

OR/18/015 Summary of 2017 seismicity

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Galloway, D D. 2018. Bulletin of British Earthquakes 2017. *British Geological Survey*. (OR/18/015).

There were 224 earthquakes located by the BGS seismic monitoring network during the year, with 24 having magnitudes of 2.0 ML or above, eight having magnitudes of 3.0 ML or above and two having magnitudes of 4.0 ML or above. Some 14 events with a magnitude of 2.0 ML or above were reported felt, together with a further 14 smaller ones, bringing the total to 28 felt earthquakes in 2017.

The largest onshore earthquake of the year, with a magnitude of 4.0 ML and a focal depth of around 12 km, occurred on 4 August at 14:43 UTC and located on Moidart, Highland, approximately 50 km west of Fort William, 50 km NNW of Oban and 145 km northwest of Glasgow (Figure 5). It was the largest event to occur in Scotland since the magnitude 4.0 ML Arran earthquake on 4 March 1999, which was felt over an area of around 18 500 km², with a maximum intensity of 4 EMS. The focal mechanism obtained for this event shows either right-lateral slip on a fault that strikes north-northwest south-southeast and dips at 57° to the west-southwest, or left-lateral slip on a fault that strikes approximately east-west and dips north at 65° (Figure 6). This is in good agreement with focal mechanisms calculated for other earthquakes across the region, which all show similar solutions. Data from over 350 questionnaires (Figure 7), collected online, were used to determine how widely the earthquake was felt. Analysis of these reports, received from members of the public, shows that it was felt widely across the region, from Inverness to the northeast, to Glasgow in the south and Islay to the west. Typical reports described “all our windows and doors rattled”, “our whole house shook”, “cups and saucers on the table all rattled”, “a loud bang followed by a rumble, enough for us to go outside to see what had happened” and “everyone in the shop and people in surrounding shops noticed it”. A maximum intensity of 5 EMS was assigned for this earthquake. It was followed two minutes later, at 14:45 UTC, by a magnitude 3.4 ML earthquake, in the same location, which was also felt throughout the region with a maximum intensity of 4 EMS. A further three aftershocks were detected, all on 4 August, at 15:20 UTC, 16:07 UTC and 17:35 UTC, with magnitudes of 1.1 ML, 1.2 ML and 2.2 ML, respectively. The magnitude 2.2 ML event was felt by several residents on Moidart, with intensities of at least 3 EMS (Baptie et al, 2017^[1]).

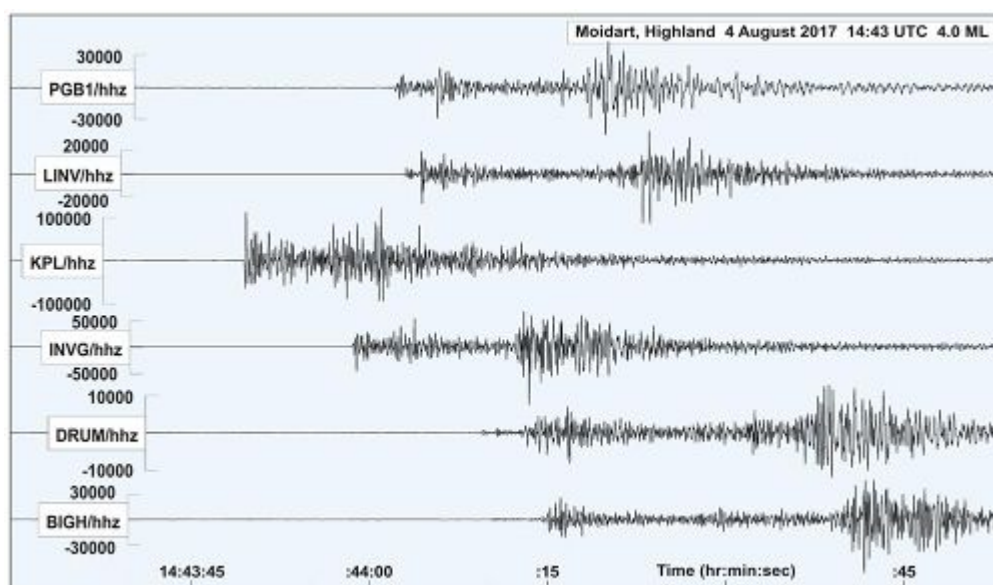


Figure 5 Seismograms of the ground displacement from the magnitude 4.0 ML Moidart earthquake, 4 August 2017, recorded by BGS seismograph stations.

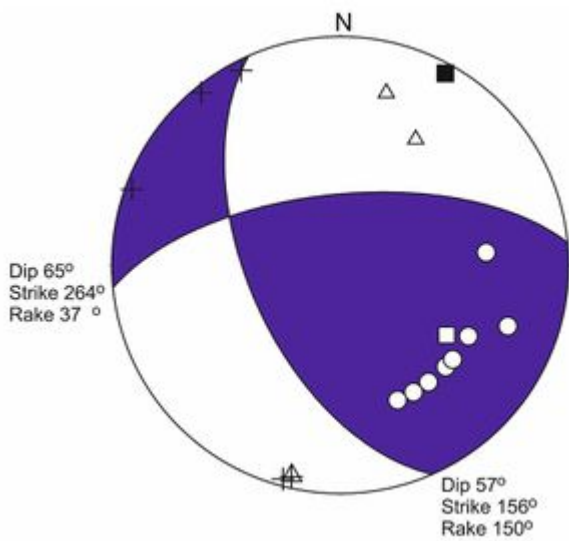


Figure 6 Lower hemisphere, equal projection of the focal mechanism for the Moidart earthquake on 4 August 2017. The blue shaded areas show areas of compressional first motion. The white circles and triangles show measured compressional and dilatational first motions, respectively. Black crosses show SH/V amplitude ratios. The black and white squares show the orientations of the axes of maximum (P) and minimum (T) compression, respectively (Snoke et al., 1984).

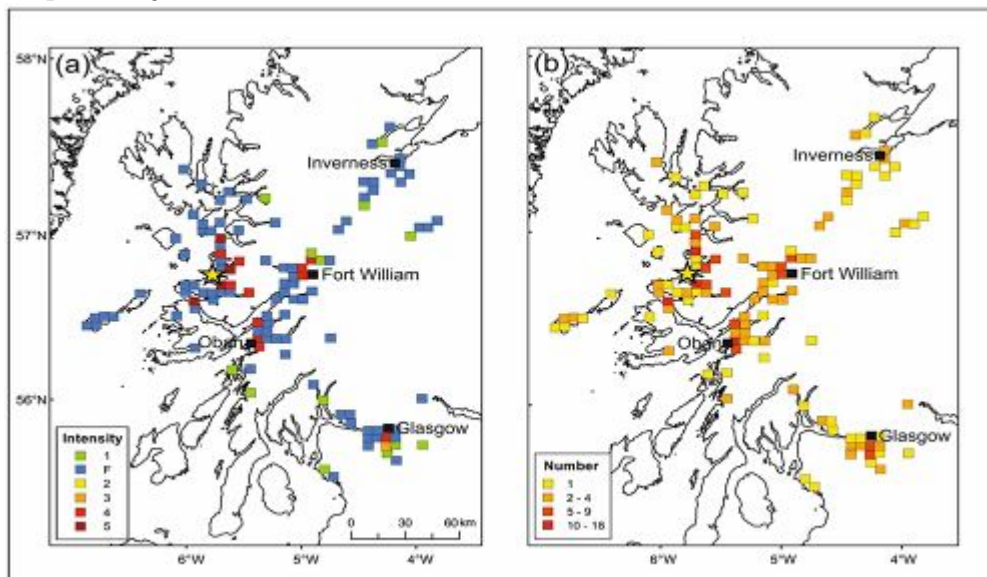


Figure 7 (a) Macroseismic intensities for the Moidart earthquake on 4 August 2017 calculated in 5 km grid squares. A minimum of five observations are required to calculate an intensity value. Squares are coloured by intensity. (b) Shows the number of observations to determine each intensity value.

The largest offshore earthquake of the year occurred in the Central North Sea, at 13:33 UTC on 30 June, with a magnitude of 4.7 ML and a focal depth of around 8 km (Figure 8). It located approximately 215 km southeast of Lerwick, Shetland Islands and 310 km northeast of Aberdeen. It

was felt in Lerwick, Sumburgh and Fair Isle (Shetland Islands), in Sanday and Kirkwall (Orkney Islands), in Wick and Thurso (Highland), in Fraserburgh (Aberdeenshire) and in a few locations in western Norway. Reports described “we were sleeping on sofa and the rumbling noise awoke both of us”, “it felt like a heavy lorry drove by just outside our house”, “the windows rattled for a few seconds” and “the sliding doors vibrated”, indicating an intensity of at least 3 EMS. The epicentre of this earthquake is approximately 100 km southwest of the magnitude 5.7 event that occurred in the Viking Graben region of the North Sea on 24 January 1927, and which was felt throughout western Norway and down most of the east coast of Scotland. Another two earthquakes, with magnitudes greater than 3.0 ML, occurred in the same general region of the Central North Sea during the year. The first, with a magnitude of 3.6 ML, occurred at 01:42 UTC on 7 July and the second, with a magnitude of 3.3 ML, occurred at 08:14 UTC on 14 September. On 3 January, at 18:52 UTC, an earthquake with a magnitude of 3.8 ML was felt in Scarborough, with intensities of 2 EMS. It occurred in the Southern North Sea region, approximately 155 km east of Scarborough, North Yorkshire (Figure 9). A further nine events occurred in the North Sea during the year, with magnitudes ranging between 1.5 ML and 3.7 ML.

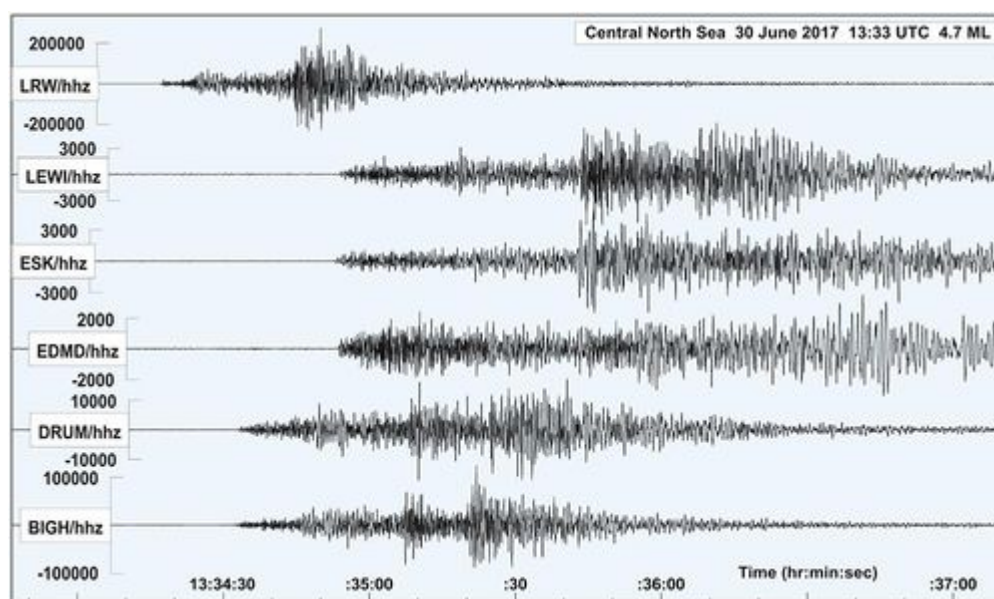


Figure 8 Seismograms of the ground displacement from the magnitude 4.7 ML Central North Sea earthquake, 30 June 2017, recorded by BGS seismograph stations.

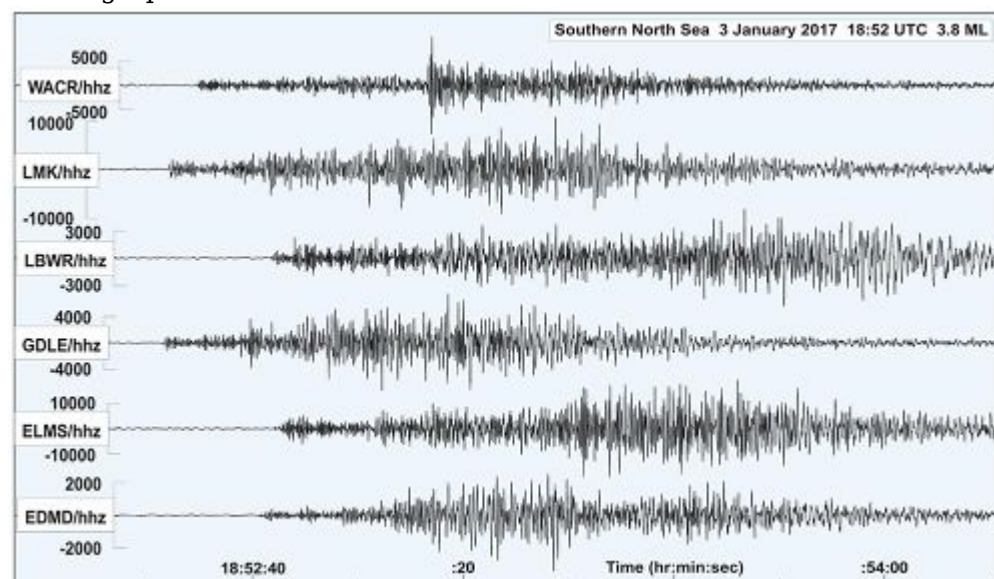


Figure 9 Seismograms of the ground displacement from the magnitude 3.8 ML Southern North Sea earthquake, 3 January 2017, recorded by BGS seismograph stations.

seismograph stations.

On 15 January, at 22:58 UTC, an earthquake with a magnitude of 1.0 ML, occurred near Beddgelert, Gwynedd. It was felt, with a maximum intensity of 3 EMS, by residents in Llanberis, Minffordd, Tremadog, Waunfawr, Pentir, Garndolbenmaen, Tregarth, Caernarfon, Penrhynddeudraeth, Blaenau Ffestiniog and Myndd Llandyai, Gwynedd.

A magnitude 1.2 ML earthquake occurred at 16:00 UTC on 21 January, near Kilmore, Argyll & Bute, approximately 8 km southeast of Oban. A single report was received from a resident in the nearby hamlet of North Connel, which described, "sounded like a goods train going past", indicating an intensity of 2 EMS.

On 24 January, at 16:35 UTC, an earthquake with a magnitude of 2.4 ML, occurred near Lephinmore, Argyll & Bute. It was felt by a number of residents in the hamlets, villages and towns of Lochgilphead, Lochgair, Kilmory, Minard, Otter Ferry, Leckuary, Ardrishaig, Castleton, Ardfern, Ardtaraig, Tayvallich, Clachan of Glendaruel, Tighnabruaich, Kilfinan, Dunoon, Cairnbaan, Tarbert, Stronachullin, Kilmelford, Melldalloch and Colintrave, Argyll & Bute. Typical reports described "a thump followed by a rumble lasting at least two or three seconds", "loud bang followed by a deep rumbling and slight shaking", "whole house shook as if something had exploded nearby" and "it sounded very similar to rocks being tipped from a lorry", indicating a maximum intensity of 3 EMS. It locates approximately 50 km southeast of the magnitude 4.1 ML Oban earthquake of 29 September 1986, which was felt over an area of around 30 000 km² with a maximum intensity of 5 EMS. It also locates approximately 14 km SSE of the magnitude 5.2 ML Argyll earthquake on 28 November 1880, the largest of all recorded Scottish earthquakes, which was felt all along the west coast of Scotland, east as far as Perthshire, throughout the Inner and Outer Hebrides and extensively in Northern Ireland. The following day, on 25 January at 16:32 UTC, an earthquake with a magnitude of magnitude 1.4 ML, occurred in the same region, near Lephinmore, and was felt by a single resident in Kilmory, Argyll & Bute.

An earthquake, with a magnitude of 2.6 ML, occurred on 3 March, at 09:28 UTC, near the market town of Stone, Staffordshire (Figure 10). It was felt by a single resident in the nearby village of Oakamoor. Earthquakes of this size are usually felt more when they occur onshore but enquiries to local Police stations and Post Offices revealed that no further felt reports were received. The depth (13.1 km) may have contributed to the lack of felt effects. Historically, the largest earthquake to have occurred nearby, approximately 7 km to the SSW, was the magnitude 4.6 ML Stafford event that occurred on 14 January 1916. It was felt throughout the region from Lancaster in the north to Bristol in the south, and from Cardiff in the west to Norwich in the east and caused considerable damage to many buildings in and around Stafford.

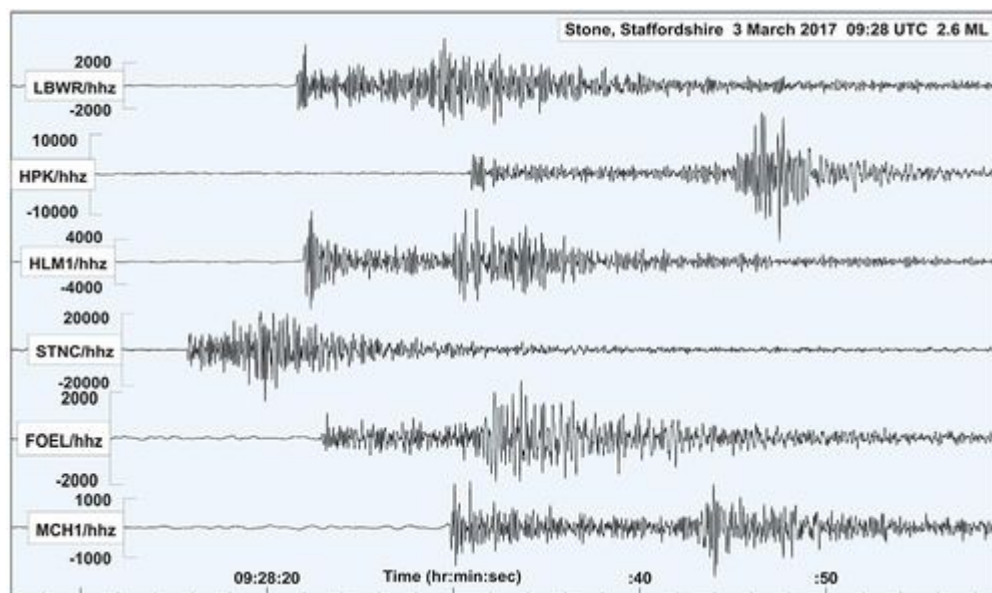


Figure 10 Seismograms of the ground displacement from the magnitude 2.6 ML Stone, Staffordshire earthquake, 3 March 2017, recorded by BGS seismograph stations.

Near Hinderwell, North Yorkshire, three events occurred on 20 March at 02:06 UTC, 02:16 UTC and 04:24 UTC, with magnitudes of 1.3 ML, 1.3 ML and 0.8 ML, respectively. Both the magnitude 1.3 ML events were felt, by several residents, in the villages of Hinderwell and Staithes, with intensities of 3 EMS. The magnitude 0.8 ML event was felt, by a single resident, in the village of Staithes. On 19 May at 23:14 UTC, an earthquake with a magnitude of 1.8 ML, occurred on the Knoydart peninsula in the Scottish Highlands. It was felt by several residents from Inverie, the main village on the peninsula, who described, “the kitchen window rattled” and “there was a single big boom, like an explosion”, indicating an intensity of around 3 EMS. A further two events were detected in the region in the following days, at 03:51 UTC on 20 May and at 21:57 UTC on 22 May, with magnitudes of 0.6 ML and 1.1 ML, respectively.

A magnitude 2.0 ML earthquake occurred at 20:08 UTC on 2 June near Spean Bridge, Highland Region. It was felt in Spean Bridge and by several residents in the surrounding villages of Gairloch, Roybridge and Banavie, who described “was like a rock blast” and “sounded like an explosion with a rumble to match”, indicating an intensity of 3 EMS.

On 5 June at 13:17 UTC, a magnitude 2.1 ML earthquake occurred approximately 5 km northeast of Lincoln, Lincolnshire. It was felt in Reepham, Stainton by Langworth, Grantham, Grimsby and Sutton-on-Sea. One report described “thought it was rumbling from neighbouring washing machine, but much louder”. An intensity of 3 EMS was assigned to this earthquake. It is the largest event detected in the general area (within 25 km) since the magnitude 2.7 ML Gainsborough earthquake on 19 June 2010. It is also located approximately 17 km SSW of the magnitude 5.2 ML Market Rasen earthquake which occurred on 27 February 2008 and was felt throughout England with a maximum intensity of 6 EMS.

An earthquake, with a magnitude of 2.4 ML, and a depth of around 7 km, occurred at 23:05 UTC on 10 June, with a location near the spa town of Malvern, Worcestershire. It was felt by three residents in Malvern who described “small items on my dressing table fell over”, “very deep rumble, like the start of some thunder” and “an unusual sound, like a large object briefly brushing the house”, indicating an intensity of 3 EMS. Historically, the largest event to have occurred in this area was the magnitude 5.3 ML Hereford earthquake on 17 December 1896, which was felt throughout most of England and Wales. Significant damage was caused in Hereford and surrounding villages, where

over 200 chimneys were damaged or twisted.

A magnitude 2.1 ML earthquake occurred at 10:28 UTC on 16 July, with an epicentre near the town of Bargoed, Caerphilly. No felt reports were received for this event. This is an area that has experienced many seismic events in the past. The event in 2017 locates in the same area as events on 10 October 2001, 18 October 2001 and 12 February 2002 with magnitudes of 3.1 ML, 2.5 ML and 3.0 ML, respectively, that were all felt with intensities of 4 EMS.

On 17 July, the BGS received several reports from residents in Jersey and Guernsey, Channel Islands of a possible event sometime around 21:00 UTC. Reports described “all doors in the house were shaking”, “we felt a faint rumble” and “the rattling of windows in their frames and a slight vibration, felt by person lying on floor”. Data from the BGS seismic networks in the region were examined and signals consistent with a possible sonic origin were recorded between 21:00:00s and 21:00:40s UTC, on several stations (namely JVM, JSA, JRS, JQE and JDC) on the BGS seismic network in Jersey.

At 07:58 UTC on 23 July, an earthquake, with a magnitude of 2.3 ML, occurred near the village of Badrallach, Highland. It was felt by residents in Badrallach and also by residents in the surrounding towns and villages of Ullapool, Dundonnell, Acheninver, Achiltibue, Ardessie, Lochbroom, Loggie, Camusnagaul and Gruinard, who described “it felt like lorries passing the house”, “the walls visibly shook”, “the whole house shook and the windows rattled” and “the mirror rattled which is lying next to the wall”. An intensity of 3 EMS was assigned to this earthquake.

On 2 August, an earthquake with a magnitude of 1.4 ML, occurred approximately 2 km WNW of the seaside village of Rathmullan, County Donegal. The BGS received information from the local Media that it was felt by several residents in the Milford area on the Fanad peninsula, County Donegal.

An earthquake, with a magnitude of 1.5 ML, and a depth of around 7 km, occurred at 02:19 UTC on 4 August, with a location approximately 7 km NNW of Kingussie, Highland. It was felt by a couple of residents in the town of Kingussie and by another, single resident in the village of Kincaig. Reports described “felt like something impacting the house”, “the windows rattled”, “thought it might be burglars trying to break the door” and “felt like a heavy train passing by”, indicating an intensity of about 3 EMS.

An earthquake, with a magnitude of 2.0 ML, occurred on 9 August at 04:41 UTC with a location in the Irish Sea, approximately 12 km NNW of Amlwch, Anglesey and 12 km NNE of Wylfa Nuclear Power Station (Figure 11). It was felt, by a single resident, in Amlwch who described “a slight shaking and a faint rumble”.

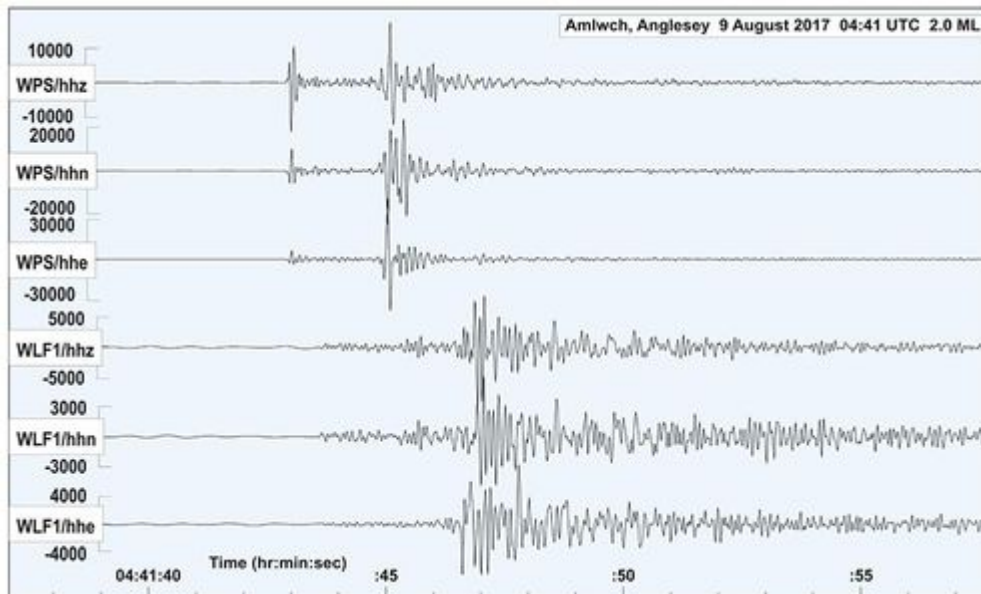


Figure 11 Seismograms of the ground displacement from the magnitude 2.0 ML Amlwch, Anglesey earthquake, 9 August 2017, recorded by BGS seismograph stations.

An earthquake, with a magnitude of 2.0 ML, occurred at 15:34 UTC on 9 August in the English Channel region, approximately 55 km SSW of Brighton, East Sussex. Four other earthquakes occurred in the English Channel region during the year, with magnitudes ranging between 0.9 ML and 1.9 ML.

On 8 September at 20:47 UTC, a magnitude 1.3 ML earthquake occurred near the village of Langham, Rutland. It was felt by several residents in Langham, Oakham, Ashwell, Market Overton, Barleythorpe, Edith Weston, Cottesmore, Whissendine and Burley, who described “a very loud rumble”, “we thought it was thunder”, “there was a loud bang and the crockery shook in the cupboard”, “it sounded like a truck crashing” and “the curtains moved”, indicating an intensity of at least 3 EMS.

A magnitude 1.2 ML earthquake occurred at 01:37 UTC on 27 September, with an epicentre approximately 3 km NNE of the village of Ringford, Dumfries and Galloway. It was felt by a single resident in Dalbeattie, who described feeling a “slight tremor”.

On 4 October, the BGS received several reports (via Media sources in Suffolk and Norfolk) of a possible event felt by residents in several towns and villages across Suffolk, Norfolk and Essex, sometime around 07:30 UTC. Reports described “the whole house shook”, “the windows rattled and all the birds outside went crazy”, “we thought it was an explosion” and “there was a loud bang”. Data from the BGS seismic networks in the region were examined and a signal consistent with a possible sonic origin was recorded at 07:37 UTC on the BGS seismic station near Elmsett, Suffolk.

On 8 October, at 22:55 UTC, a magnitude 1.4 ML earthquake occurred around 2 km SSE of Oban, Argyll and Bute. It was felt by a single resident in Croggan, Isle of Mull, approximately 15 km west of the epicentre, who described “loud roar like a plane overhead but with no build up or fade away”.

An earthquake, with a magnitude of 2.6 ML, occurred at 20:59 UTC on 1 November, near the village of Tarbert, Argyll and Bute (Figure 12). It was felt by several residents in Tarbert, Tighnabruaich, Kilfinnan, Ardrishaig, Inverneill and Ormsary, Argyll and Bute. Reports described “there was a rumbling and a bang which was longer and louder than thunder and it frightened me”, “the windows rattled”, “the shaking lasted around 3 or 4 seconds” and “we thought it was a very large and heavy

vehicle on the road outside”, indicating an intensity of at least 3 EMS.

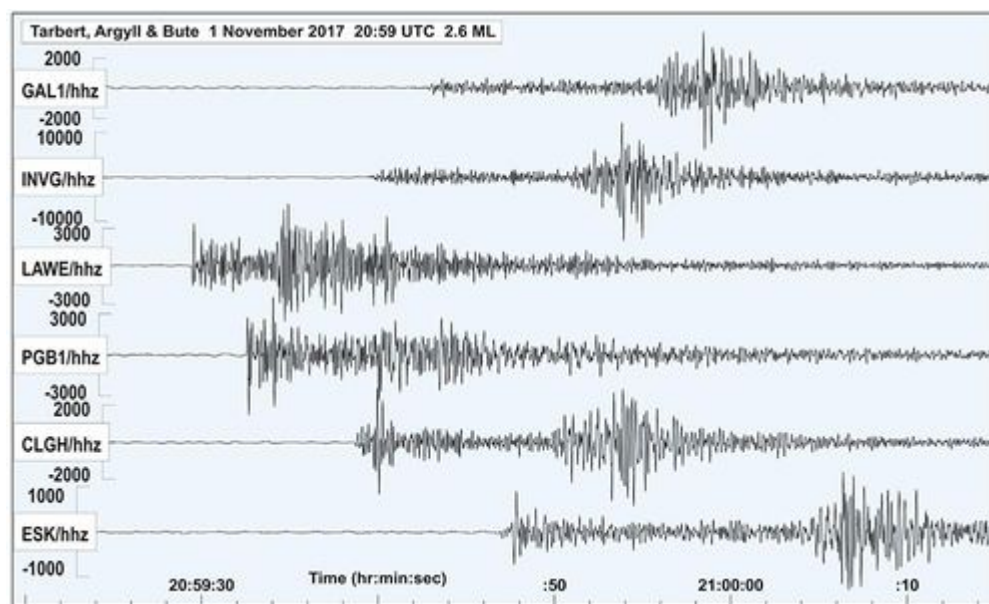


Figure 12 Seismograms of the ground displacement from the magnitude 2.6 ML Tarbert, Argyll & Bute earthquake, 1 November 2017, recorded by BGS seismograph stations.

Three earthquakes, within 15 minutes of each other, were detected on 13 December on the island of Islay, Argyll and Bute. They occurred at 02:01:29, 02:01:49 UTC, and 02:16 UTC with magnitudes of 0.9 ML, 0.8 ML and 1.1 ML, respectively. None were reported felt.

On 20 December at 08:15 UTC, an earthquake, with a magnitude of 1.5 ML, occurred on the Morvern peninsula in the Scottish Highlands. It was felt in Kilchoan, Highland, in Gruline, on the Island of Mull and in Clachan and Achnacroish, on the Island of Lismore, Argyll and Bute. An intensity of 3 EMS was assigned for this earthquake.

An earthquake, with a magnitude of 1.7 ML, occurred on 26 December at 22:40 UTC, on the Island of Mull, Argyll & Bute. It was felt by several residents on the islands of Mull and Lismore, Argyll & Bute and it was also felt on the mainland, in the township of Acharacle, Highland. Reports described, “a long extended rumble”, “sounded like a nearby quarry blast, but too unusual a date and time for this”, “loud roar for a few seconds, like previous earthquakes we have experienced” and “a noticeable rumbling for a few seconds”, indicating an intensity of at least 3 EMS. A further six events occurred on the Island of Mull during the year, with magnitudes ranging between 0.5 ML and 1.1 ML, of which none were reported felt.

References

1. [↑](#) Baptie, B, Ford, G, and Galloway, D. 2017. The Moidart Earthquakes of 4 August 2017. *British Geological Survey Open Report*, OR/17/062 25pp.

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