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Report of a visit to Gainsborough (earthquake damage)

Land Use & Development

Open Report OR/08/22



BRITISH GEOLOGICAL SURVEY

LAND USE & DEVELOPMENT

OPEN REPORT OR/08/22

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1 Introduction

On 27th February 2008 at 00:56 GMT an earthquake was recorded by BGS with a magnitude of 5.2 (ML) on the Richter scale near Market Rasen, Lincolnshire. The same day a visit was made by the authors to the town of Gainsborough, Lincolnshire from where a significant proportion of the damage reports originated. The aim of the visit was in order to examine building damage and its relation, if any, with local geological conditions. The earthquake was widely reported in the British media and several TV crews filmed at Gainsborough and also at Keyworth on 27th February.

2 Location

2.1 EARTHQUAKE (MARKET RASEN)

2.1.1 Seismic alert

The following information was taken from the BGS web-site on 27th Feb 2008 regarding details of the 'felt-event' seismic alert at Market Rasen, Lincolnshire:

PRESS RELEASE

27 February 2008

England hit by Earthquake

The British Geological Survey (BGS) recorded an earthquake with a magnitude of 5.2 (ML) on the Richter scale near Market Rasen, Lincolnshire at 00:56 GMT. The BGS has been inundated with calls from the public, media and emergency services throughout England.

Summary:

DATE : 27 February 2008

ORIGIN TIME : 00:56 GMT

LAT/LONG : 53.42° North / 0.35° West

GRID REF : 509.4 kmE / 392.7 kmN

DEPTH : 5.0 km

MAGNITUDE : 5.2 Richter Scale (ML)

LOCALITY : Market Rasen, Lincolnshire

The epicentre is approximately 4 km north of Market Rasen and reports suggest that the earthquake has been felt widely across England, with reports of damage to chimneys in the epicentral area. Earthquakes of this size occur in the mainland UK roughly every 30 years, although are more common in offshore areas. This is the largest earthquake in the UK since the magnitude 5.4 ML Lley Peninsula earthquake in 1984, which was widely felt across England and Wales.

Seismologist Dr Brian Baptie of the British Geological Survey said:

"This is a significant earthquake for the UK and will have been widely felt across England and Wales". The BGS records approximately 200 earthquakes in the UK each year on its monitoring stations. Approximately 25 earthquakes in the UK are felt by people each year.

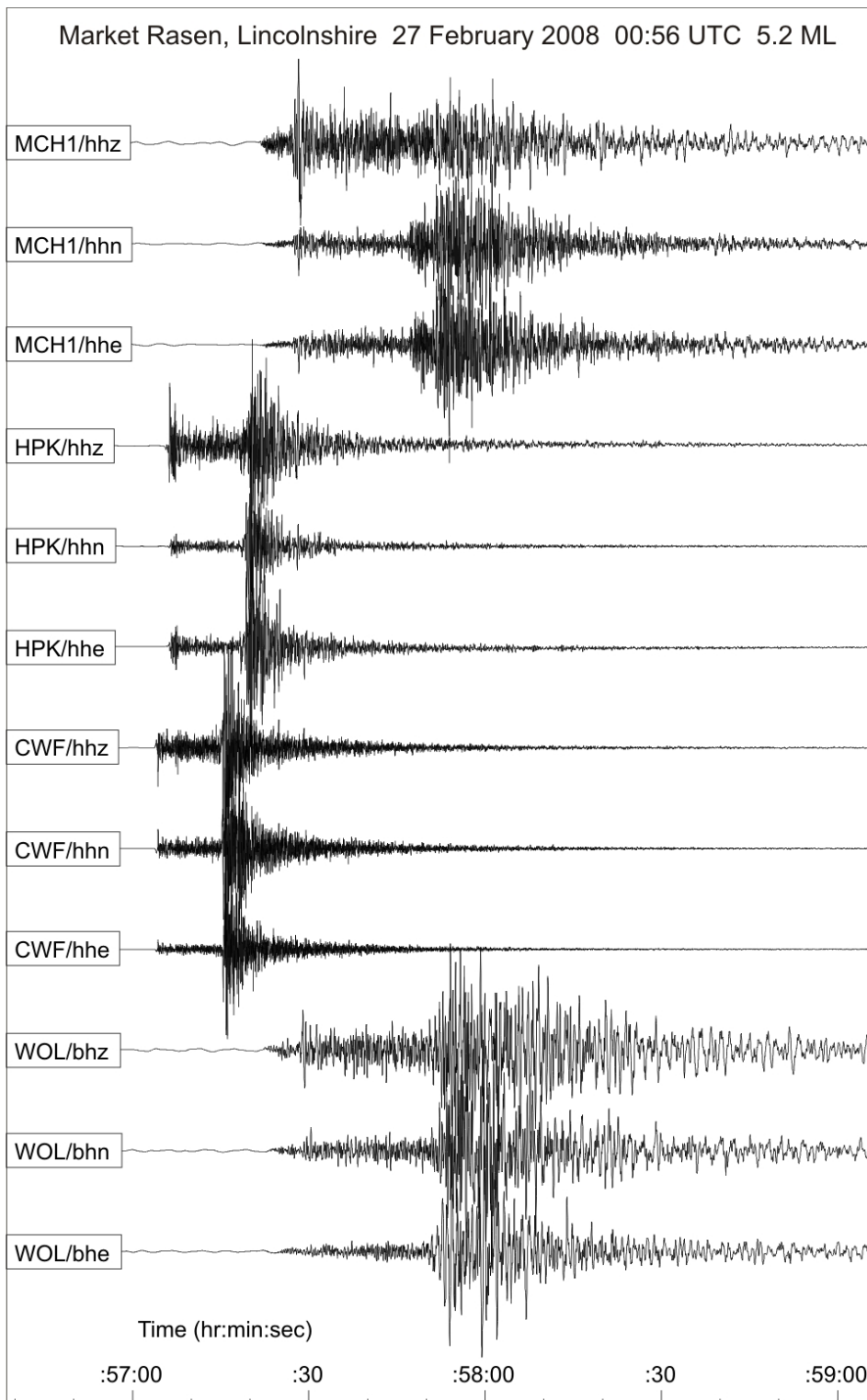
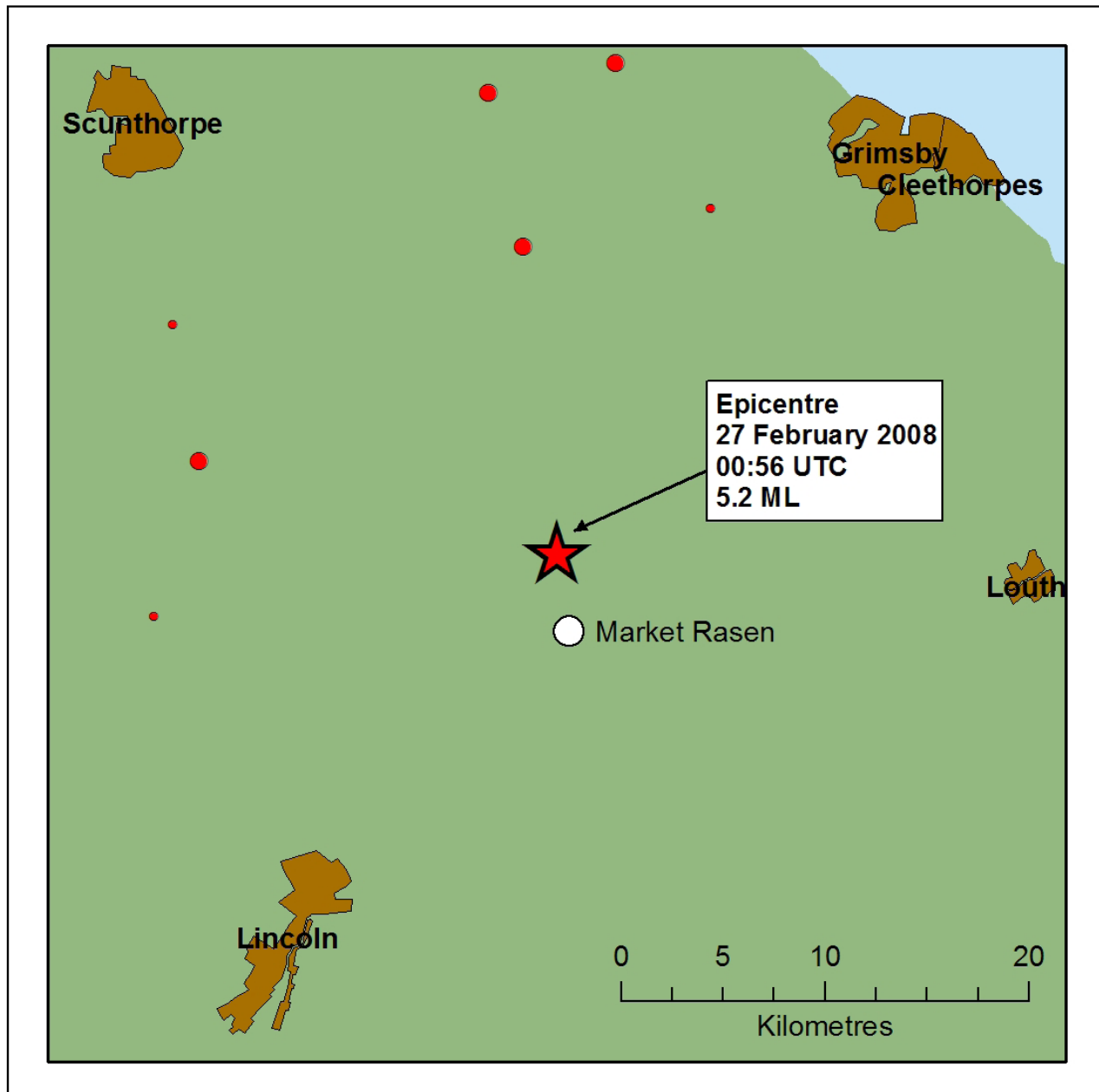


Figure 1 Seismograms of the Market Rasen earthquake as recorded on the BGS seismographic network (BGS).

Table 1 Location of BGS seismometers (Refers to Figure 1)

Seismometer code	Name	Location
MCH1	Michaelchurch	51°59'50.64'', 2°59'53.88''
HPK	Haverah Park	53°57'29.16'', 1°37'26.76''
CWF	Charnwood Forest	52°44'17.88'', 1°18'25.99''
WOL	Wolverton	51°18'45.72'', 1°13'22.12''

**Figure 2 Map showing historical and instrumental seismicity within 25 km of the Market Rasen earthquake of 27th February 2008 since 1703 (BGS).**

2.1.2 Structural damage walk-over, Gainsborough, Lincolnshire

The authors met with Suzanne Sargeant (Seismologist, BGS, Edinburgh) and Graham Weatherill (University of East Anglia) and the group toured the area affected by building damage. The team met with Fire & Rescue Service staff, West Lindsey District Council staff and TV crews on the scene to discuss events in Gainsborough and elsewhere. Sites were visited in and around Trinity Road (A159). These locations showed many examples of structural damage. The great majority of these were damaged and collapsed chimneys on Victorian terraced houses. The Fire service and contractors had begun work making these safe by removing the worst examples and generally dislodging loose brickwork and chimney pots. This necessitated cordoning-off some sections of road for public safety. Access was generally being achieved using hydraulic ‘cherry pickers’ or roofers’ ladders.

The West Lindsey District Council staff met with were:

Daren Turner, Director of Resources & Deputy Chief Executive [daren.turner@west-lindsey.gov.uk]

James Nicholson, Director of Neighbourhoods & Health [james.nicholson @ west-lindsey.gov.uk]

Patrick Warner, Building Control Officer [patrick.warner @ west-lindsey.gov.uk]

West Lindsey District Council,
Guildhall,
Marshall’s Yard,
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The map in Figure 3 shows those streets visited (outline in red). Details of the locations visited are listed in Table 2. The majority of damage observed involved chimneystacks and chimney pots. Many of these had already been made safe or were in the process of being made safe. Some remained in a precarious state and these areas were mainly cordoned off to pedestrians and in some cases traffic. Figure 4 shows a remote image of central Gainsborough.

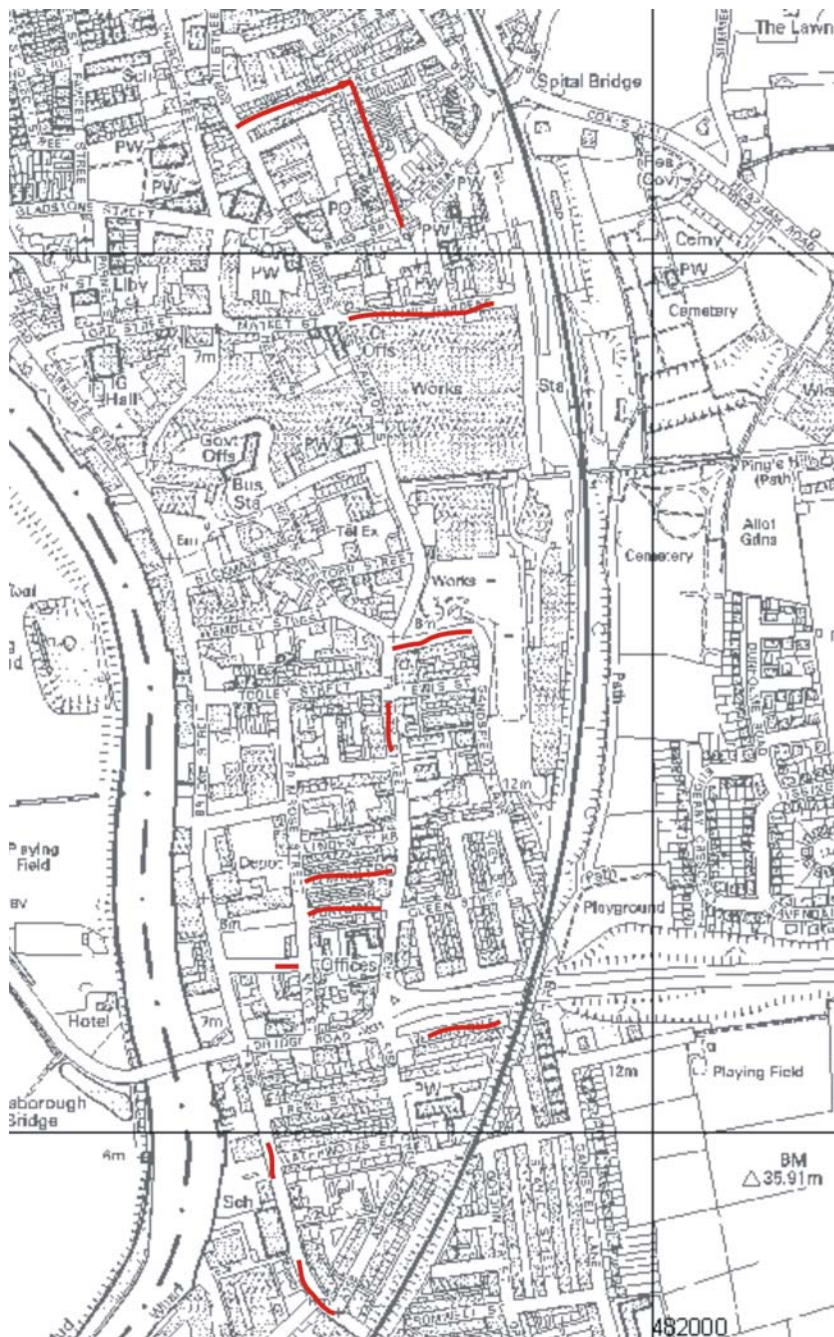


Figure 3 Map of central Gainsborough showing streets visited (shown in red line) where structural damage was seen or reported



Figure 4 Orthorectified radar image showing central Gainsborough
(note: River Trent left) (NextMap™)

The solid geology beneath the area of observed damage consists entirely of Mercia Mudstone Group rocks. The Mercia Mudstone in the area is predominantly a 'low' to 'medium' plasticity, 'weak' mudstone with thin bands of fine 'weak' sandstone or siltstone. Gypsum is present in the form of bands and nodules (Smith et al., 1973). The superficial geology is shown in Figure 5. Superficial deposits cover the whole area of observed damage. It consists of Recent River Terrace deposits and Middle-Pleistocene glaciofluvial deposits. The terrace deposits consist of sand and gravels as do the glaciofluvial deposits. The alluvium to the west of the River Trent is described as containing a layer of running sand and thin bands of peat (Smith et al., 1973).

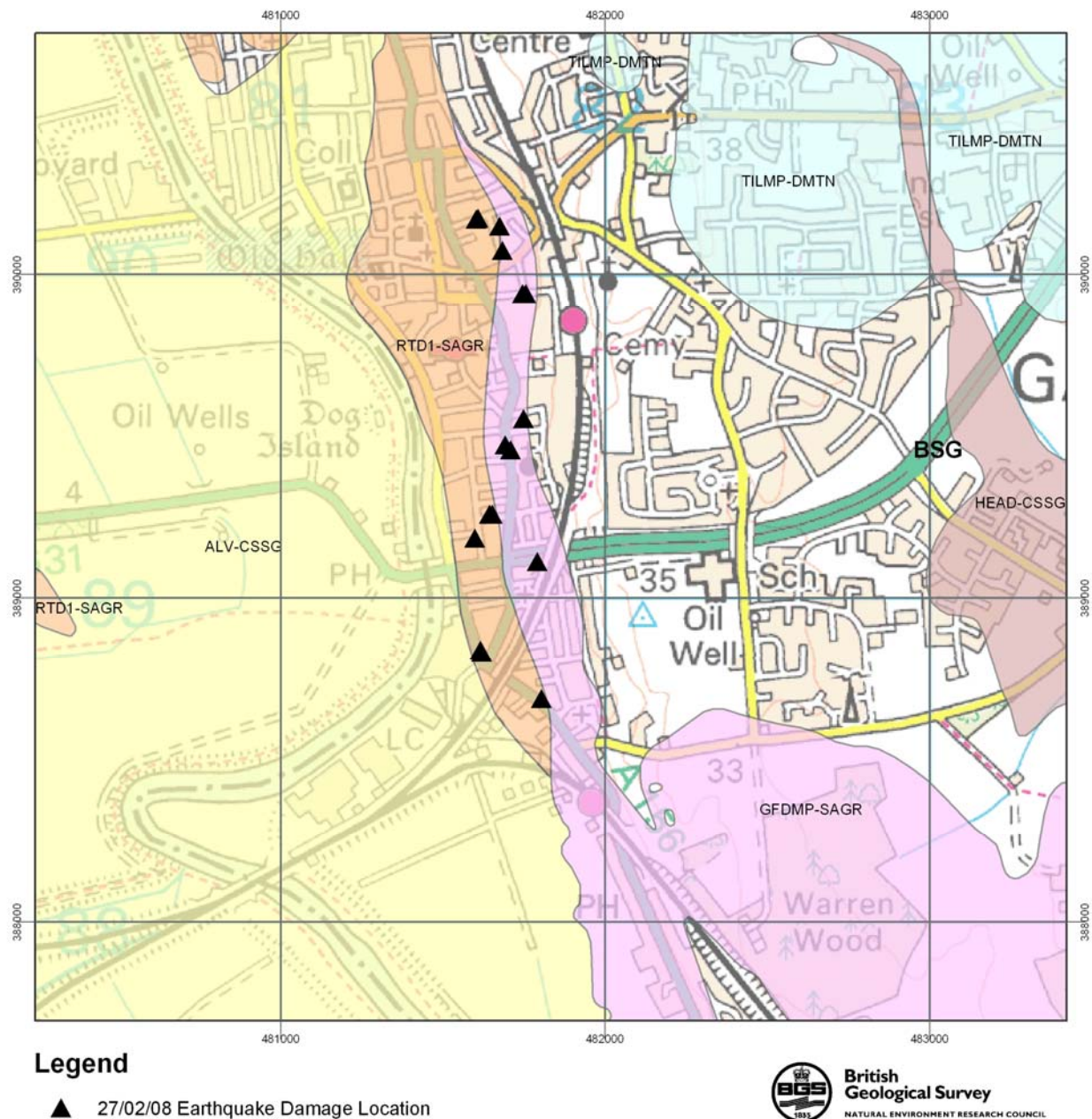


Figure 5 Map showing superficial geology, and recorded damage locations.

[yellow=alluvium, orange=river terrace, pink=glaciofluvial, light blue=till, brown=head]

Examples of typical damage seen in Gainsborough are shown in Figure 6 to Figure 9. All observed damage, with one exception, appeared to have occurred on Victorian terraced properties; the exception being a 1922 terraced property. The examples of damage to chimneys are typical and were repeated many times over within the area shown. There were several examples of tiles missing and damaged and a couple of broken out-house roofs. These appeared to have been caused by impact from falling chimneys and subsequent making-safe operations. Examples of wall collapse and fresh cracking of outside building walls were not observed, nor was damage to gable ends and roof ridges. Many chimneystacks showed evidence of disturbance by failure of mortared joints resulting in splaying of the stack; individual bricks having dislodged but the whole remaining in place. In some cases individual chimney pots had rotated and tilted or had fallen leaving the stack largely intact.

It is interesting to note that some Victorian buildings with unusually tall chimneystacks (>2.5 m) appeared to have been unaffected by the earthquake. Most of the houses affected with damage were in poor condition with old mortar. No evidence was found, or evidence obtained from the Fire & Rescue services or District Council staff at the scene, of structural damage to walls, roads, railways or services. It should be noted, however, that the walk-over was carried out shortly after the earthquake, and before all formal damage assessments had been completed.

Whilst the observations described above are the preliminary results of a short walk-over survey, the earthquake *intensity* rating for Gainsborough town, using the European Macroseismic scale (EMS98) (Grünthal, 1998), appears to lie between 6 and 7.

Table 2 List of locations visited in Gainsborough

BNG E	BNG N	Number	Street Name	Damage Category*	Damage Details/ Comments
481710	389458	31	Trinity Street	4	Chimney pot, tile, roof. House built c.1900, in poor condition, poorly maintained
		?	Clinton terrace	4	Chimney pot tilt?
481653	389259	12	Portland terrace	4	Brick went through roof at rear. Terraced redbrick house. c.1920s
481645	389258	16	Portland terrace	4	Chimney destabilised, 'made safe'. House in bad state of repair
481600	389185	NA	Corner of Thornton Street	3	Plaster cracked and fallen off brickwork onto street
481620	388832	69	Lea Road, Lyceum Terrace	4	Buckling of chimneystack. Red brick. Pots intact. Stack 2.5m high
481616	388839	65	Lea Road, Lyceum Terrace	3	Chimney pot tilted, bricks moved out
481620	388832	35	Lea Road	3	Tilted chimney. Victorian mid-terrace.
481792	389113	42	Wellington Street	4	Partial chimney collapse. West side of chimney affected. Red brick, poor/old mortar
481693	389473	96a	Trinity Street	4	Chimney pot collapse
481750	389554	8 /10	Coalville Terrace	4	Partial chimney collapse, brick and lime mortar pot debris road
481757	389940	29	Spring Gardens	4	Chimney pots bounced down roof onto pavement
481746	389940	25	Spring Gardens	4	Possible rotated chimneystack
481676	390149	22 /24	Tennyson St	4	Partial chimney collapse
481610	390173	38	Tower Street	4	Partial chimney collapse
481603	390170	34	Tower Street	4	Partial chimney collapse at rear
481685	390074	7	Tennyson Street	4	'The Limes '1888'AD' Partial chimney collapse. Debris at front and rear
481804	388690	147	Lea Road	4	Partial chimney collapse. West side of chimney affected. Red brick, poor/old mortar

*BGS Building Damage Category: 3 = Cracks which can be patched by a builder. 4 = Extensive damage requiring breaking-out and replacing.

Examples of typical damage in the area are shown in the following photographs (Figures 6 to 9):



Figure 6 Chimney damage, Tennyson Street [BGS4353] (27/02/08)



Figure 7 Chimney damage, Nos 12 (right) and 16 (left) Portland Terrace [BGS4307] (27/02/08)



Figure 8 Masonry debris from chimney, 12 Portland Terrace [BGS4314] (27/02/08)



Figure 9 Chimney and gutter damage [BGS4289] (27/02/08)



Figure 10 BGS staff recording damage on a tablet PC [BGS4296] (27/02/08)

3 Conclusions

- The damage observed in Gainsborough was confined to chimneystacks, TV aerials, and roofs and out-house roofs damaged from falling chimneystack masonry and pots.
- No evidence was found of structural damage to external walls, roads, railways or services.
- The damage observed in Gainsborough was confined to a low-lying area in the centre of the town where most properties are Victorian in age, and in some cases poorly maintained.
- The damage observed in Gainsborough was confined to terraced 2 and 3 storey houses.
- The damage observed in Gainsborough was confined to areas underlain by mapped superficial deposits of Trent 1st river terrace and glaciofluvial origin.
- The damage observed in Gainsborough was confined to areas where the superficial deposits are underlain by Mercia Mudstone bedrock.
- Earthquake *intensity* rating for Gainsborough town, using the European Macroseismic scale (EMS98) (Grünthal, 1998), appears to lie between 6 and 7.

4 Recommendations

It is recommended that building damage in other towns in Lincolnshire and South Yorkshire is investigated and reported so that the effects of solid and superficial geology, and the structural geology on the location and intensity of earthquake damage. Whilst no instances of structural damage or subsidence were observed at Gainsborough, opportunities should be sought to study whether ground subsidence has occurred in a wider area centred on the epicentre, in particular areas of superficial deposits such as alluvium and peat. This could be done using satellite-borne synthetic aperture radar (PSInSAR) coverage before and after the earthquake.

NOTE 1: Conclusions and recommendations contained in this report are based solely on brief walkover surveys only. No desk study or sub-surface investigations were made.

NOTE 2: Information contained in this report should not be used as a substitute for adequate site investigation.

5 References

Grünthal, G. (ed.) (1998) European Macroseismic scale 1998. Cahiers du Centre Européen de Géodynamique et de Séismologie Volume 15, Luxembourg.

Smith, E.G., Rhys, G.H. and Goosens, R.F. (1973) The geology of East Retford, Worksop and Gainsborough. *British Geological Survey*, Memoir 101.

Web site:

www.earthquakes.bgs.ac.uk