

I. Proposal Title: Upgrading Petrography Capabilities for Geology Research and Teaching

II. Proposal Team Members:

Team Lead: Madeline Lewis, Assistant Professor, Dept. of Geology & Geophysics

Other Members: Joseph Biasi, Assistant Professor, Dept. of Geology & Geophysics

Kevin Chamberlain, Research Professor, Dept. of Geology & Geophysics

John Kaszuba, Professor, Dept. of Geology & Geophysics and SER

III. Total Amount Requested: \$ 41,007.45

IV. Project Description

Petrography is the critical initial step in the majority of research projects in hard-rock geology. This entails observation of thin slices of rock through a specialized petrographic microscope for mineral identification and microtextural classification. Consequently, petrography is taught as a fundamental skill in multiple undergraduate courses in the Geology major, and a research-grade petrographic microscope is broadly applicable in geoscience research. Student-model microscopes in the Dept. of Geology and Geophysics (G&G) are suitable for student practice, but lack essential functions for instruction and research, including:

- reflected light capability, which is necessary for study of opaque ore minerals, including critical minerals, as well as sample preparation imaging for geochemical analyses.
- high resolution optics and camera to produce publication quality images.
- accessibility features.

We propose acquisition of a research-quality petrographic microscope that is ideal for both research and teaching, to account for necessary capabilities that are missing from microscopes currently accessible on campus. We select the Zeiss AxioScope 5 with Zeiss AxioCam 305 color camera. This is a research-quality petrographic microscope with high-resolution camera that produces publication quality images and enables quantitative microtextural analysis, polarized and reflected light views, and live camera feedback to advance our research and teaching applications.

The live camera and associated software improve equipment accessibility. The camera enables viewing through a monitor, which serves as an accessible option for users who experience motion sickness from traditional eyepiece-only microscopes. Additionally, colorblind users who commonly struggle with petrography (which relies heavily on color perception) can adjust color output in the camera software to best fit their needs. The proposed equipment acquisition addresses all of the shortcomings of the existing petrographic microscopes in G&G.

Excellence in Undergraduate Education: Use of petrographic microscopes is taught in multiple courses required for Geology majors and is applied in upper-level courses. However, the existing microscopes in G&G do not have live camera capabilities, which drastically improve teaching effectiveness and hygiene in the classroom. To teach petrography with our current resources, students must take turns looking through the same microscope to observe a feature of interest that is set up by the instructor. Acquiring a petrographic microscope with a live feed camera would improve teaching effectiveness by allowing students and instructors to view the same area through the microscope at the same time to ensure that students recognize the intended feature. Additionally, microscope viewing using a monitor maintains course hygiene because students do not have to rotate through using a single microscope and touching the same eyepieces.

Petrography is currently taught in the following courses, which would benefit from the proposed petrographic microscope and camera (*indicates a required course for Geology BS):

GEOL 2020* – Intro to Petrology; GEOL 4610* – Structural Geology; and GEOL 4210/5210

– Topics in Magmatic Processes [taught by Dr. Lewis]

GEOL 2010* – Mineralogy; GEOL 4214/5214 – Mineral Exploration; GEOL 4214/5214 –

Mineral Deposit Analysis; and GEOL 4720/5720 – Ore Deposits [taught by Dr. Biasi]
GEOL 4777/5777 – Geochemistry of Natural Waters [taught by Dr. Kaszuba]

Because petrography is a fundamental geology research technique, many undergraduate research projects use this tool to enhance the undergraduate experiential learning experience. Dr. Lewis and Dr. Biasi currently co-advise two undergraduate geology majors who will need reflected light petrography and imaging for their senior theses. We expect that petrography will be needed for many undergraduate research projects that we advise in the future.

Research and Graduate Education: The proposed microscope will support research and graduate education in research groups led by all of the proposal team members. The majority of publications in hard-rock geology research require micro-scale mineral identification, microtextural observations, and high-quality petrographic images. Applications of the proposed equipment to active geoscience research is described below:

Volcanology Research: Dr. Lewis advises two graduate students who will use microtextural analysis and petrographic imaging to constrain pre-eruptive storage conditions of volcanic deposits in Wyoming and Nevada. Dr. Lewis's research focuses on crystallization of magmas, which requires detailed observation of mineral microtextures and microscopic imaging.

Tectonics Research: Dr. Chamberlain's research in geochronology requires reflected light microscopy and imaging to collect spatially resolved age data that will determine the timing of tectonic and magmatic events in Wyoming. Many of his projects have economic geology impact and are funded by a consortium of hard-rock mining companies. Dr. Lewis has a PhD student studying metamorphism and tectonics in the Teton Range, requiring petrographic imaging to determine the pressure and temperature conditions of metamorphic reactions.

Economic Geology Research: Assessing the mineralogy and crystallization texture of mineral deposits is critical for determining how deposits formed and how their economic resources can be extracted. Dr. Biasi has six graduate students pursuing studies of mineral deposits in the Laramie Range, Ferris Mountains, and Snowy Range in Wyoming, all of whom will benefit from use of high-resolution reflected light petrography. Dr. Kaszuba's hydrothermal lab generates experimental products with grain sizes too small for practical observation with the microscopes currently available for use, and instead would benefit from higher quality optics.

Productive Economic Development through Partnerships: Acquisition of the proposed microscope will enhance our ability to collaborate with mining and mineral exploration companies. Early stages of mineral exploration require petrographic mineral identification to determine where critical minerals and economic elements are located at the microscale within a mineral deposit. Additionally, microtextural observation can constrain how deposits developed, leading to more accurate models of the three-dimensional extent and economic prospects of a deposit.

Dr. Lewis and Dr. Biasi have active partnerships with American Rare Earths (ARE) and Laramie Resources to determine mineral hosts of Rare Earth Elements in the Laramie Range and Sunrise Iron Mine, respectively. ARE is actively sponsoring analyses for a PhD student. A critical portion of this collaboration is determination of micro-textural relationships between minerals, which requires an updated petrographic microscope to produce publication-quality results. The team members have prospective mining industry partnerships in progress with Relevant Gold, Black Hills Bentonite, and Rare Element Resources that are significantly more likely to come to fruition if we have advanced petrographic and imaging capabilities at UW. The Wyoming Geological Survey has also indicated interest in using high-resolution petrographic imaging on campus. So, in addition to fostering industry partnerships, acquisition of the proposed microscope would strengthen collaboration between CEPS and the state geological survey.

Budget Request

Item	Amount Requested
Zeiss AxioScope petrographic microscope with Axiocam 305 camera and ZEN 3.11 software (quote attached)	39,207.45
Windows computer and monitor	1,800.00
Total Amount Requested:	41,007.45

Budget Justification

Zeiss AxioScope 5 with Axiocam 305: Please see the attached quote from Bartels & Stout Inc., which is the licensed Zeiss retailer for our region. This quote includes the petrographic microscope itself, with transmitted, reflected, and polarized light options (all are necessary for complete petrographic analysis) and five different magnification objectives. The quote also includes the compatible microscope camera, Axiocam 305 color, and the ZEN 3.11 software package that interfaces with the camera. We selected this model because it has high quality optics for research uses, it is camera compatible, can generate publication quality images, and includes features that suit the research and teaching needs for all of the included team members and other potential users in G&G, SER, and the Wyoming Geological Survey.

Windows 11 PC computer and monitor: A Windows 11 PC is compatible with and necessary to operate the ZEN 3.11 software, which interfaces with the microscope and runs the Axiocam camera. Zeiss recommends a computer with a dedicated graphics card and a high-resolution LCD monitor to use the software and imaging capabilities to their full potential. Cost was estimated from Amazon listings that fit these recommendations.

Statement on funding from other sources: The team members do not currently have other prospects for funding this equipment. Early career team members Lewis and Biasi were unable to budget for this equipment in faculty startup requests because the shortcomings of the existing petrographic microscopes in the Dept. of Geology and Geophysics could not be determined prior to in-person use. Essentially, we thought this equipment need was met by existing resources, but upon trying to use the existing microscopes it became clear that essential capabilities are lacking. External funding sources either tend to prohibit moderate-scale instrument acquisition in research-oriented proposals or are directed toward more expensive instrumentation in equipment-focused funding programs.

Renovations: No renovations will be needed to install the proposed equipment. The microscope will be housed in ESB3052, a shared lab facility that is already set up for microscope use. Please see the attached confirmation from the College Facilities Manager, Joe Rovani.

 Outlook

RE: Space confirmation, CEPS RFP

From Joe Rovani <Rovani@uwyo.edu>
Date Tue 1/7/2025 11:13 AM
To Madeline Lewis <mlewis48@uwyo.edu>

Hi Maddie,
Thank you for contacting me. I agree that the microscope requires no utility or power modifications and can be quite easily accommodated in your present microscopy laboratory.
Good Luck with your proposal. Happy new Year.
Joe

Joe Rovani

Facility Manager
Engineering & Physical Sciences Deans Office
EERB 401 | (307) 766-6170 | rovani@uwyo.edu



From: Madeline Lewis <mlewis48@uwyo.edu>
Sent: Tuesday, January 7, 2025 9:45 AM
To: Joe Rovani <Rovani@uwyo.edu>
Subject: Space confirmation, CEPS RFP

Good Morning Joe,

I am submitting a proposal to the CEPS one-time RFP for equipment acquisition (due tomorrow, 1/8), which requires confirmation from you that the space and power requirements to operate that equipment are met. I am proposing acquisition of an improved petrographic microscope, which runs on standard voltage (100-240V) though a typical wall plug (see attached brochure, tech specs page 19-21). Its spatial footprint is also minimal, as it is desktop equipment. I am confident that we have space and plugs for the microscope in ESB 3052, which is already set up as a microscope lab.

Please let me know if you can confirm that the power and space requirements are met with this information, and also let me know if you need any other details.

Thank you,
Maddie

Madeline Janine Lewis (she/her)
Assistant Professor
Department of Geology and Geophysics
University of Wyoming
Email: mlewis48@uwyo.edu

Bartels & Stout, Inc.

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Bellevue, WA 98008
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Quotation QJC24-035

Jan 3, 2025

Valid for 30 days

Quoted to
Madeline Lewis
University of Wyoming
1000 E University Ave
Laramie, WY 82071
(818) 219-8498
mlewis48@uwyo.edu

Details
Zeiss Axioscope 5 Polarized Light Microscope with 305 Color Camera

Item	Description	Quantity	Price	Ext.
430035-9291-000	Microscope stand Axioscope 5, TL/RL POL, 5xHD/Pol, 1xHD/DIC encoded Microscope stand Axioscope 5, TL/RL POL, 5xHD/Pol, 1xHD/DIC encoded - lower stand part with dovetail illumination interface - transmitted-light illumination with white LED10W, optional for HAL 12V 100W - dovetail mount for attachable stage carriers - 24 mm focus lift, adjustable focus stop - 6-position filter wheel for dia. 36 mm filters - mount for 2-position filter slider 14x40, d=36 mm - integrated 24V DC 60W power unit, stabilized 100...240V AC/ 50...60Hz - country-specific power cable - ECO mode and light management control button - Snap button supports on ZEISS Axiocam - USB 2.0 to PC - dust cover - filter holder in TL - upper stand part with dovetail interface for reflected illumination HAL 100 /HBO /HXP/Colibri - brightfield/darkfield reflected light illuminator LED 10w white - nosepiece 6x M27: 5x brightfield/darkfield Pol, centerable and 1x brightfield/darkfield DIC, fixed, coded - dovetail mount for encoded changeable reflector turrets and reflector Slider - built in illumination adapter, achromatic - built in luminous-field diaphragm slider - built in aperture stop slider - mount for filter slider R 14x40 mm d=36mm - mount for polarizer slider A 6x30 mm	1	\$6,387.00	\$6,387.00
424940-9001-000	Reflector turret 6x encoded, changeable, for P&C modules Reflector turret 6x encoded, changeable, for P&C modules	1	\$1,068.00	\$1,068.00
425520-9100-000	Binocular phototube Pol 20°/23 (100:0/0:100), upright image Binocular phototube Pol 20°/23 (100:0/0:100), upright image with sliding prism and upright reticle, upright and unreversed image, camera port with interface 60N	1	\$1,995.00	\$1,995.00
444036-9000-000	Eyepiece PL 10x/23 Br. foc. Eyepiece PL 10x/23 Br. foc.	1	\$471.00	\$471.00
444038-9000-000	Eyepiece PL 10x/23 Br. foc. Pol with crossline graticule Eyepiece PL 10x/23 Br. foc. Pol with crossline graticule	1	\$478.00	\$478.00
430710-9011-000	Stage carrier TL/RL; attachable and vertically adjustable AxioScope Stage carrier TL/RL; attachable and vertically adjustable_ for Axioscope, to accommodate screw-on and rotary stages with dovetail mount	1	\$346.00	\$346.00
430720-9001-000	Condenser carrier with vertical adjustment on both sides (Axioscope 5/7) Condenser carrier with vertical adjustment on both sides for use with attachable Axio Scope stage carriers, adjustable height stop	1	\$386.00	\$386.00

Account Manager

John Hudson
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Item	Description	Quantity	Price	Ext.
432035-9131-000	Rotary stage Pol, 360° with 45° clickstops - AxioScope Rotary stage Pol, 360° with 45° clickstops	1	\$1,835.00	\$1,835.00
453561-9901-000	Attachable object guide Pol, 28x48 mm Attachable object guide Pol, 28x48 mm for rotary stage Pol Axio Scope.A1	1	\$1,893.00	\$1,893.00
420920-9901-000	Objective N-Achroplan 2.5x/0.07 M27 Objective N-Achroplan 2.5x/0.07 M27 (FWD=9.8mm)	1	\$571.00	\$571.00
420933-9901-000	Objective N-Achroplan 5x/0.15 Pol M27 Objective N-Achroplan 5x/0.15 Pol M27 (FWD=12.0mm)	1	\$710.00	\$710.00
420943-9901-000	Objective N-Achroplan 10x/0.25 Pol M27 Objective N-Achroplan 10x/0.25 Pol M27 (FWD=6.5mm)	1	\$1,140.00	\$1,140.00
420953-9901-000	Objective N-Achroplan 20x/0.45 Pol M27 Objective N-Achroplan 20x/0.45 Pol M27 (FWD=0.63mm)	1	\$1,287.00	\$1,287.00
420973-9900-000	Objective N-Achroplan 50x/0.8 Pol M27 Objective N-Achroplan 50x/0.8 Pol M27 (FWD=0.41mm), incl. Cover glasses, high performance, CG=0.17mm, box with 100 pc.	1	\$2,302.00	\$2,302.00
424928-9901-000	Reflector module bright field ACR P&C for reflected light Reflector module bright field ACR P&C for reflected light	1	\$546.00	\$546.00
424941-9050-000	Reflector module with analyzer ACR P&C for reflected light Reflector module with analyzer ACR P&C for reflected light	1	\$1,138.00	\$1,138.00
424937-9901-000	Analyzer module Pol ACR P&C for transmitted light Analyzer module Pol ACR P&C for transmitted light	1	\$561.00	\$561.00
424941-9040-000	Bertrand system module Pol P&C with analyzer Bertrand system module Pol P&C with analyzer for objectives N-Achroplan 50x/0.8 Pol and EC Plan-Neofluar 40x/0.9 Pol	1	\$1,176.00	\$1,176.00
427710-9000-000	Polarizer slider A 6x30 mm, 90° rotatable Polarizer slider A 6x30 mm, 90° rotatable usable with reflected-light illuminator HD DIC	1	\$1,122.00	\$1,122.00
427706-0000-000	Polarizer D, 90° rotatable, removable Polarizer D, 90° rotatable, removable	1	\$927.00	\$927.00
428106-9010-000	Quartz depolarizer with tube-lens for tubes Axio Scope Quartz depolarizer with tube-lens for tubes Axio Scope	1	\$1,121.00	\$1,121.00
473704-0000-000	Compensator Lambda, 6x20 Compensator Lambda, 6x20	1	\$436.00	\$436.00
424225-9090-000	Condenser, achromatic-aplanatic 0.9 H Pol - AxioLab / AxioScope Condenser, achromatic-aplanatic 0.9 H Pol with front lens which can be switched on the right and left. For objectives 1.0x-100x, (2.5x-100x at use of the polarizer slider for LED illuminator), WD=1.0mm	1	\$1,414.00	\$1,414.00

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Item	Description	Quantity	Price	Ext.
426560-9031-000	Digital Microscopy Camera AxioCam 305 color R2 (D) Digital Microscopy Camera AxioCam 305 color R2 (D) Microscopy camera incl. Driver software 64bit, USB 3.0 PCIe x1 interface, USB 3.0 cable 3 m and IR barrier filter Hoya C5000 (coated) Number of Pixels: 2464 (H) x 2056 (V) = 5.07 Mega pixel color Sensor type: SONY IMX264 Exmor Pregius Global Shutter CMOS Pixel size: 3.45 µm x 3.45 µm Chip size: 8.5 mm x 7.1 mm, equivalent to 2/3" (diagonal 11.1 mm) Spectral range: With IR barrier filter app. 400 nm to 720 nm Full Well Capacity: Approx. 10,500 e Selectable Resolution: H x V Binning Factor 2464 x 2056 1x1 Basic Resolution 1232 x 1028 2x2 816 x 684 3x3 608 x 514 4x4 480 x 410 5x5 H x V Subsampling Factor 2464 x 2056 1x1 Basic Resolution 1232 x 1028 2x2 Live frame rates (depending on hardware and software configuration): H x V Frame Rate@1ms 2464 x 2056 36 fps 1232 x 1028 88 fps (2x2 Subsampling) Frame rates for time series recording (depending on computer hardware and software configuration) H x V (ROI) FrameRate 2464 x 2056 36 fps 2048 x 2048 36 fps 1920 x 1080 67 fps 1024 x 1024 70 fps 512 x 512 136 fps 256 x 256 255 fps 128 x 128 456 fps Readout of Sensor Sub-Regions ("ROI"): Adjustable Digitization: 8 and 12 Bit / Pixel Dynamic Range: Typical > 4800 : 1 (>73 dB) at typ. 2.2 e readout noise Dark current: <(><<>) 1.0 e/p/s @ 25°C Integration Time: 0.1 ms to 4 s Cooling: Temperature stable @ 25°C for ambient temperatures between 18°C and 30°C Status-LED for Camera: color coded operation status, dimmable Interface (camera): USB 3.0 interface Optional operation with USB 2.0 connection at reduced frame rate Optical Interface: C-Mount Thread depth for objectives: max. 5 mm Size / Weight: approx. App. 10.8 cm x 7.8 cm x 4.3 cm (2.3"x3.2"x1.7") / 580 g Housing: blue anodized aluminum, with cooling fins on top, 1/4" photo thread for tripod mount Registration: CE Power Supply: Max. 4W, power supply provided by USB 3.0 bus for camera electronics Environmental conditions: 5° ... +35° Celsius, max 80% relative air humidity, not condensing, free air circulation required Supported Operating Systems: for ZEN: Windows 10 x64 Supported Application Software: ZEN 3.7 (blue edition) The required application software is available via the ZEISS Download Center.	1	\$5,340.00	\$5,340.00
426113-0000-000	Camera Adapter 60N-C 2/3" 0.63x Camera Adapter 60N-C 2/3" 0.63x	1	\$882.00	\$882.00
410135-0002-311	ZEN 3.11 11 x64 User interface configurable, control of the ZEISS microscope systems and components, extensive acquisition and analysis, CZI image format The following functions are included: - Basic 3D viewing - Colocalization - Connect basic - Direct processing - Manual EDF - Measurement - Panorama - Spectral unmixing - ZEN Data Storage Client - Acquisition Base (time series and multichannel)	1	\$3,258.00	\$3,258.00
Shipping Axio Scope 5/7	Shipping - Axio Scope 5/7	1	\$417.45	\$417.45
	No Charge Installation and Training	1	\$0.00	\$0.00

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Subtotal	\$39,207.45
Total	\$39,207.45

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