Minutes
Montana Board of Regents
March 10-11, 2022

Thursday, March 10, 2022

Meeting convened at 8:28 am

Regents Present: Casey Lozar, Chair; Brianne Rogers; Joyce Dombrouski, Todd Buchanan, Loren Bough, Jeff Southworth, and Amy Sexton. Ex officio members include Commissioner of Higher Education Clayton Christian, Governor Greg Gianforte, represented by Dylan Klapmeier, and Office of Public Instruction Superintendent Elsie Arntzen.

Welcome and Comments by Chair Lozar | *00:00:40*

Chair Lozar introduced new Regent Jeff Southworth and welcomed President Sandra Boham from the Salish Kootenai College as the Tribal College Representative. He announced that Western would host the Education Hall of Fame 'Night of Stars' event in April to honor excellence in education and induct five alumni. Earl Barlow will receive a lifetime achievement award. Chair Lozar then gave an overview of the agenda.

Welcome by Chancellor Reid | Presentation | *00:08:00*

Chancellor Reid discussed several projects underway at Western, including a campaign for a new sports and activities complex since this is the only campus without a complex. They have completed a transition to the Ellucian Banner Cloud which solved some past IT issues and allowed the implementation of software previously purchased. Chancellor Reid also discussed facility updates like the Block Hall renovation, the heating plant upgrade, Atlantic Street frontage renovation, dedication of space for the Montana Youth Challenge Academy mess hall, as well as Dining Hall and SUB renovations. He talked about the Tribal College partnerships Western enjoys and announced an open educational resource published by Dr. Tyler Seacrest. He finished with Experience One, their unique block program, and included a summary of the Hogsback project as an experiential learning collaboration for science and math.

Approval of Minutes | *00:28:30*

- January 6, 2022, Meeting Minutes

A motion for approval of the January 6, 2022, Board meeting minutes was made by Regent Dombrouski; motion passed (7-0).

Commissioner's Report | *00:29:16*

Commissioner Christian began his remarks with a welcome to Regent Southworth. He commended Chancellor Reid for his work for the campus and the community and acknowledged Experience One as a unique higher education model. He congratulated

the Western Foundation for raising over 2.2 million for the sport and activities complex. Next, he discussed a $50 million gift to Montana State University for a Gianforte School of Computing from the Gianforte Foundation. Finally, he congratulated President Bodnar for the University of Montana reaching R1 status. This achievement makes Montana the only state in the region to have two schools with that designation.

Apply Montana Portal | *00:36:00*

Scott Lemmon, Director of Admissions and Enrollment Strategy, spoke to the Board on step three of the portal project and included a demonstration of the website. Other states recognized the benefits of the portal and reached out to Montana. The career section is extensive and is likely to get the most use. The next step will be the awareness campaign. Discussion followed.

Western Interstate Commission for Higher Education (WICHE) | *01:00:20*

Demaree Michelau, President of WICHE, spoke briefly about WICHE and its mission. She then spent some time discussing the three levels of WICHE's student access programs which included Western Undergraduate Exchange (WUE), Western Regional Graduate Program (WRGP), and Professional Student Exchange Program (PSEP). Discussion followed.

- Federal Update | *01:18:18*

Helen Thigpen, Executive Director of Government Relations and Public Affairs, spoke about legislation related to increasing global competitiveness, such as USICA in the Senate and the American COMPETES Act in the House. She talked about several proposals related to Pell Grant awards and FY22 appropriations. Federal agencies have been active in higher education and are looking at rules pertaining to DACA, overtime pay, and Title IX regulations.

Director Thigpen also talked about efforts on the state level as OCHE continues to engage with legislative interim committees and American Rescue Plan Act (ARPA) commissions.

- Introductions | *01:32:00*

Western's Chancellor Reid introduced Tricia Fiscus, Vice Chancellor for Administration & Finance, and Johnny MacLean, Provost.

Tech's Chancellor Cook introduced Craig Elliott, Vice Chancellor of Student Affairs and Dean of Students, and Stephen Malott, Interim Vice Chancellor of Administration & Finance.

MSU Provost Bob Mokwa introduced Kristof Zaba, Dean for Global Engagement & International Programs. He also expressed appreciation to Deborah Haynes.

Remarks by Governor Gianforte (or Designee) | *01:36:20*

Dylan Klapmeier, Governor's Education Policy Advisor, congratulated UM for their R1 designation and welcomed Regent Southworth. He summarized some of the campus

visits that the Governor has recently completed. He discussed work-based learning initiatives that the Governor is promoting, such as a pilot partnership between Glasgow public schools, Miles Community College, and long-term care facilities, which allows students work opportunities for credit. Governor Gianforte met with each Regent to discuss priorities and how to work together. Mr. Klapmeier also spoke about career and technical education discussions he recently participated in. These discussions were about encouraging post-secondary education and working to make it accessible to everyone. The next Board of Public Education meeting will discuss OPI changes to educator licensing, which fits with the Governor's red tape initiative.

Budget, Administration and Audit Committee | *01:49:05*

CONSENT

Staff Items:

a. Labor Agreements, OCHE/MUS ITEM 199-100-R0322 | Attachment #1
b. Request for Approval of University System/Employee Equity Interest and/or Business Participation Under MUSP 407 – Lucon; MT Tech ITEM 199-1502-R0322 | Attachment #1
c. Request for Approval of University System/Employee Intellectual Property Joint Participation under MUSP 407 – Kunze; MSU Bozeman ITEM 199-2005-R0322 | Attachment #1

Emeriti Faculty:

d. Lawrence; UM Missoula ITEM 199-1003-R0322
e. Maron; UM Missoula ITEM 199-1004-R0322
f. O'Reilly; UM Missoula ITEM 199-1005-R0322
g. Rossi; MT Tech ITEM 199-1501-R0322
h. Priscu; MSU Bozeman ITEM 199-2004-R0322

Foundation Operating Agreements:

i. Request for Authorization to Renew the Operating Agreement between UM Missoula and University of Montana Foundation; UM Missoula ITEM 199-1031-R0322 | Attachment #1
j. Request for Authorization to Renew the Operating Agreement between UM Western and the UM Western Foundation; UM Western ITEM 199-1601-R0322 | Attachment #1
k. Request for Authorization to Renew the Operating Agreement between Helena College and Helena College Foundation Inc.; Helena College ITEM 199-1903-R0322 | Attachment #1

l. Request for Authorization to Renew the Operating Agreement between MSU Bozeman and Montana State University, Foundation Inc.; MSU Bozeman ITEM 199-2001-R0322 | Attachment #1

m. Request for Authorization to Renew the Operating Agreement between MSU Billings and MSU Billings Foundation; MSU Billings ITEM 199-2701-R0322 | Attachment #1 | Attachment #2

n. Request for Authorization to Renew the Operating Agreement between MSU Northern and MSU Northern Foundation; MSU Northern ITEM 199-2801-R0322 | Attachment #1

o. Request for Authorization to Renew the Operating Agreement between Great Falls College MSU and Montana State University Foundation, Inc.; Great Falls College-MSU ITEM 199-2901-R0322 | Attachment #1

p. Request for Authorization to Renew the Operating Agreement between MT Tech and MT Tech Foundation; MT Tech ITEM 199-1503-R0322 | Attachment #1

Facility Items:

q. Request for Authorization to Expend $975,000 of General Spending Authority to Renovate Montana Hall Suite 216; MSU Bozeman ITEM 199-2006-R0322 | Attachment #1

r. Request for Authorization to Replace Soccer Field Turf and Construct Lights; MSU Billings ITEM 199-2702-R0322 | Attachment #1

Other:

s. Request for Approval of Montana Rural Physician Incentive Program (MRPIP) Candidate; OCHE/MUS ITEM 199-101-R0322

ACTION

Facility Items:

a. Request for Authorization to Sell Property Owned by the University of Montana-Missoula Used as the President's Residence; UM Missoula ITEM 199-1001-R0322 | Attachment #1

Deputy Commissioner Tyler Trevor explained that this property traditionally held multiple purposes, including housing meetings and entertainment, which means it must meet public access code compliance standards, which are becoming very expensive. The national trend is to provide stipends for housing. The renovated Prescott House on campus can be used for entertainment. Discussion followed.

b. Request for Authorization to Build an Athletics Indoor Practice Facility; UM Missoula ITEM 199-1034-R0322 | Attachment #1 | Attachment #2 | Attachment #3 | Attachment #4

Deputy Commissioner Trevor spoke to the proposal for the Foundation to lease the recreational fields and build this facility which would be of significant benefit to athletes.

c. Request for Authorization to Increase Spending Authority for Knowles Hall Renovation; UM-Missoula ITEM 199-1035-R0322 | Attachment #1

Deputy Commissioner Trevor reported that prices have increased after the original May 2021 approval, so the bids came back higher. The low bid would require a 6 million increase in spending authority.

d. Request for Authorization to Purchase, Finance, and Operate Equine Property/Facilities; UM Western ITEM 199-1602-R0322 | Attachment #1 | Attachment #2

Deputy Commissioner Trevor explained this facility would benefit the natural horsemanship and rodeo programs and generate income.

e. Request for Authorization to Purchase and Finance the Molecular Biosciences Building at 960 Technology Boulevard within the Montana State University Innovation Campus; MSU Bozeman ITEM 199-2008-R0322 | Attachment #1 | Attachment #2 | Attachment #3

Deputy Commissioner Trevor explained that the university has been planning to obtain this building for the last couple of years. It is 39,000 square foot, and MSU already leases a portion of the building.

INFORMATION

a. FY23 Performance Funding Allocations

Deputy Commissioner Trevor explained the history of performance funding allocation. Three goals of performance funding are to increase degree production, focus on output and input, and pay for what is valued. He then discussed how the funding is allotted and the landscape of performance funding nationwide and specific to Montana campuses. Discussion followed.

b. 2025 Biennial Budget Development

Shauna Lyons, MUS Director of Accounting and Budget, discussed how she began to develop a base budget. Influencing factors include present law adjustments, pay plan, new proposals, enrollment, and tuition revenue. The Regents will see and approve the first layers this May and approve the final items next May. She then went further into present law adjustments, including definitions and categories. Discussion followed.

c. Long-Range Building Program (LRBP), 2025 Biennium
   - Capital Projects: UM | MSU
   - Major Repairs: UM | MSU

Deputy Commissioner Trevor discussed the draft Long Range Building Program lists, including Capital Development, Major Repair, and Authority Only projects. A final list of projects will be presented at the May 2022 meeting for approval by the Regents.

d. Facility Item – MSU

Director Thigpen discussed the new building that will be built for computing with the gift from the Gianforte Family Foundation. This request for approval to name the building Gianforte Hall will be presented in May.

e. BOR Policy Revisions
   - 805 – Executive Perquisites
   - 940.24 -Contract Requirements for the University of Washington Cooperative Medical Program (WWAMI)

Deputy Commissioner Trevor briefly explained the proposed updates to these policies.

Academic, Research and Student Affairs Committee | *03:13:00*

ACTION

a. Honorary Doctorate; MSU ITEM 199-2002-R0322 | Attachment #1

b. Honorary Doctorate; MSU ITEM 199-2003-R3022 | Attachment #1

President Cruzado presented an honorary doctorate candidate for each commencement in May; Chief Judge Sidney R. Thomas in the morning and Charles (Chuck) Johnson in the afternoon.

c. Honorary Doctorate; UM ITEM 199-1032-R0322 | Attachment #1

d. Honorary Doctorate; UM ITEM 199-1033-R0322 | Attachment #1 | Attachment #2

President Bodnar presented two honorary doctorate candidates: Dennis Eck for the first commencement and Jim Scott for the second.

e. Helena College Mission and Vision; ITEM 199-1901-R0322

Dean Bauman presented the new mission and vision statement for approval and discussed the process they used as well as strategic planning.

f. Request to Plan Proposals Executive Summary and OCHE Analysis | Supporting Documentation | New Program Tracking

Deputy Commissioner Tessman summarized the format for the request to plan proposals.

Bob Mokwa, MSU Provost, presented the request to plan a proposal for a multi-

disciplinary B.S. in Data Science.

INFORMATION | *03:45:30*

Academic Review Items

a. Academic Approval Memorandum (October, November, December, January)

Deputy Commissioner Tessman spoke to the approval authority the Board has designated to the institutions or the Commissioner. Items approved under that authority are submitted in a report since the previous meeting.

Strategic Priority Items

a. MUS Mental Health Update

Crystine Miller, Director of Student Affairs and Student Engagement, discussed the MUS Suicide Prevention and Mental Health Task Force. She presented a summary of recommendations developed in 2016, such as ensuring access to clinical services and establishing depression screening in medical care settings. She touched on some highlights about current events such as the pandemic importance of in-person instruction and campus life, consistency in delivery mode, and virtual services, including Kognito, You at College, and ThrivingCampus. Key focus areas moving forward include increasing access and capacity of a broad spectrum of support, robust system-level data and evidence, expanding mental health and wellness literacy, and integrating mental health and wellness into campus and system culture. The second system-wide Mental Health and Wellness Summit will be held September 20-22 at MSU Billings.

Dennis Mohatt, Vice President for Behavioral Health, WICHE, congratulated Montana for leading the pack. He discussed pre-pandemic challenges for mental health and academic success and then spoke about a checklist for campus leaders for student wellness. Proven effective tools include community mental health centers, crisis systems, and law enforcement, among others. Other suggestions include student wellness apps such as YOU at College and campus support, including culture change and stigma reduction. Success evaluation would consist of availability, accessibility, and acceptability. He discussed the behavioral health continuum of care and what comprehensive services would look like. Whole campus coordination consists of activity, support, and coordination across all levels. Discussion followed.

b. MUS American Indian Student Success Panel

Angela McLean, Director of American Indian/Minority Achievement and K-12 Partnerships, outlined highlights since the last update in November, including workforce development growth, partnership growth such as that between Western and tribal colleges to train teachers where they live, and programming growth.

Graduate Student Kristie Russette spoke about Dr. Walter Fleming's influence on American Indian student success at MSU. The MSU American Indian Hall opened in

January. MSU received a $2.75 million Margaret A. Cargill Philanthropies grant and intends to focus on student support, peer mentoring, and outreach.

Dr. Brad Hall, Tribal Outreach Specialist, spoke to the UM Action Plan for Undergraduate Native Student Access which focuses on students moving from high school to college, as well as transfers.

Director McLean touched on the importance of data collection for these efforts. Discussion followed.

c. MUS Research Update

Joe Thiel, Director of Academic Policy & Research, introduced the R1 representatives.

Scott Whittenberg, UM, spoke to the impact of R1 designation, with the top benefit being recruiting both graduate and undergraduate students.

Jason Carter, MSU, talked about factors contributing to an R1 school, including research expenditures and research doctorates.

Director Thiel mentioned that some credit goes to Federal programs that focus on rural states, such as INBRE program, NSF EPSCoR Program, NASA EPSCoR, and Montana Space Grant Consortium.

Drs. Anneliese Ripley, Michael Morrow, and Rob Thomas combined to discuss Grants and Undergraduate Research at Montana Western.

Dr. Ripley spoke about the impact of faculty effort on the upward trend of grants and undergraduate research from 2012 to 2021.

Dr. Morrow spoke about the importance of grant funding and touched on Western's block schedule.

Dr. Thomas went into more detail about the block schedule and how it provides freedom from scheduling. He said state agencies want UMW technical graduates. He then discussed projects that benefited from block programming.

Discussion followed.

Public Comment* | *05:54:16*

Noah Durnell, ASUM President, spoke of various challenges, a common theme being a lack of resources.

Melissa Glueckert, ASUM Vice President, spoke of the student perspective on mental health and its importance.

O'Shay Birdinground, spoke against overtly racist professors.

Georgia Hawthorne, spoke in favor of increasing accessibility and dealing with the mental health crisis in an equitable way.

Cassie Williams, ASUM senator, spoke against racist or phobic teachers.

Meeting Recessed at 5:07 pm

Friday, March 11, 2022

The Board reconvened for an executive session. Chair Lozar determined the matters of the discussion related to matters of individual privacy and the demands of individual privacy outweigh the merits of public disclosure.

8:45 am Executive Session | *Swysgood Technology Center Board Room*

- Regent Professor Nomination – MSU

Meeting Reconvened at 9:35 am

Remarks by Superintendent Arntzen | *00:01:05*

Superintendent Arntzen spoke to a few items in addition to her submitted report. OPI is working with legislators and Chancellor Kegel for the May meeting in Havre to spotlight agriculture. OPI will accept news from the university to be put in their legislator newsletter. She spoke about partnerships and the status of the ACT. She mentioned that the most significant number of new licenses should be from Montana rather than out of state. OPI has held three virtual fairs and received 180 applicants. She discussed the benefits of paid student teachers and paid residencies. She finished with a brief discussion on the mental health of students and staff.

Two-Year and Community College Committee | *00:12:30*

Deputy Commissioner Brock Tessman spoke to the presenters and economic development research. He recognized Jenny Harms from Accelerate Montana, ARPA, and how that is connected to the rest of the two-year system.

INFORMATION

a. Prior Learning Assessment Update

Jacque Treaster, Director of Dual Enrollment and Career & Technical Education, discussed the 2021 annual report, beginning with a background of PLA. Most PLA students currently are advanced placement and international baccalaureate, so there is a lot of work in other areas, such as the military. Other statistics discussed include most PLA students are still 24 or less, about 1/3 of non-AP/IB are veterans, and Indian and older students are underrepresented compared to all MUS.

b. Prior Learning Assessment Policy Revision | Attachment 1 | Attachment 2

Director Treaster presented the proposed draft, which removes PLA Liaisons, the PLA Council, and the 25 percent PLA credit cap. A future program goal is to streamline the process and provide a toolkit.

Deputy Commissioner Tessman mentioned that another future goal is to connect the portal to the program.

c. Developmental Education Update

Director Miller said that there had been a lot of work on this topic, even though it has been quiet on the BOR agenda. Between ¼ and 1/3 of all two-year students are identified as having a developmental education need. This can influence enrollment and retention, time and cost to degree, as well as degree completion. Key areas are access, enrollment, retention, and equity.

Lauren Fern, Assistant Professor, and Math Discipline Lead, Missoula College, stressed the importance of meeting students where they are, and the historical or traditional response wastes time. It doesn't encourage retention compared to the more practical approach of pathways that align courses with their program of study.

Ciera Franks-Ongoy, Perkins Equitable Access Coordinator, spoke to zoomed out system-wide information and that statistically, Pell students have higher representation in developmental courses.

Discussion followed.

Public Comment* | *01:11:17*

None.

Committee Reports & Action | *01:12:15*

- Budget, Administration and Audit Committee

CONSENT

Staff Items:

a. Labor Agreements, OCHE/MUS ITEM 199-100-R0322 | Attachment #1
b. Request for Approval of University System/Employee Equity Interest and/or Business Participation Under MUSP 407 – Lucon; MT Tech ITEM 199-1502-R0322 | Attachment #1
c. Request for Approval of University System/Employee Intellectual Property Joint Participation under MUSP 407 – Kunze; MSU Bozeman ITEM 199-2005-R0322 | Attachment #1

Emeriti Faculty:

d. Lawrence; UM Missoula ITEM 199-1003-R0322
e. Maron; UM Missoula ITEM 199-1004-R0322
f. O'Reilly; UM Missoula ITEM 199-1005-R0322
g. Rossi; MT Tech ITEM 199-1501-R0322
h. Priscu; MSU Bozeman ITEM 199-2004-R0322

Foundation Operating Agreements:

i. Request for Authorization to Renew the Operating Agreement between UM Missoula and University of Montana Foundation; UM Missoula ITEM 199-1031-R0322 | Attachment #1
j. Request for Authorization to Renew the Operating Agreement between UM Western and the UM Western Foundation; UM Western ITEM 199-1601-R0322 | Attachment #1
k. Request for Authorization to Renew the Operating Agreement between Helena College and Helena College Foundation Inc.; Helena College ITEM 199-1903-R0322 | Attachment #1
l. Request for Authorization to Renew the Operating Agreement between MSU Bozeman and Montana State University, Foundation Inc.; MSU Bozeman ITEM 199-2001-R0322 | Attachment #1
m. Request for Authorization to Renew the Operating Agreement between MSU Billings and MSU Billings Foundation; MSU Billings ITEM 199-2701-R0322 | Attachment #1 | Attachment #2
n. Request for Authorization to Renew the Operating Agreement between MSU Northern and MSU Northern Foundation; MSU Northern ITEM 199-2801-R0322 | Attachment #1
o. Request for Authorization to Renew the Operating Agreement between Great Falls College MSU and Montana State University Foundation, Inc.; Great Falls College-MSU ITEM 199-2901-R0322 | Attachment #1
p. Request for Authorization to Renew the Operating Agreement between MT Tech and MT Tech Foundation; MT Tech ITEM 199-1503-R0322 | Attachment #1

Facility Item:

q. Request for Authorization to Expend $975,000 of General Spending Authority to Renovate Montana Hall Suite 216; MSU Bozeman ITEM 199-2006-R0322 | Attachment #1
r. Request for Authorization to Replace Soccer Field Turf and Construct Lights; MSU Billings ITEM 199-2702-R0322 | Attachment #1

Other:

s. Request for Approval of Montana Rural Physician Incentive Program (MRPIP) Candidate; OCHE/MUS ITEM 199-101-R0322

A motion for approval of consent items a.-s. was made by Regent Bough; motion passed (7-0).

ACTION

Facility Items:

a. Request for Authorization to Sell Property Owned by the University of Montana-Missoula Used as the President's Residence; UM Missoula ITEM 199-1001-R0322 | Attachment #1

A motion for approval of action item a., ITEM 199-1001-R0322, was made by Regent Dombrouski; motion passed (7-0).

b. Request for Authorization to Build an Athletics Indoor Practice Facility; UM Missoula ITEM 199-1034-R0322 | Attachment #1 | Attachment #2 | Attachment #3 | Attachment #4

A motion for approval of action item b., ITEM 199-1034-R0322, was made by Regent Sexton; motion passed (7-0).

c. Request for Authorization to Increase Spending Authority for Knowles Hall Renovation; UM-Missoula ITEM 199-1035-R0322 | Attachment #1

A motion for approval of action item c., ITEM 199-1035-R0322, was made by Regent Dombrouski; motion passed (7-0).

d. Request for Authorization to Purchase, Finance, and Operate Equine Property/Facilities; UM Western ITEM 199-1602-R0322 | Attachment #1 | Attachment #2

A motion for approval of action item d., ITEM 199-1602-R0322, was made by Regent Buchanan; motion passed (7-0).

e. Request for Authorization to Purchase and Finance the Molecular Biosciences Building at 960 Technology Boulevard within the Montana State University Innovation Campus; MSU Bozeman ITEM 199-2008-R0322 | Attachment #1 | Attachment #2 | Attachment #3

A motion for approval of action item e., ITEM 199-2008-R0322, was made by Regent Sexton; motion passed (7-0).

- Academic, Research and Student Affairs Committee

ACTION

a. Honorary Doctorate; MSU ITEM 199-2002-R0322 | Attachment #1

A motion for approval of action item a., ITEM 199-2002-R0322, was made by Regent Rogers; motion passed (7-0).

b. Honorary Doctorate; MSU ITEM 199-2003-R0322 | Attachment #1

A motion for approval of action item b., ITEM 199-2003-R0322, was made by Regent Buchanan; motion passed (7-0).

c. Honorary Doctorate; UM ITEM 199-1032-R0322 | Attachment #1

A motion for approval of action item c., ITEM 199-1032-R0322, was made by Regent Sexton; motion passed (7-0).

d. Honorary Doctorate; UM ITEM 199-1033-R0322 | Attachment #1 | Attachment #2

A motion for approval of action item d., ITEM 199-1033-R0322, was made by Regent Rogers; motion passed (7-0).

e. Helena College Mission and Vision; ITEM 199-1901-R0322

A motion for approval of action item e., ITEM 199-1901-R0322, was made by Regent Buchanan; motion passed (7-0).

f. Request to Plan Proposals Executive Summary and OCHE Analysis | Supporting Documentation | New Program Tracking

A motion for approval of action item f., Request to Plan Proposals was made by Regent Bough; motion passed (7-0).

- Two-Year and Community College Committee

None.

Appeal | *01:19:44*

Chair Lozar explained the process related to appeals.

- Appeal

The request to hear the appeal is denied, and the Commissioner's decision is upheld.

Meeting Adjourned at 10:58 am.

Approved by the Board of Regents on

_____ _____

Date

Clayton T. Christian
Commissioner of Higher Education
and Secretary to the Board of Regents

Date

Casey Lozar
Chair, Board of Regents

APPENDIX A

Maggie Bell- BOR Public Comment DRAFT

Chair Lozar and Members of the Board,

My name is Maggie Bell, and I am a junior double majoring in Political Science and Philosophy and a senator with ASUM at the University of Montana.

I'm here today to discuss an issue we have all dealt with, parking. Specifically, parking at the University of Montana.

Currently, UM has a total of 4,769 parking spaces on campus, including Handicap, Quick-Stop, hourly pay, reserved, and permit spaces. The great news that the University has seen an increase in enrollment, (30% in first year students and 3% overall, equating 10,106 current students), also means that these parking spaces become spread much thinner.

The University currently has construction plans beginning over spring break for the expansion of the Montana Museum of Art and Culture taking place on one-half of the largest parking lot on campus, decreasing nearly 240 spots or approximately 5% of the total existing spots.

As the University faces this wonderful enrollment increase, parking becomes not only an issue of convenience, but of safety. Freshman living on campus are forced to park clear across campus in an overnight lot and walk to their dorms early in the morning or late at night. Similarly, for students involved in athletics, music programs, and theater, or even those just hoping to study, walking across campus late at night or early in the morning should not be a risk students have to take.

The University Area Parking District contains the two-block radius surrounding campus and contains approximately 1,000 parking spaces on public streets. It allows each registered vehicle at a household to obtain a parking permit, as well as two visitor parking permits that are *explicitly* not to be used by non-Parking District members to attend the University. However, currently, students will park on the outskirts of the district, three blocks away, and walk to campus, further congesting parking for the residents who live beyond the parking district.

Ultimately, the University of Montana's unique position next to a mountain means it is running out of space for parking within its campus. While the system of the University Area Parking District is becoming increasingly unsustainable. I'm hoping to garner Regent support for this issue to work with the Missoula City Council to either fully dissolve or, at the very least, redesign the workings of the parking district. Students, staff, and faculty who commute to campus by car would be bettered by the flexibility of parking throughout the day. Residents in the district would not lose parking completely, as the peak hours on campus tend to be from around 10AM to 3PM, when most are at work. And when parking seems to be the largest issue, on football gamedays or graduation, the parking district is unmonitored anyways. Reworking the parking district would level the playing field for all those invested in the campus community at the University of Montana and is an option that needs to be taken sooner, rather than later.

Thank you all so very much for your committed dedication to bettering higher education, I appreciate your time today.

(Introduces Self in Crow) Mr. chair and esteemed members of the Board. My name is O'Shay Birdinground, I am a Senator with ASUM in Missoula. I stand before you today to discuss the how the sentiments of people like Rob Smith and Clayton Looney on the UM campus have highlighted systemic racism throughout the MUS. Twice, the students have risen and had their voices heard advocating against racist professors on campus. In my mind, the presence of overtly racist professors fails to satisfy Policy 1902 Minority Achievement. Specifically, Section B Subsection 10, which states that the Regents have a responsibility to "Develop and Maintain a Comfortable Social Environment on Campus and in the Greater Community." As an indigenous person in higher education in the State of Montana, it deeply saddens me to see the insidious impact of racism on institutions in the MUS system. I'm proud of the statements written to condemn racism and other forms of harassment on campuses, but, I beg you to consider, what actions should that condemnation lead to? What roles should this body play? Many of the students you help succeed need your attention on this matter. Reinvigorate your stated commitment to Policy 1902. Outline the new actions you as a body will take for minority achievement and wellbeing. It is time for us as a system to do better.. We must stop talking about DEI initiatives if the work isn't being done. I call on you, the Regents, President Bodner, President Cruzado, and other campus leaders to work with students and members of the community that have dealt with these tough issues to find a compromise that both enacts DEI work and condemns Racism. Thank you again Chair Lozar and members of the board for listening to the concerns of students and actively working to change the MUS system.

THE UNIVERSITY *of* MONTANA WESTERN

GEOLOGIC HISTORY

OF THE DILLON, MONTANA AREA

Produced by the Environmental Sciences Department
at the University of Montana Western

STRATIGRAPHY

ERA	PERIOD		EPOCH	AGE (MILLIONS OF YEARS AGO)	REPRESENATIVE FORMATION
CENOZOIC	QUATERNARY		HOLOCENE		Surficial deposits (lake, stream, landslide and hot spring)
			PLEISTOCENE	.0117	Pinedale glacial deposits (30-12k) Bull Lake glacial deposits (160-130k)
	TERTIARY	NEOGENE	PLIOCENE	2.58	Pediment gravel
			MIOCENE	5	Sixmile Creek Formation
		PALEOGENE	OLIGOCENE	23	Renova Formation
			EOCENE	34	Dillon Volcanics of the Renova Formation
			PALEOCENE	56	
MESOZOIC	CRETACEOUS			65	Beaverhead Conglomerate Frontier Formation Blackleaf Formation Kootenai Formation
	JURASSIC			146	Morrison Formation
	TRIASSIC			200	Thaynes Formation Woodside Formation Dinwoody Formation
PALEOZOIC	PERMIAN			251	Shedhorn Sandstone Phosphoria Formation Park City Formation
	PENNSYLVANIAN			299	Quadrant Formation
	MISSISSIPPIAN			318	Conover Ranch Formation Lombard Limestone Kibbey Sandstone Mission Canyon Formation Lodgepole Formation
	DEVONIAN			359	Three Forks Formation Jefferson Formation
	SILURIAN			416	No rocks
	ORDOVICIAN			444	Bighorn Dolomite Kinnikinic Quartzite
	CAMBRIAN			488	Snowy Range Formation Pilgrim Formation Park Shale Meagher Formation Wolsey Shale Flathead Sandstone Black Lion Conglomerate
	PRECAMBRIAN			542 4700	Wilbert Formation Belt Supergroup Metamorphic and Igneous Rock

THE BIG PICTURE

The geology of the Dillon area records an impressive amount of Earth's 4.5 billion year history. Billions of years ago, there was no breathable oxygen, the only living organisms were bacteria and mountains formed as continents collided. Over a billion years of erosion erased these mountains and they were submerged under tropical ocean water as the paleo-Pacific Ocean rifted open.

The seas went in and the seas went out, depositing sediment made from sand-sized bits of eroded rock and shells of animals and plants that lived in the water.

Shallow seas gave way to volcanoes that formed when the Pacific Ocean floor was pushed and pulled under the North America continent. All the older rocks were folded and shoved eastward, while dinosaurs flourished along streams draining the mountains into an interior seaway east of Dillon. Where magma fed volcanoes, metals like copper, silver and gold accumulated in the rocks they intruded. The basin and range topography we see today began forming around 45 million years ago when plate extension pulled the crust apart. Some of these mountains are youngsters, having formed as recently as four million years ago. As plate movement brought us closer to the Yellowstone hot spot, thermal doming and crustal stretching created a new landscape. Deposits from the ancestral Missouri River were uplifted with the new mountains, while rivers like the Red Rock flowed down the new valleys.

Glaciers sculpted the mountains and humans hunted woolly mammoths as recently as 12,000 years ago. Lewis and Clark passed through the area in the summer of 1805, making maps and documenting the colder and wetter climate of the Little Ice Age. The first non-native people arrived in mass in the 1860s, establishing mining camps, ranches and settlements we still occupy today.

The "river rock" in the photo to the right was rolling down the ancestral Missouri River drainage around four million years ago. It now sits high and dry in the Sweetwater Mountains east of Dillon as a result of thermal doming and uplift related to the Yellowstone hot spot. What was once a river is now a mountain.

READING THE RECORD

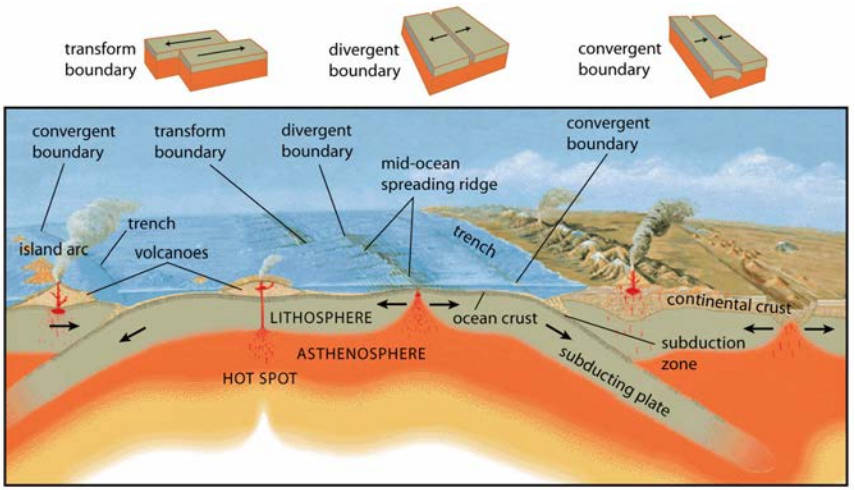
The story in the rocks is there for all of us to read with just a few tools. The rock record reads like a book, only from back to front. The oldest rock is on the bottom of the stack, unless disrupted by tectonic forces that change the order. Most layered rocks were originally horizontal, so if they are tilted or folded, it likely occurred after the layering formed. Any rock inside of another must be older, and if rocks or faults cut across rocks, they must be younger. Paleogeographic maps that show the spatial distribution of environments at any given time are constructed by correlating rocks with fossils, layers of ash, geochemical events or numerical dates from rocks.

Numerical ages are determined for many rocks using a technique called isotopic dating. Forces binding protons and neutrons together in some atoms are simply not strong enough, and the nuclei spontaneously break apart or decay. Over time, unstable (parent) atoms decay into stable (daughter) isotopes at a constant rate. The time it takes for half of the parent to decay is called the half-life of the isotope, and if it is known, and the parent to daughter ratio can be measured, then the age of a rock can be calculated. The clock starts ticking when unstable atoms reach certain temperatures as liquid rocks crystallize or heated rocks recrystallize.

The Earth evolves or changes over a span of time so long that geoscientists refer to it as deep time. The Earth is 4.5 Ga (billion years old). Put in context of a single year, the oldest rocks in the Dillon area date from about mid-March. Animals first appeared in oceans in May, and plants emerged onto land in late November. The Rockies were first uplifted and dinosaurs dominated in mid-December. Explosive volcanoes erupted in late December and the basin and range topography we see today started forming on the evening of December 31st. The most recent glacier in the Pioneer Mountains reached maximum size about 1 minute and 30 seconds before midnight, just as humans arrived to hunt woolly mammoths. Miners arrived less than 1 second before the end of the year.

The rock at right contains fossils that show it was once sediment on the ocean floor. Deep burial and compression folded the rock and made mountains. Uplift and erosion made it possible to see it at the surface today. The Earth must be very old!

PLATE TECTONICS



The geology of the Dillon area records an impressive amount of Earth's 4.5 billion year history. Billions of years ago, there was no breathable oxygen, the only living organisms were bacteria and mountains formed as continents collided. Over a billion years of erosion erased these mountains and they were submerged under tropical ocean water as the paleo-Pacific Ocean rifted open.

The seas went in and the seas went out, depositing sediment made from sand-sized bits of eroded rock and shells of animals and plants that lived in the water.

Shallow seas gave way to volcanoes that formed when the Pacific Ocean floor was pushed and pulled under the North America continent. All the older rocks were folded and shoved eastward, while dinosaurs flourished along streams draining the mountains into an interior seaway east of Dillon. Where magma fed volcanoes, metals like copper, silver and gold accumulated in the rocks they intruded. The basin and range topography we see today began forming around 45 million years ago when plate extension pulled the crust apart. Some of these mountains are youngsters, having formed as recently as four million years ago. As plate movement brought us closer to the Yellowstone hot spot, thermal doming and crustal stretching created a new landscape. Deposits from the ancestral Missouri River were uplifted with the new mountains, while rivers like the Red Rock flowed down the new valleys.

Glaciers sculpted the mountains and humans hunted woolly mammoths as recently as 12,000 years ago. Lewis and Clark passed through the area in the summer of 1805, making maps and documenting the colder and wetter climate of the Little Ice Age. The first non-native people arrived in mass in the 1860s, establishing mining camps, ranches and settlements we still occupy today.

ARCHEAN

(4.0-2.5 GA)

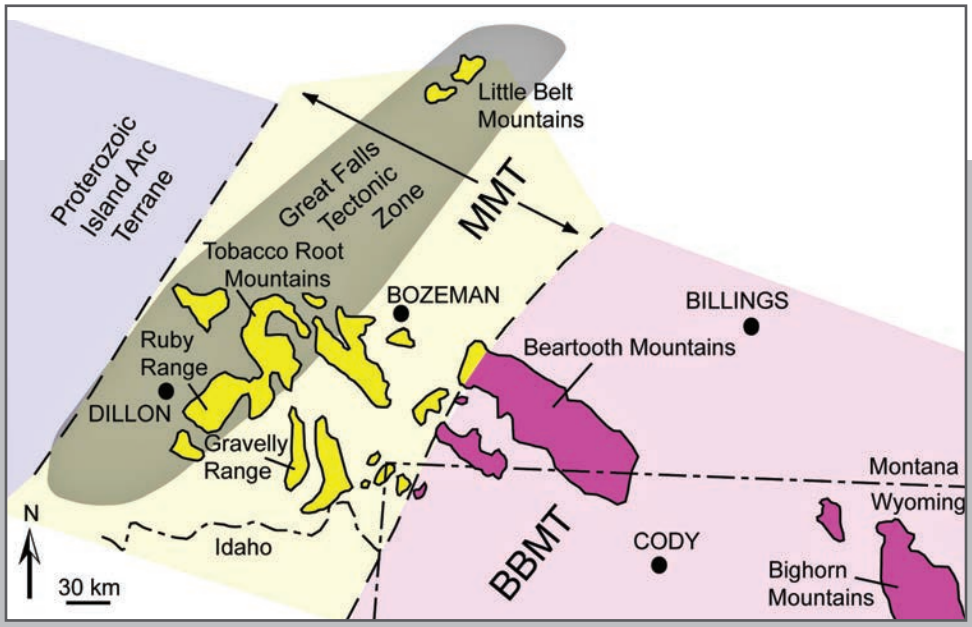
OLDEST ROCKS

The oldest rocks in the area are primarily metamorphic and may be as old as 3.3 billion years! Marble, quartzite, peridotite, gneiss, schist and banded iron formation are common rock types of the so-called basement. These rocks are loaded with interesting minerals, like garnets, corundum, graphite and magnetite. Red garnets are so abundant in some rocks that they give rise to the name Ruby Range.

Local metamorphic rocks (yellow-colored area on the map below) were originally sediments deposited in basins adjacent to the old core of the North American continent or "Wyoming province" (purple-colored area).

We know from deposits of similar age around the globe that the planet contained no free oxygen, causing ocean water to be green in color from the abundant reduced iron. Life on Earth was restricted to bacteria, which formed domed-shaped structures called stromatolites. Local marble may have precipitated from ocean water as limestone with the help of bacteria, but evidence of them and their stromatolitic structures appears to have been destroyed when the rocks were metamorphosed.

Regional metamorphism occurred several times, including during the Archean, but the main event appears to be a plate collision and mountain-building event called the Big Sky orogeny during the Paleoproterozoic.



Distribution of local Precambrian basement rocks (yellow). – Sisson, 2007

PALEOPROTEROZOIC

(2.5-1.6 GA)

BIG SKY OROGENY

The most significant metamorphic event in the region was a mountain-building event called the Big Sky orogeny. A collision between volcanic islands, a block of continental crust called the Medicine Hat block and the Wyoming province resulted in crumpling and uplift of the Earth's crust into large mountains. The collision probably occurred around 1.8 billion years ago.

Pressures up to 800 megapascals (MPa) and temperatures up to 800°C changed the older sedimentary and igneous rock into metamorphic rock. To put the pressure into perspective, 800 MPa is about 100 million pounds per square inch (psi). The typical car tire is inflated to 32 psi! The pressure and temperature caused the rock to become like Play-DohTM, forming foliation or mineral layering in the rock. Foliation is aligned perpendicular to the direction of pressure, but it can become folded if the direction of pressure changes on the rock. The pressure and temperature required to form some of the rocks indicate burial to depths up to

25 miles (40 km). Since we can see these rocks at the surface, there must have been a tremendous amount of uplift and erosion over a long period of time.

With enough pressure and temperature, the rock will melt and create igneous rock. Under pressure, the igneous rock rises up through the metamorphic rock and crystallizes into finger-like intrusions called dikes. The dikes are pegmatite, a type of igneous rock composed of large minerals of quartz, feldspar, mica and tourmaline. Some of the dikes were intruded during metamorphism, while others were intruded after compression and mountain building stopped around 1.76 billion years ago.

The rock at the right is a metamorphic rock called gneiss. The alternating light and dark layers are foliation or mineral layering. Notice that it is folded, illustrating that the direction of pressure changed on the rock after it formed. A rock like this may have been buried as deeply as 25 miles, so there was a tremendous amount of uplift and erosion of overlying rock to get it to the surface.

MESOPROTEROZOIC

(1.6-1.0 GA)

TALC, DIKES AND THE BELT BASIN

One of the most important minerals to the Dillon community is talc. The local talc is some of the purest on Earth, and is used to make paper, paints, plastics, cosmetics, ceramics and some agricultural products. Talc is a magnesium silicate clay mineral that formed 1.4 billion years ago when hot water altered Archean dolomitic marble. Hot water percolated along faults formed by crustal extension that created a basin for an inland sea called the Belt Basin. The energy needed to heat the water may have come from dark-colored dikes called diabase that injected into the basement rock during formation of the Belt Basin.

One of these dikes occurs in the wall of the Regal Mine east of Dillon on the Sweetwater Road.

About 1.5 billion years ago, the Dillon area was near the southern shore of an inland sea called the Belt Basin (see below). The sea occupied a depression formed by crustal extension and it filled with sediment eroded from the adjacent highlands. Belt rocks contain exquisitely preserved structures like cross beds, mud cracks and raindrop imprints. Their preservation is due to deposition of Belt sediments prior to the evolution of burrowing animals that destroy these structures.

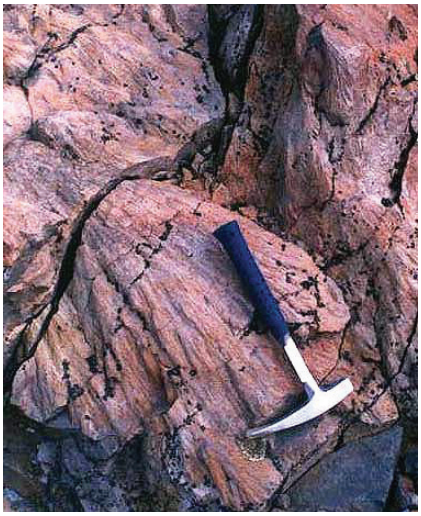
This Belt rock shows cross beds formed when sand grains were deposited by moving water. Pioneer Mountains, Montana. Scale bar is 5 cm.

NEOPROTEROZOIC

(1.0-0.542 GA)

THE GREAT UNCONFORMITY

At least 1.3 billion years of erosion left most of the Dillon area a featureless plain by the end of the Neoproterozoic. Continents were assembled into a supercontinent called Rodinia and global cooling enveloped the Earth in ice. Starting around 780 million years ago, Rodinia broke into fragments, forming the paleo-Pacific Ocean west of Dillon. The continental rifting was accompanied by a rise in sea level that deposited marine and stream sediments on the older metamorphic and igneous rocks. The boundary between them is called the Great Unconformity because it represents a gap in the rock record of at least 1.3 billion years. The two photos below are of the Great Unconformity near Melrose, Montana.



To the left is an impact-caused structure called a shatter cone from the Medicine Lodge Valley south of Dillon. It formed during a meteorite impact 900 million years ago. The crater is estimated to be 37 miles (60 km) in diameter, making it one of the largest impact craters on Earth.

Photo - Mike Plautz

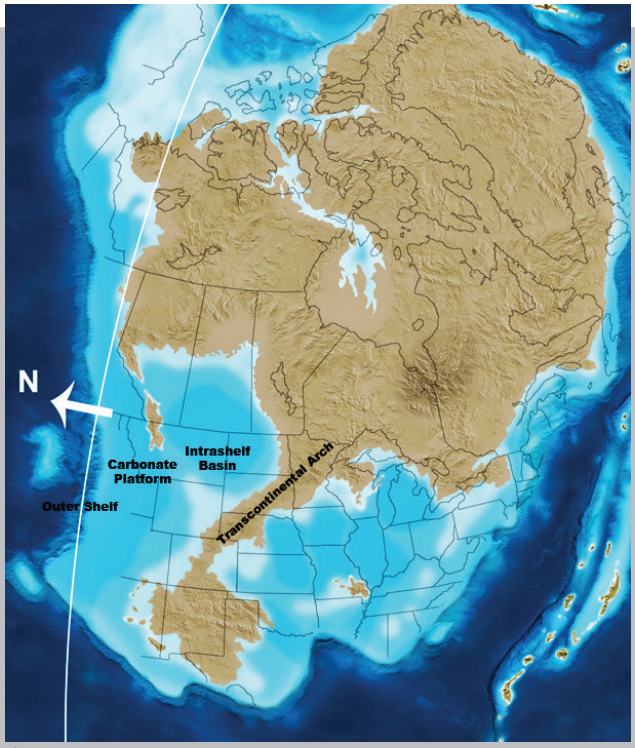
EARLY PALEOZOIC

(542-360 MA)

THE SEAS GO IN AND THE SEAS GO OUT

Early Paleozoic time might best be described as Margaritaville. Tropical ocean water inundated the North American continent, covering it first with stream and beach sand, then shelf mud and finally offshore limestone. It is not clear what caused the Cambrian transgression, but the likely culprits are warming climate and increased seafloor spreading. Relative sea level fluctuations caused the sea to transgress and regress from the continent, at times exposing the land to erosion. Unconformities produced by erosion actually represent more time than the rock record.

Diversity of oceanic life exploded in the Cambrian, resulting in deposits rich in the fossils of most modern phyla. Proposed causes include increased free oxygen, calcium for making shells and evolutionary innovations. Trilobites, extinct arthropods are hallmark fossils of the time period, and can be found in Cambrian rocks near Melrose, Montana.



TRILOBITE TAIL FOSSIL

Trilobites left an extraordinary number of shells, because they shed them when molting. Spines are about 2 cm across. The map shows Montana located near the equator and covered with shallow ocean water during the Cambrian. The ocean teamed with trilobites, brachiopods and other tropical marine life.

— Map courtesy of Ron Blakey

LATE PALEOZOIC

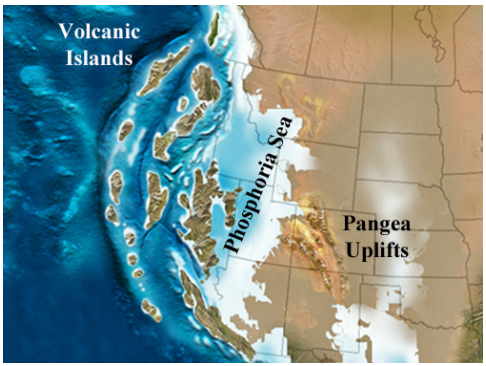
(360-251 MA)

OCEANS, DESERTS AND RESTRICTED SEAS

Tropical marine deposition continued into the later Paleozoic, with the deposition of fossil-rich limestone of Mississippian age. Fossils of crinoids, echinoids, corals (see photo), bryozoans and brachiopods are common in the Lodgepole Formation, especially at Clark Canyon Reservoir south of Dillon. Because limestone resists erosion in arid climates, it forms prominent landmarks like Clark's Lookout and Beaverhead Rock. During past wet periods, these rocks dissolved and formed caverns, like Argenta Cave. The caves have stored water for thousands of years, and are important for the recharge of groundwater.

During Pennsylvanian time, the assembly of the supercontinent of Pangea caused regional uplift and retreat of the ocean. A large coastal dune field developed, preserved today as well rounded and sorted sandstone of the Quadrant Formation. Moisture in fractures is ideal for growing trees, so exposure of the Quadrant controls some abrupt tree lines, like the one at Badger Pass.

The sea rose again in Permian time, as Pangea-related uplifts to the south and volcanic islands to the west (Antler orogeny) made a complex shelf where chert, black shale and phosphate were deposited. Phosphate formed where deep, nutrient-rich waters were drawn to the surface by winds. The bones and feces of animals living in the upwelling zone were turned into phosphate-rich rocks of the Phosphoria Formation. It is mined today primarily for use in phosphate fertilizers.



The map shows the Phosphoria Sea during the Permian Period. Volcanic islands in the Phosphoria Sea restricted ocean circulation, causing low-oxygen water that favored the accumulation of organic-rich black shale. Black shale is well exposed at Dalys Spur south of Dillon.

— Map courtesy of Ron Blakey

EARLY MESOZOIC

(251-150 MA)

THE GREAT DYING

The Paleozoic Era ended with the elimination of over 96% of all marine species and 70% of all terrestrial species from the Earth. The Great Dying was likely caused by many environmental changes occurring all at once. There is evidence for massive volcanic eruptions in Siberia, a meteorite impact, global warming, changes in ocean chemistry and more. The extinction and recovery are not recorded in the Dillon area, but the Triassic Dinwoody Formation shows that brachiopods, snails and coiled squids were living locally in shallow seas about 15 million years after the extinction.

By the later part of the Jurassic Period, marine water retreated from the area and low-gradient streams of the Morrison Formation began draining highlands to the west. The western topography resulted from the breakup of the supercontinent of Pangea, which resulted in the collision of the North American Plate with a slab of Pacific Ocean floor called the Farallon Plate.

The movie Jurassic Park has its roots in the abundant dinosaur fossils found in the Morrison Formation throughout the intermountain west. For years, few fossils were found in this formation in southwestern Montana. Recently, abundant fossils of sauropods or longneck dinosaur have been found in this formation north of Dillon.

Pangea was in early stages of breakup by the Jurassic. Opening of the Atlantic helped drive North America into the Farallon Plate.

— Map courtesy of Ron Blakey

At right is a sauropod dinosaur fossil in the Morrison Formation of Utah. Recent local discoveries of sauropod dinosaurs show they lived in Montana as well.

— Photo courtesy of NPS

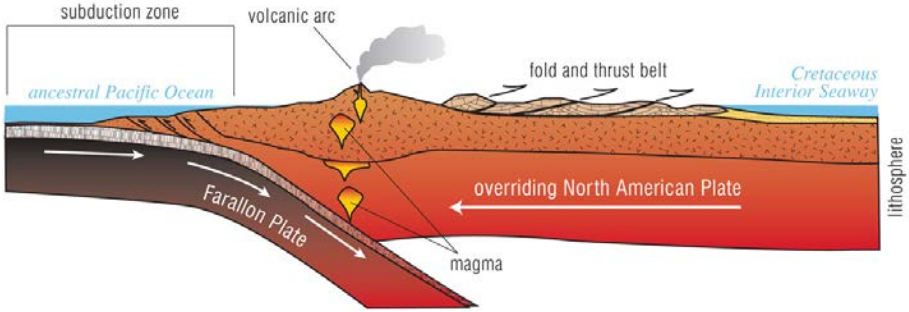
LATE MESOZOIC

(150-65 MA)

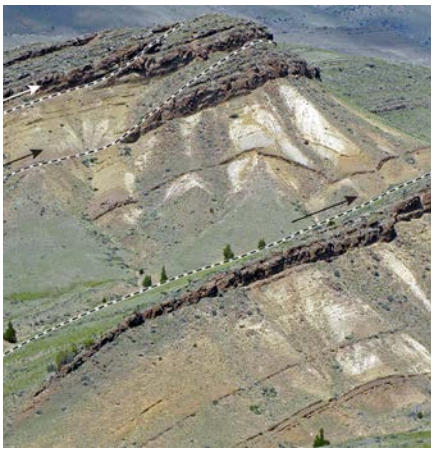
SEVIER OROGENY

Starting around 150 Ma, collision of the Farallon and North American Plates folded and shoved or thrusted rocks above the basement over 90 miles (145 km) eastward. This thin-skinned deformation is called the Sevier orogeny, and the weight of the stacked rock caused the crust to subside and form an interior seaway that connected the Arctic Ocean with the Gulf of Mexico. Alternating stream and estuarine deposits of the Kootenai Formation record sea-level fluctuations from the crustal loading. Dinosaurs roamed the coastal plain, while reptiles and ammonites ruled the seaway.

About 72 Ma, magma feeding the volcanoes crystallized into large bodies of granitic rocks that are now exposed in the Pioneer Mountains and at McCartney Mountain. Fluids from the magmas interacted with the intruded rocks, depositing gold, silver, copper and other economic minerals.



Cross section showing the elements of the Sevier orogeny. — *Fritz and Thomas, 2011*

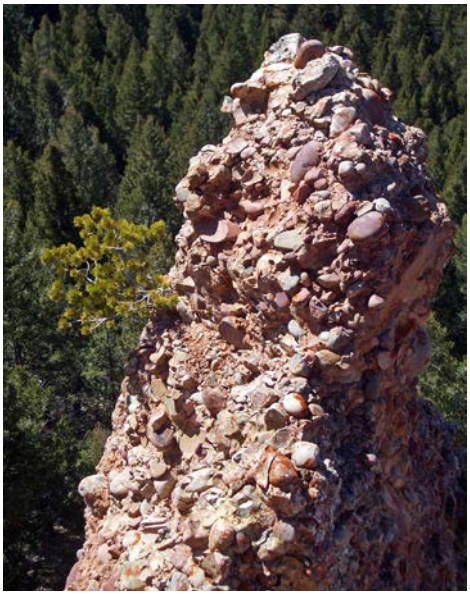


Rocks stacked by Sevier thrusting.

The interior seaway. – *Ron Blakey*

MESOZOIC-CENOZOIC

(70-53 MA)



BEAVERHEAD CONGLOMERATE

In places, it consists of alluvial fan and braided stream deposits that were shed off the mountains formed by the Sevier orogeny. As the thrust slabs were pushed eastward, the cobbles were sometimes crushed and flattened from the weight of the slabs. The K/T boundary, which marks the extinction of dinosaurs and many other animals and plants may occur in this formation, but has yet to be located.

LARAMIDE OROGENY

As the Mesozoic Era was coming to an end, the angle of subduction of the Farallon Plate decreased, causing high-angle faulting and uplift of metamorphic and igneous rocks of the basement. The thick-skinned deformation is called the Laramide orogeny, and in places the basement rose 20,000 feet (6100 m). The overlying sedimentary rocks were folded over the rising basement, which was exposed by erosion for the first time since buried by the Cambrian transgression.

The Sevier and Laramide styles of deformation overlap in time and space in the Dillon area, but in general the Sevier structures are older and found to the west, while the Laramide are younger and found to the east. Basement metamorphic rocks in the Ruby, Tobacco Root, Blacktail, Sweetwater, Greenhorn and Gravely ranges were first exposed by Laramide uplifting, but the mountains where they are exposed today are younger features formed by crustal extension and uplift in the Neogene.

Metamorphic basement rocks exposed in the Tobacco Root Mountains.

EARLY PALEOGENE

(53-40 MA)

DILLON VOLCANICS

The Farallon Plate continued to collide with the North America continent well into the early Cenozoic, but the angle of subduction steepened with time. The Dillon volcanics, a member of the Renova Formation (53 to 20 Ma), initially erupted as andesite and rhyolite from explosive volcanoes similar to Mt. St. Helens. Over time, the sagging Farallon Plate sank into the mantle, which changed the chemistry into less explosive basalt. You can no longer see volcanoes because they were eroded away. However, lava, ash and mudflows were deposited in stream valleys and are preserved. Later extension inverted many of the old stream valleys because the volcanic rock resists erosion. What was once the topographic low is now the high point, like Block Mountain north of Dillon.

Mudflows or lahars carried and buried abundant plant material, turning it into petrified wood from the volcanic silica. Cavities filled with quartz form geodes, which are easily found in these rocks. Patches of brick-red dirt in the area are remnants of laterite soils that formed in the tropical climate of the time.

Dillon Volcanics near Pipe Organ

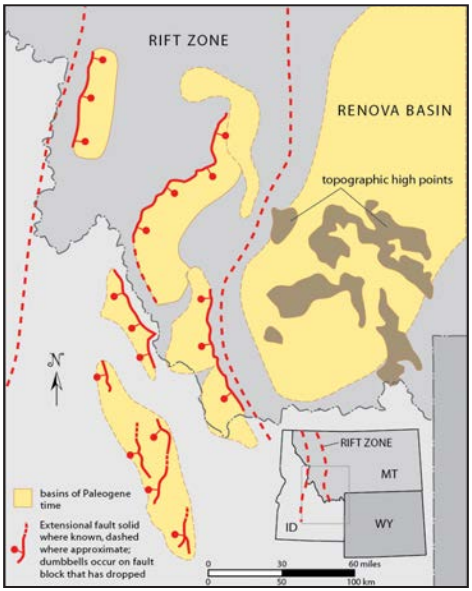
Columnar jointing in basaltic andesite of the Dillon volcanics exposed near Notch Bottom. The 47 Ma lava flow went down a stream valley, but now forms Block Mountain because hard rock resists erosion. Six-sided joints form during the cooling process, as the lava contracts and forms cracks that grow perpendicular to the surface of the flow.

LATE PALEOGENE

(40-23 MA)

RENOVA FORMATION

Three phases of crustal extension produced the basin and range topography we see today in the Dillon area. The first phase, from 48 to 20 Ma, was characterized by a zone of extension (rift zone) to the west and a tranquil basin (Renova Basin) to the east of Dillon. Extension happened because the Farallon subduction zone moved westward as crustal pieces were added to North America. Like a bulldozer backing off of a pile of dirt, the thickened crust of the Sevier orogeny simply collapsed as the subduction zone moved westward with each piece of crust that would not subduct. The Renova Basin did not extend at this time, probably because of the stable, high-angle Laramide structures in that area.



RENOVA BASIN – Fritz and Thomas, 2011.

Within the non-marine deposits of the Renova Formation are some of the best mammal fossils of this time period in the world. Fossils of an extinct, cud-chewing animal called an oreodont are common in the Renova Formation in the Dillon area (see skull at left).

The flying insect at right is preserved in fine-grained siltstone of the Renova Formation. The lake sediments were deposited in the Renova Basin during the Oligocene Epoch (~25 Ma). This specimen was collected from the Becker Quarry in the upper Ruby Valley, a world-class site for fossil insects and plants.

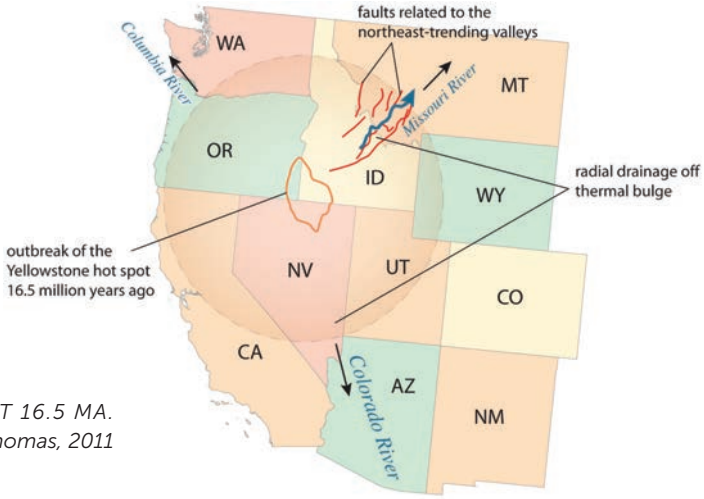
EARLY NEOGENE

(23-5.0 MA)

SIXMILE CREEK FORMATION

The second phase of extension occurred between 16.5 and 5.0 Ma. Emergence of the Yellowstone hot spot in the three corners region around 16.5 Ma caused the crust to thermally expand and stretch. The hard rock broke into blocks that went up relative to those that went down and created northeast-trending basins and ranges in the Dillon area. The ancestral Missouri River followed the basins to the northeast, depositing gravel (river rock) and ash from hot spot eruptions. At Timber Hill on the Sweetwater Road, there is even a 6.0 Ma basaltic lava flow (now several plateaus) that flowed down the old Missouri River from a vent in eastern Idaho.

Many of the deposits are found in northwest-trending mountains that uplifted in the path of the streams around 4.4 Ma. The Beaverhead and Jefferson Rivers still follow the old pathway, but the Red Rock, Blacktail and Ruby drainages follow younger, northwest-trending pathways formed with the new valleys around 4.4 Ma.



HOT SPOT BULGE AT 16.5 MA.
— Fritz and Thomas, 2011

This thick ash deposit known as the Sixmile Creek Formation occurs at Timber Hill east of Dillon. It was rapidly deposited from a thick flow of water and ash that traveled down the Missouri River drainage from a caldera in Twin Falls, Idaho. It rests on an old soil, showing the flow spilled out of the channel and spread across the floodplain.

LATE NEOGENE

(5.3-2.58 MA)

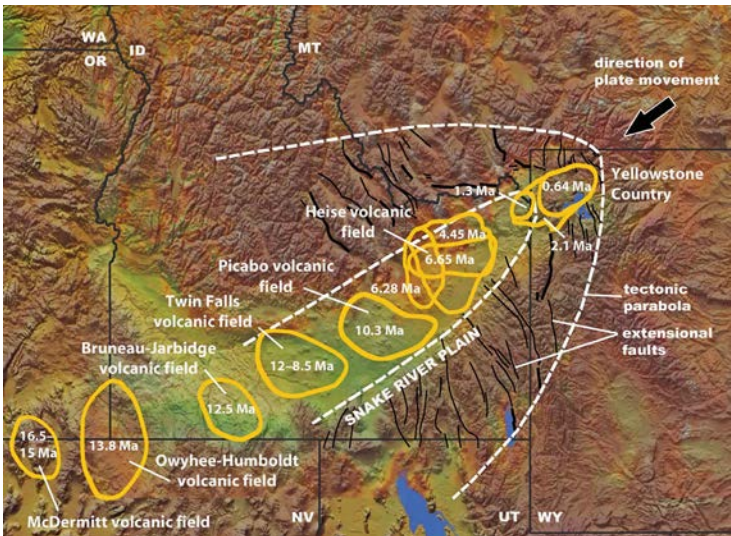
YELLOWSTONE AND THE MODERN LANDSCAPE

Development of the modern landscape started around 4.4 million years ago with the formation of northwest-trending basins and ranges. As the North American Plate moved slowly (~2 cm/year) to the southwest, the hot spot and its thermal bulge got closer to the Dillon area. Sometime after eruption of the Timber Hill basalt (6 Ma) and probably after the Kilgore Tuff (4.4 Ma) in Idaho, the thermal bulge caused the crust to break into northwest-trending basins and ranges. New streams developed and mountains were uplifted in the path of the old northeast-tending drainages. This is why Missouri River gravel and ash occur in the mountains and the Beaverhead River cuts a canyon across the Blacktail Deer Range.

About 4 million years ago, crustal extension uplifted the Blacktail Deer Range into the northeast-flowing Beaverhead River (at left). It was forced to cut through the hard rock making the canyon. The view is looking southwest from Dalys Spur.

HOT SPOT TRACK – Fritz and Thomas, 2011.

EXTENSIONAL TOPOGRAPHY – Google Earth



PLEISTOCENE

(2.58 MA-11,700)

ICE AGES

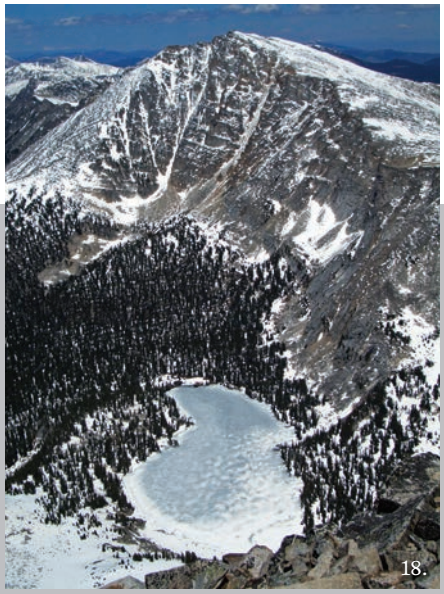
Spectacular lakes, jagged peaks and knife-edged ridges characterize the high country around Dillon. These features formed by glacial ice repeatedly scouring the rocks during the most recent Ice Age. During these times, ice advanced and retreated as orbital variations changed the position of the Earth with respect to the Sun. In the Dillon area, large advances occurred from 160 to 130 thousand years ago (Bull Lake), and from 30 to 12 thousand years ago (Pinedale). The ice was so extensive over the Pioneer Mountains, that it formed a continuous ice cap across the West and East Pioneers, an area of approximately 127 square miles (325 km2)!

The glaciers extended down the mountain valleys, but not into the large river valleys. Where they stopped, they dumped rocks and made dams that formed lakes like Brownes and Deerhead. Water melting from the ice carried large volumes of gravel and sand into the big valleys, making alluvial fans, including the large fans near Argenta and at the mouth of Birch Creek. Red Rock Lakes are remnants of a much larger lake that once filled the entire Centennial Valley.

The above artist's rendition of Pleistocene flora and fauna in North America. Roaming the valleys were Columbian mammoths, dire wolves, saber-toothed cats, horses, camels, bison and humans, who arrived as early as 14,000 years ago. The Dillon valley was much wetter, with lush grasses in the upland areas and cottonwood and birch along the rivers.

— Courtesy of Karen Carr

GLACIAL TOPOGRAPHY IN THE PIONEERS



HOLOCENE

(11,700-PRESENT)

THE FIRST PEOPLE

The earliest evidence for humans in the Dillon area comes from Clovis and Folsom artifacts, some of which may be 13,500 calendar years old. Clovis artifacts are the oldest and in the same sediment layers as mammoth remains. Folsom points are usually younger and associated with bison remains. The Clovis people hunted mammoths and other large mammals using distinctive points flaked from chert, quartzite and obsidian. It is thought that human predation caused the extinction of many large mammals, like the woolly mammoth by the close of the Pleistocene.

In the Horse Prairie, there are quarries in the Renova Formation where chert with fossil snails was excavated since humans arrived in the area. These artifacts are protected by law, so please don't disturb!

Buffalo jumps were used to kill bison. This one near the Notch is at the pointed end of a plunging syncline. The fold axis was used to funnel bison over a sandstone cliff (at the bend in the road in the photo at left), while meat was processed in camps established along the Big Hole River (green area in photo).

CLOVIS POINT – Courtesy Virginia HR

The pictographs are from Dalys Spur south of Dillon. Pictography is writing using drawings. Pictographs are sometimes confused with petroglyphs, which are made by removing part of the rock surface (they are protected by law, so don't disturb!).

METAL MINING

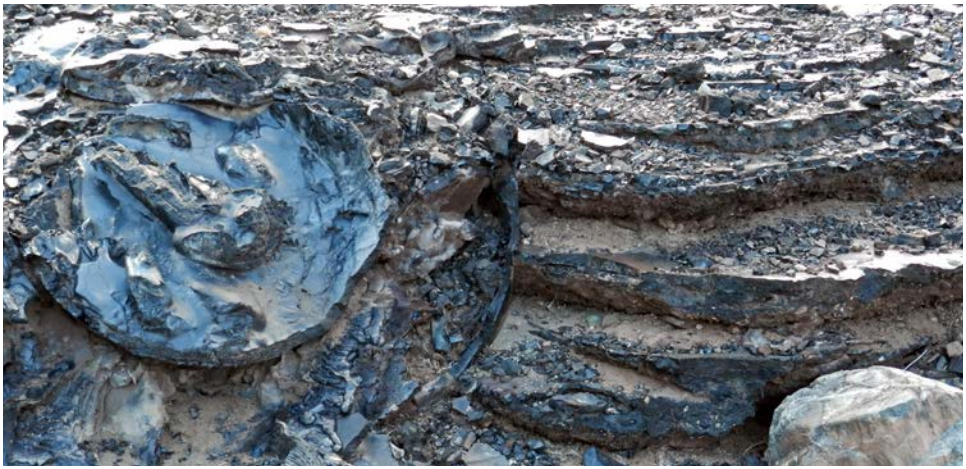
(1860-PRESENT)

MINING THE PAST

Deposits of gold, copper, silver and other economic metals abound in the Dillon area. Most were deposited during Cretaceous and early Paleogene time, when the subduction of the Farallon Plate produced magma that intruded and cooked older rocks. In some cases, heat and fluid from the magma altered rocks in contact with the magma forming economic mineral deposits. In others, fluids concentrated economic minerals in veins in the rocks.

Bannack, located southwest of Dillon was the first major gold discovery in Montana Territory in 1862. At its peak, Bannack had a population of ten thousand and briefly served as the capital of Montana Territory in 1864. Bannack saw both lode and placer (stream) mining. In 1895, the first successful gold dredging operation in the U.S. was launched along Grasshopper Creek. By 1930, mining in the district produced $12 million in gold, with gold priced at about $20 per ounce!

Other mining districts in the area include Argenta, Blue Wing, Elkhorn, Hecla, Polaris, Rochester and Farlin.



Bubbles and layers of slag occur on the bank of Birch Creek in the Farlin Mining district. The slag was molten rock discarded during the smelting process to remove ore. The waste was dumped in the creek to prevent fire in the gulch, producing metal-rich glass from rapid chilling.

HOTEL MEADE IN BANNACK, MT

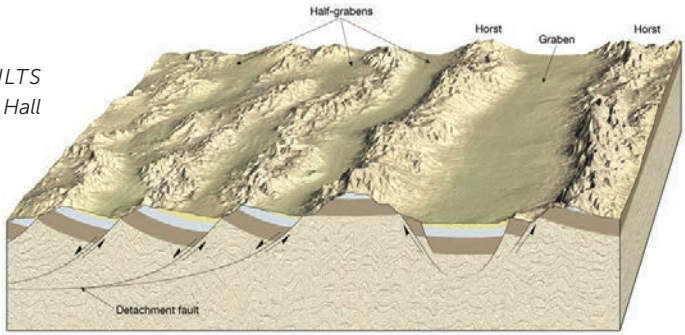
EARTHQUAKES

(1980-PRESENT)

WHOLE LOTTA SHAKIN'

Southwest Montana is within the Intermountain Seismic Belt, a region of frequent earthquakes that extends from the southwestern U.S. to Canada. Earthquakes are waves produced when stored energy is released from rocks. In the intermountain west, divergence is pulling the crust apart, forming basin and range topography. Around Yellowstone, the crust is bulged up from the heat, further extending the crust and causing even more earthquakes. Montana ranks as the 8th most active state, with about 7 to 10 earthquakes each day. Since the 1870s there have been over thirty earthquakes of magnitude 5.0 or greater.

On the evening of August 17, 1959 a 7.5 magnitude quake struck the region around Hebgen Lake, southeast of Dillon. The temblor caused a large landslide forming Quake Lake and buried 19 people camped below the slide. The ground ruptured in several places, leaving fault scarps (see photo).



EXTENSIONAL FAULTS
- Courtesy Prentice Hall

July 25th, 2005 a 5.6 magnitude quake hit 9 miles north of Dillon at Block Mountain. It caused minor damage, mostly to chimneys.

SURFACE PROCESSES

(PRESENT)

SAFETY THIRD

Hang around a bit and you will eventually hear a complaint about people building dream homes in the Dillon area. Unfortunately, the dream may be a nightmare, because the landscape is always changing through surficial processes. Few people recognize that the fan-shaped deposits along the mountain fronts are active streams that flood every decade or two. Few recognize the many slides and unstable slopes, and most of us in the City of Dillon live on a floodplain.

Hummocky topography gives away this landslide on the East Fork of the Blacktail.

In the high country, glaciers sculpted the landscape into steep-walled valleys that now shed rocks through the freezing and thawing of water that settles in the cracks. Listen carefully on a spring hike and you will likely hear rocks tumbling downhill as the snow thaws and releases its prey. The rocks commonly collect in cone-shaped piles of talus. The talus cone to the right is north of Browns Lake in the Pioneers.

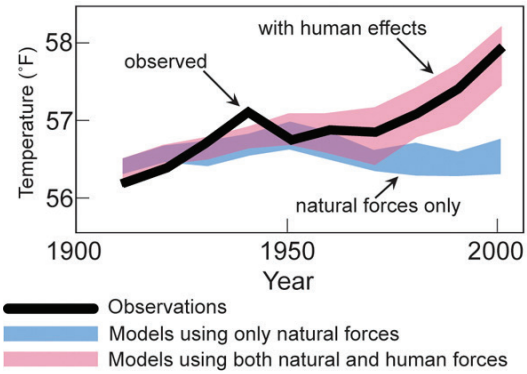
Curious features that can be seen in the high country around Dillon are sorted circles. The patterned ground forms when water freezes, expands and sorts large particles away from the smaller ones. The fine-grained sediment patches make it possible for grasses to get a foothold among the boulders. These circles are on the trail to Baldy Mountain in the Pioneers.

ANTHROPOCENE

(WHAT'S NEXT?)

CLIMATE CHANGE

Our future is about climate change. Whether it's ranching, recreation or housing development, we need water in the Dillon area. Climate change is caused by variations in the Earth-Sun distance and the quantity and quality of heat-trapping gases in the atmosphere. These cycles caused the glacial-interglacial periods of the Pleistocene, as well as a cold period from 1350 to 1850 called the Little Ice Age. They are still impacting the climate today, and the data show that we should be cooling. The fact that we are not is clear evidence of human influence on the climate. Burning fossil fuels is releasing millions of years of stored heat-trapping gases into the atmosphere faster than natural processes can absorb them. As a result, average global temperatures are expected to increase as much as 11.5° F by 2100.



Since 2006, Environmental Sciences students at the University of Montana Western have been assessing habitat restoration for fluvial Arctic grayling in the upper Big Hole River. Although habitat has greatly improved, grayling can't live in water that exceeds 77°F. Is it possible that despite our best efforts, atmospheric warming will result in their demise?

GLOSSARY

Anticline
Layered rock folded into an arch (convex).

Asthenosphere
Weak zone of upper mantle that allows the lithosphere to move.

Basement
Crystalline rock underlying sedimentary rock of Precambrian age.

Dike
A thin intrusion of igneous rock that cuts across rock layers at an angle.

Fault
A fracture in rock along which significant movement occurred.

Hot spot
Stationary volcanic center that persists for tens of millions of years.

Intrusion
Igneous rock that was injected as magma into older rock.

Lava
Magma that flows out of a volcano onto the surface of the Earth.

Lithosphere
Rigid zone of upper mantle and crust that makes up tectonic plates.

Plate Tectonics
Theory that Earth's lithosphere is fragmented and moves.

Magma
Liquid rock below the surface of the Earth.

Orogeny
A period of intense tectonic activity characterized mountain building.

Syncline
Layered rock folded into a valley or bowl (concave).

Unconformity
A contact between rock where no record of time is preserved.

ADDITIONAL READING

Fritz W.J. and Thomas R.C., 2011, Roadside Geology of Yellowstone Country: Mountain Press, Missoula, MT, 328 p.

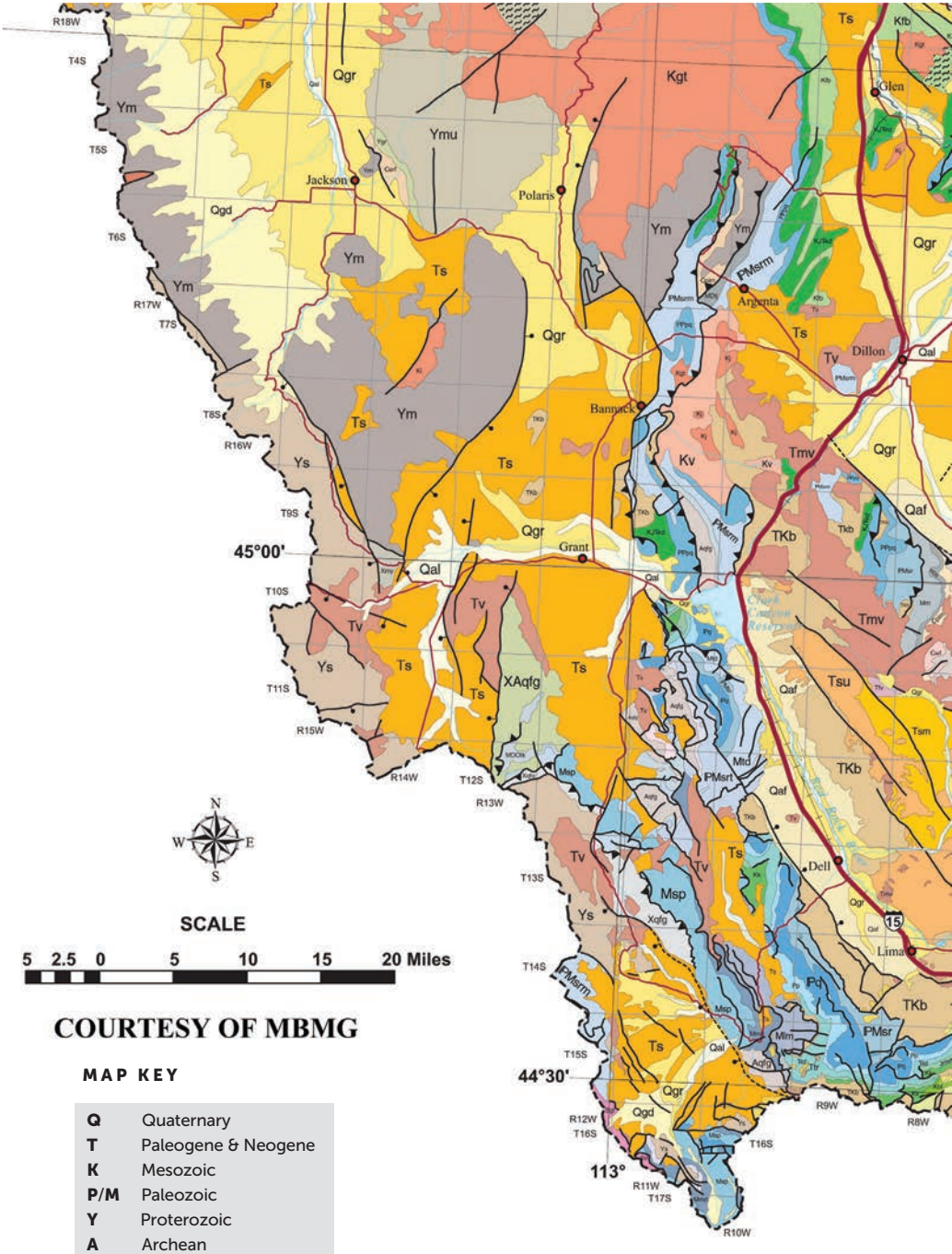
Hyndman, D.W., and Thomas, R.C., (in press), Roadside Geology of Montana: Mountain Press, Missoula, MT

Lonn J., and others, 2000, Geologic Map of the Lima 30'x60' quadrangle, sw Montana: MBMG Open File Report 408.

Ruppel E., O'Neill M., Lopez D., 1993, Geologic Map of the Dillon 10x20 quadrangle, ID and MT: USGS Map I-1803-H.

Thomas R.C., and Gibson R.I., 2007, Introduction to the geology of the Dillon area: Northwest Geology, Vol. 36, 272p.

MAP OF DILLON AREA



COURTESY OF MBMG

MAP KEY

Q	Quaternary
T	Paleogene & Neogene
K	Mesozoic
P/M	Paleozoic
Y	Proterozoic
A	Archean
Black Lines -	Faults

GEOLOGIC MAP OF THE DILLON AREA

GEOLOGIC HISTORY
OF THE DILLON, MONTANA AREA

For many years, the Dillon area has been a hub for geological education. From the summer field camps to students at the University of Montana Western, the area serves as one of the best geologic labs on Earth.

Local citizens must wonder what those "geos" find so interesting. Well, here it is, the geologic story of the Dillon area. Written for the layperson, but with enough detail to be of value to students. Use this book to help discover Earth's history in your own backyard!

Contributors

Geoscience students in the Environmental Sciences Department at the University of Montana Western helped research and produce this booklet under the direction of Dr. Robert C. Thomas in the spring of 2013.

Student research team included: Brittany Allen, Nick Bolduc, Misha Craddock, Cody Creger, Kerstin Feldhaus, Kristine Heinen, Seth Joramo, Kassie Kidrick, Phil Ley, Tyler Linse, Connor McHugh, Lacey Morrison and Elias Williams.

Find Out More

For more information about UMW and our unique approach to learning and teaching, Experience One, call 800-683-7331 or visit us on the web at *w.umwestern.edu.*

ENVIRONMENTAL SCIENCES DEPARTMENT
The University of Montana Western
710 S. Atlantic St., Dillon, Mont. 59725

UMWenvirosciences

This publication was made possible with the support of the University of Montana Western Foundation and the Montana Western Communications department