

# AST 598: Planetary Analogs Field Course

College of the Environment, Forestry, and Natural Sciences  
Department of Astronomy and Planetary Science  
Semester: Fall 2019

**Prerequisites:** None

**Location:** Physical Sciences Bldg. (#19), Rm. 111

**Meeting Time & Format:** Meet every week (Fri., 2:20pm – 3:10pm), one weekend field trip

**Instructors:** Dr. Christopher Edwards, christopher.edwards@nau.edu, (928) 523-7234  
Dr. Mark Salvatore, mark.salvatore@nau.edu, (928) 523-0324

**Office Location:** Edwards: 205 Physical Sciences Bldg. (#19)  
Salvatore: 225A Physical Sciences Bldg. (#19)

**Office Hours:** Edwards: By Appointment Only  
Salvatore: Typically, Fridays from 10:00am–12:00pm, or By Appointment (follow the 'Salvatore Office Hours' Google Calendar:  
<https://calendar.google.com/calendar?cid=bmF1LmVkdV9qdm51cjBuanY4aGNxaDVwazI3bGJiNXFrMEBncm91cC5jYWxlbmRhci5nb29nbGUuY29t>



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## Course Purpose

This course will focus on a variety field sites relevant for understanding planetary processes and interpretation of data from our solar system. Each field site, which will rotate on every offering, will be designed to provide specific insight in to a process, formation mechanism, geologic expression or remote sensing technique that has direct relevance for planetary science investigations. Particular emphasis will be placed on student-led field guides, where students will develop a thorough understanding of the field site, lead the field trip and develop assignments. This class is **Pass/Fail** in format.

## Course Description

The use of field sites as a proxy for understanding planetary surface processes and is a tried and true methodology in planetary science. We use these well-chosen, unique field sites to illuminate processes, formation, and resulting alteration of planetary surfaces where they can be more easily studied on Earth. Many different planetary analog field sites are available within a day's drive of Northern Arizona University. Prior to the start of the semester, the lead faculty will select a site and goal from a set of well documented field sites which could investigate volcanos, impact craters, sedimentary layered deposits, channels, sapping features, lava flows, etc. In addition, the style of field trip may be variable where students will create field guide, science implementation plan, or other products.

In this class, we will investigate what it's like to be a "robotic geologist". We'll work through the landing site selection process, conduct a vote where we pick our landing ellipse, "land" at our field site and carry out rover-styled field work (some details below), ultimately seeking to answer scientific questions such as:

- (1) *Ground truth the remote sensing datasets to determine:*
  - (a) *What are the compositions of the different geologic units observed in the scenes?*
  - (b) *What are the structural controls of the observed mountain and valley landscape?*
- (2) *What are the controls on the distribution and density of life?*
- (3) *What evidence is there of past human exploration in the region (not present life, e.g. our camp or vehicles, or roads/trails)?*

Students will break up into small teams, each team having 3 different roles in the mission (*Geologist/Planetary Scientist, Rover Planner, Long-Term Planner*).

- (1) *The Geologist/Planetary Scientist's role is to decide what data should be acquired at each site and what methodology to use after the "rover" arrives at the waypoint.*
- (2) *The Rover Planner controls the rover while "driving" and must ensure the "on the ground" information, including science and trafficability, is built into the original traverse plan.*
- (3) *The Long-Term Planner keeps the team focused on the overall strategy and scientific objectives and looks several "drives" ahead using remote sensing data and localizing the team on the map (recording GPS points at each waypoint).*

## **Assessment**

This is a PASS/FAIL course. Course assessment will include the following:

- **Field Plan (20%)**: Groups will prepare a three-page field plan that details the route to be taken to address one of the above scientific questions (or another approved question). Groups must include a landing ellipse (20x20m) meeting given parameters (to be detailed at a later date), the path to get from the landing site to the desired locations which address the scientific question at hand. The groups will be provided a suite of remote sensing images and a GIS interface from which to develop the field plan and notional traverse(s).
- **Landing Site Workshop Presentations (20%)**: Groups will present a summary of their field plan (~10 minutes) to the class, developing a compelling case for the landing ellipse chosen. This presentation should provide a review of the field site, address the scientific objectives to be addressed, as well as the trafficability and the possibility for “bonus” science. At the conclusion of the presentations, the class will vote on the landing ellipse.
- **Traverse Plan Presentation (20%)**: Following the selection of the chosen landing ellipse, groups will rework their traverse to account for the new ellipse. This presentation will build on the Landing Site workshop presentation, but address details of data to be acquired at each waypoint. Groups will be given limitations related to “rover performance” and data volume.
  - Drive on <30° slopes
  - 100 steps per “drive”, 100 “drives” per mission
  - Mission anomalies (reduced capabilities caused by an onboard fault)
  - 6 samples for later lab analysis
  - 20 ASD VNIR/SWIR field spectra
  - 3 Hyperspectral VNIR images
  - 100 3-band RGB images (from a camera of your choice)
- **Field Notes (10%)**: Notes should be recorded at each study site to provide context for the images and data that are acquired. These notes will also provide the foundation for interpreting the analyzed data upon return from the field. Remember that good field notes are more than simply writings and recordings from the field. They include thoughts and ponderings recorded prior to field work, observations made during field work, and synthesizing these notes following field work. Good field notes allow you to revisit these notes years later and make sense of what was observed, why it was observed, and how it was observed.
- **Final Presentations (30%)**: Students will deliver a combined 20-minute final presentation that discusses the group’s topic of interest, their observations in the field, and their synthesis of all available data, observations, and reviews. Each student is expected to contribute to this final presentation. Groups will be evaluated on the clarity of the presentation, the clear and well-defined contributions of each team member, and the ability to link and associate the literature review with the questions addressed in the field, and to the relevant field data and remote sensing measurements.

Assignments will be evaluated by Edwards, Salvatore, and guest assessors. Grading/assessment criteria will be provided prior to each assignment. A passing grade is  $\geq 65\%$  while a failing grade is  $< 65\%$ .

**Required Materials & Technology**: None.

## **Class Schedule and Expectations**

As a one-credit pass/fail course, this class is designed to consist of a minimum of 15 “contact hours” and 30 “non-contact hours” throughout the course of the semester in order to satisfy NAU’s course requirements. Considering the duration of the weekend field trip, this course will be providing approximately 32 contact hours throughout the semester.

## Course Schedule

<b>Week</b>	<b>Date</b>	<b>Topics &amp; Content</b>	<b>Materials Due</b>
1	08/30/2019	Course Introduction	
2	09/06/2019	Landing Site and Rover Experiences	
3	09/13/2019	Develop Groups, Roles	
4	09/20/2019	Instrument Discussions	
5	09/27/2019	Field Plan and Workshop Presentation Prep	
6	10/04/2019	Field Plan and Workshop Presentation Prep	
7	10/11/2019	<b>Landing Site Workshop</b>	Field Plan Due
8	10/18/2019	Traverse Plan Prep	
9	10/25/2019	Traverse Plan Prep	
10	11/01/2019	Traverse Plan Prep	
11	11/08/2019	<b>Traverse Plan Presentation</b>	
12	11/15-16/2019	<b><i>Field Trip</i></b>	
13	11/22/2019	Final Presentation Prep	Field Notes Due
14	11/29/2019	<i>Thanksgiving Break, No Class</i>	
15	12/06/2019	<b>Final Presentations</b>	
16	12/13/2019	<i>Finals Week, No Class</i>	

## **Class, Departmental, & University Policies**

- This course requires an outside of class field trip. This field trip is **required** and students are expected to attend. Students must also sign a waiver before participating in this field trip.
- While the department cannot provide camping equipment at this time, we will work to ensure every registered student has the necessary equipment.
- As a courtesy to the instructor and to your fellow students, please come to class on time.
- Please silence all cellular devices during class. Please refrain from any other “electronic distractions” (e.g., text messaging, browsing social media) during class. If you are anticipating cellular disruptions during class for any personal or professional reasons, please notify the professor prior to class.
- Please disclose any disabilities or special requirements to the NAU Disabilities Resources Office, who will contact the instructors **privately** regarding any accommodations.
- Neither audio nor video recording will be permitted except under special circumstances prescribed by the NAU Disability Resources Office or discussed with the professor prior to class.
- **Additional departmental and university policies can be found at [www.physics.nau.edu/SYLLABI/POLICY/policy.html](http://www.physics.nau.edu/SYLLABI/POLICY/policy.html).** This course falls under all departmental and university policies unless otherwise stated in this document.

**ACADEMIC INTEGRITY.** NAU expects every student to firmly adhere to a strong ethical code of academic integrity in all their scholarly pursuits. The primary attributes of academic integrity are honesty, trustworthiness, fairness, and responsibility. As a student, you are expected to submit original work while giving proper credit to other people's ideas or contributions. Acting with academic integrity means completing your assignments independently while truthfully acknowledging all sources of information, or collaboration with others when appropriate. When you submit your work, you are implicitly declaring that the work is your own. Academic integrity is expected not only during formal coursework, but in all your relationships or interactions that are connected to the educational enterprise. All forms of academic deceit such as plagiarism, cheating, collusion, falsification or fabrication of results or records, permitting your work to be submitted by another, or inappropriately recycling your own work from one class to another, constitute academic misconduct that may result in serious disciplinary consequences. All students and faculty members are responsible for reporting suspected instances of academic misconduct. All students are encouraged to complete NAU's online academic integrity workshop available in the E-Learning Center and should review the full academic integrity policy available at <https://policy.nau.edu/policy/policy.aspx?num=100601>.

**COURSE TIME COMMITMENT.** Pursuant to Arizona Board of Regents guidance (Academic Credit Policy 2-224), for every unit of credit, a student should expect, on average, to do a minimum of three hours of work per week, including but not limited to class time, preparation, homework, and studying.

**DISRUPTIVE BEHAVIOR.** Membership in NAU's academic community entails a special obligation to maintain class environments that are conducive to learning, whether instruction is taking place in the classroom, a laboratory or clinical setting, during course-related fieldwork, or online. Students have the obligation to engage in the educational process in a manner that does not breach the peace, interfere with normal class activities, or violate the rights of others. Instructors have the authority and responsibility to address disruptive behavior that interferes with student learning, which can include the involuntary withdrawal of a student from a course with a grade of “W”. For additional information, see NAU's disruptive behavior policy at <https://nau.edu/university-policy-library/disruptive-behavior>.

**NONDISCRIMINATION AND ANTI-HARASSMENT.** NAU prohibits discrimination and harassment based on sex, gender, gender identity, race, color, age, national origin, religion, sexual orientation, disability, or veteran status. Due to potentially unethical consequences, certain consensual amorous or sexual relationships between faculty and students are also prohibited. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's Safe Working and Learning Environment (SWALE) policy. EAO also assists with religious accommodations. For additional information about SWALE or to file a complaint, contact EAO located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011, or by phone at 928-523-3312 (TTY: 928-523-1006), fax at 928-523-9977, email at [equityandaccess@nau.edu](mailto:equityandaccess@nau.edu), or via the EAO website at <https://nau.edu/equity-and-access>.

**TITLE IX.** Title IX is the primary federal law that prohibits discrimination on the basis of sex or gender in educational programs or activities. Sex discrimination for this purpose includes sexual harassment, sexual assault or relationship violence, and stalking (including cyber-stalking). Title IX requires that universities appoint a “Title IX Coordinator” to monitor the institution's compliance with this important civil rights law. NAU's Title IX Coordinator is Pamela Heinonen, Director of the Equity and Access Office located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011. The Title IX Coordinator is available to meet with any student to discuss any Title IX issue or concern. You may contact the Title IX Coordinator by phone at 928-523-3312 (TTY: 928-523-1006), by fax at 928-523-9977, or by email at [pamela.heinonen@nau.edu](mailto:pamela.heinonen@nau.edu). In furtherance of its Title IX obligations, NAU will promptly investigate and equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. Additional important information about Title IX and related student resources, including how to request immediate help or confidential support following an act of sexual violence, is available at <http://nau.edu/equity-and-access/title-ix>.

**ACCESSIBILITY.** Professional disability specialists are available at Disability Resources to facilitate a range of academic support services and accommodations for students with disabilities. If you have a documented disability, you can request assistance by contacting Disability Resources at 928-523-8773 (voice), 928-523-6906 (TTY), 928-523-8747 (fax), or [dr@nau.edu](mailto:dr@nau.edu) (e-mail). Once eligibility has been determined, students register with Disability Resources every semester to activate their approved accommodations. Although a student may request an accommodation at any time, it is best to initiate the application process at least four weeks before a student wishes to receive an accommodation. Students may begin the accommodation process by submitting a self-identification form online at <https://nau.edu/disability-resources/student-eligibility-process> or by contacting Disability Resources. The Director of Disability Resources, Jamie Axelrod, serves as NAU's Americans with Disabilities Act Coordinator and Section 504 Compliance Officer. He can be reached at [jamie.axelrod@nau.edu](mailto:jamie.axelrod@nau.edu).

**RESPONSIBLE CONDUCT OF RESEARCH.** Students who engage in research at NAU must receive appropriate Responsible Conduct of Research (RCR) training. This instruction is designed to help ensure proper awareness and application of well-established professional norms and ethical principles related to the performance of all scientific research activities. More information regarding RCR training is available at <https://nau.edu/research/compliance/research-integrity>.

**SENSITIVE COURSE MATERIALS.** University education aims to expand student understanding and awareness. Thus, it necessarily involves engagement with a wide range of information, ideas, and creative representations. In their college studies, students can expect to encounter and to critically appraise materials that may differ from and perhaps challenge familiar understandings, ideas, and beliefs. Students are encouraged to discuss these matters with faculty.