from four sites from the south limb of the fold isolated a mean direction (D=177.4°, I=22.0°, K=8.5) similar to that found in an earlier study of the Maringouin Formation [DiVenere and Opdyke, 1990]. Chemical demagnetization in 3M HCl for up to 6 weeks was also used to isolate the characteristic remanence (ChRM) from 4 samples from each site. Anisotropy of magnetic susceptibility (AMS) was measured at each chemical demagnetization step to determine the AMS of the grains carrying the ChRM. Preliminary results from 3 sites indicate a shallower ChRM was isolated by chemical demagnetization (D=181.2°, I=2.6°, K=13.3), than by thermal demagnetization. The AMS data from 4 sites were used to make a correction for inclination shallowing as proposed by Tan and Kodama [2002] in their work on the Mauch Chunk Formation in Pennsylvania. The thermal demagnetization results from these sites were corrected by the AMS isolated between 3 and 6 weeks of chemical demagnetization. The results from the Maringouin Formation show a 22° steepening of the inclination once it is corrected for shallowing. The corrected paleopole for the Maringouin Formation lies at lat=21.6°N, long=117.0°E, α_{95}=29.9° which is within 13° of the corrected Mauch Chunk paleopole of Tan and Kodama [2002]. It is also reasonably close to a new, inclination-corrected paleopole from the Carboniferous magnetite-bearing Conemaugh Group sedimentary rocks of southwestern Pennsylvaniva (25°N, 106.5°E) [Kodama, 2004]. These results support the need for an inclination shallowing correction on continental red beds. They also may suggest that the North American apparent polar wander path, where it is heavily dependent on red bed-based paleomagnetic data, needs to be re-evaluated.

GP31A-14 0830h POSTER

Paleomagnetism, Geochronology, and Magnetic Mineralogy of Pleistocene Igneous Rocks, Ascension Island, South Atlantic Ocean

Michael J Valentine[1] (253-879-3129; mvalentine@ups.edu); Anna Burke[1] (253-879-3129; banannaburke@hotmail.com); John Devine[1] (253-879-3129; jdevine@ups.edu); Bradley S Singer[2] (608-265-8650; bsinger@geology.wisc.edu); Brian Jicha[2] (608-262-4927); Stephen W Field[3] (254-968-9887; field@tarleton.edu); M. Lee Allison[4] (785-864-3965; lallison@kgs.ukans.edu); Andrew Caruthers[1] (cherylthecat@yahoo.com)

[1]University of Puget Sound, Geology Dept., 1500 N. Warner, Tacoma, WA 98416, United States

[2]University of Wisconsin, Dept Geology & Geophysics, 1215 West Dayton St, Madison, WI 53706, United States

[3]Tarleton State University, Dept Physical Sciences, MS T0540, Stephenville, TX 76402, United States

[4]Kansas Geological Survey, University of Kansas, 1930 Constant Ave., Lawrence, KS 66047, United States

Paleomagnetic samples were collected from 92 sites on Ascension Island in May 2001 and May 2003. Paleomagnetic analyses of samples were performed at the University of Puget Sound paleomagnetic laboratory. Thus far, 43 sites have yielded normal directions, 12 have given reversed directions, and 6 have yielded directions with VGP latitudes of less than 70° (transitional?). Nineteen sites display too much scatter (a95 $> 10°$, k < 100) in paleomagnetic directions to be useful, and 12 sites are still being analyzed. When inverted, the mean direction for all reversed sites is statistically indistinguishable from that for normal directions. The mean value for all inverted reversed and normal sites combined is statistically indistinguishable from the direction expected for Ascension Island assuming a geocentric axial dipole field. Ar/Ar dating of 20 samples was completed at the University of Wisconsin, Madison. Ages range from 50.9±7.9 ka to 1086.2±15.2 ka. Ages and polarities indicate directions for dated units represent the Matuyama Chron, Brunhes Chron, and Jaramillo Subchron. Samples from 68 sites have been examined using reflected light microscopy at Tarleton State University. Optical examination confirms inferences from thermal demagnetization that magnetic mineralogy is largely dominated by titanomagnetite with some units containing significant hematite. Although several sites exhibit extensive post-eruptive alteration, most samples retain sufficient primary titanomagnetite to yield reliable primary, characteristic directions. Xenoliths in many samples exhibiting large scatter may significantly affect paleomagnetic directions. A substantial paleosecular variation (PSV) database has been compiled for the past 5 Ma, but numerous areas, including the South Atlantic, are underrepresented. This study will produce enough magnetic directions from the last million years or more to fill a gap in the PSV database, which can be used to test and refine emerging geodynamo models.

GP31A-15 0830h POSTER

Lineated Near Bottom Magnetic Anomalies Over an Oceanic Core Complex, Atlantis Massif (Mid-Atlantic Ridge at 30N)

Jeff Gee[1] (1-858-534-4707; jsgee@ucsd.edu)

Donna Blackman[1] (dblackman@ucsd.edu)

[1]Scripps Institution of Oceanography, UCSD, La Jolla, CA 92093, United States

Despite significant effort during the four decades since the Vine-Matthews-Morley hypothesis was first advanced, the relative importance of lower crustal (and possibly upper mantle) sources in generating lineated marine magnetic anomalies remains uncertain. Remanence measurements from samples obtained by drilling or dredging provide the most direct evidence that these deeper layers can be significant anomaly sources. Near bottom anomaly measurements over tectonic exposures of the lower crust/upper mantle can yield valuable complementary information (e.g., patterns of polarity boundaries) as well as provide constraints on the timing and uplift history of these exposures. Here we report results from a near bottom magnetic survey of the Atlantis Massif, an oceanic core complex that formed within the past 1.5-2 Myr at the intersection of the Mid-Atlantic Ridge (30N) and the Atlantis transform fault. Geological and geophysical data indicate the presence of gabbro and peridotite over much of the corrugated central dome, inferred to be the footwall of a detachment fault. A vector magnetometer deployed 25m aft of the deeply towed side scan sonar system allowed measurement of both the total field and horizontal and vertical anomalous fields. Five profiles across the central dome reveal a lineated anomaly low that was not evident in earlier sea surface profiles. The presence of lineated anomalies over presumed gabbro and ultramafic exposures may record the acquisition of remanence as these rocks were exhumed by detachment faulting. Anomaly profiles over the Lost City hydrothermal vent field exhibit a pronounced magnetic low (reversed polarity), suggesting that active serpentinization is not responsible for the overall magnetization pattern. When combined with results from planned IODP drilling at the site, these data should provide significant insights into the importance of gabbro and peridotite lithologies as sources for lineated magnetic anomalies.

GP31A-16 0830h POSTER

Fault and fold interference in the core of an orocline: preliminary paleomagnetic and structural results from the Western European Variscan Belt, NW Iberia

Arlo Brandon Weil (610-526-5113; aweil@brynmawr.edu)

Bryn Mawr College, Department of Geology 101 North Merion Ave., Bryn Mawr, PA 19010, United States

This study reports new paleomagnetic and structural analysis of the inner core of the Western European Variscan Belt (WEVB), northern Iberia in order to test opposing kinematic models for the well-documented fault and fold interference structures formed by late-stage Variscan deformation. Map-scale structural features within the WEVB core have a highly sinuous geometry characterized by transverse and thrust parallel fold systems formed by fault-bend folding over footwall ramps. The intersections of these two fold systems produce steeply plunging interference folds, which are best exposed in the Ponga and Esla thrust units. A total of 110 sites were collected in these units, with emphasis placed on detailed coverage of individual structural domains. Paleomagnetic and structural analysis in the outer horseshoe portion of the thrust belt suggest that the most viable kinematic model for Variscan deformation in northern Iberia is oroclinal bending of an originally linear belt in a two-stage tectonic history. This history represents two regional compression phases (E-W in the Late Carboniferous and N-S in the Permian - both in present-day coordinates), which resulted in the refolding (about steeply plunging axes) of initially north-south-trending thrusts and folds in the hinge zone, and arc tightening due to vertical-axis rotation of the belt's limbs. However, the orocline model has yet to be critically tested in the arc's core where the main structural features are dominated by east-west trending transverse structures that are likely the result of space accommodation during arc formation. Two kinematic models have been proposed for fold and thrust evolution in the core of the arc. The first model proposes that the complex fault and fold patterns result from lateral and frontal hanging-wall ramp interference during initial east-west shortening. Such a kinematic model requires that existing footwall ramp geometries controlled the formation and location of steeply plunging folds, with map curvature being accommodated by rotations around sub-horizontal axes. The second model argues for the modification of pre-existing, west-dipping, frontal hanging wall ramps during late-stage deformation. In this model map-scale curvature is dominated by vertical-axis rotation. Preliminary results from this study indicate that the steeply plunging interference folds found in the WEVB core are best described by late-stage modification of a much more linear fold-thrust system, and not by interference corner folding due to the complex interactions of frontal and lateral ramps. Such a model is in good agreement with the oroclinal-bending model for the WEVB.

GP31A-17 0830h POSTER

Pleistocene Magnetostratigraphy of the Gonghe Basin, NE Tibetan Plateau: Headward Incision of the Yellow River after 1.8 Ma

Maodu Yan[1] (1-734-763-2149; maoduyan@umich.edu)

Josep M Pares[1] (1-734-615-0472; jmpares@umich.edu)

Rob Van der Voo[1] (voo@umich.edu)

David K Rea[1] (davidrea@umich.edu)

Xiao-min Fan[2,3] (fangxm@lzu.edu.cn)

[1]Maodu Yan, Department of Geological Sciences, University of Michigan, Ann Arbor, MI 48109, United States

[2]Xiao-min Fang, National Laboratory of Western China's Environmental System, Ministry of Education, & College of Resources and Environment, Lanzhou University, Lanzhou, GS 730000, China

[3]Xiao-min Fang, State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, CAS, Xi'an, SX 710054, China

Headward incision in the upper reaches of the Yellow River is closely related to the uplift of the NE Tibetan Plateau. In the Gonghe Basin, NE Tibetan Plateau, the Yellow River and its tributaries have incised more than 600 m into Neogene sediments. This incision is responsible for a change in the depositional environment of the Neogene strata from a lacustrine internal-drainage system to coarse fluviatile gravel deposition. This transition of sedimentary character (from aggradation stage to degradation stage) represents the arrival of the Yellow River in the Gonghe Basin. Dating the incised sediments will give an age constraint for the (earliest) appearance of the Yellow River in that area. Our two magnetostratigraphic sections in the Gonghe Basin both contain two polarity zones (a reversed polarity zone in the lower part and a normal polarity zone in the upper part), which are through fossils constrained to be post-Olduvai. This means that the normal polarity zone is Jaramillo or even Brunhes. So the gravels and, hence, the appearance of the Yellow River in the basin, are Jaramillo in age or younger. Combined with previous studies in the Lanzhou, Linxia, Guide and Zoige basins, it is clear that, by headward incision, the Yellow River cut through the gorges in between Lanzhou and Guide and reached the Guide Basin at about 1.8 Ma, then cut through the Longyang Gorge from Guide to the Gonghe Basin after 1.1 Ma, and finally incised through the Jungong Gorge to reach the Zoige Basin at about 10 ka.

GP31B CC: 220 C-E Wednesday 0830h

Four Decades of Paleomagnetism in Canada I Posters *(joint with T, V)*

Presiding: **M T Cioppa,** University of Windsor**; M A Hamilton,** University of Toronto

GP31B-01 0830h POSTER

Variation in Magnetization Ages of Devonian and Mississippian Carbonates in the Western Canada Sedimentary Basin

Maria T. Cioppa[1] (519-253-3000 x 2502; mcioppa@uwindsor.ca)

David T.A. Symons[1] (519-253-3000 x 2493; dsymons@uwindsor.ca)

Ihsan Al-Aasm[1] (519-253-3000 x 2494; alaasm@uwindsor.ca)

[1]Department of Earth Sciences, University of Windsor, 401 Sunset Ave., Windsor, ON N9B 3P4, Canada

In the Western Canada Sedimentary Basin (WCSB), reservoir-specific paleomagnetic research has shown

that the age of the characteristic remanent magnetizations (ChRMs) in Devonian and Mississippian carbonates is primarily related to Laramide orogenesis, with some degree of variability apparent. Certain reservoirs or diagenetic phases have ChRMs of either latest Cretaceous or Tertiary age, have depleted oxygen isotopic signatures indicative of major recrystallization and / or fluid flow, have enriched strontium isotopic signatures, and have relatively large grain size e.g. Keg River Rainbow A reservoir, Wabamun Limestone mesodolomite, Mount Head Waterton dolomite, and the Sulphur Point Rainbow South saddle dolomite. In other reservoirs or diagenetic phases, the ChRM age is more variable (early Jurassic to mid Cretaceous), and the oxygen isotope values are less depleted or show a trend away from postulated sea water values, suggestive of partial rather than complete recrystallization e.g. Turner Valley Moose Reservoir, and Rainbow South fine and medium crystalline dolomites. Finally, specific diagenetic phases from three reservoirs show residual primary (syndepositional) magnetization along with a Cretaceous overprint and isotopic values consistent with postulated Mississippian or Devonian sea water values e.g. Waterton anhydrite, Rainbow South limestone, and Debolt Dunvegan fine crystalline dolomite. From the above results, we suggest that the rock permeability may significantly influence the observed ChRM age. Lithology and facies strongly affect permeability, and the more permeable phases are more likely to have been totally remagnetized. The influx of external basin-derived diagenetic fluids is dependent on permeability, and is evident in the resetting of oxygen and strontium isotopic values. Where primary isotopic values are preserved, there is often evidence for a syndepositional magnetization. As well, the degree of recrystallization - perhaps corresponding with burial depth and fluid type - of the carbonate phases is a strong influence on the observed ChRM: the more recrystallization, the more likely remagnetization. Thus, in the WCSB, the observed ChRM reflects the interplay of the above factors under local reservoir conditions. However, we cannot eliminate the possibility that the latest Cretaceous / early Tertiary ChRMs are due to tectonically-induced fluid flow through the basin.

GP31B-02 0830h POSTER

Preliminary Paleomagnetic Results From Late Cretaceous Volcanic Rocks of Northern Ellesmere Island, Canada

Daniel Sinnett[1] (ds00k2@mail.rochester.edu)

John A Tarduno[1] (john@earth.rochester.edu)

Rory D Cottrell[1] (rory@earth.rochester.edu)

[1]Department of Earth and Environmental Sciences University of Rochester, 227 Hutchison Hall, Rochester, NY 14627, United States

We report new paleomagnetic results from Late Cretaceous volcanic rocks found on northwestern Ellesmere Island (present-day latitude of 81-82^o N). These rocks, which are preserved in relatively small fault-bounded basins, appear to be younger than the widespread ∼95 Ma volcanic rocks of the Strand Fiord Formation, which have yielded paleomagnetic data that indicate latitudinal coherency with cratonal North America (Tarduno et al., 2002). Standard field-drilled samples were collected and all samples were oriented with a Sun compass (due to the high diurnal variation of the field at the sampling site). Initial results of detailed alternating field (5 mT steps to 80 mT) and thermal demagnetization (25 ^{o}C temperature steps, 50-650 ^{o}C) experiments confirm that these rocks are younger than the Strand Fiord volcanics (which formed during the Cretaceous Normal Polarity Superchron); the flows form a stratigraphic section exposed near Audhild Bay that yield reversed polarity characteristic remanent magnetizations, corresponding to chron 33r (or a more recent reversed polarity chron). Further paleomagnetic and rock magnetic data data from these rocks will be presented, as well as the implications of these results for magmatism in the Amerasian basin.

GP31B-03 0830h POSTER

U-Pb Age and Preliminary Paleomagnetism of a Melville Bugt Diabase Dyke, West Greenland, and Implications for Mid-Proterozoic Laurentia-Baltica Reconstructions

Michael A. Hamilton[1] (mahamilton@geology.utoronto.ca)

Kenneth L. Buchan[2] (KBuchan@NRCan.gc.ca)

Adam A. Garde[3] (aag@geus.DK)

James N. Connelly[4] (connelly@mail.utexas.edu)

[1]Jack Satterly Geochronology Lab, Dept. of Geology, University of Toronto, Toronto, ON M5S 3B1, Canada

[2]Geological Survey of Canada, 601 Booth Street, Ottawa, ON K1A 0E8, Canada

[3]Geological Survey of Denmark and Greenland, DK-1350, Copenhagen, Denmark

[4]Dept. of Geological Sciences, University of Texas at Austin, Austin, TX 78712, United States

The NW to WNW trending, mildly-alkaline Melville Bugt (MB) dyke swarm represents an enormous volume of fresh, undeformed, olivine-bearing gabbro emplaced over a minimum of 1000 km of strike length across Archean and Paleoproterozoic crust during mid-Proterozoic time. The swarm includes numerous, very large dykes, individually up to at least 150m thick. One dyke that extends for 400 km [1,2] was sampled on the south coast of Nuussuaq, east of Disko Island. Here, the dyke is a 70m wide, near-vertical, medium- to coarse-grained, olivine diabase with well-defined chilled margins. This dyke previously yielded a Rb-Sr WR age of 1645±35 Ma [1] suggesting a unique occurrence of extension-related magmatism in the cratonic interior of NE Laurentia at this time. Abundant, prismatic baddeleyite recovered from the dyke are less than 1% discordant and yield a precise U-Pb age of 1629±1 Ma, interpreted as a more robust estimate of the magmatic crystallization age. Seven paleomagnetic samples from the dated dyke, a satellite dyke and baked host rocks are stably magnetized with a mean direction of D=12^o, I=34^o (α_{95}=13^o) and corresponding virtual geomagnetic pole (VGP) at 38°N, 115°E (dm=15°, dp=9°). This VGP does not average out secular variation and has not been established as primary. The MB remanence is distinct from potential overprints due to nearby West Greenland Tertiary volcanism, and the metamorphic grade of the dyke is low. If the VGP for the MB dyke is primary, then it can be compared with primary Baltica paleopoles of similar age to assess Laurentia-Baltica reconstruction at 1630 Ma. The result derived thereby differs from published reconstructions based on tightly constrained data at 1270-1265 Ma from both cratons. This suggests that Laurentia and Baltica did not drift as a unit throughout the period 1630-1267 Ma, or that the MB VGP is not primary. Further sampling of other MB dykes is necessary to average out secular variation, and to carry out a baked contact test to establish whether the MB remanence is primary. [1] *Kalsbeek and Taylor (1986) Contrib. Min. Pet., 93, 439-448;* [2] *Nielsen (1990) Mafic Dykes and Emplacement Mechanisms, 497-505.*

GP33A CC: 220 C-E Wednesday 1330h

Comparing Magnetic Field Generation in the Earth and Planets Posters *(joint with G, P, T, V)*

Presiding: **M Heimpel,** University of Alberta**; J Aurnou,** University of California, Los Angeles

GP33A-01 1330h INVITED POSTER

Uranus' and Neptune's Unusual Magnetic Fields: a Result of Their Convective Region Geometry

Sabine Stanley[1] (stanley@geophysics.harvard.edu)

Jeremy Bloxham[1] (jeremy_bloxham@harvard.edu)

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

In an effort to model the Earth's magnetic field, current numerical dynamo models have produced fields dominated by an axial dipole. In these models, the dynamo is usually generated by convection in a thick, electrically conducting fluid shell surrounding a solid conducting inner core. The Voyager II observations of Uranus and Neptune revealed that these planets have non-dipolar, non-axisymmetric magnetic fields, in sharp contrast to the axially dipolar fields of Earth, Jupiter and Saturn. Determining why Uranus and Neptune possess a different field morphology is crucial for the study of these planets' interiors, as well as for understanding the dynamo process in all planetary bodies. Uranus' and Neptune's magnetic fields are most likely generated in their ionically conducting 'ice' shells. Thermal evolution models for Uranus and Neptune (Podolak et al. 1991, Hubbard et al. 1995) suggest that interior portions of these ice shells may be compositionally stably stratified and therefore unable to convect. This suggests that Uranus and Neptune may possess a different convective region geometry from the other planets: their dynamos may be generated in a thin convecting shell surrounding a stably-stratified fluid interior. We have implemented this geometry in the Kuang and Bloxham 3-D numerical dynamo model and found the resulting magnetic fields contain significant non-dipolar, non-axisymmetric structure, similar to those of Uranus and Neptune. Here we examine the dynamical processes causing this field morphology in our numerical models. We discuss the interactions between the convectively stable and unstable shells, and between the velocity and magnetic fields. We also examine the partitioning of energy into the various components of the field (axi- and nonaxisymmetric, toroidal and poloidal) and compare these characteristics to numerical dynamo models operating in thin shells surrounding solid inner cores.

GP33A-02 1330h INVITED POSTER

Compositional Dynamo in Mars and the Moon

Stephane Labrosse[1] (labrosse@ipgp.jussieu.fr)

Denis Andrault[1] (dandrau@ipgp.jussieu.fr)

[1]Institut de Physique du Globe de Paris, 4, place Jussieu, Paris cedex 5 75252, France

Recent planetary missions to Mars have shown that there once was a very energetic dynamo acting in its liquid core and that this dynamo is now extinct. Two options concerning the timing of this dynamo are highly debated, either early or delayed. The early dynamo has the advantage of being readily explained by thermal convection, that stops when the heat flow across the core mantle boundary drops below that conducted down the adiabatic temperature gradient. The delayed dynamo is more difficult to explain in this framework, since it requires a non monotonic heat flow history. However, such a timing is required to explain lunar magnetism by dynamo action operating between 4 and 3 Ga in its core. Here we explore the possibility of a dynamo sustained by compositional convection, which is known to operate more efficiently than thermal convection in the Earth core. Compositional convection is triggered by the onset of crystallisation of an inner core if the composition of the core is on the iron rich side of the eutectic. The gradual growth of the inner core leads to a change of composition of the outer core, until the eutectic is reached, shutting down compositional convection. Using all available data on the phase diagram of iron alloys, in the range of pressure relevant to cores of Mars and the moon, we determine the conditions that make possible this scenario.

GP33A-03 1330h INVITED POSTER

Earth-Based Measurements of Mercury's Forced Librations in Longitude

Jean-Luc Margot[1] (310 825 0632; jlm@ess.ucla.edu)

Stan Peale[2] (peale@io.physics.ucsb.edu)

Raymond F Jurgens[3] (jurgens@shannon.jpl.nasa.gov)

Martin A Slade[3] (Martin.A.Slade@jpl.nasa.gov)

Igor V Holin[4] (holin@mail.cnr.ru)

[1]UCLA Department of Earth and Space Sciences, 595 Charles Young Drive East, Los Angeles, CA 90095, United States

[2]UC Santa Barbara, Department of Physics, United States

[3]Jet Propulsion Laboratory, 4800 Oak Grove Drive, United States

[4]Space Research Institute, Moscow, Russian Federation

As Mercury follows its eccentric orbit (e ∼0.206) with near-zero obliquity, it experiences periodically reversing torques due to the gravitational influence of the Sun on the asymmetric figure of planet. The torques affect the spin angular momentum and cause small deviations of the spin frequency from its resonant value of 3/2 times the mean orbital frequency. The resulting oscillations in longitude are called forced librations because the forcing and rotational response occur with a period dictated by the orbital motion (P ∼88 days). The measurement of the forced librations can provide important information about the state and size of the core of Mercury, as demonstrated by Peale (1976). In order to determine the libration amplitude, we implemented a new Earth-based radar technique to measure planetary spins based on a description by Holin (1988,1992). Since May 2002, we have accumulated about a dozen measurements of the spin rate with a fractional uncertainty of 1 part in 10^5. Because the spin rate deviations due to the librations are predicted to be of order 2 arcseconds per day for a solid planet, corresponding to 1 part in 10^4 of the spin rate, our measurements can be used to measure the librational response of the planet. A libration amplitude much larger than that expected for a solid planet would indicate that the mantle is decoupled from the core and would suggest a liquid outer core. This situation would strengthen the possibility of a dynamo in a thin shell at Mercury.