RGS

Reading Geological Society

SW England Crustal Transect Field Meeting Report

Friday 19th-Monday 22nd September 2025

Leader:

Jonathan Turner

Introduction

The Reading Geological Society trip to the southwest of England was planned as something different. Any one of the three days could easily have been expanded into a multi-day event on its own. However, this was a themed trip. Devised by Dr Jonathan Turner, a structural geologist, the trip was a transect through the earth's crust. This was facilitated in the way the southwest of England was deformed during the late Palaeozoic Variscan orogeny associated with the closure of the Rheic ocean and collision of Armorica with St George's Land. We would start the trip looking at the style of deformation in the upper crust at Hartland Quay, Upton and Millook Haven (Day 1). The second day would take us to the mid crustal levels with its associated metamorphism and ductile deformation as seen at Greenaway beach, Polzeath and Perranporth beach (Day 2). This was coupled with examination of mineralisation associated with late orogenic uplift. The trip culminated in our investigation of the obducted basal oceanic crust and mantle on the Lizard Peninsula (Day 3).

Friday 19th September – Killerton Park

The southwest of England is a long drive from Berkshire, so some of us gathered en route at Killerton Park, after suffering the trials of navigating Devon back roads due to the M5 being closed. Killerton Park was not part of Jonathan's agenda, but perhaps it has a place. The National Trust property with its parkland has limited accessible outcrop. However, we persisted and walked out from the park entrance to the Chapel to get our first taste of the local geology.

Killerton Chapel

GR SS 97668 0033; 50°47'37"N, 003°27'12"W; W3W middle.rational.overdrive

The Chapel was constructed in mid-19th century and is made primarily of dark grey ashlar blocks of fine grained, igneous rock with larger flakes of biotite mica (Figure 1). This material was one of three lamprophyres found in the area. A lamprophyre is an undersaturated, potassium-rich mafic or ultra mafic igneous rock associated with subduction or late state plutonic activity. On closer examination we also found scattered xenoliths of metaquartzite inside the lamprophyre blocks. There was also debate on whether we could see alignment of vesicules.

In the chapel walls, aesthetically, the dark grey lamprophyre is contrasted by a course of yellow sandstone and the chapel entrance of pale creamy, biomicritic limestone and columns of oolitic limestone. It was proposed that the sandstone was probably from a local Permo-Triassic source. The limestones are more enigmatic, the oolite may be Bath Stone, but the pale creamy bioclastic limestone may be Beer Stone.

Figure 1 Killerton Chapel composed of lamprophyre blocks quarried locally.

The Clumps Quarry

GR SS 97545 00472; 50°47'41"N, 003°27'18"W; W3W herds.lifetimes.drank

We walked up the hill from the chapel into the woodlands above and noted the red soil with grey blocks of lamprophyre. At the edge of the woodlands, we came to a small quarry. Unfortunately, access was not permitted but we could see a quarry face comprising 20 to 30 metres of the lamprophyre. The lamprophyre is jointed but appears to comprise two to three metres thick units (Figure 2). It is reported that the lamprophyres were lavas, some of which are overlain by red sandstones. While we had seen some possible evidence of flow structures in the chapel, there remains some question whether these finely crystalline igneous rocks are lavas or high level intrusives.

Figure 2   Lamprophyre quarry, The Clumps, Killerton Park.

The Courtyard

GR SS 97621 00077; 50°47'28"N, 003°27'14"W; W3W cyclones.applause.flopping

On our return we briefly looked at the building of the courtyard where we saw a great variety of basaltic blocks. However, in contrast to the high-quality lamprophyre used in the Chapel these were very variable and many of them were highly vesicular. These are probably from the Exeter volcanics but from further afield

Conclusion

So how does this fit with the story that would unfold over the next three days? The lamprophyres at Killerton Park are part of the Exeter Group, a series of volcanics and continental redbeds deposited during the early Permian. Isotopic age dating of a lamprophyre at Killerton Park gives a date of 279 ±6 MA. The Exeter Group sediments and volcanics are undeformed by Variscan tectonism but they overly deformed Crackington and Bude formation sediments similar to those we would visit on Day 1. Mapping the Exeter volcanics suggests that they were extrusive from fissures rather than from vents and have similar ages to Dartmoor granites. We surmised that the fissures and volcanism were a manifestation of late extensional collapse of the Variscan mountains in the manner described by Jonathan in his talk to the RGS earlier in September.

Report by Ross Garden

Saturday 20th September am - Hartland Quay, Devon

GR SS 22357 24848; 50°59′44″N, 004°31′58″W; W3W motivate.birthdays.earlobe

During the field trip we were to see rocks from a transect through the Variscan Crust. At Hartland Point we were looking at the upper crust. The rocks at Hartland Quay are sandstones interbedded with mudstones. These sediments were deposited in a foredeep basin known previously as the 'Culm Synclinorium'. Foredeep basins developed in response to crustal loading in front of mountain belts that were forming to the south by northward verging thrusting. As these mountain belts eroded, they provided the sediments that are deposited in the basin. These types of sedimentary sequences can be as much as 1,000 m thick.

The sediments at Hartland Point were deposited during the Namurian Stage of the Carboniferous and are part of the Crackington Formation. The group were sent off to discover how the sediments were deposited and what controlled the folding which was chevron in style in most places and a more open style of folding further to the north (Figure 3).

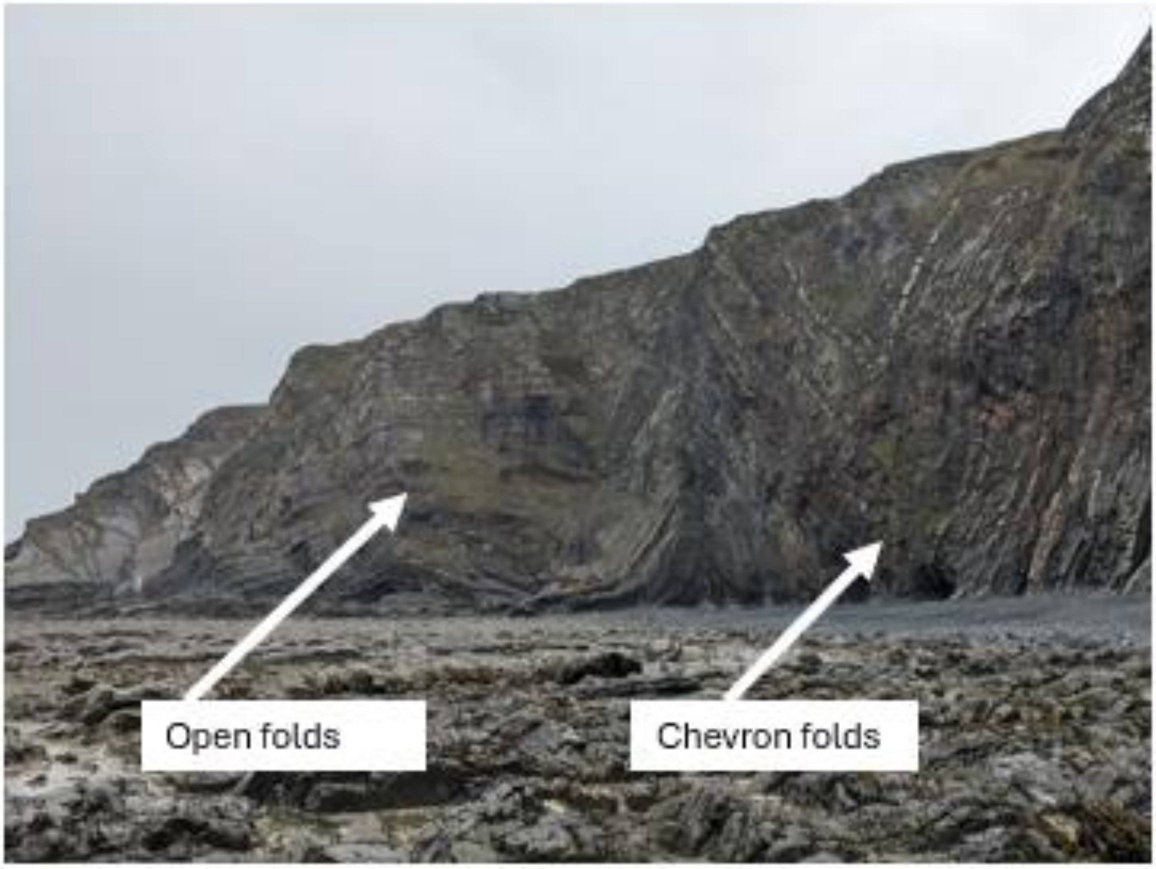

Figure 3 Folding styles in the Crackington Formation (north to the left).

The sandstones were very uniform in appearance and interbedded with variable amounts of mudstones. Very little or no sign of body fossils or trace fossils were seen. As illustrated by the photographs below (Figure 4), the sandstones occasionally had concretions within them, locally rip-up mud clasts, sometimes load casts, tool marks and other linear features that could have been load casts or a tectonic feature. Ripple marked surfaces were also seen. The environment of deposition was decided to be deepwater turbidites. We were told that the tool marks had an orientation generally parallel to the axis of the foreland basin.

Figure 4   Sedimentary features in the sandstones of the Crackington Formation.

In an area associated with chevron folding (Figure 3), slickensides were seen on bedding surfaces. This indicates that shearing along bedding planes was occurring probably facilitating folding.

The sandstone to mudstone ratio changed across the area and it was noticed that the locations with thinner sandstones interbedded with mudstones formed chevron folds (Figure 3). In contrast, areas with thicker sandstones interbedded with mudstones formed more open folds. It is thought that it was the presence of increased mudstone and thinner sandstones that facilitated bedding plane slippage which allowed the chevron folds to form. The thicker sandstones with thinner mudstone beds were considered to be a more proximal, channelised part of a turbidite fan. The thinner sandstones and mudstone sequence being a more distal turbidite environment.

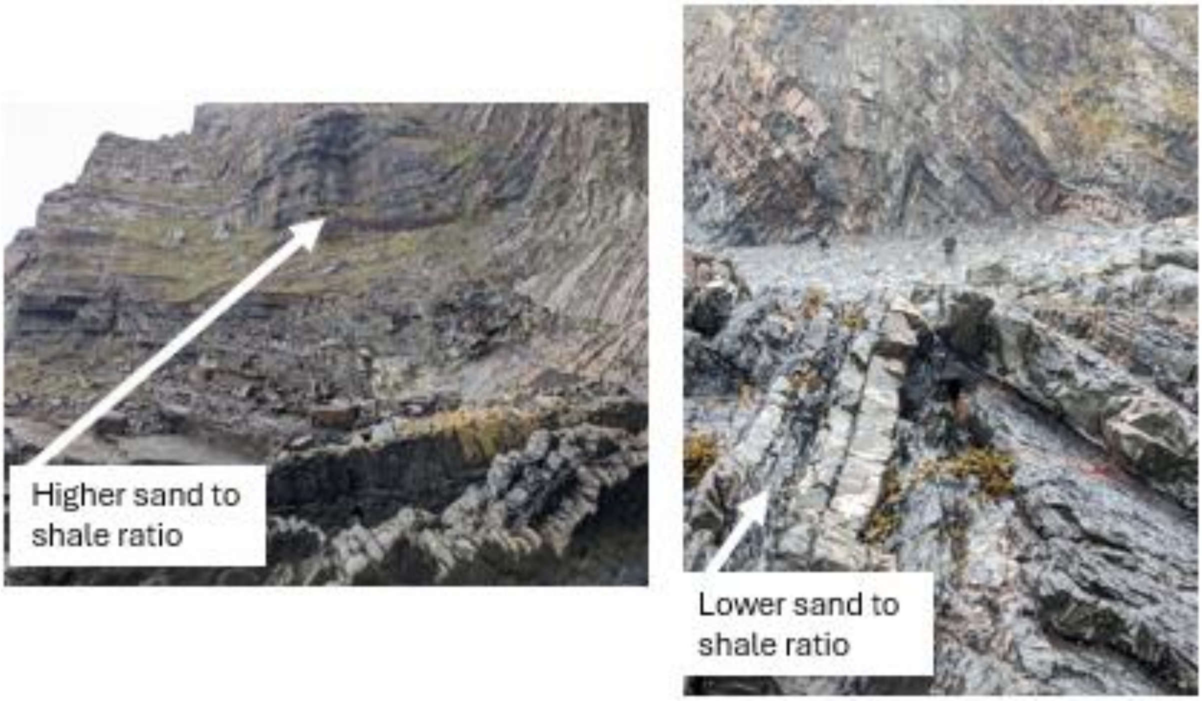

Figure 5 Fold character relating to Net Sand content. With higher proportion of sands, deformation is by more open folds.

The folding we see at Hartland Point is related to deep seated thrust faults cutting through the foreland basin sediments causing shortening and compression.

Report by Sarah Cook

Saturday 20th September pm - Lower Upton Beach and Millook Haven

Lower Upton Beach

GR - SS 20015 04817; 50°48′54″N, 004°33′23″W; W3W - finalists.cuddling.rummage

At Lower Upton beach. having scrambled down the steep path from the cliff top, the Carboniferous age rocks exposed in the cliff and foreshore are interpreted to be in the core of the large regional Culm supergroup synclinorium (Figure 6). Hartland Quay, to the north, being part of the northern “limb” of the syncline, with Millook Haven, part of the southern “limb”. In contrast to the succession at Hartfield Quay, the sediments here comprised sands and shales of the Westphalian Bude Formation.

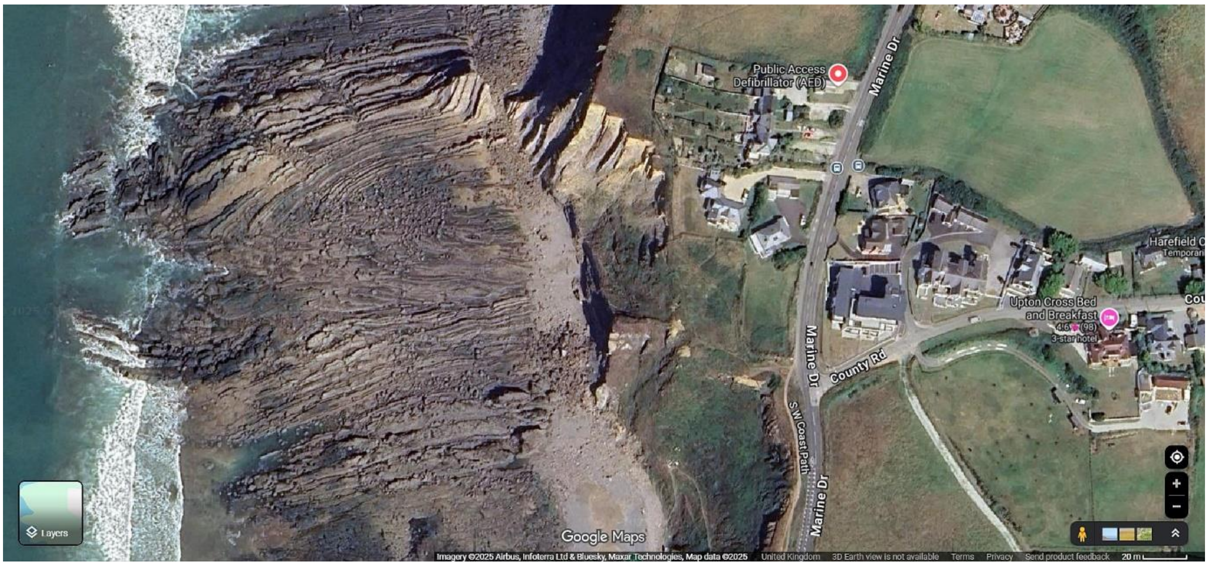

Figure 6 Satellite view of Bude Formation at Lower Upton beach (from Google Earth).

To the immediate north of the footpath (which can be seen in the centre bottom of Figure 6) the cliffs show a relatively small-scale but complex structure comprising predominantly thick bedded sands with what are now thin and relatively rare mudstones. The mudstones which appear to have been sheared into bed forms vastly different to their original depositional form.

Figure 7 View looking east of the folded and thrusted thick-bedded sandstones.

The thick bedded sandstones show a degree of open folding but, being strong and brittle, have been thrust over each other. The thrust axis, which looks like an anticline, is broadly east-west and the fold plunges to the west as can be seen on the satellite view (Figure 6).

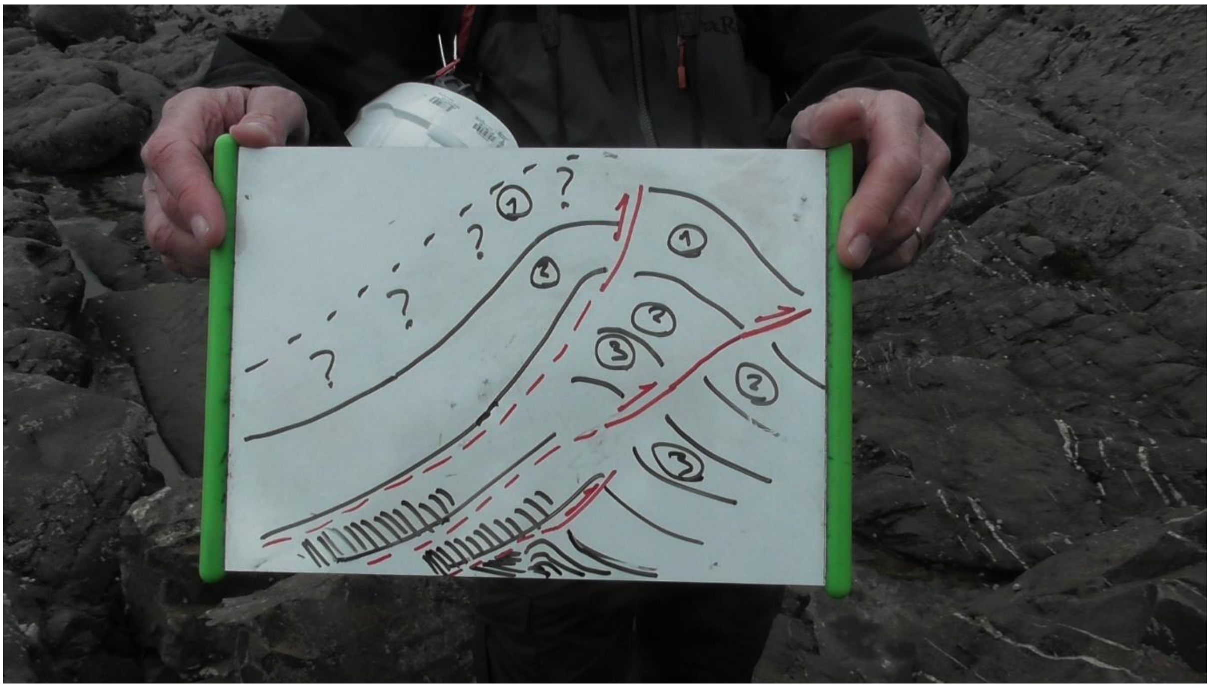

Figure 8 Structural interpretation of the folded and thrusted sands.

This illustrates the different responses to large-scale compression as a result of the nature of bed lithologies and bed thicknesses. The relatively thick sandstones are mechanically strong and resist tight folding giving rise to long wavelength folds with open hinges. At Upton the small volume of thin mudstone provided a little flexural slip between the sands but this moved the mudstones from the fold limbs to the fold axes as illustrated in the centre bottom of Figure 8. With the removal of the ductile mudstone the sandstone beds lock preventing further fold "accommodation" but with continuing compression the sands fail by fracturing into thrusts.

Within the thicker sands, bed-perpendicular quartz "veins" are considered to reflect compressional-induced quartz recrystallisation analogous to stylolites in carbonates.

To the north of the folded and thrusted massive sandstones, steeply dipping interbedded sandstones and mudstones occur.

Figure 9 View looking north showing on the right the low angle open folded massive sands in Figure 7 and on the left the steep dipping more thinly bedded sediments.

Due to the bad weather we didn't investigate the steeply dipping cliff section; however, the satellite image in Figure 6 suggests the beds seen in Figure 9 comprise the southerly dipping limb of a synclinal fold with an approximate east-west axis.

Closer examination of the sediments showed that they differed from the turbidites of the Crackington Formation. The sands are laminated with load and ripple structures. The inference is that the Bude formation was deposited under shallower water conditions consistent with storm beds within a large-scale lake developed in the foreland basin during the Westphalian.

Millook Haven

GR SS 18551 00196; 50°46′22″N, 004°34′29″W; W3W puzzles.hurtles.shoelaces

From Lower Upton we drove south-west to Millook Haven (Figure 10). The weather had deteriorated badly with strong gusting winds and horizontal rain. The rocks at Millook Haven are considered to be time equivalent to those at Hartland Quay; the Namurian Crackington Formation. As such we had driven southwards across the regional Culm supergroup E-W trending synclinorium. Millook Haven was thereby part of the southern limb of the structure.

Figure 10 Satellite view of Millook Haven.

Being on the southern limb, the structural orientation at Millook is markedly different to Hartland Quay. At Millook the fold axial planes are horizontal as opposed to vertical at Hartland Quay. Contrast Figure 3 and Figure 11. At Millook, the fold limbs are not typically symmetrical, one limb being longer than the other, as shown in Figure 11 where the northward dipping limb is much longer than the southward dipping limb.

Figure 11 Spectacular chevron folded thinly interbedded sandstones and mudstones viewed from the west (south to right).

Figure 12 shows the predominantly ductile behaviour of the moderately thin sandstones and mudstones. This can be explained by, for example, shearing a square box into a landscape parallelogram.

Figure 12 Example of chevron fold at Millook Haven with thickening of mudstones into the nose of the fold and tectonic thinning of the fold limbs.

There is evidence of quartz-filled fractures in the sandstones. These are interpreted to have formed after lithification of the sandstones and are likely to be related to pressure dissolution in the sandstones on the limbs of the folds and re-precipitation at the nose of the folds where the sandstones are in extension.

Report and photos by Jeremy Daines

Addendum: Jonathan explained that the styles of tectonics seen on this first day are consistent with upper crustal deformation of the foreland basin sediments. He reminded us that the bedding characteristics had an important role in the character of deformation. What was apparent was that the style of deformation and the extent of quartz cementation implied moderate to high temperatures. This suggested that deformation was occurring at significant depths of a number of kilometres, perhaps 5-10 km. At these depths, the sandstones and mudstones had been lithified but were not metamorphosed.

Sunday 21st September am - Greenaway Beach, Polzeath

GR SW 92803 78275; 50°34′03″N, 004°55′38″W; W3W edit.parade.beaks

On Sunday morning, we drove to Polzeath and parked in the car park overlooking the beach in Hayle Bay (SW 9334 7896). Greenaway Beach, however, is a small beach further on so we walked south along the coast footpath. We then took the path down to the beach where the rocks we were to look at are exposed. The rocks are exposed on the shore below the sandy beach but also in the cliffs at the top of the beach (Figure 13). The rocks are part of the Polzeath Slate Formation – metamorphosed mudstones, siltstones and sandstone, laid down about 372 million years ago during the Frasnian Age of the Devonian period (BGS).

Figure 13 Exposure of Polzeath Slate below the sandy beach.

On this day we were to see rocks of the middle crust. Jonathan, explained how, as we go deeper into the crust, the temperature and pressure increases. He suggested that the temperature is more important in the middle crust as pressure only becomes important when you get to greater depths. He defined the middle crust as when the minerals in the chlorite group start to form (at about 300° C) at the start of low-grade metamorphism (>10 km).

At this location, the Polzeath Slate is mainly a purple colour but with areas of pale green either side of some veins and joints (Figure 14; Figure 15). These are metamorphosed slates – purple where the iron content had been oxidised to ferric ion (Fe^{3+}) and green where the iron has been reduced to the ferrous ion (Fe^{2+}).

Figure 14   Colour banding in fractured and veined Polzeath Slate.

Figure 15   Reduction zones following near vertical bedding (left) or around veins (right) which parallel bedding.

The rocks are weakly slaty, and Ross Garden noted seeing very thinly bedded, fine-grained sandstones and siltstones interbedded with mudstones (Figure 15). He suggested that there may be some bioturbation and scours (not seen by author) and thought they may have been deposited in a low energy, moderately deepwater environment with occasional sand influx. Ross thought the identification of bioturbation was quite tenuous but described cylinders/tubes of a slightly darker colour than the matrix, i.e. burrows. Roger reported seeing a few pebbles up to 4” by 2” but there was no explanation of how they had been transported in this depositional setting.

The rocks are also faulted and veined (Figure 16). We could see that the quartz veins were formed at several different dates by their cross-cutting relationships (Figure 17). Some veins were distorted (ptygmatically folded) following the original fracturing of the rock (Figure 18) while others could be seen cutting across earlier veins and so must have formed at a later date.

Figure 16 Brittley faulted Polzeath Slate.

Figure 17 Quartz vein cutting and displacing a reduction zone and subsequently deformed.

Figure 18 Ptigmatically distorted vein.

Some of the fracturing may be due to the relaxation of pressure caused by the unroofing of these rocks.

There are also larger faults some with slickensided slip planes (Figure 19) and complex quartz veining (Figure 20) – (not seen by author).

Figure 19   Larger fault zone behind and to the left of the RGS members.

Figure 20   Deformed quartz veins in a fault zone.

Report and photos by Roger York

Sunday 21st September pm - Perranporth Beach

Introduction

Following our morning visit to Polzeath we travelled to Perranporth, assembling in the car park on the Promenade (GR - SW 7567 5429; W3W - firewall.revealing.plotted). This was conveniently located for Parade Stores, serving some fantastic ice cream. With some of us needing an ice cream boost, we set out in a northly direction across the sandy Perran beach for a walk of almost 1.5 km to Carn Clew in warm, sunny weather.

Carn Clew

GR - SW 7591 5559; 50°21'27"N, 005°09'06"W; W3W - devotion.breaches.heads

The destination of our walk was Carn Clew, a prominent headland on Perran beach with cliffs reaching around 45 m high from the beach to the clifftop South West Coast Path. The bedrock exposed in the cliffs is mapped on BGS GeoIndex Onshore and the 1:50,000 series Newquay Sheet 346 as the Trendrean Mudstone Formation. It is described as mudstone and siltstone of Devonian age, forming part of the Meadfoot Group whose age ranges from 394 Ma to 412 Ma. In the Carn Clew cliffs it was clear, however, that the simple lithological description of mudstone and siltstone did not do justice to the geological complexity.

Figure 21 shows that the Trendrean Mudstone Formation is separated by thrust faults from the Gramscatho Group to the south and the Bovisand Formation to the north. These faults formed under compression in the crust, consistent with formation during the Variscan orogeny, whose impacts on geological structure we encountered at previous localities. At Carn Clew, the predominant foliation trend in the Trendrean Mudstone Formation is sub-horizontal, dipping gently in a southerly direction (see right hand site of Figure 22) but, in detail, there are clear examples of tight, almost isoclinal folds (Figure 23). There was discussion as to whether the foliation represented primary sedimentary bedding of mudstones, siltstones and some sandstones; whether it was predominantly a tectonic fabric; or whether the primary and secondary foliations were approximately coincident. There was, however, no convincing evidence of sedimentary structures. Whatever the foliation represents, Figure 23 shows that the fabric has been deformed into tight folds that are small-scale, with amplitudes from around 10 mm to 10 cm, and form Z shapes. These parasitic folds indicate the existence of a larger scale, tight antiform whose axial plane is sub-horizontal, dipping to the south, parallel to the general foliation. The visible and inferred type of deformation is consistent with compression in the Variscan orogeny, although the direction of shear stress appears opposite to that forming the thrust faults.

Figure 21 Geological map of Carn Clew area.

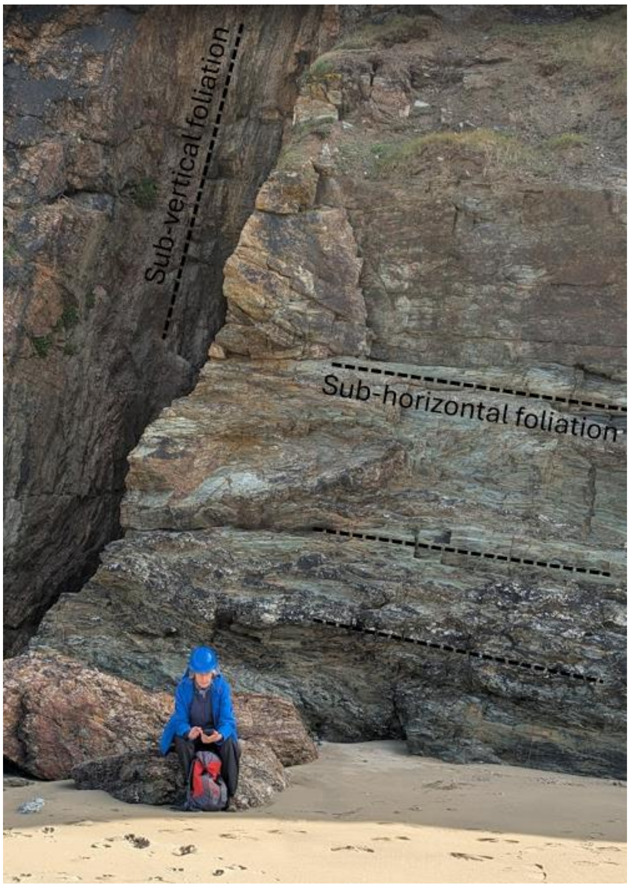

Figure 22 *Carn Clew cliffs showing sub-horizontal foliation in the Trendrean Mudstone and sub-vertical foliation in the Carn Clew fault zone.*

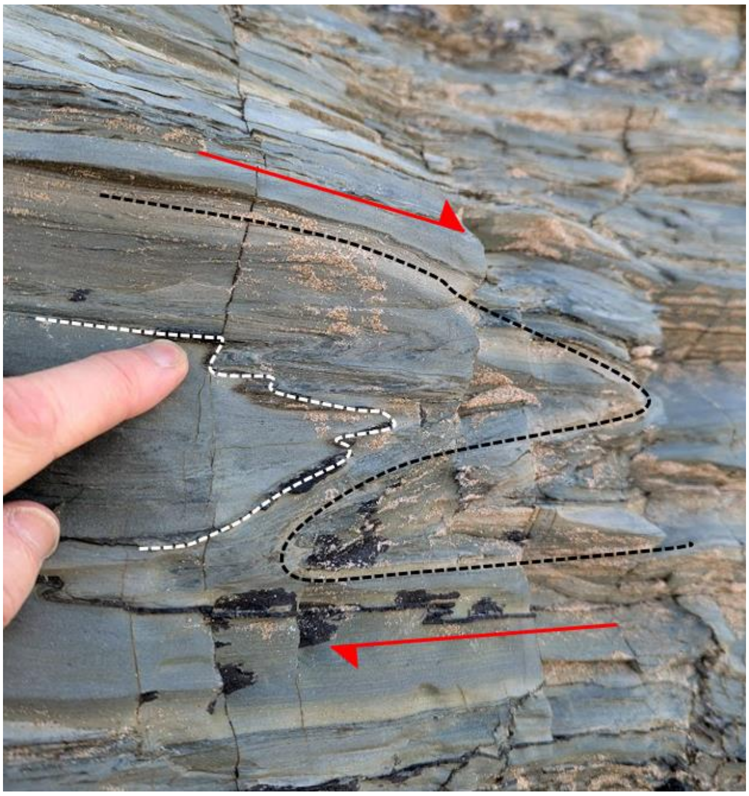

Figure 23 *Small-scale parasitic folds with evidence of changing bed thickness and inferred direction of shear stress.*

Some parts of the Trendrean Mudstone sequence also have a grey-green tinge, which was thought to be the result of chlorite formation. This is indicative of low-grade metamorphism that occurs at temperatures of around 300° C to 350° C at depths of around 15 km, which is also linked to the Variscan orogeny. These grey-green rocks were described as schists in the field, but there was discussion as to whether phyllites was a more appropriate term. Both are foliated metamorphic rocks with schists having larger platy minerals visible by eye, whereas phyllites are of lower metamorphic grade and have much finer grained platy minerals often resulting in a lustrous sheen.

A quite different geological feature cuts vertically through the cliffs at Carn Clew, with sub-vertical foliation as seen on the left-hand side of Figure 22. This is a fault zone mostly filled with a sequence of mineral veins. It is interest to note that Figure 21 shows that the Variscan thrusts are cut by later normal faults with many ore veins also being identified, but the Carn Clew fault and associated mineral veins are not included.

The internal structure of the fault zone and mineralisation is shown in Figure 24. This illustrates the multi-layered veins, predominantly of quartz, that have formed. Some dogtooth quartz is present (see evidence in left hand photo in Figure 24), indicating that the quartz has grown into open space within the fault zone. The right-hand photo in Figure 24 shows a close up of a white clay that contains sand grade quartz. This is interpreted as fault gouge formed by cataclasis during movement along the fault plane, crushing and grinding previously formed vein minerals. In contrast, the left hand photo in Figure 24 shows a very soft, orange clay-grade zone bounded by, what appears to be, another white clay fault gouge. The origin of the orange clay is uncertain, but it could be a fault gouge, derived from the Trendrean Mudstone or iron-rich mineral vein, or material washed into an open fault zone from an unknown source. Although only a small 2-D section of the orange clay was exposed, it is very soft uniform clay grade is perhaps more suggestive of a fault gouge.

Figure 24 Internal structure of Carn Clew fault zone and mineralisation, with orange clay (left) and white sandy clay beds (right).

Within the Carn Clew fault zone several specific minerals were found, together with orange, red and purple staining along exposed fracture surfaces and within fracture networks in the Trendrean Mudstone Formation. The specific minerals of note included:

- Cornwallite, a copper arsenate mineral [$Cu_5(AsO_4)_2(OH)_4$];
- Sphalerite [ZnS]; and
- Galena [PbS], reported to contain silver.

Examples of these minerals are shown in Figure 25, with cornwallite occurring in both a botryoidal encrusting form (centre top) and a more fibrous form (centre bottom). Further evidence of quartz growing into open space is also shown in a quartz-lined vug filled with sphalerite(?). Figure 25 also includes a dark red, unknown mineral (top left). As cornwallite is reported to be formed by oxidation of copper sulphide minerals, it is interesting that lead, tin and iron ore veins are mapped in the Trendrean Mudstone on the Newquay Sheet 346 but not copper veins, although copper ore veins are mapped in the Gramscatho Group to the south.

Figure 25 Minerals in and around Carn Clew fault zone. Top left: sphalerite(?); bottom left: sphalerite(?) filling quartz lined vug; centre: cornwallite; top right: unknown mineral.

The presence of fault gouge and the multi-layered mineral veins indicates that there have been multiple phases of fault movement but little, if any, evidence was seen to suggest the direction of fault movement. The fault, with its cataclastic fault gouge, has been interpreted as a strike-slip or wrench fault that formed above the brittle-ductile transition zone in the upper crust. The timing of the faulting and mineralisation has been interpreted as occurring at the around the same time that the Cornubian batholith was being intruded in the early Permian.

To help understand how the multiple phases of mineralisation may have occurred, we were introduced to the concept of arterial faults. These are fault systems rooted in the crust where pore fluids are over-pressured and serve as feeders for fluids and dissolved solids to move into the overlying crust. When fault zones rupture, permeable pathways are created and mineralising fluids can be mobilised. As mineralisation occurs the fault zone pathways are resealed, causing fluid pressure to build up until the next seismic event causes the fault to rupture again. This sequence of events, referred to as fault-valve behaviour, can lead to repeated mineralisation events (see Sibson, R., 2019. Arterial faults and their role in mineralizing systems).

The return journey

For the walk back to the car park, several chose a pleasant stroll back along the beach, although power walking was needed by some to avoid getting their feet too wet by the rising tide. The remaining group took a scenic route along the clifftop South West Coast Path. Reassembling in the car park, many took advantage of an ice cream from Parade Stores as a well-deserved reward.

Postscript

For some further information that provides additional context rather than specifics for Carn Clew, the links below may be of interest. Of potential relevance is the information on “cross-courses”, often mineralised with quartz, but little else, and sometimes clay filled. This seems similar to the Carn Clew mineralised fault zone, although the cross-courses are inferred to have been formed in the Triassic. The links also highlight that the presence of copper-bearing minerals is more widespread then inferred from the Newquay Sheet 346, which may be relevant to the formation of cornwallite.

- Geology of the Newquay district - brief explanation of the geological map Sheet 346 Newquay
- Nature and Origin of the Great Perran Iron Lode, Perranporth Area, Cornwall
- The metalliferous mining region of south-west England
- Cornish Heritage Blog - Mining in Perranporth

Report by Mike Jones. Photos by Mike Jones and Sarah Cook

Monday 22nd September am - Coverack Cove, Lizard Peninsula

Introduction

The third and final day of the field trip dawned bright and sunny – a welcome change after two days of wet weather. The itinerary had been designed to take us progressively deeper into the Earth’s crust. On Day 1 we looked at the upper crustal rocks of the Variscan foreland basin in north Cornwall and Devon, where turbidites showed spectacular isoclinal folding. On Day 2 we moved into the middle crust, examining slates and associated metamorphism. Day 3 now took us deeper still, to study rocks of the lower crust and their transition into the mantle.

Coverack Cove

GR - SW 78245 18401; 50°01'28"N, 005°05'50"W; W3W - random.seemingly.lighten

Coverack Cove on the Lizard Peninsula provides one of the best places in Britain to see the lower crust to mantle transition (Figure 26).

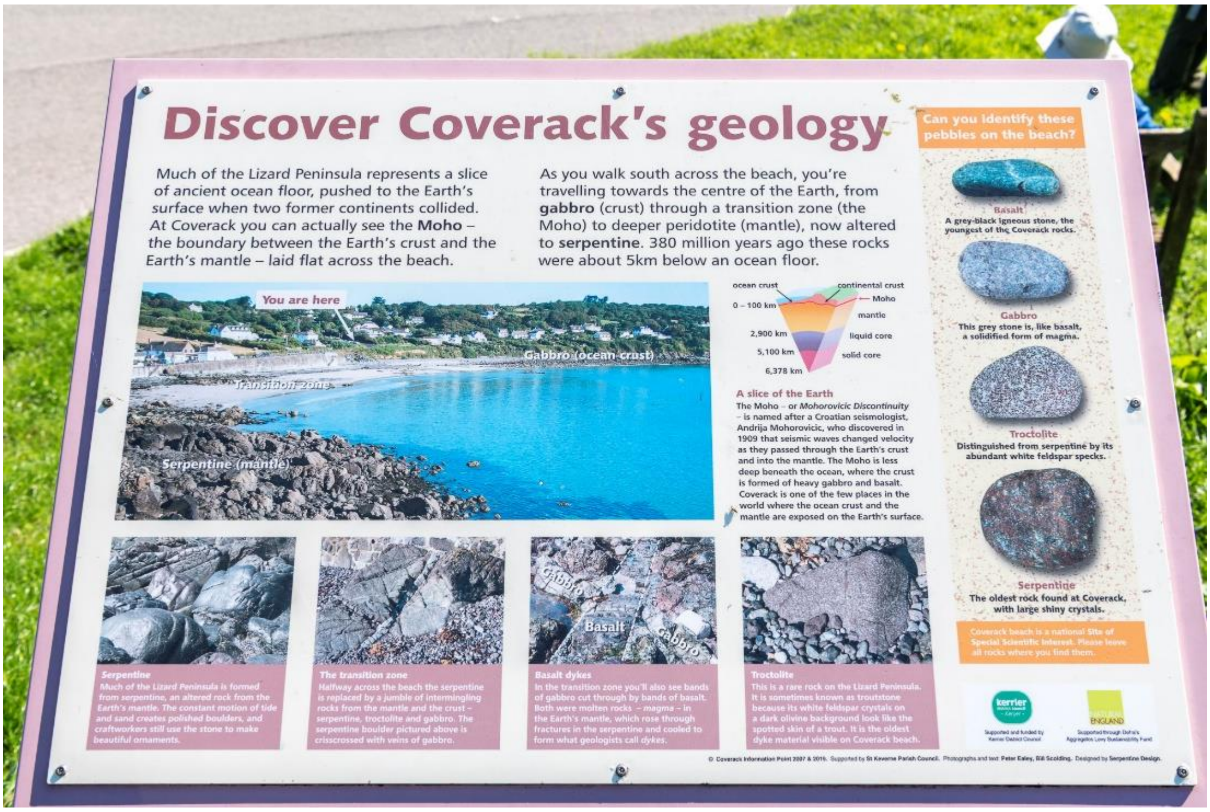

Figure 26   Information board at Coverack Cove explaining the mantle–crust transition.

Observations

At the southern end of the cove, dark fine- and coarse-grained rocks were examined (Figure 27). Many were altered by serpentinisation and are interpreted as serpentinites derived from hydrated peridotite – once part of the lithospheric mantle. Their green colour and fractured appearance was evident in hand specimen. The serpentinisation process involves hydration of mantle minerals such as pyroxene and olivine, producing amphibole and other phases. This leads to a volume increase of about one-third, accounting for the intense fracturing seen here.

Figure 27 Serpentinite and amphibolite outcrops on the southern side of Coverack beach.

Walking northwards along the beach, the lithology changes abruptly to paler, coarse-grained gabbros (Figure 28). These show interlocking crystals of feldspar and pyroxene, with pegmatitic veins containing crystals several centimetres across. The gabbros are cut by numerous basaltic and doleritic dykes, with sharp intrusive contacts visible.

Figure 28 Gabbro intruded by a basaltic dyke at Coverack Cove.

Jonathan asked us to collect pebbles of the different rock types we encountered across the cove. This collection of pebbles from along the beach illustrated the wide range of lithologies present allowing Jonathan to explain the structure and lithology of the crust and mantle (Figure 29).

Figure 29 Group discussion of the pebble collection illustrating the range of lithologies at Coverack.

Interpretation

Coverack provides a rare opportunity to see the transition from mantle to lower crust in a single traverse. The serpentinites represent hydrated mantle peridotite, while the gabbros and intrusive dykes represent the lower oceanic crust. In a typical oceanic crustal profile, these would be overlain by a sheeted dyke complex and extrusive basalts such as pillow lavas – absent at Coverack but preserved nearby on Mullion Island.

Our leader explained that the mantle–crust boundary (the Moho) here is not sharp, but represented by a kilometre-scale shear zone. Coverack is therefore regarded as one of the clearest on-land examples of the mantle–crust transition.

The discussion naturally turned to the wider question: how does a slice of oceanic lithosphere come to rest in Cornwall? The answer lies in obduction, when fragments of oceanic crust and mantle were thrust onto the continental margin during the Devonian closure of the Rheic Ocean. This theme set up the remainder of the day's programme, which considered the broader geological evolution of the Lizard ophiolite.

Report and photos by John Cole

Monday 22nd September pm - Mullion Cove and Kynance Cove, Lizard Peninsular, Cornwall

Mullion Cove

GR - SW 66633 17906; 50°00'56"N, 005°15'32"W; W3W - palm.amaze.announced

The members of the party had spoken, several times, about buying Cornish Pasties for lunch (and Ross had researched Coverack and the local area for suitable suppliers) but it was decided to leave Coverack and lunch at or on the way to our next location, Mullion Cove. In the event, several of the party coincided at Spar in Mullion where pasties and pies of various descriptions were prepared and cooked or heated. The lady serving ran out of some pasties and was heard to say that that was the busiest 15 minutes she had had in a long time. The party continued happily to Mullion Cove harbour where lunch was consumed.

During lunchtime, Jonathan explored the planned site but found that it could not be reached on the shore but only by boat. Had we been able to reach it we would have seen the Traboe amphibolite in contact with the overlying Lizard peridotite. The party, instead, studied the rock exposed above the north side of the harbour.

The rock was dark, almost black, fine-grained crystalline rock with about ~50% of green minerals (hornblende and epidote) and some feldspar and biotite. The black colour of the rock had been caused by the weathering of the surface. We discussed the lithology, some thought it igneous while others called it metamorphic. Jonathan described it as an amphibolite, a high-grade metamorphic rock alteration of the subducting oceanic plate by high temperatures and pressure metamorphism at about 40 km depth. As we had discussed at Coverack, the subducting basic to ultrabasic plate materials were obductioned during the Variscan orogeny and today form the Lizard Peninsula.

The on the BGS GeoIndex map it is described as the Traboe Hornblende schist; a metagabbro. In places the amphibolite could be seen to be laminated (Figure 30). The dominant apparent dip was about 45° to the south-east but locally the lamination became more steeply dipping, indicating that the succession was folded. Ductile deformation was indicated by a recumbent fold in the amphibolite (Figure 31).

Figure 30   Lamination in the amphibolite (Traboe Hornblende schist), which is cut by quartz veins.

Figure 31   A recumbent fold in the amphibolite.

Mullion Island just offshore from Mullion Cove is owned by the National Trust and preserved for the seabirds. Jonthan told us that the island comprises basaltic pillow lavas which have been dated about 350 Ma. These forms part of the Roseland Breccia Formation.

Kynance Cove

GR - SW 68462 13295; 49°58'29"N, 005°13'50"W; W3W - slab.kennels.sway

Kynance Cove is reached via a long path from the car park (*SW 6886 1319,* W3W *broth.financial.tilting)* then down a steep and rocky path to the beach below. It was quite late in the day and the tide was almost up to the cliffs. We walked round the shingle beach to the north to reach an outcrop of dark red and green serpentinite.

Jonathan described how, at a mid-ocean ridge, the faulted nature of the seabed allowed sea water to descend into the crust and into the mantle. The water reacted with the minerals at various depths, changing the peridotite to the hydrated form serpentinite. The sea water also dissolved other minerals and brought them to the surface at up to 200° C through black smokers including simple hydrocarbons - hydrogen and methane.

Where the mineralisation is predominately serpentinisation, the heat generated is not volcanic and the vents, such as at Lost City, produce much higher concentrations of hydrogen, methane and hydrogen sulphide that give rise to organic hydrocarbon molecules. Other minerals may be seen: antigorite, chrysotile (soapy smooth asbestos), lizardite (Figure 32).

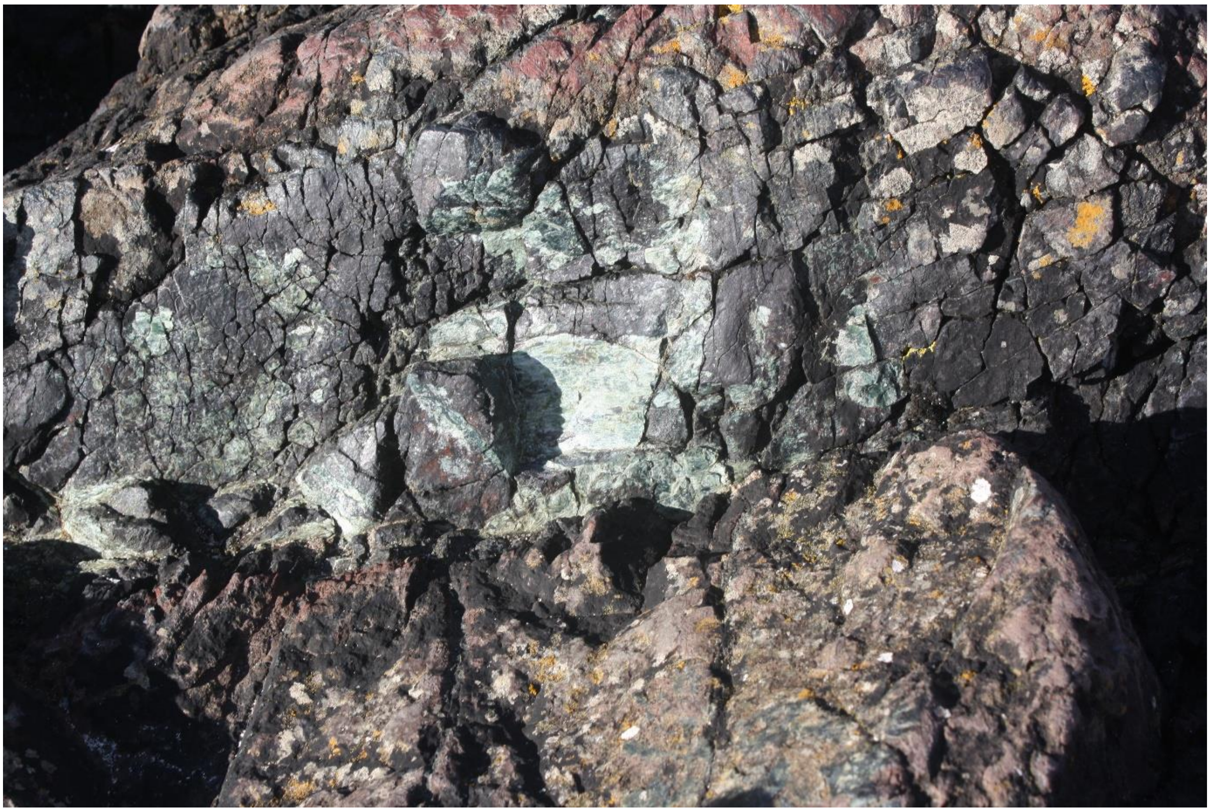

Figure 32 Chrysotile in serpentinite.

As it was getting late in the day we all stopped for the final group photograph - much to the amusement of the audience seated on deckchairs outside the café overlooking the beach. We then made our way back to the steep path to return to the car park.

Figure 33 The RGS at Kynance Cove 2025. Photo curtesy of John Cole.

The fifth day of the trip was the return to Reading for most and an extended stay in sunny Cornwall for others.

Report and photos by Roger York