source for the older sediments. This demonstrates that provenance variations are just as important as paleoclimate in controlling clay mineralogy and magnetic properties in the VLB.

GP41B MCC: Level 1 Thursday 0830h

Environmental Magnetism II Posters

Presiding: **T Evans,** University of Alberta**; A Roberts,** University of Southampton

GP41B-0045 0830h POSTER

Determining of Grainsizes of Susceptibility and Anhysteretic Remanent Magnetization Carriers in Chinese Loess-Paleosol Ssequences

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Detailed rock magnetic studies show that susceptibility (mass-specific χ) and anhysteretic remanent magnetization (ARM) of the Chinese loess/paleosol sequences are carried by almost identical magnetic carriers. Therefore, the ratio $\Delta\chi/\chi_{ARM}$ (or equivalently $\chi_{ARM}/\Delta\chi$, where $\Delta\chi$ is background-corrected χ, and χ_{ARM} is field normalized ARM) can be used to quantify the grainsize of χ and ARM carriers. By determining this ratio for three Chinese loess/paleosol profiles (Jiuzhoutai, Yuanbao, and Yichuan) characterized by different degrees of environmentally controlled pedogenesis and sedimentation rates, we show that the lower grainsize limit of aeolian magnetic particles in the less pedogenically-altered loess units is about 100-300 nm, in the finer-grained pseudo-single domain (PSD) grainsize range. In contrast, the grainsizes of pedogenically-produced magnetic particles for mature paleosols dominantly cover both the superparamagnetic (SP) and single-domain (SD) ranges. Based on plots of $\Delta\chi/\chi_{ARM}$ against $\Delta\chi$, the samples can be divided into four regions (I, II, II, and IV). Region I corresponds to the least pedogenically-altered primary loess samples, with $\Delta\chi/\chi_{ARM}$ of 0.165-0.24. Samples in region II, a transition zone between the least altered loess and the onset of development of paleosols, have χ values identical to those in region I, but have lower $\Delta\chi/\chi_{ARM}$ of 0.09-0.165. With increasing susceptibility in zone III, $\Delta\chi/\chi_{ARM}$ is positively correlated with χ, indicating the gradually-increasing influence of SP particles. Finally, in zone IV with $\Delta\chi$ higher than $6.5\times10^{-7}m^3kg^{-1}$, $\Delta\chi/\chi_{ARM}$ is independent of the variations in $\Delta\chi$, suggesting that the $\Delta\chi/\chi_{ARM}$ is totally controlled by the pedogenic finest-grained particles, and the size distribution of these particles remains almost constant. The development of soils in the Chinese loess revealed by these three profiles from three sites can be clearly explained by a continuous process of pedogenesis, increasing from zone I to zone IV. Based on further comparison of our results with European loess records (Evans and Heller, 2003), we propose that the loess units of the European profile have a higher pedogenic degree than that of the Chinese loess, and correspond to Zones (>) II. The definition of the pedogenic zones can help to improve our understanding of the underlying mechanisms and variability of pedogenesis, and thus could enable more successful and accurate separation of the authentic pedogenic signals from the background signal of the aeolian inputs at different loess sites worldwide.

GP41B-0046 0830h POSTER

Quaternary Mineral Magnetic and Free Iron Records of Climatic Change from Chinese Loess/Paleosol Sequence

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A high-resolution investigation of mineral magnetism, iron geochemistry and soil physics was carried out on a loess/paleosol sequence from Jiaodao, the central Loess Plateau of China. Our multi-parameter records reveal a gradual decrease in paleo-weathering intensity, and hence a gradual aridification of the Asian continental interior over the past 2.6 Ma, with some fluctuations. The mineral magnetic variations of the lithogenic components could be used to find the links among uplift of the Tibetan Plateau and its adjacent regions, weathering processes in source region, and dust deposition in the Loess Plateau. The changes in free iron (FeD) content and rubification were closely related to long-term paleo-weathering intensity variations in the Jiaodao loess/paleosol sequence during the entire Quaternary, thus attesting to the fact that they are good proxies of summer monsoon evolution. The gradual decrease of FeD content and rubification from the upper part of the Tertiary red clay to the last glacial loess apparently reflects a trend toward greater aridity of the climate system in eastern Asia during the Pleistocene. In addition, the FeD and rubification variations can be described as an asymmetrical saw-tooth pattern. From the upper part of the red clay to the upper sandy loess layer L9, this saw-toothed pattern is consistent with the Earth's eccentricity record of the 400-ka period. The features may suggest that the climate system in the Asian continental interior, especially the regional climate controlling atmospheric dust deposition in the Chinese Loess Plateau, is very sensitive to the direct forcing of the 400-ka Earth's eccentricity period.

GP41B-0047 0830h POSTER

Preliminary Results of Two-Year Magnetic Monitoring of Roadside Dust in Seoul, Korea

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Various mineral magnetic measurements for roadside dust samples have been carried out in Seoul, Korea, in order to reveal the spatial and temporal pollution features based on magnetic properties of dust. A total of 1,956 dust samples were collected monthly from June 1998 to June 2000 at eight locations divided into industrial areas, heavy traffic density areas and a park area. The major magnetic phase of the roadside dust was identified to be ferrimagnetic minerals, based on the results of S-ratio, isothermal remanent magnetization (IRM) acquisition pattern and hysteresis parameters. Spatial and temporal variations of magnetic concentrations were traced using the values of low field susceptibility (χ_{LF}), anhysteretic remanent magnetization (ARM) and saturation IRM (SIRM). Spatially, samples from the industrial areas show the highest values of each parameter, whereas those from a park area show the lowermost ones. Samples from the heavy traffic density areas reveal relatively low to intermediate value ranges. The highest content of magnetic materials in samples from the industrial areas can be attributed to input of the high fraction of magnetic materials emitted from nearby factories. Temporally, magnetic concentration parameters indicate that the magnetic concentration in the roadside dust is relatively higher in winter (the dry season) than in summer (the rainy season). These temporal variations of magnetic concentrations could represent the increase of fossil fuel uses in winter time. In addition, the extensive influence of the Asian dust can be detected by the maximum magnetic concentration in March, 2000. Spatial and temporal variations of magnetic grain sizes of dust were determined by interparametric ratios of ARM/χ_{LF} and ARM/SIRM. There are no distinctive spatial differences in the study area. However, values of ARM/χ_{LF} and ARM/SIRM are high in summer and low in winter, indicating that the mean grain size of magnetic materials in dust is relatively coarser in winter than in summer. This temporal pattern of magnetic grain size in dust can be ascribed to the increase of coarse-grained magnetic materials from anthropogenic sources during winter time and to the washout effect of coarse grains by heavy rainfalls during summer time. Geochemical analyses (Cr, Cu, Fe, Mn, Pb and Zn) for selected samples were performed to examine any relationship between heavy metals and magnetic parameters. Some of the analyzed elements (Cr, Cu, Fe and Zn) show similar spatial pattern to those of magnetic concentration parameters such as χ_{LF}, ARM and SIRM. Especially, the concentrations of Cr, Cu, Fe and Zn show relatively high correlation coefficient (R^2 = 0.68-0.90) with χ_{LF}. These results suggest that mineral magnetic parameters can be used as rapid proxy indicators for the degree of heavy metal pollution in urban areas, and that a combination of magnetic and geochemical methods provide more complete information than would be obtained by an individual method.

GP41B-0048 0830h POSTER

The magnetic way of quantifying road traffic pollution in atmospheric particulate matter

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The steadily increasing number of motor vehicles requires continuous air quality monitoring in large urban and sub-urban areas. We present a fast and simple method for analysing samples of atmospheric particulate matter (PM) based on magnetic measurements, which is suitable for systematic pollution monitoring of extensive areas at low costs. Representative samples have been collected in Switzerland at sites with variable exposure to pollution sources. Atmospheric PM consists of natural and of anthropogenic components which both contain magnetic mineral fractions with specific magnetic properties. Our method relies on the analysis of the remanent magnetisation of PM samples. Detailed demagnetisation curves of anhysteretic remanent magnetisation (ARM) of these samples have been modelled using a linear combination of appropriate model functions, which represent the contribution of different magnetic mineral sources to the total magnetisation. Two magnetic components C1 and C2 with well-defined magnetic properties have been identified in all samples. The low-coercivity component C1 predominates in less polluted sites, whereas the concentration of the higher coercivity component C2 is large in urban areas. Once the coercivity distributions of C1 and C2 have been characterised, a simple method has been developed to quantify C1 and C2. This method is based on four-step demagnetisation curves, which can be measured in 12 minutes using a 2G cryogenic magnetometer with an in-line AF degausser. Our results are confirmed by independent chemical investigations at the same sites. The magnetic contribution of C2 is shown to be proportional to the chemically estimated total PM10 mass contribution of exhaust emissions. The mass concentration of traffic related elements in PM10 such as Fe, Ba, Cu, Mo, Br and elemental carbon also correlates with our results. Traffic is the most important PM pollution source in Switzerland: it includes exhaust emissions and abrasion products released by vehicle brakes. The good correlation found between component C2 and traffic-related PM sources underlines the usefulness of the fast and non-destructive magnetic methods for the quantitative estimation of urban pollution as a low-cost alternative to chemical analysis.

GP41B-0049 0830h POSTER

COERCIVITY DISTRIBUTIONS OF SOFT-MAGNETIC COMPONENTS AND THEIR OCCURRENCE IN SEDIMENTS ANS SEDIMENTARY ROCKS

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The analysis of magnetization curves with model functions is a valuable tool for identifying magnetic mineral sources in sediments and sedimentary rocks. The method is limited by two main factors: the ability of the model function in reproducing appropriately the magnetic properties of an individual component, and its extreme sensitivity to measurement errors. Both factors influence the number of components, which are needed to fit a magnetization curve within the measurement error. Recent investigations on the shape of coercivity distributions (Heslop, 2003; Egli 2003) support the use of model functions introduced by Egli (2003). Extremely detailed measurements of alternating field (AF) demagnetisation curves of isothermal (IRM) and anhysteretic (ARM) remanent magnetizations have been performed on a wide variety of sediments and sedimentary rocks including sediments from rivers, lakes and oceans, recent soils, paleosols, loesses, red clays, limestones and also on atmospheric dusts, urban pollution and magnetotactic bacteria. The component analysis allowed the identification of several magnetic components with specific properties, which reflect different magnetic mineral sources: extracellular, bacterial and pedogenic magnetite, lithogenic minerals transported by water or in air, and magnetic minerals associated to anthropogenic pollution sources. Each magnetic component is described by nine parameters: four for the shape of the IRM, four for the shape of the ARM coercivity distribution, and one for the ratio of the ARM to the IRM. By comparing similar components occurring in different samples, empirical relations can be established between different parameters, which reflect fundamental physical processes that control the shape of coercivity distributions. As a consequence, only four parameters, so-called magnetic fingerprints, are necessary to characterise a magnetic component. The effect of environmental changes on the magnetic properties of specific magnetic components has been investigated in detail for sediments from lakes and oceans, highlighting the complex and non-linear behaviour of such natural systems. Heslop, D. and G. McIntosh, The influence of initial state, interaction and thermal relaxation on the isothermal remanent magnetisation curves, IUGG 2003 (GAI.03/03A/A14-007). Egli, R., The analysis of demagnetisation curves with skewed generalized functions (SGG): a novel method for the identification of magnetic sources in sediments, IUGG 2003 (GAI.03/03A/A14-008).

GP41B-0050 0830h POSTER

Environmental magnetic records of core sediments for the past 100 ka from Erhai Lake in China and Sogwipo Maar in Korea

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In order to detect high-resolution records of environmental changes in East Asia, we made environmental magnetic study of core sediments from Sogwipo Maar in Cheju Island, Korea (9.4 m long), and Erhai Lake in Yunnan Province, China (10.0 m and 42.6 m). Measurements of initial susceptibility (k), natural remanent magnetization (NRM), anhysteretic remanent magnetization (ARM) and isothermal remanent magnetization (IRM) were made by pass-through method using u-channel samples from both cores. Results of AMS radiocarbon dating suggest that the Sogwipo core is dated from 5 ka to 30 ka, and that the upper 16 m of the Erhai core is dated from 2 ka to 30 ka. Variation of NRM intensity of both cores, when normalized by ARM and IRM, showed similarity with paleointensity stack Sint-800 between 15 ka and 100 ka. Variation of magnetic concentration parameters of the Sogwipo core was consistent with lithological changes. In particular, magnetic minerals in the upper part seem to be diluted by increased biogenic productivity after 15 ka. The topmost part of the Erhai core showed rapid downcore decrease of magnetic concentration associated with increase of magnetic grain size, suggesting reductive environment before 3 ka. Negative correlation between magnetic concentration and magnetic grain size may indicate a gradual change in degree of the reductive diagenesis. In both cores, significant increases of ARM susceptibility were observed at several horizons, which can be correlated to interstadial periods of the Dansgarrd-Oeschger cycles. The increase of ARM susceptibility suggests that input of fine magnetic minerals were enhanced under increased precipitation due to activity of the Monsoon activity during the warm periods.

GP41C MCC: Level 1 Thursday 0830h

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

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

GP41C-0051 0830h POSTER

A Synthesis of Cretaceous Paleomagnetic Data From South Korea and its Tectonic Significance in East Asia

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South Korea is tectonically divided into the Gyeonggi massif, Ogcheon belt, Ryeongnam massif and Gyeongsang basin from northwest to southeast. The Cretaceous strata are mainly exposed in the Gyeongsang basin, a southeastern part of Korea, and in several small basins along the boundaries of the Ogcheon belt and on the Gyeonggi massif. A total of 43 Cretaceous paleomagnetic poles from 33 published studies in South Korea were collected and reviewed to elucidate the geodynamic evolutions of the Korean Peninsula in the tectonic framework of East Asia during Cretaceous. As a result, 24 paleopoles from 17 studies have satisfied more than four reliability criteria of Van der Voo (1990). Paleomagnetic pole positions from the Gyeongsang basin and from small basins in the Gyeonggi massif and the Ogcheon belt show a good agreement, indicating that the Korean Peninsula was a single terrane since Cretaceous. Within the Gyeongsang basin, the paleomagnetic pole of the geographically northern area (Yeongyang block) is displaced westward from those of southern area (Milyang and Uiseong blocks). Also, the late Early Cretaceous paleolatitude of the Yeongyang block is similar to or slightly lower than those of the Milyang and Uiseong blocks. These paleomagnetic results and some geological features in the Gyeongsang basin suggest that the Yeongyang block underwent counter-clockwise rotations accompanied by northwestward protrusion with respect to the Milyang and Uiseong blocks during the Late Cretaceous. These relative tectonic movements within the Gyeongsang basin were probably due to the northwestward subduction of the proto-Pacific plate during the Late Cretaceous. The average paleopole positions of the Korean Peninsula for the middle Early, late Early and Late Cretaceous are Lat./Long.=59.6°N/194.7°E (A_{95}=4.6°), 68.1°N/207.7°E (A_{95}=3.2°) and 70.9°N/215.4°E (A_{95}=5.3°), respectively, showing the gradual eastward displacement with respect to the Cretaceous mean pole of Eurasia as the age of rock units is getting older. This result indicates that the Korean Peninsula underwent clockwise rotations with respect to Eurasia during the Cretaceous Period. The clockwise rotation of Southwest Japan with respect to Eurasia is ascribed to the Miocene opening of the East Sea, and has no connection with the Cretaceous clockwise rotations of the Korean Peninsula. Thus, it is interpreted that the Korean Peninsula and Southwest Japan might not behave as a tectonically single terrane during Cretaceous.

GP41C-0052 0830h POSTER

Paleomagnetic Study for the Cretaceous Laiyang Basin in the Shandong Province, Northeast China: Tectonic Implications for East Asia

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Paleomagnetic investigation has been carried out for the Early Cretaceous Laiyang Group exposed in the eastern part of the Tan-Lu fault of the Shandong Province, Northeast China. A total of 224 independently oriented core samples were obtained from 12 sites for the study. The mean direction of high temperature/coercivity components (HC) in stratigraphic coordinates (D/I=16.0°/57.3°, k=140.5, α_{95}=3.7°) is more clustered than that in geographic coordinates (D/I=18.1°/56.7°, k=60.0, α_{95}=5.6°), yielding a positive fold test at the 95 % confidence level. Also, the parameter estimating fold test gives the maximum k value at 84.3 % unfolding. These results collectively indicate that the HC of the Laiyang Group might be a primary remanent magnetization component. The Early Cretaceous paleomagnetic pole position calculated from the mean direction of the HC is at Lat./Long.=77.1°N/198.8°E (A_{95}=4.7°). This pole position is not statistically distinguishable from coeval pole positions reported from the western part of the Tan-Lu fault within the North China Block (NCB). It indicates that the east of the Tan-Lu fault did not experience the relative movement with respect to the west of the fault since the Early Cretaceous. Thus, it is interpreted that the sinistral motion of the Tan-Lu fault, which was initiated by the collision between the North and South China blocks since the Late Paleozoic, might be ceased before Cretaceous or at least during the Early Cretaceous. To clarify the tectonic relationships of blocks in East Asia since Cretaceous, the reported Early Cretaceous pole positions of the South China Block (SCB), Mongolia, Siberia and Korea were compared with the coeval mean pole position of the NCB (78.0°N, 196.7°E, A_{95}=5.9°) calculated from paleopoles of the east and west of the Tan-Lu fault including this study. The paleopoles of the SCB (76.4°N, 211.2°E, A_{95}=6.8°) and Siberia (74.9°N, 205.6°E, A_{95}=1.9°) are indistinguishable from that of the NCB. On the other hand, the paleopoles of Mongolia (82.9°N, 249.5°E, A_{95}=5.7°) and the Korean Peninsula (65.2°N, 202.1°E, A_{95}=3.4°) are displaced westward by about 10° and eastward by about 17°, respectively, with respect to that of the NCB, indicating the rotations of opposite senses of the two blocks with respect to the NCB. Several previous paleomagnetic studies reported the Cretaceous clockwise rotations of the east of the Tan-Lu fault (e.g., Benxi area of northeast NCB and the Korean Peninsula), which were ascribed to the sinistral motion of the Tan-Lu fault. However, this study shows that the Tan-Lu fault did not experience any strike-slip motion since the Early Cretaceous, suggesting that another mechanism for the rotations might be involved. Recently, Lin et al. (2003) proposed that the clockwise rotation of the Korean Peninsula and the Benxi area might be caused by the fan-shaped intraplate rifting of the Cretaceous basins in the northeastern NCB and eastern Mongolia. The counterclockwise rotation of Mongolia and the no strike-slip motion of the Tan-Lu fault since the Early Cretaceous, identified in this study, could support the model by Lin et al. (2003) for rotations of blocks in East Asia.

GP41C-0053 0830h POSTER

Stratigraphic Correlation of Core Samples From the Osaka Bay off Kobe Based on Magnetic Properties and its Implication for Tectonic Activity of the Osaka-wan Fault for the last 6300 years

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