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- **NATURE**

MIXING, VOLATILE LOSS AND COMPOSITIONAL CHANGE DURING IMPACT-DRIVEN ACCRETION OF THE EARTH

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The degree to which efficient mixing of new material or losses of earlier accreted material to space characterize the growth of Earth-like planets is poorly constrained and probably changed with time. These processes can be studied by parallel modelling of data from different radiogenic isotope systems. The tungsten isotope composition of the silicate Earth yields a model timescale for accretion that is faster than current estimates based on terrestrial lead and xenon isotope data and strontium, tungsten and lead data for lunar samples. A probable explanation for this is that impacting core material did not always mix efficiently with the silicate portions of the Earth before being added to the Earth's core. Furthermore, tungsten and strontium isotope compositions of lunar samples provide evidence that the Moon-forming impacting protoplanet Theia was probably more like Mars, with a volatile-rich, oxidized mantle. Impact-driven erosion was probably a significant contributor to the variations in moderately volatile element abundance and oxidation found among the terrestrial planets.
Nature 427, 505 - 509 (05 February 2004); doi:10.1038/nature02275

A ROUTE TO HIGH SURFACE AREA, POROSITY AND INCLUSION OF LARGE MOLECULES IN CRYSTALS

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One of the outstanding challenges in the field of porous materials is the design and synthesis of chemical structures with exceptionally high surface areas. Such materials are of critical importance to many applications involving catalysis, separation and gas storage. The claim for the highest surface area of a disordered structure is for carbon, at 2,030 $m^2 g^{-1}$ (ref. 2). Until recently, the largest surface area of an ordered structure was that of zeolite Y, recorded at 904 $m^2 g^{-1}$ (ref. 3). But with the introduction of metal-organic framework materials, this has been exceeded, with values up to 3,000 $m^2 g^{-1}$ (refs 4–7). Despite this, no method of determining the upper limit in surface area for a material has yet been found. Here we present a general strategy that has allowed us to realize a structure having by far the highest surface area reported to date. We report the design, synthesis and properties of crystalline Zn_4O(1,3,5-benzenetribenzoate)$_2$, a new metal-organic framework with a surface area estimated at 4,500 $m^2 g^{-1}$. This framework, which we name MOF-177, combines this exceptional level of surface area with an ordered structure that has extra-large pores capable of binding polycyclic organic guest molecules—attributes not previously combined in one material.
Nature 427, 523 - 527 (05 February 2004); doi:10.1038/nature02311

HYDROGENATION AND CLEAVAGE OF DINITROGEN TO AMMONIA WITH A ZIRCONIUM COMPLEX

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Molecular nitrogen is relatively inert owing to the strength of its triple bond, nonpolarity and high ionization potential. As a result, the fixation of atmospheric nitrogen to ammonia under mild conditions has remained a challenge to chemists for more than a century. Although the Haber–Bosch process produces over 100 million tons of ammonia annually for the chemical industry and agriculture, it requires high temperature and pressure, in addition to a catalyst, to induce the combination of hydrogen (H_2) and nitrogen (N_2). Coordination of molecular nitrogen to transition metal complexes can activate and even rupture the strong N–N bond under mild conditions, with protonation yielding ammonia in stoichiometric and even catalytic yields. But the assembly of N–H bonds directly from H_2 and N_2 remains challenging: adding H_2 to a metal–N_2 complex results in the formation of N_2 and metal–hydrogen bonds or, in the case of one zirconium complex, in formation of one N–H bond and a bridging hydride. Here we extend our work on zirconium complexes containing cyclopentadienyl ligands and show that adjustment of the ligands allows direct observation of N–H bond formation from N_2 and H_2. Subsequent warming of the complex cleaves the N–N bond at 45 °C, and continued hydrogenation at 85 °C results in complete fixation to ammonia.

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LOW-VELOCITY ZONE ATOP THE 410-KM SEISMIC DISCONTINUITY IN THE NORTHWESTERN UNITED STATES

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The seismic discontinuity at 410 km depth in the Earth's mantle is generally attributed to the phase transition of $(Mg,Fe)_2SiO_4$ (refs 1, 2) from the olivine to wadsleyite structure. Variation in the depth of this discontinuity is often taken as a proxy for mantle temperature owing to its response to thermal perturbations. For example, a cold anomaly would elevate the 410-km discontinuity, because of its positive Clapeyron slope, whereas a warm anomaly would depress the discontinuity. But trade-offs between seismic wave-speed heterogeneity and discontinuity topography often inhibit detailed analysis of these discontinuities, and structure often appears very complicated. Here we simultaneously model seismic refracted waves and scattered waves from the 410-km discontinuity in the western United States to constrain structure in the region. We find a low-velocity zone, with a shear-wave velocity drop of 5%, on top of the 410-km discontinuity beneath the northwestern United States, extending from southwestern Oregon to the northern Basin and Range province. This low-velocity zone has a thickness that varies from 20 to 90 km with rapid lateral variations. Its spatial extent coincides with both an anomalous composition of overlying volcanism and seismic 'receiver-function' observations observed above the region. We interpret the low-velocity zone as a compositional anomaly, possibly due to a dense partial-melt layer, which may be linked to prior subduction of the Farallon plate and back-arc extension. The existence of such a layer could be indicative of high water content in the Earth's transition zone.

Nature 427, 530 - 533 (05 February 2004); doi:10.1038/nature02231

- **SCIENCE**

GEOCHEMISTRY

Role of Microbes in the Smectite-to-Illite Reaction
Jinwook Kim, Hailiang Dong, Jennifer Seabaugh, Steven W. Newell, and Dennis D. Eberl
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Effect of Environmental Factors on the Relationship between Concentrations of Coprostanol and Fecal Indicator Bacteria in Tropical (Mekong Delta) and Temperate (Tokyo) Freshwaters
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Integron Diversity in Heavy-Metal-Contaminated Mine Tailings and Inferences about Integron Evolution
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Natural examples of olivine lattice preferred orientation patterns with a flow-normal a-axis maximum.
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PALEONTOLOGY

Major events in the genome evolution of vertebrates: Paranome age and size differ considerably between ray-finned fishes and land vertebrates
Klaas Vandepoele, Wouter De Vos, John S. Taylor, Axel Meyer, and Yves Van de Peer
Proc. Natl. Acad. Sci. USA published 2 February 2004,
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Neanderthal taxonomy reconsidered: Implications of 3D primate models of intra- and interspecific differences
Katerina Harvati, Stephen R. Frost, and Kieran P. McNulty
Proc. Natl. Acad. Sci. USA 2004 February 3; 101(5): p. 1147-1152
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PHYLOGENETICS: A Broad Look at Tree-Building
Fredrik Ronquist
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PALEOECOLOGY: Long-Lasting Consequences
Brooks Hanson
Science 2004 February 6; 303(5659): p. 731a
http://www.sciencemag.org/cgi/content/summary/303/5659/731a?ct

- **ESA PORTAL**

The well-known extrasolar planet HD 209458b, provisionally nicknamed 'Osiris', has surprised astronomers again. Oxygen and carbon have been found in its atmosphere, evaporating at such an immense rate that the existence of a new class of extrasolar planets - 'the chthonian planets' or 'dead' cores of completely evaporated gas giants - has been proposed.
Read more: http://www.esa.int/export/esaCP/SEMJSIWA6QD_Life_0.html

An important milestone for ESA's Living Planet Programme is to be reached this spring when it will be decided which of the six candidate Earth Explorer missions are to be selected for development. Before decisions are taken, the user community is invited to express their views at the Earth Explorer User Consultation Meeting which will be held on 19-20 April at ESA's ESRIN facility in Frascati, Italy.
Read more: http://www.esa.int/export/esaLP/SEMJMGWA6QD_index_0.html

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