Surficial Geology and Geologic Hazards of Bonita and Rhyolite Canyons, Chiricahua National Monument, Arizona

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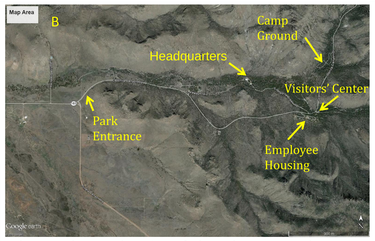
Introduction



A) Map showing location of Chiricahua National Monument in the Chiricahua Mountains in Arizona.
B) Map showing locations of park infrastructure.

Rhyolite weathered to form "hoodoos."

Geologic/Geomorphic Framework

- Turkey Creek Caldera: erupted 26.9 Ma, creating thick welded rhyolite of the Turkey Creek Formation.
- Basin and Range extension begins 20 Ma lowering the Sulphur Springs Basin relative to the mountains.
- Downcutting continues to modern time, sediment is removed through Bonita Canyon mouth and deposited in Sulphur Springs Valley.

View out of the mouth of Bonita Canyon, looking across Sulphur Springs Valley.

Climate

Climate Data Averages	
Minimum annual temperature	43.5 °F
Maximum annual temperature	73.3 °F
June temperature	90.5 °F
December temperature	30.2 °F
Total annual precipitation	19.02 in.
Annual precipitation as snowfall	10.3 in.

Vegetation

- Sky island
- High biodiversity area.
- Madrean mixed conifer-pine-oak forests and woodlands.
- Madrean pinyon-juniper-oak woodlands and grasslands.

Right) Map showing biomes of the study region (From Moore).

Figure showing moisture moving north from the Gulf of Mexico and Gulf of California during the monsoon (From DePodwin, 2012).

Monsoon Climate

- Receives half of total annual precipitation during summer monsoon from June to September.
- Generates thunderstorms that can cause flooding or spark wildfires.

Valley Deposits

- Qyr3 - Active channels, low terraces and bars
- Qyr2 - Broad valley floors, low terraces, and gravel bars and swales adjacent to active channels
- Qyr1 - Terrace deposits adjacent to active fluvial systems
- Qrt - Rhyolite Creek alluvial fan and terrace deposits
- Qaf - Young alluvial fan deposits
- Qdf3 - Younger tributary alluvial fan deposits
- Qdf2 - Intermediate tributary alluvial fan deposits
- Qdf1 - Older tributary alluvial fan deposits
- Qi - Intermediate alluvial fan and terrace deposits

Bedrock

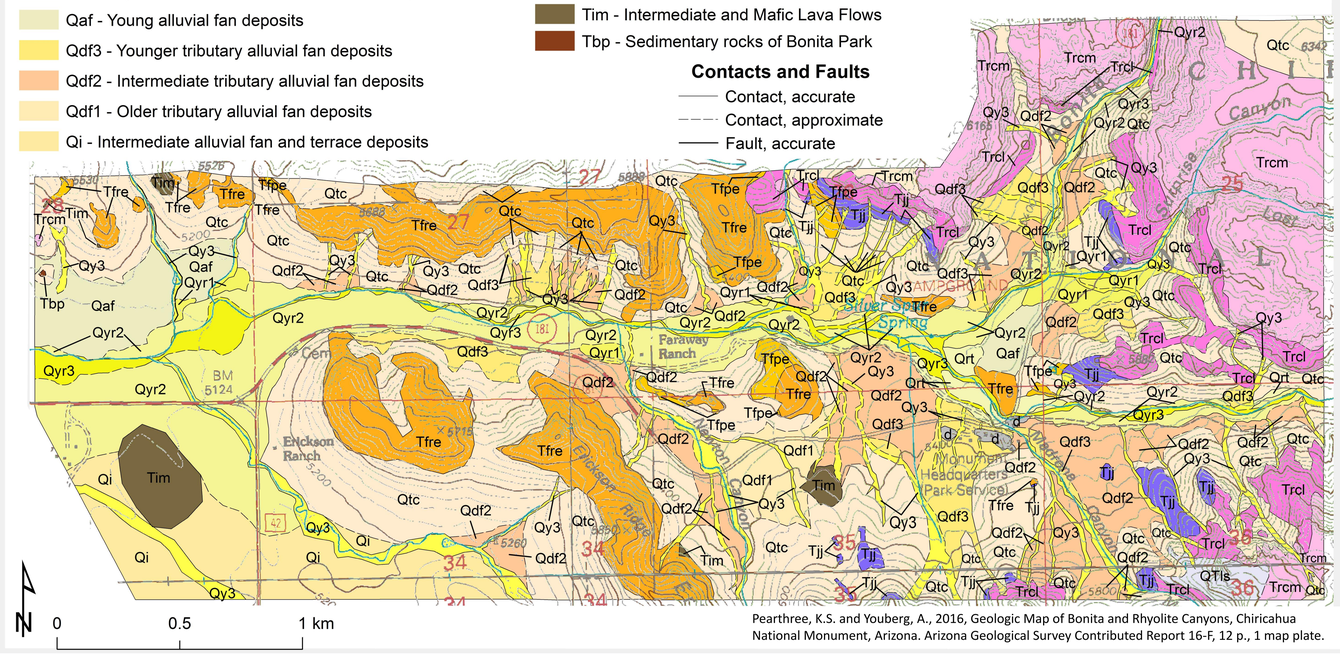
- Trcm - Turkey Creek Caldera outflow facies, middle member
- Trcl - Turkey Creek Caldera outflow facies, lower member
- Tjj - Jesse James Canyon Tuff
- Tfpe - Pyroclastic flow deposits of Erickson Ridge
- Tfre - Faraway Ranch Formation: Rhyolite of Erickson Ridge
- Tim - Intermediate and Mafic Lava Flows
- Tbp - Sedimentary rocks of Bonita Park

Other units

- d - Disturbed ground
- Qtc - Colluvium and talus
- QTls - Landslide deposits

Contacts and Faults

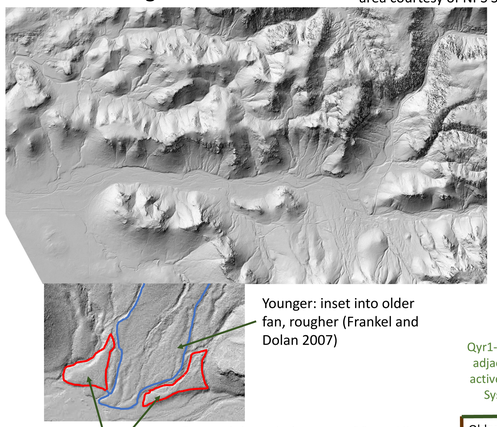
- Contact, accurate
- Contact, approximate
- Fault, accurate



Pearthree, K.S. and Youberg, A., 2016, Geologic Map of Bonita and Rhyolite Canyons, Chiricahua National Monument, Arizona. Arizona Geological Survey Contributed Report 16-F, 12 p., 1 map plate.

Relative Dating Method

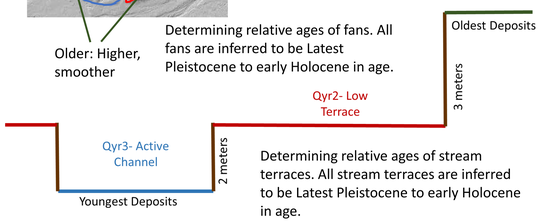
0.25 m resolution LiDAR of map area courtesy of NPS SOAR Office



Younger: inset into older fan, rougher (Frankel and Dolan 2007)

Older: Higher, smoother

Determining relative ages of fans. All fans are inferred to be Latest Pleistocene to early Holocene in age.

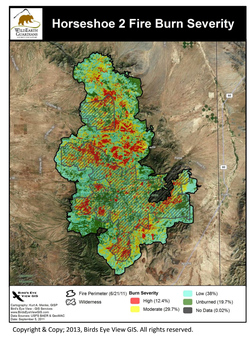


Determining relative ages of stream terraces. All stream terraces are inferred to be Latest Pleistocene to early Holocene in age.

Hazards

Wildfire/Debris Flow

- Horseshoe 2 Fire in 2011 burned 70% of Chiricahua Mountain Range.
- Most inactive alluvial fans are debris flow deposits.
- No evidence for recent debris flows in the Monument.
- Post Horseshoe 2 Fire debris flows occurred throughout the burned area of the Chiricahua Mtns.



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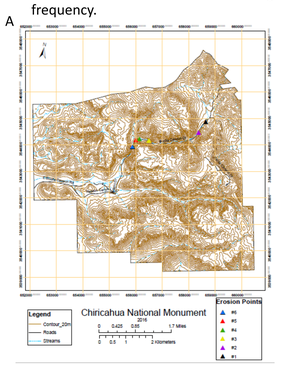
- Extensive amount of paleo-debris flow deposits indicates there may have been many debris flows earlier in Holocene.
- This may correlate to an increased rate of extensive burn or may be a climate-change signal in the Latest Pleistocene to early Holocene.
- Uncertainty of a changing climate: it is possible the number of large wildfires could increase, increasing the number of debris flows.

Flooding

- Flashy watersheds feed Bonita Creek.
- High risk to park infrastructure, especially during monsoon season.
- Horseshoe 2 Fire impacted soil and vegetation, increased runoff, and flood frequency.

A

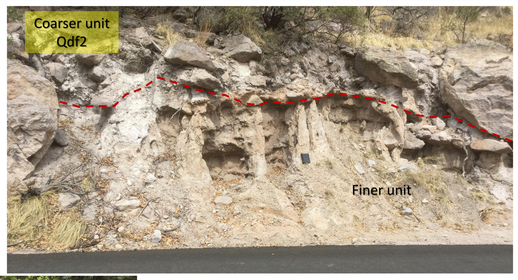


B

C

A) Map of erosion locations during monsoon flooding 2016. B) Flood deposits and damage near a culvert in Bonita Canyon Drive. C) Park staff inspect erosion. Map and photos courtesy of Colleen Fillipone and the National Park Service.

Left) Boulder levees on debris-flow dominated alluvial fan deposit unit Qdf2.



Above) Finer-grained alluvial fan deposit overridden by courser debris flow deposits of unit Qdf2. This may be the result of a change in climate or fire patterns. A future study could address this question. Finer unit is only exposed at this location; it is not included in the map.

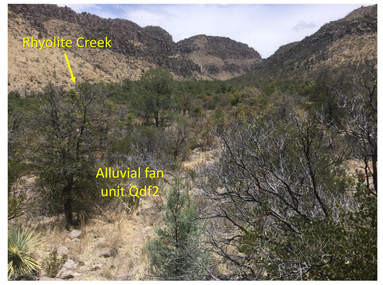
Above) Boulders in Rhyolite Creek active channel deposit (Qyr3). Rhyolite Creek carries much coarser material than Bonita Creek.

Left) Silt, sand, and gravel-sized clasts dominate Bonita Creek active channel deposit (Qyr3).

Right) Snout of a debris flow deposit consist of large boulders located on alluvial fan unit Qdf2.

Left) Boulders in bar and swale micro-topography on terrace unit Qyr2.

Left) Large boulder on terrace unit Qyr2. Could have been transported by flooding, debris flow or a combination of the two.



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