[3]Institute for Geothermal Sciences, Graduate School of Science, Kyoto University, Noguchibaru, Beppu, Oita 874-0903, Japan

Detailed correlation of bore-hole cores that collected around an active fault provides fundamental data for estimating vertical displacement of the strata generated by the fault movement. In order to recognize characteristic horizons for correlations, measurements of magnetic properties can be applied to core sediments, even if they seem homogeneous by visual inspections. For example, variation of initial susceptibility is often used for correlation of core samples, for its measurement can be made readily and rapidly. In this study, we have made detailed analysis of lithology and magnetic properties of bore-hole cores from sub-bottom sediments of Osaka Bay, central Japan, which were recovered from two sites at the both sides of the Osaka-wan fault off Kobe. These cores are composed of massive marine clay of the Holocene, intercalating a widespread tephra layer, K-Ah tephra, dated at 6300 14C years BP. We obtained u-channel samples from these cores and measured low-field magnetic susceptibility and anhysteretic remanent magnetization (ARM) by pass-through method. While we also measured natural remanent magnetization (NRM), reliable records of paleosecular variation were not obtained due to physical distortion of the core samples. The magnetic concentration parameters, however, show characteristic variations which are useful for stratigraphic correlations. The curve of ARM intensity corresponded to that of initial susceptibility. It is suggested that relative variation of ARM intensity supports the correlation obtained from the initial susceptibility measurement. The horizon of the K-Ah ash indicates a peak of initial susceptibility and ARM intensity, providing a key for correlation between the two sequences. The two parameters show increased value at the interval below the K-Ah ash at both sites, suggesting enhanced input of magnetic minerals into the Osaka Bay before 6300 yrs BP. Minor variations of the magnetic parameters were observed at several horizons, showing similar features at both sites. Based on these features and several radiocarbon dates, we established high-resolution correlation of the two sequences and compared accumulation history between both sides of the Osaka-wan fault. Our result delineates that the Osaka-wan fault has been active twice for the last 6300 years. It is also concluded that ARM intensity variation can improve the accuracy in correlating bore-hole cores based on initial susceptibility measurement.

URL: http://www.geor.or.jp/

GP41C-0054 0830h POSTER

Paleomagnetism of the Upper Cretaceous Units of the Gold Beach Terrane, Southwest Coastal Oregon

Noel Christian Liner[1] (425-772-9013; sleepymonk@yahoo.com)

bernard housen[1] (bhousen@cc.wwu.edu)

[1]Western Washington University, 516 high st. ms 9080, bellingham, wa 98225, United States

Latitudinal displacement of the Gold Beach terrane, southwest coastal Oregon, is enigmatic. Gold Beach terrane is composed of Jurassic vocaniclastic sandstone and Upper Cretaceous marine sandstone. Previously published paleomagnetic evidence using the Jurassic Otter Point formation indicates 1200 to 1400 km. of post-Jurassic northward displacement along the Cordilleran margin (Blake, et al. 1985). The Upper Cretaceous formations are the subjects of a new paleomagnetic study intended to quantify the amount of displacement, age of magnetization and effects of compaction. Initial results indicate well-defined, consistent directions in some samples, and a positive intraformational conglomerate test indicating an ancient magnetization. Using a combination of rock magnetic tests of partial anhysteretic remanence and the Lowrie (1990) method has shown a combination of coarse to medium-grained pyrrhotite and magnetite present in several samples. Pretreatment by cooling in liquid nitrogen significantly reduced the magnitude of NRM, consistent with presence of coarse-grained magnetite. It may be possible to show that pyrrhotite carries an ancient magnetization if vectors isolated between 160 to 320 degrees can pass a conglomerate test. If both pyrrhotite and magnetite carry a definable set of ancient directions, a detailed comparison between inclinations of both authigenic and presumably detrital remanence carriers can be made.

GP41C-0055 0830h POSTER

Paleomagnetic Vertical Axis Rotations Caused by Oblique Deformation Within the Grand Hogback Monocline, Colorado Plateau

Joya L Tetreault[1] ((303)492-7296; joya@cires.colorado.edu)

Craig H Jones[1] ((303) 492-6994; cjones@cires.colorado.edu)

Byron Boyle[1]

[1]Dept. Geosci., Univ. Colorado, CB 399, Boulder, CO 80309-0399, United States

The monoclines of the Colorado Plateau, formed over reactivated Precambrian faults during the Laramide Orogen, locally absorb oblique deformation (e.g. Tinsdall and Davis, 1999; Bump and Davis, 2003). Thus it can be assumed that the distributed deformation in the overlying, folded strata from oblique slip would be in the form of a strike-slip shear zone with some unknown amount of vertical axis rotation. Paleomagnetic vertical axis rotations in the monoclines of the Colorado Plateau can constrain such a rotation from strike-slip motion on the underlying thrust-faults. This study focuses on new paleomagnetic work performed on the anticlinal hinges of the San Rafael monocline, central Utah, and the Grand Hogback monocline, Colorado. The San Rafael monocline is a large, curvilinear structure with oblique deformation from right lateral slip proposed on the southern, northeast-southwest oriented limb (Bump and Davis, 2003). The Grand Hogback monocline is a large, highly sinuous feature, with left-lateral strike-slip deformation proposed along the central, east-west oriented limb (Murray, 1966). Three sites sampled within the anticlinal hinge of the north and south limbs of the San Rafael monocline, yielded no vertical-axis rotations. Two sites were sampled along the northern, north-south oriented limb and the central limb of the Grand Hogback monocline. A minimum rotation of -15° ± 8° was determined from Upper Triassic strata sampled on the anticlinal hinge of the central limb (39.5 N, 107.4 W). The tilt-corrected direction for this site is D = -23.6°, I = 24.3°, α_{95} = 9.6°, N = 16. Correlative strata sampled on the north limb (39.8 N, 107.9 W) contain a clockwise rotation of 8.8° ± 4.5°. This paleomagnetic result provides a minimum constraint of 23° of differential tectonic rotation absorbed in this Laramide structure. Further work in the overlying pre-Laramide strata will provide further information on the amount and distribution of rotation, and thus constrain the mechanism of deformation for the Grand Hogback monocline. The presence of rotations at this monocline and the absence of rotations on the San Rafael monocline must be further investigated to understand how the Laramide Orogen formed the monoclines of the Colorado Plateau.

GP41C-0056 0830h POSTER

Testing for compaction-shallowing, and tectonic implications of the paleomagnetism of the late Cretaceous sediments of the Gualala Block, northern California

Kirk A. Heim[1] (360-441-1407; kheim02@yahoo.com)

Bernard A. Housen[1] (360-650-6573; bernieh@cc.wwu.edu)

[1]Western Washington University, 516 High Street MS 9080, Bellingham, WA 98225

The Gualala Block is a discrete package of sediments of late Cretaceous to Eocene age contained in the Point Arena Terrane. The terrane is located on the continental margin outboard of the San Andreas Fault in northern California. Rudistid bivalves were discovered in the late Cretaceous Anchor Bay member, suggesting a sub-tropical paleolatitude (Kodama and Ward, 2001). A paleomagnetic study will be undertaken to determine paleolatitude to provide an estimate of post-Cretaceous displacement with implications for Cordilleran margin paleogeography. A total of 395 specimens from 26 sites were collected from the Anchor Bay and Stewarts Point members of the Gualala Block. At present, 130 specimens have been demagnetized via several methods with varying results. Among the demagnetization methods employed are low temperature treatment with liquid nitrogen, alternating field, thermal, and combinations of alternating field and thermal. Most specimens so far exhibit a well-behaved first-removed component of magnetization. After removal of this magnetization component, the vast majority of the specimens do not display a well-defined primary magnetization. At present 4 of the sites exhibit the potential to contain definable second-removed components. The anisotropy of magnetic susceptibility will be measured for each specimen indicating the amount of magnetic fabric. The magnetic fabric will be compared with the inclination to evaluate for possible compaction shallowing. The results of the compaction shallowing study will be used to determine the paleolatitude of the Anchor Bay Formation.

GP41D MCC: 2000 Thursday 1020h

Tectonic and Geochronologic Applications of Sedimentary Paleomagnetism II *(joint with T)*

Presiding: **K P Kodama,** Lehigh University**; B M Clement,** Florida International University

GP41D-01 1020h

The Sedimentary, Isotopic, and Magnetostratigraphic Signature of a Pair of Pre-Sturtian (~850 Ma) Rapid True Polar Wander (TPW) Events in the Akademikerbreen Group, NE Svalbard

Adam C Maloof[1] (617-495-0367; maloof@fas.harvard.edu)

Galen P Halverson[2]

Joseph L Kirschvink[3]

[1]Department of Earth and Planetary Sciences, Harvard University 20 Oxford Street, Cambridge, MA 02138, United States

[2]Department of Geology, University of Namibia, Windhoek 9000, Namibia

[3]Division of Geological and Planetary Sciences, California Institute of Technology 1200 E. California Blvd, Pasadena, CA 91125, United States

Since the 1950's, rapid true polar wander (TPW) has been recognized as a physically viable process in which the entire silicate shell of the Earth may shift as much as 90° with respect to the spin axis in 10^6-10^7 years. Recently, numerous studies have suggested that rapid TPW occurred repeatedly in the latest Proterozoic and Cambrian and may have influenced patterns of climate change and the evolutionary radiation of animals. However, analyses have been plagued by uncertainties in the age, quality, and correlation of paleomagnetic poles collected from various types of rocks on different continents. Using an integrated sedimentary, isotopic, and paleomagnetic approach, we document two possible rapid TPW events of > 50° magnitude in the pre-Sturtian carbonate-dominated succession of East Svalbard. The nature of our carbonate magnetostratigraphy, extending through 650 m of coherent section and reproduced at five locations spread out over 160 km on a single craton, ensures that correlation, secular variation, inclination shallowing, tectonic rotation, and uncertainty of paleohorizontal do not contribute significant error. Rigorous AF and thermal demagnetization procedures and at least one semi-quantitative field test constrain each reported paleomagnetic result to date from the time of sedimentation or early diagenesis. Calculated paleomagnetic poles fall on a single great circle swath which is compatible with the occurrence of two rapid TPW events centered around a pole located in Ungava, Canada (after restoration of Eastern Svalbard to the northeastern margin of Laurentia). The older TPW event is marked by a karstic surface and a crash in δ^{13}C from +6 to -1 per mil PDB. Anomalously low δ^{13}C values are maintained for ~300 meters before they rise again sharply, at a second sequence boundary, to the strongly positive values characteristic of the rest of the Akademikerbreen Group. The younger TPW event is constrained to have occurred either within the isotope stage or very shortly thereafter, and likely corresponds to the sequence boundary that delineates the end of the low δ^{13}C interval. We tentatively interpret the stratigraphic and isotopic data in terms of the 'methane-fuse' hypothesis (Kirschvink and Raub, 2003), where TPW-induced sea level changes are manifested as sequence boundaries on continental shelves and destabilize frozen clathrates stored on continental margins, thus contributing isotopically light carbon to the ocean-atmosphere system. Because a rapid TPW event will affect every continent differently but predictably (depending on the continent's changing position relative to the Earth's spin axis), the TPW hypothesis is testable. The well-defined carbon-isotopic stage containing the rapid TPW event in Svalbard is matched in the Shaler Group of Arctic Canada and the Bitter Springs Formation of central Australia. Following correllations made by Walter et al. (2000), radiometric dates from Australia suggest that the isotopic stage ended by 830 Ma. In order to test the TPW hypothesis, we make model predictions about the sedimentary, chemostratigraphic, and paleomagnetic patterns we expect to see in contemporaneous basins of East Greenland, Arctic Canada, and Central Australia.

GP41D-02 1035h

A New Late Neoproterozoic and Early Cambrian Paleogeography in the True Polar Wander Paradigm

Timothy D. Raub[1] (timothy.raub@yale.edu)

David A. D. Evans[1] (dai.evans@yale.edu)

Adam C. Maloof[2] (maloof@fas.harvard.edu)

[1]Yale University, Department of Geology and Geophysics, New Haven, CT 06511

[2]Harvard University, Department of Earth and Planetary Sciences, Cambridge, MA 02138

Seemingly anomalous paleomagnetic pole determinations from all continents during post-Cryogenian and early Cambrian time may reflect the governance of one (or a combination) of several nonuniformitarian geodynamic processes. Conceivable explanations for paleomagnetic pole dispersion over that duration include enhanced subordinate or predominant geocentric axial non-dipole geomagnetic fields; unexpected geocentric, non-axial dipole geomagnetic fields; a sustained regime (or multiple bursts) of true polar wander; and invocation of multiple, site-specific geological explanations for individual pole position differences. Time-sequence magnetostratigraphic data from appropriate sedimentary intervals may test among these possibilities. Both a new compilation of recently-reported and in-progress paleomagnetic poles determined from strata belonging to Laurentia, East Gondwanaland, Siberia, and Avalonia and also an inclusive review of the paleomagnetic database from other continents are consistent with first-order expectations of a standard plate-tectonic world undergoing nonuniformitarian oscillatory true polar wander. In this compilation, superposition of APWP swaths from all continental fragments defines discrete paleogeographies permitted in the true polar wander paradigm. These reconstructions provide critical constraints on models concerning global climate and biological change during the Terminal Neoproterozoic.

GP41D-03 1050h

Initial India-Asia Collision: Sedimentologic, Paleomagnetic and Paleontologic Evidence From the Ghazij Formation, Balochistan, Pakistan

William C Clyde[1] (will.clyde@unh.edu)

Intizar H Khan[1,2] (ikhan@cisunix.unh.edu)

Philip D Gingerich[3] (gingeric@umich.edu)

[1]Dept. Earth Sciences, University of New Hampshire, 56 College Rd., Durham, NH 03824, United States

[2]Geological Survey of Pakistan, Sariab Rd., Box 15, Quetta 00000, Pakistan

[3]Dept. Geological Sciences and Museum of Paleontology, University of Michigan, 1109 Geddes Rd., Ann Arbor, MI 48109, United States

Initial continental collision between India and Asia is thought to have caused significant changes to global climate and biota, yet its timing and biogeographic consequences are uncertain. Structural and geophysical evidence indicates initial collision during the early Paleogene, but sedimentary evidence of this has been controversial owing to the intense deformation and metamorphism along the suture zone. Modern orders of mammals that appeared abruptly on northern continents coincident with the global warming event marking the Paleocene-Eocene boundary are hypothesized to have originated on the Indian subcontinent, but no relevant paleontologic information has been available to test this idea. Here we present sedimentologic, paleomagnetic, and paleontologic results that show the lower Eocene Ghazij Formation of western Pakistan records continental sedimentation and mammalian dispersal associated with initial India-Asia collision. Sedimentologically, the Ghazij exhibits a clear transition from shallow-marine facies in the lower part, to paralic deltaic facies in the middle part, and continental fluvial facies in the upper part. Paleomagnetic data indicate that Ghazij deposition occurred just before a pronounced decrease in the sea-floor spreading rate of the Indian Ocean. Large fossil mammal assemblages show strong endemism in the middle part of the formation but increasing cosmopolitanism and affiliation with northern continents higher in the formation. Our results support the hypothesis that initial continent-continent contact occurred near the Paleocene-Eocene boundary along the northwest edge of the Indo-Pakistan plate and that subsequent closure occurred diachronously along the rest of the suture. However, it appears that during initial collision, modern orders of mammals dispersed into India rather than out of it.

GP41D-04 1105h INVITED

Shallowed vs. Concordant Paleomagnetic Inclinations in Asian red Beds: Tectonic Implications

Guillaume Dupont-Nivet[1] (gdn@geo.uu.nl)

Fatima Martin-Hernandez[1] (fatima@geo.uu.nl)

Mark J. Dekkers[1] (dekkers@geo.uu.nl)

Ken Kodama[2] (kpk0@lehigh.edu)

[1]Utrecht University-Paleomagnetic laboratory, Budapestlaan 17, Utrecht 3584 CD, Netherlands

[2]Lehigh University; Dept. of Earth and Environmental Sciences, 31 Williams Drive, Bethlehem, PA 18015, United States

Anomalously low paleomagnetic inclinations are often recorded in Asian red beds. Based on the available age control, most Tertiary sections show low inclinations while inclinations concordant with the paleomagnetic pole of Eurasia are generally recorded in Cretaceous red beds. This inclination pattern hinders tectonic interpretations but may also yield important constraints on the development of the Indo-Asia collisional system. To better constrain the reliability of the paleomagnetic record, we investigate the rock magnetic and petrologic signature in samples from 21 stratigraphic sections collected north of the Tibetan plateau. In addition to classic thermal demagnetization of NRM, IRM acquisition curves in fields up to 8 T were used to characterize magnetic mineralogy. Magnetite and hematite bearing samples can both be affected by inclination shallowing. AMS reveals a characteristic sedimentary fabric regardless of the degree of inclination shallowing. Separation of the paramagnetic from the ferromagnetic contribution of the anisotropy is performed according to Hernandez and Hirt (2001) technique. In samples with shallowed inclination, the anisotropy of the ferromagnetic fraction mimics the sedimentary fabric of the paramagnetic fraction. Determination of AAR using both the thermal themagnetization of Tan et al. (2002) protocol as well as a high-field IRM protocol involving IRM acquisition in 13 Tesla fields to erase the magnetic history of previous steps (Kodama and Dekkers, submitted) was carried out on representative samples with shallowed and with concordant inclinations. We hope that the distinct properties of the analyzed sediments will provide us with tools to discriminate red beds affected by inclination shallowing from sediments recording the correct paleomagnetic inclination from which paleopole positions can be confidently calculated

GP41D-05 1120h

Paleomagnetism of Late Paleozoic series in Morocco and Argentina: implications for GAD Hypothesis and Pangea reconstruction

Jean Besse[1] (33144272827; besse@ipgp.jussieu.fr)

Omar Oufi[1] (33144273273; oufi@ipgp.jusssieu.fr)

Augusto Rapalini[2] (rapalini@tango.gl.fcen.uba.ar)

Vincent E Courtillot[1] (33144272434; courtil@ipgp.jussieu.fr)

[1]Institut de Physique du Globe, 4 Place Jussieu, Paris 75252, France

[2]Laboratorio de Paleomagnetismo Daniel Valencio, Departamento de Ciencias Geológicas, Universidad de Buenos Aires, Pab. 2, Ciudad Universitaria,, Buenos Aires 1428, Argentina

The configuration of Pangea during the upper Paleozoic is still strongly debated: the APWP for Gondwana and Laurussia should fit in the GAD hypothesis when Pangea is reconstructed using marine data. But they appear to be significantly distinct, by as much as 15° for certain periods. Motion between the two blocks has been proposed (B Pangea of Irving) but is geologically problematic. Erroneous age assignments, magnetic overprints, insufficient demagnetization, problems with the recording of geomagnetic field in sediments (f.i. flattening) and finally non-dipole contributions have all been invoked to reconcile apparently discrepant poles. In this talk, we investigate the geometry of the geomagnetic field during the Late Carboniferous-Early Triassic period (320-240 Ma). As a starting point, we use two recent surveys in Morocco and Argentina, which provide paleomagnetic tests and good age control that were missing in most previous studies and yield respectively paleolatitude data close to the equator and mid/high latitudes. Using a compilation of poles from the GPMDB, we analyze the positions of mean poles for mid-northern and southern, and equatorial latitudes, searching for the distinctive antisymmetrical pattern expected for a dipole with an octupole contribution. We also discuss the main causes of errors, such as the occurrence of lithospheric deformation, which induces important rotations at various scales, particularly in future rift or mountain zones (Colorado, South of France, South American cordilleras, east of Australia, etc...). Even when using only sampling sites close to the Paleo-equator (which minimizes any octupolar effect), the APWP of Gondwana remains offset from that of Laurussia. The plate configuration inferred is a classical A Pangea reconstruction at about 260 Ma, but data do not rule out the possibility of a B Pangea before 270 Ma, which would account for a large number of geological constraints. In contradiction with recently proposed persistent octupolar components of the geomagnetic field through the Paleozoic, we find no statistical evidence for a significant octupolar component of the field (or flattening) for most periods in the 200-320 interval, with exceptions around 250 Ma, when more data are required for a robust analysis.

GP41D-06 1135h

Paleomagnetism of Devonian Red Beds in the Appalachian Plateau and Valley and Ridge Provinces

Eric Cox[1] (405-325-5135; mmkec@aol.com)

R. Douglas Elmore[1] (405-325-3101; delmore@ou.edu)

Mark Evans[2] (mae6+@pitt.edu)

[1]School of Geology and Geophysics, 100 E. Boyd St., University of Oklahoma, Norman, OK 73019, United States

[2]Department of Geosciences and Planetary Sciences, University of Pittsburgh, Pittsburgh, PA 15260, United States

Samples of fluvial to marine sandstones of the Chemung and Hampshire formations were analyzed from regional-scale and roadcut-scale folds across the structural trend of the Valley and Ridge (VR) and Appalachian Plateau (AP) provinces of northeast Virginia, western Maryland, and northeast West Virginia. Alternating field demagnetization only removes a modern VRM. After removal of a modern VRM, thermal demagnetization of most specimens reveals a characteristic remanent magnetization (ChRM) with southerly declinations and shallow inclinations between 350-600oC. Rock magnetic studies indicate this component resides in hematite. An additional hematite component is removed at temperatures greater than 600oC in a few specimens but is obscured by erratic decay and/or creation of new magnetic phases. Specimens without the ChRM generally have weak NRMs, lack red pigment, only contain the modern VRM, and are dominated by magnetite based on rock magnetic studies. Incremental fold tests for the ChRM yield generally prefolding results from the AP and synfolding results from the VR. The pole positions at the 95% confidence level overlap the late Carboniferous to middle Permian part of the APWP. Low burial temperatures indicate that the ChRMs are chemical remanent magnetizations (CRMs). Thin section analysis shows the presence of detrital magnetite with oxidation rims, authigenic specularite (some within quartz overgrowths), and a submicron size red pigment. Geochemical/fluid inclusion studies indicate that mixed orogenic/meteoric fluids altered the VR red beds; the CRM in the VR could be related to such fluids. In the AP, there is no evidence that the red beds have been altered by orogenic fluids and another chemical mechanism is needed to explain the remagnetization.

GP41D-07 1150h INVITED

Astronomical Forcing in Miocene Continental Sediments: Implications for the Geomagnetic Polarity Time Scale

Wout Krijgsman[1] (858-534-6531; krijgsma@geo.uu.nl)

Hayfaa Abdul Aziz[1] (+31.30.2535246; haziz@geo.uu.nl)

Frits Hilgen[1] (+31.30.2531673; fhilgen@geo.uu.nl)

[1]Paleomagnetic Lab. Fort Hoofddijk Utrecht University, Budapestlaan 17, Utrecht 3584 CD, Netherlands

High-resolution magnetostratigraphic and cyclostratigraphic studies have been carried out on cyclically bedded sedimentary successions of Miocene distal alluvial fan to lacustrine deposits in northeast Spain. The magnetic polarity patterns of the composite sections can be correlated straightforwardly to the most recent GPTS of Cande and Kent (1995), providing first order age models. Spectral analyses of the color records in the time domain reveal periodicities for the sedimentary cyclicities close to 23, 41, 100 and 400 kyr, strongly supporting an astronomical origin. Hence, we can determine the astronomical durations of subchrons from the number of sedimentary cycles per polarity interval. Comparison of these results with the GPTS shows significant discrepancies, especially at the upper part of Chron C5n. The duration pattern of our polarity intervals is, however, confirmed by many detailed magnetostratigraphic records from

the ocean floor, indicating errors in the reversal ages of the GPTS. In addition, our astronomical tuning provides astronomical ages for all polarity reversals in the interval between 12.9 and 10.6 Ma. Comparison with the GPTS shows that astronomical ages are older by 50 - 100 kyr. Consequently, we demonstrate that astronomical forcing in continental sequences can be a powerful tool to improve the fundamental dating techniques of the geological record.

GP41D-08 1205h

How Long Does it Take for the Earth's Magnetic to Reverse?

Bradford M Clement (305.348.3085; clementb@fiu.edu)
Department of Earth Science, Florida International University SW 8th St & 107th Ave, Miami, FL 33199, United States

One of the most fundamental questions about geomagnetic polarity reversals is that of duration: how long does it take for the field to reverse? Detailed paleomagnetic records across polarity boundaries provide our best source of information about what happens as Earth's magnetic field reverses. An analysis of the duration estimates available from paleomagnetic records of the past four polarity transitions has been presented elsewhere. That analysis, based on thirty transition records, yielded an estimate of 6000 years for the average duration of the directional change during the reversals. The durations do not vary randomly about this mean, but exhibit a pronounced dependence upon the site latitude. The directional change took nearly four times longer to occur at mid- to high-latitude sites that it did at low latitude sites. The analysis has been extended to include the older transition records from the TRANS00 database. As in the previous study two methods are used to define the transition zone thickness, one based on the circular standard deviation (CSD) of the full polarity mean directions, and one based on a VGP latitude cutoff of plus or minus 45 degrees. Unlike the case for the past four reversals, not all of the older reversals have multiple records. Therefore it is more difficult to assess the effect of the geographical distribution of site locations on the dataset. Nevertheless, the average duration of directional change based on the total dataset is statistically indistinguishable from 6000 years. The combined dataset still exhibits a marked overall dependence of transition duration with site latitude. Both the average duration and the variation with latitude provide a useful constraint for numerical simulations of the geodynamo.