

NATURE'S UNDERGROUND LIBRARIES

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Jon Blundy

The city of Oxford (UK), where I have relocated since my last editorial, is a provincial metropolis of some 150,000 souls about 90 km northeast of London. Oxford is famous for its ancient collegiate university, with colleges dating back to 1096. The University of Oxford is slightly less well-known for its remarkable Bodleian Library, created in its present form in 1598 by Sir Thomas Bodley. It is one of just six copyright libraries in Britain and Ireland. A copyright library (or 'library of legal deposit') is one that, since 1662, has the right to request and store for posterity a copy of every new work published in English. As you can imagine, one copy of every book published in English amounts to quite a few books over the years. The challenge for any of the copyright libraries is where to store them all. For the Bodleian, in the spirit of the iceberg, the answer lies under the surface, where a substantial fraction of its 13 million print items is stored in vast underground vaults. Some of these spaces are accessible to scholars of the university; others, including a network of tunnels under the city streets, are accessible only on demand. One subterranean branch is the Radcliffe Science Library (RSL), a place I spent many a pleasant afternoon as a student in the early 1980s. As its name suggests, the RSL hosts collections of scientific periodicals. These are stored on a plexus of metal shelves, each labelled with such irresistible titles as *Lethaia*, *Acta Crystallografica*, and *Ofioliti*, and marked with the year of publication. The end of each shelf is empty, allowing space for the next instalment, which arrives regularly from the library's mailroom – a steady trickle of new information from the world above. The neatly stacked, coloured spines of the journals grow at a rate of a few centimetres per year (or metres per year in the case of the *Journal of Geophysical Research*), each arriving underground as a messenger from beyond.

Editing this issue of *Elements* on speleothems, I could not fail to be struck by parallels to the Bodleian: speleothems are nature's underground libraries, drip-fed from above to create an ever-growing archive of environmental information. The speleothem archive even has its own exotic and evocative glossary – snottites, moonmilk, helictites (see Feinberg and Johnson 2021 this issue) – which can rival the more obscure journal titles of the RSL. Just like a copyright library, the

speleothem archive is enduring and objective: what arrives gets stacked, stored, and catalogued for eternity (barring the occasional fire or flood). The speleothem archive is a unique record of global change. In this issue, we learn that this archive pertains not only to global climate and hydrology but also, surprisingly, to oscillations and reversals of Earth's magnetic field (see Feinberg and Hobart 2021 this issue). The spectacular hollow chambers of the underground natural cathedrals, such as that on the cover of this issue, echo the sepulchral splendour of some Bodleian reading rooms (FIG. 1). And, from experience, the temperature is comparable in both places, regardless of the weather outside.

Interpreting any archive (historical, geological, archaeological) is a scholarly and non-trivial task. It must contend with the cryptic and incomplete nature of the archive and address the twin challenges of deconvolution and interpretation. For example, measuring the trace element chemistry or magnetisation of a thin speleothem layer is, to some extent, the easy part; working out what

they mean is where it gets tricky. In this issue, we learn of the extraordinary sophistication required to unlock and quantify the speleothem archive. The use of clumped isotopes and noble gases to unpick the subtleties of the temperature signal (see Meckler et al. 2021 this issue) are particular favourites of mine. As with so much in the Earth sciences, speleothem research is all about interrogating mute archives with ever-more sophisticated tools, and evermore stringent tests of the archives' fidelity.

Returning to my metaphor of the Bodleian Library, one might imagine that here, at least, the mute archive is easy to access. We simply have to read the words on the pages of the journals. But what if we want to extract more from the written page? What, for example, if we want to uncover the evolution of the global kaolin market from the chemical analysis of paper coatings? Or understand changing demographics from the affiliations and genders of the authors? Or interpret journal contents in the context of the contemporary geopolitical climate? This is a rather less straightforward endeavour. It is still worthwhile, but is it fraught with many of the same challenges faced by speleothem researchers. In these strange times, it makes one wonder what library scholars of the future might make of the shelves labelled '2020'.

Jon Blundy
Principal Editor



FIGURE 1 The interior of the oldest reading room of the Bodleian Library in the University of Oxford (UK). PHOTO BY DAVID ILIFF. LICENSE: CC BY-SA 3.0

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