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

overturned, so dips steeply to the left) The right limb of the anticline is very short, and just to the right of the anticline the beds again dip gently to the left – so this is an anticline-syncline pair. And it looks as though there is another anticline-syncline pair at the right-hand edge in the middle distance. The folds are Z-shaped as you are looking at them. Rocks that are thinly interbedded tend to produce 'chevron' folds, which have very tight hinge regions – that is, they form a zig-zag pattern rather than gently curved folds. The hinge regions (where all the bending occurs) therefore often form faults if the folding is very tight.

Image 1: Large overturned anticline, compressed syncline and Z structure

These elements explain your other images, I think – chevron folds with one gently dipping and one steeply dipping limb, with an inequality of limb length and some fold 'cores' represented by faults. Image 2 looks a complete mess but the left side of the cliff in the background is a gently dipping limb and the steeply dipping rocks in the foreground are the steep limb (here slightly overturned); you can see the hinge region of an anticline just to the left of the cave in the centre. The jumble to the right of the central cave must be a syncline, and another anticline is visible at the extreme right end of the cliff at eye level. I think the hinge of this anticline forms the raised rock on the right hand side of the foreground platform. There may be a fault running across the image between the foreground and the cliff, offsetting the structures slightly.

Image 2: Overturned fold, highly compressed syncline with thrust above

Image 3, the annotated one, shows similar features. It shows that the syncline is really squashed. Not surprisingly, when such tight folding occurs, thrust faults are common, and I think this explains the discontinuity half-way up the cliff."

Image 3: Annotated to show intense folding and faulting

Dr. Owen concludes by calling this "Terrific stuff" and that he should be getting his students to make field sketches of the features as well as looking at the sedimentary features in the cliffs and the sea-defence blocks.

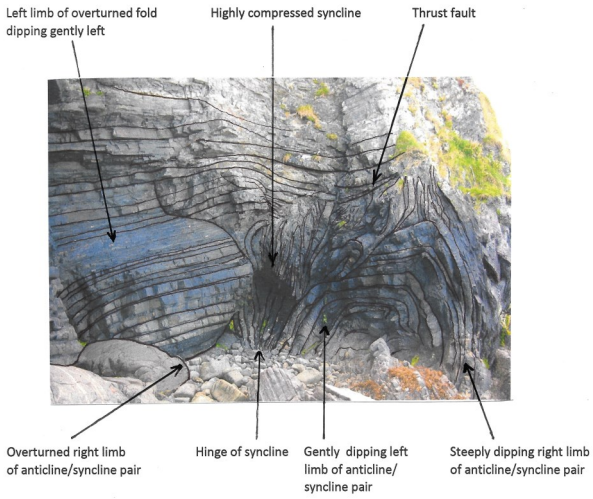

Image 4: Cationed to show structural details

I thank Dr. Owen for taking the time to interpret my photographs and for giving such a comprehensive summary.

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Kimmeridge Bay Field Trip 4th May 2019 led by Graham Hickman.
By Phil Burge

Introduction

A group of 15 members met at the car park at Kimmeridge Bay after an enjoyable drive through the country side on a glorious spring day. Having met, we walked eastwards to gather at the Wild Seas Centre where we reviewed the regional structural and tectonic history of southern England from the Variscan to the Alpine orogeny. This set the scene for the subsequent observations of the structural geology of the Bay and the origin of the thickness of the Kimmeridge Clay. Following this scene setting we walked back along the cliff top, past the car park and down the path at Gaulters Gap onto the beach. The first item of interest on the beach is the Mk25 pill box. A relic of the fears of an invasion during the early years of WW2. Apparently there were seven types of pill box designated, in true military fashion as Type 22 to Type 28.

Having contemplated on the potential efficacy of such a defensive structure the group reviewed the stratigraphy visible along the cliffs moving from east to west before being let loose to explore and, without the aid of hammers look for fossils. The Kimmeridge Clay is abundant in fossils. Although it is always exciting to find a fossil, our finds were as nothing compared to the fantastic exhibits to be seen in the Etches collection which was visited in the afternoon.

Structural Geology
There are two major structural features. The first is the fault system to the north, a product of the Variscan orogeny which occurred during the Carboniferous. It was likely reactivated during the Jurassic resulting in a downward throw to the south. Eroded sediments from land masses found in Wales, South East England and Scotland extending south into Yorkshire fed into a deep (+/-100m) boreal to sub-tropical sea, with the basin deepening as the fault moved. This resulted in, amongst other things, deposits of Kimmeridge Clay up to 550m in thickness.

The second major event is the folding along an east – west line during the Alpine orogeny of the late Cretaceous and thereafter. This tectonic event produced the anticlines of the North and South Downs and the syncline of the Weald. This tectonic event at Kimmeridge Bay formed a shallow dipping anticline as can be clearly seen in the cliff exposure.