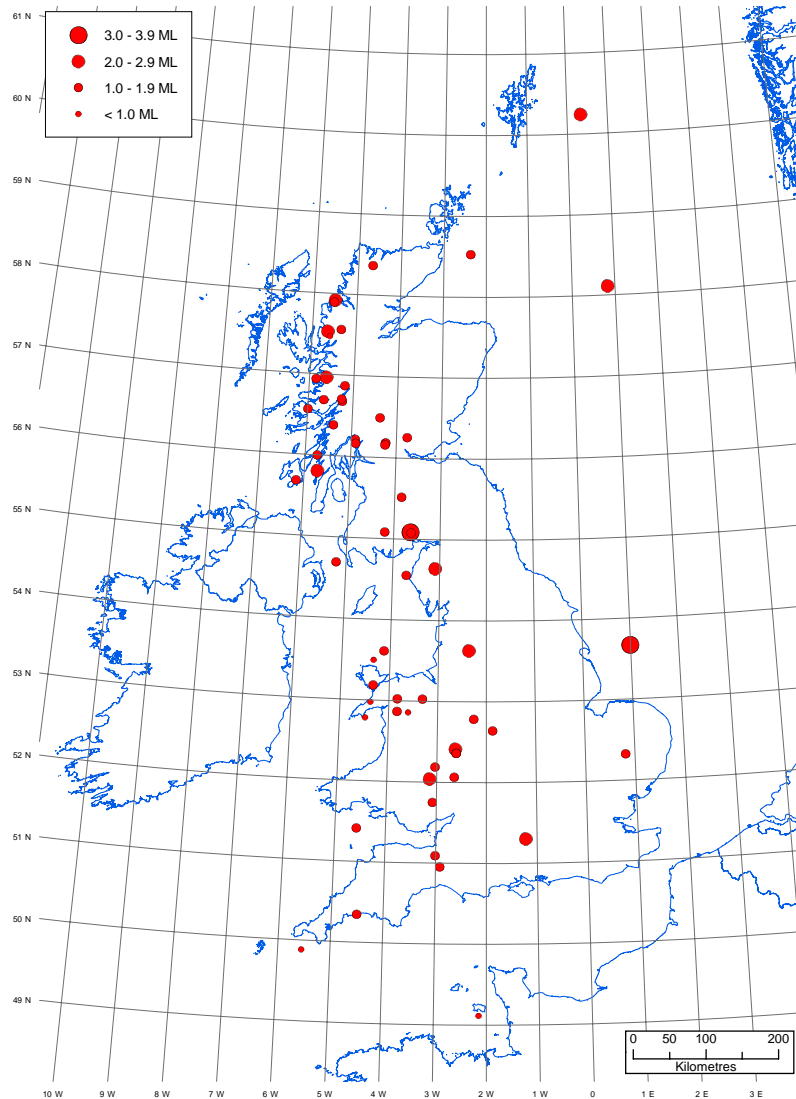


# Bulletin of British Earthquakes 2006

B.A. Simpson (Editor)

*Contributors:* J Bukits, G D Ford, and D D Galloway



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# 1 Introduction

The British Geological Survey's (BGS) Seismic Monitoring and Information Service operate a nationwide network of seismograph stations in the United Kingdom (UK). Earthquakes in the UK, and coastal waters, are detected within limits dependent on the distribution of seismograph stations. Location accuracy is improved in offshore areas through data exchange with neighbouring countries. This bulletin contains locations, magnitudes and phase data for all earthquakes detected and located by the BGS during 2006, listed in Tables 1 and 2. Maps showing seismic activity in 2006 (Figure 8), and the larger magnitude events since 1979 ( $ML > 2.5$ ) and since 1970 ( $ML > 3.5$ ) are also included. The bulletin covers all of the UK land mass and its coastal waters including the North Sea to 800 kmE and 1500 kmN.

All events believed to be of true tectonic origin are included. No coalfield events were detected during the year. Acoustic disturbances, such as sonic booms from supersonic aircraft, are included when they are felt. The air-borne waves are readily identified by their slow travel time across an array or by their signature on a microphone but they are frequently mistaken as small earthquakes by the public. They are indicated by 'SONIC' in both the locality and comments column of Table 1.

Significant non-natural events, such as explosions, which received media attention or were greater than magnitude 2.5 ML or felt by local residents, are also included in Table 1. Smaller events that are known, or suspected to be of explosive origin are excluded from the bulletin where possible. These include explosions due to quarrying, mining, weapon testing or disposal, naval exercises, geophysical prospecting and civil engineering. Unfortunately, identification by record character, location and time of occurrence is not always conclusive and some man-made events may be included in the bulletin or, more rarely, a small natural event may have been excluded.

## 2 The BGS UK Seismograph Network

The UK seismograph network consists of a number of sub-networks, which, in turn, consist of up to ten 'outstation' vertical seismometers radio-linked over distances of up to 100 km to a central site. Here, the data, along with that from a local 3-component set of two horizontal and one vertical seismometer, are recorded digitally by SDAS or the SEISLOG data acquisition system (Utheim and Havskov, 1993). The system records data continuously, but also creates event-triggered files. The sub-networks are accessed for data transfer to Edinburgh several times a day through Internet or dial-up modems. Once transferred, the events are analysed to determine location and magnitude. At a number of sites, low-gain vertical seismometers are installed to extend the dynamic range of the system (by 34 dB) to stronger motions, and low frequency microphones are used to aid the discrimination of sonic booms. In addition, strong motion accelerometers have been installed at locations throughout the country and record accelerations up to 0.1g. At present the seismic network is undergoing an upgrade with the installation of broadband seismometers that record with a larger dynamic range and over a wider frequency band. Data from these together with some short-period data is transmitted and processed at the central recording site in Edinburgh in real time. Operational seismograph stations in December 2006 are shown in Figure 9.

The detection capabilities of a network depend upon station distribution, instrument sensitivity and background noise levels. Figure 10 shows the magnitude detection thresholds for the

seismograph stations operational in December 2006. The contours illustrate the lower threshold magnitude for an earthquake to significantly exceed 4 nanometres of noise (average) at 10 Hz on at least four seismographs. These detection levels hold true only if data from all stations are continuously monitored. Small events may go undetected unless they are felt and reported to BGS by local inhabitants, so the detection capabilities of this process are strongly dependent on the population density.

The whole of the UK is covered by the seismograph network for approximately magnitude 1.5 ML, and above, at times of average ambient noise levels. Noise sources such as wind, ocean waves and traffic vary considerably with time (typically 0.5 to 15 nanometres, at 10 Hz) causing the magnitude thresholds to increase or decrease. In conditions of high noise, 0.8 ML should be added to the contour values, causing the threshold to rise to about 2.3 ML. Normally, however, an earthquake of this size would be felt, if not detected, in the areas of poorer instrumental coverage. The bulletin can, therefore, be assumed to be complete for all earthquakes of magnitude 2.3 ML and above.

Given the variability in the earthquake detection threshold, as governed by ambient noise conditions and the geometry of the observing network, the bulletin is biased towards certain localities. Figure 11 shows only earthquakes with magnitude 2.5 ML or greater, in the period 1979 to 2006. The data set is considered complete for these magnitudes in all localities onshore. Seismicity for the period 1970 to 2006 is shown in Figure 12 with a threshold magnitude of 3.5 ML. This is the period covered by BGS instrumentation that, in the early years, only consisted of the network around Edinburgh (LOWNET) and Eskdalemuir (ESK) and a station near Kyle of Lochalsh (KYL). The data set is likely to be complete for such magnitudes.

## 3 Earthquake Parameters and Their Errors

### **EPICENTRE LOCATION**

By accurately timing the signal onsets at a minimum of three stations, a location can be found for an earthquake that satisfies the observed pattern of arrivals. Instrumental locations in the bulletin were obtained using the computer program HYPOCENTER (Lienert and Havskov 1995) that iteratively adjusts a trial hypocentre (latitude, longitude, depth, and origin time) until the observed and computed arrival times coincide closely.

The accuracy of locations is dependent on distances from the closest stations, the distribution of the stations around the epicentre, the resolution to which signal onsets can be timed from the records, and the accuracy with which the seismic wave velocities through the Earth are known.

### **DEPTH DETERMINATION**

The accurate determination of earthquake depth presents a more difficult problem, mainly because phase arrival patterns at the seismographs can still be satisfied for a large range of depths merely by adjusting the origin time to suit. Depth is usually only well constrained when there is a station very close to the epicentre.

The best depth determinations are obtained when an earthquake or earthquake series occurs almost beneath a network. For events at larger distances the depth errors can be many kilometres. Where the depth error, ERZ in Table 1, is 0.0, this indicates that the depth has been fixed in the hypocentre calculation. This is the case for explosions, which are known to occur at the surface, and for events at larger distances, where depth control is poor.

## MAGNITUDE

All earthquakes in the bulletin have been assigned a local magnitude (ML) as defined by Richter (1935):

$$ML = \log_{10} (A/A_0)$$

Where A is the maximum deflection (centre to peak in mm) registered on a Wood-Anderson seismograph and A<sub>0</sub> is that for a 'standard' magnitude zero earthquake at the same distance. The A<sub>0</sub> term is thus a distance correction factor, tabulated by Richter to 200 km, and later adjusted to include up to 600 km. Although Richter intended his method to be an approximate quantification of earthquake size and his attenuation term, A<sub>0</sub>, strictly only applies to California, the formula is still used worldwide today. The ML magnitudes in this bulletin have been calculated according to Richter's formula after converting the output of the BGS instruments to an equivalent Wood-Anderson deflection. Ideally, the measurements are made on two horizontal instruments and averaged but, if this is not possible, the mean of the magnitudes from a number of verticals are used. Ground motion registered at a seismograph varies with site conditions, distance and direction from the earthquake, and the nature of the ray path. Consequently, it is important to take the mean from a good distribution of stations. The resulting errors on magnitudes quoted in the bulletin will normally be less than 0.4 ML.

## INTENSITY

Intensity is a measure of the effect of the shaking produced by the earthquake on people, structures and objects. It decreases with distance from a maximum value (I<sub>max</sub>) usually found close to the epicentre. The maximum felt intensity is quoted, where known, with reference to the European Macroseismic Scale (EMS), (Grünthal, 1993).

## 4 Summary of 2006 Seismicity

There were 64 earthquakes located by the monitoring network during the year, with 15 having magnitudes of 2.0 ML or greater and four having magnitudes of 3.0 ML or greater. Three events with a magnitude of 2.0 ML or greater were reported felt, together with a further four smaller ones, bringing the total to seven felt earthquakes in 2006.

The largest onshore earthquake of the year with a magnitude of 3.5 ML occurred approximately 8 km north-north-west of Dumfries on 26 December at 10:40 UTC, at a depth of 8 km. BGS received a number of reports via the media, Dumfries Police and from a number of residents in the Dumfries area of Dumfries & Galloway. The reports described "people came out into the street to see what was going on", "the whole experience was really scary", "the roof slates and timbers rattled and shook" and "I was awoken by a noise and the shaking and swaying of the house". This earthquake was followed by an event with a magnitude of 1.7 ML with a similar location, on 30 December. A macroseismic survey was launched on the BGS 'Earthquakes' web site, which yielded over 300 replies and the resulting map of felt effects is shown in Figure 3. The most distant felt reports were from the southern Glasgow area approximately 100 km away and from the Stranraer area approximately 95 km to the west. The earthquake was felt over an area of 3,600 sq km for isoseismals 3-5. The highest observed intensity was 5 EMS which was observed over an area of approximately 230 sq km. This event locates in a similar location to the magnitude 3.0 ML Dumfries earthquake of 13 May 2001, which was also felt with intensities of 5 EMS.

Dumfries, D & G, 26 December

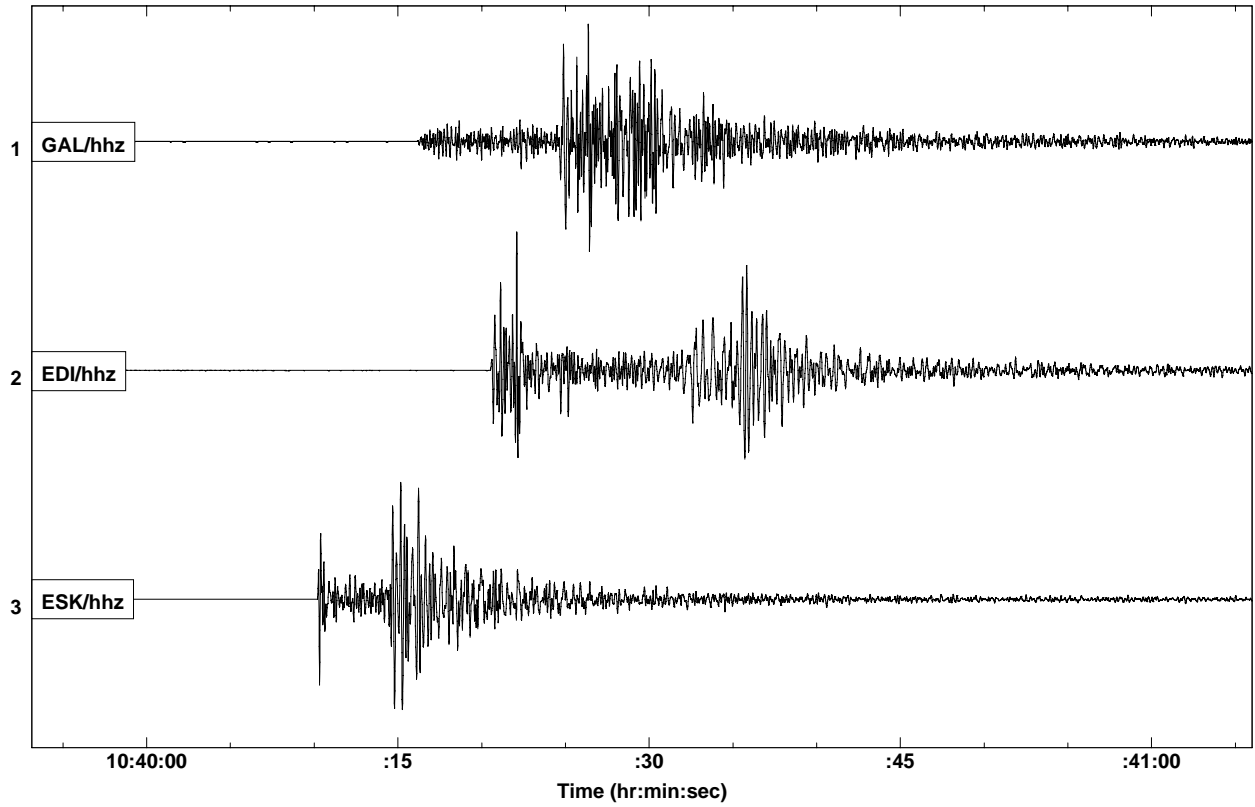


Figure 1. Seismograms of the ground displacement from the Dumfries earthquake, 26 December 2006, recorded by BGS seismograph stations.

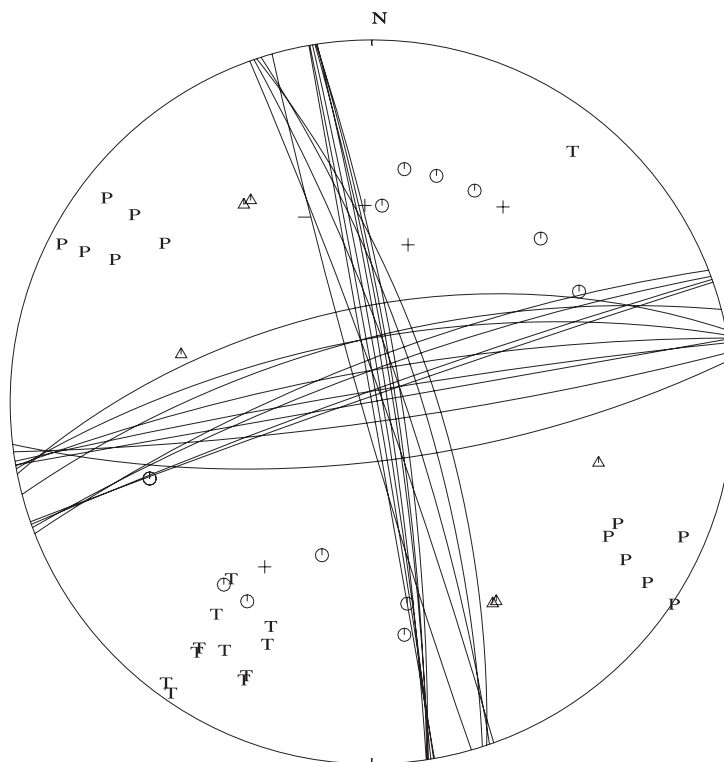
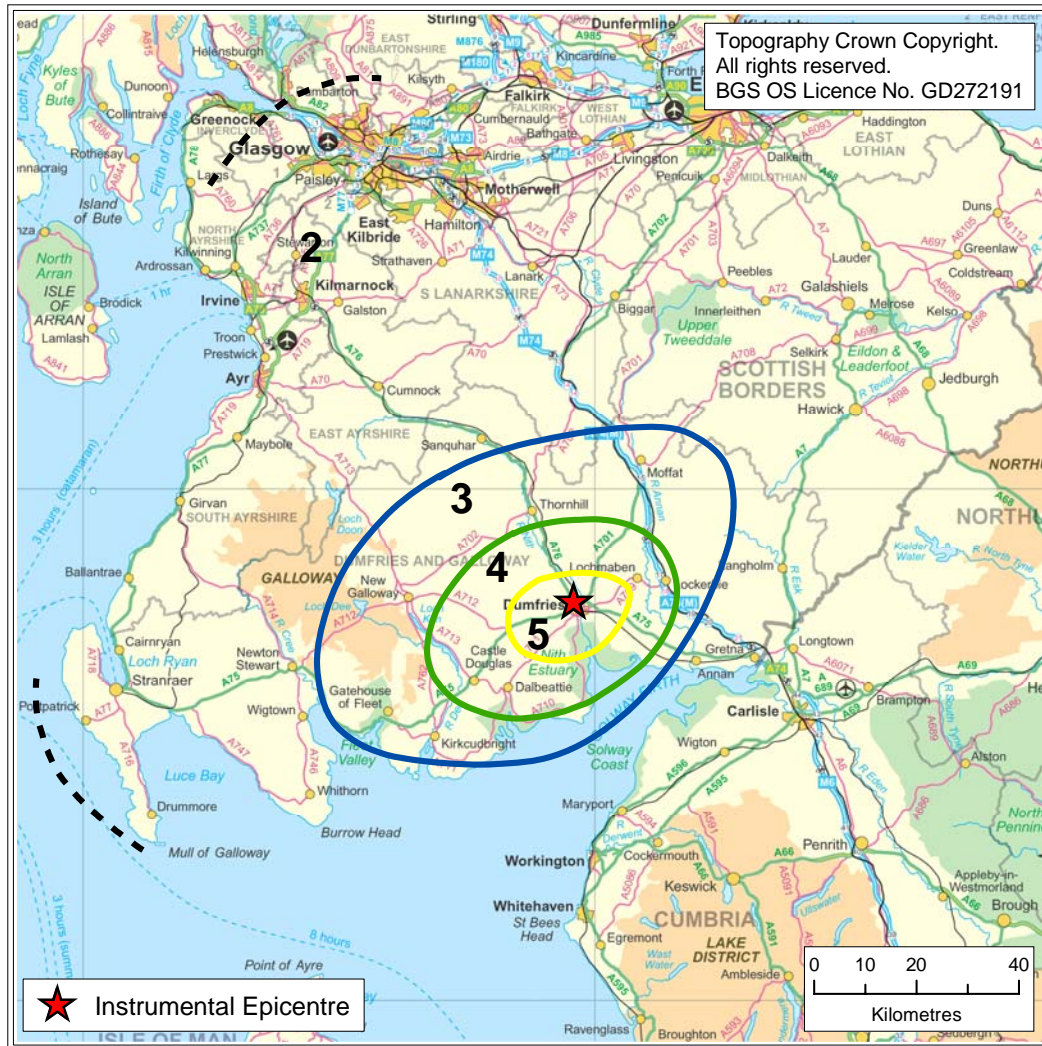


Figure 2. Focal mechanism for the Dumfries earthquake.





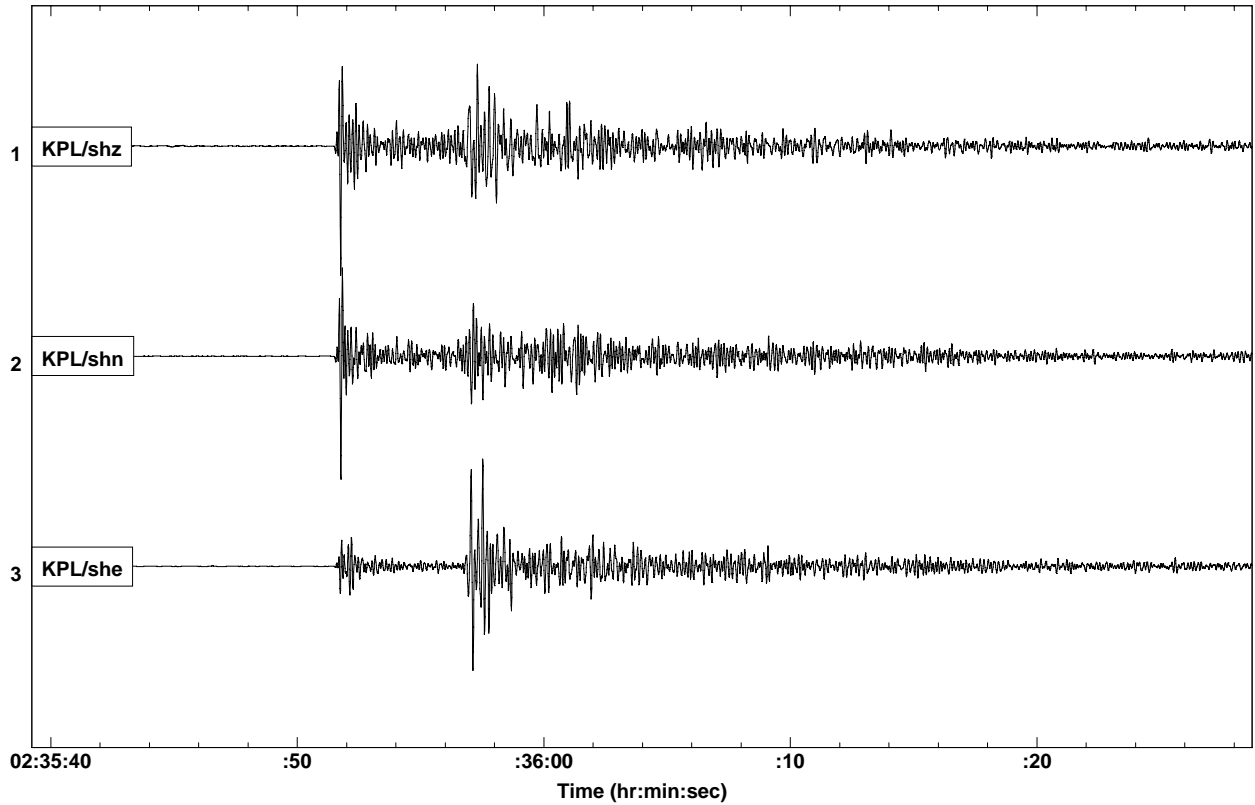
**Figure 3. Isoseismal map for the Dumfries earthquake.**

A source mechanism for the earthquake was determined. The solution shows a strike slip mechanism. Left lateral faulting on a north-northwest south-southeast or right lateral faulting on an east-northeast west southwest fault. Both possible orientations are consistent with previous mechanisms obtained for earthquakes in this area and with observed fault strikes and offsets.

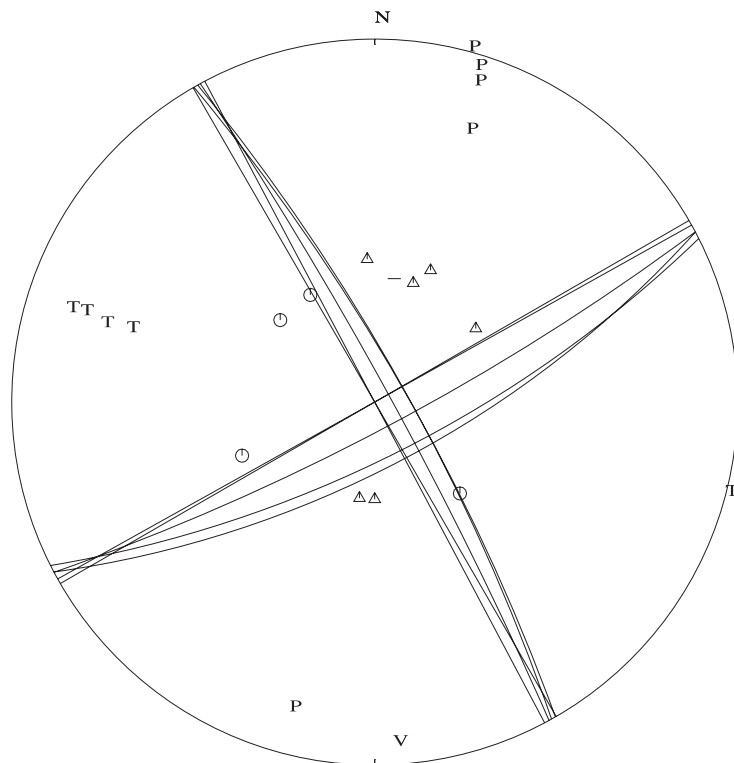
The largest offshore earthquake occurred in the Norwegian Sea on 18 August, with a magnitude of 3.8 ML. It was located approximately 360 km north of Lerwick, Shetland Islands. A further four events occurred in the North Sea and surrounding waters during the year, with magnitudes ranging between 2.3 and 3.3 ML.

On 12 January an earthquake with magnitude of 2.6 ML, occurred near Basingstoke, Hampshire. This earthquake is located in an area where only two other earthquakes have been recorded within 25 km of the epicentre. One with a magnitude of 3.0 ML, which occurred on 19 July 1982, was felt with an intensity of at least 4 EMS. The other event with a magnitude of 2.1 ML occurred on 27 July 1985.

An earthquake with a magnitude of 2.8 ML occurred on 19 January, with a location approximately 10 km east of Mallaig, Highland. The BGS received reports from residents in Mallaig and from Glenfinnan, which described a “loud bang followed by a loud rumbling noise”, indicating an intensity of at least 3 EMS. This event locates approximately 27 km northwest of the magnitude 3.0 ML Fort William earthquake on 10 December 2005, which had a maximum intensity of 4 EMS.



**Figure 4. Seismograms of the ground displacement from the Mallaig earthquake, 19 January 2006, recorded by BGS seismograph stations.**



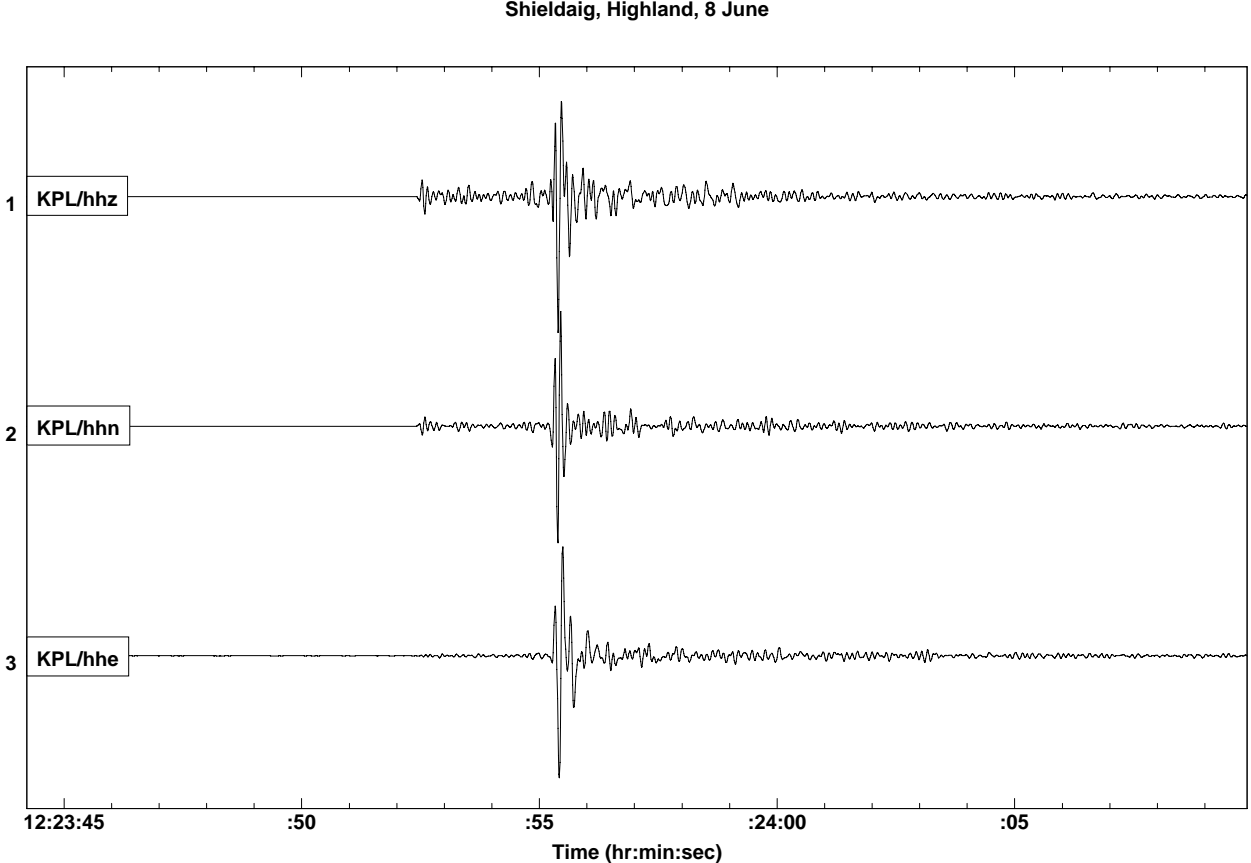
**Figure 5. Focal mechanism for the Mallaig earthquake.**

The focal mechanism obtained for this event shows a strike slip mechanism, with right lateral faulting on a north-northwest south-southeast or left lateral faulting on an east-northeast west southwest fault.

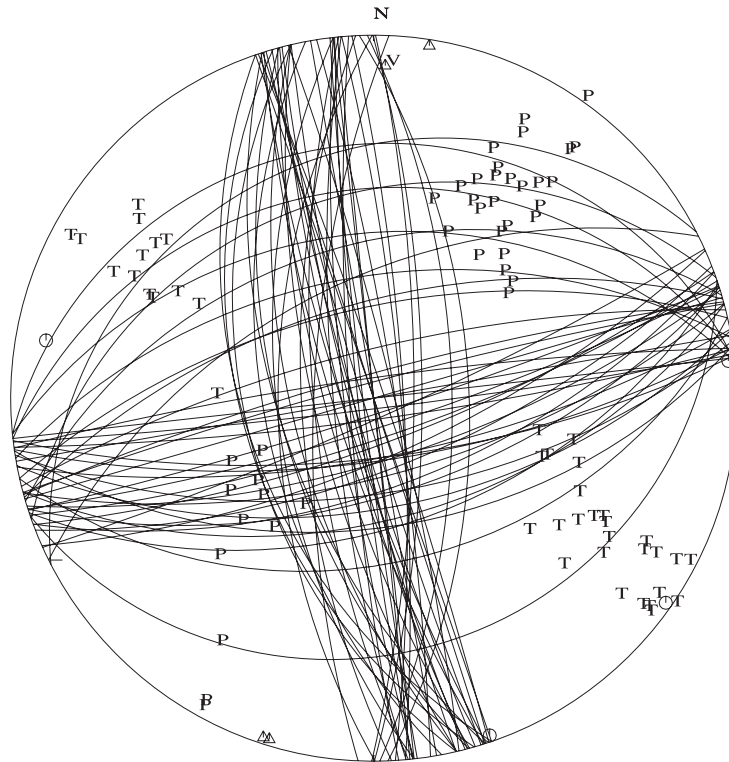
A magnitude 1.9 ML earthquake occurred on 20 April, with an epicentre close to Ballachulish, Highland. The BGS received a single report from a resident of Ballachulish describing, “it sounded like a blast going off and a rumble”, indicating an intensity of 3 EMS. The earthquake was the largest in the general area since a magnitude 3.0 ML event on 10 December 2005, which was felt with intensities of at least 4 EMS in the epicentral area. A second event was felt in the Ballachulish area on 13 October, and was also reported felt by a resident of Ballachulish, who described, “I felt a slight shaking”, indicating an intensity of 2 EMS.

An earthquake with a magnitude of 1.5 ML occurred near Anglesey, North Wales, on 23 May. The BGS received reports via BBC North Wales stating that several residents in the south Anglesey area “felt a slight vibration”, indicating an intensity of 2 EMS.

On 8 June, a magnitude 2.9 ML earthquake occurred near Shieldaig, Highland. The BGS received a number of reports from people in Gairloch, Achnasheen, Stromeferry and Ardaneaskan, Highland region. Reports described, "the whole floor vibrated", "the whole house shook", and "we thought the chimney had fallen down", indicating an intensity of at least 4 EMS. A magnitude 0.4 ML earthquake also occurred in the Shieldaig area on 29 June.



**Figure 6. Seismograms of the ground displacement from the Shieldaig earthquake, 8 June January 2006, recorded by BGS seismograph stations.**



**Figure 7. Focal mechanism for the Shildaig earthquake.**

The focal mechanism obtained for the Shildaig earthquake was a poorly constrained strike slip mechanism, with right lateral motion on a north-northwest south-southeast sub-vertical fault or left lateral faulting on an east-northeast west southwest fault whose dip is poorly constrained.

An earthquake with a magnitude of 1.8 ML occurred on 19 December near Looe, Cornwall. BGS received reports of the earthquake being felt by residents in Carludden, St Austell and Herodsfoot. The reports described “thought it was thunder, “it only lasted about a second” and “the whole house really shook”. Historically, the largest event in the region with a magnitude of 3.4 ML, occurred on 12 August 1852 near Callington, Cornwall and was felt with intensities of approximately 4 EMS.

In the Gruinard Bay area of the Highland region, two earthquakes with magnitudes of 2.0 and 1.6 ML occurred on 6 February and 2 April.

Two earthquakes, both with magnitudes of 1.1 ML, occurred in the Ludlow area of Shropshire 8 minutes apart, on 23 March. Another event in the same area, with a magnitude of 2.0 ML, occurred on 5 November.

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Scottish Water

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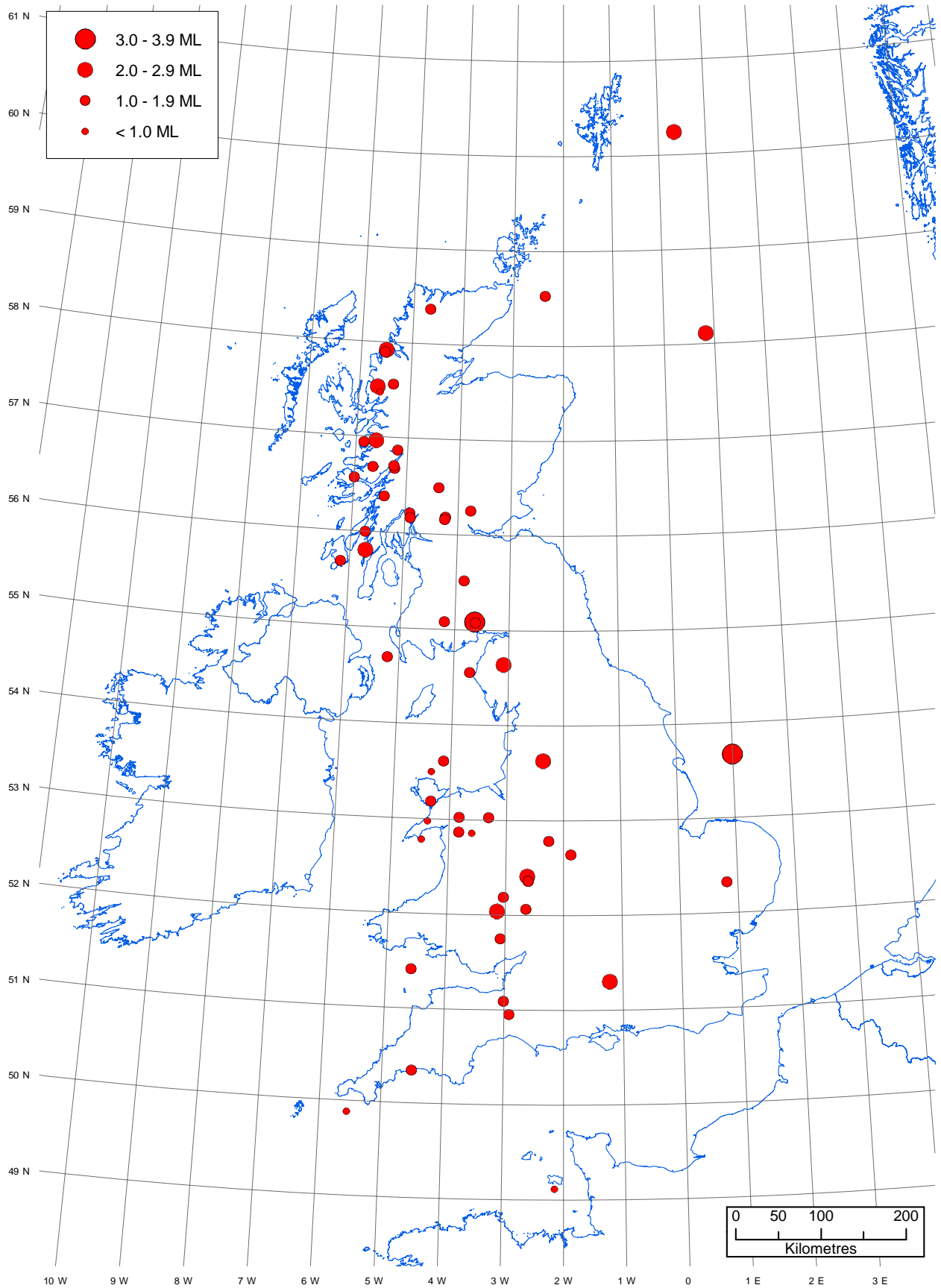
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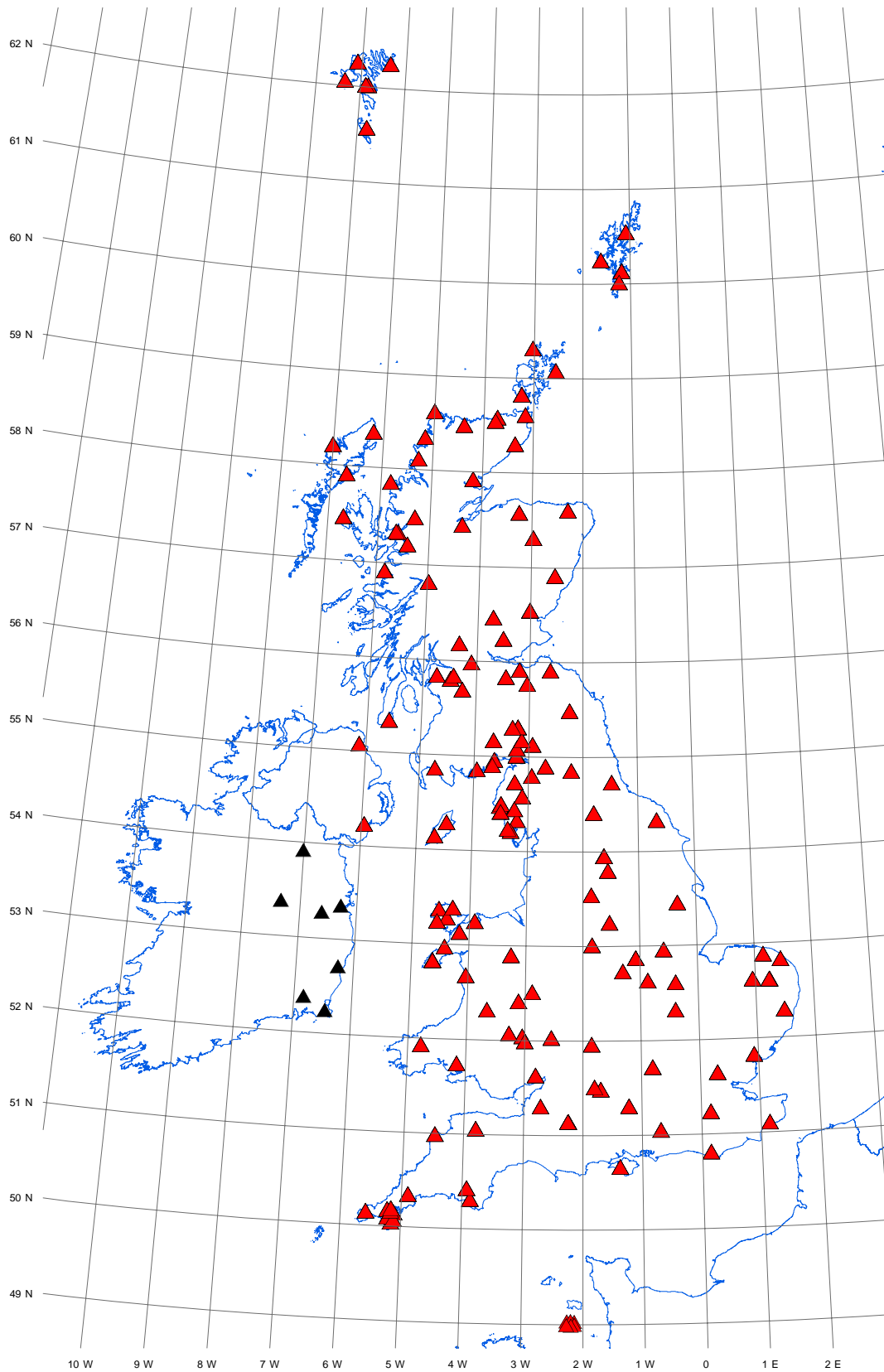
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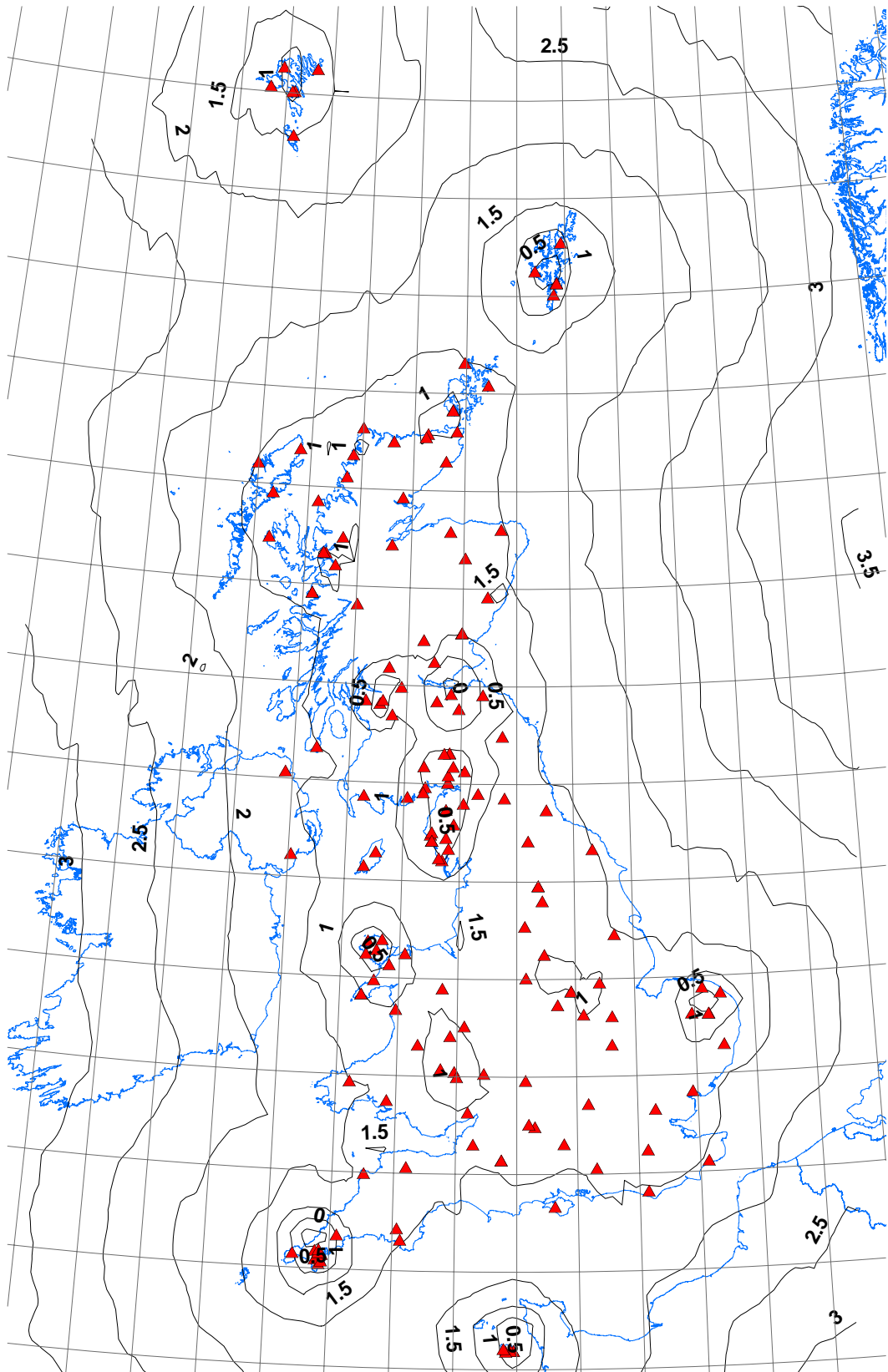


**Figure 8. Epicentre map of earthquakes in 2006 as listed in Table 1.**

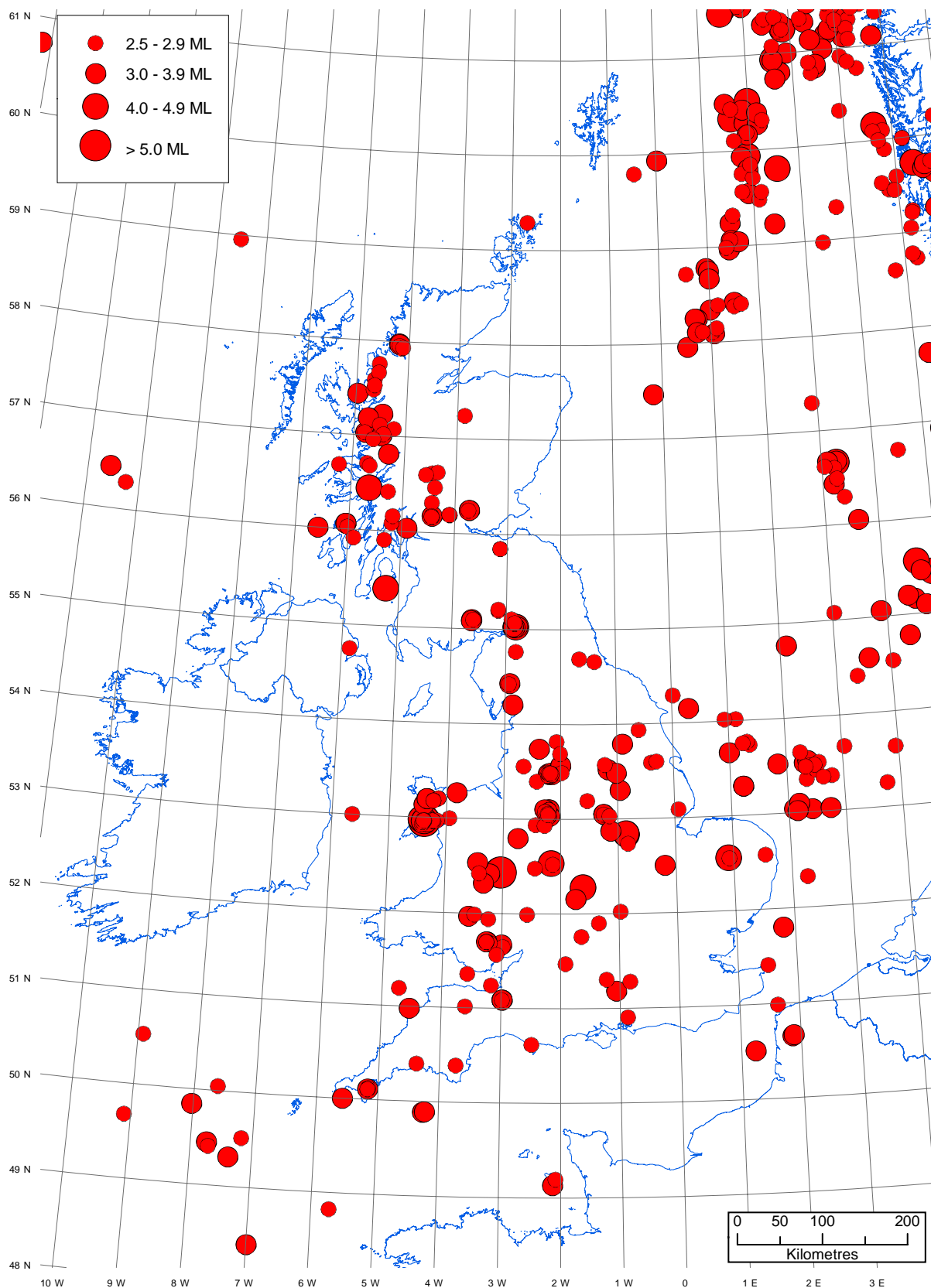


**Figure 9. Seismograph network operational in December 2006. Red triangles indicate BGS stations; black triangles indicate stations operated by the Dublin Institute of Advanced Studies (DIAS).**

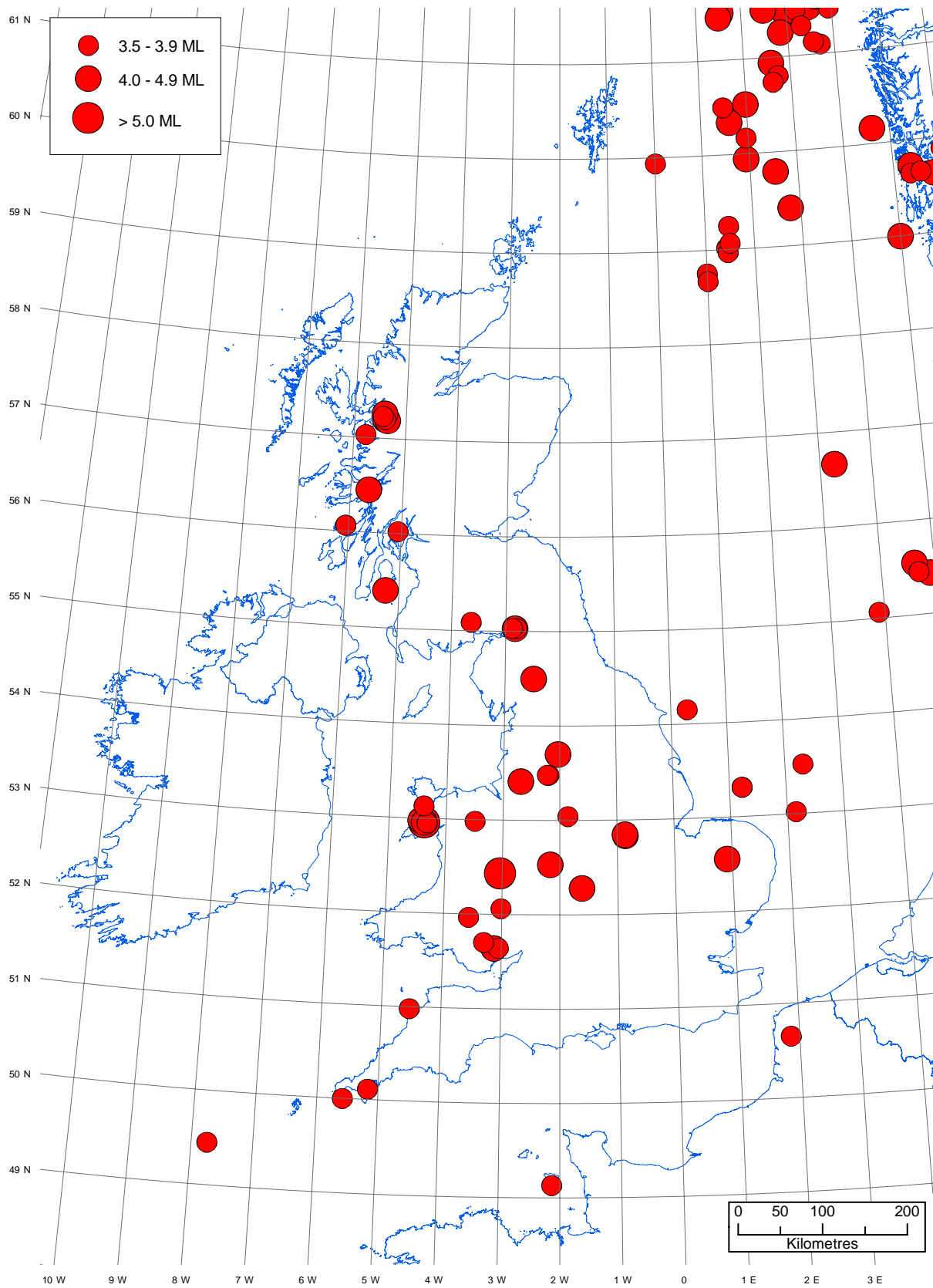




**Figure 10. Earthquake detection capability in December 2006. Contour values are for Richter local magnitude (ML) calculated for average background noise conditions (4nm) where the detection criterion is that the signal has to exceed 4nm at 10Hz at 4 stations.**



**Figure 11. Epicentres of earthquakes with magnitudes of 2.5 ML and above, in the period 1979 to 2006.**



**Figure 12. Epicentres of earthquakes with magnitudes of 3.5 ML and above, in the period 1970 - 2006.**

**TABLE 1 : CATALOGUE OF EVENTS : 2006**

YearMoDy	HrMnSecs	Lat	Lon	kmE	kmN	Dep	Mag	Locality	Int	No Gap	RMS	ERH	ERZ	Comments
20060107	185428.1	57.56	-5.34	200.3	857.1	5.0	1.1	KINLOCHEWE, HIGHLAND	10	96	0.60	9.53	9.20	
20060112	190352.1	51.30	-1.22	454.4	156.6	14.8	2.6	BASINGSTOKE, HAMPSHIRE	16	95	0.30	7.46	5.00	5KM NW OF BASINGSTOKE
20060113	035535.1	52.33	0.81	591.5	273.5	18.5	1.5	BURY ST EDMUNDS, SUFFOLK	6	204	0.10	4.24	2.20	8KM NE OF BURY ST EDMUNDS
20060119	023544.4	56.96	-5.61	180.4	791.6	2.6	2.8	NR MALLAIG, HIGHLAND	3	10	0.10	9.35	7.90	FELT MALLAIG, GLENFINNAN...
20060122	000710.0	58.37	-4.66	244.4	944.9	6.3	1.8	NR TONGUE, HIGHLAND	10	224	0.20	7.22	31.30	20KM SW OF TONGUE
20060125	161911.5	52.19	-3.03	329.5	255.3	2.3	1.1	KINGTON, HEREFORDSHIRE	5	178	0.00	2.02	1.50	
20060202	043505.1	58.53	-2.37	378.7	959.9	16.2	1.9	MORAY FIRTH REGION	14	118	0.50	18.96	48.00	43KM EAST OF WICK
20060206	184319.7	57.92	-5.50	192.6	897.9	6.1	2.0	GRUINARD BAY, HIGHLAND	12	61	0.20	3.85	4.00	
20060207	215905.3	55.67	-6.17	138.0	650.3	2.7	1.5	ISLAY, INNER HEBRIDES	5	245	0.40	19.71	56.70	
20060211	202553.9	56.56	-6.00	154.6	748.4	5.0	1.8	ISLE OF MULL, HIGHLAND	6	253	0.20	20.20	0.00	
20060214	014555.8	56.26	-3.76	291.2	708.4	4.1	1.6	BLACKFORD, TAYSIDE	9	114	0.10	3.12	3.30	
20060303	161054.2	52.98	-4.38	240.4	344.8	19.2	0.6	PWLLHELI, GWYNEDD	6	234	0.10	6.44	7.10	8KM N OF PWLLHELI
20060304	044915.4	50.96	-2.92	335.5	117.9	2.6	1.1	ILMINSTER, SOMERSET	8	166	0.30	6.04	12.50	
20060304	121422.9	55.81	-5.71	167.5	663.2	2.6	2.2	SOUND OF JURA	11	158	0.30	6.18	11.20	
20060306	190332.1	49.88	-5.55	145.2	4.4	5.0	0.1	ENGLISH CHANNEL	5	299	0.10	6.52	0.00	25KM WSW OF LIZARD POINT
20060311	152723.5	53.02	-3.83	277.3	349.1	20.4	1.1	BETWS-Y-COED, GWYNEDD	11	120	0.10	2.48	4.70	6KM SSW OF BETWS-Y-COED
20060322	031131.8	56.18	-4.24	261.2	700.5	4.1	1.0	THORNHILL, CENTRAL	4	191	0.10	136.31	19.20	5KM W OF THORNHILL
20060322	031249.5	56.18	-4.23	261.3	700.9	2.6	1.1	THORNHILL, CENTRAL	4	196	0.10	216.59	28.20	5KM W OF THORNHILL
20060323	075459.0	52.36	-2.61	358.4	274.0	15.4	1.1	LUDLOW, SHROPSHIRE	5	219	0.10	4.34	2.70	5KM SE OF LUDLOW
20060323	080254.2	52.36	-2.61	358.3	273.9	15.4	1.1	LUDLOW, SHROPSHIRE	5	218	0.10	3.45	10.40	5KM SE OF LUDLOW
20060323	185629.2	51.75	-3.08	325.7	206.5	14.3	1.8	ABERTILLERY, GWENT	12	75	0.20	2.55	1.90	
20060402	212724.2	57.90	-5.53	191.1	895.0	4.3	1.6	GRUINARD BAY, HIGHLAND	11	66	0.20	3.85	5.00	
20060414	205627.4	62.01	-2.41	630.6	1355.7	15.0	3.3	NORWEGIAN SEA	13	346	0.30	51.85	0.00	
20060420	014550.7	56.68	-5.23	202.0	758.5	7.5	1.9	BALLACHULISH, HIGHLAND	3	17	0.20	10.28	15.20	FELT BALLACHULISH
20060425	134400.0							SONIC-FELT LANCASHIRE						
20060425	135400.0							SONIC-FELT LANCASHIRE						
20060425	140000.0							SONIC-FELT LANCASHIRE						
20060523	032241.9	53.19	-4.33	244.2	367.9	9.5	1.5	ANGLESEY, GWYNEDD	2	14	0.10	2.92	2.70	FELT SOUTHERN ANGLESEY
20060607	110000.0							SONIC-NW ENGLAND						FELT CHESHIRE...
20060630	144613.4	53.50	-4.34	245.1	402.9	14.3	0.7	OFF ANGLESEY, GWYNEDD	7	150	0.10	3.42	3.10	9KM NORTH OF ANGLESEY
20060608	122348.1	57.53	-5.64	182.0	854.8	8.3	2.9	SHIELDAIG, HIGHLAND	4	22	0.20	6.62	58.90	FELT STROMNESS, ROUSAY
20060619	140314.1	55.08	-4.19	260.1	578.6	7.5	1.1	NEW GALLOWAY, D & G	12	90	0.50	8.09	19.60	FELT GAIRLOCH...
20060622	042335.7	56.21	-4.91	219.6	706.0	2.2	1.9	LOCHGOILHEAD, S'CLYDE	14	113	0.40	5.41	20.10	5KM N OF LOCHGOILHEAD
20060627	131000.0							SONIC-NORTHUMBERLAND						FELT NORTHUMBERLAND
20060629	143058.2	57.47	-5.58	185.1	848.1	2.9	0.4	SHIELDAIG, HIGHLAND	2	245	0.30	3.64	293.80	
20060629	212233.2	56.00	-5.74	167.1	684.6	6.0	1.6	SOUND OF JURA, S'CLYDE	10	247	0.40	18.15	0.00	
20060703	145248.6	52.64	-1.88	408.3	305.0	7.5	1.5	WALSALL, WEST MIDLANDS	11	191	0.30	9.30	13.20	
20060703	151740.5	56.87	-5.19	205.6	779.8	3.5	1.5	LOCH EIL, HIGHLAND	12	112	0.20	7.24	8.40	
20060709	210500.0							POSSIBLE SONIC-THAMES						FELT CANTERBURY...
20060709	210949.5	56.16	-4.90	219.9	700.4	1.6	1.5	LOCHGOILHEAD, S'CLYDE	11	162	0.20	4.35	4.70	
20060720	231511.9	56.38	-5.41	189.4	726.1	4.6	1.1	OBAN, STRATHCLYDE	6	207	0.00	2.31	3.10	
20060804	092608.9	55.52	-3.85	283.3	626.2	4.3	1.1	ABINGTON, STRATHCLYDE	11	170	0.40	10.63	12.80	
20060814	164045.7	51.09	-3.01	329.3	133.1	6.0	1.9	BRIDGWATER, SOMERSET	12	139	0.30	4.00	16.80	
20060815	055905.0	53.61	-4.13	259.2	415.2	9.5	1.0	IRISH SEA	7	190	0.00	1.21	1.20	
20060818	204544.3	63.36	-0.88	456.3	1498.1	20.0	3.8	NORWEGIAN SEA	10	293	0.20	19.34	0.00	

**TABLE 1 : CATALOGUE OF EVENTS : 2006**

YearMoDy	HrMnSecs	Lat	Lon	kmE	kmN	Dep	Mag	Locality	Int	No Gap	RMS	ERH	ERZ	Comments
20060829	160500.7	56.49	-4.38	253.8	735.4	11.9	1.9	KILLIN, CENTRAL		11	146	0.30	11.08	10.40
20060904	154716.7	54.64	-3.08	330.0	527.9	6.3	2.2	KESWICK, CUMBRIA		14	100	0.20	2.28	1.40
20060924	223445.6	54.55	-3.71	289.7	519.0	5.0	1.1	IRISH SEA		14	115	0.50	5.13	0.00 OFFSHORE WHITEHAVEN
20060926	193436.6	52.04	-3.14	321.8	238.7	19.2	2.1	HAY-ON-WYE, HER & WORC		19	56	0.20	3.28	2.30
20060926	212035.0	52.06	-2.65	355.8	240.9	9.7	1.3	HEREFORD, HER & WORC		8	211	0.10	3.07	2.60
20061006	120655.0	54.69	-5.21	193.0	537.3	5.6	1.2	NORTH CHANNEL		11	83	0.30	4.24	7.70
20061011	180747.4	56.94	-5.85	165.9	790.0	4.8	1.2	ARISAIG, HIGHLAND		12	164	0.20	4.66	5.70
20061013	042103.8	56.70	-5.25	201.0	761.7	6.8	1.4	BALLACHULISH, HIGHLAND	2	7	150	0.40	11.48	15.60 FELT BALLACHULISH
20061015	043518.7	52.86	-3.60	292.5	330.2	14.9	0.9	BALA, GWYNEDD		10	119	0.30	5.42	6.60
20061015	110445.7	56.68	-5.66	176.2	760.6	5.3	1.3	LOCH SUNART, HIGHLAND		8	159	0.20	13.96	7.60
20061017	064748.8	60.24	0.34	529.8	1153.1	13.9	2.3	OFFSHORE SHETLAND		13	156	6.00	89.77	0.00 90KM EAST OF LERWICK
20061024	230001.0	58.11	0.84	567.2	917.4	11.5	2.5	CENTRAL NORTH SEA		14	246	0.50	25.55	15.30
20061025	041400.7	56.16	-4.25	260.3	698.2	1.0	1.2	THORNHILL, CENTRAL		9	142	0.30	3.38	0.00
20061028	110740.6	51.61	-3.94	265.5	192.0	0.0	1.4	EXPL-SWANSEA BAY	2	12	167	0.40	7.29	0.00 FELT SWANSEA
20061105	223539.7	52.41	-2.62	357.7	279.8	3.3	2.2	LUDLOW, SHROPSHIRE		16	83	0.30	5.01	15.60
20061128	233040.2	52.87	-3.83	276.9	331.7	9.3	1.0	TRAWSFYNYDD, GWYNEDD		9	131	0.20	5.59	10.10 5KM SE TRAWSFYNYDD
20061129	054502.0	53.02	-3.31	312.1	348.4	13.3	1.3	RUTHIN, CLWYD		4	334	0.10	4.75	1.50
20061130	215109.1	51.41	-4.58	220.7	171.2	6.2	1.6	BRISTOL CHANNEL		8	219	0.20	9.84	12.60
20061209	112204.9	49.12	-2.15	389.3	-87.2	7.6	0.0	JERSEY, CHANNEL ISLANDS		3	314	0.70	26.57	0.00 OFFSHORE LOCATION
20061216	160852.4	53.63	-2.36	376.1	414.9	9.8	2.1	BOLTON, GTR MANCHESTER		30	36	0.50	5.28	7.10
20061219	022055.0	50.35	-4.51	221.3	52.7	8.0	1.8	LOOE, CORNWALL	3	7	171	0.30	4.31	16.50 FELT HERODSFOOT...
20061223	011929.6	52.78	-4.48	233.0	323.6	12.6	0.8	PWLLELI, GWYNEDD		4	317	0.00	1.35	0.30 12KM OFFSHORE
20061223	121932.2	52.78	-2.26	382.7	320.9	11.8	1.5	NEWPORT, SHROPSHIRE		7	149	0.10	2.62	2.80 7KM EAST OF NEWPORT
20061226	104004.1	55.09	-3.64	295.6	578.1	7.4	3.5	DUMFRIES, D & G	5	39	43	0.40	3.80	5.60 FELT DUMFRIES...
20061230	091543.0	53.67	1.00	598.0	423.0	8.0	3.1	SOUTHERN NORTH SEA		12	217	0.30	24.10	12.90 75KM EAST OF HULL
20061230	162213.2	55.08	-3.62	296.5	577.3	5.6	1.7	DUMFRIES, D & G		18	64	0.30	3.67	8.80











# TABLE 2 : PHASE DATA

<p>EBL SZ 180.0 EP 15:18 09.31 0.39</p> <p><b>July 9 2006</b> Time: 21:05 00.0 UTC            Lat: 56.162N Lon: -4.901W            Grid Ref: POSSIBLE SONIC-THAMES            Comment: FELT CANTERBURY...            Magnitude: 1.5 ML            Depth: 1.6 km            RMS: 0.20 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>KPL HN 139.0 AML 21:10 30.23 12 0.21            EAB SZ 35.1 IP C 21:09 55.92 -0.19            EDI HN 110.0 ES 2 21:10 21.62 0.23            EBL SZ 124.0 EP 21:10 10.09 -0.02            EAU SZ 97.3 EP 21:10 06.16 0.17            EDI HN 110.0 AML 21:10 25.23 36 0.25            KAR SZ 102.0 EP 21:10 06.75 0.10            KAC SZ 151.0 EP 21:10 13.35 -0.69            ESK HN 142.0 ES 2 21:10 30.49 0.62            ESK HN 142.0 AML 21:10 32.35 8 0.20            PGB HZ 46.9 IP C 21:09 58.18 0.08            KPL HZ 139.0 EP 21:10 11.71 -0.59            ESK HZ 142.0 EP 21:10 13.25 0.43            EDI HZ 110.0 EP 21:10 08.23 0.31            PGB HE 46.9 ES 2 21:10 04.28 -0.11            PGB HE 46.9 AML 21:10 05.09 17 0.21            KPL HE 139.0 ES 2 21:10 27.69 -1.28            KPL HE 139.0 AML 21:10 28.43 14 0.23            ESK HE 142.0 AML 21:10 32.10 13 0.18            EDI HE 110.0 AML 21:10 24.72 16 0.31            PGB HN 46.9 AML 21:10 04.64 22 0.25            PMS SZ 36.5 IP D 21:09 56.25 -0.11            PCO SZ 53.5 IP C 21:09 59.32 0.14</p> <p><b>July 20 2006</b> Time: 23:15 11.9 UTC            Lat: 56.380N Lon: -5.412W            Grid Ref: 189.36 kmE 726.07 kmN            Locality: OBAN,STRATHCLYDE            Velocity model: Lownet Xnear: 100.0 Xfar: 200.0            Magnitude: 1.1 ML            Depth: 4.6 km            RMS: 0.00 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>EAB SZ 69.8 EP D 23:15 23.83 -0.01            PMS SZ 72.5 IP D 23:15 24.27 0.01            PCO SZ 92.4 EP D 23:15 27.33 0.00            KPL HZ 108.0 EP 23:15 29.64 -0.04            KPL HE 108.0 ES 23:15 42.65 0.00            KPL HN 108.0 AML 23:15 46.27 2 0.20            KPL HE 108.0 AML 23:15 48.24 4 0.22            KAC SZ 125.0 EP 23:15 32.42 0.07            MCD SN 188.0 AML 23:16 06.74 3 0.40            MCD SE 188.0 AML 23:16 07.14 4 0.46</p> <p><b>August 4 2006</b> Time: 09:26 08.9 UTC            Lat: 55.516N Lon: -3.849W            Grid Ref: 283.26 kmE 626.25 kmN            Locality: ABINGTON,STRATHCLYDE            Velocity model: Lownet Xnear: 100.0 Xfar: 200.0            Magnitude: 1.1 ML            Depth: 4.3 km            RMS: 0.40 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>BWH SZ 39.8 EP 09:26 16.05 -0.49            EAU SZ 44.5 EP 09:26 17.16 -0.19            ESK HZ 46.4 IP C 09:26 17.40 -0.25            ESK HN 46.4 ES 09:26 23.97 -0.09            ESK HN 46.4 AML 09:26 25.16 14 0.54            ESK HE 46.4 AML 09:26 30.05 21 0.56            PCO SZ 54.9 EP 09:26 19.33 0.29            EBL SZ 58.1 EP 09:26 18.81 -0.77            EDI HZ 61.5 EP 09:26 20.89 0.84            BHH SZ 61.8 EP 09:26 20.36 0.25            BBH SZ 72.2 EP 09:26 22.12 0.39            EAB SZ 80.9 EP 09:26 22.62 -0.46            ESY SZ 89.5 EP 09:26 24.61 0.17            XDE SZ 115.0 EP 09:26 28.77 0.43</p> <p><b>August 14 2006</b> Time: 16:40 45.7 UTC            Lat: 51.092N Lon: -3.009W            Grid Ref: 329.35 kmE 133.06 kmN            Locality: BRIDGWATER,SOMERSET            Velocity model: default (Lownet) Xnear: 100.0 Xfar: 200.0            Magnitude: 1.9 ML            Depth: 6.0 km            RMS: 0.30 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>MCH SE 101.0 AML 16:41 14.92 68 0.34            MCH SN 101.0 ES 16:41 14.51 -0.34            DYA EN 97.8 ES 16:41 13.50 -0.57            DYA EZ 97.8 EP C 16:41 02.82 0.53            SWN SN 96.4 AML 16:41 15.84 38 0.40            HEX SZ 55.7 EP 16:40 55.93 0.50            SWN SN 96.4 ES 16:41 13.76 0.11            SWN SZ 96.4 EP 16:41 02.00 -0.05            SWK SZ 53.7 IP C 16:40 54.85 -0.27            SSW SZ 126.0 EP 16:41 06.99 0.08            SKP SZ 168.0 EP 16:41 12.03 -0.23            MCH SN 101.0 AML 16:41 15.09 109 0.14            MCH SZ 101.0 EP 16:41 02.76 0.02            SWN SE 96.4 AML 16:41 19.41 45 0.74            HLM SZ 159.0 EP 16:41 11.28 0.14            HTR SZ 111.0 EP 16:41 04.32 -0.15            HSA SZ 108.0 EP 16:41 04.12 0.16            HTL HN 104.0 AML 16:41 19.48 21 0.28            HTL HE 104.0 AML 16:41 18.71 17 0.40            HTL HE 104.0 ES 16:41 15.39            HTL EN 104.0 ES 16:41 15.39 -0.35            HTL EZ 104.0 EP 16:41 03.46            HTL HZ 104.0 EP 16:41 03.46 0.19            HGH SZ 62.3 EP 16:40 56.66 0.15</p>	<p><b>August 15 2006</b> Time: 05:59 05.0 UTC            Lat: 53.614N Lon: -4.128W            Grid Ref: 259.25 kmE 415.18 kmN            Locality: IRISH SEA            Velocity model: Lownet Xnear: 50.0 Xfar: 100.0            Magnitude: 1.0 ML            Depth: 9.5 km            RMS: 0.00 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>WCB SE 38.2 AML 05:59 16.95 18 0.08            WLF SZ 40.3 IP D 05:59 12.17 0.01            WPM SZ 42.3 EP 05:59 12.52 0.00            YRC SZ 50.2 EP 05:59 13.71 0.03            YLL SZ 52.8 EP 05:59 14.12 0.01            WIM SZ 69.4 EP 05:59 16.74 0.01            YRE SZ 73.2 EP 05:59 17.23 -0.04            WCB SZ 38.2 EP C 05:59 11.85 0.00            WCB SN 38.2 ES 2 05:59 16.69 -0.13            WCB SN 38.2 AML 05:59 17.11 20 0.10</p> <p><b>August 18 2006</b> Time: 20:45 44.3 UTC            Lat: 63.356N Lon: -0.875W            Grid Ref: 456.28 kmE 1498.15 kmN            Locality: NORWEGIAN SEA            Velocity model: North Sea Xnear: 400.0 Xfar: 600.0            Magnitude: 3.8 ML            Depth: 20.0 km            RMS: 0.20 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>FSV SZ 305.0 IP C 20:46 25.72 -0.10            FTO SZ 339.0 EP 20:46 29.92 -0.13            FTO SN 339.0 ES 2 20:47 03.37 -0.06            FTO SE 339.0 AML 20:47 05.14 208 0.32            FTO SN 339.0 AML 20:47 08.56 135 0.47            WAL SZ 348.0 EP 20:46 30.85 -0.24            LRW HZ 359.0 EP 20:46 32.74 0.22            LRW HN 359.0 ES 2 20:47 07.89 0.19            LRW HE 359.0 AML 20:47 11.96 120 0.29            LRW HN 359.0 AML 20:47 12.92 87 0.28            FVA SZ 361.0 EP 20:46 33.14 0.29            OBR SZ 543.0 EP 20:46 54.79 -0.51            ORE SZ 558.0 EP 20:46 56.76 -0.45            ORE SN 558.0 AML 20:47 54.12 68 0.32            ORE SE 558.0 AML 20:47 56.08 102 0.40            MVH SZ 631.0 EP 20:47 05.93 -0.41            MCD SZ 656.0 EP 20:47 09.28 -0.16            MCD SE 656.0 ES 2 20:48 11.02 -0.55            MCD SE 656.0 AML 20:48 15.85 62 0.38            MCD SN 656.0 AML 20:48 15.90 82 0.28            EDI HZ 838.0 EP 20:47 33.69 1.69            EDI HN 838.0 AML 20:48 55.13 22 0.59            EDI HE 838.0 AML 20:48 57.60 26 0.37</p> <p><b>August 29 2006</b> Time: 16:05 00.7 UTC            Lat: 56.488N Lon: -4.375W            Grid Ref: 253.78 kmE 735.39 kmN            Locality: KILLIN,CENTRAL            Velocity model: Lownet Xnear: 100.0 Xfar: 200.0            Magnitude: 1.9 ML            Depth: 11.9 km            RMS: 0.30 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>PCO SZ 58.3 EP 16:05 10.63 -0.04            PGB HZ 75.7 EP 4 16:05 33.32 19.97            PGB HE 75.7 ES 4 16:05 41.98 19.41            EAU SZ 91.9 EP 16:05 15.71 -0.18            EDI HZ 96.9 EP 16:05 17.22 0.60            EDI HE 96.9 AML 16:05 31.41 30 0.33            EDI HN 96.9 AML 16:05 31.69 26 0.17            KAR SZ 101.0 EP 16:05 17.44 0.16            KSB SZ 103.0 IP C 16:05 17.29 -0.25            EBL SZ 115.0 IP D 16:05 19.22 -0.07            KPL HZ 123.0 EP 16:05 20.49 0.18            KPL HE 123.0 ES 2 16:05 35.10 0.48            KPL HN 123.0 AML 16:05 35.68 30 0.14            KPL HE 123.0 AML 16:05 35.76 42 0.29            KAC SZ 126.0 EP 16:05 20.63 -0.17            ESY SZ 126.0 EP 16:05 20.54 -0.38            ESK HZ 150.0 EP 16:05 24.25 0.04            ESK HE 150.0 ES 2 16:05 41.64 0.27            ESK HN 150.0 AML 16:05 44.41 12 0.14            ESK HE 150.0 AML 16:05 44.52 19 0.17            EAB SZ 33.5 IP D 16:05 06.72 -0.15</p> <p><b>September 4 2006</b> Time: 15:47 16.7 UTC            Lat: 54.641N Lon: -3.085W            Grid Ref: 329.98 kmE 527.87 kmN            Locality: KESWICK,CUMBRIA            Velocity model: Lownet Xnear: 75.0 Xfar: 150.0            Magnitude: 2.2 ML            Depth: 6.3 km            RMS: 0.20 secs</p> <p>STAT CO DIST PHAS WT P HrMn SECS AMPL PERI RES</p> <p>CKE SZ 6.1 IP D 15:47 18.79 0.29            BBO SZ 14.9 EP 15:47 19.74 -0.07            BBO SN 14.9 ES 15:47 22.06 -0.03            BDL SZ 20.4 IP C 15:47 20.60 -0.11            XDE SZ 30.2 EP 15:47 22.30 -0.06            CDU SZ 34.6 IP D 15:47 22.83 -0.23            BHH SZ 51.1 IP D 15:47 25.59 0.01            BHH SE 51.1 ES 2 15:47 32.25 0.18            BBH SZ 55.7 EP 15:47 26.24 -0.06            BWH SZ 69.9 EP 15:47 28.62 0.11            GIM SZ 97.6 EP 15:47 32.91 0.09            GIM SN 97.6 ES 15:47 44.64 0.04            GIM SN 97.6 AML 15:47 46.32 139 0.56            GIM SE 97.6 AML 15:47 47.05 107 0.34            GAL SZ 108.0 EP 15:47 34.49 0.16            GAL SN 108.0 ES 15:47 47.04 -0.17            GAL SN 108.0 AML 15:47 48.06 91 0.58            GAL SE 108.0 AML 15:47 48.35 49 0.20            WIM SZ 117.0 EP 15:47 35.82 0.00            HPK SN 122.0 ES 2 15:47 51.62 0.59            EBL SZ 126.0 EP 15:47 37.55 0.31            WCB SE 170.0 AML 15:48 05.84 20 0.30</p>
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## TABLE 2 : PHASE DATA

AEU	SE	117.0	AML	09:16	19.80	524	0.22		ESK	HE	37.4	AML	16:22	24.62	79	0.18	
LWH	SZ	132.0	EP	09:16	04.56			0.39	ESK	HN	37.4	AML	16:22	24.72	56	0.34	
KBI	SZ	174.0	EP	09:16	09.11			-0.24	CKE	SZ	64.0	EP	16:22	24.43		0.28	
LHO	SZ	189.0	EP	09:16	10.70			-0.59	GAL	SZ	73.7	EP	16:22	25.23		-0.39	
KWE	SZ	202.0	EP	09:16	12.93			0.03	GAL	HZ	73.7	EP	16:22	25.25			
SKP	SZ	248.0	EP	09:16	19.14			0.54	GAL	HN	73.7	ES	3	16:22	33.81	-0.86	
SSW	SZ	269.0	EP	09:16	21.00			-0.22	GAL	HN	73.7	AML		16:22	34.94	35	0.50
WOL	BZ	302.0	EP	09:16	27.62			2.35	GAL	HE	73.7	AML		16:22	35.31	21	0.46
WOL	BN	302.0	AML	09:17	15.32	51	0.55		EBL	SZ	85.4	EP		16:22	27.38		-0.12
WOL	BE	302.0	AML	09:17	18.32	92	0.50		EAU	SZ	86.0	EP		16:22	27.80		0.22
SWN	HE	305.0	AML	09:17	15.79	105	0.48		XAL	SZ	93.3	EP		16:22	28.82		0.09
SWN	HN	305.0	AML	09:17	16.88	112	0.40		EDI	HZ	97.9	EP		16:22	29.56		0.18
MCH	HZ	327.0	EP	09:16	28.63			0.26	EDI	HN	97.9	ES	3	16:22	41.06		-0.11
MCH	HE	327.0	AML	09:17	17.84	39	0.46		EDI	HN	97.9	AML		16:22	44.50	37	0.36
MCH	HN	327.0	AML	09:17	19.59	45	0.42		EDI	HE	97.9	AML		16:22	44.53	59	0.42
<b>December 30 2006      Time: 16:22 13.2 UTC      Magnitude: 1.7 ML</b>																	
<b>Lat: 55.079N      Lon: -3.622W      Depth: 5.6 km</b>																	
<b>Grid Ref: 296.46 kmE 577.27 kmN      RMS: 0.30 secs</b>																	
<b>Locality: DUMFRIES, D &amp; G</b>																	
<b>Velocity model: Lownet      Xnear: 100.0      Xfar: 300.0</b>																	
STAT	CO	DIST	PHAS	WT	P	HrMn	SECS	AMPL	PERI	RES							
BWH	SZ	11.0	EP			16:22	15.46			0.08	GMM	SZ	177.0	EP	16:22	41.62	0.60
BHH	SZ	25.8	IP		C	16:22	17.94			0.06							
BHH	SE	25.8	ES	2		16:22	21.18			-0.10							
GCD	SZ	31.5	EP			16:22	18.53			-0.32							
ESK	HZ	37.4	IP		C	16:22	19.28			-0.58							
ESK	HN	37.4	ES	3		16:22	23.81			-0.89							

TABLE 3

## GEOGRAPHIC COORDINATES OF SEISMOGRAPH STATIONS, 2006

Code	Name	Lat	Lon	KmE (km)	KmN (km)	Ht (m)	Comp
ABA	BACONSTHORPE	52.8884	1.1453	611.58	337.00	74	1
AEA	EAST ANGLIA UNIV	52.6208	1.2403	619.30	307.53	45	3M
AEU	EAST ANGLIA	52.6202	1.2347	618.93	307.45	28	SM
APA	PACKWAY	52.3006	1.4782	637.12	272.68	58	1
AWH	WHINBURGH	52.6297	0.9507	599.67	307.68	64	1R
AWI	WITTON	52.8319	1.4471	632.17	331.65	46	1
BBH	BRUNTSHEIL	55.1333	-2.9299	340.72	582.50	216	1
BBO	BOTHEL	54.7367	-3.2464	319.76	538.69	209	3
BCC	CHAPELCROSS	55.0153	-3.2201	321.99	569.66	138	1SM
BCM	CHAPELCROSS MIC	55.0151	-3.2212	321.92	569.64	78	M
BDL	DOBCROSS HALL	54.8030	-2.9385	339.68	545.76	157	1
BHH	HOWATS HILL	55.0931	-3.2181	322.27	578.31	216	3
BNA	NEW ABBEY	54.9658	-3.6242	296.03	564.68	28	1
BTA	TALKIN	54.9057	-2.6844	356.12	557.00	279	3
BWH	WARDLAW	55.1758	-3.6549	294.62	588.09	269	1
CBW	BUDOCK WATER	50.1482	-5.1144	177.53	32.29	94	1
CCA	CARNMENELLIS	50.1866	-5.2277	169.62	36.90	210	1
CCO	CONSTANTINE	50.1357	-5.1957	171.66	31.14	168	1
CDU	DUNNERDALE	54.3362	-3.1952	322.30	494.08	355	1
CGH	GOONHILLY	50.0507	-5.1649	173.46	21.60	97	1
CGW	GWEEK	50.1006	-5.2228	169.56	27.32	9	1
CKE	KESWICK	54.5877	-3.1059	328.54	521.96	304	1
CMA	MANACCAN	50.0821	-5.1274	176.29	24.98	42	1
CPZ	PENZANCE	50.1566	-5.5828	144.12	34.72	199	1R
CR2	ROSEMANOWES 2	50.1667	-5.1687	173.74	34.51	143	3
CRQ	ROSEMANOWES	50.1672	-5.1726	173.46	34.57	156	SM
CSA	ST AUSTELL	50.3527	-4.8919	194.30	54.38	112	1
CSF	SCAFELL	54.4478	-3.2430	319.41	506.55	540	1
CSM	SELLAFIELD MIC	54.4183	-3.4913	303.24	503.58	50	M
CST	STITHIANS	50.1952	-5.1635	174.24	37.66	141	1
CWF	CHARNWOOD FST	52.7385	-1.3076	446.74	315.91	203	3BB
DCO	COMBE FARM	50.3201	-3.8721	266.74	48.43	117	1R
DYA	YADSWORTHY	50.4353	-3.9310	262.88	61.34	292	3BB
EAB	ABERFOYLE	56.1887	-4.3373	254.97	702.02	279	1R
EAU	AUCHINOON	55.8454	-3.4474	309.38	662.30	359	1R
EBH	BLACK HILL	56.2476	-3.5084	306.54	707.13	375	1R
EBL	BROAD LAW	55.7723	-3.0445	334.48	653.71	436	1R
ECK	CAULDKAINE HILL	55.1810	-3.1292	328.10	588.00	351	1R
EDI	EDINBURGH	55.9233	-3.1875	325.80	670.66	125	3BB
EDR	DRUMTOCHTY	56.9190	-2.5393	367.17	780.97	401	1R
EDU	DUNDEE	56.5477	-3.0110	337.85	739.97	421	1R
ELO	LOGIEALMOND	56.4703	-3.7112	294.59	732.21	523	1R
ESK	ESKDALEMUIR	55.3165	-3.2052	323.52	603.16	261	3BB
ESY	STONEYPATH	55.9175	-2.6141	361.62	669.55	337	1R
FHV	HALDARSVIK	62.2597	-7.0984	135.46	1385.95	380	1R
FSD	SUDUROY	61.5701	-6.7884	145.86	1308.06	480	1R
FSV	SVINOY	62.2598	-6.3550	173.99	1383.14	430	1R
FTO	TORSHAVN	62.0199	-6.8274	147.51	1358.21	325	3R
FVA	VAGAR	62.0575	-7.3520	120.46	1364.55	430	1R
GAL	GALLOWAY	54.8664	-4.7114	226.02	555.78	117	3BB
GCD	CASTLE DOUGLAS	54.8630	-3.9403	275.48	553.76	184	1R
GCL	CUSHENDALL	55.0783	-6.1264	136.66	583.77	278	1R
GIM	ISLE OF MAN (North)	54.2923	-4.4672	239.44	491.35	346	3R
GMK	MULL OF KINTYRE	55.3458	-5.5934	172.19	611.64	164	1R
GMM	MTNS OF MOURNE	54.2377	-5.9498	142.66	489.67	155	1R
HAE	ALDERS END	52.0368	-2.5434	362.73	237.79	260	1R
HBL2	BONNYLANDS	52.0508	-3.0384	328.80	239.71	437	SM
HCG	CRAIG GOCH	52.3231	-3.6570	287.08	270.78	533	1R
HEX	EXMOOR	51.0664	-3.8026	273.71	131.28	230	1R

TABLE 3

## GEOGRAPHIC COORDINATES OF SEISMOGRAPH STATIONS, 2006

Code	Name	Lat	Lon	KmE (km)	KmN (km)	Ht (m)	Comp
HGH	GRAY HILL	51.6379	-2.8057	344.25	193.59	223	1R
HLM	LONG MYND	52.5184	-2.8807	340.25	291.57	429	1
HPE	PEMBROKE	51.9372	-4.7746	209.29	230.21	349	1R
HPK	HAVERAH PARK	53.9581	-1.6241	424.66	451.42	233	3R
HSA	SWANSEA	51.7500	-4.1532	251.38	207.94	293	1R
HTL	HARTLAND	50.9943	-4.4849	225.64	124.66	86	3BB
HTR	TREWERN HILL	52.0785	-3.2679	313.12	243.04	337	1R
JDC	DAM (CREST)	49.1947	-2.0469			39	SM
JDG	DAM (GALLERY)	49.1947	-2.0469			7	SM
JRS	MAISON ST LOUIS	49.1922	-2.0922			56	3RLG
JSA	ST AUBINS	49.1878	-2.1717			39	1R
JVM	VALLE D.L.MARE	49.2169	-2.2067			64	1R
KAC	ACHNASHELLACH	57.4989	-5.2988	202.36	850.19	206	1R
KAR	ARISAIG	56.9188	-5.8290	166.98	787.34	186	1
KBI	BIRLEY GRANGE	53.2543	-1.5279	431.49	373.17	272	1
KEY	KEYWORTH	52.8779	-1.0757	462.20	331.59	59	LG
KEY2	KEYWORTH (SM)	52.8790	-1.0770	462.13	331.73	76	SM
KNR	NEVIS RANGE	56.8219	-4.9714	218.68	773.97	1147	1R
KPL	PLOCKTON	57.3391	-5.6527	180.21	833.50	13	3BB
KSB	SHIEL BRIDGE	57.2099	-5.4214	193.40	818.40	417	1R
KSK	SCOVAL	57.4659	-6.7002	118.21	851.46	265	1R
KSY	SYSTON	52.9642	-0.5872	494.88	341.73	121	1R
KTG	TILBROOK GRNGE	52.3264	-0.4019	508.90	271.06	83	1
KUF	UFFORD	52.6170	-0.3907	508.94	303.39	38	1R
KWE	WEAVER FARM	53.0164	-1.8412	410.65	346.61	328	1R
LCP	CASSOP	54.7370	-1.4744	433.84	538.14	185	1R
LDU	LEEDS	53.8058	-1.5540	429.37	434.51	74	MLGSM
LHO	HOLMEFIRTH	53.5453	-1.8548	409.62	405.44	462	1R
LMI	MILLOM	54.2206	-3.3070	314.79	481.35	129	3R
LMK	MARKET RASEN	53.4569	-0.3260	511.14	396.90	146	1R
LRN	RICHMOND	54.4165	-1.8007	412.93	502.37	313	1R
LRW	LERWICK	60.1360	-1.1779	445.66	1139.27	98	3BB
LWH	WHINNY NAB	54.3338	-0.6717	486.36	493.97	277	1R
MCD	COLEBURN DISTIL	57.5828	-3.2541	325.02	855.42	293	3RMLGSM
MCH	MICHAELCHURCH	51.9974	-2.9983	331.47	233.74	219	3BB
MDO	DOCHFOUR	57.4409	-4.3633	258.17	841.39	415	1R
MFI	FISHRIE	57.6119	-2.2956	382.34	858.00	232	1R
MLA	LATHERON	58.3055	-3.3627	320.15	935.98	188	1
MME	MEIKLE CAIRN	57.3149	-2.9647	341.90	825.32	475	1
MVH	ACHVAICH	57.9250	-4.1825	270.75	894.90	185	1
OBR	BRABSTER	58.6142	-3.1626	332.47	970.13	89	1R
ODR	DOUNREAY	58.5822	-3.7256	299.68	967.27	100	SM
OHO	HOY	58.8322	-3.2465	328.05	994.48	172	1R
ORE	REAY	58.5480	-3.7622	297.45	963.52	100	3RMLG
OST	STRONSAY	59.0860	-2.5516	368.39	1022.20	21	1R
OTO	TONGUE	58.4953	-4.3939	260.49	958.79	338	1R
OWE	WESTRAY	59.3180	-3.0289	341.44	1048.36	87	1R
PCA	CARROT	55.7007	-4.2550	258.30	647.55	302	1
PCO	CORRIE	55.9880	-4.1002	269.00	679.21	267	1
PGB	GLENIFFERBRAES	55.8115	-4.4837	244.38	660.37	199	3BB
PMS	MUIRSHIEL	55.8459	-4.7452	228.15	664.82	351	1
POB	OBSERVATORY	55.8458	-44299	247.88	664.06	34	MLG
RCR	CAPE WRATH	58.6245	-4.9987	225.90	974.58	100	1R
REB	EISG-BRACHAIDH	58.1194	-5.2802	206.82	919.16	100	1R
RFO	FORSNAVAL	58.2133	-7.0052	106.10	935.83	195	1R
RRH	RHENIGDALE	57.9197	-6.6881	122.43	901.86	103	1R
RRR	RUBHA REIDH	57.8577	-5.8067	174.19	891.68	61	3RMLGSM
RSC	SCOURIE	58.3485	-5.1683	214.61	944.33	60	1R
RTO	TOLSTA	58.3778	-6.2092	153.95	950.93	74	1R



**TABLE 3**

**GEOGRAPHIC COORDINATES OF SEISMOGRAPH STATIONS, 2006**

<b>Code</b>	<b>Name</b>	<b>Lat</b>	<b>Lon</b>	<b>KmE (km)</b>	<b>KmN (km)</b>	<b>Ht (m)</b>	<b>Comp</b>
SAN	SANDWICK	60.0179	-1.2392	442.41	1126.08	150	1
SBD	BRYN DU	52.9055	-3.2585	315.37	335.01	489	1
SFH	HASELMERE	51.0604	-0.6912	491.71	129.88	260	1
SHSD	LERWICK	60.1360	-1.1779	445.66	1139.27	98	BBSM
SIW	ISLE OF WHITE	50.6711	-1.3747	444.18	85.97	162	1
SKP	KOPHILL	51.7218	-0.8096	482.22	203.29	212	1
SMD	MENDIPS	51.3083	-2.7170	350.03	156.88	310	1
SSP	STONEY POUND	52.4177	-3.1119	324.39	280.59	428	3
SSW	STOW-ON-WOLD	51.9667	-1.8499	410.31	229.86	291	1
SWK	WARMINSTER	51.1483	-2.2471	382.72	138.87	266	1
SWN	SWINDON	51.5137	-1.8007	413.83	179.49	192	3BB
TBW	BRENTWOOD	51.6549	0.2913	558.48	197.66	89	1R
TCR	COLCHESTER	51.8347	0.9212	601.24	219.20	45	1R
TEB	EASTBOURNE	50.8187	0.1457	551.13	104.39	68	1R
TFO	FOLKESTONE	51.1135	1.1409	619.81	139.66	202	3MLGSM
TSA	SEVENOAKS	51.2426	0.1561	550.48	151.53	177	1
WAL	WALLS	60.2564	-1.6173	421.18	1152.46	167	1
WCB	CHURCH BAY	53.3782	-4.5467	230.62	389.87	139	3MSM
WFB	FAIRBOURNE	52.6831	-4.0383	262.23	311.48	316	1R
WIM	ISLE OF MAN(South)	54.1475	-4.6738	225.39	475.73	386	1R
WLF	LLYNFAES	53.2894	-4.3966	240.27	379.65	58	1
WME	MYNDD EILIAN	53.3969	-4.3032	246.88	391.40	129	1R
WPM	PENMAENMAWR	53.2581	-3.9048	272.95	375.18	353	1R
XAL	ALLENDALE	54.8617	-2.2147	386.22	551.91	458	1R
XDE	DENT	54.5056	-3.4902	303.52	513.29	301	1R
XSO	SOURHOPE	55.4924	-2.2510	384.14	622.10	516	1R
YEL	YELL	60.5509	-1.0830	450.29	1185.55	203	1
YLL	LLANBERIS	53.1402	-4.1704	254.84	362.57	159	1R
YRC	RHOSCOLYN	53.2508	-4.5753	228.21	375.77	22	1R
YRE	YR EIFL	52.9811	-4.4254	237.19	345.43	193	1R
YRH	RHIW	52.8336	-4.6288	222.94	329.51	286	1R

**Component Codes:**

- 1 Single vertical seismometer
- 3 Orthogonal set of 3 seismometers
- M Low-frequency microphone
- R Station coordinates registered with the International Seismological Centre (ISC), England and the National Earthquake Information Centre (NEIC), USA
- LG Single low-gain vertical seismometer
- SM Strong motion seismometers
- BB Broadband Instrument

**TABLE 4****Depth / crustal velocity models used in earthquake locations**

<b>Structural area</b>	<b>Depth to top of layer (km)</b>	<b>P-wave velocity (km/sec)</b>	<b>Vp/Vs</b>
North Sea	0.00	6.20	1.73
	12.00	6.50	
	23.00	7.10	
	31.00	8.05	
Lownet and general UK	0.00	4.00	1.73
	2.52	5.90	
	7.55	6.45	
	18.87	7.00	
	34.15	8.00	
Borders	0.00	4.10	1.71
	3.00	5.60	
	4.10	6.15	
	17.00	6.60	
	30.00	8.00	
North Wales (Lleyn)	0.00	5.40	1.68
	2.00	6.05	
	13.00	6.50	
	25.00	6.80	
	34.00	8.00	
Mid Wales	0.00	5.40	1.72
	3.80	6.05	
	15.50	6.65	
	34.30	8.00	
Cornwall	0.00	5.50	1.77
	0.30	5.76	
	15.00	6.90	
	30.00	8.00	

# Appendix 1 Key to Bulletin Encoding

YearMoDy	Year, month and day of event.
HrMn Secs	Time of occurrence of event in hours, mins and secs, (UTC).
Lat	Latitude of the event, positive latitude indicates north.
Lon	Longitude of the event, positive longitude indicates east.
kmE	UK National Grid Reference in kilometres east of grid origin.
kmN	UK National Grid Reference in kilometres north of grid origin.
Dep	Depth of the hypocentre in kilometres.
Mag	Richter local magnitude of the event.
Locality	A geographical indication of the epicentral area, usually the nearest town followed by the region. A key to the abbreviations used in the locality column are given below.
Int	Maximum EMS intensity. 2+ indicates felt, no macroseismic details. 3+, 4+ etc indicates felt at 3 or 4, but no survey carried out. 3, 4, 5 etc describes the maximum EMS intensity produced by the event.
Comments	Additional comments about the event eg: C/F, see below under comments abbreviations.

The following abbreviations are extracted from the output of the location program HYPO71 (Lee and Lahr,1975)

No	Total number of P and S readings used in the event location.
Gap	Largest azimuthal separation in degrees between stations.
RMS	Root Mean Square of the travel time residuals in seconds.
ERH	Standard error of the epicentre in kilometres. When this column is blank, the error is large and indeterminate.
ERZ	Standard error of the focal depth in kilometres. When this column is blank, the error is large and indeterminate.

## Locality abbreviations

Sonic	Sonic boom	N Yorkshire	North Yorkshire
Expl	Explosion	Staffs	Staffordshire
D & G	Dumfries and Galloway	W Midlands	West Midlands
Gtr	Greater	Salop	Shropshire
S Yorkshire	South Yorkshire	W Sussex	West Sussex

## Comments abbreviations

... and felt elsewhere

## Appendix 2 Key to Phase Data Encoding

Time	Time of occurrence of event in hours, mins and secs, (UTC).
Lat	Latitude of the event, N indicates North.
Lon	Longitude of the event, W indicates West, E indicates East.
Depth	Depth of the hypocentre in kilometres.
Grid Ref	UK National Grid Reference in kilometres east (kmE) and kilometres north (kmN) of grid origin.
RMS	Root Mean Square of the travel time residuals in seconds.
Velocity Model	Velocity model used in location.
Magnitude	Richter local magnitude of the event.
Locality	A geographical indication of the epicentral area, usually the nearest town followed by the region.
Intensity	Maximum EMS intensity. 2+ indicates felt, no macroseismic details. 3+, 4+ etc indicates felt at 3 or 4, but no survey carried out. 3, 4, 5 etc describes the maximum EMS intensity produced by the event.
Comments	Additional comments about the event eg: C/F see list of comments abbreviations below.
STAT	Station name
CO	Station component S=short period Z=vertical N=north south E=east west
DIST	Distance from earthquake to station (km)
PHAS	Phase identifier; the first letter characterizes onset E=emergent I=impulsive, the second indicates the phase eg P, S, PG and PN. AML
WT	Hypo weighting factor to arrival. 0 or blank=full weighting to 4=zero weighting (ignore). 9=use P S interval only for this line.
P	Polarity C=Compression/up D=Dilatation/down
HrMn	Hour, Minute of event
SECS	Seconds of event
AMPL	Amplitude centre to peak in nanometres (nm)
PERI	Period in seconds
RES	Station residual

## Appendix 3 The European Macroseismic Scale (EMS 98)

### 1 - **Not felt**

Not felt, even under the most favourable circumstances.

### 2 - **Scarcely felt**

Vibration is felt only by individual people at rest in houses, especially on upper floors of buildings.

### 3 - **Weak**

The vibration is weak and is felt indoors by a few people. People at rest feel a swaying or light trembling.

### 4 - **Largely observed**

The earthquake is felt indoors by many people, outdoors by very few. A few people are awakened. The level of vibration is not frightening. Windows, doors and dishes rattle. Hanging objects swing.

### 5 - **Strong**

The earthquake is felt indoors by most, outdoors by few. Many sleeping people awake. A few run outdoors. Buildings tremble throughout. Hanging objects swing considerably. China and glasses clatter together. The vibration is strong. Top heavy objects topple over. Doors and windows swing open or shut.

### 6 - **Slightly damaging**

Felt by most indoors and by many outdoors. Many people in buildings are frightened and run outdoors. Small objects fall. Slight damage to many ordinary buildings eg; fine cracks in plaster and small pieces of plaster fall.

### 7 - **Damaging**

Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many ordinary buildings suffer moderate damage: small cracks in walls; partial collapse of chimneys.

### 8 - **Heavily damaging**

Furniture may be overturned. Many ordinary buildings suffer damage: chimneys fall; large cracks appear in walls and a few buildings may partially collapse.

### 9 - **Destructive**

Monuments and columns fall or are twisted. Many ordinary buildings partially collapse and a few collapse completely.

### 10 - **Very destructive**

Many ordinary buildings collapse.

### 11 - **Devastating**

Most ordinary buildings collapse.

### 12 - **Completely devastating**

Practically all structures above and below ground are heavily damaged or destroyed.

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A complete description of the EMS-98 scale is given in: Grunthal, G., (Ed) 1998. European Macroseismic scale 1998. Cahiers du Centre European de Geodynamique et de Seismologie. Vol 15.