

Historical Scientific Interest

Dating the Dales caves

Apologies for this being a personal account. While searching through files during compilation of the BCRA book on the Yorkshire Dales caves and karst (Waltham and Lowe, 2013), I found a letter dating from 1975 that could perhaps rank as a historical document. Because this was long before everyone had a keyboard on their desk, and far preceded any e-mail, the item was a hand-written note, and it had come from Russ Harmon, with details of the first-ever determinations of the ages of stalagmites from the Yorkshire Dales, or indeed from anywhere in Britain (Fig.1).

These days it might be difficult to conceive of a time when we had no idea of the ages of landforms, caves, sediments or anything else in the landscape of the Dales, the Pennines, or even Britain.

Dating igneous rocks by methods related to the radioactive decay of unstable isotopes of uranium began in the early 1900s, but was restricted by the long half-life to igneous minerals older than about a million years, which rendered it inapplicable to most studies of landforms. The potential of radiocarbon dating, which was recognised in the late 1940s, was limited because it can reach back only about 60,000 years, beyond which isotope concentrations are immeasurably small; this was too young to relate to most aspects of landscape evolution. As late as 1976, a major review (by King) of northern England's geomorphology referred only to a relatively ordered sequence of glacial events, with a complete lack of any absolute ages.

McMaster University starts dating stalagmites

Stalagmite dating represented a huge leap forward, because it could date events between the ranges of the other methods.

And this is where the story centres on cavers. The first attempts to date stalagmites by their ratios of uranium and thorium isotopes had failed, because those involved were not cavers and had collected only contaminated material from near cave entrances (Rosholt and Antal, 1962; Cherdynstev, *et al.*, 1965).

Then Derek Ford, a successful Mendip caver who had been through Oxford University, joined the Geography Department at McMaster University in Canada. There, during the late 1960s, he teamed up with Henry Schwarcz in the Geology Department, to establish a laboratory for dating stalagmites (Harmon, *et al.*, 1975). Their first postgraduate researcher was Pete Thompson, who was an ex-Bradford caver. He garnered the first results, and Derek made a short presentation at the International Geographical Congress in Canada in 1972. I joined Derek's post-Congress fieldtrip in the Rockies. The stalagmite dating report had generated some excitement, and I thought of the Dales, but Derek had other plans.

The Berger-Castleguard link

Out in the Rockies I met some of the McMaster cavers and generated a bit more excitement because I had been to the Gouffre Berger the previous summer. The Berger already had a fierce reputation, because whereas without doubt it was a fabulous cave, it was mired in a mythology derived from stories about "horrendous" expeditions led by Ken Pearce in the 1960s. I had been there with a mixed bag of Leeds and London university cavers on the first British visit by a small team. Some of the McMaster team were coming to the Speleo Congress in Czechoslovakia in 1973, and were travelling through Europe; could I take them to the Berger?

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5 October 1975

TONY:

Well are you ready? Can you believe that I actually have some numbers for you? Sit down 'cause here they are.

Sample #	U ppm	$^{230}\text{Th}/^{234}\text{U}$	$^{234}\text{U}/^{238}\text{U}$	$^{230}\text{Th}/^{232}\text{Th}$	age
TW # 1*	4.4	$.710 \pm .03$	$1.34 \pm .07$	21	$131,000 \pm 10,000$
TW # 3**	0.8	$.615 \pm .06$	$1.33 \pm .10$	26	$105,000 \pm 20,000$
TW # 5***	3.8	$.108 \pm .005$	$.829 \pm .012$	16	$12,500 \pm 700$

* oldest layer of stalagmite ** avg of 2 ages (top & bottom layers) *** topmost layer of flowstone

The ages are exactly as you thought, but that's usually the way it turns out. The large errors assoc. w/ TW # 1 & 3 so due to an error the lab tech made during the analysis resulting in a low U yield. The samples are good for dating though, i.e., reasonable U conc, and high U ratios. Send more ASAP including the Yugoslavian beast. I'm ready! Basically, you have two specimens from the last interglacial and one from the beginning of this one. Sounds like a reasonable story - no? at some time we will have to do a major paper on these & future dating results. For now -

Cheers
Russ

Figure 1: 1975 letter with the first stalagmite dates for the Yorkshire Dales. The comment about "ages not exactly as you thought" referred to my prior guesses that the Gavel Pot samples (#1 and #3) would be more like 200,000 years old, and that the County Pot sample (#5) would be pre-Devensian, but that was probably more like wishful thinking.

So in 1973 we were there, for a delightful long-day down to the big galleries as far as the Balcony. We were using ladders, but had arranged to leave the gear in the cave so that a Craven Pothole Club team could follow us down, go deeper into the cave and then de-rig. The Canadians loved it. In return they invited me to Castleguard in 1974.

There I met Russ Harmon again. He had been another McMaster postgraduate working with Derek Ford, but had then moved on to Michigan State University. There, he set up his own dating laboratory, and was on the look-out for good projects. And that is how the first dating of Dales stalagmites came about.

From within Gavel Pot and County Pot I collected a few samples of stalagmites that looked as if they could be old, and then mailed them to Russ in Michigan. Several months later, the letter (Fig.1) came back with details of the first set of results: the two samples collected from Gavel Pot both dated into the Ipswichian interglacial, with dates that were way beyond the limit of carbon dating.

Cave chronology marches on

The Gavel Pot age determinations were later joined by more that went through Russ's laboratory, and included older material from White Scar Cave and Kingsdale's Roof Tunnel. The first results were published in the proceedings of the Speleo Congress at Sheffield (Waltham and Harmon, 1977), and were joined by dates from Mendip for a more authoritative paper (Atkinson, *et al.*, 1978).

By then, Derek Ford had made progress working, on field areas that included the Yorkshire Dales, with Mel Gascoyne, a caver from Lancaster University, who moved to McMaster as a postgraduate. He had a few preliminary dates for Lancaster Hole stalagmites in time for the Sheffield Congress (Gascoyne, 1977), and went on to produce a plethora of age determinations for Dales stalagmites (Gascoyne *et al.*, 1983; Gascoyne and Ford, 1984).

Stalagmite dating reached its limitation where the uranium/thorium technique using alpha spectrometry could not reach beyond ages of about 350,000 years, just short of the Anglian glaciation and its major changes to Dales landscapes. But then the introduction of thermal ionization mass spectrometry pushed the limit back to about 600,000 years, and a paper on Victoria Cave's flowstones (Lundberg *et al.*, 2010) was a breakthrough for Dales chronology.

Subsequently there have been advances in dating with optically stimulated luminescence and the dating of cosmogenic chlorine within the surface karst, along with significant advances in the palaeo-climatic interpretation of stalagmites (Atkinson and Hopley, 2013; Wilson *et al.*, 2013; Latham and Ford, 2013). The next stage in the Dales has to be aluminium/beryllium dating, which can reach back a few million years (Granger and Muzikar, 2001), and has already produced some spectacular results at Mammoth Cave in Kentucky (Granger *et al.*, 2001) and elsewhere. This method determines ages of quartz sediments, and the thick, stratified, sand sequences in Gaping Gill, Ireby Fell Cavern, Witches Cave and Lancaster Hole are prime targets for a future research project with a healthy budget. Their results should be even more exciting than that letter in 1975.

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Figure 2: Far Streamway in White Scar Cave, which later yielded the first stalagmites dated to more than 200,000 years and therefore pre-dating the Wolstonian glaciation.