Abstracts for the AGU Fall Meeting 8–12 December 2003

Union

U11A MCC: 3001-3003 Monday 0800h

Union Tutorials I

Presiding: **R L Wesson,** U.S. Geological Survey**; J T Snow,** University of Oklahoma

U11A-01 0800h INVITED

What is an Earth System Model?

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Global three-dimensional Earth System Models have their roots in numerical weather prediction models, which predict the processes that accelerate air masses and change temperature and moisture. Models of the last two decades have focused on the physics of the coupled atmosphere-ocean-land-ice system, and how alteration of the physical forcing affects the fluxes of energy and water and hence the circulation and climate. Current earth system models include chemistry and biogeochemistry of the Earth System, and attempt to predict changes in atmospheric composition and their consequence on circulation, climate and the biosphere. The hierarchy of Earth System Models will be reviewed. An Earth System Model that includes interactive terrestrial and oceanic carbon cycles will be presented. Data not available but urgently needed to test and validate/falsify the models will be emphasized.

U11A-02 0900h INVITED

A Biased View of Data Assimilation

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Modern data assimilation for the atmosphere and ocean combines information from observations and a prediction model to produce an estimate of the state of the physical system. Data assimilation is used not only to generate 'analyses' of the system state, but also to produce initial conditions for prediction models. In addition, it can be used to improve both the observing system as well as the prediction model. All of the methods in common use can be derived as heuristic simplifications of an elementary Bayesian filtering algorithm. An introduction to general filtering will be followed by a brief description of several prominent assimilation algorithms. Special attention will be given to ensemble-based filtering methods which have been developed relatively recently. A number of interesting research problems, related both to innovative applications of existing assimilation methods and to improving these methods will be outlined.

U11B MCC: Level 1 Monday 0830h

The Contributions of 20 Years of Scientific Ocean Drilling I Posters

Presiding: **K Becker,** Rosenstiel School of Marine and Atmospheric Science, University of Miami**; N Pisias,** Oregon State University

U11B-0001 0830h POSTER

The Advisory Structure of the Drilling Program Over the Past Forty Years

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The JOIDES advisory structure for DSDP and ODP has changed in significant ways during the 36-year existence of these ocean drilling programs. This paper discusses these changes in the light of the new IODP drilling program that will have started by the time of the AGU fall meeting. In the first phase of drilling, the advisory structure was centered on regional goals, since the program was at that time a very exploratory one. As drilling became more sophisticated, it was necessary to start new kinds of advisory structures, in which specific elements of drilling were studied and recommendations made. Throughout, the highest authority has been the Executive Committee, which has approved both the program plan and the science plan for each year. It has also made recommendations about eh new program that have had a significant effect on the development of the new drilling program. Recently the next committee down the ladder has been the Science Committee that has essentially been a review committee for the various proposals that have been submitted, and has ranked these proposals. The Operations Committee then arranges the ranked proposals into a coherent drilling program. The Science Committee also oversees the other committees in the science advisory structure. Over the years the rules about conflict of interest have been strengthened, such that in many cases, members of the Science Committee have been recused from ranking proposals when they have an interest in the proposals. Also, scientists cannot sit on more than one committee at a time (apart from members of the Budget Committee - drawn from Science Committee and Executive Committee - and members of the Operations Committee). The advisory structure has also become much less restrictive over the years, and the US members of the Science Committee is now formed of scientists who have an interest in marine drilling, and the membership is drawn from the national community, and not just from members of JOI Inc. The presence of non-US scientists on the advisory structure has been of immense benefit, as has their participation in the shipboard science crew. The new drilling program, jointly funded by the United States and Japan, will hopefully draw on an enthusiastic body of scientists from other countries.

U11B-0002 0830h POSTER

Monitoring co-seismic plate deformation and fluid flow with ODP hydrogeologic observatories

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ODP CORK (Circulation Obviation Retrofit Kit) instrumentation was originally developed to seal holes and determine fluid flow rates and driving forces in hydrologically active settings. Over the first decade of CORK monitoring, a number of observations have been made that range well beyond these objectives. In several instances, records of formation pressure and temperature have provide quantitative information about local and regional (up to 250 km range) crustal strain and fluid flow associated with inter- and intra-plate seismogenic slip. These include two seafloor spreading events and associated seismic swarms on the Juan de Fuca Ridge, slip on the Nootka transform fault, a mid-plate earthquake on the Juan de Fuca Ridge flank, and two deep Mariana subduction zone earthquakes. With the exception of the Mariana events, signals associated with seismic wave ground motion are not resolved, although improvements to instrumentation will allow these to be studied in the future. Pressure transients of all the events observed to date include a coseismic component that is believed to be the response to elastic plate strain, and a post-seismic component that reflects hydrologic diffusion along pressure gradients between volumes of rock with contrasting elastic response or drainage through the seafloor. The coseismic components vary in sign and relative amplitude in a manner consistent with seismic moment tensors, although the absolute amplitudes of the strain-induced pressure anomalies are often much larger than predicted from seismic moment. The post-seismic transients occur over time scales that range from hours to a few hundred days, generally consistent with the hydrologic structure at the various borehole sites, but often indicating formation-scale permeabilities that are considerably higher than estimated from borehole pumping and flow experiments. Data from CORKs have also shown that transient changes in mechanical and hydrologic properties, inferred from changes in the formation-pressure response to seafloor tidal loading, result from plate strain. CORK monitoring continues on the axis and flank of the Juan de Fuca Ridge and at the Nankai and Middle America subduction zones, and opportunities exist for refurbishing old sites in the Cascadia, Mariana, and Barbados subduction zones and the Costa Rica Rift flank. It is our hope that long-term hydrologic monitoring at these and new sites will provide new knowledge and understanding of earthquake rupture and plate strain processes, and the role of water in both.

U11B-0003 0830h POSTER

Third Party Borehole Seismic Experiments During the Ocean Drilling Program

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Third party borehole seismic experiments on the Ocean Drilling Program began with an oblique seismic experiment on Leg 102 at Site 418 in the Western Atlantic. Upper ocean crust here is characterized by a normal seismic layer 2 vertical velocity gradient, lateral velocity variations, azimuthal anisotropy, and azimuth dependent scattering. A normal incidence VSP was run on Leg 118 in the gabbro sequence at Hole 735B on the Southwest Indian Ridge. The vertical seismic velocity inferred from arrival times is similar to that observed horizontally by refraction in ocean layer 3, but attenuation is anomalously high, which prompted the hypothesis that the gabbro cored may not actually represent the bulk of Layer 3 material. The VSP data acquired at Hole 504B in the eastern equatorial Pacific on Legs 111 and 148 helped to constrain the P and S velocity structure at the site and showed that upper layer 3 at this site, at a depth of over 2 km into the crust, consisted of the lower portion of the sheeted dikes rather than gabbro. Both offset and normal incidence VSPs were run on Leg 164 to study the seismic velocity structure of gas hydrates on the Blake Ridge. A new innovation on ODP was the deployment of broadband seismometers in boreholes. Whereas the conventional VSPs and offset VSPs mentioned above operate in the frequency range from 1 to 100Hz, broadband seismometers are used in earthquake seismology and operate in the range from 0.001 to 10Hz. The first broadband seismometer test was carried out from the drill ship on Leg 128 in the Japan Sea. Subsequently 4 permanent broadband borehole seismic observatories were installed in the Western Pacific and Japan Trench on Legs 186, 191 and 195. The ODP era also saw the development of systems for re-entering boreholes from conventional research vessels after the drill ship left the site. Borehole seismic experiments and installations that used this wireline reentry technology were carried out in DSDP Holes 534 (Blake-Bahama Basin) and 396 (Mid-Atlantic Ridge at 23degr north) and ODP Hole 843B (south of Oahu). The latter experiment (Ocean Seismic Network Pilot Experiment) carried out a test of 3 configurations of broadband seafloor seismic installation in preparation for extending the Global Seismic Network to the deep ocean.

U11B-0004 0830h POSTER

Early development of black halos during low-temperature alteration of young oceanic basalts

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The most visible effect of low-temperature alteration during seawater - basalt interaction is the formation of variously colored zones adjacent to exposed surfaces, cracks, and veins along which aqueous solutions once circulated. Young oceanic basalts commonly exhibit a single black zone contiguous with exposed surfaces that surrounds apparently unaltered dark gray cores. These "black halos" are the earliest evidence of oceanic crust alteration since they are observed alone in zero age oceanic basalts and are overprinted by later alteration processes in older samples. Black halos are ubiquitous in basalts from the upper oceanic crust of all ages. In order to constrain the mechanisms and processes responsible for the formation of black halos we have undertaken a detailed petrographical, mineralogical, and geochemical study of a suite of basalts that range in age from 0.54 to 2.73 My recovered during DSDP Legs 54 and 70 from the Galapagos Spreading Center (GSC). Black halo widths range from a few millimeters up to 4 - 5 cm. The black halos are characterized by the precipitation of secondary minerals in vesicles and void spaces along with common replacement of olivine when present. Primary pyroxene is rarely altered and plagioclase is always fresh. Secondary minerals consist mainly of clay minerals (celadonitic phyllosilicates, smectites, and mixtures), iron oxyhydroxides, carbonates, and rare quartz. Geochemical analyses and oxygen isotope ratios clearly demonstrate that precipitation of secondary phases control the chemical changes resulting from the formation of black halos. Elements such as K, Rb, Cs, and B as well as H_2O^+ content are all increased in black halos relative to least-altered dark gray basalts and unaltered glass. Black halos also have elevated $\delta^{18}O$ ratios due to the precipitation of ^{18}O enriched secondary minerals. We are also able to demonstrate that the mechanism of black halo formation is at least a two stage process and is not simply related to ageing.

U11B-0005 0830h POSTER

Extending the deep biosphere through ocean drilling: Bioalteration of volcanic glass in the oceanic crust

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Scientific ocean drilling through the Deep Sea Drilling Program (DSDP) and Ocean Drilling Program (ODP) has provided a window into the deep biosphere. Microbial communities have been identified within hydrothermal vent systems at ocean floor spreading centers, deep within oceanic sediments, and within glassy portions of the basaltic oceanic crust of varying age. Questions still remain regarding the utilized metabolic pathways, how long such microbial activity persists within the oceanic crust, and how well it may be preserved on Earth or other planets. Microbial alteration of basaltic glass from ODP/DSDP cores and ophiolites can be documented by petrographic and biogeochemical techniques. Microbial alteration is seen as either tubular or granular textures. Tubular textures are characterized by micron-scale channel-like features extending from palagonite alteration rims into fresh glass. Granular textures appear as irregular patches of spherical bodies protruding into fresh glass. Detailed SEM imaging of these features commonly reveals delicate filament-like structures and material resembling desiccated biofilm. X-ray element maps invariably show elevated levels of C, N, P, and K associated with suspected microbial alteration features. Comparison of glasses from different ODP/DSDP holes indicates that carbon isotope ratios of carbonates in samples of microbially altered volcanic glass are commonly depleted by as much as -20 per mil, except in samples from slow-spreading ridges where both elevated and depleted C-isotope ratios are observed. In general, the microbes appear to be living off of dissolved organic matter with some evidence of lithoautotrophy at slow-spreading ridges. Maximum microbial activity seems to occur at $\sim 70^{\circ}$C but is moderated by pore water flow. We have applied nucleic acid staining techniques to many samples and imaged them with epifluorescence and laser scanning confocal microscopy. This has produced exceptional images that provide high resolution spatial information on the presence of DNA/RNA associated with areas of suspected microbial alteration. The biogenic features in samples of varying ages may, therefore, be relatively recent and the microbes may be currently active. We suggest that volcanic glass in the upper oceanic crust may host a previously overlooked and still unquantified flourishing deep biosphere that contributes significantly to global geochemical fluxes. Since key constituents in Martian soil appear to be analogous to palagonite the techniques developed for tracing biosignals could be easily applied to returned samples from regions where liquid water and conditions suitable for life may have existed.

U11B-0006 0830h POSTER

Exploring Cyclic Changes of the Ocean Carbon Reservoir in Deep-Sea Records from the South China Sea

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ODP Leg 184 drilled 17 holes at 6 deep water sites in the South China Sea (SCS), resulting in high-resolution long isotope sequences in the Western Pacific for the first time, such as a 5-myr record with 2-3 ka time resolution in the South (ODP Site 1143, 9°22'N, 113°17'E, water depth 2772 m), and a continuous 23-Ma isotope sequence with 20 ka resolution in the North (ODP Site 1148, 18°50'N, 116°34' E, w.d.3294m). A distinguished feature in the 13C curves is the occurrence of long-term cycles of 400-500 ka superimposed on high- frequent fluctuations, and the 13C sequence is periodically punctuated by carbon isotope maximum events or 13Cmax, which are present in all long sequences over the global ocean. According to the Quaternary records from Site 1143 and elsewhere, major ice-sheet expansion and major transition in glacial cyclicity (such as the Mid-Brunhes Event and the Mid-Pleistocene Revolution) were all preceded by disturbance in the ocean carbon reservoir expressed as an episode of 13Cmax, implying the role of carbon cycling in modulating the glacial periodicity. This disturbance in carbon reservoirs might be attributed to changes in phytoplankton functional groups, the diatom/coccolith ratio, which determines 'rain ratio' in oceanic carbon deposition. Because the diatom/coccolith ratio depends on the availability of silica mostly provided by tropical rivers, eventually the long-term variations of oceanic 13C are related to low-latitude processes such as monsoon. Judging from the records at Site 1148 and elsewhere,13C and 18O co-varied throughout the Miocene at the 400-ka eccentricity band, and the covariance persisted until at least 3 Ma ago. This is believed to be the characteristic of Antarctic glacial cycles. With the development of Arctic ice sheet, the relation between 13C and 18O in long-term cycles has been complicated: Over the last myr, the 100-ka periodicity turned predominant and the 400-ka vanishes in the 18O record but extended to 500-ka in the13C record. Therefore, the carbon cycling has its own periodicity in reposing to orbital forcing. As the Earth is now passing through a new carbon isotope maximum, it is of vital importance to understand the cyclic variations in the ocean carbon reservoir and its climate impact.

U11B-0007 0830h POSTER

Downcore Contrasts in the Provenance of Cenozoic Pelagic and Hemipelagic Sediment, Central North Pacific: Deep Ocean vs. Near-Continental Margin Sites

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We are currently investigating the source characteristics and downcore variation of detrital components extracted from pelagic and hemipelagic clays covering a large area of the central Pacific Ocean basin. Eolian dust is the primary component of red clays forming in the Pacific pelagic clay province today. We have begun assembling a database from 14 new piston cores that span some 30 degrees of latitude in the central North Pacific. These cores contain a record of Neogene pelagic sedimentation that will allow us to track changes in the source and flux of eolian dust over time. Stratigraphic ages and continental source areas can be precisely determined for the extracted dust component using radiogenic isotopes. We have developed a reliable method for dating red clay cores by matching the strontium isotopic composition of cleaned fish teeth with the Cenozoic seawater strontium isotope curve. Age-resolution down to the ± 0.5 m.y. level can be obtained this way for intervals younger than 40 Ma. Radiogenic isotopic signatures of the associated eolian dust extract can then be used to identify distinct continental source areas for this component. Nd-Sr-Pb-Ar isotopic analysis the sub 5-micron dust fraction in these cores demonstrates the increasing dominance of Chinese loess as the primary source of Pacific dust deposited north of the Intertropical Convergence Zone (ITCZ) during the Neogene. This Asian component, becoming dominant in the late Pliocene, is characterized by an average 40Ar/39Ar retention age of 220 Ma. The longest, most continuous record of eolian dust accumulation comes from Giant Piston Core LL44-GPC3, recovered near 30 degrees North in the central Pacific. The 70 m.y. record from LL44-GPC3 reveals systematic downcore changes in the provenance of the dust component which, when corrected for plate motion, are suggestive of significant latitudinal excursions of the paleo ITCZ. Work is proceeding to improve the age-resolution for these apparent excursions, particularly a large shift that occurs at, or near, the Eocene-Oligocene boundary. By contrast, the downcore record from hemipelagic muds near the North and South American continental margins reveals distinctly different continental sources, demonstrating the unique source signature carried by the eolian component in Pacific pelagic clays. These findings will help us to correctly interpret changing source characteristics through time for the recently returned ODP Leg 199 cores. Combined, these data should provide us with the most detailed record yet of climatic transitions recorded in the central Pacific basin since the late Cretaceous.

U11B-0008 0830h POSTER

Astronomical Calibration of the Late Oligocene Through Early Miocene Geomagnetic Polarity Time Scale

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At Ocean Drilling Program Site 1090 (subantarctic South Atlantic) benthic foraminiferal stable isotope data (from Cibicidoides and Oridorsalis) span the late

Oligocene through the early Miocene (24-16 Ma) at a temporal resolution of 5 kyr. In the same time interval, a magnetic polarity stratigraphy can be unequivocally correlated to the geomagnetic polarity timescale (GPTS), thereby providing direct correlation of the isotope record to the GPTS. In an initial age model we use the newly derived age of the Oligocene/Miocene boundary of 23.0 Ma (Shackleton et al., 2000) revised to the new astronomical calculation of Laskar (2001) to recalculate the spline ages of Cande and Kent (1995). We then tune the site 1090 oxygen isotope record to obliquity, assuming a 7.2 kyr phase lag, using the new astronomic solution of Laskar (2001). In this manner we are able to refine the ages of polarity chrons C7n through C5Cn.1n. The new age model is consistent, within one obliquity cycle, with previously tuned ages for polarity chrons C7n to C6Bn from Shackleton et al. (2000), rescaled to the new astronomical solution of Laskar (2001). For early Miocene polarity chrons C6AAr through C5Cn, our obliquity-scale age model is the first to allow a direct calibration to the GPTS. The new ages are also close to, within one obliquity cycle, to those obtained by rescaling the Cande and Kent (1995) interpolation using the new age of the O/M boundary (23.0 Ma), and the same middle Miocene control point (14.8 Ma) used by Cande and Kent (1992). Thus we have confidence in the orbitally tuned age model and the refined GPTS calibration for the late Oligocene through early Miocene.

U11B-0009 0830h POSTER

Model for the Establishment of Modern Atolls during the Mid Brunhes MIS 12 to MIS 11 Sea Level Transgression in the Maldive Archipelago (Equatorial Indian Ocean)

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The Maldive archipelago consists of 22 main atolls characterized by a marginal rim surrounding a lagoon commonly less than 50-60 m deep, though some lagoons reach depths of more than 80 m. The overall evolution of the carbonate system in the Maldive Archipelago clearly shows that the slow subsidence of hypothetical volcanic edifices buried under the atolls cannot explain their typical ringed morphology. On the contrary, the atolls in the Maldives, as most likely the majority of the modern atolls, are probably young (less than 0.5 My old) carbonate edifices. Our research in the Maldives was developed based upon the interpretation of two Elf-Aquitaine and Royal Dutch Shell MCS grids, groundtruthed by ODP Site 716 and two deep exploration wells. Several seismic profiles across the modern atoll margins clearly illustrate a shift from middle Miocene-early Pliocene sigmoid lateral margin progradation of flat-topped carbonate banks to late Quaternary bank top vertical aggradation evolving into the modern atoll physiography. This well-marked transition is first illustrated by a regionally observed initial downward shift of the depositional system dated at 3.0-2.5 Ma. This downward shift of onlap and subsequent deposition in sedimentary wedges below the early Pliocene bank margins are explained by a late Pliocene-early Pleistocene (3.0-0.5 My) gradual sea level regression tied to the onset and successive expansions of major continental ice sheets in the northern Hemisphere. This regression is clearly defined in several Pliocene-Quaternary high resolution benthic isotope records, best proxy for ice volume variations in the past 5 My, at ODP sites such as 659, 677, 846, and 849.The early Pliocene flat-topped carbonate banks, exposed for about 2.5 My in the late Pliocene and early Pleistocene, were fully re-flooded for the first time at the glacial MIS 12 to interglacial MIS 11 transition. This sea level transgression is unique by its highest amplitude among the multiple sea level transgressions in the past 5 My and by its occurrence directly after a 2.5 My-long sea level regression The unique character of the MIS 12 to MIS 11 sea level transgression is clearly shown in the Karner et al. stack of six tropical high resolution 18-O records (five of them are from ODP Sites 659, 664, 677, 846, and 849) from the Atlantic and eastern Pacific oceans. In conclusion, the atolls in the Maldives and probably most of the modern atolls are very young, less than 0.5 My old, edifices. Early Pliocene flat topped bank remained mostly exposed and were karstified during a late Pliocene to early Pleistocene 2.5 My.-long sea level regression. This karst morphology served as substratum and, therefore, template for the atoll development first during the unusually high amplitude MIS 12 to MIS 11 sea level transgression. Subsequently the successive exposures and floodings related to the series of late Brunhes, 120 m high amplitude, sea level transgressions and regressions, enhanced the initial mid Brunhes ring-shaped morphology, so typical of the modern atolls observed in the Maldive Archipelago.

U11B-0010 0830h POSTER

A New Automated Technique for the Construction of More Accurate Composite Depth Scales and an Analysis of Core Deformation in Different Sediment Types

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A composite depth section reconstructs a continuous record of the sediment at a drilling site by splicing together cores from different holes; its corresponding composite depth scale describes the correlation of the sediments between holes. Both are important tools for analyzing the sediment recovered from a drilling site. The standard splicing technique for creating composite depth sections does not correct for distortion within cores, so that a sedimentary feature may have a slightly different composite depth in each hole. Additionally, the splicing technique often results in composite depths which are ∼10% greater than recorded drill depths. A new automated compositing technique aligns features between holes and prevents the artificial increase in composite depth. The results of this technique are compared with the traditional composite depth scale. Additionally, the new technique allows for analysis of the deformation and extension that occurs in cores during the drilling and extraction process. This study describes typical core deformation and its effect on calculated sedimentation rates for the carbonate and siliceous sediments of ODP Leg 138 and the terrigenous-dominated pelagic sediments of ODP Leg 154. Preliminary results indicate that cores from Leg 138 are stretched by more than 5% and those from Leg 154 by nearly 3%. For both legs, extension is greatest in the top half of cores, but variability in deformation may increase toward either end of a core.

U11C MCC: 3001-3003 Monday 1020h

Union Tutorials II

Presiding: **R L Wesson,** U.S. Geological Survey**; J T Snow,** University of Oklahoma

U11C-01 1020h INVITED

Mars: A Scientific Revolution in the Making?

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The planet Mars has always been an object of fascination for scientists and the public alike, in part because of a never-ending set of enigmas it has always presented. Today, international spacecraft-based exploration of Mars has been reinvigorated, in part thanks to the discovery of meteorites bearing carbon-based molecules from Mars, as well as a consequence of the remarkable suite of discoveries made by NASA's Mars Global Surveyor and Odyssey orbiter missions. Indeed, in little more than the past 6 years, the underlying paradigms for how Mars has operated as a dynamic silicate planet since its time of formation have been recast, rethought, and revolutionized on the basis of the ongoing observations of the Global Surveyor and Odyssey. The current view of Mars is so rapidly evolving that one can offer only generic statements as to what is unambiguously understood. What can be said is that scientists are now viewing Mars as an inner planet for which the history of water, climate variability, and of the entire interior are complex, dynamic, and inadequately explored. A series of robotic spacecraft missions are presently enroute to the red planet in an aggressive attempt by scientists from NASA, ESA, the Japanese Space Agency, and many other international partners to re-examine the history of water, explore atmospheric loss mechanisms, explore the shallow subsurface, investigate the hydrological cycle, and even to begin exploration for the molecular building blocks of life. Because the state of scientific understanding of Mars has been changing so rapidly, it has been suggested that a scientific revolution is underway. This Union Tutorial will highlight current thinking about Mars on the eve of the most intensified robotic exploration of any planet other than the Earth's Moon, in the history of humanity. As has been said, perhaps too often, at least in terms of science, "Mars rocks".

URL: http://mars.jpl.nasa.gov

U11C-02 1120h INVITED

Temporal and Spatial Scaling in the Earth Sciences

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The *AGU Focus Group on Nonlinear Geophysics* began in 1998, focusing on the general area of nonlinear and complex geophysical systems, with an emphasis on developing the mathematical, theoretical, numerical, experimental and observational tools to understand and simulate the dynamics of these systems. Nonlinear geophysics is fundamentally the application of nonlinear and/or stochastic partial or total differential equations to geophysical problems. Some key concepts and philosophies related to *Nonlinear Geophysics* include fractals, multifractals, chaos, nonlinear waves, solitons, turbulence, cascades and vortex dynamics, scaling, critical phenomena and nucleation, time series, and self-organizing systems. Scaling in both time and space is an underlying attribute of many of these concepts, and is included in a majority of talks presented by the general *Nonlinear Geophysics* community at AGU. The purpose of this one-hour union tutorial will be to introduce students and experienced researchers alike (particularly those outside of the general area of nonlinear geophysics) to some of the basic concepts, techniques and examples surrounding temporal and spatial scaling in the Earth Sciences. As many are familiar with the idea of spatial scaling in the Earth Sciences (e.g., the concepts of fractals and self-similarity that approximately the same pattern repeats itself at many different scales in nature), ideas of spatial scaling will be briefly introduced, with the majority of the talk concentrating on temporal scaling. This tutorial will include 40' 'lecture' + 15' for questions/comments. Key terms will be introduced and defined (e.g. self-affine, persistence), some of the major techniques used will be briefly described (e.g. Hurst, Fourier-Analysis, Semivariograms, Wavelets), and throughout, examples and applications to the Earth Sciences will be used. Concepts and techniques will be presented from an intuitive perspective, without the use of extensive mathematics. A reference list for further reading will be available and a power-point version of this presentation will be available via the *AGU Nonlinear Geophysics* website. Finally, a secondary purpose of this tutorial will be to highlight major advances made in the general area of *Nonlinear Geophysics* and to summarize, from a non-mathematical perspective, the major focus and highlights of related sessions at this conference. A prepared handout will be available with this information.

U12A MCC: 3001-3003 Monday 1340h

The Contributions of 20 Years of Scientific Ocean Drilling II

Presiding: **K Becker,** Rosenstiel School of Marine and Atmospheric Science, University of Miami**; M F Coffin,** Ocean Research Institute, University of Tokyo

U12A-01 1345h

Tales of Two LIPs: Kerguelen/Broken Ridge (Indian Ocean) and Ontong Java (Pacific Ocean)

Scientific Parties

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The Kerguelen Plateau/Broken Ridge (KP/BR) and Ontong Java Plateau (OJP) are among Earth's largest igneous provinces (LIPs), with crustal volumes of 2.5 and 5.7 x 10^7 km^3, respectively. Recent investigations, culminating in ODP Leg 183 to KP/BR, and Leg 192 to OJP, have revealed significant differences between the two. The Kerguelen hotspot has been active since at least 120 Ma. KP/BR contain microcontinental fragments. Upper crust of KP/BR is structurally complex, and although dominantly tholeiitic basalt, it includes basalts to rhyolites. Nearly all of the drilled upper crust formed subaerially, and subsequently subsided beneath sea level at rates comparable to those of typical oceanic crust. In contrast to KP/BR, OJP is entirely oceanic, includes no continental material, and cannot be linked to any hotspot track or currently active hotspot. It formed instantaneously, in a geological sense, at ∼120 Ma, together with flood basalts in