Andrew Joseph Ryan

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Curriculum Vitae

Education

2018, 2013 **Ph.D. and M.S. in Geological Sciences,** School of Earth and Space Exploration, Arizona State University, Tempe, AZ. Advisor: Phil Christensen

2011 **B.S. in Environmental Geosciences** (with physics minor)*,* Department of Geography, Geology, and the Environment, Slippery Rock University, Slippery Rock, PA. *Magna Cum Laude.*

Professional Experience

2020– **Staff Research Scientist (Researcher/Scientist IV)**
Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ

2019–2020 Postdoctoral Research Associate
Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ.

2018–2019 Postdoctoral Researcher
Observatoire de la Côte d'Azur and Université Côte d'Azur, Nice, France.

2011 Internship Program Staff Assistant, NASA Lunar and Planetary Science Academy, Goddard Space Flight Center, Greenbelt, MD

2010 Undergraduate Intern, NASA Lunar and Planetary Science Academy, Goddard Space Flight Center, Greenbelt, MD

2009 Undergraduate Intern, NASA Undergraduate Student Research Program (USRP), Johnson Space Center, Houston, TX

Mission Experience

OSIRIS-REx **Mission Co-I** (2021–present), **Working Group Lead**: Sample Physical and Thermal Analysis Working Group (SPTAWG, 2020–present), **Thermal Analysis Lead**: OSIRIS-APEX extended mission (2022–present), **Instrument Operations Specialist**: OTES Instrument (2016–2017)

Mars Exploration Rovers **Payload Downlink Lead** (2015–2017)
Opportunity Rover – Pancam Instrument

Mars Odyssey **THEMIS Science Team Member** (2011–2018)
THEMIS calibration and data analysis

Grants and Fellowships

2021–2024 **Co-Investigator,** NASA Solar System Workings (SSW), *The spectral and thermophysical effects of thin dust coatings in a simulated airless body environment*, PI: Timothy Glotch

2021–2024 **Collaborator**, NASA New Frontiers Data Analysis Program (NFDAP), *Timescales for boulder evolution from thermal fatigue and impacts on asteroid (101955) Bennu*, PI: Jamie Molaro

2021–2024 **Co-Investigator,** NASA New Frontiers Data Analysis Program (NFDAP), *Integrated boulder properties on rubble pile asteroid (101955) Bennu as tracers of parent body history*, PI: Erica Jawin

2020–2023 **Principal Investigator,** NASA Solar System Workings (SSW), *Thermal Conductivity and Apparent Thermal Inertia of Coarse and Porous Planetary Regoliths.*

2015–2017 **Student Collaborator,** NASA OSIRIS-REx Mission, *OSIRIS-REx Regolith Thermal Conductivity Laboratory Experiment*, PI: Phil Christensen

2012–2016 **Student Collaborator,** NASA Mars Fundamental Research Program (MFRP), *Thermal Conductivity Laboratory Measurements of Complex Surfaces with Applications to Mars,* PI: Phil Christensen

Refereed Publications

[22] Ryan, A.J. et al., Full-Field Modeling of Heat Transfer in Asteroid Regolith 2: Effects of Porosity (2022). *Journal of Geophysical Research: Planets* 127, e2022JE007191. DOI: 10.1029/2022JE007191

[21] Rozitis, B., **Ryan, A.J.**, Emery, J. P., et al. High-Resolution Thermophysical Analysis of the OSIRIS-REx Sample Site and Three Other Regions of Interest on Bennu (2022), *Journal of Geophysical Research: Planets* 127, e2021JE007153. DOI: 10.1029/2021JE007153

[20] Lauretta et al., Spacecraft sample collection and subsurface excavation of asteroid (101955) Bennu (2022), *Science*, DOI: 10.1126/science.abm1018.

[19] Walsh et al., Near-zero cohesion and loose packing of Bennu's near-subsurface revealed by spacecraft contact (2022), *Science Advances*, abm6229.

[18] Walsh et al., Assessing the sampleability of Bennu's surface for the OSIRIS-REx asteroid sample return mission (2022), *Space Sci. Rev. 218,* 20. DOI: 10.1007/s11214-022-00887-2

[17] Jawin, E.R., McCoy, T.J., Walsh, K.J., Connolly Jr., H.C., Ballouz, R.-L., **Ryan, A.J.**, et al. (2022), Global geologic map of asteroid (101955) Bennu indicates heterogeneous resurfacing in the past 500,000 years, *Icarus*, 114992. DOI: 10.1016/j.icarus.2022.114992

[16] Cambioni, S., Delbo, M., Poggiali, G., Avdellidou, C., **Ryan, A.J.**, Deshapriya, J.D.P., et al. (2021), Fine-regolith production on asteroids controlled by rock porosity, *Nature* 598. DOI: 10.1038/s41586-021-03816-5

[15] Golish, D.R., Li, J.-Y., Clark, B.E., DellaGiustina, D.N., Zou, X.-D., et al. (2021), Regional Photometric Modeling of Asteroid (101955) Bennu, *Planetary Science Journal* 2, 124.

Refereed Publications continued

[14] Li, J.-Y., Zou, X.-D., Golish, D.R., Clark, B.E., Ferrone, S., et al. (2021), Spectrophotometric Modeling and Mapping of (101955) Bennu, *Planetary Science Journal* 2, 117.

[13] Rozitis, B., **Ryan, A.J.,** Emery, J.P., Christensen, P.R., et al. (2020), Asteroid (101955) Bennu's Weak Boulders and Thermally Anomalous Equator, *Science Advances* 6, eabc3699. DOI: 10.1126/sciadv.abc3699

[12] DellaGiustina, D.N., Burke, K.N., Walsh, K.M., et al. (2020) Variations in color and reflectance on the surface of asteroid (101955) Bennu, *Science* 370. DOI: 10.1126/science.abc3660

[11] Simon, A.A., Kaplan, H.H., Hamilton, V.E., Lauretta, D.S., et al. (2020) Widespread carbon-bearing materials on near-Earth asteroid (101955) Bennu, *Science* 370. DOI: 10.1126/science.abc3522

[10] Daly, M.G., et al., Hemispherical Differences in the Shape and Topography of Asteroid (101955) Bennu (2020), *Science Advances* 6, 41. DOI: 10.1126/sciadv.abd3649

[9] Scheeres, D.J., et al., Heterogenous mass distribution of the rubble-pile asteroid (101955) Bennu (2020), *Science Advances* 6, 41. DOI: 10.1126/sciadv.abc3350

[8] Ryan, A.J. and K.X. Whipple (2020), Amphitheater-headed canyons of southern Utah: Stratigraphic control of canyon morphology, *Earth Surface Processes and Landforms* 45. 3607–3622. DOI: 10.1002/esp.4987

[7] Ryan, A.J., Pino-Munoz, D., Bernacki, M., and M. Delbo (2020), Full-Field Modeling of Heat Transfer in Asteroid Regolith: Radiative thermal conductivity of polydisperse particulates, *Journal of Geophysical Research: Planets* 125, e2019JE006100.

[6] Molaro, J.L., Walsh, K.J., et al. (2020), In situ evidence of thermally induced rock breakdown widespread on Bennu's surface, *Nature Communications* 11, 2913.

[5] DellaGiustina, D.N., Emery, J.P., et al. (2019), Properties of rubble-pile asteroid (101955) Bennu from OSIRIS-REx imaging and thermal analysis, *Nature Astronomy* 3, p. 341–351.

[4] Walsh, K.J., Jawin, E.R., et al. (2019), Craters, boulders and regolith of (101955) Bennu indicative of an old and dynamic surface, *Nature Geoscience* 12, p. 242–246.

[3] Cambioni, S., Delbo, M., **Ryan, A.J.**, Furfaro, R., and E. Asphaug (2019), Constraining the Thermal Properties of Planetary Surfaces using Machine Learning: Application to Airless Bodies, *Icarus* 325, p. 16–30.

[2] Kletetschka, G., Hooke, R. L., **Ryan, A. J.**, Fercana, G., McKinney, E., and K. P. Schwebler (2013), Sliding stones of Racetrack Playa, Death Valley, USA: The roles of rock thermal conductivity and fluctuating water levels, *Geomorphology* 195, p. 110 – 117.

[1] Ryan, A. J. and P. R. Christensen (2012), Coils and Polygonal Crust in the Athabasca Valles Region, Mars, as Evidence for a Volcanic History, *Science* 336, p. 449–452.

Teaching and Mentorship

Advisor to undergraduate student employees/interns
Maanyaa Kapur (2021–present), Jackson Barger (2021–2022), Zane Craddock (2021), Matthew Askins (2016), Jon Zaloumis (2013-2015)

2021–2022 **Project Sponsor**, Univ. of Arizona senior design Capstone project to design and build a gas pycnometer for OSIRIS-REx sample analysis. Mentor to 6 undergraduate engineering students.

2020–2021 **Project Sponsor**, Univ. of Arizona senior design Capstone project to develop a thermal conductivity measurement device for OSIRIS-REx returned samples. Mentor to 6 undergraduate engineering students.

2016–2017 **Phoenix Cubesat Mission Advisor**
Arizona State University Sun Devil Satellite Laboratory

2014–2015 **Introduction to Geology Lecture (GLG-101) - Instructor**
Mesa Community College, Mesa, AZ

2013 **Introduction to Exploration (SES-100) - Assistant**
Arizona State University, Tempe, AZ

2011–2012 **Introduction to Geology Lab (GLG-103) - Instructor**
Arizona State University, Tempe, AZ

Laboratory and Instrument Development

2021– Co-Leading development of gas pycnometer for OSIRIS-REx sample analysis at curation facility (with Robert Macke, S.J.)

2020– Leading development of novel thermal conductivity measurement apparatus for OSIRIS-REx sample analysis.

2015–2018 Design, assembly, calibration, operation, and data analysis of thermal vacuum conductivity experiment for asteroid regolith simulants, Arizona State University, Tempe, AZ.

2016–2017 Thermal vacuum chamber instrument testing: Instrument operator for OSIRIS-REx Thermal Emission Spectrometer (OTES) for instrument tests at ASU and full spacecraft test at Lockheed Martin. Chamber operator for the student-led “Phoenix” CubeSat infrared camera instrument TVAC test.

2016–2017 Thermal infrared dispersion prism spectrometer design, assembly, and testing with SciSight LLC startup, Tempe, AZ.

2013–2017 Operation, calibration, and maintenance of Mars environmental vacuum chamber for thermal conductivity experiments, Arizona State University, Tempe, AZ.

Awards and Honors

2021 **Asteroid (31985) Andrewryan**

2020 **Reviewer recognition,** 3 or more reviews in 2020 for *Journal of Geophysical Research: Planets*; https://doi.org/10.1029/2021JE006865

2018 **NASA Group Achievement Award** - OSIRIS-REx Earth Gravity Assist Team

2017 **NASA Group Achievement Award** - OSIRIS-REx OTES Development Team

2017 **NASA Group Achievement Award** - OSIRIS-REx Team

2016 **Edson Student Entrepreneurship Initiative Award Recipient** - Seed funding, resources, and mentorship for IR spectroscopy startup concept at Arizona State

2013 **Scholarship Recipient** - NASA Planetary Volcanology Field Workshop, Hawaii

2012 **Scholarship Recipient** - LPI/NLSI Sudbury, Ontario Impact Structure Camp

2012 **Dwornik Award – Best Graduate Poster (honorable mention)**
GSA Planetary Geology Division, 43rd Lunar and Planetary Sci. Conf.

2011 **University Graduate Fellowship** - School of Earth and Space Exploration and Graduate College, Arizona State University

2011 **Outstanding Senior Man** - Awarded to one male in graduating class by faculty nomination. Slippery Rock University.

2010 **Departmental Service Award** - Department of Geography, Geology, and the Environment, Slippery Rock University.

2008, 2009 **Presidential Scholar,** Awarded to top 20 students in each class, based on GPA. Slippery Rock University.

Field Work

2015 **Iceland - Laki 1783–84 and Haluhraun 2014–15 lava flows**
Effusive flow and hydrovolcanic feature mapping and interpretation

2014 **Hawaii - Dec. 1974 Kilauea fissure eruption**
Flow texture mapping and interpretation

2012 **Southern Utah - Escalante National Monument and Henry Mountains**
Amphitheater-headed canyon reconnaissance

Outreach and Invited Lectures

2021 **Invited Speaker**, Undergraduate seminar class “The Heritage and Traditions of the University of Arizona” (AED295b)

2021 “**Space Show” Guest,** Motherboard (Vice Magazine) *Space Show* – “How to Grab an Asteroid” (https://www.youtube.com/watch?v=ASrjZlmPavw)

2020 **Invited Speaker**, Observatoire de la Côte d’Azur Planetary Science Seminar

2016, 2017 **Science Panelist,** Phoenix Comic Con (now Phoenix Fan Fusion)

2016–2017 **Mars Science Consultant,** “Port of Mars” Massive Multiplayer Online (MMO) game, Arizona State University Interplanetary Initiative

Spring 2016 **Science Career Mentor**, ASU Sundial Mentoring Program, demonstrate research to undergraduates interested in science.

Outreach and invited lectures continued

Fall 2013 **Invited Speaker**, ASU College of Liberal Arts and Sciences (CLAS) Academy Forum

2012–2016 **Mars Science Educator,** ASU Earth and Space Open House**,** share recent Mars science with local families.

June 2012 **Assistant Field Guide**, NASA Lunar and Planetary Science Academy, assist in planning and leading planetary geology field trip in Arizona.

2011–2016 **Guest Instructor and Panel Member***,* Mars Student Imaging Project, work with 5^{th}-12^{th} grade student scientists.

June 2011 **Assistant Field Guide**, NASA Lunar and Planetary Science Academy, assist in planning and leading planetary geology field trip in the Channeled Scablands, eastern Washington.

Service to Scientific Community

Peer-Reviewer (Journals): *Earth and Space Science; Geology; Icarus; Journal of Geophysical Research - Planets; Monthly Notices of the Royal Astronomical Society; Nature Astronomy; Planetary Science Journal; Planetary and Space Science*

NASA ROSES reviews: Served as a panelist (2x), external reviewer (2x), and executive secretary (1x)

PDS (Planetary Data System) Small Bodies Node data delivery peer-reviewer (1x)

Technical Skills

Spacecraft and remote sensing data (high-level user):

Bennu*: OSIRIS-REx Thermal Emission Spectrometer (OTES), OSIRIS-REx Camera Suite (OCAMS) data products*, *OSIRIS-REx Laser Altimeter (OLA) data products*

Mars: Mars Global Surveyor *Thermal Emission Spectrometer (TES)*, Mars Odyssey *Thermal Emission Imaging System (THEMIS)*, Mars Reconnaissance Orbiter *High Resolution Imaging System (HiRISE) data products*

Earth: *Thermal Infrared Multispectral Scanner (TIMS)*

Computer languages and software:

Extensive experience: UNIX/Linux, COMSOL Multiphysics (heat transfer; optimization), Cimlib FE library, J-Mars/J-asteroid, LabView, ArcGIS, Python, Davinci, emacs, Paraview, Netgen, OAR and TORQUE batch schedulers for cluster computing

Some experience: C/C++, MySQL, PostgreSQL, Matlab, Java, Solidworks, FreeCAD

Languages

English - Native

French - Intermediate-high proficiency

Conference Participation (first author only)

[18] Ryan, A.J., Craddock Z.A., Cherian S.K., Gibson M.N., McCommon A.T., Ochoa, A.D., Ouyang, J., Siegler, M., Lauretta, D.S. (2021), Thermal Conductivity Measurement Plan for Samples Returned by OSIRIS-REx. *84th Annual Meeting of the Meteoritical Society*, #6237 (talk)

[17] Ryan, A.J., Pino-Muñoz, D., Rozitis, B., Bernacki, M., Delbo, M., et al. (2020), Thermophysical Analysis of Regolith on (101955) Bennu: The Coarse Regolith Conundrum. *Europlanet Science Congress ESPC2020* (invited talk).

[16] Ryan, A.J., Pino-Muñoz, D., Rozitis, B., Emery, J., and others (2019), Physical Interpretation of Bennu's Thermal Inertia. *Joint meeting of the DPS/EPSC*, EPSC-DPS2019-324-1 (poster).

[15] Ryan, A.J., Pino-Muñoz, D., Emery, J. P., Delbo, M., Rozitis, B., et al. (2019), Thermal Modeling to Determine the Existence and Nature of Layered Material on Bennu, *Asteroid Science in the Age of Hayabusa2 and OSIRIS-REx*, LPI Contrib. No. 2189, Abstract 2071 (talk).

[14] Ryan, A.J., Pino-Muñoz, D., Bernacki, M., Delbo, M., Emery, J., and D. Lauretta (2019), Asteroid regolith thermophysical properties: Porosity and skin-depth effects, *Asteroid Science in the Age of Hayabusa2 and OSIRIS-REx*, LPI Contrib. No. 2189, Abstract 2070 (poster).

[13] Ryan, A.J., Pino-Muñoz, D., Bernacki, M., Delbo, M., Emery, J., Christensen, P.R., and D. Lauretta (2019), Full-Field Modeling of Heat Transfer in Asteroid Regolith: Thermal Conductivity Results for Mono- and Polydisperse Particulates, *50th Lunar and Planetary Science Conference*, Abstract 2512 (Poster).

[12] Ryan, A.J., Delbo, M., Pino-Muñoz, D., Bernacki, Christensen, P.R., Emery, J.P., and D.S. Lauretta (2018), Regolith Thermophysical Properties: Experimental Thermal Conductivity Results and a New Full-field Thermophysical Model, *TherMoPS III Meeting*, Budapest, Hungary (Talk).

[11] Ryan, A.J., Pino-Muñoz, D., Bernacki, M., and M. Delbo, (2018), Full Field Modeling of Heat Transfer in Asteroid Regolith, *Programme National de Planétologie 2018*, Nice, France (poster).

[10] Ryan, A.J. and P.R. Christensen (2017), Measurements of Regolith Simulant Thermal Conductivity Under Asteroid and Mars Surface Conditions, *American Geophysical Union 2017 Fall Meeting*, P33H-05 (Talk).

[9] Ryan, A.J. and P.R. Christensen (2016), New laboratory technique to determine thermal conductivity of complex regolith simulants under high vacuum, *American Geophysical Union 2016 Fall Meeting,* P21A-2078 (Poster).

[8] Ryan, A.J., and K.X. Whipple (2014), An Investigation of Amphitheater-Headed Canyon Distribution, Morphology Variation, and Longitudinal Profile Controls in Escalante and Tarantula Mesa, Utah, *American Geophysical Union 2014 Fall Meeting,* EP31D (Poster).

Conference Participation cont.

[7] Ryan, A.J., Hamilton, C.W., and P.R. Christensen (2014), Coils in context: Dynamics of the Athabasca Valles Lava Flow, *8th International Conference on Mars*, 1404 (Poster).

[6] Ryan, A.J., Piqueux, S., and P.R. Christensen (2014), Radiometric determination of thermal conductivity of complex particulate materials under Mars-like conditions, *45th Lunar and Planetary Science Conference*, 2220 (Poster).

[5] Ryan, A.J., Salvatore, M. R., Smith, R. E., Edwards, C. S., and P. R. Christensen (2013), Solving for the Surface: An Automated Approach to THEMIS Atmospheric Correction, *American Geophysical Union 2013 Fall Meeting*, P51G (Poster).

[4] Ryan, A. J., Whipple, K. X., and J.P. Johnson (2012), Are amphitheater-headed canyons indicative of a particular formative process?, *American Geophysical Union 2012 Fall Meeting,* EP51A-0969 (Poster).

[3] Ryan, A. J. and P.R. Christensen (2012), Lava Coils and Drifting Polygonal Terrain in Cerberus Palus, Mars, *43rd Lunar and Planetary Science Conference*, abstract 2552 (Poster).

[2] Ryan, A.J. and 9 others (2011), Lifting of the Clast by Water and Ice: An Explanation for the Trails of the Racetrack and Bonnie Claire Playas, *Geological Society of America Abstracts with Programs* 43, p. 139.

[1] Ryan, A.J. and M.J. Zieg (2010), Petrographic and Geochemical Analysis of a Nipigon Diabase Sill. *Institute on Lake Superior Geology Proceedings* 56, p. 58-59.