Rock Identification Report

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Abstract:

Following contact from Bernard Jones of the local Archaeology Group, Bedfordshire Geology Group undertook an investigation into a site of archaeological interest that had unusual geology. Archaeologists excavating Anglo-Saxon burials discovered an apparently well-compacted chalky deposit where they expected to find glacial till. Bedfordshire Geology Group was invited to investigate this unusual outcrop and produce a report of their findings.

Aims and Objectives:

The aim of this rock identification exercise was to investigate a possible chalk outlier discovered through an excavation by an archaeological team. The aims were to:

1. Determine the geological nature of the chalk anomaly.
2. Determine the extent of the chalk anomaly.
3. Determine a possible date for the chalk anomaly.

These aims were to be achieved by the following objectives:

1. To survey the immediate area of the chalk anomaly.
2. To extract soil samples in the immediate vicinity of the chalk anomaly.
3. To analyse the soil samples determining if chalk was present and to what extent.
4. To take rock samples for future dating analysis.

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1. Introduction

The archaeological excavation area in question is situated at grid ref. SP962273 (Grid reference finder, 2011) near a prominent local manor house, Hockliffe Grange, in the Bedfordshire village of Hockliffe. The site is on a relatively high area about 130m OD and approximately 275m due South West of the main A5 trunk road.

Bedfordshire Geology Group (BGG) supplied a small team of people to auger the area around the archaeological excavation site in order to establish the extent of the chalk anomaly, if possible.

2. Geology of site

According to both the British Geological Survey (BGS) viewer (2015) and the geological map of the area (Moorlock *et al.,* 1992), it appears the site is underlain by undifferentiated glaciofluvial deposits of Middle Pleistocene age covering bedrock of the Gault Formation (Figure 1).

Figure 1: Geological base map of the site.

Archaeological excavation revealed chalk rock with flints more indicative of the Chalk Group, as seen in the Chiltern Hills to the south. If it were an outlier, it would be Lower Chalk which lacks flints.

2.1 Glaciofluvial deposits

Lithologically, this deposit is sand and gravel, with local lenses of silt, clay and/or organic material. These deposits are glaciofluvial in origin and deposited via streams from glacial meltwater. Their age is difficult to ascertain due to their undifferentiated nature. The extent of these deposits is widespread throughout the region (BGS Lexicon of Named Rock Units, 2015).

2.2 Chalk Group

The Cretaceous Chalk Group is Cenomanian to Maastrichtian in age (approximately 100.5 to 66 million years ago) (Cohen *et al.,* 2013). Its lithology is described as chalk, with or without flints, and

discrete limestone, marl (calcareous mudstone, with sponge, calcarenite, phosphatic, hardground and fossil-rich beds (BGS Lexicon of Named Rock Units, 2015). The Chalk's lower boundary has a burrowed surface and is generally unconformable sitting on the Lower Cretaceous strata of the Upper Greensand and Gault Formations (BGS Lexicon of Named Rock Units, 2015).

2.3 Gault Formation

The Gault Formation is a pale to dark grey, or blue-grey, clay or mudstone. It has the mineral glauconite in part and has a sandy base with distinctive but discrete bands of phosphatic nodules (commonly preserving fossils) with some pyrite and calcareous nodules. In some places, there are thin, variable junction beds at the base that can include some limestone (BGS Lexicon of Named Rock Units, 2015).

3. Materials and methods

To determine the extent of the chalk anomaly, a brief survey of the excavation site was undertaken along with a series of soil samples. A 1-inch auger was used with the straight handle being utilised as a depth marker. A 30m tape measure was used to measure between soil samples along the ground and a compass used to take bearings. Results were recorded on a pre-prepared table with notes and comments added (Appendix 1). Decisions on where to take the samples from were taken on site and related to the previous sample findings.

Some chalk and flint samples were taken and recorded for dating analysis. These samples were taken from inside the excavation site. They include: flint from the anomalous flint bands and chalk hammered from deeper in the excavation at undisturbed bedrock levels, as well as chalk samples off the weathered surface. These samples have been sent to a colleague who will carry out the dating analysis.

4. Results

The initial survey of the excavation site revealed a rectangular area of cleared topsoil showing clearly a chalky layer with distinctive bands of fractured flint crossing the site (Figure 2). Obviously the site has been disturbed by human burials that dissect the flint bands. The chalk is extremely hard and compacted. Jointing typical of periglacial erosion and frost-shattering is evident. The top layer has been weathered to some extent, evidenced by a marly chalk layer of orangey-brown surface colouring and a rendzina soil (Appendix 2) layer.

In total, eleven soil samples were taken and measurements from the four corners of the archaeological excavation. The results show that the excavation site is covered by a layer of rendzina ranging from 15cm to a depth of 30cm (Figure 3).

a) Aligned flints b) Double band of aligned flints

Figure 2: Aligned flints showing in bands across the excavation site.

Ex A: 24cm deep. Ex B: 15cm deep. Ex C: 20cm deep. Ex D: 30cm deep.

Figure 3: Measurements of the four corners of the archaeological excavation.

The extent of the chalk anomaly reaches far wider than the exposed archaeological burial site. From the samples taken: chalk was found on three sides between Ex A to Ex C, Ex A to Ex B and Ex C to Ex D (Figure 4). Soil sampling continued outwards between two points, Ex A to Ex B, and from corner Ex C. Results show that the extent of hard chalk reached at least a further 3m all around the excavation and for 12m to the west of the site with hard chalk discovered 12m down slope to the east and south of the excavation. Although the auger emerged with a chalky tip, no certainty is given that this is proof of chalk in situ only that chalk was present either as in situ chalk or a chalk clast.

Samples taken have been sent to a specialist company for dating analysis but these results are still to be returned.

To establish the full width of the outcrop much more extensive investigation would be required and to determine the depth of the chalk, perhaps a drill core or deeper geophysical examination would reveal the vertical extent.

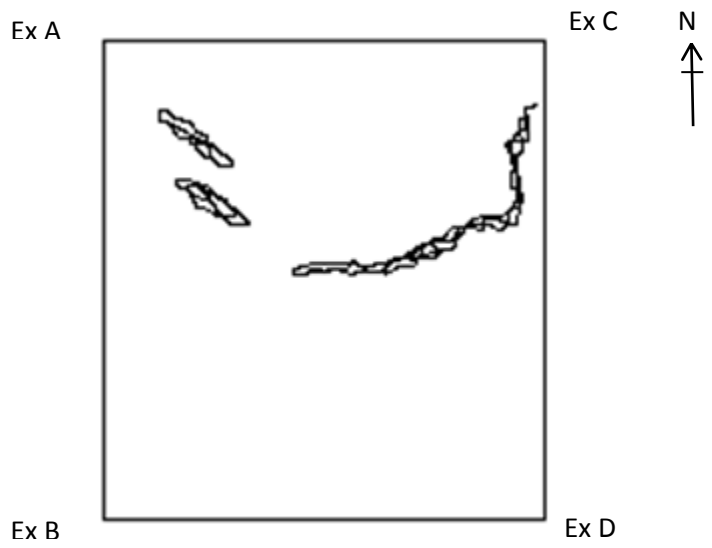

Figure 4: Rough sketch of flint bands identified with excavation corners labelled.

5. Discussion

There are several suggestions to the possible origin of the chalk anomaly uncovered by archaeological excavation. These include: a chalk outlier, glacial till, head deposit or an ice-rafted block of chalk. The geological maps indicate the area has sand-rich head deposits over glacial till over Gault (Moorlock *et al.,* 1992). This information was also confirmed by one of the surveyors for the BGS Memoir of the area, Dr E.R. Shephard-Thorn (pers. comm., 19 Aug 2015).

5.1 Chalk outlier

A chalk outlier of the size and extent of this outcrop would have required a massive faulted throw of a hundred metres (Farrant, 2015b). This is highly unlikely with no evidence of large faulting in the area.

5.2 Glacial till

Glacial till is described as sediments deposited by the direct action of glacial ice with a variable lithology which is usually sandy, silty clay or chalky marl with pebbles and has a varied colour and consistency (BGS Lexicon of Named Units, 2015). The very top layer of the exposed outcrop does resemble glacial till in that it is chalky marl but this layer is only a few centimetres thick. The BGS (Farrant, 2015a) commented that “the deposit may be glacial till, comprising the Oadby Member of the Wolston Formation (also known as ‘chalky boulder clay’). This is a grey, weathering brown silty clay, characterised by Cretaceous and Jurassic rock fragments with subordinate lenses of sand and gravel, clay and silt”. The BGS description is not what was seen on the ground at Hockliffe. The layer of weathered brown chalk was very thin and, within ten centimetres, hardground was uncovered and hard chalk with bands of flint dipping at a shallow angle was revealed.

5.3 Head deposits

Head deposits are described as polymict; consisting of fragments of different rock types. They comprise mainly gravel, sand and clay depending on the original upslope source and its relative distance from that source. These deposits are often poorly sorted and poorly stratified. They form from solifluction and/or hillwash and soil creep (BGS Lexicon of Named Rock Units, 2015). The BGS (Farrant, 2015a) suggest this outcrop is a form of superficial, or head, deposit. Farrant (2015a) proposes the outcrop could be "chalk and flinty Head, i.e. a superficial periglacial deposit" and advises that "head deposits can be several metres thick, and where derived as outwash fans from the Chalk, they can be composed of reworked chalk mud which can look like weathered Chalk including lots of flints".

5.4 Ice-rafted blocks.

There is evidence for massive ice-rafted blocks of Chalk in Southern England (Mortimore *et al.,* 2001). These blocks have been moved by glacio-tectonic processes which is not inconceivable to have occurred in the geological past in this area of England too. There is evidence of faulting in the Upper Chalk at Kensworth, a chalk quarry approximately 10 km to the south (Figure 5).

Figure 5: Normal faulting in the Upper Chalk at Kensworth, arrow indicates fault.

As the outcrop of hard chalk is so large, the only real explanation is an ice-rafted block of chalk that was deposited during one of the ice ages (Farrant, 2015b).

6. Conclusion

Although the full extent of the outcrop is difficult to prove through the limited means BGG were able to use on the day of the survey, results conclude that the outcrop does extend beyond the exposed excavation site. The aims and objectives of the investigation were completed within our means. The BGG concurs with the suggestion of Farrant (2015b) that the outcrop of rock is most likely an ice-rafted block of Chalk that has been deposited during one of the numerous ice ages since the deposition of the Chalk during the Cretaceous Period of earth history.

Appendix 1: Chalk Outlier Survey

Date: Tuesday 18th August 2015 **Weather**: Cool and overcast

Surveying Team: Bev Fowlston, Anne Williams, Tony Baker, Maryla Carter

Aim: To establish extent and depth of chalk outlier found at Hockliffe Grange during an archaeological dig.

Sample No.	Depth to bedrock (cm)	Soil Type	Bedrock Type	Comments
A1	64cm	Rendzina	Chalk	Half way between excavation corners Ex A & Ex C and 3m to North of excavation. Definite chalk at base of hole.
B1	50cm	More silty, fine textured clay	Chalk	Half way between excavation corners Ex A & Ex B and 3m to West of excavation. Definite chalk at base of hole.
C1	71cm +	Rendzina	Chalk ?	Half way between excavation corners Ex B & D and 3m to South of excavation. No longer deepening, no definite chalk at base, just flecks.
D1	66cm	Rendzina	Chalk	Half way between excavation corners C & D and 3m to East of excavation. Definite chalk at base of hole.
E1	96cm +	More clay-like	Chalk ?	22.5m from excavation corner C, North East of excavation. ~ 50cm down, gritty band with flint flecks.
F1	68cm	Rendzina	Chalk	3m from point A1, bearing ~340°.
G1	30cm	Rendzina	Marly/ weathered chalk	3m from point F1, bearing ~340°.
H1	51cm	Rendzina	Chalk	3m from point G1, bearing ~340°.
I1	38cm	Rendzina	Marly chalk then hard chalk	3m from point H1, bearing ~340°. 23cm down reached marly chalk then 38cm down hard chalk.
J1	28cm	Rendzina	Hard chalk	12m from point I1, bearing ~250° perpendicular and down slope.
K1	90cm +	Rendzina	Clay	3m from point J1, bearing ~250°. No hard rock found.

Appendix 2: Rendzina

The term rendzina is used for a class of shallow, stony soils over chalk, limestone or extremely calcareous unconsolidated material (2015, Wikipedia Rendzina).

Rendzina is a dark, greyish-brown, humus-rich, intrazonal soil, usually shallow, with an A/C profile. It is one of the soils most closely associated with bedrock type and is usually formed by weathering of soft rock types: especially carbonate rocks like dolomite, limestone, marl and chalk, but occasionally sulphate rocks such as gypsum (2015, Wikipedia Rendzina).

References

BGS Geology Viewer. (2015) Available from: *http://mapapps.bgs.ac.uk/geologyofbritain/home.html?location=Bedfordshire*. [15 October 2015].

BGS Lexicon of Named Rock Units. (2015) Available from: *http://www.bgs.ac.uk/lexicon/home.html*. [15 October 2015].

Cohen, K.M., Finney, S.C., Gibbard, P.L. & Fan, J.-X., (2013; updated) *The ICS International Chronostratigraphic Chart*. Episodes 36: 199-204. Available from: http://www.stratigraphy.org/index.php/ics-chart-timescale . [16 October 2015].

Farrant, A.R., arf@bgs.ac.uk, 2015a. *Ask about geology question - IDA 239209.* [E-mail] Message to: A. Williams (annew36@hotmail.com). Sent: 26 Aug 2015, 11:48. Available at: bev.fowlston@gmail.com [Accessed 26 August 2015].

Farrant, A.R., arf@bgs.ac.uk , 2015b. *Ask About Geology Question - IDA 239209*. 2015. [E-mail] Message to: A. Williams (annew36@hotmail.com). Sent: 1 Sep 2015, 13:27. Available at: bev.fowlston@gmail.com [Accessed 2 Sep 2015].

Grid Reference Finder. (2011) Available from: *http://gridreferencefinder.com/*. [15 October 2015].

Moorlock B.S.P., Shephard-Thorn, E.R., Wyatt, R.J., Lake, R.D., Colleran, J.P., Horton, A., Thurrell, R.G., Aldiss, D.T., Barron, A.J.M., Sumbler, M.G. and Williams, B.J. (1992) *Geological Survey of England and Wales New Series Map, Sheet 220*. British Geological Survey.

Mortimore, R.N., Wood, C.J. and Gallois, R.W. (2001) *British Upper Cretaceous Stratigraphy*, Geological Conservation Review Series, No. 23, Chapter 4: Transitional Province, England Site: Overstrand to Trimingham Cliffs, Joint Nature Conservation Committee, Peterborough, 558 pp.

Shephard-Thorn, E. R., Moorlock B. S. P., Cox, B. M., Allsop, J. M. and Wood, C. J. (1994). *Map and Memoir of the British Geological Survey, Sheet 220*. British Geological Survey.

Wikipedia Rendzina. (2015) Available from: *https://en.wikipedia.org/wiki/Rendzina*. [16 October 2015].