



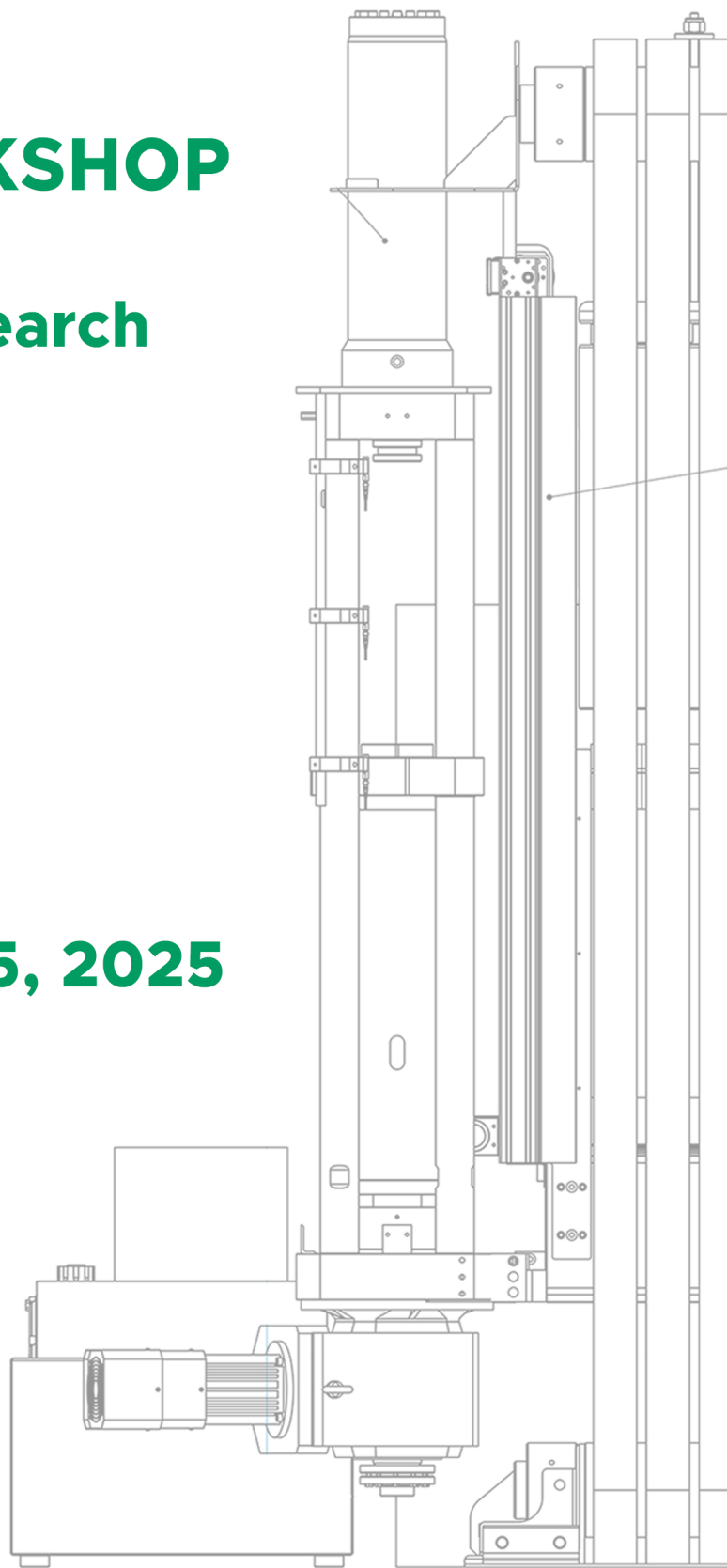
3rd WINTER WORKSHOP on Recent Advances in High Pressure Research

VIRTUAL ONLY

**TUESDAY JAN. 14 &
WEDNESDAY JAN. 15, 2025**
8:00–13:00 MST (UTC-7)



Sponsored by Advanced Diamond Products





Tuesday January 14 (all times in MST / UTC-7)

Moderator: Kara Brugman (Arizona State University)

- 8:00 **Tom Sharp**, FORCE Science Director (Arizona State University) Welcome
- 8:10 **Kurt Leinenweber**, FORCE PI (Arizona State University) FORCE Update
- 8:20 **Invited: Fabrice Gaillard** (CNRS-Institut des Sciences de la Terre d'Orléans) "Volatiles, redox state, and metals in magmas"
- 9:00 **Melanie J. Sieber** (University of Potsdam) "Advancing Experimental Petrology with IHPVs: Insights into Sn Enrichment in Granitic Melts, Carbonatitic Systems, and Fluid-Melt Inclusions"
- 9:20 **Bence Horányi** (Institut des Sciences de la Terre d'Orléans) "Experimental Investigation of Lithium Partitioning between Minerals and Melts using Internally-Heated Pressure Vessels"
- 9:40 **Invited: Tomo Katsura** (University of Bayreuth) "The CaSiO₃ solubility in bridgmanite as a function of pressure, temperature and composition"
- 10:20 **Break**
- 10:40 **Krzysztof Wozniak** (University of Warsaw) "Quantum Crystallographic Studies of Phase Transitions in Minerals under Pressure"
- 11:00 **Benjamin Brugman** (Arizona State University) "Energetics of high P-T monoclinic Y₂O₃ and Er₂O₃"
- 11:20 **Axel Wittmann** (Arizona State University) "Highly siderophile element nuggets in Wabar impact glass"
- 11:40 **Devika Padmakumar** (Michigan State University) "Thermal Conductivity of Ilmenite at Lunar Mantle Pressures"
- 12:00 **Invited: Kevin Righter** (University of Rochester) "A push for new inter-laboratory multi-anvil pressure calibration comparisons"
- 12:40 **Open Discussion – Moderator: Kyusei Tsuno (Arizona State University)**
- 13:00 **End Session**



Wednesday January 15 (all times in MST / UTC-7)

Moderator: Tom Sharp (Arizona State University)

- 8:00 **Invited: Dan Frost** (University of Bayreuth) “Investigating planetary interiors using a large-large volume multianvil press”
- 8:40 **Junjie (“JJ”) Dong** (California Institute of Technology) “Nonlinearity of the post-spinel transition and its expression in slabs and plumes worldwide”
- 9:00 **Jonathan Dolinski** (University of Oxford) “Precision Stress Measurement in High-Pressure Deformation: A Novel Piezoelectric Approach”
- 9:20 **Reidar G. Tronnes** (University of Oslo) “The bridgmanite to post-bridgmanite phase loops in the systems $\text{MgSiO}_3\text{-FeSiO}_3$, $\text{MgSiO}_3\text{-FeAlO}_3$ and $\text{MgSiO}_3\text{-Al}_2\text{O}_3$ ”
- 9:40 **Ben Kalman** (University of Western Ontario) “Phase Transitions of Solid and Liquid Fe-Si Alloys with Applications to Planetary Core Composition and Dynamo Processes”
- 10:00 **Erin Lenhart** (University of Western Ontario) “Adiabatic Heat Flow through the Tops of the Cores of Small Planetary Bodies through Electrical Resistivity Measurements of Fe-S-Si Alloys at High-P,T”
- 10:20 **Break**
- 10:40 **Invited: Megumi Kawasaki** (Oregon State University) “High-Pressure Torsion for Metal Nanostructuring and Alloy Manufacturing”
- 11:20 **Invited: Jorge Cubero Sesín** (Instituto Tecnológico de Costa Rica) “Ultra-fine dispersion of ω phase in α matrix: a path to enhanced mechanical properties in pure titanium”
- 12:00 **Open Discussion – Moderator: David Smith (Arizona State University)**
- 12:45 **Closing Remarks**



Abstracts

Invited Abstracts

Fabrice Gaillard¹

Volatiles, redox state, and metals in magmas

Internally heated pressure vessels are used here to unravel some thermodynamic properties of volatile-bearing silicate melts. The illustrated results address a broad range of geological applications ranging from phase/redox equilibria in magmatic reservoirs, volatile solubilities in basaltic melts and metal-gas attachment in magma oceans of planetary embryos.

¹CNRS-Institut des Sciences de la Terre d'Orléans

Tomo Katsura¹, Lin Wang¹, Nobuyoshi Miyajima¹, Fei Wang¹

The CaSiO₃ solubility in bridgmanite as a function of pressure, temperature and composition

Davemaoite (CaSiO₃ perovskite) plays a crucial role in understanding the chemical evolution and dynamics of the Earth's lower mantle. Despite its significance, the existence of davemaoite has been debated due to the potential for high calcium solubility in bridgmanite ((Mg,Fe)(Al,Si)O₃), the most abundant lower mantle mineral. This study systematically investigates the solubility of CaSiO₃ in bridgmanite using high-pressure multi-anvil experiments at pressures of 27–50 GPa and temperatures of 2300–2700 K. The effects of temperature, pressure, and composition were studied using five starting materials with different compositions. The results consistently show that CaSiO₃ solubility in bridgmanite remains extremely low, with CaSiO₃ fractions never exceeding 0.03 per formula unit, even at the highest temperatures and pressures. The time study demonstrates that the observation of davemaoite in many previous experiments was not due to the persistence of davemaoite formed at lower temperatures during temperature increases due to sluggish kinetics but instead due to equilibrium chemistry. These results confirm that davemaoite is a stable and persistent phase throughout the lower mantle. The limited solubility of calcium in bridgmanite underpins the stability of davemaoite over geological timescales, contributing to compositional heterogeneities and refining our understanding of lower mantle mineralogy and its long-term evolution.

¹University of Bayreuth



Kevin Righter¹

A push for new inter-laboratory multi-anvil pressure calibration comparisons

Interlaboratory comparisons of pressure calibration in high pressure apparatuses are of fundamental importance to understanding experimentation at high pressure [1,2]. Significant effort was spent on assembling information from international multi-anvil laboratories in the 1997–2000 timeframe, with an emphasis on comparison of pressure calibrations [3]. The comparisons highlighted differences such as tungsten carbide grade, pressure medium, assembly parts, gasketing, lubrication, and temperature [3,4]. In parallel with the interlaboratory comparisons, was the development of the COMPRES multi-anvil assemblies widely used throughout the multi-anvil community since ~2006 [5]; but a systematic comparison of new calibration results has not been undertaken. We propose initiating a new round of comparisons to assess the extent to which use of standardized sample assemblies has led to more comparable pressure calibrations.

[1] Ito, E. and Presnall, D.C. (1998) The Review of High Pressure Science and Technology 7:151-153. [2] Shen, G., et al. (2020) High Pressure Research 40: 299-314. [3] http://multianvil.asu.edu/MainPage_compare.html. [4] Ito, E (2015) Multi-anvil cells and high-pressure experimental methods, Chapter 2.10, in Treatise on Geophysics 2nd edition, G. Schubert, Editor. 2015, Elsevier: Amsterdam. p. 233-261. [5] Leinenweber, K. et al. (2006) High Pressure Research 26: 283-292.

¹*University of Rochester*

Dan Frost¹

Investigating planetary interiors using a large-large volume multianvil press

TBD

¹*University of Bayreuth*

Megumi Kawasaki¹

High-Pressure Torsion for Metal Nanostructuring and Alloy Manufacturing

Metal processing through high-pressure torsion (HPT) enables the production of bulk nanostructured metals and materials. One unique aspect of HPT is its ability to process nanostructure in any hard-to-process engineering metals and alloys at ambient temperatures for a short duration without microstructural recovery through severe strain under hydrostatic compressive pressure. HPT-processed nanocrystalline metals often exhibit superior mechanical properties and functionality. This presentation provides principles for processing bulk nanostructured metals through the application of HPT, along with recent studies on characterizing the behaviors of major crystalline defects created during HPT. Special emphasis is placed on exploring HPT's manufacturing capability for the rapid fabrication of metal matrix nanocomposites and metastable alloys, the scaling up of severely deformed metals, and processing glassy metals to improve their ductility.

¹*Oregon State University*



Jorge Cubero Sesín¹

Ultra-fine dispersion of ω phase in α matrix: a path to enhanced mechanical properties in pure titanium

Pure titanium is widely used for medical devices due to its excellent combination of biocompatibility and corrosion resistance. It exhibits an allotropic phase transformation from the α phase with an HCP crystal structure to the ω phase with a simple hexagonal crystal structure upon the application of pressures exceeding ~ 4 GPa. However, the ω phase is brittle and is not suitable for a simple mixture of the two phases. Improved mechanical properties can be achieved if fine particles of the ω phase are finely dispersed in the ductile α matrix, similar to conventional dispersion-strengthening materials. This study aims to produce a two-phase structure in pure Ti, where the ω phase is finely dispersed in the α phase matrix while controlling the fraction of the ω phase by High-Pressure Torsion (HPT) process under different pressures and temperatures. Microstructure analyses by X-ray diffraction (XRD), scanning electron microscopy (SEM), electron backscatter diffraction (EBSD) and transmission electron microscopy (TEM) were carried out. The analysis confirms an increase of the fraction of the ω phase with increasing pressure. It is also shown that the sample with 5 GPa presents a better relation between resistance and ductility. This study demonstrates the potential use of nanostructured pure titanium in the biomedical field due to the improved mechanical properties achieved by controlling the ω phase distribution.

¹*Instituto Tecnológico de Costa Rica*



Contributed Abstracts

Melanie J. Sieber¹, Christian Schmidt², Yongchao Liu², Stephan Klemme³, Max Wilke¹

Advancing Experimental Petrology with IHPVs: Insights into Sn Enrichment in Granitic Melts, Carbonatitic Systems, and Fluid-Melt Inclusions

The application of internally heated pressure vessels (IHPVs) in experimental petrology offers exceptional potential for investigating melt-mineral equilibria in upper crustal magmatic systems. This presentation highlights ongoing IHPV-projects, focusing on two studies with significant implications for advancing our understanding of magmatic processes.

Fluid-absent melting experiments were conducted at 750–950 °C and 300–900 MPa on natural Sn-bearing metasedimentary schists. A critical advancement was the successful elimination of Sn loss to metallic capsules, an issue in previous investigations. This improvement enables precise determination of Sn behavior in high-temperature systems, providing new insights into the geochemical mechanisms governing Sn distribution during crustal melting and its implications for the formation of Sn-specialized granites.

Partition coefficients between apatite and carbonatitic melt are being examined as functions of pressure, temperature, and, most notably, melt composition (Si and Na content). Preliminary results reveal the coexistence of a 'brine'-component and carbonatitic melt under experimental conditions for high Na content. These findings shed light on element partitioning in carbonatitic systems and the compositional interplay between carbonatitic and brine-melts.

Additionally, ongoing IHPV projects synthesizing inclusions of aqueous fluids and melts in quartz will be outlined, further illustrating the versatility of IHPV techniques in petrological research.

¹University of Potsdam, ²GFZ German Research Centre for Geoscience, ³University of Münster

Bence Horányi¹, Fabrice Gaillard¹, Austin M. Gion², Éric Gloaguen^{1,3}, Alexis Plunder³, Jérémie Melleton³

Experimental Investigation of Lithium Partitioning between Minerals and Melts using Internally-Heated Pressure Vessels

Mineral-melt partition coefficients have been widely used to interpret trace element dynamics during magmatic processes. The partitioning behavior of lithium in pegmatite-forming melts has received increasing attention due to the rising demand of critical metals for modern-day technologies. The enrichment of lithium during crustal processes, such as anatexis and magmatic differentiation, remains poorly constrained due to the lack of mineral-melt partition coefficients in felsic systems. In order to further constrain the partitioning behavior of lithium in felsic systems, crystallization experiments were performed on metaluminous to



peraluminous glasses using an internally-heated pressure vessel. The experiments were conducted at 600-750°C and 300 MPa on up to 12 capsules at a time. The starting materials were doped with fluxing elements (Li, F, P) and mineral seeds to investigate the effect of mineral and melt compositions on the distribution of lithium. The experiments produced a felsic melt in equilibrium with biotite, muscovite, quartz, alkali feldspar, and plagioclase. Lithium is moderately to highly incompatible in quartz and the feldspars, whereas it is moderately incompatible to slightly compatible in the micas. Partition coefficients vary by up to an order of magnitude which is interpreted to be a complex function of mineral/melt compositions and the crystallization conditions.

¹*Institut des Sciences de la Terre d'Orléans*, ²*University of Oxford*, ³*Bureau de Recherches Géologiques et Minières*

Krzysztof Wozniak¹, Piotr Rejnhard¹, Roman Gajda¹, Agnieszka Huć¹, Marcin Stachowicz¹
Quantum Crystallographic Studies of Phase Transitions in Minerals under Pressure

We will present details experimental electron density changes resulting from multipole refinement of phase transition in important minerals: Calcite (CaCO₃) and Natrochalcite. We traced a reversible phase transformation of Calcite to Calcite-II, from R-3c to P21/c symmetry at pressure ranging from 0.85 GPa to 2.07 GPa. The reversible phase transition takes place at 1.5 GPa. It involves twinning of crystals into two domains. The decrease of pressure removed twinning in all crystals which regained the quality suitable for multipole modelling. Will present detailed changes of atomic basins, atomic charge, atomic volumes under pressure.

Natrochalcite is rare mineral possesses H₃O²⁻ units forming one of the shortest hydrogen bond (HB) reported so far in inorganic compounds. High pressure conditions lead to the formation of an extremely short single-well HB and to the phase transition connected with symmetry lowering above 2 GPa. It crystallizes in the monoclinic space group C2/m. In this contribution, we will present details of changes of H-bonding in this mineral as a function of pressure as well as analyse variation of electronic parameters.

Acknowledgements. KW, AH, PR and RG acknowledge a financial support within the Polish National Science Centre (NCN) OPUS21 grant number DEC-2021/41/B/ST4/03010

¹*University of Warsaw*

Benjamin Brugman¹, Ivan Matyushov¹, Blaine Abera¹, Godwin Agbanga¹, Ved Dhola¹, Logan Leinbach¹, Kurt Leinenweber¹, Sergey Ushakov¹, Qijun Hong¹, Alexandra Navrotsky¹
Energetics of high P-T monoclinic Y₂O₃ and Er₂O₃

Rare earth sesquioxides (RE₂O₃) are an important class of materials with applications ranging from barrier coatings to lasers and electronics. Several of the RE₂O₃ undergo a transition from the cubic C-type to the monoclinic B-type structure at high pressure. B-type



RE₂O₃ are recoverable to ambient conditions where they are metastable relative to the cubic phase and exhibit different physical properties. Despite this potential for the use of B-type RE₂O₃ in new technological applications, there is little experimental data on the energetics of the transformation reaction. We used high pressure and temperature in the multianvil press to drive the C → B transition in RE₂O₃ (RE = Y, Er). The transformation enthalpy of the C → B transformation determined by oxide melt solution calorimetry is 15.57 ± 4.50 kJ/mol and 15.88 ± 4.02 kJ/mol for Y₂O₃ and Er₂O₃, respectively. These values are comparable to predictions from complementary first principles calculations and agree with the value for Er₂O₃ determined by differential scanning calorimetry (DSC). Y₂O₃ undergoes a sluggish reversal to the cubic phase when heated, observed by DSC and in situ high temperature X-ray diffraction, suggesting that kinetics control the reaction. Preliminary results on Dy₂O₃ and Ho₂O₃ will also be presented.

¹Arizona State University

Axel Wittmann¹, Marc Biren¹, Laurence Garvie¹

Highly siderophile element nuggets in Wabar impact glass

The impact of a 15-m iron asteroid in dune sand of Saudi Arabia's Empty Quarter 300 years ago formed the Wabar craters and left iron meteorite fragments. A significant portion of the impactor dissolved into the melted sand forming impactites including glassy Wabar pearls, dumbbells, and dark scoria-like material. We found ~60 to 1400 nm nuggets of refractory highly-siderophile elements (HSE) dominated by Pt, Os, Ru, Ir, Re, and Rh in Wabar impact glass. These HSE were distributed in the IIIAB iron impactor at low ppm and became concentrated up to ×43000 in the nano-nuggets. The petrologic context of the nano-nuggets is consistent with the rapid dissolution of the iron meteorite into the dune sand target triggered by the impact shockwave. This induced a shock pressure >20 GPa and the separation of immiscible HSE from the silicate impact melt at 1900 °C to >2700 °C. Our study reveals new insights into the fate of impactors and the potential for similar findings of HSE nano-nuggets at other impact sites.

¹Arizona State University

Devika Padmakumar¹, Luisa Chavarria¹, Susannah M. Dorfman¹, Wen-Pin Hsieh²

Thermal Conductivity of Ilmenite at Lunar Mantle Pressures

The geochemistry of lunar basalts and geophysical data from the Gravity Recovery and Interior Laboratory (GRAIL) mission support the hypothesis that the lunar mantle contains an ilmenite-rich cumulate layer. The physical properties of this cumulate layer are important to the dynamics of lunar mantle overturn, interpretation of lunar structure from seismic data, possible partial melts in the lunar interior, and secular cooling rate of the Moon. However, the thermal conductivity of ilmenite has not been examined under lunar mantle pressure and temperature conditions, and differences in the thermal conductivity of the ilmenite-rich layer



compared to the average lunar mantle have not been included in the existing models of the Moon's thermal evolution. In our study, we measure the lattice thermal conductivity of ilmenite up to approximately 22 GPa using time-domain thermoreflectance (TDTR) spectroscopy within a diamond anvil cell. The thermal conductivity of ilmenite at ambient conditions is ~ 2.8 W/mK, with a measurement uncertainty of $\sim 10\%$. Over pressures corresponding to the lunar mantle (up to ~ 5 GPa), we observe an $\sim 11\%$ increase in thermal conductivity of ilmenite relative to ambient conditions. Although thermal conductivity of olivine was used in previous lunar geodynamic studies to represent the lunar mantle, thermal conductivity of ilmenite is $\sim 22\%$ lower than that of olivine at ambient conditions, and the difference increases with pressure to $\sim 47\%$ at the lunar core-mantle boundary. This disparity could influence the interpretation of experimental studies on the lunar interior, a factor that has not been explored to date. Consequently, our findings on ilmenite's thermal conductivity can serve as a valuable input for future models of the Moon's chemical and physical evolution.

¹Michigan State University, ²Academia Sinica

Junjie ("JJ") Dong¹², Rebecca A. Fischer², Lars P. Stixrude³, Matthew C. Brennan², Kierstin Daviau², Terry-Ann Suer², Katlyn M. Turner², Yue Meng⁴, Vitali B. Prakapenka⁵

Nonlinearity of the post-spinel transition and its expression in slabs and plumes worldwide

Phase transitions in the mantle control its internal dynamics and structure. The post-spinel transition marks the upper-lower mantle boundary, where ringwoodite dissociates into bridgmanite plus ferropericlase, and its Clapeyron slope regulates mantle flow across it. This interaction has previously been assumed to have no lateral spatial variations, based on the assumption of a linear post-spinel boundary in pressure and temperature. Here we present laser-heated diamond anvil cell experiments with synchrotron X-ray diffraction to better constrain this boundary, especially at higher temperatures. Combining our data with results from the literature, and using a global analysis based on machine learning, we find a pronounced nonlinearity in the post-spinel boundary, with its slope ranging from -4 MPa/K at 2100 K, to -2 MPa/K at 1950 K, and to 0 MPa/K at 1600 K. Changes in temperature over time and space can therefore cause the post-spinel transition to have variable effects on mantle convection and the movement of subducting slabs and upwelling plumes.

¹California Institute of Technology, ²Harvard University, ³UCLA, ⁴HPCAT, ⁵University of Chicago

Jonathan Dolinschi¹, Daniel J. Frost²

Precision Stress Measurement in High-Pressure Deformation: A Novel Piezoelectric Approach

High-pressure and high-temperature deformation experiments are essential for understanding the rheology of mantle rocks. Classical deformation devices are limited to pressures of 2 GPa, while large volume presses (LVP) allow higher pressures but rely on



XRD Debye ring distortion for stress measurements, which are imprecise and require synchrotron facilities. A novel stress determination method using piezoelectric single crystal disks within an LVP assembly has been developed. By measuring the piezoelectric charge generated during deformation, stresses as low as 0.01 GPa can be resolved, significantly improving sensitivity over XRD, which has a ± 0.1 GPa uncertainty. Challenges with α -quartz piezoelectric elements, including ferroelastic twinning, were addressed by using CTGS, a material that avoids twinning and provides greater stability under experimental conditions. Deformation experiments on San Carlos olivine and other materials demonstrated good agreement between piezoelectric and XRD-derived stresses, with the new method providing superior precision. Creep experiments yielded activation energies and volumes consistent with literature values. This approach enables accurate stress measurements at mantle-relevant conditions without reliance on synchrotron XRD, representing a significant advancement in high-pressure deformation studies.

¹University of Oxford, ²Bayerisches Geoinstitut/University of Bayreuth

C.E. Mohn¹, Reidar G. Tronnes¹

The bridgmanite to post-bridgmanite phase loops in the systems $\text{MgSiO}_3\text{-FeSiO}_3$, $\text{MgSiO}_3\text{-FeAlO}_3$ and $\text{MgSiO}_3\text{-Al}_2\text{O}_3$

Bridgmanite (bm) and post-bridgmanite (pbm) in the systems $\text{MgSiO}_3\text{-FeSiO}_3$, $\text{MgSiO}_3\text{-FeAlO}_3$ and $\text{MgSiO}_3\text{-Al}_2\text{O}_3$ (MS-FS, MS-FA, MS-AA) were examined by Boltzmann statistics and density functional theory (GGA+U, HSE06). The vibrational contribution to the free energy was calculated by the quasi-harmonic approximation. The Clapeyron slope for the slightly curved bm-pbm boundary (for MS) is 8.0, 8.7 and 9.3 MPa/K at 2000, 3000 and 4000 K, respectively, with a transition pressure of 126.3 GPa at 3000 K. The FS and FA components partition preferentially into pbm, whereas the AA component prefers bm. The MS-FA and MS-AA joins are characterised by narrow and flat phase loops near MS. At 3000 K and 50 mol% AA, the assemblage stishovite + Ca-ferrite-structured MgAl_2O_4 is stabilised above 71-72 GPa, dramatically reducing the AA solubility in bm from about 43 mol% at 71 GPa to considerably less than 5 mol% at 126 GPa. With CMB temperatures of 3700-4000 K, our results exclude the "double-crossing" scenario and demonstrate omnipresence of pbm up to 200-400 km above the CMB, even in the hot LLSVP regions of the D" zone.

¹University of Oslo

Ben Kalman¹, Wenjun Yong¹, Richard A. Secco¹

Phase Transitions of Solid and Liquid Fe-Si Alloys with Applications to Planetary Core Composition and Dynamo Processes

It is widely accepted that the convection of the liquid metallic outer core is the driver of the dynamo-produced magnetic field in terrestrial bodies, yet the processes which occur within the core are difficult to study due to the extreme temperatures (T) and pressures (P). By



examining the phase changes that occur with varying P, T, and composition (X), phase diagrams may be constructed for expected core compositions. The constructed phase diagrams of Fe-Si alloys along with known or modeled P,T conditions of solid/liquid phases within the cores of interest can then be used to determine likely compositions of these cores. Experiments were conducted in a 1000-ton cubic anvil press at P from 2–5 GPa and T into the liquid state. Fe-Si samples were prepared from pure Fe up to 33 wt% Si using mixtures of powders with known compositions. Following quenching of each experiment, the samples underwent electron microprobe analysis (EPMA) and along with textural analyses, these are used to map the T-X phase diagram at constant P. These phase diagrams will then be applied to the cores of small terrestrial bodies, such as the Moon, Mercury, and Vesta, to identify potential core compositions.

¹University of Western Ontario

Erin Lenhart¹, Wenjun Yong¹, Richard A. Secco¹

Adiabatic Heat Flow through the Tops of the Cores of Small Planetary Bodies through Electrical Resistivity Measurements of Fe-S-Si Alloys at High-P,T

In the cores of small terrestrial planetary bodies, the generation of a magnetic field is driven by the convective motion of liquid iron alloys. The thermally driven convection through these cores may be found by combining thermal evolution models with laboratory experiments at the conditions of these planetary cores. This study seeks to find adiabatic heat flow and thermal conductivity by direct laboratory measurements of electrical resistivity at high temperatures and pressures.

Experiments were performed in a 1000-ton cubic press and a 3000-ton multianvil press into the melt of Fe-S-Si. In situ measurements of temperature and voltage drop allow for the calculation of electrical resistivity and thermal conductivity through the Wiedemann-Franz Law. Post-experimental analysis was performed with a JEOL JXA-8530F electron microprobe.

Results were used to find the adiabatic heat flux through a sulfur-rich iron alloy planetary core, such as that of a sub-Earth exoplanet. For the asteroid 4 Vesta, these results indicate that the likely proportion of S and Si in the core decrease the estimated adiabatic heat flow by half relative to the case of pure Fe. This, in turn, increases the duration of thermal convection as a source for the magnetic dynamo in early Vesta.

¹University of Western Ontario