GP11C MCC: Level 1 Monday 0830h

General Geomagnetism and Paleomagnetism Posters

Presiding: **O Ozdemir,** University of Toronto at Mississauga**; J L Kirschvink,** California Institute of Technology

GP11C-0265 0830h POSTER

Atmospheric Radiocarbon Production Between 30,000 and 50,000 Years B.P. and the Influence of Geomagnetic Field Intensity Fluctuations

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Near the limits of radiocarbon dating techniques, the Earth's geomagnetic field intensity transitioned from field strengths about 20 percent higher than modern values to a near collapse of the geomagnetic field during the Laschamp excursion. The production of ^{14}C and all other cosmogenic radioisotopes increased dramatically during this transition. The time interval between 52,000 and 38,000 years B.P. is also especially important to anthropologists due to the active migration pathways of early man. However, the ^{14}C production increase during this time interval produced a dramatic distortion in the ^{14}C radiometric clock that has confounded efforts to accurately date this interval. Fossil corals provide a superior archive for measuring changes in ^{14}C because they also contain the very accurate and precise uranium series radiometric clocks, $^{238}U/^{234}U/^{230}Th$ and $^{235}U/^{231}Pa$. We have developed a procedure to date a single-piece coral sample by both $^{238}U/^{234}U/^{230}Th$ and $^{235}U/^{231}Pa$ methods using a multiple-collector, magnetic sector, ICP mass spectrometry (Plasma 54). The configuration of our mass spectrometer simplifies chemical preparation of samples and provides internal mass bias and detector gain corrections during analysis. The corresponding ^{14}C ages of corals were made on an accelerator mass spectrometer (AMS) at Lawrence Livermore National Laboratory. Replicate radiocarbon analyses of progressively leached samples is an effective strategy for radiocarbon dating samples older than eight half-lives.

GP11C-0266 0830h POSTER

Paleointensity Determination on the Late Jurassic Lavas in Northeastern China

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The variations in the strength of the geomagnetic field over geologic time is crucial to a complete understand of the workings of Earth's dynamo. While many paleointensity data were recently reported and hence enhancing our understanding of the geodynamo, few data except one datum from SBG in the present paleointensity database were obtained from the late Jurassic by passing certain criteria (Thellier method with system p-TRM check and so on) and, in particular, the lack of data from East Asia. We recently carried out an integrated paleomagnetic, rock-magnetic and paleointensity study of the late Jurassic volcanic succession from Beipiao in the west of Liaoning province, northeastern China. A total of 19 lava flows were sampled. The eruption ages of these lava flows were dated by SHRIMP, about 145Ma. Detailed rock magnetic experiments of thermomagnetic curves and hysteresis loops show the primary carrier of remanence to be pseudo-single domain hematite. Stepwise alternating field and thermal demagnetizations isolated a well-defined direction of characteristic remanent magnetization in all studied lava flows. The modified version (Coe, 1967) of Thellier method with system p-TRM check was used to determine paleointensity. Eight out of nineteen lava flows met the selection criteria (positive p-TRM check, at least three points in a line) and the paleointensity and corresponded VDM values were calculated. An average of about fifth of the present day magnetic field, (1.5+/-0.6)E+22 Am2, was recorded by the eight lava flows. This is the first paleointensity results obtained from the Chinese lava flows erupted in the late Jurassic and well-consistent with the results from SBG (Juarez et al., 1998), suggesting the MDL into the late Jurassic, and further confirming the inverse relationship between reversal frequency and paleointensity.

GP11C-0267 0830h POSTER

Multi-component Magnetization Of The Late Pliocene Pyroclastic Flow Deposit In Central Japan, Indicating Early Early Pleistocene Fault Activity

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The Late Pliocene Ichiuda Welded Tuff Bed in central Japan acquired three magnetization components. All of primary reverse intermediate temperature component, and secondary normal low and high temperature components show positive fold tests, indicating that fault-related folding structure postdated the Olduvai normal subchron. The northern segment of Itoigawa-Shizuoka Tectonic Line that bounds the North American and Eurasian Plates in central Japan, comprises the geological Otari-Nakayama and active Kamishiro faults. The Ichiuda Welded Tuff Bed intruded by the 2.1 Ma Taro-yama Andesite is subjected to the NE-SW trending folding structure adjacent to the Otari-Nakayama fault. PAFD and PThD were performed to the drilled samples of Taro-yama Andesite and the Ichiuda Welded Tuff Bed at three and five sites on both limbs of the syncline, respectively. Positive fold test for the tilt-corrected site-mean directions of the andesite indicates prefolding magnetization. The fresh welded tuff bed at one site yields similar reverse direction. Whereas the greenly altered beds at four sites shows normal tilt-corrected site-mean directions by PAFD, and following three temperature-dependent directional components by PThD: normal below 350 degree, reverse from 350 to 530 degree, and normal above 530 degree, all which show positive fold test. IRM acquisition, thermal demagnetization of three orthogonal IRM, thermomagnetic analysis with VSM, and low temperature magnetization measurements with MPMS indicate that the Ichiuda Welded Tuff Bed with single and three magnetization components contains titanomagnetites, and both titanomagnetites and magnetite, respectively. Magnetization of the Taro-yama Andesite is dominated by titanomagnetites under high temperature oxidation state and minor proportion of titanomaghemites. The Taro-yama Andesite and the Ichiuda Welded Tuff Bed exhibit primary reverse magnetism corresponding to the Matsuyama Chron. The Ichiuda Welded Tuff Bed additionally acquired normal magnetization components by hydrothermal alternation in the Olduvai Subchron; low and high temperature components are secondary TRM by re-heating for titanomagnetites and CRM by formation of magnetite, respectively. Positive fold test for secondary magnetization of the welded tuff bed would introduce the early Early Pleistocene activity of the Otari-Nakayama fault.

GP11C-0268 0830h POSTER

Sediment Magnetism and Paleo-depositional Environment of Deep-sea Sediments From KODOS Area in the Northeastern Equatorial Pacific

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Paleomagnetic properties of sediment cores of the KODOS (Korea Deep Ocean Study) area located in the northeastern equatorial Pacific were studied to understand paleo-depositional condition. In the northeastern equatorial Pacific, magnetic properties of sediment samples for this study were recorded by stable NRM carriers, and the paleomagnetic directions were well-grouped in each polarity interval. The values of inclination in the surface sediments were similar to the expected inclination values for the period from present to Pleistocene at the sampling sites. The polarity sequence of the studied sediments can be correlated with the geomagnetic polarity time scale for the period of early Pliocene and Pleistocene time. The paleomagnetic stratigraphy shows that the sedimentation rates were 1.04 mm/kyr for Pleistocene and 0.75 mm/kyr for Late Pliocene. The average sedimentation rate of Pleistocene is about 1.53 times higher than that of late Pliocene. The variations of sedimentation rates with age can be explained by the paleoceanographic event. For Pliocene and Pleistocene age, the depositional environment in the Pacific is characterized by the onset of northern hemisphere glaciation and subsequent climatic deterioration. During these periods, large amount of eolian materials were transported to the deep-sea floor. An increasing sedimentation rates for Pleistocene imply that the terrestrial materials were primarily transported to the ocean and the biogenic sedimentation was also increased as a result of increased primary productivity. The down-core variations of paleomagnetic and rock-magnetic properties of the KODOS core sediments were affected by the dissolution processes in an oxic depositional regime. The high NRM stability in the upper yellowish brown layers implied that the magnetic carrier was initially in SD and PSD states. In the lower dark brown sediments, only fine magnetic carrier was survived from the dissolution and NRM was carried by more abundant MD grains, which had the low magnetic stability. When sufficient high-stability detrital magnetic grains exist, paleomagnetic directional components carried by such grains can survive despite active diagenetic process.

GP11C-0269 0830h POSTER

Low Latitude Glaciation in Arabia - A Palaeomagnetic Study of the Neoproterozoic Huqf Supergroup, Oman

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The Huqf Supergroup of Oman consists of a sedimentary sequence which was deposited in the Neoproterozoic. Within the Huqf Supergroup there are two distinct glacial packages; the Ghubrah (∼710Ma) and the Fiq (∼600Ma) formations. These have been correlated with the Sturtian and Marinoan glaciations respectively. Higher up in the sequence, part of the Shuram formation (∼560Ma), has been tentatively correlated with the Gaskiers glaciation. In the south of Oman, the Mirbat formation, consisting of siltstones and diamict, is thought to be equivalent in age to the Huqf Supergroup. Samples from 100 sites were demagnetised using either AF or thermal treatment. In all sites a low stability remanence (component A), removed between 0 to400°C was identified,. It is indistinguishable from present earth field, and is therefore interpreted as a recent VRM. Samples from the middle part of the Huqf; the Fiq diamict and the lower Mirbat formation, have a high stability characteristic component (B). This is removed between 400-585°C, plat=-51.8° and plong=64.9°. Reversal, folding and conglomerate tests all yield positive results, and the result is therefore interpreted as primary. Samples from the upper Huqf and the upper Mirbat formation, also have a high stability characteristic component (C), distinct from both A and B. It is removed between 400 to °C, plat=12.9°, plong=130.1°. This result yields positive

folding and reversal tests and is therefore also interpreted as primary. Two distinct primary components have been identified in both the middle and upper Huqf Supergroup, and in the lower and middle Mirbat formation. This result links the lower Mirbat with the Fiq diamict and therefore the Marinoan glaciation. In the 50My between the deposition of the Fiq and the Shuram formations, Arabia crossed the equator and rotated clockwise. This is the first evidence of Neoproterozoic drift of the Arabian plate prior to collision with Africa. Component C correlates well with similarly aged poles from Africa, suggesting that by 550Ma the African and Arabian plates had collided. Component B from the Fiq diamict has a palaeolatitude of 13°, a confirmation of massive global cooling during the Marinoan.

GP11C-0270 0830h POSTER

New Paleomagnetic and Rock Magnetic Data From 10-12 Ma Basaltic Cores in ODP Site 1243, Eastern Equatorial Pacific

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We present paleomagnetic and rock magnetic results from samples recovered during ODP Leg 203. Eighty-seven meters of basement rocks were drilled at Site 1243, which is located near a proposed fossil spreading center that became inactive 10-12 Ma. Petrological and geochemical observations distinguish 6 different units within the basement rocks. All units consist of fresh pillow basalts, sometimes with glasses present. Paleomagnetic results indicate that the basaltic cores record a stable component of magnetization with both normal and reversed inclinations after a pervasive drilling-induced remagnetization is removed. The lava sequence recovered at Site 1243 may record a reversal sequence (normal-reversed-normal). Two general types of behavior were found in the rock magnetic measurements of Leg 203 cores. One group has a single phase of Ti-poor titanomagnetite. Basalt samples of this titanomagnetite group exhibit a Verwey transition in the vicinity of 110 K, which is in good agreement with the thermomagnetic characteristics of titanomagnetites with Curie temperatures of 580°C that were identified. The second group is characterized by more than one Curie temperature, which suggests the presence of multiple magnetic phases. Low temperature curves do not clearly show the Verwey transition. Thermomagnetic signatures indicate the inversion of titanomaghemite to a strongly magnetized magnetite. Variations of Curie temperatures, oxidation state, titanium content, and domain range suggest that a stratigraphically distinct change in magnetic minerals may exist at Site 1243.

GP11C-0271 0830h POSTER

Paleomagnetic Records of Corals From the Solomon Islands

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The paleomagnetism of corals is potentially important because corals may afford high-resolution records of the geomagnetic field. Given the known ages of available corals, it may be possible to get such records for various times in the past few tens of thousands of years. To this end we have investigated the rock magnetism and possible paleomagnetic records of corals from the Solomon Islands. The magnetism of the corals studied is of order 10-7 to10-8 Am2/kg. However samples with masses of about 10 gms can be reliably measured with modern magnetometers. The Natural Remanent Magnetization (NRM) is of variable quality yielding some PCA MAD angles between 1 and 5 and inclinations consistent with the site at which the were drilled. Others are much less precise determinations and in erratic directions. We compared the AF demagnetization characteristics of the NRM with those of Anhysteretic Remanent Magnetization (ARM) and Isothermal Remanent Magnetization (IRM). This revealed that the better determinations are from samples in which the demagnetization behavior of NRM is very similar to that of ARM and in a ratio of approximately a few parts in a thousand to IRM.

GP11C-0272 0830h POSTER

Paleomagnetism of a Long Sequence of Lavas Recorded on the Island of Lana'i, Hawai'i, USA

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Previous published work on Lana'i indicated that the volcano was formed mainly during the Matuyama Chron (Herrero-Bervera et al., 2000). In order to constrain further the timing of the active phases of the Lana'i volcano, we conducted a paleomagnetic and rock magnetic study involving a 250 m thick sequence of at least 300 flows that were erupted between 0.76+/-0.66 Ma and 1.46 +/-0.25 Ma according to previous K/Ar dating. Low-field susceptibility versus temperature (k-T) and SIRM experiments performed on a dozen flows indicate that magnetite dominates the remanent magnetization (575° C). In a few cases a low-temperature mineral phase (300-400° C) could reflect the presence of titanomagnetite with low Ti content but the presence of maghemite or pyrrhotite cannot be completely excluded. Additional investigations are in progress on this matter. All specimens were stepwise demagnetized by alternating fields from 5 to 100 mT. Companion specimens from the same samples were demagnetized at 15 temperature steps. The demagnetization diagrams obtained with each technique showed a stable direction of remanence. In all cases, the characteristic (ChRM) component was clearly defined from at least seven successive directions isolated during stepwise demagnetization. The succession of the mean directions caclulated for each lava flow reveals the existence of three polarity intervals. Based on radiometric dates they were assigned to the Cobb, Jaramillo and Kamikatsura Subchrons. Thus, the present results, along with the radiometric ages of the lavas indicate that the tholeiitic flows that formed the Lanai volcano were erupted over a short time period and only during the Matuyama Chron (0.780-2.58 Ma). No eruption occurred during the Brunhes Chron (0.78 Ma) as previously reported for the K-Ar dated lavas in the Maunalei Gulch.

GP11C-0273 0830h POSTER

Paleomagnetism of Eocene Intrusive Rocks, Black Hills of South Dakota and Wyoming

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The Black Hills of South Dakota and Wyoming are a large Precambrian-cored Laramide uplift. Intruding the Black Hills are a diverse suite of igneous rocks, which include phonolites, trachytes, latites, garnet-bearing rhyolites, and pyroxenites. These intrusive bodies range in size from several meter outcrop-scale bodies, to several 10s of km wide intrusive complexes. New geochronology (^{40}Ar-^{39}Ar) data indicate many of these intrusive rocks are between 58 and 45 Ma in age (Duke at al, 2002). As part of a larger paleomagnetic study aimed at Jurassic strata surrounding the Black Hills, a collection of 20 sites and 145 samples of the Eocene intrusive rocks was made. A combination of alternating field, thermal, and liquid nitrogen step-wise demagnetization revealed that, with a few exceptions, these rocks have two well-defined magnetization components. The first-removed component is interpreted to be a present (dipole) field magnetization, and is removed by 10 to 30 mT a.f., or 200 C thermal demagnetization steps. The second-removed components have either positive or negative inclinations, and are defined by demagnetization steps between 30 and 200 mT a.f., or 300 to 630 C thermal demagnetization steps. These components are interpreted to be ancient, presumably Eocene, magnetizations. A preliminary mean of the normal-polarity sites is D=352, I=59.3, k=26.7, a95=18.2, N=4, and of the reverse-polarity sites is D=154.9, I=-61.3, k=23.1, a95=18.2, N=4. The combined mean direction is D=344.9, I=60.3, k=28.8, a95=10.5, N=8. Two sites of rhyolites at Mt. Theodore Roosevelt have well-defined magnetization components, but either mixed polarity (Site 99Trr1), or reverse-polarity with what might be a transitional-field direction (D=27.7, I=-37.4, k=18.0, a95=18.6, n=5), and are not included in the calculation of means. The magnetizations recorded by these Eocene rocks are essentially identical to the expected direction for the Black Hills calculated from the Diehl et al., 1983 Eocene reference pole for North America. This result indicates that the Black Hills have experienced no rotation or large-scale tilting since the Eocene, that these intrusive rocks are suitable for additional study of geomagnetic field behavior. In addition, the mean direction reported here is similar to the Jurassic Morrison Formation from the Black Hills (D=349.7, I=61.8, k=87.4, a95=4.5, N=13), supporting an assertion that the Jurassic rocks had been remagnetized during the Eocene.

GP11C-0274 0830h POSTER

Paleomagnetic Evidence for Neogene Tilting of Crustal Panels in Southeastern Alaska

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Paleomagnetic samples were collected from Tertiary (mostly Oligocene) plutons and dikes along a transect from west of Prince of Wales Island to the mainland near Wrangell, Alaska. Thermal demagnetization and principal component analysis were used to determine the characteristic remanent magnetization (ChRM). Site-mean ChRM directions with 95% confidence limit ($\alpha 95$) < 15° were acquired from 19 normal-polarity sites and nine reversed-polarity sites located on the western part of the transect. These directions pass the reversals test with class C designation. The observed mean paleomagnetic direction is: I= 72.5°; D = 47.0°; $\alpha 95$ = 5.1°. The expected Oligocene direction is: I = 73.3° ± 2.5° and D = 350.0° ± 7.8°. The observed concordant inclination and discordant declination indicate either: (1) 57.0° ± 15.1° clockwise vertical-axis rotation or, (2) ESE-side-up tilt by 17° with azimuth of tilt axis = 18°. Several lines of geologic evidence favor the crustal tilt interpretation. Rocks in this region ranging in age from Proterozoic to Tertiary form elongate crustal panels consistently oriented NW-SE. The continental margin has experienced strike-slip to transtensional Tertiary deformation with dominant structural grain oriented NW-SE. Thus large Neogene vertical-axis rotation is unlikely to have affected this area. Additionally, evidence from metamorphic grade of Alexander terrane rocks on Prince of Wales Island and crustal levels within the igneous complex of Zarembo and Etolin Islands suggest SE-side-up tilting. Paleomagnetic analyses of Tertiary dikes from the central and eastern parts of the transect are underway and should determine the amount and direction of Neogene crustal tilt across the full width of the continental margin.

GP11C-0275 0830h POSTER

Neogene Magnetostratigraphy of the Guide Basin and its Implications for Pliocene Evolution of the NE Tibetan Plateau

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In order to provide age constraints to the Cenozoic clastic sedimentary rocks in the intramontane Gonghe and Guide Basins, we carried out a lithostratigraphic and magnetostratigraphic investigation of two sections north of the town of Guide. The resulting correlation

of the magnetic stratigraphy with the geomagnetic polarity time scale and the lithological changes along the sections, allow us to propose new unit divisions of the sedimentary infilling of the Guide Basin. The strata are divided into two groups: the Oligocene Xining Group and the Miocene to Pliocene Guide Group. The Guide Group can now be further divided into five informal formations (with ages shown in parentheses): the Amigang (1.8 to 2.6 Ma), Ganjia (2.6 to 3.6 Ma), Herjia (3.6 to 7.8 Ma), Ashigong (7.8 to >12 Ma), Garang (<16 to 18.4 Ma) and the Guidemen Formation (18.4 to 20.5 Ma). Three episodes of rapid (>20 cm/ka) sediment accumulation are observed in our section during the late Miocene to latest Pliocene, with ages of about 6 Ma, 3 Ma and 1.9 Ma. Massive conglomerates of the Ganjia Formation characterize the 3.6 to 2.6 Ma interval. Massive gravels of similar ages appear to be widespread in the nearby basins of Linxia, Jiuquan (northern Qilian Shan), Hexi and Qaidam, documenting enhanced Pliocene tectonic activity and erosion in the NE Tibetan Plateau. Five S-vergent thrust faults, affecting the Miocene and Pliocene molasse sediments, caused shortening of the basin section estimated at about 25 km since 8 Ma.

GP11C-0276 0830h POSTER

A Study of Mid-Miocene Yellowstone Hotspot Volcanics and the Search for the Steens Mountain Reversal

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It has been suggested that SE Oregon, NW Nevada and SW Idaho were quickly covered by Steens-type basalts at the beginning of Yellowstone hotspot volcanism. Only Steens Mountain has been studied in detail, but exploratory paleomagnetic sampling at six other sites suggests that the R-N polarity reversal recorded at Steens is common throughout the area (Mankinen et al., 1987). By sampling a large number of lava flow sequences and using current paleomagnetic and Ar/Ar dating techniques, we hope to compile a more detailed composite record of the magnetic field during the Steens Mountain reversal and locate it exactly in the geomagnetic polarity timescale of Cande and Kent (1995). Current dates for the reversal between 16-17 Ma need to be refined. After finding and dating reversals throughout the area, we can then use the stratigraphic position of the reversal within the lava flow sequence to place the local volcanic events into the larger geographical framework with a greater time precision than radiometric dating alone could give us. With enough volcanic sequences, the propagation of initial Yellowstone hot spot magmatism should be better understood. We have sampled two flow-on-flow sequences in the area. Initial core analysis and portable fluxgate magnetometer readings on hand samples from the Pueblo Mountains suggest a flow sequence that is normal at the top and reversed at the bottom. Data from the Summit Springs section suggest a thick normally magnetized top with a few transitional flows near the bottom. Next we plan to drill several other sections suspected to be Steens equivalents, including a recently scouted section in the Owyhee Mountains that shows a normal top and reversed bottom.

GP11C-0277 0830h POSTER

High-Resolution, Low-Altitude Helicopter-Borne Aeromagnetic Survey over Unzen Volcano, Kyushu, Japan

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We try to use repeated high-resolution aeromagnetic surveys at low altitudes to detect the geomagnetic field changes associated with volcanic activity. Previous magnetic studies in volcanic areas using fixed station distributions have detected small temporal changes, however, they do not have the spatial resolution to detect spatial changes. It may be possible to make repeated magnetic surveys even during active volcano eruptions using, for example, unmanned helicopters. On September 18, 2002, we conducted a high-resolution and low-altitude helicopter-borne magnetic surveys in and around Unzen Volcano in Kyushu, Japan. Unzen is an active volcano that had a sequence of eruptions from November, 1990 to 1995, after a quiescence of 198 years. The first flight covers an area over the Futsu, Chijiwa, and Kanahama faults, which are major normal faults that form the Unzen graben system. The second andthird flights cover the summit area of Unzen volcano with spiral trajectories at altitudes of 1000 and 500 ft, respectively. The spacing between the survey lines is about 50 m. The total geomagnetic was recorded by an optical pumping magnetometer installed in the sensor bird and the sampling intervals are 0.1 sec. Precise positioning data of the sensor bird was obtained by a differential GPS technique, with a time resolution of 1 sec. Diurnal magnetic variations of extraterrestrial origin were removed by subtracting the total field data recorded at a nearby temporary station. In order to eliminate the effects of topography, the average terrain magnetization was estimated using a statistical correlation method (Grauch, 1987). Finally, an inversion was carried out for the terrain corrected anomalies, after removing the linear regional trend. From the results of this inversion, a low magnetized area was seen around the lava dome, while high magnetization is distributed around Mt.Fugen. The low magnetized area suggests that the rock bodies with remanent magnetization is fractured into pieces, and the pieces were then oriented into random directions. Another possibility is that the shallower region under the lava dome was not completely cooled, after the rock magnetization was reduced by the hight temperatures of the eruption. In addition, lava flows in the vicinity of a lava dome can also be recognized by magnetization lows. This study shows the spatial distribution of the magnetization intensity in and around Unzen Volcano and will provides important information regarding the temporal change in the geomagnetic field associated with the volcanic activity.

GP11C-0278 0830h POSTER

Study of Flow in a Rotating and Precessing Spheroid Using an Overlapping-Grid Finite-Difference Code

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A numerical code for solving the time-dependent incompressible dissipative MHD equations with finite differences on overlapping grids in a spheroid is being developed. It is based on a method developed by Henshaw (1994). In our code, the momentum equation for the velocity and the induction equation for the magnetic field are solved together with the Poisson equation for the pressure. The velocity and the magnetic field are advanced explicitly in time using a Runge-Kutta scheme. The grids are chosen to overcome pole and origin problems, which limit the time-step size, and to enhance spatial resolution at places where high resolution is required such as at boundary layers. We are using this code to study the fluid motion in a rotating and precessing spheroid, a significant problem in astrophysics and geophysics. In the non-magnetic case, the numerical solutions for both viscous and pressure couplings are consistent with those of Poincaré (1910) and Stewartson and Roberts (1963). Including the magnetic field, we are studying the dynamo action driven by the precession. We shall report the code structure, the boundary conditions, and the computational results in the studies mentioned above.

GP11C-0279 0830h POSTER

Modeling Subgrid Scales in Geodynamo Simulations

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Understanding of geodynamo mechanism is in progress through numerical simulations, although parameters employed are still far from those of the real Earth. Very small diffusivities must be adopted to carry out realistic numerical simulations. In reality, a range of spatial scales of convective motions in the core is very broad, from global core scales to dissipative scales. It is impossible, at the present, to resolve such small scales in global numerical simulations, but they cannot be neglected; large-scale fields are diffused much more effectively by turbulent eddies than by molecular processes. It is hence significant to model physical processes in subgrid scales. We have been performing direct numerical simulations (DNS) of magnetoconvective turbulence in a rapidly rotating system to understand its anisotropy and to model it for use in global geodynamo simulations. We have derived expressions of the turbulent flux for heat and momentum by second moment closure. Comparison of the turbulent flux estimated in the second-moment closure model with that obtained through DNS suggests that the model represents anisotropic eddy diffusivities well. It should be noted that values of Reynolds stress obtained through DNS are used to compute the turbulent heat flux in the model, for example. When we determine the turbulent flux for heat and momentum simultaneously in the model, we find that the realizability is not always satisfied. It is necessary to improve the model. We examine the scale similarity for results of DNS. We here apply a filter function to smaller regions into which the computational box in DNS is divided. Using values thus obtained, the turbulent heat flux is computed for the whole computational region. It turns out that there is a linear relationship between the turbulent flux and the relative length scale of smaller regions. By applying this relationship to larger scales, it is possible to model subgrid scales in numerical simulations.

GP11C-0280 0830h POSTER

Geodynamo Simulations Using a High Order Cartesian Magnetohydrodynamics Code

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Most numerical simulations of the geodynamo are cast in spherical geometry, using a spherical harmonic representation for lateral variations and an expansion in Chebyshev polynomials or discretisation in radius. A number of research groups have produced time dependent, three dimensional, self-consistent solutions to the geodynamo problem using this pseudospectral methodology. Computational limitations currently place a practical bound on the parameter regime that can be explored in this context, with values appropriate for Earth out of reach by several orders of magnitude. For the spherically pseudospectral codes, the absence of an efficient Legendre transform is a strong factor contributing to this limitation. As a first step towards alternative computational methods for geodynamo modelling, we have adapted an existing, efficiently parallelised magnetohydrodynamics (MHD) code, originally developed for weakly compressible, turbulent astrophysical MHD problems. The Pencil-Code (Dobler and Brandenburg, reference URL) is a Cartesian code that uses sixth-order finite differences, applied to "pencils" (i.e. array sections) in the x direction in a cache-efficient way. The domain is tiled in the y and z directions, with the communication of boundary elements handled by Message Passing Interface (MPI). Time stepping is via a third order Runge-Kutta method. The code's modular structure allows a flexible selection of various physical processes and variables, making it easily adaptable for many types of MHD problems, including the geodynamo. Modifications toward a viable planetary dynamo code include the implementation of the spherical shell geometry of Earth's outer core, and modifications of the hydrodynamic and thermodynamic modules towards the Boussinesq or anelastic approximations. We report on our current feasibility study and compare preliminary results with physically similar spherical computations and the geodynamo benchmark (Christensen et al., Phys. Earth Planet. Int., 128, 25-34, 2001).

URL: http://www.nordita.dk/data/brandenb/pencil-code/

GP11C-0281 0830h POSTER

Conceivable Scenario for the Earth's Collapsing Dipole and for the Increase of the Magnetic Pole Motion: Development of Geomagnetic Excursion

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A sharp increase in the velocity of motion of the geomagnetic pole has recently been detected and at present it is equal to 40 km per year, whereas almost prior to the end of the last century the velocity was equal to about 10 km per year. Furthermore, during the last 150 years the magnitude of the Earth's dipole moment has noticeably reduced. Such changes in the dipole motion and in the dipole moment are likely to point to onset of the inversion of the geomagnetic field or geomagnetic excursion, when the north geomagnetic pole can pass into Southern Hemisphere during the short time and then comes back. It is known that inversions(excursions) of the geomafnetic field are accompanied by a 2-4 fold decrease in the geomagnetic dipole value. Such changes in the intensity and configuration of the geomagnetic field are supposed to lead to drastic ecological and climatic changes on the time scale of 100-200 years. We have analyzed the development of the "Etrussia-Sterno"geomagnetic excursion, which occured 2600-2800 years ago. This excursion has been detected in 15 sites of the Northern and Southern Hemispheres in palaeo-and archeomagnetic data. During the "Etrussia-Sterno" geomagnetic excursion the north geomagnetic pole moved during 100-200 years to the Southern Hemisphere and then back along approximately the Greenwich meridian and the intensity of the geomagnetic field decreased by a factor of 1.5. The development of the excursion was accompanied by considerable climatic and ecological changes of the global scale. It has been found that this excursion was characterized by considerable decrease in temperatures at high and middle latitudes of the Northern Hemisphere and also droughts at the African continent. A substantial change in the level of the Caspian Sea has also been reveald. The development of geomagnetic excursion essentially changes the distribution of energetic particle fluxes (including cosmic rays) in the magnetosphere, the ionosphere and the atmosphere on global scale. Historical chronics poin to the development of coronal forms of aurora in the lower latirudes during time interval of the "Etrussia-Sterno"geomagnetic excursion. Redistribution of energetic particle fluxes during geomagnetic excursion produced more extensive radiation damage for geostationary satellites. Changes of the structure and intensity of cosmic ray fluxes in the atmosphere act on planetary atmospheric conditions and atmospheric circulation. The work was suppotred by RFBR (grants 03-05-65063 and 03-04-48769)

GP11C-0282 0830h POSTER

Confirming an Imminent Reversal From Information Content Analysis of a Simulated Geodynamo Compared With Present Global Field Models

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Concepts of information theory are applied to both global models (IGRF) of the geomagnetic field B of the last century and a dynamo simulation including a reversal. Temporal behavior of information content of the present observed field suggests that B is in a chaotic state characterized by timescales close to those of its westward drift and of the convective overturn in the outer core. The main implication of these results is the possibility that a geomagnetic reversal is currently in progress. Results from a selfconsistent 3d dynamo simulation have also been examined. This numerical model undergoes nearly periodic reversals with one reversal period covering roughly one dipole decay time, i.e. 20,000 years. The temporal behavior of the information content shows the expected linear decrease due to chaotic dissipation on two distinct time scales. A slow decrease with a memory time of 12,000 years reflects the slow internal reversal process. This is followed by a fast process with a memory time of 2,000 years, representing the field reversal at the core-mantle-boundary. The latter is ruled by the advective overturn time. After the reversal, the system increases its information content as if energized until it again reaches the level it had before the start of the process. Similarities to the behavior of information content in the observed global field models during the last century suggest that the geomagnetic field might be in the state of fast information decrease. This implies that the next polarity change might happen within the next 1,000 years.

GP11C-0283 0830h POSTER

Research on Seismo-Electromagnetic Precursors of Earthquake – New geomagnetic network of Taiwan

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In Taiwan, fluctuation in the geomagnetic field associated with change in tectonic stress is identified as one facet of the Research on Seismo-Electromagnetic Precursors of Earthquake program. A new geomagnetic network of twelve stations equipped with continuous recording systems will be completed before June 2003 by the Institute of Geophysics, National Central University. All stations are location in areas of high seismicity or crustal activity except the Kinmen station. The geomagnetic observation station on Kinmen Island will be a reference station in this network. The accuracy of the instruments will be 0.1 nT, the sampling rate is at 1 minute interval, and apart from being stored in the hard disks of the observation instruments, the geomagnetic data recorded will be relayed back to the National Central University Data center by way of telephone lines daily. In order to detect changes in geomagnetic field associated with tectonic stress, it is necessary to eliminate the changes originating from external sources in the observed data. A simple way is by using the differences of geomagnetic data between field stations and the reference station. The goals of this network will investigate the temporal geomagnetic variations, as well as their associated with earthquake occurrences and changes in tectonic stress.

GP11C-0284 0830h POSTER

Correlations Between Mass Disasters, Climate Change, Motion of the North Magnetic Pole and Nuclear Tests

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Essential data on the occurrence and effects of over 12,800 mass disasters in the world from 1900 to 2000 was analysed. The temporal behavior has clear exponential trend since 1970. The existence of modulation by solar activity is shown. All data are strongly correlated with the motion of the North Magnetic Pole, which has been drastically sped since early 70s (from 9 km/yr up to 40 km/yr). The same is valid for tropospheric heating, CH_4 and CO_2 growth and stratospheric cooling (anti-correlation). The hypothesis is proposed, that the shift of the pole has been initialized by nuclear tests, as far as atmospheric explosions shows clear correlation with slight oscillations of the pole, while intense underground tests in the end of 60s caused the trigger effect. Consequently, considering the motion of the magnetic pole as a marker of litospheric processes, their intensification is suggested, resulted in modification of the outwards thermal fluxes. Some possible positive feedbacks are discussed. Work was sponsored by Russian Science Support Foundation.

GP11D MCC: Level 1 Monday 0830h

Magnetic Anisotropy and Its Applications I Posters *(joint with T, V)*

Presiding: **W D MacDonald,** State University of New York at Binghamton**; B Housen,** Western Washington University

GP11D-0285 0830h POSTER

MAGNETIC PROPERTIES OF THE FOUM-ZGUID DYKE (SOUTH MOROCCO)

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This work focuses on the study of magma flow and propagation, using rock magnetic methods on a group of cross sections of the Foum-Zguid Jurassic dyke in Southern Morocco. Thermomagnetic analysis show that Ti-poor titanomagnetite is the main magnetic carrier and petrographic analysis shows that the main Ti phase (ilmenite) can be either as exsolution within magnetite (core of the dyke) or as isolated grains (dyke rim). Bulk magnetic properties display distinct behavior according to distance to the dyke rim; grain size of the main magnetic carrier decreases towards the core of the dyke, while the natural remanent magnetization and the bulk magnetic susceptibility increase. Only the magnetic susceptibility ellipsoid close to the dyke rim corresponds to that usually found in thin dykes, with the magnetic foliation parallel to dyke borders. Maximum principal axis is in most cases either parallel or perpendicular to the intersection between the planes of magnetic foliation and dyke wall. Moreover, when this axis is perpendicular to the intersection it is associated with a more oblate magnetic susceptibility ellipsoid shape, indicating the presence of complex magnetic fabrics. Magnetic properties show that flow structures related with dyke propagation are only preserved close to the fast cooled dyke rims.

GP11D-0286 0830h POSTER

The AMS of Dykes: Should Kmax Axes be Imbricated Everywhere?

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Most studies of the anisotropy of magnetic susceptibility (AMS) of dykes have assumed that the axes of maximum susceptibility (kmax) should define an opposed imbrication pointing along the direction of magma flow, and that this orientation should be preserved along the dyke. This assumption is supposedly based in a model predicting the orientation of ellipsoidal particles immersed in a moving liquid. However, this model actually predicts a cyclic movement of the ellipsoidal particles that has been overlooked without further justification. By using the complete model of ellipsoidal movement, we have developed a model of the expected AMS on different places within the dyke. A consequence of the cyclic movement of the particles is that the imbrication of kmax axes is not preserved along flow direction. Further, depending on the particle elongation ratio and on the amount of shear, it is possible to find an imbrication that is pointing in the wrong direction. Fortunately, by paying attention to the systematic variations of the orientation of the particles as predicted by the complete model of particle movement, it is possible to determine flow directions confidently. Moreover, our results explain satisfactorily recent observations of variations of AMS along flow direction in the same dyke, and provide simple explanations for many of the "abnormal" fabrics reported in many dyke swarms around the world.