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GeoExposures: documenting temporary geological exposures in Great Britain through a citizen-science web site.

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Abstract

GeoExposures is a newly developed crowd-sourcing web site for recording temporary geological exposures in the Great Britain that might be lost to science. It has been developed and deployed by the British Geological Survey (BGS) using the Ushahidi Crowdmap service. Geological site information can be recorded and uploaded using a 'smart phone' or via a personal computer to the common-access web site. Geological data is recorded using a pro-forma and is uploaded along with digital photographs. Support is provided through linked web sites including Google Maps, BGS digital geological maps, the BGS Stratigraphical Lexicon and BGS TimeChart (geochronology). As a contribution to citizen science, GeoExposures will enable the geoscience community to contribute to preserving important geological information. Geoexposures is made available under a Creative Commons licence. As with other citizen-science initiatives, the information and photographic records are available to the community and copyright is not vested with the individual respondent or BGS.

Keywords: GeoExposures, temporary geological exposure, crowd sourcing, citizen science, Ushahidi, Crowdmap

1. Introduction

1.1 Here today—gone tomorrow

The geological community in the UK has for many years recognised that scientifically important information revealed in temporary exposures of bedrock and superficial (Quaternary) deposits is frequently 'lost to science' (Gray, 2004; Prosser et al., 2011). This is due, in part, to the temporary nature of the exposures and the inability of the geoscience community to respond at short notice, but is also a result of the geological sciences having no formal links to the UK planning process, in contrast to the archaeological community. The latter, represented by County or Regional archaeological authorities, are informed, through the statutory planning process, of excavations and likely exposures that might reveal important archaeological information that would otherwise be lost to the nation. Although the GeoExposures web-site is not aimed

primarily at conservation of geological sites *per se*, the permanent record is a contribution to a better understanding of the British geology as outlined in Prosser et al. (2011)

The Geological Society Stratigraphy Commission (GSSC) recognised that geological information seen in temporary exposures may provide highly valuable information that should be recorded, archived and made available to all. In discussions at the Commission (minutes: 11th February, 2009) it was noted that a procedure was needed to expedite the recording and storage of information observed in temporary exposures such as pipeline trenches, shallow excavations, road cuttings, civil engineering schemes, active quarries and engineered embankments. This initiative was taken forward at the British Geological Survey (BGS). The geological imperative, outlined above, coincided with the desire of the BGS Knowledge Exchange programme to consider how citizen-science methods might be used to further the organisations knowledge base. The web site GeoExposures (Figure 1) was deployed and launched via a poster at the Geologists' Association Meeting, 2011 '*Geoconservation for Science and Society: An Agenda for the 21st Century*' on 9th September 2011 (Powell et al., 2011).

In this paper we outline the methodology, software requirements and principal features of the first crowd-sourcing web site, with universal access, dedicated to the recording of temporary geological sites. The BGS Citizen Science web site also incorporates reporting of landslides, flood events and soils.

2. Key issues

The archaeological community is informed of major excavations, pipeline routes and civil engineering schemes through statutory planning legislation under PPG15 (DoE, 1994) and PPG16 (DoE, 1990); these were replaced by Planning Policy Statement PPS 5 in 2010 (DCLG, 2010). Archaeology probably has a higher level of recognition than geoscience among the public, probably as a result of its immediate historical and human associations with which the general public can identify, and the value of artefacts and archaeological sites that may be unique. Geological exposures may also be 'unique', but the scientific information that they reveal is often replicable at adjacent sites or elsewhere in the region. The scientific and societal importance is also less in the public consciousness, unless publicised, say, as a unique or special fossil locality.

The British Geological Survey (BGS) is the repository for the UK's geoscience data, but has no statutory rights in this area except to be informed of boreholes drilled for water or minerals, onshore, to depths of 30 m or more. In practice, the BGS collects borehole site investigation reports that include borehole logs and trench descriptions through active projects and it also receives an enormous volume of borehole data (often as drillers' logs) on a voluntary basis from private sector companies and other organisations. These records are held as hard copy and in digital format at the National Geosciences Data Centre at the BGS Nottingham and Edinburgh offices, and have recently been made available free of charge via the BGS OpenGeoscience platform as digital pdfs of the original records (<http://mapapps.bgs.ac.uk/boreholescans/boreholescans.html>). This sub-surface information is highly valuable for the economic development and environmental safeguarding of the nation, but it does not address information that might be gleaned from temporary surface exposures such as stratigraphical and structural relationships of geological units; sedimentological features; fossils and mineral

occurrences. BGS has active survey projects throughout the UK, but as funding for core geological mapping and 3D modelling becomes tighter, these activities are focussed at any one time on fewer areas. Although BGS geologists respond whenever possible to record information on major construction projects, such as the South Wales pipeline, it is inevitable that many sites are missed due the reasons noted above.

The Geological Survey Act 1845, as amended by the Science and Technology Act 1965 empowers officers of the Survey, after notice has been given in writing, to enter upon the land of any owner for the purpose of making a geological survey. However, recent Health and Safety legislation imposes strict conditions for access to active civil engineering sites and active quarries (<http://www.hse.gov.uk>). It has been suggested that the BGS might appoint 'volunteer geoscientists' to visit temporary exposures, but personal indemnity insurance and H&S regulations would not allow BGS to transfer any right of access to others.

3. Top-down or bottom-up approach?

Two approaches, outlined below, to recording and reporting geological information from temporary exposures can be summarised as 'top-down' and 'bottom-up'.

A **top-down approach** (Figure 1) would rely on information about civil engineering schemes being provided via the UK planning system to interested parties such the Geology Trusts and BGS in a timely fashion, in order to allow a timely response. Informal discussions between members of the GSSC and the archaeological community indicated that the sheer volume of planning applications of potential interest to geoscientists might swamp the system. A better solution might be for the Regional and/or County archaeological authorities to 'filter' the Planning Applications so that only major schemes are forwarded to the geological community. This approach would rely on a formalised link between the Planning Authorities (on a county basis) and other nationwide organisations such as the Highways Agency with the BGS or the Geology Trusts in order to highlight potential geological exposures. However, with current and declining public sector funding it is unlikely that organisations will have sufficient resources to set up, monitor and manage such a scheme. Furthermore, these organisations may not have the resources to get expert geologists on the ground in all but the largest civil engineering schemes, such as major pipeline routes.

The **bottom-up approach** (Figure 2) adopted by GeoExposures (<http://www.bgs.ac.uk/citizenScience/geoexposures.html>) is based on the crowd-sourcing methodology that relies on motivated individuals to locate, record, and upload information to an open-access web site, shared by all. This has only recently been feasible as a result of the development of crowd-sourcing software such as Ushahidi. Adoption of this freely available software has allowed BGS to design a bottom-up web site for recording temporary geological information, outlined below (<http://www.bgs.ac.uk/citizenScience/geoexposures.html>).

4. Ushahidi crowd-sourcing software

Ushahidi (pronounced oo-shah-hee-dee) means "testimony" in Swahili, and was a website that was initially developed to map reports of violence in Kenya after the post-

election fallout at the beginning of 2008, and was later deployed during national emergencies such as the devastating earthquake in Haiti in 2009. The original website was used to map incidents of violence and peace efforts throughout the country based on reports submitted via the web and mobile phones. This provided a catalyst for the development of a free and open source platform which could be used by organisations around the world for gathering and reporting data using geographical mapping tools.

A key feature of the Ushahidi platform is the ability to use mobile/smart phones as a primary means of gathering and reporting data, and for receiving updates (Ushahidi, 2011). It is equally well suited to communication via a personal computer at the home or office. Ushahidi is available to be downloaded and installed on your own web server. BGS have opted to use the accompanying Crowdmapper service which provides a cloud-based deployment of the Ushahidi platform. Crowdmapper enables anyone to rapidly deploy Ushahidi without any required technical acumen in the shortest amount of time possible. Crowdmapper provides all the benefits of Ushahidi out of the box but with nothing to install. Within a matter of minutes, a Crowdmapper site can be set up and information can be being gathered from the public. This flexibility will enable BGS to react quickly should it need to set up new, focussed citizen science initiatives in the future in response to geological events such as major earthquakes or landslides. The main features of the Ushahidi platform and its application to citizen geoscience are outlined in Table 1.

<<Table goes here>>

5. GeoExposures in action

GeoExposures (<http://www.bgs.ac.uk/citizenScience/geoexposures.html>) is concerned only with the recording of *temporary* exposures and is not aimed at documenting natural exposures (e.g. inland exposures and coastal cliffs; disused quarries etc.) or with the conservation of geological sites (e.g. Sites of Special Scientific Interest and Regionally Important Geological Sites) (Prosser et al., 2011). Geoconservation in the UK has a long and successful history of site recording, maintenance of important geological sites and landscape features, and in promoting their value in education and to the general public, as outlined in papers in this volume (for further information see; [Natural England](http://www.naturalengland.org.uk/) (<http://www.naturalengland.org.uk/>), [Scottish Natural Heritage](http://www.snh.gov.uk/) (<http://www.snh.gov.uk/>), [Countryside Council for Wales](http://www.ccw.gov.uk/) (<http://www.ccw.gov.uk/>) and the [GeoConservationUK](http://wiki.geoconservationuk.org.uk/) (<http://wiki.geoconservationuk.org.uk/>).

Using the GeoExposures web site (Figure 3), amateur and professional geologists are able locate a temporary exposure visually using Google Maps on a mobile device (i.e. iPhone/iPad or Android smartphone), then log briefly the site's geology on a pro-forma, and upload digital photographic images (.jpg) to the web site either via their smart phone or from their home or office computer. Some users may prefer more traditional methods to map, log and record the information, using a field notebook, hard-copy Ordnance Survey and BGS geological maps, and subsequently upload at their convenience from a computer. The essential components are an accurate geological description of the site and good quality digital photographs to act as a permanent record.

To assist geological recording, the web site provides the user with links to background information on the geology and stratigraphy of the UK, such as digital BGS geological maps (http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html), the BGS

Stratigraphical Lexicon (<http://www.bgs.ac.uk/Lexicon/home.html>) and the BGS Timechart <http://www.bgs.ac.uk/discoveringGeology/time/timechart/home.html>. In addition, there is a converter (<http://www.bgs.ac.uk/data/webservices/convertForm.cfm>) to transfer latitude-longitude locations taken from a Google Map image to an 8 figure British National Grid (BNGR) (e.g. SE 3445 6720 or ⁴3445 ⁴6720). The fundamental site description and photographs uploaded on the pro-forma can be supplemented by additional information such as a site sketch map and geological log. These can be drawn freehand on a template with a scale graticule, as one would in a geological field notebook, and submitted as additional photographic images. We hope that professionals in the civil engineering and quarrying industries will also be keen to submit records of short-lived exposures at their sites (e.g. ephemeral exposures of geological features as the working face is cut back).

5.1 First response

During development of a 'beta' test site we received an e-mail from Andrew Hunn, an archaeologist, who was logging a pipeline trench near Tirley, Gloucestershire. His images and site description became the first external GeoExposures record (Figure 3) Coincidentally, the faulted Mercia Mudstone (Upper Triassic) exposure is the same age and formation as our example site which is based on temporary exposures of the foundations (in 2008) of the William Smith Building at BGS Keyworth (Figure 4). We would like to think that the 'Father of English Geology' would approve of the latest format for recording geological information.

5.2 Data availability and copyright

We are keen to see this as a geoscience community web site and not an official BGS site; our vision is to deploy the software in a useable format for common access and, as such, Geoexposures is made available under a Creative Commons licence. As with other citizen-science initiatives, the information and photographic records are available to the community and copyright is not vested with the individual respondent or BGS.

We recommend that any information lodged on the GeoExposures site that is subsequently used in a scientific publication or popular publication is acknowledged, e.g. *the section described in figure xx is taken from a temporary exposure reported by A.N.Other on the GeoExposures website (Number 0000).*

5.3 Site monitoring and verification

BGS will provide a moderator to monitor submissions for improbable records such as 'dinosaur footprints found in Cambrian rocks' and to check for spurious or 'joke' submissions, but we do not currently have the resources to rigorously verify the geological records in detail. There is a means to send in comments and suggestions on individual site records, and we hope Geoexposures will generate vibrant discussions among the geosciences.

5.4 Health and Safety

Gathering and recording data at temporary exposures may involve the need for geologists to enter civil engineering sites. It is incumbent upon individuals to arrange their own insurance and any permission to enter onto sites through liaison with local site

managers to ensure their own and others' health and safety. There are strict rules concerning access to working quarries and civil engineering sites in the UK (<http://www.hse.gov.uk/>) and it is important that these are adhered to.

6. Conclusions

The GeoExposures web site provides a crowd-sourced application for recording temporary geological exposures in the Great Britain. Some temporary geological site information may be immediately valuable to the geological sciences; other sites may only be appreciated in the future during subsequent geological investigations. The web site has been produced by the British Geological Survey (BGS) using Crowdmap, a Cloud-based deployment of the Ushahidi Platform to provide a system and database that is available to all. Geological site information can be recorded and uploaded using a 'smart phone' or via a personal computer to the common-access web site. Traditional methods of gathering site data using hard copy are also possible as long as the data is uploaded digitally to the web site. Geological data is recorded using a pro-forma and is submitted along with digital photographs that provide a permanent record. Links to Google Maps, BGS digital geological maps, the BGS Stratigraphical Lexicon and BGS TimeChart (geochronology) provide additional support to the user on the background geology of Great Britain. As a contribution to citizen science, GeoExposures will enable the geosciences community including professionals and volunteers to contribute to recording and preserving important geological information for the nation. Future developments might include top-down notifications from national organisations on sites of potential interest to the geoscience community.

Acknowledgements

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Ushahidi, 2011. <http://www.ushahidi.com> (November 2011)

Table caption

Table 1. The main features of the Ushahidi crowd-sourcing platform and its application to geoscience reporting. After Ushahidi (2011) with additions.

Figure captions

Figure 1. A possible top-down scheme (grey boxes) for recording temporary exposures.

Figure 2. The current, simplified, GeoExposures scheme for recording temporary exposures.

Figure 3. GeoExposures landing web page: britishgeologicalsurvey.crowdmap.com

Figure 4. The first GeoExposures record submitted by Andrew Hunn showing minor faults in the Upper Triassic Branscombe Mudstone Formation, Mercia Mudstone Group recorded in a pipeline trench near Tirley, Gloucestershire (Worcester Graben).

Figure 5. GeoExposures web site example showing the Upper Triassic Branscombe Mudstone Formation, Mercia Mudstone Group, exposed in the excavations for the William Smith Building, BGS, Nottingham in 2008.



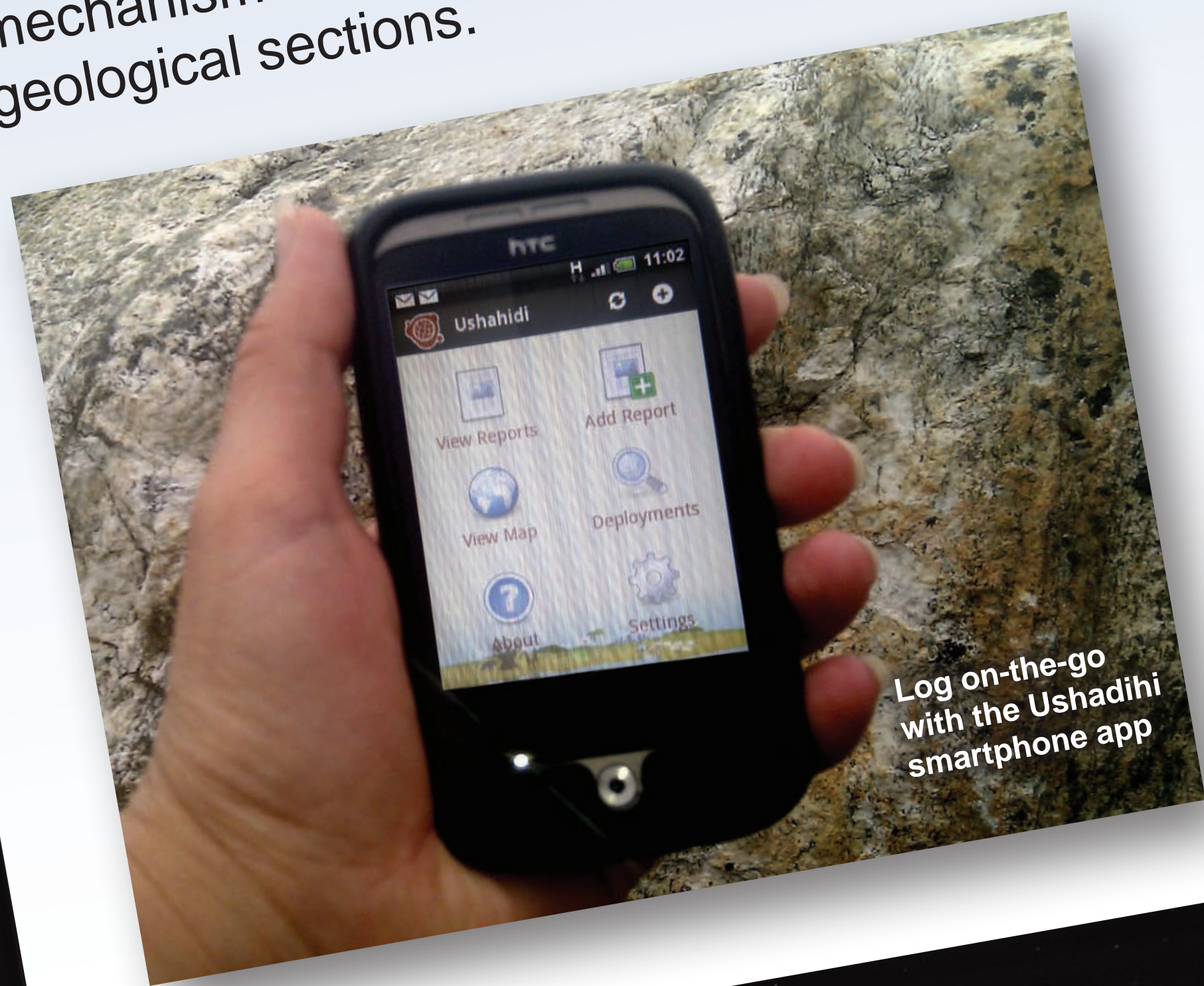
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

GeoExposures

Creating a geological community web site for the recording of temporary exposures

Get logging! GeoExposures has been designed and deployed by the British Geological Survey (BGS) using Ushahidi crowd-sourcing software to provide the geoscience community with a web site to enable recording of **temporary** geological exposures, and to make the information available to all.

The geological community in the UK has long recognised that scientifically important information revealed in temporary exposures of bedrock and superficial (Quaternary) deposits frequently 'lost to science'. This is largely due to the temporary nature of the exposures and the inability of the geoscience community to respond at short notice. Amateurs and professionals will be able locate a temporary site (excavation; pipeline; road cut etc.) on a Google map, briefly log the site geology on a pro-forma, and upload .jpg photo images via a smart phone or via the web site from their PC. Some of the site information will be very important—other sites may be initially of low impact, but valuable in future investigations or geological studies, both professional and academic. GeoExposures will support the work of the geological conservation community and provide a mechanism accessible to all for recording temporary geological sections.



Log on-the-go with the Ushahidi smartphone app

1. Log on to the GeoExposures site via smartphone or PC

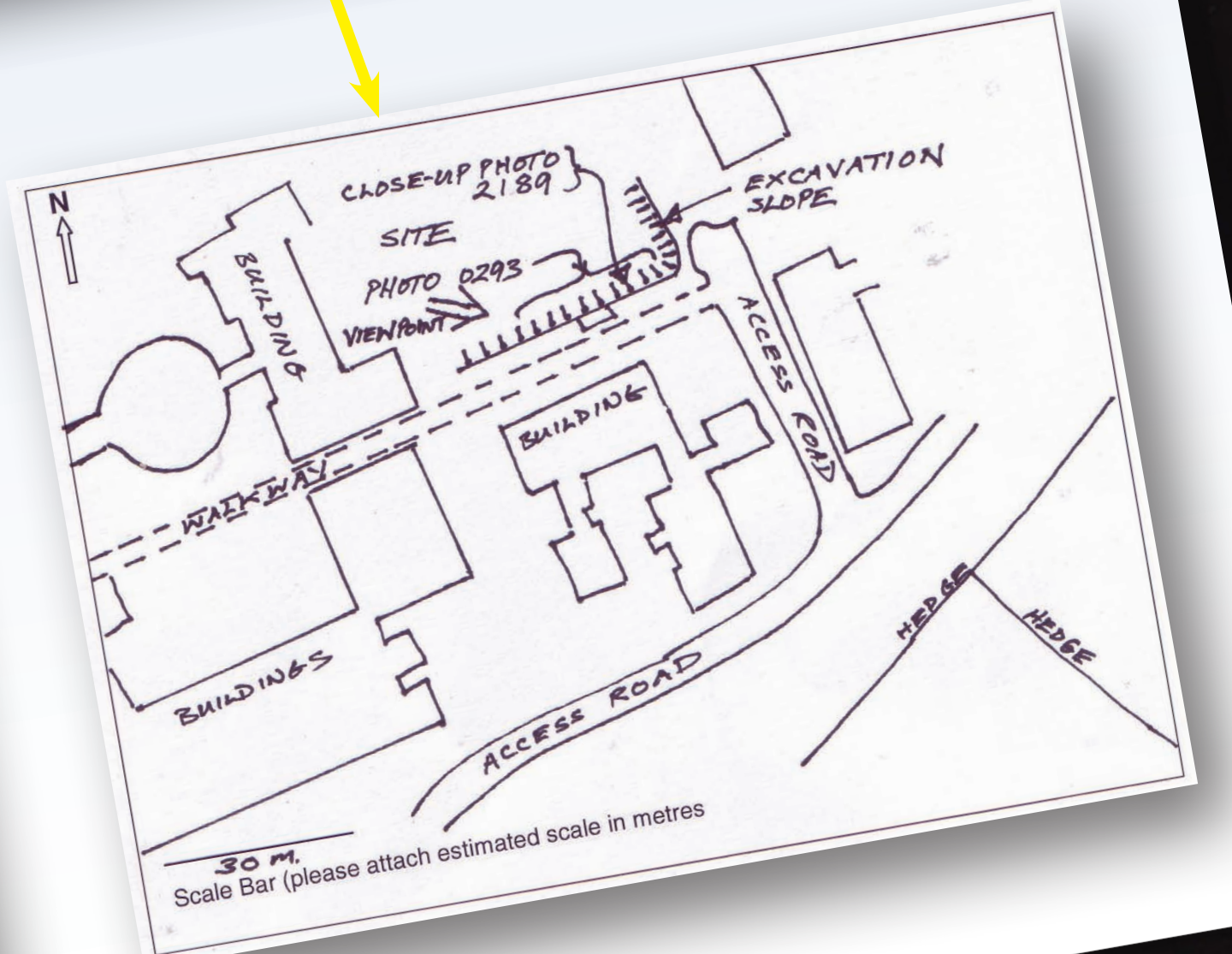
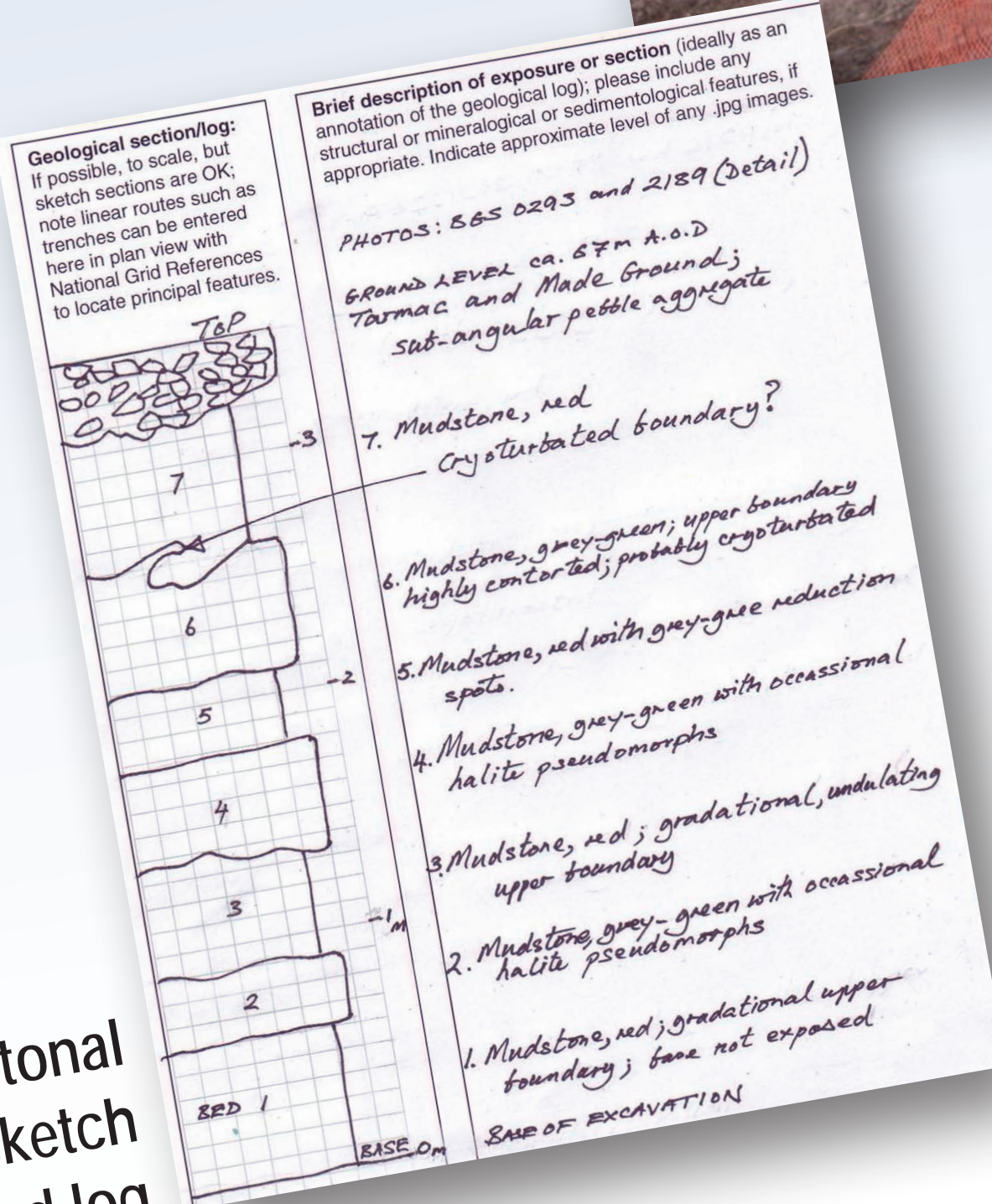


2. Locate exposure, record details, upload photographs



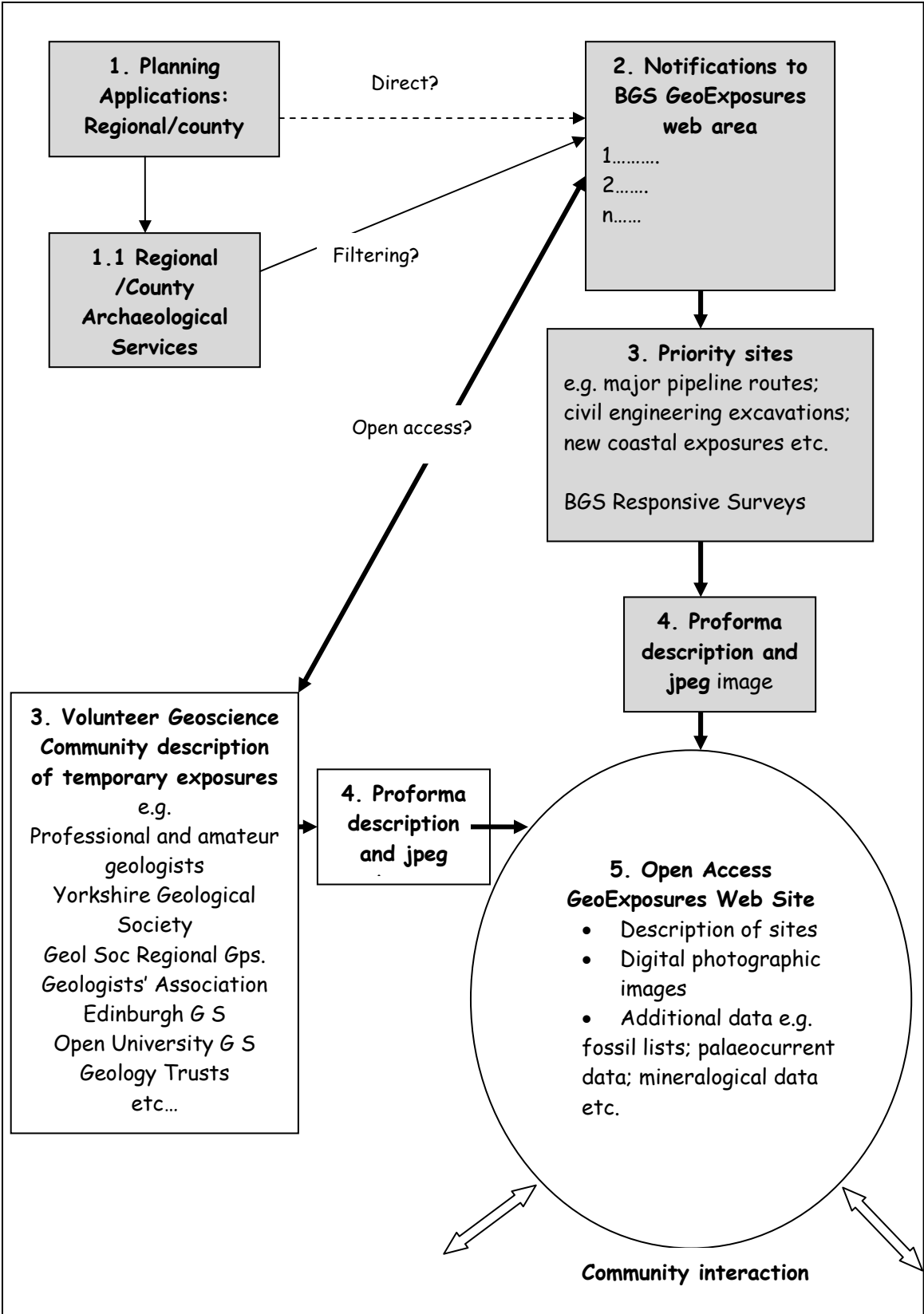
William Smith Building foundations; Triassic Mercia Mudstone Group, Branscombe Mudstone Fm. dipping NE

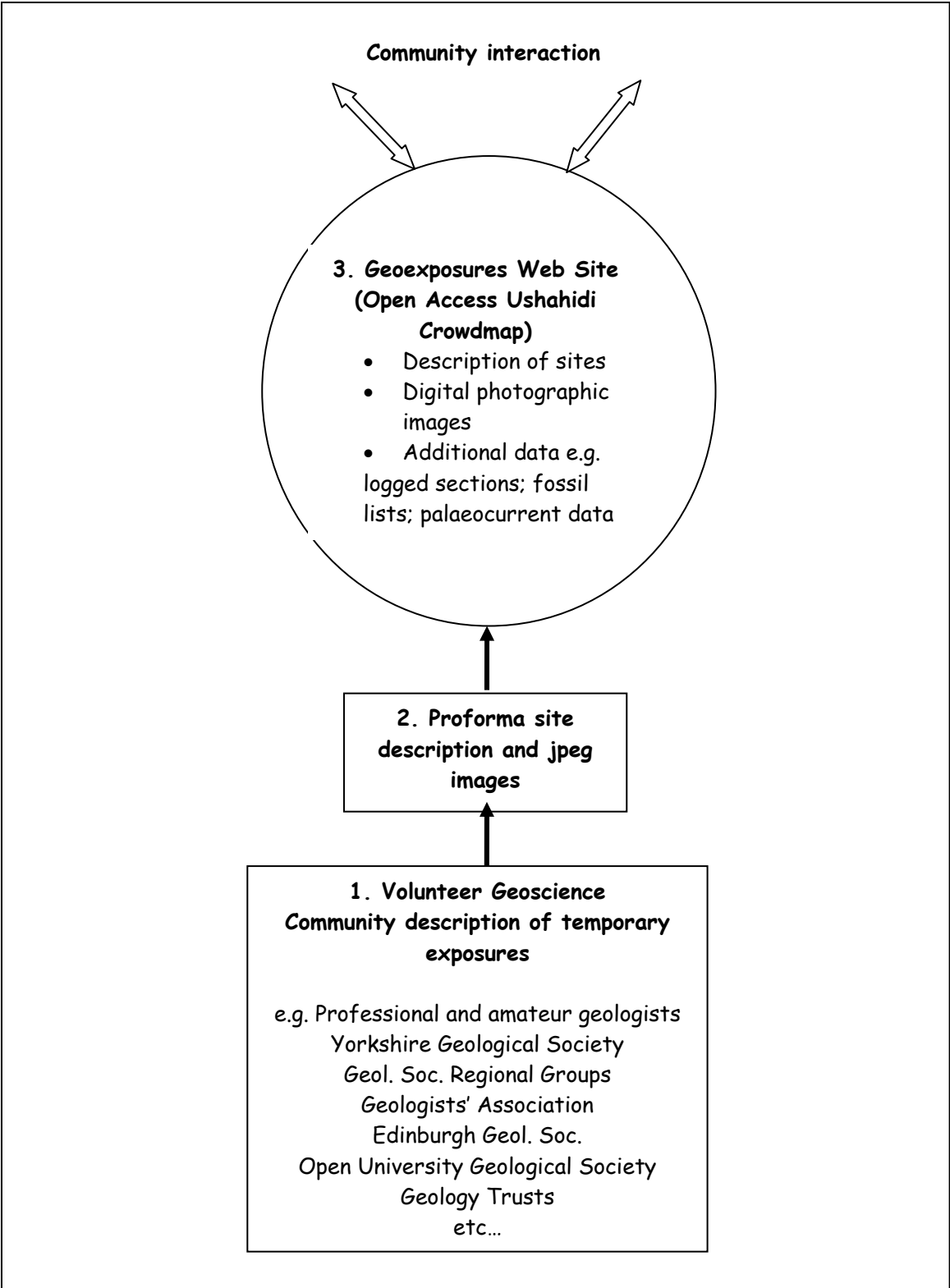
3. Add additional (optional) sketch map and log



How do I get involved?
See <http://www.bgs.ac.uk/citizenScience/geoexposures.html>
for launch on
(site is in test mode, but watch out for launch on
<http://britishgeologicalsurvey.crowdmap.com/main>)

Contact:
John Powell,
Gemma Nash and Patrick Bell
British Geological Survey, Keyworth
jhp@bgs.ac.uk;
gvp@bgs.ac.uk; pdbe@bgs.ac.uk





Exposure in foundations for William Smith Building, May 2008

VERIFIED

01:33 Sep 13 2011 Exposure in foundations for William Smith Building, May 2008

Geoexposures

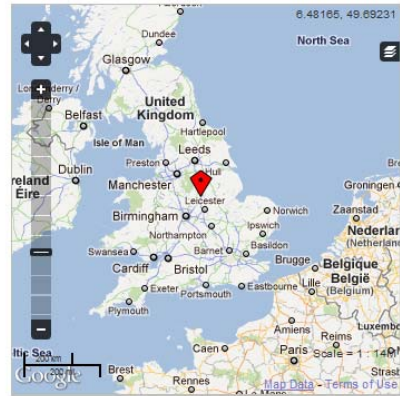


Description

Excavated face on the south south-east side of the construction site for the new William Smith Building. The 3.5 m high section exposes red-brown mudstone interbedded with pale green-grey mudstone. The beds dip gently to the north-east at the southern end of the site, becoming horizontal to the north east [Photo 1; BGS 0293]. The bedrock is overlain by approximately 0.35 m of made ground deposits consisting of sub-angular aggregate. The upper part of the exposed section is disturbed, possibly a result of glacial cryoturbation although there are also indications of man made disturbance in the south of the site [Photo 1]. In detail [Photo 2; BGS_2189], there are four beds of red-brown mudstone between 0.35 m and 0.60 m thick, interbedded with three beds pale green grey mudstone between 0.25 and 0.35 m thick, the latter containing small pseudomorphs after halite. Boundaries between the beds are undulating, the boundary between the highest pale green mudstone bed and the topmost red mudstone bed is highly contorted [Photo 2] probably as a result of cryoturbation during Quaternary glaciations. There are no Quaternary deposits exposed.

Additional Data

Status of the site/exposure: Excavated face on south southeast and north northwest sides of building; subsequently obscured.
County or district: Nottinghamshire
Ordnance Survey Sheet no: 129 Landranger 1:50 k
National Grid Reference(s): SK 6218 3160
BGS 1:50k sheet no: 142 Melton Mowbray
Date of record: Jan 24 2008
Additional information



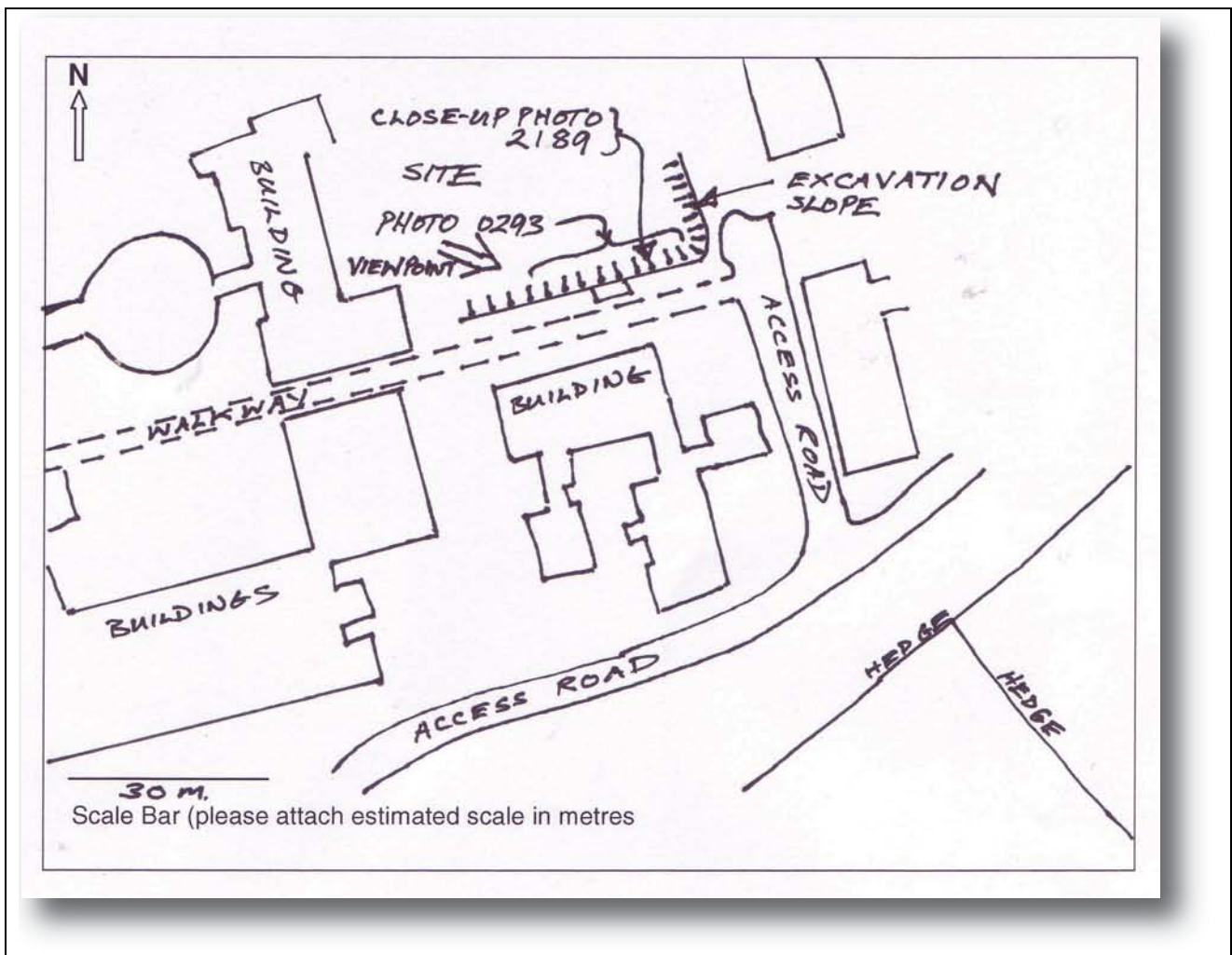
Additional Reports

- Tirley PRI** 01:12 Sep 07, 2011
Exposure on South side of B4211 in gaspipe auger bore trench August 2011; SO81573-29566, 80.73 Kms
- Landslide at Blubberhouses, North Yorkshire** 01:26 Sep 02, 2011
Blubberhouses, North Yorkshire, 81.96 Kms
- Flooding in Cumbria, November 2009** 11:40 Sep 02, 2011
Pepcastle, west Cockerthorpe, 154.93 Kms
- Landslides at Folkestone Warren, Kent** 01:39 Sep 02, 2011
Folkestone Warren, Kent, 158.81 Kms

Sketch Map of Site (optional) (Site Name : William Smith Building, British Geological Survey, Keyworth, Nottingham, NG12 5GG)

Please download the pdf, add information, scan and submit the pdf to the BGScitizenScience@bgs.ac.uk with the unique record number that is at the end of the URL on the crowdmap page for your report. I.E. <http://britishgeologicalsurvey.crowdmap.com/reports/view/>

If possible, please label the position(s) of key geological/geomorphological features and the orientation of view of any .jpg images,

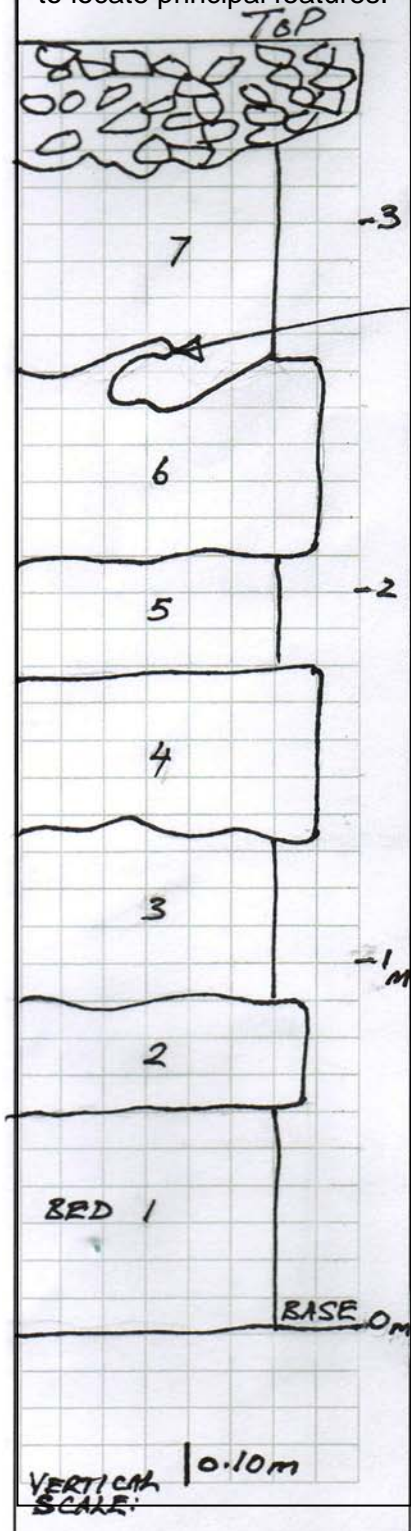


Geological section or log (optional)

Please download the pdf, add information, scan and submit the pdf to the BGScitizenScience@bgs.ac.uk with the unique record number that is at the end of the URL on the crowdmap page for your report. I.E. <http://britishgeologicalsurvey.crowdmap.com/reports/view/3>

Geological section/log:

If possible, to scale, but sketch sections are OK; note linear routes such as trenches can be entered here in plan view with National Grid References to locate principal features.



Brief description of exposure or section (ideally as an annotation of the geological log); please include any structural or mineralogical or sedimentological features, if appropriate. Indicate approximate level of any .jpg images.

PHOTOS: BGS 0293 and 2189 (Detail)

GROUND LEVEL ca. 57m A.O.D
Tarmac and Made Ground;
sub-angular pebble aggregate

7. Mudstone, red
CRYOTURBATED boundary?
 6. Mudstone, grey-green; upper boundary highly contorted; probably cryoturbated
 5. Mudstone, red with grey-green reduction spots.
 4. Mudstone, grey-green with occasional halite pseudomorphs
 3. Mudstone, red; gradational, undulating upper boundary
 2. Mudstone, grey-green with occasional halite pseudomorphs
 1. Mudstone, red; gradational upper boundary; base not exposed
- BASE OF EXCAVATION





