EXCURSIONS

Field excursion to Garforth, Micklefield and Darrington, West Yorkshire

Leader: R. A. Ellison, British Geological Survey, Keyworth, Nottinghamshire.

Saturday 29 April 1990

This excursion, held on a balmy spring day, provided members with an opportunity to examine Permian and Quaternary deposits and to look at the relationship between topographical features and Coal Measures sandstones. The effects of gypsum dissolution on the Brotherton Formation (Upper Magnesian Limestone) and the problems of surface subsidence caused by deep coal mining and by the collapse of shallow pillar and stall mines in the Basal Permian Sand were also seen.

The area had been recently surveyed by the BGS at the 1:10 000 scale as part of a project commissioned by the Department of the Environment to provide a geological background to land-use planning in the region including Garforth, Castleford and Pontefract. The project report, recently published (Barclay *et al.*, 1990), gives an account of the geology and engineering geology and includes a set of thematic maps dealing with topics including shallow coal mining, hydrogeology and geomorphology.

On arriving at Garforth, a brief stop was made on the crest of the escarpment [SE 405 318] formed by the Cadeby Formation (Lower Magnesian Limestone). The panorama looking west, revealed, in the near distance to the south-west, the faulted, flat-topped and tree-covered outliers of Permian rocks in the vicinity of Kippax. Beyond are the rolling hills of Lower Coal Measures and the upper part of the Millstone Grit in the Leeds area.

The coach was parked at Brecks Farm [SE 395 315] and the party strolled a kilometre along the footpath leading to the disused railway track running between Garforth and Kippax. *En route* it was explained that in mapping the alternations of sandstones and mudstones in the Coal Measures, over which the footpath traverses, observations of topographical slope features and debris in the soil are used. In general terms the sandstones, being more resistant to erosion, form positive features and the mudstones and siltstones give rise to slack areas with concave slopes. The area was undermined in the mid 1970's in the Middleton Little Coal which is about 2m thick and occurs at about 80m below the surface at Sparrow Hill. The coal was extracted by the longwall method from panels about 100m wide and up to 300m long. The subsequent collapse of the roof above these panels has given rise to relatively severe surface subsidence resulting in uneven and rolling topography with broad depressions up to 2m deep. Unusually, the subsidence has been sufficiently great to allow the approximate position of the mined areas to be mapped at the surface (Fig. 1). Particularly striking is the deformation of the once near-level track bed which is now warped down above the edge of one of the panels.

The first outcrop of the day was reached by walking along the railway track towards Kippax. Thick-bedded dolomites of the lower part of the Cadeby Formation are exposed in the railway cutting through the Permian outlier that forms Townclose Hill [SE 406 305] and in former quarries west of the railway. The dolomites have a granular texture and there are few sedimentary structures preserved. The beds display prominent open joints caused by cambering on the steep-sided valley slopes. The dip of the beds is relatively steep and variable, caused by fault drag on the Water Haigh Fault and its subsidiary, neither of which is currently exposed (Ellison, 1989). The Water Haigh Fault is one of a series

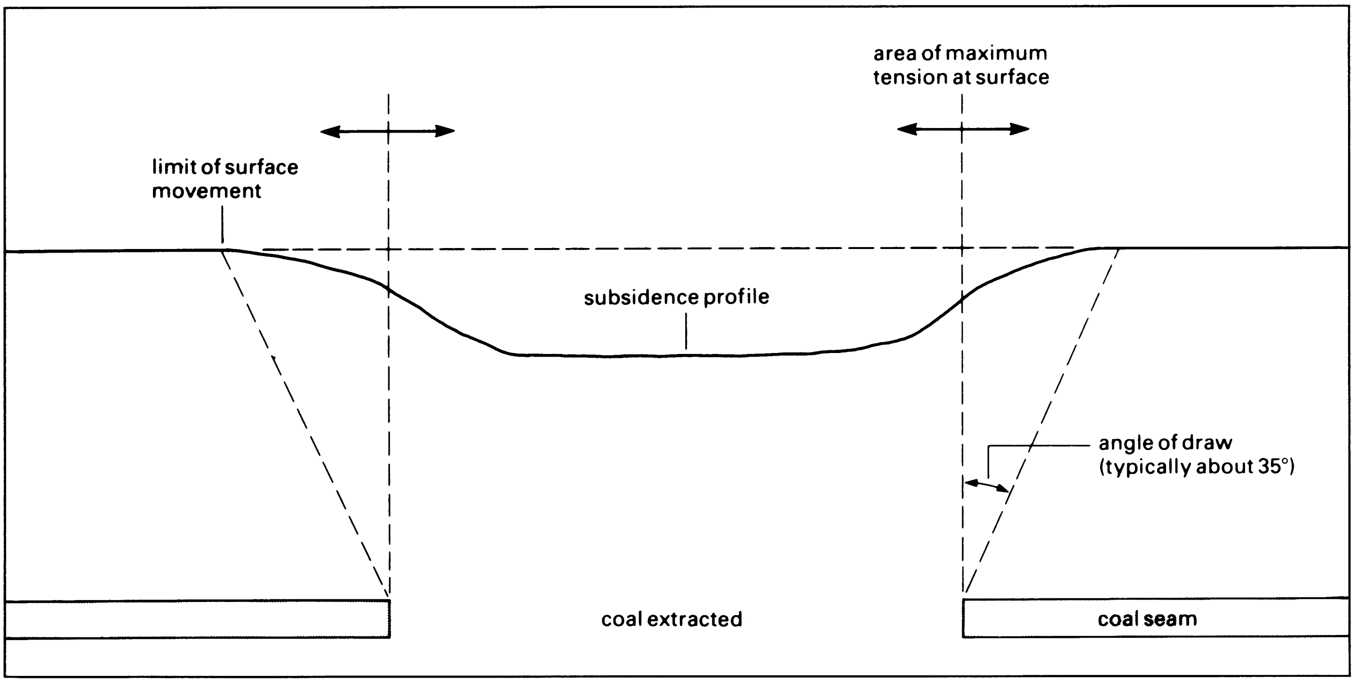

Fig. 1. Simplified geometry of subsidence effects resulting from longwall mining.

of north-east south-west trending normal faults in the Yorkshire coalfield with a large throw in the Coal Measures and a small throw or no detectable movement in the Permian rocks. The throw at Townclose is about 100m down to the south.

The party also discussed the effect of springs that emanate from the Basal Permian Sand and flow over the mudstones of the underlying Coal Measures. It was agreed that the small mudslides in the field west of the railway are the result of the failure of these oversaturated and weathered mudstones.

On climbing around the north side of Townclose Hill it was possible to see the location of a former adit to the pillar and stall workings in the Basal Permian Sand. Collapse of these workings has given rise to oval-shaped, enclosed depressions known as crown holes which were observed in the scrubby ground on the higher slopes of the hill. The sand was formerly in demand as a moulding sand in foundries and was fairly extensively mined close to the outcrop in the area between Garforth and Pontefract. Many of these mines are undocumented and are a problem in land use planning. Several interdependent factors, common to most pillar and stall workings, contribute to their instability. The principal factors are (1) the depth of the workings, (2) the size of the underground voids in relation to the pillars and (3) the condition of the roof (Fig. 2). In the case of the Townclose Hill mine the workings are less than 10m below the surface and the roof lithology is Cadeby Formation dolomite. Where it is thickly bedded, a relatively wide roof span can be maintained and subsidence is limited; where thinly bedded or weakly cemented roof collapse and void migration to the surface ensue more readily (Fig. 2). Mechanical and chemical weathering by percolating surface water causes slow deterioration in the strength of pillars. In addition the subsidence effects of deep coal mining can cause dilation of joints in the Cadeby Formation and exacerbate roof instability in the Basal Permian Sand mines.

There was discussion about the remedial action taken by the local authority to make safe known areas of shallow pillar and stall mining. Grouting has not been entirely successful and in one case, where mines have been discovered at less than 5m below the surface, the entire area has been excavated to the level of the mine floor and then backfilled.

On returning to the coach the party was transported to Ledsham for a pub lunch.

The second locality of the day was the disused Micklefield quarry [SE 4460 3246], an SSSI which provides an excellent section in the middle part of the Cadeby Formation. It includes the Hampole Beds that contain a disconformity of regional significance (Smith, 1968); a section is given in Harwood *et al.* (1982). The lowest beds, part of the Wetherby Member, consist of parallel-bedded dolomites with some oolitic and grainstone fabrics. The Hampole Beds, classified as the top part of the Wetherby Member, are about 1m thick. They are mainly finely laminated (? cryptalgal) dolomite with irregular laminae of very fine-grained structureless dolomite that may represent emergent conditions. At the top of the Hampole Beds are two partings of pale green-grey claystone separated by a bed of finely laminated dolomite 50mm thick. The overlying strata, the Sprotborough Member, are mainly large scale cross sets of fine-grained dolomite, probably ooid grainstones. High on the quarry face, lenses of rather rubbly dolomite draped by thinly bedded dolomite are interpreted as patch reefs with fringing small talus slopes. Members' attention was drawn to the numerous horizontal, cylindrical, modern borings in the quarry face, caused by rather indiscriminate and insensitive sampling for research purposes.

From Micklefield the party drove south to Darrington Quarry [SE 515 207], entering a disused part of the complex via a private road past Scrombeck Farm. The Brotherton Formation (Upper Maganesian Limestone) is excavated in the quarry and used mainly as crushed aggregate. It is capped by a veneer of Quaternary deposits.

The quarry owner, Mr. Downham, briefly entertained the party with an explanation of the workings of the quarry, including a pioneering system involving a succession of settling ponds which occupy worked out parts of the quarry complex. Other worked out areas are backfilled with domestic refuse and the methane generated by its putrefaction is piped off and used for heating the quarry offices.

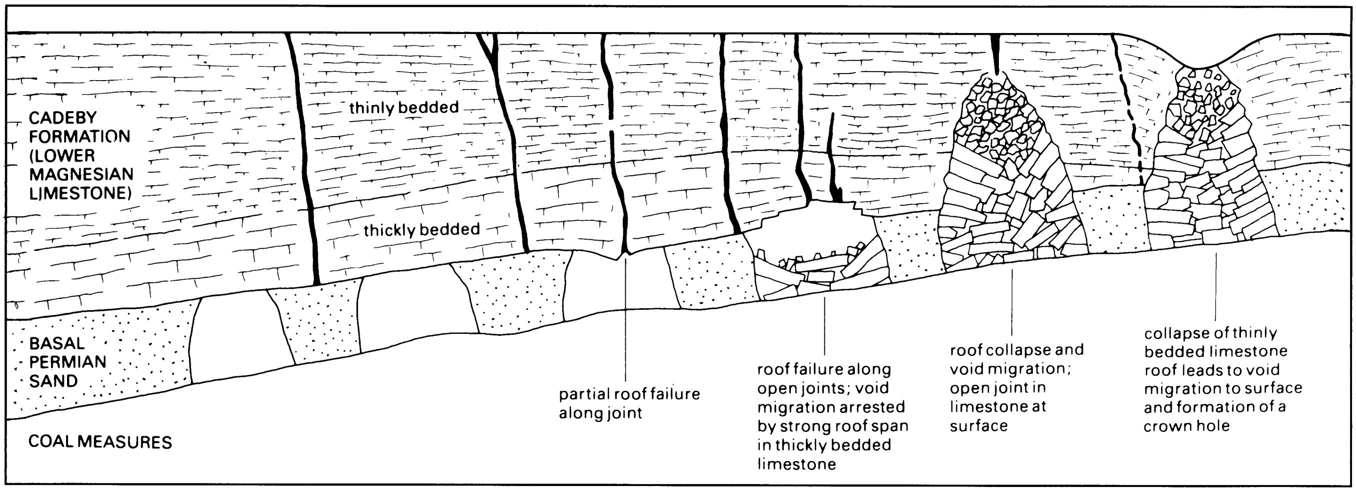

Fig. 2. Diagrammatic representation of collapse of Basal Permian Sand mines and the formation of crown holes.

The Brotherton Formation, about 20m thick, is distinguishable from the Cadeby Formation by its thin bedding. It consists of pale grey and cream dolomitic limestones of fine sand to silt grade in beds that average about 50mm in thickness. Beds of coarse, vuggy dolomite up to 0.3m thick also occur. Thin parallel lamination, ripple lamination, shallow cross bedding and small scale scours were seen. The beds are gently undulating in broad, shallow folds. A steeper fold at one locality in the quarry face brings up the underlying red mudstone of the Edlington Formation (Middle Permian Marl). These folds are superimposed on the regional dip of less than 2° to the north-east and are generally held to be caused by foundering resulting from the dissolution of gypsum in the Edlington Formation (Smith, 1972).

The Quaternary deposits show several interesting features. Red till is preserved in cryoturbation pockets in the top of the Brotherton Formation on the south face of the quarry. It probably represents the remnants of a formerly extensive till sheet of Anglian age. In the far side of the quarry, at its eastern end, a thick sequence of gravels occupies a channel coincident with a synform in the Brotherton Formation. The section, based on that recorded by W. J. Barclay during the recent survey (Barclay, 1989) is as follows:

Gravel, almost entirely of Brotherton Formation; clast supported; tabular, subrounded pebbles average 30 to 40mm; also well rounded pebbles and some cobbles; cryoturbated	0.8m
Gravel; cobbles of Brotherton Formation with brown sand matrix	0.5m
Sand, brown, with scattered pebbles and cobbles of Brotherton Formation and a few coal fragments; cryoturbated	0 to 0.5m
Gravel; tabular cobbles; fills base of channel	up to 1.2m

The age and origin of these gravel deposits is uncertain. They postdate the till which is probably of Anglian age and predate the Devensian drift deposits of the Vale of York. The cryoturbation at the top of the section has been interpreted as being caused by the last (Devensian) glaciation. The cryoturbated unit in the middle of the sequence indicates deposition in a cold climate. Frost shattering of outcrops of the local limestone bedrock would have provided a source of clasts subsequently redeposited in an ephemeral stream which, on the evidence of cross-bed foresets, flowed towards the east (Barclay, 1989).

The coach returned to Nottingham with the members' appetite whetted for subsequent visits to Permian rocks elsewhere in northern England.

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The weekend field excursion to Permo-Triassic sections in the Nottingham Area

Leaders: Dick Crofts, Mark Dean, Andy Howard and Dave Lowe, British Geological Survey, Keyworth, Nottinghamshire.

14-15 July 1990

The excursion was organised by Mark Dean to complement the East Midlands Geological Society's Symposium entitled "Recent advances in East Midlands geology", held at BGS, Keyworth on 1 July 1989 (Miles 1991). The leaders were members of the BGS Nottingham Project team that had recently remapped the Nottingham area (Charsley *et al.*, 1990). A summary of their revised lithostratigraphy is shown in Table 1.

Day 1 (14 July 1990)

In order to avoid the inner city traffic and parking problems, we spent our first day out of town, south of the River Trent, where the following exposures and features in the Mercia Mudstone and Penarth groups (Radcliffe to Westbury formations) were studied.

Radcliffe-on-Trent River Cliff [c. SK 6461 3987]

This is the type locality for the Radcliffe Formation, which on average comprises 12m of red-brown, pink and grey-green laminated mudstone, siltstone and subordinate fine-grained sandstone, with rare thicker beds of fine-grained sandstone. Thin, impersistent veins of satin spar, an attractive form of gypsum were also seen interspersed through the section. Lowe (1989) gave a detailed measured section for this locality.

Radcliffe-on-Trent Weir [SK 6507 4053]

Walking along the base of the river cliff we passed an oxbow lake, bright in the morning sunshine with yellow waterlilies. Continuing downstream, we crossed the Harlequin Fault, which is downthrown to the north and reached the cliff at the weir where the Gunthorpe Formation is exposed. At river level the rocks are about 12 to 15m stratigraphically above the base of the formation and comprise mainly inter-bedded green and red mudstone and siltstone with intricate networks of gypsum veins. Rathbone (1989) gave a detailed measured section at this locality. Beds and loose blocks demonstrate numerous and often large pseudomorphs after halite, ripple marks and dessication cracks. The path back to the cars followed a steep, overgrown, wooded gully thought to be the surface expression of the Harlequin Fault.

MIDLANDS HULL (1869)		NOTTINGHAM LAMPLUGH AND OTHERS (1908/10)	NOTTINGHAM SWINNERTON (1918) SMITH (1912)	NOTTINGHAM ELLIOTT (1961)		NORTHEASTERN MIDLANDS KENT (1968)		NOTTINGHAM WARRINGTON AND OTHERS (1980)		NOTTINGHAM PROJECT (1989)	
KEUPER	Rhaetic or Penarth Beds	"White Lias"/ Upper Rhaetic		KEUPER		UPPER RHAETIC	Cotham Beds	PENARTH GROUP	Lilstock Formation Cotham Member	PENARTH GROUP	Lilstock Formation Cotham Member
		Avicula contorta shales				LOWER RHAETIC	Westbury Beds		Westbury Formation		Westbury Formation
	NEW RED MARL	Tea Green Marl			Parva Formation			MERCIA MUDSTONE GROUP	Blue Anchor Formation	MERCIA MUDSTONE GROUP	Blue Anchor Formation
		KEUPER MARL							Glen Parva Formation		Cropwell Bishop Formation
					Trent Formation				Trent Formation		
					Hollygate Skerries				Hollygate Skerries		Hollygate Sandstone
					Edwalton Formation				Edwalton Formation		Edwalton Formation
					Cotgrave Skerry				Cotgrave Skerry		Cotgrave Sandstone
					Harlequin Formation				Harlequin Formation		Gunthorpe Formation
					Carlton Formation				Carlton Formation		
					Radcliffe Formation				Radcliffe Formation		Radcliffe Formation
	Waterstones	Keuper Waterstones	Keuper Waterstones		Waterstones				Colwick Formation		Sneinton Formation
	Building Stones		Keuper Basement Beds		Woodthorpe Formation				Woodthorpe Formation		
	Basement Beds										
BUNTER	Upper Red and Mottled Sandstone	Bunter Pebble Beds	BUNTER	BUNTER				SHERWOOD SANDSTONE GROUP	Nottingham Castle Formation	SHERWOOD SANDSTONE GROUP	Nottingham Castle Sandstone Formation
	Conglomerate or Pebble Beds										
	Lower Red and Mottled Sandstone	Lower Mottled Sandstone							Lenton Sandstone Formation		Lenton Sandstone Formation

Table 1. Summary of the lithostratigraphy of the Trissic rocks in the Nottingham area. Reproduced from Charsley *et al.* (1990, table 22).

Wilford Hill Brick Pit [SK 5693 3558]

The upper, blocky, silty mudstone of the Gunthorpe Formation has been worked here in the past for brick clay. A sandstone bed near the top of the pit was identified as the Cotgrave Sandstone Member which marks the base of the Edwalton Formation. We had a good view north across the River Trent to Nottingham. The regional dip of the Permo-Triassic rocks beneath the City is broadly south-east at approximately 1-2° (Dean, 1989), and we could identify features such as the asymmetric Leen Valley in the west, the minor bench formed by the Sherwood Sandstone Group, and the Mercia Mudstone Group scarp to the east.

Flawforth Church Yard [SK 5928 3318]

This ancient church yard, which has been cleared of overgrowth, is at the summit of a small hill that slopes gently away to the south-east. The hill and dip-slope are formed by the Hollygate Sandstone Member at the top of the Edwalton Formation.

Lunch was taken in the sunshine at the "Inn at Tollerton", overlooking the activities of the flying club at Nottingham Airport [SK 619 363]. This too is situated on the gentle dip slope of the Hollygate Sandstone. We travelled back to the A52 and took the turning to Cropwell Bishop via Cotgrave. The road south-east from the Shepherd's Houses [SK 6360 3752] runs up through the Gunthorpe Formation and over the small escarpment formed by the Cotgrave Sandstone. Near Windmill Hill [c. SK 642 360] the Hollygate Sandstone forms a prominent ridge in the same road.

Cropwell Bishop Gypsum Quarry [c. SK 677 353]

The Cropwell Bishop Formation was seen at the British Gypsum working quarry south-west of the village. Exposed was a long, deep section of red-brown blocky and silty mudstone with a few impersistent beds of grey-green siltstone and silty mudstone. Gypsum was abundant, occurring as veins, beds and large nodules, many of which were over a metre in diameter. The origin of the nodules was the subject of a lively debate! The major gypsiferous level, within the upper half of the formation at Cropwell Bishop, includes beds which are equivalent to the Newark Gypsum (Firman, 1964).

Limited exposures of the Blue Anchor Formation, the equivalent of the former Tea Green Marl, marking the top of the Mercia Mudstone Group, were also seen in the south-east corner of the quarry above the workings.

Normanton-on-the-Wolds Railway Cutting [c. SK 627 321]

The last location of the day was rather overgrown but contained scruffy exposures of both the Blue Anchor Formation and the Westbury Formation, which is the lowest subdivision of the Penarth Group.

The Blue Anchor Formation in the Nottingham area is about 6 to 7.5m thick and mainly consists of yellow-green dolomitic silty mudstone and siltstone, whilst the Westbury Formation is up to about 7.5m thick and comprises predominantly dark grey to black fissile mudstone.

The junction between these formations, marked by the sporadic and impersistent "Rhaetic Bone Bed", was not exposed at Normanton. However, a loose slab of fine-grained, micaceous sandstone from the Westbury Formation, showing numerous bedding plane specimens of the small bivalve *Eotrapezium concentricum* (Moore) was found.

Day 2 (15 July 1990)

The second day was spent at locations north of the River Trent and included both the Sherwood Sandstone Group and lower Mercia Mudstone Group (Lenton Sandstone to Radcliffe Formations).

Nottingham University [SK 544 386] and University Hospital [SK 547 388]

The Lenton Sandstone Formation has its type locality on the north side of the Queen's Medical Centre, Lenton, Nottingham. Here in road cuttings, and in a bluff behind the Physics building on the University campus we saw what is typically a vivid red-brown sporadically mottled yellow or buff sandstone that is fine to medium-grained and cross-bedded.

Bobbers Mill [SK 5544 4165]

In a disused sand pit just off Gauntley Street, we examined the boundary between the Lenton Sandstone and the succeeding Nottingham Castle Sandstone Formation. Details of the exposure are given in Dean (1989).

Castle Rock [SK 569 394]

This is the type locality for the Nottingham Castle Sandstone Formation and excellent sections were seen in the imposing crag below Nottingham Castle itself. The sandstone is buff to pale red-brown and medium to coarse-grained. It contains sporadic intra-formational mudstone clasts and numerous extra-formational pebbles (mostly rounded quartzites), which are commonly aligned along foreset laminae and concentrated on scour surfaces. Channel bedforms are common.

A relaxed lunch was taken in the Brewhouse Yard, following which we ascended Mortimer's Hole, excavated into the south side of the Castle Rock.

The Park Tunnel [SK 565 399]

In 1855 this magnificent tunnel was cut through the Nottingham Castle Sandstone to link the Park Estate with Derby Road. We approached it however, by descending the steps at the top of College Street. The tunnel clearly shows the structures in the sandstone, the wind and rain having accentuated the cross-bedding which is excellently displayed. The section is about 14m thick and was summarised by Charsley (1989).

Former Railway Cutting at Colwick [SK 582 397]

Here we examined a section which showed the boundary between the Nottingham Castle Sandstone and the Sneinton Formation — the lowest formation of the Mercia Mudstone Group. At the top of the pale yellow and pale red-brown Nottingham Castle Sandstone is an erosive surface superseded by a thin conglomerate. Above this, more than 20m of the Sneinton Formation was partially exposed, consisting of interbedded fine to medium-grained, commonly micaceous sandstone, siltstone and mudstone (see Charsley, 1989 for a summary section).

Colwick Woods [SK 601 397]

From Greenwood Road we walked down a pleasant path to a disused quarry to view the upper Sneinton Formation and its boundary with the Radcliffe Formation. The lower boundary of the latter is taken above the highest readily identified sandstone of the Sneinton Formation, but below a sequence of colour laminated red-brown and green mudstones and siltstones. The highest obvious sandstone at this locality occurs about 7m above the base of the exposure, above which are about 2m of red, green and pink mudstones and siltstones of the Radcliffe Formation (see also Lowe, 1989).

On returning to the cars the President warmly thanked the leaders for a highly interesting, well organised and exhausting weekend.

Acknowledgements

Acknowledgement must be made to British Gypsum PLC and the authorities at Nottingham University, University Hospital and British Rail for access onto their land. We are particularly grateful to Mr. Byron Barrett, a member of "The Friends of Nottingham Castle", for his kind guidance and entertaining commentary at Mortimer's Hole, and Dr. H. C. Ivimey-Cook (BGS) for his identification of *E. concentricum*. Table 1 is reproduced by permission of the Director, British Geological Survey: NERC copyright reserved. Mark Dean and Dave Lowe kindly checked the script and provided the following references.

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