GP12A MCC: Hall C Monday 1330h

Paleogeomagnetism: Structure and Dynamics of the Geomagnetic Field Posters

Presiding: **J Tarduno,** University of Rochester**; R Van der Voo,** University of Michigan

GP12A-1082 1330h POSTER

Persistent Non-Dipolar Fields in the Precambrian: A re-examination of Inclination Distributions

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The paleomagnetic assumption that the Earth's magnetic field is reduced to a geocentric axial dipole when sufficiently sampled has been called into question for Mesozoic and earlier times. It has been suggested, for example, that modest contributions for axial quadrupolar (10 percent) and octupolar (25 percent) fields are resolvable using inclination only data from paleomagnetic studies for the Precambrian and Paleozoic datasets (Kent and Smethurst, 1998). One possible explanation for these persistent non-dipolar fields is that the growth of the inner core through time has stabilized the geodynamo. Previous analyses of GAD model using inclination only data did not fully examine biases resulting from either sampling location or data quality. In addition, should the hypothesis that core growth has stabilized the field through time prove correct, the evolution of these axial multipole fields may be resolvable through a temporal evaluation of the Precambrian dataset. We have re-analyzed Precambrian inclination data from the recently updated global paleomagnetic database. We have graded each of the paleomagnetic poles according to the criteria set forth in Van der Voo (1990) and compared the observed inclination frequency distributions to the expected GAD distribution. We have developed an algorithm that calculates both the range of statistically significant G2 (quadrupolar)and G3 (octupolar) solutions and a best fit to the observed inclination frequency. We will report these results and their implications for the evolution of the Earth's magnetic field through time.

URL: http://www.clas.ufl.edu/users/jmeert/progs.htm

GP12A-1083 1330h INVITED POSTER

Long-term Phanerozoic Octupole Fields

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The assumption that the ancient geomagnetic was purely dipolar is fundamental to paleomagnetism. However, one sign that something may be amiss is that observed inclinations at mid-latitudes are often lower than expected, even for volcanic rocks. A zonal octupole field in the Late Carboniferous, Permian, Mesozoic and Early Tertiary was revealed by comparing the observed paleomagnetic paleolatitude distributions for Laurussia (North America, Greenland, and Europe) with those predicted from the mean paleopoles. Estimates of the magnitude of the octupole/dipole field ratio center around 0.1, which could cause errors in conventional paleopoles of about 7.5 degrees; because of the antisymmetry of octupole fields a comparison of paleomagnetic poles from mid-northern and mid-southern hemisphere locations could thus be off by as much as 15 degrees. The well-known misfit between the paleomagnetic results from the Laurentia-European and Gondwana continents in a classical Pangea A configuration could be explained by such errors due to octupole fields. This explanation would negate the need to seek tectonic (Pangea B type) solutions for the misfit. Another misfit based on too-low inclinations is seen in a comparison of Central Asian poles with those for the Eurasian reference path, and here as well do octupole fields provide a possible solution, although sedimentary inclination shallowing is another possibility. When including Pre-Permian poles for Gondwana in a similar test for non-dipole fields, an increase in the percentage octupole contribution is suggested for older times. Undoubtedly, the octupole field contributions have varied in magnitude over shorter time scales as well.

GP12A-1084 1330h POSTER

Was the ancient geomagnetic field dipolar?: Sources of shallow bias in paleomagnetic inclinations

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One of the most useful assumptions in paleomagnetism is that the geomagnetic field is on average approximated by a geocentric axial dipole (GAD). This has been found to be true for at least the last 5 million years with the largest non-GAD contribution to the spherical harmonic expansion generally less than 5%. It becomes increasingly difficult to test the GAD hypothesis farther back in time owing to plate motions, true polar wander and accumulating problems of overprinting, and difficulty in reconstructing paleo-horizontal. While most paleomagnetic studies make the implicit assumption of a GAD field, several recent studies have called the essential GAD nature of the ancient field into question. These fall into two groups: studies that use reference poles to predict directions and THOSE that use the statistical distribution of inclinations. Both have called for large (20%) contributions of the axial octupolar term to the spherical harmonic expansion. We examine the data and invoke two mechanisms that can explain the apparent departures from the GAD field hypothesis: depositional inclination error in sediments and unrecognized tilting in igneous rocks. Although non-GAD field models are difficult to test and thus significant contributions of non-dipole fields cannot be summarily rejected, the principle of least astonishment requires us to consider these plausible geological mechanisms as the cause of the persistent shallow bias prior to the very "expensive" option of throwing out the GAD null hypothesis. We will also discuss the implications of pervasive shallow bias for APWPs.

GP12A-1085 1330h POSTER

Paleosecular Variation in the Southern Hemisphere: Paleomagnetic and Geochronologic Results from Meseta del Lago Buenos Aires, Patagonia

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As part of a larger project investigating paleosecular variation in South America, 36 paleomagnetic and geochronology sites were sampled on Meseta del Lago Buenos Aries (47S, 289E), 200 km east of the active plate boundary in central Patagonia. Basaltic lavas sampled range from late Miocene to late Pleistocene with most of the flows being younger than 3.3 Ma. 38 isochron ages determined via 40Ar/39Ar incremental-heating experiments frame a detailed stratigraphy of the sampled flows. The isochron ages range from 66.9 +/- 4.1 ka for cinder cones in the Rio Pinturas valley to 10.12 +/- 1.35 Ma for lavas exposed along the SE edge of the mesa. The last 3.3 myr is characterized by seven episodes of volcanism at ca. 3.2-3.0 Ma, 2.4 Ma, 1.7 Ma, 1.35 Ma, 1.0 Ma, 750 ka, 430-330 ka, and <110 ka. The bulk of lavas forming the Meseta erupted in the last 1.7 my. All sites have stable magnetization, and after step demagnetization using either thermal or alternating field techniques, yield characteristic directions held by magnetite and/or titanomagnetite. Eight sites have distinct transitional directions (defined by pole latitudes less than 45 degrees), and associated isochron ages indicate possible connections to known reversals within the Matuyama Chron, including the onset of the Jaramillo (1.016 +/- 0.01 Ma), the Cobb Mountain (1.25 +/- 0.03 Ma), the Ontong-Java 1 (1.37 +/- 0.03 Ma), and the Gilsa (1.72 +/- 0.02 Ma). Remaining sites are divided into normal polarity (16 sites) and reversed polarity (12 sites). At the 95% confidence mean normal and reversed directions overlap. Mean direction for 28 sites is I = -64.5, D = 3.3, a95 = 5.5, which is indistinguishable from the expected geocentric axial dipole direction. Paleosecular variation, measured by the dispersion of virtual geomagnetic poles about the rotation axis, is higher than expected at 21.8 degrees. Model G, using data for the past 5 Myr, predicts a dispersion of 17 degrees. This discrepancy may be due to true dispersion of the field in the Southern Hemisphere or it may be an artifact of inadequate or biased sampling.

GP12A-1086 1330h POSTER

Toward Determinations of Regional 0–5 Ma Paleofield Behavior

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Over the past decade there has been considerable interest in the structure of the time-averaged paleomagnetic field, and whether it reflects the influence of lower mantle processes on outer core dynamics. Substantial effort has been invested in the collection and analysis of new, high-quality paleomagnetic data to address this question. Directional data from 18 studies that form the Time Averaged Field Initiative (TAFI) and focus on under-sampled regions raise the possibility that the 0-5 Ma time-averaged paleomagnetic field structure is less complex than previously suggested, and that normal and reverse polarity directional data cannot be distinguished from antipodal.

However, major outstanding issues in understanding geomagnetic field behavior - both its average structure and its temporal (secular) variations (PSV) - are the number and internal consistency of data required to accurately characterize the paleofield. A recent study of both new TAFI data and existing published data from the southwestern U.S. (Tauxe et al., 2001 (Fall AGU abstract), 2002 (submitted manuscript)) suggests that 100 sites, with 5 samples per site and site-level Fisher precision parameters of at least 100, are desirable for robust estimates of regional paleofield behavior. In this paper we will summarize existing major results from the TAFI project. We follow the approach of Tauxe et al. (2002): where possible, we will combine new paleomagnetic data from TAFI studies with previously published paleomagnetic data to establish 0-5 Ma field behavior at a regional level. This will eventually lead to robust estimates of global variability in PSV, as well as improved models for the time-averaged field.

GP12A-1087 1330h POSTER

Inferences on the Cretaceous Superchron geodynamo

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Superchrons provide an opportunity to view the geomagnetic field in its extreme, when reversals are rare, or absent altogether. They represent robust features that are useful for the affirmation of theoretical and numerical models of the geodynamo. However, to gain a complete picture of the geodynamo, we must move beyond polarity to characterize the morphology, secular variation and intensity of the field. Unfortunately, geologic and associated experimental alteration often prohibits the simultaneous definition of paleofield directions and intensities. Recently we developed a method for the measurement of paleointensity that utilizes single plagioclase crystals separated from basaltic lava flows. These crystals, which contain sub-micron sized titanomagnetite and magnetite inclusions, are less susceptible to alteration during the laboratory heatings required by paleointensity analysis. This method provides a means to obtain high resolution paleointensity data from sequences of basalt flows, which can in turn be used to characterize secular variation.

Paleomagnetic and paleointensity data collected using this approach from lavas of the Rajmahal Traps (113-116 Ma) and the high Arctic (∼95 Ma) indicate that the time-averaged Cretaceous Normal Polarity Superchron field was remarkably strong and stable. When compared with global results available at lower latitudes, these data define a time-averaged field that is overwhelmingly dominated by the axial dipole (octupole components are insignificant). Superchrons may reflect times when the nature of core-boundary heat flux allows the geodynamo to operate at peak efficiency.

GP12A-1088 1330h POSTER

Holocene Relative Paleointensity Record From the St. Lawrence Estuary, Eastern Canada: Millennial to Centennial-scale Variability of the Global Scale Geomagnetic Field

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Two long piston cores (MD99-2220: Lat. 48°38.32N, Long. 68°37.93W, water depth 320 m, length 51.6 m and MD99-2221: Lat. 48°10.60N, Long. 69°30.35W, water depth 212 m, length 31.0 m) were raised from the St. Lawrence Estuary, Eastern Canada because of the expanded Holocene sediment sequence this location provides. A u-channel based paleomagnetic study, augmented by AMS ^{14}C dates, rock-magnetic and sedimentological data, indicates that these sediments provide a geomagnetic directional paleomagnetic secular variation (PSV) and relative paleointensity (RPI) proxy records for the last ∼8500 cal BP, with sedimentation rates varying from ∼1.2 to 4.2 m/kyr in the postglacial sediments. Paleomagnetic data are characterized by a strong and generally stable single component magnetization that is carried by pseudo-single domain (PSD) magnetite for cores 2220 and 2221 along with a less stable component carried by a coarser grain magnetic assemblage in core 2221. Component inclinations, as determined by principal component analysis, vary about the expected inclination for the sites latitude, with maximum angular deviation (MAD) values generally lower than 2° and 6° for cores MD99-2220 and -2221 postglacial sediments, respectively. Concentration dependent magnetic parameters vary by less than one order of magnitude. Isothermal remanent magnetization (IRM) normalization of the natural remanent magnetization (NRM) intensity is not coherent with its normalizer nor with any other environmentally sensitive rock-magnetic parameters at significant frequencies observed in the power spectrum of core MD99-2220 NRM/IRM record. Therefore, we interpret the NRM/IRM record from core MD99-2220 as a relative paleointensity (RPI) proxy that reflects changes in the strength of the Earth's geomagnetic field. This new RPI record compares favorably with RPI records from North America and Europe at millennial and even some centennial timescales. Comparisons between core MD99-2220 RPI proxy with the ^{10}Be flux record from the Greenland Summit (GISP2) ice core and a smoothed ^{14}C production rate record suggest that geomagnetic modulation, rather than solar variability, may control the millennial and some centennial scale variability within cosmogenic isotope records. And in turn, these correlations imply that core MD99-2220 RPI record reflects changes in global scale geomagnetic field at these timescales.

GP12A-1089 1330h POSTER

Initial Shipboard Paleomagnetic Results From ODP Site 1233, Leg 202: A new Window Into the Temporal Variability of the Geomagnetic Field During the Late Quaternary

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Recent studies of sedimentary relative paleointensity suggest that global scale geomagnetic field intensity changes occur at millennial time scales. Yet, only a few records with the highest temporal resolution are able to resolve this variability and therefore a clear understanding of the time scales over which the intensity of geomagnetic field varies has not emerged. We present shipboard data from Ocean Drilling Program (ODP) Leg 202, Site 1233 (41°0 S and 74°26 W) that provides a remarkable ∼ 130 meter composite depth (mcd) sediment sequence at a resolution high enough to capture the millennial scale component of the geomagnetic field over at least the last 45 kyrs. Site 1233 was drilled off the coast of Southern Chile from a small forearc basin on the continental slope at 838 m water depth. A gravity core from this location documents, through radiocarbon dating, that sedimentation rates exceed 1m/kyr for the last ∼ 8 ka. Seismic data suggested that such high sedimentation rates should continue into the Pleistocene. Five holes were drilled recovering lithologically homogenous, fine-grained siliciclastic sediments with varying amounts of well-preserved biogenic components. Shipboard derived whole core magnetic susceptibility values are high (∼ 4 x 10^{-3} SI) and relatively uniform. Shipboard pass-through paleomagnetic measurements were made on the archive half sections after AF demagnetized at peak fields up to 25 mT. The NRM intensities after demagnetization are still strong (mean ∼ 0.1 A/m) and inclinations are close to expected values for this Sites latitude (−52° compared to −59° for GAD). Directional variability, both declination and inclination recorded in five holes show reproducible patterns that are consistent with paleomagnetic secular variation. Fully reversed inclination and antipodal declinations are observed over a one meter interval at ∼ 68 mcd. These excursional directions are recorded in three independent holes and assuming a constant sedimentation rate would occur at ∼ 50 ka. Therefore, its quite conceivable that this reflects the Laschamp event at ∼ 41 ka. The NRM intensity after 25mT AF demagnetization was normalized by magnetic susceptibility to provide a first order assessment of relative paleointensity. Assuming the reversed directions reflect the Laschamp geomagnetic excursion, and using the radiocarbon chronology within the Holocene, the normalized remanence record from 1233 can be clearly correlated to the highest resolution sedimentary relative paleointensity records from the North Atlantic, South Atlantic, Indian and Equatorial Pacific Oceans. Based on shipboard data, these chronologies can be transferred to Site 1233 illustrating a new step forward in paleointensity stratigraphy. The millennial scale variability observed from the normalized remanence records are consistent with high resolution cosmogenic isotope records further suggesting that the high frequency content of this record reflects global scale changes within the geomagnetic field. The morphology of the paleointensity features are well defined and suggest that the rates of change of geomagnetic intensity over the last 45 kyr are similar to those observed from directional records. Therefore, the difficulty in defining the millennial content of the paleointensity record reflects the extremely high rate of change of the geomagnetic field that only the highest resolution records are able to resolve.

GP12A-1090 1330h POSTER

Duration and Structure of the Matuyama-Brunhes Geomagnetic Polarity Reversal from ^{40}Ar/^{39}Ar Dated Lava Flows

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A fundamental property of the geomagnetic reversal process that remains poorly understood is the duration. Radioisotopic ages determined from transitionally magnetized lava flows erupted at four globally-separated sites constrain the Matuyama-Brunhes (M-B) transition to have lasted no less than 14 kyrs, and perhaps as long as 28 kyrs–that is, several times longer than widely thought. The paths of the virtual geomagnetic pole (VGP) contain a quasi-stationary clustering in or about Australia preceded and succeeded by apparently rapid movement away from and toward the geographic poles. These results mirror records from sediments that imply alternating steady-rapid directional movement to be an important characteristic of the dynamo reversal process. Further, however, our findings suggest that during the interval of the last reversal the geocentric dipole may have crossed the equator on five occasions. Most transitional VGPs overlie regions of faster seismic velocity and possibly lower temperature in the lowermost mantle. The long duration of the M-B reversal and the complex, yet geographically-restricted positions and movements of the lava-derived VGPs match a numerical dynamo simulation that imposes lateral variability in lowermost mantle temperature. Hence, more than reinforcing the hypothesis that the thermal state of the lower mantle modulates the geodynamo during reversals, the M-B lava record can be used to quantitatively constrain future attempts to numerically model the process.

GP12A-1091 1330h POSTER

The Origin of Geomagnetic Jerks

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Following the 1978 discovery of the 1969 geomagnetic jerk, and the discovery of later jerks in 1978, 1991 and 1999, there has been much speculation on their origin. Although it is acknowledged that they are of internal origin and that they most likely result from a change in the fluid flow at the core surface, no physical mechanism has been identified as their cause.

Geomagnetic jerks are most readily observed in the east component of the field at European permanent magnetic observatories. This suggests that they may be due to some localized change in the flow in the core. Here, though, we examine a global phenomenon, namely torsional oscillations. Torsional oscillations have two symmetry properties: they are axisymmetric about the rotation axis and symmetric about the geographical equator. Despite these symmetry properties we find that torsional oscillations can explain the salient features of geomagnetic jerks.

This shows that the localization of geomagnetic jerks is not a result of the mechanism that causes them; instead, it is a result of the main geomagnetic field morphology. Thus, if the magnetic field morphology were different, as it was in the past and will be in the future, jerks might not be observed, making them a possibly transitory phenomenon.

GP12A-1092 1330h INVITED POSTER

Rayleigh Number for Core Convection: Three Independent Estimates

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The Rayleigh number (R_a) for the Earth's core is a dimensionless measure of the heat flux crossing the core-mantle boundary (CMB). Recent calculations on the properties of liquid iron mixtures at core pressures and temperatures have provided reliable data for thermodynamic estimates of core heat flow, all of which suggests that heat budget is rather tight: Either the core is cooling so fast that the inner core is young and formed only 1 Gyr ago, or the core contains substantial radiogenic heating from K^40. These heat flow estimates translate into $R_a \approx 1000 R_a^c$, the critical value for convection assuming a magnetic field of typical core strength and turbulent values of viscosity and thermal diffusivity [Gubbins, *Phys. Earth Planet. Int.*, **128** 3–12, 2001]. Magnetic fields facilitate convection in a rotating system; for core parameters they lower R_a^c by a factor of about 1000. The estimate of R_a is therefore close to the marginal value, the minimum heat flux needed for convection in the core if the magnetic field were absent. Another estimate was made by Jones [*Phil. Trans. R. Soc. Lond.*, **358** 871–872, 2000] by considering the heat transported by convection in the core. This gives a similar value of $500 R_a^c$; it is independent because the basic information used is a typical estimate of core flow speed rather than CMB heat flux. The third estimate comes from the observation of low secular variation in the Pacific. Seismic tomography shows low velocity, probably hot material, at the base of the mantle in the Pacific region. Using this as a boundary condition for simple convection calculations shows that the usual Busse rolls are completely suppressed in the Pacific when lateral variations are 30% of the mean heat flux and total heat flux is just above critical. While much work needs to be done on extending these simple calculations, they imply that the heat flux from the Pacific region is subadiabatic. Converting the variations of seismic velocity within D″ to heat flux, and assuming this to 30% of the mean, again gives a Rayleigh number of about $1000 R_a^c$. All 3 independent estimates are low in that they are close to the lowest possible value required to sustain core convection without a magnetic field. This has important implications for geodynamo models, which should be easier in the low R_a regime.

GP12A-1093 1330h POSTER

Geomagnetic Field Inclinations and Absolute Paleointensities for a 350 kyr Time gap From the 350m Core of the Kalihi Scientific Drilling Project Recovered From the Ko'olau Volcano, O'ahu, Hawai'i

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In order to investigate the volcanic evolution of the Ko'olau Volcano, O'ahu, Hawai'i and the geomagnetic field behavior recorded by the lavas, a paleomagnetic and rock magnetic was conducted on a 350 m thick sequence of flows from the Kalihi Scientific Drilling Project. This drill core records geomagnetic field inclination for the period approximately between 2.75 to 3.1 Ma. The core extends deeper stratigraphically any surface exposures of the volcano and the rocks obtained have experienced less tropical weathering than surface rocks. Previous published work on Ko'olau has indicated that the volcano was formed during the Matuyama Chron (Doell and Dalrymple, 1973, GSA Bull, 84, 127-42). We drilled multiple one-inch long samples from each of the 103 flows in the drill core section. The paleomagnetic results of all the specimens were stepwise demagnetized by alternating fields from 5-100mT. Companion specimens from the same core were demagnetized at 15 temperature steps. In both cases the demagnetization diagrams obtained with each technique showed a stable and unambiguous characteristic direction of remanence (ChRM). The ChRM calculated using principal component analysis for the demagnetization diagrams with a well-defined component trending towards the origin. No bias or systematic departure from the origin was accepted and in all cases the ChRM relies on a minimum of seven successive directions isolated during demagnetization. In addtion, low-field susceptibility versus temperature (k-T) and SIRM experiments were performed on a dozen or so flows at different levels of the core. As a result of such tests, we were able to identify magnetite and and in few instances a low-temperature mineral phase (300-400 ^{o}C), reflecting the presence of titanomagnetite with low Ti content as suggested by its large susceptibility. We used the modified Thellier-Coe double heating method to determine paleointensities. pTRM checks were performed systematically one temperature step down the last pTRM acquisition in order to document magnetomineralogical changes during heating. We were able to obtain paleointensity determination for 25 lavas (out of 103 flows) which represent about 25 percent success rate. The analyses reveals two instances of near-zero and two instances of low negative inclination (reversed polarity, 7.5 uT of low paleointensity) within an otherwise normal polarity. In particular, flow units 34-50 record a horizontal inclination and may be associated with the top of the Kaena Subchron. This interpretation is supported also by two Ar-Ar age determinations for flow 14 (2.89+/-0.12 Ma) and flow 66 (3.06+/-0.15 Ma old), and subaerial lavas at several localities where the Reunion II Subchron (ca. 2.11 to 2.15 Ma) is recorded and which previous results were reported by Herrero-Bervera et al (2002, PEPI, 129, 83-98). Our findings lead us to conclude that the growth of the Ko'olau Volcano was concomitant with respect to the youngest exposed lavas of the Wai'anae Volcano and both were forming during the Kaena Subchron.

GP12A-1094 1330h POSTER

Towards a Continuous Record of Earth Magnetic Field Reversals by Secondary Pyrrhotite pTRMs

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Partial Thermoremanent Magnetisations (pTRMs) by secondary pyrrhotite, recorded during fast cooling in contact metamorphic limestone, were used for the first time to test the possibility of recording Earth Magnetic Field (EMF) Reversals within a single sample. For this propose, samples from marly limestones of Mid-Elba (Italy) were taken in the vicinity of intrusions. Pyrrhotite was identified by the unblocking spectra of the NRM and the thermal demagnetisation of IRM. Thellier-Thellier-tests of a laboratory TRMs incl. MD checks have proven that pyrrhotite particles are in the SD range and, therefore, are able to record independent pTRMs. Thermal demagnetisation of the NRM reveals a reversed low temperature (150^{o}C-250^{o}C) and a normal high temperature (290^{o}C-320^{o}C) component. The two components include an angle of $\sim$150^{o} and are linked by a gradual transition over an average temperature range of $\sim$40^{o}C. Positive fold tests on the low (k = 10.2 ; α^{95} = 11.0) and the high temperature component (k = 20.4 ; α^{95} = 8.4) evidence that the NRM is a TRM. A scenario where the low temperature component is caused by a second heating event is unlikely due to the gradual transition of the NRM and the lack of evidence for a multiple intrusion. An estimation of the time enveloped in the transitional temperature range retrieved by thermal modelling of the contact metamorphism lies at 10000 yr. This time span is comparable with an average value for EMF reversals.

URL: http://www.uni-tuebingen.de/geo/gpi/ag-appel/projekte/palaeomag/ptrmpro/index.html

GP12A-1095 1330h POSTER

A Detailed Paleomagnetic Record From the Bahamas Bank: a Record of the Blake Event?

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Detailed demagnetisation of 51 Pleistocene carbonate samples from hole 1006a, ODP Leg 166, in the Bahamas Bank, yield anomalous paleomagnetic directions over a sediment thickness of 40 cm (328-368 core depth). Samples above and below this horizon are characterised by a steeply directed remanence component at low coercivities, which likely represents a drill-induced component, which is succeeded at higher coercivities by a component with a shallower inclination, close to that of the geomagnetic field at this site. In contrast, the samples from 328-368 core depth, yield negative inclinations after removal of the low coercivity component. These negative inclinations are accompanied by small swings in declination. These anomalous directions are either due to disturbance of the sediment or reflect the presence of geomagnetic field excursion; likely the Blake event. While we cannot completely exclude sediment disturbance, we believe that our paleomagnetic data marks a record of geomagnetic field behaviour for the following reasons: examination of the core yields no evidence for disturbance; relative paleointensity determinations indicate an intensity low through this part of the core; and the excursion is a double event, with an intervening positive inclination within the zone of negative inclinations, in line with other studies of the Blake event. We are currently carrying detailed U/Th age determinations on this part of the core with a view to obtaining a estimate of the timing and duration of the event.

GP12A-1096 1330h POSTER

A Study of Geomagnetic Field Variations of a Low-Latitude Station.

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The field variations of a Low Latitude Station, Ile-Ife in Nigeria (Dip latitude 4o) were analyzed using data for four consecutive years (1993 1996). The study shows that the most prominent value of the geomagnetic k index is 4 and in general, the k distribution has significant peaks at k =3, 5, and 6. The daily Ak index shows that majority of days in this four-year period can be classified as either active days or days with minor storms. The study also reveals there were virtually no severe storm during the period under consideration. This behavior has been shown to be consistent with the geomagnetic field variations at equatorial electrojet zones.

GP12A-1097 1330h POSTER

Elongation in distributions of paleomagnetic field directions and corresponding poles

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Properties of paleosecular variation (PSV), mainly derived from lava flow data for the last few million years, were often discussed in terms of the latitudinal dependence of angular standard deviation (ASD) of virtual geomagnetic poles (VGPs) distributions after Cox (1970). Generally the ASD of VGP has a feature that it is smallest in the equatorial region and becomes higher in the higher latitude (e.g. McFadden et al., 1988). However mapping of each directional datum into the corresponding VGP is nonlinear and distorted on the unit sphere. Therefore it is not feasible that both distributions become synchronously circular except for sites around the geomagnetic poles. Recent accumulation of reliable paleomagnetic directional data has enabled us to discuss the more details of the nature of PSV, not only the ASD but also the shape of the distributions (Kono, 1997; Tanaka, 1999; Khokhlov et al., 2001).

In this study, by using Bingham statistics (Bingham, 1973; Onstott, 1980) we made a comparison in the shape of distributions between actual paleomagentic data obtained from several sites on the Earth, where data from enough flows are available, and our recent PSV model (Hatakeyama and Kono, 2002) which was derived by nonlinear inverse procedures. Some important characteristics of the PSV appearing in the data and relation to the remarkable components in the Gauss coefficients were indicated as following, (1) the shape of the VGP distribution shows much circular than that of the field directions especially in the low latitude region, (2) the distribution of paleodirections is elongated to the direction of the meridian, while that of VGPs is distorted toward the perpendicular direction, and (3) the circular nature of the pole distributions depends on the "isotropic" PSV (Constable and Parker, 1988) but the elongation perpendicular to the meridian is likely to be caused by large variances of a special component (ℓ = 2, m = 1) of spherical harmonics. This component is also regarded as important for the latitudinal dependence of the ASD of VGP (Kono and Tanaka, 1995; Hulot and Gallet, 1996).

GP12B MCC: 130 Monday 1330h

The Use of Magnetic Properties as a Petrologic Tool II *(joint with OS)*

Presiding: **B MacDonald,** State University of New York, Binghamton**; O Ozdemir,** University of Toronto

GP12B-01 1330h

Late Quaternary Magnetic Mineral Accumulation in the Western Equatorial Atlantic - South American Versus African Provenance

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Magnetic mineral accumulation at the Ceara Rise has been studied with the aim to discriminate and reconstruct fluvial South American and eolian African terrigenous fluxes to the late Quaternary western Equatorial Atlantic. Seven sediment series recovered along two bathymetric transects were investigated with standard environmental magnetic techniques. Climatically controlled fluctuations in continental detrital discharge and marine biogenic carbonate fluxes strongly modulate the susceptibility records. Their coherent precessional and higher-frequent signal components could be used to establish a high-resolution age framework for these sediments. On average 79% of susceptibility originate from magnetite of different grain size, 13% from hematite and 8% from paramagnetic matrix compounds. Hence, hematite concentrations are on average almost twenty times higher than magnetite concentrations. The longitudinal gradients of their respective accumulation rates document a delivery from two major sources characterized by largely different magnetite to hematite ratios (about 1:12 versus 1:50). A