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Preliminary Results on Growth Rate and Paleoclimate Studies of a Stalagmite from Ogle Cave, New Mexico

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ABSTRACT

$^{230}Th/^{234}U$ dating and morphologic study of a portion of a stalagmite from Ogle Cave, New Mexico indicate continuous deposition from about 205,000 to 125,000 years B.P. This is the period to which is commonly assigned the penultimate glaciation in North America, suggesting that deposition of speleothems in arid areas of the western United States was more intense during the pluvial periods accompanying glaciation than at present.

INTRODUCTION

IN MARCH, 1975, an upper portion of a broken stalagmite estimated to have been 33 cm in diameter was collected from the floor of Ogle Cave, New Mexico. It is believed that the stalagmite was previously broken during guano mining in the cave, but this is not certain. The section of the stalagmite studied here is shown in Figure 1.

ANALYTICAL RESULTS

The top and bottom 2 cm of a 2.5 cm slab from the inner portion of the stalagmite section were dated by the $^{230}Th/^{234}U$ method using a procedure slightly modified from that described by Thompson (1973). The details, assumptions, and limitations of the method have been previously presented in Harmon, *et al.* (1975). Analytical data for the Ogle Cave stalagmite are given in Table 1.

The uncertainties in the isotope ratios are large, due to the low U content of the specimen and the small sample (40 g) used for each analysis. Nevertheless, we have confidence in the calculated ages because the ages are in correct stratigraphic order and no detrital Th was detected.

The detailed morphology and crystal growth of the stalagmite was also studied. There are no apparent internal discontinuities, and crystal growth appears to be quite uniform across the specimen from bottom to top. As well as can be determined, the growth layers are equally spaced parallel to the growth axis. This would imply growth under a nominally constant rate of water supply. The uppermost growth layer (about 1 cm at the apex—see Fig. 1) converges more rapidly than the others, indicating a final period of growth under conditions of reduced flow. The outer surface of cave "coral" suggests a period of increased dessication before the stalagmite finally stopped growing (or was broken naturally).

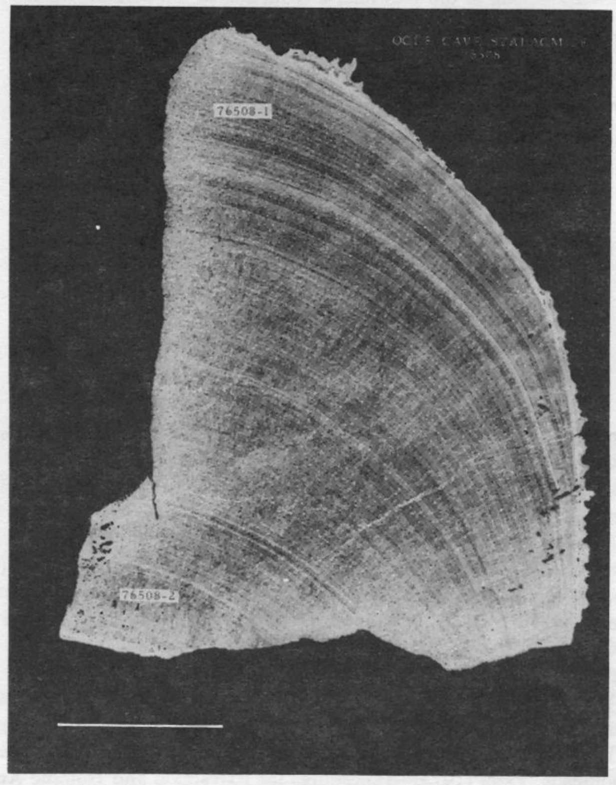

Figure 1. Photograph of the Ogle Cave stalagmite, made from an acetate surface peel. The $^{230}Th/^{234}U$ dated horizons are indicated. Note the equal spacing of growth layers and the more rapid convergence of the topmost growth layer.

TABLE 1. Uranium concentrations, isotope activity ratios, and calculated ages for the Ogle Cave stalagmite.

Sample Number	Description	U conc. (ppm)	$\frac{^{230}Th}{^{234}U}$	$\frac{^{234}U}{^{238}U}$	$\frac{^{230}Th}{^{232}Th}$	Calculated Age (x10³ years B.P.)
76508-1	top layers	0.25	.713 ± .08	1.28 ± .07	g.t. 1000	126 ± 26
76508-2	basal layers	0.27	.849 ± .07	.985 ± .06	g.t. 1000	207^{+64}_{-40}

The average rate of water supply can be estimated. The stalagmite grew at an average rate of 6.4×10^{-12} cm/s which, for an equilibrium stalagmite 33 cm in diameter, implies a volume accretion rate of 5.4×10^{-9} cm³/s (Curl, 1973). With water bearing from 4 to 20 x 10^{-5} cm³ precipitable solid calcite per cm³ solution (the range for saturated solutions from 10° to 25°C and P_{CO_2} from 0.001 to 0.1 atm) the flow rate would have been between 2.7×10^{-5} and 1.4×10^{-4} cm³/s. For drop volumes of about 0.075 cm³, the period between drops would have been from 500 to 3000 seconds. Considerable temporal variation was likely, which may have contributed to the banding shown in Figure 1.

DISCUSSION

There is much evidence to suggest that lakes in many presently arid regions were expanded or created during the Pleistocene glacial epochs (see summary in Flint, 1971), due to an increase in the ratio of precipitation to evaporation. An example of this is the classic study of Gilbert (1890), which related the maximum lake levels of ancient Lake Bonneville to periods of glaciation in the adjacent area. In New Mexico, Leopold (1951) developed a model for glacial Lake Estancia based upon a lowering of the snowline, a reduction in temperature, and an increase in precipitation during the last glacial period. Under such conditions, it is likely that there would be a concurrent increase in regional plant cover and ground water recharge. The result of this climate change should be an increase in both drip rates and dissolved carbonate in subjacent cave seepage waters and ultimately an increase in the rate of speleothem deposition.

Our study indicates that the Ogle Cave stalagmite grew continuously from about 205,000 to 125,000 years B.P. This 80,000 year period is synchronous with the penultimate glaciation, as recorded in the marine and terrestrial paleoclimate records (see, *e.g.*: Mesolella, *et al.*, 1969; Bloom, *et al.*, 1974; Shackleton and Opdyke, 1973; Pierce, *et al.*, 1976). We feel that it is likely that the Ogle Cave stalagmite began growing shortly after the initiation of North American glaciation some 200,000 years B.P., at which time climate in New Mexico changed from arid to pluvial. Deposition was continuous over the next 80,000 years, slowing somewhat during retreat of the continental glaciers at about 125,000 years ago as the change back from pluvial to arid climate conditions was realized. The "coraline" surface overgrowth probably is indicative of the deposition that occurred during the arid interglacial conditions was realized. The "coraline" surface overgrowth probably is indicative of the deposition that occurred during the arid interglacial was broken by some natural cause or that the feeder channels became inactive during the last interglacial period.

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