S12B-0396 1330h POSTER

Low Temperature Thermochronology From the SAFOD Pilot Hole: Constraining the Thermal History With Apatite Fission-Track and (U-Th)/He Analyses

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The San Andreas Fault Observatory at Depth (SAFOD) pilot drillhole traverses the upper $\sim$2 km of a site 1.8 km west of the San Andreas fault near Parkfield, California. We use apatite fission-track and (U-Th)/He analyses of drillhole cuttings samples to document the thermal signature of downhole samples currently at a temperature range of $\sim$ 20 to 95 ^oC. Knowing the long-term thermal history of the site will be important for interpreting geochemical, structural, and geophysical observations in the SAFOD project. With these data we evaluate the geothermal gradient and exhumational history of the drillhole site. Preliminary (U-Th)/He analyses from drillhole samples decrease in age with depth, with He ages of $\sim$ 20 Ma for samples at 800 m (where the Pilot Hole first encounters Salinian granitic rocks; current temperature $\sim$ 50 ^oC) to a He age of 1 Ma in the deepest sample from the base of the hole (at 2.2 km depth; current temperature 95 ^oC). The pattern of ages is consistent with that expected for the observed geothermal gradient of $\sim$ 35 $^oCkm^{-1}$ and shows little or no evidence of recent exhumation. Preliminary modeling of fission track length distributions also show that the block has been exhumed less than 1 km in the last 5 m.yr., despite its proximity to the active strand of the San Andreas fault and other related faults.

S12C MCC: 3011 Monday 1340h

Novel Ways of Analyzing the Seismic Coda II

Presiding: **R Snieder,** Center for Wave Phenomena/Colorado School of Mines**;** **M Fehler,** Los Alamos National Laboratory

S12C-01 1340h INVITED

Extracting and Using Time Domain Green's Functions From Ocean Acoustic Noise

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The long-time temporal correlation of random wave fields received at two receivers basically extracts the time domain Green's function (TDGF) between the receivers. This process applies to either scattered fields or noise, the former often referred to as signal-generated noise. We have shown with theory and data that the long-term temporal correlation of ocean noise between two points yields the effective TDGF between those two points. The deterministic nature of the random-noise extracted TDGF is further demonstrated by utilizing these TDGF's for time reversal (TR) focusing through the background ocean medium. The combination of extracting TDGF's from random fields and deterministic based TR processing suggests a potential for passive tomography and imaging.

S12C-02 1410h INVITED

Interferometric Imaging

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Seismic codas contain information about the environment in which the waves travel. How can this information be extracted and what can it be? I will present some recent work (jointly with L. Borcea and C. Tsogka) that models that behavior of cross correlations of seismic codas, which may also be called coda interferometry. I will use recent results about the time reversal of signals in randomly inhomegenous media which help delimit the information content of the cross correlations. I will also present the results of numerical simulations that illustrate the way in which interferometry can be used for imaging.

URL: http://georgep.stanford.edu

S12C-03 1440h INVITED

Ultrasonic Waves in Strongly Scattering Media: a Symphony of Ultrasound That is Almost all Coda.

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Waves traveling through strongly scattering materials can behave in unusual ways, and in this presentation, I will review recent progress in probing their behavior using ultrasonic techniques. In random systems, ultrasonic experiments on simple model materials (spherical beads suspended in a liquid, porous materials made from sintered glass beads) have shown how the coherent ballistic component can be separated from the dominant multiply scattered waves (the coda), allowing a rather complete picture of wave propagation in such systems to be established. These experiments have also helped to elucidate how multiply scattered waves diffuse, giving a unified physical picture of the relationship between the velocities of energy transport by diffusive and ballistic waves. These fundamental studies of wave transport by multiply scattered waves have facilitated the development of three new techniques in ultrasonic correlation spectroscopy (or coda wave interferometry) for measuring the dynamics of strongly scattering materials: Diffusing Acoustic Wave Spectroscopy (DAWS), Diffusing Reverberant Acoustic Wave Spectroscopy (DRAWS) and Dynamic Sound Scattering (DSS). Very different wave behavior can be observed by arranging the beads in an ordered crystalline array (a phononic crystal), giving rise to a complete bandgap through which the ultrasonic waves travel by tunneling. The presentation will end with a brief description of elastic wave diffusion in porous materials, where the multiply scattered ultrasonic energy is partitioned between P and S waves and remarkably strong scattering can be observed. Work performed with H.P. Schriemer, M.L. Cowan, Suxia Yang, J. Bobowskl, R. Holmes, J. Beck, J. de Rosny, D.A. Weitz, Ping Sheng and Zhengyou Liu.

URL: http://www.physics.umanitoba.ca/~jhpage

S12C-04 1510h INVITED

Partitioning between P and S energies in the long-period seismic coda

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Long-period seismic signals excited by large ($M > 8$) earthquakes remain above the noise level for tens of hours. This long-period seismic coda is composed of surface and body waves that circle or cross the Earth many times and, therefore, can be used to study its average anelastic and scattering properties. Because both direct and scattered waves remain trapped in the Earth, the scattering does not change the average energy balance of the long-period coda. As a consequence, traditional methods based on average time decay cannot be applied to the long-period coda to extract information about the Earth's scattering. Therefore, we propose here another approach that is based on recent theoretical developments of the radiative transfer theory and uses a partitioning between P and S energies as a marker for presence of multiple scattering. Without scattering, the P-to-S energy ratio and, as a consequence, the vertical-to-horizontal energy ratio (VHR) would grow infinitely with time because the quality factor inside the Earth is much higher for P waves than for S waves. This behavior is well predicted by synthetic seismograms computed in an average spherically symmetrical model (PREM). However, VHR calculated using the observed seismograms tend to stabilize after certain time (typically 40000 s at 100 s period) at a value that is independent of earthquake and station locations. We interpret the observed stabilization as an indication of the presence of the multiple scattering and the diffuse waves. This motivates further investigations of a possibility to use the long-period seismic coda, and specifically the cross-correlations between records at two stations, to extract a coherent information about the elastic response of the Earth.

S12D MCC: 2002-2004 Monday 1340h

Theories of Earth's Interior III *(joint with T, V)*

Presiding: **P J Tackley,** University of California, Los Angeles**;** **J D Bass,** University of Illinois

S12D-01 1340h INVITED

20 years of seismic tomography

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With the papers by Masters *et al.* (1982), Nakanishi and Anderson (1982), Woodhouse and Dziewonski (1984) and Dziewonski (1984), global seismic tomography was well on its way to becoming one of the most important geophysical tools in the investigation of the Earth's interior. These early studies demonstrated the power of the method to discover new, unexpected features, such as the degree-two signal in the transition zone, the ring of fast velocities above the core-mantle boundary, and the Pacific and African megaplumes. Since then, tomography has moved towards higher resolution and the mapping of additional structural details, such as the topography of the internal boundaries and azimuthal and radial anisotropy. Anisotropy, in particular, is turning out to be a property that is likely to map the dynamic history of the Earth's interior. Tomographic studies extend to the very center of the Earth, where the inner core has been found to be anisotropic and, recently, to have an inner-most structure with a 300-km radius, which was discovered by identifying its distinct anisotropic properties. Higher resolution has its limits, and reports of slabs penetrating directly into the lower mantle and the detection of mantle plumes extending from the CMB to the surface remain controversial. An irreplaceable resource that has made this progress possible is the Global Seismographic Network, now transmitting most of the data in nearly real time, as envisioned 20 years ago by a small group of forward-looking seismologists.

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S12D-02 1405h INVITED

Mantle Mineralogy and Mineral Physics: Paradigms and Paradoxes

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Don Anderson has made important contributions to our understanding of the mineralogy and mineral physics of the earth's mantle and core for more than 4 decades. For example, Don's elucidation of elasticity systematics and his perceptive application of such knowledge to understanding the Earth's mantle has been one of the prime motivations for more than a generation of experimental studies. In this talk, we summarize the current status of laboratory experimentation on the mineralogy of the deep mantle, focusing on the areas of elasticity and phase changes. The connection of mineral physics to seismology, a particular area of interest to Don Anderson, will be emphasized. Recently, the study of elastic properties of mantle and core materials has mushroomed as a result of new experimental capabilities. These include the development of several synchrotron-based tools including, for example, x-ray inelastic scattering and lattice strain anisotropy measurements. These have greatly