

Vita

Stephen Guggenheim
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Professional Interests Mineral chemistry and physics. Clay mineralogy/environmental mineralogy. Clays as materials. Current interests involve the understanding of the relationship of atomic structure (bulk and surface) and chemistry to layer silicate stability and properties.

Education

Degrees

Ph.D., University of Wisconsin-Madison, Wisconsin: 1976 (Geology), S.W. Bailey, advisor

M.S., S.U.N.Y. at Stony Brook, L.I., New York: 1972 (Geology), J.J. Papike, advisor

B.S., Marietta College, Marietta, Ohio: 1970 (Geology)

Thesis Titles

Ph.D., Cation Ordering in Subgroup Symmetry in the Micas

M.S., X-ray Diffraction Study of Heat-treated Lunar Pigeonites

Awards/honors **Marilyn and Sturges W. Bailey Distinguished Member Award**, for scientific, outstanding original research in clay science, awarded October, 2013 by the Clay Minerals Society (of North America)

Foreign Member, Accademia Nazionale dei Lincei (Italian Academy of Sciences and Humanities), elected 2007

AIPEA Medal for Research Excellence for 2005-09 presented by the Association Internationale pour L'Etudes des Argiles (International Association for the Study of Clays).

Editor-in-Chief, *Clays and Clay Minerals*, Journal of The Clay Minerals Society, Oct., 1998-Jan., 2001

President, Clay Minerals Society of America, 1996-7

Recipient, UIC Teaching Recognition Award, UIC Council for Excellence in Teaching and Learning (1997)

Marion L. and Chrystie M. Jackson Mid-Career Clay Science Award for 1994 presented by the Clay Minerals Society (of North America) for research excellence in clay science.

Fellow: Mineralogical Society of America, elected Nov., 1989

Hawley Medal of the Mineralogical Association of Canada for the best paper of 1986 published in the Canadian Mineralogist (see listing below for "Structural modulations in iron-rich and magnesium-rich minnesotaite"), with R.A. Eggleton.

Keynote speaker, 10th International Clay Conference, Adelaide, Australia, 20 July 1993; 12th International Clay Conference, Bahia Blanca, Argentina, 22-28 July 2001; EuroClay Conference, Modena, Italy, 23 June, 2003; 50th Anniversary Meeting of the Clay Minerals Society (Bailey Awardee) 6-10 October 2013, Urbana, IL.

Experience

Sept., 2016 - Present Professor Emeritus, Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, IL

Sept., 1988 - Aug., 2016 Professor, Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, IL

Aug., 1990 - July, 1991 Visiting Fellow, Department of Geology, Australian National University, Canberra, A.C.T., Australia

Sept., 1982 - Aug., 1988 Associate Professor, Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, IL

Aug., 1983 - Aug., 1984 Visiting Fellow, Department of Geology, Australian National University, Canberra, A.C.T., Australia

Sept., 1976 - Aug., 1982 Assistant Professor, Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, IL

Consultant:

March, 1980 - June, 1983 Consultation for government: City of West Chicago subcontracting through Radiation Safety Services, Inc., Evanston, IL. Geological appraisal of proposed plans by Kerr-McGee Chemical Division to dispose of thorium contaminated buildings from a 27 acre site in West Chicago.

1980 - 1999 Mineralogical studies: Several x-ray studies for engineering or consulting companies or through subcontracting agreements have been done over the past several years. (Companies have included Rockwell International, Harza Engineering, Illinois Institute of Technology Research Institute, Oil Dri Corporation, SDS Consultants, and others.)

2000 - 2007 Expert witness:
2000 - 2003 Expert witness testimony has been provided to the law firm of Foley and Lardner (Washington, D.C. office). The lawsuit involved patent infringement of key automotive parts that use clay minerals in their construction.
2005 - 2007 Expert witness was provided to the law firm of Smart & Bigger (Toronto, Canada office). The lawsuit involves the use of synthetic smectite and patent infringement in the papermaking process.

RESEARCH EXPERIENCE

Overview of research objectives and research

I define research problems that are of special significance in mineralogy and materials science. Generally, these problems relate to the understanding of phyllosilicate (clay mineral) stability by understanding atomic structure. I try to “re-invent” myself every 7 to 8 years, so that I work on new topics that allow a greater understanding and appreciation of phyllosilicates in general. Thus, instead of one or two research areas involving special techniques or research with two or three minerals, I have had many major directions of research over the last twenty-five years, capitalizing on diverse techniques (e.g., XRD and high-temperature and high-pressure powder and single-crystal XRD, HR TEM, high-pressure DTA, optical harmonics, computer simulations of crystal structures, etc) to solve problems in all the phyllosilicate mineral groups.

1. *Current/future research plans: environmental chamber for liquid/gas/solid interactions.* A major goal of oceanographic research is to understand sea-water chemistry and how it is affected by reactions with sediments and rock on the ocean floor and by the influx of material from continents. An X-ray based high-pressure environmental system for studies to 1000 bars pressure and from 0 to 200 °C, i.e. deep ocean-floor conditions, is being designed to investigate possible reactions between seawater (or brines) and ocean-floor materials (minerals, biomass) under controlled conditions in real time. The high-pressure environmental chamber (HPEC) will use seawater plus solids in suspension, that can be pressurized with various gases (e.g., CH₄, CO₂, O₂). The HPEC will be equipped with injection and extraction valves to allow the chemistry of the sample environment to be changed and analyzed and an internal pump to obtain a dynamic flow to maintain equilibrium conditions. The HPEC will mimic the deep-ocean environment, and I anticipate that it will lead to a new, transformative paradigm of how rocks, oceans, and life are interconnected. Besides oceanographic studies, a wide-range of applications in materials science, bore-hole environments, climate-related studies (e.g., CO₂ sequestration), etc. is possible because materials and reactions can be studied with almost any liquid/gas as a component.

2. *Current/future research plans: Clay-hydrate intercalates and an environmental chamber for gas/solid interactions.* Methane hydrates are ubiquitous on the ocean floor and represent a vast reservoir of methane, a greenhouse gas. A low-temperature (0 - 150 °C), elevated-pressure (to 70 bars) powder X-ray diffraction environmental chamber was developed to study primarily gas/solid interactions for hydrate formation intercalated in the clay structure. Methane hydrates do indeed intercalate in swelling clays, suggesting an additional reservoir for methane that may have important implications for climate change, for energy-resource development, for understanding geologic hazards on the ocean floor, and for energy-exploration strategies. There are also important implications for clays on Mars, where methane and carbon dioxide may be candidates for clay intercalates located at the Martian poles. Studies are now involving mineral alterations in H₂O using static experiments with CO₂ gas.

3. *Organo-clay interactions.* Interactions between organic molecules and clays represent an important part of the field of “environmental mineralogy”. Understanding these interactions is critical in developing new materials for remediation of polluted ground water and soil. Organic molecule interstratifications in vermiculite have been studied by single crystal X-ray methods. Previous workers did not have a systematic approach to investigate the atomic structure of the organic molecule in the clay they studied. In contrast, I have been studying both the atomic structure of the organic molecule and the clay and how

organic-molecule complexity affects the overall structure of the clay. Thus, individual studies of tetramethylammonium (TMA-) and tetramethylphosphonium (TMP)-exchanged vermiculites have showed the effects of organic-molecule size on the structure, and monomethylammonium and dimethylammonium-exchanged vermiculite along with TMA-exchanged vermiculite showed the effects of increasing the complexity of the organic molecule on the structure. By transmission electron microscopy (TEM), I showed that structural defects play an important role in how organic molecules interact in certain clays, e.g., palygorskite. I am also considering how organo-clay interactions can self-assemble organic molecules perhaps as a prelude to the origin of life. More recently, along with a former student, I am developing clays as universal nucleants for the crystallization of protein structures.

4. *Dehydration and dehydroxylation reactions.* The role of water (H_2O , OH) in reactions involving phyllosilicates is fundamental in sedimentary, metamorphic, and diagenetic processes, as well as in many industrial and engineering applications. My research combines high-temperature, X-ray diffraction techniques with high-pressure DTA to propose atomistic models for these reactions, in addition to the description of the thermodynamic properties. Studies have included a wide range of interlayer cation-exchanged smectite minerals to understand the dehydration and dehydroxylation of these minerals. During the same period, high-temperature studies of the atomic structure of muscovite (for dioctahedral micas), phlogopite (for trioctahedral micas), lizardite (for serpentines), and chlorite were made to understand how phyllosilicate atomic structures respond to temperature increases. The muscovite structure paper was seminal in the use of Pauling's rules to develop an atomistic dehydroxylation model. I was quite pleased that this approach was used later by Drits and co-workers to develop models for the dehydroxylation of *cis*-vacant micas.

5. *Modulated phyllosilicates.* The characterization of modulated layer silicates is important in the understanding of topological limits and possible chemical variations of common layer silicates. This work emphasizes the use of high-resolution transmission electron microscopy (HR TEM) and electron diffraction to determine the complex crystal structures of the modulated phyllosilicates. Structural models were developed that allowed the prediction of which structures of some phyllosilicates should be considered candidates for structural modulations. In addition, a general classification scheme was developed for the modulated phyllosilicates. Much of the TEM work on developing structural models was done in the 1980s, long before most workers (at least in the West) recognized that structures could be obtained from TEM intensity data.

6. *Structure studies of phyllosilicates.* Understanding the crystal structures of layer silicates is fundamental in predicting the physical and chemical properties of these materials. Current work involves X-ray structural studies at high temperatures (see dehydration and dehydroxylation studies), in addition to examining phyllosilicates of unusual chemistries. My earlier studies, in collaboration with my doctoral advisor, S.W. Bailey, developed models of cation ordering in subgroup symmetries, in particular, for mica minerals such as margarite, lepidolite, and zinnwaldite. The idea that ordering effects could only be recognized by considering subgroup symmetries of the space groups was novel, and we were the first to develop techniques where subgroups could be tested.

Publications

Guggenheim, S. and Bailey, S.W. (1975) Refinement of the margarite structure in subgroup symmetry. *American Mineralogist*, 60, 1023-1029.

Hall, S.H., Guggenheim, S., Moore, P. and Bailey, S.W. (1976) The structure of Unst-type 6-layer serpentines. *Canadian Mineralogist*, 14, 314-321.

- Guidotti, C.V., Cheney, J.T. and Guggenheim, S. (1977) Distribution of titanium between coexisting muscovite and biotite in pelitic schists from northwestern Maine. *American Mineralogist*, 62, 438-448.
- Guggenheim, S. and Bailey, S.W. (1977) The refinement of zinnwaldite-*IM* in subgroup symmetry. *American Mineralogist*, 62, 1158-1167.
- Guggenheim, S. and Bailey, S.W. (1978) Refinement of the margarite structure in subgroup symmetry: Correction, further refinement, and comments. *American Mineralogist*, 63, 186-88.
- Guggenheim, S. (1978) Polytype transformations in experimentally deformed wollastonite. *American Mineralogist*, 63, 1260-1263.
- Guggenheim, S. and Schreckeis, J. (1980) Mechanical aids for the alignment of four-circle single-crystal diffractometers. *Review of Scientific Instruments*, 51 (8), 1138-1139.
- Lee, J. and Guggenheim, S. (1981) Single crystal X-ray refinement of pyrophyllite-1Tc. *American Mineralogist*, 66, 350-357.
- Guggenheim, S. (1981) Cation ordering in lepidolite. *American Mineralogist*, 66, 1221-32.
- Baur, W.H., Guggenheim, S. and Lin, J.-C. (1982) Rutile-type compounds. VI. Refinement of VF_2 and computer simulation of V:MgF_2 . *Acta Crystallographica*, B38, 351-5.
- Guggenheim, S., Bailey, S.W., Eggleton, R.A. and Wilkes, Peter (1982) Structural aspects of greenalite and related minerals. *Canadian Mineralogist*, 20, 1-18.
- Cramer, W.E., Guggenheim, S. and Port, E. (1982) A fail safe design for X-ray safety shutters. *Journal of Applied Crystallography*, 15, 138-9.
- Guggenheim, S. and Bailey, S.W. (1982) The superlattice of minnesotaite. *Canadian Mineralogist*, 20, 579-84.
- Lin, J.-C. and Guggenheim, S. (1983) The crystal structure of a Li,Be-rich brittle mica: A dioctahedral-trioctahedral intermediate. *American Mineralogist*, 68, 130-142.
- Guggenheim, S., Schulze, W.A., Harris, G.A. and Lin, J.-C. (1983) Noncentric layer silicates: An optical second harmonic generation, chemical, and X-ray study. *Clays and Clay Minerals*, 31, 251-260.
- Koster van Groos, A. F. and Guggenheim, S. (1984) The effect of pressure on the dehydration reaction of interlayer water in Na montmorillonite (SWy-1). *American Mineralogist*, 69, 872-879.
- Guggenheim, S. and Kato, T. (1984) Kinoshitalite and Mn phlogopites: Trial refinements in subgroup symmetry and further refinement in ideal symmetry. *Mineralogical Journal*, 12, 1-5.
- Yeskis, D., Koster van Groos, A. F. and Guggenheim, S. (1985) The dehydroxylation of kaolinite. *American Mineralogist*, 70, 159-164.

- Koster van Groos, A.F. and Guggenheim, S. (1986) The dehydration of K-exchanged montmorillonite at elevated temperatures and pressures. *Clays and Clay Minerals*, 34, 281-286.
- Vaughan, M.T. and Guggenheim, S. (1986) Elasticity of muscovite and its relationship to crystal structure. *Journal of Geophysical Research*, 91, 4657-4665.
- Eggleton, R.A. and Guggenheim, S. (1986) A re-examination of the structure of ganophyllite. *Mineralogical Magazine*, 50, 307-318.
- Guggenheim, S. and Eggleton, R.A. (1986) Cation exchange in ganophyllite. *Mineralogical Magazine*, 50, 517-520.
- Guggenheim, S. and Eggleton, R.A. (1986) Structural modulations in iron-rich and magnesium-rich minnesotaite. *Canadian Mineralogist*, 24, 479-498.
- Koster van Groos, A.F. and Guggenheim, S. (1987) Dehydration of a Ca- and a Mg-exchanged montmorillonite (SWy-1) at elevated pressures. *American Mineralogist*, 72, 292-298.
- Guggenheim, S., Chang, Y.-H. and Koster van Groos, A.F. (1987) Muscovite dehydroxylation: High temperature studies. *American Mineralogist*, 72, 537-550.
- Guggenheim, S. and Eggleton, R.A. (1987) Modulated 2:1 Layer Silicates: Review, Systematics and Predictions. *American Mineralogist*, 72, 726-740.
- Koster van Groos, A.F. and Guggenheim, S. (1987) High pressure differential thermal analysis (HP-DTA) of the dehydroxylation of Na-rich montmorillonite and K-exchanged montmorillonite. *American Mineralogist* 72, 1170-1175.
- Komarneni, S. and Guggenheim, S. (1988) Comparison of cation exchange in ganophyllite and [Na + Al]-substituted tobermorite: Crystal chemical implications. *Mineralogical Magazine* 52, 371-375.
- Guggenheim, S. and Bailey, S.W. (1989) An occurrence of a modulated serpentine related to the greenalite-caryophyllite series. *American Mineralogist* 74, 637-641.
- Koster van Groos, A.F. and Guggenheim, S. (1989) Dehydroxylation of Ca- and Mg-exchanged montmorillonite. *American Mineralogist* 74, 627-636.
- Johnson, S.L., Guggenheim, S., and Koster van Groos, A.F. (1990) Thermal stability of halloysite by high-pressure differential thermal analysis. *Clays and Clay Minerals* 38, 477-484.
- Guggenheim, S. and Bailey, S.W. (1990) Baumite discredited. *American Mineralogist* 75, 705.
- Guggenheim, S. (1990) The dynamics of thermal decomposition in aluminous dioctahedral 2:1 layer silicates: A crystal chemical model. *Sciences Geologiques v. II*, 99-107.
- Miller, A.K., Guggenheim, S., and Koster van Groos, A.F. (1991) Bond energy of adsorbed and interlayer water: Kerolite dehydration at elevated pressures. *Clays and Clay Minerals* 39, 127-130.

- Miller, A.K., Guggenheim, S., and Koster van Groos, A.F. (1991) The incorporation of "water" in a high-pressure 2:1 layer silicate: a high-pressure differential thermal analysis of the "10A phase". *American Mineralogist* 76, 106-112.
- Tyrna, P.L. and Guggenheim, S. (1991) The crystal structure of norrishite, $\text{KLiMn}^{3+}_2\text{Si}_4\text{O}_{12}$: an oxygen based mica. *American Mineralogist* 76, 266-271.
- Martin, R.T., Bailey, S.W., Eberl, D.D., Fanning, D.S., Guggenheim, S., Kodama, H., Pevear, D.R., Srodon, J., and Wicks, F.J. (1991) Revised classification of clay materials: Report of the Clay Minerals Society Nomenclature Committee for 1986-1988. *Clays and Clay Minerals* 39, 333-334.
- Coey, J.M.D., Bakas, T., and Guggenheim, S. (1991) Mossbauer spectra of minnesotaite and ferrous talc. *American Mineralogist* 76, 1905-1909.
- Guggenheim, S. and Koster van Groos, A.F. (1992) High-pressure differential thermal analysis (HP-DTA): I. Dehydration reactions at elevated pressures in phyllosilicates. *Journal of Thermal Analysis* 38, 1701-1728.
- Guggenheim, S. and Koster van Groos, A.F. (1992) High-pressure differential thermal analysis (HP-DTA): II. Dehydroxylation reactions at elevated pressures in phyllosilicates. *Journal of Thermal Analysis* 38, 2529-2548.
- Bai, T.-B., Guggenheim, S., Wang, S.-J., Rancourt, D.G., and Koster van Groos, A.F. (1993) Metastable phase relations in the chlorite-H₂O system. *American Mineralogist* 78, 1208-1216.
- Nelson, D.O. and Guggenheim, S. (1993) Inferred limitations to the oxidation of iron in chlorite: A single-crystal high-temperature X-ray study. *American Mineralogist* 78, 1197-1207.
- Heinrich, A.R., Eggleton, R.A., and Guggenheim, S. (1994) Structure and polytypism of bementite, a modulated layer silicate. *American Mineralogist*, 79, 91-106.
- Eggleton, R.A. and Guggenheim, S. (1994) The use of electron optical methods to determine the crystal structure of a modulated phyllosilicate: Parsettensite. *American Mineralogist* 79, 426-437.
- Guggenheim, S. and Eggleton, R.A. (1994) A comparison of the structures and geometric stabilities of parsettensite and stilpnomelane: A Distance Least-Squares (DLS) study. *American Mineralogist* 79, 438-442.
- Bai, T.B., Koster van Groos, A.F., and Guggenheim, S. (1994) Phase transition, dehydration, and melting relationships of portlandite. *American Mineralogist* 79, 1223-1226.
- Guggenheim, S. and Martin, R. T. (1995) Definition of clay and clay mineral: Joint report of the AIPEA Nomenclature and CMS Nomenclature Committees. *Clays and Clay Minerals*, 43, 255-6, and *Clay Minerals*, 30, 257-259.
- Guggenheim, S. (1995) Structural studies and recent trends in the research of phyllosilicates. *Clays Controlling the Environment, Proceedings of the 10th International Clay Conference, Adelaide, Australia*, Churchman, G.J., Fitzpatrick, R.W., and Eggleton, R.A., eds, 24-29.

- Guggenheim, S. (1995) Oxidation and thermal decomposition of chlorite. *Clays Controlling the Environment, Proceedings of the 10th International Clay Conference, Adelaide, Australia*, Churchman, G.J., Fitzpatrick, R.W., and Eggleton, R.A., eds, 213-218.
- Zhan, W. and Guggenheim, S. (1996) The dehydroxylation of chlorite and the formation of topotactic product phases. *Clays and Clay Minerals*, 43, 622-629.
- Wang, S., Koster van Groos, A.F., and Guggenheim, S. (1996) The effect of CaCl₂-H₂O fluids on the dehydration of Ca-exchanged montmorillonite (SWy-1) at elevated temperatures and pressures: The significance of brines in sedimentary basins. *Geochimica Cosmochimica Acta*, 60, 2167-2172.
- Guggenheim, S. and Martin, R. T. (1996) Reply to comment by D.M. Moore on "Definition of clay and clay mineral: Joint report of the AIPEA Nomenclature and CMS Nomenclature Committees". *Clays and Clay Minerals*, 44, 713-715. Also published in *Clay Minerals*.
- Wu, T-c., Bassett, W.A., Huang, W-L., Guggenheim, S., and Koster van Groos, A.F. (1997) Montmorillonite under high H₂O pressures: stability of hydrate phases, rehydration hysteresis, and the effect of interlayer cations. *American Mineralogist*, 82, 69-78.
- Guggenheim, S., Alietti, A., Drits, V., Formoso, M., Galan, E., Paquet, H., Watanabe, T., Bain, D., and Hudnall, W. (1997) Report of the Association Internationale pour L'Etudes des Argiles (AIPEA) Nomenclature Committee for 1996. *Clays and Clay Minerals*, 45, 298-300, and *Clay Minerals* 32, 493-495.
- Vahedi-Faridi, A. and Guggenheim, S. (1997) Crystal structure of tetramethylammonium (TMA)-exchanged vermiculite. *Clays and Clay Minerals*, 45, 859-866.
- Guggenheim, S. and Eggleton, R.A. (1998) The crystal structures of greenalite and caryopilite: A system with long-range, in-plane structural disorder in the tetrahedral sheet. *Canadian Mineralogist*, 36, 163-179.
- Rieder, M. Cavazzini, G., D'Yakonov, Yu. S., Frank-Kamenetskii, V.A., Gottardi, G., Guggenheim, S., Koval, P.V., Müller, G., Neiva, A.M.R., Radoslovich, E.W., Robert, J.-L., Sassi, F.P., Takeda, H., Weiss, Z., and Wones, D.R. (1998) International Mineralogical Association Report: Nomenclature of the micas. *Clays and Clay Minerals*, 46, 586-595. Also concurrent in *Canadian Mineralogist*, *European Journal of Mineralogy*, *American Mineralogist-Electronic format* and several other journals
- Guggenheim, S. and Zhan, W. (1998) Effect of temperature on the structures of lizardite-*1T* and lizardite-*2H₁*. *Canadian Mineralogist*, 36, 1587-1594.
- Vahedi-Faridi, A. and Guggenheim, S. (1999) Structural study of tetramethylphosphonium(TMP)-exchanged vermiculite. *Clays and Clay Minerals*, 47, 219-225.
- Vahedi-Faridi, A. and Guggenheim, S. (1999) Structural study of monomethylammonium and dimethylammonium-exchanged vermiculite. *Clays and Clay Minerals*, 47, 338-347.

- Russell, R.L. and Guggenheim, S. (1999) Crystal structures of hydroxyphlogopite at high temperatures and heat-treated biotites: The influence of the O,OH,F site. *Canadian Mineralogist*, 37, 711-720.
- Guggenheim, S. and Zhan, W. (1999) Crystal structures of two partially dehydrated chlorites: the 'modified' chlorite structure. *American Mineralogist*, 84, 1415-1421.
- Guggenheim, S. and Frimmel, H.E. (1999) Ferrokinoshitalite, a new species of brittle mica from the Broken Hill mine, South Africa: Structural and mineralogical characterization. *Canadian Mineralogist*, 37, 1445-1452.
- Koster van Groos, A.F. and Guggenheim, S. (2000) Can the loss of the Mars Polar Lander be attributed to gas hydrates? *Science*, February 11, 2000 (letter).
- Awad, A., Koster van Groos, A.F., and Guggenheim, S. (2000) Forsteritic olivine: Effect of crystallographic direction on dissolution kinetics. *Geochimica et Cosmochimica Acta*, 64, 1765-1772.
- Guggenheim, S. and Koster van Groos, A.F. (2001) Baseline Studies of the Source Clays of The Clay Minerals Society. Part 5. Thermal analytical techniques. *Clays and Clay Minerals*, 49, 433-443.
- Guggenheim, S., Bain, D.C., Bergaya, F., Brigatti, M.F., Drits, V., Eberl, D.D., Formoso, M., Galán, E., Merriman, R.J., Peacor, D.R., Stanjek, H., and Watanabe, T. (2002) Report of the Association Internationale pour L'Etudes des Argiles (AIPEA) Nomenclature Committee for 2001: Order, disorder, and crystallinity in phyllosilicates and the use of the "crystallinity" index. *Clays and Clay Minerals*, 50, 406-409, and *Clay Minerals*, 37, 389-393.
- Brigatti, M.F., Guggenheim, S. and Poppi, M. (2003) Crystal chemistry of the 1M mica polytypes: The octahedral sheet. *American Mineralogist*, 88, 667-675.
- Koster van Groos, A.F., Guggenheim, S., and Cornell, C. (2003) Elevated-pressure, low-temperature environmental chamber for powder X-ray diffractometers. *Reviews of Scientific Instruments*, 74, 273-275.
- Guggenheim, S. and Koster van Groos, A.F. (2003) A new gas hydrate phase: Synthesis and stability of clay-methane hydrate intercalate. *Geology*, 31, 653-656
- Krekeler, M..P.S., Guggenheim, S. and Rakovan, J. (2004) A microtexture study of palygorskite-rich sediments from the Hawthorne Formation, southern Georgia, by transmission electron microscopy and atomic force microscopy. *Clays and Clay Minerals*, 52. 263-274.
- Cygan, R.T., Guggenheim, S. and Koster van Groos, A.F. (2004) Molecular models for the intercalation of methane hydrate complexes in montmorillonite clay. *Journal of Physical Chemistry B*, 108, 15141-15149.
- Krekeler, M.. P. S., Hammerly, E., Rakovan, J, and Guggenheim, S (2005) Microscopy studies of the palygorskite to smectite transformation. *Clays and Clay Minerals*, 53, 92-99.
- Guggenheim, S. (2005) Simulations of Debye-Scherrer and Gandolfi patterns using a Bruker SMART/APEX diffractometer system. *Bruker-AXS Application Notes Series*, 1-8.

- Deamer, D., Singaram, S., Rajamani, S., Kompanichenko, V., and Guggenheim, S. (2006) Self-assembly processes in the prebiotic environment. *Philosophical Transactions of the Royal Society, B-Biological Sciences* 361:1474, 1809-1818.
- Guggenheim, S., Adams, J.M., Bain, D. C., Bergaya, F., Brigatti, M.F., Drits, V.A., Formoso, M.L.L., Galan, E., Kogure, T., and Stanjek, H. (2006) Summary of recommendations of nomenclature committees relevant to clay mineralogy: Report of the Association Internationale pour L'Etudes des Argiles (AIPEA) Nomenclature Committee for 2006. *Clays and Clay Minerals*, 54, 761-772 and *Clay Minerals*, 41, 863-878. Corrigendum, *Clays and Clay Minerals* (2007) 646-7.
- Lee, S.S., Guggenheim, S., Dyar, M. D., and Guidotti, C.V. (2007) Chemical composition, statistical analysis of the unit cell, and electrostatic modeling of the structure of Al-saturated chlorite. *American Mineralogist*, 92, 954-965.
- Rule, A. C. and Guggenheim, S. (2007) A standards-based curriculum for clay science. *Journal of Geoscience Education*, 55, 257-266.
- Shaibat, M.A., Casabianca, L.B., Wickramasinghe, N.P., Guggenheim, S., de Dios, A.C., Ishii, Y. (2007) Characterization of polymorphs and solid-state reactions for paramagnetic systems by ^{13}C solid-state NMR and *Ab Initio* calculations. *Journal of the American Chemical Society*, 129, 10968-10969.
- Phillips, B.L, Mason, H.E., and Guggenheim, S. (2007) Hydrogen bonded silanols in the 10 Å phase: Evidence from NMR spectroscopy. *American Mineralogist*, 92, 1474-1485.
- Krekeler, M. and Guggenheim, S. (2008) Defects in microstructure in palygorskite-sepiolite minerals: A transmission electron microscopy (TEM) study. *Applied Clay Science*, 39, 98-105.
- Koster van Groos, A.F. and Guggenheim, S. (2009) The stability of methane hydrate intercalates of montmorillonite and nontronite: Implications for carbon storage in ocean-floor environments. *American Mineralogist*, 94, 372-379.
- Guggenheim, S., Adams, J.M., Bergaya, F., Brigatti, M.F., Drits, V.A., Formoso, M.L.L., Galan, E., Kogure, T., Stanjek, H., and Stucki, J. (2009) Nomenclature for stacking in phyllosilicates: Report of the Association Internationale pour L'Etudes des Argiles (AIPEA) Nomenclature Committee for 2008. *Clays and Clay Minerals*, 57, 46-47 and simultaneously published in *Clay Minerals*, 44, 157-9.
- Bujnowski, T.J., Guggenheim, S. and Kato, T. (2009) Crystal structure determination of anandite-2M mica. *American Mineralogist*, 94, 1144-1152.
- Bujnowski, T. J., Guggenheim, S., and Brigatti, M.F. (2010) Al-saturated phlogopite: Charge considerations and crystal chemistry. *Clays and Clay Minerals*, 57, 673-685.
- Zhang, G., Wei, Z., Ferrell, R.E., Guggenheim, S., Cygan, R.T., and Luo, J. (2010) Evaluation of the elasticity normal to the basal plane of non-expandable 2:1 phyllosilicates by nanoindentation. *American Mineralogist*, 95, 863-869.

- Wahle, M.W., Bujnowski, T.J., Guggenheim, S., and Kogure, T. (2010) Guidottiite, the Mn-analogue of cronstedtite: A new serpentine mineral from South Africa. *Clays and Clay Minerals*, 58,364-376.
- Giesting, P., Guggenheim, S. Koster van Groos, A.F., and Busch, A. (2012) Interaction of carbon dioxide with Na-exchanged montmorillonite at pressures to 640 bars: Implications for CO₂ sequestration. *International Journal of Greenhouse Gas Control*, 8, 73–81.
- Giesting, P., Guggenheim, S. Koster van Groos, A.F., and Busch, A. (2012) X-ray diffraction study of K- and Ca-exchanged montmorillonites in CO₂ atmospheres. *Environmental Science & Technology*, 46, 5623-5630.
- Drits, V.A., Guggenheim, S., Kogure, T., and Zviagina, B.B. (2012) Structures of the 2:1 layers of pyrophyllite and talc. *Clays and Clay Minerals*, 60, 574-587.
- Elmi, C., Brigatti, M.F., Guggenheim, S., Pasquali, L., Montecchi, M., Malferrari, D., and Nannarone, S.(2013) Sodian muscovite-2M₁: Crystal chemistry and surface features. *Canadian Mineralogist*, 51, 5-14.
- Martos-Villa, R., Guggenheim, S., and Sainz-Diaz, C. I. (2013) Interlayer water molecules in organocation-exchanged vermiculite and montmorillonite: A case study of tetramethylammonium. *American Mineralogist*, 99, 1535-1542.
- Johns, C. A., Martos-Villa, R., Guggenheim, S., and Sainz-Diaz, C. I. (2013) Structure determination of trimethylsulfoxonium-exchanged vermiculite. *Clays and Clay Minerals*, 61, 218-230.
- Martos-Villa, R., Guggenheim, S., Mata, M.P., Sainz-Diaz, C. I., and Nieto, F. (2014) Interaction of methane hydrate complexes with smectites: Experimental results compared to molecular models. *American Mineralogist*, 99, 401-414
- Elmi, C., Brigatti, M.F., Guggenheim, S., Pasquali, L., Montecchi M.,and Nannarone, S. (2014) Crystal chemistry and surface configurations of two iron-bearing trioctahedral mica-1M polytypes. *Clays and Clay Minerals*, 62, 243-252.
- Elmi, C., Brigatti, M.F., Guggenheim, S., Pasquali, L., Montecchi M.,and Nannarone, S. (2014) Crystal chemistry and surface configurations of two polyolithionite-1M crystals. *American Mineralogist*, 99, 2049-2059.
- Guggenheim, S. and Koster van Groos, A. F. (2014) An integrated experimental system for solid-gas-liquid environmental cells. *Clays and Clay Minerals*, 62, 479-485.
- Tosca, N.J., Guggenheim, S., and Pufahl, P.K. (2016) An authigenic origin for Precambrian greenalite: Implications for iron formation and the chemistry of ancient seawater. *Geological Society of America Bulletin*, 128, 511-530.
- Mates, J.E., Ibrahim, R., Vera, A., Guggenheim, S., Qin, J., Calewatts, D., Waldroup, D.E., and Megaridis, C.M. (2016) Environmentally-safe and transparent superhydrophobic coatings. *Green Chemistry*, 18, 2185 – 2192.

- Brigatti, M.F., Elmi, C., Guggenheim, S., Malferrari, D., and Poppi, M. (2016) Crystal chemistry of true micas and implications of cleavage-surface properties. *American Mineralogist*, 101, 2738-2746.
- Elmi, C., Guggenheim, S., and Gieré, R. (2016) Surface crystal chemistry of phyllosilicates using X-ray photoelectron spectroscopy: A review. *Clays and Clay Minerals*, 64, 537-551.
- Pandya, M., Liu, H., Dangaria, S.J., Zhu, W., Li, L.L., Pan, S., Abufarwa, M., Davis, R.G., Guggenheim, S., Keiderling, T., Luan, X., and Diekwisch, T.G.H. (2017) Integrative Temporo-Spatial, Mineralogic, Spectroscopic, and Proteomic Analysis of Postnatal Enamel Development in Teeth with Limited Growth. *Frontiers in Physiology*, 8, Oct., 2017, 1-15.
- Mates, J.E., Song, J., Palumbo, J., Guggenheim, S., Schenk, A., Pourdeyhimi, B., and Megaridis, C.M. (2019) Microfiber piezoelectric textiles for rapid high-efficiency emulsion separation. *Nature Communications* (in review)
- He, H., Yang, Y., Ma, L., Su, X., Xian, H.Y., Zhu, J., Teng, H.H., Guggenheim, S. (2019) A two-stage particle attachment for phyllosilicate crystallization in geological processes. *Nature Communications* (in review).

Chapters in books

- Guggenheim, S. (1984) The brittle micas. In *Micas* (Mineralogical Society of America Reviews in Mineralogy, v. 13.) Chapter 3. Ed. by S.W. Bailey.
- Evans, B.W. and Guggenheim, S. (1988) Talc, pyrophyllite and related minerals. In *Hydrous phyllosilicates exclusive of the micas* (Mineralogical Society of America Reviews in Mineralogy, v. 19) Ed. by S.W. Bailey, 225-294.
- Guggenheim, S. and Eggleton, R.A. (1988) Crystal chemistry, classification, and identification of modulated layer silicates. In *Hydrous phyllosilicates exclusive of the micas* (Mineralogical Society of America Reviews in Mineralogy, v. 19) Ed. by S.W. Bailey, 675-725.
- Koster van Groos, A.F. and Guggenheim, S. (1990) High pressure differential thermal analysis (HP-DTA): Applications to clay minerals. In *Thermal Analysis in Clay Science* (CMS Workshop Lectures, v. 3) Eds. J.W. Stucki, D. Bish, and F.A. Mumpton, 49-94.
- Guggenheim, S. (1997) Introduction to the properties of clay minerals (*and a discussion on the application of clay minerals to low-level radioactive waste disposal*). MSA Monograph: *Teaching Mineralogy*, Brady, J.B., Mogk, D.W., and Perkins, D., III, Eds., 371-388.
- Brigatti, M.F. and Guggenheim, S. (2002) Mica crystal chemistry and the influence of intensive variables on atomistic models. In *Micas: Crystal Chemistry and Metamorphic Petrology*, Ed. by A. Mottana, F. Sassi, J. B. Thompson, and S. Guggenheim, Reviews in Mineralogy, 1-99.
- Guggenheim, S. (2002) An introduction to the analysis of clay minerals by laser and X-ray diffraction techniques. In *Teaching Clay Science*, CMS Workshop Notes series, v. 11, Ed. by A. Rule and S. Guggenheim, Clay Minerals Society, 143-160.

Guggenheim, S. and Kane, S. (2002) Cooperative learning techniques: Applications to clay science. In *Teaching Clay Science*, CMS Workshop Notes series, v. 11, Ed. by A. Rule and S. Guggenheim, Clay Minerals Society, 45-58.

Ross, B. and Guggenheim, S. (2002) Interlayer reactions in expandable clays: Exchange, solvation, and intercalation experiments. In *Teaching Clay Science*, CMS Workshop Notes series, v. 11, Ed. by A. Rule and S. Guggenheim, Clay Minerals Society, 161-180.

Guggenheim, S. and Krekeler, M.P.S. (2011) The structures and micro-structures of the palygorskite-sepiolite group minerals. In Part 1. Advances in the Structure and Chemistry of Sepiolite and Palygorskite. *Developments in Palygorskite-Sepiolite Research. A new outlook of these nanomaterials*, E. Galán, Ed., Elsevier, 1-32.

Guggenheim, S. (2011) An overview of order/disorder in hydrous phyllosilicates. In European Mineralogical Union (EMU) Notes in Mineralogy Series, *Layered mineral structures*. M.F. Brigatti, Ed., 73-121.

Guggenheim, S. (2015) Introduction to Mg-rich clay minerals: Structure and composition. In *Magnesian clays: Characterization, origin, and applications*, Pozo, M. And Galán, E., Eds. AIPEA Publication No. 2, 1-62.

Guggenheim, S. (2015) Phyllosilicates used as nanotube substrates in engineered materials: Structures, chemistry, and textures. In *Natural Mineral Nanotubes: Properties and Applications*, Pasbakhsh, P. and Churchman, J., Eds., Apple Academic Press, New Jersey, USA., 3-48.

Books or Journals Edited

Editor-in-Chief, Oct., 1998 to Jan., 2001, The Journal: *Clays and Clay Minerals*

Baseline studies of the Clay Minerals Society Source Clays, P.M. Costanzo and S. Guggenheim, Eds., volume 49, issue 5, *Clays and Clay Minerals*, 2001

Micas: Crystal chemistry and metamorphic petrology. Reviews in Mineralogy and Geochemistry. Mottana, A., Sassi, F.P., Thompson, J.B., Jr. and Guggenheim, S. Editors. Mineralogical Society of America and Accademia Nazionale dei Lincei, Washington, DC. (2002), 499 p.

Teaching Clay Science. CMS Workshop Notes Series, A. Rule and S. Guggenheim, Eds., The Clay Minerals Society, Boulder, CO (2002), 223 p.

Miscellaneous publications

X-ray powder patterns of micas: Appendix in *Micas* (Mineralogical Society of America Reviews in Mineralogy, v. 13) Appendix, 573-584 (with S.W. Bailey)

Hawley Medal Acceptance Speech (for 1987) *Canadian Mineralogist* 25, 786-788

Interview of S.W. Bailey for "Interviews of Pioneers in Clay Mineralogy" series, Clay Minerals Society Newsletter, September, 1990, 4-11.

Report of the Secretary for 1991. (Mineral. Soc. of America) American Mineralogist 77, 874-875 (1992)

Report of the Secretary for 1992. (Mineral. Soc. of America) American Mineralogist 78, 858-859 (1993)

Report of the Secretary for 1993. (Mineralogical Society of America) The Lattice 10, 8-9 (1994).

Report of the Secretary for 1994. (Mineralogical Society of America) The Lattice 11, 10-11 (1995).

Muscovite, Phlogopite, Lepidolite, Vermiculite: Four separate articles for McGraw-Hill Encyclopedia Of Science and Technology, 8th edition, S.P. Parker, editor, New York, McGraw-Hill, 1997, v. 15. Updated in 2010.

Memorial: Sturges ("Bull") William Bailey, same article published in American Mineralogist, 1995, v. 80, in press, Clay Minerals, 1995, v. 30, 87-88, and the Clay Minerals Society Newsletter, Winter, 1995, 3-7.

The Bragg equation: What to do with "n" and other comments. Clay Minerals Society Newsletter, Summer, 1995, 14-15.

Allen, C.C., Beaty, D.W., Blake, D.F., Bridges, N.T., Council, J-L., Guggenheim, S., MacPherson, G.J.McDonald, G.D., Ming, D.W., Papanastassiou, D.A., Owen, T., and Trent, J. (2001) Mars return sample temperature study. Internal document, NASA/JPL, 1-12.

Guggenheim, S. (Editor), (2009-present) *Glossary of clay science*. The Clay Minerals Society, published on the CMS website at: <http://www.clays.org/> Expanded versions are published annually.

Reviews

Guggenheim, S. (1985) Review of Crystal Structures of Clay Minerals and their X-ray Identification, ed. by G. W. Brindley and G. Brown. In Journal of Sedimentary Petrology 55, 786.

Guggenheim, S. (1997) Review of Crystallography, by W. Borchardt-Ott. In American Mineralogist 82, 840.

Guggenheim, S. (2005) Deer, Howie, and Zussman Rock-Forming Minerals, Sheet Silicates: Micas, by M.E. Fleet. In American Mineralogist, 90, 774-775.

Guggenheim, S. (2014) Deer, Howie, and Zussman Rock-Forming Minerals, Sheet Silicates: Clay Minerals, by M.J. Wilson. In Clays and Clay Minerals, 61, 475-476.

Formal Talks Given (with Abstracts)

All abstracts are published, in the respective meeting abstract volume unless indicated otherwise.

- Guggenheim, S., Wilkes, P. and Bailey, S.W. (1977) X-ray and electron diffraction study of greenalite and minnesotaite. American Geophysical Union Transactions, EOS (invited paper, AGU Spring 1977 Meeting).
- Guggenheim, S., Wilkes, P. and Bailey, S.W. (1979) The nature of greenalite. 25th Annual Institute on Lake Superior Geology.
- Lin, J.-C. and Guggenheim, S. (1981) The Li,Be Micas: Dioctahedral/ Trioctahedral Structural Intermediates. Clay Mineral Society Annual Meeting.
- Guggenheim, S., Bailey, S.W., Eggleton, R.A. and Wilkes, P. (1981) Structural Aspects of Greenalite. Clay Mineral Society Annual Meeting (invited paper).
- Koster van Groos, A.F. and Guggenheim, S. (1982) The effect of pressure on the dehydration reaction of montmorillonite, SWy-1. Clay Mineral Society Annual Meeting.
- Yeskis, D., Guggenheim, S. and Koster van Groos, A.F. Member, (1983) Differential Thermal Analysis (DTA) of kaolinite, pyrophyllite and muscovite at high pressures. North Central Section of the Geological Society of America 17th Annual Meeting.
- Medaris, G., Jr. and Guggenheim, S. (1983) An occurrence of agrellite and miserite in the Wausau Complex, Marathon County, Wisconsin. Mineralogical Society of America Symposium on Alkaline Complexes. September 16-18, 1983. Wausau, Wisconsin.
- Vaughan, M. and Guggenheim, S. (1985) Elasticity of micas. International Clay Conference.
- Guggenheim, S. (1985) Across interlayer space: Modulated layer silicates, systematics and predictions. International Clay Conference.
- Guggenheim, S. (1986) Modulated 2:1 layer silicates. International Mineralogical Association, 14th General Meeting, Stanford University, 116-117.
- Guggenheim, S., Chang, Y.-H. and Koster van Groos, A.F. (1986) Muscovite dehydroxylation. Geological Society of America Annual Meeting.
- Bouchard, S. and Guggenheim, S. (1987) Structural changes in margarite with increasing temperature. GSA North Central Section Meeting.
- Buseck, P.R., Ahn, J.H., Guggenheim, S. and Rimsky, A. (1987) Tetrahedral strip disorder in minnesotaite. Geological Society of America Annual Meeting.
- Wiet, S. L., Koster van Groos, A. F., and Guggenheim, S. (1988) Morphologic control of Halloysite Dehydroxylation. Clay Minerals Society Annual Meeting.
- Kokines, A., Guggenheim, S., Koster van Groos, A. F., and Sclar, C. B. (1988) Interlayer water loss in a high-pressure mica-like phase. Clay Minerals Society Annual Meeting.
- Eggleton, R.A. and Guggenheim, S. (1988) A new model for the structure of bementite, a modulated 1:1 layer silicate. Geological Society of America Annual Meeting.

- Guggenheim, S. (1989) The dynamics of thermal decomposition in aluminous dioctahedral 2:1 layer silicates. AIPEA-9th International Clay Conference (invited), Strasbourg, France.
- Tyrna, P. and Guggenheim, S. (1989) The crystal structure of norrishite, an anhydrous mica. Geological Society of America Annual Meeting.
- Rakovan, J.F. and Guggenheim, S. (1991) Rietveld refinement of clinochlore-I**b**-2. Clay Minerals Society Annual Meeting.
- Guggenheim, S., Eggleton, R.A., Mackinnon, I.D.R. (1991) The crystal structure of greenalite and caryopilite: A system of regularly interstratified crystalline and semi-amorphous sheets. Clay Minerals Society Annual Meeting.
- Eggleton, R.A. and Guggenheim, S. (1991) The crystal structure of parsettensite by electron-optical methods and comparisons to stilpnomelane. Geological Society of America Annual Meeting.
- Farrow, EA., Livi, K. J.T., Guggenheim, S., Veblen, D.R., and Morad, S. (1991) The structure of bannisterite: An experimental and computer simulated transmission electron microscopy (TEM) study. Terra Abstracts, 3, 401.
- Nelson, Daniel O. and Guggenheim, S. (1992) High-temperature single-crystal X-ray study of chlorite. Clay Minerals Society Annual Meeting. (Abstract presented orally and not included in volume owing to an error)
- Guggenheim, S. (1993) Recent trends in structural studies of the phyllosilicates 1989-1992. AIPEA 10th International Clay Conference, Adelaide, Australia, invited.
- Guggenheim, S. and Eggleton, R.A. (1993) Crystal-glass sandwiches: The structure of greenalite-caryopilite. AIPEA 10th International Clay Conference, Adelaide, Australia. Keynote speaker.
- Guggenheim, S. (1993) Oxidation and thermal decomposition of chlorite. AIPEA 10th International Clay Conference, Adelaide, Australia, **Keynote Speaker**.
- Guggenheim, S. (1993) Environmental mineralogy at UIC. Geological Society of America Annual Meeting.
- Wu, T-c., Bassett, W.A., Huang, W-L., Guggenheim, S., and Koster van Groos, A.F. (1995) Dehydration and rehydration of Ca-exchanged montmorillonite in H₂O at high pressures and temperatures: an in situ X-ray diffraction study in a hydrothermal diamond-anvil cell. Goldschmidt Conference, May 24-26, 1995.
- Vahedi-Faridi, A. and Guggenheim, S. (1996) Single crystal X-ray structure determination of TMA-vermiculite. Clay Minerals Society Annual Meeting, Gatlinsberg, TN.
- Vahedi-Faridi, A. and Guggenheim, S. (1997) Structure of TMP-exchanged vermiculite. International Clay Conference, Ottawa.

- Vahedi-Faridi, A. and Guggenheim, S. (1998) Structural study of monomethylammonium and dimethylammonium-exchanged vermiculite, Clay Minerals Society Annual Meeting, Cleveland, Ohio
- Awad, A., Koster van Groos, A.F., and Guggenheim, S. (1998) Directional dissolution kinetics of forsteritic olivine. American Geophysical Union Fall Meeting
- Vahedi-Faridi, A. and Guggenheim, S. (1998) Pillared clays: crystal structures of a series of organic-cation exchanged vermiculites. Geological Society of America Annual Meeting, Toronto, Canada
- Johns, C. and Guggenheim, S. (1999) X-ray structure of a trimethylsulfoxonium-exchanged vermiculite. Annual Meeting, Clay Minerals Society, Purdue University, June, 1999.
- Guggenheim, S. and Zhan, W. (1999) The Heat-treatment test to discriminate between Fe-rich chlorite and kaolinite: Why does it work? Euroclay Conference, Kraków, Poland, Sept. 5, 1999.
- Hammerly, E., Rakovan, J. and Guggenheim, S. (2001) An AFM study of the palygorskite-sepiolite to smectite transformation in the Meigs-Attapulgas-Quincy district. Goldschmidt Conference, May, 2001, Hot Springs, Virginia.
- Krekeler, M., Guggenheim, S., and Rakovan, J. (2001) Palygorskite deposits from the Hawthorne Formation, southern Georgia: A complex history of sedimentation and authigenesis. GSA Annual Meeting, Boston.
- Guggenheim, S. (2001) Recent Structural Studies of Organo-pillared clays. The 12 th International Clay Conference, 22-28 July 2001, Bahia Blanca, Argentina. **Keynote speaker**
- Krekeler, M., Guggenheim, S., and Rakovan, J. (2002) TEM investigation of apatite and oxide minerals in palygorskite deposits from the Hawthorne Formation, Clays and Clay Minerals Annual Meeting, June, 2002, Boulder, CO.
- Guggenheim, S. and Koster van Groos, A. F. (2002) Relations of methane and smectite at 40-bar pressure and temperatures between 22 and -9°C. International Mineralogical Association Meeting, Sept., 2002, Scotland
- Krekeler, M. and Guggenheim, S. (2003) Polysome-related defects in palygorskite-sepiolite minerals: A transmission electron microscopy (TEM) study. Clay Minerals Society Annual Meeting, June, 2003, Athens, Georgia.
- Guggenheim, S. and Koster van Groos, A. F. (2003) Clays and methane hydrate. Clay Minerals Society Annual Meeting, June, 2003, Athens, Georgia.
- Guggenheim, S. and Koster van Groos, A. F. (2003) Smectites, Gas Hydrates, and Interlayer H₂O: Recent Developments. Euroclay, June, Modena, Italy, Keynote speaker.
- Guggenheim, S. (2004) Simulations of Debye-Scherrer and Gandolfi powder patterns using the Bruker SMART/APEX three-circle diffractometer system. American Crystallographic Association Annual Meeting, Chicago, Il., 18-22 July 2004.

- Krekeler, M., Rakovan, J., and Guggenheim, S. (2004) Polysome-width variation in palygorskite-sepiolite minerals: A TEM and AFM investigation of structural variation and transformation. GSA Annual Meeting, Denver, Nov., 2004.
- Kelkar, K., Guggenheim, S. and Koster van Groos, A. F. (2004) Methane hydrate-smectite clay complexes in Na-exchanged nontronite and K-exchanged montmorillonite, GSA Annual Meeting, Denver, 2004
- Guggenheim, S. and Koster van Groos, A. F. (2005) Phase equilibria applications: Gas hydrate-smectite clay complexes. Micas 2005, Italian Mineralogical Society meeting, Rimini, Italy (invited talk)
- Brigatti, M.F., Guggenheim, S., Laurora, A., Malferrari, D., Poppi, M., and Poppi, L. (2005) Crystal chemical models on trioctahedral and dioctahedral micas. Micas2005, Italian Mineralogical Society meeting, Rimini, Italy (invited talk).
- Lee, S.S., Guggenheim, S., Dyar, D. and Guidotti, C.V. (2005) Relationship of unit-cell parameters with chemical composition for aluminum-saturated chlorite. Clay Minerals Society Annual Meeting, June, 2005
- Guggenheim, S. and Koster van Groos, A.F. (2005) Methane hydrate-smectite clay complex stability. AIPEA Annual Meeting, August, 2005 (invited talk).
- Guggenheim, S. and Koster van Groos, A.F. (2006) Complexes of methane hydrate and clay. International Mineralogical Association Meeting, Kobe, Japan (invited talk).
- Guggenheim, S. and Koster van Groos, A. F. (2007) Methane + H₂O in smectite. Clay Minerals Society Annual Meeting, June, 2007
- Guggenheim, S. and Koster van Groos, A. F. (2007) Experimental studies of methane and smectite. Euroclay 2007, July, 2007, Aveiro, Portugal.
- Medaris, L.G., Jr., Fournelle, J.H., and Guggenheim, S. (2007) An occurrence of agrellite in the Wausau alkaline igneous complex, Marathon County, Wisconsin. Institute on Lake Superior Geology, 53rd Annual Meeting, 8-13 May 2007, Lutsen, Minnesota, 50-51.
- Koster van Groos, A. F. And Guggenheim, S. (2008) A High-Pressure X-Ray Environmental Chamber to Simulate Ocean-Floor Conditions. American Geophysical Union Annual Meeting, Dec., 2008, San Francisco.
- Guggenheim, S. And Koster van Groos, A.F. (2009) Deep ocean-floor and bore-hole simulations: Examples involving montmorillonite and nontronite. 14th International Clay Conference, 14-20 June 2009, Italy.
- Wei, Z., Zhang, G., Ferrell, R. And Guggenheim, S. (2009) Elastic moduli and nanohardness of talc and pyrophyllite. Clay Minerals Society Annual Meeting, 6-11 June 2009, Montana.

- Guggenheim, S. (2010) Structures of the palygorskite-sepiolite group minerals: Comments on the formation of polysomes. Clay Minerals Annual Meeting, Trilateral Meeting on Clays, 6-11 June 2010, Sevilla, Spain.
- Guggenheim, S. and Koster van Groos, A. F. (2010) A High-Pressure X-ray Environmental Chamber Suitable for Solid-Liquid-Gas Studies. International Mineralogical Association Meeting, 23-27 August 2010, Budapest, Hungary.
- Giesting, P., Guggenheim, S., and Koster van Groos, A. F. (2010) Smectite-CO₂ interactions to 400 bars and 65 °C. International Mineralogical Association Meeting, 23-27 August 2010, Budapest, Hungary.
- Koster van Groos, A.F., Giesting, P., Guggenheim, S., and Busch, A. (2010) Interaction of CO₂ and brines with montmorillonite to 400 bars and 45 °C. American Geophysical Union, Fall Meeting, San Francisco, 13-17 December.
- Giesting, P., Guggenheim, S., Koster van Groos, A. F. and Busch, A. (2011) Carbon dioxide intercalation in Na- and Ca-exchanged montmorillonite. European Geological Union General Assembly, 3-8 April 2011, Vienna, Austria.
- Dangaria, S., Guggenheim, S. and Diekwisch, T.G.H. (2011) Hydroxyapatite nucleation in developing mouse molar enamel matrix. Enamel Conference VIII, Starved Rock Lodge, 8-12 June 2011, Starved Rock, IL.
- Giesting, P., Guggenheim, S., Koster van Groos, A. F. and Busch, A. (2011) Reactions between CO₂ and montmorillonite: A preliminary study of the effect of interlayer Na, Ca, and H₂O content on CO₂ intercalation. EuroClay 2011, Antalya, Turkey, 26 June-1 July 2011.
- Giesting, P., Guggenheim, S., Koster van Groos, A. F. and Busch, A. (2011) Interactions of CO₂ and montmorillonite: implications for CO₂ sequestration. Clay Minerals Society Annual Meeting, 26-29 September 2011, Lake Tahoe, CA
- Busch, A., Bertier, P., Gensterblum, Y., Giesting, P., Guggenheim, S., and Koster van Groos, A.F. (2012) Clay/CO₂ interactions in the context of geological storage of carbon dioxide. Shale physics and chemistry, 3rd Annual European Association of Geoscientists and Engineers (EAGE) Workshop, 23-25 January 2012, Barcelona, Spain.
- Koster van Groos, A.F. and Guggenheim, S. (2012) A Pressure Cell to Study Kinetic Processes in Real Time. 14th International Conference on Experimental Mineralogy, Petrology and Geochemistry, University of Kiel, Germany, 4-7 March 2012, Conference Abstracts, 87.
- Koster van Groos, A.F. and Guggenheim, S. (2012) A high-pressure environmental chamber for clay studies. Clay Minerals Society Annual Meeting, Golden, CO, 7 - 11 July 2012, Program, 61.
- Guggenheim, S. and Koster van Groos, A.F. (2013) New X-ray environmental instrumentation for studying solids in solid-liquid-gas systems under confining pressures at elevated temperatures. Clay Minerals Society Annual Meeting, Urbana, Illinois, 5-9 October 2013, 89. **Bailey Award Presentation.**

- Guggenheim, S. (2013) S.W. Bailey: Modest and reserved, teacher and researcher. Clay Minerals Society Annual Meeting, Urbana, Illinois, 5-9 October 2013, 88.
- Elmi, C., Brigatti, M.F., Guggenheim, S., Pasquali, L., Montecchi, M., and Nannarone, S. (2013) Crystal chemistry and surface configurations of two iron-bearing trioctahedral mica-1M polytypes. Clay Minerals Society Annual Meeting, Urbana, Illinois, 5-9 October 2013, 56-57.
- Tosca, N. And Guggenheim, S. (2014) Experimental constraints on Precambrian seawater chemistry: Solubility in the Fe²⁺-SiO₂(aq) system. Goldschmidt Conference, Sacramento, CA 8-13 June 2014.
- Kowalik, J., Guggenheim, S., and Koster van Groos, A.F. (2015) Effects of temperature, pressure, and brine composition on the interlayer spacing of montmorillonite at in situ conditions using CO₂. EuroClay 2015, Edinburgh, Scotland, 5-10 July 2015.
- Ömeroğlu, I., Guggenheim, S., Türkmenoğlu, A., Koster van Groos, A.F., and Sayın, A. (2015) An experimental study of CO₂-H₂O-listwanite-based reactions using serpentine from the Ahırözü kaolin deposits, Eskişehir-Mihalıççık, Turkey. EuroClay 2015, Edinburgh, Scotland, 5-10 July 2015.
- Benavides, P.A., Kowalik, J., Guggenheim, S. and Koster van Groos, A.F. (2018) Effect of CO₂ pressure, temperature, and brine composition on the interlayer spacing of Na- and Ca-exchanged montmorillonite. Clay Minerals Society Annual Meeting, Urbana, Illinois, 11-14 June 2018, 9.
- Benavides, P.A., Kowalik, J., Guggenheim, S. and Koster van Groos, A.F. (2018) In-situ powder X-ray diffraction of a smectite-CO₂-brine system using a high-pressure environmental chamber. Goldschmidt2018, Boston, MA.
- Argyilan, E., Monaghan, G., Thompson, T.A., Guggenheim, S., Mastalerz, M., Avis, P.G., Johnson, M., Russell, K.P., and Huysken, K.T. (2018) Updating our understanding of collapse features in a migrating coastal dune, Indiana Dunes National Lakeshore. GSA Annual Meeting, Indiana, USA.
- Benavides, P.A.D., Guggenheim, S., and Koster van Groos, A.F. (2019) Effects of CO₂ pressure, temperature and brine composition on the interlayer spacing of a Mg-exchanged montmorillonite. Euroclay 2019: International Conference on Clay Science and Technology, Abstracts, 126.

Invited (Informal) Seminars (Abstracts not published)

- Department of Chemistry, Loyola University of Chicago, 18 March 1980
- Department of Geology, University of Illinois at Urbana, 4 December 1981
- Research School of Earth Sciences, Australian National University, December 1983
- C.S.I.R.O., Division of Soils, Glen Osmond, South Australia, 19 March 1984
- Department of Geology, Melbourne University, Melbourne, Victoria, Australia, 27 March 1984
- Research School of Chemistry, Australian National University, 3 April 1984
- Department of Geology, Sydney University, Sydney, New South Wales, Australia, 13 April 1984
- Department of Geology, Australian National University, 13 June 1984
- Department of Geological Sciences, Harvard University, 4 February 1985
- Harvard Museum Association, Harvard University, 4 February 1985

State Microscopical Society of Illinois, 13 November 1987
 Department of Geology, University of Illinois at Urbana: The Ralph Grim Lecture, 12 February 1988
 Department of Geophysics, University of Chicago, 15 April 1988
 Associated Colleges of the Chicago Area Guest Lecture, Materials Science Seminar, Argonne National
 Laboratory, 24 October 1989
 Department of Geology, Australian National University, 28 March 1991
 C.S.I.R.O., Division of Soils, Glen Osmond, South Australia, 8 April 1991
 Electron Microscope Centre and Department of Geology, University of Queensland, 26 April 1991
 Department of Geology and Geophysics, University of Wisconsin-Madison, 2 December 1991
 Department of Geology and Department of Physics, joint seminar, University of Ottawa, 7 May 1992
 Electron Microscope Centre and Department of Geology, joint seminar, Univ. of Queensland, 15
 July 1993
 Center for Fundamental Materials Research, Department of Chemistry, Michigan State University, 12
 November 1993
 University of Wisconsin-Madison, Alumni Association, Symposia: Advances in the Geosciences, 23
 September 1994.
 University of Illinois at Champaign/Urbana, Department of Soil Science, 25 April 1997
 Oil-Dri Corporation, Chicago, IL, 19 November 1997
 Northwestern University, Department of Geophysics, 24 April 1998
 Department of Geology, Miami University, Oxford, Ohio, April, 1999
 Accademia Nazionale dei Lincei (Italian Academy of Sciences), Rome, 2 November 2000
 Dipartimento di Scienze della Terra dell'Università di Modena e Reggio Emilia, Modena, Italy, 10
 November 2000
 Sandia National Laboratory, 11 July 2002
 Department of Geology, Washington University (St. Louis), 10 April 2003
 Department of Geology, Indiana University, 20 September 2004
 Department of Environmental Sciences and Policy, George Mason University, 21 April 2005
 Department of Earth and Planetary Sciences, Northwestern University, 11 November 2005
 Department of Geology, University of Cincinnati, 20 May 2005
 Department of Geology, Miami University of Oxford, Ohio, 1 Feb. 2006
 Department of Geography, University of Louisville, Kentucky, 23 February 2006
 UOP LLC, A division of Honeywell, Chicago, IL 24 March 2006
 Department of Geology and Geophysics, University of Wisconsin-Madison, 28 April 2006
 Institut fuer Kristallographie, Freie Universitaet Berlin, Berlin, Germany, 14 May 2007
 Dipartimento di Scienze della Terra e Geologico-Ambientali Università di Bologna, Bologna, Italy, 14
 December 2007
 National Energy Technology Laboratory (NETL), U.S. Department of Energy, Pittsburgh, PA. 3
 December 2009, with simulcasts to NETL-Morgantown, WV, and NETL-Albany, OR.
 Oil-Dri Corporation, Chicago, IL, 24 March 2014
 Department of Geology, Oxford University, Oxford, England, 3 July 2015
 State Microscopical Society of Illinois, 26 February 2016
 Guangzhou Institute of Geochemistry, 13 March 2019
 Department of Geology and Environmental Science, James Madison University, Virginia, 19 September
 2019

TEACHING EXPERIENCE

Overview of goals and philosophy

Goals in teaching. I realized about 20 years ago that the discipline of mineralogy was undergoing a contraction in its development. At a time when great advances were being made in understanding minerals by utilizing new and powerful instrumentation and mineral analogues were being engineered for advanced technologies (e.g., lasers, nanoscience components, parts in cars, etc.), many geology departments were eliminating mineralogy as an area of study. Incredibly, geologists did not appreciate the importance of research in the basic building blocks of the earth, nor the relevance of studying minerals as exploitable materials. The idea that mineral science is important just to graduate-level researchers in geology can be countered only if the potential and actual contribution of mineral science to society is recognized. A general awareness of mineral science is required at all levels, including undergraduate, graduate, and perhaps most importantly, the K-12 level. Thus, my overall goal in teaching is to resurrect mineral science as an important discipline in its own right and to promote its relevance in other disciplines, such as materials engineering, environmental engineering, and ceramic science. Obviously, such a goal must be long-term, and implementation takes planning over many years. However, I have been able to initiate the process by organizing a K-12 program while I was president of the Clay Minerals Society. The K-12 Committee developed a web page of resources for teaching clay science and developed sets of teaching materials. Along with A. Rule, we have worked on curriculum development projects, and we organized a workshop on “Teaching Clay Science” that included K-12 teachers. This workshop produced a book on teaching clay science (Rule and Guggenheim, 2002), which is unique because it conforms to current teaching practice of how students learn via the “learning cycle”. The workshop was a greater success than anticipated and I organized, along with A. Rule, a symposium on teaching mineralogy at the jointly held 2003 Annual CMS meeting/MSA spring meeting.

My goals for teaching have broadened with time. Early in my career, I taught quality mineralogy courses to geology students, and I still do this. Like many mineralogists, I considered the crystal structure as the most fundamental way to describe a mineral. In contrast, however, I considered also how minerals were used in Society and how to combine crystal-structure concepts with ideas that were being developed in materials science. This meant developing a new curriculum, i.e., new topics emphasizing minerals as materials and not just geologic building blocks, new elementary and advanced laboratories, etc., and new ways to challenge students to be innovative in their thinking. I have now published five such laboratories/innovative approaches for high school and undergraduate programs in various professional society publications. In parallel to my curriculum development, my research was evolving, and I was investigating how materials behave in a process, such as how a structure decomposes during a heating event. Thus, I started to consider the atomic structure of minerals as something dynamic, rather than static.

Teaching philosophy. I learned early on that people must be “intellectually mature” before becoming receptive to new ideas. For example, a student (or his teacher) cannot easily learn new concepts, unless that person has been adequately prepared intellectually to understand these ideas, by realizing that an observation does not fit a preconceived (and faulty) vision of “reality”. Thus, “reality” must change to incorporate the new observation, and this process is called “learning”. Furthermore and most importantly, I learned that teaching requires a mutual respect between teacher and student.

My approach to dealing with students at all levels has developed concurrently with my teaching philosophy of mutual respect: treat the student as a respected colleague and develop in that student the importance of respecting the individual rather than the individual’s position. It is particularly important for the student to feel sufficiently comfortable with his/her advisor to question the doctrine of the science, and to argue against what is being taught if he/she has the facts or observations to back up his/her views. In many students, there is too much respect of authoritative thinking. For example, there are many

cultures that demand respect for a person's position, and the ability to question authority is greatly limited. Thus, I make an effort to break down such barriers, first by simple procedures, such as the use of my first name, and finally by encouraging discussion and disagreement. In general, my philosophy in teaching is based on respect of the individual.

Sept., 1976 - Courses taught at the University of Illinois at Chicago

Present

denotes semester course, all others are based on the quarter system

All courses in EaES (Earth and Environmental Sciences Dept) or CHEM (Chemistry Dept.)

Freshman level

101. Principles of Geology I. Surface Processes.

102/102#. Principles of Geology II. Internal Processes

107. Gems and Minerals

107# The Evolving Earth (approx. equiv. to 122)

110/200# Field Work (in the St. Francois Mountains, Missouri)

122. The Earth

Upper Level Undergraduate

200. Introduction to Crystallography (Optical Mineralogy)

201. Introduction to Mineralogy

220#/320# Introduction to Mineralogy (equiv. of 200, 201)

300. Mineralogy

302. Introduction to the Rock Forming Minerals

317. Field Geology (Summer Field Camp - Black Hills)

345/424# X-ray Crystallography

390#. Special topics: Technical Communication in Earth and Environmental Sciences

422# Crystal Chemistry of the Rock Forming Minerals

Graduate Level

CHEM 519. Special topics in inorganic chemistry (X-ray crystallography)

430. Advanced Mineralogy (Crystal Chemistry)

430. Advanced Mineralogy (Layer Silicate Mineralogy)

520# Advanced Mineralogy (Layer Silicate Mineralogy)

520# Advanced Mineralogy (Environmental Mineralogy)

520# Advanced Mineralogy (Organoclays)

434. Clay Analysis

495/499/596#/598#/599#. Independent Research*

*Student supervision for the Masters Degree, graduation date:

Jung Lee, 1979	Paul Tyrna, 1990	Qianyi Wu, 2015
J.-C. Lin, 1982	John Rakovan, 1990	Jacqueline Kowalik, in progress
Doug Yeskis, 1983	Dan Nelson, 1993	
Yu-Hwa Chang, 1984	Ron Russell, 1998	
Steve Bouchard, 1988	Candice Johns, 2000	
Sherri Wiet Johnson, 1989	Tom Bujnowski, 2009	
Anna Kokines Miller, 1989	Mike Wahle, 2009	

*Student supervision for the Doctoral Degree:

Ardisher Vahedi-Faridi, 1998
Mark Krekeler, 2003
Paolo Andre D. Benavides, in progress

Post-doctoral fellows and short term scholar visits

Paul Giesting, 2009-11, post-doc
Chiara Elmi, April, 2012; Sept.-October, 2013; August-Oct. 2014
Ruben Martos-Villa, Spring, 2012
Işıl Ömeroğlu, Oct., 2014-Mar., 2015

- July, 2013 Presented lectures on: Introduction to Mg-rich clay minerals: Structure and composition. In Rio de Janero, Brazil. Also published In Magnesian clays: Characterization, origin, and applications. AIPEA Publication No. 2, M. Pozo, Ed.
- July, 2011 Presented lecture on: An overview of order/disorder in hydrous phyllosilicates at the European Mineralogical Union (EMU) lecture series (in Rome, Italy), also published in Notes in Mineralogy series, Layered mineral structures, Ed. By M.F. Brigatti.
- June, 2002 Organized Teaching Clay Science Workshop with A. Rule at the Clay Minerals Society Annual Meeting, Boulder, Colorado on 9 June 2002. Also gave three presentations: laser vs X-ray analogues for teaching clay science, use of cooperative teaching methods to efficiently present laboratory-preparation techniques, and exercises in exchange, solvation, and intercalation experiments .
- Nov., 2000 Presented lecture on: “Mica crystal chemistry” at the “Mica” Short Course presented by the Italian Academy of Sciences (Accademia Nazionale dei Lincei), Rome, Italy
- March, 1999 Presented short course on: “Phyllosilicate mineralogy” at the Campus do Vale, Institute of Geosciences, University Federal do Rio Grande do Sul, Porto Alegre, Brazil

- April, 1997 Recipient of UIC Teaching Recognition Award, UIC Council for Excellence in Teaching and Learning (recognized in first recipient group), salary increment of \$1,500
- June, 1996 NSF sponsored "Teaching Mineralogy Workshop", held at Smith College. Laboratory presented "Introduction to the properties of clay minerals"
- May, 1996 Presented short course on: "Clays, Organo-clays, and clay analysis" at the University of Utrecht, Netherlands
- Oct., 1988 Mineralogical Society of America Short Course on Hydrous Layer Silicates Excluding the Micas. Topic presented: Talc, pyrophyllite, and related minerals. Course given immediately prior to the Annual Geological Society of America Meeting, Denver, Colorado.
- Oct., 1987 Clay Minerals Society of America Short Course on Thermal Analysis. Topic Presented: High pressure differential thermal analysis (HP-DTA): Applications to clay minerals. Course given immediately prior to the annual meeting, Socorro, New Mexico.
- Nov., 1984 Mineralogical Society of America Short Course on Micas. Topic Presented: The Brittle Micas. Course given immediately prior to the Annual Geological Society of America Meeting, Reno, Nevada.
- 1970-1972 Teaching Assistant, S.U.N.Y. at Stony Brook, N.Y. in Mineralogy, Petrology and Physical Geology
- 1970-1974 Secondary School Teaching Certification, State of Ohio (in the Earth Sciences). Provisional for 1970-1974.
- 1969-1970 Laboratory Assistant, Marietta College, Marietta, Ohio

SERVICE

Professional Service

Mineralogical Society of America

MSA Kraus Award Committee member, 2012-2014; 2016; Associate Editor, *American Mineralogist*, Sept., 2004-Aug., 2007; Benefactors Committee, Nov., Member, 2004-6, Member, Committee on Committees (to set up committee assignments), 2002-3, 2000-1; Member, Roebling Medal Committee, May, 1998-Aug., 2001; Dec., 1980-Dec., 1981; Member, Benefactors Committee, Nov., 1996-May, 1998; Chair, Benefactors Committee, Nov., 1995-Nov., 1996, Nov., 2004-present; Secretary, Mineralogical Society of America (elected by membership for two two-year terms), MSA Committee assignments for the Secretary include: Member, MSA Executive Committee, Member, Committee on Committees, Member, Committee on Management, Oct., 1991-Oct., 1995; Member, Nominating Committee for Officers, Nov., 1990-Oct., 1991; Chairman, Publications Committee, Jan., 1988-Nov., 1989; Member, Publications Committee, Feb., 1986-Nov., 1989.

Clay Minerals Society

Science Program Organizer, 55th Annual Meeting, Urbana; Member, Ad-hoc Committee to investigate Clay and Clay Minerals merger with Clay Minerals, 15 March, 2016 - 15 June 2016; Society liaison representative to AIPEA, Sept., 1989-present; Chair, Clay Minerals Society Nomenclature Committee for

Clay Minerals, 2006-present; Member, Clay Minerals Society Nomenclature Committee for Clay Minerals, 1987-present; Member, Search Committee for CMS Treasurer, April, 2014-July, 2015; Organizing Committee, Scientific Program Chairman, 50th Anniversary Meeting, Urbana, IL, 6-10 October 2013; Member, Continuing Education Committee, July, 2004-Aug., 2006; Nominations Committee for Officers, June, 2001-May, 2004; Chair, Liaison Committee, July, 2004-5; Editor-in-Chief, *Clays and Clay Minerals*, The Journal of the Clay Minerals Society (includes service on several committees, including Executive Committee, Publications Committee), Oct., 1998-Jan., 2001; Member, Jackson Award Committee, May, 1998-May, 1999; Member, Policy and Administration Committee, Nov., 1994-Nov., 1998; Member, Finance and Budget Committee, Nov., 1994-Nov., 1998; Chair, K-12 Education Committee, June, 1997-May, 1998; Past-president, Clay Minerals Society, (includes service on Policy and Administration Committee, Finance and Budget Committee) June, 1997-May, 1998; President, Clay Minerals Society, June, 1996-June, 1997; Vice-President, Clay Minerals Society, July, 1995-June, 1996; Vice-President elect, Clay Minerals Society (elected by membership), Aug., 1994- July, 1995; Member, Awards Committee, June, 1993-June, 1995; Member, Program Development Committee, Sept., 1991-Aug., 1994; Member, 1989 Brindley Lecture Committee, Nov., 1988-Sept., 1989; Council member (elected by membership), Oct., 1986-Sept., 1989; Chairman, Publications Committee, Jan., 1987-Sept., 1989; Member, Publications Committee, May, 1982-Sept., 1989

AIPEA (Association Internationale pour L'études des Argiles)

Member, Advisory Committee, 16th International Clay Conference, Granada, Spain, Nov., 2015-17; Member, EuroClay 2019 Organizing Committee, Paris, May-2014-Present; Chair, Nomenclature Committee, Aug., 1991-present; Council member, Aug., 1991-present; Member, Nomenclature Committee, Jan., 1990-Aug., 1991

Mineralogical Association of Canada

Member, Hawley Award Committee, Dec., 1992-Nov., 1993; Dec., 1987-Nov., 1989; Associate Editor, *Canadian Mineralogist*, Jan., 1987-Dec., 1989

Other professional service

International Scientific Committee for 2019 EuroClay Conference in Paris France, Committee member, 2014-2019; Editorial Board, *Rendiconti Lincei*, Journal of the Italian Academy of Sciences (Accademia dei Lincei), Aug., 2007- present; Referees Association for the Italian Ministry of University Instruction and Science Research, 2003-2006; External review committee to review Dept. of Geology, Georgia State University, March, 2002; Member, International Mineralogical Association (I.M.A.) Subcommittee for Mica Nomenclature June, 1985-Dec., 1997; NSF Panel member for Environmental Geochemistry and Biogeochemistry, June-1995; Member, Research Advisory Council, Illinois Mining and Mineral Resources Research Institute (IMM RRI), June, 1980-June, 1982

University Service

Member, Faculty Senate, Aug., 2015-June, 2016; Member, Senate Committee on Academic Freedom and Tenure, Aug., 2015-June, 2017; Member, Natural Science Representative, Bargaining Committee, UIC United Faculty Union, April, 2015-May, 2016; Member, Radiation Safety Committee, Jan., 1977-2000; Member, Campus Research Board, Natural Sciences and Engineering, Sept., 1994-Dec., 1997; Member and Subcommittee Chairman, Research Resources Center Review Committee, Sept., 1989-Aug., 1990; Member, University of Illinois Research Board, Sept., 1982-June, 1983

College Service

Member and Vice-Chair, Executive Committee of the College of Liberal Arts and Sciences (elected by college-wide ballot), Aug., 2015-June, 2017; Member, Executive Committee of the College of Liberal

Arts and Sciences, Aug., 2008-Aug., 2010; Member, LAS Academic Priorities Committee, Jan., 2010-June, 2010, Chair, Committee to evaluate 5-year term of the Math Head, 2006; Member, Executive Committee of the College of Liberal Arts and Sciences (elected by college-wide ballot), Aug., 2000-July, 2002- Chair from Aug., 2001; Aug., 2005-July, 2007; Aug., 2008-July, 2010; Member, LAS Review Committee for the Physics Department Jan., 2001-July, 2001; Member, Review Committee for the Germanic Studies Department Head, Nov., 2001-Feb., 2002; Member, Search Committee for Geological Sciences Department Head, Sept., 1978-June, 1982; Member, Committee on Archeological Studies, Sept., 1977-June, 1980

Department Service

Member, Quorum Committee, 2015-6; Member and Chair, Ad-hoc committee to write a mission statement, 2015; Member, LAS (Physics) Shop Committee, 2013-present; Undergraduate Curriculum Committee, 2005-2006; Member, Search Committee, Climate change, Biochemistry, 2005-2006; Chair, Facilities and Research Committee, Jan., 2000-Aug., 2003; Member, Graduate Admissions Committee, Sept., 1998-Current; Chair: Sept., 1991-Aug., 1994; Sept., 1980-Aug., 1990; Sept., 1982-Aug., 1989; Lecture Series Coordinator, Sept., 1995-Aug., 2000, 1976-1978, 1982-1983; Member, Ad-hoc committee for program development for elementary geology courses, Jan., 1996-Aug., 1998; Chairman, Search Committee, Organo/biogeochemistry position May, 1994- Mar., 1995; Chairman, Environmental Geochemistry position, Sept., 1993-May, 1994; Chairman, Mineralogist/Geochemist/ Petrologist, Aug., 1986-Mar., 1987; Graduate Director for Admissions, Sept., 1991-Aug., 1994; Sept., 1985- Aug., 1989; Alternate Graduate Director, Sept., 1982-Aug., 1985; Advisory Committee to the Department Head, Sept., 2003-current; Sept., 1991- Aug., 1992; Sept., 1989-Aug., 1990; Sept., 1980-Aug., 1986; Faculty Secretary, Sept., 1989-Aug., 1990; Member, Student Advisory Committee, Sept., 1985-Aug., 1989; Sept., 1980-June, 1981; Member, Graduate Curriculum Committee, Sept., 1984-Aug., 1989; Member, Doctoral Program Proposal Committee, Jan., 1986-Sept., 1988, Chair: June, 2001-Jan., 2002; Organizational Chairman, Tri-State Field Trip, UIC host Sept., 1983- Mar., 1985; Editor, Alumni Newsletter Jan., 1979-June, 1982; Library Committee, Sept., 1978-Sept., 1979; Curriculum Committee, Member, Sept., 1976-Sept., 1979.

ADDITIONAL DATA

Honors and University of Illinois Summer Faculty Fellowship (1977)
Appointments Research conducted at University of Wisconsin-Madison

Sigma Xi; honorary scientific research society member since 1975

Research Assistantship; continuous while at the University of Wisconsin-Madison

Teaching Assistantship; continuous while at S.U.N.Y.at Stony Brook, L.I., N.Y.

Dean's List; Marietta College, Junior and Senior Years

GRANTS

Grants
(External) National Science Foundation, Geochemistry Section: Structural aspects of layer silicates, \$30,100. (6/81-5/83)

Union Oil, Amoco Oil, Conoco Oil: Effect of Pressure on Clay Mineral Reactions, \$78,000. (5/81-6/83) with A. F. Koster van Groos

National Science Foundation, Experimental and Theoretical Geophysics Program: Elasticity of Layer Silicates Using Brillouin Scattering, \$56,000. (1/83-12/84) with M. Vaughan

National Science Foundation, Experimental and Theoretical Geochemistry Program: Structural Aspects of Layer Silicates, \$69,000. (7/83-6/85)

Petroleum Research Fund of the American Chemical Society: The crystal structure of an oxonium (H_3O^+) oxy-mica and characterization of oxonium loss with respect to temperature and pressure, \$32,900. (7/85-8/87)

National Science Foundation, Experimental and Theoretical Geochemistry Program: Thermal decomposition of the micas: a process-oriented structural approach, \$70,194. (11/87-5/90)

National Science Foundation, Earth Science Equipment Program: Acquisition of powder X-ray diffraction system, \$206,420 (including 50% cost sharing), (12/88-5/90)

Petroleum Research Fund of the American Chemical Society: The thermal stability of trioctahedral layer silicates. \$40,000. (7/89-8/92)

National Science Foundation, Experimental and Theoretical Geochemistry Program and the U.S.-Australia Cooperative Science Program: Modulated layer silicates, \$57,000.(8/90-7/92)

National Science Foundation, Earth Science Equipment Program Support of UIC X-ray Diffraction Facility, \$96,710 (including 50% cost sharing), 1/97-12/98

Petroleum Research Fund of the American Chemical Society: Structural studies of pillared clays, 1 May 1998 - 31 Aug. 2000, \$59,780

National Science Foundation, Earth Science Equipment Program Support of UIC Electron Microprobe Facility, \$130,547 (including \$49,000 cost sharing), 1/98-12/00, with M.F. Flower, A.F. Koster van Groos, N. Sturchio, and K. Bartels

The Clay Minerals Society, Editorial Office, \$57,000 per year, 1/99-12/2000

National Science Foundation, Earth Science, EAR-0001122, The palygorskite-sepiolite to smectite transformation and the influence on reactive surface sites. \$127,987 (6/00-5/03)

National Science Foundation, EAR 0129824, 15 Feb. 2002- 31 Jan. 2004, Support of UIC single-crystal X-ray diffraction facilities, \$312,300 (includes 50% cost sharing)

National Science Foundation, EAR 0207770, Intercalation of gas hydrates into clays, \$91,222, 12 June 2002-11 June 2004, with A.F. Koster van Groos

National Science Foundation, EAR 0308588, The crystal chemistry of rock-forming chlorite, 1 June 03 - 31 May 06, with C.V. Guidotti, Univ. of Maine; (\$170,333 for SG, \$60,285 for CVG, \$10,500 funds transferred from Maine after the death of CVG)

Petroleum Research Fund, #48371-AC2, Clay–Gas Hydrate Intercalates, May, 2006 - Aug., 2009, \$80,000

Shell Oil Company (Netherlands), CO₂-induced clay/shale mineral sorption and swelling behavior, investigation for CO₂ storage. 1 July 2009 - 30 June 2011, \$360,000; 30 June 2011 - 30 September 2011, \$150,000; no cost extension to Sept., 2012; with A.F. Koster van Groos.

National Science Foundation, EAR-0929312, Development of high-pressure environmental chamber, 1 January 2010 - 31 December 2010, \$85,141, with A.F. Koster van Groos

Grants
(Solicited
gifts)

Grants for 1985 Tri-State Field Trip: Exxon Education Foundation, Harza Engineering, American Colloid Co., Union Oil Company, \$2,500.

X-ray equipment: ITT Research Institute of Chicago, \$20,000 (estimated).

X-ray Crystallography (Student) Fellowship for 1980: Analytical X-ray Corp. of Denver, Co, \$500.

Siemens (Bruker) D-5000 diffractometer, 2002, Searles Pharmaceutical Co., Skokie, IL., \$90,000 (estimated)

Grants
(Internal)

Nanotechnology symposium, Dean's Office, Liberal Arts and Sciences (2008) \$5,000
International Development Fund Award, Office of the Chancellor, (2006-7)

Crystallization of membrane proteins by using modified clays. Program development with Freie Universität Berlin, \$700

University of Illinois Campus Research Board (1999): High resolution electron microscopy of the palygorskite-sepiolite to smectite transformation, \$8500

University of Illinois Research Board (1994): Imaging and X-ray analysis upgrade for microprobe X-ray analyzer. \$31,200 (incl. support from Research Resources Center), with R. Kleps, S. Campbell, J. Drummond

University of Illinois Research Board (1994): Film measurer/microdensitometer. \$12,800 (incl. support from Geology, Physics, and Materials Engineering), with C. Rhodes, M. McNallan

University of Illinois Research Board Grant (1993): partial travel support to Brisbane, Australia; \$500

University of Illinois Research Board Grant (1987): partial support for X-ray tube modification to Picker system; \$1,300 contribution to \$4,300 upgrade.

University of Illinois Research Board Grant (1985): partial support for ion thinning system; \$4,000 contribution to \$37,000 system purchased in 1985

University of Illinois Research Board Grant (1981) : for x-ray safety/generator components, \$500

University of Illinois Research Board Grant (1980) for student support and travel expenses, \$3,918.

Vice Chancellor's Instructional Equipment Reserve Fund (1980): for elementary laboratory materials in gemology, \$2,600.

Vice Chancellor's Instructional Equipment Reserve Fund (1979); X-ray safety shutters, \$3,690

University of Illinois Research Board Grant (1977): for student support, \$2,000.

**Professional
Affiliations**

American Crystallographic Association, member 1974-2001, 2004

American Society of Mechanical Engineers, member 1975-2006

Clay Minerals Society of America, member since 1980

Clay Minerals Society of Australia, member since 1983-1995

Mineralogical Society of America, Fellow, 1989 (member since 1973)

Mineralogical Association of Canada, member, 1974-2014

Mineralogical Society of Great Britain, 1975-2004

Mineralogical Society of Italy, member since 1994

Association Internationale pour L'Etudes des Argiles, (AIPEA) member since 1986

Sigma Xi, member since 1975