Calcite-Aragonite Speleothems from a Hand-Dug Cave in Northeast Kansas

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With one figure in the text

Recently, the writers were informed that a speleothem-containing cave was present in Doniphan County (Section 2 NENW, Township 2S, Range 22E), Northeast Kansas. A field trip to the area and an informative conversation with the cave owner, Mr. Oliver Propheter, aided us in locating the cave in the bluff overlooking the Missouri River. The cave was apparently hand-dug in a Pennsylvanian shale below a dolomitic cap-rock and is estimated to be between 150 and 200 years old. Local lore has it that American Indians originally excavated the cave and that during the Civil War and thereafter, the same cave was frequently used as a hiding place. It was reported to at one time have been high enough for a man to stand in. At present, the cave is about 12 meters long, two meters wide, and one meter high. Slumping from the sides has caused considerable filling.

Speleothems are present throughout the cave in the form of stalactites (straws and solid), linear stalactitic growths, flowstone, ceiling crust, and popcorn growths around pieces of the ceiling rock that have fallen into a pool of standing water in the back part of the cave. Maximum stalactite length is about three centimeters and crusts and flowstone have thicknesses of about one to three millimeters. If the estimated age of the cave is correct (i.e., 150 to 200 years old), the maximum rate of stalactite growth along the stalactite vertical axis is about 0.20 to 0.15 millimeters per year. Moore (1962) notes that the rate of stalactite growth is variable, but that it never exceeds several millimeters per year; he also states that unpublished observations

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suggest that the average rate of stalactite elongation is about a quarter of a millimeter a year. Radiocarbon data (Broecker and others, 1960) give a growth rate of 0.06 millimeters a year for a stalagmite from Moaning Cave, California. The growth rate given in this study, 0.15 to 0.20 millimeters per year, is consistent with the estimates given above and those given in Table 1.

X-ray diffraction determinations of the speleothem mineralogy showed that the stalactites contain only calcite and aragonite with calcite being the dominant mineral (Figure 1a). The flowstone and ceiling crust have this same mineralogy but contain detrital siliceous impurities (Figures 1b and 1c). Linear stalactitic growths have aragonite as the major carbonate mineral (Figure 1d). A small pool of water exists in the rear of the cave and pieces of the ceiling rock which had dropped into the pool in the past are now enclosed by a popcorn type growth which is 100 percent calcite (Figure 1e).

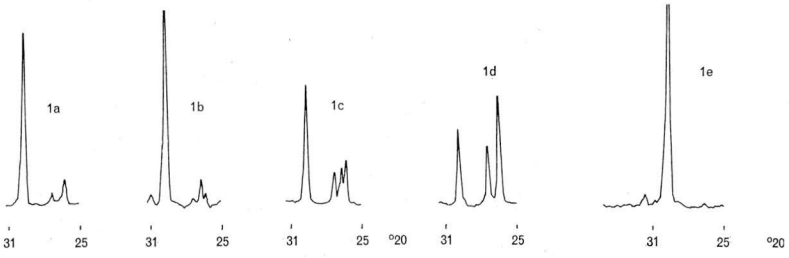

Figure 1.

X-ray diffractogram of selected speleothems from Propheter's Cave, Doniphan County, Northeast Kansas.

Qualitative emission spectrograph analyses of the ceiling rock, the encrusted wall rock (shale), and the different speleothem types, are given in Table 2. It should be mentioned that the dolomitic nature of the overlying carbonate ceiling rock is reflected in the slightly higher 2 ⌀ position of the major carbonate diffraction peaks of the speleothems. A most interesting aspect of the chemical data is the apparent high concentration of strontium in the fresh cap-rock and in the speleothems. As noted in other studies, strontium tends to be more abundant where aragonitic material is more abundant (White, personal communication; Siegel, 1965). However, the fact that strontium is

Table 1

Speleothem growth rate (Modified from Moore, 1962)

Locality	Speleothem Type	Time (Years)	Growth (millimeters)	Rate (millimeters/ year)	Reference
Ingleborough Cave, England	Stalactite	35	1–6	0.03–0.17	Dawkins (1874)
Slouper Cave, Czechoslovakia	Stalactite	11	30–40	2.7–3.6	Kriz (1892)
New Cave, Ireland	Stalactite	36	80	2.2	Coleman (1945)
Moaning Cave, California, U.S.A.	Stalagmite	1400	88	0.06	Broecker and others (1960)
Propheter's Cave, Kansas, U.S.A.	Stalactite	150–200	30	0.20–0.15	This study (1966)

present in considerable quantity in all the speleothems at this cave indicates that it was not a factor that promoted the crystallization of the aragonite polymorph instead of the calcite polymorph.

Another interesting fact which relates to the aragonite-calcite polymorphism question is that the predominantly aragonitic speleothems were forming from water which was slowly oozing or diffusing through the ceiling rock. This contrasts notably with the calcite-rich speleothems which are being developed from rather rapidly dripping waters. Perhaps, therefore, this field observation can be suggested as affirming the hypothesis of Pobeguin (1955) who believes that a slow, oozing supply of water and rapid evaporation should result in the precipitation of the metastable aragonite polymorph. This is apparently the type of process that is taking place to form the aragonitic speleothem growths from the ceiling rock while in the same cave, about three meters away, the rapid flow of dripping water and relatively slow rate of evaporation have not allowed the water to become supersaturated with respect to aragonite so that the less soluble calcite is the carbonate phase that has crystallized. Continuous field studies throughout sev-

Table 2

Qualitative emission spectrograph analyses giving the order of magnitude of the elements observed. Analyses were provided courtesy of the Geochemistry Division of the State Geological Survey of Kansas

t = <0.1% m = 10%
T = 0.1–1% M = >10%

Element	Sample Number							
	C–1	C–2	C–3	C–4	C–5	C–6	C–7	C–8
B	t	t	t	—	t	—	t	t
Na	T	T	T	t	T	t	T	T
Mg	m	m	m	T–m	m	T–m	T–m	m
Al	m	m	m	T–m	m	T–m	m	m
Si	T–m	T–m	T–m	T	T–m	T–m	T–m	M
K	t	t	—	—	t	t	T	T
Ca	M	M	M	M	M	M	m	m
Ti	t	t	t	—	t	—	t	—
V	t	t	t	t	t	t	t	t
Cr	t	t	t	t	t	T	t	t
Mn	t	T	t	t	t	T	t	T
Fe	T–m	m	T–m	T–m	m	m	m	T–m
Ni	t	t	—	t	t	t	T	t
Cu	t	t	t	t	t	t	t	t
Sr	T–m	T–m	T–m	T–m	T–m	T–m	t	t
Pb	—	—	—	—	—	—	t	t

Key to sample numbers: C–1 = straw stalactite
C–2 = crust on ceiling rock
C–3 = popcorn type growth around a fallen fragment
C–4 = linear stalactitic growth
C–5 = flowstone over wallrock shale
C–6 = fresh, unleached ceiling rock
C–7 = leached ceiling rock
C–8 = shale in which cave was dug

eral field seasons, complemented by laboratory experiments on the kinetics of evaporation, must be made to assess the true role of rate of solution supply and rate of evaporation on the polymorphism that exists between calcite and aragonite in a cavern environment.

SUMMARY

Speleothems in the form of stalactites, linear stalactitic growths, flowstone, and crusts, from a hand-dug cave in Northeast Kansas (Sec. 2 NENW, T2S, R22E) are composed of calcite and aragonite. If the estimated age of the cave is correct, i.e., 150 to 200 years old, the stalactites have grown at a maximum rate of 0.20 to 0.15 millimeters per year along their vertical axes. All of the speleothems examined contain about one percent strontium (based on qualitative emission spectrograph analyses). Rate of supply and evaporation of the vadose waters may dictate whether aragonite or calcite is the polymorph that precipitates from the cave waters.

RESUMEN

Espeleotemas en forma de estalactitas, crecimientos estalactíticos lineales, travertina, y costras, de una caverna cavada a mano en el Noreste de Kansas (Sec. 2NENW, T2S, R22E) se componen de aragonito y calcita. Si la edad estimada de la caverna es correcta, esto es 150–200 años, las estalactitas han crecido a razon de 0.20 a 0.15 milímetros por año a lo largo de los ejes verticales. Todas las espeleotemas contienen más de un porciento de estroncio (a base de análisis cualitativos espectrográficos de emisión). La cinética de flujo y evaporación de las aguas vadosas pueden dictar si el aragonito o la calcita es el polimorfo que se precipita de las aguas de la caverna.

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