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The Age of the Woolly Rhino from Dream Cave, Derbyshire, UK

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Abstract: The Dream Cave woolly rhinoceros, *Coelodonta antiquitatis*, is a 'classic' specimen of a 'cold-stage' fossil fauna from central England. The find was illustrated and described by Dean William Buckland in his seminal tome *Reliquiae Diluvianae* (1823) during the first half of the 19th century, and made a significant contribution to the development of Buckland's views on the origin of extinct and extirpated fossil vertebrates. Here we present the first, albeit indirect, radiometric dates on the specimen, and argue that the animal fell into the cave just before 37,000 years before present, during the middle of Marine Isotope Stage 3 Interstadial (39-41 ka).

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BACKGROUND AND HISTORICAL INTRODUCTION

Dream Cave first came to attention in December 1822, as a result of lead mining activity near the hamlet of Callow, near Wirksworth, Derbyshire. Miners sinking an exploratory shaft just north of Sprink Wood (NGR 275 530) breached a natural cave, completely (or almost completely) filled with clastic sediments. Whilst excavating this material they encountered the bones of '*ante* Diluvian' animals. William Buckland, first Professor of Geology at Oxford University, learned of the discovery through the property owner, Phillip Gell, and a mutual friend, the Reverend D Stacy. Buckland made haste to the site *"... for the purpose of examining all* [the discovery's] *circumstances..."* (Buckland, 1823, p.61). The principal discovery was of the skeletal remains of an adult woolly rhinoceros, *Coelodonta antiquitatis,* (Fig.1), together with fragmentary remains of horse, bear, and deer. Continued excavation of the fill exposed a natural fissure entrance, which forms both the original and modern entrance to the cave. Buckland figured the cave in a copperplate illustration (Fig.2), drawn by T Webster from Buckland's original notes.

Despite the prominence afforded to Dream Cave in *Reliquiae Diluvianae*, the site has not been re-examined critically in more recent times. The presence of *Coelodonta* is characteristic of a cold-stage fauna, so the site has been generally assumed to be later Devensian in age (e.g. Sutcliffe, 1983). All radiometrically-dated *Coelodonta* specimens from Britain fall in the range 35,000 – 22,350 ^{14}C years BP, but records are scarce (Table 1). Thus, a possibility that *Coelodonta* persisted through the Devensian maximum at ~ 18,000 ^{14}C years BP cannot be discounted. It might even have extended into the Younger Dryas (~ ~11,000-10,000 ^{14}C years BP: chronozones from Mangerud *et al,* 1974), which supported a fauna of reindeer (*Rangifer tarandus*) and steppe pika (*Ochotona pusilla*). The latest European continental record of *Coelodonta* is *c.*12,500 ^{14}C years BP (skeletal remains and late Magdalenian engravings; Bosinski, 1978; 1981). If the species was eliminated locally during the Devensian maximum it may have failed to recolonise Britain as the ice front retreated.

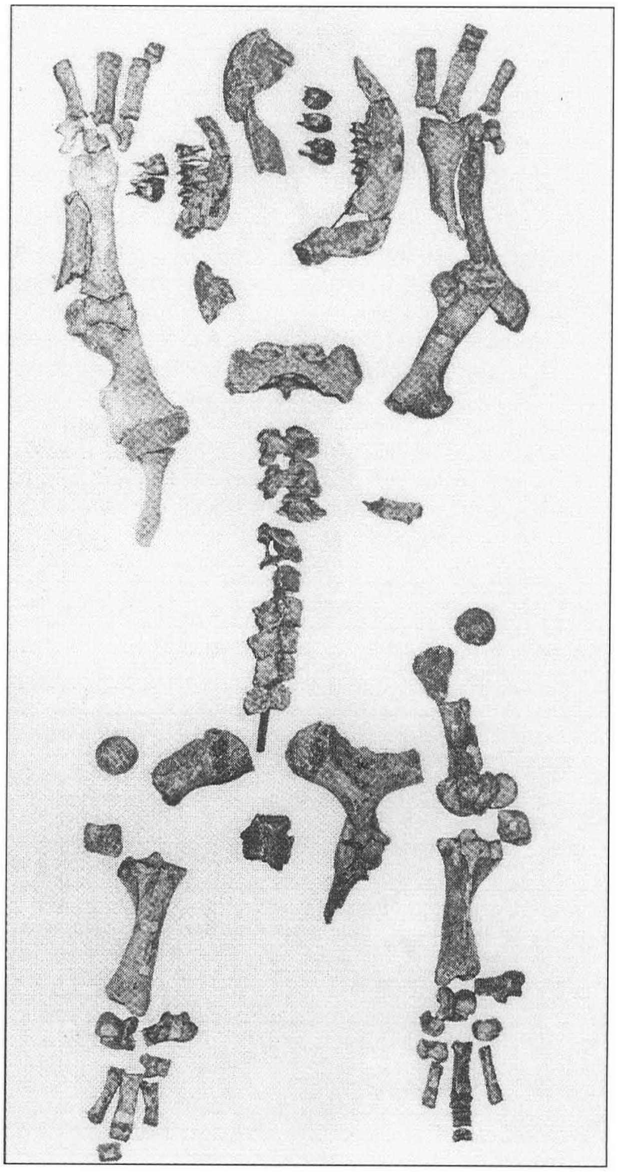

Figure 1. Buckland's Dream Cave Coelodonta specimen, courtesy of the Oxford University Museum.

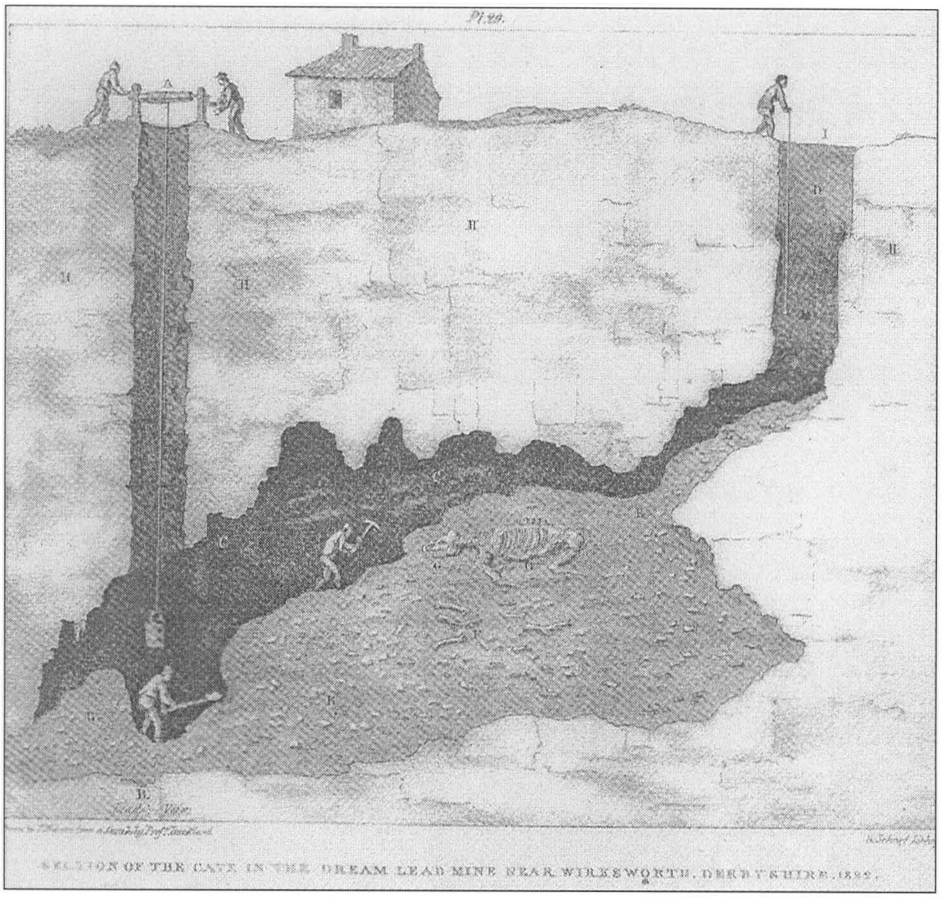

Figure 2. Copperplate illustration of Dream cave in 1822 (Buckland, 1823).

DISCUSSION OF THE CURRENT WORK

Examination of the *Coelodonta* specimen in the collections of the University Museum, Oxford University, uncovered the presence of a hitherto un-noted block of flowstone. The block carried the notation, tten in Indian Ink in Buckland's handwriting, *"from out the Dream Cave"*. As indicated by the moulds of clastic fragments and the ochre-coloured clay adhering to the lower surface, this flowstone overlay the soft sediment that preserved the bones of the woolly rhinoceros. Unfortunately none of this flowstone or equivalent material remains at the site today. The specimen consists of a layer of dense, laminated flowstone, several centimetres thick, whose underside preserves traces of a yellowish, argillaceous sediment and moulds of rounded clasts 1 to 5mm in diameter. A sketch of the sub-sample taken from Buckland's block is shown in Fig. 3.

Uranium series disequilibrium dating by thermal ionisation mass spectrometry was conducted at McMaster University. Two samples of ~1g each were taken, and laboratory preparation and dating followed standard procedures (see for example, Lauritzen and Lundberg, 1999). Isotope measurement was carried out using a VG354 thermal ionization mass spectrometer. Results are presented in Table 2. The low value for the activity ratios of $^{230}Th/^{232}Th$ suggests the presence of some detrital or non-radiogenic ^{230}Th. Correction for this would reduce the ages a little. However, the very low absolute concentrations of thorium (below 0.1 ppm) and the relatively high value of $^{234}U/^{232}Th$

22,350 620	Ogof Yr Ychen, Caldey Island.
22,500 700	Pin Hole Cave, England.
24,372 153 (weighted mean of 5)	Earls Barton, Northampton.
27,550 + 1370 / -1680	Bishopbriggs, Scotland.
28,160 435	Kent's Cavern, Devon.
29,300 480	Robin Hood's Cave, England.
29,450 350	Leadenhall Street, London.
30,729 405 (weighted mean of 2)	Ash Tree Cave, England.
32,180 580	Tornewton Cave, Somerset.
33,200 650	Pontnewydd Caves, Wales.
34,101 779 (weighted mean of 3)	Conningbrook, Kent.
34,559 573 (weighted mean of 2)	Kent's Cavern, Devon.
40,900 1800	Ash Tree Cave, England.
42,700 2200	Pin Hole Cave, England.
42,900 2400	Robin Hood's Cave, England.

Table 1. Radiometric dates on Coelodonta antiquitatis *(Gowlett, et al., 1987; Hedges et al., 1989; 1994; 1996)*

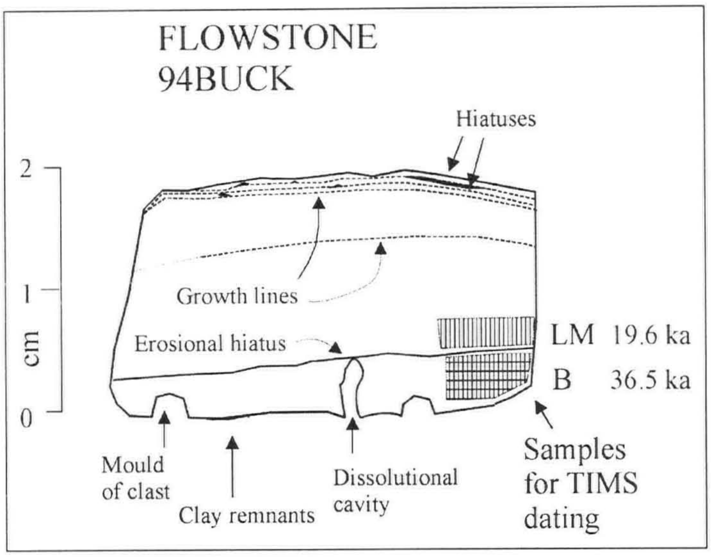

Figure 3. Diagrammatic sketch of the flowstone from Buckland's Dream Cave collection.

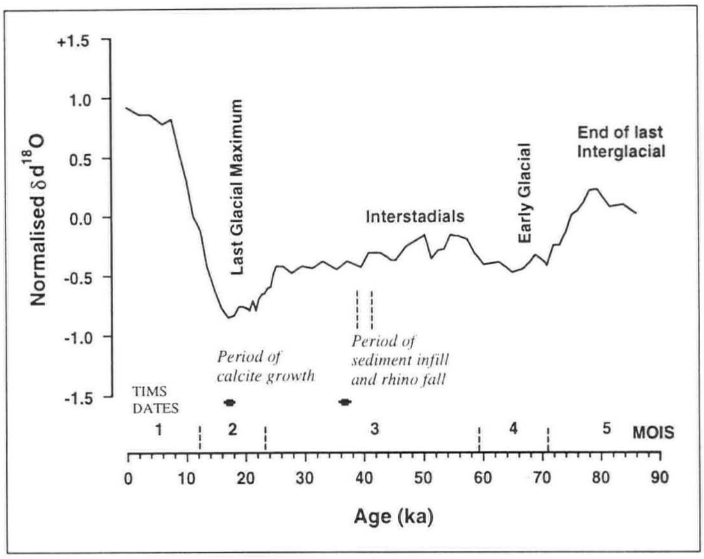

Figure 4. Marine isotope chronology of the Devensian and the Dream Cave deposits.

suggest that the detrital component is insignificant, so that use of the corrected value is probably not justified.

Sample B was cut from the basal layer, separated from the next layer, which provided sample LM, by an obvious erosional hiatus, marked by unconformable growth layers. A date of 36,451 -1262 +1277 ka on the basal sample of calcite just above the sediment fill indicates that calcite deposition began towards the end of isotope stage 3. The hiatus probably represents the Late Glacial Maximum, isotope stage 2, when conditions would have been cold and dry. A date of 19,600 -690 +695 just above the hiatus level suggests that calcite deposition resumed immediately after local deglaciation. Higher layers of the sample have not been dated; the topmost few millimetres show a distinct change in colour and several clay-lined, but not erosional, hiatuses, one of which is the top layer. Dissolutional cavities shown in the basal layer in Fig. 3 developed upwards from the base, but the hiatus level limited their penetration. This dissolutional etching probably occurred as water penetrated the sediment-calcite interface after calcite deposition had ceased.

Because its lower surface demonstrates clearly that the flowstone was deposited on top of the cave sediment, the rhino must have fallen into the cave before calcite deposition began, i.e. before 36 ka. *C. antiquitatis* is known from remains dated (stratigraphically) as 'early Devensian' (*c.*70 – 54 ka) in the Crayforth brickearths of Kent (West, *et al.,* 1964), and from Tornewton Cave, Somerset (Sutcliffe and Zeuner, 1962). So, the species undoubtedly entered Britain following the Eemian Interglacial (marine isotope stage 5). However, the steppe-tundra climate of central England during marine isotope stage 4, 'early Devensian', time was interrupted between about 43 – 41 ka by a warm interstadial, evidenced by a fossil beetle fauna (Huizjer and Isarin, 1996). It seems likely that, had the Dream Cave *Coelodonta* deposit been in place, interstadial conditions would have initiated speleothem growth and capped the deposit. The flowstone shows no evidence of deposition at this time. Therefore, it is most parsimonious to conclude that the rhino and the sediment deposit were emplaced during the sharp, cold stadial (Heinrich 4 event), which prevailed from about 41-39 ka (Fig.4). Sediment infilling must have been rapid, because the rhino was preserved intact (Appendix 1; Fig.1), which could not have occurred if the carcass had remained exposed for many seasons under such harsh conditions. An amelioration of climate at 39-36 ka followed the Heinrich H4 stadial, and the timing of this mild interstadial correlates well with the deduced date of initiation of speleothem growth over the sediment infill at Dream Cave.

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Table 2. U-series data. All errors quoted are 2Φ. All ratios are activity ratios.

Sample Lab code	mm from base	Age (years before 1997)	U conc (ppm)	Th conc (ppm)	$^{230}Th/^{234}U$	$^{234}U/^{238}U$	$^{230}Th/^{232}Th$	Initial $^{234}U/^{238}U$	$^{234}U/^{232}Th$
94 BUCK LM2	2-5	19,600 - 690 +695*	1.272 ±0.0030	0.0411 ±0.0002	0.165 ±0.005329	1.084 ±0.003407	17.67 ±0.566	1.08924 ±0.00018	107.14 ±4.84
94 BUCK B2	5-8	36,451 -1262 +1277*	1.539 ±0.0034	0.0892 ±0.0005	0.287 ±0.008459	1.196 ±0.003883	18.92 ±0.551	1.21778 ±0.00078	65.88 ±0.11

*Correction for detrital thorium using an initial 230/232 activity ratio of 1.7 gives an age of 17,895 -680 +684 and 33,726 -1232 +1246 respectively.

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APPENDIX I

Skull and Jaw	
	Nasal region with septum Partial maxilla 5 detached upper molariform teeth Left mandible Right mandible 1 detached lower molariform tooth
Trunk	Atlas 3rd and 4th cervical vertebrae 2 dorsal vertebrae 3 lumbar vertebrae Sacrum 1 rib fragment Partial left scapula
Limbs	Left and right humerus, ulna, radius Left and right scaphoid, lunar, cuneiform (left only), magnum(left only) and unciform carpals Left and right II, III, and IV forelimb metacarpals Left and right portions of pelvis Left and right femora and tibia Left and right patella Left and right astragalus, calcaneum, and cuboid tarsals Right navicular tarsal II, II, IV hind metatarsals