

CURRICULUM VITAE

Peter Crowley Ryan

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Academic Degrees:

Dartmouth College, Geology, **PhD**, 1994.

- Dissertation Topic: Geochemistry and clay mineralogy of Cretaceous sandstones.
- Advisor: Robert C. Reynolds, Jr

University of Montana, Geology, **MS**, 1991

- Thesis Topic: Diagenesis of Precambrian sandstone and shale.
- Advisor: Graham Thompson

Dartmouth College, Earth Sciences, **BA**, 1988. Honors.

Appointments:

2009 – present Professor of Geology and Environmental Studies, Middlebury College
2008-12, 2020- Chair, Department of Geology, Middlebury College
2003-07, 2015-16 Director, Program in Environmental Studies, Middlebury College
2012-13, 18-19 Visiting Researcher, Instituto Andaluz de Ciencias de la Tierra, Spain
2003 – 2009 Associate Professor, Geology and Env. Studies, Middlebury College
2007 – 2008 Visiting Researcher, Estación Experimental del Zaidín, Spain
1998 – 2003 Assistant Professor, Geology Dept., Middlebury College
1999, 2002 Visiting Research Scientist, Macaulay Institute, Aberdeen, Scotland
1995 – 2002 Faculty Affiliate (Adjunct), University of Montana, Missoula
1994 – 1998 Instructor, Environmental Science Program, Salish Kootenai College

Textbook

Ryan, P.C., 2019. *Environmental and Low-Temperature Geochemistry, Second Edition*. Wiley-Blackwell. ISBN: 978-1-119-56858-2. (This follows 2014 first edition).

Research Papers (* = student/alum co-author):

- Ryan, P.C.**, Alvarado, G.E., McCanta, M., Barca, M*, Davis, G*., 2022. The importance of overbank deposits and paleosol analyses for comprehensive volcanic hazard evaluation: the case of Holocene volcanism at Miravalles Volcano, Costa Rica. *Nat Hazards* 112, 413–449. <https://doi.org/10.1007/s11069-021-05187-6>.
- Munroe JS, Ryan PC, Proctor A*, 2021. Pedogenic clay formation from allochthonous parent materials in a periglacial alpine critical zone. *Catena* 203, 105324
- Munroe, J.S., Norris, E.D.*, Olson, P.M.* , **Ryan, P.C.**, Tappa, M.J., Beard, B.L., 2020. Quantifying the contribution of dust to alpine soils in the periglacial zone of the Uinta Mountains, Utah, USA. *Geoderma* 378, 114631.
- Ryan, P.C.**, Huertas, F.J., Pincus, L.N.* , Painter, W.* , 2020. Arsenic-bearing serpentine group minerals: Mineral synthesis with insights for the arsenic cycle. *Clays and Clay Minerals* 67, 488-506. DOI: 10.1007/s42860-019-00040-1.
- Armfield, J., Perdrial, J., Gagnon, A., Ehrenkranz, J., Perdrial, N., Cincotta, M., Ross, D., Shanley, J., Underwood, K., **Ryan, P.C.**, 2018. Does stream water composition at Sleepers River in Vermont reflect dynamic changes in soils during recovery from acidification? *Frontiers in Earth Science* 6: 246. doi: 10.3389/feart.2018.00246.
- Van Hoesen, J., Arriaza, B., **Ryan, P.C.**, Grady, C.M.* , 2018. A multi-analytical approach for identifying a manganese source for the black pigment of the Chinchorro mortuary palette. *Geoarcheology* DOI:10.1002/gea.21713.
- Pincus, L.N.* , **Ryan, P.C.**, Huertas, F.J., Alvarado, G.E., 2017. The influence of soil age and regional climate on clay mineralogy and cation exchange capacity of moist tropical soils: A case study from Late Quaternary chronosequences in Costa Rica. *Geoderma* 308, 130-148. <https://doi.org/10.1016/j.geoderma.2017.08.033>
- Ryan, P.C.**, Huertas, F.J., Hobbs, F.C.* , Pincus, L.N.* , 2016. Kaolinite and halloysite derived from sequential transformation of pedogenic smectite and kaolinite-smectite in a 120 ka tropical soil chronosequence. *Clays and Clay Minerals*, 64, 488–516. <https://doi.org/10.1346/CCMN.2016.064030>
- Kim J.J., Comstock J., **Ryan P.C.**, Heindel C., Koenigsberger S.* , 2016. Denitrification and dilution along fracture flowpaths influence the recovery of a bedrock aquifer from nitrate contamination. *Science of the Total Environment* 569–570, 450–468. <http://dx.doi.org/10.1016/j.scitotenv.2016.06.091>.
- Ryan, P.C.**, West, D.P., Hattori, K., Studwell, S.* , Allen, D., Kim, J., 2015. The influence of metamorphic grade on arsenic in metasedimentary bedrock aquifers: A case study from western New England, USA. *Science of the Total Environment* 505, 1320–1330. <http://dx.doi.org/10.1016/j.scitotenv.2014.05.021>.
- Mango, H. and **Ryan, P.C.**, 2015. Source of arsenic-bearing pyrite in southwestern Vermont, USA: Sulfur isotope evidence. *Science of the Total Environment* 505, 1331-1339. <http://dx.doi.org/10.1016/j.scitotenv.2014.03.072>.
- Kim, J., **Ryan, P.C.**, Klepeis, K., Gleeson, T., North, K.* , Bean, J.* , Davis, L.* , Filoon, J.* , 2014. Tectonic evolution of a Paleozoic thrust fault influences the hydrogeology

- of a fractured rock aquifer, northeastern Appalachian foreland. *Geofluids* 14, 266-290. DOI: 10.1111/gfl.12076.
- Ryan, P.C.**, Kim, J.J., Mango, H., Hattori, K., Thompson, A.*, 2013. Arsenic in a fractured slate aquifer system, New England (USA): Influence of bedrock geochemistry, groundwater flow paths, redox and ion exchange. *Applied Geochemistry* 39, 181-192. doi: <http://dx.doi.org/10.1016/j.apgeochem.2013.09.010>.
- Ryan P.C.**, Huertas, F.J., 2013. Reaction pathways of clay minerals in tropical soils: insights from kaolinite-smectite synthesis experiments. *Clays and Clay Minerals* 61, 303-318.
- Ryan, P.C.**, Kim, J., Wall, A.J., Moen, J.C.*, Corenthal, L.G.*, Chow, D.R.*, Sullivan, C.M.*, Bright, K.S.*, 2011, Ultramafic-derived arsenic in a fractured bedrock aquifer. *Applied Geochemistry* 26, 444-457.
- Kim, J., Klepeis, K., **Ryan, P.C.**, Gale, M., McNiff, C., Ruksznis, A., and Webber, J., 2011, A bedrock transect across the Champlain and Hinesburg thrusts in west-central Vermont: integration of tectonics with hydrogeology and groundwater chemistry. In *Guidebook for Field Trips in Vermont and Adjacent New York: New England Intercollegiate Geological Conference Guidebook* (West, D.P., Jr., Ed.), C5 1-23.
- Ryan P.C.**, Huertas, F.J., 2009. The temporal evolution of pedogenic Fe-smectite to Fe-kaolin via interstratified kaolin-smectite in a moist tropical soil chronosequence. *Geoderma* 151, 1-15.
- Ryan P.C.**, Hillier S, Wall A.J., 2008, Stepwise effects of the BCR sequential chemical extraction procedure on dissolution and metal release from common ferromagnesian clay minerals: a combined solution chemistry and X-ray powder diffraction study. *Science of the Total Environment* 407, 603-614.
- Munroe J.S., **Ryan P.C.**, Carlson H.A.*, and Miller E.K., 2008, Testing Latest Wisconsinan Ice Flow Directions in Vermont through Quantitative X-ray Diffraction Analysis of Soil Mineralogy. *Northeastern Geology and Environmental Sciences*, 29(4): 263-275.
- Munroe J.S., Farrugia G.*, **Ryan P.C.**, 2007, Parent material and chemical weathering in alpine soils on Mount Mansfield, Vermont, USA. *Catena* 70(1), 39-48.
- Fisher G.B.*, **Ryan P.C.**, 2006, The smectite to disordered kaolinite transition in a tropical soil chronosequence, Pacific Coast, Costa Rica. *Clays and Clay Minerals* 54, 571-586.
- Kautz C.Q.*, **Ryan P.C.**, 2003, The 10 Å to 7 Å halloysite transition in a tropical soil sequence, Costa Rica. *Clays and Clay Minerals* 51, 252-263.
- Sears J.W., **Ryan P.C.** 2003, Cenozoic evolution of the Montana Cordillera: Evidence from paleovalleys. In *Cenozoic Systems of the Rocky Mountain Region* (Raynolds RG and Flores J, eds.): Special Publication, Rocky Mountain SEPM, 289-301.
- Ryan P.C.**, Wall A.J.*, Hillier S., Clark L., 2002, Insights into sequential chemical extraction from quantitative XRD: A study of trace metal partitioning in sediments related to frog malformities. *Chemical Geology* 184, 337-357.

- Ryan P.C.**, Hillier S., 2002, Facies relationships of Fe-rich clays in the Sundance Formation. *American Mineralogist* 87, 1607-1615.
- Hillier S., **Ryan P.C.**, 2002, Identification of halloysite (7Å) by ethylene glycol solvation: The MacEwan effect. *Clay Minerals* 37, 395-404.
- Ryan P.C.**, Conrad M.E., Brown K.*, Chamberlain C.P., Reynolds, R.C. Jr., 1998, Oxygen isotopic compositions of serpentine/chlorite and illite/smectite in the Tuscaloosa Formation (US Gulf Coast): Implications for pore fluids and mineralogic reactions. *Clays and Clay Minerals* 46, 357-368.
- Ryan P.C.**, Buckley S.N., 1998, Sedimentation, stratabound Cu-Ag mineralization, and syndepositional tectonics in the Revett Formation, Flathead Indian Reservation, western Montana: *in* The Belt Supergroup, Proc. Belt Symposium III, Special Pub. 112, Mont. Bur. of Mines Geol., 278-289.
- Ryan P.C.**, Reynolds R.C., Jr., 1997, The chemical composition of serpentine/chlorite: SEM-EDX vs. XRD determinations, implications for mineralogic reactions, and the origin of anatase. *Clays and Clay Minerals* 45, 339-352.
- Ryan P.C.**, Reynolds R.C., Jr., 1996, The origin and diagenesis of grain-coating serpentine/chlorite in Tuscaloosa Formation sandstone, U.S. Gulf Coast. *American Mineralogist* 81, 213-225.
- Moe J.A., **Ryan P.C.**, Elliott W.C., Reynolds R.C., Jr., 1996, Petrology, chemistry, and clay mineralogy of a K-bentonite in the Proterozoic Belt Supergroup of western Montana: *Journal of Sedimentary Research* 66, 95-99.
- Buckley S.N., Sears J.W., **Ryan P.C.**, and Lauer D., 1994, Base-metal and PGE mineralization, sedimentation and mafic magmatism related to rifting of the Middle Proterozoic Belt Supergroup, western Montana: *Northwest Geology* 23 (Metallogeny of the Belt-Purcell Basin), 13-18.

Technical Report

- Loewald, A.M.*, **Ryan, P.C.**, Kim, J.J., 2020. *A Review of Phosphorous and Nitrogen in Groundwater and Lakes*. Vermont Geological Survey Technical Report VGTR2020-2, 36 p. <https://anrweb.vt.gov/PubDocs/DEC/GEO/TechReports/>

Recent Abstracts, Conference Presentations (past 10 years, * = student co-author):

- Ryan, P.C., Kim, J., Cobb, A.*, Klepeis, K., Romanowicz, E., Boyles, J., 2020. Processes governing distribution of AFFF-derived PFAS in a fractured carbonate aquifer, west-central Vermont, USA. Geological Society of America Abstracts with Programs. Vol 52, No. 6, doi: 10.1130/abs/2020AM-358391.
- Ryan, P.C. and Huertas, F.J., 2019. Arsenic speciation in trioctahedral clays: insights from a serpentine synthesis study. Session E1, Euroclay Conference, Paris, p. 539.
- Kim, J.J.; Ryan, P.C.; Schroeder, T.; Romanowicz, E.; Boutt, D.F.; Belaval, M., 2019. Using multiple groundwater tracers to assess the fate and transport of PFOA in a surficial- fractured rock aquifer system: Bennington, Vermont. Geological Society of America Abstracts with Programs. Vol. 51, No.2. doi: 10.1130/abs/2019NE-328058.

- Hitzelberger, M.; Schroeder, T.; Ging, A.; Kim, J.J.; Ryan, P.C.; Boutt, D., 2019. Tracing infiltration of pfas contamination from soil to a fractured bedrock aquifer using trace element and isotope geochemistry. Geological Society of America Abstracts with Programs. Vol. 51, No. 2. doi: 10.1130/abs/2019NE-328248.
- Ryan, P.C., Alvarado, G.E., McCanta, M., Barca, M.*, Davis*, G. and Huot, S. 2018. Identification and correlation of volcanic deposits by mineralogy, geochemistry, and luminescence age analysis, with implications for assessing volcanic activity and risk: the case of two dormant volcanoes in Costa Rica. Geological Society of America Abstracts with Programs. Vol. 50, No. 6. doi: 10.1130/abs/2018AM-323765
- Ryan, P.C.; Kim, J.J.; Norris, E.D.; Allen, D., 2018. Tracing groundwater flow by inorganic hydrogeochemistry: a tool to understanding PFOA migration in a fractured rock aquifer. Geological Society of America Abstracts with Programs. Vol. 50, No. 2. doi: 10.1130/abs/2018NE-311303
- Belaval, M.; Boutt, D.F.; Schroeder, T.; Ryan, P.C.; Kim, J.J., 2018. Characterizing the groundwater-surface water system in a PFOA contaminated fractured rock aquifer using radon and stable isotopes. Geological Society of America Abstracts with Programs. Vol. 50, No. 2. doi: 10.1130/abs/2018NE-310939.
- Kim, J.J.; Ryan, P.C.; Romanowicz, E.; Schroeder, T.; Belaval, M.; Boutt, D.F., 2018. 4D characterization of a fractured bedrock aquifer contaminated with PFOA, Bennington, Vermont. Geological Society of America Abstracts with Programs. Vol. 50, No. 2. doi: 10.1130/abs/2018NE-310924.
- Schroeder, T.; Kim, J.J.; Ryan, P.C., 2018. Widespread PFC contamination by aerosol deposition in Bennington, Vermont: a long-term problem due to retention in vadose zone soils. Geological Society of America Abstracts with Programs. Vol. 50, No. 2. doi: 10.1130/abs/2018NE-311080.
- Beningson, N*; Ryan, P.C.; Kim, J.J., 2018. The effect of calcite-bearing veins on groundwater geochemistry in a fractured rock aquifer system. Geological Society of America Abstracts with Programs. Vol. 50, No. 2. doi: 10.1130/abs/2018NE-311117.
- Meredith, T.*, Ryan, P.C., Bachman, N.*, Kim, J., 2017. Synsedimentary phosphorite in Late Cambrian dolostone of the northern Appalachians as the source of elevated radionuclides in a fractured rock aquifer. Geological Society of America Abstracts with Programs, NEGSA 2017.
- Ryan, P.C., Huertas, F.J., 2016. Origin of halloysite and kaolinite by alteration of early-stage pedogenic smectite and kaolinite-smectite: implications for understanding and predicting tropical soil mineralogy. 53rd Annual Meeting, Clay Minerals Society, Atlanta, Georgia, June, 2016
- Ryan, P.C., Koenigsberger, S.*, Norris, E*, Kim, J., 2016. Elevated uranium in a fractured sedimentary rock aquifer affected by dissolution of U-bearing fluoroapatite in phosphorite. Geological Society of America Abstracts with Programs.
- Grady, C.M.*, Ryan, P.C., 2016. Creating a Landscape-Scale Model of Soil Evolution on the Pacific Coast of Costa Rica. Geological Society of America Abstracts with Programs.

- Cowan, S. *, Ryan, P.C., 2016. Analysis of groundwater quality in a fractured rock aquifer influenced by black shales in the central Champlain Valley, western Vermont. Geological Society of America Abstracts with Programs.
- Fishbin, A. *, Ryan, P.C., Kim, J., 2016. Geochemical and hydrochemical analysis of a quartzite-dolostone bedrock aquifer in the central Champlain Valley, Monkton, Vermont. Geological Society of America Abstracts with Programs.
- Ryan, P.C., Huertas, F.J., 2015. Formation of halloysite and kaolinite in tropical soil via sequential transformation of pedogenic smectite and kaolinite-smectite. Joint meeting of EuroClay and Clay Minerals Society, Edinburgh, July 2015.
- Ryan, P.C., Kim, J., West, D.P., 2015. Along-strike variation in arsenic and other trace elements in metapelites of the Connecticut Valley/Gaspe Sequence (NE Vermont and SE Quebec). Geological Society of America Abstracts with Programs. Vol. 47, No. 3, p.101.
- Ryan, P.C., Pincus, L.*, Huertas, F.J., 2014. Cation exchange capacity of tropical soil clays as a function of time and precipitation. Geological Society of America Abstracts with Programs, 46 (6), p.150
- Ryan, P.C., Koenigsberger, S.*, Bachman, N.*, Kim, J., 2014. Uranium-rich phosphorite breccias in Cambrian dolostone as source of elevated uranium and alpha radiation in a bedrock aquifer, Vermont, USA. Geological Society of America Abstracts with Programs, 46 (6), p. 101.
- Van Hoesen, J., Grady, C.M.*, Ryan, P.C., Arriaza, B., 2014. reconstructing the Chinchorro palette: A possible origin for manganese-based paint. Geological Society of America Abstracts with Programs, 46 (6), p. 93.
- Ryan, P.C., Pincus, L.*, Falcones, K*, 2013, Mineralogical and geochemical evolution of tropical soils in a coastal terrace sequence. Geological Society of America Abstracts with Programs, 45 (7).
- Ryan, P.C., Kim, J., Mango, H., 2013, Roles of bedrock geochemistry, groundwater flow paths, redox and ion exchange on distribution of arsenic in a fractured slate aquifer system, New England, USA. Geological Society of America Abstracts with Programs, 45 (7).
- Ryan, P.C., Huertas, F.J., Hobbs, F.C. *, 2013, Halloysite and Fe-kaolinite in soils from dry tropical forest: Origin from pedogenic smectite and kaolin-smectite and implications for reaction mechanisms and rates. 50th Annual Meeting, Clay Minerals Society, Univ of Illinois, October, 2013.
- Studwell, S., Ryan, P.C., West, D.P., Jr, Kim, J., 2013, Examining the potential effect of metamorphism on arsenic concentration in metapelite bedrock aquifers: a case study of the Taconic sequence. Geological Society of America Abstracts with Programs, 45 (1).
- Mango, H., Ryan, P.C., 2013, Source of arsenic-bearing pyrite in southwestern Vermont: sulfur isotope evidence. Geological Society of America Abstracts with Programs, 45 (1).

- Ryan, P.C., 2012, Integrating field work, laboratory techniques and instrumental analysis into a research component of an undergraduate environmental geochemistry course. Geological Society of America Abstracts with Programs, 44 (7), p. 446. *Invited lecture.*
- Ryan, P.C., Kim, J., Silverman, A.*, and Russell, D*, 2012, The effect of metamorphism on arsenic concentration in metapelite bedrock aquifers: a case study of the Connecticut Valley/Gaspé sequence (NE Vermont and SE Quebec). Geological Society of America Abstracts with Programs, 44 (7), p. 52. *Invited lecture.*
- Kim, J., Ryan, P.C., 2012, An across-strike survey of arsenic distribution in lithologies and groundwater in the Pre-Silurian Vermont Appalachians. Geological Society of America Abstracts with Programs, 44 (7), p. 52.
- Ryan, P.C., Hattori, K., Takahashi, Y, 2012, Arsenic in tetrahedral and octahedral sites in phyllosilicates. Program and Abstracts, 49th Annual Meeting of the Clay Minerals Society, Golden CO, June 2012.
- Hobbs, F.C*, Ryan, P.C., 2012, Mineral reaction pathways and rates in a tropical soil chronosequence, Nicoya Peninsula, Costa Rica. Geological Society of America Abstracts with Programs, 44 (2), p. 111.
- McDonald, E.C.*, Ryan, P.C., Kim, J., 2012, Relationship between bedrock geochemistry and uranium in groundwater in a carbonate aquifer, NW Vermont. Geological Society of America Abstracts with Programs, 44 (2), p. 48.
- Russell, D.*, Kim, J., Ryan, P.C., 2012, Evidence for the relationship between arsenic and metamorphic grade and implications for bedrock aquifer geochemistry. Geological Society of America Abstracts with Programs, 44(2), p. 47.
- Thompson, A. *, Ryan, P.C., Hattori, K.H., Kim, J., 2011, Geochemical and sulfur isotope analysis of Taconic slates: implications for arsenic source and mobility in a bedrock aquifer system. Geological Society of America Abstracts with Programs, Vol. 43, No. 1, p. 106.
- Rosenberg, B. *, Bigl, M.F. *, Munroe, J.S., Ryan, P.C., 2011, X-ray diffraction analysis of weathering patterns in high-elevation glacial, periglacial, and eolian sediments in northern Nevada and Utah. Geological Society of America Abstracts with Programs, Vol. 43, No. 1, p. 114.
- Rosenberg, B. *, Meyer, E.E., Ryan, P.C., Eberl, D.D., 2011, K-Ar dating of illite-rich rocks in the Champlain Valley, Vermont: an investigation of post-Taconian faulting and fluid flow. Geological Society of America Abstracts with Programs, Vol. 43, No. 1, p. 151.
- Brooks, E. *, Kim, J., Ryan, P.C., 2011, Geochemical analysis of groundwater quality in the fractured bedrock aquifer of the town of Craftsbury, NE Vermont. Geological Society of America Abstracts with Programs, Vol. 43, No. 1, p. 107.

- Mango, J., Ryan, P.C., 2011, Pyrite as the source of groundwater arsenic in Taconic slates, southwestern Vermont. Geological Society of America Abstracts with Programs, Vol. 43, No. 1, p. 135.
- Ryan, P.C., Moen, J.C. *, Corenthal, L.G. *, Chow, D.R. *, Kim, J., 2010, Tetrahedral arsenic (As⁺⁵) in antigorite: Geological origin and implications for groundwater quality: SEA-CSSJ-CMS Trilateral Meeting on Clays, Spain, June 2010, T2-P-25.
- Clark, Arthur*, Smith, Taylor*, Kim, Jon, Ryan, Peter C., Mango, Helen, 2010, Elevated arsenic in domestic wells from the Taconic allochthons in southern Vermont. Geological Society of America Abstracts with Programs, Vol. 42, No. 1, p. 185.
- Corenthal, Lilly*, Ryan, Peter C., Kim, Jon, 2010, Arsenic in groundwater wells in glacial drift, north-central Vermont. Geological Society of America Abstracts with Programs, Vol. 42, No. 1, p. 122.
- Moen, Jonathan*, Ryan, Peter C., Kim, Jon, 2010, Analysis of arsenic speciation in ultramafic rocks by sequential chemical extraction: implications for Taconian fluid source and modern aquifer contamination. Geological Society of America Abstracts with Programs, Vol. 42, No. 1, p. 122.

Research Grants and Awards (See below for teaching-related grants)

- 2019-2020 **US EPA:** 2020 Environmental Merit Award Recipient for Collaborative Research on PFAS in Groundwater, Bennington Vermont.
- 2019 – 2021 **NSF-MRI:** Acquisition of a Cavity Ring-Down Spectrometer for Analyzing Stable Isotopes in Water Samples at Middlebury College. \$103,295. With PI Jeff Munroe.
- 2017 – 2018 **NSF-ROA:** Identification and Correlation of Volcaniclastic Deposits by Integration of Plagioclase Luminescence Dating with Mineralogical, Trace Element and VSWIR Correlation. \$36,880, PI with Molly McCanta, UTK.
- 2012 – 2016 **NSF-Geobiology-Low-Temperature Geochemistry:** RUI: Landscape-scale Implications of Mineral Reaction Rates and Mechanisms in Tropical Soils: Insights from Soil Chronosequences and Synthesis. \$127,880. PI.
- 2010 – 2013 **NSF-MRI-R²:** Acquisition of an XRD, FTIR, and WDS for Integrated Mineralogical and Geochemical Studies at Middlebury College. \$299,584. PI (Pat Manley and Jeff Munroe, co-PIs).
- 2009 – 2012 **NSF-MRI:** Acquisition of a Multi-Sensor Core Logger, Pycnometer, C:N Analyzer, and Freeze Dryer for use in Lake and Paleoclimate Studies at Middlebury College. \$270,557. Co-PI (Jeff Munroe, PI; Pat Manley, co-PI).

- 2008 **Lintilhac Foundation:** The Barnes Hill Project – installation of monitoring wells to assess arsenic sources in a bedrock aquifer. \$15,000, PI.
- 2005 – 2007 **Mellon Foundation:** Funded for research as part of two collaborative multi-institution projects, one with colleagues from Middlebury, Vassar and Furman titled *A Watershed Research Consortium for Undergraduate Institutions*— it funded field and laboratory research for Carrie Childs’ thesis (in collaboration with M Costanza-Robinson, P Manley, B Hegman). The other project is *Interdisciplinary Ecological Research and Education at the Firestone Tropical Preserve, Costa Rica*, and it funded a research trip to Costa Rica in May 2007 to (1) work with the Claremont Colleges and colleagues on study abroad development in the field of tropical soil-geology-ecology, and (2) enable me to sample soils and bedrock for 2007-2008 sabbatical research.
- 2002 – 2005 **NSF-Hydrological Sciences-RUI:** Quantitative XRD-sequential extraction analyses of trace metal speciation in ultramafic soils and waters, \$116,369, PI.
- 2001 – 2004 **Ecosystems Research-USDA-USFS:** Analysis of soil buffering capacity by quantitative XRD and ICP-AES. Collaborator on large, multi-institutional project coordinated by Ecosystems Research Group, Norwich, VT, \$31,505.
- 1998 – 2000 **NSF-AMP:** Integrated study of surficial geology, Flathead Indian Reservation (1998 - 2000), \$85,159, PI.
- 1997 – 1998 **NASA-MSGC:** DEM-based study of surficial geology on the Flathead Indian Reservation, \$14,994, PI.
- 1996 – 1997 **NSF-AMP:** Undergraduate geology research at a Montana Tribal College (1996 - 97), \$58,040, PI.
- 1994 **Gary Malone Graduate Student Award,** Dartmouth College.

NSF Review Panels

NSF-EAR Geobiology and Low-temperature Geochemistry: Nov 2015, April 2017

TEACHING

Courses Taught at Middlebury College

- ENVS 112 Natural Science and the Environment
‘98, ‘99, ‘03, ‘06, ‘08, ‘10, ‘11, ‘13, ‘16, ‘17, ‘20
- ENVS 360 Research Practicum in Environmental Science ‘02, ‘04

(Co-taught with Steve Trombulak)

ENVS 401	Environmental Studies Senior Seminar	'00, '10, '15
FYSE 1434	Humans and their Geological Environment	'06, '15
FYSE 1275	The Landscape of Native America	'09
FYSE 1563	Landscapes of Central America	'20
GEOL 201	Climate and Earth History	'03, '09, '12, '17
GEOL 104	Earthquakes and Volcanoes (3 discussion sections)	'00
GEOL 112	Environmental Geology (2 laboratory sections)	'99, '01, '06
GEOL 170	The Dynamic Earth	'09, '19
GEOL 255	Surface and Ground Water (1 or 2 laboratory sections) (cross-listed with GEOG)	'98, '00, '02, '05, '09, '11, '12, '14, '16, '18
GEOL 257	Soils, Geology and the Environment (1 lab section) (cross-listed with GEOG)	'01, '03, '04, '07, '10, '14
GEOL 323	Environmental Geochemistry (1 laboratory section)	'99, '00, '02, '05, '11, '13, '15, '18
GEOL 400	Geology Research Seminar	'99, '02, '03, '08, '14
GEOL 1035	Field Geology in Active Tectonic Environments (Costa Rica)	January '18
ID 082	Geology and Natural History of Costa Rica (Off-campus course— co-taught with Helen Young)	January '00
	Finalist for Perkins Teaching Award at Middlebury College.	'03, '11.
	Finalist, Campus Compact Engaged Scholar Award (ENVS 401)	2010-11

Courses Taught at Salish Kootenai College (1994-98)

Air Quality

Environmental Geochemistry

Environmental Geology

Introduction to Inorganic Chemistry

Introduction to Organic Chemistry
Physical Field Methods
Mineralogy
Introductory Physical Geology
Project Planning and Management
Scientific Research Papers
Science and Society
Soil Science
Water Quality
Water Resources

National Corp. for Service Learning Award for Excellence in Math/Science Service Learning, 1996.

Other Courses Taught

- October 2000 *Acid Mine Drainage and the Elizabeth Mine*. Presented to the Elizabeth Mine Community Action Group and other interested community members as a 3-day course.
- June 1999 *Acid Mine Drainage on Tribal Lands*. Presented to natural resource managers in two separate 3-day courses on the Flathead and Fort Belknap Indian Reservations, Montana.

Middlebury College Theses Directed, 1998-present

- A flowing artesian aquifer in western Vermont: Water chemistry and flow patterns.
Emma Waugh (ES-GEOL '21.5)
- An analysis of the potential for groundwater transport of P to a eutrophic lake, northwestern Vermont (Lake Carmi)
Anna Loewald (GEOL '20)
- Mineralogy and geochemistry of landslide slip faces in response to Hurricane Maria, central and western Puerto Rico
Virginia Stanley (GEOL '20)
- Water chemistry and potentiometric surface anomalies in a fractured carbonate aquifer in Weybridge, Vermont.
Torre Davy (GEOL '21)
- Geochemical and Mineralogical Analysis of Terrestrial and Reef Sediments: Implications for Reef Ecosystems and Human Health
Valeriia Vakhitova (ES-GEOL '20.5)
- Delineating Groundwater Flow Paths in a PFAS-affected Aquifer, Clarendon, Vermont.
Alexandra Cobb (GEOL '20)
- A Geochemical and Mineralogical Analysis of a Volcaniclastic Aquifer with Elevated Groundwater Arsenic, Guanacaste, Costa Rica
Kira Waldman (GEOL '20)
- Correlation of Volcanic Deposits by Mineralogy, Geochemistry, and Radiocarbon Dating: Implications for Assessing Volcanic Activity and Risk in Costa Rica

- Malia Barca (ES-GEOL '19)
- The Effect of Calcite Veins on Groundwater Chemistry in Fractured Rock Aquifers
Nathan Beningson (GEOL '18)
 - Mineralogical, Chemical and Isotopic Analysis of Atmospheric Dust in Alpine Environments of the Uinta Mountains
Emmet Norris (GEOL '18)
 - Analysis of the effect of regional climate on soil mineralogy and chemistry in the tropics: A case study from the Pacific coast of Costa Rica
Connor Pisano (ES-GEOL '18)
 - Geochemical analysis and origin of uranium in groundwater wells in the Clarendon Springs, Skeels Corner, and Danby Formations, Colchester/Milton, VT
Tucker Meredith (GEOL '17)
 - Synthesis of proto-serpentine to assess potential for arsenic incorporation
William Painter (GEOL '17)
 - Creating a Landscape-Scale Model of Tropical Soil Evolution on the Pacific Coast of Costa Rica.
C. Maeve Grady (GEOL-GEOG '16.5)
 - Analysis of uranium speciation in phosphorites: insights from sequential chemical extraction & mineral synthesis experimentation
Stephan Koenigsberger (GEOL '16)
 - Analysis of groundwater quality in a fractured rock aquifer influenced by black shales in the central Champlain Valley, western Vermont.
Sam Cowan (GEOL '16)
 - Geochemical and hydrochemical analysis of a quartzite-dolostone bedrock aquifer in the central Champlain Valley, Monkton, Vermont.
Amanda Fishbin (GEOL '16)
 - Source, speciation and mobility of uranium derived from phosphate breccias in the Clarendon Springs Formation, NW Vermont.
Nicholas Bachman (GEOL '15)
 - Geochemical and mineralogical assessment of alkali-sulfate surface water and groundwater in eastern Montana.
Brent Nixon (GEOL '15)
 - Cartographic analysis of watershed scale surface and groundwater interactions in Bristol, Vermont.
Kevin Chu (ES-GEOL '14)
 - Rates of Soil Formation and Tectonic Uplift of Marine Terraces, Osa Peninsula, Costa Rica.
Kris Falcones (GEOL '14)
 - An analysis of the lithologic control on major elements, radionuclides, and other trace elements in groundwater south of Bristol, Vermont
Julia Favorito (GEOL '14)
 - Variations in cation exchange capacity of tropical soils as a function of age and climate.
Lauren Pincus (GEOL-CHEM '14)

- Chemical and mineralogical evolution of arid tropical soils (Pacific Coast, Ecuador).
Daphnee Tuzlak (GEOL '14)
- A Model for Uranium Occurrence in the Late Cambrian Clarendon Springs Formation: Implications for Groundwater Quality in Northwestern Vermont
Emily McDonald (GEOL '12)
- A Hydrologic, Structural, and Cartographic Analysis of Groundwater in the Vicinity of the Hinesburg Thrust, West-Central Vermont
John Filoon (GEOL '12)
- Assessment of Metamorphic Grade on Arsenic in Metapelites in Vermont: Potential Implications for Bedrock Aquifers
Diego Russell (GEOL '12)
- Geochemistry of Groundwater and Bedrock in the Plainfield Quadrangle, Vermont
Robert Nicholas Daly (GEOL '12)
- Mineral Reaction Pathways and Rates in a Tropical Soil Sequence, Nicoya Peninsula, Costa Rica
Franklin Hobbs (GEOL '12)
- Geochemistry and Radionuclide Potential in a Fractured Bedrock Aquifer System, Craftsbury, Vermont.
Erik Brooks (ES-GEOL '11)
- K-Ar Dating and Mineralogical Analysis of Illite-rich Rocks in the Champlain Valley: An Investigation of Post-Taconian Fluid-Driven Flow.
Braden Rosenberg (GEOL '11)
- Geochemical and Sulfur Isotope Analysis of Taconic Slates: Implications for Arsenic Source and Mobility in a Bedrock Aquifer System.
Ali Thompson (ES-GEOL '11)
- A Mineralogical, Geochemical and Geospatial Analysis of the Source of Elevated Arsenic in Glacial Aquifers of North Central Vermont.
Lilly Corenthal (ES-GEOL '10)
- Analysis of Arsenic Speciation in Ultramafic Rocks by Sequential Chemical Extraction: Implications for Taconian Fluid Source and Modern Aquifer Contamination.
Jon Moen (GEOL '10)
- Geochemistry of U-rich groundwater and bedrock of the aquifer in the lower plate of the Hinesburg Thrust Fault, Hinesburg, Vermont.
Jared Bean (GEOL '09)
- Mineralogy and geochemistry Quaternary paleosols, Granada, Spain.
Tucker Levy (ES-GEOL '09)
- Ground water and bedrock aquifer geochemistry of three monitoring wells, Stowe, Vermont.
Daniel Chow (ES-GEOL '09)
- Bedrock geochemistry in arsenic-rich groundwater, northern Vermont.
Colleen Sullivan (ES-GEOL '07)
- Otter Creek sediment record of post-1800 settlement.

- Carrie Childs (GEOL-GEOG '07). Co-advised with Pat Manley.
- Geochemistry of U-rich groundwater and bedrock of the Knox Mountain pluton, Vermont.
Mike Gleason (GEOL '07). Co-advised with Ray Coish.
 - An evaluation of soil chemistry for acid deposition, Bolton Mountain, Vermont
Dan Berkman (GEOL-GEOG '06.5)
 - Ultramafic bedrock source of arsenic in ground water, Stowe, Vermont.
Kevin Bright (ES-GEOL '06)
 - Geochemistry of Ordovician K-bentonites, western Vermont.
Kristiaan Joseph (GEOL '06)
 - An evaluation of soil geochemistry and forest health, Bartlett Forest, NH
Lynne Zummo (ES-GEOL '06)
 - Belvidere asbestos mine: site suitability for CO₂ sequestration through mineral carbonation.
Levi Doria (ES-GEOL '05). Co-advised with Ray Coish.
 - An evaluation of geologic controls on elevated naturally-occurring radioactivity in bedrock water wells, NW Vermont.
Katharine North (GEOL '05)
 - Sequential Chemical Extraction of Costa Rican and Green Mountain Soils: A Quantitative and Qualitative Examination of the SCE Procedure.
J. Trevor Cloak (ES-CHEM '05)
 - Sequential Chemical Extraction: Determination of Reagent Selectivity On Eight Mineral Standards
Nicole Grohoski (ES-CHEM '05)
 - Acid Precipitation and Nutrient Cycling: Analysis of a Watershed in the Breadloaf Area of Ripton, VT.
Caitlyn Long (ES-CHEM '05)
 - A tropical terrace progression and implications for fore-arc dynamics on the Pacific Coast, Costa Rica.
G. Burch Fisher (GEOL '04)
 - Geochemical analysis of the Clarendon Springs Formation: Implications for naturally-derived lead in carbonate aquifer, NW Vermont.
Susannah Cowden (ES-GEOL '04)
 - Chemical weathering of serpentinites and trace metal mobility in soils and streams on the Lizard Peninsula, Cornwall, England.
Marty Wesolowski (GEOL '03).
 - Geochemical and mineralogical correlation of volcanic ash deposits, northern Chile.
Brian McCurdy (ES-GEOL '03).
 - Evaluation of the Hazen's Notch Formation as a source of trace metals to streams and soils, northern Vermont.
Dana Chapin (ES-GEOL '03).
 - Geochemical, stratigraphic and structural framework for natural sources of lead and uranium in groundwater in Addison County.
Nora Greenglass (ES-GEOL '03). Co-advised with David West.

- Paleoclimatic record of clay minerals in the John Day Formation, Oregon.
Christopher Kautz (GEOL '02).
- Application of clay mineralogy and chemical analysis to stratigraphic correlation of Quaternary lahars, Mt. Hood.
Robyn Cook (GEOL '02).
- Trace metal mobility in association with ultramafic rock, East Dover, Vermont.
Dana Drummond (ES-GEOL '02).
- Quantitative XRD analysis of glacial till origins and ice migration, Vermont.
Holly Carlson (GEOL '02). Co-advised with Jeff Munroe.
- Sediment chemistry downstream of the Elizabeth copper mine, S. Strafford, VT.
Maggie Sullivan (ES-GEOL '01).
- Mineralogy and origin of the Brandon Residual Formation/Brandon Lignite, Vermont.
Drew Nichols (GEOL '01).
- Analysis of soil mineral formation in the wake of the 1980 eruption of Mt. St. Helens.
Matt Whitcomb (GEOL '01).
- Modeling snow avalanche spatial and temporal distributions using snow-tel data, western US.
David Selkowitz (ES-GEOG '01).
- Heavy metal speciation and chemical weathering of ultramafic rock in Vermont.
Brooke Laundon (ES-GEOL '00). Co-advised with Ray Coish.
- Mineralogy and geochemistry of the Raasay Ironstone, Inner Hebrides, Scotland.
Elizabeth Hunter (ES-GEOL '00).
- Geochemical analysis of the logged and old growth forests, Middlebury Vermont.
Josh Nothwang (ES-GEOL '00).
- Geochemical and macrofossil analysis of a lake sediment core as a record of Holocene environmental change in the Ritterbush Pond basin, northern Vermont.
Amanda Ayres (ES-CHEM '00). Co-advised with Andrea Lloyd.
- Analysis of heavy metals in two Vermont wetlands associated with frog malformations.
Andrew Wall (ES-GEOL 99.5).
- Geochemistry and mineralogy of iron-oxide acid drainage coatings, Pike Hill Mine, Vermont.
Brian Totten (ES-GEOL '99).
- Geochemistry and mineralogy of sulfide-rich mine tailings, Pike Hill Mine, Vermont.
Scott Wiercinski (ES-GEOL '99).
- Geochemistry of Eocene-Oligocene lateritic paleosols in western Montana.
Bryan Hopping (ES-GEOL '99).

Non-Geology Middlebury College Thesis Committee Member

- Kae Fink, ES-CHEM, 2016
- Ben Estabrook, ES-CHEM, 2009
- Ross Lieb-Lappen, ES-CHEM, 2007

- EveLyn Hinkley ('01). ES-BIOL. Nitrogen cycling in a transitional terrestrial-marine system, Cape Cod.
- Cynthia Whittington ('00). ES-BIOL. Fire chronologies in peatland, Alaska.
- David Grass ('99). ES-CHEM. Nutrients in precipitation and forest throughfall forest, Chile.

PhD Dissertation Committee Member

- Université du Québec en Abitibi-Témiscamingue, Raphael Bondu, “Origine et distribution de l’arsenic dans l’eau souterraine de l’aquifère rocheux fracturé du Bouclier Canadien en Abitibi-Témiscamingue”, April 2017
- Instituto Andaluz de Ciencias de la Tierra (Spain), Maria Elena Ramos, “Dissolution mechanism of smectite in simulated lung fluids: effects of organic ligands and biodurability”, April 2013.
- Dartmouth College, James Kaste, “Tracing the retention and redistribution of lead and other atmospheric fallout in soils”, April 2003.

Research Advising for Post-graduate Students at the Universidad de Costa Rica

Project: Trace metal speciation in ultramafic soils and rocks, northwestern Costa Rica (NSF-funded).

Students: Paulo Hidalgo and Natalia Zamora

- Field work in the ultramafic belt of northwestern Costa Rica in January 2002.
- Laboratory work at Middlebury College Geology Department, June 2002.
- Continuing advising via e-mail through 2002 and 2003.

Education Grants

- 1998 – 2000 **NSF-CCLI**: Laser Particle Size Analysis in Geoscience Education, \$43,785, PI.
- 1999 – 2000 **EPA Mine Waste Program**: Acid Mine Drainage on Tribal Lands Short Course (1999), \$10,000, PI.
- 1998 – 1999 **NSF-DUE**: Montana Tribal College Faculty Enhancement Project, \$157,653, PI.
- 1996 – 1998 **NSF-DUE**: Environment and the curriculum, \$180,562, co-PI.
- 1996 – 1997 **USDA**: Indian at-distance learning grant, \$80,000, co-PI.

Professional Society Affiliations and Activities

- 1989 – present Clay Minerals Society (CMS).
Associate Editor, *Clays and Clay Minerals* (2014 – present)
 Organizer and host of 2005 CMS annual meeting.
 Chair, Membership Committee (2017)
 Program Committee for CMS (2011 – present)
 Continuing Education Committee for CMS (2008 – 2011)
- 2017 – present Secretary General, AIPEA (International Association for the Study of Clays)

1988 – present Geological Society of America.
2003 – present Northeast Environmental Studies Group
2000 – present Vermont Geological Society.