Jennifer GIRARD

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Research interest: My research interests focus on experimental deformation of single phase and multi-phase minerals that form the Earth mantle to better constrain their rheological laws in laboratory conditions and extrapolate those laws to the Earth interior conditions. I am also participating in the development of deformation techniques to improve rheological data estimates. My other interest includes chemistry of the Earth mantle, with for example some recent studies on hydrous melting and partitioning in bridgmanite and as well as effect of oxygen fugacity on lower mantle mineralogy and iron disproportionation.

Education:

2008-2011 **PhD** in Materials Science and Engineering from the Mechanical and Materials Engineering Department (MME) at FIU

2006-2008 **Master Recherche sciences de la matière** (M.S. in Materials Sciences) Université des Sciences et Technologies de Lille 1 (USTL 1, France)

2003-2006 **Licence Physique/chimie** (B.S. in Physics and chemistry) Université des Sciences et Technologies de Lille 1 (USTL 1, France)

Research Experience:

Aug2020-Present: **Research Scientist in the high-pressure multi-anvil deformation laboratories of the Earth and Planetary Sciences department, at Yale University and Director of The Earth Material Characterization Center (EMC2) starting July 2021**: Study rheological properties of Earth mantle mineral and mineral mixtures to estimate strain/stress partitioning between existing phases. Estimate effect of thermodynamic parameters (P,T, Water content, Fo2) of rheological properties, mantle mineralogy and chemistry, and on melting properties.

Jan2015-Aug2020: **Associate Research Scientist in the high-pressure multi-anvil deformation laboratories of the Earth and Planetary Sciences department, at Yale University (PI: Professor S-I Karato).** Conduct deformation of single phase and multi-phase minerals to estimate their rheological properties at various conditions. Develop deformation techniques to improve rheological data estimates. Maintain high pressure and material characterization equipment in Shun Karato and Kanani Lee (until 2019) laboratories.

Oct2012-Dec2014: **Postdoctoral associate at Yale University Geology and Geophysics department**: My main focus during my second postdoc was on the study of the deformation bridgmanite $(Mg,Fe)SiO_3$ + ferropericlase (Mg,Fe)O mixture using Rotational Drickamer Apparatus (RDA), coupled with synchrotron X-ray sources to measure *in situ* stress, strain and strain rate. My second project consisted in exploring the effect of pressure on Fe disproportionation in bridgmanite as well as the effect of pressure on the reduction of (Mg, Fe) O.

Jan2012-Sept2012: **Post-doctoral researcher at CeSMEC, FIU:**

During my first post doc, my work consisted in synthesizing high pressure materials using Walker type apparatus, in order to study their physical properties. I synthesized Gamma-boron to study its electrical conductivity. I also conducted high pressure deformation experiments of single crystal minerals, such as periclase and olivine $(Mg, Fe)_2SiO_4$, using D-DIA and Walker module.

2008-2011: **Research Assistant and TA at Cemex, FIU.**

As a PhD candidate my work as research assistant was to prepare and characterize different carbonates and minerals at high pressure and high temperature using multi-anvils press and X-ray beam and Raman spectroscopy. My PhD dissertation was on the effect of water on olivine single crystal plasticity under upper mantle conditions (2-9GPa and 1200-1400K). Experimental work consisted in performing in-situ high pressure deformation experiment on various single crystal orientations in order to test different slip systems, using D-DIA coupled with synchrotron X-ray beam. In order to prepare desired single crystal, I established single crystal orientation routine using white X-ray Laue technique.

2007 - 2008 : **Master on deformation of dry olivine single crystal under Earth's upper mantle conditions at laboratoire de structure et propriété de l'état solide** (LSPES) -**université des sciences et technologies de Lille 1** (USTL 1, France)

For my master thesis, I conducted high-pressure high-temperature deformation experiments of Earth's materials (olivine single crystals) in order to find olivine rheological laws under high pressure and high temperature in anhydrous conditions. This study was realized with high pressure press (deformation DIA) coupling X-ray synchrotron. Strain was measured with radiography of the sample, and stress was deduced with diffraction on poly crystal sample. These experiments were carried out to better understand the effect of pressure on the plastic deformation of the Earth upper mantle minerals.

Publication:

SILBERT, R.E., **GIRARD, J.**, KARATO, S-I., Effects of pressure on diffusion creep on wet polycrystalline olivine, (under review)

TSUJINO, N., **GIRARD, J.**, BI W., ALP, E. E., KARATO, S-I, Formation of metallic Fe in bridgmanite under shallow lower mantle conditions (in preparation)

AMULELE, G., KARATO, S-I., **GIRARD, J.**, Melting of bridgmanite under hydrous shallow lower mantle conditions, Earth and Planetary Science Letter, (under review)

CREASY, N., **GIRARD, J.**, ECKERT, J., LEE, K. M., The Role of Redox on Bridgmanite Crystal Chemistry and Calcium Speciation in the Lower Mantle, Journal of Geophysical Research: Solid Earth, 125, (2020)

GIRARD, J., SILBER, R. E., MOHIUDDIN, A., CHEN H., KARATO, S., (2020) Development of a stress sensor for *in-situ* high-pressure deformation experiments using radial X-ray diffraction, Minerals, 10, 166.

MOHIUDDIN A., KARATO S-I., **GIRARD J.,** (2020) Slab weakening during the olivine to ringwoodite transition in the mantle, Nature Geosciences, 13, 170-174.

MASUTI S., **GIRARD J.**, BARBOT S., KARATO S-I., (2019), Anisotropic high-temperature creep in hydrous olivine single crystals and its geodynamic implications. Physics of The Earth and Planetary interior, 290, 1-9.

NZOGANG B.C., BOUQUEREL J., CORDIER P., MUSSI A., **GIRARD J.,** KARATO S., (2018), Characterization by Scanning Precession Electron Diffraction of Bridgmanite and ferropericlase aggregates deformed at HP-HT, Geochemistry, Geophysics, Geosystems, 19, (3) 582-594.

RATERRON P., FRAYSSE G., **GIRARD J.,** HOLYOKE C. W. III., (2016) Strength of Orthoenstatite Single Crystals at Mantle Pressure and Temperature and Comparison with Olivine, Earth and Planetary Science Letters, 450, 326-336.

GIRARD J., AMULELE G., FARLA R., MOHIUDDIN A., KARATO S-I., (2016) Shear deformation of bridgmanite and magnesiowustite aggregates at lower mantle conditions, Science, 351, 144-147.

CHEN J., LIANG X., YANG B., **GIRARD J.**, DROZD V., LIU Z., (2016) Band Gap of Semiconducting High-Pressure Phase of Boron, in proceedings of 2016 International Conference on Material Science and Civil Engineering (MSCE 2016), ISBN: 978-1-60595-378-6, 172-180.

FARLA R., AMULELE G., **GIRARD J.**, MIYAJIMA N., KARATO S-I., (2015) High-pressure and high-temperature deformation experiments on polycrystalline wadsleyite using Rotational Drickamer Apparatus, Physics and Chemistry of Minerals, 47, 7, 541-558.

CHEN J., YU T., HUANG S., **GIRARD J**., LIU X., (2014), Compressibility of liquid FeS measured using X-ray radiograph imaging, Physics of the Earth and Planetary Interiors, 228, 294-299.

GIRARD J., CHEN J., RATERRON P., HOLYOKE, C. (2013), Hydrolytic weakening of Olivine at mantle pressure: Evidence of [100](010) slip system softening from single crystal deformation experiments, Physics of the Earth and Planetary Interiors, 216, 12-20.

RATERRON P., **GIRARD J**., CHEN J., (2012) Activities of olivine activation slip in the upper mantle. Physics of the Earth and Planetary interiors 200-201, 105-112.

GIRARD J., CHEN J., RATERRON P., (2012), Deformation of periclase single crystals at high pressure and temperature: Quantification of the effect of pressure on slip-system activities, Journal of Applied Physics, 111**,** 112607.

RATERRON, P., CHEN, J., GEENEN T., **GIRARD, J** (2011) Pressure effect on forsterite dislocation slip systems: Implication for LPO and low viscosity zone, Physics of the earth and planetary Interiors, 188, 1-2.

CHEN J., LIU H., **GIRARD J**., (2011), Influence of water on the 410-kilometer seismic velocity jump in Earth's mantle, American Mineralogists, 96, 697-702

GIRARD J., CHEN J., RATERRON P., HOLYOKE C., (2010), Deformation of single crystal sample using D-DIA apparatus coupling with synchrotron X-ray beam: in situ stress and strain measurements at high pressure and temperature , Journal of Physics and Chemistry of Solids, 71, 1053-1058

Conference presentation:

Jennifer Girard, Anwar Mohiuddin, Reynold E Silber, Shun-Ichiro Karato, Development of a Stress Sensor for In-Situ High-Pressure Deformation Experiments in D-DIA, American Geophysical Union annual meeting, December 2019

Jennifer Girard, Noriyoshi Tsujino, Anwar Mohiuddin, Shun-Ichiro Karato, Synchrotron Radial X-ray Diffraction Studies of Deformation of Polycrystalline MgO, American Geophysical Union annual meeting, December 2016

Jennifer Girard, Shun-Ichiro Karato, Some applications of RDA (Rotational Drickamer Apparatus) under the shallow lower mantle conditions: *in-situ* studies of rheological properties of a lower mantle mineral assembly and the pressure dependence of concentration of metallic Fe, COMPRES meeting, Colorado Spring, Colorado 6th-9th July 2015

Jennifer Girard, George Amulele, Robert Farla, Anwar Mohiuddin, Shun-Ishiro Karato, Synchrotron *in-situ* deformation experiments of perovskite + (Mg, Fe)O aggregates under shallow lower mantle conditions, American Geophysical Union annual meeting, December 2014

Jennifer Girard, Shun-Ishiro Karato Evidence and implication of the limited depth range of metallic-Fe-bearing layer in the lower mantle, American Geophysical Union annual meeting, December 2014

Jennifer Girard, George Amulele, Robert Farla, Zhen Liu, Anwar Mohiuddin, Shun-Ishiro Karato, Synchrotron *in-situ* deformation experiments of perovskite + (Mg, Fe)O aggregates under shallow lower mantle conditions, American Geophysical Union annual meeting, December 2013

Jennifer Girard, George Amulele, Robert Farla, Zhen Liu, Anwar Mohiuddin, Shun-Ishiro Karato, Deformation of uppermost lower mantle minerals using Rotational Drickamer Apparatus, COMPRES meeting, June 2013

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, Hydrolytic weakening of Olivine at mantle pressure: Evidence of [100](010) slip system softening from single crystal deformation experiments, American Geophysical Union annual meeting, December 2012

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, Hydrolytic weakening of Olivine at mantle pressure: Evidence of [100](010) slip system softening from single crystal deformation experiments, 2011 Annual Meeting of COMPRES, kingsmill resort, Williamsburg VA June 14 –17, 2011

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, Study of Material Deformation at High Pressure Using Synchrotron X-Rays, TMS annual meeting, San Diego, March 27th-april 3rd 2011

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, Effect of water on high pressure and high temperature deformation of forsterite single crystal $[110]_c$ and $[011]_c$ and quantification of activation volume, ESPCA Workshop, Synchrotron school, Brazil January17-27th 2011

Jennifer Girard, Jiuhua Chen, Paul Raterron Caleb W. Holyoke, Effect of water on high pressure and high temperature deformation of forsterite single crystal $[110]_c$ and $[011]_c$ and quantification of activation volume, American Geophysical Union annual fall meeting, San Francisco, December 12-17, 2010

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, Effect of water on the slip systems activity in olivine single crystal, HPCAT/CDAC Short Course, Argonne National Laboratory, Chicago, Il September 15– 19, 2010

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb, WIII, Holyoke, Effect of water on the slip systems activity in olivine single crystal, CIDER workshop, UC Santa Barbara, CA, June 27 – July 15, 2010

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, Effect of water on the slip systems activity in olivine single crystal, 2010 Annual Meeting of COMPRES, Skamania Lodge, Stevenson WA June 22 – 25, 2010

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, Effect of water on the slip systems activity in olivine single crystal, EMPG meeting, Toulouse (France), April 2010

Jennifer Girard, Jiuhua Chen, Paul Raterron, Caleb W. Holyoke, the effect of water on the slip systems activity in olivine single crystal, American Geophysical Union annual fall meeting, San Francisco, December 2009

Jennifer Girard, Jiuhua Chen, Paul Raterron, Effect of water in high pressure and high temperature deformation of olivine single crystal, COMPRES annual meeting, Mont Washington, New Hampshire, June 2009.

Jennifer Girard, Jiuhua Chen, Paul Raterron, Effect of water in high pressure and high temperature deformation of olivine single crystal, The fifth International Meeting of Study of Matter at Extreme Conditions, Miami - Western Caribbean. March 28 - April 2, 2009

Jennifer Girard, Jiuhua Chen, Paul Raterron, Deformation of Olivine single crystal at mantle pressure and temperature in dry condition: pressure effect on olivine dislocation slip-system activities American Geophysical Union annual fall meeting, San Francisco, December 2008

Honor and fellowship:

2011 Florida International University Presidential Award: Worlds Ahead Graduate
2011 Florida International University Doctoral Evidence Acquisition fellowship (fall 2011**)**
2011 COMPRES meeting invited student oral presentation
2010 Cider research grant on water cycling in the earth and the effect of water on the plate tectonics motion: Founding for pursue the research teamwork.
2010 COMPRES meeting invited student oral presentation
Award of 2010 Material Advantage research poster competition (Second Place): Application of mechanical properties study to solve the earth puzzle
Award of 2009 Material Advantage technical oral presentation competition: Deformation of olivine single crystals to study olivine plasticity
2009, 2010, 2011 COMPRES Student Travel Scholarship

Languages:

French, native speaker; **English,** spoken and written

Other:

Beamtime Proposal Reviewer for High Pressure Review panel: November 2017 to present
AED/CPR First aid certified from American heart association
Volunteer and panelist for Girls Science Investigation (GSI) at Yale: 2018, 2019
OSPA Judge at the American Geophysical Union annual conference since 2017
Peer Reviewer for Physics of the Earth and Planetary Interior: 2018
NSF proposal reviewer: 2017, 2020
Peer Reviewer for Scientific Report: 2016, 2017

Science News Magazine interview on recently publish peer paper, 2014
Peer reviewer for Journal of Physics and Chemistry of Solids, 2011
President of Material Advantage (Student association for materials science and engineering) FIU chapter, 2011
Event Coordinator of Material Advantage (Student association for materials science and engineering) FIU chapter. Representing of Material Advantage at CSO event, and organize material advantage events, Club fair, engineering expo 2009, 2010, 2011.
Event coordinator of Nano Club 2009, 2010, 2011 President of Nano Club 2012: Organize visits to Miami high schools to educate students about nanoscience, material science and engineering, and to promote scientific college education.
Member of Hands on Miami protection and conservation of historical places/monuments in Miami, restoration of Dade County's Historic Doc Thomas House, damaged after a hurricane.
Member of Habitats for Humanity for a Greater Miami, in collaboration with Hands on Miami Participate to the construction of houses and landscape around houses built for family with low incomes.
Member of Tau Beta Pi (National engineering honor society) Got involved in 2010
Member of International Student Club: To share and learn about the different culture present a FIU. We also share our experience of living in a foreign country.