



Final Report for NPS Permit number DEVA-2019-SCI-0035 (NPS permit application 451309) “Request for bat guano from Devils Hole Cave 2, Nevada”

by

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Abstract

During the past three decades, studies at Devils Hole, Nevada, have identified high uranium concentrations in mammillary calcites. Devils Hole Cave 2 is home to bats, and it has been proposed that a source of uranium is bat guano. The mass fraction of uranium in bat guano collected from Devils Hole Cave 2 was as high as 3.07 $\mu\text{g/g}$. We conclude that bat guano can serve as a source of uranium within calcites having high uranium concentrations.

Introduction

During the past three decades the U.S. Geological Survey (USGS), as well as others, have conducted investigations of Quaternary paleoclimate at Devils Hole and at Devils Hole Cave 2, both part of Death Valley National Park (Carr, 1988; Coplen et al., 1994; Hoffman, 2017; Ludwig et al., 1992; Ludwig et al., 1993a,b; Moseley et al., 2016a,b; Riggs et al., 1994; Szabo et al., 1994; Wendt et al., 2018a,b; Wendt et al., 2020; Winograd et al., 1988; Winograd et al., 1992; Winograd et al., 1997; Winograd et al., 2006). Some of these studies, especially the study of Szabo et al. (1994) in Brown’s Room, have identified high uranium concentrations in mammillary calcites that line the walls of these caverns. The source of these high concentrations of uranium is a mystery and deserves investigation. Devils Hole Cave 2 is home to bats and it has been proposed that bat guano is enriched in uranium. In order to evaluate this hypothesis, a campaign to collect a small amount of bat guano from Devils Hole Cave 2 and analyze it for its uranium concentration was proposed and undertaken.

Methods

Sample collection

To collect bat guano and soil samples, National Park Service (NPS) personnel identified two local caving experts (Randall Paylor and Jessica Preston), who would be capable of descending into Devils Hole Cave 2 via repelling from the surface in a conscientious manner to avoid damage to the bat's habitat.

Sample analysis

Measurements of uranium in bat guano were performed by microwave-assisted digestion with nitric acid followed by inductively coupled plasma–mass spectrometry (ICP-MS) using an Agilent 7900 ICP-MS at the U.S. Geological Survey National Center, Reston, Virginia.

Results

Guano and soil samples were collected by local caving experts Randall Paylor and Jessica Preston on January 8, 2020. Bat guano was distributed in Devils Hole Cave 2 thinly all along the slope down to the water table (Figure 1). The concentration of bat guano increased at the water's edge. There was a “bathtub ring” of guano at the water line, some of it dry and some recently wet. There was guano underwater that had settled onto the sloping shelf. Some of the guano had floated on the water surface and adhered to the back wall.

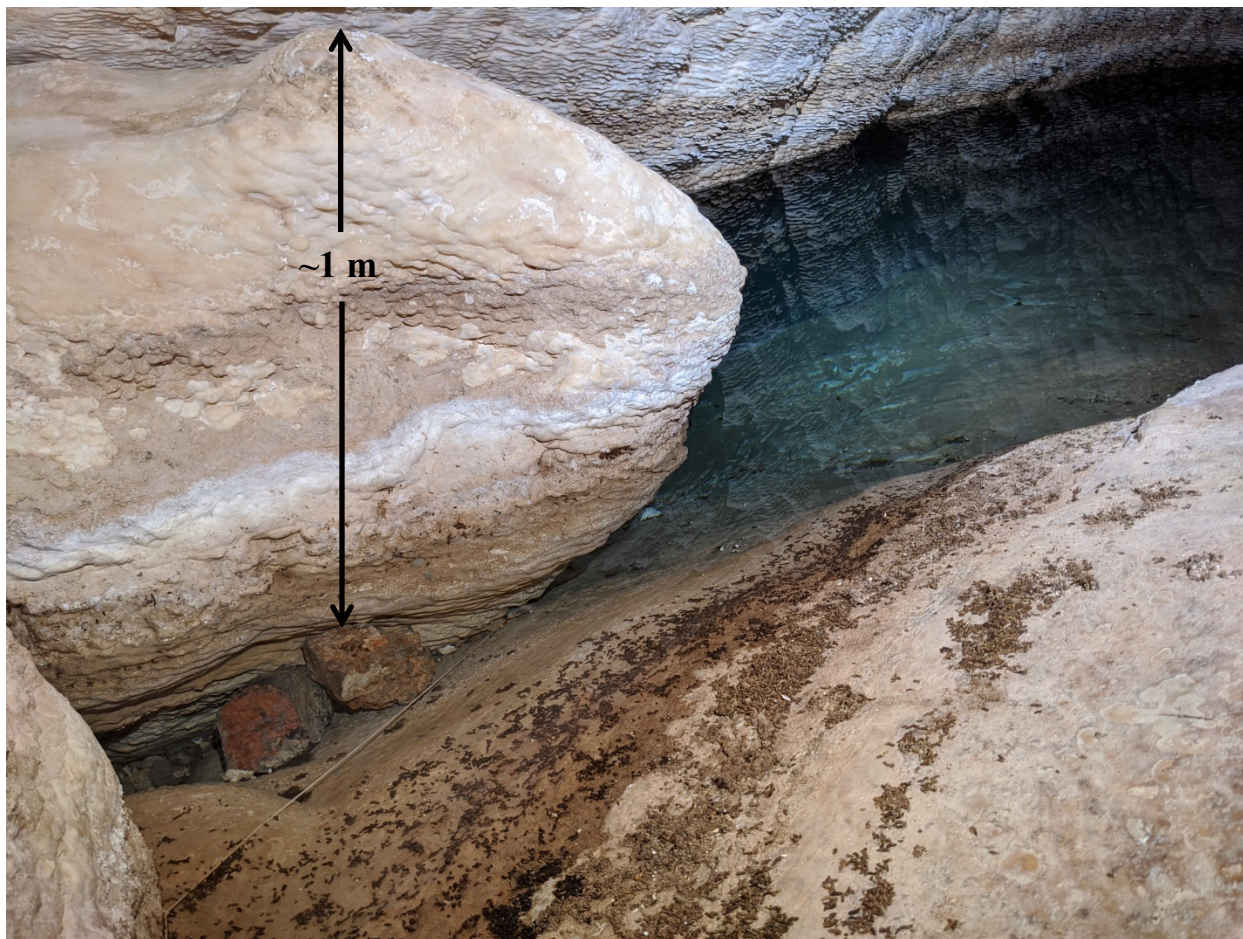


Figure 1. Bat guano on shelf in lower right of photograph of Devils Hole Cave 2. Photo by Randall L. Paylor, U.S. Geological Survey.

Three samples of bat guano were collected: one at the water level, one about 1.7 m above water level, and one about 5 m above water level. Samples were shipped to the National Center of the U.S. Geological Survey. Bat guano and soil samples were analyzed. Uranium mass fractions ranged between 0.78 and 3.07 $\mu\text{g/g}$, the highest of which was bat guano.

Discussion and Conclusions

Szabo et al. (1994) measured the uranium concentration of mammillary calcite and folia samples from Browns Room, a subterranean air-filled chamber connected to Devils Hole. The mass fraction of uranium ranged between 0.428 and 2.91 $\mu\text{g/g}$. We conclude that bat guano can serve as a source of uranium in mammillary calcite in the Devils Hole system, some of which has high uranium concentrations. How the uranium might have been transported into Browns Room remains a mystery in that presently this room is not open to the atmosphere.

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