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Article 151

FLUVIAL SEDIMENTATION IN MAMMOTH CAVE, KENTUCKY

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Work done in cooperation with the National Park Service

Abstract.—Alternating deposition and erosion occur in Mammoth Cave by flooding from the Green River. In 2½ years, numerous low floods deposited 0.5 foot of sediment in the lowest levels. Three high floods removed that sediment, but caused thinner deposits at higher levels. The coarsest sediment is deposited in the lower parts of the cave.

The sources of sediment and rate at which it is being deposited in Mammoth Cave, Ky., have long been of interest to geologists and speleologists. Detailed measurements by the U.S. Geological Survey of erosion and deposition between October 1959 and June 1962 indicate that sedimentation in the cave is closely related to flooding of the nearby Green River.

The Green River, which is hydraulically connected to Mammoth Cave by Echo River spring and River Styx spring, is the chief source of sediment and floodwater to the cave. These springs are submerged during floods of the Green River, and water then enters the cave through them so that the water level in the cave corresponds closely to the level of the Green River (Hendrickson, G. E., 1961). W. E. Davies and E. C. T. Chao (written communication, 1959) found in their studies of Mammoth Cave that the sediments in the lower levels of the cave are similar in physical character and mineralogy to the sediments on the flood plain of the Green River. The turbulence and velocity of the floodwater entering the cave are sufficient to transport sediment into the cave, particularly during rapidly rising water levels. These same forces may cause a flushing of sediment from the cave during rapidly falling water levels.

Thirteen lines were surveyed across cave passageways that are subject to flooding, and the elevations above gage datum of the sediment deposits on these lines were determined. These lines, or ranges, served as bases from which changes in deposition were determined by later surveys. The approximate locations of the ranges are shown in figure 151.1, and the elevations of the cave floor at each range are shown in the accompanying table.

Resurveys of the ranges in August 1961 and in January and June 1962 indicated that the greatest changes in deposition occurred at the lowest elevations (see table). Alternating deposition and erosion were observed at some ranges. Movement and redeposition of sediments were shown by recovery of ribbons placed vertically in the deposits of sediment. The lower and more frequent floods apparently caused deposition in the boat-ride section of Echo River. The higher and less frequent floods, however, tend to remove these deposits from the Echo River channel but cause deposition at the highest flooded and intervening levels.

From October 1959 to January 1962, as much as 0.4 foot of sediment was deposited in the boat-ride section of Echo River (ranges 1, 2, 3, table). In the higher passages, at elevations of 5 to 25 feet above the gage datum, only small changes in deposition or erosion were observed. No floods exceeded 31.4 feet during this period, although 2 floods exceeded 21.5 feet and 8 exceeded 17.7 feet.

Three floods exceeded 21.5 feet in January, February, and early March 1962. One of these floods reached 57.1 feet and is the highest flood of record. All three floods generally caused deposition in the passages above the 5-foot elevation, but they removed about 0.5 foot of sediment from the boat-ride section of Echo River.

The particle size of the deposited sediment is somewhat related to the elevation of the deposit. Deposits at elevations below 16 feet are predominantly sand (0.062 to 2.0 mm diameter), and the deposits at higher elevations are predominantly silt (0.004 to 0.062 mm diameter). This correlation is shown by the grouping of points in figure 151.2, a plot of the median particle

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Flooding and changes in deposition at sedimentation ranges in Mammoth Cave, October 1959 to June 1962

Range No.	Elevation of cave floor (ft) Oct. 1959 [1]			Oct. 1959 to Aug. 1961			Aug. 1961 to Jan. 1962			Jan. 1962 to June 1962			Oct. 1959 to June 1962		
	Low	High	Mean	Times flooded [2]	Percentage of days flooded [2]	Net change (ft)	Times flooded [2]	Percentage of days flooded [2]	Net change (ft)	Times flooded [2]	Percentage of days flooded [2]	Net change (ft)	Times flooded [2]	Percentage of days flooded [2]	Net change (ft)
1	−1.3	+5.0	+0.3	------	100	+0.48	------	100	−0.03	------	100	−0.55	------	100	−0.10
2	−4.9	−.3	−2.1	------	100	+.20	------	100	------	------	100	[3] −.45	------	100	−.25
3	−3.2	+1.7	−1.6	------	100	+.34	------	100	------	------	100	[3] −.46	------	100	−.12
4	−8.0	+1.5	−5.4	------	100	.00	------	100	------	------	100	[3] +.04	------	100	+.04
5	5.2	18.1	9.8	18	34	+.22	2	17	−.15	6	58	−.24	26	36	+.31
6	13.4	18.2	15.3	19	12	−.11	2	7	+.08	6	20	−.18	27	12	+.15
7	11.2	14.9	11.9	18	15	+.01	2	7	+.14	6	23	+.42	26	15	+.57
8	3.5	11.4	6.6	15	77	−.10	6	29	−.13	------	100	+.33	21	75	+.10
9	3.4	9.5	5.6	15	86	−.29	6	44	+.07	------	100	+.13	21	83	−.09
10	17.8	24.6	20.0	6	4	+.05	1	2	.00	3	14	+.13	10	6	+.18
11	17.7	26.4	20.3	7	4	+.13	1	2	+.06	3	14	−.02	11	6	+.17
12	21.5	30.9	25.6	2	1	−.11	0	------	------	3	10	+.28	5	3	+.17
13	31.4	34.5	32.2	0	------	------	0	------	------	1	5	+.20	1	1	+.20

[1] Arbitrary gage datum. [2] Includes both complete flooding and partial flooding. [3] August 1961 to June 1962.

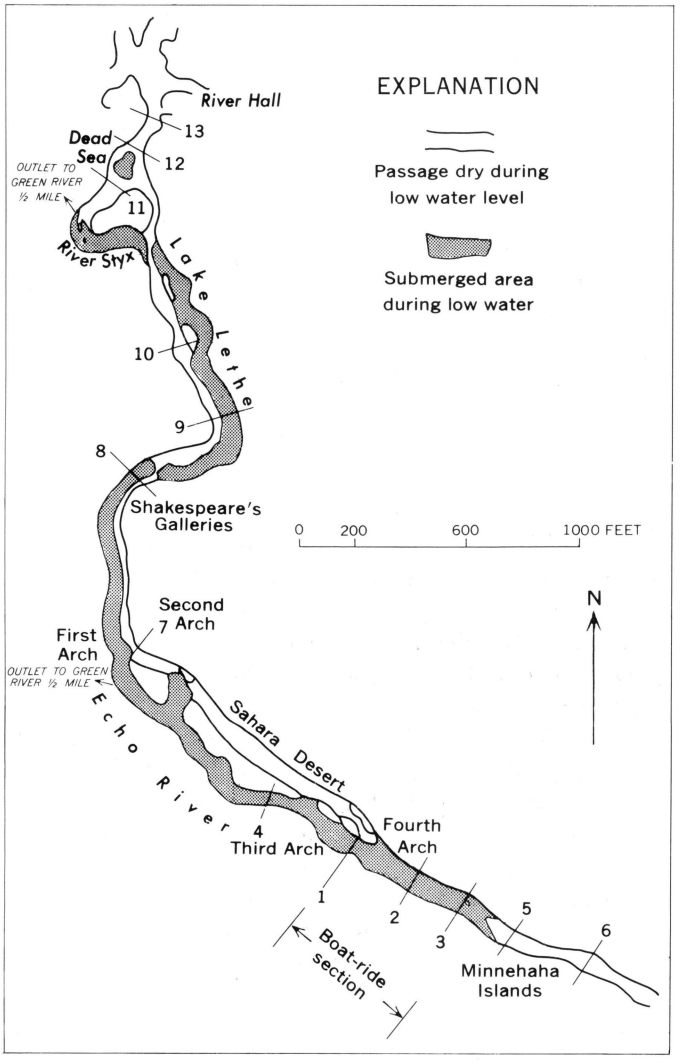

FIGURE 151.1.—Map of lower level of Mammoth Cave, showing approximate location of sediment ranges. Pattern indicates area submerged at low water level. Base from National Park Service map, 1935.

size against the average elevation of the floor at each range. A noticeable inconsistency in this grouping is the January 1962 sampling from ranges 7 and 8. The samples from these two ranges included only the surface material, whereas samples at the other ranges were taken at depths of 1 to 4 feet.

The coarser particles tend to migrate by successive floods to higher elevations. This conclusion is supported by the position of the June 1962 triangles in figure 151.2 for elevations between 10 and 25 feet. Sediment deposited at these elevations generally had a larger median diameter after the floods of January to March 1962 than before. This increase in median diameter would occur if, during rising water level, there were sufficient turbulence and velocity to

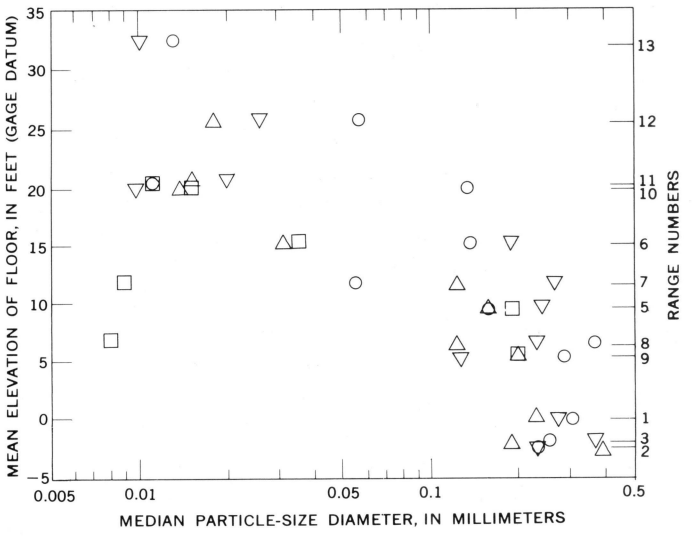

FIGURE 151.2.—Relation of median particle size of deposited sediment to mean elevation of floor, Mammoth Cave, Ky. Circles, samples taken October 1959; triangles (point up), August 1961; squares, January 1962; triangles (point down), June 1962.

transport coarser particles through the passages to settle at higher elevations. Hydrographs of the water level in the cave show that during floods the water generally rises more rapidly than it falls. Turbulence and velocities probably are greatest during the more rapidly changing water levels during the rise of a flood.

Clay particles are more easily transported than silt or sand and therefore are moved for greater distances by floodwater. After every flood, a thin layer of clay is deposited over all the submerged passageways. The record flood in February–March 1962 left an average deposit of 0.2 foot of clay and silt at range 13, elevation 32.2 feet.

The three resurveys of the range lines in Mammoth Cave over a period of less than 3 years provide an indication of sediment movement in the cave. Deposition or erosion during a given flood depends upon (1) the rate at which the water rises, (2) the height of the flood, (3) the duration of the flood, and (4) the rate of fall. The rate of rise or fall and the height of the flood influence the turbulence and velocity of the water in the cave and, therefore, the capacity of the water to transport sediment. The duration of the flood, particularly the period of little change in water level at the flood crest, determines the time available for settling and deposition of the sediment.

REFERENCE

Hendrickson, G. E., 1961, Sources of water in Styx and Echo Rivers, Mammoth Cave, Kentucky: Art. 308 *in* U.S. Geol. Survey Prof. Paper 424–D, p. D41–D43.