MSGC 2021 Fall Conference Agenda

Saturday, October 16th | **Prince Conference Center**

For those of you joining us virtually: https://umich.zoom.us/j/97617964277
Webinar ID: 976 1796 4277 | Passcode: 061522| +1 312 626 6799 US (Chicago)

8:00am – 9:00am	**Registration, Breakfast & Poster Set Up**
9:00am – 9:05am	**Welcome & Introductions** (Great Hall) *Mark Moldwin, PhD - Arthur F. Thurnau Professor, Department of Climate & Space Sciences & Engineering, Director of NASA's Michigan Space Grant Consortium*
9:10am – 9:20pm	**Dean's Special Welcome** (Great Hall) *Arlene Hoogewerf, Ph.D., Dean of the School of STEM and Health Sciences, Calvin University.*
9:30am – 10:30am	**Keynote: What We Can Learn about Science from Michigan Dune Research** (Great Hall) *Deanna van Dijk – Professor of geography, Department of Geology, Geography, and Environment, Calvin University*
10:30am – 10:40am	**Break**
10:40am – 11:40am	**Oral Presentations Session 1** *(Great Hall)*
	Experiential Training of STEM Teachers *Susan Ipri Brown, Assistant Professor of Engineering Instruction, Hope College, BSE/MS Mechanical Engineering*
	COVID Camp: Process and outcomes from a remote summer STEM camp experience *Kris Pachla, PhD., Director, GVSU Regional Math & Science Center. GVSU* *Chelsea Ridge, MEd., Mathematics Program Coordinator, GVSU Regional Math & Science Center, GVSU*

Diane Miller, MPA, Business and Community Outreach Coordinator, GVSU Regional Math & Science Center, GVSU

The Hygiene Hypothesis: Far-reaching implications for immune health
Kristin Renkema, PhD, Assistant Professor, Biomedical Sciences Dept., GVSU

Surface Coatings from Composite Dry Lubrication Schemes
Alana Policastro, Chemistry Dept., Hope College
Meagan Elinski, PhD, Chemistry Dept., Hope College

Land use, but not altitude, affects airborne bacterial community composition
Christian Smith, BS, MS Student, Dept. of Biological Sciences, WMU
Kathryn Docherty, PhD, Associate Professor of Biological Sciences, Dept. of Biological Sciences, WMU

Forward Image Prediction for Environment Exploration Using Model Predictive Control
Dominic Messina, B.S. Chemical Engineering, Dept. of Chemical Engineering & Materials Science, WSU
Helen Durand, Ph.D. Chemical Engineering, Dept. of Chemical Engineering & Materials Science, WSU

11:40am – 1:10pm **Lunch, Networking and Dune, Ecosystem Preserve & Dice Museum** *(Lunch in Great Hall & Fireside Room)*

1:10pm – 2:10pm **Oral Presentations Session 2** *(Great Hall)*

Constructing Digital Terrain Models from Lake Michigan Dune Imagery
Blake Harlow, Undergraduate Student, Mr., Hope College

Lake Responses to Elevated Levels of Chloride and Phosphorus
Ellen Foley, Graduate Student, Annis Water Resources Institute, GVSU
Alan Steinman, Ph.D., Allen & Helen Director, Annis Water Resources Institute, GVSU

Topography-Based Tectonic Analysis for Interpretation of Magma Migration Under the Southern Mid-Atlantic Ridge

	Simon Detmer, Geology major, Dept. of Geology, Geography & Environmental Sciences *C. Renee Sparks, Phd Geology, Hope College, Calvin University*
	Mineral film growth at the air/liquid/iron interface and the effect of cations from chloride electrolytes *Kathryn A. Perrine, Ph.D., Assistant Professor, Dept. of Chemistry, MTU*
	Exploring the Effects of Prairie Restoration Management on Soil Microbial Carbon Storage *Ellen Badger Hanson, PhD Student, Biological Sciences, WMU* *Kathryn Docherty, PhD, Associate Professor, Biological Sciences, WMU*
	Meteorite or Meteor-Wrong: Recognizing minerals and textures that are out-of-this-world *C. Renee Sparks, PhD, Visiting Professor, Hope College*
2:10pm – 3:10pm	**Poster Presentations** *Great Hall & Fireside Room*
3:10pm – 4:00pm	**Oral Presentations Session 3** *(Great Hall)*
	The cosmic-ray positron spectrum and its implications on the properties of Milky Way pulsars *Ilias Cholis, PhD, Ass. Prof., Physics, Oakland University*
	Using MESA to Test our Theory of Contact Binary Star Evolution *Lauren Henderson, Undergraduate, Calvin University Physics and Astronomy* *Jenn Lau, Undergraduate, Calvin University Physics & Astronomy* *Larry Molnar, Ph.D., Professor, Observatory Director, Calvin University Physics & Astronomy*
	BLUE Program: Student-Developed Spacecraft *Owen Marr, BSE Aerospace Eng, pursuing MEng in Space Eng, UM* *Lucas Lorenz, pursuing BSE Computer Eng. Marlee Trager, pursuing BSE Aerospace, Eng. UM* *Jack Liu, pursuing BSE Computer Science, UM*

Liam Spence, BSE Aerospace Eng, pursuing MEng in Space Eng. UM
Taha Teke, pursuing BS Computer Science. UM

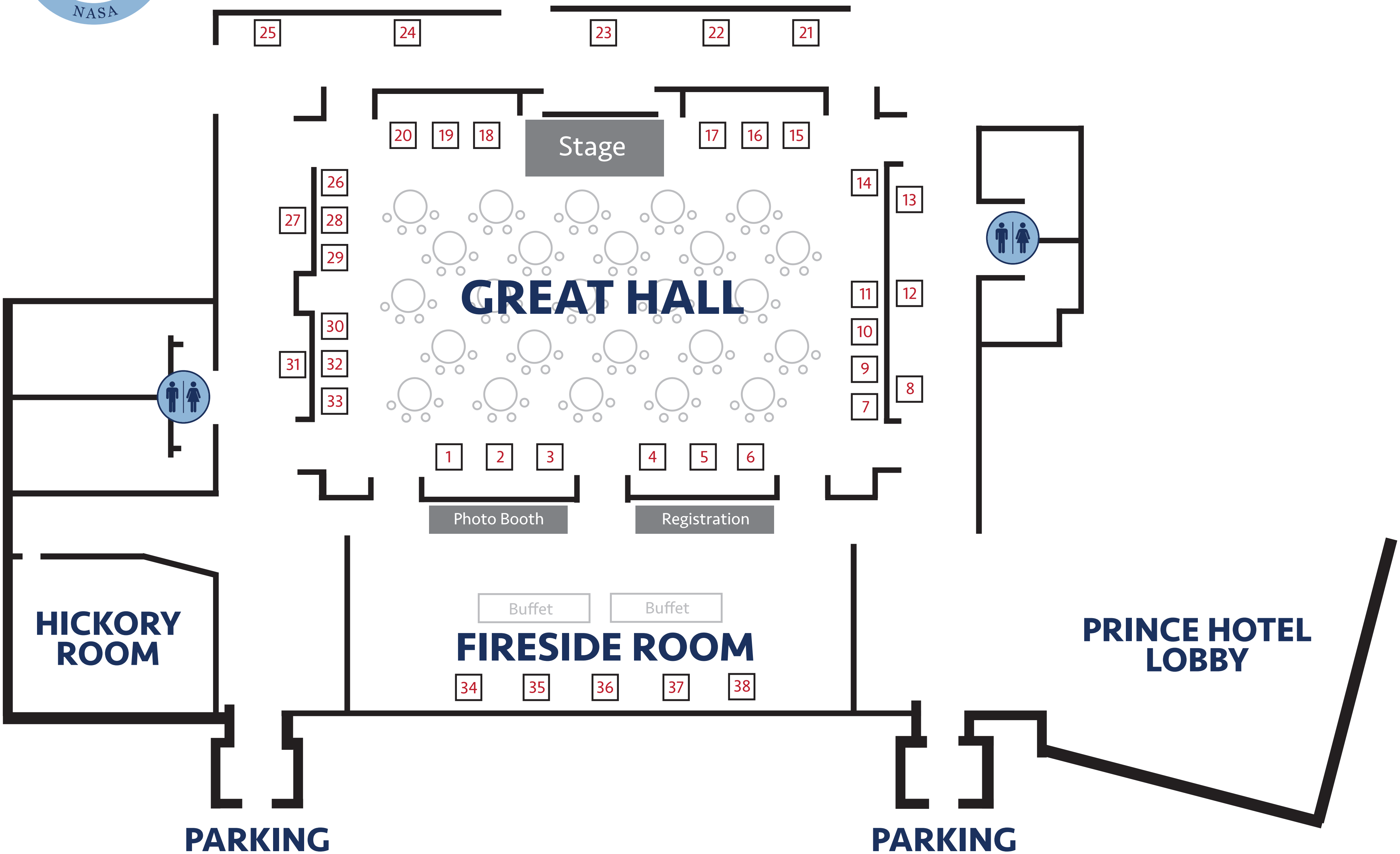
Multiple Stellar Populations in Globular Clusters
Willem Hoogendam, N/A, Mr., Physics & Astronomy, Calvin University
Jason Smolinski, Ph.D., Dr., Physics & Astronomy, Calvin University

Control of Residual Stress in Powder Bed Fusion for Space Manufacturing
Kip Nieman, B.S. in chemical engineering, PhD student, Dept. of Chemical Engineering and Materials Science, WSU

4:00pm – 4:05pm **Closing Comments** (Great Hall)

4:05pm **Adjourn** (Great Hall)

Prince Conference Center Map



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Poster Presentations

1. **Rare-earth ,ÄòSalen,Äô Phosphors as Up-converting Antennae for Photovoltaics**
   Jacob A. Adamski, Undergraduate Student, Dept. of Chemistry, OU
   Alexander A. Rusakov, PhD. Theoretical Physics, PhD. Physical Chemistry, Assistant Professor, Dept. of Chemistry, OU
   Matthias Zeller, PhD. Organometallic Chemistry, X-ray Crystallographer and Assistant Professor, Dept. of Chemistry/Purdue University
   Svetlana V. Eliseeva, PhD., Candidate of sciences diploma (equivalent of PhD), Center for Molecular Biophysics, University of Orleans, France
   Evan R. Trivedi, PhD. Inorganic Chemistry. Associate Professor, Dept. of Chemistry, OU
   PETOUD Stephane PhD, Research Director at Center of Biophysics University of Orleans

2. **A Case Study of Scientific Identity Formation In STEM Graduate Students**
   Shadi Adineh, PhD student in Science Education, Mallinson Institute of Science Education, WMU

3. **Quantitative Research Using Digitized Historic Short-period Nuclear Explosion Seismograms**
   Josie Anderson, Undergraduate Researcher, Dept. of Earth & Environmental Sciences at MSU

4. **Michigan Resources for Climate and Land-cover Change Education: Vulnerability and Justice**
   Samuel Bonser, Bachelors degree candidate, Student, College of Education, GVSU
   Elena Lioubimtseva, PhD, Full Professor, GVSU Geography & Sustainable Planning
   Cody Thammavongsa, B.S. candidate, Geography senior, GVSU
   Janet Vail, Ph.D., Research scientist emirita, Annis Water Resources Institute, GVSU

5. **Influence of Grain Size and Soil Moisture on Ground Penetrating Radar at Dunes 1 and 2, Hoffmaster State Park**

Caitlyn Bott an undergraduate student researcher, Calvin University
Melinda C. Higley (Mentor) a professor; Department of Geology, Geography and Environment, Calvin University

6. **Electronic Implementation of a Chaotic Chen System**
   Jadon Clugston, WMU, Department of Electrical and Computer Engineering
   Dr. Damon Miller, WMU, Associate Professor, Dept. of Electrical and Computer Engineering
   Dr. Giuseppe Grassi, University of Salento, Professor, Department of Engineering for Innovation

7. **Synthesis of Titanium Dioxide Nanoparticles for Solar Disinfection from Aqueous Solutions**
   S. Charles Davenport, Undergrad, Chemistry, Hope College
   Anna Molloy, Undergrad, Chemistry and Neuroscience, Hope College
   Liam Diephuis, Undergrad, Engineering and Chemistry, Hope College
   Lindsey Boltz, Undergrad, Neuroscience, Hope College
   Luke George, Undergrad, Chemistry, Hope College
   Tristan Porter, Undergrad, Chemistry, Hope College
   Dr. Natalia I. Gonzalez-Pech Ph.D, Chemistry Dept., Hope College

8. **Geospatial mapping of wildland fire air pollution for human exposure**
   Gabrielle DeMott, BS in progress, Student, UM LSA
   Dr. Patricia Koman, MPH PhD, Research Investigator, UM School of Public Health
   Dr. Nancy French, PhD, Senior Research Scientist, Michigan Tech Research Institute

9. **Engineering the Future: Hands-On Experience for High Needs Students**
   Carrie Dummer, BS Biochemistry, MA Education, Assistant Professor of Chemistry Instruction, Hope College Chemistry Dept., ExploreHope Academic Outreach

10. **Metagenomic characterization of surface waters in West Michigan**
    Babasola Fateye PhD. Assistant Professor, Biomedical Sciences Dept., GVSU

11. **Validating the Use of an IMU-based System to Capture Patient-handling Tasks**
    Bridget Gagnier: Undergraduate student, Hope College Engineering Dept.
    Reese Moschetta: Undergraduate student, Hope College Engineering Dept.
    Yeageon Song: Undergraduate student, Hope College Engineering Dept.
    Dr. Brooke Odle: M.S and Ph.D Biomedical Engineering, B.S Bioengineering, Mentor, Hope College Engineering Dept.

12. **Sediment characteristics of the upper units of landslide-prone bluffs along the Southeast shoreline of Lake Michigan**

Onyinyechi Iheme, undergraduate in the Dept. of Geology, Geography and environments at Calvin University.

13. **Synthesis of Liquid Crystal Elastomers Functionalized with an Amino Cinnamate**
    Jacob Kowalski, Engineering, Hope College
    Abby LaDuke, Engineering, Hope College
    Matthew Smith, PhD., Engineering, Hope College

14. **Multidisciplinary Design Program (MDP) Projects at Wireless Sensor Network Lab**
    Justin Zhang, BS, Student Researcher, UM
    Dean Aslam, Ph.D, Professor, ECE, MSU
    Xiaogan Liang, Ph.D, Associate Professor, UM

15. **Irradiation Source for Exoplanet Atmospheric Spectra**
    Savannah Lyons, Graduate Student, EMU, Dept. of Physics & Astronomy

16. **STEPS Camp 20th Anniversary**
    Sara Maas, (FSU, AS '98) Technical Drafting & Tool Design, (FSU, BS '00) Plastics Engineering Technology, (GVSU, MSE '04) Manufacturing Operations, Outreach Coordinator, Padnos College of Engineering & Computing Student Services, GVSU

17. **Evaluations of Model Simulated Ozone and its Precursors in MUSICA-V0 Against In-situ Airborne Measurements over the Continental US**
    Noribeth Mariscal, Dept. of Civil & Environmental Engineering, WSU
    Yaoxian Huang, Ph.D., Dept. of Civil & Environmental Engineering, WSU
    Louisa Emmons, Ph.D., Atmospheric Chemistry Observations & Modeling Laboratory, National Center for Atmospheric Research
    Duseong S. Jo, Ph.D., Atmospheric Chemistry Observations & Modeling Laboratory, National Center for Atmospheric Research
    Jiajue Chai, Ph.D., Dept. of Earth, Environmental & Planetary Sciences, and Institute at Brown for Environment & Society, Brown University

18. **The effects of iron oxide nanoparticles on the sensory physiology in house sparrows (Passer domesticus)**
    Molly McLinden, Undergraduate Biology Dept., Hope College
    Lindsay Jankowski, Undergraduate Biology Dept., Hope College
    Dr. Kelly Ronald PhD. Biology Dept, Hope College
    Dr. Natalia Gonzalez-Pech PhD. Chemistry Dept., Hope College

19. **Exploring hand gesture based user authentication using smartwatch**
    Kristina Mullen, Student, Computer Science & Information Systems, SVSU
    Khandaker Rahman, PhD, Associate Professor, Computer Science & Information Systems, SVSU

Avishek Mukherjee, PhD, Assistant Professor, Computer Science & Information Systems, SVSU

20. **Application of Artificial Neural Networks in Estimating Ground Reaction Forces Using Inertial Data of the Lower Body**
Kenneth Munyuza, Undergrad, Electrical Engineering & Computer Science, Hope College
Trevor Palmatier, Undergrad, Computer Science, Hope College
Bridget Gagnier, Undergrad, Biomedical Engineering, Hope College
Reese Moschetta, Undergrad, Biomedical Engineering, Hope College
Yea Geon Song, Undergrad, Biomedical Engineering, Hope College
Brooke Odle, PhD, Professor of Engineering, Hope College
Omofolakunmi Olagbemi, PhD, Professor of Computer Science, Hope College.

21. **Habitat Use and Movement Patterns of Burbot (Lota lota) in the Grand River Watershed**
Alexis Neff, Bachelors of Science, Graduate Student, Biology, GVSU
Eric Snyder, Ph. D., Professor, Dept. of Biology, GVSU
Alexandra Locher, Ph. D., Professor, Dept. of Biology, GVSU
Marty Holtgren, Ph. D., Private Consultant, Encompass Socio-ecological Consulting.
Carl Ruetz III, Ph. D., Professor, Annis Water Resources Institute, GVSU

22. **Microplastic ingestion by fathead minnows and their impact on gut microbial communities**
Maggie Petersen, MSc Candidate, Annis Water Resources Institute, GVSU

23. **Multiple Wavelength Measurements of the Optical Properties of Volcanic Ash, relating to Chemical Composition**
Renato Pinto Reveggino, Undergrad, Physics, MTU

24. **Changes in Chromatic Contrast of Avian Plumage in Forests with Different Levels of Deer Browsing**
Morgan Sherrard, Undergrad, Biology Dept., Hope College
Dr. Megan Gall, Vassar College, Biology Dept., Poughkeepsie, NY (PhD)
Timothy Boycott, College of William & Mary, Biology Dept., (Master's Degree)
Dr. Kelly L. Ronald, Hope College, Biology Dept., (PhD)
Suihnem Mawi, Undergraduate Researcher, Hope College

25. **Dancing the night (and day) away: Extant mat world microbes synchronize migration to a diel tempo**
Ian Stone, B.S. in Natural Resources Management from GVSU, Research Technician, Annis Water Resources Institute, GVSU
Tony Weinke, M.S. in Biology-Aquatic Science from GVSU, Research Technician/Observatory Manager, Annis Water Resources Institute, GVSU

Bopi Biddanda, Ph.D. in Marine Microbial Ecology from the University of Georgia, Professor, Annis Water Resources Institute, GVSU

26. **Understanding the Link between Spaceflight and Candida albicans Biofilm Formation**
    Evan Sidebotham, Undergrad, Dept. of Biomedical Sciences, GVSU
    Ian Cleary, Ph. D, Associate Professor, Dept. of Biomedical Sciences, GVSU
    Derek Thomas, Ph. D, Associate Professor, Dept. of Biomedical Sciences, GVSU

27. **Developing efficient algorithms to compute the exact widths of the QED cyclotron resonance of Compton scattering in strong magnetic fields**
    Peter Gonthier, PhD in Nuclear Chemistry, Professor, Department of Physics, Hope College
    Matthew Baring, PhD in Theoretical Astrophysics, Department of Physics and Astronomy, Professor at Rice University
    William Vance, Undergrad, Physics major, Hope College

28. **Mapping the Spread of Invasive Plants in Michigan Wetlands**
    Jonathan Walt, Graduate Student, Biology, GVSU

29. **Design of a Torsional Thrust Stand for Milli-Newton Cold Gas Thrust Measurements**
    Hannah Watts, Bachelors of Science from WMU, Maters Student, Mechanical & Aerospace Engineering Dept. at WMU
    Dr. Kristina Lemmer, Bachelors, Masters & PhD from UM, Associate Professor, Mechanical & Aerospace Engineering Department at WUM
    Asif Mohammed, Bachelors and Masters, PhD pre-Candidate, Mechanical and Aerospace Engineering Department at WMU
    Nate Allwine, Undergrad, Mechanical & Aerospace Engineering Dept, WMU
    Luke Fouch, Undergrad, Mechanical & Aerospace Engineering Dept, WMU

30. **On the Role of Stable Eigenmodes in Resistive Magnetic Reconnection**
    Dr. Zach Williams, Assistant Professor of Physics, Hope College

31. **Towards predictive modeling of astatine compounds**
    James MacLean, Undergrad, Chemistry, Oakland University
    Vincent T. Casetti, Graduate Student, Chemistry, Oakland University
    Jacob Adamski, Undergrad, Chemistry, Oakland University
    Adam D. Ayoub, Undergrad, Chemistry, Oakland University
    Alexander A. Rusakov, Professor/PhD, Chemistry, Oakland University

32. **Selective Preservation of Structural Carbohydrates During Peat Formation**
    Lauren Bryan, Student, Geological & Environmental Sciences, Hope College
    Christian Lundy, Student, Geological & Environmental Sciences, Hope College
    Erik Schoonover, Student, Geological & Environmental Sciences, Hope College

Trevor Hile, Student, Chemistry, Hope College
Rachel Shaw, Student, Chemistry, Hope College
Ali Koehl, Student, Chemistry, Hope College
Grace Beherens, Student, Geological & Environmental Sciences, Hope College
Dr. Michael Philben, Assistant Professor, Geological & Environmental Sciences, Hope College

33. **Minimizing Power Consumption of Run-Time Software Testing Strategies in Cyber-Physical Systems**
Abigail Diller, BS Computer Science, Undergraduate Research Assistant, School of Computing, GVSU
Erik Fredericks, PhD Computer Science, Assistant Professor, School of Computing, GVSU

34. **Out of oxygen: Exploring bottom water hypoxia dynamics in a Great Lakes estuary**
Nate Dugener, B.S. in Environmental Science from Loyola University Chicago, Graduate Student, Annis Water Resources Institute at GVSU
Ian Stone, B.S. in Natural Resources Management from GVSU, Lab Technician, Annis Water Resources Institute at GVSU;
Anthony Weinke, M.S. in Biology-Aquatic Science from GVSU, Lab/Observatory Manager, Annis Water Resources Institute at GVSU;
Bopaiah Biddanda, Ph.D. in Marine Microbial Ecology from the University of Georgia, Principal Investigator/Professor, Annis Water Resources Institute at GVSU

35. **Roger That! V (V is for Virtual)**
Karen Gipson, Ph.D, Professor of Physics, GVSU; Samhita Rhodes, Ph.D., Professor of Engineering, GVSU; Glen Swanson, M.S., Roger B. Chaffee Scholarship Foundation; Deana Weibel, Ph.D, Professor of Anthropology, GVSU

36. **Connecting Chemical Composition and Methane Production in a West Michigan Peatland**
Rachel Shaw, Undergrad, Chemistry & Biochemistry, Hope College
Alexis Koehl, Undergrad, Geological & Environmental Science, Hope College
Grace Behrens
Lauren Bryan, Undergrad, Geological & Environmental Science, Hope College
Christian Lundy, Undergrad, Geological & Environmental Science, Hope College
Michael Philben, Assistant Professor, Geology & Environmental Science, Hope College

37. **Understanding the impact of chronic, low-dose GCR particles on behavior and systemic inflammation in mice**
Corine LaFrenier, Research Assistant, Hope College

38. **Properties and Stability of Perovskite Crystals for Application in Solar Cells**

James Mandeville, Undergrad, Biochemical Engineering, Hope College
Josie Surel, Undergrad, Chemical Engineering, Hope College
Dr. Jeffery A. Christians, Professor, Engineering, Hope College

Oral Presentation Abstracts

Session 1

Experiential Training of STEM Teachers

Susan Ipri Brown, Assistant Professor of Engineering Instruction, Hope College, BSE/MS Mechanical Engineering

Preparing STEM Teachers will increase the capacity to meet the quickly growing need for STEM (science, technology, engineering, and math) education teachers in the state. Specifically, attention will be given to providing pre-service teachers exposure to effective, inquiry-based techniques for working with diverse learners and students from a range of socioeconomic and demographic backgrounds. Empowering future STEM educators to combine best practices in inquiry-based learning as well as techniques for inspiring diverse learners to enter STEM fields will significantly impact multitudes of students across those teachers' careers. This proposal seeks funding for pre-service teacher stipends, mentoring, evaluation, and materials to support our unique hands-on training in the context of Hope College's Summer Science Camps. Complementing in-classroom learning, this impactful experiential learning immerses pre-service teachers in STEM classroom experiences and builds a pipeline of teachers that can inspire and mentor a diverse future workforce.

COVID Camp: Process and outcomes from a remote summer STEM camp experience

Kris Pachla, PhD., Director, GVSU Regional Math and Science Center. GVSU
Chelsea Ridge, MEd., Mathematics Program Coordinator, GVSU Regional Math & Science Center, GVSU
Diane Miller, MPA, Business and Community Outreach Coordinator, GVSU Regional Math & Science Center, GVSU

The GVSU Regional Math and Science Center designed and implemented Energizing our World: A remote, virtual summer camp experience for middle school students to explore learning and careers in renewable energy and sustainability. Using a delivered kit, campers engaged in a week of hands-on guided activities, culminating with a career fair with business partners and a presentation of a design prototype to experts and their peers. Camp activities were designed and prototyped by GVSU pre-service teachers and STEM students and were enacted and revised before posting as open-source resources. Campers utilized the Design Thinking process/Innovators Compass and incorporated new content learning throughout the week while revising their designs. Campers focused on answering the question: How might we make our communities more sustainable? This presentation explores the structure and planning associated with camp, camper outcomes, and potential implications for future summer experiences.

The Hygiene Hypothesis: Far-reaching implications for immune health

Kristin Renkema, PhD, Assistant Professor, Biomedical Sciences Department, GVSU

My lab investigates how environmental exposures influence the immune system during homeostasis and disease. Specifically, we measure how microbial experience shapes immune cell signaling pathways and ability to respond. Previous research has shown that traditional specific pathogen free (SPF) mouse models do not replicate human adult immunity, at least in part due to the lack of microbial exposure. We expose SPF mice to diverse microbes by cohousing SPF mice with mice purchased from pet stores to study how the microbial environment shapes the immune cells throughout development, and how microbial exposure translates into signals that are interpreted by immune cells. Space flight results in both immunosuppression and microbial exposure for astronauts, yet very little is known regarding how these microbial exposures impact their immune systems and overall health. Our studies have significant implications for a wide-range of immune-related diseases and health implications.

Surface Coatings from Composite Dry Lubrication Schemes

Alana Policastro, Chemistry Department, Hope College
Meagan Elinski, PhD, Chemistry Department, Hope College

Two-dimensional (2D) solid materials are at the forefront of dry lubrication research due to their surface compatibility, unique structural-chemical properties, and potential to function as multifaceted coatings with specialized mechanical, electronic, and optical properties for emerging technologies such as space-based lubrication needs. Moreover, when specific 2D materials are combined with nanoparticles, the composite system facilitates superlubricity (ultra-low friction). Other nanoparticles can independently form tribofilms, protective surface coatings that build up from friction in situ (during sliding). Bringing together distinct optoelectronic properties, superlubricity sliding behavior, and film-forming surface protection into a tailored surface coating, however, remains challenging due to the lack of predictive capabilities for composite lubrication schemes. To better understand composite film formation, this work focuses on determining the impact of interfacial parameters on tribofilm properties. Interfacial chemistry was controlled through self-assembled monolayers on silica (e.g., aminopropyltriethoxysilane, APTES). Interfacial roughness was controlled through spincoated silica nanoparticles. A series of nanomaterials (molybdenum disulfide, phosphorene, and nanodiamonds) were deposited onto the controlled surfaces, comparing dropcasting vs spincoating methods. The composite interfaces were then both imaged and subjected to high stress sliding tests in an atomic force microscope (AFM). Preliminary results suggest scrolling of the 2D materials is one possible film formation mechanism. Future work will continue to isolate what surface parameters are needed for controlled tribofilm formation, ultimately leading to the design of tailored multifaceted surface coatings.

Land use, but not altitude, affects airborne bacterial community composition

Christian Smith, BS, MS Student, Department of Biological Sciences WMU
Kathryn Docherty, PhD, Associate Professor of Biological Sciences, Dept. of Biological Sciences WMU

Bacteria are ubiquitous in the air, yet our understanding of airborne microbial ecology is in its infancy. Airborne dispersal of bacteria is important for ecosystem health and function. Continental scale investigation of urban areas reveals convergence patterns of ecological processes, plant and animal communities. Similarly, there are site-specific effects of land use on airborne communities, but these effects have not been quantified on a continental scale. This study analyzed airborne bacterial community composition at two altitudes across four biomes to investigate continental scale effects of urbanization. Urban communities were significantly less dispersed than rural communities, on a continental scale, exemplifying the urban convergence observed in other ecosystem properties. However, altitude had no significant effect on community composition indicating that near-surface airborne communities are elevated to 150m where they are dispersed greater distances. Land use change affects the microbes available for dispersal, impacting ecosystem health and function in a broader region.

Forward Image Prediction for Environment Exploration Using Model Predictive Control

Dominic Messina, B.S. Chemical Engineering, Dept. of Chemical Engineering & Materials Science, WSU
Helen Durand, Ph.D. Chemical Engineering, Dept. of Chemical Engineering a& Materials Science, WSU

When operating in uncertain environments, an autonomous system may need to collect more information about its surroundings in order to adequately perform the tasks required of it. As the collection and processing of visual data has become important in facilitating the interaction between an intelligent agent and its environment, using this data to predict how an environment will evolve as camera sensor positions change may enable an agent to choose from a number of potential actions. In this work, we use OpenGL to simulate the navigation of a camera near an unidentified object under model

predictive control (MPC) using image predictions to determine an optimal course for collecting the data needed to identify the object.

Session 2

Constructing Digital Terrain Models from Lake Michigan Dune Imagery

Blake Harlow, Undergraduate Student, Mr., Hope College

Lake Michigan dune complexes evolve as winds and waves erode the sand, causing major topographic changes over time which are not fully understood or modeled. Drone photography is an efficient method for collecting precise multispectral imagery for these areas. The Hope College Dune Group has been using this remote sensing data to model various aspects of the dune, although much remains to be understood about sand transport mechanisms. In this research, we have used machine learning to create digital terrain models (DTMs) which map the bare-ground surface of the dune. One of our overall aims is to use machine learning along with DTMs created at different points in time to model changes in surface topography. In this talk, we report on our method of constructing DTMs for this unique terrain. Modeling changes of the dune surface in this way will provide useful information for protecting and maintaining healthy dune ecosystems.

Lake Responses to Elevated Levels of Chloride and Phosphorus

Ellen Foley, Graduate Student, Annis Water Resources Institute, GVSU
Alan Steinman, Ph.D., Allen & Helen Director, Annis Water Resources Institute, GVSU

Increasing chloride concentrations from road salt runoff have been observed in lakes throughout the north temperate region. Excess salt can negatively impact the biological, chemical, and physical properties of freshwater systems. For the past year, we have monitored the water quality of a chloride-impaired lake in Grand Rapids, Michigan. Preliminary results reveal the lake has not fully mixed during the study period due to this salt-induced concentration gradient, and the hypolimnetic waters are permanently anoxic with chloride levels exceeding the EPA chronic toxicity threshold, at times reaching 324 mg/L. The absence of dissolved oxygen (DO) in the bottom waters has significant implications for internal phosphorus loading, which increases under low DO conditions. Should the lake turn over, either partially or totally, the high phosphorus levels may induce algal blooms. An ongoing study is examining the impacts of excess chloride on sediment phosphorus release and will help inform lake remediation efforts.

Topography-Based Tectonic Analysis for Interpretation of Magma Migration Under the Southern Mid-Atlantic Ridge

Simon Detmer, Geology major, Dept. of Geology, Geography & Environmental Sciences
C. Renee Sparks, Phd Geology, Hope College, Calvin University

Tectonic forces govern processes at depth under mid-ocean ridges leading to volcanism and crustal growth as well as brittle deformation of the oceanic crust. In this study of the Mid-Atlantic Ridge system between 0 and 30¬∞S latitude, ocean-floor topography is used to identify fault patterns and examine relationships between ridge and transform segments to develop a conceptual model for underlying magma migration. Our model incorporates the stresses exerted by magma migration in the 3-D melt prism under the ridge system. Lithostatic loads, calculated to a depth of 50 km below sea level for ridge and transform junctures, reveal a pressure gradient associated with equatorial bulge that could drive horizontal magma migration. Shearing forces, including the Coriolis parameter, could influence the stresses exerted on existing faults producing the observed geometry. Rotation and drift connected with this conceptual model provide variables not previously addressed within the context of global plate tectonics.

Investigating the Photochemical Fate of Dissolved Free Amino Acids in Natural Aquatic Environment through Coupled Experimental and Theoretical Approaches

Benjamin Mohrhardt, Graduate Student, Dept. of Civil & Environmental Engineering, MTU
Benjamin Barrios, Graduate Student, Dept, of Civil & Environmental Engineering, MTU
Ryan Kibler, Graduate Student, Dept. of Civil & Environmental Engineering, MTU
Paul Doskey, PhD, Co-Principal Investigator, School of Forest Resources & Environmental Science, MTU
Daisuke Minakata, PhD, Principal Investigator, Dept. of Civil & Environmental Engineering, MTU

Dissolved free amino acids (DFAAs) and AA-based molecules are key sources of nitrogen in natural waters, providing building blocks for protein synthesis and energy for microbial growth. In sunlit waters, abiotic transformation such as photochemical oxidation plays an important role for the fate of DFAAs Photochemical oxidation occurs via direct and indirect photolysis by photochemically produced reactive intermediates (PPRIs), such as excited triplet state chromophoric dissolved organic matter (3CDOM*), singlet oxygen (1O2), and hydroxyl radicals (HO‚Ä¢). Due to the complex nature of CDOM and subsequent radical-involved reaction mechanisms, little is known about the fate of DFAAs in natural waters. Thus, there is a need to understand and predict the fate and transformation of DFAAs and their role in the nitrogen cycle. In this talk, we present the experimental and theoretical initial reactivities of three structurally unique, photo-viable DFAAs: tyrosine, histidine, and methionine in the presence of three surrogate CDOM.

Mineral film growth at the air/liquid/iron interface and the effect of cations from chloride electrolytes

Kathryn A. Perrine, Ph.D., Assistant Professor, Dept. of Chemistry, MTU

Earth and planetary soils are largely comprised of iron oxides. The surface of iron materials will undergo chemical and physical transformations through redox processes where ions are known to catalyze surface corrosion to produce complex oxides. This study investigated how cations in ionic electrolytes affect the transformation of iron surfaces at the air/liquid/solid interface to produce minerals. The surface reaction at complex interfaces was investigated using surface infrared spectroscopy and atomic force microscopy. The effect of KCl(aq) and MgCl2(aq) electrolytes and atmospheric CO2 and O2 was found to produce carbonate films at the air/electrolyte/iron interface that is unique to the type of cation in solution. At either electrolyte/Fe interface, the same heterogenous mixture of lepidocrocite and iron hydroxy carbonate minerals were grown. These surface reactions and transformations to minerals are critical for understanding environmental and atmospheric surface chemistries for planetary processes.

Exploring the Effects of Prairie Restoration Management on Soil Microbial Carbon Storage

Ellen Badger Hanson, PhD Student, Biological Sciences, Western Michigan University; Kathryn Docherty, PhD, Associate Professor, Biological Sciences, Western Michigan University

Agricultural ecosystems are a major contributor to greenhouse gas emissions. One mitigation method involves integrating native prairie vegetation in marginal lands within agroecosystems. However, these restored prairies often do not regain the soil microbial community structure nor soil carbon storage found in untouched remnant prairies. Further study on the mechanisms behind these discrepancies is necessary to restore prairies more effectively for carbon storage. This study leverages a long-term, ongoing experiment at Kellogg Biological Station in southwest Michigan. In Summer 2021, we examined the effects of restoration size and plant seed mix diversity on soil microbial communities and soil carbon. We hypothesized that restorations with high seed mix diversity would have more soil carbon than those with low, and that soil carbon would increase with restoration size. Trends in initial microbial biomass carbon data support these hypotheses. This study aims to provide insight to inform better land management strategies.

Session 3

Meteorite or Meteor-Wrong: Recognizing minerals and textures that are out-of-this-world

C. Renee Sparks, PhD, Visiting Professor, Hope College

The focus of this project was to provide educational outreach opportunities through the development of a meteorite-specific display and accompanying materials in the Bruce Dice Mineralogical Museum at Calvin University. As with many projects in 2020, plans were rerouted due to COVID19 restrictions, and we shifted to the college community. In August 2020 the project launched with acquisition of several meteorites including the Seymchan stony-iron, Dimmitt H4 chondrite, as well as the Aba Panu L3.6 chondrite and corresponding thin section microscope slide. These new meteorites complemented the existing collection including the Allende carbonaceous chondrite, Canyon Diablo iron, a sliced Lodranite, and small pieces of meteorites in the teaching collection. Materials were developed for courses in Earth Science and Petrology ranging from a guided examination of the display to a three-hour laboratory exercise using textures, minerals, presence of a fusion crust, and geochemical methods to differentiate between meteorites and meteor-wrongs.

The cosmic-ray positron spectrum and its implications on the properties of Milky Way pulsars

Ilias Cholis, PhD, Ass. Prof., Physics, Oakland University

Measurements of cosmic-ray electron and positron spectra at energies from a GeV to 5 TeV, as well as radio, X-ray and a wide range of gamma-ray observations of pulsar-wind nebulae, indicate that pulsars are significant sources of high-energy cosmic-ray electrons and positrons. To probe the physical properties of the high-energy emission from pulsars we generated 8000 distinctive simulations on their contribution to the locally observed cosmic-ray electron/positron energy spectra. Our models account for (a) the initial properties and time-evolution of pulsars energetics; (b) the emitted spectra of cosmic-rays from pulsars; (c) their occurrence in the Milky Way and (d) the physics of cosmic-ray propagation through the interstellar medium and the Heliosphere. I will discuss the implications that measurements from AMS-02 and CALET on-board the International Space Station and the DAMPE satellite have on the properties of pulsars and the interstellar medium.

Using MESA to Test our Theory of Contact Binary Star Evolution

Lauren Henderson, Undergraduate, Calvin University Physics and Astronomy
Jenn Lau, Undergraduate, Calvin University Physics and Astronomy
Larry Molnar, Ph.D., Professor, Observatory Director, Calvin University Physics & Astronomy

A contact binary star system consists of two stars orbiting so closely together that they share an outer atmosphere. Although common, there is not yet a consensus on how these systems form, evolve, and ultimately die. Over the past two years, we have developed a comprehensive theory describing the lifetime of these systems, from how the two stars come together to how they eventually spiral together and explode. In this presentation, I will describe the MESA models we calculated this summer. Based on our calculations, we have added two new insights to our theory: 1) an initial instability in stars that form with a high mass ratio, and 2) two possible mechanisms for contact binary mergers. I will also compare the temperature distributions of our models with contact binary data from the Kepler space telescope.

BLUE Program: Student-Developed Spacecraft

Owen Marr, BSE Aerospace Eng, pursuing MEng in Space Eng, UM
Lucas Lorenz, pursuing BSE Computer Eng. UM
Marlee Trager, pursuing BSE Aerospace, Eng. UM
Jack Liu, pursuing BSE Computer Science, UM
Liam Spence, BSE Aerospace Eng, pursuing MEng in Space Eng. UM
Taha Teke, pursuing BS Computer Science. UM

The BLUE Program at the University of Michigan gives undergraduate and graduate students the opportunity to develop spacecraft and satellites. Our current spacecraft (BX-4) is a 3U deployable that tests our in-house developed 3-axis reaction wheel control system and a computer vision system that can detect rocket bodies in space. This presentation will highlight past projects at BLUE and summarize the current work being done on BX-4.

Multiple Stellar Populations in Globular Clusters

Willem Hoogendam, N/A, Mr., Physics and Astronomy, Calvin University
Jason Smolinski, Ph.D., Dr., Physics and Astronomy, Calvin University

Globular Clusters were once the archetype of a simple, homogeneous stellar population. However, observations made in recent decades have revealed the existence of two or more stellar populations in Globular Clusters identified by elemental differences. Our research focuses on distinguishing these different populations using photometric data. We introduce a new method of distinguishing multiple populations using photometry and apply our method to the well-studied Milky Way Globular Cluster M13. Furthermore, we also used our method to analyze eight Milky Way Globular Clusters presented in Lardo et al. 2011 with their data as well as data released in Stetson et al. 2019. We find that Lardo et al. 2011 may have biased their result due to their uncertainty normalization which makes their results inconsistent with our work and other studies in the literature. We find that when re-done using our method, the results are more consistent with other studies.

Control of Residual Stress in Powder Bed Fusion for Space Manufacturing

Kip Nieman, B.S. in chemical engineering, PhD student, Dept. of Chemical Engineering & Materials Science, WSU

NASA's long-term goals of space travel and habitation necessitate space manufacturing, as required supplies will be circumstantial and transportation from Earth will take long periods of time. Powder bed fusion (PBF) uses lasers to melt successive layers in metal powder and might meet this need. The temperature changes during PBF create residual stress that remain in and weaken the completed part. Applying heat treatment would require large amounts of energy, representing a barrier to applying PBF is space. The long-term goal of this research is to develop a data-driven model of stress in the completed part based on a high-fidelity model of PBF. Subsequently, advanced control will be applied to minimize the stress in the completed part. This talk will describe our progress toward these goals, along with a discussion of implementation problems for advanced control in space and the theoretical challenges which it introduces.

International OBSERVE THE MOON NIGHT 2021

SATURDAY OCTOBER 16TH

NORTHERN HEMISPHERE MOON MAP FOR TELESCOPE VIEWING

Moon Map
This map was created for International Observe the Moon Night 2021. It depicts the Moon as it will appear from the northern hemisphere at approximately 11:00 PM EDT on October 16, 2021 (3:00 AM UTC on October 17). Many of the best views will occur along the terminator (the line between the day and night side of the Moon).

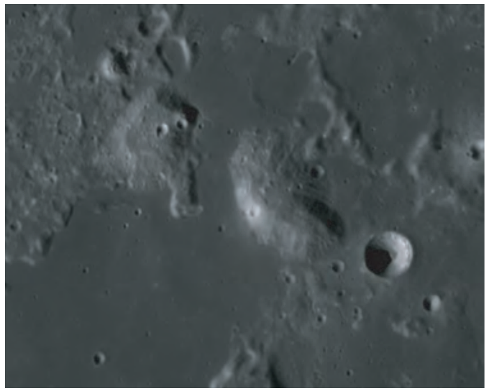
Selected Features
Some of the more interesting lunar landforms that have favorable lighting for viewing tonight are identified here. Details for each are on the reverse side of this map.

A. Sinus Iridum
B. Gruithuisen Domes
C. Harbinger Mountains
D. Copernicus Crater
E. Gassendi Crater
F. Schiller Crater

Map generated with NASA's Dial-A-Moon (https://svs.gsfc.nasa.gov/4874)

International OBSERVE THE MOON NIGHT 2021

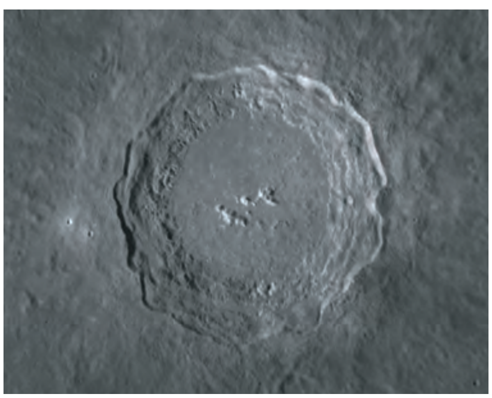
Selected Features for Telescope Viewing



A. Sinus Iridum, the “Bay of Rainbows,” is a bay along the northwest edge of Mare Imbrium. This 161-mile-wide (260 km) crater’s floor was once flooded with lava. Its north and west rim forms the Jura Mountains.

B. Gruithuisen Domes: These lunar volcanoes, reaching about a mile (1,600 m) high, are unusually tall and steep for volcanoes on the Moon. They seemed to be formed by lava that was particularly thick and pasty.

C. Tonight we see the Harbinger Mountains just after they have experienced sunrise. This small range measures about 59 miles (95 km) long and reaches heights of about 1.2 miles (2 km). Larger telescopes show volcanic vents and channels on the range’s western edge.



D. Copernicus is a magnificent 57-mile-diameter (93 km) crater with terraced walls, a flat floor, and a group of central peaks towering almost a mile (1,200 m) above the floor. The crater is over 2.2 miles (3,700 m) deep.

E. Gassendi: This 68-mile-diameter (110 km) floor-fractured crater lies on the northern rim of Mare Humorum. It had its floor pushed up by magma rising from below. Larger telescopes will reveal a network of fractures across the crater floor.

F. Near the Moon’s edge, all craters appear oval and foreshortened. However, Schiller is actually very elongated, measuring 111 x 43 miles (180 x 70 km). It was likely formed by the impact of an asteroid striking the ground nearly horizontally.

Detailed images are from **NASA’s Lunar Reconnaissance Orbiter** with north up and lunar west to the left. Find more high-resolution images of the Moon at:

lroc.sese.asu.edu
trek.nasa.gov/moon

OBSERVE the MOON

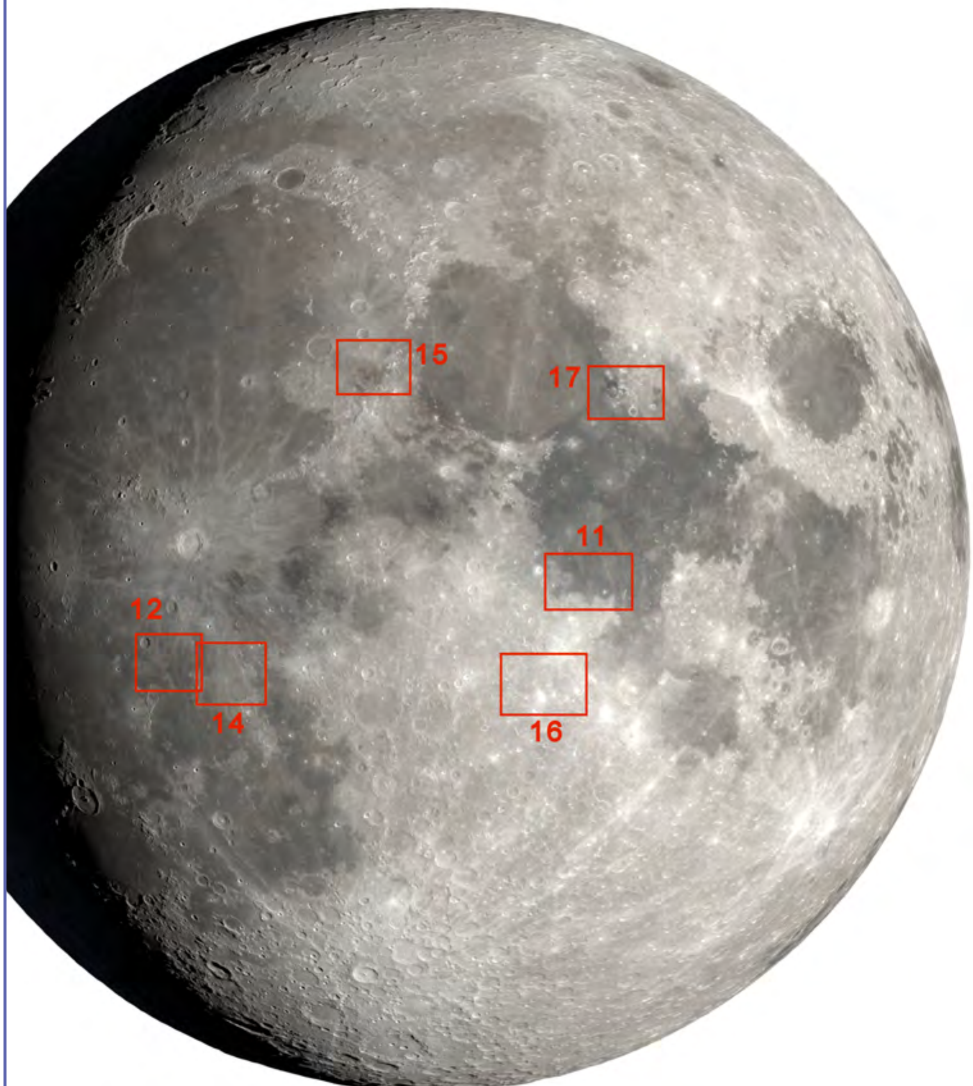
International OBSERVE THE **MOON** NIGHT 2021

SATURDAY OCTOBER 16TH

NORTHERN HEMISPHERE MOON MAP with HUMAN LANDING SITES

Moon Map
This map was created for International Observe the Moon Night 2021. It depicts the Moon as it will appear from the northern hemisphere at approximately 11:00 PM EDT on October 16, 2021 (3:00 AM UTC on October 17).

Human Lunar Landing Sites
Between July 1969 and December 1972, a total of 12 astronauts landed on the surface of the Moon as part of six of the Apollo missions. Apollo missions 11, 12, 14, 15, 16, and 17 each landed in different locations on the lunar surface. These locations, each fascinating for their own particular reasons, sampled a wide range of lunar geology and terrain, from smooth mare plains to rugged ancient highlands. All six landing sites are visible tonight. Use this map and the magnified charts on the other side of this sheet to find and observe all six historic sites.



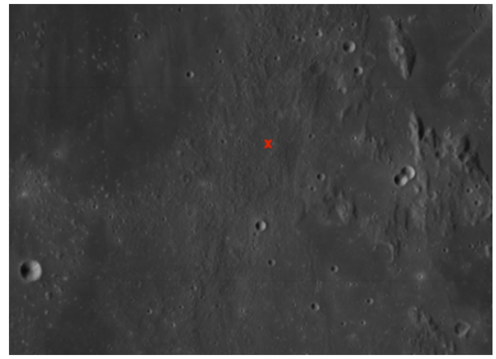
Map generated with NASA's Dial-A-Moon (https://svs.gsfc.nasa.gov/4874)

International OBSERVE THE MOON NIGHT 2021

Selected Objects for Telescopic Viewing

Apollo 11: The first human landing site on the Moon was on the smooth, flat plains of the Sea of Tranquility. Despite how flat the area looks from Earth and from lunar orbit, astronauts Armstrong and Aldrin had to maneuver their lander in the last minutes of their descent in order to avoid a field of giant boulders.

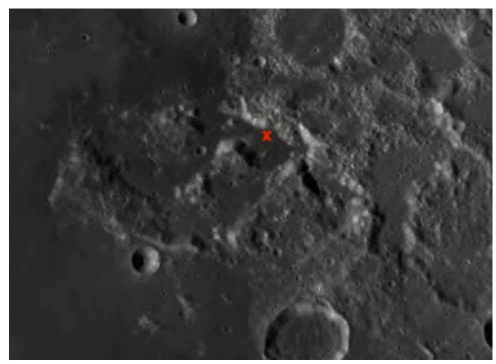
Apollo 12: In November 1969, a pinpoint landing brought astronauts Conrad and Bean down right next to the robotic Surveyor 3 spacecraft, which had landed there in April 1967. The astronauts collected samples of material blasted from the formation of Copernicus Crater over 217 miles (350 km) away and 800 million years ago.



Apollo 14: Astronauts Shepard and Mitchell landed in a broad expanse of low, rolling hills in February 1971. The rock samples collected by Apollo 14 revealed that the topography within Mare Imbrium was formed nearly four billion years ago by debris blasts from the basin's formation.

Apollo 15: In July 1971, astronauts Scott and Irwin landed at the edge of Mare Imbrium at the base of the towering Apennine Mountains. Driving their rover across the mare and up the lower mountain slope, they gathered samples from the dark mare plains and the surrounding, light lunar highlands.

Apollo 16: This was the first and only mission to land in the rugged lunar highlands. In April 1972, astronauts Young and Duke collected rock samples more than four billion years old. These showed that the ancient lunar crust formed from rock that crystalized and floated to the top of a global lunar magma ocean.



Apollo 17: The final Apollo mission to land on the Moon visited the spectacular Taurus-Littrow Valley, deeper than Earth's Grand Canyon. In December 1972, astronauts Cernan and Schmitt (the first professional geologist on the Moon) explored an active fault, a gigantic landslide deposit, and brought back samples that included beads of volcanic glass from an ancient lunar fire fountain.

Detailed images are from **NASA's Lunar Reconnaissance Orbiter** with north up and lunar west to the left. Find more high-resolution images of the Moon at:

lroc.sese.asu.edu
trek.nasa.gov/moon

OBSERVE the MOON

International OBSERVE THE MOON NIGHT 2021

SATURDAY OCTOBER 16TH

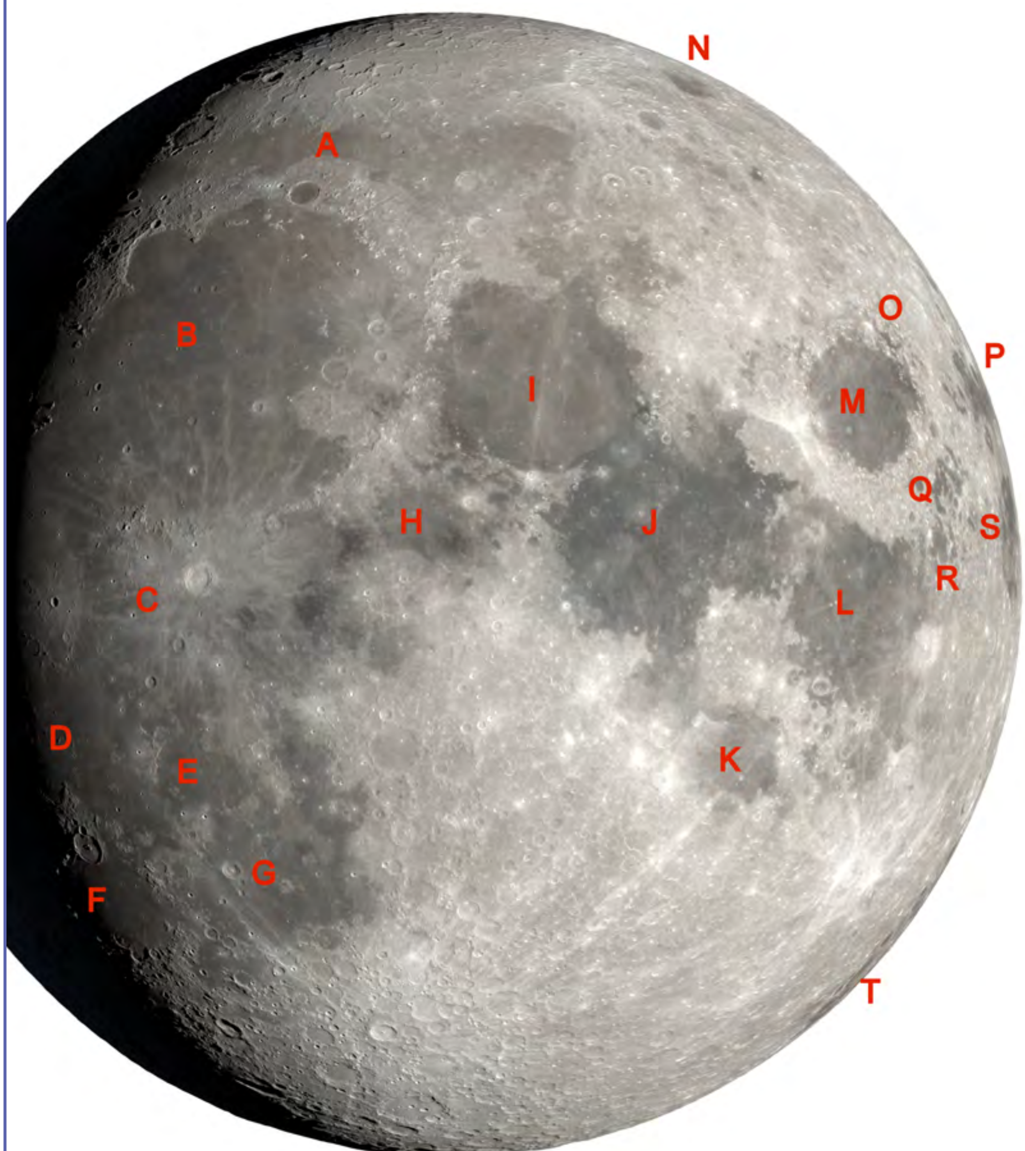
NORTHERN HEMISPHERE MOON MAP WITH LUNAR MARIA (SEAS OF BASALT)

Moon Map

This map was created for International Observe the Moon Night 2021. It depicts the Moon as it will appear from the northern hemisphere at approximately 11:00 PM EDT on October 16, 2021 (3:00 AM UTC on October 17).

Lunar Maria (Seas of Basalt)

You can see a number of maria tonight. Once thought to be seas of water, these are actually large, flat plains of solidified basaltic lava. They can be viewed in binoculars or even with the unaided eye. Tonight, you may be able to identify 18 maria on the Moon. This includes four seas along the eastern edge that are often hard to see. Because of libration, a slight apparent wobble by the Moon in its orbit around Earth, tonight we get to peek slightly around the northeast edge of the Moon, glimpsing a sliver of terrain normally on the Moon's far side.

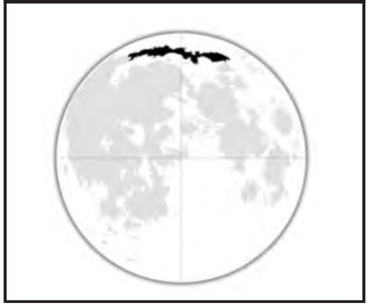


Map generated with NASA's Dial-A-Moon (https://svs.gsfc.nasa.gov/4874)

A. Mare Frigoris (Sea of Cold)
B. Mare Imbrium (Sea of Rains)
C. Mare Insularum (Sea of Isles)
D. Oceanus Procellarum (Ocean of Storms)
E. Mare Cognitum (Known Sea)
F. Mare Humorum (Sea of Moisture)
G. Mare Nubium (Sea of Clouds)
H. Mare Vaporum (Sea of Vapors)
I. Mare Serenitatis (Sea of Serenity)
J. Mare Tranquillitatis (Sea of Tranquility)
K. Mare Nectartis (Sea of Nectar)
L. Mare Fecunditatis (Sea of Fertility)
M. Mare Crisium (Sea of Crises)
N. Mare Humboldtianum (Humboldt's Sea)
O. Mare Anguis (Serpent Sea)
P. Mare Marginis (Border Sea)
Q. Mare Undarum (Sea of Waves)
R. Mare Spumans (Sea of Foam)
S. Mare Smythii (Smyth's Sea)
T. Mare Australe (Southern Sea)

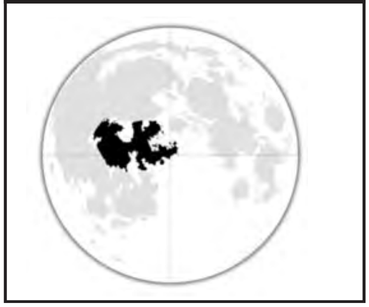
INTERNATIONAL OBSERVE THE MOON NIGHT 2021–The Lunar Maria (Seas of Basalt)

A. Mare Frigoris (Sea of Cold)



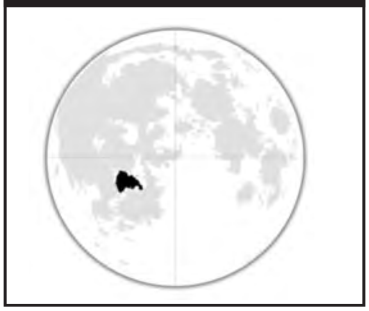
B. Mare Imbrium (Sea of Rains)

C. Mare Insularum (Sea of Isles)



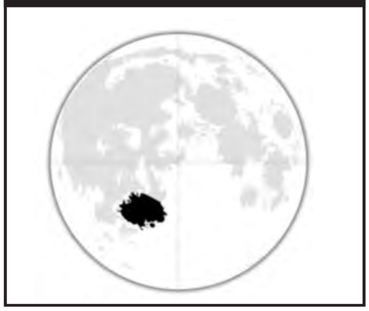
D. Oceanus Procellarum (Ocean of Storms)

E. Mare Cognitum (Known Sea)

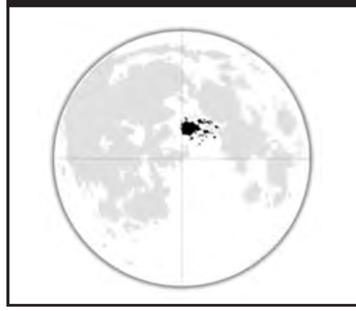


F. Mare Humorum (Sea of Moisture)

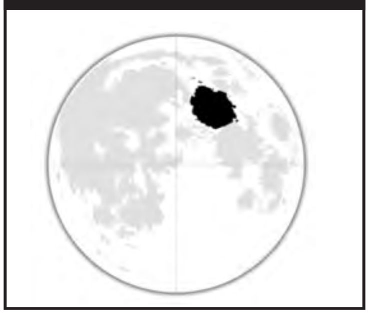
G. Mare Nubium (Sea of Clouds)



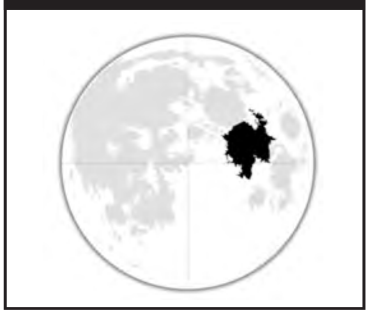
H. Mare Vaporum (Sea of Vapors)



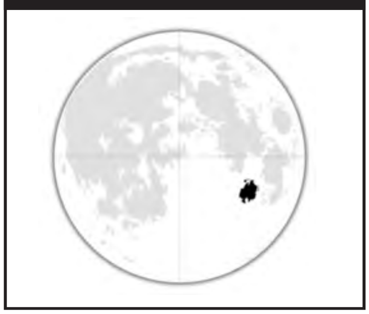
I. Mare Serenitatis (Sea of Serenity)



J. Mare Tranquillitatis (Sea of Tranquility)

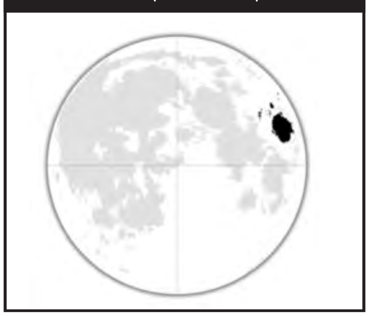


K. Mare Nectartis (Sea of Nectar)

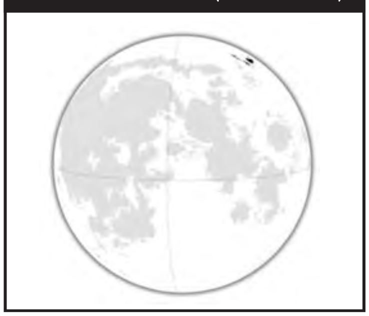


L. Mare Fecunditatis (Sea of Fertility)

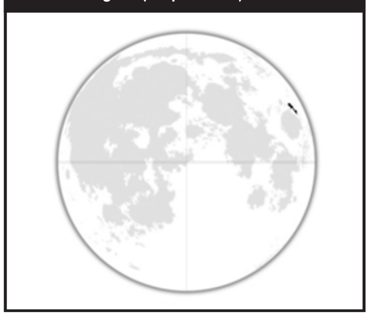
M. Mare Crisium (Sea of Crises)



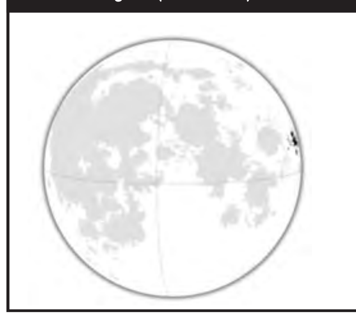
N. Mare Humboldtianum (Humboldt's Sea)



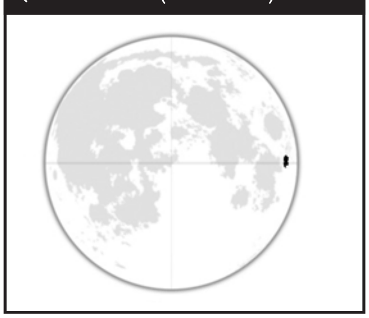
O. Mare Anguis (Serpent Sea)



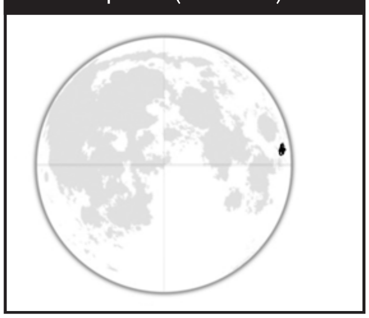
P. Mare Marginis (Border Sea)



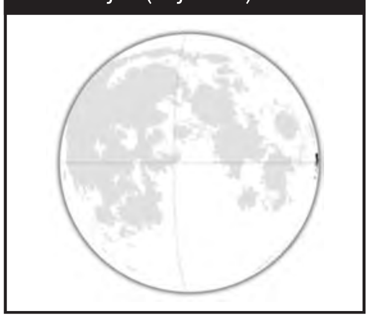
Q. Mare Undarum (Sea of Waves)



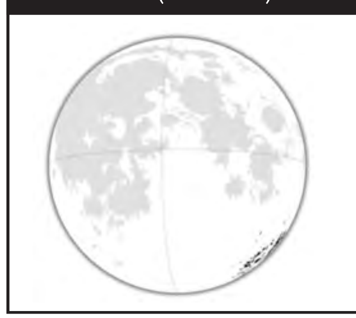
R. Mare Spumans (Sea of Foam)



S. Mare Smythii (Smyth's Sea)

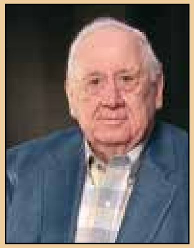


T. Mare Australe (Southern Sea)



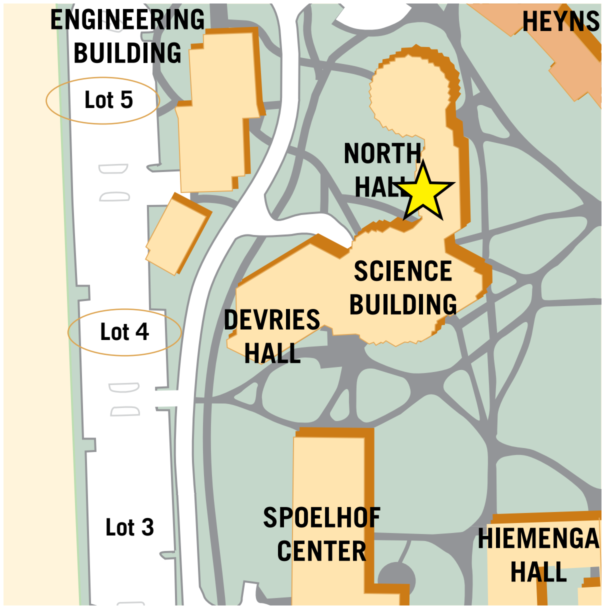
These are the 20 lunar seas visible tonight, with north up and lunar west to the left. You may be able to see some of the larger seas with your unaided eyes. Smaller seas may provide challenges even through binoculars. Combine these charts with the accompanying map (on the front page) and see how many of the Moon's maria you can track down tonight!
Note: Mare Orientale is not included here, because it is obscured in the dark western portion of the Moon as seen tonight.

HISTORY OF THE COLLECTION



Bruce Dice, a 1948 Calvin alumnus and geologist from Houston, Texas, has been an avid rock and mineral collector for as long as he can remember. From childhood digging in his backyard, to spelunking in mines in New Zealand and Mexico, Dice has practiced the art of mineral collecting. During the last 30 years, Dice has invested considerable time and effort into improving his exquisite collection. World-wide travels provided him opportunities to acquire rare and valuable samples. One of his favorite minerals on display is a sample of Crocoite, an unusual and rare lead chromate ($PbCrO4$) which forms into orange, tabular crystals (see inside picture). Our Museum specimen was obtained from a small, family-owned mine in Australia. Through the years Dice has worked to improve the variety and quality of minerals in the collection. Recent purchases included a suite of stunning fluorescent specimens from Franklin, New Jersey. Nevertheless, he felt something was missing: “I decided it was time to share … so [the collection] went to the love of my life — Calvin College.” A short time later, his mineral collection was delivered to professional museum staff for mounting, photographing, appraisal and documentation. Back at Calvin College, faculty, staff and students were enthusiastic when construction broke ground in March of 2012. A new addition to North Hall was erected, and over 300 mineral, meteorite and fossil specimens were relocated to their new home on Calvin’s campus. Both Dice and those at Calvin College agree that the collection is a magnificent way to marvel at God’s creation and to enjoy God’s handiwork. With time, the museum will continue to change as new specimens are displayed from acquisitions and storage, thereby offering fresh displays of God’s handiwork to be enjoyed time after time.

CALVIN COLLEGE – NORTH HALL



The museum is accessed from the first floor of North Hall on Calvin College’s campus (indicated by the yellow star). Parking is located to the west of the building in lots 4 and 5

Bruce Dice
MINERALOGICAL MUSEUM

Calvin College
North Hall
1740 Knollcrest Circle S.E.
Grand Rapids, MI 49546-4403

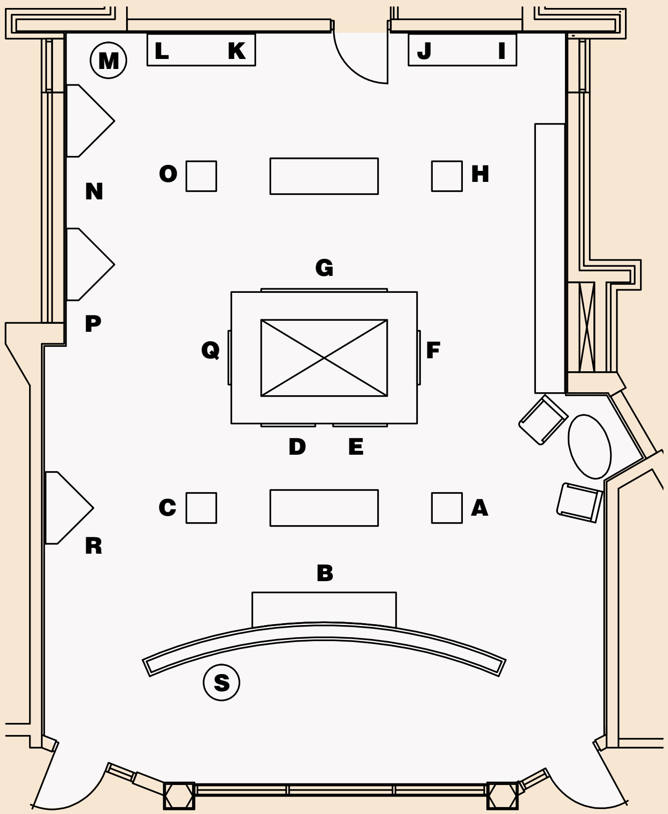
Open Hours: Mon., Wed., Fri. 1:30-5 p.m.,
Wed. evening tours available by prior arrangement.
Call Cheryl at (616) 526-3423 to schedule.

When you see the
beautiful things
that God has created,
you want to
keep them in front of you
and delight in them.
— Bruce Dice

CALVIN
College

WELCOME TO THE DICE MINERALOGICAL MUSEUM

The museum is a place where everyone, regardless of mineralogical background, can come and marvel at the beauty of God's creation. The collection houses more than 300 unique specimens collected from around the world. The museum showcases an array of mineralogical treasures: gold nuggets, copper leafs, 100-million year old fossils and an interactive ultraviolet case. These specimens show the wide diversity of color, shape and size that make the minerals interesting and fascinating to all ages. The map and list below serves to highlight a selection of mineral specimens you will want to make sure to see.



BE SURE TO SEE THESE MINERALS:

A. Large, sky-blue **kyanite**
B. 6.8-ounce **gold** nugget
C. Bright pink **rhodochrosite**
D. Green-fluorescing **franklinite**
E. Marvelous, clear **topaz**
F. Cubic, green **fluorite**
G. The **copper** case: The copper "terrier"
H. Orange pendent of **amber** (tree resin)
I. Green, tabular **vivianite**
J. **Quartz/sphalerite/pyrite** "seahorse"
K. Rare sample of **crocoite**
L. Blue-shimmering **labradorite**
M. Four-foot tall **amethyst** geode
N. **Banded iron formation (BIF)** slabs
O. Two growth-phases of **gypsum**
P. 100 m.y. fossilized **octopus**
Q. Cotton-ball shaped **okenite**
R. Two **Allende meteorites**
S. Large **clevelandite/quartz/tourmaline**

OUR MISSION

Calvin College invites you to experience and appreciate some of the wonderful and beautiful specimens from God's Good Creation. The Dice Museum is available for casual visits, informal tours and educational programs through the Department of Geology, Geography and Environmental Studies and Calvin Academy of Life-long Learning (CALL) at Calvin College. Visit often or occasionally and enjoy a quiet and reflective setting with beautiful, natural objects. We hope you encounter rocks and minerals in a unique and personal way at the Dice Mineralogical Museum, a display of God's handiwork.

MUSEUM OPPORTUNITES

- Informal tours available during open hours by a museum staff member.
- Educational lectures on minerals facilitated by faculty and/or staff from Calvin College
- Interactive displays and pamphlets to assist in understanding the minerals, fossils and meteorites found within the museum.

Calvin Ecosystem Preserve & Native Gardens

To ensure your safety and the preservation of our plants and animals, please respect these rules:

- **Stay on Path**
- **No Collecting** Do Not Pick Flowers
- **Do Not Climb Rocks**
- **No Dogs**
- **No Running**
- **No Biking**
- **No Skiing**
- **No Fishing**

TRAILS ARE WOOD CHIPPED

PERIMETER TRAILS ~ .9 MILES
TRAILS IN TOTAL ~ 1.7 MILES

TRAILS	STAFF ONLY ACCESS
BOARDWALK	OVERLOOK
BRIDGE	SEATING
PAVED PATH	EMERGENCY PHONE