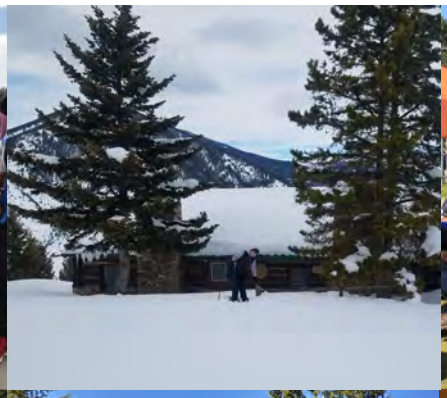
YBRA UPLIFT

Issue 25 Annual Newsletter of the Yellowstone-Bighorn Research Association (www.ybra.org) 2019








YBRA in Pictures. *Top row*: (left) Southern Illinois Univ. field geology course at Yellowstone Nat. Pk., (middle) lodge and snow depths (!), March 2019, (right) YBRA booth at Red Lodge Fun Run fundraising event. *Second row*: (left and middle) Bonini faculty cabin construction, and (right) 2018 YBRA Alumni Day symposium. *Third row:* (left to right) YBRA Science Teachers Workshop, in the classroom and field, and group participants. *Bottom row*: (left) removing large boulder(!) from the Howell Gulch Rd., (middle) remodeled old wash house, and (right) sunset view from the porch of the lodge.

YBRA in Transition

From the President,

I am pleased to report that YBRA continued to thrive in 2018-19 amid a period of transition for our organization. We accomplished or made significant progress toward several important goals including modifying our Bylaws, launching a new education initiative, and making physical improvements to the camp. These efforts are central to our mission of Earth Science education and research, and promote our vision of enhancing the educational experience of faculty and students, expanding our outreach, and generating new revenue streams.

Over the past six years, the number of groups utilizing YBRA facilities has increased from 6 to 12 (see p. 3), although the total number of students, faculty, and researchers peaked in 2016 and has declined since. Moreover, our client demographics have changed to a larger portion of teenagers, seniors, and professionals in non-geology groups compared to earlier years. This transition has resulted in a greater demand for classroom space, dormitories, and higher quality cabins. Fortunately, due to the generosity of our members, we have been able to respond to these needs through our recent building projects and ongoing upgrades.

YBRA also has expanded it's educational outreach over the past seven years through our Alumni Day Symposia (see p. 7), Open Houses, public tours at Tippet Rise and, for the first time in decades, a YBRA Science Teachers Workshop. In July, fifteen middle and high school teachers primarily from SE Montana spent most of three days in the field and classroom learning the geology of the area and reviewing the Next Generation Science Standards. All expenses were covered due to funding by the Sibanye-Stillwater company, Montana Geological Society, and Red Lodge Area Community Foundation, the latter resulting from our participation in their Fun Run fundraising event. The workshop was enthusiastically endorsed by the teachers, funding groups, and YBRA participants.

Notably, we successfully modified our Bylaws for the first time since 1985. Changes to these governing documents are designed to make YBRA more efficient and aligned with current best practices of non-profit organizations. Hence, among other changes, "Council" and "Councilors" will now be referred to as "Board of Directors" and "Directors", the number of Officers and Directors will be reduced from 17 to no fewer than 5 and no more than 9 individuals, and the cumbersome 1936 process of electing new members will be replaced by procedures determined by the new board. At this time, we are identifying volunteers to serve on the board or supporting committees and welcome suggestions or nominations. Be assured that throughout our deliberations we have been careful to preserve the unique character of YBRA including its mission, member-based structure, and traditions.

In 2018-19, YBRA made considerable progress in addressing maintenance issues and completing the Bonini Cabin, thanks in large part to the hard work and management skills of Greg Creasy, our operations manager. A sizable section of the Howell Gulch road has been rebuilt, the Old Washhouse has been renovated, and floors in the lodge kitchen and bathroom of the Tom Dorf cabin have been replaced. The Bonini cabin is made of whole logs, beautifully furnished, and accommodates 3 or a small family. It is a welcome addition to campus.

Our fundraising focus continues to be on deferred maintenance, upgrades, and renovations to the camp infrastructure under the umbrella of a **Restore YBRA** campaign. We have already received $20,000 toward our goal of $40,000 due to a Bonini Family Fundraising Challenge that matched dollar-for-dollar up to first $10,000 received for the **Restore YBRA** campaign. Funds will be used to support the upkeep of student and faculty cabins, finish rebuilding the camp road, and address some overdue plumbing maintenance. Information for contributing to YBRA and this campaign is on page 6 of this newsletter, and on our website, **www.ybra.org**.

Finally, this year marks a transition for me as I am stepping down from the role of YBRA President when the new board is constituted. Over the past 10 years it has been a privilege to know and work with many outstanding individuals dedicated to serving YBRA and our clients. I am confident YBRA will continue to play a vital role in careers of future geoscientists as it has for the past 83 years.

Richard Fifarek….rhfifarek@gmail.com

2019 Camp Schedule

Nine university geology field courses and the BBPI paleontological research group (formerly New Jersey State Museum) return to YBRA in 2019. In mid-July, we revived a long dormant **YBRA Science Teachers Workshop**, and late in the season the Univ. of Wyoming will bring a class of incoming freshmen to camp to mentor and inspire the next generation of geoscientists. The continued use of YBRA facilities by 10 to 12 groups annually is a testament to our reputation, service, and outstanding location. New interest in YBRA is generated by word-of-mouth "advertising" and our GSA promotions. The **YBRA Annual Meeting** was held on July 14, the dedication of the **Bonini Cabin** on August 15, followed by the **YBRA Alumni Day Symposium and Open House** on August 17.

MAY — JUNE

May 27-June 4: Univ. of Texas-San Antonio Geology
June 2-10: Montclair State Univ. Geology Course
June 3-21: Univ. of Houston Geology Course I
June 6-15: Pennsylvania State Univ. Geology Course
June 16-30: Southern Illinois Univ. Geology Course
June 13-30: Adelphi Univ.
June 22-30: California State Univ.- Long Beach Geology
June 25-30: Bighorn Basin Paleontological Group

JULY

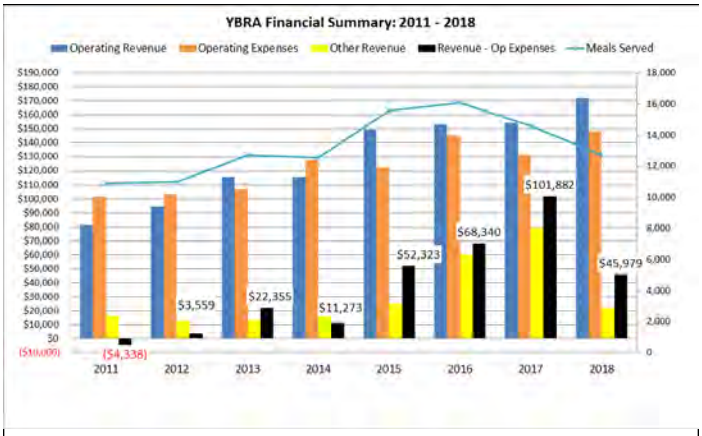
July 1-4: California State Univ.-Long Beach Geology
July 1-7: Southern Illinois Univ. Geology Course
July 1-9: Adelphi Univ.
July 1-31: Bighorn Basin Paleontological Group
July 6: Univ. of Houston Geology Course I
July 7-25: Univ. of Houston Geology Course II
July 11-13: YBRA Science Teachers Workshop
July 14: YBRA Annual Meeting & Board Meeting
July 29-31: Ohio Univ. Geology Course

AUGUST — SEPTEMBER

August 1-10: Bighorn Basin Paleontological Group
August 1-12: Ohio Univ. Geology Course
August 9: Univ. of Houston Geology Course II
August 3-10: Drexel Univ. Geology Course
August 15: Bonini Cabin Dedication
August 17: YBRA Alumni Symposium & Open House
August 30-September1: Univ. of Wyoming Geology

YBRA Financial Summary for FY 2018

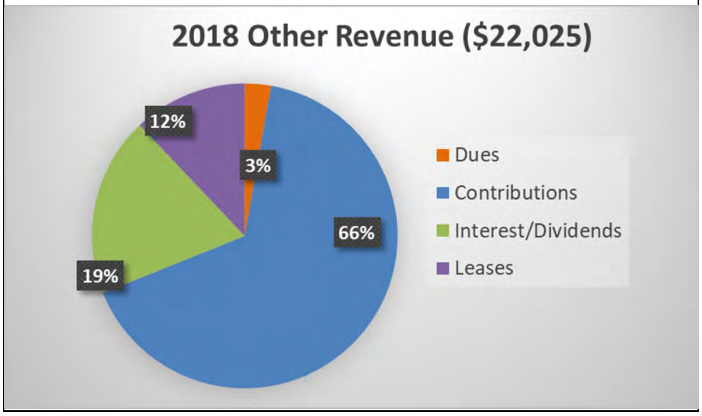
Financial data for fiscal year 2018 ending May 31, 2019 shows that YBRA is in a sound financial position and carries no debt. Operating revenues were at a record level of ~$172K, an approximate increase of 12% over the the previous year, whereas operating expenses also increased approximately 12% to a record ~$148K (bar chart). For the past 8 years, operating margins for 2015 through



2018 were substantially higher than those from 2011 through 2014. This trend was the result of a surge in the number of groups, an increase in course enrollments between 2013 and 2016, a gradual increase in camp rates, and our ability to control costs. However, the total number of clients using our facilities peaked in 2016 and has fallen over the past two years, as reflected in total meals served per season (bar chart), and decreased again in 2019. In 2018, Jeanette and her staff prepared 12,694 meals, a ~21 % decrease from the peak level in 2016. The revenue effect of declining enrollment in the geology courses for 2018 was offset by BBPI filling all allotted slots in the camp schedule in its second year of operations.

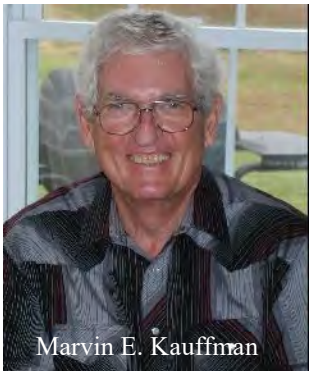
Revenues other than those generated by client groups totaled ~$22K in FY 2018 representing a sharp decrease from previous levels as fundraising for the building projects ended (bar chart). A majority of these revenues continues to be contributions from YBRA members and supporters (pie chart). When operating expenses are deducted from total revenue (operating + other) we finished FY 2018 with almost $46K (bar chart).

Clearly, our continued success is largely due to the financial support from YBRA members, alumni and friends. On behalf of YBRA and the students and others we serve, **Thank You!**



YBRA People

With sadness we note the passing of **Edward S. Belt** on March 23, 2019, and **Marvin E. Kauffman** on August 15, 2019. Both individuals had a tremendous impact on YBRA and the many students they taught in the Princeton Geology field course (and its derivatives). Each served on the YBRA council for many years including as President. Marv's obituary may be viewed at https://lancasteronline.com/obituaries/dr-marvin-e-kauffman/article_7332fefd-3024-5db8-b0a7-7d9126e7e367.html A memorial service will be held at the Old Main Nevin Chapel on the campus of Franklin & Marshall College on Saturday, October 5, 2019, at 1:00 p.m. **Marv requested memorial donations be directed to support YBRA (see details, p. 6)** or the Founders Society (see obituary). Ed's obituary is at: https://www.legacy.com/obituaries/gazettenet/obituary.aspx?n=edward-scudder-belt&pid=191943406&fhid=15492


Marvin E. Kauffman


Edward S. Belt

Gretchen Moore is our new YBRA Membership and Marketing Director who lives in Red Lodge, MT. She earned a MS degree in Geology at the University of Washington and presently works for the Sibanye Stillwater company. She brings considerable digital marketing skills to her position and already has had a big impact on our organization. Welcome Gretchen!

Featured Article

"Geohydrobiology" of Yellowstone – where Earth, water, and life intersect!

by Ken Sims, Professor of Geology and Geophysics, University of Wyoming

"Geohydrobiology" sounds like a made-up word—as if the prefixes from multiple scientific fields were strung together to score big points in a game of Scrabble. But it makes more sense when you break it down: geo, meaning Earth; hydro, meaning water; and bio, meaning life. One can quickly understand why studying geohydrobiology is an important endeavor at Yellowstone—a place where Earth, water, and life intersect in unusual and stunning ways.

Yellowstone Volcanic Plateau hosts the world's largest, most profound, and visually stunning example of an active continental hydrothermal system, with over 10,000 springs, geysers, fumaroles and mudpots. Equally stunning is the diversity of Yellowstone's hydrothermal fluids, which range in temperature from ambient to 93°C (the temperature of boiling water at Yellowstone's elevation), span pH levels from 1.5 (acidic) to 10 (basic), and have highly variable compositions (Figure 1). This diversity occurs on both large scales, park scale; and small scales, meter scale and less. Where does this diversity come from?

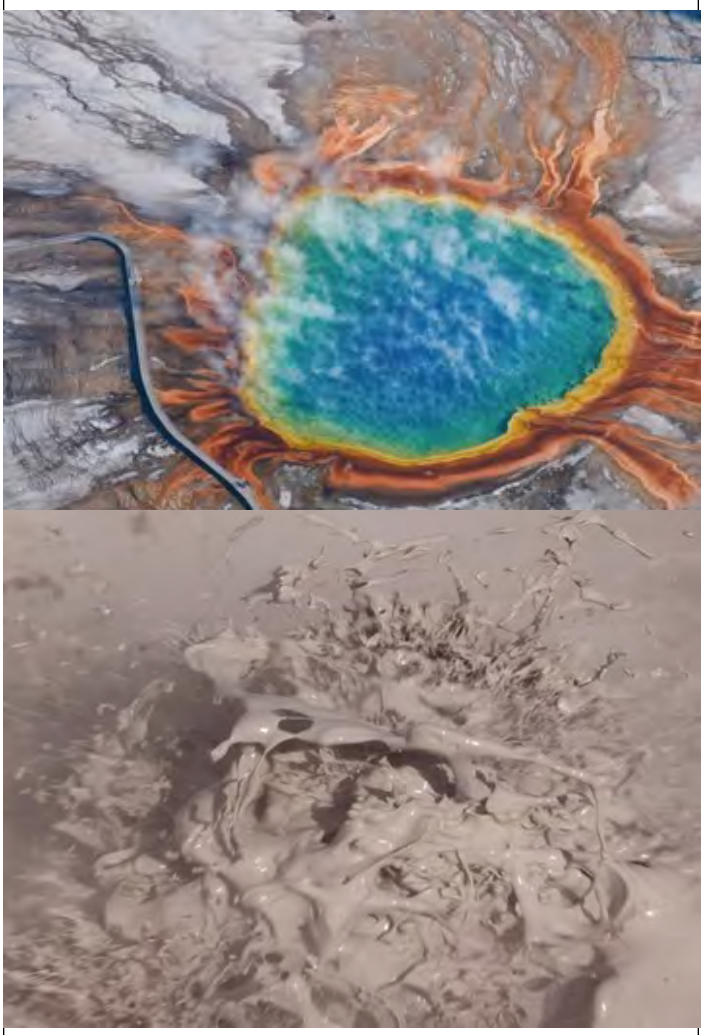


Figure 1: Two Yellowstone iconic geothermal features which cover the range of chemical compositions resulting from subsurface phase separation processes. Top) Grand Prismatic Spring in Geyser Basin is neutral chloride (pH = 7-8). Photo by Sarah Aciego. Bottom) Mud Volcano is acidic (pH 2-3) and has dissolved its near surface rock making it muddy. Photo by Ken Sims.

The basic picture of Yellowstone's hydrothermal plumbing system (Figure 2) involves a hydrothermal reservoir deep beneath the surface that is recharged by rain and meltwater from high elevations. These meteoric fluids descend into the Earth, are heated, and pick up new chemicals, like chloride (Cl) and sulfate (SO_4), from the volcanic system. The chemically enriched hot waters then rise back up to surface to form Yellowstone's iconic thermal features.

During ascent to the surface, the waters boil as pressure decreases. This boiling results in what is known as "phase separation," where the vapor and liquid separate and migrate to the surface along different paths. The fluids of the liquid phase tend to be neutral to basic in pH and retain most of the Cl. In contrast, the vapor-phase contains most of the SO_4

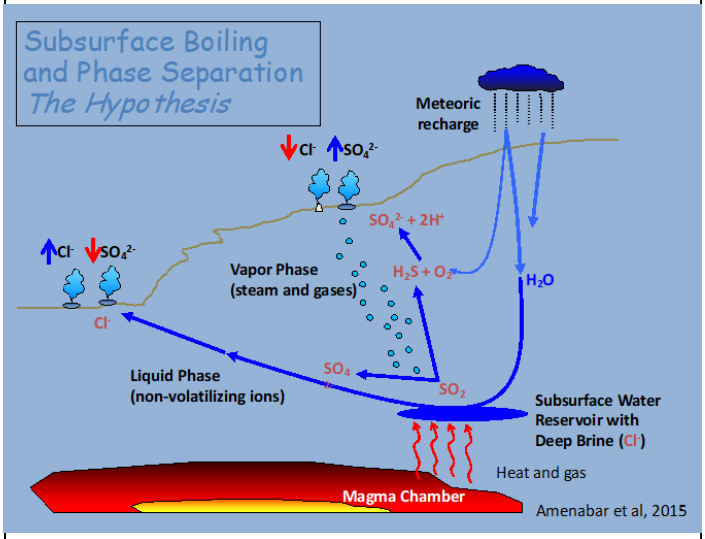


Figure 2: Schematic of Phase Separation Processes (after Amenbar, 2015). Meteoric water infiltrates the crust through fractures and fissures recharging the deep hydrothermal aquifer. Infiltrating waters have circumneutral pH and have negligible concentrations of solutes. In the "deep hydrothermal reservoir" (340-370°C) this water is infused by volcanic gases including hydrochloric acid (HCl), carbon dioxide (CO_2), and sulfur dioxide (SO_2) gases that maintain estimated concentrations of 10 mM chloride (Cl^-) and 300 µM sulfate (SO_4^{2-}) through ionization of HCl and disproportionation of SO_2, respectively. Heat-induced pressure and density differences cause the hydrothermal water to ascend and infiltrate the crust along fissures and fault lines where it can be further altered by processes such as water-rock interaction, decompressional boiling, and mixing with near-surface groundwater. Decompressional boiling can result in separation of ascending hydrothermal fluids into a liquid phase and a vapor phase. Vapor phase influenced springs have low concentrations of non-volatilizing ions such as Cl^- but are enriched in hydrogen sulfide (H_2S), sourced from disproportionation of volcanic SO_2. The oxidation of H_2S with oxygen in near-surface waters leads to increased SO_4^{2-} concentrations (low Cl^-/SO_4^{2-} ratio) and acidic pH in vapor phase influenced springs. These acidified waters can enhance the dissolution of country rock leading to mud pots.

and is acidic. These separated water and vapor phases also mix with colder ground and surface water as they ascend, further changing their compositions.

While this basic hydrological and geochemical model can explain much of the chemical variation seen in Yellowstone's hydrothermal fluids, our understanding of this important process is severely limited by our lack of knowledge of the shallow plumbing of Yellowstone's hydrothermal features, and the time scales over which the phase separation takes place. In essence, we have a two-dimensional understanding of a four-dimensional problem. We know surface geometry, water chemistry, and heat flow for many of the thermal features, but we don't understand the ultimate composition of the deep hydrothermal reservoir, nor the timing and pathways for ascent of the fluids.

The problem of subsurface boiling and phase separation is important for understanding not only the chemistry of the water and gas discharged at the surface, but also the microbial life that inhabit Yellowstone's hot springs. To address this gap in knowledge, scientists from the University of Wyoming (Ken Sims, Brad Carr, Andy Parsekian) and Montana State University (Eric Boyd) are collaborating to research the four-dimensional process of phase separation and its impact on the biological communities that thrive in thermal waters. The research has several goals:

1) use geophysical tools, like electrical resistivity, electromagnetics, nuclear magnetic resonance, ground penetrating radar and seismic refraction, to obtain an image of the subsurface plumbing of hydrothermal features,

2) measure the chemistry of the fluids, especially with regard to radioactive elements that change in composition over time, to understand the nature of the deep source reservoir, the timing of interactions between water and rock, and the ages of the fluids,

3) measure the fluid chemistry and DNA of microbial life in hot springs.

This multi-faceted investigation will address all aspects of Yellowstone's hydrothermal system—geo (rock), hydro (water), and bio (life). Research into the geohydrobiology of Yellowstone will provide a better understanding of not just phase separation and the chemistry of the resulting fluids, but also how those fluids impact the diverse organisms that lend Yellowstone's thermal features their spectacular forms and colors.

Book Review

by Jinny Sisson

This fall, go out of this world and read "**Before Mars**" by Emma Newman. This is the third volume in the Planetfall series. You can read it without reading its predecessors (Planetfall and After Atlas). This book can stand-alone as a work of science fiction. The heroine is a geologist, Anna Kubrin. The first scene starts on a beach in Oregon with her dog, Basalt, husband Charlie and young daughter Mia. After she looks at grains of beach sand, her view comes crashing down as her world switches from this virtual reality "mersive" to her landing on Mars. Anna was the sole astronaut sent to Mars to be part of a small colony operated by a powerful corporation, Gabor Corp. During her six-month journey to Mars, she became too immersed in virtual reality, which the doctor on Mars is worried might cause flashbacks. On her first trip outside the colony home of Mars Principia, she begins to question what is real when she finds footprints in what is supposed to be an unexplored crater. A twist is that the colony is both a home and artificial intelligence that controls all they do. In addition to exploring the geology of Mars, Anna is the first artist on Mars and is supposed to create paintings of the alien planet that will sell for millions for her boss. Her keen eye for geological details and artist's sense of wonder make her question what she is seeing and whether something is wrong at their colony. At one point, she issues a statement to "trust her as she is a geologist". She must learn to trust her own observations just as YBRA instructors are always telling their students.

The first person narrative from Anna continues as an exploration of reality, mental health, memory, how corporations might control our world in the future, and artificial intelligence. This new colony on Mars does not have the checks and balances present in our society. Is it right to have a global corporation control life and resources on another planet? These are some of the issues brought up by this novel. In addition to these issues, Emma Newman describes results from various Martian missions such as Pathfinder. So, if you are interested in the life of a geologist in the future, read this intriguing book.

Contributing to YBRA

Contributions to YBRA are vital for sustaining our camp and operations, and fulfilling our mission supporting Earth Science education and research. With your help we can continue to provide the exceptional study environment that thousands of students have experienced over the last 83 years. Donations in any amount can be made to YBRA and, if desired, directed toward several funds including these high-priority projects:

1) "**Restore YBRA**" for maintaining, renovating, and upgrading camp infrastructure, goal is $40,000 (1/2 of total already received!),

2) "**Marvin E. Kauffman Memorial Fund**", in memory of Marv, a long time member and supporter of YBRA, and

3) "**Metal Roofs**", replacing shake/shingle roofs on-Thom and Rouse to minimize fire hazard; goal is $4,500.

Please send your donations to YBRA by **December 31, 2019** using one of the following methods:

1) Check, made out to:
YBRA - (designate project or fund)
and sent to**:**

YBRA
c/o Denny McGinnis
P. O. Box 20598
Billings, MT 59104-0598.

2) Credit card, using the "**Donate**" button at the YBRA website, www.ybra.org, and adding a comment to direct your contribution to a specific purpose, and

3) Donating stocks; contact **Denny McGinnis (dbmcginnis@outlook.com)** for information.

Do you or your *company* shop on Amazon.com? If so, you can donate 0.5 % of the purchase price for most items to YBRA at no extra cost. Simply go to smile.amazon.com (note this is not amazon.com) from the web browser on your computer or mobile device, log on to your amazon account, and choose YBRA as your designated charity.

Thank you for your continued support!

YBRA Alumni Day Symposium 2019 Agenda

1:00 – 1:15 pm	**Richard Fifarek**, **YBRA President** *Introductions & YBRA's Legacy*
1:15 – 2:00 pm	**Robert B. Smith**, *Keynote Speaker,* **Professor Emeritus, Dept. of Geology and Geophysics, University of Utah** *Old Faithful Anatomy and Magma from Earth's Core Fueling the Volcanism of Yellowstone and Its Geysers and Hot Springs*
2:00 – 2:45 pm	**Kenneth Sims, Dept. of Geology and Geophysics, University of Wyoming** *A Tale of Two Pools: The Geohydrobiology of Phase Separation in a Yellowstone Hydrothermal System*
2:45 – 3:15 pm	*Coffee Break*
3:15 – 3:45 pm	**Susan Petty, President and Chief Technology Officer, AltaRock Energy, Inc.** *Journey to the Brittle-Ductile Transition - Coal to Geothermal Energy*
3:45 – 4:15 pm	**Kate Miller, Provost and Vice President for Academic Affairs, University of Wyoming** *Crustal structure of the Bighorn Mountains region*
4:15 – 4:45 pm	**Joel Adams, Hydrogeologist, Managing Director, IPI** *Hydrogeology of the east and west benches, Red Lodge, MT*
4:45 – 5:00 pm	**Tyler Krutzfeldt, Founder and Managing Director, Mont Vista Capital** *Wrap-up, Questions & Answers*
5:00 – 7:00 pm	*Bighorn Beverages*

YBRA Personnel

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