REPORT

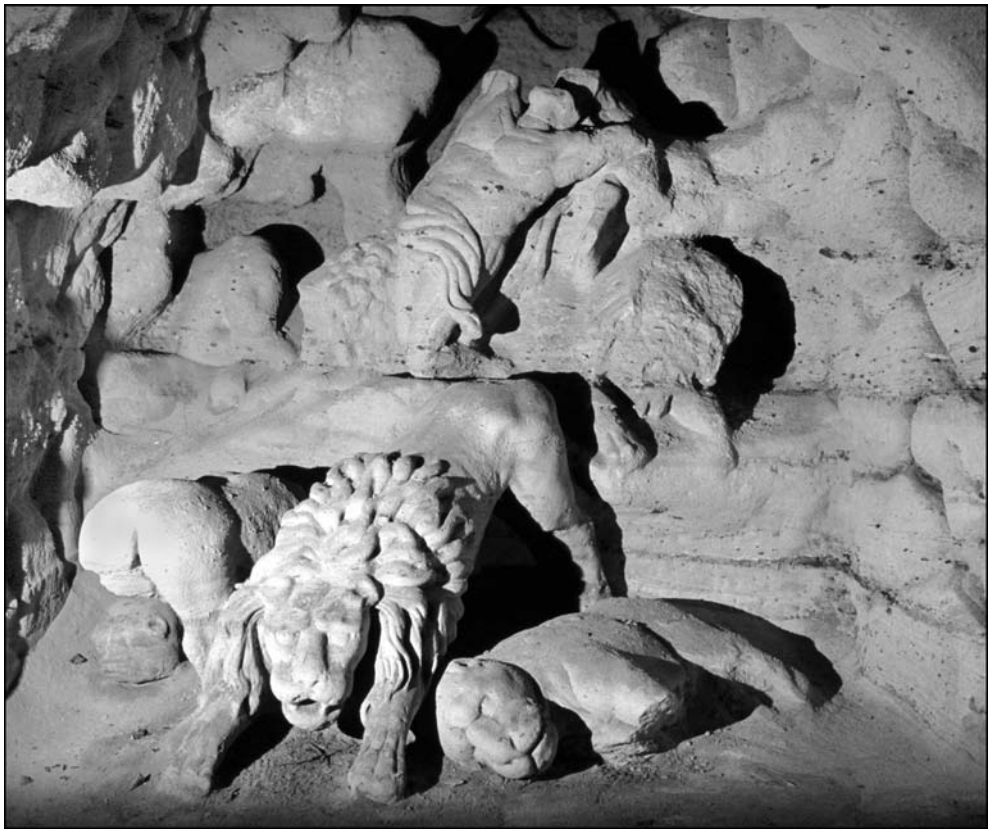
Conservation of the cave statues in the Nottingham sandstone

Without doubt the finest single feature within the sandstone caves that underlie Nottingham is the group of statues depicting "Daniel in the Lions' Den", which lie inside a cave cut into the sandstone escarpment overlooking The Park from the northeast. These life-size statues are a real work of art, carved from bedrock in the back wall of a cave excavated under the garden of Alderman Thomas Herbert some time in the mid-1800s (Waltham, 1996). Sadly, they are suffering from the ravages of time, and a measure of conservation was becoming appropriate. The owner of the site was unable to take action, and the city of Nottingham takes almost no interest in its cave heritage (this cave has no listed status, unlike six elsewhere under the city), so the East Midlands Geological Society stepped in.

Preservation of the statues would ideally be by improving the very porous and weak sandstone. Various techniques exist whereby a strengthening fluid can be injected into the stone or painted on to its surface so that it soaks in. However, all known attempts at doing this on the Nottingham sandstone have resulted in stability for some few years followed by the improved surface layer flaking away in small slices and chunks. No method has yet been found that appears to be totally satisfactory and is also worth the major problems of applying it by hand to the complex details of the statues. Recent work on Castle Rock has successfully prevented erosion by applying a thick layer of fibre-glass, with its surface disguised by loose sand brushed onto it before setting, but this is not applicable to the intricacies of the statues. Rock treatment remains an option for the future, though there is a certain reluctance to start experimental work on the statues themselves.

The alternative was to reduce the natural weathering. Previous investigations within the caves had shown that the rates of sandstone weathering were directly related to exposure to outdoor weather, in terms of the access and distance from open entrances (Waltham & Cubby, 1997). It appears that weathering is mainly due to cyclic changing of atmospheric conditions that induce wetting and drying of the weak clay cement that bonds the grains of sands in the decalcified sandstone. Local variations in the sandstone lithology also have an effect, but these are uncontrollable. The statues are particularly vulnerable because they stand at the back of a cave that has a doorway and window holes that open out to the garden through the locally steep sandstone slope.

Consequently wooden doors and shutters were fitted to the cave late in 2005. These were paid for by the Society, notionally and appropriately from proceeds from sales of the Society's book on the caves (which is shortly going into a third edition). The new doors and shutters are solid panels of treated wood



The cave statues of "Daniel in the Lions' Den", as they are today; the detached head of one lion can be seen on the floor below the missing back leg of the same lion.

monitoring period	*weathering rate*
Nov 96 – Mar 97	0.110 mm/year
Mar 97 – Dec 97	0.080
November 2005	***doors installed***
Dec 05 – Apr 06	0.005 mm/year
Apr 06 – Oct 06	0.040
Oct 06 – Dec 06	0.002
Dec 06 – Apr 07	0.003
Apr 07 – Aug 07	0.007

Table 1. *Weathering rates beside the statues.*

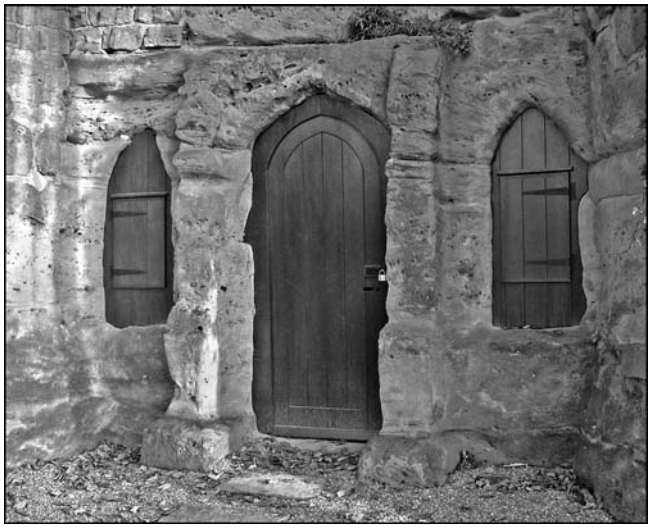
attached to the iron railings that were there before and thereby provide the seating into the rock. These will hugely reduce air circulation in and out of the cave in times of changing weather. Their frames were cut to follow closely the irregular rock profile, but they do not provide tight seals. This was intentional, as a complete lack of air circulation can allow growth of mosses and fungus on the exposed rock, which is currently very clean within these caves.

The effect of the new doors will only be seen in the long term, but monitoring of the cave has been carried out over the last few years. This follows the method started by Tommy Cubby in 1996, whereby sand grains falling off a measured area of wall are caught in trays and then weighed to derive a mean rate of wall retreat due to weathering within the test period. Weathering rates have been measured on a section of wall adjacent to the statues and recalculated into annual rates of wall retreat (Table 1). These do indicate that weathering has been reduced to about one tenth of its rate before the doors were installed. The data have been matched by that recorded (on fewer occasions) within the corridor cave from the "Haddon Hall stairs", that lies adjacent to the statues cave (Table 2), which again show the reduced weathering further away from the open entrances.

The high values from the summer of 2006 were of some concern, until it was learned that a TV crew had briefly worked unsupervised in the caves just before the end of this period. Loose wall sand could have been rubbed off by the crew (or accidentally kicked into the trays), but wall desiccation by the heat of strong film lights would have had a similar effect. Either would have caused loosened sand to fall into the trays, and would then have left wall surfaces that were

monitoring period	*weathering rates in mm/year*	
	3 m in	*12 m in*
Nov 96 – Mar 97	0.057	0.029
Mar 97 – Dec 97	0.068	*no data*
November 2005	***doors installed***	
Dec 05 – Apr 06	0.009	0.0002
Apr 06 – Oct 06	0.033	0.002

Table 2. *Weathering rates in the corridor cave.*



The cave from the outside with its new doors and shutters.

temporarily stabilised, and thereby also account for the very low weathering rate recorded in the following period. There was no recognisable impact from the very heavy rainfalls in June 2007.

Monitoring has not been totally systematic, and has not been fully correlated with internal and external micro-climates, but it does appear to indicate that installation of the doors has reduced the rate of rock weathering inside the caves to less than a fifth of its previous rate. If this extends the life of the cave statues on a comparable scale, the new doors will have proved worthwhile.

Past years of open access to the caves had also allowed deterioration of the statues by rather more than weathering, probably deliberate vandalism, by which they had lost various limbs. Rumours of a "souvenir head" that someone had in their own garden were followed up, but yielded only a life-size head of Jesus, instead of that of a lion. This had come from the site, but was made of Ancaster Limestone, and was probably from an ornamental feature within Thomas Herbert's garden; it now stands within a dark corner of the caves, much to the consternation of some unprepared visitors! One lion's head has been found, half-buried in sand within the cave, but this is from the inward-facing lion, so the expense of restoring it to the lion has not been undertaken.

References

Waltham, T., 1996. *Sandstone Caves of Nottingham*. East Midlnads Geological Society, 56pp.

Waltham A.C. & Cubby, T.J., 1997. Developments in Nottingham's sandstone caves. *Mercian Geologist*, **14**, 58-67.

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