We have had a number of Field Trips this year including our February clean-up of Brown's Folly, a visit to the Etches Museum and Kimmeridge Bay in Dorset. A few other field trips were made with other local societies.

We have had another successful year with a range of topics for talks and field trips. However, membership remains at about 70 members after a brief reduction during the year. We have had to keep to the smaller room for our lectures as attendance is usually around 20. Once again we have had an excellent selection of speakers and topics and would like to thank our Committee Members for their help in suggesting and arranging the speakers.

Finally, would like to thank all the committee members for all of their help and to Melissa Freeman for producing the Journal.

Our stand at the Festival of Geology, UCL, 2018 by Mellissa Freeman

Browns Folly, site 5. Some of the crew hard at work! By Mellissa Freeman

Kaikoura Earthquake and after
By Isabel Buckingham

On 14th November 2016 at 2 minutes after midnight an earthquake started 60 km south of Kaikoura off the east coast of South Island New Zealand. The rupture spread north and lasted about 2 minutes. The strongest part of the quake was felt north of the epicentre near Seddon a few km south of Blenheim. This 7.8M quake was the second largest to hit NZ since European settlement and also caused damage in Wellington and Lower Hutt in North Island. In all 21 faults moved and in one case by >10m. What is less widely appreciated is that a tsunami followed, this being recorded by the tide gauge at Kaikoura, and debris lines. Initially the sea withdrew then water returned in waves. The highest 7m was recorded at Goose Bay which is south of Kaikoura from stranded debris. The drop was 2.5m complicated by the land lifting by 1m at the gauge site. At Goose Bay, unlike the rest of NZ there is no continental shelf, as the Hikurangi trench starts 1.6km offshore at a depth of <2,000m and extends north to just off Gisborne as it continues as the deeper Kermadoc trench. *This shows well on Google Earth.*

Image by Isabel Buckingham: Large Slide , full height

This trench had just been surveyed at the time of the earthquake. Part of the interest is the similarity with the sea bed off Japan. Unlike the area off the west coast of USA little is known of the frequency of earthquakes, so geologist look for turbidites off shore, raised sea beds and tsunami deposits. There seems for example to be a tsunami deposit from about 800 BP at Lake Grassmere a salt lake near Seddon The most recent orogeny is called the Kaikoura Orogeny and is known to have been at an increasing rate over the last 5 million years.

Many images can be found by searching *Kaikoura quake images.* The damage at Wellington led to several demolitions and put the container port out of action for 10 months. Kaikoura was totally cut off by road and rail and a naval exercise was diverted to evacuate many people, the town being a popular destination for marine wildlife watching. Water and sewage were affected. The main N-S road State Highway 1 goes through Kaikoura as does the rail link from Picton, the port for the inter-island ferry, to Christchurch. Innumerable landslides, damaged bridges, blocked rail tunnels and movement along faults damaged rail and road. Heroic efforts resulted in some land access being possible but the main road was not opened to "selected" day time traffic for 5 months. The innumerable aftershocks kept the rocks falling and many parts are still single lane with major engineering works underway. Whole hillsides have just slipped down and seem to be rebuilt from scratch. Innumerable smaller slips scar the hillsides. Some rotational slips, and wash outs add variety. Bridges are being replaced and the movement along faults smoothed out. Gullies scar the bare graded slopes despite efforts at planting.

Image 2: Gulley in slide by Isabel Buckingham

The hope/plan is to open the rail link by 1st December 2018 with a crew riding in advance of the train to check the track and deal with minor falls. In places the workers are protected by shipping containers piled two deep and filled with boulders. I observed some of the people with the stop go board using binoculars to check the slopes above. Unused equipment was being stored in the tunnels to protect from falling rocks.

Serious consideration was given to just abandoning the route and going inland, but then the Alpine fault would have to be dealt with. On places further north I could see where the railway ballast had been replaced having been washed away by the tsunami.

Kaikoura itself was up and functioning and tourists were back by road. I'd revisited Christchurch where I'd been before the earthquake and seen the changes and on going work. This really brought home to me the long term effects of an earthquake in which luckily only two were killed. All in NZ should keep an emergency pack at home for 2 days minimum survival. When my little granddaughter went to Nursery in NZ there was a weekly earthquake drill so they knew what to do.

We all see the news when it happens. The long term aftermath is not reported.

Image 3: tackling small slide by Isabel Buckingham

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Interesting Geological Localities in West Wales – a much Belated Postscript
By Charles Hiscock

In the autumn 2014 edition of the Bath Geological Society Journal, I wrote about three localities in west Wales, one of which was the coast between Newquay and Aberaeron. I described and showed photographs of the fascinating formations seen in the cliff a short distance south of Aberaeron harbour in which the Aberystwyth Grits had been folded and faulted. The structures, folding and faulting seemed so complicated that I was unable to explain what had happened and expressed the hope that someone reading the article could interpret the rocks for me.

In October 2017, I was on the field trip to Ogmore-by-Sea and Dunraven, on the Glamorgan Heritage coast, led by Dr. Geriant Owen of Swansea University. During our walk across the beach at Dunraven, I asked him if he knew the locality at Aberaeron and he agreed that he did and that he takes students there to look at the sedimentology of the Aberystwyth Grits along that section of coast. As a result of our conversation, I sent my photographs of the outcrop to him for his interpretation. His reply was very comprehensive and, now with his help, I have a much better understanding of the processes that had occurred at Aberaeron south beach.

Dr. Owen starts by emphasising that he is a sedimentologist! However, he goes on to say "It has been suggested that the folds had formed in unconsolidated sediment, near the surface, in response to slopes, as opposed to 'tectonic' deformation structures formed slowly in rock at depth. However, the structural geologists rejected the idea due to cleavage, veins and fracture patterns.

Image 1 is easiest to interpret. The folds are highly asymmetrical. Looking at the anticline in the centre left, the left limb dips gently to the left; the right limb is vertical (and in some folds at Aberaeron it is