A close-up photograph of a gravel bar on the Yellowstone River. The gravel consists of numerous smooth, rounded stones in various shades of blue, grey, and brown, densely packed together. The background is a soft-focus continuation of the same gravel.

Montana Agate

Nittany Mineralogical Society

February 15, 2006

Presented by Mark Ralston

Information on agate

QUARTZ

Macrocrystalline



Quartz point from
Jessieville, Arkansas

Acebucho Agate
Acton Agate
Ada Wood

Adna Carnelian
Afghan Canyon Dendritic Agate
African Blue Lace Agate
African Brecciated Jasper
African Jasper
African Queen Picture Rock
Africa Oxblood Jasper
Afton Canyon Agate

Agate Beans,
Agate Flat Agate
Agate Flat Jasper
Agate Onyx
Agate Point Agate
Agate Springs Agate
Agatized Honey Coral
Agatized Palm Nodules
Agatized Palm Root
Agave Wood
Agua Nueva Agate
Agua Prieta Agate
Airplane Hill Agate

Not opaque

Aldama Agate
Alder Creek Jasper
Aleppo Stone
Algae Agate
Algae Jasper
Alibates Agate/Flint
Alkali Springs Wood
Allendale Chert
Almar Brazilian Rainbow Agate
Alpine Agate
Alsatian Jasper
Amarillo Stone
Amazon Jasper

Crypto-crystalline

Opaque

Amber Agate
Amboy Crater Jasper
Amethyst Agate
Amethyst Sage Agate
Anderson Agate
Andros Agate
Angel Wing Agate
Antelope Agate
Antelope Jasper
Antique Pink Agate
Antonio Nodules
Apache Agate

Jasper

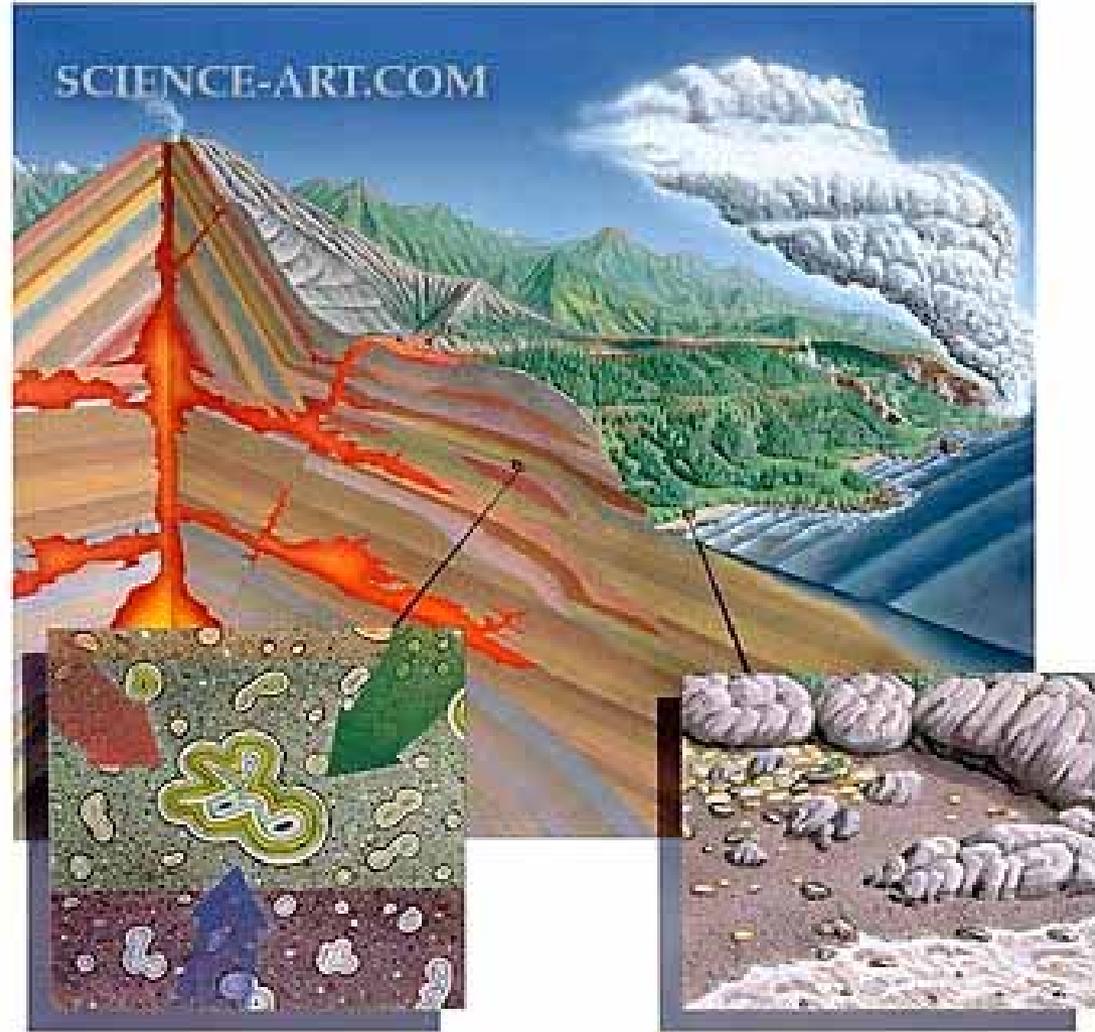
Chert

Flint

Formation of agate

Agates form when silica is deposited in a void or as a replacement of existing material.

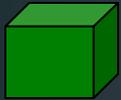
However, details of agate formation are not well understood.



Information on agate

***AGATE
FACTS***

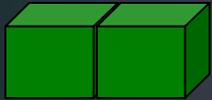
***AGATE
FOLKLORE***



Agate is a cryptocrystalline rock with a mohs hardness of about ~ 7.

Information on agate

AGATE FACTS

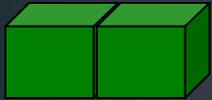


AGATE FOLKLORE

Agate is somewhat porous. Water may migrate into an agate along cracks and/or structures, and then diffuse into the rock.

Information on agate

AGATE FACTS



AGATE FOLKLORE



**A person who wears Montana Agate
is likely to have balanced emotions
and an enhanced ability to discern
the truth and to accept
circumstances.**

Information on agate

AGATE FACTS



AGATE FOLKLORE



Agate is not opaque, and
may have visually-
discernable internal
banding.

Information on agate

AGATE FACTS



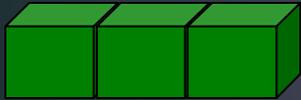
AGATE FOLKLORE



Wearing quartz may make
you less susceptible to the
effects of alcohol.

Information on agate

AGATE FACTS



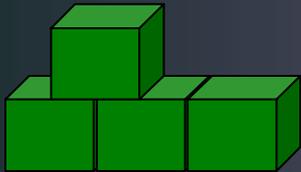
AGATE FOLKLORE



The intricate scenes in Montana
Agate were “captured” from
actual landscapes in the
prehistoric past by some
unknown mechanism.

Information on agate

AGATE FACTS



AGATE FOLKLORE



The intricate scenes in Montana

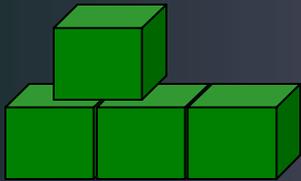
Agate evolved from the

intrusion of minerals such as

iron and manganese.

Information on agate

AGATE FACTS



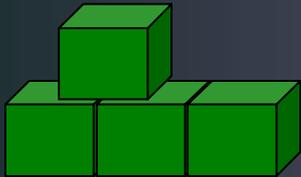
AGATE FOLKLORE



Wearing agate will prevent
insomnia and ensure
pleasant dreams.

Information on agate

**AGATE
FACTS**



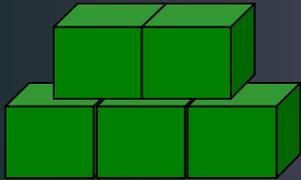
**AGATE
FOLKLORE**



**Agate helps to develop and
to increase one's analytical
skills, especially for
Gemini's.**

Information on agate

AGATE FACTS



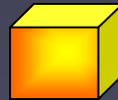
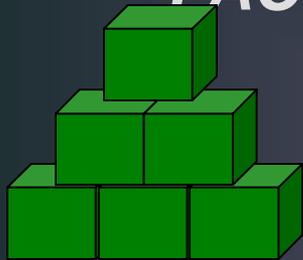
AGATE FOLKLORE



Cracks or secondary porosity features in an agate may be “healed” or cemented by silica in groundwater.

Information on agate

**AGATE
FACTS**



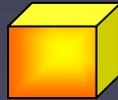
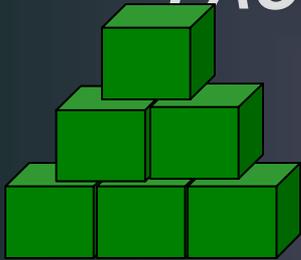
**AGATE
FOLKLORE**



Deposition of silica in an
agate is controlled by
external factors, mainly the
circulation of groundwater.

Information on agate

**AGATE
FACTS**



**AGATE
FOLKLORE**



If external factors were the main control on agate formation, then most agates that form in a given area would be similar in appearance. Because this is not the case, it is likely that internal features (such as cracks, tubes, etc.) also control how silica and impurities are deposited in an agate.

Agate forms

Mineral habit – “The characteristic crystal form or combination of forms of a mineral” (*Dictionary of Geological Terms*, 3rd ed. American Geological Institute, 1984).

Quartz mineral habits: drusy, twinned, sceptered, phantomed, botryoidal, granular, stalactitic, fibrous amorphous, etc.

Botryoidal form – “Having the form of a bunch of grapes” (Ibid.)

Geodes often have banding along botryoidal surfaces and a drusy-lined void in the interior.



Geologic setting

The great Yellowstone rhyolite (silica rich) volcanism (3 major episodes), some changes to geochemical environments, silicification and modification of inclusions (???)

Episodes of energetic river transport & deposition of gravel & agates, different climatic and geochemical environments, some coloration of agates (???)

Absaroka volcanism, many mudflows and burial of organic objects, abundant petrified wood found at in-situ deposits. Agates start here (???)

Montana's geologic history

Cenozoic

1.8 MY Yellowstone
2.5 MY Glaciation, v
10 MY Dry period w/ gravel deposition. 6-Mi Crk onto laterite soils, Flaxville.
20 MY Tropical clim
40 MY Quiet again
50 MY More tecton
60 MY Relative quiet.

Mesozoic

80 MY Uplift & ma
100 MY Plate collisi

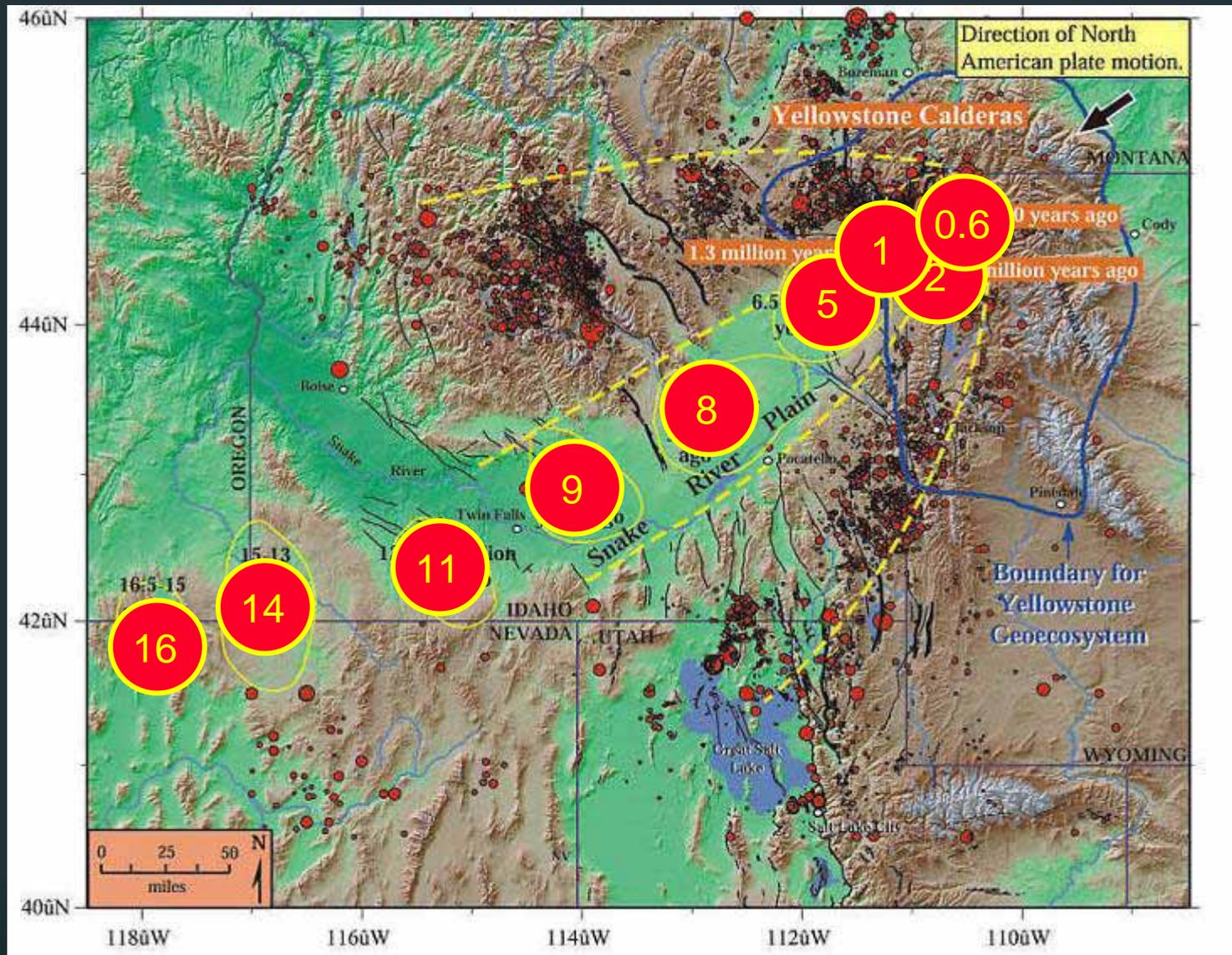
Paleozoic

500 MY Island continent in western MT, ocean in center & east MT.

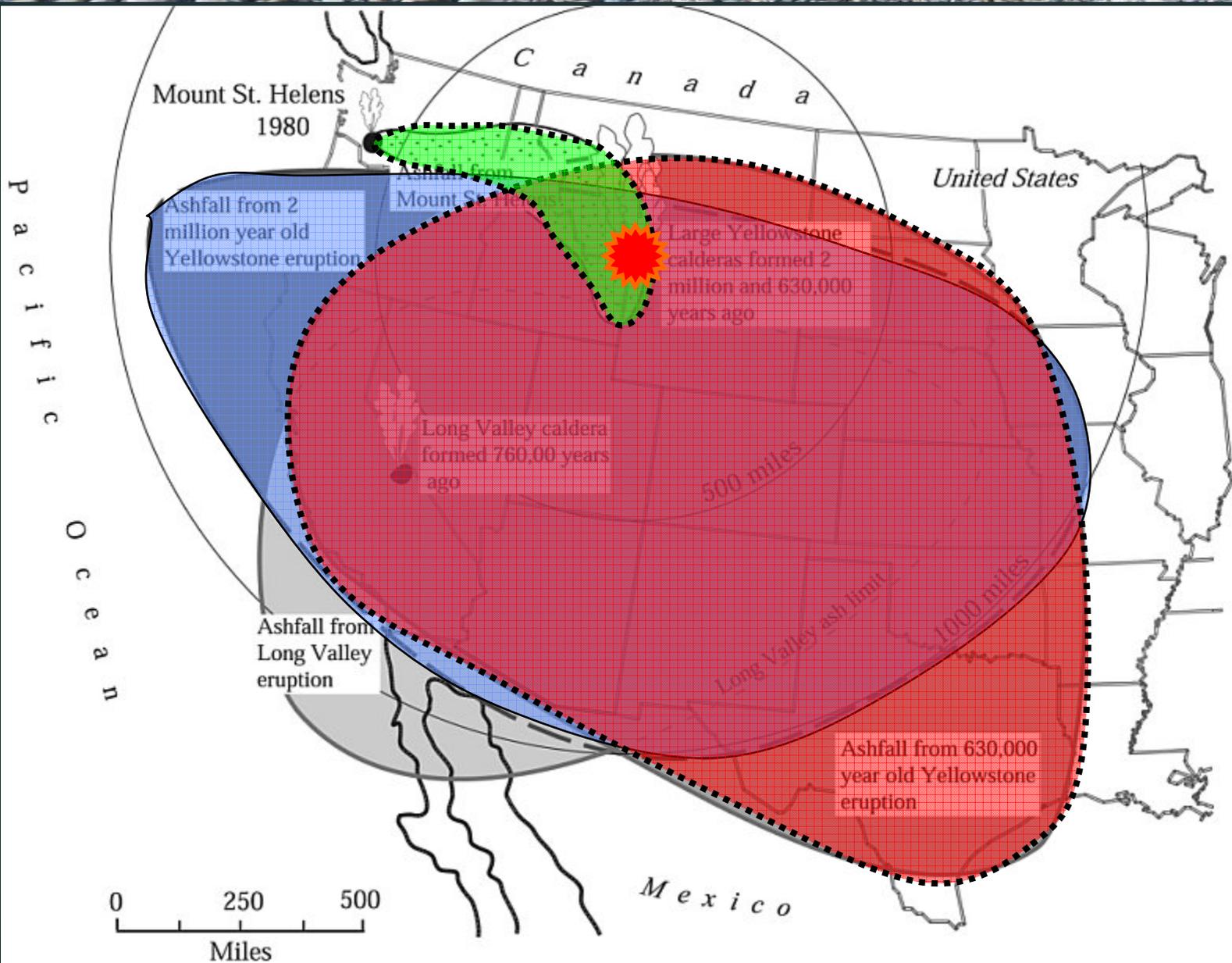
PreCambrian

800 MY Rifting – Shoreline just west of Montana-Idaho border
~ 1,000 MY Belt Formation - sedimentary rock in NW Montana

String of volcanic centers



Yellowstone "Super-Volcanism"



Physiographic setting

Gravel deposits from the eastern front of the Rocky Mountains onto the Great Plains.

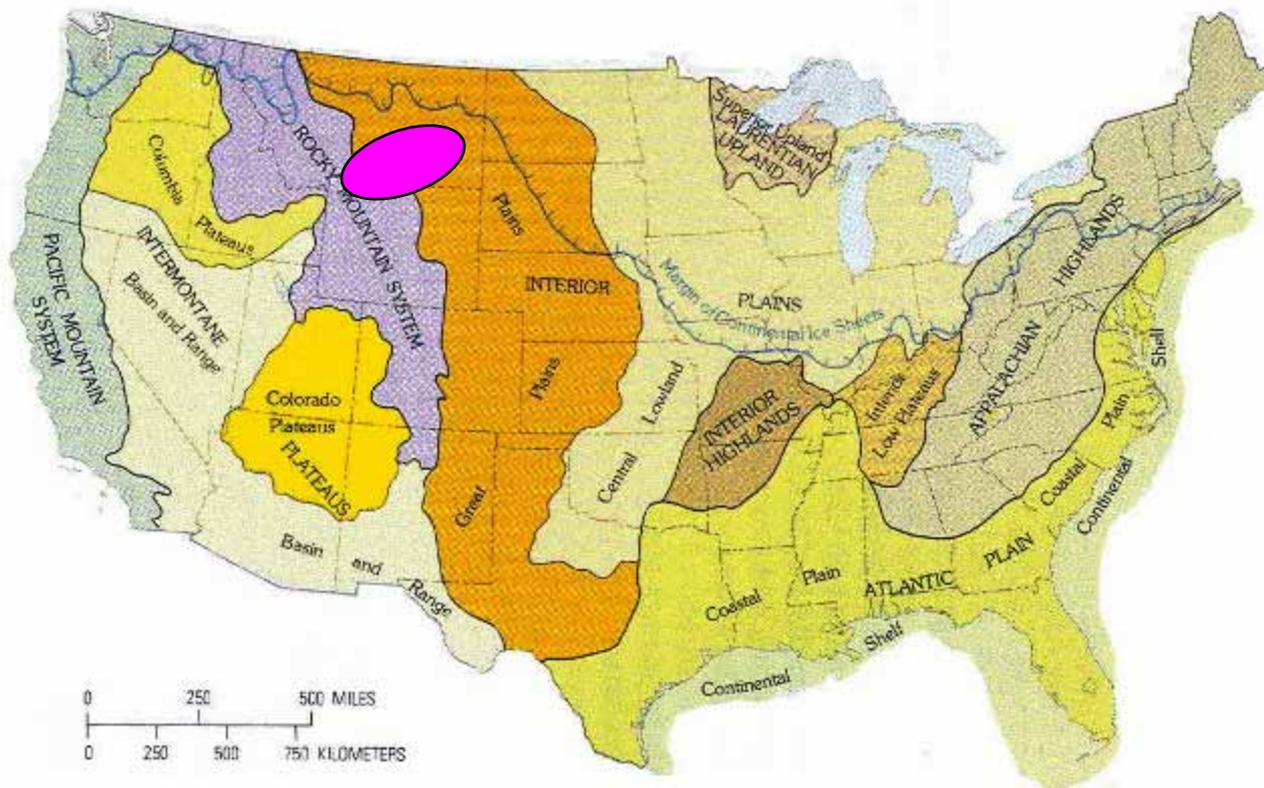


Figure 2. — Physical divisions of the United States and maximum extent of the continental ice sheets during the Great Ice Age.

What makes Montana agate desirable?

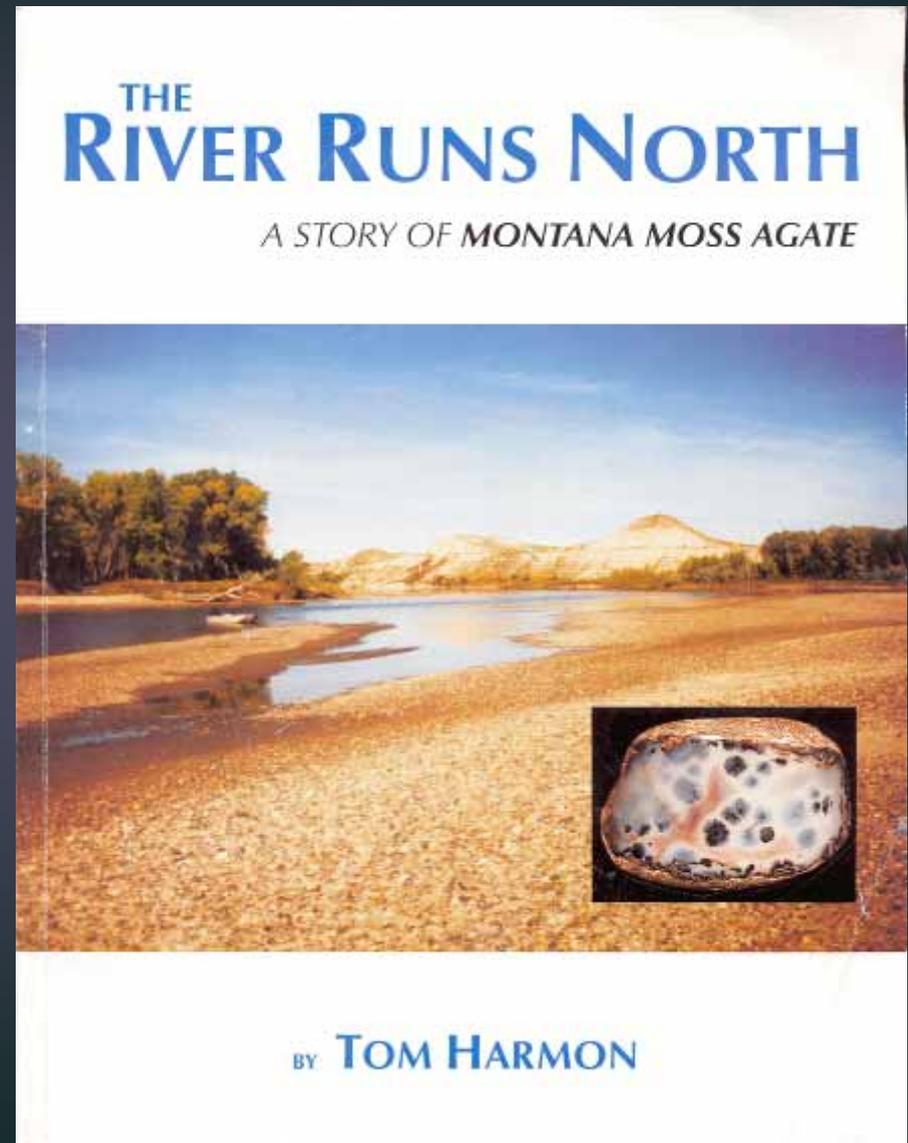
- Scenic features w/ distinct, prominent blacks & reds
- Well-silicified, takes a good polish
- The really good stuff is VERY, VERY UNCOMMON !! On a really productive 5-day rockhunting trip, I may collect as much as 150 – 200 lbs of agate. If I'm lucky, a few rocks will be "Omigosh" quality.

Tom Harmon's Montana agate classification

Tom Harmon of Crane, MT has been collecting and working with Montana agates for many years.

Harmon has developed a descriptive system for classifying Montana agates.

His book is highly recommended ! ! ! ! !
You can get a copy at www.Harmons.net



Formation of scenic features

Some observations and speculation:

- Entry and migration of minerals through cracks, botryoidal surfaces, and other internal structures (secondary porosity features).
- Deposition of minerals along secondary porosity features.
- Deposition of flat “snowflake” dendrites along botryoidal surfaces... retreating water leaves behind mineral precipitate in dendritic form.
- Climate – widely variable water level and infiltrating water conditions, highly variable geochemical conditions.
- Transport in flowing water re-working, cracking & healing.
- Formation of free-floating, 3-d dendrites, seems to be more characteristic of black inclusions than brown/red inclusions
- “Chromatographic” dispersal, by water movement through primary porosity features
- Red/brown inclusions (ribbon bands) seem more susceptible to “smearing” of ribbon banded inclusions than black inclusions.

A Brief Trip to Montana agate country



From east of the Mississippi River, head for Interstate 90. It's a very straight shot across North Dakota. The last few miles across North Dakota go through the Theodore Roosevelt Badlands.

A Brief Trip to Montana agate country



Bridge over the Yellowstone River at Terry, MT.



Gravel bar near Terry.



Gravel bar near Calypso.

A Brief Trip to Montana agate country



Bridge over the Yellowstone River at Calypso, MT.



Low water !!!!!

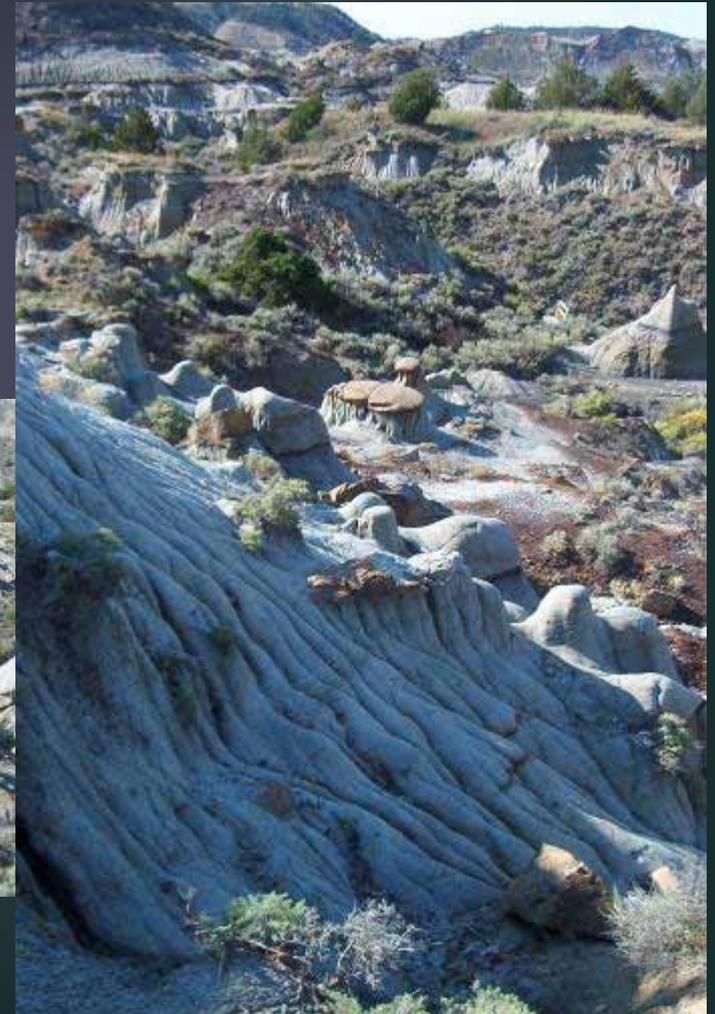


Campsite on the Yellowstone River.



Sportsman's access near Fallon, MT.

A Brief Trip to Montana agate country



Be sure to visit Makoshika State Park near Glendive.

Collecting Montana agate

WHERE ARE THE BEST PLACES TO COLLECT ?

- Gravel bars
- Tributaries
- Fields in river valley & uplands.
- County roads

ALWAYS ASK PERMISSION BEFORE ENTERING PRIVATE LAND ! ! ! !

Collecting Montana agate

GRAVEL BARS

- Best to access by boat.
- Relatively few access points – look for “sportsman’s access” locations on State road maps.
- Gravel bars in the River are public land.... should be OK to collect.
- In early spring, the River is high..... late summer is probably better on the River.
- The best collectors can distinguish agates by the “skin” texture, even with a mud coating. Some people can even distinguish agates under water.



ALWAYS ASK PERMISSION BEFORE ENTERING PRIVATE LAND ! ! ! !

Collecting Montana agate

GRAVEL BARS

- In late summer, some of the areas high up on the gravel bars are scoured by wind-blown sand – agates may be more visible than early in year.
- To start, use a rock hammer to chip likely-looking rocks. After your eyes are “calibrated” (may take 3 – 5 outings), you’ll be less reliant on chipping rocks.
- Some of the gravel bars are huge. Walk them systematically..... set up a grid system and walk a pattern.
- The river is treacherous..... fast current, many large rocks..... be careful !!



ALWAYS ASK PERMISSION BEFORE ENTERING PRIVATE LAND ! ! ! !

Collecting Montana agate

TRIBUTARIES



- Use 30' x 60' USGS topo maps to identify tributaries that have large drainage areas.
- Look for access where the tributaries flow from the upland area out onto the Valley floor..... seems to be a setting where stream bedload is dropped.
- Some DeLorme maps show the location of BLM land..... BLM land is open for public access.

If you have a GPS unit and a laptop, this is a GREAT application for GPS !! Otherwise, it can be difficult to navigate to some of the out-of-the-way locations. I really like DeLorme "Streets"..... good coverage of county roads.

ALWAYS ASK PERMISSION BEFORE ENTERING PRIVATE LAND ! ! ! !

Collecting Montana agate

COUNTY ROADS

- Some County roads are maintained by patching w/ gravel and/or by grading to remove ruts. Large gravel is gradually exposed and “kicked” to the sides of the roads by traffic.
- You can cruise the County roads slowly and look for agate chips in the road. If you see agate chips and large gravel, it may be worth getting out and looking along the swales along the shoulder. If all you see is small gravel, it’s probably not worth stopping.
- In the spring, grass may be thick and rocks may be hard to see. The rattlesnakes are harder to see, too. In the fall, grass is usually dried up and rocks are more visible.



ALWAYS ASK PERMISSION BEFORE ENTERING PRIVATE LAND ! ! ! !

Collecting Montana agate

FIELDS

- Look for fields with at least some large gravel at the surface.
- If you see large gravel in a field with some agate present, try to get permission to walk the field and plan to spend some time.
- Walk the field methodically. Identify landmarks for your starting and ending points, then walk a pattern of parallel lines ~ 20 feet between lines.
- Upland agates will often have a distinctive white crust on the surface.



RESPECT LANDOWNERS ! ! ! !

ALWAYS ASK PERMISSION TO WALK INTO FIELDS ! !

NEVER WALK ON GROWING CROPS ! !

ALWAYS ASK PERMISSION BEFORE ENTERING PRIVATE LAND ! ! ! !

Working with Montana agate

CUTTING



- To inspect the rock, wet it and hold under a bright light
- Spend some time and thought to assess features carefully, decide the best orientation to cut
- Does the rock have full-bodied dendrites ? Ribbon banding? Cut perpendicular to the banding.
- Is the rock checked ? Try to cut parallel to checks so that you get more unchecked slab.
- Does the rock have thin line dendrites? Try to cut parallel to the best, flattest, botryoidal surfaces.
- Does the rock have flat, planar features ? Cut parallel to planes, try to “nick” the planes that have some dark features.
- If the rock has a coarse crystalline center, you may get full-bodied dendrite “trees” at the intersections of botryoidal surfaces.

Working with Montana agate

CUTTING

- For small or irregularly-shaped pieces, glue to wooden sticks (such as 2" x 2" x 6" pine)
- Use a mixture of Elmer's glue & sawdust.
- Touch up the glue as needed. Let the glue harden for at least 3 days after the last application of glue.



Working with Montana agate

CUTTING



- I use 25% mineral oil, 75% odorless mineral spirits as a lubricant for my rock saw.
- I usually squirt in a small amount of rubbing alcohol to reduce oil mist. However, I have to let the alcohol evaporate from the reservoir before cutting rocks on sticks or else the Elmer's glue will release and the rocks will fly off.
- Cut slabs at least 4 mm thick. Use heel pieces to make thick, deep-crowned cabs.

Working with Montana agate

LAYERED DENDRITES

Cut slabs parallel to planar features



Al Siegel of Terry Montana suggested gluing agates to wood using a mixture of sawdust and Elmer's glue. This makes it easy to clamp the wood into your rock saw carriage. This won't work if you're using water as a coolant/lubricant.



Working with Montana agate

CUTTING



- For rocks that appear to have very good features, consider grinding away skin to get a better look at interior.
- If, after first cut, it looks like a better orientation is possible, re-set the stone on stick.
- For planar features, take your time..... if first cut is a bust, advance the rock only to the next plane w/ dark features.
- Use a very slow advance rate on rock saw carriage.

Working with Montana agate

SLABS



- Soak slabs in soapy water to remove cutting oil. Can remove excess oil first using kitty litter.
- Identify checks in slab. May want to trace checks w/ sharpie. Don't try to include unhealed checks in cabs.
- For small slabs that don't immediately suggest good cab features tumble them and re-inspect. Will make features easier to see, pick cab outline better, slab may fall apart along weak cracks.
- Whack the slabs on bench surface..... slab may break along weak cracks.

Working with Montana agate

CABS

- For free-forms, use a pencil to outline cabs. Once you're satisfied with the result, re-trace w/ fine-point Sharpie. Trim the form on trim-saw.
- Glue pre-forms to dowels using glue gun & high-temperature glue. Heat the rock first (under lamp) – will drive out water & make glue bond better.
- I do a preliminary grind on #80 diamond disk w/ lots of water.... saves wear on the #80 grinding wheel.



Working with Montana agate

CABS

- Always finish bottom. Put flat crown on bottom, small bevel on bottom edge.
- It's very difficult to put a good finish on flat surfaces using a cab machine.... make sure that you have at least a slight curvature.
- Can tumble to finish after #80 grind I do this sometimes if I'm making a lot of cabs of one particular type of stone such as Cripple Creek jasper, but who'd really want to do this for a top-grade Montana agate ???

Working with Montana agate

HAND SPECIMENS



- For hand specimens, either use the “heel” from the first cut, or else don’t cut the rock all the way through.
- Grind and polish a flat crown on the cut surface of the hand specimen.
- If you don’t cut the specimen, you may want to wet it w/ baby oil or Vaseline periodically to enhance appearance.



Working with Montana agate

JEWELRY

- Lots of sources of information on silver working, but you really learn from experience.
- Don't be afraid to ruin some silver – better to start over than to try to salvage a burned, puckered, or poorly-fit piece.

Yellowstone Jewelry

I like to use a minimal amount of silver so that the setting doesn't detract from the stone..... the stone is the main attraction.



Yellowstone Jewelry



Large, free-floating, 3-D dendrites and dendrite specks.



Small 3-D dendrites, larger dendrite in white-banded central region.



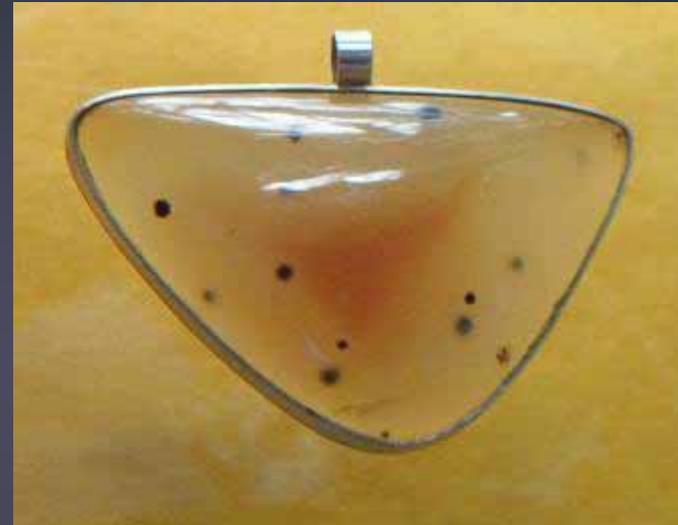
Free-floating, 3-D dendrites and some brown ribbon banding.

Yellowstone Jewelry



Small dendrite specks and red ribbon banding. Some of the crust was left on the right side of this cab.

Linda found this rock on a county road near Terry, MT.



Small, subtle dendrites and a pretty, amorphous, red central region. This was a “heel” piece (i.e., first piece cut from the rock), so it’s fairly thick.

Yellowstone Jewelry



**Brown ribbon banding and black “tubes”
(almost like sagenite ???) .**

**Notice how the matrix is clear
surrounding the black “tubes” on the left
side of the stone. Did the “tubes” present
an avenue for preferential water
circulation and alteration of the matrix ?**



**Nice red central area, one well-
formed, 3-D black dendrite at top.**

Yellowstone Jewelry



A nice example of thin line crust dendrite.



This cab came from near the exterior of the stone, so you can see some healed cracks and crust-associated features along the top of the stone.
Nice red ribbon banding.

Yellowstone Jewelry



The area near the bottom that looks like giraffe skin is uniform mineral (iron ?) coating on botryoidal surface. The intersections between “lumps” are clear, which gives nice definition to the shapes.



Everyone has a few “That looks like.....” stones. This one looks like a Blue jay sitting on a nest.

Places to go in Montana

TERRY

Prairie Unique (Store w/ some agates & local info)

Terry Badlands (North of Yellowstone River)

GLENDIVE

Mart's Agates

Makoshika State Park

CRANE

Harmon's Rock Shop