South Devon GA Field Trip notes

Led by John C.W.Cope

5-7 April 2019

Ray Pratt

Field Notes - Berry Head 6/4/19 PostcodeTQ6 0RG
(Pages 49-52 in the GA Guide)

Regional Background

SW England Devonian differ from the rest of UK, as are the Carboniferous. During Variscan earth movements a whole block of SW England was moved in a WNE direction becoming stuck to the rest of Britain along a major fault line running through the Bristol Channel, through the Isle of White at grey depth and through into the Pey de Brie of France during the Variscan movements. We can make some matches north of the fault, ie in S Wales and North Devon. latitudinal difference, there are broad comparisons of geology. W Smith end of eighteenth century Car - Tertiary. Sedgwick & Murchison, but Devon fossils did not match anywhere else in Britain. Not until Murchison doing fieldwork in Germany recognised that the rocks of Devon were the same as the Eifel region in Belgium. It dawned on him that these rocks were older than the Carboniferous but younger than the Silurian. Together with Sedgwick they proposed the Devonian system in 1839. A few months later James Hall in New York State cane to a similar conclusion.

The rocks here the rocks have been severely disturbed by the Variscan orogeny.
The Cross section of Devon (figure 4) shows a number of basins younging to the north resting on a basement of unknown age. Indirect evidence from S Wales, south of Carmarthen. Here we see a lot of mica in rocks from Cambrian to Devonian. The source must be a mica schist not too far away. Geophysics over Bristol Channel & N Devon indicate a rock such as a quartz mica schist. In The SW peninsula, volcanic rocks have inclusions of metamorphic and igneous rocks that have come from depth. Nothing known in this area of Cambrian, Ordovician or Silurian age. Ordovician fossils in Corwall found in blocks thrust from the South, not in situ. Therefore what we know is that these Devonian rocks rest on an unknown basement probably late Pre Cambrian.

A series of basins developed progressively northwards during Devonian times over SW England, with the oldest basins in the south. Started in south and began to extend northwards. Formed by extension and underlain by listric faults. The faults have acted as conduits for volcanic material. Have had deep water basins interrupted by sea floor volcanic activity. Could have even become sub aerial in some places. Get large accumulations of igneous material on the sea bed within the basinal succession which reduced the depth of water sufficiently for the growth of reef orgainsims. End up with limestones forming on highs.

The Devonian deposits are overlain by Permian then the hole lot compressed by the Variscan event. The deformation occurred from south to north, with the earliest seen in Cornwall early in Carboniferous times. As the basin in S Cornwall becoming compressional, basins to the north were still opening up. In the Central part of Deveoin the oldest rocks are Carboniferous. Not aware of any Devonian rocks below them. These lower carboniferous deposits are deep water cherts with some igneous material, and the upper part is a thick turbidite succession. As the Variscan folds developed to the south the erosive material was deposited into the basins to the north. Succession of events happening from South to North which characterises the Variscan deformation in SW England. Resulted in severe crustal shortening. A lot of the Listric faults became thrusts along which was considerable shortening took place. Distances were at least halved. The tectonic compression has led to the complexity of the geology resulting a long time to unravel the geology of this region, much of which has happened in

the last 65 years. The area has been mapped in great detail by researchers from the University of Exeter. Many of the rocks have been so altered that they are no longer fossiliferous. In many areas a strong cleavage has developed. In the southernmost part of Devon, the Start peninsula, the older geological maps were logged as Pre Cambrian. These are highly metamorphosed mica schists and hornblende mica schists. Today we believe these are Devonian rocks which have simply been buried more deeply, resulting in a higher degree of metamorphism. The later stages of the Variscan orogeny was the intrusion of granites in the area - Dartmoor.

Geologically Devon & Cornwall belong to the Reno Hercynian Zone, which extends into the Rhine land and the Eifel region - extending westwards along the Whiteray fault zone, and stuck onto the rest of Britain during Carboniferous times. The extension goes across Europe, all at the same time

Looking around the coast we see a flat surface all around at the top of the cliffs, all at 200 ft, known as the 200ft platform. Also found in South Wales and Pembrokeshire and Gower. Believed to be a Pliocene Sea Level.

The Brixham High. Tamar Group -, Brixham limestone - Berry Head member formation

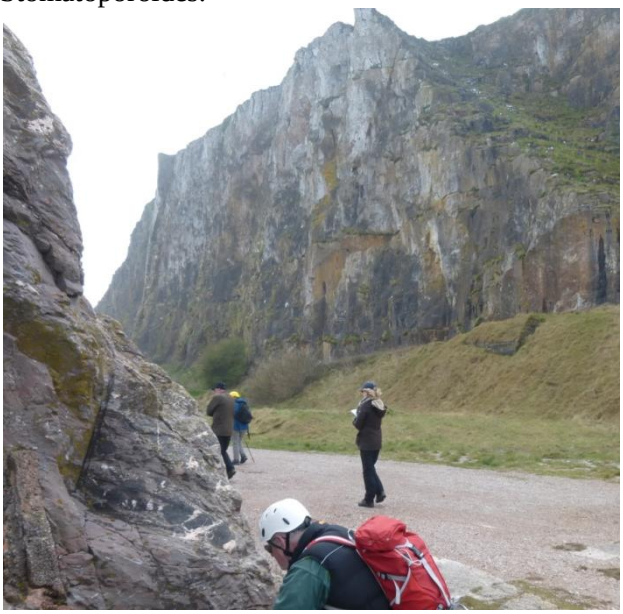
Ashprington Volcanics (Torbay Group) sufficiently reduced water depths in this area for carbonate deposition to take place.

In this area there would presumably have been Carboniferous rocks deposited which, after the Variscan, have been eroded. We have ended up with Permian rocks resting on Devonian. In this quarry we see fissures that have been filled with Permian sediments.

At the top of the quarry is a Napoleonic fort.

To build reefs you need a reef building organisms to grow which then acts as a trap for sediments which builds up the reef. The main reef building organisms here are Stromatoporoids. These display growth bands and well preserved vertical pillars. Very little structure is seen in these. These organisms ceased to be important after the Devonian. Major reef building structures in the Silurian e.g. Wenlock Edge. Related to a modern group of sponges called sclerosponges. Can be found through the Mesozoic, but not as reef builders.

All the white coloured rocks in the exposures are Stomatoporoides.



Associated is Radiaxial Calcite, something that is not found at all in younger sediments. Dont know how this formed. Characteristic of Stomatoporoid reefs.

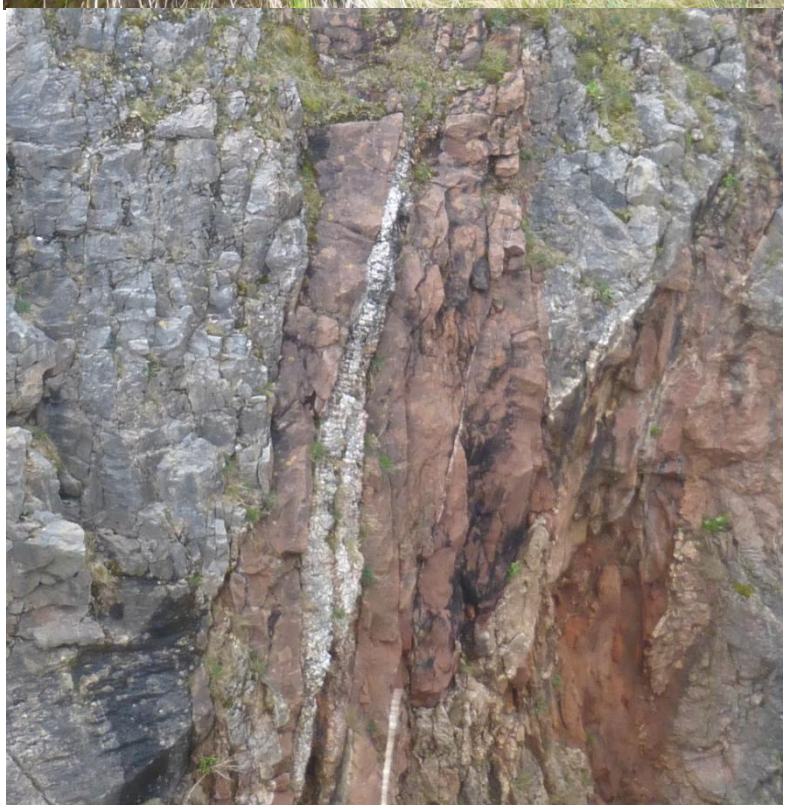
Can also see other fossils, Sometimes reddish shaly interbeds with other fossils such as crinoid stems

The whole area has been severely tectonised. The softer shaly beds take the deformation whereas the more competent beds like this reef can withstand a lot of the deformation, suffering only some recrsytallisation. Therefore see most of the deformation in the shaly beds. The crinoid stems tend to have the ossicles dislocated, strung out en-echelon.

Walking further along the coastal path we see a light pinkish. blue, white, mottled grey floor. This is a metamorphosed limestone (marble) with clay giving the pink colour. Lots of calcite veining throughout

Calcite veins. Below running at right angles to each other. Some bifurcate at acute angles. Seem to be associated with Neptunian dykes

Walked back to the quarry to look at the large scale neptunian dykes filling the fractures in the reef. During Variscan earth movements the area was uplifted and the Carboniferous eroded off. Periodically, this eroded, weathered and karstified surface would become flooded. During these periods the calcite rich waters would enable the veins to develop. John believes the calcite veins began to develop before the Permian sands were introduced (also by water) and that the fissures remained water filled. Given the relationship between the calcite veins and the neptunian dykes this is difficult to envisage and it is probable that the occured simultaneously.



Field Notes Shoalstone Beach 6/4/19 Postcode. TQ5 9AB

(pages 54 & 55 in the GA Guide)

Park in the car park just past the Berry Head hotel on the hill.
Series of neptunian dykes in the area - 2 sets of dykes almost perpendicular to each other..
See figure 34 in the guide. The sandstone dykes are more prominent than the limestones in which they are located. Early Devonian limestones, infilled with Permian (waterborne) sands

No sign of the stromatoporoids in these limestones.

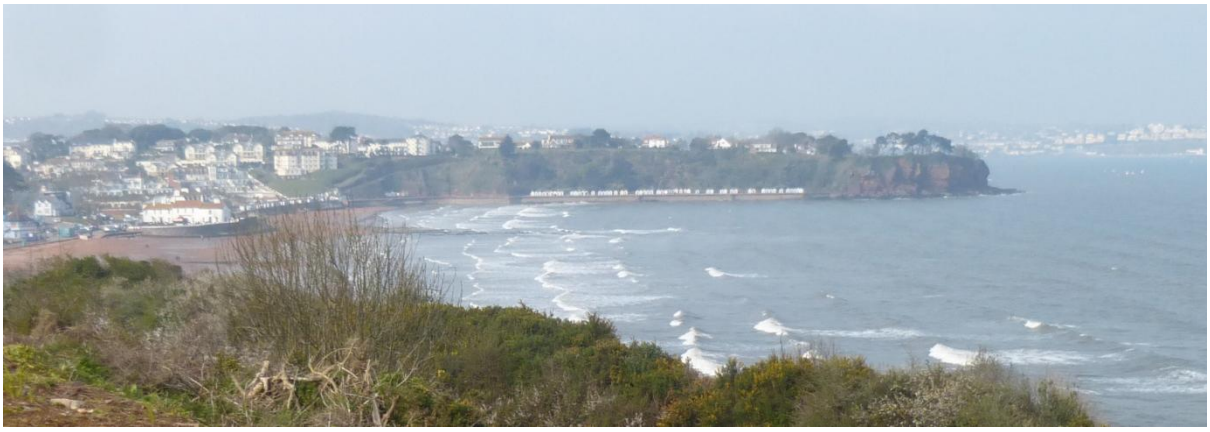
	Red sandstone dykes

	The deep red colour (younger) are finer grained than the lighter red coloured sandstone dykes.

	Series	Stage	Age (Ma)	Group	Formation	Member
Devonian	Upper	Famennian	358.9	Torbay	Saltern Cove	
			372.2			
		Frasnian				
			382.7	Tamar	Brixham	
	Middle	Givetian				Churchstone
			387.7			St. Marys Bay
		Eifelian				Sharham Point
			393.3			Basic tuff & Basalt
	Lower	Emsian				
			407.6	Meadfoot	Staddon	
		Pragian			Bovisand	
			410.8			
		Lochovinian		Dartmouth		
			419.2			

Field Notes Goodrington Beach 6/4/19 Postcode. TQ4 6LN

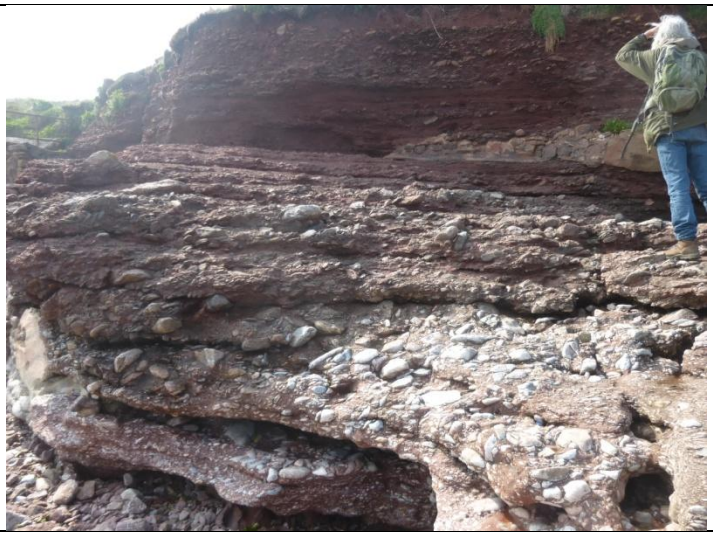
(pages 46 & 47 in the GA Guide)



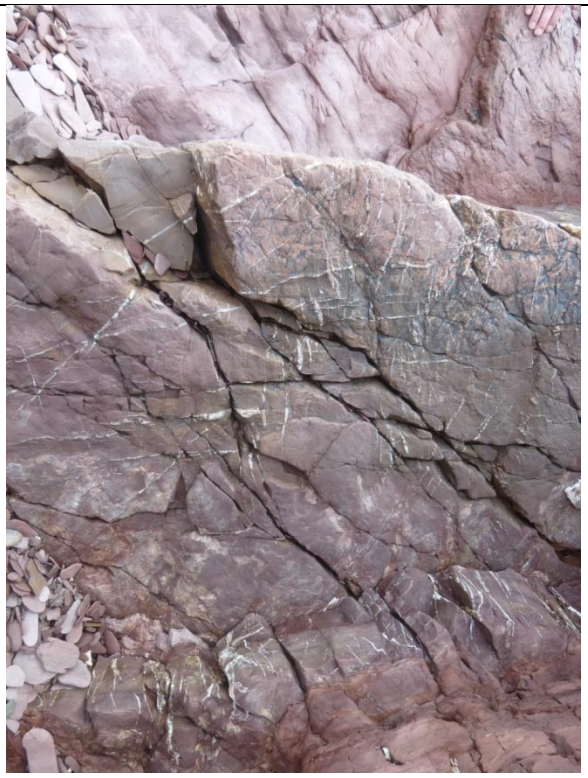
Park in the car on left (not on beach) if longer than 3 hours is desired.. Head to the west side of the beach

Looking at the Basal Permian, The Tor Bay Breccia Formantion. Deposited by flash floods over a desert floor.

	Clast supported breccia with a red sand matrix sediment. In the area find some Devonian rocks in the breccia with fossils such as corals.

	Imbrications of the boulders is clearly identifiable

	Angular unconformity
	Synform fold with its axis shown by the hammer. Tightly packed Isoclinal fold to the left. Cleavage is parallel to the axial plain of the fold and more of less parallel to bedding.



Competent rock fracture during folding. The maximum tension is going to be in the hinge. Quartz veins enter the fractures. At the hinge the veins are subvertical to the surface of the fold hinge, however on the inner part of the fold where there is compression there are no veins

Moving westwards along the beach we find some steeply inclined fissile beds some showing current bedding. Further west we have a fault

Moving west we saw that the westerly Meadfoot beds are not as deformed as seen earlier where we saw the Permian overlying the Saltern Cove Formation (separated from the Meadfoot group by a fault). The intense folding is associated with the faulting.

Looking over Torbay that is where the Torquay high is, where another Limestone reef developed (to the north). Today we are looking at only 1/2 the distance that was original at time of deposition

Walk further westwards to where a set of stairs can be seen leading up the cliff goving access to the beach.

On the east side of this cove we see an Angular unconformity and a low angle fault. Torbay Breccia Formation overlying the Meadfoot group

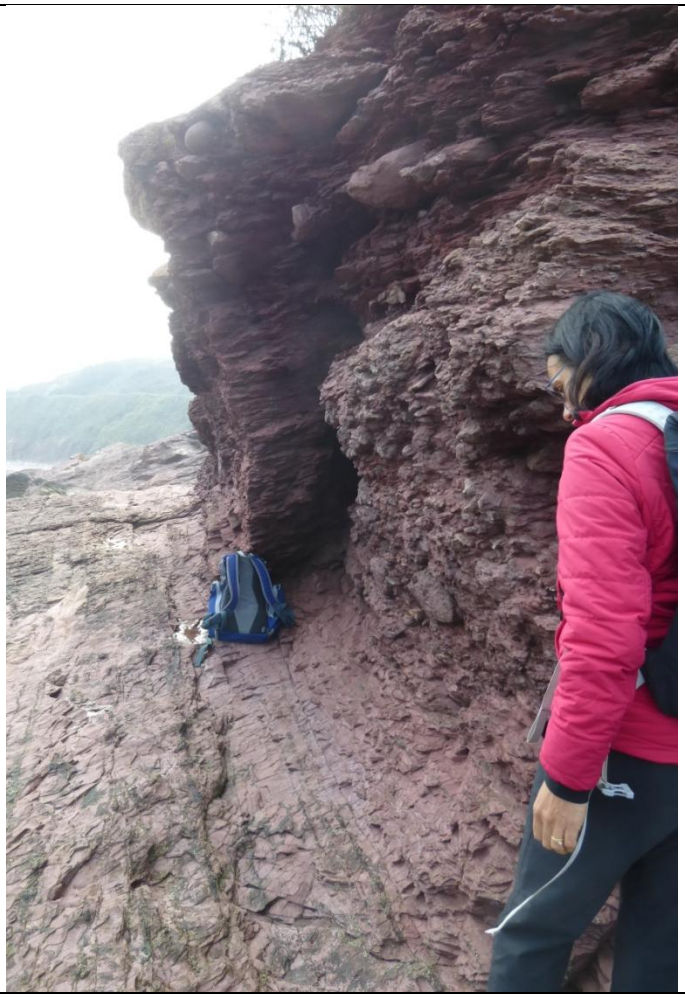
Only find trace fossils in the Permian rocks due to the high oxidisation environment which even destroyed the highly resilient plant spores. We have to rely on palaeomagnetic dating techniques backed up with radiometric dating. In these rocks we have natural remnant magnetism. The iron coated grains orientated themselves to the magnetic pole at the time of deposition. Able to reconcile these red to particular beds Permian marine stages using paleomagnetic data.

There is a considerable thickness of red beds in East Devon as we progress upwards through the Permian into the overlying Triassic. Traditionally the boundary was placed at the Budley Saltstone Pebble Beds, which the paleaomagnetic data has substantiated. It has also shown that there is a big time gap of at least 10mm years below the pebble beds, showing that the succession of red beds was incomplete.

Fossils have been found on this foreshore (rare). This informs us that bedding and cleavage are the same (co-incident) otherwise the fossils would have been destroyed.

The Meedfoot group are marine. The colouration may have resulted in staining from the overlying Permian deposits.

Moving to the west (left) side of the beach the question is what are we looking at and do we see any bedding. This is a challenge as the cleavage is the dominant fabric. Walking past the stairs we cross a fault into the Saltern Cove Formation. This is on the downthrown side of the fault. Here the dominant fabric seen is cleavage.



Move to the promontory at the end of the cliff we become parallel to cleavage. Vertical cleavage dictates the fabric. The boulders we see are limestone beds which have been elongated and deformed.

	Series	Stage	Age (Ma)	Group	Formation	Member
Devonian	Upper	Famennian	358.9	Torbay	Saltern Cove	
			372.2			
		Frasnian				
			382.7	Tamar	Brixham	
	Middle	Givetian				Churchstone
			387.7			St. Marys Bay
		Eifelian				Sharham Point
			393.3			Basic tuff & Basalt
	Lower	Emsian				
			407.6	Meadfoot	Staddon	
		Pragian			Bovisand	
			410.8			
		Lochovinian		Dartmouth		
			419.2			

Saltern Cove Formation

Computer Code:	SACO	Preferred Map Code:	Not Entered
Status Code:	Pending Upgrade		
Age range:	Frasnian Age (DR) — Famennian Age (DA)		
Lithological Description:	*none recorded or not applicable*		
Definition of Lower Boundary:	*none recorded or not applicable*		
Definition of Upper Boundary:	*none recorded or not applicable*		
Thickness:	*none recorded or not applicable*		
Geographical Limits:	*none recorded or not applicable*		
Parent Unit:	Torbay Group (TBAY)		

Torbay Breccia Formation

Computer Code:	TOBR	Preferred Map Code:	notEntered
Status Code:	Pending Upgrade		
Age range:	Cisuralian Epoch (PLC) — Cisuralian Epoch (PLC)		
Lithological Description:	*none recorded or not applicable*		
Definition of Lower Boundary:	*none recorded or not applicable*		
Definition of Upper Boundary:	*none recorded or not applicable*		
Thickness:	*none recorded or not applicable*		
Geographical Limits:	*none recorded or not applicable*		

Parent Unit:	Exeter Group (EXE)
Previous Name(s):	Torre Breccia Formation (-2492)

Field Notes Blackpool Beach 7/4/19 Postcode. TQ6 0RG

Shingle on the beach covers a submerged forest of around 6000 years old. Several other places along this coast also have submerged forests e.g. Goodrington, and all around the Bristol channel coast (Swansea Bay).

Currently south of the Brixham high in the Looe Basin, **Dartmouth Group**. (early Devonian) Antiformal fold hinge, Rocks clearly strongly cleaved. Low grade metamorphis - Phyllites. Bedding planes slipped & polished with mica growth and alignment.

Circa 20 years ago the road above collapsed as the underlying rocks slipped. Currently the cleavage dips seawards making them prone to slippage. Need to install rock anchors. Piled vertical holes with rock bolts. Move the road inland. Whole area at risk as the rocks goes inland for a half a mile or so.

At the car park end of the beach the rocks are silvery in colour whereas at the east end of the beach there is a lot or red colouration, most probably staining from the red soils above.

The cliff face show the phyllites with their fabric steeply dipping. In the middle of the cliff face is a blocky mass of sandy material. This is a boudan. during the compression the sand bed has been squeezed into a blob.

These micro folds cut across the cleavage, perpendicular to the cleavage planes indicating a second period of deformation

	Series	Stage	Age (Ma)	Group	Formation	Member
Devonian	Upper	Famennian	358.9	Torbay	Saltern Cove	
			372.2			
		Frasnian				
			382.7	Tamar	Brixham	
	Middle	Givetian				Churchstone
			387.7			St. Marys Bay
		Eifelian				Sharham Point
			393.3			Basic tuff & Basalt
	Lower	Emsian				
			407.6	Meadfoot	Staddon	
		Pragian			Bovisand	
			410.8			
		Lochovinian		Dartmouth		
			419.2			

	Series	Stage	Age (Ma)	Group	Formation	Member
Devonian	Upper	Famennian	358.9	Torbay	Saltern Cove	
			372.2			
		Frasnian				
			382.7	Tamar	Brixham	
	Middle	Givetian				Churchstone
			387.7			St. Marys Bay
		Eifelian				Sharham Point
			393.3			Basic tuff & Basalt
	Lower	Emsian				
			407.6	Meadfoot	Staddon	
		Pragian			Bovisand	
			410.8			
		Lochovinian		Dartmouth		
			419.2			

Brixham Limestone Formation

Computer Code:	BRXL	Preferred Map Code:	notEntered
Status Code:	Pending Upgrade		
Age range:	Eifelian Age (DI) — Frasnian Age (DR)		
Lithological Description:	*none recorded or not applicable*		
Definition of Lower Boundary:	*none recorded or not applicable*		
Definition of Upper Boundary:	*none recorded or not applicable*		
Thickness:	*none recorded or not applicable*		
Geographical Limits:	*none recorded or not applicable*		
Parent Unit:	Torbay Group (TBAY)		
Previous	Brixham Limestone (-3876)		

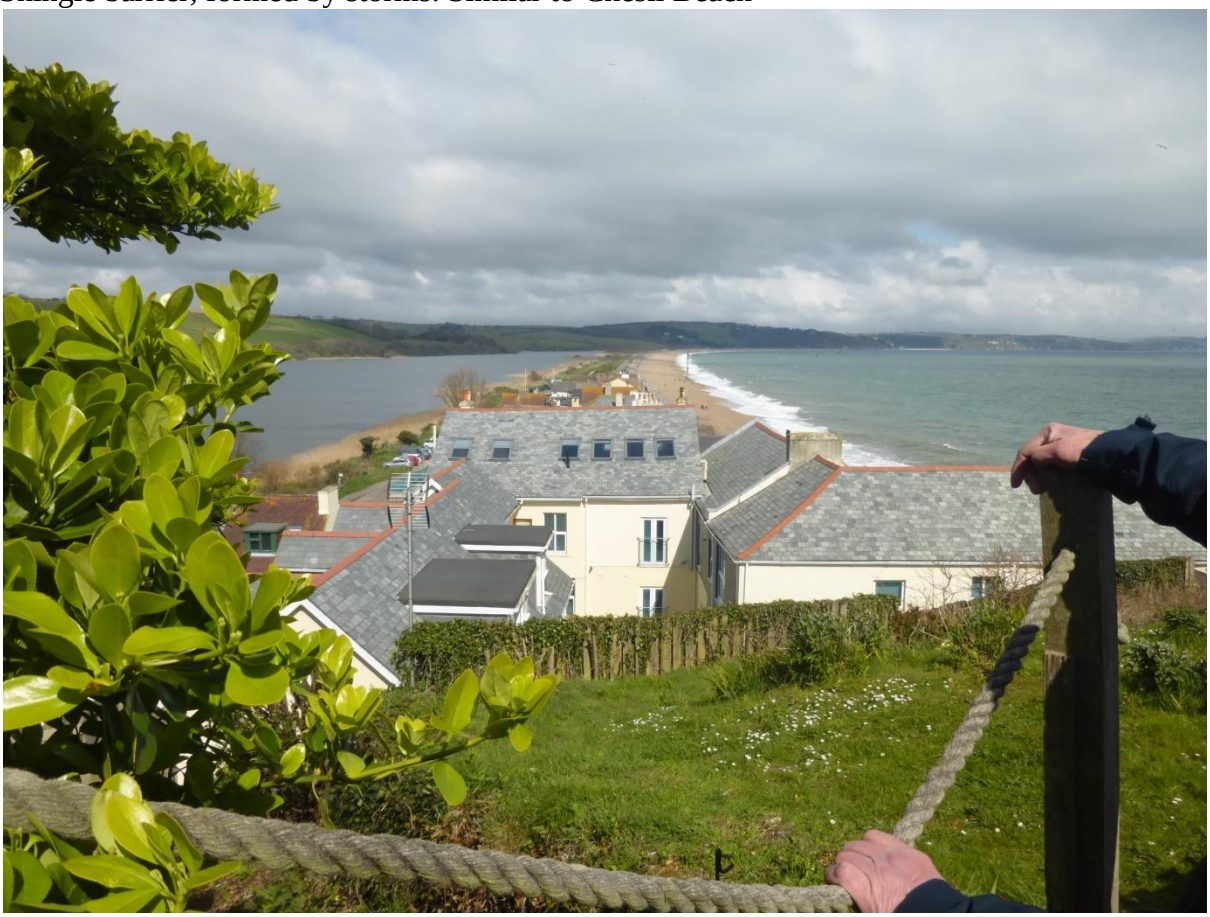
Name(s):	

Ashprington Volcanic Formation

Computer Code:	AVS	Preferred Map Code:	notEntered
Status Code:	Pending Upgrade		
Age range:	Eifelian Age (DI) — Frasnian Age (DR)		
Lithological Description:	*none recorded or not applicable*		
Definition of Lower Boundary:	*none recorded or not applicable*		
Definition of Upper Boundary:	*none recorded or not applicable*		
Thickness:	*none recorded or not applicable*		
Geographical Limits:	*none recorded or not applicable*		
Parent Unit:	Torbay Group (TBAY)		

Field Notes Torcross 7/4/19

Slapton Sands
Shingle barrier, formed by storms. Similar to Chesil Beach



At west end of Slapton Sands follow the cliff path, walk up stairs then down into the cove beyond

Meadford Group. Rocks are Phyillites, brown grey, silver. bedding parallel to cleavage, dipping into cliff face, stable, lots of quartz veining.

Compositional differences.
Paler sandy beds where we see the cleavage (parallel to bedding in the shaly beds) being refracted across the sandy beds cutting the bedding i.e. at an angle to the bedding

Just looking at it the initial thought is that it is cross bedding but there is a realignment of clays across the sand unit.

The cleavage is parallel to the axial plane of folding.

	Photograph of the cliff fold axis almost isoclinal cleavage is parallel to the fold axis The dark layers are the original bedding, cleavage is horizontal

.

	Light coloured grey brown.rock is a dolerite intrusion (Dyke or sill) that has been altered. The pyroxenes have broken down to clays such as sericite. Looks nothing like an igneous rock. Scratches easily.

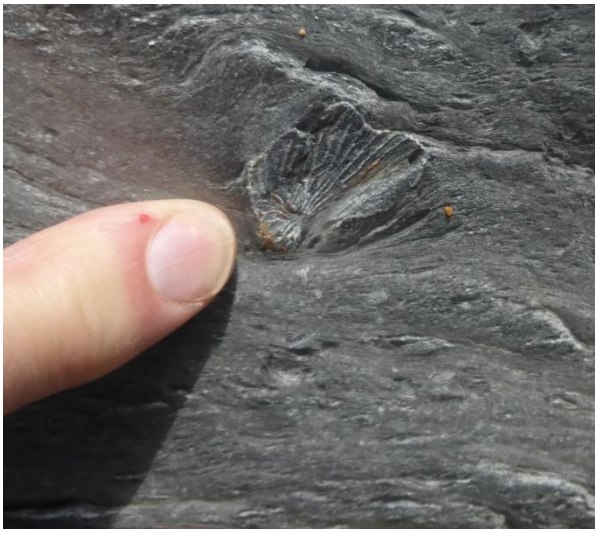
	Looks laminated, and wavy indicating subjected to stresses, Full of quartz veins. Mico wavy in the basalt also a big fold.
	Dark rock a meta turbidite. Dark red colours are oxidised pyrite Brown layers of sericite in the altered dolerite

Where the cleavage planes intersect the bedding planes on these surfaces they form crude lineation's across the rock where they intersect we see the dip of the axial plane of the fold.

	Secondary folding. Darker rock grains aligned as a result of sliding, but not so the lighter which are more resistant. The axis of the folds similar to the deflected cleavage in the sandy beds. Boudinage effect. See same in these mini folds, the lighter material being sandy. The sands fold and the clays slide.

	Igneous doleritic dyke, very light grey in colour intruding into meta sammites and pelites. (John Cope calls these slates, but is that correct?). Dyke is cut by a number of quartz veins. Can see phenocryts of altered feldspar in the rock, all aligned. Contact between dyke and country rock. (Unable to identify a chilled margin nor a baked margin).
	Honeycomb weathering of the doleritic intrusion

Meadford Group marine - selection of fossils survived where cleavage parallel to bedding



	Series	Stage	Age (Ma)	Group	Formation	Member
Devonian	Upper	Famennian	358.9	Torbay	Saltern Cove	
			372.2			
		Frasnian				
			382.7	Tamar	Brixham	
	Middle	Givetian				Churchstone
			387.7			St. Marys Bay
		Eifelian				Sharham Point
			393.3			Basic tuff & Basalt
	Lower	Emsian				
			407.6	Meadfoot	Staddon	
		Pragian			Bovisand	
			410.8			
		Lochovinian		Dartmouth		
			419.2			

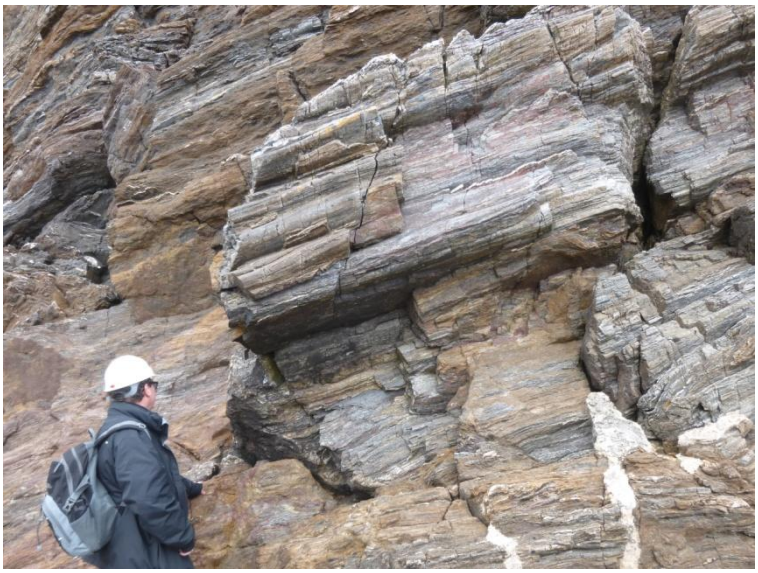
Field Notes - Hope Cove 7/4/19 PostcodeTQ7 3HQ

Park in car park at Outer Hope and walk through village to beach by the harbour masters hut, then down into Hope Cove.

Start metamorphic complex. On old maps marked as Pre Cambrian, now believed to be Devonian in age, highly metamorphosed because of deeper burial than as seen in the phyllites of the Looe basin to the north. Observe several phases of folding.

*Note the fold hinges.

The lineation visible is the bedding cleavage intersection here is exactly as the plunge of the fold. Once identified can say all these folds are pitching in a certain direction.



Look further into this we can see that some of the folds have another series coming across them almost at right angles.. These are a second generation of folds. 2 generations of fold nearly at 90 degrees to each other

.

Initial fold from top to bottom produces an isocline fold. If the major compression then switches left to right then the isocline becomes warped as a new series of folds is superimposed onto the fabric as shown in this sketch in the sand. Workers on these rocks have determined that there have been 5 episodes of folding during the Variscan, each with its own recognisable fabric.	

Colouration partially due to constituents in the rocks and subsequent staining during the Permian. Iron staining along fractures very evident.

Walk back through village and down onto the beach in front of the car park and walked right into the adjoining cove **(Victory Bay)**

Look at junction between the Start Group and the Dartmouth Group *
Major fault zone with associated quartz veining. Major fault zone of hundreds of meters. Faulting of incompetent shaly rich rocks against the metamorphic rocks results in the stresses being taken up by the shales, lots of shearing with lots of quart. Thick fault zone of disturbed material. Red staining from the oxidation of the pyrite in the shales known as pressure solution cleavage.
The quartz veining is extensive indicating huge stresses and effects. The quartz veins are running NE and the fault zone is reportedly EW. Fault not seen

Cleavage is the prevailing fabric, difficult to find the bedding. Relying on compositional differences to do this. Have to look hard. These two photos indicate that the bedding is near vertical. (as they were taken on rocks exposed on the beach)	
	

* The BGS Map shows the rocks in this are to be those of the Meadfoot Group

Picture below appears to show a sharp boundary between the black metamorphosed shales with lots of quartz veins and a lighter coloured rock. However, they are reportedly the same and vary only in composition which has allowed the lighter colour to develop.

	Series	Stage	Age (Ma)	Group	Formation	Member
Devonian	Upper	Famennian	358.9	Torbay	Saltern Cove	
			372.2			
		Frasnian				
			382.7	Tamar	Brixham	
	Middle	Givetian				Churchstone
			387.7			St. Marys Bay
		Eifelian				Sharham Point
			393.3			Basic tuff & Basalt
	Lower	Emsian				
			407.6	Meadfoot	Staddon	
		Pragian			Bovisand	
			410.8			
		Lochovinian		Dartmouth		
			419.2			

Dartmouth Group

Computer Code:	DRTM	Preferred Map Code:	Drtm
Status Code:	Full		
Age range:	Lochkovian Age (DO) — Pragian Age (DP)		
Lithological Description:	In the Plymouth region, the Dartmouth Group is divided into the Whitsand Bay Formation and the Bin Down Formation; this is an intercalation towards the top of the Whitsand Bay Formation. The Whitsand Bay Formation comprises reddish purple mudstone and silty mudstone (beds commonly up to 2m thick), green silty mudstone to muddy siltstone (with bedding units of between 5 to 10m thick), green to mauve siltstone (in massive beds up to 6m thick that are predominantly structureless but have local lenses and laminae), grey-green with some purple sandstone (beds up to 0.8m thick with local conglomerate above erosional bases) and off-white to pale green quartzite (isolated beds up to 0.5m thick, with some grading and low-angle cross lamination). The Bin Down Formation includes grey to dark grey cleaved mudstone, grey siltstone (laminated in place) and pale grey quartzitic sandstone. Interbedded with these sedimentary rocks are basaltic lavas and volcaniclastic beds including tuff and hyaloclastite.		
Definition of Lower Boundary:	This is a thrust-fault contact; this unit forms the hanging walls of two thrusts to the west of the Cawsand Fault. The thrusts are dextrally displaced by the Portnadler, Portwrinkle and Rame Faults, and place the Dartmouth Group on top of the Bovisand Formation of the Meadfoot Group. In the field, the lower boundary of the Dartmouth Group is distinguished by an abrupt transition from grey slaty mudstone with thin interbeds of grey-green siltstone and fine-grained sandstone of the Meadfoot Group at the fault plane, up into reddish purple mudstone and green silty mudstone to muddy siltstone of the Dartmouth Group.		
Definition of Upper Boundary:	This is a transitional boundary with the overlying Bovisand Formation of the Meadfoot Group. The contact is seen at Tregantle Cliffs [SX 388 526], where the uppermost strata of the Whitsand Bay Formation of the Dartmouth Group comprise interbedded red and green slaty mudstone with sporadic thin quartzose sandstone beds and grey slaty mudstone; this sequence is succeeded by rocks of the overlying Bovisand Formation, which comprise bioturbated grey mudstone with sandstone laminae, thin beds and load casts and black phosphatic nodules. Near Oldhouse Cove [SX 367 536] the contact is expressed as an upward passage into grey slaty mudstone with thin interbeds of grey-green siltstone and fine sands		

Meadfoot Group

Computer Code:	MDT	Preferred Map Code:	Mdt
Status Code:	Full		
Age range:	Pragian Age (DP) — Emsian Age (DE)		
Lithological	Dark shales and siltstones with sporadic grey-brown sandstones and beds of		

Description:	decalcified shell debris. Upper part exhibits red coloration in places.
Definition of Lower Boundary:	Drawn at base of Meadfoot Group where it rests conformably on non-marine or brackish water deposits called Dartmouth Beds.
Definition of Upper Boundary:	Drawn at conformable upward passage from commonly reddened sandstone of Meadfoot Group to sandstones and shales of the Staddon Grits.
Thickness:	Not known.
Geographical Limits:	South-west England.
Parent Unit:	Not Applicable (-)
Previous Name(s):	MEADFOOT BEDS MEADFOOT GRITS (MDT) MEADFOOT SERIES
Alternative Name(s):	MEADFOOT GROUP.