

## PETER J. HEANEY

Department of Geosciences  
540 Deike Building  
Penn State University  
University Park, PA 16802  
Tel: (814) 865-6821  
Fax: (814) 863-7823  
email: pjheaney@psu.edu

Home Address:  
1774 Cambridge Dr.  
State College, PA 16803  
Tel: (814) 861-1797

### EDUCATION

Harvard University, Cambridge, MA	History and Science	A.B. 1984
A.B. Thesis: "Smiting the edge of luckless rock: Geological stagnation in early nineteenth-century Boston"		
The Johns Hopkins University, Baltimore, MD	Geology	M.A. 1988
The Johns Hopkins University, Baltimore, MD	Geology	Ph.D. 1989
Ph.D. Dissertation: "Transmission electron microscopy of phase transitions and microstructures in minerals". Advisor: D.R. Veblen		

### AREAS OF SPECIALIZATION:

**Fields of Interest:** Crystal structure analysis of minerals; Environmental geochemistry; Phase transitions in rock-forming minerals

**Primary Techniques:** Powder X-ray and neutron diffraction; Transmission electron microscopy

### PROFESSIONAL EXPERIENCE:

6/05 to present: Professor of Mineral Sciences, Department of Geosciences, Penn State University.

6/12 to 6/16: Associate Head for Undergraduate Programs, Department of Geosciences, Penn State University.

8/04-6/05 and 8/11-6/12: Visiting Research Scientist, Department of Mineral Sciences, Smithsonian Institution.

9/98-6/05: Associate Professor of Mineral Sciences, Department of Geosciences, Penn State University.

9/91-8/98: Assistant Professor of Mineralogy, Department of Geosciences, Princeton University.

8/90-8/91: NSF-NATO Postdoctoral Fellow, Department of Earth Sciences, Cambridge University, with Dr. Michael Carpenter.

7/89-7/90: Smithsonian Postdoctoral Fellow, Department of Mineral Sciences, National Museum of Natural History, with Dr. Jeffrey Post.

## HONORS and AWARDS

Miller Faculty Research Fellowship, College of Earth and Mineral Sciences, Penn State University, 2017.  
 Faculty Advising Award, College of Earth and Mineral Sciences, Penn State University, 2016  
 Distinguished Honors Faculty Member, Schreyer Honors College, Penn State University, 2011-2013  
 Wilson Award for Excellence in Teaching, College of Earth and Mineral Sciences, Penn State University, 2011  
 G. Montgomery and Marion Hall Mitchell Award for Innovative Teaching, College of Earth and Mineral Sciences, Penn State University, 2008  
 Honorary Award, American Federation of Mineral Societies, Eastern Division, 2007  
 Fellow, Geological Society of America, 2006  
 Faculty Mentoring Award, College of Earth and Mineral Sciences, Penn State University, 2006  
 Excellence in Teaching Award, Princeton Undergraduate Engineering Council, Princeton University, 1998  
 Fellow, Mineralogical Society of America, 1997  
 Distinguished Lecturer, Mineralogical Society of America, 1994-1995  
 NSF-NATO Postdoctoral Fellowship, Visiting Scholar, Wolfson College, Cambridge University, 1990-1991  
 Smithsonian Institution Postdoctoral Fellowship, 1989-1990

## PROFESSIONAL SOCIETIES

Mineralogical Society of America	Geological Society of America
American Geophysical Union	American Chemical Society
American Association for the Advancement of Science	Clay Minerals Society

## PROFESSIONAL SERVICE

Coordinator, International Travel Grants and Awards Program, Geological Society of America (2019-present)  
 Chair, MSA Centennial Committee, Mineralogical Society of America (2015-2019)  
 Chair, Distinguished Public Service Award Committee, Mineralogical Society of America, (2010-2016)  
 Review Committee, Geological Institute of America Annual Symposium (2011)  
 Advisory Committee, Consortium for Materials Properties Research in Earth Sciences (COMPRES), (2009-2011)  
 Chair, Benefactors Committee, Mineralogical Society of America (2010-2012)  
 Vice-President, President, Past-President (Elected), Mineralogical Society of America (2006-2009)  
 Associate Editor, *Clays and Clay Minerals* (1998-2007)  
 Editor of "Triple Point," *Elements* (2004 to 2007)  
 Chair, Minerals Subcommittee, International Centre for Diffraction Data (2004-2005)  
 Councilor (Elected), Mineralogical Society of America (2001-2004)

MSA Award Committee, Chair, Mineralogical Society of America (2002-2003)  
Meetings Coordinator, Mineralogical Society of America (2001-2004)  
Committee on Short Courses, Mineralogical Society of America (1999-2005)  
Publications Committee, Chair, Mineralogical Society of America (1997-1999)  
Kraus Crystallography Award Committee, Mineralogical Society  
of America (1998-1999)  
Committee for Public Outreach, Mineralogical Society of America (1996-1998)

**SYMPOSIA ORGANIZED:**

*MSA Centennial Symposium: The Next 100 Years of Mineral Sciences.* P.J. Heaney and Steven Shirey. Carnegie Institute for Science, June 20-21, 2019.

*Mineralogy Writ Small: A Tribute to the Distinguished Career of David R. Veblen.* P.J. Heaney, J. Stubbs, D. Elbert, Fall Meeting Geological Society of America. Nov. 2, 2015.

*Environmental Mineralogy.* P.J. Heaney and J.E. Post, Fall Meeting, Geological Society of America. Oct. 5, 2008.

*Environmental Mineralogy.* J.E. Post and P.J. Heaney, Spring Meeting, American Geophysical Union. Mar. 23, 2006.

*Advanced Characterization of the Structures and Behaviors of Minerals.* P.J. Heaney, J.E. Post, and M.A. Carpenter, Fall Meeting, Geological Society of America. Nov. 7, 2004.

*Electronic Student Response Technology in the Geoscience Classroom: Is it a Valuable Teaching Tool?* L. Greer and P.J. Heaney. Fall Meeting, Geological Society of America. Nov. 10, 2004.

*The Science of Gem Materials.* P.J. Heaney, T. Moses, and J.E. Post. Fall Meeting, Materials Research Society. Dec. 2-3, 2003.

*Determining Diamond Provenance.* P.J. Heaney and E.P. Vicenzi, Spring Meeting, American Geophysical Union. May 29, 2002.

*The Geochemistry and Mineralogy of Gemstones.* P.J. Heaney and G. Harlow. Eleventh Annual Goldschmidt Conference. May 21, 2001.

*Rietveld Analysis Workshop.* J.E. Post, P.J. Heaney, C.T. Prewitt. MSA-sponsored workshop at the Carnegie Institute of Washington. May 30, 2000.

*Advances in Mineral Structure Analysis.* J.E. Post, P.J. Heaney, C.T. Prewitt. Symposium at the Spring Meeting of the American Geophysical Union. Washington, D.C. May 31, 2000.

*Advances in Silica Geochemistry.* P.J. Heaney and P. Dove. Oct. 24, 1994. MSA-sponsored symposium at the Annual Meeting of the Geological Society of America. Seattle, WA.

*Interactions between the Geosphere and the Biosphere: A Symposium in Honor of David A. Crerar.* S.L. Brantley and P.J. Heaney. May 21-22, 1993. Department of Geological and Geophysical Sciences, Princeton University.

## **PUBLICATIONS**

### ***Articles published in refereed journals***

- 1) Veblen, D.R., Heaney, P.J., Angel, R.J., Finger, L.W., Hazen, R.M., Prewitt, C.T., Ross, N.L., Chu, C.W., Hor, P.H., and Meng, R.L. (1988) Crystallography, chemistry, and structural disorder in the new high- $T_C$  Bi-Ca-Sr-Cu-O superconductor. *Nature*, 332, 334-337.
- 2) Hazen, R.M., Finger, L.W., Angel, R.J., Prewitt, C.T., Ross, N.L., Hadidiacos, C.G., Heaney, P.J., Veblen, D.R., Sheng, Z.Z., El Ali, A., and Hermann, A.M. (1988) 100 K superconducting phases in the Tl-Ca-Ba-Cu-O system. *Physical Review Letters*, 60, 1657-1660.
- 3) Hazen, R.M., Prewitt, C.T., Angel, R.J., Ross, N.L., Finger, L.W., Hadidiacos, C.G., Veblen, D.R., Heaney, P.J., Hor, P.H., Meng, R.L., Sun, Y.Y., Wang, Y.Q., Xue, Y.Y., Huang, Z.J., Gao, L., Bechtold, J., and Chu, C.W. (1988) Superconductivity in the very high  $T_C$  Bi-Ca-Sr-Cu-O system: Phase identification. *Physical Review Letters*, 60, 1174-1177.
- 4) Morris, D.E., Nickel, J.N., Wei, J.Y.T., Asmar, N.G., Scott, J.S., Scheven, U.M., Hultgren, C.T., Markelz, A.G., Post, J.E., Heaney, P.J., Veblen, D.R., and Hazen, R.M. (1989) Eight new high-temperature superconductors with the 1:2:4 structure. *Physical Review B*, 39, 7347-7350.
- 5) Heaney, P.J. and Veblen, D.R. (1990) A high-temperature study of the low-high leucite phase transition using the transmission electron microscope. *American Mineralogist*, 75, 464-476.
- 6) Heaney, P. J. and Veblen, D. R. (1991) An examination of spherulitic dubiomicrofossils in Precambrian banded iron formations using the transmission electron microscope. *Precambrian Research*, 49, 355-372.
- 7) Heaney, P.J. and Veblen, D.R. (1991) Observations of the  $\alpha$ - $\beta$  phase transition in quartz: A review of imaging and diffraction studies and some new results. *American Mineralogist*, 76, 1018-1032.
- 8) Heaney, P.J. and Veblen, D.R. (1991) Observation and analysis of a memory effect at the  $\alpha$ - $\beta$  quartz transition. *American Mineralogist*, 76, 1459-1466.

- 9) Heaney, P.J., Post, J.E., and Evans, H.T., Jr. (1992) The crystal structure of bannisterite. *Clays and Clay Minerals*, 40, 129-144.
- 10) Heaney, P.J. and Post, J.E. (1992) The widespread distribution of a novel silica polymorph in microcrystalline quartz varieties. *Science*, 255, 441-443.
- 11) Cellai, D., Carpenter, M.A., and Heaney, P.J. (1992) Phase transitions and defect microstructures in natural kaliophyllite. *European Journal of Mineralogy*, 4, 1209-1220.
- 12) Veblen, D.R., Banfield, J.F., Guthrie, G.D., Jr., Heaney, P.J., Ilton, E.S., Livi, K.J.T., and Smelik, E.A. (1993) High-resolution and analytical transmission electron microscopy of mineral disorder and reactions. *Science*, 260, 1465-1472.
- 13) Guthrie, G.D., Jr. and Heaney, P.J. (1993) Mineralogical characteristics of the silica polymorphs in relation to their biological activities. *Notes of the Second International Conference on Silica, Silicosis, and Cancer*, pp. 128-135.
- 14) Gislason, S.R., Heaney, P.J., Veblen, D.R., and Livi, K.J.T. (1993) The difference between the solubility of quartz and chalcedony: The cause? *Chemical Geology*, 107, 363-366.
- 15) Heaney, P.J. (1993) A proposed mechanism for the growth of chalcedony. *Contributions to Mineralogy and Petrology*, 115, 66-74.
- 16) Mehta, A. and Heaney, P.J. (1994) Structure of  $\text{La}_2\text{NiO}_{4.18}$ . *Physical Review B*, 49, 563-571.
- 17) Heaney, P.J., Veblen, D.R., and Post (1994) Structural disparities between chalcedony and macrocrystalline quartz. *American Mineralogist*, 79, 452-460.
- 18) Heaney, P.J. (1995) Moganite as an indicator for vanished evaporites: A testament reborn? *Journal of Sedimentary Research*, A65, 633-638.
- 19) Tseng, H.-Y., Heaney, P.J., and Onstott, T.C. (1995) Characterization of defects induced by neutron irradiation using powder X-ray diffraction. *Physics and Chemistry of Minerals*, 22, 399-405.
- 20) Heaney, P.J. and Davis, A.M. (1995) Observation and origin of self-organized textures in agates. *Science*, 269, 1562-1565.
- 21) Guthrie, G.D., Jr. and Heaney, P.J. (1995) Mineralogical characteristics of the silica polymorphs in relation to their biological activities. *Scandinavian Journal of Work, Environment, and Health*, 21, Supp. 2, 5-8.

- 22) Petrovic, I., Heaney, P.J., and Navrotsky, A. (1996) Thermochemistry of the new silica polymorph moganite. *Physics and Chemistry of Minerals*, 23, 119-126.
- 23) Gislason, S.R., Heaney, P.J., Oelkers, E.H., and Schott, J. (1997) Kinetic and thermodynamic properties of moganite, a novel silica polymorph. *Geochimica et Cosmochimica Acta*, 61, 1193-1204.
- 24) Xu, H. and Heaney, P.J. (1997) Memory effects of domain structures during displacive phase transitions: A high-temperature TEM study of quartz and anorthite. *American Mineralogist*, 82, 99-108.
- 25) Kim, C.S., Yates, D.M., and Heaney, P.J. (1997) Layered Na-silicate: An analog to smectite for benzene sorption from water. *Clays and Clay Minerals*, 45, 881-885.
- 26) Yates, D.M., Joyce, K.J., and Heaney, P.J. (1998) Complexation of copper with polymeric silica in aqueous solution. *Applied Geochemistry*, 13, 235-241.
- 27) Heaney, P.J., Mehta, A., Sarosi, G., Lamberti, V.E., and Navrotsky, A. (1998) Structural effects of Sr-substitution in  $\text{La}_{2-x}\text{Sr}_x\text{NiO}_{4+\delta}$ . *Physical Review B*, 57, 10370-10378.
- 28) Lichtenstein, A.I., Jones, R.O., Xu, H. and Heaney, P.J. (1998) Anisotropic thermal expansion in the silicate  $\beta$ -eucryptite: A neutron diffraction and density functional study. *Physical Review B*, 58, 6219-6223.
- 29) De, S., Heaney, P.J., Hargraves, R.B., Vicenzi, E.P., and Taylor, P.T. (1998) Microstructural observations of polycrystalline diamond: A contribution to the carbonado conundrum. *Earth and Planetary Science Letters*, 164, 421-433.
- 30) Xu, H., Heaney, P.J., Yates, D.M., Von Dreele, R.B., and Bourke, M.A. (1999) Structural mechanisms underlying near-zero thermal expansion in  $\beta$ -eucryptite: A combined synchrotron X-ray and neutron Rietveld analysis. *Journal of Materials Research*, 14, 3138-3151.
- 31) Xu, H., Heaney, P.J., Navrotsky, A., Topor, L., and Liu, J. (1999) Thermochemistry of stuffed quartz-derivative phases along the join  $\text{LiAlSiO}_4 - \text{SiO}_2$ . *American Mineralogist*, 84, 1360-1369.
- 32) Xu, H., Heaney, P.J., and Böhm, H. (1999) Structural modulations and phase transitions in  $\beta$ -eucryptite: An in-situ TEM study. *Physics and Chemistry of Minerals*, 26, 633-643.
- 33) Phillips, B.L., Xu, H., Heaney, P.J., and Navrotsky, A. (2000)  $^{29}\text{Si}$  and  $^{27}\text{Al}$  MAS-NMR spectroscopy of  $\beta$ -eucryptite ( $\text{LiAlSiO}_4$ ): The enthalpy of Si,Al ordering. *American Mineralogist*, 85, 181-188.

- 34) Xu, H., Heaney, P.J., and Beall, G.H. (2000) Phase transitions induced by solid solution in stuffed derivatives of quartz: A powder synchrotron XRD study of the  $\text{LiAlSiO}_4$  --  $\text{SiO}_2$  join. *American Mineralogist*, 85, 971-979.
- 35) De, S., Heaney, P.J., Vicenzi, E.P., and Wang, J. (2001) Chemical heterogeneity in carbonado, an enigmatic polycrystalline diamond. *Earth and Planetary Science Letters*, 185, 315-330.
- 36) Xu, H., Heaney, P.J., and Navrotsky, A. (2001) Thermal expansion and structural transformations of stuffed derivatives of quartz along the  $\text{LiAlSiO}_4$  join: A variable temperature powder synchrotron XRD study. *Physics and Chemistry of Minerals*, 28, 302-312.
- 37) Heaney, P.J., Vicenzi, E.P., Giannuzzi, L.A., and Livi, K.J.T. (2001) Focused ion beam milling: A method of site-specific sample extraction for microanalysis of Earth materials. *American Mineralogist*, 86, 1094-1099.
- 38) Gulians V.V., Holmes S.A., Benziger J.B., Heaney P., Yates D., Wachs I.E. (2001) In situ studies of atomic, nano- and macroscale order during  $\text{VOHPO}_4 \cdot 0.5\text{H}_2\text{O}$  transformation to  $(\text{VO})_2\text{P}_2\text{O}_7$ . *Journal of Molecular Catalysis A*, 172, 265-276.
- 39) Heaney, P.J. and Post, J.E. (2001) Evidence for an *I2/a* to *Imab* phase transition in the silica polymorph moganite at ~570 K. *American Mineralogist*, 86, 1358-1366.
- 40) Zhang, J., Celestian, A., Parise, J.B., Xu, H., and Heaney, P.J. (2002) A new polymorph of eucryptite ( $\text{LiAlSiO}_4$ ),  $\beta$ -eucryptite, and thermal expansion of  $\beta$ - and  $\alpha$ -eucryptite at high pressure. *American Mineralogist*, 87, 566-571.
- 41) Post, J.E., Heaney, P.J., and Hanson, J. (2002) Rietveld refinement of a triclinic structure for synthetic Na-birnessite using synchrotron powder diffraction data. *Powder Diffraction*, 17, 218-221.
- 42) Post, J.E., Heaney, P.J. and Hanson, J. (2003) A synchrotron X-ray diffraction study of the structure and dehydration behavior of todorokite. *American Mineralogist*, 88, 142-150.
- 43) Heaney, P.J. and Fisher, D.M. (2003) A new interpretation of the origin of tiger's-eye. *Geology*, 31, 323-326.
- 44) Post, J.E., Heaney, P.J., Von Dreele, R., Hanson, J. (2003) Neutron and temperature-resolved synchrotron X-ray powder diffraction study of akaganéite. *American Mineralogist*, 88, 782-788.
- 45) Zhang, M., Xu, H., Salje, E.K.H., and Heaney, P.J. Vibrational spectroscopy of beta-eucryptite ( $\text{LiAlSiO}_4$ ): Optical phonons and phase transitions. (2003) *Physics and Chemistry of Minerals*, 30, 457-462.

- 46) Kubicki, J.D. and Heaney, P.J. (2003) Molecular orbital modeling of aqueous organosilicon complexes: Implications for silica biomineralization. *Geochimica et Cosmochimica Acta*, 67, 4113-4121.
- 47) Post, J.E., Heaney, P.J., Cahill, C.L., and Finger, L. (2003) Woodruffite: A new Mn oxide structure with 3x4 tunnels. *American Mineralogist*, 88, 1697-1702.
- 48) Komarneni, S., Newalkar, B.L., Li, D., Gheyi, T., Lopano, C.L., Heaney, P.J., and Post, J.E. (2003) Anionic clays as potential slow-release fertilizers: Nitrate ion exchange. *Journal of Porous Materials*, 10, 243-248.
- 49) De, S., Heaney, P.J., Fei, Y., and Vicenzi, E.P. (2004) Microstructural study of synthetic sintered diamond and comparison with carbonado, a natural polycrystalline diamond. *American Mineralogist*, 89, 438-445.
- 50) Post, J.E. and Heaney, P.J. (2004) Neutron and synchrotron X-ray diffraction study of the structure and dehydration behavior of ramsdellite and groutellite. *American Mineralogist*, 89, 969-975.
- 51) Greer, L. and Heaney, P.J. (2004) Real-time analysis of student comprehension: An assessment of electronic student response technology in an introductory Earth science course. *Journal of Geoscience Education*, 52, 345-351.
- 52) Heaney, P.J. and Fisher, D.M. (2004) New interpretation of the origin of tiger's-eye: Reply to Comment of J. Gutzmer, N.J. Beukes, and B. Cairncross. <http://www.gsjournals.org/gsaonline/>.
- 53) Icopini, G., Brantley, S.L., and Heaney, P.J. (2005) Kinetics of silica oligomerization and nanocolloid formation as a function of pH and ionic strength at 25 °C. *Geochimica et Cosmochimica Acta*, 69, 293-303.
- 54) Heaney, P.J., Vicenzi, E.P., and De, S. (2005) Strange diamonds: The mysterious origins of carbonado and framesite. *Elements*, 1, 85-89.
- 55) McConnell, D.A., Steer, D.N., & Owens, K., Borowski, W., Dick, J., Foos, A., Knott, J.R., Malone, M., McGrew, H., Van Horn, S., Greer, L., and Heaney, P.J., (2006) Using Conceptests to Assess and Improve Student Conceptual Understanding in Introductory Geoscience Courses, *Journal of Geoscience Education*, 54, 61-68.
- 56) Post, J.E., Bish, D.L. and Heaney, P.J. (2007) Synchrotron powder X-ray diffraction study of the structure and dehydration behavior of sepiolite. *American Mineralogist*, 92, 91-97.
- 57) Lopano, C.L., Heaney, P.J., Post, J.E., Hanson, J., and Komarneni, S. (2007) Time-resolved structural analysis of K- and Ba-exchange reactions with synthetic Na-



- birnessite using synchrotron X-ray diffraction. *American Mineralogist*, 92, 380-387.
- 58) Conrad, C.F., Icopini, G.A., Yasuhara, H., Bandstra, J., Brantley, S.L., Heaney, P.J. (2007) Modeling the kinetics of silica nanocolloid formation and precipitation in environmentally relevant aqueous solutions. *Geochimica et Cosmochimica Acta*, 71, 531-542.
- 59) Heaney, P.J., Post, J.E., and McKeown, D.A. (2007) Anomalous behavior at the *I2/a* to *Imab* phase transition in SiO<sub>2</sub>-moganite: An analysis using hard-mode Raman spectroscopy. *American Mineralogist*, 92, 631-639.
- 60) Hummer, D.R., Heaney, P.J., and Post, J.E. (2007) Thermal expansion of anatase and rutile between 300 and 575 K using synchrotron powder X-ray diffraction. *Powder Diffraction*, 22, 352-357.
- 61) Eaton-Magaña, S., Post, J.E., Heaney, P.J., Walters, R.A., Breeding, C.M., and Butler, J.E. (2007) Fluorescence spectra of colored diamonds using a rapid, mobile spectrometer. *Gems and Gemology*, 43, 332-351.
- 62) Eaton-Magaña S., Post J.E., Heaney P.J., Freitas J.A. Jr., Klein P.B., Walters R.A., Butler J.E. (2008) Using phosphorescence as a fingerprint for the Hope and other blue diamonds. *Geology*, 36, 83-86.
- 63) Post, J.E. and Heaney, P.J. (2008) Synchrotron powder X-ray diffraction study of the structure and dehydration behavior of palygorskite. *American Mineralogist*, 93, 667-675.
- 64) Post, J.E., Heaney, P.J., and Ertl, A. (2008) Rietveld refinement of the ranciéite structure using synchrotron powder diffraction data. *Powder Diffraction*, 23, 10-14.
- 65) Heaney, P.J., Post, J.E., Fischer, T.B., Hummer, D.R., Lopano, C.L., and Wall, A.J. (2008) Applications of time-resolved synchrotron X-ray diffraction to cation exchange, crystal growth and biomineralization reactions. *Mineralogical Magazine*, 72, 179-184.
- 66) Fischer, T.B., Heaney, P.J., Jang, J.-H., Ross, D.E., Brantley, S.L., Post, J.E., and Tien, M. (2008) Continuous time-resolved X-ray diffraction of the biocatalyzed reduction of Mn oxide. *American Mineralogist*, 1929-1932.
- 67) Lopano, C.L., Heaney, P.J., and Post, J.E. (2009) Cs-exchange in birnessite: Reaction mechanisms inferred from time-resolved X-ray diffraction and transmission electron microscopy. *American Mineralogist*, 94, 816-826.

- 68) Hummer, D.R., Kubicki, J.D., Kent, P.R.C., Post, J.E., and Heaney, P.J. (2009) The origin of nanoscale phase stability reversals in titanium oxide polymorphs. *Journal of Physical Chemistry C*, 4240-4245.
- 69) Tan, H., Zhang, G., Heaney, P.J., Webb, S.M., and Burgos, W.D. (2010) Characterization of manganese precipitates from Appalachian coal mine drainage treatment systems. *Chemical Geology*, 25, 389-399.
- 70) Stubbs, J.E., Post, J.E., Elbert, D.C., Heaney, P.J., and Veblen, D.R. (2010) Uranyl phosphate sheet reconstruction during dehydration of metatorbernite [Cu(UO<sub>2</sub>)<sub>2</sub>(PO<sub>4</sub>)<sub>2</sub> • 8H<sub>2</sub>O]. *American Mineralogist*, 95, 1132-1140.
- 71) Hu, K. and Heaney, P.J. (2010) Serpentine doublets, sold as “pietersite.” *Gems and Gemology*, 46, 157-158.
- 72) Hu, K. and Heaney, P.J. (2010) A microstructural study of pietersite from Namibia and China. *Gems and Gemology*, 46, 280-286.
- 73) Jin, L., Ravella R., Ketchum, B., Bierman, P.R., Heaney, P.J., White, T., and Brantley, S.L. (2010) Mineral weathering and hillslope evolution at Shale Hills catchment: a Critical Zone Observatory in central Pennsylvania, USA. *Geochemistry and Cosmochemistry Acta*, 74, 3669-3691.
- 74) Post, J.E., Heaney, P.J., and Cho, Y. (2011) Neutron diffraction study of hydrogen in birnessite structures. *American Mineralogist*, 96, 534-540.
- 75) Wall, A.J., Heaney, P.J., Mathur, R., Post, J.E., Hanson, J.C., and Eng, P.J. (2011) A flow-through reaction cell that couples time-resolved X-ray diffraction with stable isotope analysis. *Journal of Applied Crystallography*, 44, 429-432.
- 76) Lopano, C.L., Heaney, P.J., Bandstra, J.Z., Post, J.E., and Brantley, S.L. (2011) Kinetic analysis of cation exchange in birnessite using time-resolved synchrotron X-ray diffraction. *Geochimica et Cosmochimica Acta*, 75, 3973-3981.
- 77) Wall, A.J., Mathur, R., Heaney, P.J., Post, J.E. (2011) Cu isotope fractionation during bornite dissolution: *in situ* X-ray diffraction analysis. *Ore Geology Reviews*, 42, 62-70.
- 78) Cygan, R.T., Post, J.E., Heaney, P.J., and Kubicki, J.D. (2012) Molecular models of birnessite and related hydrated layered minerals. *American Mineralogist*, 97, 1505-1514.
- 79) Hummer, D.R., Heaney, P.J., and Post, J.E. (2012) In situ observations of particle size evolution during the hydrothermal crystallization of TiO<sub>2</sub>: A time-resolved synchrotron SAXS and WAXS study. *Journal of Crystal Growth*, 344, 51-58.
- 80) Fleeger, C.R., Heaney, P.J., and Post, J.E. (2013) A time-resolved X-ray diffraction study of Cs exchange into hexagonal H-birnessite. *American Mineralogist*, 98, 671-679.

- 81) Hummer, D.R., Kubicki, J.D., Kent, P.R.C., and Heaney, P.J. (2013) Single-site and monolayer surface hydration energy of anatase and rutile nanoparticles using density functional theory. *Journal of Physical Chemistry B*, 49, 26,084-26,090.
- 82) Post, J.E. and Heaney, P.J. (2014) Time-resolved synchrotron X-ray diffraction study of the dehydration behavior of chalcophanite. *American Mineralogist*, 99, 1956-1961.
- 83) Peterson, K.M., Heaney, P.J., Post, J.E., and Eng, P.J. (2015) A refined monoclinic structure for a variety of "hydrohematite". *American Mineralogist*, 100, 570-579.
- 84) Hummer, D.R. and Heaney, P.J. (2015) MinKin: A kinetic modeling program for the precipitation, dissolution, and phase transformation of minerals in aqueous solution. *Chemical Geology*, 405, 112-122.
- 85) Xu, H., Heaney, P.J., Yu, P., and Xu, H. (2015) Synthesis and structure of a stuffed derivative of  $\alpha$ -quartz,  $Mg_{0.5}AlSiO_4$ . *American Mineralogist*, 100, 2191-2198.
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- 108) Post, J.E., McKeown, D.A., and Heaney, P.J. Raman spectroscopy study of manganese oxides – Layer structures. *American Mineralogist*, 106, 351-366.
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### **Books**

- 1) Heaney, P.J., Prewitt, C.T., and Gibbs, G.V., Eds. (1994) *Silica: Physical behavior, geochemistry and materials applications*. *Reviews in Mineralogy*, vol. 29, 606 p.

### **Chapters in Books**

- 1) Heaney, P.J. and Banfield, J.F. (1993) Structure and chemistry of silica, metal oxide, and phosphate minerals. In: Guthrie, G.D., Jr. and Mossman, B.T., Eds. *Health Effects of Mineral Dusts*. *MSA Reviews in Mineralogy*, 28, 185-233.
- 2) Heaney, P.J. (1994) Structure and chemistry of the low-pressure silica polymorphs. In: P.J. Heaney, C.T. Prewitt, G.V. Gibbs, Eds., *Silica: Physical behavior, geochemistry and materials applications*. *Reviews in Mineralogy*, vol. 29, 1-40.
- 3) Heaney, P.J. (1997) *Crystal Growth Fast and Slow*. In: J.B. Brady, D.W. Mogk, and D. Perkins, Eds. *Teaching Mineralogy*. *Mineralogical Society of America*, Washington, D.C. pp. 67-78.
- 4) Heaney, P.J. (2000) Phase transformations induced by solid solution. In: Redfern, S.A.T. and Carpenter, M.A., Eds., *Transformation Processes in Minerals*. *Reviews in Mineralogy and Geochemistry*, 43, 135-174.

### **Government Reports**

- 1) Smelik, E.A. and Heaney, P.J. (1995) Optical and X-ray diffraction examination of selected concrete aggregates for moganite content. *Federal Highway Administration Report FHWA-RD-95-XXX*.

**Conference Programs**

- 1) Heaney, P.J. (2019) MSA Centennial Symposium: The Next 100 Years of Mineral Sciences. Mineralogical Society of America.

**Other Written Contributions**

- 1) Heaney, P.J. (1992) What future, mineralogy? *The Lattice*, 8, 4-5.
- 2) Heaney, P.J. (1993) Bragg, William Lawrence and William Henry. *MacMillan Encyclopedia of the Earth Sciences*, Simon and Schuster, New York, pp. 57-59.
- 3) Heaney, P.J. (1996) Book Review: *Handbook of Mineralogy, Vol. II: Silica, Silicates*. By Anthony, J.W. et al., Eds. (Mineral Data Publishing, Tucson, 1995, 904 p.), *American Mineralogist*, 81, 524.
- 4) Heaney, P.J. (1997) Quartz. *McGraw-Hill Encyclopedia of Science and Technology*, 8<sup>th</sup> ed., vol. 14, McGraw-Hill, New York, pp. 709-710.
- 5) Heaney, P.J. (1997) Oscillatory Banding in Minerals. *McGraw-Hill Yearbook of Science and Technology 1998*, McGraw Hill, New York, pp. 253-255.
- 6) Heaney, P.J. (1998) Living in a Material World. *The Lattice*, 14, 6-7.
- 7) Heaney, P.J. (2002) Presentation of MSA's Distinguished Public Service Award to Jeffrey Post. *American Mineralogist*, 87, 796-797.
- 8) Heaney, P.J. (2005) Triple Point. *Elements*, 1, 7.
- 9) Heaney, P.J. (2005) Science Societies and the Democratic Process. *Elements*, 1, 61.
- 10) Heaney, P.J. (2005) Voices from our Past. *Elements*, 1, 133-134.
- 11) Heaney, P.J. (2005) Searching for Geodiversity. *Elements*, 1, 191.
- 12) Heaney, P.J. (2006) Reflections on Bragg's Law. *Elements*, 2, 69-70.
- 13) Heaney, P.J. (2006) Grace under Pressure: A Challenge to the Modern Reviewer. *Elements*, 2, 261-262.
- 14) Heaney, P.J. (2006) Sorry, Levi, but Thanks for the Memories: An Elegy for a Historic Mineral Collection. *Elements*, 2, 327-328.
- 15) Heaney, P.J. (2007) Mineralogy and the Composition of an American Science. *Elements*, 3, 7.
- 16) Heaney, P.J. (2007) Caught in the Web of Virtual Education. *Elements*, 3, 87.
- 17) Heaney, P.J. (2007) What's Your h-Index? *Elements*, 3, 229-230.

- 18) Dong, H., Heaney, P.J., and Rakovan, J. (2007) Who's Who in Mineral Names: Donald R. Peacor. *Rocks and Minerals*, 81, 34-35.
- 19) Heaney, P.J. (2007) The Extinction of Geology. *Elements*, 3, 301-302.
- 20) Heaney, P.J. (2012) Celestine for State Mineral! A Sabbatical Project. *Elements*, 8, 325.
- 21) Heaney, P.J. (2013) Quartz. *Encyclopedia of Scientific Dating Methods*. Springer, Dordrecht. DOI 10.1007/978-94-007-6326-5\_78-2. 3 pages.
- 22) Heaney, P.J. (2015) At the blurry edge of mineralogy. *American Mineralogist*. 100, 3.
- 23) Heaney, P.J. (2016) Presentation of MSA's Distinguished Public Service Award to J. Alexander Speer. *American Mineralogist*, 101, 1005.
- 24) Heaney, P.J. (2017) Animal, Vegetable, or Mineral? *Natural History Magazine*, February issue, 32-37.
- 25) Heaney, P.J. (2017) Defining minerals in the Age of Humans. *American Mineralogist*, 102, 925-926.
- 26) Heaney, P.J. (2018) Endpaper: The Gemstone Analogy. [What Gems Tell Us About Climate Change]. *Natural History Magazine*, November issue, 48.
- 27) Heaney, P.J., and Gunter, M.E. (2019), The Mineralogical Society of America turns 100, *Eos*, 100, <https://doi.org/10.1029/2019EO125537>. Published on 03 June 2019.
- 28) Heaney, P.J. and Shirey, S. (2019) The MSA Centennial Symposium: Meeting Summary, *Elements*, 15, 285.
- 29) Heaney, P.J. and Kaliwoda, M. (2020) Walter Friedrich Unplugged: His 1963 Interview in East Berlin. Annotated Translation (German) with Preface. *IUCr Newsletter*, vol 28, no. 3  
[https://www.iucr.org/news/newsletter/etc/articles?issue=149786&result\\_138339\\_result\\_page=25](https://www.iucr.org/news/newsletter/etc/articles?issue=149786&result_138339_result_page=25)

#### **GRANTS and CONTRACTS -- Funded**

NSF #EAR-9206031: Microstructural investigations of phase transitions in rock-forming minerals. 6/15/92-12/1/94. Principal Investigator. \$123,429.

NSF #EAR-9304438: Acquisition of an analytical transmission electron microscope for geological research. Instrumentation. Principal Investigator. \$385,000.  
-In conjunction with Division of Materials Research

NSF #EAR-9408031: Microstructural analysis of evaporitic silica. 3/15/95-2/28/97. Principal Investigator. \$140,000.

Unocal Corp.: Chromatographic analysis of silica polymerization in aqueous fluids. 8/01/96-8/31/98. Principal Investigator. \$98,871.

NSF #EAR-9706143: The formation of polycrystalline diamond: A microstructural and microanalytical study of carbonado. 7/1/97-6/30/99. Principal Investigator. \$149,559.

DOE #DE-FG07-00ID13954: A geochemical and microanalytical study of silica scale deposition in geothermal brines. 8/1/00-7/1/03. Principal Investigator. \$210,490.

NSF #EAR-0073862: A mantle or crustal origin for carbonado? Synthesis and microanalytical studies of polycrystalline diamond. 7/15/00-7/14/03. Principal Investigator. \$149,767.

Pennsylvania State University Center for Environmental Chemistry and Geochemistry: Real-time structural analysis of heavy metal cation exchange reactions in anionic clays and manganese oxides. 6/01/01-5/31/03. Principal Investigator. \$10,000.

NSF #EAR-0125908: Time-resolved structural analysis of heavy metal cation exchange reactions in anionic clay and manganese oxide nanoparticles. 01/01/02-12/31/04. Principal Investigator. \$225,957.

NSF #EAR-0417714: Time-resolved diffraction studies of cation exchange reactions and hydrothermal synthesis of minerals. 09/01/04-08/31/07. Principal Investigator. \$334,930.

NSF DMR-0420744: MRI: Acquisition of focused ion beam instrument for interdisciplinary research and education. 07/01/04-06/30/05. Co-Principal Investigator with E.C. Dickey (P.I.) and J.M. Catchmark. \$482,888.

NSF CHE-0431328: EMSI: Center for environmental kinetic synthesis. 09/01/04 – 08/31/09. S.L. Brantley (P.I.). One of 12 co-P.I.s. \$6.7 million from NSF and \$2.5 million from DOE.

NSF EAR-0745374: Time-resolved diffraction studies of soil-forming mineral reactions. 08/15/08-08/14/11. Principal Investigator. \$280,000.

DOE-NETL: 9.3.2 Mineralogical and Geochemical Impacts of Leaked CO<sub>2</sub>-enriched Fluids. 01/15/10-11/14/10. Co-Principal Investigator with William Burgos (P.I.). \$131,377.

DOE-NETL: 9.3.2 Mineralogical and Geochemical Impacts of Leaked CO<sub>2</sub>-enriched Fluids. 11/15/10-11/14/11. Co-Principal Investigator with William Burgos (P.I.). \$162,101.

DOE-NETL: 9.3.2 Mineralogical and Geochemical Impacts of Leaked CO<sub>2</sub>-enriched Fluids. 11/15/11-11/14/12. Co-Principal Investigator with William Burgos (P.I.). \$105,000.

NSF EAR-1147728: Mechanisms of mineral dissolution: Time-resolved synchrotron X-ray diffraction of Fe- and Mn-oxides with dissolved organic ligands. 02/15/12-02/14/15. Principal Investigator. \$350,349.

2014/2015 PSIEE Seed Grant: Chromium fate in groundwater systems: In situ investigation of chromium oxidation by manganese oxide using electrochemical and



synchrotron diffraction analyses. 03/15/15-07/31/16. C. Gorski and P.J. Heaney. \$25,000.

NSF EAR-1552211: In situ synchrotron X-ray diffraction of Fe oxide transformations in aqueous solutions. 02/15/16-01/31/20. P.J. Heaney, J.E. Post, J.D. Kubicki. \$408,616

Dept. Geosciences, Penn State University: Blue Sky Proposal: Exploring Earth's History through Mineral Evolution: Constructing an Interactive, Web-based Mineralogy Tree. 01/15/19-07/14/20. P.J. Heaney. \$15,000.

Penn State Center for Global Studies: Career Development Award. April-May 2019. P.J. Heaney. \$2,500.

NSF EAR-1925903: Structural controls on Fe oxide formation: A crystallographic analysis of the growth of hematite versus goethite. P.J. Heaney, J.E. Post, J.D. Kubicki. 8/15/2019 to 7/31/2022. \$474,916

MRI PSIEE Seed Grant 2020: Characterizing structural changes in sodium-ion battery electrodes in real time. 2/25/20-2/24/21. C. Gorski and P.J. Heaney. \$30,000.

## **EDUCATION -- Advising**

### **Postdoctoral Researchers**

Douglas M. Yates -- Analysis of polynuclear species by gel filtration chromatography: Controls on crystallization and adsorption in low-temperature fluids. 6/94 - 8/98

Gary Icopini -- A geochemical and microanalytical study of silica scale deposition in geothermal brines. 8/00 to 8/03.

Charles Magee -- Microanalysis of inclusions in natural polycrystalline diamonds. 8/02 to 1/03.

Christine Conrad -- Kinetics of silica polymerization. 9/05 to 12/06.

Lachlan MacLean -- Time-resolved X-ray diffraction of dissolution processes. 9/07 to 8/08.

### **Graduate Students**

#### **Graduate Theses and Projects Supervised**

Hongwu Xu -- Ph.D. in Geosciences, 1998. *Structural effects of atomic substitutions in silicates*. Princeton University

Subarnarekha De -- Ph.D. in Geosciences, 2000. *Microanalytical studies of carbonado and synthetic polycrystalline diamond*. Princeton University

Song Yang -- Non-Degree, 2000. *Microstructural characterization of tiger's-eye*. Pennsylvania State University. Non-degree.

- Vivian Schatz -- M.A. in Geological Education, 2001. *Mechanisms of silicification of fossil stromatolites*. Pennsylvania State University
- Christina Lopano – Ph.D. in Geosciences, 2007. *Synthesis of Mn oxide cation exchange agents*. Pennsylvania State University
- Yun Chul Cho, Ph.D. in Soil Sciences, 2008. *Analysis of H speciation in Mn oxides*. Pennsylvania State University. Primary Advisor: Sridhar Komarneni.
- Daniel Hummer, Ph.D. in Geosciences, 2010. *Mechanisms of Aqueous Crystallization and Phase Transformation in Titanium Oxide Minerals*. Pennsylvania State University
- Timothy Fischer, Ph.D. in Geosciences, 2010. *Structural Transformations of Birnessite ( $\delta$ -MnO<sub>2</sub>) during Biological and Abiological Reduction*. Pennsylvania State University
- Andrew Wall, Ph.D. in Geosciences, 2011. *Abiotic Controls on Copper Isotope Fractionation during the Dissolution of Copper Sulfide Minerals*. Pennsylvania State University
- Claire Fleeger, Ph.D. in Geosciences, 2011. *Contaminant Sequestration and Phase Transformation Properties of Birnessite-like Phases ( $\delta$ -MnO<sub>2</sub>)*. Pennsylvania State University
- Kaifan Hu, Ph.D. in Gemology, 2011. *Microanalysis of chatoyant silica gem materials*. Visiting student from China University of Geosciences-Wuhan, 2008-2010. China Scholarship Council Postgraduate Program.
- Kristina Peterson, Ph.D. in Geosciences, 2014. *Nucleation, growth and phase transformation mechanisms of the iron (oxy)hydroxides*. Pennsylvania State University
- Matthew Oxman, M.S. in Geosciences, 2015. *A time-resolved synchrotron X-ray diffraction study of the in situ, hydrothermal synthesis of goethite from 2-line ferrihydrite*. Pennsylvania State University
- Xiayang (Sunny) Lin, M.S. in Geosciences, 2015. *Causes of iridescence in natural gem materials*. Pennsylvania State University
- Kimberly Foecke, M.S. in Geosciences, 2016. *Analysis of exterior stains on fossil bone and taphonomic implications*. Co-advisor with Russell Graham and Tim White. Pennsylvania State University
- Florence Ling, Ph.D. in Geosciences, 2016. *Mineralogical and geochemical analysis of synthetic and natural birnessite*. Pennsylvania State University
- Kyeong Pil (Phil) Kong, M.S. in Geosciences, 2017. *Mineralogical and geochemical constraints on the chromium oxidation induced by birnessite*. Pennsylvania State University

Si (Athena) Chen, Ph.D. in Geosciences, in progress. *Geochemical analyses of synthetic and natural hydrous hematite*. Pennsylvania State University

Chengsi Wang, Ph.D. in Gemology, in progress. *Influence of metal-semiconductor nanoparticles on the optical properties of minerals as determined by TEM/FIB*. Visiting student from China University of Geosciences-Wuhan, 2019. China Scholarship Council Postgraduate Program.

Yu Yan, Ph.D. in Geosciences, in progress. *Microanalysis of chatoyant silica gem materials*. Visiting student from Peking University, 2019-2020. China Scholarship Council Postgraduate Program.

Dongyoun Chung, Ph.D. in Geosciences, in progress. *Transition metal isotope fractionation by birnessite*. Pennsylvania State University.