Michael C. Cheshire

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EDUCATION

December 2011	Ph.D. in geological sciences, Indiana University, Bloomington, IN
December 2003	M.S. in geochemistry, Texas Tech University, Lubbock, TX
December 2001	B.A. in geology, Texas Tech University, Lubbock, TX

PROFESSIONAL EXPERIENCE

November2016 to Present

Experimental Geochemistry Researcher, Oak Ridge National Laboratory, Oak Ridge, TN

- I investigate how subsurface geochemical processes influence national energy security related to CO_2 sequestration, heavy element transport and containment during energy extraction processes, and porosity/permeability alteration during perturbations. This work has produced 13 publications in well-respected international journals. Additionally, I am a Laboratory Space Manager responsible for the safe operations of our research laboratories.

October 2014 to October 2016

Post-Doctoral Fellow at Oak Ridge National Laboratory, Oak Ridge, TN

- I conceived and implemented a concept for evaluating mineral precipitation based on nano-scale characteristics of carbonate minerals. Scattering and direct imaging techniques were used to characterize the pore volume and structure changes due to mineral dissolution and precipitation.

January 2012 to October 2014

Post-Doctoral Associate at Los Alamos National Laboratory, Los Alamos, NM

- **Repository/Engineered Barrier Systems** -- I studied the reaction dynamics of a bentonite-based engineered barrier system for nuclear waste disposal. I conducted hydrothermal experiments at elevated pressures/temperatures to monitor mineralogical changes to bentonite and to evaluate the corrosion products forming on various metal plates. These experiments showed, for the first time, that bentonite does not undergo significant alteration, whereas much of the secondary mineralogy experiences substantial alteration. The lack of smectite alteration appears to be kinetically driven due to the solution chemistry and limited supply of K^+ in the system. At the request of DOE and Sandia National Laboratories project managers, I presented my findings at high-level domestic and international meetings and the results of the research have been used for the design of nuclear waste disposal systems.

- **Generic Salt Repository Systems** -- In addition to bentonite repository systems, I studied hydrous mineral stability under salt repository conditions and helped determine how loss of H_2O influences brine migration. I utilized *in situ* X-ray diffraction and hydrothermal experiments to evaluate the loss or recovery of H_2O from minerals associated with the Waste Isolation Pilot Plant, i.e., sulfate and mixed-layer clay minerals.
- **Environmental Programs (EP)** -- I worked with EP providing geological and mineralogical expertise to the chromium removal and storm water runoff projects. Understanding the iron-bearing and clay minerals associated within the regional aquifer is the focus of the chromium removal project, as it is believed that some level of natural Cr^{6+} attenuation is occurring in the subsurface.
- **New Mexico Small Business Assistance** -- I evaluated mineralogy and geochemistry of local materials to determine their suitability for various products or strategic materials. Part of this work focused on regulatory issues regarding heavy metals, organic geochemistry, and mineral toxicity.
- **Clay/Biomarker Interactions** -- I initiated a project focused on the interaction of a variety of natural organic compounds with clay minerals to better understand how diagenesis in a clay-rich environment influences data from biomarker investigations. Neutron spectroscopy and gas chromatography/mass spectrometry are being utilized in the analyses of the biomarker reaction products.

May 2008 to August 2008

Intern at Imerys, Deepstep, GA

I evaluated exploration properties for kaolin mining using Surpac mine planning and evaluation software. I recommended to Exploration Geologists whether or not to proceed with further exploration of various locations. I also developed exploration maps detailing the location of Tertiary kaolins in the Washington County, Georgia, mining district.

February 2004 to August 2007

Research Scientist at Oil-Dri Corporation of America, Vernon Hills, IL

I conducted research and development of new products, mineral-processing techniques, and mineral applications. I was Oil-Dri's lead mineralogist evaluating the mineralogy of their mined and processed materials. In addition to my mineralogical responsibilities, I either led or assisted multiple plant trials in clay processing plants, brick manufacturing plants, and vegetable oil refineries to test the viability of the clay products**.**

May 2000 to August 2003

Research Assistant to Dr. Necip Güven, Lubbock, TX

I performed a variety of experiments with synthetic clay and layered double hydroxides to evaluate the potential to scale to industrial production. I characterized the reaction products along with a variety of geological samples for mineral content, chemical composition, cation-exchange capacity, particle size, rheological and morphological characteristics, using X-ray diffraction, analytical electron microscopy, and other analytical methods.

PUBLICATIONS

Cheshire, M.C., Deng, H., Anovitz, L.M., Stack, A.G., Steefel, C., Gilbert, B., Bingham, P. (2018) Experimental evidence for partial fracture sealing/healing during $scCO_2$-H_2O flow, in prep

Cheshire, M.C., Anovitz, L.M., Stack, A.G., Sacci, R., DiStefano, V.H. (2018) Method for making synthetic rock using piston-cylinder for ex-situ geochemical investigations, in prep

Rother, G., Cheshire, M.C., Leu, L., Bertier, P., Busch, A., Wallacher, D., Hauss, T., Grimm, N., Gautam, S., Bourg, I.C., Cole, D.R. (2018) Geo-Fluid Sorption to Montmorillonite Clay – Accessibility of the Interlayers, in prep.

DiStefano, V.H., McFarlane, J., Stack, A.G., Perfect, E., Mildner, D., Bleuel, M., Chipera, S.J., Littrell, K., Cheshire, M.C., Manz, K., Anovitz, L.M. (2018) Solvent-Pore Interactions in the Eagle Ford Shale Formation, Fuel, Accepted.

Cheshire, M.C., Caporuscio, F.A., Jové Colón, C.F., Norskog, K.E. (2018) Fe-saponite growth on low-carbon and stainless steel in hydrothermal-bentonite experiments. Journal of Nuclear Materials, Accepted.

Rodriquez, E.T., Anovitz, L.M., Clement, C.D., Rondinone, A.J., Cheshire, M.C. (2018) Facile emulsion mediated synthesis of phase-pure diopside nanoparticles. Scientific Report, 8, 1-7.

Cheshire, M.C., Bish, D.L., Cahill, J.F., Kertesz, V., Stack, A.G. (2018) Geochemical Evidence for Rare-Earth Element Mobilization during Kaolin Diagenesis. ACS Earth and Space Chemistry, 2, 506-520.

Gadikota, G., Dazas, B., Rother, G., Cheshire, M.C., Bourg, I. (2017) Solubility of gases (CO_2, CH_4, H_2, noble gases) in clay interlayer nanopores. The Journal of Physical Chemistry C, 121, 26539-26550.

DiStefano, V.H., Cheshire, M.C., McFarlane, J., Kolbus, L.M., Hale, R.E., Perfect, E., Bilheux, H.Z., Santodonato, L.J., Hussey, D.S., Jacobson, D.L., LaManna, J.M., Bingham, P.R., Starchenko, V., Anovitz, L.M. (2017) Spontaneous Imbibition of Water and Determination of Effective Contact Angles in the Eagle Ford Shale Formation using Neutron Imaging. *Journal of Earth Sciences*, 28, 874-887.

Anovitz, L.M., Rondinone, A.J., Sochalski-Kolbus, L., Rosenqvist, J., Cheshire, M.C. (2017) Nano-Scale Synthesis of the Complex Silicate Minerals Forsterite and Enstatite. *Journal of Colloid and Interface Science*, 495, 94-101.

Wang, H-.W., Daemen, L., Roback, J., Cheshire, M.C., Kidder, M., Stack, A.G., Neuefeind, J., and Page, K. (2017) Synthesis and structure of synthetically pure and deuterated amorphous (basic) calcium carbonates. *Chemical Communication*, 53, 2942-2945

Caporuscio, F., Palaich, S.E., Cheshire, M.C., and Jove-Colon, C (2017) Authigenic mineral growth and copper corrosion in hydrothermal bentonite experiments. *Journal of Nuclear Materials*, 485, 137-146.

Cheshire, M.C., Stack, A.G., Carey, J.W., Anovitz, L., Prisk, T., Ilavsky, J. (2016) Wellbore cement porosity evolution in response to mineral alteration during CO_2 flooding. *Environmental Science and Technology*, 51, 692-698.

WoldeGabriel, G., Boukhalfa, H., Ware, S. D., Cheshire, M., Reimus, P., Heikoop, J., Conradson, S. D., Batuk, O., Havrilla, G., House, B., Simmons, A., Clay, J., Basu, A., Christensen, J. N., Brown, S. T., and DePaolo, D. J. (2014) Characterization of cores

from an in-situ recovery mined uranium deposit in Wyoming: Implications for post-mining restoration. *Chemical Geology*, **390**, 32-45.

Cheshire, M.C., Caporuscio, F.A., Jove-Colon, C., and McCarney, M.K. (2014) Bentonite evolution at elevated pressures and temperatures: An experimental study for generic nuclear repositories. *American Mineralogist*, **99**, 1662-1675.

Cheshire, M.C. and Bish, D.L. (2012) Mineralogical and sulfur isotopic evidence for sulfate reducing and disproportionating bacteria influencing pyrite and marcasite formation in the Georgia kaolins. *Clay Minerals*, **47**, 559-572.

Cheshire, M.C., Bish, D.L, and Brassell, S. (2012) Organic geochemical signatures of Georgia kaolins and their diagenetic evolution. *Clays and Clay Minerals*, **60**, 419-439.

Cheshire, M.C. and Güven, N. (2005) Conversion of chrysotile asbestos to magnesian smectite. *Clays and Clay Minerals*, **53**, 155-161.

Jones, J.E., Cheshire, M.C., Casadonte, Jr., D.J., and Phifer, C.C. (2004) Facile sonochemical synthesis of graphite intercalation compounds. *Organic Letters*, **6**, 1915-1917.

GOVERNMENT REPORTS

Caporuscio, F.A., Cheshire, M.C., Jove-Colon, C., and Rearick, M.S. (2014) Argillite Disposal R&D--Hydrothermal-Bentonite Investigations under Repository Conditions - FY 2014. FCRD-UFD-2014-000491.

Caporuscio, F.A., Boukhalfa, H., Cheshire, M.C., Ding, M. (2014) Brine migration experimental studies for salt repositories. FT-14LA081803.

Caporuscio, F.A., Cheshire, M.C., Rearick, M.S., Jove-Colon, C., and McCarney, M.K. (2013). EBS Report - LANL Experimental update of buffer/backfill at elevated P,T. FCRD-USED-2013-000207.

Caporuscio, F.A., Boukhalfa, H., Cheshire, M.C., Ding, M. (2013) Brine migration studies for salt repositories. FCRD-UFD-2013-000204.

Caporuscio, F.A., Cheshire, M.C., Levy, S.S., McCarney, M.K. (2012) Used Fuel Disposition R&D--Engineered Barrier Systems Report FY 2012 - Experimental Results. In Jove Colon, C.F. et al. (2012) Evaluation of Generic EBS Design Concepts and Process Models: Implications to EBS Design, FCRD-USED-2012-000140, June 2012.

CONFERENCE PROCEEDINGS

J. McFarlane, R.E. Hale, V. DiStefano, L.M. Anovitz, H.Z. Bilheux, M.C. Cheshire, L.L. Daemen, R.L. Howard, and E. Perfect (2018) Water Migration in Engineered Barrier Materials for Radioactive Waste Disposal. Proceedings from the 29th International High-Level Radioactive Waste Management Conference

Cheshire, M.C., Hardin, E., Caporuscio, F.A., Jove-Colon, C., and McCarney, M.K. (2014) Geochemical Investigation in an Effort to Increase Bentonite Barrier's Thermal Load Capacity to Accommodate 32-PWR Dual Purpose Canisters. Proceedings from the International Conference on the Performance of Engineered Barriers, 185-190.

Cheshire, M.C., Caporuscio, F.A., Jové-Colón, C., and McCarney, M.K. (2013) Alteration of clinoptilolite into high-silica analcime within a bentonite barrier system under used nuclear fuel repository conditions. Proceedings from the 14th International High-Level Radioactive Waste Management Conference, 410-415.

PROFESSIONAL AFFILIATIONS

Member, Clay Minerals Society (CMS)

Clays and Clay Minerals reviewer

Councilor, 2014 – 2017

Program Development Committee, 2014 – present

Chairperson, 2015 - present

Council Nomination Committee, 2015 – 2018

Chairperson, 2017 - 2018

Member, Association Internationale Pour L'Etude des Argiles (AIPEA)

Co-Organizer for the United States' bid to host the 2017 International Clay Conference.

Past Member, Society of Mining, Metallurgy, and Mining Engineering (SME)

Technical Vice-Chair, 2007 – 2013. Responsible for organizing industrial mineral review articles to be published in *Mining Engineering*.

SELECTED PRESENTATIONS

Anovitz, L., Cheshire, M., DiStefano, V., Prisk, T., Mildner, D., Littrell, K. (2015) Architected geomaterials development for geochemical research. Goldschmidt, Yokohama, Japan.

Cheshire, M.C., Stack, A.G., Carey, J.W., Prisk, T.R., Anonvitz, L.M., Ilavsky, J. (2015) Cement porosity evolution during CO_2 alteration. 53rd Annual Meeting for Clay Minerals Society.

Cheshire, M.C., Stack, A.G., Carey, J.W., Prisk, T.R., Anonvitz, L.M., Ilavsky, J. (2015) Cement porosity evolution during CO_2 alteration. Center for Nanoscale Control of Geologic CO_2- All Hands Meeting, Berkely, CA.

Tinnacher, R.M., Davis, J.A., Cheshire, M.C., Caporuscio, F.A. (2015) Potential differences in uranium(IV) sorption to sodium montmorillonite, and untreated and heat-treated bentonite. 2015 Radionuclide Migration Conference, Santa Fe, NM.

Cheshire, M.C., Caporuscio, F.A., Jove-Colon, C. (2014) Interaction between bentonite and various metals mimicking spent nuclear waste packages at elevated temperatures and pressures. 51st Annual meeting of the Clay Minerals Society, College Station, TX.

Cheshire, M.C., Hardin, E., Caporuscio, F.A., Jove-Colon, C., and McCarney, M.K. (2014) Geochemical Investigation in an Effort to Increase Bentonite Barrier's Thermal Load Capacity to Accommodate 32-PWR Dual Purpose Canisters. International Conference on the Performance of Engineered Barriers, Hanover, Germany. **(Invited by Sandia Project Management)**

Cheshire, M.C., Caporuscio, F.A., Jove-Colon, C., and McCarney, M.K. (2014) Increased bentonite stability or: How I learned to stop worrying and love the interlayer cations. 2013 Annual Meeting on Fuel Cycle Technology, Lemont, IL. **(DOE Invited Talk)**

Caporuscio, F.A., Cheshire, M.C., and Boukhalfa, H. (2013) WIPP hydrous mineral phase transformations at elevated temperatures. 2013 Geological Society of American Annual Meeting, Denver, CO.

Caporuscio, F.A. and Cheshire, M.C. (2013) A potential steel passivating layer: Fe-saponite and chlorite growth on steel in hydrothermal Engineered Barrier Experiments. 2013 Goldschmidt Conference, Florence, Italy.

Caporuscio, F.A., Cheshire, M.C., and Boukhalfa, H. (2013) WIPP hydrous mineral phase transformations at elevated temperatures. Actinide Brine Chemistry Salt Conference, Santa Fe, NM.

Cheshire, M.C., Caporuscio, F.A., Jove-Colon, C., and McCarney, M.K. (2013) Alteration of clinoptilolite into high-silica analcime under nuclear repository conditions. International High-Level Radioactive Waste Management Conference, Albuquerque, NM.

Cheshire, M.C., Caporuscio, F.A., McCarney, M.K. (2012) Fe-saponite and chlorite growth on stainless steel in hydrothermal Engineered Barrier Experiments. American Geophysical Union Fall Meeting, San Francisco, CA.

Caporuscio, F.A., Cheshire, M.C., McCarney, M.K. (2012) Bentonite Clay Evolution at Elevated Pressures and Temperatures: An experimental study for generic nuclear repositories. American Geophysical Union Fall Meeting, San Francisco, CA.

Cheshire, M.C., Bish, D.L. (2012) Mineralogical and sulfur isotopic evidence for sulfur disproportionating bacteria in the Georgia kaolins. Annual Meeting of the Clay Minerals Society, Golden, Colorado.

Cheshire, M.C. and Bish, D.L. (2011) Isotopic and organic geochemical composition of the Georgia kaolins: insights into formation and diagenetic conditions. Euroclay 2011. Antalya, Turkey.

Cheshire, M.C. and Bish, D.L. (2011) Understanding early diagenetic conditions of the southeastern United States kaolin deposits using rare-earth element geochemistry. Euroclay 2011. Antalya, Turkey.

Cheshire, M.C., Grassa, F., Schimmelmann, A., and Bish, D.L. (2011) Mineralogical and organic matter compositions of Sicilian mud volcanoes. Euroclay 2011. Antalya, Turkey.

Schieber, J. and Cheshire, M. (2011) Marcasite in clastic sediments formative processes and deep time stability. Goldschmidt Conference, Prague, Czech Republic.

Cheshire, M.C. and Bish, D.L. (2010) Isotopic and geochemical composition of the Georgia kaolin organic matter. 2010 SME Annual Meeting. Phoenix, Arizona.

Cheshire, M.C. and Bish, D.L. (2009) Organic matter of the middle Georgia kaolins. 45th Forum on the Geology of Industrial Minerals. Delaware, Ohio **(Invited Talk)**.