

# SANDS AND GRAVELS IN BUTLER CAVE (BATH COUNTY, VIRGINIA) ARE FLUVIAL FLOOD-PULSE DEPOSITS THAT ACCUMULATED IN PERMAFROST ENVIRONMENTS ~ 108,000–104,000 YEARS AGO (MIS 5D) AND ~ 52,000–27,000 YEARS AGO (MIS 3)

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## Abstract

Butler Cave is on the east flank of Jack Mountain in Burnsville Cove, Bath County, Virginia. Water flows down the mountain over Silurian sandstone and shale until it encounters the Silurian Tonoloway Limestone, where water enters the cave via sinkholes. These sinkholes connect to joint-controlled cave passages that descend to the southeast and intersect the northeast-trending cave trunk passage. One of these joint-controlled passages is Dave's Gallery, which extends southeast from the SOFA entrance of the cave to the trunk passage. Where Dave's Gallery shifts to the northeast toward Rimstone Passage, an alcove in the southwest wall contains a ~ 4.9 meter (m)-thick exposure of sand and gravel. In 2022, sand from a bed ~ 0.3 m above the base of this exposure yielded an optically stimulated luminescence (OSL) age of  $99,910 \pm 7,890$  years (USGS OSL sample BC6), and sand from a bed ~ 3.6 m above the base of this exposure yielded an OSL age of  $110,490 \pm 6,910$  years (USGS OSL sample BC5). Along the cave trunk passage, an ~ 250-m-long, 6–8-m-high, and 7–30-m-wide section of the passage named Sand Canyon contains several 2–3 m high terraces of sand and gravel along the passage sides. Each terrace consist of an ~ 2 m thick lower unit of poorly sorted sand and gravel (mostly cobbles and pebbles), overlain by an ~ 0.5 m thick upper unit of medium sand with parallel laminations. In 2022, sand from the lower unit of sand and gravel at a terrace named Sand Canyon Camp yielded an OSL age of  $28,320 \pm 1,040$  years (USGS OSL sample BC4). Also in 2022, sand from the lower unit of sand and gravel at the terrace ~120 m northeast of Sand Canyon Camp yielded an OSL age of  $49,480 \pm 2,430$  years (USGS OSL sample BC3), and sand from the upper unit of medium sand at this terrace yielded an OSL age of  $33,460 \pm 2,160$  years (USGS OSL sample BC2). In 2020, sand from the upper unit of medium sand at a terrace ~ 70 m northeast of Sand Canyon Camp yielded an OSL age of  $34,090 \pm 3,210$  years (USGS OSL sample BC1). These sediments from Butler Cave are interpreted as deposits of fluvial flood-pulses during spring thaw when the area was affected by permafrost. The sediments in Dave's Gallery were deposited ~ 108–104 thousand years ago (ka) during marine isotope stage (MIS) 5d, whereas the sediments of the terraces in Sand Canyon were deposited ~ 52–27 ka during MIS 3.

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