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)

Andre W Droxler[1] (713 3484880; andre@rice.edu)

Andrei V Belopolsky[2] (281 366 3032; belopoav@bp.com)

[1] Rice University, Dept. of Earth Science, MS 126 P.O. Box 1892, Houston, TX 77251, United States

[2] BP America Inc, 501 Westlake Park Blvd, Houston, TX 77079, United States

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

Lorraine E Lisiecki (401-863-2810; Lorraine_Lisiecki@brown.edu)

Brown University, Box 1846, Providence, RI 02912, United States

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 $\sim$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?

James B Garvin (202-358-1798; james.b.garvin@nasa.gov)

NASA Headquarters, Code SE, NASA HQ 300 E Street SW, Washington, DC 20546, United States

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

Bruce D Malamud (bruce@malamud.com)

Environmental Monitoring and Modeling Research Group, Department of Geography, King's College London, Strand, London WC2R 2LS, United Kingdom

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.

U

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

Millard F Coffin[1] (+81-3-5351-6430; mcoffin@ori.u-tokyo.ac.jp)

[1] Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164-8649, Japan

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 $\sim$120 Ma, together with flood basalts in