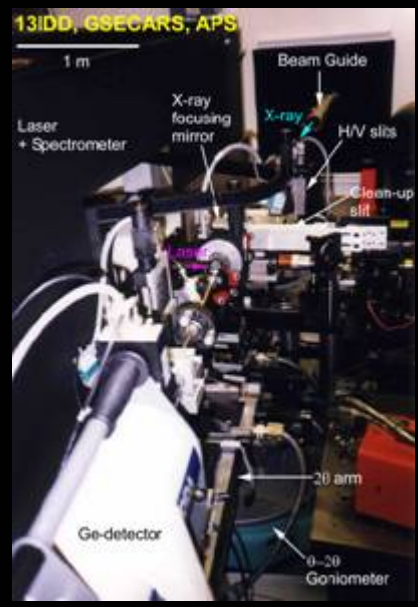
Recent Results using the Laser Heating System at GSECARS



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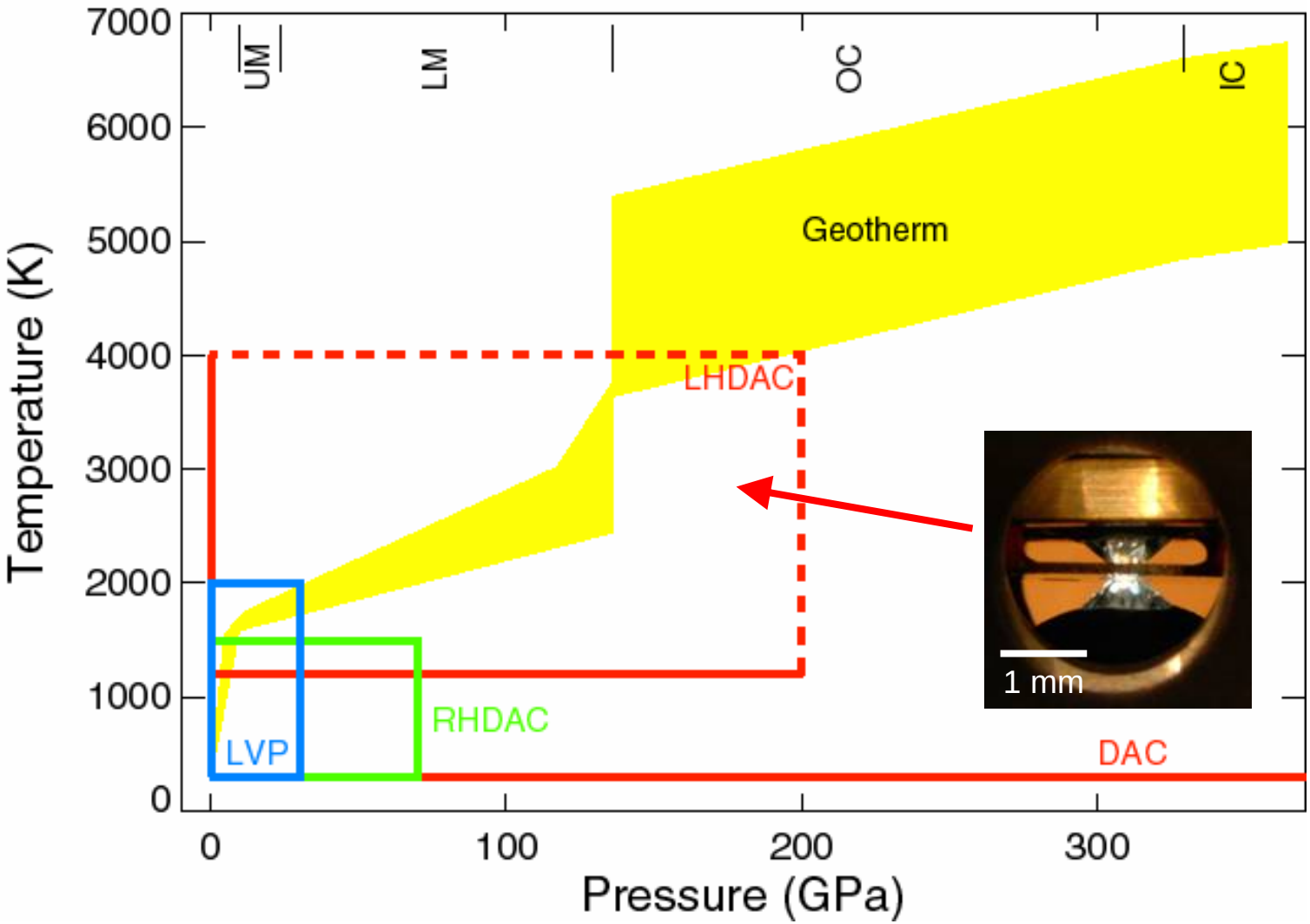
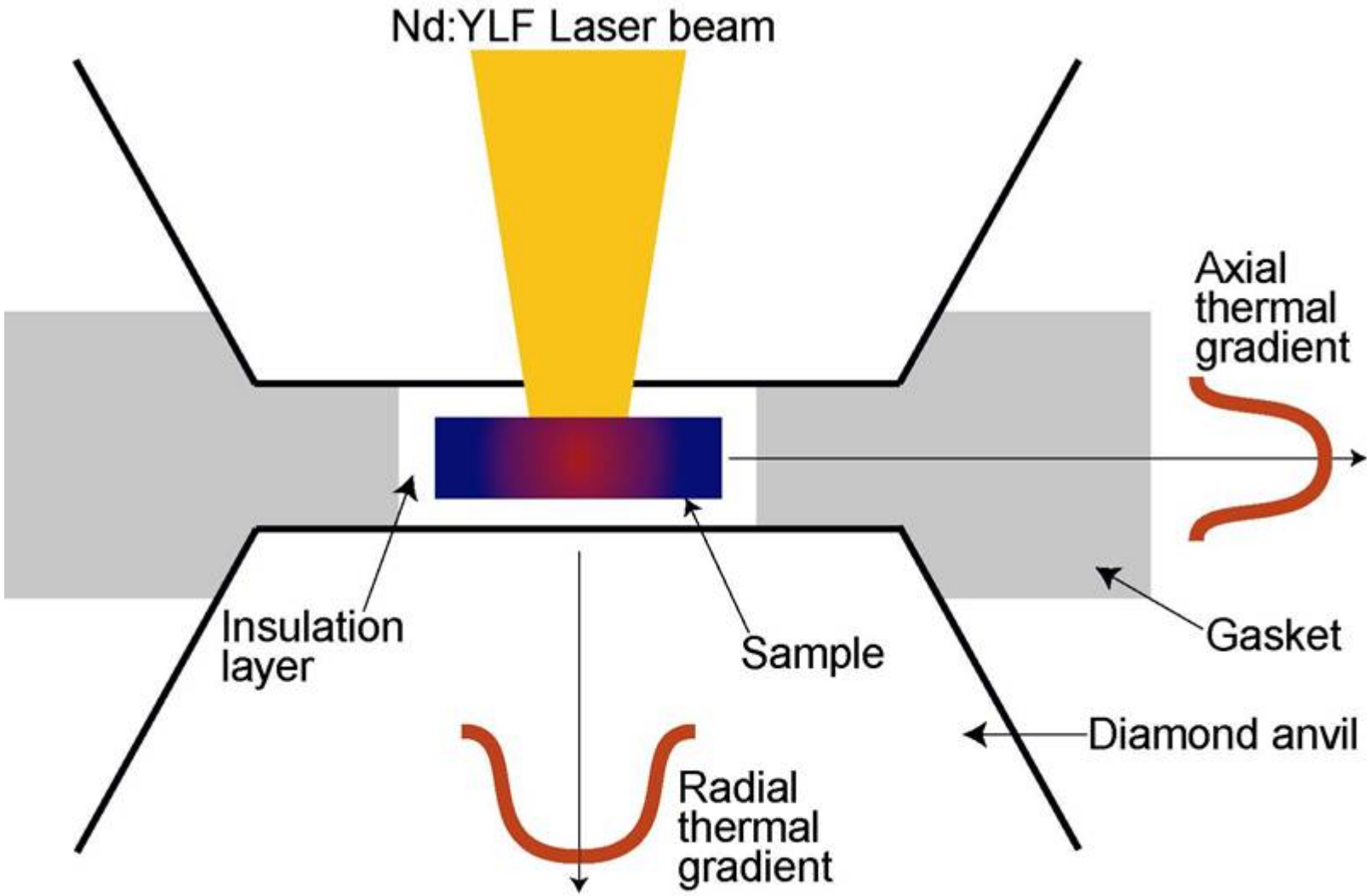
Laser-Heated Diamond Anvil Cell

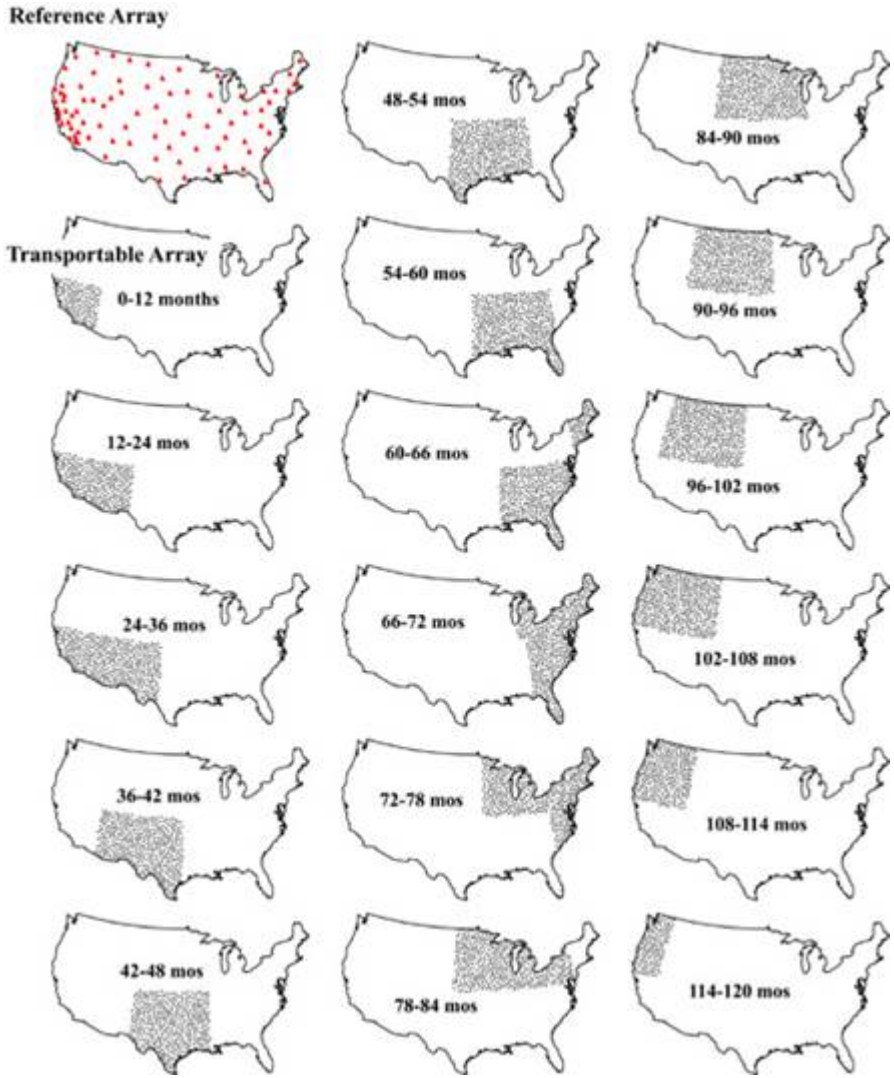


LHDAC: Laser Heated Diamond Anvil Cell
LVP: Large Volume Press
RHDAC: Resistance Heated Diamond Anvil Cell

Thermal Gradients

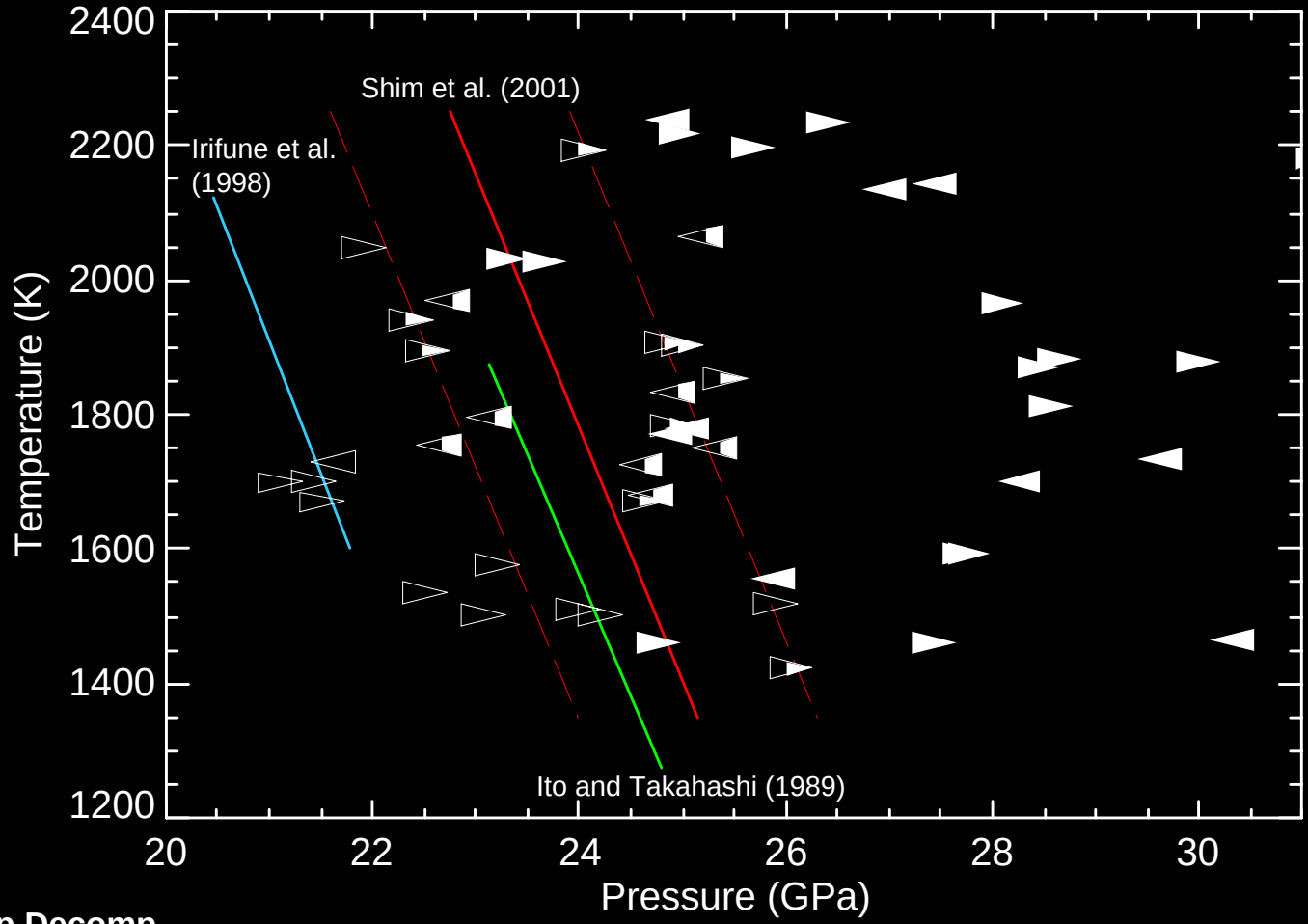


USArray



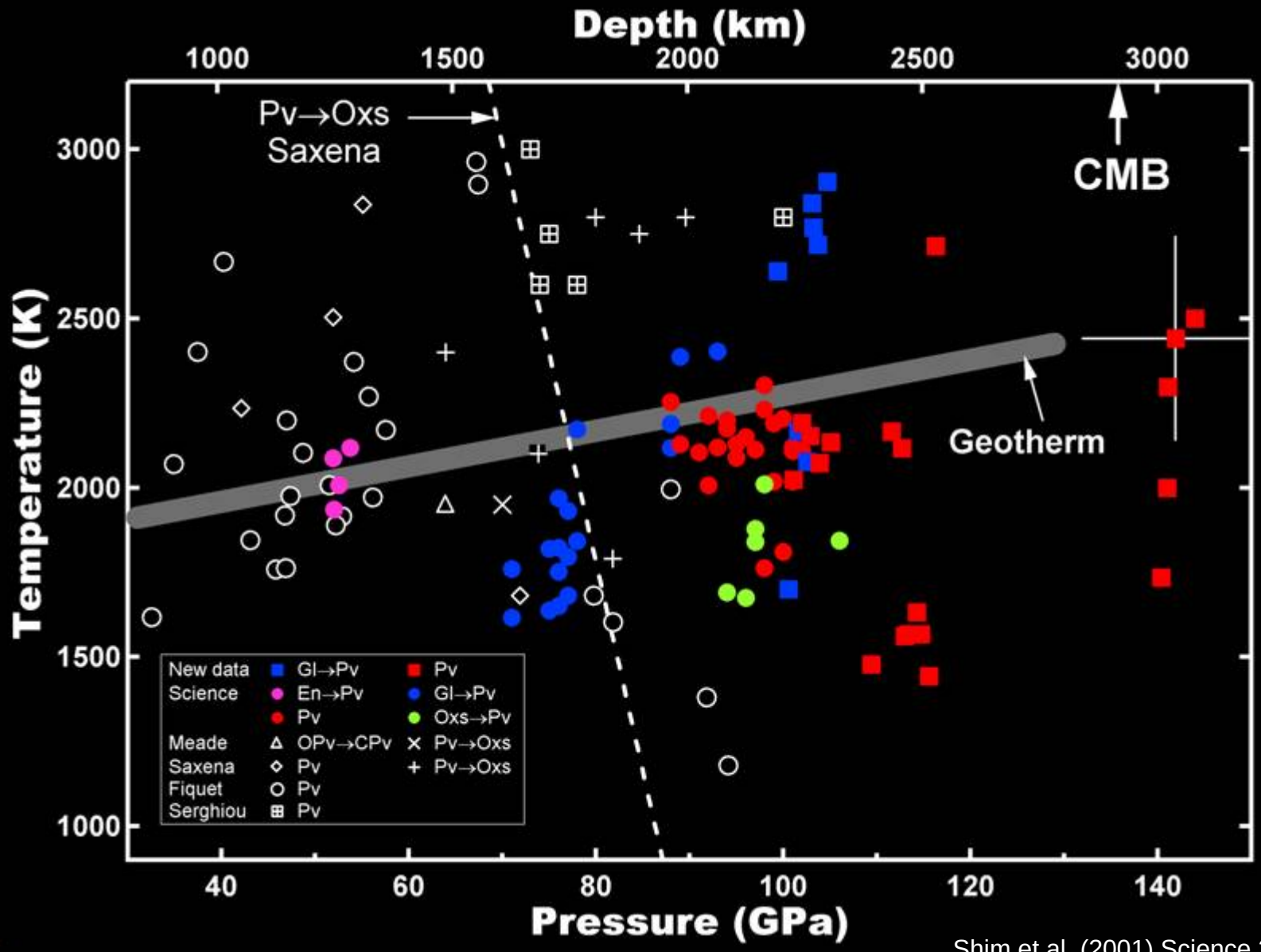
http://www.iris.iris.edu/USArray/usarraylinks.html

Post-spinel Transitions at the 660 Discontinuity



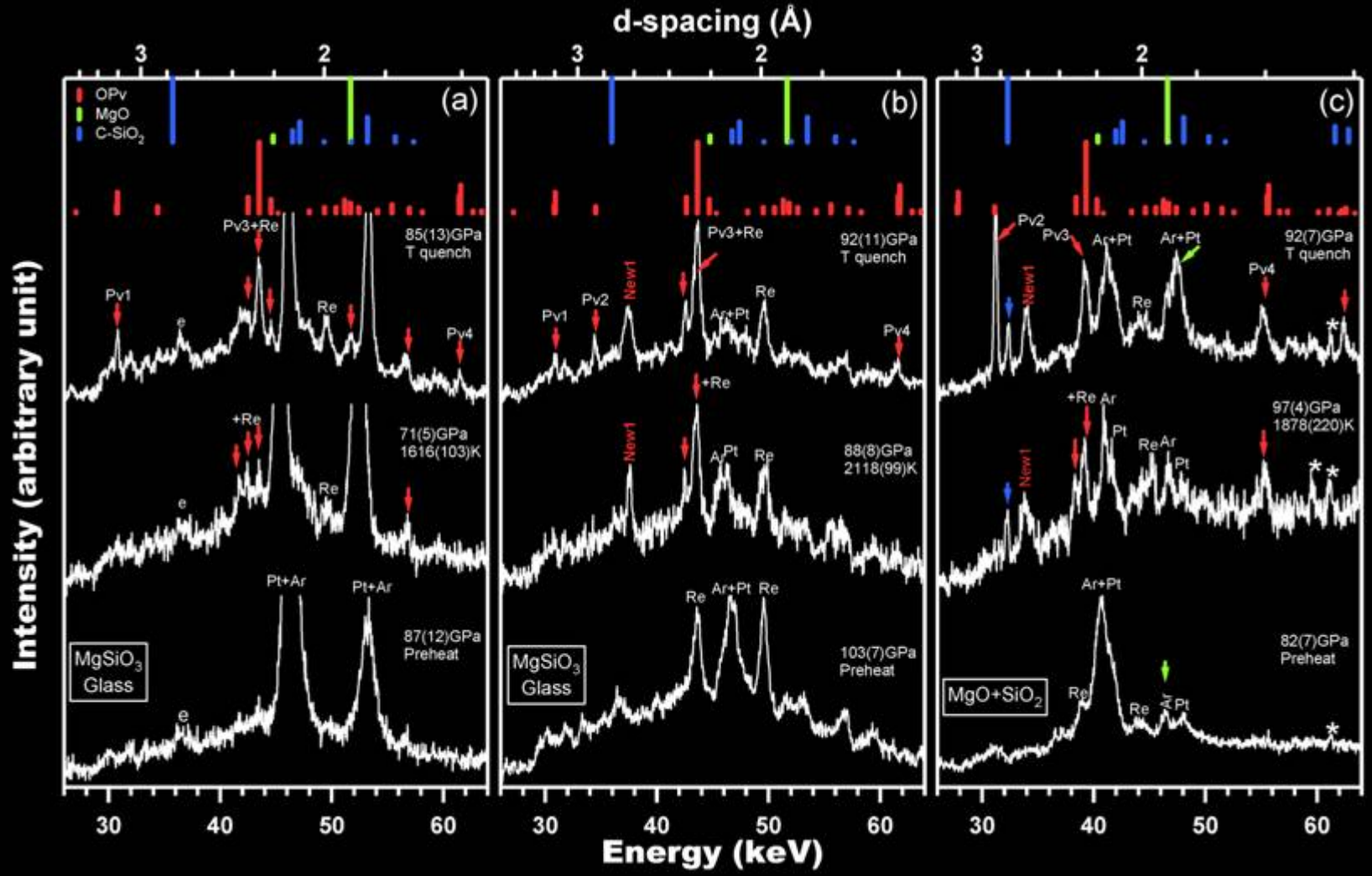
Shim et al. (2001) Nature 411, 571+

Stability of $MgSiO_3$ Perovskite



Shim et al. (2001) Science 293, 2437+
Shim et al. (2004) GRL, submitted

Modification in $MgSiO_3$ Perovskite at 88 GPa

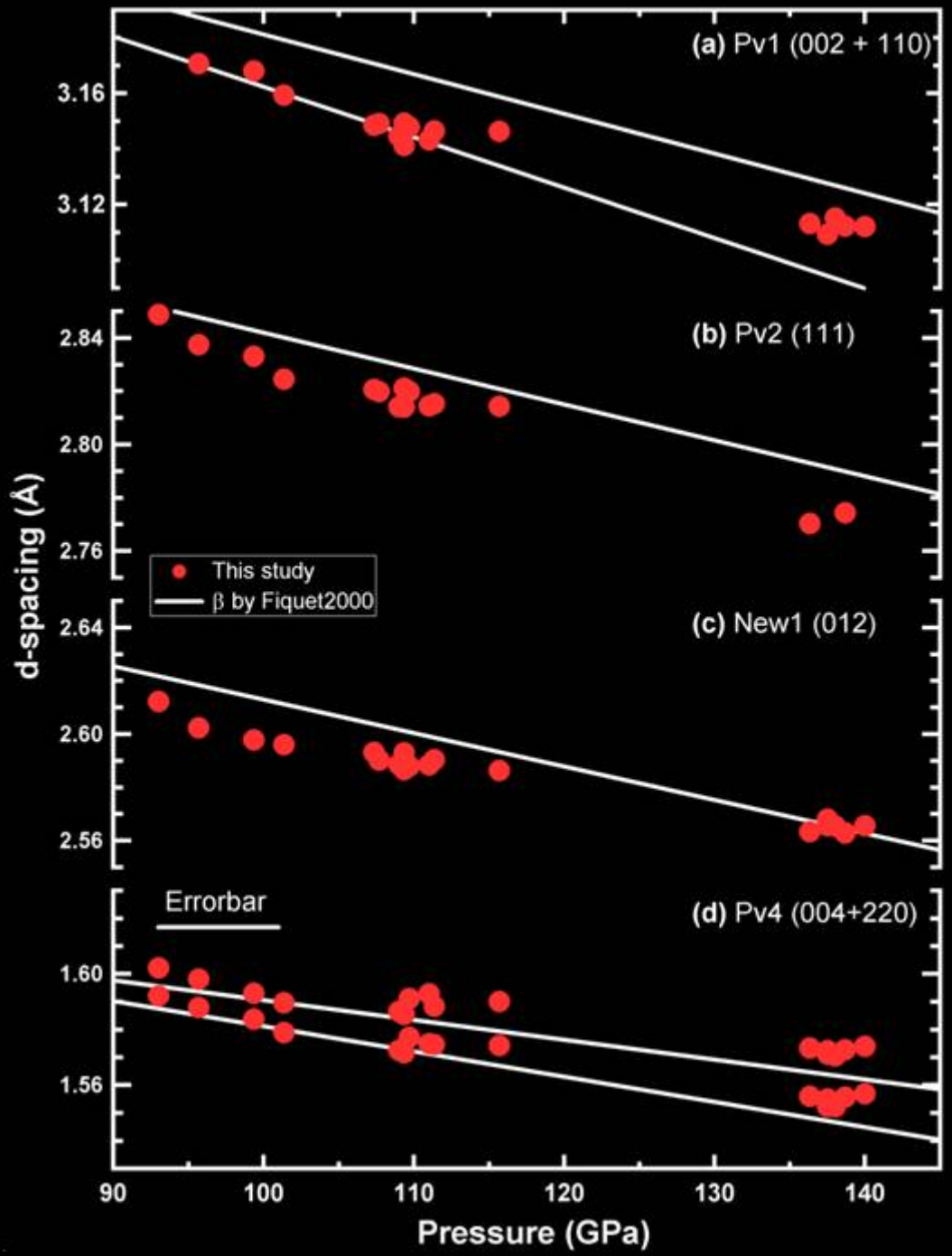


Shim et al. (2001) Science 293, 2437+

OPv: orthorhombic (Pbnm) $MgSiO_3$ perovskite
Pt: platinum (laser absorber and P-standard)

MgO: periclase
Ar: argon (pressure medium and insulator)

C-SiO_2: $CaCl_2$-structure SiO_2
Re: rhenium (gasket)

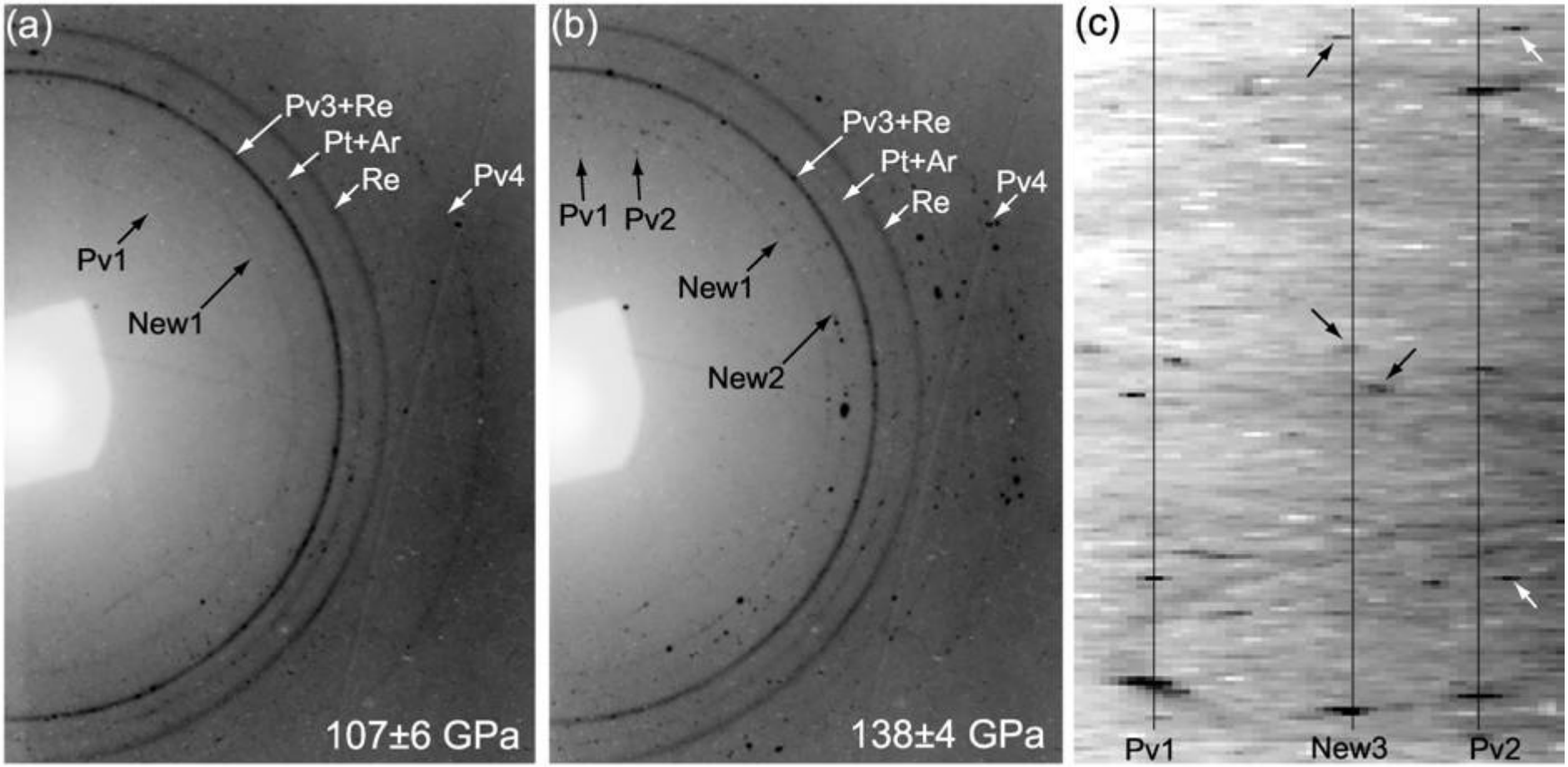


Pressure Induced Shift of the New Line and Pv Lines

d-spacing = distance between parallel atomic plane

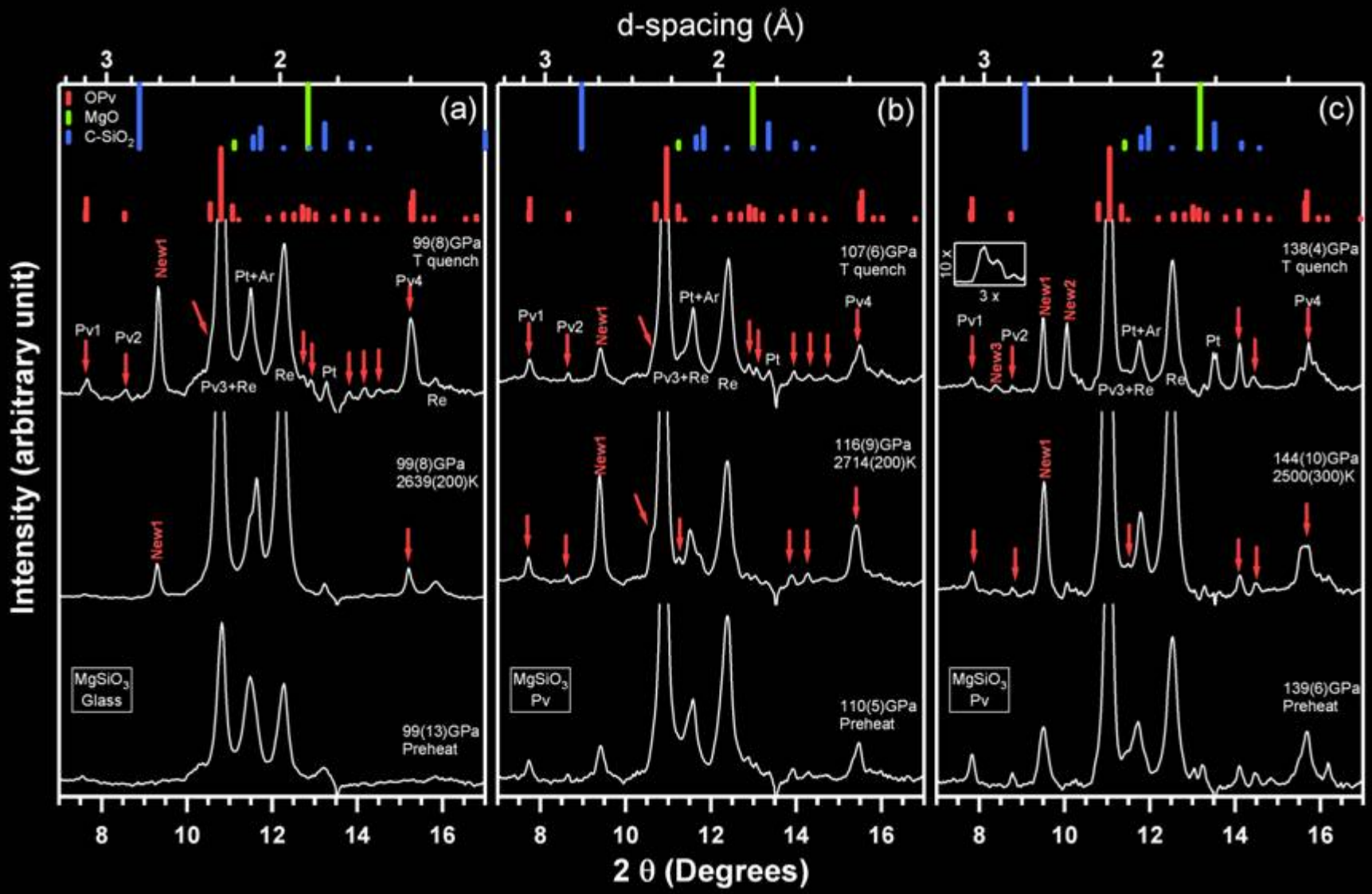
The new line is associated with $MgSiO_3$ perovskite or a material with a similar compressibility.

$MgSiO_3$ Perovskite at the Lowermost Mantle



Pv: $MgSiO_3$ perovskite, Re: rhenium gasket, Pt: platinum laser absorber, Ar: argon pressure medium

Change in Crystal Structure of $MgSiO_3$ at 140 GPa

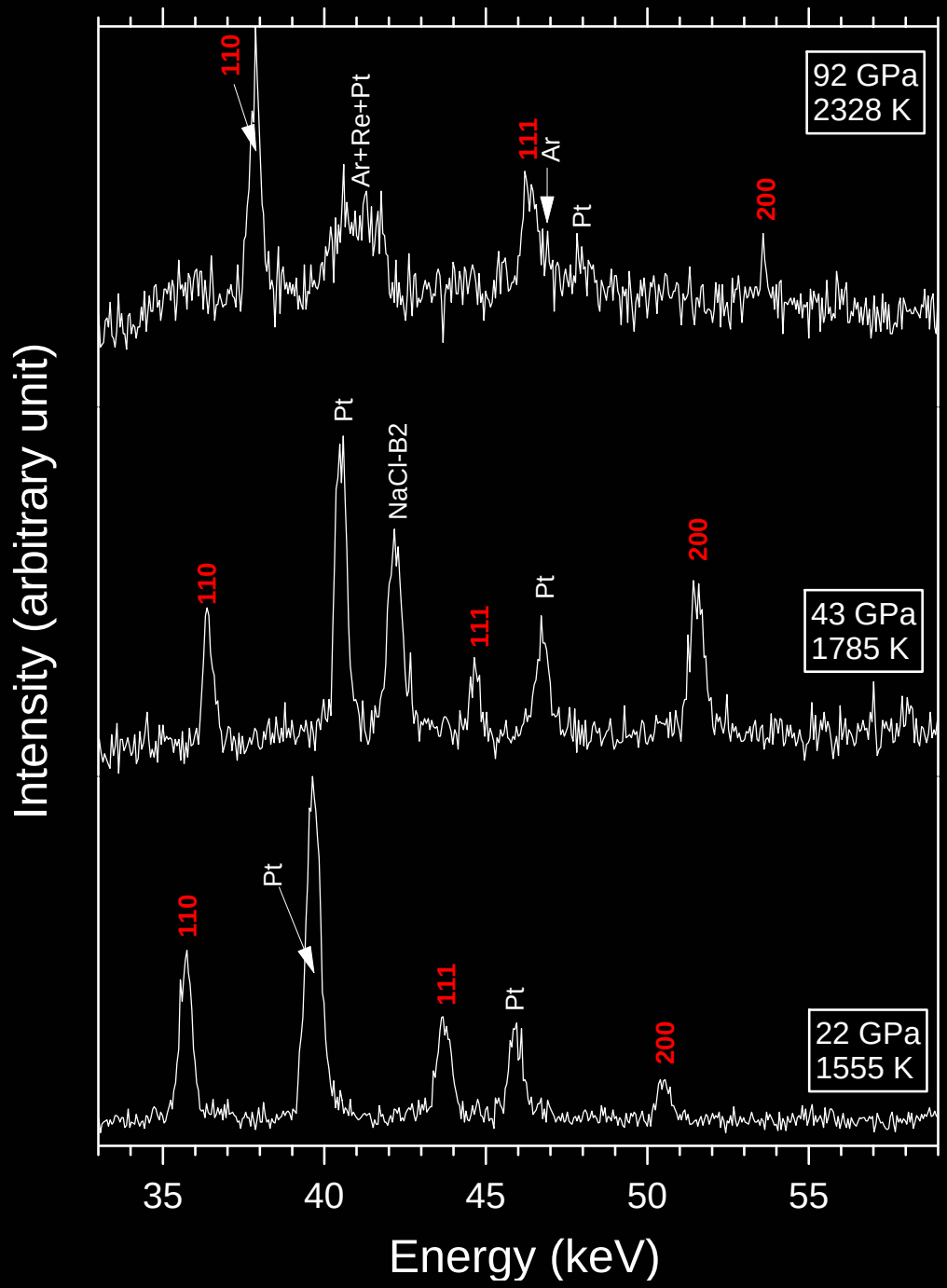


OPv: orthorhombic (Pbnm) $MgSiO_3$ perovskite
Pt: platinum (laser absorber and P-standard)

MgO: periclase
Ar: argon (pressure medium and insulator)

C-SiO_2: $CaCl_2$-structure SiO_2
Re: rhenium (gasket)

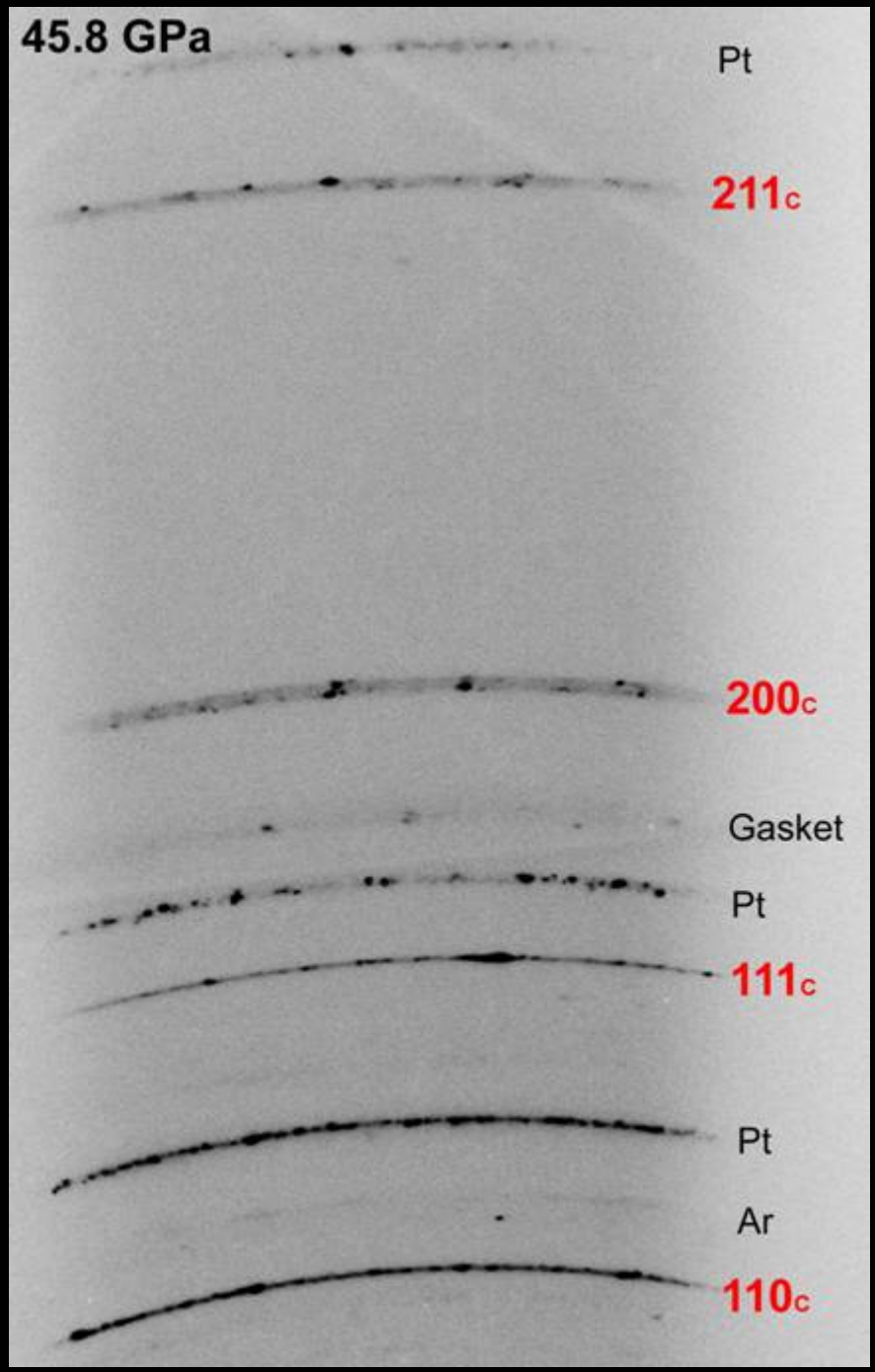
Energy-dispersive X-ray Diffraction



- GSECARS at Advanced Photon Source
- Starting material: wollastonite
- Double side laser heating

110,111,200 : $CaSiO_3$ perovskite
Pt : Platinum (laser absorber, pressure standard)
NaCl-B2 : NaCl (pressure medium, insulator)
Ar : Argon (pressure medium, insulator)
Re: Rhenium (gasket)

Shim et al. (2000) JGR 105, 25955+



Angle-dispersive X-ray Diffraction

- Stanford Synchrotron Radiation Laboratory
- Cornell High Energy Synchrotron Source
- Monochromatic X-ray, Image plate
- Starting material: wollastonite
- Laser heating/annealing

$CaSiO_3$ perovskite with cubic unit-cell index
Pt: Platinum (laser absorber, pressure standard)
Ar: Argon (pressure medium, insulator)

Shim et al. (2002) GRL 29, 2166+

Summary

- Phase boundary can be measured using laser heating system with ±1-2 GPa uncertainty.
- Stability and crystal structure of lower mantle silicate perovskite can be studied at in situ conditions.
- Equation of state can be measured at in situ lower mantle P-T conditions.
- Subtle distortion (< 0.4%) in crystal structure can be detected using angle-dispersive diffraction and laser annealing.

Collaborations

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Mark Bukowinski
Robin Benedetti
Kanani Lee (Caltech)

Advanced Photon Source
Guoyin Shen
Mark Rivers

Livermore National Lab
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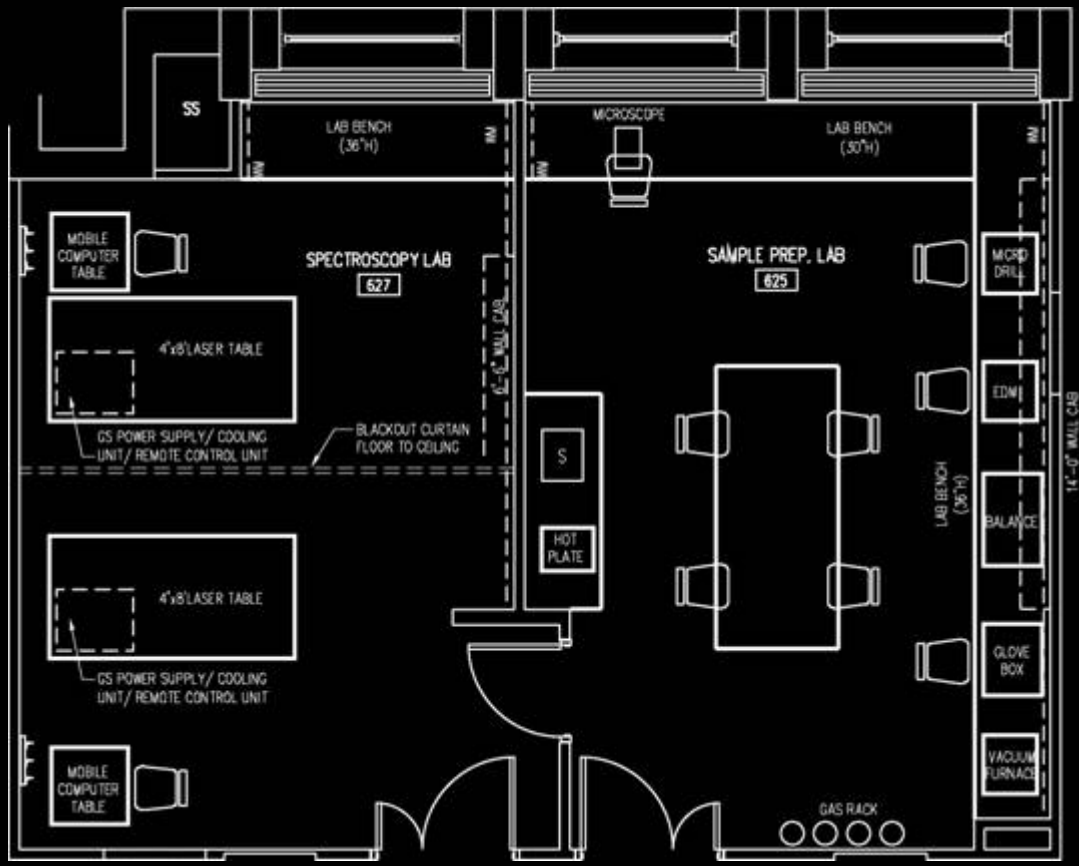
Valentin Iota
Hyunchea Cynn

Cornell High Energy Synchrotron Source
Chang-Sheng Zha

National Synchrotron Light Source
Jingzhu Hu
Madduri Somayazulu (HPCAT)



Mineral Physics Lab at MIT