Photographic Guide to Erionite vs. Non-Erionite Bearing Rocks
Sioux District, Custer National Forest

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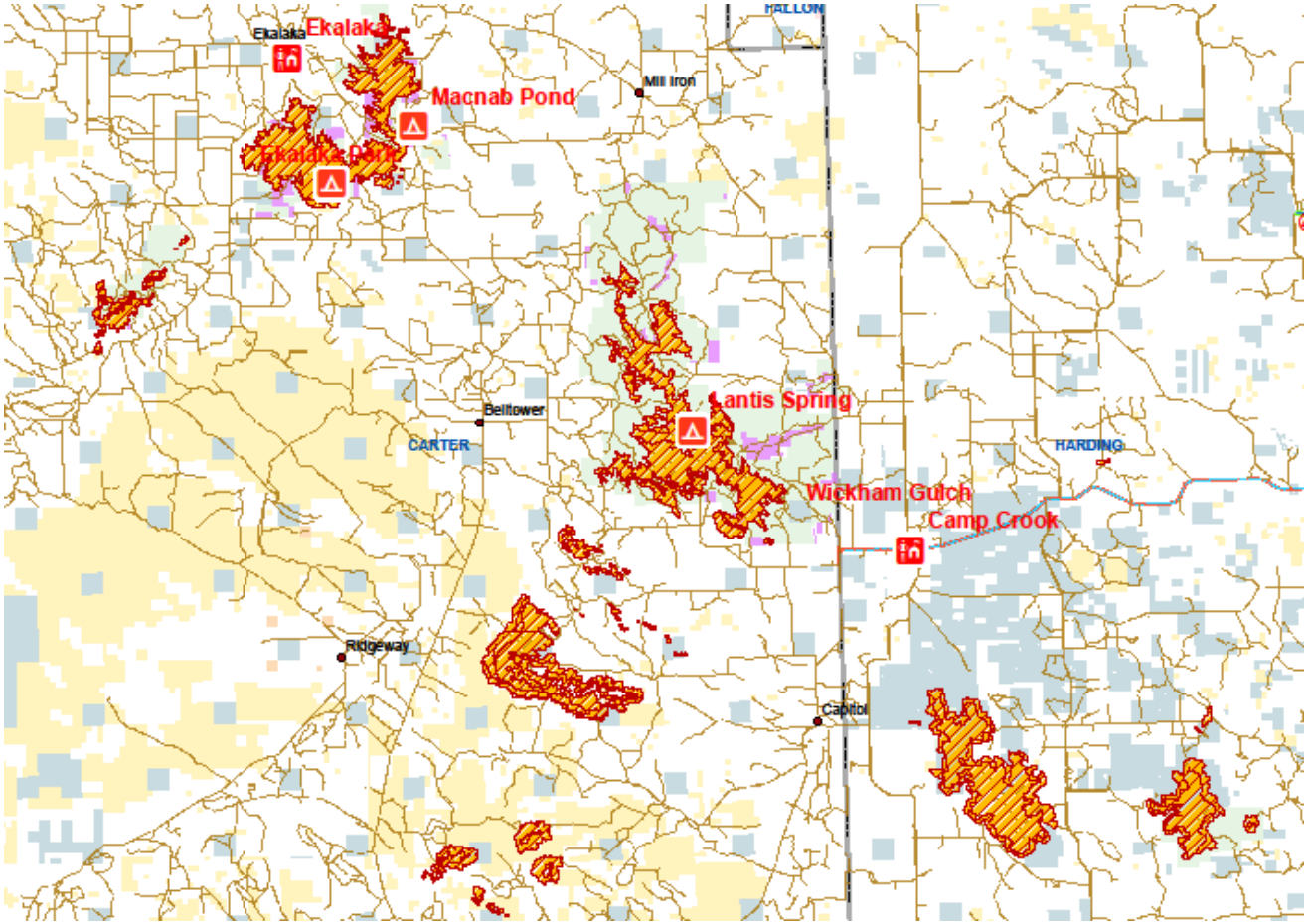
Introduction: Thank you for using the erionite bearing rock photo guide. This guide is presented in layman's terms and intended for use by field going personnel with little if any geologic knowledge. If for any reason, users find this guide difficult, you are strongly encouraged to contact the Custer National Forest Geologist or Sioux District personnel in order to bring forward your suggestions for improvement.

Erionite Overview: Erionite is a naturally occurring mineral associated with volcanic ash altered by weathering and groundwater. Erionite is often termed an "asbestos-like mineral" due to its fibrous nature and needle-like structure. Erionite fibers are microscopic in scale and not possible to see without magnification.
On the Sioux District of the Custer National Forest, geologic formations which have been analyzed and determined to contain erionite mineralology include the Arikaree and White River (including the Brule and Chadron Members) Formations. Geologic descriptions of each of these formations or members are included latter in this document.

Erionite Health and Safety Considerations: Erionite is classified as a Class I Carcinogenic Agent. Erionite fibers, just like asbestos, when inhaled can become lodged in the linings of the lungs, heart, and abdomen and cause cancer. Many researchers have indicated that it is more dangerous than the 6 regulated forms of asbestos. Cancer development is associated with early (childhood and young adult) exposure. Currently, there is no Federal or State regulatory oversight related to the use of erionite.

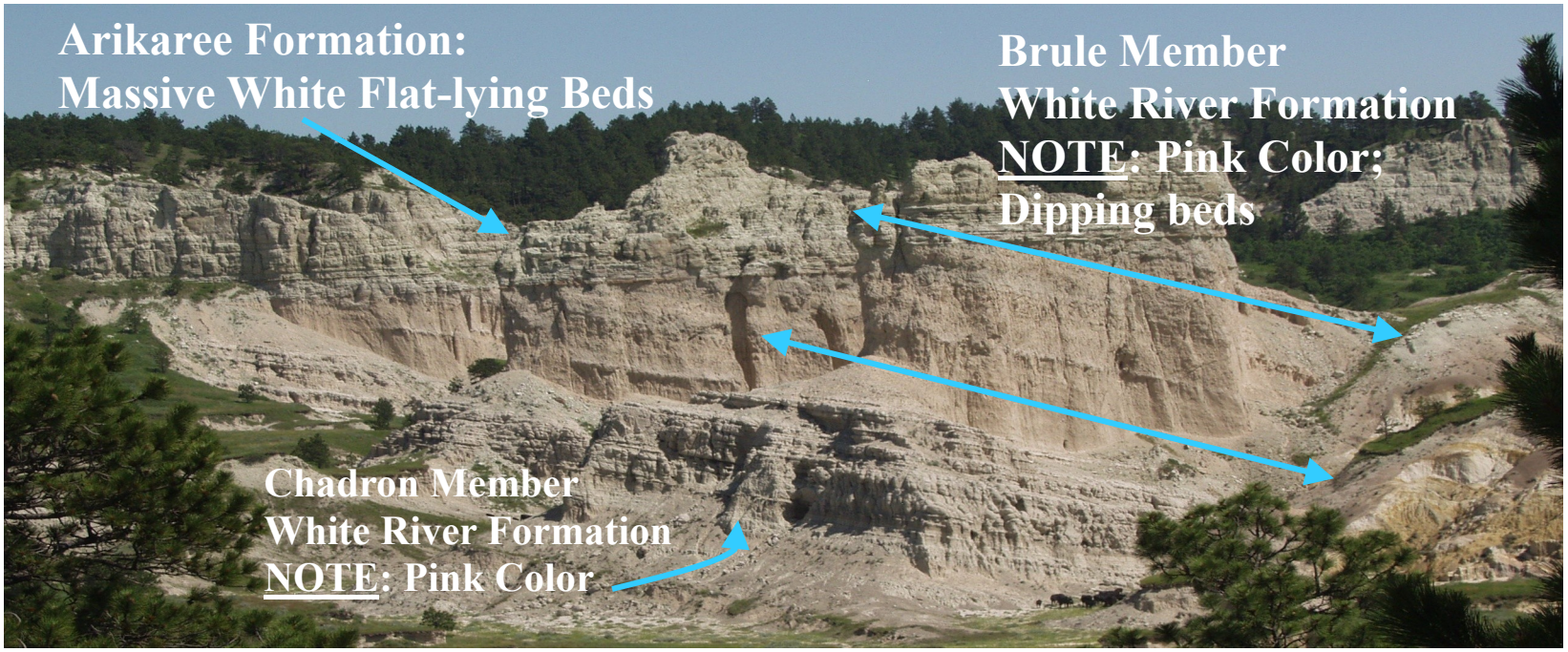
Intent and Objective: The intent and objective related to the development of this erionite bearing rock photo guide is to provide a portable, simple, user friendly guide to help our workforce identify potential erionite occurrence. Ultimately, it is the intent and objective of this effort to fulfill guidance contained within one of our standard firefighting orders, "Fight fire aggressively, but provide for safety first…." Our shared objective includes providing visual tools in order to identify areas potentially containing erionite.

Map of Identified Erionite Areas
within Southeast Montana and Northwest South Dakota



Erionite-Bearing Rocks

Reva Gap, Slim Buttes, Sioux District CNF



Arikaree Formation (Erionite Bearing Rocks)

Greenish gray to light gray to white cross-bedded or massive sandstone. Formation is generally capped by several feet of resistant greenish quartzite with small quartz pebbles and granules. The lower portion is buff to greenish colored coarse sandstone with local conglomerate at the base which may be cross-bedded. The upper portion is a hard massive sandstone with concretions formed through conglomeration of small quartz crystals.

An obvious feature of this formation is the **flat lying** nature of these **massive white to greenish beds**, while immediately under the Arikaree, the Brule is steeply dipping and not flat lying. Thickness 200 to 250 feet.

White River Formation (Erionite Bearing Rocks)

This formation is divided into 2 parts, the Brule and Chadron. The character of the White River in Slim Buttes is almost identical to the same formation in the Badlands National Monument, 140 miles to the southeast. On the west, north, and east sides of Slim Buttes, the formation is generally distorted by landslides or slumping; some areas are grassed over. Reva Gap (Highway 20) contains exposures of both the Brule and Chadron Members of the White River Formation. Further detailed descriptions for both members are found below.

Erionite Bearing Rock Descriptions Continued

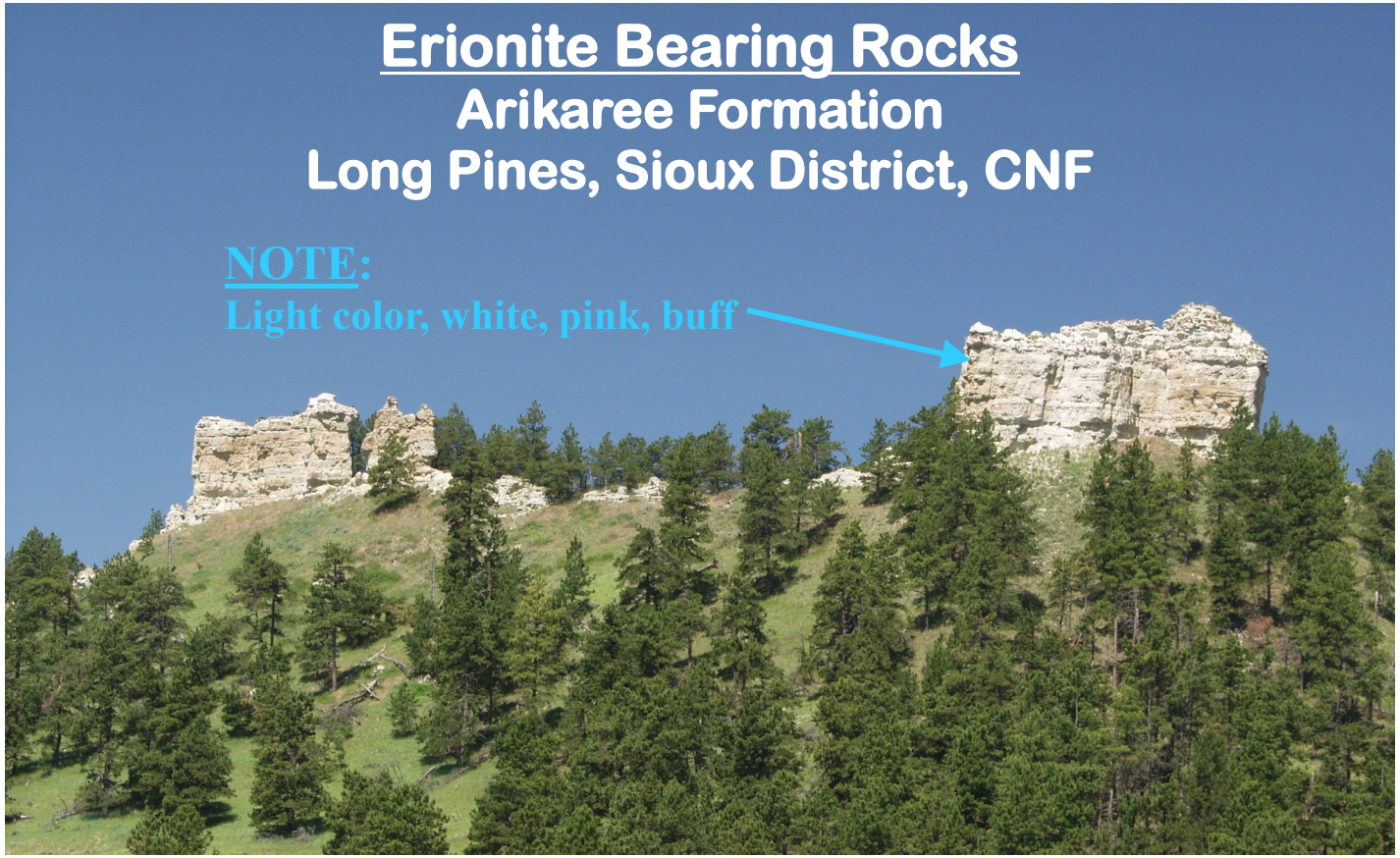
Brule Member, White River Formation - may only be present at Capitol Rock (SE 1/4 sec. 17; T3S; R.62 E) in the Montana portion of the Sioux District. Located at the base of the Arikaree Formation. **Massive pinkish** gray, calcium containing, **clayey siltstone**: nodular **claystone**: and channel sandstone. Contains abundant vertebrate fossils. Thickness 0-30 ft.

The member is composed of **massive pink clay**, exposed in the badlands just Southeast of Reva Gap, **well-bedded**, hard **pale green sandstones alternation with very pale brownish gray clay**. Weathering causes a tread and riser affect much like a staircase. Both the sandstone and the clay are generally calcareous and Bentonitic. The lower portion of the vertical cliffs in Slim Buttes is generally Brule.

Chadron Member, White River Formation - only located in the southern Long Pines within Montana. Found at the base of the Arikaree formation and beneath the Brule Formation at Capitol rock (SE 1/4 sec. 17 T, 3 S., R. 62 E). Basal conglomerate sandstone overlain by beds 10 to 15 ft thick of dark gray bentonite and cream colored siltstone. Thickness 0-100 ft.

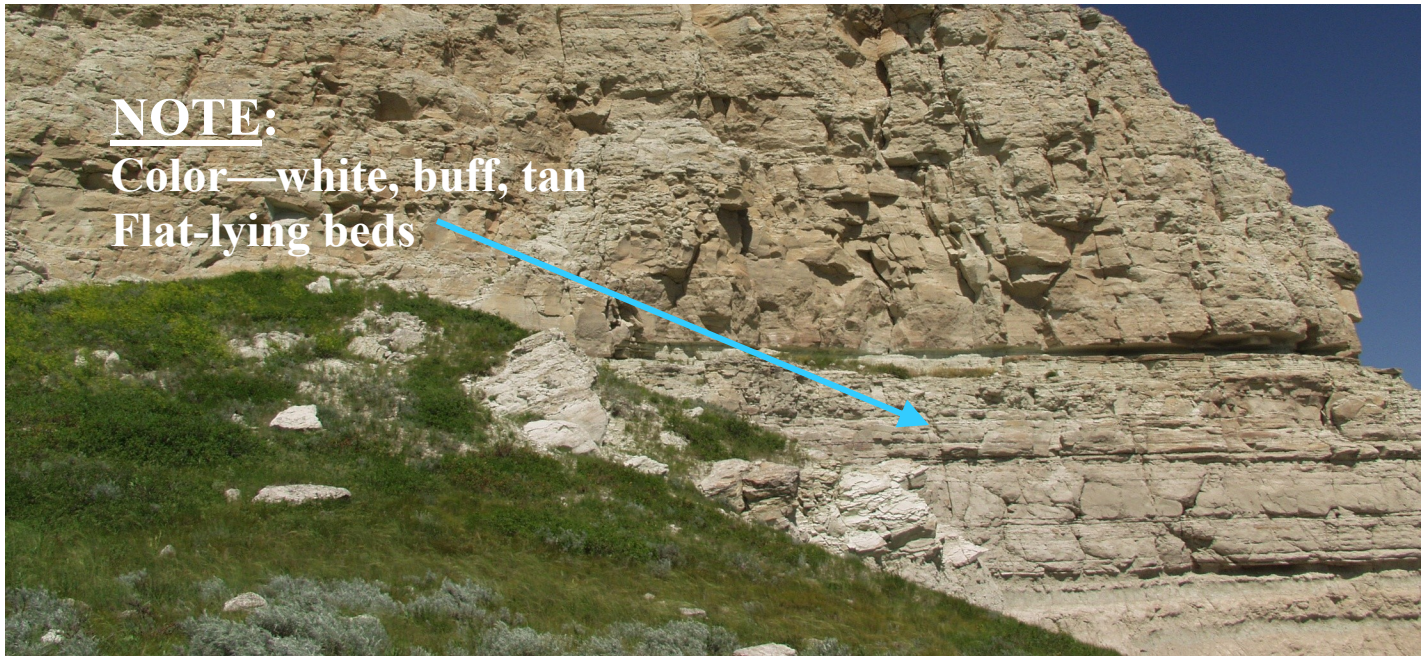
Erionite Bearing Rock Descriptions Continued

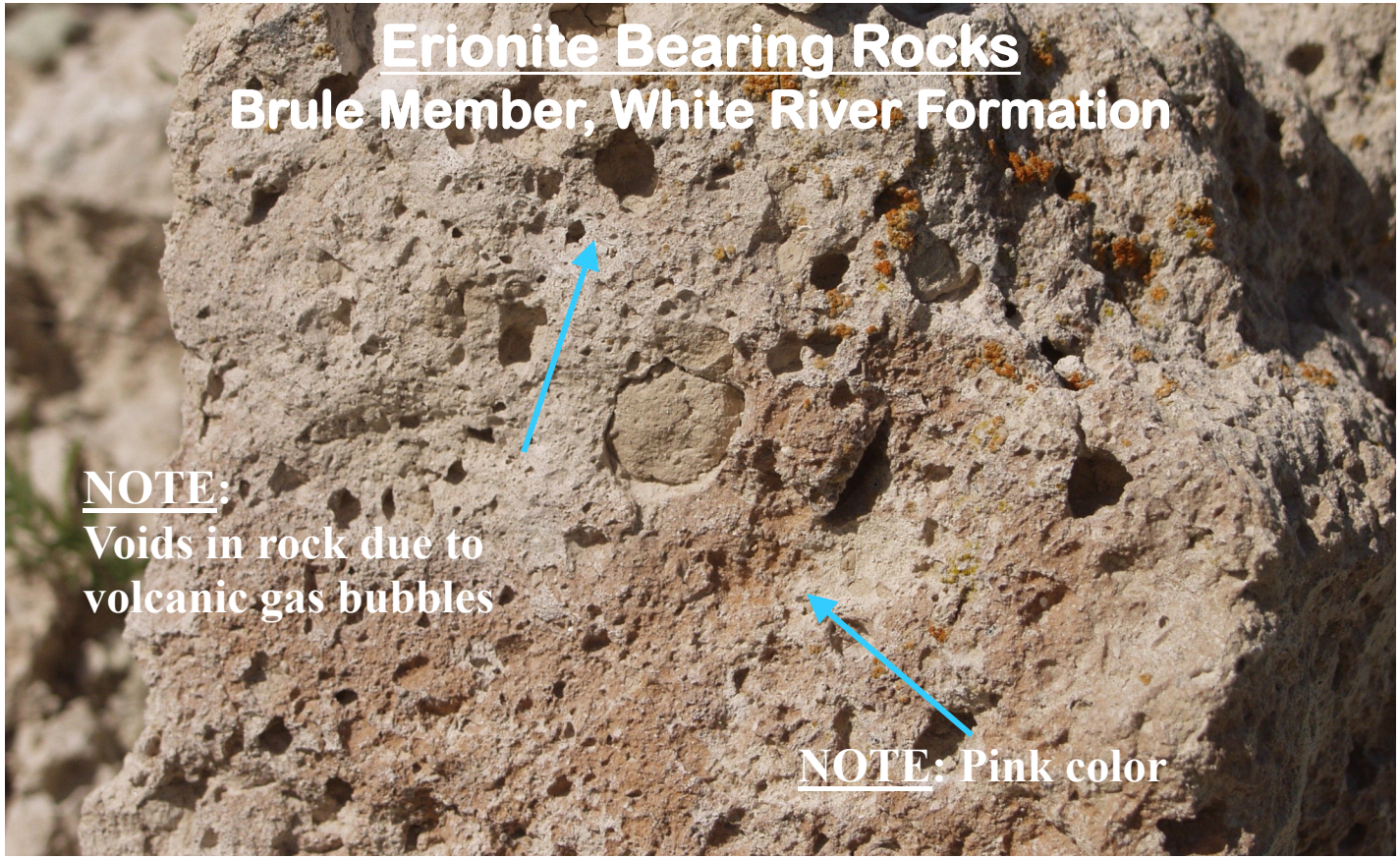
The Chadron member can be roughly divided into 3 parts. The upper part is massive bentonitic pale brown clay; near the top are lenses of limestone with gas bubble voids and numerous hard siliceous beds. An outcrop is a low “haystack” hill or gentle clope with a crust that resembles “popcorn”. The middle portion is a dazzling white coarse sandstone with lenses of coarse conglomerate, generally standing vertical when exposed. The lower portion gray and tan clays, rusty iron concretions, and iron stone streaks giver the outcrop a golden brown color. Occasionally a thin black carbonaceous streak lies at the base. The Chadron can be 160 ft thick

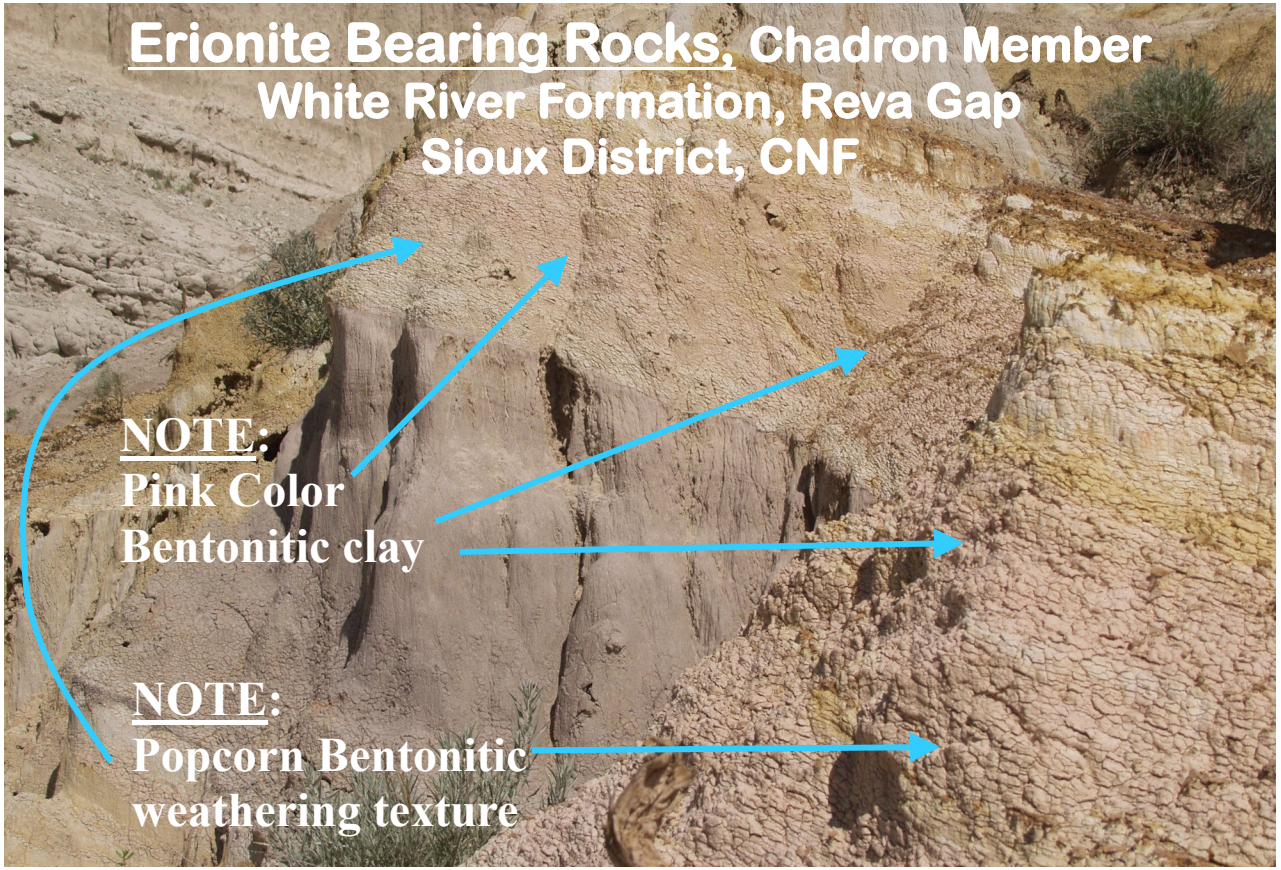

Erionite Bearing Rocks
Arikaree Formation
Long Pines, Sioux District, CNF
NOTE:
Light color, white, pink, buff

Erionite Bearing Rocks

Arikaree Formation, Reva Gap
Slim Buttes, Sioux District CNF




Erionite Bearing Rocks
Brule Member, White River Formation
NOTE:
Voids in rock due to
volcanic gas bubbles
NOTE: Pink color

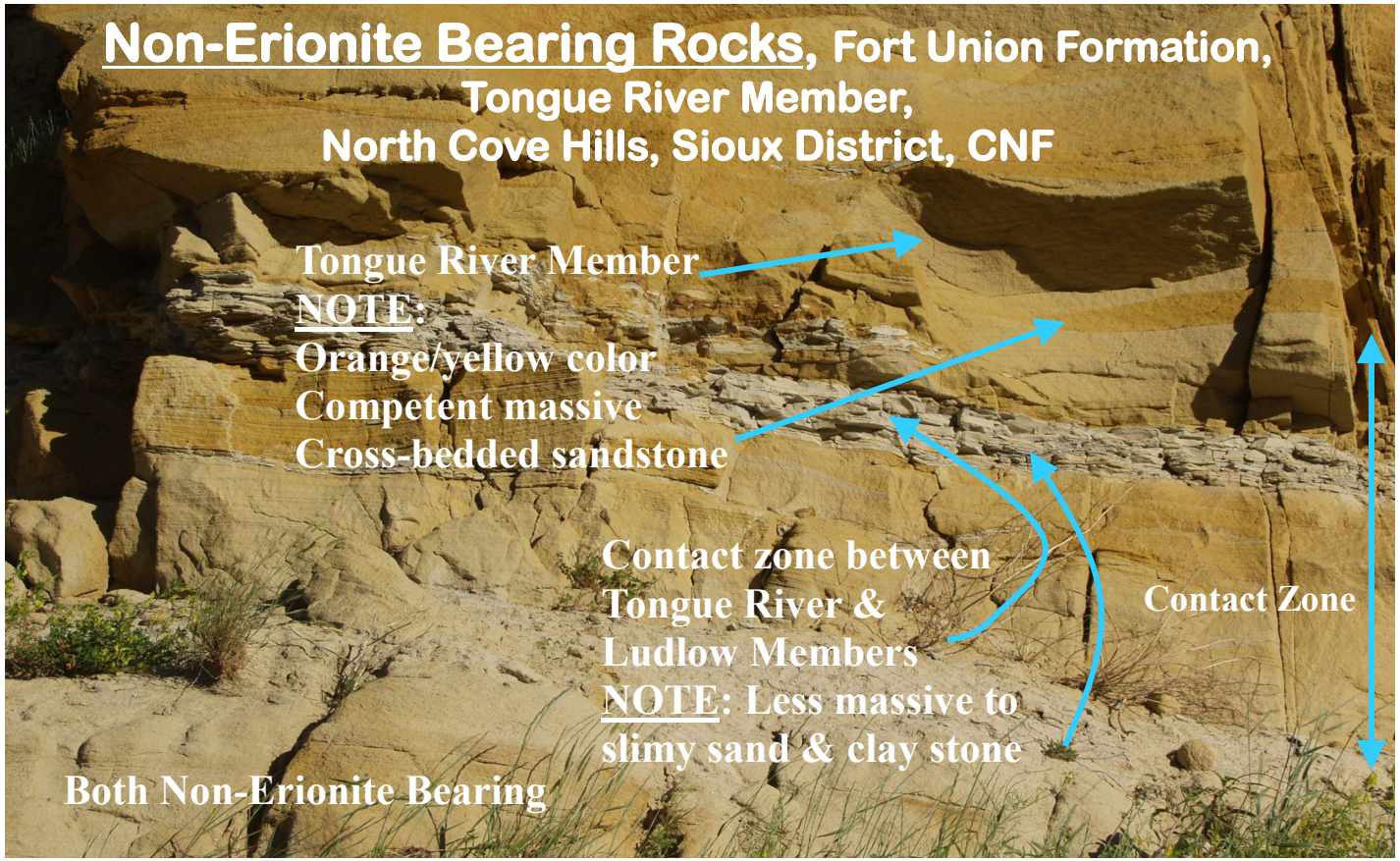

Erionite Bearing Rocks, Chadron Member
White River Formation, Reva Gap
Sioux District, CNF
NOTE:
Pink Color
Bentonitic clay
NOTE:
Popcorn Bentonitic
weathering texture

Fort Union Formation (Non-Erionite Bearing Rock Descriptions)

Ludlow Member – Rock color of the Ludlow member of the Fort Union Formation is very different from the overlying White River Formation. The **White River Formation is characterized by white, pink, and greenish sandstones, claystones and siltstones as compared to the tan, buff to brown and grays of the Ludlow Member of the Fort union Formation.**

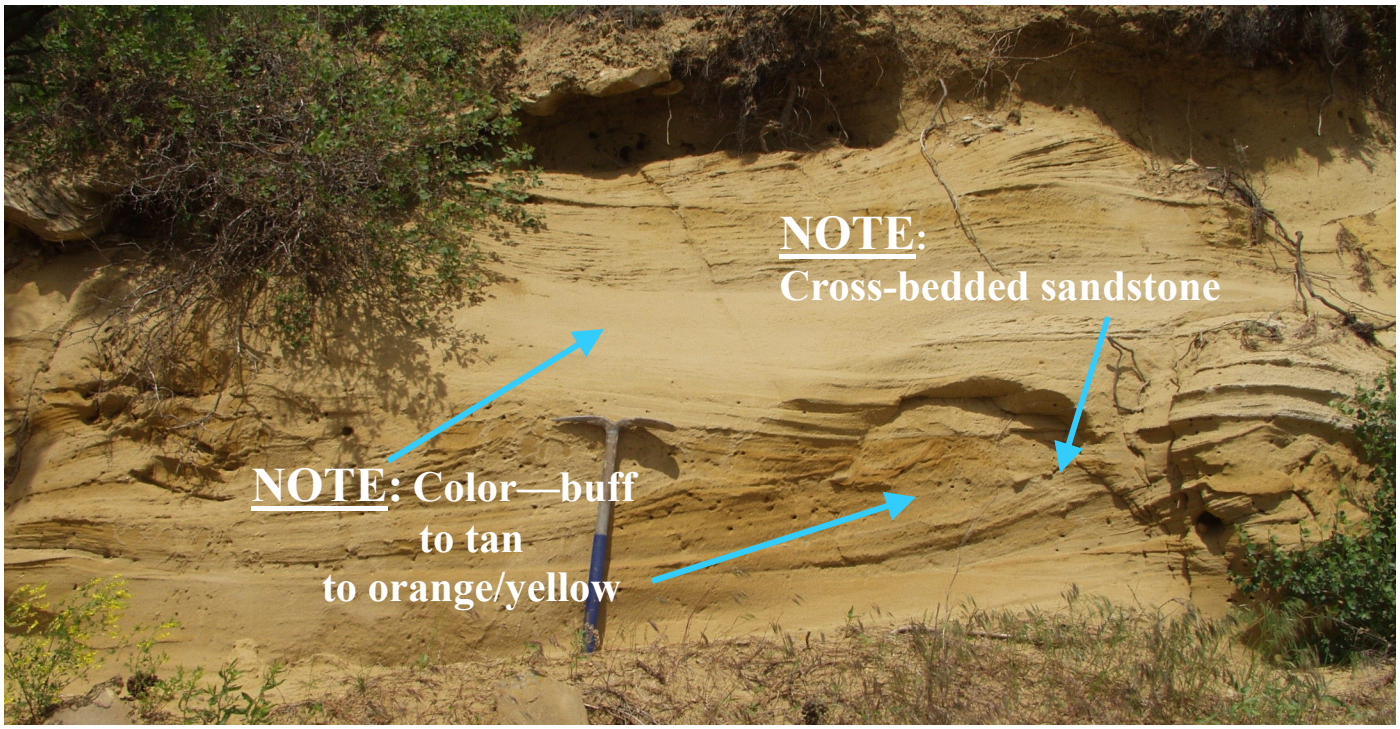
Rock unit is dominantly gray and gray-brown sandstone, siltstone and mudstone imbedded with yellow or orange, fine-grained sandstone. It is differentiated from the **Tongue River member of the Fort Union** which contains **bright yellow/orange to tan, buff and grays sandstone**. The formation contains numerous lignite beds, peat clay carbonaceous shales. Besides the characteristic layers mentioned, they contain ledge making sandstone lenses, soft sandstone and darker clays and shales. Unit can be as much as 100 ft. thick.

Tongue River Member – Recognized by its generally bright colors and bluff capping or ledge forming characteristics. The **formation consists of bright yellow/orange/brown colors with a porous texture** to a **massive orange/ yellows/buff and tan siltstones and sandstones**. Commonly **cross bedded** and has hard calcareous cementations which are sometimes **ledgemakers**. Alternating with the sands are hard to soft, gray to brown, thick shale beds with occasional iron stone concretions, peat clay, and woody lignite.

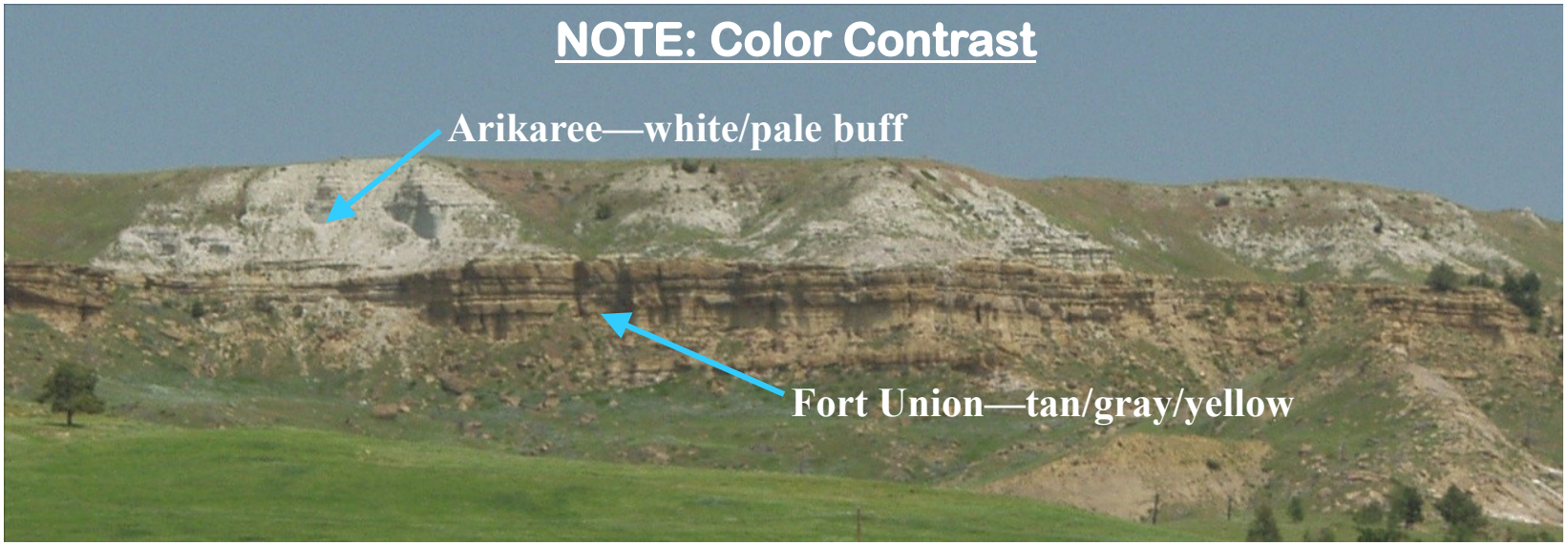

Non-Erionite Bearing Rocks, Fort Union Formation,
Tongue River Member,
North Cove Hills, Sioux District, CNF
Tongue River Member
NOTE:
Orange/yellow color
Competent massive
Cross-bedded sandstone
Contact zone between
Tongue River &
Ludlow Members
NOTE: Less massive to
slimy sand & clay stone
Contact Zone
Both Non-Erionite Bearing

Non-Erionite Bearing Rocks

Fort Union Formation Tongue River Member



Contact Between Arikaree Formation (Erionite) overlaying the Fort Union Formation (Non-Erionite) at a distance of about 10 miles from formations



ERIONITE ACTION PLAN FOR FIREFIGHTERS

Erionite Areas of Concern

These areas are predominantly identified on US Forest Service administered lands within the Sioux Ranger District, (the North and South Cave Hills have very small outcrops). The geologic formations also occur on adjacent lands managed by the BLM, MT DNRC, SD state lands and private individuals.

This plan is to be used when engaging in suppression action in the identified areas of concern (refer to accompanying map). In addition to specific areas identified, any ignition within the areas of concern may potentially have a high occurrence of naturally occurring Erionite bearing material.

ALARA CONCEPT

As **L**ow **A**s **R**easonably **A**chievable

Assumes there is no "safe" exposure to erionite.

Basic principles to consider:

- ✓ Reduce soil disturbance to minimize exposure to erionite (do not disturb soil if possible)
- ✓ Minimize the time spent within potential erionite smoke and dust
- ✓ Maximize distance from erionite source (indirect tactics)
- ✓ Increase travel distance between vehicles to avoid dust
- ✓ Close windows on vehicles when in travel status to and from incidents. Utilize a/c in vehicle and make sure that the air is re-circulating in the cab and not bring in outside air.

Procedures for Suppressing Fires in Erionite Areas

- **Upon report of an initial attack incident within the identified areas of concern with the use of the erionite hazard maps and photo guides.**
  - ✓ Initial briefing should include hazard awareness
  - ✓ Coordination will occur with duty officer (BLM) to ensure appropriate management response.
  - ✓ Limit access to erionite hazard areas during times of suppression actions.
  - ✓ Wash vehicles and other equipment at the incident before demob.
  - ✓ Wash fire clothing ASAP post exposure
  - ✓ Boots should be knocked free of excess soil on fire

Suppression Tactics **(!MINIMIZE SOIL DISTURBANCE!)**

- Incident Commander will implement tactics according to NWCG **M**inimum **I**mpact **S**uppression **T**actic guidelines
  - ✓ Establish non-soil disturbing anchor points whenever possible before engaging in suppression tactics
  - ✓ Utilize water during suppression operations
  - ✓ Use water tenders more during suppression operations to wet roads and supply more water to fires.

Aviation

- ✓ Identify helispots and staging areas with assistance from Sioux Ranger District personnel.
- ✓ Stay upwind of rotor operations and wet down helispots and helibases

Logistics

- ✓ Do not clear vegetation or trench to create bedding site.
- ✓ Travel between camp and fire should take into account dust prevention.
- ✓ For extended attack situations, camp should not be set up in areas with known erionite hazard soils.

Glossary of Geologic Terms

Bentonitic: Clay derived from decomposition of volcanic ash with a high content of the mineral montmorillonite. These types of clay can take on or release relatively large volumes of water. This wetting and drying produces the popcorn structure observed at the ground surface.

Competent: A rock formation which due to its inherent strength holds together when under stress. A rock unit that is relatively strong and not easily eroded or broken into smaller units.

Contact: The place or surface where two different types of rock meet.

Cross-bedded: Have convergent and divergent bedding within a rock or formation.

Massive: Homogenous structure or formation with limited individual bedding