Proactive Prospect Advancement:

Discovery, Permitting, Community Outreach, and Pilot Drilling of the Clementine Prospect- Northern Pioneer Mountains of Southwest Montana.

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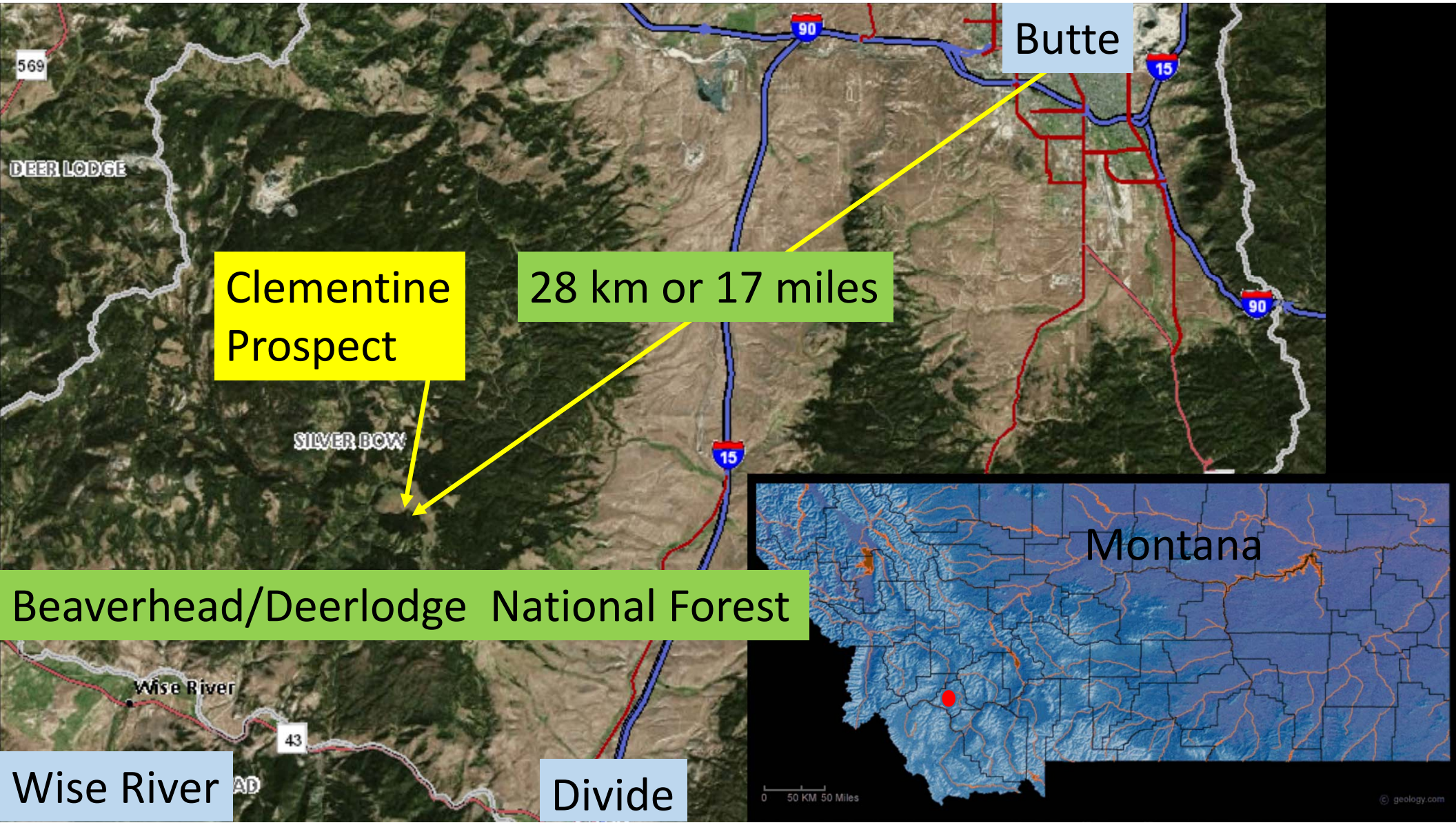

Butte
Clementine Prospect
28 km or 17 miles
Beaverhead/Deerlodge National Forest
Wise River
Divide
Montana
DEER LODGE
SILVER BOW
Wise River
569
90
15
43
0 50 KM 50 Miles

(1)Discovery *Process*

Exploration strategy- deserving of a social license

New regional tectonic **ore-forming model** constrained by-

Overlay of **regional environmental sensitivity**

Limiting **target selection** to **under-explored** prospective areas **outside of** and well **away from** proposed special land use areas of proposed **wilderness**, **recreation**, or **protection**

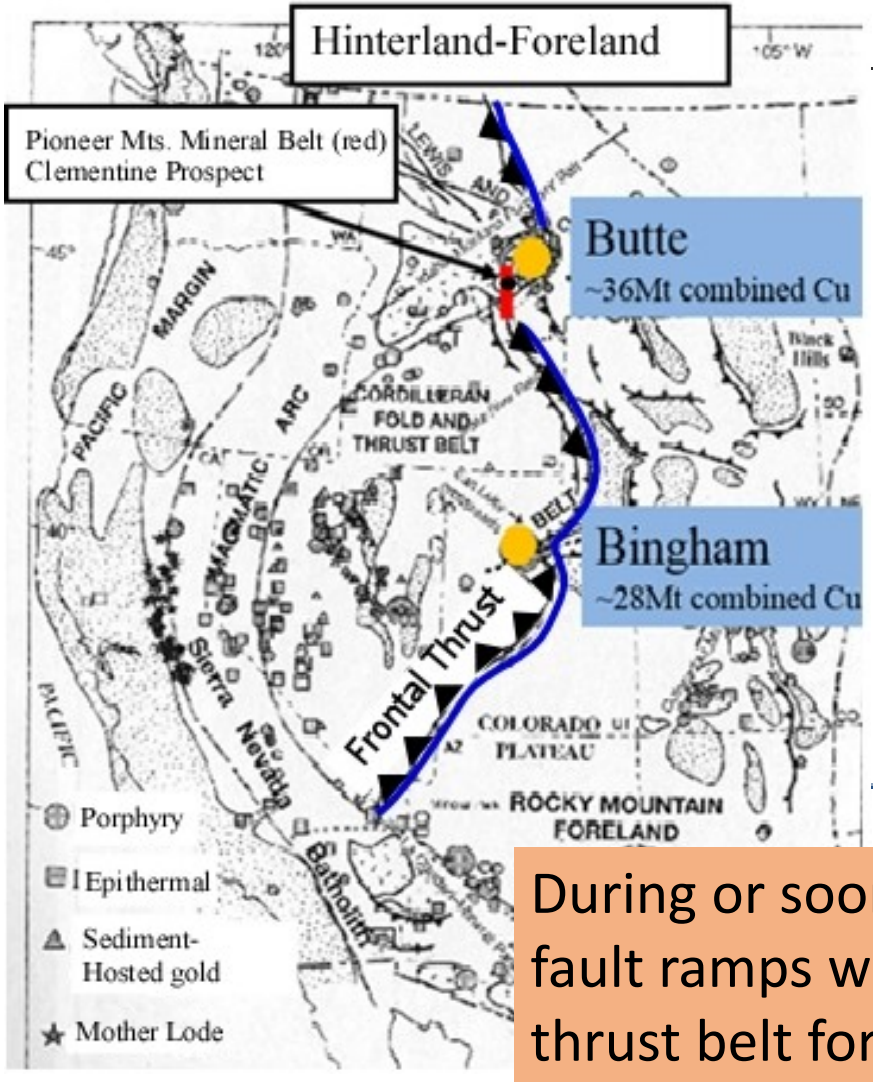
Technical strategy: Use **state of the art, real-time, field** methods

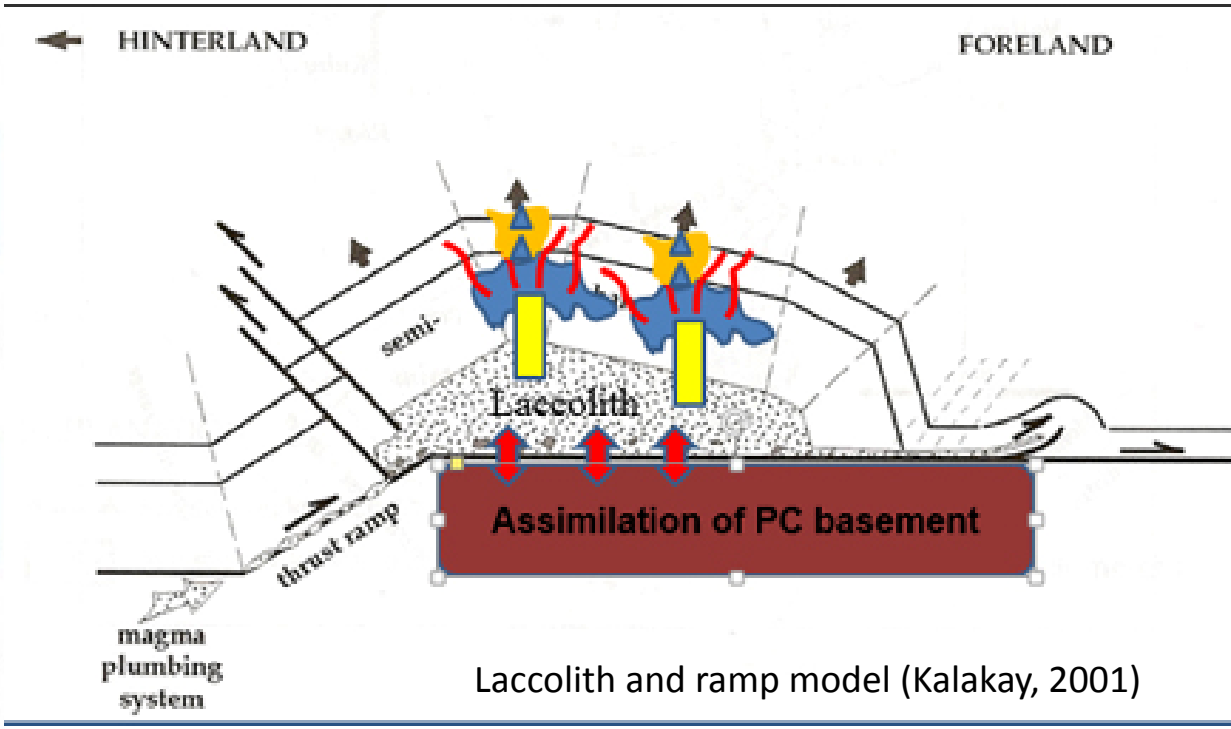
GPS supported **mapping**- ***not*** just **point data capture**

The **evolving map pattern** guides the geologist **in the field**

Supporting previously impossible field work in remote forests

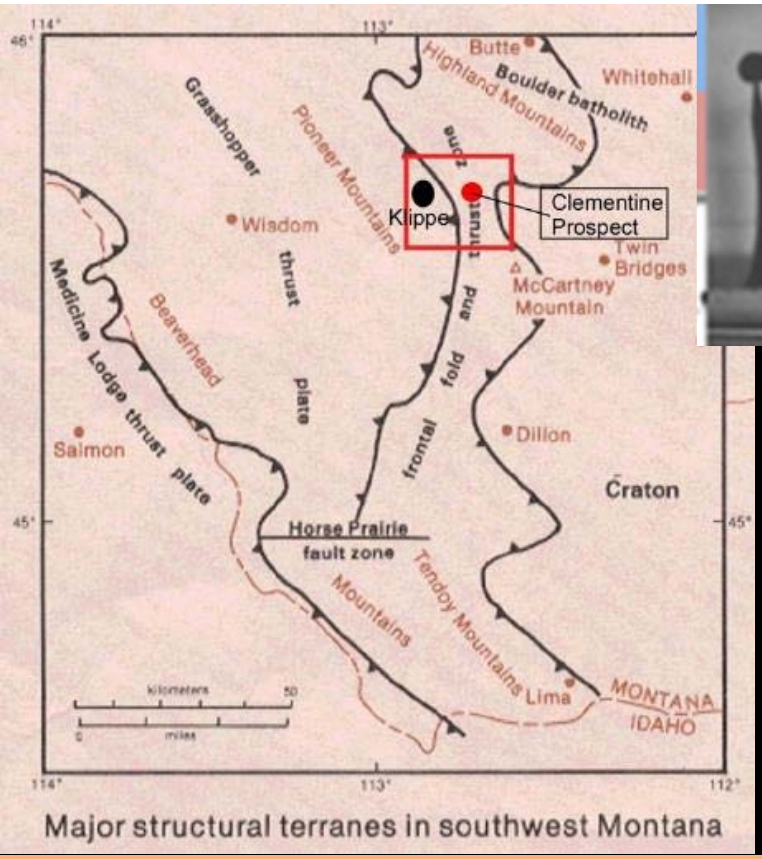
Regional Ore-Forming Model

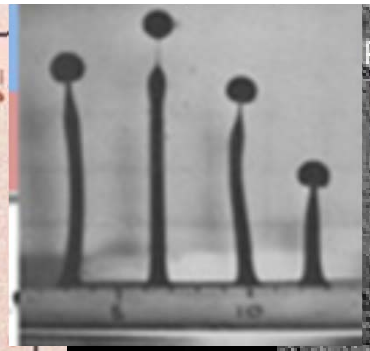




Laccolith and ramp model (Kalakay, 2001)

During or soon after thrusting, igneous plutons ascended fault ramps within the anticlinal hinge of the frontal fold and thrust belt forming a regional anticlinorium



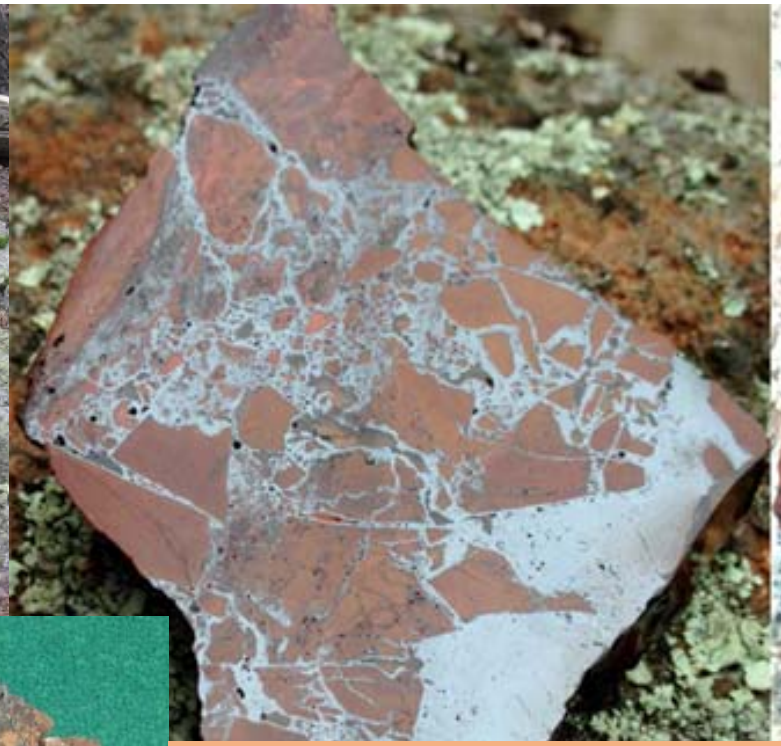


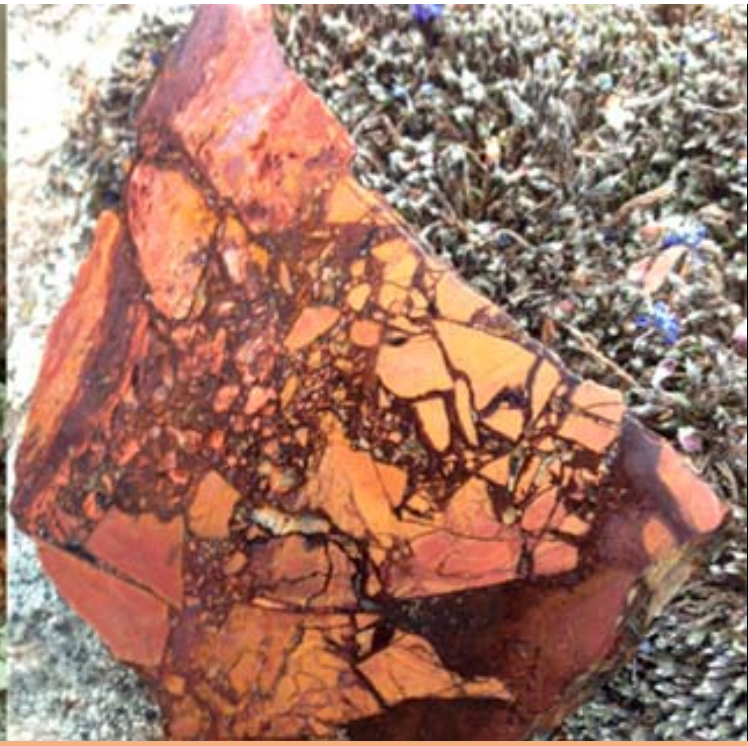
Syntectonic frontal thrust fault-bend anticlinal mineral belt exposed in a nappe window into the Lewis Over-Thrust (Brimhall and Marsh, 2014)

Rayleigh-Taylor instabilities manifest as a linear north-south belt of mines spaced about 7 km from each other

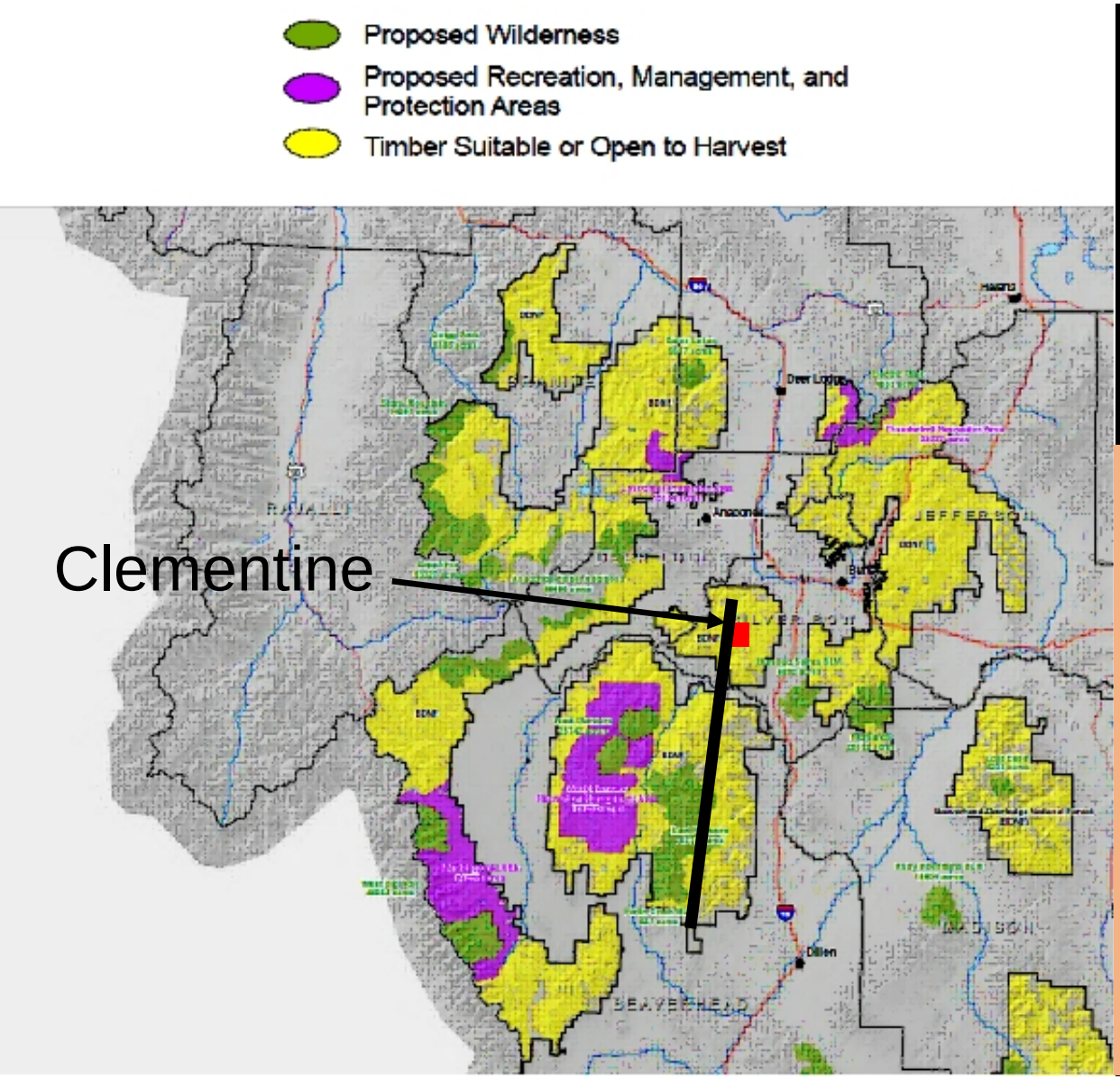

Mapping contacts requires finding definitive rocks even where exposure is poor by using tree root heave mounds


GPS
Pen Tablet- real-time Digital geological mapping

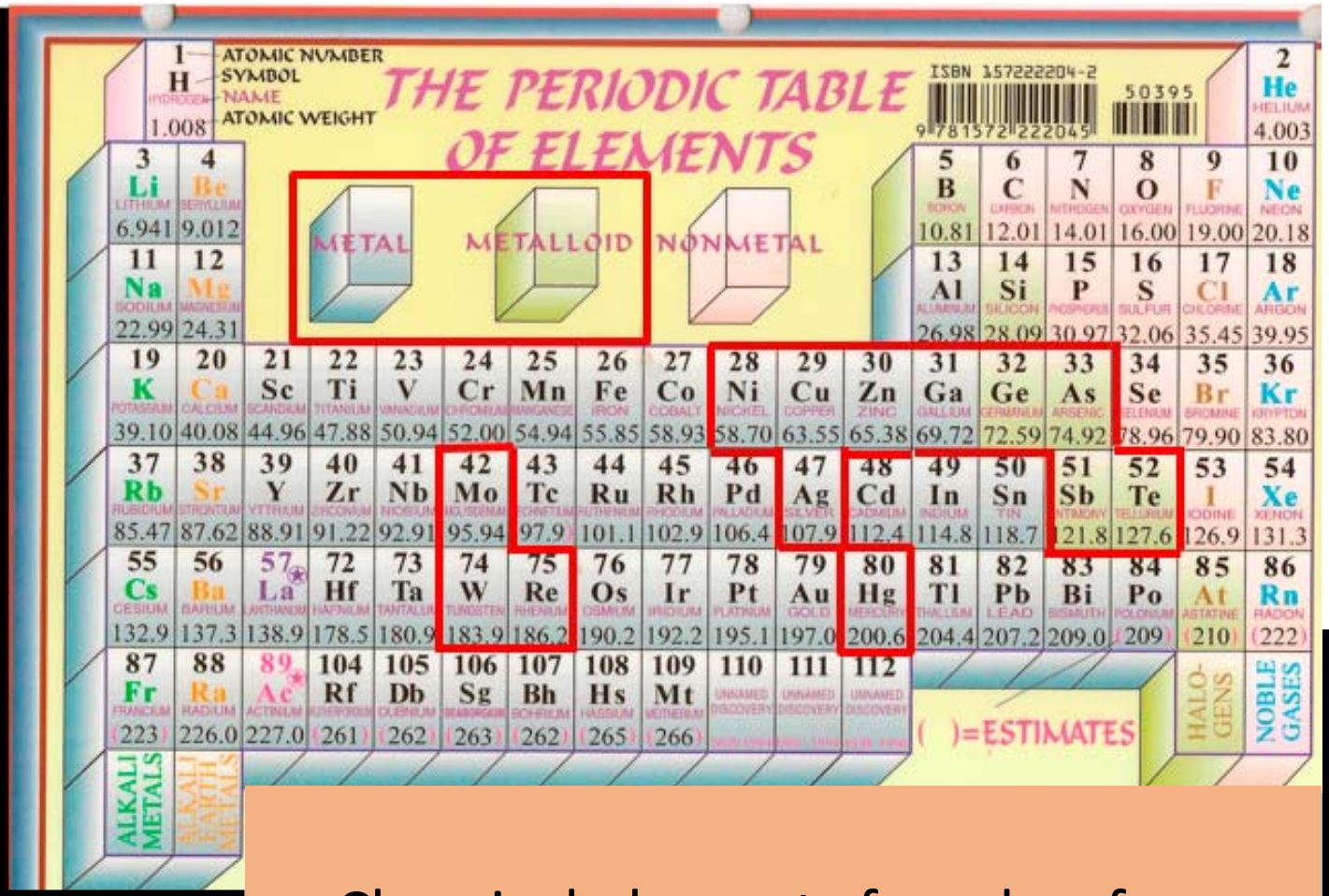




Through mapping prospective corridors along at the **apical anticlinal hinge** of our model, we discovered a mineralized breccia vein system where ascending hydrothermal fluids would ascend and be trapped.



We interpret the vein breccias as the possible top of an intact cordilleran Cu, W, rare metal (metalloid) system likely only amenable to 21st Century underground mining minimizing surficial disturbance.



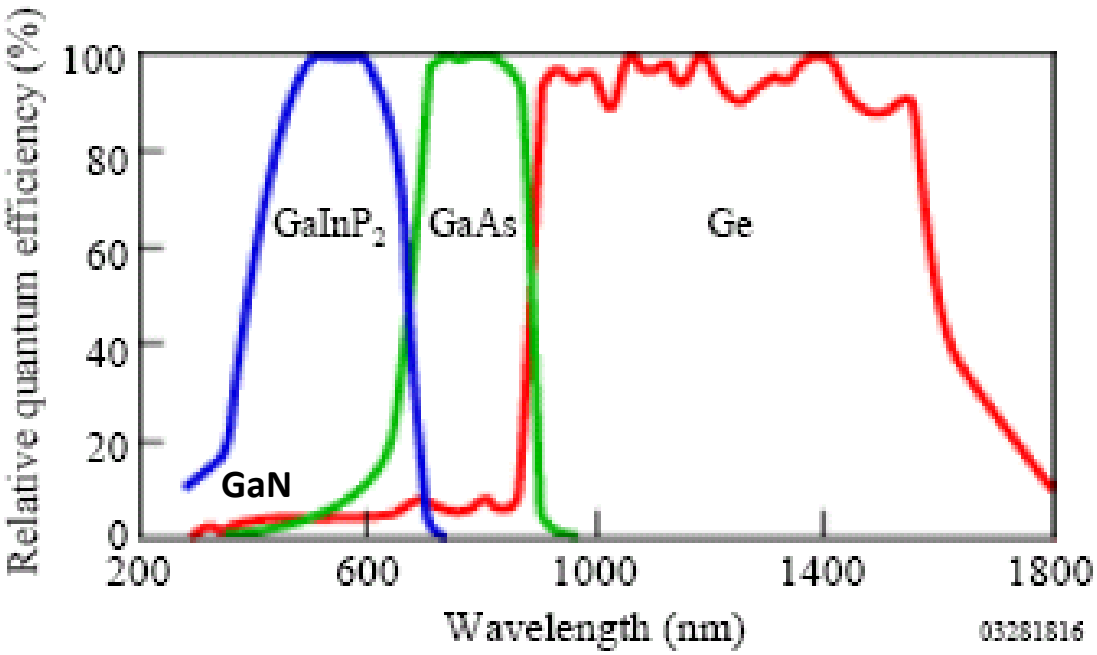
Chemical elements found so far

Clementine Exploration ®

Applications of **GaN**

- Wireless power
- LiDAR
- Self-driving cars
- Non-invasive X-ray “Pills”
- Robotic power w/o wires
- Imagery

Multi-junction solar cells



GaP, GaAs, GaSb, and InSb

High Electron Mobility Transitors (HEMT)

Heterojunction BiPolar Transitors (HBT)

(2) Permitting Process

Being situated within the Deerlodge-Beaverhead National Forest, required us securing an **operating permit** from USFS- then …

Exploration permit DEQ based on the USFS **Plan of Operation**

Posted **environmental restoration bond** satisfying the USFS conditions

We **welcomed scientific input** from **all** specialists- Essential in designing a plan of operations wrt to: **spring** access for grazing cattle and sub-alpine **white bark pine** trees (threatened by pine beetle) **organic poor Inceptisols**

Acknowledgements

MT Tech	Susie Anderson	Organizing this conference
USFS		
	Licette Hammer-	Geology and environmental specialist
	Jessie Salix-	Botanist
	Kevin Weinner-	Hydrologist
	Ryan Powell-	Archeologist
	Dorothy Wallace-Senft	Botanist
	Sam Larkin	Botanist
DEQ		
	Bob Cronholm	Manager Exploration License Section
	Amanda Miller	Environmental Specialists
	Ann Sam	Environmental Specialists

(3) Community Outreach

Community outreach is approached through free open education sponsored by the Wise River Community Foundation

HOME ABOUT ADVENTURES IN READING MAR 28

28 Professional development credits free

EarthBook Montana©

Discovering the Geological World through Community Engagement in Earth Science Learning

URL: www.earthresourcesmt.org

2017 Schedule

Our Program has four all-day Saturday events each summer with narrated slide shows by Brimhall followed by discussion

Historical photo essays by Alta Miller

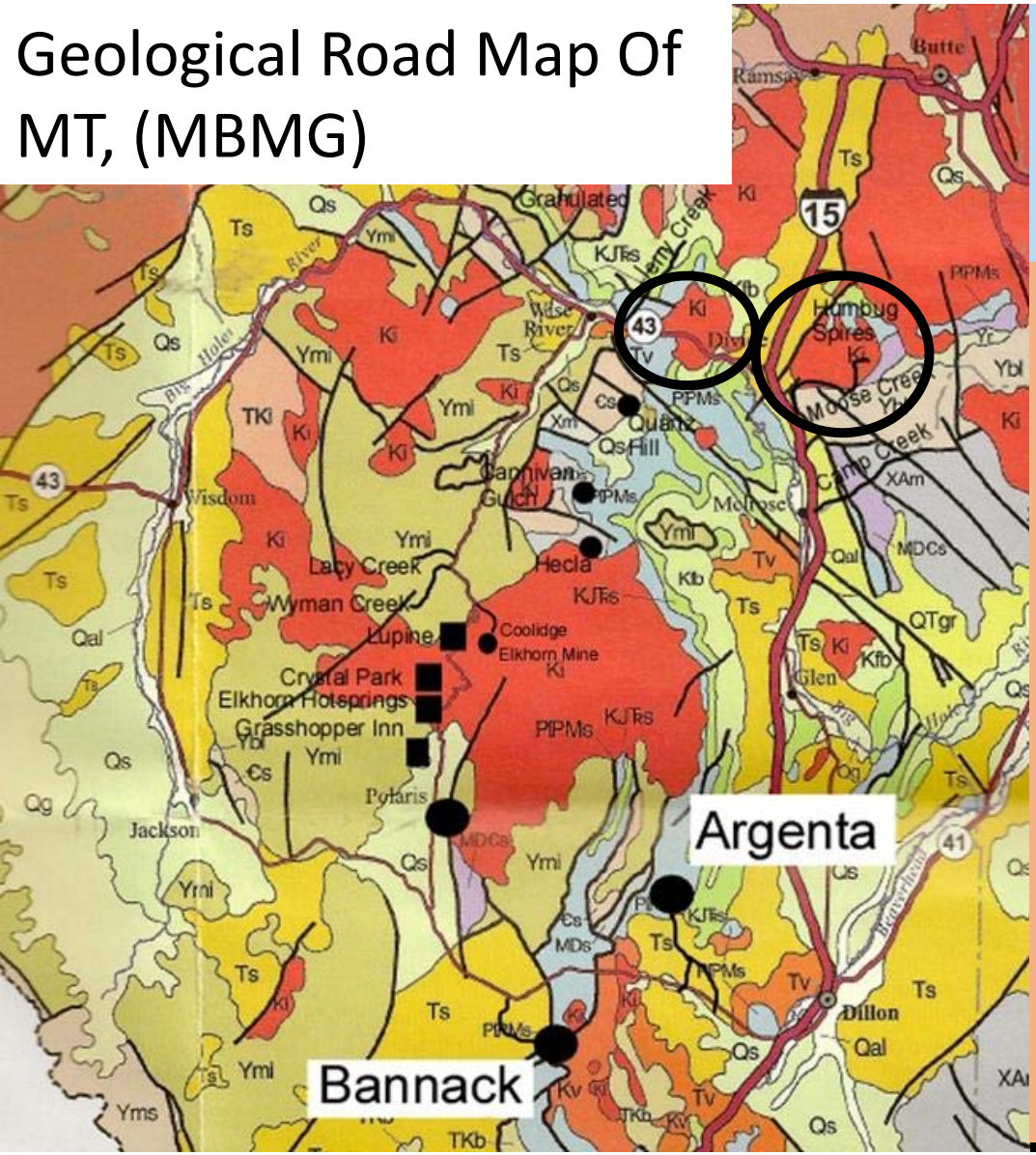
Afternoon field trips

Going far beyond “transparency” to communicate exploration activities within a multi-year program of organized lectures and field trips designed around a **Questionnaire** seeking input on geological topics of greatest interest to ***local residents***

Sufficient geology for attendees to ***understand*** exploration in a scientific, historical, economic, environmental, and social **context**.

Focused on **geological reality,** what broad **knowledge of science is** essential to fulfilling our charter as a country of informed citizens

Geological Road Map Of MT, (MBMG)

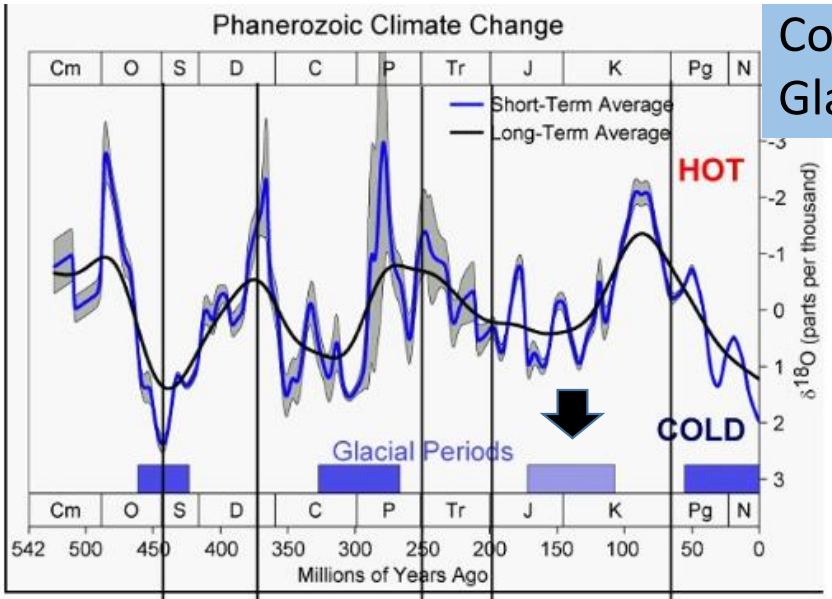


Making geology come alive as a ***personal*** **experience** being able to actually **read** geological maps

Topics:

Age of the Earth and nearby rocks
Geological hazards- rock falls
Failure of Pattengail Dam & flood
Places of interest- Humbug Spires
Global warming evidence & impact
Butte ore deposit
How exploration works?
Yellowstone hot spot
Glacier Park Chief Mountain thrust

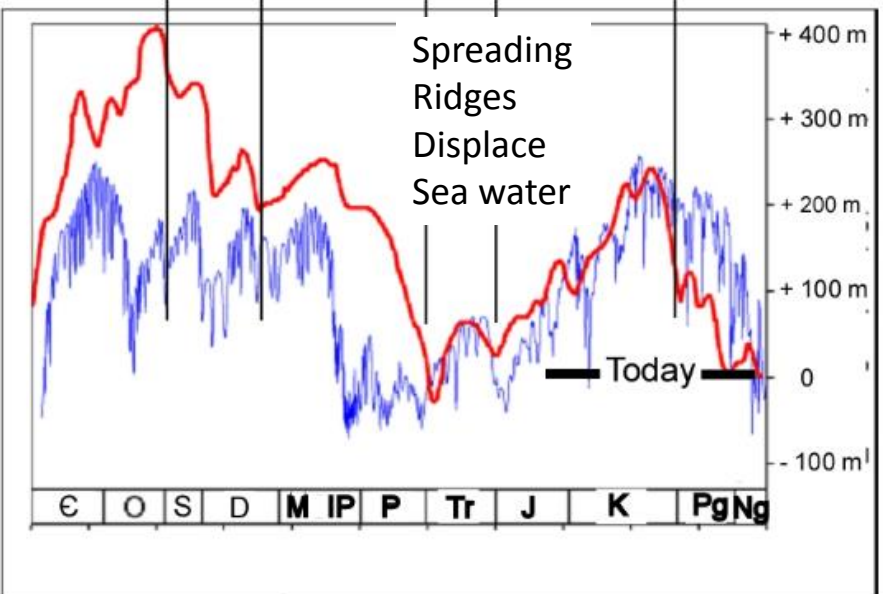
Aalta Miller's Historical Photo essays



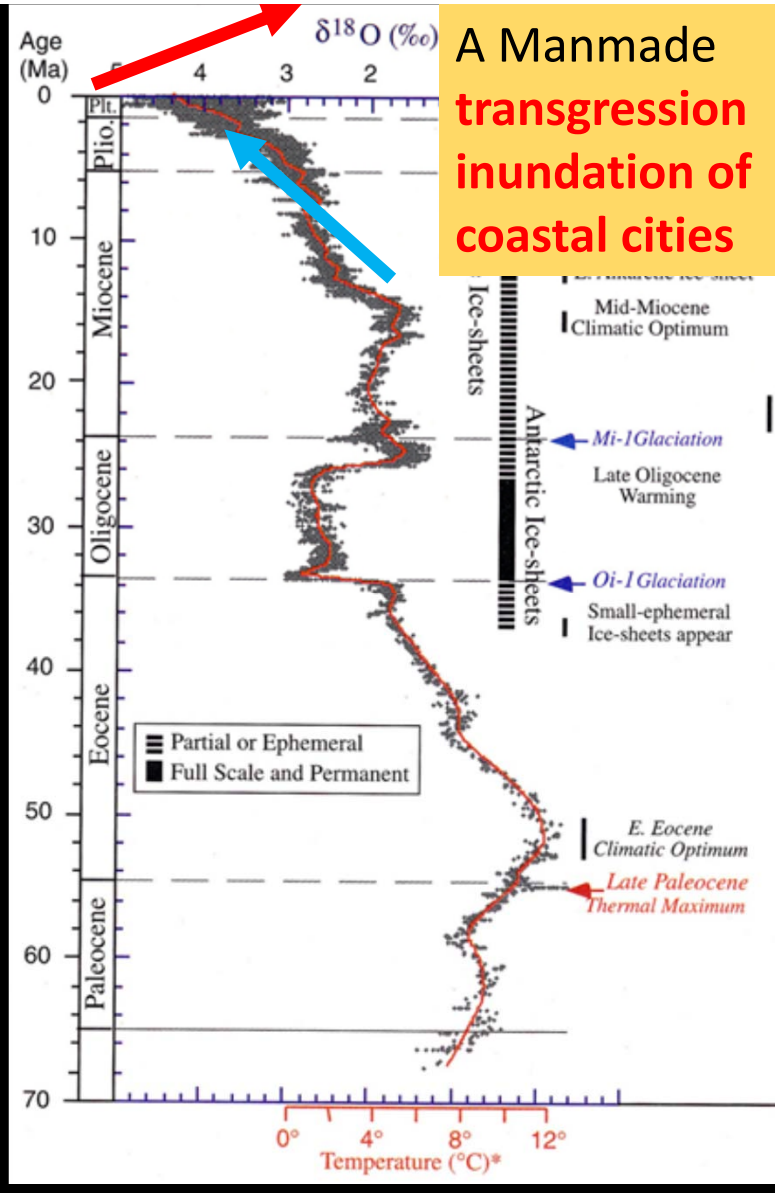
Cooling causes
Glacial deposits

Temperature

Pangea
Breakup
Massive
Sea floor
volcanism



Ice Cap
Formation
Lowers sea
Level

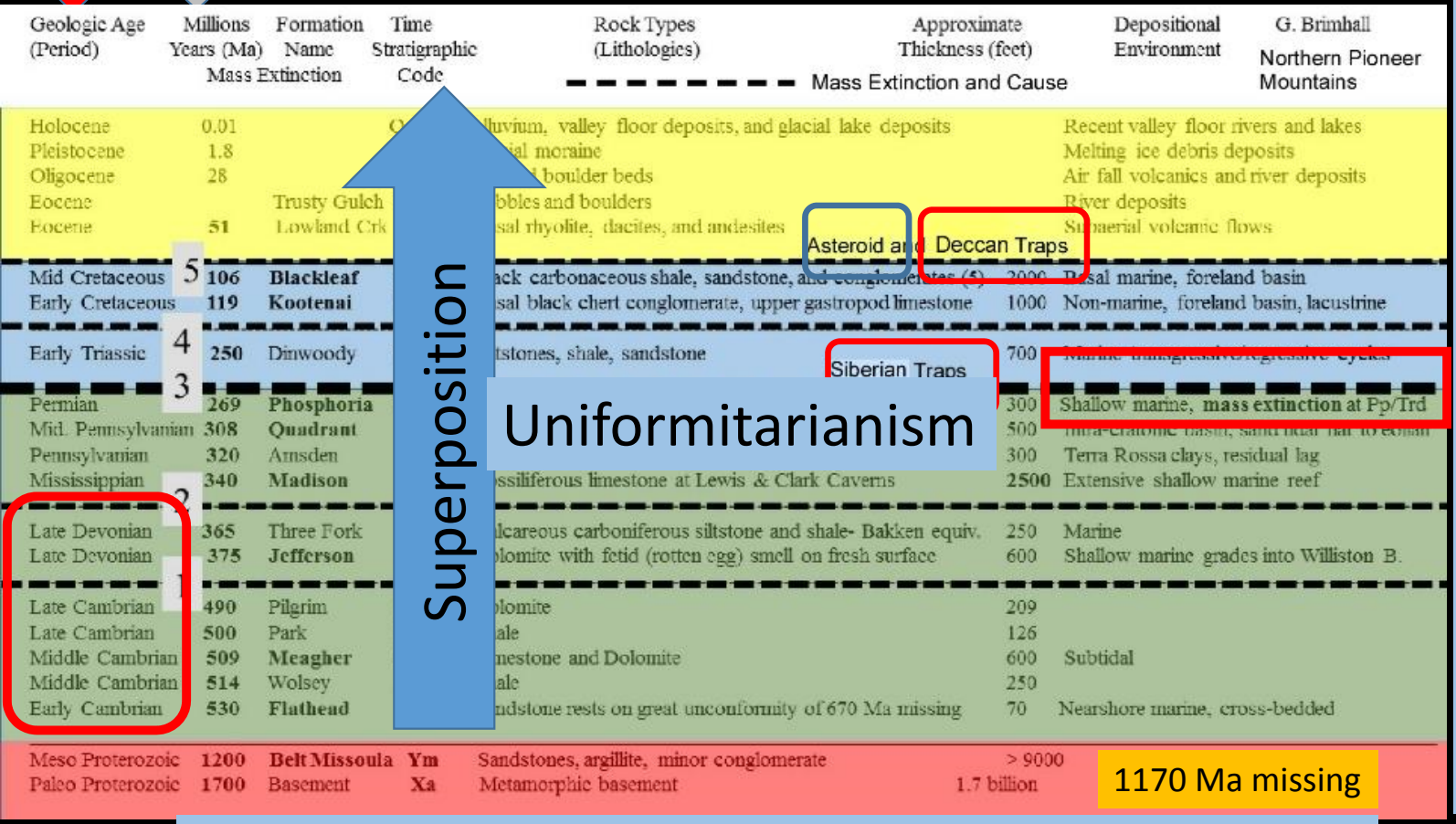


A Manmade
transgression
inundation of
coastal cities

Time

Extinctions

Local Geological Column- **Then Explain WHY it exists**



Geologic Age (Period)	Millions Years (Ma)	Formation Name	Time Stratigraphic Code	Rock Types (Lithologies)	Approximate Thickness (feet)	Depositional Environment
Mass Extinction and Cause						
Holocene	0.01		Q	luvium, valley floor deposits, and glacial lake deposits		Recent valley floor rivers and lakes
Pleistocene	1.8			al moraine		Melting ice debris deposits
Oligocene	28			boulder beds		Air fall volcanics and river deposits
Eocene		Trusty Gulch		bbles and boulders		River deposits
Eocene	51	Lowland Crk		sal rhyolite, dacites, and andesites		Subaerial volcanic flows
Asteroid and Deccan Traps						
Mid Cretaceous	106	Blackleaf		ack carbonaceous shale, sandstone, and conglomerates (5)	2000	Basal marine, foreland basin
Early Cretaceous	119	Kootenai		sal black chert conglomerate, upper gastropod limestone	1000	Non-marine, foreland basin, lacustrine
Early Triassic	250	Dinwoody		tstones, shale, sandstone	700	
Siberian Traps						
Permian	269	Phosphoria			300	Shallow marine, mass extinction at Pp/Trd
Mid. Pennsylvanian	308	Quadrant			500	
Pennsylvanian	320	Amsden			300	Terra Rossa clays, residual lag
Mississippian	340	Madison		ssiliferous limestone at Lewis & Clark Caverns	2500	Extensive shallow marine reef
Late Devonian	365	Three Fork		lcareous carboniferous siltstone and shale- Bakken equiv.	250	Marine
Late Devonian	375	Jefferson		lomite with fetid (rotten egg) smell on fresh surface	600	Shallow marine grades into Williston B.
Late Cambrian	490	Pilgrim		lomite	209	
Late Cambrian	500	Park		ale	126	
Middle Cambrian	509	Meagher		nestone and Dolomite	600	Subtidal
Middle Cambrian	514	Wolsey		ale	250	
Early Cambrian	530	Flathead		ndstone rests on great unconformity of 670 Ma missing	70	Nearshore marine, cross-bedded
Meso Proterozoic	1200	Belt Missoula	Ym	Sandstones, argillite, minor conglomerate	> 9000	
Paleo Proterozoic	1700	Basement	Xa	Metamorphic basement	1.7 billion	

5 4 3 2 1

Superposition

Uniformitarianism

1170 Ma missing

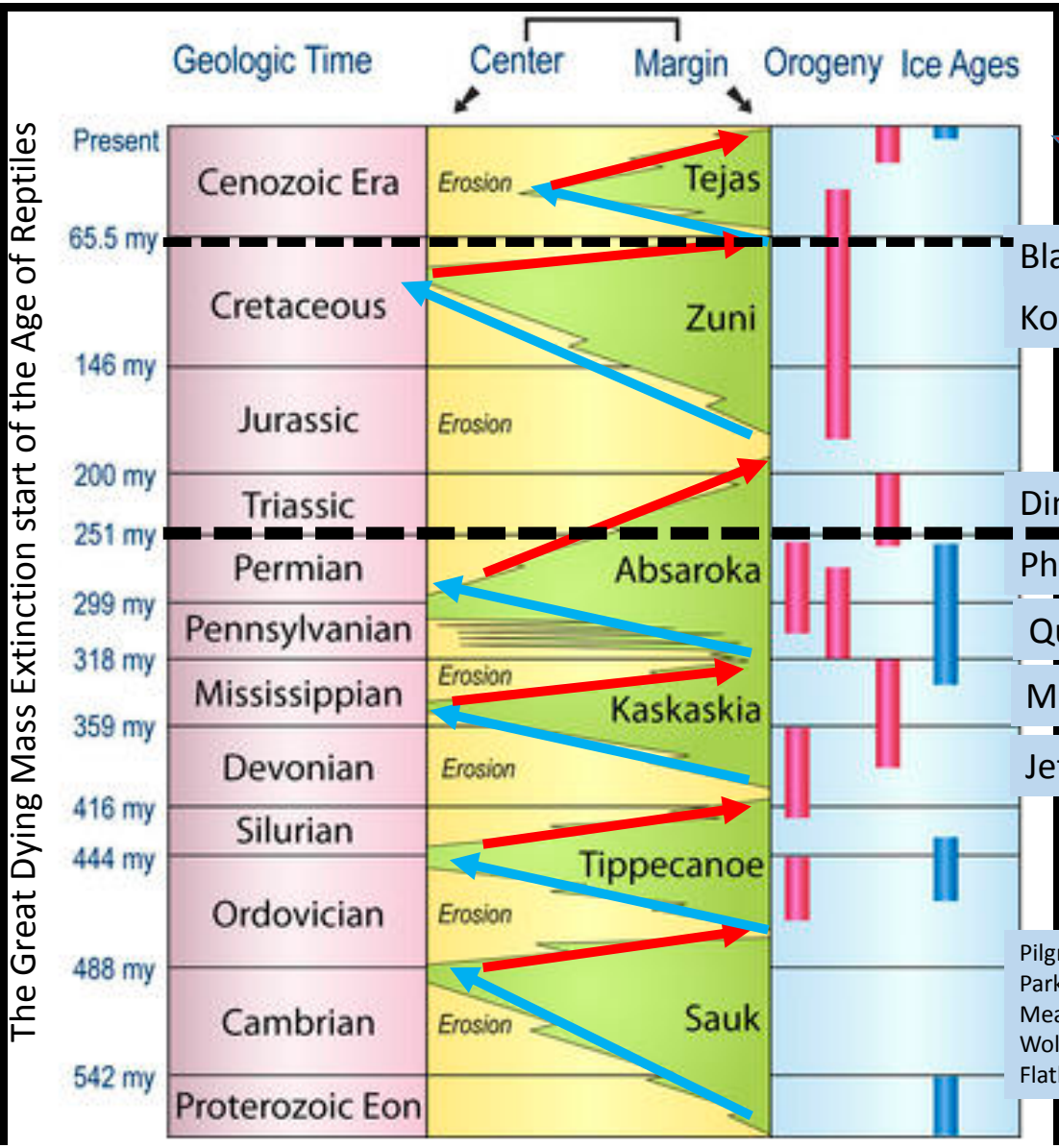
4.55 billion years ago Formation of the Earth

A few **key** types of rocks :

Limestones
Sandstones
Shales
Granites

That tell us a lot about earth processes and history

The Great Dying Mass Extinction start of the Age of Reptiles



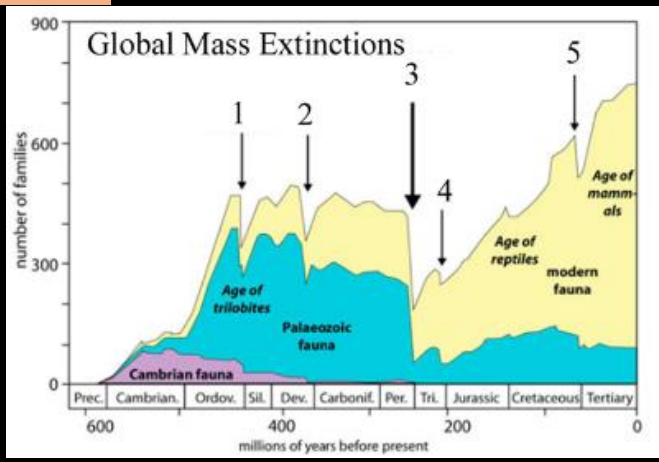
Repeating Cycles

CK-12.org

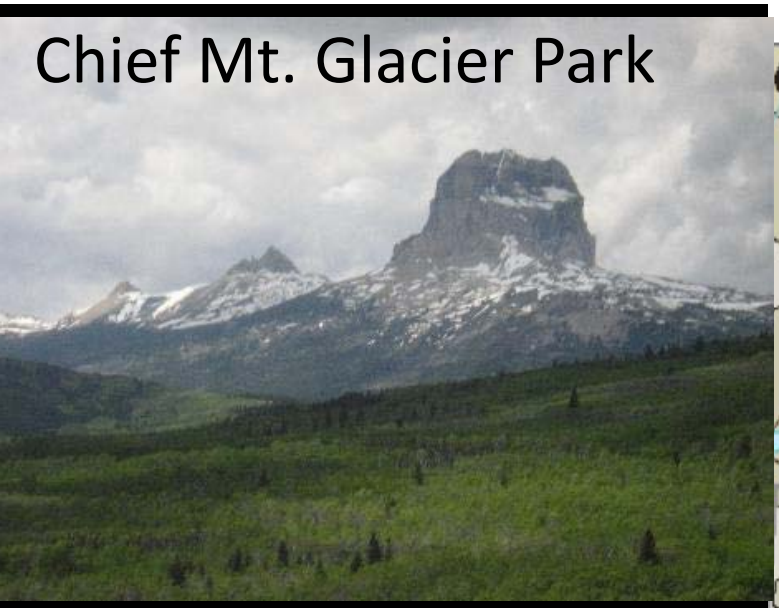
Blackleaf
Kootenai
Dinwoody Sandstone
Phosphoria Shale
Quadrant Sandstone
Madison Limestone
Jefferson Dolomite
Pilgrim Dolomite
Park Shale
Meagher Limestone
Wolsy Shale
Flathead Sandstone

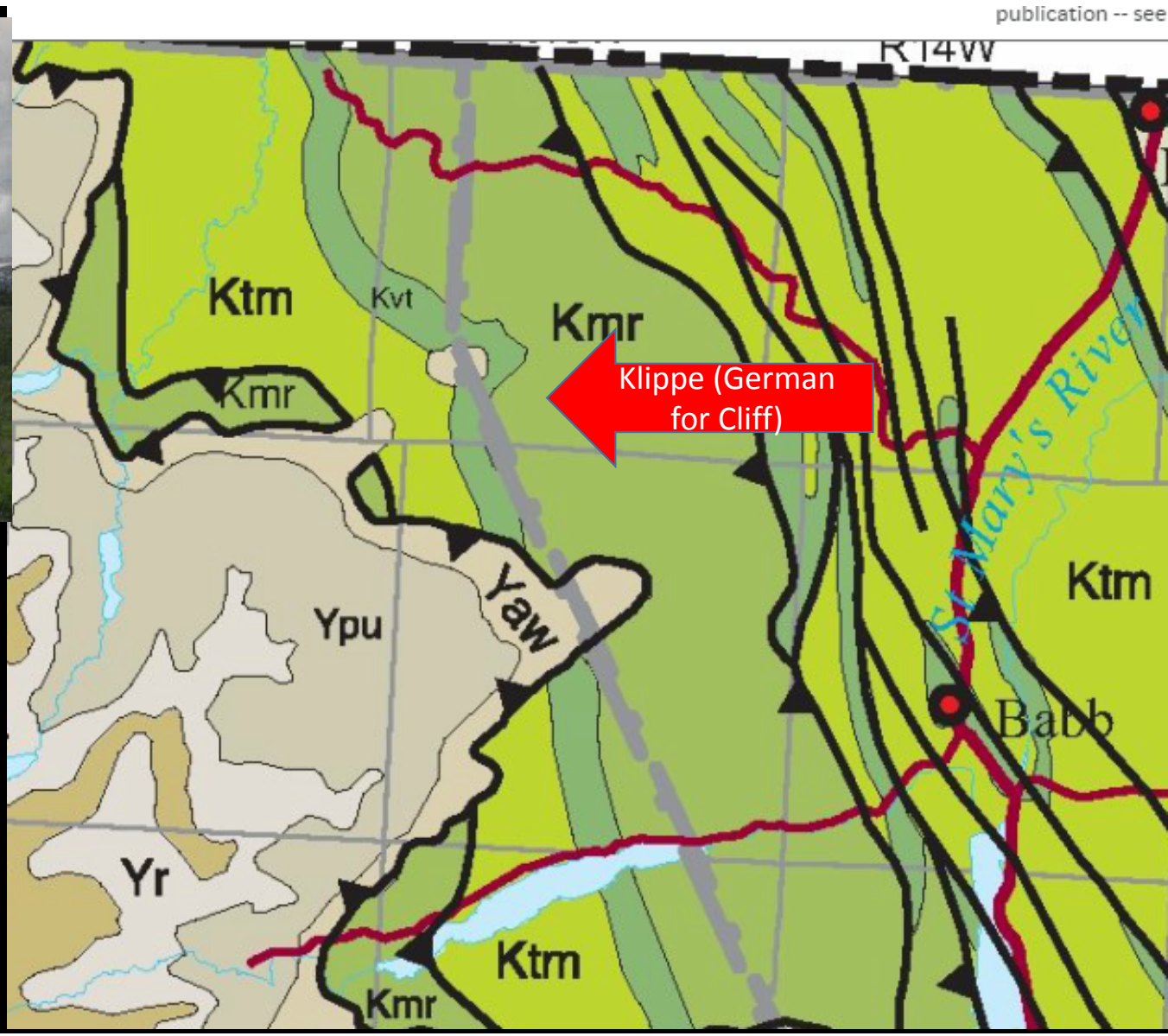
Marine Regression

Marine Transgression



Chief Mt. Glacier Park





(4) Pilot Diamond Drilling

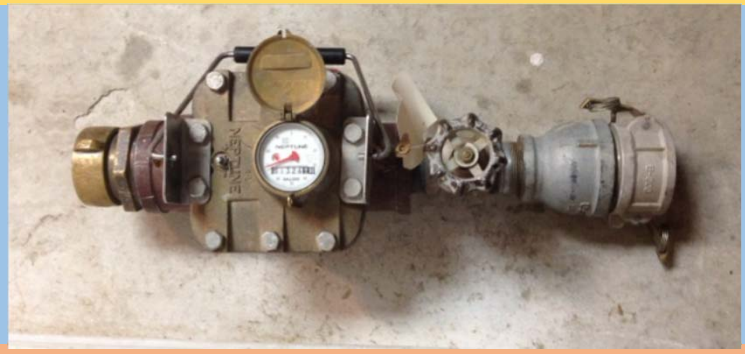
Major **challenges** and how they were **overcome**:

Access and installation of Boart-Longyear LT-70 diamond drill

Water supply in **a very dry locale during drought**

Water Supply

Big Hole River Pumping Station



Water delivery: tanker truck and 4,500 feet of rolled polyline from tank to drill site

Gravity head feed so no in-line pumps were necessary

Pilot drilling

Veinlet **stockwork** with low grade **Cu-Ag-As-Sb** relict sulfide mineralization

Confirmed two key aspects:

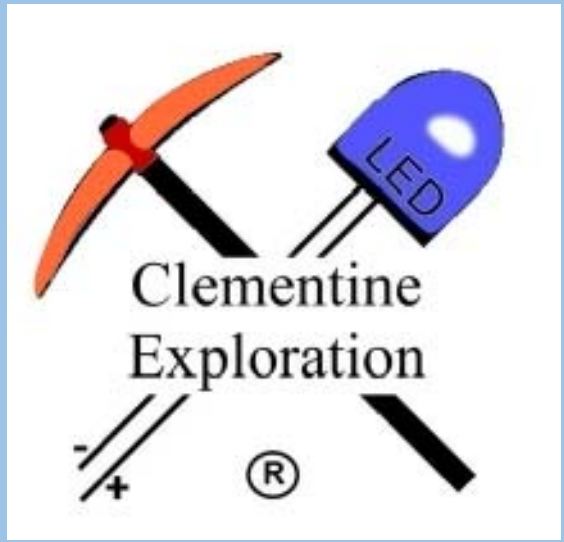
Intense mineralized hydrofracturing

Increased the level of certainty of Cu –Ag As Sb mineralization at depth, rather than a Yellow Pine arsenopyrite Au deposit.

Summary

Proactive Prospect Advancement

(1) Discovery
(2) Permitting
(3) Community Outreach
(4) Pilot Drilling



References

Brimhall, G. and Marsh, B. D., 2014, "Syntectonic formation of giant porphyry copper and intrusion-related ore deposits in linear belts by decompression fluid saturation of regularly spaced diapiric plutons ascending fault ramps within the anticlinal hinge of the frontal Cordilleran fold and thrust belt," Soc. of Econ. Geol. Conference: Exploration Capability for the 21st Century held in Keystone, CO, USA]