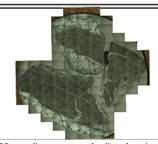
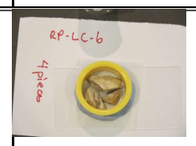
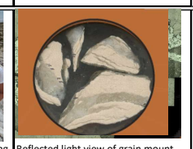
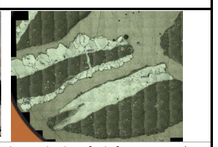
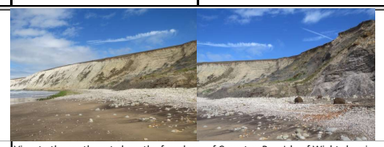
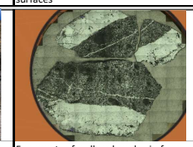
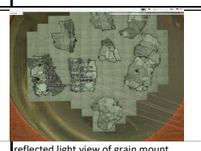
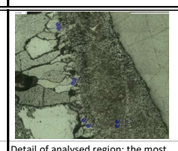
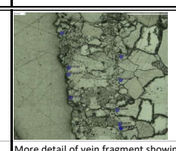
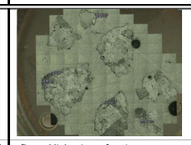
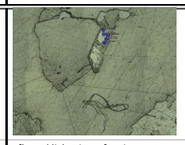
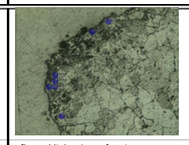
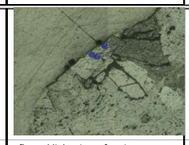
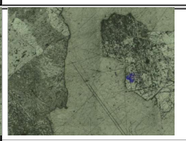
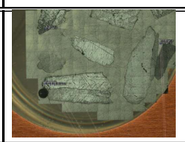
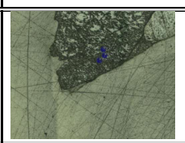
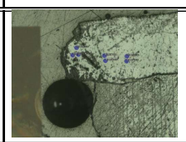
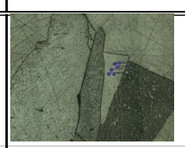
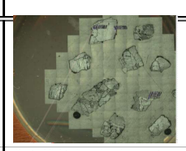
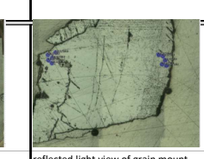
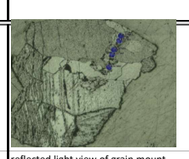
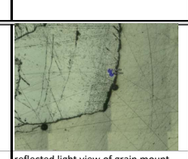
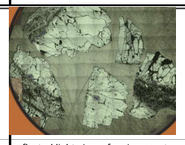
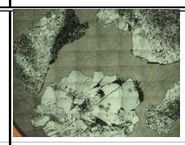
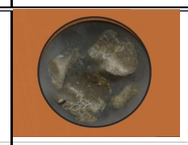
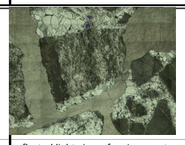
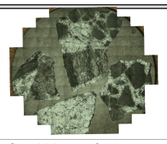
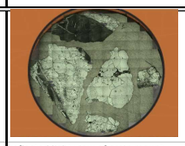
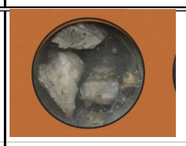
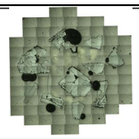
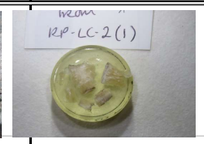
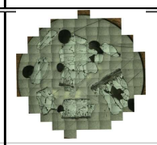
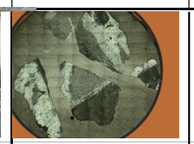
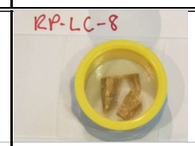
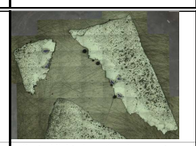
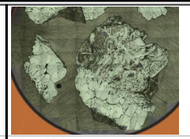
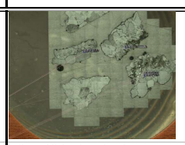
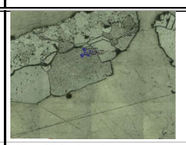
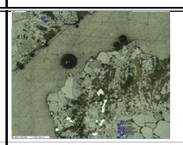
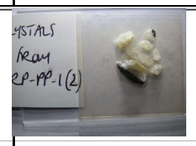
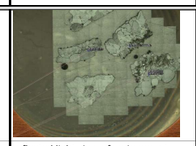
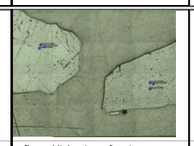
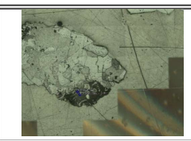
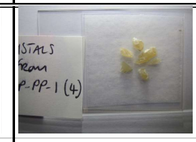
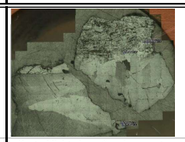
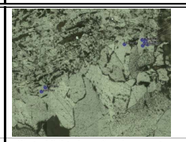
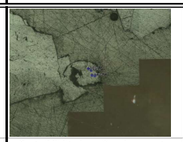
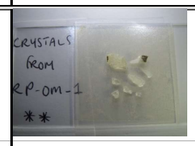
Supplemental Appendix 2: *Outcrop, sample, structural data, and vein and microscopic descriptions*

Sample # & Age (Ma)	GPS coord.	Stratigraphic Unit	Wall rock lithology	Structural Info/Orient'n	Vein information	U-Pb Analysis spatial information	Photograph #1	Photograph #2	Photograph #3	Photograph #4	Photograph #5	Photograph #6	Photograph #7
DD-5	50 37.337 N, 2 16.	Lowermost Chalk less than 10m above Greensand	Grey to white thick bedded Chalk	Chalk dip steeply northwards, strikes ~E-W and has notable fracture cleavage dipping ~50S axial planar to monocline; there are some discreet faults within Chalk	Veins are along fracture cleavage planes but also in networks of fractures within this zone; crystals grow from wall to interior of veins and some are vuggy and some veins are decorated with slickensides								
							East view; vertical bedding in lowermost chalk with S-dipping marked fracture cleavage making a network of fractures	East view; low angle post-cleavage fault with breccia	network of fractures made by cleavage and bedding fracturing; view to east	vein in fill within frcture network	veins within fracture network		
LC-3(1,2,3) Subsamples 1,2, and 3 are from the same place but from different veins; 3(3) has no slickensides associated	50° 37.157'W 2° 14	Lowermost Chalk less than 20m above Greensand	Grey to white thick bedded Chalk	Chalk dip steeply northwards, strikes ~E-W and has notable fracture cleavage dipping ~50S axial planar to monocline;	Veins are along fracture cleavage planes but also in networks of fractures within this zone; crystals grow from wall to interior of veins and some are vuggy and some veins are decorated with slickensides indicating movement after vein formation								
							View to west showing N-dipping bedding in Chalk with fractures that are steeper and which form a network of fractures/bedding cracks	Vein on outcrop surface showing its irregular shape and chalk amongst fractures	Vuggy vein along somewhat irregular fracture	Slickensides developed within fracture in Chalk	Fractured chalk with steeply dipping fracture decorated with vuggy cream-coloured vein	Vuggy vein within fracture in Chalk	25mm diamter sample disc showing textures in veins against Chalk
LC-4(2)	50° 37.157'W 2° 14	Lowermost Chalk less than 20m above Greensand	Grey to white thick bedded Chalk	Chalk dip steeply northwards, strikes ~E-W and has notable fracture cleavage dipping ~50S axial planar to monocline;	Veins are along fracture cleavage planes but also in networks of fractures within this zone; crystals grow from wall to interior of veins and some are vuggy and some veins are decorated with slickensides indicating movement after vein formation		see above as these types of fractures are common to this locality at the same GPS						
LC-5(1,2)	50° 37.157'W 2° 14.294'N	Lowermost Chalk less than 20m above Greensand	Grey to white thick bedded Chalk	Chalk dip steeply northwards, strikes ~E-W and has notable fracture cleavage dipping ~50S axial planar to monocline;	Veins are along fracture cleavage planes but also in networks of fractures within this zone; crystals grow from wall to interior of veins and some are vuggy and some veins are decorated with slickensides indicating movement after vein formation		see above as these types of fractures are common to this locality at the same GPS						
LC-6	50° 37.166'W 2° 14.893'N	Lower Chalk	Grey to white thick bedded Chalk	Chalk dip steeply northwards, strikes ~E-W and has notable fracturs with some development of slickensides	Veins are along fracture cleavage planes but also in networks of fractures within this zone; crystals grow from wall to interior of veins and some are vuggy and some veins are decorated with slickensides indicating movement after vein formation								
							vein with vuggy texture	photograph of chalk with network of veins, looking N	slickensides on surface of chalk	detail			
SB-2	50o 39.935'N 1o 6.467'W	Lowermost Chalk less than 30m above Greensand	Grey to white thick bedded Chalk; thickly bedded, massive and devoid of flint nodules	Chalk dips 110/55N steeply north, has notable fracture cleavage dipping ~50S axial planar to monocline; slickensides' trend/plunge 210 / 25-30;	Veins are along fracture cleavage planes but also in networks of fractures within this zone; SB-2 consists of 3 fragments each is like a tapered slickensided fragment, quite thin and tapering to near zero thickness. Each is effectively a vein within a sheared slickensided zone. Internally each has an asymmetric sheared fabric with thin sub-veins of vein as well as thin Chalk layers. Veins are colourless glassy crystals but there could be new slickenfibre growth.								
							View to west of lower thick bedded chalk just above Greensand showing N dip and some S-dipping fractures	Outcrop view of thick bedded chalk	thin veins of calcite with some slickensides plastered across outcrop; view to North	Close up view of thin vein with some slickensides	View to east showing N dipping bedding and both steep and more shallowly dipping fractures, all decorated with veins with slick's	Reflected light view of grain mount	
SB-3(1)	50o 39.943'N 1o 6.621'W	Lowermost Chalk less than 30m above Greensand	Grey to white thick bedded Chalk; thickly bedded, massive and devoid of flint nodules	Strike and dip of bedding ; 110 / 55-60 N; Fracture cleavage strike and dip : 140 / 30 SW; Slickenside trend and plunge : 170 / 25; This sample is of impressive 1 cm thick veins that have an assymetric step-like fabric induced probably by shear developing these complex slickensides	Initially a thicker vein of calcite 0.5 – 1cm thick formed along a fracture cleavage plane. This vein is then sheared within a wider zone. Samples collected have a bottom surface of Chalk with stepped streaked slickensides. Adjacent to this and on the top of the samples are thick coarser veins of calcite so the veins are several mm and the grain size is up to 2mm. These thicker veins have a micro stepped appearance apparently produced by extensional fracturing of the coarser vein with infill calcite between these extensional fractures. There also appears to be shear band type development within the coarser vein which produces asymmetric fine grained new calcite growth. In my opinion the shear sense of both the top and the bottom are consistent. These samples have several generations of vein calcite growth.	Analyses are partly on the main part of veins and partly within the assymetric slickenfibres; it is not clear whether fibres are neoblastic or rotated pre-existing vein crystals							
							West view of lowermost Chalk, thick bedded, dipping north	View to north of plane of fracture cleavage with vein plastered upon this fracture surface	Step-like slickensides, view to N on fracture cleavage surface	fracture surface with slickensides	Step-like slickensides, view to N on fracture cleavage surface	Step-like slickensides, view to N on fracture cleavage surface	Step-like slickensides, view to N on fracture cleavage surface

Sample # & Age (Ma)	GPS coord.	Stratigraphic Unit	Wall rock lithology	Structural Info/Orient'n	Vein information	U-Pb Analysis spatial information	Photograph #1	Photograph #2	Photograph #3	Photograph #4	Photograph #5	Photograph #6	Photograph #7
CB-3	50o 40.064'N 1o 29.346'W	Lowermost Chalk	Thick bedded medium grey chalk without flint nodules	bedding 080/40N; fracture cleavage is 040/60SE; slickensides plunge south	fractures have veins of calcite many of which are vuggy; most fractures relate in origin to fracture cleavage or form in networks of fractures made by intersections of fracture cleavage and bedding								
							East view of lowermost Chalk with Needles peninsula in backgroud,		thin calcite seam developed on fracture cleavage surface	network of irregular and in part sheared veins, looking north	view of obliquely exposed vein with slickensides indicating shear following formation	network of irregular and in part sheared veins, looking north	microscopic view of vein fragments, partly showing vugs growing away from the wall rock Chalk
CB-4(2)	50o 40.071'N 1o 29.389'W	Lowermost Chalk	Thick bedded medium grey chalk without flint nodules	bedding 080/40N; fracture cleavage is 040/60SE; slickensides plunge south	This sample consists of the originally planar veins but now have well developed slickensides. Some of these veins were originally up to 4mm thick fracture fills but due to shear are thinner and variable thickness; it is unclear as to whether there is any new calcite growth.								
							Veins with slickensides	Eastward view showing N dipping Chalk with very well developed S-dipping fracture cleavage	Thin cross sections of slickensided plates showing vein crystals that have been truncated by slip or shearing on microfault surfaces				
CB-2	50o 40.006'N 1o 29.052'W	Upper Greensand	Grey limey calcareous sandstone with detrital fragments of fine grain sand and silt sizes		Greensand with fractures was not observed along foreshore but this is a sample from a larger fallen boulder from Greensand cliffs that contains a planar sharp walled calcite fracture 3mm thick. The vein has sharp planar wall contact, with very thin milky initial deposit that grades sharply into transparent/clear glassy calcite with grain size 1-3mm.								
							View to the northwest along the foreshore of Compton Bay, Isle of Wight showing Chalk on left, dipping ~50-60 degrees to the north and in the right hand photo, Weald and Greensand dipping less steeply.		Fragments of wall rock and vein from sample CB-2, showing some of the locations of spots analysed. Reflected light view.	Plain view of vein fragments analysed by U-Pb; note the laminations and texture of the veins.			
DD-1	50o 37.285N, 2o 16.561 W	Purbeck Limestone	Limestone bed 0.5m thick in upper 5m of Purbeck within a shaley-limestone succession	Purbeck bedding is vertical and east-striking on N limb of Purbeck monoclime; vein is nearly horizontal and is lensoid in shape, 0.3-1cm thick in the upper part of the bed as a clean calcite filled fracture.	vein is nearly horizontal and is lensoid in shape, 0.3-1cm thick in the upper part of the bed as a clean calcite filled fracture. The vein only penetrates part of the bed								
							View to east of bed of indurated limestone between shaley layers; vein is 2/3 towards top of photo	Vein within bed; not its flat orientation, orthogonal to bedding	Detail of vein	reflected light view of grain mount	Detail of analysed region; the most favourable retions were close to wall of vein where U is higher.	More detail of vein fragment showing spots analysed.	
DD-2	50o 37.285N, 2o 16.561 W	Purbeck Limestone	Limestone bed 0.5m thick in upper 5m of Purbeck within a shaley-limestone succession	Purbeck bedding is vertical and east-striking on N limb of Purbeck monoclime; veins are nearly horizontal and	The veins are a quasi-parallel anastomosing network, thin and some lens like. They give the appearance of the rock being shattered. The veins are up to 6 – 7 mm thick. They taper in thickness over distances of 5 – 20cm to zero cm.								
							Vertical bed with orthogonal network of shattering filled with calcite; looking east; vertical limb of fold	Vertical bed with orthogonal network of shattering filled with calcite, detail	reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount
DD-3	50o 37.285N, 2o 16.561 W	Purbeck Limestone	Limestone bed 0.5m thick in upper 5m of Purbeck within a shaley-limestone succession	Purbeck bedding is vertical and east-striking on N limb of Purbeck monoclime; vein is from a loose boulder of the same rocks and is about 1cm thick									
							reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount			
DD-4	50o 37.285N, 2o 16.561 W	Purbeck Limestone	Limestone bed 0.5m thick in upper 5m of Purbeck within a shaley-limestone succession	Purbeck bedding is vertical and east-striking on N limb of Purbeck monoclime; vein is nearly horizontal and is lensoid in shape, 0.3-1cm thick in the upper part of the bed as a clean calcite filled fracture.	thin in situ vein (orthogonal) from a 1m thick limestone layer in Purbeck beds								
							Vertical bed with orthogonal calcite filled vein in fracture; looking east; vertical limb of fold; looking east		reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount	
MoW-1	50° 37.206'W 1° 16.485'N	Purbeck beds	limestone layer adjacent shaley organic bed with woody? Debris	vein strike/dip 190/80E	Near the top of the Purbeck beds at the west end of Man o' War Bay just near bottom of steps. Ribs of Purbeck here have some fractures and there is a zoned vein that cross-cuts a layer containing woody organic black fragments. Vein texture shows several zones of growth.								

Sample # & Age (Ma)	GPS coord.	Stratigraphic Unit	Wall rock lithology	Structural Info/Orient'n	Vein information	U-Pb Analysis spatial information	Photograph #1	Photograph #2	Photograph #3	Photograph #4	Photograph #5	Photograph #6	Photograph #7
							Looking south at vertically dipping rib of Purbeck with vertical fracture cutting across the bed.	Looking south at vertically dipping rib of Purbeck with vertical fracture cutting across the bed.	Detail of vein showing compositional variation		grain mount fragments	reflected light view of grain mount	grain mount
SH-1	50° 37.072'W 2° 15.110'N	Purbeck	Thick (1m) layer of hard limestone with veins impregated with tar from oil seep	Strike 090/near vertical dip	At this locality large vuggy layers are exposed across cracks in Purbeck and oil tarry material is in the cracks, on the vugs, and within vugs. There are conspicous vuggy veins with coarse crystals of calcite and tar can be found between grains, on the outcrop surface and within pores of veins								
							View to SE of vertically dipping vein covered with vuggy calcite	View to NE showing tar impregnation on and within vein	View to E of fracture filled with calcite, dipping vertically	Detail of cross section of vein exposed on right side of photo, looking S	reflected light view of grain mount	grain mount showing wall rock, vuggy crystals, etc.	
SH-2	50° 37.082'W 2° 15.111'N	Purbeck	Thick (1m) layer of hard limestone with veins	Strike 090/near vertical dip	Slabs of Purbeck limestone with abundant fractures in part forming a conjugate set. The samples comprising this site are from two parts of this vein: the conjugate portion and the lower fractures that bisect the orientation of the conjugates. There is an abundance of E-W extensional fractures in Purbeck competent beds.								
							Purbeck bed looking down, North to top; shows extension with wedge bounded by conjugate fractures merging into orthogonal fracture	location of one sub-sample	location of another sub-sample	other adjacent fractures	reflected light view of grain mount		
SH-3	50° 37.099'W 2° 15.200'N near the west end of the bottom of Stair Hole	Purbeck limestone	in exposed ribs of Purbeck beneath the mudslides of the slope to north and cliffs to west.	Beds strike E-W and dip near vertically	fault that cross-cuts a veined fracture paralle to fault, which in turn is sheared to produce slickensides. SH-3 is collected from veins along this fracture/fault. Slickensides are nearly horizontal and trend 210degrees and plunge about 20degrees.								
							View to W of vertical bed that is offset by small conjugate fault that itself offsets a pre-existing vein with well developed slickensides	detail	detail of slickensides on vein	view to West looking up a bit showing vertically dipping beds that have listic offset, indicating E-W extension of beds	reflected light view of grain mount		reflected light view of grain mount
SH-4	018 50° 37.098'W 2° 15.200'N 10 metres from SH-3	Purbeck limestone	Oyster shell Purbeck bed	bedding E-W striking and nearly vertical	There is an abundance of E-W extensional fractures in Purbeck competent beds here in the oyster shell layer with slickensided vein. Slickensides are nearly horizontal and trend 050degrees and plunge about 20degrees. Vein is striking 068 and dipping 70 to the NW.								
							View to NW of bed with fracture that has veins developed but which are further offset along the fracture	detail	detail	reflected light view of grain mount	grain mount		
LC-1(2)	50o 37.075'N 002o 14.997'W	Purbeck, uppermost bed	Oyster shell limestone	strike is E-W, dip is 80 to north; many orientations of fractures and veins criss cross beds but nearly all are orthogonal to bedding	A set that dips down to west is common but steeper and less steep ones are also present. There is a crack network with brown staining but no apparent calcite as well. It is not that easy to tell which cuts which. Some veins clearly appear bent and appear cut by straight ones, but the relative relationship with straight ones is ambiguous. this sample is of a steeply west dipping set associated with brown staining and a slightly vuggy texture.								
							View to S of near vertical bed of Purbeck limestone showing network of fractures mainly orthogonal to bedding but in various orientations; sampled vein dips west (to right) about 60 degrees		detail	reflected light view of grain mount			
LC-2(1)	008 50o 37.058'N 002o 14.941'W only exposed at lower tide levels	Purbeck	light grey limestone with fractures	strike is E-W with dip to N at ~ 75 degrees	At this particular outcrop it is a bed about 20cm thick of medium grey limestone Purbeck bed with adjacent more shaley beds. The photograph below looks south onto a bedding plane top surface and you see veins up to nearly 1cm thick that are sinistrally offset in this view, being displaced as noted in photo. They thin on the limbs where there is displacement.								
							View to S of top of bed showing oblique veins that have shear offset and considerable thinning	view of beds	view of beds		reflected light view of grain mount		
LC-2(2)	50o 37.058'N 002o 14.941'W same outcrop as LC-2(1) but at opposite end of vein	Purbeck	light grey limestone with fractures	strike is E-W with dip to N at ~ 75 degrees	See above for LC-2(1); this sample is of the same vein but on the other side of the limestone bed where the vein is present.								
							View of opposite end of outcrop shown in LC-2(1) showing offset and sheared veins	fragments for analysis	View looking down from above top of outcrop; N is to the top				

Sample # & Age (Ma)	GPS coord.	Stratigraphic Unit	Wall rock lithology	Structural Info/Orient'n	Vein information	U-Pb Analysis spatial information	Photograph #1	Photograph #2	Photograph #3	Photograph #4	Photograph #5	Photograph #6	Photograph #7
LC-2(3)	009 50o 37.060'N 002o 14.955'W (about 15m farther west along this set of beds from LC-2(1)	Purbeck	light grey limestone with fractures	strike is E-W with dip to N at ~ 75 degrees BUT there is a twist in these beds to the west (see photo) and in this region are additional fractures; Orientation of these cracks is strike 182, dip 60 E	To the east of this spot along strike the beds dip N about 50-60 degrees but to west dip 75 deg south and are overturned; therefore the beds are twisted; There are some ~N-S minor cracks or faults that displace the set of beds and appear related to the twisting of the beds and accommodation of structures. The cracks do not always penetrate into the adjacent mudstone.								
							View to west of Purbeck beds that change orientation from foreground to background	detail of beds looking East	View to east onto outcrop sampled	view to south of detail of fracture and calcite veins	detail, looking S	reflected light view of grain mount	
LC-8	50° 37.009'W 2° 14.690'N	Purbeck	hard buff coloured limestone	Core of monocline; beds dip gently northwards about 20-30 degrees; fractures are irregular	This is a sample of a vein in a crack in an area of other minor veins. This sample is stratigraphically below a 5-6m thick layer of debris flow – composed of chaotically broken beds and chunks resembling a syndepositional landslide								
							View down and to SW of bedding surface of Portland limestone decorated with fractures in irregular orientations	detail of fractures	detail		reflected light view of grain mount		
LC-9	50° 37.050'W 2° 14.655'N East side Lulworth cove very near the prominent first major slab of Purbeck	Purbeck beds	Limestone	Fold trends E-W and is upright and open	This locality is almost at the top of the Purbeck above the anticline-syncline couplet described in locality RP-LC-7. It is about 3-5m below the gypsum beds; there is an undulation of these well bedded Purbeck beds. The layers have lots of calcite veins in fractures that are very common.								
							View to east of bed of Purbeck with fractures			reflected light view of grain mount			
PP-1(1)	50o 36.43 N 1o 56.67 W	Purbeck beds	Limestone	Fold trends E-W and is upright and open but overall beds here gently dip to north	Vein is preserved on a near vertical face; vein trends N-S and is orthogonal to bedding. Vein is 2-3mm thick, it begins with really fine grained layer that's a little milky, then a sharp boundary with crystals that are colourless, reasonably transparent to translucent with a grain size 0.3 – 1mm equant.								
							View to S of edge of small cliff facing the sea where near vertical fractures are covered partially with thin calcite veins	detail of vein	detail of vein	reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount	
PP-1(2)	50o 36.43 N 1o 56.67 W	Purbeck beds	Limestone somewhat greenish grey	Fold trends E-W and is upright and open but overall beds here gently dip to north	Bedding parallel vein. Vein varies between 2mm and 10mm wide. The vein is split into two halves. At the wall edge, the grain size is finer 0.3 – 0.5mm, rapidly succeeded by much coarser grains that are somewhat orthogonal and between 3-5mm long and 1-2mm wide. There is a further thin top layer, about 0.5 – 1mm thick made up of crystals which are approx. 0.3mm wide by about 1-2mm. These are arranged on their sides so they look like individual walls.								
							View to west of bedding parallel vein	detail			reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount
PP-1(4)	50o 36.43 N 1o 56.67 W	Purbeck beds	Limestone	Fold trends E-W and is upright and open but overall beds here gently dip to north	a layer parallel vuggy layer, somewhat discontinuous with a coarse yellowish cream-coloured appearance.								
							View to S of edge of small cliff facing the sea	bedding parallel veins, discontinuous		reflected light view of grain mount	reflected light view of grain mount	reflected light view of grain mount	
OM-1	50o 38.08N 2o 22	Oolite	Limestone is grey to tan with rusty coloured oolites – not overly abundant.	This area has a bend in strike of oolite beds with lots of fractures in the area of bending; Most fractures or orthogonal and indicate extension in E-W direction	There is a prominent fracture fill 1.5cm wide which is sheared and tapered/thinned and offset dextrally looking N; vein is clearly deformed with offset; sample is from lower part of vein where it is thickest.								
							sketch, north up, of beds and a vein trending up to right that is offset by bedding parallel shear	**photo corresponding to sketch on left**	**detail of part of offset vein**		reflected light view of grain mount	reflected light view of grain mount	
OM-2	50o 38.08N 2o 22.65 W ; an orthogonal fracture just north a couple of metres from RP-OM-1.	Oolite	Limestone is grey to tan with rusty coloured oolites – not overly abundant.	This area has a bend in strike of oolite beds with lots of fractures in the area of bending; Most fractures or orthogonal and indicate extension in E-W direction	orthogonal fracture filled with 1cm thick calcite vein that facilitates extension and partly small offsets of segments of the bed.	Main vein was undatable with extremely low U; the irregular vein within the oolite was dated and is a maximum age of the crosscutting orthogonal fracture shown in photos							

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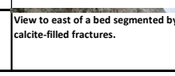
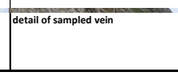
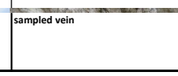
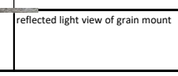
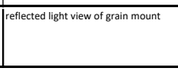
							 **View to east of a bed segmented by calcite-filled fractures.**	 **detail of sampled vein**	 **sampled vein**			 reflected light view of grain mount	 reflected light view of grain mount