shock just sufficiently intense to evoke a headturning response was given immediately before the leg shock. Thirty reinforced trials per day were given, with two additional nonreinforced striatal test shocks. Anticipatory flexions began to appear on the fourth day of training and continued during the subsequent 5 days of training and testing. The flexion response failed to appear to a test shock given 2 months later, but reappeared on the second day of retraining. The electrodes were in the right forebrain, and the right thigh was shocked.

That cues arising out of head movement were not operative is suggested by the following observation. Conditioned flexion was not established in three pigeons given 200, 400, and 600 trials when a bright light, toward which the birds turned their heads, was substituted for the striatal shock. Whether the striatal shock evoked a sentient response, such as an aura, or a motor response, such as an adversive movement, cannot be specified. It is interesting to note that investigation of this area, under Nembutal, with a 5-micron glass microelectrode showed many tonically active units (which were diphasic and initially negative with respect to the indifferent electrode), but no units responsive to leg shock. It was necessary to penetrate below this area, probably to tractus thalamo-frontalis medialis of the forebrain bundle, to find fiber activity. In this region, a good primary response with a latency of about 14.5 msec was recordable following leg shock. A reflex discharge from leg movement subsequent to the leg shock was also found. The lesser amplitude and pure positivity of this response suggested that it was somewhat removed from the point of recording.

Two birds were trained to peck at one of two simultaneously presented visual figures when a striatal shock or external light was presented in order to obtain food reward. Twenty trials were given daily until a criterion of 16 consecutive correct responses was attained. One pigeon was required to peck a black triangle after striatal shock and horizontal black lines after bright light. This subject reached the criterion performance level in 113 trials and maintained a very high level of performance during the 160 trials of overtraining. The other bird, given the reverse task, attained the criterion in 86 trials. The light and shock were presented in random sequence, and the visual figures appeared randomly to the right or the left of each other in a discrimination apparatus that has been described in detail elsewhere (*2*).

Usually, a pigeon requires about eight training trials before it discriminates perfectly between the two figures used in the customary discrimination procedure. Thus, this far more complex task was mastered in only 10 times the number of trials. Acquisition of the two discriminatory-conditioned responses appeared at about the same rate, possibly signifying that the striatal stimulation was also operating on the sensory side. An auditory signal presented after learning did not evoke pecking; hence the mere lack of light or the presence of some stimulus other than light was probably not sufficient to produce the "striatal-conditioned response."

If purely motor effects resulted from the striatal stimulus, the instrumental discriminative response is in line with previous observations, but the classical leg conditioning is not (*3*). Ancillary experiments indicated that movement-produced cues were not operative in this situation. It therefore appears that the neostriatal stimulation gave rise to a sentient response that was more efficacious than the peripherally evoked sensory response in the nonreward situation, and was equally efficacious in the instrumental-discriminative situation.

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28 November 1955

Chinese Walls of New Cave, Carlsbad Caverns National Park

Speleothems—Moore's proposed term for cavern formations (*1*)—are as variable as the caverns and caves in which they form. Although I have seen many types of speleothems in Carlsbad Caverns National Park, New Mexico, there are none that challenge one's imagination

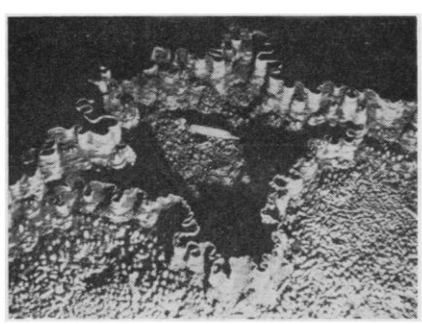

Fig. 1. View of several feet of the Chinese Wall. Two levels of terracing shown. Size is indicated by the pocketknife in the foreground between the walls.

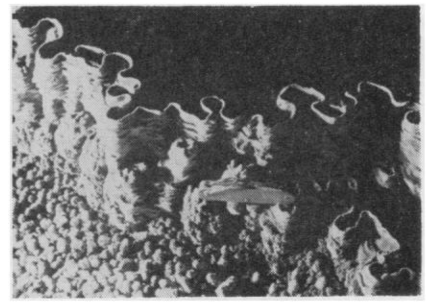

Fig. 2. Close-up view of a small section of the Chinese Wall. Gravel-size accretions are in the foreground. Scale is indicated by the pocketknife in the foreground.

more than the Chinese Walls (Figs. 1 and 2) of New Cave (once known as Slaughter Cave).

Unlike most speleothems, these walls have no apparent pattern other than that of growing vertically. There are no shelves of minerals or water lines that might indicate water levels. The trace of the meandering tops of the walls curve or furl as often in one direction as in another. Some furlings are so well developed that they nearly form vertical tubes. Only one characteristic seems to have any consistency: the degree of furling apparently increases with the amount of vertical growth. Unlike retaining dams (*2*) and embaying walls of Carlsbad Caverns, the Chinese Walls do not overhang or obviously grow toward any particular direction. Tests made on small sections indicated that these walls are able to withstand more than 100 pounds of compressive pressure to each inch of trace. The furling course of the trace probably accounts for the strength that has preserved it from vandalism. When I last observed it in 1951, only a few small pieces had been broken from the wall.

To complicate their study still further, free, gravel-like accretions cover the flat floors between the walls. These accretions have a rough, granular surface (Figs. 1 and 2) and should not be considered to be cave pearls. Apparently they are in place, since no stream channels or gravels were noted.

Many speleologists would consider the meandering and furled walls to be just "rimstone." Although they apparently did "rim" pools of water at one time, they definitely differ from any of the rimstone I have seen in Carlsbad Caverns. The trace of that in the former is very irregular, whereas the traces of the latter are often gently arching for a distance of several feet. It is my opinion that the Chinese Walls of New Cave should be considered a special type of "furled retaining wall."

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25 November 1955

Some Potassium-Argon Ages for Western Canada

Recent deep exploratory drilling has provided core samples of the Pre-Cambrian basement rocks that underlie the plains of western Canada. A number of these samples (*1*) contain potassium-bearing minerals in sufficient quantity to permit age determinations to be made by the potassium-argon method. Table 1 gives the ages determined for 15 core samples from Alberta and Saskatchewan. The ages of two outcrop samples from the Marian River area of the Northwest Territories are also given.

The basis of selection of core samples was high potassium content and lack of evidence of hydrothermal alteration or weathering. All of the samples are of granitic composition. Samples 1268, 1290, 1291, and 1292 are alkali granites. Sample 1295 is an alkali rhyolite. The remaining samples are calc-alkali granites and adamellites. Potash feldspar supplies the greater part of the potassium content of the rocks. The mica content is generally less than 5 percent. In only three samples—1268, 1433, and 1434—does the mica content exceed 10 percent.

Potassium-argon ages are calculated from the formula

$$t = \frac{1}{(1+R)\lambda_\beta} \cdot \ln \left\{ 1 + \frac{1+R}{R} \cdot \frac{A^{40}}{K^{40}} \right\}$$

where, in the absence of loss of argon from the minerals, R is the branching ratio, defined as the rate of orbital electron capture divided by the rate of beta-particle emission. Two values of R have been reported from argon measurements on dated feldspars, $R = 0.089$ (*2*) and $R = 0.085 \pm 0.005$ (*3*). However, it has now been verified at several laboratories that micas give consistently higher potassium-argon ages than do feldspars from the same deposits, indicating the probable loss of argon from feldspars. If the loss from feldspars is nearly constant, the afore-mentioned values for R can be used in the equation to determine the approximate ages of feldspars. This was the procedure adopted for this preliminary report.

For λ_β, the transformation constant for beta emission, a value of 0.503×10^{-9} yr^{-1} has been obtained from 11 of the most recent counting experiments (*4*).

K^{40} is the mass of potassium-40 per gram of sample. It was calculated from the potassium analyses by assuming Nier's value of 0.0119 percent for the isotopic abundance of potassium-40 (*5*). Total potassium was determined by gravimetric analysis as the chloroplatinate, following decomposition of the sample by the J. Lawrence Smith method. Potassium was corrected for rubidium content, which was determined by flame spectrophotometer.

A^{40} is the mass of radiogenic argon-40 present per gram of sample, as determined by a procedure that has already been described (*4*). At least two determinations were made on all samples except 1295, 1436, and 1437. All argon samples were analyzed by mass spectrometer and corrected for contamination by atmospheric argon. This correction was generally less than 10 percent. The error placed on the potassium-argon ages has been calculated by using an estimated mean probable error of 10 percent in the A^{40}/K^{40} ratio. The agreement between individual analyses was generally more accurate than this.

Table 1. Potassium-argon ages for some core samples from western Canada.

Toronto No.	Location (lat. N. and long. W.)	Sample depth (ft)	A^{40}* wt. (% × 10^{-5})	K_2O wt. (%)	A^{40}/K^{40}	Age (10^6 yr)
1290	Imperial Bistcho Lake (59°52′, 118°19′)	6,120	4.58 ± 0.02	5.12	0.089	1350 ± 90
1291	Imperial Lutose Creek (59°20′, 117°20′)	4,525	3.97 ± 0.12	5.11	0.077	1210 ± 80
1434	Imperial Loon Lake (56°28′, 115°20′)	4,980	5.62 ± 0.80	4.33	0.129	1730 ± 120
1293	Shell B. A. Whitelaw (56°06′, 118°12′)	7,492	4.90 ± 0.40	4.60	0.106	1520 ± 100
1292	Imperial Tangent (55°56′, 117°36′)	7,596	8.23 ± 0.70	8.17	0.100	1460 ± 100
1266	Shell Reno (55°58′, 116°31′)	6,768	4.73 ± 0.03	5.96	0.079	1220 ± 90
1294	Imperial Clairmont (55°16′, 118°37′)	11,700	4.77 ± 0.07	5.15	0.092	1380 ± 90
1270	Bear Biltmore (56°32′, 112°35′)	2,855	8.12 ± 0.10	6.13	0.134	1770 ± 120
1289	Bear Biltmore (56°32′, 112°35′)	2,857	7.48 ± 0.30	6.45	0.115	1600 ± 110
1267	Bear Vampire (56°34′, 111°50′)	2,302	6.20 ± 0.05	7.09	0.087	1310 ± 90
1432	Alberta Govt. Salt Well No. 2 (56°40′, 111°15′)	789	5.10 ± 0.30	6.08	0.083	1270 ± 80
1433	Imperial Grosmont (54°49′, 113°29′)	6,405	1.88 ± 0.40	6.09	0.030	570 ± 50†
1268	Imperial Ardrossan (53°33′, 113°03′)	7,800	4.70 ± 0.02	6.19	0.075	1180 ± 80
1269	Imperial Leduc No. 530 (53°19′, 113°45′)	8,985	3.38 ± 0.12	3.73	0.088	1330 ± 90
1295	Tide Water Crown Johnson Lake (50°11′, 106°14′)	7,785	5.15	5.03	0.101	1470 ± 100
1436	Marian River Area, NWT TXG 51 Claim (63°24′, 116°40′)		5.77	4.85	0.118	1630 ± 110
1437	Marian River Area, NWT FG 1 Claim (63°27′, 116°33′)		2.97	5.07	0.078	1220 ± 80

* Uncertainty shown is standard deviation of individual measurements.
† Anomalously low result believed to be in error.

The determination of potassium-argon ages of core samples from Alberta was undertaken in order to extend Pre-Cambrian geochronology to a previously inaccessible area. In view of the subsequent discovery of the leakage of argon from potash feldspar, the reported ages must be regarded as tentative. Their value is that they represent the minimum ages of the rocks concerned. Also, the agreement of a number of the ages from western Alberta may indicate the existence there of a Pre-Cambrian terrain somewhat younger than the previously dated Churchill province of northern Saskatchewan (*6*). Further age determinations on biotite separated from these samples will be required to confirm the age of the Pre-Cambrian of this area.

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References and Notes

1. Samples for this study were supplied by Imperial Oil Limited, Pacific Petroleums Limited, Shell Oil Company, and Tide Water Associated Oil Company. The research was aided by fellowships awarded by Standard Oil Company to