[1]SPbF IZMIRAN, Muchnoy per. 2, P.O. Box 188, St. Petersburg 191023, Russian Federation

[2]Ioffe Physical-Technical Institute of RAS, Politechnicheskaya 26, St. Petersburg 194021, Russian Federation

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

Angelo De Santis[1] (+39 06 51860327; desantis@ingv.it)

Roberta Tozzi[1] (+39 06 51860389; tozzir@ingv.it)

Johannes Wicht[2] (+49 5556 979 437; wicht@linmpi.mpg.de)

[1]Istituto Nazionale di Geofisica e Vulcanologia - INGV, Via di Vigna Murata 605, Rome 00143, Italy

[2]Max Planck Institut für Aeronomie, Max-Planck-Str. 2, Katlenburg-Lindau 37191, Germany

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

Horng-Yuan Yen[1] (yenhy@earth.sinica.edu.tw)

Yih-Hsiung Yeh[2] (yehyh@earth.sinica.edu.tw)

. iSTEP Group[1] (bubble@geps.gep.ncu.edu.tw)

[1]Institute of Geophysics, National Central University, Chung-Li, Taiwan, ROC, No.300 Jung-da Rd., Jungli 320, Taiwan

[2]Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan, ROC, 128 Academia Road Sec. 2, Nankang, Taipei 115, Taiwan

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

Andrey N Lyakhov (+7-095-939-79-69; alyakhov@idg3.chph.ras.ru)

Institute of Geospheres Dynamics, Leninskij pr-kt, 38, korp.1, Moscow 119334, Russian Federation

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)

Pedro M Silva[1,2] (351217500809; pmfsilva@fc.ul.pt); Jorge Miguel Miranda[1] (351217500809; jmiranda@fc.ul.pt); Fernando Ornelas Marques[1] (fmarques@fc.ul.pt); Bernard Henry[3] (bhenry@ipgp.fr); Antonio Mateus[4] (amateus@fc.ul.pt); Nuno Lourenco[1] (nlouren@fc.ul.pt)

[1]CGUL, FCUL, Campo Grande, Ed C8, Lisboa 1749-016, Portugal

[2]ISEL, Rua Conselheiro Emídio Navarro, 1, Lisboa 1950-062, Portugal

[3]IPGP, 4 Av. de Neptune, Saint-Maur, Paris 94107, France

[4]CREMINER, FCUL, Campo Grande, Ed C6, Lisboa 1749-016, Portugal

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?

Maria Jazmin Chavez-Alvarez[1] (01152646-1750500; jchavez@cicese.mx)

Edgardo Cañón-Tapia[1] (01152646-1750500; ecanon@cicese.mx)

[1]CICESE, Dept. of Geology, P.O. Box 434843, San Diego, CA 92143, United States

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.

GP11D-0287 0830h POSTER

Magnetic Anisotropy and Paleomagnetic Studies in Relation to the Tectonic Evolution of the Miocene-Pleistocene Accretionary Sequence in the Boso and Miura Peninsulas, Central Japan

Toshiya Kanamatsu[1] (+81-468-67-9331; toshiyak@jamstec.go.jp)

Emilio Herrero-Bervera[2] (808-956-6192; herrero@akolea.soest.hawaii.edu)

[1]Japan Marine Science And Technology Center, 2-15 Natsushima -cho, Yokosuka 237-0061, Japan

[2]SOEST-HIGP, University of Hawaii, 1680 EAST WEST ROAD, Honolulu, HI 96822, United States

In order to distinguish the invisible deformation sense as well as the intensity of deformation of sediments, anisotropy of magnetic susceptibility (AMS) and paleomagnetic methods have been applied on the middle Miocene-Pleistocene accretionary sequence in the Boso and Miura Peninsulas of central Japan. These peninsulas were formed in an arc-arc tectonic collision with subdivisions of two contrasting tectonic provinces: the southern province, which is a highly deformed accretionary prism and slope basin, and the northern province, which is a gently deformed forearc basin. The sequence in the southern province is associated with abundant synsedimentary deformation structures of folding and faulting generated in accretionary tectonics. Results of the AMS experiment of the sequence show the developing of a strong magnetic lineation. It is conceivable that such lineation had to be generated during the process of deformation, and in a direction perpendicular to the shortening of the fabric of the rock still in an unconsolidated state. Such magnetic lineations reconstructed by the paleomagnetic declinations reveal a more complicated localized rotation at the accretionary prism and slope basin area. These lineations show a consistent pattern in the east-west direction in each region. It also suggests that the sedimentary sequence was subjected to a north-south compression, although the compressive direction since 3 Ma ago has been in the northwest direction caused by the subduction of the Philippine Sea Plate. Our results indicate a northward subduction system of the Philippine Sea plate during the middle Miocene-Pliocene, and also a change in the subduction direction at about 3 Ma.

GP11D-0288 0830h POSTER

Magnetic versus Crystallographic Fabrics in Basaltic Lava Flows

Jerome Bascou[1] (33-467143944; bascou@dstu.univ-montp2.fr)

Pierre Cr. Camps[1] (33-467143938; camps@dstu.univ-montp2.fr)

Guillaume Plenier[2] (plenier@cerege.fr)

Jean-Marie Dautria[1] (33-467143293; dautria@dstu.univ-montp2.fr)

[1]Laboratoire de Tectonophysique, CNRS and ISTEEM, Université Montpellier 2, cc049,Pl. E. Bataillon, Montpellier 34095, France

[2]CEREGE, Université Aix Marseille III, BP 80, Europôle méditerranéen de l'Arbois, Aix en Provence 13545, France

Indicators of flow direction and sense in lava flows are often difficult to observe. To overcome this difficulty, anisotropy of magnetic susceptibility (AMS) can be used. However, a major issue is to know how consistently the axes of magnetic susceptibility (K1, K2 and K3) correlate with the flow direction.
We carried out a systematically sampling of the base, the middle part and the top of lava flow for which the flowing directions are well known. These quaternary flows, located in the area of Pézenas (southern France), are pluri - kilometric long, between 2 and 10 m thick, rather narrow (< 500 m) and characterized by a weak slope (<10°). Oriented cores offer an opportunity to investigate the relationships between flow direction, principal susceptibilities and crystallographic preferred orientations (shape and lattice orientations) of rock-forming minerals.
In thin-section, the opaque grains observed in reflected light are abundant (about 5 percent) and the largest in size (15-20 μm) are sub-automorphous. Microsonde analyses and thermomagnetic curves measured in the range 80 - 900 K indicate that titano magnetite (x = 0.6) is the dominant oxide mineral. FORC diagrams reveal that the magnetic grain sizes are both PSD-MD and PSD-SD assemblages. AMS measurements from 180 specimens reveal a tight clustering of the K3 axes close to the vertical and a weaker degree of clustering of K1, K2 axes. A significant enhancing of the magnetic fabric is observed after demagnetization by thermal treatment. Lattice Preferred Orientation (LPO) measurements of titano magnetite and plagioclase were performed using the electron backscattered diffraction (EBSD) technique. The highest fabric strength is observed from plagioclase measurements and the LPO of this mineral are correlated to the flow dynamic. For the samples collected from near the flow base a good correlation is observed between the AMS ellipsoid axes and the LPO of plagioclase: the K1 axis is close to the maximum concentration of the [001] axes, the K2 axis is close to the maximum concentration of [100] axes and the K3 axis is close to the preferential orientation of the (010) poles. The angle between the K3 axes and the vertical plane define a significant flow related imbrication of the magnetic foliation that can be used to infer the flow direction. Determination of relationships between the AMS axes and the flow related LPO of the plagioclase may represent a valuable constraints to interpret the ASM signature in lava flows.

GP11D-0289 0830h POSTER

An Example of Inverse Magnetic Fabric in a Lava Pile From the Kerguelen Archipelago

Guillaume Plenier[1] (rochette@cerege.fr)

Jerome Bascou[2] (jerome.bascou@dstu.univ-montp2.fr)

Jerome Gattacceca[3] (gattacceca@cerege.fr)

Pierre Camps[2] (pierre.camps@dstu.univ-montp2.fr)

Pierre Rochette[3] (rochette@cerege.fr)

[1]Earth Science Departement, University California, Santa Cruz, CA 95064, United States

[2]ISTEEM, Université Montpellier 2, Montpellier 34095, France

[3]CEREGE, BP80, Aix en Provence 13545, France

Because of their low degree of anisotropy associated with a relatively high magnetic susceptibility, AMS measurements of lava flows often provide scattered results and a large number of sample is needed to well define the mean directions. However, the use of complementary AMS methods combined with other technics allow to infer flowing directions of lava piles. Such a study was performed on six volcanic sections (9 up to 20 lava flows) from the Kerguelen Archipelago(southern Indian Ocean) in order to complete regional geological observations of Nougier (1970) and identify the locations of the different eruptive centers. Unfortunately, one of these sequences, the Mont de la Rabouillère, yielded an unexpected inverse fabric which did not allowed us to undoubtly interpret its flowing direction. We thus present a detailed analysis of this particular section including an additional AMS study on the same samples but at a demagnetized state. To complete this approach, we determined the anhysteretic remanent anisotropy (ARA) of theses samples to compare the magnetic fabrics obtained. Also further rock magnetic studies were performed. Normal and high resolution FORC analysis of one sample per flow were realized in order to detect eventual characteristic signatures associated with the inverse fabric. Endly, an Electron BackScattered Diffraction analysis (EBSD) of one thin section allowed to determine the cristalline orientation of the plagioclases to check its relation with the magnetic signal. Surprisingly, the [001] axis of the plagioclase minerals was found to be aligned with the mean kmax determined using the AMS. The study is still on progress but our preliminary interpretations indicate that the inverse magnetic fabric can be used to infer a confident flowing direction for this section. J. Nougier, 1970. Contribution a l'etude geologique et geomorphologique des iles Kerguelen. C.N.F.R.A., Vol 27, 2 tomes, 440pp and 256pp

GP11D-0290 0830h POSTER

Magnetic Anisotropy in Carbonate Rocks: Revisiting the Carrara Marble

Volkmar Schmidt[1] (+41 1 633 2626; schmidt@mag.ig.erdw.ethz.ch)

Ann M Hirt[1] (hirt@mag.ig.erdw.ethz.ch)

Bernd Leiss[3] (bleiss1@gwdg.de)

Pascal Piguet[2] (piguet@erdw.ethz.ch)

Luigi Burlini[2] (burlini@erdw.ethz.ch)

[1]ETH-Zurich, Institute of Geophysics, ETH Hoenggerberg, Zurich CH-8093, Switzerland

[2]ETH-Zurich, Geological Institute, Zurich CH-8092, Switzerland

[3]Geoscience Center of the University of Goettingen, Goldschmidtstr. 3, Goettingen D-37077, Germany

Magnetic anisotropy has been used in numerous investigations since the 1950's as an indicator of petrofabric. In deformed rocks the anisotropy of magnetic susceptibility (AMS) has been shown to qualitatively, and sometimes quantitatively reflect finite strain. In low-field AMS all minerals contribute to the measured anisotropy. Over the past years several methods have been used to isolate different components to the AMS. Various high-field methods are used to separate the paramagnetic, diamagnetic and high coercivity antiferromagnetic components from the ferrimagnetic component. In spite of these advances, our understanding of the factors controlling the total AMS signal in a rock remains limited, which has hampered the quantitative use of magnetic fabrics in deformation studies. This is partly due to the limited data available on the intrinsic anisotropy of single mineral crystals. Calcite is one mineral whose AMS is well-determined. Earlier studies have shown that the magnetic fabric in deformed pure marble can be related to the crystallographic orientation of the calcite crystals (Owens and Rutter, 1978, PEPI, 16 2115; deWall et al., 2000, J. Struct. Geol., 22, 1761). De Wall et al (2000) were able to model quantitatively the AMS from the mineral fabric and AMS of calcite for coarse-grained marbles, but were less successful for fine-grained ones. In this study we have used low-field AMS and high-field torque magnetometry to isolate the diamagnetic signal of Carrara marbles. The magnetic fabric has been compared with the calcite fabric in the rocks. Preliminary results will be presented of synthetic calcite aggregates prepared from Carrara marble powder, which was initially uniaxially cold pressed at different amount of load, in order to induce a c-axis maximum type of fabric of various strength, and compare it with the magnetic anisotropy. This was later Hot Isostatic Pressed at about 150 MPa and 700° C to reduce porosity and increase/homogenize the grain-size. In this way we could compare a defined deformation (compaction) with mineral fabric and AMS. Our project will continue adding white mica to the Carrara marble powder, in order to obtain synthetic samples of controlled proportion of calcite and mica, and controlled fabric. The final goal will be to show if it is possible to separate the contribution of the mica from that of the calcite to the total AMS.

GP11D-0291 0830h POSTER

Magnetic Fabric Development During Hydrothermal Alteration And Brittle Deformation In Granite From The EPS-1 Drilling, (Soultz-sous-Forêts, France)

Jana Just[1] (jana.just@urz.uni-heidelberg.de)

Agnes Kontny[1] (agnes.kontny@urz.uni-heidelberg.de)

Helga deWall[2] (deWall@urz.uni-wuerzburg.de)

[1]University of Heidelberg Geol.-Pal. Institute, INF 234, Heidelberg 69120

[2]University of Würzburg, Pleicherwall 1, Wuerzburg 97070

The EPS-1 drilling occurs within the Upper Rhine Graben and penetrates Variscan granites from 1420 to 2200 m depth. According to studies of Traineau et al. (1991) two main hydrothermal alteration stages were determined. An early propyllitic and pervasive alteration took place during cooling and uplift history of the pluton. The multiphase evolution of the Cenozoic rift was accompanied by an intense brittle deformation of the pluton causing a vein alteration within discrete fault zones and their wall rocks. We present a rock-magnetic and fabric study of the fresh, pervasive and vein-altered granite comparing petrofabrics, fracture patterns and the anisotropy of magnetic susceptibility (AMS). AMS is caused by the directional dependence of the magnetic susceptibility based on the distribution of magnetic minerals, mostly Fe oxides. The magnetic foliation in the fresh granite is interpreted as a magmatic flow fabric which is oriented almost horizontal in the deeper part and reveal a steeper dip-values in the upper part according to wrench tectonics (Ziegler, 1986) during Variscan time. The AMS ellipsoids of the fresh granites show only oblate shapes with relative high magnetic anisotropy due to the association of clustered magnetite with Fe-Mg silicates describing the weak magmatic foliation. The magnetic foliation in the pervasive altered granite reveals similar orientations as the fresh granite with steeper dip-values indicating formation in a similar paleostress field. This alteration caused a major transformation of magnetite to hematite, started with the growth of hematite platelets relative to the {111} planes of magnetite expressed by low magnetic anisotropies. The magnetic foliation of the vein-altered granite is randomly oriented according to the multiphase Cenozoic rifting with successive compressional and extensional paleostress directions. New formed minerals like hematite show crystal growth in the veins but also due to the alignment of altered minerals. Both pervasive and vein-altered granites display oblate as well as prolate ellipsoids. The decreasing effect of magnetite and the increasing influence of new formed minerals like hematite, illite and Fe carbonates on the shape and orientation of the AMS ellipsoid will be demonstrated using AMS measurements performed at different temperatures. Traineau et al., 1991. Geotherm. Sci. Techn., 3(1-4), 1-29. Ziegler et al., 1986. Tectonopysics, 126, 303-328.