

## Geology & Cultural History of Grand Canyon-Parashant National Monument (GCPNM), Arizona

### GCPNM Parameters

- *Established* 11 Jan. 2000 - Exe. Order President W.J. Clinton
- *Land Management:* Bureau of Land Management & Natl Park Service
- *Footprint:* 1,017,200 acres (808,747 acres BLM; 208,453 acres NPS; 23,205 acres State Land); 7,290 acres private lands.
- *Cultural features:* 100+ archaeological sites, Designated Parashant International Night Sky Province, karst features (caves).
- *Current Use(s):* Recreation,

### Physiographic Features

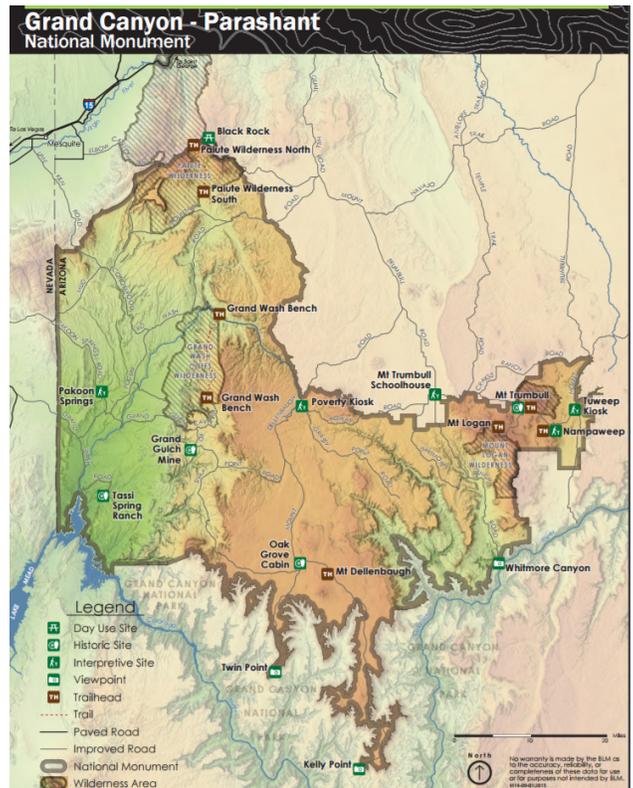
Colorado Plateau, Grand Canyon, Grand Wash Cliffs, Grand Wash Bench, Colorado River, Whitmore Canyon, Mt. Trumbull, Mt. Logan.

**Historical Mineral Resources:** Copper, Uranium, Lead, Zinc, Gold, Silver, Gypsum; most of the area is underlain by Kaibab Limestone, which lacks significant mineral resources outside of the breccia pipes and solution collapse features (Source, AZGS Briefing Paper 2015).

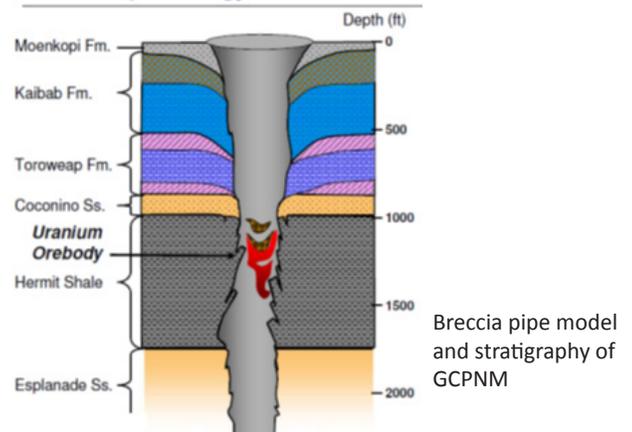
**Ore Deposits – Metals & Uranium.** The Northern Arizona Breccia Pipe Province includes most or all of the GCPNM. Breccia pipes are vertical pipe-like structures comprising broken rock (breccia). They are collapse features that originate in the cavernous Redwall Limestone and subsequently propagate upward through upper Paleozoic and lower Mesozoic rock formation. Uranium ore (U<sub>3</sub>O<sub>8</sub>) is hosted in the Hermit Shale at depths of 300 m to 900 m below the ground surface. Physically, breccia pipes are tens of meters in diameter and hundreds of meters in vertical extent and formed more than 200 million years ago.

In a recent review of breccia pipe density on the Colorado Plateau, Spencer and others (2015) inferred that there could be hundreds or even thousands of unidentified (buried) breccia pipes across the province. US Geological Survey scientists estimated that 10% of breccia pipes could host mineralization. The veracity of that estimate is questionable given the paucity of exploration data from the province.

Uranium ore extraction from breccia pipes of northern Arizona began in the 1950s (Wenrich, 1985). Rock samples hosting up to 55 percent U<sub>3</sub>O<sub>8</sub> yielding between 0.30 and 0.60 percent, and rarely 1 percent, uranium ore. Prior to the 1950s, copper ore was the chief focus of breccia mining, with accessory lead, vanadium, silver, and gold. Several pipes have yielded high concentrations of rare earth elements (REE), but there is simply too little exploration and production data to yield meaningful estimates of REE concentrations in mineralized pipes.



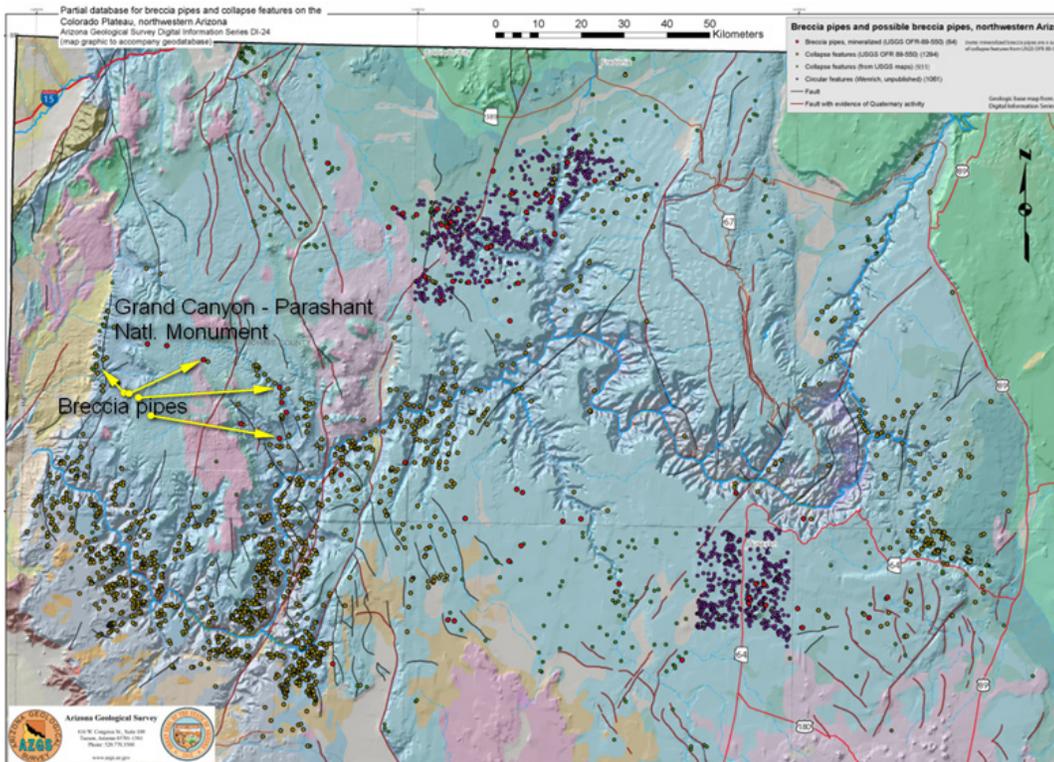
### Breccia Pipe Geology



The GCPNM hosts several dozen breccia pipes, including six mineralized pipes (figure on flip side).

**Concluding Statement.** Challenges facing Arizona's uranium ore industry are substantial: 1) stagnant uranium ore prices; 2) availability of inexpensive imported uranium ore; 3) plateauing of uranium consumption nationally; 4) the substantial political challenges to growing America's nuclear energy industry.





Breccia Pipe Province of northern Arizona, including the GCPNM area. Mineralized pipes are represented by red dots, other pipes and collapse features are represented by black dots.

### Recent or pending uranium mines in northern Arizona

Mineral exploration of northern Arizona's Breccia Pipe Province has been at a standstill since Secretary of the Interior Salazar withdrew public lands near Grand Canyon from new mining claims in January 2012. Production and establishing new mine sites continues at active mines and at mines that were being permitted. Table 1 shows uranium ore production values for select breccia pipe mines from northern Arizona.

- Canyon Mine. Operated by Canyon Mine and fully permitted, the Canyon Mine near Tusayan south of Grand Canyon is scheduled to go into production later in 2017. The uranium ore grade is 0.98%, a particularly rich ore.
- Arizona 1 Mine. Located near the Arizona – Utah border, ceased production in 2014.
- Pinenut Mine.
- Hack 1, 2, & 3.
- Kanab North
- Hermit
- Pigeon

### Select Literature Resources

AZGS Publications at <http://repository.azgs.az.gov>

Billingsley, G.R., Harr, Michelle, and Wellmeyer, J.L., 2000, Geologic map of the upper Parashant Canyon and vicinity, Mojave County, northwestern Arizona: U.S. Geological Survey, Miscellaneous Field Studies Map MF-2343, scale 1:31,680.

Finch, W.I., Sutphin, H.B., Pierson, C.T., McCammon, R.B., and Wenrich, K.J., 1990, "The 1987 estimate of undiscovered uranium endowment in the solution-collapse breccia pipes in the Grand Canyon region of northern Arizona and adjacent Utah," U.S. Geological Survey Circular 1051, 19 p.

[Grand Canyon – Parashant National Monument Bibliography](#) (dozens of potentially relevant mineral resource assessment documents)

Spencer J.E., Wenrich, K.J. and Cole, T., 2015, Partial database for breccia pipes and collapse features on the Colorado Plateau, northwestern Arizona, v 1.0. Arizona Geological Survey Digital Information, DI-42, 5 p., 1 map plate, shapefiles, and Excel Workbook.

Truini, Margot, 2013, Preliminary hydrogeologic assessment near Tassi and Pakoon Springs, western part of Grand Canyon - Parashant National Monument, Arizona: U.S. Geological Survey, Scientific Investigations Report SIR-2012-5276, scale 1:667,000.

Wenrich, K.J., and Titley, S.R., 2008, Uranium exploration for northern Arizona (USA) breccia pipes in the 21st century and consideration of genetic models, in Spencer, J.E., and Titley, S.R., eds., Ores and orogenesis: Circum-Pacific tectonics, geologic evolution, and ore deposits: Arizona Geological Society Digest 22, p. 295-309.

Wenrich, Karen J., and Spencer, Jon E., 2013, "Uranium and Rare Earth Element (REE) Resources in Northern Arizona Breccia-Pipe Orebodies," Geological Society of America Abstracts with Program, Vol. 45, No. 7, p. 610, [https://gsa.confex.com/gsa/2013AM/finalprogram/abstract\\_232631.htm](https://gsa.confex.com/gsa/2013AM/finalprogram/abstract_232631.htm)

Wenrich, Karen, 2015, "Colorado Plateau breccia-pipe uranium and REE resource estimates," unpublished report submitted to Arizona Geological Survey, 5 pages.