

REPORT

Rock fall at Bridgnorth cave

In April of this year, slabs of rock fell away from the roof of a sandstone cave at Bridgnorth, killing a teenage boy who was sleeping below. This tragic accident has implications for the East Midlands as the cave is very similar to those that lie under and around Nottingham.

Bridgnorth has many caves, all of which are entirely artificial and were cut into the low cliffs of soft red sandstone centuries ago; details of the original reasons for their excavation are lost in the mists of time. There are at least 60 caves within High Town, on the west side of the River Severn.

The rock fall was in one of the Hermitage Caves, a group of about 20 in the hills on the east side of the Severn, above Low Town. These have been cut into the Permian Bridgnorth Sandstone, a red, aeolian, dune-bedded rock, but some rise into the overlying, fluvial Kidderminster Conglomerate that straddles the Permo-Triassic boundary. The sandstone appears to be slightly weaker than Nottingham's rock (though the conglomerate is stronger). Comparisons of roof failures in the Bridgnorth and Nottingham caves would therefore appear to be valid with the proviso that the rocks are not identical but only broadly similar.

Processes behind the fall of roof rock in the Bridgnorth cave were multiple. The cave is only a small rock shelter reaching back about 5 m from the vertical cliff face. Natural stress relief within the entire outcrop will have allowed micro-fractures to open up within the rock, which has conspicuous bedding planes but relatively few joints through the beds. The cave has been exposed to weathering for some hundreds of years, in which time any fractures would have further developed and the sandstone would have weakened by



Two of the Hermitage Caves, in the dune-bedded Bridgnorth Sandstone with the Kidderminster Conglomerate above.



Aftermath of the roof fall in the Hermitage cave (photo: AP).

softening of its natural cement. It may be significant that the summer of 2008 was very wet and was followed by a hard winter with many frosts, perhaps weakening the cave rock even further prior to April 2009.

A critical factor in the roof fall appears to have been the fire that the teenagers had built in the cave when they decided to camp there for the night. Flames were reported to have reached over two metres high, which would have taken them right to the cave roof; it was nearly 2 am when the roof fell, by which time the flames would have significantly heated the rock. The blocks that fell were from a bed over 100 mm thick; a block "the size of a suitcase" landed on the chest of the sleeping boy. He stood no chance, and a nearby girl was also injured. The cave rock fall was therefore a simple case of artificially induced thermal weathering, whereby the roof rock was heated and expanded so that it separated from the cooler and unexpanded rock above it. Pre-existing bedding planes within the rock, already opened by natural weathering and stress relief, would have acted as foci for this separation, and it was unfortunate that their wide spacing allowed such large blocks to fall away.

Falls of large blocks are rare in the Nottingham caves, where roof sandstone in tension tends to split into beds only about 10 mm thick; this commonly happens where the rock is saturated by a broken pipeline, but the Bridgnorth rock was not saturated and did not delaminate. Tree roots are known to be very destructive in the Nottingham caves, where they reach into the thinnest of bedding planes and fractures, there to grow and expand and eventually heave away blocks of the sandstone. They have also been seen to damage some caves at Bridgnorth, but do not appear to have been significant at the Hermitage cave site, as none is seen on the new fracture surfaces exposed by the roof fall.

The rock fall at Bridgnorth appears to have been a very sad accident. It has no implications for the stability of caves in either Bridgnorth or Nottingham, except for the clear evidence that it is unwise to build a fire inside any cave. Fire-splitting was a standard method of excavation in all types of rock before explosives were available; without a fire, these sandstone caves are very stable.

Tony Waltham and Christine Rayner