



## Zircon Crystals of Volcanic Origin Allow the First Radiometric Age in the Vicksburg Group of Mississippi

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Zircon is a birthstone for the month of December, but geologists know it as a birthstone for the Earth. The oldest known rocks on earth are zircon crystals from Jack Hills, Australia (Figure 1), with a radiometric age of 4.375 billion years plus or minus 6 million years (*Nature Geoscience*, February 23, 2014). Zircon crystals are one of the toughest mineral substances and preserve a trustworthy chemical record. Zircons occur as grains in the heavy mineral fraction of recent and ancient beach sands along the Gulf and Atlantic Coastal Plains and are an ore of zirconium. Zirconium serves as a refractory (a substance resistant to heat) and opacifier (a substance added to make a material opaque) but is also a tough metal, highly resistant to both heat and chemical corrosion, used to clad fuel rods in nuclear reactors.

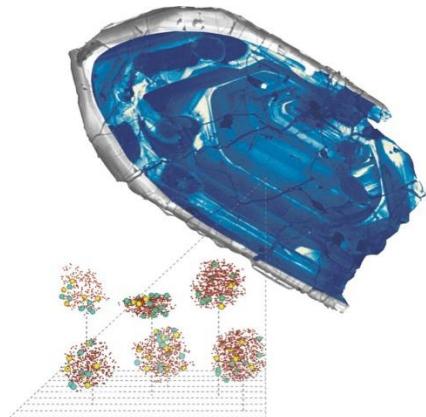


Figure 1. Cathodoluminescence image of a 400-micron zircon and the 3-D map made by atom-probe tomography of a group of 10-nanometer clusters of radiogenic atoms of lead with an age of 4.375 billion years (John Valley, University of Wisconsin).

Zircon crystals contain trace amounts of uranium and thorium and can survive geological processes such as high-grade metamorphism and erosion. For this reason, they are valuable as sources for uranium-lead radiometric age dates. LaFleur, Miller, Yancey, and Dockery published an article in the 2018 Gulf Coast Association of Geological Societies Transactions (pages 299-307) on "Zircon Geochronology of Glendon Formation Bentonite, Rankin Trails Park, Brandon, Mississippi." This article came about after Yancey read "Geological Finds at the Rankin Trails Park and Amphitheater" in May 2017 issue of MDEQ's *Environmental News*. The article illustrated a foot-thick bentonite clay layer at the base of the Glendon Limestone of the Vicksburg Group (figures 2 and 3).

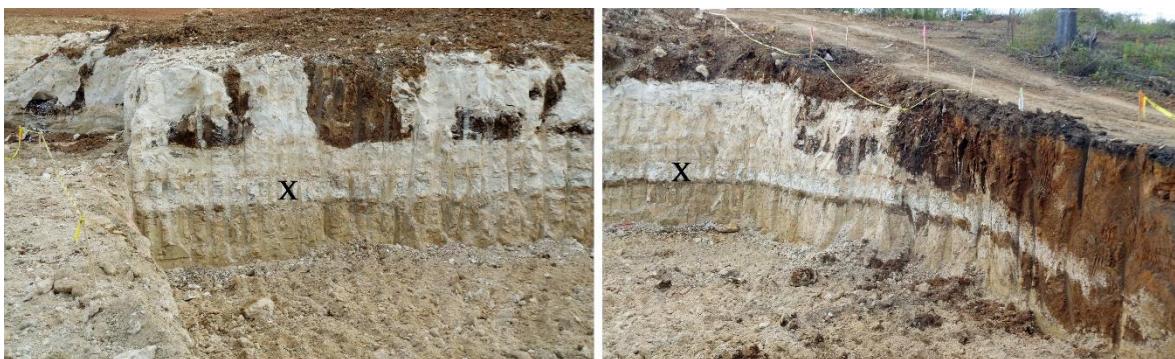


Figure 2. Karst caverns in the lower ledge of the Glendon Limestone filled with clay from the overlying Bucatunna Formation. Xs mark the location of the bentonite bed below the Glendon Limestone. Pictures were taken on October 27, 2016.



Figure 3. Left, trackhoe operator uncovers bentonite bed for sampling. Right, Tyler Berry (at left) and a Millsaps student collect bentonite samples. Pictures were taken on October 27, 2016.

Within an hour of the article's release, a request was received from Yancey for a bentonite sample for radiometric age analysis. Upon arrival at Texas A&M University, a five-kilogram sample of bentonite was sieved and sorted for zircon crystals. Small rounded crystals in the extracted sample are detrital, heavy-mineral grains derived from continental bedrock, while the prismatic, euhedral (with pristine crystal faces) crystals are of fallout volcanic ash origin (Figure 4).



Figure 4. Morphology of zircon crystals extracted from bentonite at the base of the Glendon Limestone at Brandon, Mississippi.

Zircon crystals were analyzed by laser ablation inductively couple plasma mass spectrometry (LA-ICP-MS) at Texas A&M University. Detrital crystals with a small rounded morphology yielded radiometric ages clustering around 900-1300 million years and 400 million years old. The older age is from Grenvillian orogenic rocks of the Appalachian Piedmont (980-1,250 million years old), and the younger age is from rocks of the Taconic-Acadian orogenic phase of the Appalachian Mountains (350-420 million years old). The larger prismatic, euhedral, volcanic crystals had an age of around 30-35 million years old.

Subsequent to publication, the crystals of a volcanic source were dated with thermal ionization mass spectrometry dilation (ID-TIMS), which determined a more precise date that is now in press in the *Journal of Geology* (March 2019 issue). This age will tie the Vicksburg bentonite to volcanic eruptions of similar age in the American West and will provide an important date within the Rupelian Stage (28.1-33.9 million years old) of the Early Oligocene Epoch, the age of the Vicksburg Group.