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[PK2005 #001]

High velocity dust-dust collisions and their importance for planet formation.

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It is common belief that terrestrial planets (planetesimals) form through collisions of smaller dusty bodies in protoplanetary disks. Dust grows to m- and km-sized objects. With the mass increasing, the collision velocities increase and larger bodies will be compact aggregates. A body of 1m might collide with smaller bodies at velocities of several tens of meters per second. It is often argued that high velocity impacts cannot lead to growth. We carried out experiments with compact mm to cm-sized projectiles and targets where both bodies are aggregates of submicrometer dust particles. The impact velocities varied from 6 to 25m/s. The results show that the accretion efficiency depends on the impact speed. At 25m/s as much as 50% of the projectile sticks to the target surface, below 13m/s the accretion efficiency is only 10% on average. Our experiments indicate that net growth is possible in dust-dust collisions and in fact high collision velocities seem to be preferable. The fragments that do not stick to the growing body will feed the dust reservoir of the protoplanetary disk again. This can explain the evidence of small dust particles in disks, which are a few million years old.

[PK2005 #002]

U-Pb isotope systematic of SNC meteorites

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A stepwise dissolution technique was applied to several Nakhlite meteorites that were heavily contaminated by terrestrial Pb. Pulverized samples were subjected to three acid leaches of increasing strength followed by $HF-HNO_3$ digestion of the remaining residue.

Using this procedure the major portion of the terrestrial contamination was removed in leaches 1 and 2 (L1, L2), while essentially uncontaminated Pb was recovered in leach 3 (L3) and the residue. We give further details here about some of the insights gained from this improved ability to distinguish between the primary and terrestrial Pb components in meteorites.

Firstly, we ran one sample of Nakhla as a test of the procedure. The result showed L1 and L2 to be mainly dominated by terrestrial Pb while L3 yielded Pb close to the initial Pb of other Nakhlites. The Pb in the residue, however, was very radiogenic and had a $^{206}Pb/^{204}Pb$ relative to $^{207}Pb/^{204}Pb$ indicating a drastic increase of the U/Pb at 1.3 Ga. Furthermore, the relatively unradiogenic $^{208}Pb/^{204}Pb$ suggested that there might be zircon or other high U/Th mineral in the residue. We made an in-depth study on a thin-section using an electron microscope and found indeed tiny 10 μm grains of baddeleyite. The same dissolution technique was then applied to other Nakhlites from the Antarctic NIPR collection and NASA (MIL) with similar results, indicating that all Nakhlites may have the same age. In addition, an identical initial Pb isotopic composition indicates that all of these meteorites were derived from the same homogeneous source. Moreover, it is strongly suggested by their initial Pb that the "olivine Shergottites", like SAU, DAG, Que, and Y, likewise come from this Nakhla source. While "normal" Shergottites like Shergotty and LA are from sources having a more evolved Pb isotopic composition. "Olivine Shergottites" are clearly younger than Nakhlites. Their Sm-Nd and Rb-Sr isotopic systems are highly disturbed. Analyzing the existing data we favor an age of 800 my for the "olivine Shergottites" which is also suggested by Ar-Ar systematic.

The Nakhla reservoir was sampled at least 2 times: at 1300 my (Nakhlites) and at 800 my (olivine Shergottites). However, the Pb isotopic compositions plot close to the geochrone at a $^{238}U/^{204}Pb$ of about 2. This gives interesting implications for the evolution of this reservoir and their parent body.

[PK2005 #003]

Cosmogenic Ne in SNCs: Chemistry vs. SCR

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Neon found in bulk samples of Martian meteorites generally is almost exclusively of spallogenic origin. Based on low cosmogenic $^{21}Ne/^{22}Ne$ ratios Garrison et al. [1] have identified several SNCs with noticeable contributions from solar cosmic ray (SCR) spallation. This implies that the samples came from the outermost 2–3 cm of the meteoroid, also implying little ablation loss during atmospheric entry. However, while these authors' statement that Al and Na (both yielding low $^{21}Ne/^{22}Ne$ in GCR production [2, 3]) are "relatively less important" in cosmogenic Ne production holds true for chondrites, it is not always correct for SNC meteorites with often low Mg contents. We re-analyze our own and literature Ne data for SNCs using modern production rates [3] not available to [1].

[1] Garrison, D. H. et al. (1995) Meteoritics, 30**,** 738–747. [2] Smith, S. P. & Huneke, J. C. (1975) EPSL 36, 359–362. [3] Leya, I. et al. (2000) MAPS, 35**,** 259–286.

[PK2005 #004]

Early solar system chronology: Simultaneous accretion of chondrules and differentiated/metamorphosed asteroidal clasts?

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If the model of Kleine et al. [1,2] derived from W-isotope data is correct, differentiated and metamorphosed "precursor" asteroids were destroyed prior to formation of at least some chondrite parent bodies; fragments of these early-formed bodies may be mixed with later formed chondrules and should exist in Type 3 or other primitive chondrites or breccias (e.g., Krymka, Semarkona, Adrar 003 (all of subtype 3.0-3.3), Adzhi-Bogdo (LL3-6), Acfer 094 (primitive C-chondrite)).
Several fragments from primitive ordinary and carbonaceous chondrites were detected that may represent lithic clasts of precursor planetesimals. Such fragments will be discussed in detail.

[1] Kleine, T., Mezger, K., Palme, H., Scherer, E., and Münker, C. (2004) EOS Transactions AGU 85 (47), Fall Meeting Supl. Abstract P31C-04. [2] Kleine, T., Mezger, K., Palme, H., and Scherer, E. (2005) LPSC XXXVI, 1431.

[PK2005 #005]

Surface studies and preliminary noble gas data from bulk metallic glass flown on GENESIS.

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The Bulk Metallic Glass (BMG) flown on GENESIS survived the impact landing without major damage. Preliminary noble gas data from pyrolysis extraction confirm previous values measured in SWC foils exposed on the lunar surface [1]. The search for the He and Ne composition of Solar Energetic Particles with stepwise etching has not been yet successful due to a molecular contamination (brown stain). It was deposited on the BMG surface in space and is resistant to HNO_3. Extensive X-ray photoelectron spectroscopy (XPS) analyses were carried out to determine composition and distribution of this brown stain. These data show that the brown stain is an organic layer mainly consisting of Si, C, O and F. Ultrasonic cleaning with common solvents removed about 50 % of the particles but did not affect the brown stain. Cleaning with oxygen plasma lowered the carbon amount, however it did not remove the brown stain either. A combination of oxygen plasma ashing followed by plasma etching with SF_6 has potential to fully remove the Si-based contamination.

[1] Geiss, J. et al. (2004), SSR 110, 307-335.

[PK2005 #006]

Modeling 3-dimensional objects from 2-dimensional thin sections

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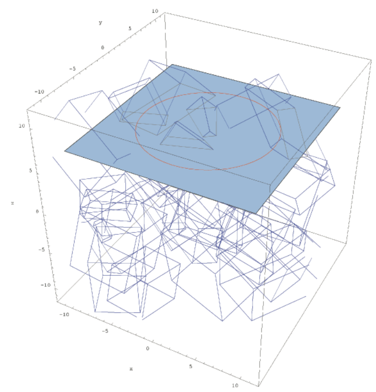
The bulk compositions of chondrules are difficult to obtain and therefore poorly known, but are essential for any theory of chondrule formation. One approach is calculating the 2-dimensional (2-d) "bulk composition" of an object in a thin section and taking this as the 3-dimensional (3-d) composition. To prove whether this can be done, I developed a program to test this assumption (see Figure). The results show that 2-d bulk compositions can deviate more than 40% (1σ) from the true 3-d bulk composition.



[PK2005 #007]

Noble gas measurements in Grant IIIAB iron meteorite

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We are able to measure routinely the He, Ne and Ar isotopic compositions in iron meteorites.
In a first experiment a stepwise heating procedure has been performed to determine the required temperature to fully degas a sample from an iron meteorite. In a second step, the distribution of noble gases in Grant has been tested in order to choose representative sample weights for further analyses. The third experiment concerned the recalibration of the preatmospheric centre of Grant. Our experimental results clearly demonstrate that the preatmospheric centre of Grant is significantly different from the location assumed so far. This finding is of special importance because Grant is the base for several models developed to calculate cosmogenic production rates in iron meteoroids, e.g. the Signer-Nier model [1, 2].

[1] Signer P. and Nier A. O. 1960. *J. Geophys. Res.*, 65, No 9, 2947-2964. [2] Voshage H. *1984. Earth and Planet. Sci. Let.* 71, 181-194.

[PK2005 #008]

Chemical evidence for a post-accretionary bombardment on Earth's?

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Impact cratering is a major process in the origin and evolution of solid bodies in our solar system. The platinum group element (PGE) and Ni composition of the Earth's upper continental crust (UCC) is essential for understanding its origin and the processes by which it formed. It is well known that the Moon was subjected to intense post-accretionary bombardment. The widespread existence of impact craters in the solar system demonstrates that they must have been equally abundant on Earth. Average PGE and Ni abundances in the Earth's UCC derived from European melt sheets, crater suevites and basement rocks from the Ries crater are highly fractionated, compared to the Earth's mantle. The highly fractionated Ru/Ir ratio in these rocks is unparalleled in terrestrial magmatic systems. The PGE and Ni systematics strongly supports a genetic link between the PGE and Ni component of the upper crust and some main group pallasites and/or magmatic iron meteorites. One possible explanation is that these elements have been added during solidification of the growing Earth's crust by impact(s) of IIIAB iron and/or main group pallasitic bodie(s).

[PK2005 #009]

Anatomy of an ejecta plume – Insights from a detailed study of suevites from Chicxulub.

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We present first results from an image-analysis based study of ejecta components from the K/T Chicxulub impact crater. Some 20,000 particles of the 100 m sequence of suevitic ejecta deposits of the ICDP-drillcore Yaxcopoil-1 were analyzed with regard to their modal abundance, orientation, shape and spatial distribution. Previously obtained compositional data of the particles and the distribution of different types of melt particles enables to constrain the physical boundary conditions and their temporal variation during the evolution of the ejecta plume at Chicxulub. This data set is used to verify and advance previous models of ejecta emplacement and vapor plume collapse [1, 2, 3, 4] that were based on qualitative analyses. We expect to attain a better understanding of the largest known impact event of the Phanerozoic and to substantiate models for its atmospheric effects.

[1] Stöffler, D. et al. (2004) MAPS 39, 1035–1067. [2] Tuchscherer, M. G. et al. (2004) MAPS 39, 899-930. [3] Dressler, B. O. et al. 2004 MAPS 39, 857–878. [4] Kring, D. A. et al. (2004) MAPS 39, 879–897.

[PK2005 #010]

Fractionation of nickel isotopes during formation of iron meteorites

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Fractionation of stable isotopes can provide new insights into the planetary accretion and differentiation processes in the early solar system. Transition metals are of particular interest because they do not show large isotope fractionation as a result of geological processes. We recently completed at the ETH a detailed study of magmatic and non magmatic iron meteorites, coupling Ag, Tl, Fe and Ni isotope analyses. Only the nickel data will be presented here. Nickel isotopes have already been measured in several bulk iron meteorites [1]. We analyzed in this work bulk magmatic and non magmatic samples, as well as the two distinct iron-phases (Ni-poor kamacite or "α-Fe, Ni phase", and Ni-rich taenite or "γ-Fe, Ni phase") and sulphide inclusions. Kamacite and taenite do not display the same isotopic composition. The isotopic composition of the samples of bulk metal can therefore depend on their mineralogy. The sulphide is generally heavier than the corresponding metal. The data are difficult to reconcile with the generally accepted models of crystallization.

[1] Moynier et al. (2004) LPSC, CD-ROM abstract #1286.

[PK2005 #011]

Nickel isotopic anomalies in iron meteorites

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Magmatic iron meteorites are generally thought to represent cores of planetary bodies that formed within the first ten million years of the solar system. The short-lived ^{60}Fe-^{60}Ni chronometer ($t_{1/2}$=1.49 Myr) potentially provides precise constraints on the timescale of core formation processes. In the present study, we analysed nickel isotopes in the metal phase of more than 30 iron meteorites as well as Ni-poor sulfide inclusions from 10 samples. The Fe/Ni ratio is strongly fractionated between metal and sulfide so that we should be able to define isochrons if iron meteorites formed indeed during the lifetime of ^{60}Fe. Nickel was separated from the matrix elements by ion-exchange. Isotopic measurements were performed using a MC-ICPMS (Nu 1700) with a mass resolution of ~2600 to avoid ArO and ArNe interferences. The technical procedure will be presented in detail. In the metals, no excess of radiogenic ^{60}Ni was observed. In most sulfides, excesses of ^{61}Ni and deficits in ^{60}Ni were detected and interpreted as a nucleosynthetic anomaly that prevents us from determining isochrons.

[PK2005 #012]

Lognormal mass distributions of pre-solar nanodiamonds

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We present a mass distribution measurement of presolar nanodiamonds, which were obtained as acid-resistant residue from the primitive meteorites Murchison and Allende. For the record of nanodiamond masses, we use laser desorption/ionization mass spectrometry. The mass distributions of both meteoritic samples were found to be lognormal, in good agreement with former TEM measurements. For comparison, the mass distribution of synthetic detonation diamonds has been measured. The differences in the distribution parameters allow for some statements about the prevailing interstellar, resp. laboratory conditions, as well as about the physical modes of diamond formation.

[PK2005 #013]

Concerning the importance of recoil in understanding presolar nanograins

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Recoil during radioactive decay may be of importance for isotopic signatures observed in presolar grains [1]. In order to test the reliability of recoil ranges calculated using the SRIM code [2], we irradiated with thermal neutrons Br-containing synthetic nanodiamonds [3] and determined recoil losses during emission of prompt γ-rays. The >80 % loss is significantly larger than the ~50 % expected from ranges calculated using SRIM code and the size distribution of the diamonds determined by LDI-TOF-MS [4]. Further tests are in progress.

[1] Besmehn A. et al. 2000. Abstract #1544. 31th Lunar & Planetary Science Conference. [2] Ziegler, J. F. 2003. Nuclear Instruments and Methods in Physics Research B 219-220, 1027-1036. [3] Kuznetsov V. L. et al. 1994. Carbon 32:873-882. [4] Maul, J. et al. 2005. Physical Review E, submitted.

[PK2005 #014]

The exposure history of the JaH 073 meteorite

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For reasons not yet understood, large chondrites appear to have complex exposure histories with a first stage exposure on the parent body. In order to check whether this observation also holds for the L6 chondrite JaH 073 we analyzed various samples from this well studied strewnfield (Oman). We measured bulk samples of about 150 mg, for He, Ne and Ar isotopic concentrations. The ^{3}He as well as the Ne isotopes are clearly cosmogenic. The ^{3}He/^{21}Ne ratios indicate only minor (if any) ^{3}He and/or ^{3}H diffusive losses. Surprisingly, all ^{22}Ne/^{21}Ne ratios are below 1.06, i.e. below the lower limit assumed so far for the shielding indicator, indicating a rather large pre-atmospheric size of JaH073. Due to a high degree of weathering, the Ar data are significantly compromised by atmospheric contamination. In order to better constrain the exposure history, i.e. getting a depth profile, and to reduce the amount of trapped Ar, i.e. by measuring less weathered samples from within the meteorite, we will probe the main mass of JaH 073 (about 80 kg).

[PK2005 #015]

Experimental evidence of cosmogenic effects on tungsten isotopic composition in iron meteorites

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Core formation in planetesimals can be dated using the ^{182}Hf-^{182}W chronometer. However, models predict that burnout and production of W isotopes by spallation reactions can substantially modify the isotopic composition of iron meteorites when exposed for several 100 Myrs to galactic cosmic rays. We present here the first evidence of W isotopic composition in two iron meteorites, Carbo (IID) and Grant (IIAB), disturbed by cosmogenic effect. We sampled these meteorites at various preatmospheric depths and found a difference of ~ 0.4 epsilon between the isotopic composition of the inner part and those of the external part in Carbo, the surface being more radiogenic than the inner part of the meteorite. The ^{182}W/^{184}W ratio is correlated with the ^{3}He content, which therefore seems to be a good proxy for cosmogenic effects. With this correlation, we can quantify and correct the cosmogenic effect contribution to W isotopes in the studied iron meteorites.

[PK2005 #016]

Age and origin of IAB iron meteorites and their silicate inclusions inferred from Hf/W systematics

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The decay of ^{182}Hf to ^{182}W (half live of 9 million years) allows to date metal-silicate fractionation in the early solar system. During separation of metal the siderophile W partitions into the metal phase while Hf prefers silicates. Metal-silicate fractionation may either occur during condensation or by core formation [1].

Iron meteorites with silicate inclusions are particularly interesting for the application of the Hf-W system. We have begun a systematic study of IAB iron meteorites and their silicate inclusions. So far we have analysed three iron meteorites (Landes, Copiapo and Caddo County) and their silicate inclusions. Data for metals are in agreement with earlier analyses [2] at around -3 ε_w , while silicates show large excesses of $^{182}W/^{184}W$. The combined metal and silicate data define isochrones with initials indistinguishable from CAIs (Ca, Al-rich inclusions) and ages in the range of CAI-ages.

[1] Harper, C.I.. et al. (1996) GCA 60, 1131 [2] Kleine, T. et al. (2005) GCA (in press)

[PK2005 #017]

In-situ Search of Presolar Grains.

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The conventional method for the isolation of presolar grains from primitive meteorite is by chemical separation. This has led to the discovery of various presolar grains like, e.g., nanodiamonds, SiC and Oxides. This method, however, destroys less refractory presolar minerals such as silicates. The in-situ search of presolar grains achieved importance once spatial resolution of around 50 nm was achieved using the NanoSIMS. This led to the discovery of presolar silicates, which cannot be chemically separated from the silicate matrix.

The abundances of the various presolar grains from primitive meteorites give a clue of the alteration processes taking place in the meteorite parent bodies and also give a helping hand in understanding the survival of these presolar grains in the interstellar medium before they were incorporated in the meteorite parent bodies.

As an example, the Tagish Lake meteorite, being primitive in nature, has been used in the present work for the in-situ search of various presolar grains using high spatial resolution of the NanoSIMS. The abundances of different presolar grains found in this work confirm the primitive nature of the Tagish Lake meteorite and that it has undergone aqueous alteration.

[PK2005 #018]

Iron isotope fractionation during planetary differentiation and the homogeneity of the solar system

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In this study, Fe isotope fractionation during planetary core formation and differentiation of the silicate portion of planets was investigated to study the isotopic homogeneity of the solar system for iron, and get additional constraints on planetary evolution. For this, rocks and minerals from different planetary bodies (Mars, Moon, Earth, HED, pallasite parent bodies) and from different planetary reservoirs (core, mantle, crust) were measured.

There is no evidence for Fe-isotope fractionation during core formation, as indicated by the indistinguishable Fe isotope composition of pallasite bulk metal (including troilite and schreibersite) and olivine separates within 0.1‰ for $\delta^{56}Fe$. In contrast, differentiation of the silicate portion of planets seems to fractionate Fe isotopes. Notably, igneous rocks (partial melts) are systematically isotopically heavier than their mantle protoliths. The similar values for bulk planets, which overlap with literature values for chondrites and iron meteorites imply that the solar system is quite homogeneous in its Fe isotope composition.

[PK2005 #019]

Silicon content in iron meteorites.

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Iron meteorites represent fragments from asteroidal FeNi cores, separated from the silicate mantle during core formation. This process is accompanied by reduction of some Si from the silicate, which partitions into the FeNi.

The resulting Si content in FeNi reflects T and $f(O_2)$ during core formation. Contents are not well known, (below 20 ppm, referring to [1]), because detection limits are reached.

We used a SIMS to determine Si content in several iron meteorites from different groups (IAB, IIAB, IIC, IIE, IIIAB, IIICD).

The contents lie between 0.1 μg/g and 0.3 μg/g, with no difference between magmatic and non-magmatic groups. Model calculations showed, that these remarkably low contents can only be achieved by a final metal-silicate equilibration at about 1250 °C.

Possible explanations are metamorphic equilibration or small degrees of partial melting.

[1] Wai C. M. and Wasson J. T. 1969. *Geochimica et Cosmochimica Acta* 33:1465–1471

[PK2005 #020]

Sedimentary characteristics of the Chicxulub ejecta blanket: A model for Martian rampart crater.

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Identification of numerous localities of the Chicxulub ejecta blanket in combination with remote sensing data allowed an aereal mapping of the southeastern Yucatán peninsula. The ejecta overran a karstified land surface that formed upon an emerged Cretaceous carbonate platform. The secondary, ground-hugging ejecta flow eroded the subsurface and was deviated by the relief, as is evident from systematic measurements of motion indicators. Its large runout is related to abundant water within the flow and eroded Karst lithologies as clays, that acted as lubricants. Sedimentary features such as clast abrasion and abundance of slickensided shear planes indicate water detrainment from the flow and rising cohesiveness and internal friction with crater distance. These observations favour the subsurface volatile model for the formation of fluidized ejecta blankets on Mars (FEB). In analogy with the Chicxulub ejecta blanket, decreasing strain rates and increasing effective viscosity and strain localization are probably responsible for the distinct ramparts that formed at the terminus of many Martian ejecta blankets.

[1] Miller, H. et al. (1879) GCA 54, 345–567. [2] Edmund, G. & Huisl, K.D. (1968) Icarus 45, 7–12.

[PK2005 #021]

Hf–W chronometry of lunar metals and the age and early differentiation of the Moon

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^{182}Hf–^{182}W chronometer potentially provides powerful constraints on the age and early differentiation of the Moon but cosmogenic ^{182}W–production mainly via neutron–capture of ^{181}Ta at the lunar surface precludes chronological interpretations. We report the first W isotope data for lunar metals, which have low Ta/W and, hence, contain no cosmogenic ^{182}W. The data reveal differences in indigenous ^{182}W/^{184}W of lunar mantle reservoirs, indicating crystallization of the lunar magma ocean 43±7 Myr after formation of the solar system. This is consistent with the Giant Impact hypothesis and defines the completion of the major stage of Earth's accretion.

[PK2005 #022]

Shock pressure calibration by Ramanspectroscopy

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Raman spectroscopy as a method for shock pressure calibration of plagioclase is suggested by different authors, e.g. [1]. In shock recovery experiments we investigated plagioclase at increasing shock pressures and detected the structural change by means of Raman spectroscopy. With increasing shock pressure we found decreasing intensities of the Raman bands and their half-lives increasing. The characteristic Raman bands for plagioclase are at 482 cm^{-1} and 508 cm^{-1} and merge to one single band at 510 cm^{-1} in result of shock metamorphoses. The merged band moves to higher wave numbers with increasing shock pressure. These first results indicate possible applicability of Raman spectroscopy as a further method for shock pressure calibration.

[1] Fritz, J., et al. (2005) Antarctic Meteorite research. 18. 96-114.

[PK2005 #023]

3-dimensional, chemical analysis of Efremovka (CV3) chondrules

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The chemical bulk compositions of chondrules provide important information about their formation conditions. At the moment such data are rare and mostly incomplete with respect to different types of chondrules, meteorites, etc. In this study we determine the bulk compositions of Efremovka chondrules. We apply serial sectioning as technique to obtain the 3-dimensional chemical information. The step size is ~100 μm. We measure Al, Ca, Cr, Fe, Mg, Mn, Na, Ni, Si and Ti using an electron microprobe. In addition we obtain element maps of each chondrule. An image processing program is used to determinate the 2-dimensional bulk composition of the chondrule at each grinding step. Combining these 2-dimensional bulk compositions allow calculating the true 3-dimensional bulk composition of the chondrule.

A second goal is to investigate how representative a 2-dimensional bulk composition is with respect to the true 3-dimensional chondrule.

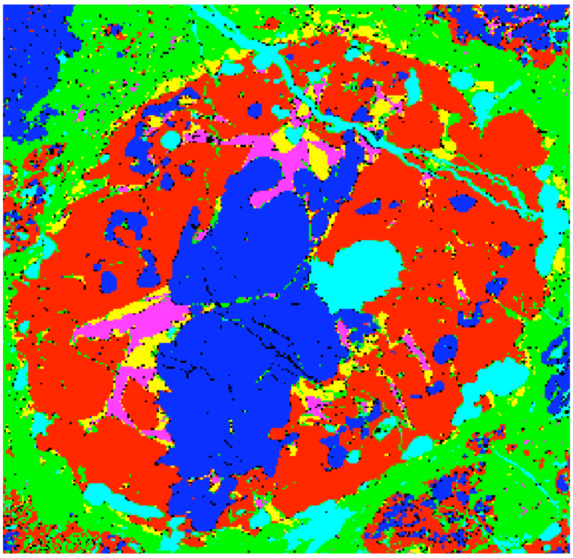

Fig. 1: Efremovka (CV3$_{red.}$) chondrule, Mg-Si element distribution map.

[PK2005 #024]

Precise determination of bulk compositions of metal-rich chondrites by X-ray fluorescence.

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Meteorite classification is based on petrographic aspects as well as the bulk chemical composition. The latter is determined by X-ray fluorescence (XRF) in combination with instrumental neutron activation analysis (INAA). XRF analyses are performed on fused beads prepared in platinum crucibles. However, this preparation method is potentially susceptible to iron loss since iron forms stable alloys with platinum. Hence the sample is depleted in Fe to an unknown extent. This applies generally to analysis of all metal-bearing meteorites. We will present a new method to precisely determine major element composition of meteorites using wet digestion prior to fused bead preparation to minimize iron loss due to sample preparation.

This method is also capable to analyze small sample sizes of less than 20 mg. Therefore it is well suited to study rare meteorites or even single components of meteorites such as chondrules or matrix.

[PK2005 #025]

Noble gas study of the Dhofar 018 howardite.

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We measured noble gases in the Dhofar 018 howardite, which shows brecciated textures [1]. Isotopic ratios of He and Ne showed that the meteorite contains solar noble gases. The presence of solar gases and brecciated textures indicate the meteorite is a regolith breccia. Concentrations of ^{20}Ne and ^{36}Ar are higher than those in the Fayetteville H4 chondrite, which is the most solar-gas-rich meteorite of all non-lunar meteorites [2]. On the other hand, ^{4}He concentration of Dhofar 018 is lower than of Fayetteville, suggesting ^{4}He diffusive loss. We may expect some solar-Xe, because the meteorite contains large amounts of solar gases. However, isotopic ratios of Xe showed that Xe is dominated by atmospheric, cosmogenic, and Q-like primordial components. Solar-Xe cannot be clearly observed. Cosmic ray exposure age is calculated from cosmogenic-^{21}Ne concentration, assuming that the meteorite was exposed to cosmic rays with 4π exposure geometry and with an average shielding. Exposure age is calculated as around 22 Ma.

[1] Lorenz, C. et al. (2001) LPS XXXII, #1778. [2] Wieler, R. et al. (1989) GCA 53, 1441–1448.

[PK2005 #026]

Carbon spherules with diamonds in soils

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A new type of spherule-shaped, mm-sized, carbonaceous particles is found wide-spread over Europe in top soil samples. A preliminary characterisation is made using various microscopic, spectroscopic, and physical analytical techniques. Most of the particles are cenospheres with open spaced, glassy, foam-, cell-, honeycomb- or sponge-like internal structures with cell sizes of a few microns. They consist of almost pure amorphous carbon with minor amounts of oxygen and trace amounts of some metals. HRTEM studies reveal the presence of several populations of nano- and micro-diamonds within the spherules, Raman spectra indicate fullerene-like structures, and their physical properties resemble those of novel, technogenic, carbon materials.

This type of particles is not known from anthropogenic, biogenic, or geogenic sources. Their occurrence is independent from geology and points towards a complex, regional, high-energy process, which is necessary for formation of the observed carbon phases. Several possible formation mechanisms are discussed, and, after careful consideration, an impact related origin is proposed.

[PK2005 #027]

Highly siderophile elements as tracers for late accretion

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Core formation likely stripped the silicate Earth of elements with very high metal-silicate partition coefficients, the highly siderophile elements (HSE) Re, Os, Ir, Ru, Pt, Rh, Pd and Au. In spite of this inferred, nearly quantitative removal, HSE in the Earth's mantle are only approximately 150 times less abundant than in chondrites. This excess abundance of HSE in the Earth's mantle is commonly explained by late accretion of large planetesimals after formation of the Earth's core. A new estimate of the HSE composition of the primitive mantle, obtained using improved digestion techniques on terrestrial lherzolites, indicates that while Re, Os, Pt and Ir occur in chondritic proportions, Ru and Pd are suprachondritic. A similar HSE pattern has been reported for lunar impact melt rocks from the Serenitatis basin. The terrestrial mantle pattern may represent mixtures of chondritic and indigenous components from Earth's Hadean crust recycled back into the mantle. Nature and origin of HSE patterns in indigenous and other components of the lunar crust need further evaluation using Os isotope data and high-precision HSE concentration data.

[PK2005 #028]

Lithium isotope compositions of martian and lunar reservoirs

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Li-isotopes of high-Ti and low-Ti mare basalts, KREEP-rich highland breccias, orange and green glass, the martian meteorites, Shergotty, Nakhla, Zagami, Lafayette, EETA 79001A, ALHA 77005 and ALHA 84001, were measured using MC-ICP-MS.

The basaltic shergottites depict a narrow range in their δ^7Li-values (+3.6 to +5.2‰). While the lherzolitic shergottite and the clinopyroxenite samples show similar δ^7Li-values (+4.1 to 5.0‰), the orthopyroxenite ALHA 84001 has a much lighter isotopic signature (δ^7Li -0.6‰).

Samples from Moon depict large variation in Li-content (5-49 ppm). With the exception of a KREEP highland breccia (15445), which has a δ^7Li-value of +18.3‰, Li-isotope variation is very limited (+3.9 to +6.6‰) with an average of +5.2‰ (1.2, 2σ).

Neither lunar samples nor SNC meteorites exhibit a correlation between their Li-abundances and their Li-isotopic signatures, suggesting that Li isotopes do not fractionate during magmatic differentiation. The majority of the lunar basalts investigated here have δ^7Li-values around +5.1‰, similar to melts from the Earth mantle, such as MORB and OIB e.g. [2]. Li abundances and isotopic signatures of the basaltic and lherzolitic shergottites are also very similar to the values of C1 chondrites, fresh MORB and bulk silicate earth (BSE) [1,2,3]. It is inferred that the primitive reservoirs of the terrestrial planets have an unfractionated Li-isotopic signature of around δ^7Li (+4‰). This value may further reflect the isotopic signature of the early inner solar system.

[1] James R.H. and Palmer M.R. 2000. CG, 166: 319-326. [2] Chan, L.-H et al. 1992. EPSL 108, 151-160 [3] Seitz H.-M. et al. 2004. CG 212, 163-177.