic earthquakes to the detailed deformation observed. With > 7 yrs of continuous data from the BARGEN network, we are now in a position to begin evaluating two important avenues of research, including transients or accelerations in site motion, and the vertical component of deformation. A subset of BARGEN sites now shows temporal variations in velocity that are as high as 0.4 mm yr^{-2}. Although we do not yet know whether these motions are related to tectonic processes, they have systematic properties, including regional coherence and displacements in accord with slip directions of nearby faults. Vertical velocities show a broad pattern of subsidence of ∼1 mm yr^{-1} with coherent spatial variations of ±2 mm yr^{-1}. Even if the overall subsidence is in error on account of reference frame problems, the coherent variations of subsidence cannot be explained by any long-term, steady-state geophysical process such as thermal subsidence, erosion, or strain accumulation along faults.

G32B-07 1510h

Crustal Deformation of the Northern Basin and Range from Measurement with the Global Positioning System

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In northeast California, southern Oregon, and northwest Nevada the three major plate boundary elements of western North America interact, exhibiting a complex pattern of crustal deformation. Between latitudes 40 − 44°N, deformation associated with translation of the Sierra Nevada microplate, the Cascadia convergent margin, and the extending Basin and Range province overlap. Boundaries for geodetic domains associated with each of these tectonic elements are not well located, and as a result the contributions that each component has on the broad pattern of crustal motion are not well understood. To distinguish among various influences on crustal motion in the northwestern Basin and Range, a 700 km wide network of 86 geodetic sites was established and surveyed in September, 1999, and in June, 2003 with the Global Positioning System (GPS). The network provides a first look at the plate boundary scale deformation pattern of the northwest Basin and Range. We report geodetic velocities and strain rates inferred from the pattern of motion, and use their spatial characteristics to infer the dynamic sources of deformation. Locating the most rapidly deforming areas is necessary to guide the establishment of future sites in the extensional tectonics cluster of the nascent Plate Boundary Observatory. Results indicate that velocities in the eastern half of our network (between 114°W and 119°W longitude) are approximately 2-3 mm/yr westerly with respect to non-deforming North America. Strain rates between 114°W and 119°W are not resolvable, similar to GPS results obtained from campaign and permanent sites east of the Central Nevada Seismic Zone near latitude 39°N. West of 119.5°W the velocity magnitudes begin to increase and change to a more northwesterly azimuth, again similar to the transition between roughly non-deforming central Nevada and the Central Nevada Seismic Zone seen at 39°N. Velocities in the northernmost part of our network, near 43.5°N latitude, have a small eastward velocity component, possibly showing the influence of the Cascadia convergent margin at least as far east as longitude 120°W. Right lateral simple shear deformation is observed near the southwestern part of the network, and is most likely attributable to transform motion between the Sierra Nevada microplate and adjacent northeast California.

G32B-08 1525h

Before PBO: What Do We Know About Ground Deformation in the Cascade Range?

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Three of thirteen active volcanic centers in the Cascade Range are known to be deforming and therefore are among the candidates for PBO instrument clusters (*i.e.*, concentrations of continuous GPS stations and borehole strainmeters to be installed as part of the Plate Boundary Observatory). At Three Sisters in central Oregon, a broad area of uplift centered 5 km west of South Sister volcano was discovered in April 2001 using satellite radar interferometry (InSAR). Subsequent InSAR, campaign GPS, continuous GPS, and tilt-leveling observations indicate that the inflation is centered near 6 km depth, began in 1997 or 1998, and has continued at a constant rate of 0.005±0.001 km^3/yr. The total volume increase through September 2002 was 0.027±0.005 km^3. Results of the most recent (September 2003) campaign GPS and tilt-leveling surveys will be reported at the meeting. Medicine Lake Volcano in northeast California is known from repeated geodetic leveling, campaign GPS, and InSAR observations to be subsiding 8±1 mm/yr at the summit. A leveling survey in June 2003 between Tionesta and Alturas east of the volcano suggests fault displacements of several centimeters at three sites along the route since the previous survey in 1940. At Mount St. Helens in southwest Washington, a 14-station Geodolite EDM network centered near the volcano and extending 30 km across and 90 km along the volcanic arc was established in 1982. All 26 line lengths were remeasured in 1991, and 10 line lengths between 7 central stations were recovered by GPS in 2000. Strain accumulation between 1982 and 1991 was dominated by areal dilatation (0.15±0.06 μstrain/yr) in the central part of the network around Mount St. Helens. No significant strain accumulation was observed in the same area between 1991 and 2000. A continuous GPS station (JRO1) located 9 km north of the volcano is moving 8±1 mm/yr north-northeast relative to interior North America, which is generally consistent with rigid rotation of coastal Oregon as determined from modeling of regional GPS-measured deformation. A dense 40-station campaign GPS network around Mount St. Helens was established in 2000 and remeasured in 2003. Preliminary results indicate no significant deformation of the volcano beyond the 1980-86 lava dome, part of which is subsiding 8 cm/yr. The source of apparent far-field deformation is not yet clear. InSAR observations show that thick 1980 deposits in the North Fork Toutle River valley north of the volcano are subsiding and presumably compacting a few cm/yr.

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G32C MCC: 2010 Wednesday 1600h

Before PBO: What Do We Know? III

(joint with S, T)

Presiding: **R A Bennett,** Harvard-Smithsonian Center for Astrophysics**; K W Hudnut,** U.S. Geological Survey

G32C-01 1600h INVITED

The Resolving Power of the Current State of GPS Information in North America: Implications for PBO Planning

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We combine both permanent and campaign GPS data from mostly published work to infer a kinematic solution within western North America plate boundary zone. We interpolate 1603 GPS velocity vectors to infer the horizontal velocity gradient tensor field, which is important for both seismic hazards analysis and for constraints on the dynamics. The interpolation algorithm uses continuous bi-cubic splines on the surface of a sphere. The GPS vectors are matched by the model velocity field, in a specified reference frame, in a weighted least-squares inversion. The reference