PK2010 # 1

Zr isotope heterogeneities in the solar system.

Akram*, W.M., Schönbächler, M., Williams, H.M., Halliday, A.N. *SEAES, The University of Manchester, M13 9PL, UK, waheed.akram@postgrad.manchester.ac.uk.

The Zr isotope composition of our solar system reflects a mixture of different nucleosynthetic components. The isotopes ^{90}Zr, ^{91}Zr, ^{92}Zr, ^{94}Zr are thought to be produced by the s-process, whereas ^{96}Zr requires an environment with higher neutron flux densities (10^{27}-10^{40} n cm^{-3}s^{-1}) and may thus be mainly produced by the r-process. Previous measurements hinted at a possible enrichment in ^{96}Zr/^{90}Zr relative to the Earth and Moon in CV bulk carbonaceous chondrites [1]. Here, we present new high precision Zr isotope data obtained by MC ICPMS that confirm this enrichment, not exceeding 3ε units. The data comprise results for two CV meteorites (Allende, Grosnaja), three CM meteorites (Murchison, Murray and Cold Bokkeveld), one Ca-Al rich inclusion (CAI), and various terrestrial and lunar samples. Mass balance calculations point to the CAIs as a likely source for these positive ^{96}Zr anomalies. Such anomalies are indicative of a nucleosynthetic heterogeneity in the solar nebula, which may be the result of a late injection of neutron-rich nuclei from a supernova, or evidence of ^{96}Zr production in AGB stars.

[1] Schönbächler M. et al. (2003) EPSL, 216, 467-481.

PK2010 # 2

Noble gases in Chinese and Swedish mid-Ordovician fossil micrometeorites

Alwmark*, C., Meier, M. M. M., Schmitz, B., Baur, H., Wieler, R., *ETH Zürich, Earth Sciences, NW C82, CH-8092 Zürich. E-mail: alwmark@erdw.ethz.ch.

Sediment-dispersed extraterrestrial chromite (SEC) grains of L-chondritic composition from Sweden and China [1] were analyzed for noble gases in an ultra-high-sensitivity mass spectrometer [2]. The SEC grains were extracted from limestone of mid-Ordovician age, deposited when the meteorite flux was enhanced by two orders of magnitude following the disruption of the L-chondrite parent body at ~470 Ma [3]. The measurements show that all of the SEC grains contain solar wind implanted Ne, implying that they were delivered to Earth as micrometeorites or parts thereof. Furthermore, the percentage of grains that showed cosmic-ray exposure (CRE) ages >3 Ma, decreases with time of delivery to Earth, following the disruption event. The high CRE-ages indicate that these grains have been pre-exposed, most likely in the asteroidal regolith, thus implying that the amount of regolith material delivered to Earth in the aftermath of the disruption diminishes with time.

[1] Schmitz, B. et al. (2008). Nat Geosci 1, 49-53. [2] Baur, H. (1999). Abstract #F1118 Eos T Am Geophys Un 46. [3] Korochantseva, E.V. (2007). MAPS 42, 113-130.

PK2010 # 3

Noble gas inventory of micrometeorites.

B., Baecker*, U., Ott, *Max-Planck-Institut für Chemie, J.-J.-Becher-Weg 27, 55128 Mainz. b.baecker@mpic.de.

The bulk of extraterrestrial matter collected by Earth is in the form of micrometeorites, similar (but most likely not identical) in composition to meteorites of the CM type [1]. According to some models [2], they may have made important contributions to the volatile inventory of the Earth. While helium and neon in micrometeorites are generally dominated by the solar wind contribution, the inventory of heavy primordial noble gases is not well characterized. In particular, useful data are lacking on the diagnostic isotopic composition of xenon. We will analyze Antarctic micrometeorites using our new multi-ion-counting Nu Instruments noble gas mass spectrometer [3], which allows crucial isotopic ratios like ^{129}Xe/^{132}Xe and ^{136}Xe/^{132}Xe to be determined with a precision of ~2% and ~3 % on as little as ~2x10^{-14} cc STP (~ 500,000 atoms) of ^{132}Xe. Samples will be selected from the CONCORDIA collection ([4]; collaboration with J. Duprat and C. Engrand) and the Frontier Mountain ([5]; collaboration with L. Folco).

[1] Kurat, G. et al. (1994) GCA 58, 3879-3904. [2] Maurette, M. et al. (2000) PSS 48, 1117–1137. [3] Ott, U. et al. (2010) MAPS 45, A158. [4] Duprat, J. et al. (2007) ASR 39, 605-611. [5] Rochette, P. et al. (2008) PNAS 105, 18206-18211.

PK2010 # 4

The German Meteorite Road

Bartoschewitz R., Meteorite Lab, Lehmweg 53, 38518 Gifhorn, Germany. bartoschewitz.meteorite-lab@t-online.de.

At time 46 meteorites with known still existing material are reported from the area of the Federal Republic of Germany. The exact find sites often are poorly known today, although some are very well documented in ancient literature. To hold these sites of natural events in remind and to sensitize people regarding scientific importance of meteorites, the project German Meteorite Road is started. Before this project started there were four meteorite find sites marked by information tables (Krähenberg, Meuselbach, Rittersgrün, Treysa). The unveiling ceremony of a memorial rock for the Salzwedel meteorite will happen within the "1. Deutsches Meteoriten Kolloquium" regarding the 25th falling anniversary. The next meteorite find site markings will happen in Ramsdorf, Kiel (50th), Erxleben (200th), and Trebbin (25th anniversary). Part of the project is a scientific revision of material from all German meteorites. The German Meteorite Road will not

only cover the find sites of German meteorites, but also impact craters and museums with meteorite exhibitions. The long-term target of this project is to connect these sites under touristic aspects.

PK2010 # 5

Rare earth elements as indicator for volatility controlled fractionation processes on planetary scale

Bendel*, V., Patzer, A., Pack, A., Allen, C., Münker, C. *Geowissenschaftliches Zentrum, Universität Göttingen, Goldschmidtstraße 1, D-37077 Göttingen, vbendel@uni-goettingen.de.

Rare earth elements (REE) are important indicators for fractional condensation and evaporation processes in the early solar system. Fractionation occurs due to differences in condensation temperature among REEs [1]. We analyzed REE contents in several bulk chondrites and some terrestrial samples. Samples were prepared following the method described in [2] and analyzed by means of high precision LA-ICPMS. As a reference for the bulk solar system we use the Orgueil (CI1) meteorite. Our terrestrial samples have smooth REE patterns with depletions in Eu and Tm, indicating that the bulk earth has possibly volatility-controlled fractionated REEs. Our measurements on bulk chondrites show that most chondrites have fractionated REEs. The CV3 chondrites Allende and Mokoia have distinct REE fractionations with a signature of group II REE calcium aluminium rich inclusions (CAIs). Ordinary and enstatite chondrites show REE patterns complementary to group II REE CAI patterns, suggesting that the CAI component is missing in these chondrites.

[1] Boynton, W. V. (1975) GCA 39, 569–584. [2] Pack, A. et al. (2010) Geochem. Trans., in press.

PK2010 # 6

Pre-irradiation of chondrules in the Early Solar System

Beyersdorf*, U., Trieloff, M., Ott, U., *Max Planck Institute for Chemistry, J.-J. Becherweg 27, 55128 Mainz, uta.beyersdorf@mpic.de.

Previous work [1-3] has provided hints for a pre-irradiation of chondrules in the Solar Nebula, before they became part of chondrite parent bodies. However, significant uncertainties remain. We have started a project to compare the difference between cosmic-ray exposure (CRE) ages of chondrules and matrix of primitive meteorites. For this we have selected fourteen carbonaceous, enstatite and ungrouped chondrites for noble gas, chemical and mineralogical analyses, based on the following criteria: 1) low petrological type (2 to 4), 2) low CRE ages, and 3) chondrule size. Chondrules were separated using the freeze-thaw technique similar to [4]. SEM analyses will be applied to define mineralogical features, while EMPA or INAA will be used to determine elemental abundances. Noble gas measurements (He, Ne & Ar) using stepwise heating will enable calculation of CRE ages.
Our results shall contribute to constrain the timing of chondrule formation, and chondrite compaction.

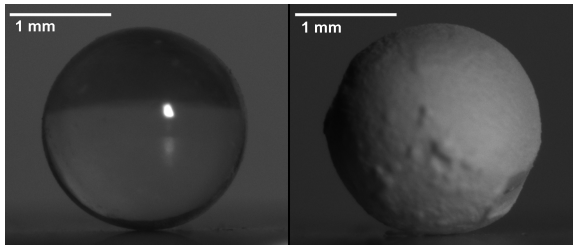
[1] Das, J. P. and Murty, S. V. S. (2009) MAPS 44, 1797-1818. [2] Polnau, E. et al. (2001) GCA 65, 1849-1866. [3] Eugster, O. et al. (2007) MAPS 42, 1351-1371. [4] Grossman, L. (2010) MAPS 45, 7-20.

PK2010 # 7

Laboratory experiments on the formation of accretionary rims around chondrules

Blum*, J., Beitz, E., *IGEP, TU Braunschweig, j.blum@tu-bs.de

The dusty rims around chondrules are hypothesized to have either formed by accretion of dust particles while freely floating in the solar nebula or by compaction processes on their parent bodies [1,2]. We are setting up new laboratory experiments to test both hypotheses and to con-strain the origin of the chondrule rims in the early solar system. In the first set of experiments, we either levitate artificial chondrules and measure the thickness and porosity of the dusty envelopes, which form when the chondrules are subjected to a flux of μm-sized dust grains (see picture below), or we coat the chondrules in a dusty bed. The second experiment intends to measure the differential compaction of dust around chondrules embedded in a dusty matrix. First results of both experimental sets will be presented in the meeting.



[1] Morfill, G. et al. (1998) Icarus 134, 180-184.
[2] Trigo-Rodriguez, J. et al. (2006) GCA 70, 1271-1290.

PK2010 # 8

The search for truly "regolithic" howardites

Cartwright*, J.A., Herrin, J. S., Herrmann, S., Ott, U., Mittlefehldt, D. W. * MPIC, Joh.-Joachim-Becher-Weg 27, 55128 Mainz, Germany. julia.cartwright@mpic.de.

The howardite meteorites are polymict breccias of eucrite (basaltic) and diogenite (orthopyroxenitic) material [1] that likely originate from the asteroid 4 Vesta [2]. The true regolithic nature of the suite is not well defined, with previous research suggesting correlations between Ni and solar wind noble gas contents, and minimal variation in Al_2O_3 content [3]. Through combined petrological, compositional and noble gas analyses, we aim to better understand howardite petrological diversity, regolith formation

processes on the parent asteroid, and to establish what defines a truly "regolithic" howardite.
Our petrological study of 30 polymict eucrites and howardites has identified regolithic features (e.g. melt clasts, chondrite fragments), used to develop a regolith grading scheme. Bulk major element compositional data have been collected [4], and both trace-element and noble gas analyses are underway. We expect those howardites with regolithic petrological and chemical features to have high abundances of implanted solar wind noble gases.

[1] Mittlefehldt, D.W. *et al*. (1998) *Rev. Min*. 36: 4.1-4.195. [2] Drake M.J. (2001) *MAPS* 36:501-513. [3] Warren, P.H. *et al*. (2009) *GCA* 73:5918-5943. [4] Mittlefehldt D.W. *et al*. (2010) *41st LPSC* #2655.

PK2010 # 9

Gravoturbulent Planetesimal Formation in the Early Solar System

Dittrich*, K., Klahr, H., *Max Planck Institute for Astronomy, Königsstuhl 17, 69117 Heidelberg dittrich@mpia.de

"Gravoturbulent Fragmentation" of a cloud of relatively small icy and dusty objects is a very attractive way to form kilometer sized Planetesimals in the early phase of the solar system. The icy and dusty object can be approximated with a fluid [1], whereas, they should be treated as particles [2]. Here, we want to show recent research of "Gravoturbulent Fragmentation" and discuss the goals of this project. The aim is to investigate the physical and mineralogical consequences of this new formation scenario for the bodies in the early solar system (Planetesimals, Asteroids, Comets, Chondruls, etc.) in a qualitative as well as a quantitative way and contrast it with observations.

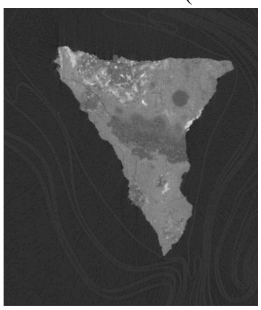
[1] Johansen, A. & Klahr, H. (2005) APJ 634, 1353–1271. [2] Johansen, A. et al. (2007) Nature 448, 1022–1025.

PK2010 # 10

Automatic phase segmentation of chondrule and matrix from micro-CT meteorite slices.

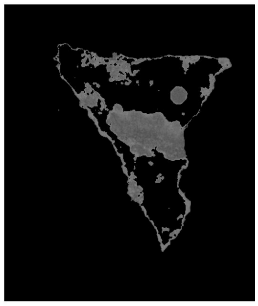
Elangovan*, P., Abel, R., Hezel, D.C., Armstrong, R., Williams, T., *Natural History Museum, London, UK, SW7 5BD p.elangovan@nhm.ac.uk.

Micro-CT has enormous potential for allowing non-destructive digital analysis of structure and composition of meteorites. However, the densities of phases often overlap which blurs the boundaries between chondrules and matrix. Consequently, materials usually have to be segmented manually which is subjective, inaccurate, labour intensive and time consuming. We are working on a software package that can accurately and precisely extract phases from meteorite in a repeatable and objective fashion. We have also developed methods along the lines of fitness functions (statistical modelling) and surface integrity checks (integration of human vision principles). The complex, grainy structure of meteorite was difficult to distinguish and segment accurately. The software uses the method of Bayesian statistics to use extant information about the material being scanned—e.g., the number of phases expected, approximate shape of the internal phases, and their probability distributions—and have yielded promising results. Following figure illustrates our current method of automatic phase segmentation applied on a meteorite slice (Allende CV3).

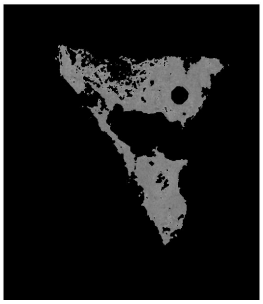


Meteorite slice

Metal phase



Chondrule phase



Matrix phase

PK2010 # 11

Search for young close-in planets with the transit technique

Errmann*, R., Neuhäuser, R., Maciejewski, G., Redmer R.+ more observers from YETI team, *Astrophysikalisches Institut und Universitätssternwarte, Schillergäßchen 2-3, 07745 Jena, ronny.errmann@uni-jena.de.

The transit technique is the only method to determine the radius of a planet. Together with the mass from radial velocities, information about density and the inner structure can be obtained. So far, only old transiting exoplanets are known. For testing planetary formation models and to compare to our Solar System giant planets, observational parameters for young exoplanets need to be gathered and should be compared with theoretical predictions. We monitored the few Myr young cluster Trumpler 37 to search for transiting planets. We observed the cluster with our 90 cm telescope near Jena in the summers of 2009 and 2010. Additionally, in a campaign with several telescopes around the world, we try to get continuous light curves (summer 2010). For 3000 out of the 17000 stars in the field, we achieve the precision (few milli mag) to detect transiting planets. We found one transit candidate, several eclipsing young binaries and stars with rotation periods.

PK2010 # 12

Temperature- and fO_2-Dependence of the Volatility and Condensation Behavior of Volatile Elements: Latest Experimental Results

Ertel-Ingrisch[(1)], Werner and Dingwell[(1)], Donald B. [(1)]Department of Earth and Environmental Sciences, Ludwig Maximilian University; ertel-ingrisch@lmu.de

The volatility of elements is an important aspect in the Earth´s past, present and future. Precise knowledge of the parameters controlling volatility is still lacking. The Volatility of an element or compound depends on temperature and oxygen fugacity (fO_2). In consequence, a systematic study in respect to fO_2 and temperature was launched applying the modified MAE technique in the eutectic Anorthite-Diopside composition doped with up to 5000 ppm of 18 volatile elements. Run conditions were $\log fO_2$ = -11.3 (~ IW -0.5) and – 0.7 (air) at 1300°C (fO_2 dep.); while the T dependence was investigated at 1300 and 1500 °C at constant fO_2 (in air).

Present results indicate: 1) both volatility as well as condensation behaviour can be investigated at the same time; 2) some volatile elements do not generally decrease continuously with time as anticipated in previous studies; 2) a very complex behaviour of volatile elements in T and fO_2 space.

PK2010 # 13

Production and acceleration of cosmic dust analogues.

Fiege*,K., Kempf S., Trieloff, M., Srama, R. * MPI für Kernphysik , Saupfercheckweg 1, 69117 Heidelberg, email:katherina.fiege@mpi-hd.mpg.de

In situ analysis of cosmic dust enables the dust composition to be linked to the dynamical properties of the particle and hence to its source. Dust composition is usually obtained via the process of impact ionization TOF mass spectrometry. However, in situ dust detectors need terrestrial calibration. This process requires particles of well defined composition travelling at hyper velocity speeds. Suitable speeds (up to ~100 kms^{-1}) can often only be obtained using a Van de Graaff accelerator. However, electrostatically accelerating particles requires that they hold charge. Mineral particles with accurately characterized physical and chemical properties must therefore be synthesized or obtained and coated with a conductive layer prior to acceleration.

Here we present the current progress in the production, acceleration and analysis of cosmic dust analogue particles.

PK2010 # 14

Highly siderophile element abundances and $^{187}Os/^{188}Os$ in Apollo 16 impact melt rocks

Fischer-Gödde*, M., Becker, H., *Institut für Geologische Wissenschaften, Freie Universität Berlin, Malteserstr. 74-100, mafische@zedat.fu-berlin.de.

Ancient lunar impact melt rocks provide important information on the nature and origin of the projectiles and on the timing of the early impact flux to the Moon and by inference to the Earth and other terrestrial planets. Concentrations of the highly siderophile elements (HSE) and $^{187}Os/^{188}Os$ have been determined for subsamples of Apollo 16 poikilitic (60315) and basaltic (67935) impact melt rocks, and the granulitic impactit 67955. Excellent linear correlations displayed by subsamples of a given impact melt rock in plots of HSE vs. Ir are explained by dilution and binary mixing between a high HSE impactor composition and a low HSE composition representing the lunar target rocks. The HSE composition of the impactor component in 67955 is similar to chondrites, while the impactor composition recorded in 60315 and 67935 is characterized by subchondritic Os/Ir and suprachondritic $^{187}Os/^{188}Os$, Ru/Ir, Pt/Ir, Rh/Ir, Pd/Ir and Au/Ir, similar to IVA iron meteorites. The HSE composition of the bulk silicate Earth may be explained by addition of a late veneer comprised of a mixture of differentiated planetary core material and chondritic materials.

PK2010 # 15

An unusual chondritic meteorite.

P. Friend*, J. Zipfel, M. Gellissen, R. Kleinschrodt, A. Pack, A. Stracke and H. Palme, *Universität zu Köln, Zülpicherstr. 49b, 50674 Köln, piafriend13@googlemail.com.

We present data on a new desert meteorite with the provisional designation NWA 5492. The bulk chemistry is chondritic, except for high Fe and Ni excesses evident in extremely high contents of Fe,Ni metal. The Mg/Si-ratio is similar, refractory elements (Al, Ca, Ti, REE etc.) are depleted as in OC, but the low Mn/Mg is different from OC, resembling the CV-ratio. The texture is chondritic with well delineated chondrules and chondrule fragments (PP, RP, POP and rare BO). Large FeNi and sulfide grains are abundant. Typically they are irregularly shaped and occur in chondrule interstitials. Matrix is largely absent. The dominant minerals are low-Ca pyroxenes with Fs below 0,5 % and low CaO (<0,5 %). Olivine is rare but also very reduced (Fa <0,3%) and has very low contents of CaO (<0,02%) and Cr_2O_3 (<0,3 %). The oxygen isotopes are close to OC, with a $\Delta^{17}O$, close to H-chondrites. A classification within the framework of known meteorite types is impossible.

PK2010 # 16

Thermal history of meteoritic parent bodies with porous mineral mixtures.

Gail H.-P.*, Henke S., Trieloff M., Hopp J., Schwarz W.H., Kleine Th. *Inst. Theoretische Astrophysik, ZAH, Heidelberg, gail@ita.uni-heidelberg.de

We present models for the growth and thermal evolution of small bodies in the early solar system. The bodies are assumed to consist of porous material that is a mixture of all abundant dust species present in a protoplanetary accretion disk. The heat conduction coefficient is calculated by applying the mixing rules developed for calculating heat conduction of multicomponent porous mixtures used for technical purposes. The thermal model includes heating by energy release from ^{26}Al and ^{60}Fe decay and a growth equation to follow the accretion of the bodies. Furthermore, the interaction of the bodies with the accretion disk is considered for the first ~6 million years. The first results indicate that the heating and cooling history of meteoritic parent bodies is significantly different from the standard model that assumes instantaneous formation and constant heat conduction coefficient. Parent body properties based on modelling of time-temperature profiles derived from cooling ages will thus need revision.

PK2010 # 17

Time-, temperature-, fO_2- and surface dependent volatilisation of Na from silicates and silicate melts.

Marko Gellissen et al., Universität Kiel, Institut für Geo–wissenschaften, Ludewig-Meyn-Str. 10, 24118 Kiel, mgellissen@web.de.

Most inner solar system materials are depleted in Na and other moderately volatile elements, either as result of evaporation or by incomplete condensation. To clarify this, heating experiments with crystals, crystal powders and melts were begun in 1 atm gas mixing furnaces. Initial experiments with albite and nepheline chips and melts showed no Na losses independent of T, fO_2 and time. Powdered albite lost 50 % of its Na after 5 minutes with no losses at further heating. Up to 40 % losses of Na were found for sodalite crystals under similar conditions.
Experiments with Al-free andesitic melts (T from 1100-1500°C, log fO_2 from air to IW-2 and t up to 5 hrs) led to strong losses of Na after 240 min at 1300°C, increasing with increasingly reducing conditions. In further experiments we need to disentangle the effects of geometry, grain size of the starting material and the degree of silicate melt depolymerisation.

PK2010 # 18

Crystal chemistry of hibonite as indicator for oxygen fugacity during solar nebula condensation

Giannini, M.*, Boffa Ballaran, T., Langenhorst, F.. *Bayerisches Geoinstitut, Universität Bayreuth, Universitätsstraße 30, 95447 Bayreuth, Mattia.Giannini@uni-bayreuth.de

Chondritic meteorites are representative primordial matter of the solar nebula. They contain calcium-aluminum-rich inclusions (CAIs), which yield the oldest measured ages of our planetary system. The most Al-rich phase found in CAIs is hibonite which is one of the first major phases to condensate from the solar nebula [1]. Ti can be accommodated in the hibonite structure in different oxidation states. The determination of Ti^{3+}/Ti^{4+} ratio may hence allow the estimation of the oxygen fugacity (fo_2), at which the mineral has equilibrated in the solar nebula. To address this question we have synthesized polycrystalline and single crystal hibonite at different fo_2, and containing variable amounts of Ti and Mg. The site distribution and valence state of Ti has been determined by means of X-ray single-crystal diffraction and electron energy loss spectroscopy (EELS) [2], respectively. It seems that Ti^{3+} may be present in hibonite structure, even when it is synthesized at very high oxygen fugacity due to a coupled substitution mechanism with Mg.

[1] Grossman, L. (1972) Geoch.Cosmoch.Acta 86, 597-619; [2] Stoyanov, E. *et al*. (2007) Am.Min. 92, 577-586.

PK2010 # 19

New SEM methods to identify shocked quartz

Hamers*, M.F., Drury, M.R. *Department of Earth Sciences, Faculty of Geosciences, Utrecht University, Budapestlaan 4, 3584 CD Utrecht, The Netherlands. hamers@geo.uu.nl.

Planar deformation features (PDFs) in quartz are the most reliable type of impact evidence. However, in light microscopic images, they are often confused with tectonic deformation lamellae (DL). We are developing new SEM methods to identify and characterise PDFs in quartz, in order to distinguish them from other, non-shock related planar microstructures, such as DL.

[1] showed that with a cathodoluminescence detector attached to an SEM, PDFs can be imaged and distinguished from tectonic microfractures, but they did not consider DL. We use a panchromatic CL detector in an SEM in combination with red, green and blue colour filters to image both PDFs and DL. These composite colour images show that in general, PDFs emit a mainly red CL signal and they are easily distinguished from DL on the basis of these images. Furthermore we test whether Orientation Contrast (OC) imaging and Electron Backscatter Diffraction (EBSD) techniques can confirm the amorphous nature of fresh PDFs.

[1] Boggs, S. et al. (2001) MAPS 36(6), 783-791.

PK2010 # 20

A FIB-TEM study of sulfide mineralogies in CM chondrites.

Harries*, D., Langenhorst, F., *Bayerisches Geoinstitut, University of Bayreuth, 95440 Bayreuth, Germany dennis.harries@uni-bayreuth.de.

Assemblages containing iron- and nickel-rich monosulfides such as troilite (Tro, FeS), pyrrhotite (Po, $Fe_{1-x}S$) and pentlandite (Pn, $(Fe,Ni)_9S_8$) are potentially interesting proxies for physicochemical conditions of formation and alteration of planetary materials. Fe deficiency in pyrrhotite is directly related to fS_2 and temperature [1] and can be linked indirectly to fO_2 if certain buffer assemblages are present.

We sampled sulfides from four antarctic CM chondrites by the focused ion beam (FIB) technique and studied their mineralogies by analytical transmission electron microscopy (TEM). The CM2 chondrites Yamato (Y)791198 and Y793321 contain Tro with abundant Pn and Po exsolution. In both cases Po occurs as strongly twinned 6C superstructure (~$Fe_{0.92}S$). The thermally metamorphosed anomalous CM chondrites Y86720 and Belgica 7904 show intimate associations of Tro with metallic (Fe,Ni) and only traces of Po on grain margins. Considering the latter group formed from CM2 precursors the metamorphism must have taken place under reducing, low fS_2 conditions.

[1] Toulmin, P. & Barton, B.B. (1964) GCA 28, 641–671.

PK2010 # 21

Modelling the internal constitution of planetesimals with sintering

Henke S.*, Gail H.-P., Trieloff M., Hopp J., Schwarz, W.H., Kleine, Th. *Inst. Theoretische Astrophysik, ZAH, Heidelberg, shenke@ita.uni-heidelberg.de .

We present models for the thermal evolution of small bodies in the early solar system, taking for the first time into account sintering of porous material during heating of the bodies by the short living isotopes ^{26}Al and ^{60}Fe. The model calculation solves the heat conduction and hydrostatic equations by a finite-difference scheme. The material of the bodies is assumed to be porous and to consist of uniform material otherwise. The dependency of the heat conduction coefficient on porosity is considered by empirical recipes. The equations are solved simultaneously with a set of equations for the evolution of porosity by sintering as given by [1]. First results are presented.

[1] Yomogida, K. et. al. (1983) EPSL 68, 34-42.

PK2010 # 22

High pressure environments during evaporation of chondrules and meteorite fusion crusts.

Hezel et al.*, *The Natural History Museum, Cromwell Road, SW7 5BD, London, UK; d.hezel@nhm.ac.uk

Chondrules and meteorite fusion crust formed during brief high temperature events. Chondrules have Fe-isotope variations of <2‰ δ^{56}Fe, with chondrules being enriched in either heavy or light isotopes. Fusion crust is always enriched in the heavy isotopes with a maximum fractionation of 0.35‰ δ^{56}Fe.

The small fractionations in bulk chondrules have been puzzling, as fractionations up to 30-40‰ are expected, if Fe is evaporated from chondrule melts into vacuum. It has been suggested that high gas pressures during chondrule formation suppressed significant isotope fractionations.

When the surface of a meteorite melts during atmospheric entry, this is probably accompanied by element evaporation. The pressures above this melt are around a few bar. The small Fe-isotope fractionation of fusion crust can be explained by high ambient pressures during melting of the meteorite surface, and, hence, bulk chondrule Fe-isotope fractionation might also be best explained by high ambient pressures during chondrule formation.

PK2010 # 23

Complex magnetic record and phase composition of the Almahata Sitta meteorite

Hoffmann V.H.*, Mikouchi T., Hochleitner R., Kaliwoda M., Funaki M., Torii M., Zolensky M., *Institute for Geosciences, University of Tübingen, Sigwartstraße 10, 72076 Tübingen, hoffmann.viktor@gmx.net

Almahata Sitta (AS) meteorite fall occurred in October 2008 and since that numerous fragments and individuals could be recovered [1]. AS was classified as a polymict Ureilite, however, recently AS was found to be a complex breccia consisting of many different meteoritic lithologies including ureilites and various chondrites [1, 2]. The magnetic signature and phase composition of chips #4 and 39 [3] have been studied in detail by [4, 5]. Here we report new results obtained on a number of fragments of ureilitic (#22/27/36/44/49/138 and others) and chondritic lithology (EL 5/6, H 5/6) [see also 2 for details]. In the ureilitic lithologies Ni/Si poor kamacites were identified as the dominating magnetic phases. Additionally suessite, schreibersite, cohenite, troilite, daubreelite and chromium bearing spinel(s) could be detected in various amounts.

[1] Jenniskens P. et al (2009), Nature 458: 485-488. [2] Bischoff A. et al., (2010), MAPS, in press. [3] http://asima.seti.org/2008TC3. [4] Hoffmann V. et al. (2010), MAPS, reviewed. [5] Hochleitner et al., (2010), Antarct. Meteor. XXXIII, 22-23.

PK2010 # 24

The Omani-Swiss meteorite search project: Status and 2010 field campaign.

Hofmann*, B.A., Gnos, E., Walbrecker, J.O., Zurfluh, F.J. *Naturhistorisches Museum Bern, Bernastrasse 15, CH-3005 Bern, Switzerland beda.hofmann@geo.unibe.ch.

The 5400 meteorite samples recovered during nine field campaigns are attributable to ~600 fall events. We find a significant part of the surface of Oman is suitable for meteorite search. The 6 week 2010 search campaign was conducted mainly in the dune belt E-SE of the Saudi border from 23-20°N and yielded 165 meteorite samples, including 3 achondrites. 13 systematic foot searches on 500x500 m each resulted in 9 unpaired meteorites, corresponding to 2.1 finds/km^2. In the giant JaH 091 strewn field we performed a geomagnetic survey at the largest impact site, after recovery of all visible fragments. A 200x200 m grid was searched with a line separation of 1 m and a 30x30 m with a line separation of 0.5 m. The survey demonstrated the presence of a large anomaly close to the surface finds. Digging in the area of the anomaly confirmed the presence of numerous, densely packed large (10-30 cm) meteorite fragments (estimated 200-300 kg). Future work on the data will constrain the buried mass, allowing a determination of the total mass of the JaH 091 meteorite fall on the ground (estimated 3-5 t).

PK2010 # 25

A detailed study of micrometeorite and heavy mineral distribution across the mid-Ordovician Täljsten event.

Holm*, S., Schmitz, B. *Department of Geology, University of Lund, Sölvegatan 12, Lund SE-22362, Sweden. Sanna.Holm@geol.lu.se.

At Kinnekulle in southern Sweden, an impressive sequence of Middle Ordovician strata can be studied. The section is almost exclusively composed of condensed red limestone, with the exception of a noticeable one meter thick interval of grey limestone, known as the Täljsten. This anomalous layer has previously been interpreted to have been deposited during a regression [1-3]. The limestone beds across this interval contain abundant sediment-dispersed extraterrestrial chromite (SEC) grains [4], and Ti-rich opaque terrestrial minerals. A detailed study of the distribution of SEC grains and Ti-rich minerals show that the Täljsten and the surrounding red limestone were deposited at similar sedimentation rates. The results also show that the depositional environment for the grey interval was not significantly shallower than that of the adjacent red strata.

[1] Tinn, O. & Meidla, T. (2001) GFF 123, 129-136. [2] Dronov, A. et al. (2001) WOGOGOB Abstracts 2001. [3] Mellgren, J.S. & Eriksson, M.E. (2010) Earth Env Sci T R So, in press. [4] Schmitz, B. et al. (2003) Science 300, 961-964.

PK2010 # 26

Trace element abundances of Ca,Al-rich inclusions from Rumuruti chondrites.

Horstmann*, M., Bischoff, A., Berndt, J., Wombacher, F. *Institut für Planetologie, WWU Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, marianhorstmann@uni-muenster.de.

Ca,Al-rich inclusions (CAIs) are the oldest constituents known in the solar system. Trace element compositions provide important constraints on the formation conditions of these refractory inclusions.
We obtained data for up to 50 elements for 19 measured CAIs from Rumuruti (R) chondrites described by [1] using a Finnigan Element 2 single collector ICP-MS coupled to a laser ablation system (Excimer-laser, 193 nm). The spot size was varied (25-60 μm) depending on the individual inclusion size.
The REE patterns were classified, where possible, according to [2]. The majority of REE patterns are generally flat, displaying ~5 to 30 times CI abundances for most REEs. Most inclusions exhibit rather smooth patterns of Group V, patterns similar to Group II with strong volatility-controlled HREE fractionation, and several patterns are characterized by a negative Eu anomaly. This project is supported by the German Research Foundation (DFG, SPP 1385; BI 344/10-1).

[1] Rout, S.S. and Bischoff, A. (2008) MAPS 43, 1439-1464. [2] Mason, B. and Martin, P.M. (1977) Smith. Contr. Earth Sci. 19, 84-95.

PK2010 # 27

Processing of silicates by ion irradiation

Jäger*, C., Huisken, F., Mutschke, H., *Laboratory Astrophysics and Cluster Physics Group, Institute of Solid State Physics, Friedrich-Schiller-Universität Jena, Helmholtzweg 3, 07743 Jena, Cornelia.Jaeger@uni-jena.de

Ion irradiation may play a significant role in the structural and chemical modification of cosmic silicates. In particular, GEMS that are dominant components of most cometary IDPs are supposed to be formed from circumstellar silicates by ion irradiation. Our laboratory experiments are dedicated to the study of the formation processes of GEMS from circumstellar silicates by ion irradiation. For this purpose, we have irradiated silicate dust analogs produced in the laboratory with the astrophysically abundant H+ ions at energies of 190 and 95 keV, respectively, to study their effects on structure and composition of silicates. The ion-induced processing of silicates can be monitored by IR spectroscopy and electron microscopy combined with energy dispersive X-ray analysis.

PK2010 # 28

Determination of stable valence state of Ge oxide in silicate melts during core formation of the Earth.

Philip Kegler*, Astrid Holzheid, *CAU Kiel, Institut für Geowissenschaften, Germany. PhK@min.uni-kiel.de

The abundance of Germanium in today's Earth mantle is caused by the conditions and processes during accretion of the Earth and the formation of its core. The knowledge of the geochemical behavior of Ge at core formation conditions is crucial for the interpretation of the Ge abundances in Earth mantle in regard to the accretion and core formation processes. But even the valence state of Ge under oxygen fugacities (fO_2) assumed at core formation of the Earth is still unclear. Therefore the metal-silicate partition coefficients of Germanium in dependence on oxygen fugacity and melt composition at 0.5 GPa and 1350°C were experimentally determined. Piston cylinder press experiments were performed under effectively closed system conditions to avoid the loss of Germanium caused by its high volatility. The results of the experiments show a correlation between log $D^{met\text{-}sil}Ge$, oxygen fugacity and NBO/T which could be described by the regression:

$$\log D^{met\text{-}sil}Ge = 3.32\ (\pm 0.07) - 0.50\ (\pm 0.03) * \log fO_2 - 0.29\ (\pm 0.04) * NBO/T$$

This allows the NBO/T independent determination of the fO_2 dependence of $D^{met\text{-}sil}Ge$ and from this the valence state of Ge in the silicate melt. Within the fO_2 range of the experiments (-2.7 to –0.9 log units below IW) the valence state of Ge is +2 (± 0.1), i.e. GeO is the stable species in the silicate melt at fO_2.of core formation of the Earth.

PK2010 # 29

The Role and Nature of turbulence in the formation of planetesimals.

Klahr, H.H.*, Trieloff M., Spurzem, R. Johansen, A., *Max-Planck-Institut für Astronomie, Königstuhl 17, 69117 Heidelberg; klahr@mpia.de

Planetesimals may well form from the gravitational collapse of a particle cloud, the so called, pre-planetesimals, once they got concentrated by turbulent flow features, possibly enhanced by a streaming instability [1,2,3]. This talk shall give an overview of the state of the field and summarize what we know and what we still have to learn about this mechanism. I will discuss the formation and redistribution of the pre-planetesimals. I will also address the role of resolution in our numerical simulations and in how far this relates to the possible initial planetesimal masses. I show that the mass of the planetesimals is actually determined by the rate at which pre-planetesimals drift through the disk. The talk shall further discuss a list of open questions concerning gravoturbulent planetesimal formation and how this model may fit to the observational findings of our solar system.

[1] Johansen A. et al. (2006) *ApJ* 636, 1121-1134.[2] Johansen A. et al. (2007) *Nature* 448, 1022-1025. [3] Johansen A. et al. (2009) *ApJ* 697, 1269-1289.

PK2010 # 30

Mg isotope composition of presolar silicate grains

Kodolányi*, J., Hoppe, P. *Max Planck Institute for Chemistry, Johann-Joachim-Becher-Weg 27, D-55128, Mainz, Germany, j.kodolanyi@mpic.de.

We analysed in situ the Mg isotope composition of silicate material produced in the stellar outflows of asymptotic giant branch stars, which was subsequently trapped in the primitive carbonaceous chondrite Acfer 094 [1], in order to learn about the nucleosynthesis of Mg isotopes. We followed the sample preparation technique designed by [2].

Both group 1 presolar silicate grains [3] analysed by us have $^{25}Mg/^{24}Mg$ indistinguishable from that of the meteorite matrix ($\delta^{25}Mg$ = -9 ± 17 ‰ and 11 ± 17 ‰), which is assumed to have solar Mg isotope ratios. One grain has solar $^{26}Mg/^{24}Mg$ ($\delta^{26}Mg$ = -13 ± 16 ‰). However, the other grain, which is also richer in Al, shows excess ^{26}Mg ($\delta^{26}Mg$ = 35 ± 16 ‰), possibly due to the in situ decay of ^{26}Al (half-life: ~0.7 Ma). The inferred initial $^{26}Al/^{27}Al$ ratio of 0.016 ± 0.006 is at the upper end of compositions found in group 1 oxide grains [4, 5].

[1] Newton, J. et al. (1995) Meteoritics 30, 47–56. [2] Nguyen, A. N. et al. (2010) 41st Lunar Planet Sci Conf, abstr. 2413. [3] Nittler, L. R. et al. (1994) Nature 370, 443-446. [4] Zinner, E. K. et al. (2005) GCA 69, 4149-4165. [5] Nittler, L. R. et al. (2008) ApJ 682, 1450-1478.

PK2010 # 31

Modelling Giant Planets

Kramm*, U., Nettelmann, N. et al., *Institute of Physics, University of Rostock, D-18051 Rostock, Germany, ulrike.kramm2@uni-rostock.de.

Planet modeling can give further insight into their formation processes. By determining their interior structure, particularly core mass and metallicity, we obtain results for their development which should provide constraints for formation models.

A major ingredient for planetary models is the equation of state (EOS) used for the most abundant elements H, He and water (as representative for metals). We show how ab initio EOS data is derived based on Finite Temperature Density Functional Theory Molecular Dynamics (FT-DFT-MD) simulations. Furthermore, we describe the procedure of planet modelling and show some resulting structure models for solar and extrasolar planets such as GJ436b. In the future, we plan to apply our knowledge about planet modelling and ab initio EOS data to young extrasolar planets in order to reveal their composition and with it derive constraints for their formation history. In particular, we will concentrate on the young transiting planets discovered by our colleagues from the University Observatory Jena.

PK2010 # 32

Condensation of SiO_2 into CaO-Al_2O_3-SiO_2 melts at high SiO(g) partial pressures

Kropf*, A., Libourel, G., *CRPG-CNRS, 15, Rue Notre-Dame des Pauvres, BP20, 54501 Vandoeuvre les Nancy, France, akropf@crpg.cnrs-nancy.fr

Ca-Al-rich inclusions (CAI) show evidence for formation in a hot, reducing stellar environment. Especially type A-CAI are interpreted as solar nebula condensates. The observed zoned mineralogy matches with a theoretically calculated formation sequence that is based on fractionary crystallization [1]. We conduct experiments at 1550°C and low fO_2 in order to investigate the role of SiO(g) partial pressures on the diffusion of Si into CAS melts and finally its importance to the formation of zoned CAIs. The experiments show that the P_{SiO} can be controlled at high temperatures by using SiO-powder as source and data from [2, 3]. The kinetics of captation of silica from the gas phase depends on the melt composition. For Si-free starting matter, SiO_2 increases with 3 wt.% SiO_2/min. Materials with an initial value of 40 wt.% SiO_2 increase with 0.3 wt.% SiO_2/min. The isothermal entry of SiO into molten silicates can change dramatically phase relationships in a very short period of time (minutes).

[1] Ebel, D.S. & Grossman, L., (2000) GCA 64, 339-366. [2] Lou et al., (1985) JAmCerSoc 68, 49-58. [3] Tissandier, L. et al. (2002) MAPS 37, 1377-1389.

PK2010 # 33

^{182}Hf-^{182}W chronometry of weakly irradiated iron meteorites.

Kruijer*, T., Sprung, P., Kleine, T., Leya, I., Wieler, R., *ETH Zürich, Institute of Geochemistry and Petrology, Zürich, Switzerland. thomas.kruijer@erdw.ethz.ch

Previous Hf-W studies revealed some magmatic iron meteorites to be as old as CAIs, the oldest known objects formed in the solar system [1,2]. However, minor cosmic-ray induced W isotope variations may at least in part be responsible for the old apparent ages of some iron meteorites [3]. By combining noble gas and Hf-W analysis on the same specimens, we were able to identify iron meteorite samples that have essentially been shielded from any (high energy) cosmic ray induced nuclear reactions. Cosmogenic noble gas contents in the analyzed samples are at the lowest end of the range previously observed in irons, while $\varepsilon^{182}W$ values of our samples range from -3.3 to -3.2, indistinguishable from the CAI initial of -3.28±0.12 [4]. The lack of W isotope compositions significantly less radiogenic than the initial W isotope composition of CAIs connotes that any $\varepsilon^{182}W$ values lower than the CAI initial result from interaction with cosmic rays. The W isotope

results indicate that iron meteorite parent bodies differentiated within <1 Myr after CAI formation.

[1] Kleine, T. et al. (2005) GCA 69, 5805–5818 [2] Markowski, A. et al. (2006) EPSL 242, 1-15. [3] Leya, I. et al. (2000) EPSL 175, 1-12. [4] Burkhardt, C. et al. (2008) GCA 72, 6177-6197.

PK2010 # 34

Variable geometry in shock wave interference patterns - Clues to shatter cone formation in terrestrial impact structures?

Kübler*, T., Schmieder, M., Buchner, E. *Institut für Geowissenschaften, Universität Heidelberg, Germany, thilo.kuebler@web.de.

Shatter cones are distinct, subconical fracture patterns in rocks subjected to shock metamorphism [1,2]. However, shatter cone formation is still poorly understood but it is widely accepted that shatter cones are generated when shock waves pass through lithologic heterogeneities within the target rock [2].
We used the Maple 14 software to simulate shock wave interference [1] by phase shift (different λ in and outside a rock heterogeneity) within geometrically defined 'shock wave obstacles'. The model is based on the Huygens' principle, assuming Fresnel diffraction of shock waves behind an obstacle.
The results suggest that different shapes, orientations, and sizes of target rock heterogeneities (e.g., concave or convex fossil shells, irregular mineral grain boundaries, etc.) with respect to the shock wave direction and wavelength account for variable specific interference patterns. These patterns are in analogy to variable shapes of shatter cones observed in various types of natural shocked rocks.

[1] Baratoux, D. & Melosh, H. J. (2003) EPSL 216, 43-54. [2] Sagy, A. et al. (2004) JGR 109, B10209.

PK2010 # 35

Isotopic Analysis of Presolar Material in Primitive Solar System Matter.

Leitner*, J., Hoppe, P., and Zipfel, J., *Max Planck Institute for Chemistry, J.-J.-Becherweg 27, 55128 Mainz, Germany. jan.leitner@mpic.de.

Primitive solar system materials contain varying amounts of so-called presolar grains that formed in the outflows of evolved stars or in the ejecta of supernovae [e.g.,1]. Silicates and oxides are among the most abundant presolar grains types. Variations in the presolar grain abundances of primitive meteorites and comets are indicators for parent body processes as well as possible heterogeneities in the protosolar nebula. Fine-grained matrix in thin sections from the chondrites NWA 852 (CR 2) and Isheyevo (CH/CB) as well as matter from comet 81P/Wild 2 were analyzed by NanoSIMS. We identified a total of 41 presolar grains. NWA 852 contains abundant presolar dust (77 ppm silicates, 39 ppm oxides, ~160 ppm SiC) and may be linking presolar-silicate-rich, nearly unaltered CR chondrites and CRs with low presolar grain abundances. Discovery of a first presolar grain in Isheyevo allows some new insights into its formation history. Investigation of the cometary matter suggests that the presolar grain abundance in 81P/Wild is significantly higher than indicated by previous calculations.

[1] Hoppe P. (2008) *Space Sci. Rev.* 138:43–57.

PK2010 # 36

Beryllium-10: Protosolar Irradiation Origin, not from the Trapping of Galactic Cosmic Rays.

Liu, M.-C*., Nittler, L. R., Alexander, C. M. O'D., and Lee, T. CRPG-CNRS, mcliu@crpg.cnrs-nancy.fr.

Short-lived radionuclides ($t_{1/2} \leq 100$ My) in the early Solar System provide important constraints on the astrophysical environment in which the Solar System formed. Amongst all short-lived radionuclides whose prior existence has been successfully inferred in meteoritic material, ^{10}Be ($t_{1/2}$ = 1.5 My) exclusively requires a spallation origin. It has been well established that live ^{10}Be was present at variable inferred abundances in various types of refractory inclusions [e.g., 1, 2]. Such a variation could have been a result of protosolar irradiation [1]. Alternatively, trapping of ^{10}Be-enriched Galactic Cosmic Rays (GCRs) by the magnetic fields of the progenitor molecular cloud core has been proposed as a source for ^{10}Be [3]. In this scenario, a uniform distribution of ^{10}Be would exist in the solar nebula, which would allow ^{10}Be to be used for chronology. Here we present the latest Be-B data obtained with the Carnegie NanoSIMS to examine the feasibility of ^{10}Be chronology, and its implication for the origin of ^{10}Be in the early Solar System.

[1] McKeegan et al. (2000) Science, 289, 1334. [2] MacPherson et al. (2003) GCA, 67, 3165. [3] Desch et al. (2004) ApJ, 602, 528.

PK2010 # 37

The origin of calcium- aluminium rich inclusions.

Luettjohann*, E., Gail, H.-P., Tscharnuter, W. M., Schönke, J., *University Heidelberg, Albert-Ueberle-Str. 2, 69120 Heidelberg eluettjohann@ita.uni-heidelberg.de

The experimental study of CAIs shows, that this material belongs to the oldest material in our Solar system. According to high precision U-Pb dating the age of CAIs is ~4.67 Ga[1]. Furthermore they seem to have very short formation times. Analysis of radionuclides shows that CAIs were formed within only <20 ka [2]. The isotopic composition of CAIs indicate that all these objects formed under similar conditions in high temperature regions.
In this work we follow the evolution of CAIs concentrations during rapid protostellar collapse of a molecular cloud till 100 a after second collapse. The model describes the hydrodynamical evolution of a cloud [3] including radiative transfer and realistic

equation of state. The calculations show that high temperatures (up to 1700 K) are reached within a period of the order 3 ka. At the same time accretion and large-scale transport CAIs from the inner hot region to several AU take place.

[1] Amelin, Y. (2002) Science 297,1678-1682. [2] Jacobsen, B. et al. (2008) Earth and Planetary Science Letters 272, 353-364. [3] Tscharnuter, W. M., et al. (2009) Astronomy and Astrophysics 504, 109-113.

PK2010 # 38

Constraining Chondrules Formations using an Aerodynamic Levitation Apparatus

Mathieu, R., Pack, A. Georg-August-Universität, Geowissenschaftliches Zentrum, Goldschmidtstraße 1, D-37077 Göttingen, Germany, romain.mathieu@geo.uni-goettingen.de

Chondrules are millimetre-sized, igneous spherules and are a major component of chondritic meteorites [1]. Since chondrules formed as molten objects, they provide important information regarding physico-chemical conditions in the solar nebula [1]. Indeed, textures are results of bulk compositions and thermal history (1200<T(°C)<1900ºC and 10<cooling rates(K.hr^{-1})<1000 ; [2]). Otherwise, a major topic of literature discussion [3, 4] is to know if chondrules were chemically opened or closed; notably if gas-melt interactions occurred. These aspects played a major role in evolution of mineralogy, bulk chemical and isotope compositons of chondrules. An aerodynamic levitation device in combination with laser melting has been developed to clarify the formation mechanism of chondrules, In this study, we expect having results, in which crystallization patterns very similar to texture of chondrules are reproduced.

[1] Jones et al. (2005) ASPCS, 341, 251–285. [2] Hewins et al. (2005) ASPCS, 341, 286–317. [3] Borisov et al. (2008) GCA, 72, 5558-5573. [4] Chaussidon et al. (2008) GCA, 72, 1924-1938.

PK2010 # 39

X-ray and mineralogical characterization of olivine in Ol-phyric Shergottites.

Matthes*, M., Bischoff, A., Heying, B., Rodewald, U.C., Hoffmann, R.-D., Pöttgen, R. *Institut für Planetologie, WWU Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany. MaxMatthes@uni-muenster.de

Several olivine megacrysts from Dar al Gani (DaG) 476 and Sayh al Uhaymir (SaU) 005 were studied in detail by light and electron microscopy, microprobe, and X-ray diffraction. This study was conducted in order to find out, why the cores of these olivines have a strong reduction of birefringence combined with significant staining. The olivines are heavily fractured, preferentially within their cores. The cores of typical olivines from DaG 476 (core: Fa_{22}; rim: Fa_{38}) and SaU 005 (core: Fa_{28}; rim: Fa_{38}) were drilled out from the thin section and studied with a single-crystal diffractometer. The crystal data and structure refinement for the DaG olivine revealed: $Mg_{1.58(2)}Fe_{0.42(2)}SiO_4$; lattice parameters: a = 1024.4(3) picometer (pm), b = 602.0(2) pm, c = 476.8(2) pm; cell volume: 0.294 nm^3. Similar results were obtained for the SaU crystal.

In conclusion, no indication for the occurrence of high-pressure polymorphs within the olivines was found. The reduced birefringence and staining of the olivine cores may be caused by a combination of shock-induced brecciation and Fe-oxidation.

PK2010 # 40

Mn-Cr systematics of pallasite olivine by SIMS .

McKibbin*, S. J., Ireland, T.R., O'Neill, H.St.C., Holden, P., Lanc, P. *Research School of Earth Sciences, Australian National University, Bldg 61, Mills Road, Acton, Australia 0200 seann.mckibbin@gmail.com

Pallasite meteorites are composed of mixtures of Fe-Ni metal and olivine and would appear to be good candidates for Mn-Cr dating (^{53}Mn-^{53}Cr, $t_{1/2}$ 3.7 Ma) but conflicting results have been reported for these rocks [e.g. 1, 2]. To explore this problem, we have determined Mn/Cr and ^{53}Cr/^{52}Cr in olivine from two pallasites by Secondary Ion Mass Spectrometry (SIMS). The Brahin and Brenham pallasites differ petrographically [3], in terms of trace element distributions [4], and in Mn-Cr systematics: Brahin has no resolved ^{53}Cr excess, but Brenham has apparent initial ^{53}Mn/^{55}Mn of 2.6±0.9 × 10^{-5}. The latter is inconsistent with the current understanding of Solar System evolution, which should have initial ^{53}Mn/^{55}Mn of only 9.1±1.7 × 10^{-6} [5]. Results for Brenham could represent high-temperature redistribution of Cr and Mn, possibly from Mn-phosphates similar to those in some iron meteorites [6].

[1] Hsu W. 2005 Geochem. J. 39, 311 [2] Tomiyama T. et al. 2007 LPSC 2007 [3] Scott E. 1977 GCA 41, 693 [4] McKibbin et al. submitted. [5] Nyquist L. et al. 2009 GCA 73, 5115 [6] Sugiura N. & Hoshino H. 2003 MAPS 38, 117

PK2010 # 41

Pre-irradiation in Almahata Sitta non-ureilite samples?

M. M. M. Meier*, K. C. Welten, P. Jenniskens, H. Baur[1], R. Wieler *Departement of Earth Sciences, ETH Zurich, meier@erdw.ethz.ch.

On October 7th, 2008, asteroid 2008 TC3 entered the Earth's atmosphere above Sudan and produced a strewn field now known as Almahata Sitta (AS) [1]. In addition to the several hundred ureilite fragments, a small number of non-ureilite fragments have been found that have been attributed to the AS fall, based on short-lived radionuclides and other arguments. In order to analyze the relationship between these non-ureilites and the predominantly ureilitic parent asteroid, we have measured the concentrations and isotopic ratios of He, Ne and Ar in two non-ureilitic (L

and H chondritic) samples of AS and compared them with ureilitic samples [2]. Using the cosmogenic 21Ne concentration and 21Ne/26Al ratio, we can estimate a cosmic-ray exposure age of 23±2 Myrs for the two samples, compared to 19□}2.5 Myrs for the average ureilitic AS sample. We discuss the possible implications of a small pre-irradiation (on the order of a few Myrs) for the non-ureilite samples. The analysis of more non-ureilites is necessary.

[1] Jenniskens P. et al., 2009 *Nature*, Volume 458, Issue 7237, pp. 485-488 [2] Welten, K.C. et al., *Meteoritics & Planetary Science*, 2010 (accepted).

PK2010 # 42

Evidence for hot chondrule accretion in primitive chondrites and its relevance for theories of chondrule formation and planetary accretion

Metzler, K., Institut für Planetologie, WWU Münster, 48149 Münster, Germany. knut.metzler@hotmail.de

Some unequilibrated ordinary chondrites were described to contain mutually indented chondrules [1]. Own preliminary studies show that those textures are much more widespread than previously thought and that they are restricted to clasts of specific chondritic rocks, which are tentatively named “cluster chondrites”. Their textures may indicate that hot and plastic chondrules accreted together with rigid chondrules, followed by instantaneous compaction and lithification of the resulting rocks. Chondrule textures in general indicate rapid cooling within hours to a few days [e.g.2]. Formation of chondritic rocks within this short period would be a very restrictive constraint for models of chondrule formation and planetesimal accretion and would indicate that both processes may have been linked. The ubiquity of cluster chondrite clasts may indicate that the process of hot chondrule accretion was fundamental to the formation history of many chondritic planetesimals.

[1] Hutchison R. et al. (1979) Nature 280, 116-119. [2] Hewins et al. (2005) In: Chondrites and the Protoplanetary Disk, Astronomical Society of the Pacific Conference Series 341, 286-316.

PK2010 # 43

Observations of Planet Embryos and their Collision Fragments

Michael Mommert*, Alan W. Harris, *DLR, Institute of Planetary Research, Rutherfordstr. 2 12489 Berlin, Germany, michael.mommert@dlr.de

Small bodies in the Solar System are remnants of the era of planet formation. The most pristine population, the Transneptunian Objects (TNOs), resides in the outer parts of the Solar System, whereas Near-Earth Objects (NEOs) have undergone multiple alteration processes. Both classes have in common, that very little is known about the physical properties of these objects. We report on our first results in investigating the physical characteristics of NEOs and TNOs using thermal and thermophysical models. This work is done within the 'ExploreNEOs' [1] project, which utilizes the 'Warm Spitzer' space telescope and the 'TNOs are Cool' [2] Herschel space observatory Open Time Key Programme. Both projects aim to determine size and albedo distributions and provide further information on physical properties, which help to better understand the processes of planet formation, prepare for asteroid rendezvous and mitigation missions and the transport of carbonaceous material to the young Earth.

[1] Trilling, D. E. et al. (2010) AJ 140:770. [2] Müller T.G. et al. (2010) A&A 518:L146.

PK2010 # 44

Cosmic Petrology: Comparison of Circumstellar Dust with Solar System Extraterrestrial Materials.

Morlok*, A., Lisse, C.M.., Howard, K.T., *PSSRI, The Open University, Walton Hall, MK7 6AA Milton Keynes, UK and a.morlok@open.ac.uk.

Astronomical infrared observations allow us to obtain mineralogical information about micron-sized dust in various circumstellar environments like young stellar objects (YSO), but also in mature systems like debris disks. This allows to link astronomical observations with the knowledge of the compositions of extraterrestrial materials in our Solar System. Meteorites represent such material from the time when our own Solar System was a YSO. Thus the comparison of these data sets would allow a better interpretation of the astronomical data. We present first results of a project where mineralogical data from infrared observations of circumstellar, transitional and debris disks, as well as related objects is compared with the abundant modal mineralogical data available for the composition of meteorites from laboratory studies.

PK2010 # 45

VIS/NIR absorption of solar-nebula dust analogs

Mutschke*, H., Zeidler, S., Posch,T., *Astrophysical Institute and University Observatory, FSU Jena, Schillergäßchen 2-3, 07745 Jena, mutschke@astro.uni-jena.de.

In young (and also older) planetary systems, solid particles are heated by absorption of stellar radiation, which is dominated by photons in the visible and near-infrared wavelength ranges. Temperatures of such particles have been determined from photometric and spectroscopic observations of protoplanetary disks around other stars. These temperatures are often in disagreement with the low absorption efficiencies of pure minerals at visible wavelengths which can be found in tables of optical constants of solids. Thus, we have started to measure spectral absorption coefficients of natural minerals containing impurities, such as olivines containing

iron and spinel containing chromium and iron. The results are interpreted in terms of crystal-field transitions of the transition metal ions [1] as well as of vibrational transitions of other impurities determining the absorption properties.

[1] Burns, R.G. Mineralogical Applications of Crystal Field Theory", 2nd Ed., Cambridge Univ. Press, 1993.

PK2010 # 46

Direct detection of Jovian planets around young solar analogs and their atmospheres

Neuhaeuser R., Adam C. (AIU Univ. Jena), Hauschildt P.H. (Sternwarte Uni Hamburg)

It is not yet clear how frequent and typical our solar system is compared to other planetary systems. Between April 2005 and November 2008, 12 planet candidates detected by direct imaging have been published. The first few planet candidates were found around very young stars; more recently, planets were found around stars with debris disks. For companions imaged directly, i.e. in wide long orbits, it is difficult to constrain the mass well. Hence, it remains often unclear whether the companion is a planet or a brown dwarf. We will present Sinfoni spectra of some exo-planet candidates younger than 10 Myrs and comparison with Drift-Phoenix model atmospheres. Then, we will compare all detected objects and determine their mass ranges in a homogeneous way. Based on that we will discuss their formation and nature. We can use the sample of young massive planets around young solar analog stars to investigate how typical our solar system is and to constrain its formation scenario.

PK2010 # 47

Modeling of differentiation, convection and magnetic field generation in accreting planetesimals.

Neumann, W., Breuer, D., Spohn, T., Deutsches Zentrum für Luft- und Raumfahrt, Institut für Planetenforschung, Rutherfordstraße 2, 12489 Berlin, wladimir.neumann@dlr.de

Compositional differences between meteorites may indicate wide variations in the degree of differentiation of their parent bodies. Differentiated planetesimals must have undergone (partial) melting. The radioactive decay of ^{26}Al and ^{60}Fe is considered as capable of providing sufficient amount of thermal energy. Thermal models have shown that variations of the onset time of accretion relative to the CAIs formation time, the accretion time, and the final size lead to differing degrees of partial melting. However, the cooling is assumed to proceed mainly by thermal conduction and the influence of magma transport and convection is neglected. We study both processes using 1D thermal energy balance models that include magma heat transport and 3D mantle convection models. We improve the 1D thermal model of Merk et al. (2002) by additional parameters such as porosity, sintering, redistribution of heat sources etc. to study the influence on the thermal evolution. Furthermore, we intend to examine with the 3D convection code ([2]) the conditions sufficient for the onset of the convection and the associated efficient heat transport in a partly molten planetesimal.

[1] Merk, R. et al. (2002) Icarus, 159, 183–191. [2] Hüttig, C. and Stemmer, K., (2008) GGG 9.

PK2010 # 48

Simulation of high speed impacts of cosmic dust into STARDUST aerogel and foil collectors

Postberg F.*, Trieloff M., Srama R., Hillier J.K., Gainsforth Z., Westphal A.J., Bugiel S., Grün E., Kearsley A., Schwarz W.H., Höfer C. and the ISPE team. *Universität Heidelberg, Institut für Geowissenschaften, INF 234-236, 69120 Heidelberg; MPI für Kernphysik, 69117 Heidelberg, Frank.Postberg@mpi-hd.mpg.de.

Our project aims at laboratory simulation of high speed cometary, interplanetary or interstellar dust impacts onto aerogel or foil collectors used for the Stardust Mission. High velocity shots up to 50 km/sec are performed by a Van de Graaff accelerator at the MPI für Kernphysik. A newly installed Particle Selection Unit allows individual shots with defined speed and particle size. We have prepared and analysed cosmic dust analogue materials (silicates, sulfides, oxides, carbides). The grains have been coated by a thin conductive layer of platinum or polypyrrole to allow electrostatic acceleration. Using this new setup, we carried out a major campaign of shots into aerogel flight spare tiles within narrow grain speed and size windows (e.g. 14 - 16km/s, 0.37 –0.43μm). Investigation of the tracks and the analysis of chemical alteration during impact is in progress.

PK2010 # 49

Young planetary systems in the 25 Ori cluster

Raetz St. (1,2), Roell T. (1), Neuhäuser R. (1), Briceno C. (3), Errmann R. (1), Schmidt T. (1), (1) AIU Jena, Schillergäßchen 2-3, 07745 Jena, Germany, (2) straetz@astro.uni-jena.de, (3) CIDA, Venezuela

Young open clusters provide an ideal environment for the search for extrasolar planets, since they feature a relatively large number of stars of the same known age and metallicity at the same distance. In our project we study one carefully selected young open cluster (25Ori, 10 Myrs) by searching for Jupiter-like planets with transit, astrometry, and direct imaging, so that we can find all planets in a given mass range for all possible separations. For our transit search in 25Ori started in January 2010, we used the 90 cm telescope of the University Observatory Jena and a similar telescope in Venezuela (CIDA). We will present first results. In Dec 2010 as well as Jan and Feb 2011, we will do international observing campaigns to detect transiting planets in 25Ori. The

program is realized by collecting data from 0.6 – 2.2-m telescopes spread worldwide at different longitudes. For the first epoch of our astrometric and direct imaging planet search, Adaptice Optics observing time with NaCo at the 8 meter VLT was granted to us for Dec 2010.

PK2010 # 50

Early evolution of meteorite parent bodies: Chemical and isotopic constraints on meteoritic zircon, baddeleyite, and phosphate grains.

Roszjar*, J., Bischoff A., Mezger, K., Srinivasan, G., Whitehouse, M., Scherer, E. E., Geisler, T., *Institut für Planetologie, WWU Münster, 48149 Münster, Germany, j_rosz01@uni-muenster.de.

We will present our current progress on the study of phosphate, baddeleyite, and zircon grains identified in both undifferentiated and differentiated meteorites using electron microscopy. Selected zircon grains (5-25 μm in diameter) from three eucrite samples (NWA5073, HaH286, NWA2550), an L5 chondrite (Barwell) and an angrite (Sahara99555) were analyzed for their Hf-W, U-Th-Pb isotope compositions, and rare earth element (REE) abundances (IMS1280 IonProbe), together with major and trace element data (electron microprobe). The grains were also studied by μ-Raman spectroscopy. Initial results reveal that all zircon grains have strongly variable isotope compositions and REE abundances, while being homogeneous in major element chemistry. In NWA5073, zircon grains were chemically separated using alternating HF-HNO_3-HCl. These will be analyzed for Lu-Hf isotopic composition.
This project is supported by the DFG (BI 344/9-1).

PK2010 # 51

Heterogeneous accretion and core-mantle differentiation of the terrestrial planets.

Rubie*, D.C., Frost, D.J., Nimmo, F., O'Brien, D.P., Nakajima, Y., Vogel, A., Mann, U., Palme, H., *Bayerisches Geoinstitut, Universität Bayreuth, D-95440 Bayreuth, Germany, dave.rubie@uni-bayreuth.de.

We present a new model of core formation by which terrestrial planets accrete through a series of impacts with smaller differentiated bodies. Each collision involves the impactor's core equilibrating in a magma ocean before merging with the planet's proto-core. Compositions of metal and silicate that result from the equilibration process are determined from the bulk composition by a novel approach involving mass balance combined with element partitioning. In the case of the Earth, model parameters (e.g. metal-silicate equilibration pressures) are determined by a least squares fit based on constraints provided by the concentrations of 12 major and trace elements in the Earth's mantle. Results show that accretion of the Earth was heterogeneous: early accreting material was highly-reduced and volatile-poor and later accreted material was relatively oxidized and volatile-rich. The Earth's water inventory was accreted at a late stage, possibly with the later veneer. The model is currently being combined with the results of N-body accretion simulations in order to incorporate time (Hf-W isotopes) and stable isotope fractionation.

PK2010 # 52

The shock wave synthesis laboratory at the TU Bergakademie Freiberg/ Germany

Schlothauer, T*., Schwarz, M. R., Heide, G. *TU Bergakademie Freiberg, Brennhausgasse 14, 09596 Freiberg/Germany thomas.schlothauer@mineral.tu-freiberg.de

Available technology and selected results of the shock wave laboratory of the Freiberg High Pressure Research Centre (FHP, [1]) at the Technische Universität Bergakademie Freiberg are presented. Located 150 m below surface in the university's own teaching and research mine "Reiche Zeche", the laboratory offers excellent conditions for explosive shock recovery experiments. The current focus of the FHP is mainly on the synthesis of novel superhard materials, using a planar impact geometry. However, also metallic phases, minerals and rocks can be shocked (pressure in iron ca. 90 GPa, in granites 40 GPa, in quartz 40 GPa). A technology for sample encapsulation under protective atmos-phere (Ar, N_2) has been developed. A new blasting chamber with larger capacities (e.g. for multi-stage planar or coaxial impact experiments) with achievable pressures > 100 GPa and *in-situ* data recording with an 8-channel-oscilloscope will be completed at the beginning of 2011.

[1] http://tu-freiberg.de/ze/hochdruck/.

PK2010 # 53

Impact crater in Europe

Schmidt, G., Schloss Rennhof, Litauisches Gymnasium, D-68623 Hüttenfeld schmdtgerhard@aol.com.

On Earth approximately 176 impact craters up to ~ 300 km in diameter and up to ~ 2 Ga in age are recognized. About 20 iron meteorites and 20 chondrites have been identified as projectiles. In Europe 37 impact craters have been identified. 10 craters are located in Finland (projectile type; one magmatic iron), 7 in Ukraine (one magmatic iron), 6 in Sweden (two magmatic irons), 4 in Estonia (one IAB iron), 2 in Germany, 2 in Norway, 2 in Lithuania (Vepriai N 55° 5' E 24° 35'; Mizarai N 54° 1'; E 23° 54'), 1 in France (magmatic iron), 1 in Latvia, 1 in Belarus and 1 in Poland (octahedrite fragments). Understanding the origin of planets it is important to know abundances and ratios of refractory highly siderophile elements (RHSE: Os, Ir, Ru, Rh). The RHSE and Ni systematics of the Earth upper continental crust (UCC) including rocks from the Ries crater (suevite, graded unit, etc.) closely resembles IIIAB magmatic irons, pallasites, and Martian mete-

orites, derived from Martian crust. If these signatures are relicts of early bombardments than 160 impacting fragments of M-type asteroids (e.g., Psyche, Kleopatra) with radii of 10 km would yield total abundances of RHSE and Ni in the UCC.

PK2010 # 54

New investigations into the Steinheim impact structure (Baden-Württemberg, Germany) – Part I: A first attempt of $^{40}Ar/^{39}Ar$ dating

Schmieder*, M., Buchner, E., Jourdan, F., *Institut für Planetologie, Universität Stuttgart, Germany, martin.schmieder@geologie.uni-stuttgart.de.

The ~3.8 km Steinheim Basin is a well-preserved, complex impact structure hosted by a sequence of Triassic to Upper Jurassic sedimentary rocks of the eastern Swabian Alb, SW Germany. The Steinheim crater is thought to have been struck simultaneously with the ~24 km Nördlinger Ries crater ~14.5 Ma ago [1]. Among the recently discovered impact melt lithologies at Steinheim is a pebble of partially molten, fluidally-textured Middle Jurassic sandstone recovered from the central uplift ('Steinhirt') [2]. $^{40}Ar/^{39}Ar$ dating of white to reddish feldspathic cryptocrystalline to glassy domains of the partially molten sandstone failed to yield any statistically representative age but resulted in strongly scattered age data with individual steps ranging from ~0 Ma to ~600 Ma, inconsistent with the local Miocene crater lake biostratigraphy and earlier stratigraphic age estimates [1]. From an argon isotopic point of view, the Steinheim impact age still remains elusive.

[1] Stöffler, D. et al. (2002) MAPS 37, 1893-1907. [2] Buchner, E. & Schmieder, M. (2010) MAPS (in press).

PK2010 # 55

New investigations into the Steinheim impact structure (Baden-Württemberg, Germany) – Part II: Steinheim shatter cones revisited

Schmieder*, M., Buchner, E., *Institut für Planetologie, Universität Stuttgart, Germany, martin.schmieder@geologie.uni-stuttgart.de.

Shatter cones in Upper Jurassic limestones from the ~3.8 km complex Steinheim Basin count among the most typically developed specimens known from terrestrial impact sites. In addition to these, shatter cones were also noted in Middle Jurassic sandstones of the Steinheim central uplift ('Steinhirt'). We recently discovered shatter cones in concretionary claystone nodules of the Middle Jurassic 'Opalinuston' that was temporarily accessible during water catchment works on top of the Steinhirt. The Opalinuston shatter cones are highly variable in their structural properties, with well-defined individual cones running in one main or opposite directions, as well as cones arranged in a 'sun-like' pattern radiating outward from a concretionary core. It is suggested that shock wave scattering and shatter cone formation [1] at Steinheim was strongly dominated by local (micro- to meso-scale) target rock effects. In particular, the Opalinuston shatter cones indicate that even comparatively soft clayey lithologies may be conductive to high-pressure shock waves.

[1] Sagy A. et al. (2004) JGR 109, B10209.

PK2010 # 56

High-precision $^{40}Ar/^{39}Ar$ dating of the Lappajärvi impact structure (Finland) using mixed and monomineralic impact melt lithologies

Schmieder*, M., Jourdan, F., Bockstaller, P., Buchner, E. *Institut für Planetologie, Universität Stuttgart, Germany, martin.schmieder@geologie.uni-stuttgart.de.

The ~23 km Lappajärvi crater is the youngest of the larger impact structures in Fennoscandia. Impact lithologies comprise autochthonous impact breccias and melt rocks ('kärnäite') at the central island of Lake Lappajärvi, as well as reworked impact ejecta some km SE of the lake [1]. Earlier $^{40}Ar/^{39}Ar$ dating of impact melt rocks resulted in scattered data with a mean age of 77.3 ± 0.8 Ma (MSWD=5.1) using the K decay constant by [2]; U/Pb dating of melt-grown zircons suggested an indistinguishable age of 73.3 ± 5.3 Ma [3]. We report a refined $^{40}Ar/^{39}Ar$ age for five fresh single-grain impact melt rocks and one monomineralic K-feldspar melt particle separated from impact-metamorphosed granite (compare [4]), which yielded six well-defined and concordant individual plateau ages and a combined mean age of 76.15 ± 0.29 Ma (2σ) (MSWD=0.92, p=0.46) using the recently revised K decay constants [5].

[1] Jessberger, E. K. & Reimold W. U. (1980) J. Geophys. 48, 57-59. [2] Steiger, R. H. & Jäger, E. (1977) EPSL 36, 359-362. [3] Mänttäri, I. & Koivisto, M. (2001) MAPS 36, 1087-1095. [4] Buchner, E. et al. (2010) MAPS (in press). [5] Renne, P. et al. (2010) GCA 74, A862.

PK2010 # 57

Investigation of interstellar dust candidates using Synchrotron XRF and XRD.

S. Schmitz*, F. Brenker, B. Vekemans, L. Vincze, T. Schoonjans, M. Burghammer, C. Allen, S. Armes, S. Bajt, A. Ball, R. Bastien, H. Bechtel, J. Borg, J. C. Bridges, D. E. Brownlee, M. J. Burchell, A. Butterworth, R. Chater, P. Cloetens, G. Cody, A. Davis, T. Ferroir, C. Floss, G. Flynn, D. Frank, Z. Gainsforth, E. Grün, P. R. Heck, J. Hillier, P. Hoppe, F. Hörz, L. Howard, B. Hudson, G. R. Huss, J. Huth, A. T. Kearsley, B. Lai, M. Landgraf, J. Leitner, L. Lemelle, H. Leroux, L. Nittler, R. Ogliore, M. C. Price, F. Postberg, S. Sandford, G. Silversmit, A. Simionovici, R. Srama, F. Stadermann, T. Stephan, R. Stroud, S. Sutton, R. Toucoulou, M. Trieloff, J. Trigo-Rodriguez, P. Tsou, A. Tsuchiyama, T. Tyliczszak, J. Warren, A. J. Westphal, M. E. Zolensky. Stardust Interstellar Preliminary Examination (ISPE) team. *Geoscience Dept., Goethe University, Altenhoefer Allee 1, D-60438 Frankfurt / M., schmitz@em.uni-frankfurt.de.

Two impact tracks of interstellar candidate grains collected by *NASA's Stardust* mission which had trajectories approximately consistent with an origin of the interstellar dust stream (midnight tracks [1]), were investigated using synchrotron XRF and XRD at the nano focusing beamline ID13 (ESRF, Grenoble). During two beamtimes the spot size could be optimized to several hundred nanometers (FWHM ~400-500nm), which makes high resolution XRF/XRD imaging of these particles possible. Track 34 (I1047,1,34) reveals two particles with sizes between 2–2.5µm. The terminal (end-) particle shows Fe, Ni, Cr as trace elemental concentrations and from STXM measurements [2] it is known that the TP is Mg-rich. Track 30 (I1043,1,30) shows an Fe, Ni, Cr, Mn-rich elongated TP with several Fe, Ni correlated hotspots. STXM shows an Mg, Al-rich particle. XRD has indicated the presence of fine-grained material.

[1] Westphal A. J. et al. (2010) 41st Lunar and Planetary Science, Abstract#2050; [2] Westphal et al. (2010) Meteorit. Planet. Sci. A215

PK2010 # 58

Timescales of early solar system homogenisation from ^{180}W distributions in iron meteorites

Schulz, T.[1,2] and C. Münker[1]. [1]Institut für Geologie und Mineralogie, Zülpicher-Str. 49b, 50674 Köln, Germany; [2]Steinmann Institut für Endogene Prozesse, Poppelsdorfer Schloss, 53115 Bonn, Germany. E-mail: toni.schulz@arcor.de

Here we present the first high-precision measurements of the heavy p-process nuclide 180W in iron meteorites. Using the Neptune MC-ICP MS, equipped with high sensitivity 1012 Ohm amplifiers (for measuring 180W and the 180Hf interference monitor), we were able to identify significant and systematic 180W abundance variations between different groups of iron meteorites. These variations are consistent, even when applying different ratios for internal normalization and range from values as high as +2 to +7 ε-units for magmatic iron meteorites. Conversely, non-magmatic IAB iron meteorites display the smallest ε180W anomalies of ~ +1 ε-unit that are barely resolvable from the terrestrial value. An increasing homogenization of the early solar system is mirrored by increasingly lower 180W anomalies in younger iron meteorite groups, suggesting mixing-timescales in the order of several million years. Additionally cosmogenic effects due to burnout of 180W were observed for the meteorites with the longest exposure ages.

PK2010 # 59

Extraterrestrial noble gases in magnetic fractions from Massignano sediments

Schwarz*, W.H., Trieloff, M., *Universität Heidelberg, Institut für Geowissenschaften, INF 234-236, 69120 Heidelberg Winfried.Schwarz@geow.uni-heidelberg.de.

In Earth´s history, the influx of extraterrestrial matter was not constant, as e.g. demonstrated by an increased mid ordovician meteorite infall and cratering rate [2], or a spike of ^{3}He from IDPs in carbonate rocks from the 35 Ma old Massignano section. Here, also Iridium-spikes from larger impactors (e.g. Popigai) were found. To get isotopic and elemental data for all noble gases trapped in Massignano rocks, we enriched IDP material by separating the magnetic fraction from acid residues (see [3]).
The first results for He agree with [1]. ^{3}He/^{4}He, Ne isotopic data and noble gas elemental ratios tend to solar wind implanted composition characteristic for IDPs. One of our aims is to quantify possible losses of extraterrestrial noble gases by atmospheric entry heating in order to correct the influx estimate based on helium isotopes only.

[1] Farley, K.A. et al. (1998) Science 280, 1250–1253. [2] Schmitz B. et al. (2001) EPSL 194, 1-15. [3] Schwarz W.H. et al. (2005), Contrib. Mineral. Petrol., 149, 675-684.

PK2010 # 60

High and low temperature radiochronometer trace cooling histories of meteorite parent bodies

Schwarz*, W.H., Trieloff, M., Hopp, J., Henke, S., Gail, H.-P., Ott, U., Kleine, T. *Universität Heidelberg, Institut für Geowissenschaften, INF 234-236, 69120 Heidelberg Winfried.Schwarz@geow.uni-heidelberg.de.

Asteroidal-sized meteorite parent bodies in the early Solar System were heated by short-lived nuclides (e.g., ^{26}Al) and cooled over tens of Ma. These early thermal histories can be constrained using radiochronometers with different closure temperatures (e.g, Hf-W, I-Xe, U-Pb-Pb, Ar-Ar, ^{244}Pu fission tracks). The best documented example is the H chondrite parent body [1-3], which cooled in an onion shell like structure, accompanied by minor impacts affecting the surface. For enstatite chondrites, fragmental data need to be augmented within accompanying DFG/SPP projects. In order to infer

parent body properties (e.g., size, structure, layering depth of specific meteorites, sintering grade) thermochronological data need to be modeled realistically (see abstracts by Henke et al. and Gail et al.) using advanced models implementing e.g. the accretionary process, initial porosity, sintering effects and boundary conditions.

[1] Trieloff M. et al. 2003. Nature 422:502-506. [2] Kleine T. et al. (2009) EPSL 270, 106-118. [3] Schwarz W.H. et al. (2006) MAPS 41, A161.

PK2010 # 61

Lithium isotopes of chondrules, CAIs and a DI from Allende and from ordinary chondrites

H.-M. Seitz, J. Zipfel, G.P. Brey, U. Ott[3]. Inst. of Geoscience, Universität Frankfurt, Altenhöferallee 1, 60438 Frankfurt, Germany, H.-M.Seitz@em.uni-frankfurt.de.

89 chondrules, 10 CAIs and one dark inclusion (DI) from Allende and their bulk compositions were studied. We find that (1) chondrules from all chondrites have similar Li compositions, implying that there are no significant compositional differences between sources. (2) Higher Li abundances and slightly heavier Li isotopes in bulk chondrites compared to chondrules and CAIs require the presence of another component that is enriched in Li and heavier in δ^7Li. Allende DI, which has high Li concentration and a heavier Li isotope composition than bulk Allende, may be such a complementarity. It remains unclear at present whether Li isotopes are fractionated as a consequence of condensation, high temperature thermal processing or whether observed signatures are a result of various nucleosynthetic processes. (3) The lighter bulk Li-isotope compositions observed in ordinary chondrite groups [1] are likely to be controlled by the proportions of CAI's and chondrules in the bulk chondrite.

[1] Seitz et al. (2007) *Earth & Planetary Science Letters 260*, 582-596.

PK2010 # 62

Chemo-dynamical evolution of the Solar nebula

Semenov*, D.A., Wiebe**, D.S., *Max-Planck-Institut fuer Astronomie, Koenigstuhl 17, D-69117 Heidelberg semenov@mpia.de, **Institute of the Astronomy of RAS, Pyatnitskaya str. 48, 119017 Moscow, Russia

The importance of 2D turbulent diffusion and non-thermal desorption mechanisms for the chemical evolution of the Solar-like nebula will be discussed. Our chemical model is based on the modern gas-grain reaction network supplied with a large set of surface reactions to produce organic molecules, coupled to a 1+1D flared physical model of the nebula covering 10-800 AU. We simulate chemical evolution of the nebula within 5 Myr and study how molecular abundances and column densities of the gas-phase and frozen species change under the influence of turbulent transport, thermal desorption, and UV/X-ray-irradiation. Several most sensitive, potentially observable molecular tracers of disk dynamics are identified, e.g. CCS, SO, CO2(ice), CH3CHO. The transport in the nebula affects most strongly slowly evolving complex (organic) molecules formed on dust grains. We also compare the resulting column densities with observed/measured values in the DM Tau disk (a Sun-like star at ~4-7 Myr) and found a general good agreement with our chemo-dynamical model.

[1] Semenov, Wiebe, Henning, 2006, ApJL, 647, 57 [2] Semenov, Wiebe, 2011, ApJ, in prep.

PK2010 # 63

Isotope Study of Interplanetary Dust Particles (IDPs) from Five Dust Collections.

Spring*, N., Busemann, H., Nittler, L.R., Crowther, S.A. and Gilmour, J.D., * School of Earth, Atmospheric and Environmental Sciences, University of Manchester, UK. nicole.spring@student.manchester.ac.uk.

IDP collection during Earth's passage through a cometary dust stream increases the probability to examine dust of a known source [1]. Previously, Xe was detected exclusively in IDPs collected during encounters with the comet Grigg-Skjellerup (GS) dust stream (collectors L2054/5) [2]. We aim to link the potential detection of Xe to specific dust streams, degree of primitiveness of IDPs and ultimately to carriers and origin of trapped cometary noble gases.
This study reports the extreme variations in texture, bulk composition and isotopic anomalies (some amongst the highest observed in IDPs) of 13 IDPs, including possible GS and comet Schwassmann-Wachmann-3 dust (L2009/11 [3]) and non-specific collections (L2008/36).
IDPs were analysed with NanoSIMS (Carnegie Institution) and ESEM/EDX, with Xe analysis planned with high-sensitivity resonance mass spectrometry (RELAX, Manchester).

[1] Busemann H. et al. (2009) *EPSL* 288:44-57. [2] Busemann H. et al. (2010) #1947. 41st LPSC. [3] Messenger S. & Walker R.M. (1998) #1906. 29th LPSC.

PK2010 # 64

Hf-W and Pb-Pb constraints on the thermal evolution of the L chondrite parent body

Sprung, P.*, Göpel, C., Kleine, T., Van Orman, J.A., Maden, C., Bourdon, B., *ETH Zürich, Institut für Geochemie und Petrologie, Clausiusstrasse 25, 8092 Zürich, Switzerland peter.sprung@erdw.ethz.ch.

Knowledge of the earliest evolution of small planetary objects is key to understanding the evolution of the early solar system and the formation of the terrestrial planets. Constraining the thermal history of a parent body (PB) provides direct information concerning its accretion age, size, internal structure and differentiation style.

We here present Hf-W age data (Δt_{CAI}, closure temperature ~750 – 950°C) for equilibrated L chondrites of petrologic types 4 – 6 that range from 2.5 ±0.9 Myr (Saratov, L4) to 11.8 ±1.3 Myr (Ladder Creek, L6) and increase with petrologic type. In conjunction with existing Pb-Pb age data for apatites and merrilites (closure temperature ~375 – 575 °C) from the same meteorites (e.g., [1]) and thermal modeling, our data depict a high-temperature history and primary structure of the L chondrite PB consistent with those of the H chondrite PB ([2], [3]): ~200 km wide, concentrically layered, internally heated by the decay of ^{26}Al, possibly modified by impacts.

[1] Göpel, C. et al. (1994) EPSL 121. [2] Trieloff, M. et al. (2003) Nature 422. [3] Kleine, T. et al. (2008) EPSL 270.

PK2010 # 65

ALHA 77307: a combined NanoSIMS and TEM study of an argon ion sliced (ArIS) meteorite sample

Stojic*, A.N., Brenker, F.E. & Hoppe, P. * Geosciences Institute, Goethe University Frankfurt, D-60438 Frankfurt/Main stojic@em.uni-frankfurt.de.

We performed ArIS, a new TEM sample preparation technique [1], on Allan Hills 77307 and obtained a TEM thin foil of app. 22.000 μm^2, out of which app. 10.000 μm^2 are matrix material. Then, a consecutive area of 800 μm^2 and four additional randomly chosen (10 x 10) μm^2 areas out of the huge electron transparent matrix area were scanned by NanoSIMS to identify presolar grains. Two supposedly group I grains were detected. Further chemical and structural information on the grains will be obtained from a pending TEM analysis. In previous attempts, where combined NanoSIMS and TEM analysis were applied [2], the identified presolar grains required a complex and risky extraction procedure out of the scanned thin section by FIB. ArIS prepared samples yield the enormous advantage of enabling NanoSIMS scans and TEM analysis on the same target area of the sample without the necessity of additional preparation, since the NanoSIMS scan is performed already on an electron transparent area.

[1] Stojic A.N. & Brenker F.E. (2010) Eur. J. Mineral. 22, 17 – 21 [2] Vollmer et al. (2009) Geochim. et Cosmochim. Acta. 73, 7127-7149.

PK2010 # 66

Thermographic studies on chondrules – Implications for photophoresis.

Teiser, J., Dürmann, C., Wurm, G., Faculty of Physics, Universität Duisburg-Essen, jens.teiser@uni-due.de.

Several studies give evidence for radial material transport in the Solar Nebula [1,2] and photophoresis is one possible mechanism [3]. To understand photophoretic motion of chondrules, an experimental technique has been developed to study the thermal conductivity and the emissivity of chondrules using a high-resolution thermographic camera. Samples are illuminated at one side. The light is absorbed at the surface of the chondrule and the heated parts emit infrared light according to their surface temperature and their emissivity. The evolving temperature profiles along the surface can be resolved spatially and chronologically. The temperature distribution on a chondrule surface depends on its mineralogical composition and influences the sensitivity with respect to photophoresis. Within the SPP 1385 we will present first results of thermography on chondrules. The chondrules are gained from the L/LL4 chondrite Bjurböle and cleaned from any matrix material. From thermography we can derive thermal conductivities of single chondrules.

[1] Zolensky, M.E. et al. (2006), Science, 314, Issue 5806, pp. 1731. [2] Rout, S.S. et al. (2009) GCA, 73, 4264. [3] Wurm, G. et al. (2010), Icarus, 208, 482-491.

PK2010 # 67

A possible origin of misaligned planetary systems

Thies*, I.T., Kroupa, P., *Argelander-Institut für Astronomie, Universität Bonn, Auf dem Hügel 71, D-53121 Bonn, Germany, e-mail: ithies@astro.uni-bonn.de.

The recent discovery of planets on misaligned or even counter-rotating orbits by WASP poses one of the greatest challenges to the theoretical understanding of planet formation. Such randomly aligned orbits contradict the classical model of planet formation out of a rotating circumstellar disc around a single host star. Here we show that repeated accretion during close encounters with massive discs or other dense gas aggregates in a star-forming cloud may lead to the formation of randomly aligned planets around stars. The accretion of gas onto a pre-existing disc can lead to two temporary circumstellar discs which will merge with time into a disc tilted against the stellar equator. Furthermore, the pre-existing disc is condensed, possibly enhancing dust coagulation. We further predict the existence of multi-plane planetary systems as a consequence of multi-stage accretion in dense inhomogeneous star-forming clouds. These processes may be relevant for understanding the inclination of the ecliptic to the solar equator and the flaring of the Kuiper Belt.

PK2010 # 68

Quantitative structural analyses of HEDs using EBSD techniques. Howardite NWA 2696

Tkalcec, B.J., Brenker, F.E., Geoscience Institute, Goethe University, Frankfurt, Germany, e-mail: tkalcec@em.uni-frankfurt.de.

HED meteorites are thought to have originated from various crustal levels of the asteroid 4 Vesta, or a Vesta-like body [1]. Structural analysis on NWA

2696, a polymict regolith breccia of both eucritic and diogenitic fragments in a finer grained matrix, is being carried out using electron backscatter diffraction (EBSD), which allows the axis orientation of each crystal to be measured and visualized to discover any preferred crystal alignment [2]. Comparison of structural results between intraclasts and matrix offers first insight into the complex, polyphase deformation undergone during Vesta's formation, crustal evolution and impact history. We present results of a preliminary study on NWA 2696. This study, which will be extended to different types of both eucrites and diogenites, is of particular interest, since Vesta itself in 2011 awaits the arrival of NASA's DAWN probe, from which further information on the structural evolution and current state of its surface is expected.

[1] McSween Jr., H. (2010) Space Sci Rev DOI 10.1007/s11214-010-9637-z. [2] Prior, D. et al. (1999) Am. Min. 84, 1741-1759

PK2010 # 69

Conditions prevailing at chondrule formation: a window to trigger planetesimal formation

Trieloff M.*, Blum J., Zsom A., Klahr H.H., Dullemond C., Palme H. *Universität Heidelberg, Institut für Geowissenschaften, INF 234-236, 69120 Heidelberg; Mario.Trieloff@geow.uni-heidelberg.de

To form planets in protoplanetary discs, micrometer sized dust particles need to grow by hit-and-stick collisions to km sized planetesimals, until they grow by gravitational forces. However, as larger particles move with Kepler velocity, they experience a head wind causing large differential speeds [1] which prevents growth beyond dm size as demonstrated by coagulation experiments [2]. We show that chondrule formation regions provide necessary conditions (e.g., enhanced dust to gas ratios [3]) in which the classical "head wind" problem hardly occurs and where formation of larger bodies is promoted, possibly by gravoturbulence [4]. This agrees with chemical complementarity [5] and chondrule and chondrite parent body ages that imply fast parent body growth after chondrule formation.

[1] Weidenschilling S. J. (1977) *Monthly Not. Roy. Astr. Soc.* 180, 57 [2] Blum J., Wurm G. (2008). *Ann. Rev. Astr. Astrophys.* 46, 21-56. [3] Alexander C. M. O'D. et al. (2008) *Science* 320, 1617 [4] Johansen A. et al. (2007) *Nature* 448, 1022-1025. [5] Hezel D.C. & Palme H. (2010) EPSL 294, 85.

PK2010 # 70

An improved way to confirm PDFs in quartz: U-stage and EBSD techniques combined

Voorn, M.H*., Hamers, M.F., Drury, M.R., *Faculty of Geosciences, Department of Earth Sciences, Utrecht University, Budapestlaan 4, 3584 CD, Utrecht, The Netherlands. E-mail: maartenvoorn@hotmail.com

Orientation statistics of planar microstructures in quartz are often used as proof for a shock origin of the lamellae. We use a combination of Universal Stage (U-stage - 3D orientations) and electron backscattered diffraction (EBSD – full crystallographic grain orientation) to collect orientation data of planar deformation features (PDFs) and tectonic deformation lamellae (DL) in quartz. Orientation measurements are indexed according to the standard method described by [1]. Samples from three different impact craters are used to measure PDF orientation; samples from two different tectonic settings are studied for DL orientations. Orientation plots of PDFs and DL (from U-stage data only) turn out to be very similar, and thus not provide clear criteria for distinction between the planar microstructure formation mechanisms. Addition of EBSD data does provide a clear distinction as it pinpoints the crystallographic reference frame. Conclusively, the combination of U-stage and EBSD data provides a better way for confirming PDFs in quartz.

[1] Ferrière et al. (2009) MAPS 44(6), 925-940.

PK2010 # 71

^{182}Hf-^{182}W age of the Mount Egerton aubrite

Weinauer J. [2], Schulz T. [1,2], Münker C. [1,2], [1]Institut für Geologie und Mineralogie, Zülpicher-Str. 49b, 50674 Köln, Germany; [2]Steinmann Institut für Endogene Prozesse, Poppelsdorfer Schloss, 53115 Bonn, Germany. E-mail: weinauer@yahoo.de

Mount Egerton is an anomalous aubrite composed of cm-sized enstatite crystals with ~21 wt.% metallic Fe,Ni [1]. It is unusual in being unbrecciated and containing a much greater percentage of Fe,Ni metal than other aubrites. Here we present Hf-W data for mineral separates and metal of Mount Egerton. The Hf-W data are complemented by electron microprobe data, constraining the mineralogy of the separates analyzed. The radiogenic 182W signature of the metal (~ +1.3 ε-units) as well as a maximum isochron age of ~4540 Ma, defined by four silicate separates, can be interpreted in two ways: (1) impact-metamorphism causing diffusion of radiogenic W from silicates into metal, or (2) slow cooling of an internally heated aubrite parent body, with late stage equilibration between metals and silicates. The second scenario provides a link to previously reported Hf-W data for the brecciated and pre-irradiated [3] Khor Temiki and Norton County meteorites, yielding ages of ~4560 Ma and ~4550 Ma [2]. This prolonged age interval may reflect fast cooling in the surface-regolith regions of the aubrite parent body accompanied by slower cooling of the interior portion beneath a heat insulating regolith cover.

[1] Casanova et al. (1993); [2] Petitat et al. (2008); [3] Lorenzetti et al. (2003).

PK2010 # 72

Condensation and solid phase reaction of Fe in Mg silicate systems

Wetzel*, S., Gail, H.-P., and Pucci, A., *Kirchhoff Institute for Physics, Im Neuenheimer Feld 227, 69120 Heidelberg, swetzel@kip.uni-heidelberg.de

Fe-Mg silicates are among the most abundant minerals in space and their spectral features not only reveal the relative abundance of the respective elements but as well the formation conditions such as temperature or gas pressure. In order to obtain reliable information from the analysis of observations a broad database and a better understanding of the origin of IR spectral changes is required.
In our experiments we intend to investigate the influence of elemental Fe in silicates by performing in situ IR spectroscopy during condensation and further solid-phase reaction of layers made by co-evaporation of Fe, Mg, MgO and SiO under UHV conditions. Details on the experimental setup and results from the condensation of SiO and SiO_2 [1,2] will be presented.

[1] Klevenz, M. et al. (2010) Applied Spectrosc. 64(3), 298–303. [2] Klevenz, M. et al. (2010) Phys. Status Solidi B 247(9), 2179-2184.

PK2010 # 73

The Outgassing History of Titan's Atmosphere.

Williams*, N. H. and Burgess, R., School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Oxford Road, Manchester, M13 9PL. Niel.Williams-2@postgrad.manchester.ac.uk

The abundances of primordial and radiogenic Ar isotopes provide important constraints on the out gassing history of Titan and formation of its atmosphere. A chondritic reference model for the composition of Titan was used to constrain the abundances of ^{40}K available to decay to ^{40}Ar. The CV carbonaceous chondrites were chosen as the reference for the starting composition of Titan and moments of inertia values were modeled to place constraints on the internal structure. The current atmospheric $^{40}Ar/^{36}Ar$ ratio is inferred to de dependent upon the amount of ^{36}Ar that was retained during initial formation and subsequent atmospheric loss through atmospheric sputtering and hydrodynamic escape. The range of $^{40}Ar/^{36}Ar$ ratios calculated for the atmosphere of Titan was between 110-450. Further constraints could not be placed on the out-gassing rates due to the lack of Xe and ^{36}Ar values from the lower atmosphere obtained by the GCMS instrument aboard the Huygens probe (part of the Cassini mission). The N_2/Ar ratios calculated for Titan's atmosphere are greater than 100, which indicates that nitrogen arrived on Titan as ammonia and was subsequently altered to N_2.

PK2010 # 74

Dust in young stellar and substellar objects

Witte*, S., Helling, Ch., Hauschildt, P.H., *Hamburger Sternwarte, Germany, switte@hs.uni-hamburg.de.

Atmospheres of young stellar and substellar objects feature a growing complexity of their chemistry with decreasing temperatures. At some point, condensation sets in and extended, optically thick dust clouds form which have a considerable impact on the emergent spectrum as well as the local energy budget and are accompanied by a strong element depletion of the gas phase.
We develop the Drift-Phoenix atmosphere code [1,2,3] in order to calculate self-consistent atmospheres with respect to the gas phase chemistry, the dust cloud, the hydrostatics and the radiative field. The dynamics of the dust cloud consider nucleation, growth/evaporation and gravitational settling of dust grains, combined with gas phase element replenishment by turbulent mixing.
I will give a brief overview of the model and present results of our simulations, followed by a comparison with observations.

[1] Witte, S. et al. (2009), A&A 506, 1367-1380. [2] Hauschildt, P.H. & Baron, E. (1999) JCAM 109, 41–63. [3] Helling, Ch. et al. (2008) A&A 485, 547–560.

PK2010 # 75

High-Temperature Optical Constants of Corundum.

Zeidler*, S., Mutschke, H., *AIU, Friedrich Schiller University Jena, Schillergäßchen 2-3, 07745 Jena, sz@astro.uni-jena.de

In the first 10 million years of the solar system the dust which formed the protoplanetary disk and later on the planets has been influenced by a lot of different effects. One of the most important influences is the heating to high temperature, which can change both the physical and the chemical properties of a dust particle. In order to compare observed infrared spectra of young stellar systems with laboratory data of heated circumstellar-dust analogues, we investigate materials like Al_2O_3, spinel, TiO_2 and amorphous and crystalline silicates which are important components of dust in protoplanetary disks. We present the first results of infrared spectroscopic measurements on Al_2O_3 at temperatures up to 700°C. We calculated the optical constants by means of a simple Lorentz-Oszillator-fit and apply them to simulations of small-particle emission spectra. The measurements have been taken with a Bruker 113v FTIR-Spectrometer equipped with a high-temperature-high-pressure-cell.

PK2010 # 76

What stories tell us 300 s measurements of meteorite surfaces with HandheldXRF (HXRF)?

Zurfluh*, F.J., Hofmann, B.A., Gnos, E., Eggenberger, U., *Institut für Geologie, Universität Bern, Baltzerstrasse 1 + 3, CH-3012 Bern, Switzerland; florian.zurfluh@geo.unibe.ch.

Handheld energy dispersive X-ray fluorescence (HXRF) recently reached a high development. Nearly all elements heavier than potassium are quantifiable. To reach accurate data for elements difficult to trace such as barium, measurement times of 300 s are required. Several applications of the HXRF were tested: a) the identification of meteorite wrongs, b) fast classification of meteorites, c) weathering effects in soil under meteorites, d) detection of possible desert varnish on hot desert meteorites and e) measuring the degree of terrestrial contamination by using Sr and Ba as proxies to estimate the terrestrial age. HXRF is a well-suited tool for fast collection of geochemical data. Since surfaces are measured in a nondestructive way no special sample preparation is needed. For meteorite classification the best results were obtained on cut surfaces since weathering effects cause accumulation of Sr, Ba, Fe & Mn on the natural surfaces. On the other hand, these surface effects allow a relative estimation of the terrestrial residence time.

PK2010 # 77

RaS 309: The first Brachinite from the Sultanate of Oman

Zurfluh*, F.J., Hofmann, B.A., Gnos, E., Eggenberger, U., Janots, E., Greenwood R.C. *Institut für Geologie, Universität Bern, Baltzerstrasse 1 + 3, CH-3012 Bern, Switzerland; florian.zurfluh@geo.unibe.ch.

Brachinites are dunitic meteorites with near primitive composition but igneous textures. So far, brachinites were found in Australia (6), Antarctica (4) and NWA (8); no fall is recorded [2]. Here we present the first brachinite from Asia, found 2009 in the Sultanate of Oman, and discuss its mineralogy and geochemistry in order to evaluate its origin and to trace the terrestrial weathering.

RaS 309 shares the characteristics of all other brachinites [1], consisting of 94 vol% olivine ($Fa_{33.1}$), 4 vol% Ca-rich pyroxene ($Fs_{9.1}Wo_{47.4}$), 1 vol% chromite and traces of Ca-poor pyroxene, iron metal, troilite, apatite and graphite (no plagioclase). It has a bulk Fe/Mn ratio of 74.3 and oxygen isotope composition ($\Delta^{17}O$) of -0.19 ‰. Unique features of this brachinite are at least two parallel veins or bands of Ca-rich pyroxene visible of X-ray tomography imagery. EMP and LA analysis show that pyroxene in these bands is similar in composition to pyroxene in other parts of the meteorite.

[1] Mittlefehldt, D. W. et al. (2003) MAPS 38, 1601–1625
[2] http://tin.er.usgs.gov/meteor/metbull.php, Sept. 2010