

## David M. Hyman

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## Research Interests

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As a mathematical volcanologist, I combine mathematical tools, geophysical remote sensing and field techniques, and analog experiments to investigate the characteristics and dynamics of volcanic systems from the near surface to the atmosphere and their associated hazards. I am interested in volcanic gas and ash emissions, conduit and lava dome dynamics, hydrothermal pressurization and destabilization, probabilistic hazard studies, and other applications of geophysical fluid dynamics and probability theory in physical volcanology. These studies are driven by a deep interest in the ways that individuals and societies interact with active earth processes and continually assimilate, accommodate, and mitigate their attendant risks.

## Education

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Ph.D., Geological Sciences, University at Buffalo, June, 2018. Dissertation: *Pressurization-induced failure of deforming lava domes: theory, experiment, and application* (Advisors: Marcus Bursik, Tracy Gregg, E. Bruce Pitman, Greg Valentine, Chris Lowry).

B.A., Geosciences (Mathematics minor), Hamilton College, May, 2012. Thesis: *Relationship between regional graben and local fold structures in Eocene carbonates, Western Desert, Egypt* (Advisor: Barbara Tewksbury).

## Professional Experience

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Postdoctoral Research Associate, Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin - Madison, October 2018 - present. Atmospheric Remote Sensing/Physical Volcanology. Development and implementation of probabilistic SO<sub>2</sub> retrieval scheme for layer height and mass loading; Development of probabilistic hazard maps for volcanic SO<sub>2</sub> clouds; Analysis of rapidly evolving volcanic thermal signals from geostationary data; Contributions to the VOLcanic Cloud Analysis Toolkit (VOLCAT, <https://volcano.ssec.wisc.edu/>) (Supervisor: Michael J. Pavolonis)

Research Assistant, Department of Geology, University at Buffalo, June 2015 - September 2018. Physical Volcanology/Geophysical Modelling Statistics/Research in support of dissertation. Development and analysis of coupled gas-lava system of gas flow in viscously deformable porous media; Analog and mathematical modelling of pore pressurization in volcanic rocks; Collection, processing, and analysis of ground-based thermal imagery of volcanic degassing; Characterization of rheologically complex geophysical flows over natural terrain; Development of generalized probabilistic hazard map statistics and analysis of specific cases. (Supervisors: Marcus Bursik, Tracy Gregg)

## Teaching Experience

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Summer Geological Field Camp (GLY 407), Lead Teaching Assistant, University at Buffalo, 2017. Instructed and assessed students on geological map and stratigraphic column construction, rock identification, note-taking, and hypothesis testing in the field. Management of other Field Camp TA's and all Field Camp personnel safety.

Matlab Tutorials, Instructor, University at Buffalo, 2016-2018. Designed and delivered tutorials in the use of Matlab for scientific computing, data analysis, and visualization for interested undergraduate and graduate students.

Igneous and Metamorphic Petrology (GLY 306), Teaching Assistant, University at Buffalo, 2015. Developed, delivered, and assessed lab exercises for two sections of undergraduate geology majors including petrographic microscope use and analysis of igneous and metamorphic rocks in thin section. Lectured on igneous and metamorphic processes during primary instructor absences.

Global Environmental Science (GLY 101), Teaching Assistant, University at Buffalo, 2014. Developed and delivered lab activities as well as assessments for two sections of introductory environmental science students.

Mathematics (several courses, high school-level), Instructor, Brightmont Academy, Seattle, 2014. Taught courses in precalculus, geometry, and algebra for high school students with nontraditional backgrounds including students with disabilities.

## Publications

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**Hyman, D. M.** and Pavlonis, M. J.: Probabilistic retrieval of volcanic SO<sub>2</sub> layer height and cumulative mass loading using the Cross-track Infrared Sounder (CrIS), *Atmospheric Measurement Techniques*, pp. 1–35, doi: 10.5194/amt-2020-41, URL <https://doi.org/10.5194/amt-2020-41>, 2020, accepted

Patra, A., Bevilacqua, A., Akhavan-Safaei, A., Pitman, E. B., Bursik, M., and **Hyman, D.:** Comparative Analysis of the Structures and Outcomes of Geophysical Flow Models and Modeling Assumptions Using Uncertainty Quantification, *Frontiers in Earth Science*, 8, 275, doi: 10.3389/feart.2020.00275, URL <https://www.frontiersin.org/article/10.3389/feart.2020.00275>, 2020

**Hyman, D. M.**, Bevilacqua, A., and Bursik, M. I.: Statistical theory of probabilistic hazard maps: a probability distribution for the hazard boundary location, *Natural Hazards and Earth System Sciences*, 19, 1347–1363, doi: 10.5194/nhess-19-1347-2019, URL <https://www.nat-hazards-earth-syst-sci.net/19/1347/2019/>, 2019

**Hyman, D. M.**, Bursik, M. I., and Pitman, E. B.: Pressure-driven gas flow in viscously deformable porous media: application to lava domes, *Journal of Fluid Mechanics*, 869, 85109, doi: 10.1017/jfm.2019.211, URL <https://doi.org/10.1017/jfm.2019.211>, 2019

Bevilacqua, A., Patra, A. K., Bursik, M. I., Pitman, E. B., Macías, J. L., Saucedo, R., and **Hyman, D. M.:** Probabilistic forecasting of plausible debris flows from Nevado de Colima (Mexico) using data from the Atenquique debris flow, 1955, *Natural Hazards and Earth System Sciences*, 19, 791–820, doi: 10.5194/nhess-19-791-2019, URL <https://www.nat-hazards-earth-syst-sci.net/19/791/2019/>, 2019

**Hyman, D. M.**, Bursik, M. I., and Legorreta Paulín, G.: Time Dependence of Passive Degassing at Volcán Popocatepetl, Mexico, From Infrared Measurements: Implications for Gas Pressure Distribution and Lava Dome Stability, *Journal of Geophysical Research: Solid Earth*, 123, 8527–8547, doi: 10.1029/2018JB015674, URL <https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JB015674>, 2018

**Hyman, D. M.** and Bursik, M. I.: Deformation of volcanic materials by pore pressurization: analog experiments with simplified geometry, *Bulletin of Volcanology*, 80, 19, doi: 10.1007/s00445-018-1201-9, URL <https://doi.org/10.1007/s00445-018-1201-9>, 2018

## Publications in Preparation:

**Hyman, D. M.** and Pavolonis, M. J.: A novel approach to estimating volcanic SO<sub>2</sub> flux from infrared satellite measurements using artificial intelligence and simplified plume physics, Remote Sensing, anticipated submission Nov. 2020

Pavolonis, M. J., **Hyman, D. M.**, and Sieglaff, J.: A Generalized Method for Detecting and Characterizing Volcanic Thermal Anomalies using Geostationary or Low Earth Orbit Satellites., Remote Sensing of Environment, anticipated submission Jan. 2021

## Conference Abstracts (Lead Only)

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**Hyman, D. M.** and Pavolonis, M. J.: Probabilistic retrieval of volcanic SO<sub>2</sub> altitude and loading from the Cross-track Infrared Sounder (CrIS): Examples from Raikoke, Sierra Negra, Bogoslof, and Anak Krakatau, URL <https://tinyurl.com/agu2019-prob-so2>, American Geophysical Union 2019 Fall Meeting, poster, 2019

**Hyman, D. M.**, Bursik, M. I., and Bevilacqua, A.: Statistical theory of probabilistic hazard maps: a probability density function for inundation edge location, American Geophysical Union 2018 Fall Meeting, talk, 2018

**Hyman, D. M.** and Bursik, M. I.: Gas flow instability onset in lava domes, Cities on Volcanoes 10, talk, 2018

**Hyman, D. M.**, Bursik, M. I., and Pitman, E. B.: Numerical analysis of pressure and porosity evolution in lava domes during periodic degassing conditions, American Geophysical Union 2017 Fall Meeting, talk, 2017

**Hyman, D. M.** and Bursik, M. I.: Transient lava dome pressurization and degassing at Volcán Popocatepetl, Mexico: numerical analysis and degassing flux calculations from thermal infrared images, IAVCEI 2017 Scientific Assembly, poster, 2017

**Hyman, D. M.** and Bursik, M. I.: Time-dependence of passive degassing at Volcán Popocatepetl, Mexico from infrared measurements: implications for gas pressurization of a lava dome, American Geophysical Union 2016 Fall Meeting, poster, 2016

**Hyman, D. M.** and Bursik, M. I.: Deformation of a volcanic edifice by pore pressurization: an analog approach, American Geophysical Union 2015 Fall Meeting, poster, 2015

## Awards

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2017: Duane Champion Research Award, University at Buffalo.

2016, 2017: Reginald Pegrum Professional Development Award, University at Buffalo.

2016: Center for Geohazards Student Research Award, Center for Geohazards Studies, University at Buffalo.

2016: Buffalo Graduate Student Association Conference Funding Award, University at Buffalo.

## Professional Synergistic Activities

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### Reviewer:

Geophysical Research Letters, Bulletin of Volcanology, Journal of Geophysical Research: Atmospheres, Transport in Porous Media.

### **Affiliations:**

International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), American Geophysical Union (AGU).

### **Other:**

University of Wisconsin Postdoctoral Association Diversity and Inclusion Committee, 2020-present. <https://uwpa.wisc.edu/diversity/diversity-inclusion>

Graduate Student Representative, Center for Geohazard Studies, University at Buffalo, 2015-2017. <https://geohazards.buffalo.edu>

Tutorials Committee Member, Geology Graduate Student Association, University at Buffalo, 2016-2018. <https://ubwp.buffalo.edu/geology>

## **Geological Field Experience**

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2016, 2017: Thermal imaging of gas plume, sample collection of dome fragments, and ballistic impact crater measurement, Volcán Popocatepetl, Mexico.

2016: Mapping lithologies, fractures, and porosity in dissected lava domes and distal ash sectioning and collection, Mammoth Mountain and Mono Craters, California.

2016: Field study of volcanic rocks and structures at various sites in New Mexico and Colorado including Zuni Salt Lake, Valles Caldera, and Summer Coon volcano.

## **Computer and Technical Skills**

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**Python:** Technical computing, large dataset collection, processing, and handling, probabilistic analysis, model development, image processing, algorithm development, geospatial analysis, data visualization.

**MATLAB:** Technical computing, model development, image processing, data visualization.

**Thermal Infrared Camera (FLIR):** Imaging, radiometric image analysis, measurement parameterization

**Geological Mapping:** structural and lithological, volcanic features

**Advanced Mathematical Methods:** dynamical systems, partial differential equations, probability theory, non-parametric statistics, nonlinear waves and integrable systems, stability analysis, integral transforms, complex analysis, asymptotics, approximation schema, inverse methods.

**Other:** ArcGIS, ImageJ, L<sup>A</sup>T<sub>E</sub>X, experimental design and execution, petrographic microscope, wilderness first aid.