

# **GEOL G429 – FIELD GEOLOGY IN THE NORTHERN ROCKY MOUNTAINS**

**(6 credit hours)**

**Judson Mead Geologic Field Station  
Department of Geological Sciences,  
Indiana University**



## **Course Description**

The G429 curriculum is divided into two parts. The first part emphasizes close instruction in small working groups. Topics included in this first part of the course are techniques of mapping simple structures on aerial photographs and topographic maps, reconnaissance mapping of a relatively large area of moderate structural complexity, the study of sedimentary rocks through detailed description and measurement of stratigraphic sections, the interpretation of stratigraphic sequences, detailed mapping and reconstruction of the geologic history of a highly complex structure characterized by numerous folds and faults, and field studies of igneous and Archean metamorphic rocks.

As a culmination of the intense instructional portion of the course students are given the option to select a particular focus for the final week of instruction. Options for this week include an emphasis on crystalline rocks (G429c); and emphasis on hydrologic and environmental studies (G429e); or the integration of different geophysical techniques (G429g). This work is set within the overall framework that has been developed up to this point in the course allowing students to explore how more in-depth techniques can be adapted within a field setting.

The second part of the course consists of a single Final Study Area where the student is given independence to conduct field work in a much more independent fashion with the ultimate goal the synthesis of the geologic history of the area along with detailed interpretations of discipline specific problems related to areas of the students interest. The FSA project involves mapping in an area characterized by both geologic diversity and complexity. The student works independently in one of several FSAs and produces extensive sets of different types of supporting data; geologic maps on aerial photographs (stereographic pairs) and a topographic base maps; geologic cross sections; other appropriate projects of data as determined by the student; and a summary of the geologic history of the region as a final project. The maps and written report for the project are due on the last day of the course.

## **Caravan Trips**

To take advantage of the range of geology available in the northern Rocky Mountains, two field excursions are included within the course. The first takes place at the start of the courses, using localities encountered on the drive to the IUGFS to develop a sense of the regional stratigraphy and structural and tectonic setting of the region. This involves stops in the: Black Hills, Powder River Basin, Big Horn Mtns, Big Horn Basin, Owl Creek Mtns, Wind River Basin, Wind River Mtns, Absaraka Mtns, Jackson Hole, and Teton Mtns, and Grand Teton and Yellowstone National Parks. As a break between the two parts of the course a second excursion to NW Montana is taken to study the: Montana Overthrust Belt in Sun River Canyon, Glacier National Park, Flathead Valley Continental Glacial History.

## **Prerequisites**

Students are expected to have completed at least the first two–three years of a standard undergraduate program in the geosciences. This would normally include an introductory course and two or more courses in the disciplines of mineralogy, petrology, sedimentology, stratigraphy, and structure/tectonics. Additional topical coursework is beneficial for some of the areas of concentration that are available.

## **Explanation of G429 Course Philosophy and Grading**

The following information highlights and clarifies the philosophy, approaches and grading used in the G429 Field Geology of the Rocky Mountains course offered by Indiana University. We have always expected that students participating in our course will have had a complete suite of undergraduate level science courses. As such, and historically, G429 typically serves as a capstone course for an undergraduate degree in the geological sciences. The schedule of exercises and activities has been designed such that successive exercises build upon experiences and skills learned in the previous activities. The pace of the course increases as students gain experience and become more comfortable with the routine field measurements and observational tasks as well as the tabulation, display, and analysis of the field data collected. The days are long with rigorous field work followed by evening activities that

may include lectures, data compilation and analysis, or study sessions; good time management becomes essential to ensure sufficient time for the critical analysis and synthesis portions of each exercise/project. There are four major components to the course: 1.) Caravan style road trips that combine regional overviews with local geologic details (2%); 2.) Instructional exercises that aim to provide students with the foundations of mapping and analysis techniques by providing the opportunity for students to work extensively with staff (32.5%); 3.) A Final Study Area project that involves a single, moderately large study area with multiple levels of problems to be addressed by the students individually, although with access to faculty for discussions and guidance (30%); and 4.) Independent Field Examinations (35.5%) [4 spaced throughout the course, completed as a single, all day event undertaken entirely independently by the students in an area not previously known to the student (but similar and related to areas the students have previously worked in)]. Due to the range of activities, demands of the learning environment (both physical and intellectual), and level of achievement required, when coupled with a diverse national student body, the grades awarded to students may or may not reflect how those students perform in a traditional classroom setting. Some students are able to excel in ways not germane in a traditional classroom. However, others struggle with time management, inability to successfully adapt to the rigors and complexities of the field setting, or some combination of the above, which may not be as critical or even relevant in a classroom setting. Nonetheless, there is no grade inflation in the G429 field course. Therefore, any student receiving a passing grade (C- or better) is considered to have proven themselves to be competent and capable geoscientists. All work in G429 must be conducted in adherence to the academic code of conduct, as stated in *The Code of Student Rights, Responsibilities, and Conduct*. Copyright 1998 The Trustees of Indiana University.

## **Texts**

A number of guidebooks, manuals, and handouts are provided to students within G429. These have all been prepared specifically for this course and provide all of the necessary materials needed. Additional resources are available that include a range of discipline specific textbooks (e.g. Sedimentology and Stratigraphy, Structural Geology, Petrology) and research articles covering a wide range of subjects.

## **Concentration Options**

### **G429c–Crystalline Rocks and Economic Geology**

G429c explores the topics associated with crystalline rocks, both igneous and metamorphic, from an integrated field and geochemical approach. A number of extremely well exposed areas within the region allow for detailed mapping of a zoned plutonic complex associated with the regional late Cretaceous igneous activity of the western cordillera. Mapping is augmented with a suite of whole rock and isotope geochemical data that permits a more robust analysis to be completed than might be possible with fieldwork alone. A second project focuses on the 3.4 Ba Archean metamorphic suite that the Field Station is located on. Like with the igneous project, the fieldwork is augmented by integrated sets of petrographic analysis, whole rock geochemistry, and isotope geochemistry for samples collected within the study areas.

### **G429g–Geophysics and Neotectonics:**

G429g utilizes geophysical tools (e.g. seismic, gravity, electrical resistivity, terrestrial laser survey, and GPS) to build data sets that can be used to interpret a number of geologic problems that exist within the region. Specific topics and techniques are chosen on an annual basis all of which are designed to integrate geophysical techniques with traditional geologic investigations. The emphasis is on field deployment of geophysical instruments with time spent learning about the instruments, defining how to best deploy the instruments to solve the problem to be addressed, working on data reduction and interpretation and finally, developing models to test and refine the geologic interpretation of the data. The problems, instruments, and deployment techniques selected are formulated to address questions that arise from the experiences leading up to this week. Concepts and information developed during this week will be applied during the final study area. A critical component of the work is to integrate traditional geological data (e.g. sedimentology, stratigraphy, structural analysis) into any interpretation. Recent work has focused on monitoring neotectonic activity in the vicinity of the Field Station.

### **G429s–Stratigraphy and Subsurface Exploration Techniques**

G429s provides students with an opportunity to explore problems in regional stratigraphy using a combination of field data, wireline logs, and/or seismic reflection data. These advanced exercises will build on the basic principles of facies analysis introduced earlier in the course. Possible topics include sequence stratigraphic analysis of Paleozoic carbonates, lithostratigraphic correlation of Mesozoic clastics and carbonates, and stratigraphic architecture of Tertiary units. Together, these techniques and exercises will provide students with a fuller understanding of the interplay between tectonics, eustasy, climate, and sedimentation recorded by the regional stratigraphy.

**INDIANA UNIVERSITY JUDSON MEAD GEOLOGIC FIELD STATION**  
**G429 – SUMMER 2016 SCHEDULE**

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
June 19	June 20	June 21	June 22	June 23	June 24	June 25
G429 students arrive in Bloomington; Evening Meeting 6:00 PM	Caravan leaves Bloomington 7:00 AM;  Missouri Valley, MS DeSoto Inn	Badlands N.P. Arrive Rapid City, SD; G429 Introductory Evening Lecture  Rapid City, SD Best Western	Geology of the Black Hills  Spearfish, SD Rodeway Inn & Suites	Geology of the Big Horn and Owl Creek Ranges; Powder River and Big Horn Basins  Riverton, WY; Sundowner Station	Wind River Range, Teton Range Cenozoic Geology Yellowstone N.P.  Yellowstone N.P. Teton/Yellowstone	Yellowstone N. P. Cenozoic Geology  Tobacco Root Mtns. IUGFS
June 26	June 27	June 28	June 29	June 30	July 1	July 2
OFF	Lower Paleozoic Stratigraphy of the Tobacco Root Mountains	Lower Paleozoic Stratigraphy Cont. Intro. to Mapping on Air Photos and Topographic Maps	Reconnaissance Structural Analysis of the Mt. Doherty Area	Reconnaissance Structural Analysis Cont.; Practice Independent Field Exercise	Completion of Mt. Doherty Instructional Project	Independent Field Exercise #1
July 3	July 4	July 5	July 6	July 7	July 8	July 9
OFF	Mesozoic Stratigraphy of the Tobacco Root Mountains	Cenozoic Extensional Basins, Tertiary Stratigraphy, Recent Seismicity	Detailed Structural Analysis of the Highway 2 Area	Detailed Structural Analysis of the Highway 2 Area Cont.	Completion of Highway 2 Area Project	Independent Field Exercise #2
July 10	July 11	July 12	July 13	July 14	July 15	July 16
OFF	Stratigraphic Correlations	Stratigraphic Correlations	Concentration Areas: c, g, s	Concentration Areas: c, g, s	Concentration Areas: c, g, s	Concentration Areas: c, g, s
July 17	July 18	July 19	July 20	July 21	July 22	July 23
OFF	Intro. to Volcanic Geol. & Geol. of the N. Doherty Igneous Complex	Completion of North Doherty Igneous Complex	Northwest Montana Field Trip Day 1; Sun River Canyon  Choteau, MT Stage Stop Inn	Northwest Montana Field Trip Day 2; Glacier N.P.  Kalispell, MT Super 8 Kalispell	Northwest Montana Field Trip Day 3; Butte, MT  IUGFS	Independent Field Exercise #3
July 24	July 25	July 26	July 27	July 28	July 29	July 30
Pig Roast 4:30 to 7:00	Final Study Area	Final Study Area	Final Study Area	Final Study Area	Final Study Area	Final Study Area
July 31	August 1	August 2	August 3	August 4		
Independent Field Exercise #4	Final Study Area (in camp)	G429 students leave IUGFS  Kadoka, SD America's Best Value Inn	Coralville, IA Super 8,	G429 students arrive back in Bloomington		