M. J. Drake's research while affiliated with The University of Arizona and other places

Overview

Publications (281)

Thermal infrared observations and thermophysical characterization of OSIRIS-REx target asteroid (101955) Bennu

Article

- May 2014

- Joshua Emery
- Y.R. Fernández
- M.S.P. Kelley
- [...]
- Julie E. Ziffer

Near-Earth Asteroids (NEAs) have garnered ever increasing attention over the past few years due to the insights they offer into Solar System formation and evolution, the potential hazard they pose, and their accessibility for both robotic and human spaceflight missions. Among the NEAs, carbonaceous asteroids hold particular interest because they ma...

Cite

Request full-text

Partition coefficients at high pressure and temperature

Article

- Jan 2014

- Kevin Righter
- Lisa R. Danielson
- M.J. Drake
- K. Domanik

Cite

Request full-text

Accretion disk origin of Earth's water

Article

- Jun 2013

- Luca Vattuone
- Marco Smerieri
- Letizia Savio
- [...]
- Mario Rocca

Earth's water is conventionally believed to be delivered by comets or wet asteroids after the Earth formed. However, their elemental and isotopic properties are inconsistent with those of the Earth. It was thus proposed that water was introduced by adsorption onto grains in the accretion disc prior to planetary growth, with bonding energies so high...

Cite

Request full-text

A first-principles characterization of water adsorption on forsterite grains
Article

- Jun 2013

- Abu Md Asaduzzaman
- Slimane Laref
- P A Deymier
- [...]
- M J Drake

Numerical simulations examining chemical interactions of water molecules with forsterite grains have demonstrated the efficacy of nebular gas adsorption as a viable mechanism for water delivery to the terrestrial planets. Nevertheless, a comprehensive picture detailing the water-adsorption mechanisms on forsterite is not yet available. Towards this...

Cite

Request full-text

Thermal and Physical Characterization of the OSIRIS-REx Target Asteroid (101955) 1999 RQ36
Article

- Oct 2012

- Joshua Emery
- M. S. Kelley
- Y. R. Fernandez
- [...]

- M. J. Drake

The OSIRIS-REx mission, the third in NASA’s New Frontier line, will launch in 2016, visit the near-Earth asteroid (101955) 1999 RQ36, and return samples of its regolith to Earth in 2023. Ground-based observations have already revealed a great deal about 1999 RQ36, including the spectral type (B-type), size, and rotation period. To further character...

Cite

Request full-text

Electronic Structure Calculations of Water Adsorption on Forsterite Grains: Implications for Planetary Water
Article

- Sep 2011

- K. Muralidharan
- M. J. Drake

Cite

Request full-text

Accretion Disk Origin of Earth's Water: Laboratory Experiments
Article

- Sep 2011

- Luca Vattuone
- Marco Smerieri
- Letizia Savio
- [...]
- Mario Rocca

Cite

Request full-text

Experimental Evidence of Adsorption as a Source of Planetary Water
Article

- Mar 2011

- Luca Vattuone
- Mario Rocca
- K. Muralidharan
- [...]
- M. J. Drake

Many Earth oceans of water could have been adsorbed onto grains in the accretion disk prior to the formation of the terrestrial planets.

Cite

Request full-text

Computer simulations of water interactions with low-coordinated forsterite surface sites: Implications for the origin of water in the inner solar system

Article

- Nov 2010
- Helen E King
- M. Stimpfl
- P Deymier
- [...]
- Nora H. de Leeuw

Adsorption of water to fractal dust grains during accretion has been proposed as a possible source of water for rocky planets. We have used computer simulations to study the feasibility of chemisorption onto forsterite dust grains by investigating the adsorption of dissociated water to stoichiometric and defective surfaces. Defects were modeled usi...

Cite

Request full-text

Where on Earth has our water come from?
Article

Full-text available

- Oct 2010

- Nora H. de Leeuw
- Richard Richard A Catlow
- Helen E King
- [...]
- Michael J Drake

The presence of water in the Earth has long been an enigma. However, computer modelling techniques have shown that the adsorption of water onto the fractal surfaces of interplanetary dust particles, which are present in the planetary accretion disk, is sufficiently strong to provide a viable origin of terrestrial water.
Cite

Download full-text

Asteroid (101955) 1999 RQ36: Optimum Target for an Asteroid Sample Return Mission
Article

- Jul 2010

- D. S. Lauretta
- M. J. Drake
- R. P. Benzel
- [...]
- D. J. Scheeres

Cite

Request full-text

Atomistic Simulations of Adsorption of Water onto Forsterite and Fayalite Planar Surfaces: Implication for the Origin of Water in the Inner Solar System
Article

- Mar 2010

- M. Stimpfl
- K. Muralidharan
- Nora H. de Leeuw
- [...]
- M. J. Drake

Using atomistic and electronic structure calculations, it is shown that adsorption is a significant source of terrestrial planetary water.

Cite

Request full-text

Subsolidus Metal --- Olivine Trace Element Partitioning
Article

- Mar 2010

- Eddy Hill
- G. R. Huss
- K. Domanik
- M. J. Drake

Metal - olivine subsolidus diffusion experiments provide diffusion rates and trace-element diffusion profiles that allow us to study the cooling rates of mesosiderites and calculate subsolidus distribution coefficients .

Cite

Request full-text

Thermophysical Characterization of Potential Spacecraft Target (101955) 1999 RQ36
Article

- Mar 2010

- Joshua Emery
- Y. R. Fernández
- M. S. Kelley
- [...]
- H. Campins

We report on thermal emission measurements of 1999 RQ36 from Spitzer. The derived size is in agreement with radar measurements, and we find a moderately high thermal inertia and homogeneous surface properties.

Cite

Request full-text

Metal/Silicate Partitioning of the Moderately Siderophile Elements: The Effect of Temperature and C Concentration

Article

- Mar 2010

- Eddy Hill
- K. Domanik
- M. J. Drake

Increasing T in a magma ocean would result in reduced metal/silicate partitioning for Mo, W and V, simultaneously, the C-concentration in the metal may determine the presence or absence of V in the metal-melt.

Cite

Request full-text

Crystallization of magmatic iron meteorites: The role of mixing in the molten core

Article

- Feb 2010

- Nancy Chabot
- Michael J. DRAKE

Abstract— The IIIAB group is the largest of the magmatic iron meteorite groups and consequently is commonly used to test models of asteroid core crystallization. Simple fractional crystallization calculations appear to reproduce the general shape of the

elemental trends observed in the IIIAB group when these trends are plotted vs. Ni, as is traditi...

Cite

Request full-text

Crystallization of magmatic iron meteorites: The effects of phosphorus and liquid immiscibility

Article

- Feb 2010

- Nancy Chabot
- Michael J. DRAKE

Abstract— Magmatic iron meteorites are commonly thought to have formed by fractional crystallization of the metallic cores of asteroid-sized bodies. As fractional crystallization proceeds, light elements such as P and S become enriched in the molten portion of the core. The light element content of the metallic liquid influences the partitioning be...

Cite

Request full-text

A magma ocean on Vesta: Core formation and petrogenesis of eucrites and diogenites

Article

- Feb 2010

- Kevin Righter
- MICHAEL J. DRAKE

Abstract— Available evidence strongly suggests that the HED (howardite, eucrite, diogenite) meteorites are samples of asteroid 4 Vesta. Abundances of the moderately siderophile elements (Ni, Co, Mo, W and P) in the HED mantle indicate that the parent body may have been completely molten during its early history. During cooling of a chondritic compo...

Cite

Request full-text

An experimental study of Ag and Pd partitioning between solid and liquid metal, with applications to iron meteorites

Article

- Feb 2010

- Nancy Chabot

- MICHAEL J. DRAKE

Abstract— Solid metal/liquid metal partition coefficients for Ag and Pd were determined experimentally as a function of the S concentration of the metallic liquid. Silver is incompatible in solid metal and strongly sensitive to the S content of the metallic liquid; partition coefficients for Ag decrease more than an order of magnitude with increasi...

Cite

Request full-text

Accessory silicate mineral assemblages in the Bilanga diogenite: A petrographic study

Article

- Jan 2010

- Kenneth Domanik
- Serena Kolar
- Donald Musselwhite
- Michael J. Drake

Abstract— The petrographic relationships in diogenites between orthopyroxene and minor phases such as chromite, troilite, diopside, plagioclase, and silica are often obscured by the intense brecciation that characterizes these meteorites. Although brecciated, Bilanga preserves numerous clasts displaying primary textural relations between orthopyrox...

Cite

Request full-text

Metal/Silicate Partitioning of Mo, W and V: Effects of T, P, X and fO2

Article

- Dec 2009

- Eddy Hill
- K. J. Domanik
- M. J. Drake

Existing studies have produced some confusion concerning the trends found for Mo and W metal/silicate partitioning. The behavior of V, however, is reasonably understood and hence allows for cross-laboratory comparisons. We are undertaking high-pressure, high-temperature experiments to study the metal/silicate partitioning behavior of all three elem...

Cite

Request full-text

Water in the Inner Solar System: Insights from Atomistic and Electronic-Structure Calculations
Article

- Sep 2009

- K. Muralidharan
- M. Stimpfl
- Nora H. de Leeuw
- [...]
- M. J. Drake

Cite

Request full-text

Silicon Mantle/Core Fractionation and the Origin of Pallasites
Article

- Sep 2009

- Eddy Hill
- K. Domanik
- G. R. Huss
- M. J. Drake

Cite

Request full-text

2009 Service Award for Derek Sears
Article

- Jul 2009

- Michael J. Drake

Cite

Request full-text

Some - Perhaps Most - Water in the Earth Must Result from Adsorption on to Grains in the Accretion Disk
Article

- Mar 2009

- K. Muralidharan
- M. Stimpfl

- Nora H. de Leeuw
- [...]
- M. J. Drake

We show that adsorption of water onto grains in the accretion disk must be a significant source of Earth's water. Using density functional theory we show that HDO may be preferentially retained relative to H2O in adsorption/desorption kinetics.

Cite

Request full-text

Experimental studies of metal–silicate partitioning of Sb: Implications for the terrestrial and lunar mantles
Article

- Mar 2009

- Kevin Righter
- Munir Humayun
- A.J. Campbell
- [...]
- M.J. Drake

The terrestrial mantle has a well defined Sb depletion of ~7 ± 1 (Jochum and Hofmann, 1997), and the lunar mantle is depleted relative to the Earth by a factor of ~50 ± 5 (Wolf and Anders, 1980). Despite these well defined depletions, there are few data upon which to evaluate their origin—whether due to volatility or core formation. We have carried...

Cite

Request full-text

Melosh Receives 2008 Harry H. Hess Medal
Article

- Jan 2009

- Michael J. Drake
- Jay Melosh

H. Jay Melosh was awarded the 2008 Harry H. Hess Medal at the AGU Fall Meeting Honors Ceremony, held 17 December 2008 in San Francisco, Calif. The medal is for ``outstanding achievements in research in the constitution and evolution of Earth and sister planets.''

Cite

Request full-text

14. Oxygen Isotopie Composition and Chemical Correlations in Meteorites and the Terrestrial Planets
Chapter

- Dec 2008

- David W. Mittlefehldt
- Robert N. Clayton
- Michael J. Drake
- Kevin Righter

Cite

Request full-text

Origin of water in the inner Solar System: A kinetic Monte Carlo study of water adsorption on forsterite
Article

- Dec 2008

- Krishna Muralidharan
- Pierre Deymier
- M. Stimpfl
- [...]
- Michael J. Drake

The origin of water in the inner Solar System is not well understood. It is believed that temperatures were too high in the accretion disk in the region of the terrestrial planets for hydrous phases to be thermodynamically stable. Suggested sources of water include direct adsorption of hydrogen from the nebula into magma oceans after the terrestria...

Cite

Request full-text

Metal/olivine partition coefficients and the cooling rates of pallasites
Article

- Jul 2008

- Eddy Hill
- K. Domanik
- M. J. Drake

Cite

Request full-text

Oxygen Isotopic Composition and Chemical Correlations in Meteorites and the Terrestrial Planets
Article

- Jan 2008

- David W. Mittlefehldt
- Robert N. Clayton
- Michael J. Drake
- Kevin Righter

Recent models attempting to explain non-mass-dependent oxygen isotopic anomalies in meteorites and planets posit that they may have originated within the gas phase of the solar nebula, which suggests the potential for correlations of non-mass-dependent oxygen isotopic anomalies with other chemical fractionations generated during cooling and condens...

Cite

Request full-text

Metal/Olivine Partitioning Experiments and the Cooling Rates of Pallasites
Article

- Aug 2007

- Eddy Hill
- M. J. Drake
- K. Domanik

Cite

Request full-text

Adsorption of Water Gas on to Grains in the Accretion Disk as a Source of Inner Solar System Water: Direct Evidence from Monte Carlo Simulation
Article

- Jul 2007

- K. Muralidharan
- P. A. Deymier
- M. Stimpfl
- [...]
- Nora H. de Leeuw

Cite

Request full-text

Thermal Observations of OSIRIS target 1999 RQ36
Article

- Mar 2007

- Joshua Emery
- Michael Drake
- Yanga Fernandez
- [...]
- Dante Lauretta

We propose to observe the near-Earth asteroid (101955) 1999 RQ36, the target of the OSIRIS sample return mission, with IRS and IRAC. These observations will provide characterization of the composition, structure, and thermophysical properties of this distinctive asteroid. Compositionally diagnostic emissivity features measured by IRS at two longitu...

Cite

Request full-text

Water Matters
Article

- Feb 2007

- M. J. Drake
- M. Stimpfl

The origin of water on Earth and the other rocky planets is uncertain. There are problems with commonly accepted sources such as comets and asteroids. We explore adsorption of water onto grains in the accretion disk as a source.

Cite

Request full-text

Water in the Accretion Disk: Effect of Composition and Surface Structure on the Energy of Adsorption onto Olivine Grains
Article

- Feb 2007

- M. Stimpfl
- Nora H. de Leeuw
- M. J. Drake
- P. Deymier

The surface of olivine presents a variety of bonding environments for the adsorbed molecular water. Binding energies range from <44 kJ/mole to >200 kJ/mole. These interactions are strong enough to retain water on the surfaces at high temperature.

Cite

Request full-text

Petrology and geochemistry of the NWA 3368 Eucrite
Article

- Sep 2006

- K.G. Gardner
- D. S. Lauretta
- D. H. Hill
- [...]
- M. J. Drake

We report the petrology and geochemistry of NWA 3368, a new non-cumulate, monomict eucrite breccia with a variety of clast sizes and a pink-tinted matrix. Analytical techniques include electron microprobe, INAA, and ICP-MS.

Cite

Request full-text

Can the Water Pressure in the Accretion Disk Sustain Water Adsorption on Olivine?
Article

- Sep 2006

- Nora H. de Leeuw
- M. Stimpfl
- Richard Richard A Catlow
- [...]
- A. W. Walker

Cite

Request full-text

An ångström-sized window on the origin of water in the inner solar system: Atomistic simulation of adsorption of water on olivine
Article

- Aug 2006

- M. Stimpfl
- Auriana Miranda Walker
- M.J. Drake
- [...]

- P. Deymier

The origin of water in the inner solar system is not yet well understood. Because of the coexistence of water and small solid particulates in the accretion disk from which our planetary system formed, we propose that adsorption of water onto the surfaces/pores of forsterite could play and important role in the delivery of water to the rocky planets...

Cite

Request full-text

Effect of composition on adsorption of water on perfect olivine surfaces
Article

- Aug 2006

- M. Stimpfl
- M.J. Drake
- Nora H. de Leeuw
- [...]
- Auriana Miranda Walker

Cite

Request full-text

The earliest history of the Earth
Article

- Aug 2006

- M. J. Drake

Cite

Request full-text

Experimental study of platinum solubility in silicate melt to 14GPa and 2273K: Implications for accretion and core formation in Earth
Article

- May 2006

- Werner Ertel-Ingrisch
- Michael J. Walter
- Michael J. Drake
- Paul Joseph Sylvester

We determined the solubility limit of Pt in molten haplo-basalt (1 atm anorthite-diopside eutectic composition) in piston-cylinder and multi-anvil experiments at pressures between 0.5 and 14 GPa and temperatures from 1698 to 2223 K. Experiments were internally buffered at ~IW + 1. Pt concentrations in quenched-glass samples were measured by laser-a...

Cite

Request full-text

In the Beginning There Was Water and Dust: A Look into Adsorption as a Mechanism to Explain Water in the Inner Solar System
Article

- Feb 2006

- M. Stimpfl
- Nora H. de Leeuw
- P. Deymier
- [...]
- Auriana Miranda Walker

Atomistic techniques are employed to study the interaction between water and olivine surfaces with the aim to explore if water gas adsorbed onto the dust in the accretion disk could be a possible source for water in the inner solar system.

Cite

Request full-text

Water in the Early Earth
Article

- Jan 2006

- Yutaka Abe
- Eiji Ohtani
- Takuo Okuchi
- [...]
- M. Drake

In this chapter we discuss the behavior of water in the early Earth. Earth likely formed through accretion of water-bearing planetesimals. An H2O-rich proto-atmosphere should have formed during accretion by degassing from planetesimals and/or gravitational attraction of solar-nebula gas, and it may be a direct ancestor of Earth's present atmosphere...

Cite

Request full-text

Compositional Relationships Between Meteorites and Terrestrial Planets

Article

- Jan 2006

- Kevin Righter
- M. J. Drake
- Edward R. D. Scott

Terrestrial planets exhibit a range of core sizes, mantle, and surficial magma compositions. Determining the bulk compositions of terrestrial planets presents a challenge faced by geochemistry and cosmochemistry. Traditionally, chondritic meteorites have been called upon as suitable bulk compositions. Detailed examination of such building blocks, h...

Cite

Request full-text

A review of meteorite evidence for the timing of magmatism and of surface or near-surface liquid water on Mars

Article

Full-text available

- Dec 2005

- Lars E. Borg
- Michael J Drake

1] There is widespread photogeological evidence for ubiquitous water flowing on the surface of Mars. However, the age of surface and near-surface water cannot be deduced with high precision from photogeology. While there is clear evidence for old and young fluvial features in the photogeologic record, the uncertainty in the absolute calibration of...

Cite

Download full-text

Melting of Allende at Pressures Between 1 and 25 Mpa

Article

- Sep 2005

- Steven Singletary
- Timothy L Grove
- M. J. Drake

Cite

Request full-text

Bulk Composition of the Moon: 2. Volatiles and Isotopes
Article

- Sep 2005

- M. J. Drake
- G. J. Taylor

Cite

Request full-text

Origin of water on the terrestial planets
Article

- Aug 2005

- Michael J. Drake
- Humberto Campins

We examine the origin of water in the terrestrial planets. We list various geochemical measurements that may be used to discriminate between different endogenous and exogenous sources of water. Late stage delivery of significant quantities of water from asteroidal and cometary sources appears to be ruled out by isotopic and molecular ratio consider...

Cite

Request full-text

The Leonard medal address: Origin of water in the terrestrial planets
Article

- Apr 2005

- Michael J. Drake

I examine the origin of water in the terrestrial planets. Late-stage delivery of water from asteroidal and cometary sources appears to be ruled out by isotopic and molecular ratio considerations, unless either comets and asteroids currently sampled spectroscopically and by meteorites are unlike those falling to Earth 4.5 Ga ago, or our measurements...

Cite

Request full-text

Influence of Silicate Melt Composition on Metal/Silicate Partitioning of W, Ge, Ga and Ni

Article

Full-text available

- Feb 2005

- Steven Singletary
- K. Domanik
- M. J. Drake

The depletion of the siderophile elements in the Earth's upper mantle relative to the chondritic meteorites is a geochemical imprint of core segregation. Therefore, metal/silicate partition coefficients (Dm/s) for siderophile elements are essential to investigations of core formation when used in conjunction with the pattern of elemental abundances...

Cite

Download full-text

NWA 2736: An Unusual New Graphite-bearing Aubrite

Article

- Feb 2005

- J. J. Lowe
- D. H. Hill
- K. J. Domanik
- [...]
- Marvin Killgore

Aubrites are enstatite-rich achondrites that are probably related to enstatite chondrite parent bodies. The exact link, if any, is not understood. They may have formed from

melting within one or more enstatite chondrite parent bodies. Description of NWA 2736: One complete stone weighing 171.51 grams was recovered from the Sahara Desert by nomads so...

Cite

Request full-text

Olivine and Ca-Phosphate in the Diogenites Manegaon and Roda
Article

- Feb 2005

- K. J. Domanik
- L. C. Sideras
- M. J. Drake

The textural relationships between the different primary minerals in igneous rocks provide one of the most fundamental pieces of evidence available for inferring the crystallization history of their parent magmas. Unfortunately, the high degree of brecciation that characterizes most diogenites, along with the low modal abundance and small grain siz...

Cite

Request full-text

Early Accretion of Water: Implications for the Oxidation State of the Planets
Article

- Dec 2004

- M. Stimpfl
- M. J. Drake
- D. S. Lauretta

Introduction: There are two main scenarios that account for the accretion of water to the terrestrial planets: either the water originated outside of the inner solar system and was later delivered to the terrestrial planets by means of some suitable mechanism, or the source of water was local, i.e. it came from the same feeding zone of the Earth's...

Cite

Request full-text

Metal/Silicate Partitioning of W, Ge, Ga and Ni: Dependence on Silicate Melt Composition
Article

- Dec 2004

- Steven Singletary
- M. J. Drake

Metal/silicate partition coefficients (Dm/s) for siderophile elements are essential to investigations of core formation when used in conjunction with the pattern of elemental abundances in the Earth's mantle (Drake and Righter, 2002; Jones and Drake, 1986; Righter et al. 1997). The partitioning of siderophile elements is controlled by temperature,...

Cite

Request full-text

Origin of water in the terrestrial planets
Article

- Aug 2004

- M.J. Drake

I examine the origin of water in the terrestrial planets. Late-stage delivery of water from asteroidal and cometary, sources appears to be ruled out by isotopic and molecular ratio considerations, unless either comets and asteroids currently sampled spectroscopically and by meteorites are unlike those falling to Earth 4.5 Ga ago, or our measurement...

Cite

Request full-text

Adsorption as a Mechanism to Deliver Water to the Earth
Article

- Aug 2004

- M. Stimpfl
- D. S. Lauretta
- M. J. Drake

Cite

Request full-text

Metal-Silicate Partitioning of Volatile, Siderophile Elements: New Results for Sb and As
Article

- Aug 2004

- Kevin Righter
- A. J. Campbell

- Munir Humayun
- M. J. Drake

Cite

Request full-text

Implications of Chondrule Formation in a Gas of Solar Composition
Article

- Jan 2004

- D. S. Lauretta
- M. J. Drake
- M. Stimpfl

Cite

Request full-text

How did the Terrestrial Planets Acquire Their Water?
Article

- Jan 2004

- M. J. Drake
- M. Stimpfl
- D. S. Lauretta

Cite

Request full-text

Partition Coefficients at High Pressure and Temperature
Article

- Nov 2003

- Kevin Righter
- M. J. Drake

Differentiation of terrestrial planets includes separation of a metallic core and possible later fractionation of mineral phases within either a solid or molten mantle (Figure 1). Lithophile and siderophile elements can be used to understand these two different physical processes, and ascertain whether they operated in the early Earth. The distribu...

Cite

Request full-text

Vanadium, Cr, and Si and the Mg/Si Ratio in the Earth
Article

- Jul 2003

- M. J. Drake
- K. Domanik
- Kevin Righter

Cite

Request full-text

Citation for presentation of the Distinguished Service Award to Denis M. Shaw
Article

- Jul 2003

- Michael J. Drake

Cite

Request full-text

Trace Elements in High-Ca Pyroxene and Plagioclase in the Bilanga Diogenite: Implications for the Magmatic Evolution of Diogenites
Article

- Feb 2003

- K. J. Domanik
- C. K. Shearer
- Justin Hagerty
- [...]
- M. J. Drake

High-Ca pyroxene and plagioclase are typically present as minor phases in diogenites. However, although the trace element content of diogenite orthopyroxene has been measured in a number of studies; almost no trace element data is available for the high-Ca pyroxene and plagioclase with which it routinely coexists in these meteorites. These data cou...

Cite

Request full-text

Bilanga: A Unique Diogenite
Article

- May 2002

- S. E. Kolar
- K. J. Domanik
- D. S. Musslewhite
- M. J. Drake

The Bilanga diogenite is petrographically examined and found to contain diopside and plagioclase aggregates up to several 100 microns in size. Small scale, original igneous contacts between these phase are often preserved despite brecciation. Additional information is contained in the original extended abstract.

Cite

Request full-text

Petrology of Antarctic Eucrites PCA 91078 and PCA 91245
Article

- May 2002

- L. M. Howard
- K. J. Domanik
- M. J. Drake
- David W. Mittlefehldt

Antarctic eucrites PCA 91078 and PCA 91245, are petrographically characterized and found to be unpaired, type 6, basaltic eucrites. Observed textures that provide insight into the petrogenesis of these meteorites are also discussed. Additional information is contained in the original extended abstract.

Cite

Request full-text

What is the Earth Made Of?
Article
Full-text available

- May 2002

- M. J. Drake
- Kevin Righter

Measurements made on materials from Earth, Mars, comets, and meteorites of Mg/Si, Al/Si, oxygen, Os, D/H, Ar/H2O, and Kr/Xe ratios, all lead to the conclusion that no primitive material similar to Earth mantle material is currently represented in our meteorite collections. Additional information is contained in the original extended abstract.
Cite

Download full-text

Determining the composition of the Earth
Article

Full-text available

- Apr 2002

- Michael J Drake
- Kevin Righter

A long-standing question in the planetary sciences asks what the Earth is made of. For historical reasons, volatile-depleted primitive materials similar to current chondritic meteorites were long considered to provide the 'building blocks' of the terrestrial planets. But material from the Earth, Mars, comets and various meteorites have Mg/Si and Al...
Cite

Download full-text

Narrow horizons in astrobiology
Article

- Mar 2002

- Michael J Drake
- Bruce M Jakosky

Mission planners must realize that astrobiology is more than a search for life

Cite

Request full-text

Experimental Studies of Metal-Silicate Partitioning of Sb
Article

- Sep 2001

- Kevin Righter
- D. Hill
- J. Collins
- [...]

- M. J. Drake

Cite

Request full-text

Constraints on the Depth of an Early Terrestrial Magma Ocean
Article
Full-text available

- Aug 2001

- Kevin Righter
- M. J. Drake

Cite

Download full-text

Presidential Address: Presented 2000 August 28, Chicago, Illinois, USA The eucrite/Vesta story
Article

- Apr 2001

- Michael J. DRAKE

Abstract— Many lines of evidence indicate that meteorites are derived from the asteroid belt but, in general, identifying any meteorite class with a particular asteroid has been problematical. One exception is asteroid 4 Vesta, where a strong case can be made that it is the ultimate source of the howardite-eucrite-diogenite (HED) family of basaltic...

Cite

Request full-text

Experimentally Determined Solubilities of Pt up to 90 Kbars and 1850°C
Article

- Jan 2001

- Werner Ertel-Ingrisch
- M. J. Walter
- Paul Joseph Sylvester
- M. J. Drake

PGEs are indicators of planetary differentiation processes based on their siderophility. Results of our HP experiments (5 to 90 kbar; 1400 to 1850°C) indicate that P does not influence the Pt partitioning, supporting the late veneer hypothesis.

Cite

Request full-text

Metal-silicate partitioning of Co, Ga, and W: Dependence on silicate melt composition
Article

- Nov 2000

- Lv Windy
- Michael J. Drake

This study investigates the effect of silicate melt composition on metal/silicate partitioning for Co^{2+}, Ga^{3+}, and W^{4+} at 1300°C, 1 atm, and a log fO_2 of −12. Five glasses in the system MgO–CaO–Al_2O_3–TiO_2–SiO_2 with nbo/t (nonbridging oxygens/tetrahedrally coordinated cations) values ranging from 0.25 to 1.52 were used as starting materials. For W a...

Cite

Request full-text

Early Outgassing of Mars: Implications from Experimentally Determined Solubility of Iodine in Silicate Magmas
Article

- Nov 2000

- Donald S. Musselwhite
- Michael J. Drake

We have determined experimentally the solubility of iodine in a range of synthetic basaltic (CMAS) liquids. The solubility of iodine ranges from 1.2×10−4 to 2.6×10−3 g/g·atm (0.02 to 0.45 ccSTP/g·atm) over the range of compositions studied. These values are a few orders of magnitude greater than the solubility of xenon in silicate liquids. This dif...

Cite

Request full-text

Metal/silicate equilibrium in the early Earth-New constraints from the volatile moderately siderophile elements Ga, Cu, P, and Sn
Article

- Oct 2000

- Kevin Righter
- Michael J Drake

We report new measurements of metal/silicate partition coefficients for Ga, Cu, and Sn at 10 to 90 kb and 1250 to 1900°C. We show that all three of these siderophile elements (D(metal/silicate) > 10) become more lithophile at high pressure and temperature conditions. Metal/silicate partition coefficients calculated for the conditions of an early de...

Cite

Request full-text

Accretion and primary differentiation of the Earth: A personal journey
Article

- Jul 2000

- Michael J Drake

The accretion of the Earth was a violent series of events dominated by the addition of objects one third to one tenth of the mass of the growing planet. During the later stages of accretion, these collisions deposited enough energy to at least partly melt the Earth, possibly multiple times. The result was an ocean of magma. Metal sank through this...

Cite

Request full-text

Crystallization of magmatic iron meteorites: The effects of phosphorus and liquid immiscibility
Article

- Jul 2000

- Nancy Chabot
- M.J. Drake

Magmatic iron meteorites are commonly thought to have formed by fractional crystallization of the metallic cores of asteroid-sized bodies. As fractional crystallization proceeds, light elements such as P and S become enriched in the molten portion of the core. The light element content of the metallic liquid influences the partitioning behavior of...

Cite

Request full-text

Accretion of the Earth: Implications from Experimental Constraints: Pt
Article

- Mar 2000

- Werner Ertel-Ingrisch
- Paul Joseph Sylvester

- M. J. Drake

Cite

Request full-text

Potassium solubility in metal: The effects of composition at 15 kbar and 1900°C on partitioning between iron alloys and silicate melts
Article

- Oct 1999

- Nancy Chabot
- Michael J Drake

To determine the role of radioactive heating as an energy source in planetary cores, the solubility of K in metal has been examined experimentally. All experiments were conducted at 15 kbar and 1900°C and involved K partitioning between Fe alloys and silicate melts. Experiments conducted with different concentrations of S in the metallic liquid ind...

Cite

Request full-text

Siderophile geochemistry of Ga, Ge, and Sn: Cationic oxidation states in silicate melts and the effect of composition in iron-nickel alloys
Article

- Oct 1999

- Christopher J. Capobianco
- Michael J. Drake
- Jessie de'Aro

We report a series of metal–silicate partitioning experiments for Ga, Ge, and Sn to characterize the dependence of the partition coefficient, D, on oxygen fugacity, fO2. These were isothermal (1260°C) and isobaric (1 bar) experiments using a silicate composition that approximates a eucritic meteorite. It is well known that elements such as Ni, whic...

Cite

Request full-text

Effect of water on metal-silicate partitioning of siderophile elements: A high pressure and temperature terrestrial magma ocean and core formation
Article

- Sep 1999

- Kevin Righter
- Michael J. Drake

Recent proposals of metal-silicate equilibrium at the base of a deep hydrous magma ocean are based on experimental data obtained under anhydrous conditions. We have undertaken a series of experiments at 10 kbar and 1300°C, designed to isolate the effect of dissolved water on the partitioning of the siderophile elements Ni, Co, Mo, W, and P between...

Cite

Request full-text

Crystallization of Magmatic Iron Meteorites and Liquid Immiscibility in the Iron-Phosphorus-Sulfur System
Article

- Jun 1999

- Nancy Chabot
- M. J. Drake

Cite

Request full-text

Scientists debate origin of Earth and Moon
Article

- May 1999

- Alex N. Halliday
- Michael J. Drake

The big questions of how the Earth and Moon formed and first developed have, for many years, been at the borderline of tractability because of what appears to be an almost complete obliteration of any physical, chemical, or isotopic record of the first 500 million years of Earth history. We do know that in the first 200 million years the Earth acqu...

Cite

Request full-text

Colliding Theories
Article

- Mar 1999

- Alex N. Halliday
- Michael J. Drake

When researchers try to find out how the Earth and the moon formed, they quickly come up against the problem that direct evidence is impossible to come by. Halliday and Drake discuss recent progress towards understanding Earth and moon formation using simulations, high pressure experiments and isotope geochemistry. The most widely accepted theory a...

Cite

Request full-text

Partitioning of W Between Liquid Metal, Solid Silicates, and Liquid Silicates at High Pressures and Temperatures: Implications for the 182W Isotope Anomalies in Lunar and Martian Samples
Article

- Mar 1999

- Kevin Righter
- M. J. Drake

New high pressure and temperature experiments on partially molten basalt and chondrite show that the 182W anomalies measured in lunar and martian samples must be interpreted with a full undertsanding of metal-silicate and clinopyroxene-silicate liquid partitioning.

Cite

Request full-text

Experimental Constraints on the Accretion of the Earth: Pt
Article

- Mar 1999

- Werner Ertel-Ingrisch
- Paul Joseph Sylvester
- M. J. Drake

Pt equilibrium solubilities in An-Di eutectic silicate melt was determined at 10 to 20 kbars and 1450o to 1850oC in piston cylinder experiments. Results are compared to previous work at 1 atm and 2 to 4 kbar.

Cite

Request full-text

Crystallization of magmatic iron meteorites: The role of mixing in the molten core
Article

- Mar 1999

- Nancy Chabot

- M.J. Drake

The IIIAB group is the largest of the magmatic iron meteorite groups and consequently is commonly used to test models of asteroid core crystallization. Simple fractional crystallization calculations appear to reproduce the general shape of the elemental trends observed in the IIIAB group when these trends are plotted vs. Ni, as is traditionally don...

Cite

Request full-text

Potassium solubility in metal: the effects of composition at 15kbar and 1900 on partitioning between iron alloys and silicate melts
Article

- Jan 1999

- Nancy Chabot
- M.J. Drake

Cite

Request full-text

The Effect of Silicate Composition on the Solubility of K in Metal
Article

- Jan 1999

- Nancy Chabot
- M. J. Drake

[D(K)] metal/silicate increases by ~100 with increasing depolymerization of the silicate melt. At 15 kb and 1900oC D(K) for the Earth yields a present day heat generation ~100 lower than needed to drive the Earth's geodynamo. Higher P and T will be studied.

Cite

Request full-text

Examining Crystallization Scenarios for Magmatic Iron Meteorites with a Mixing Model
Article

- Jul 1998

- Nancy Chabot
- M. J. Drake

Cite

Request full-text

Uranium in the Lunar Crust: Implications for Lunar Origin and Evolution
Article

- Jul 1998

- M. J. Drake
- J. P. Lowe
- Kevin Righter
- [...]
- P. E. Clark

Cite

Request full-text

Ion Microprobe Study of Plagioclase-Basalt Partition Experiments at Natural Concentration Levels of Trace Elements
Article

- Apr 1998

- Ilya Bindeman
- Andrew M. Davis
- Michael J. Drake

We present here a study of plagioclase/melt partitioning of trace elements at their natural concentration levels, using sample charges from the widely cited plagioclase/melt partitioning experiments of Drake and Weill (1975). In these experiments, sample charges were doped to ~1 wt% with Sr, Ba, rare earth elements (REE) and Y, but each charge was...

Cite

Request full-text

Metal-Silicate Equilibrium in the Early Earth -- New Constraints from Volatile Moderately Siderophile Elements Ga, SN and CU
Article

- Mar 1998

- Kevin Righter
- M. J. Drake

Cite

Request full-text

The Effect of S on the Solubility of K in Metal
Article

- Mar 1998

- Nancy Chabot
- M. J. Drake

Cite

Request full-text

Determination of RE Contents in Experimental Glasses by Two Techniques: Ion Microprobe and Neutron Activation Analysis
Article

- Jan 1998

- Kevin Righter
- D. J. Lindstrom
- R. R. Martinez
- […]
- M. J. Drake

Cite

Request full-text

An experimental study of silver and palladium partitioning between solid and liquid metal, with applications to iron meteorites
Article

- Sep 1997

- Nancy Chabot
- M.J. Drake

Solid metal/liquid metal partition coefficients for Ag and Pd were determined experimentally as a function of the S concentration of the metallic liquid. Silver is incompatible in solid metal and strongly sensitive to the S content of the metallic liquid; partition coefficients for Ag decrease more than an order of magnitude with increasing S conte...

Cite

Request full-text

An Experimental Investigation of Liquid Immiscibility During Crystallization of Magmatic Iron Meteorites
Article

- Jul 1997

- Nancy Chabot
- M. J. Drake

Cite

Request full-text

Prediction of siderophile element metal-silicate partition coefficients to 20 GPa and 2800°C: The effects of pressure, temperature, oxygen fugacity, and silicate and metallic melt compositions
Article
Full-text available

- Mar 1997

- Kevin Righter
- M.J. Drake
- Gregory M Yaxley

We report new metal-silicate partition coefficients for Ni, Co and P at 7.0 GPa (1650–1750°C), and Ni, Co, Mo, W and P at 0.8, 1.0 and 1.5 GPa (1300–1400°C). Guided by thermodynamics, all available metal-silicate partition coefficients, D(i), where i is Ni, Co, P, Mo and W, are regressed against , , lnf(O2), ln(1 − Xs) (XS is mole fraction of S in...
Cite

Download full-text

Formation of eucrites and diogenites on a Vesta-sized asteroid. I - Core formation
Article

- Feb 1997

- Kevin Righter
- Michael J. Drake

Core formation in asteroid-sized planetesimals occurred early (less than 15 Ma after T(0)) as has been recently demonstrated using W-182/W-184 ratios. Depletion of siderophile elements in the mantle of the HED parent body has been cited as evidence that metal had segregated into a core before the eucrites formed. Calculations and experiments indica...

Cite

Request full-text

1

2

3

Citations

... The early Earth experienced at least one episode of extensive silicate melting, also known as magma ocean (e.g., Abe and Matsui, 1988;Abe, 1993;Solomatov and Stevenson, 1993a;Abe, 1997;Solomatov, 2000;Drake, 2000;Elkins-Tanton, 2012). upwards until it reaches the surface of the planet, and the BMO front progresses downwards until it reaches the CMB. ...

Reference: Timescales of chemical equilibrium between the convecting solid mantle and over-/underlying magma oceans

Accretion and primary differentiation of the Earth: A personal journey

Citing article

- Jul 2000
- M. J. Drake

View

... Primitive NEAs have and continue to be targeted by spacecraft, including robotic and human space missions (e.g., Abell et al. 2015, Mazanek et al., 2016. The two primitive NEAs that are about to be visited by sample-return missions are (101955) Bennu, target of NASA's OSIRIS-REx (Lauretta et al., 2010), and (162173) Ryugu, target of JAXA's Hayabusa2 (Tsuda et al., 2014). Both missions will rendezvous their respective asteroids in 2018. ...

Reference: Compositional Diversity Among Primitive Asteroids

Asteroid (101955) 1999 RQ36: Optimum Target for an Asteroid Sample Return Mission

Citing article

- Jul 2010
- D. S. Lauretta
- M. J. Drake
- R. P. Benzel
- H. Campins

- Daniel J. Scheeres

View

... Volatiles can be present in planets from the early stages of planet formation, when there is still gas in the disc; or reach the protoplanets after the gas is gone. In the former case, in principle only planets located beyond the iceline can have volatiles, although water could also be produced within a dry protoplanet from a reaction between H 2 and FeO (Ikoma and Genda, 2006), or retained in olivine grains via adsorption (Drake, 2005). ...
Reference: Setting the Stage: Planet formation and Volatile Delivery
Origin of water in the terrestrial planets
Citing article

- Aug 2004

- M. J. Drake

View

... Jones and Drake, 1983;Haack and Scott. 1993;Ulff-Møller, 1998;Chabot and Drake, 1999) may have been wrongly assuming that effects from subsolidus schreibersite evolution were negligible on the Ni solid metal composition. While Ni is clearly affected by schreibersite growth, whether the effects on other elements are indeed negligible or not is less clear. ...
Reference: Experimental Partitioning of Trace Elements into Schreibersite with Applications to IIG Iron Meteorites
Crystallization of magmatic iron meteorites: The role of mixing in the molten core
Citing article

- Mar 1999

- N. L. Chabot
- M. J. Drake

View

... Morbidelli et al. (2000) proposed that the bulk of Earth's water was accreted from a few water-rich embryos from the outer asteroid region, beyond 2-2.5 AU (a lesser amount of water, according to Morbidellie et al. (2000), was accreted as well from smaller bodies in the asteroid belt and comets). The water content of protoplanets 1 in the habitable zone is assumed to be very small, based on a number of considerations (Lunine, 2006; but see Drake and Righter, 2002), so an external source of water is needed. The work of Morbidelli et al. (2000), as well as earlier authors (e.g., Wetherill, 1996), showed that planetary accretion is a stochastic process, especially if much of the mass is contained in a small number of large embryos. ...
Reference: High-Resolution Simulations of The Final Assembly of Earth-Like Planets. 2. Water Delivery And Planetary Habitability

What is the Earth Made Of?
Citing article

- May 2002
- NTRS

- M. J. Drake

- K. Righter

View full-text

... Papoular suggests that in diffuse clouds, the grain temperature is too high for water to stick to carbonaceous grains, for which calculations predict adsorption energies of 2−9 kJ mol −1 on the bare surface (Papoular, 2005). However, water has a much higher interaction energy with silicate grain surfaces, (Stimpfl et al., 2006) where, in principle, ice formation could be easily nucleated. That water ice is not observed is thus probably due to the interstellar radiation field which penetrates further into diffuse clouds, leading to photodissociation of any adsorbed water (Cuppen and Herbst, 2007;Williams et al., 1992). ...
Reference: How Hydroxylation Affects Hydrogen Adsorption and Formation on Nanosilicates
Effect of composition on adsorption of water on perfect olivine surfaces
Citing article

- Aug 2006

- M. Stimpfl
- M. J. Drake

- Nora H. de Leeuw
- P. A. Deymier

- AM Walker

View

... Diogenites consist mainly of orthopyroxene with or without olivine. They are usually coarse-grained and have Mg/(Mg + Fe) values higher than eucrites, suggesting that they were derived from the lower crust or the mantle of Vesta, based on magma ocean models [3][4][5][6][7][8] . Howardites are mechanical mixtures of eucrite and diogenite components, representing materials from the surface of Vesta. ...
Reference: Evidence of metasomatism in the interior of Vesta
A magma ocean on Vesta: Core formation and petrogenesis of eucrites and diogenites
Citing article

- Feb 2010

- K. Righter
- M. J. Drake

View

... Spitzer thermal emission data provide firm constraints on the average regolith grain size (Fig. 7a; Emery et al. 2014). Regolith grains that are comparable in size to the thermal skin depth would behave like bedrock. ...
Reference: The OSIRIS-REx target asteroid (101955) Bennu: Constraints on its physical, geological, and dynamical nature from astronomical observations
Thermal and Physical Characterization of the OSIRIS-REx Target Asteroid (101955) 1999 RQ36
Citing article

- Oct 2012

- J. P. Emery
- M. S. Kelley
- Y. R. Fernandez

- C. W. Hergenrother
- M. J. Drake

View

... On the ongoing debate, terrestrial planets are argued to have accreted from different classes of chondrites (i.e. carbonaceous (CC), ordinary (OC), and enstatite chondrites (EC)), achondrites or no longer extant meteorites combining in variable proportions [1][2][3][4][5] . It is generally assumed that all planetary bodies were formed from primitive solar nebula that had carbonaceous chondritic composition because of the similar relative elemental abundances of CI chondrite as solar photosphere for all except the most volatile elements 6 . ...
Reference: Si-Mg isotopes in enstatite chondrites and accretion of reduced planetary bodies
Determining the composition of the Earth
Citing article

- Apr 2002
- PubMed

- M. J. Drake

- K. Righter

View full-text

... e l s e v i e r . c o m / l o c a t e / p e p i and high temperature (e.g., Ito et al., 1993;Ohtani and Yurimoto, 1996;Chabot and Drake, 1999;Gessmann and Wood, 2002;Murthy et al., 2003;Hirao et al., 2006;Bouhifd et al., 2007;Corgne et al., 2007).

These studies reported that the partition coefficient of potassium, D K (=the content of potassium in metal [wt%]/ the content of potassium in silicate [wt%]), could vary from 0.0047 to 2.4, depending on the effects of temperature, pressure, oxygen fugacity, and metal and silicate compositions (e.g., NBO/T; the number of non-bridging oxygen divided by the number of tetrahedral cations). ...
Reference: The abundance of potassium in the Earth's core

Potassium solubility in metal: the effects of composition at 15kbar and 1900 on partitioning between iron alloys and silicate melts

Citing article

- Jan 1999

- N. L. Chabot
- M. J. Drake

View

Top co-authors (50)

Kevin Righter

- NASA

M. Stimpfl

- The University of Arizona

James H Jones

- Indiana University-Purdue University Indianapolis

Nancy Chabot

- Johns Hopkins University

Allan Treiman

- Universities Space Research Association

Eilis Mcfarlane

- University College Dublin

Christopher J. Capobianco

Kenneth J. Domanik

P. A. Deymier

D. S. Lauretta

Top journals

Geochimica et Cosmochimica Acta (46)

Meteoritics (30)

Meteoritics & planetary science (15)

Earth and Planetary Science Letters (9)

Affiliations

The University of Arizona
Department

- Department of Planetary Sciences
- Department of Materials Sciences and Engineering

Lunar and Planetary Institute

Universitat Oberta de Catalunya

Disciplines

Physics

Topic

- Materials Science
- Condensed Matter Physics
- Materials Physics
- Solid State Physics

Support

Help Center

Business solutions

Advertising

Recruiting