
Figures

(Figure 1) Map of the North Pennines Area of Outstanding Beauty

(Figure 2) Jeffrey's chimney above Ramshaw Elizabeth Pickett/NPAP

(Figure 3) North of Nenthead — Charlie Hedley © Countryside Agency.

(Figure 4) Dufton Pike (left), Knock Pike (right) and Dufton Fell — Charlie Hedley © Countryside Agency.

(Figure 5) Geological time. Stratigraphic column

(Figure 6) A simplified geological map of the North Pennines AONB

(Figure 7) Park Level, Killhope © Elizabeth Pickett/NPAP

(Figure 8) Outcrop of Ordovician and Silurian rocks

(Figure 9) The currently accepted classification of the Ordovician and Silurian rocks of the AONB is shown in the table above.

(Figure 10) Keisley Limestone Quarry, Dufton. © S. Clarke, BGS, NERC.

(Figure 11) Knock Pike and Dufton Pike. © B. Young, BGS, NERC.

(Figure 12) Outcrop of Devonian rocks

(Figure 13) Exposure of the 'polygenetic Conglomerate' near Melmerby. © B. Young, BGS, NERC

(Figure 14) Stratigraphy of the Carboniferous table

(Figure 15) The formation of Yoredale Cyclothems. © Elizabeth Pickett

(Figure 16) Namurian shales in old ironstone workings © B. Young, BGS, NERC.

(Figure 17) Outcrop of Dinatian rocks

(Figure 18) Falcon Clints, Teesdale. Conglomerates and shales of the Orton Group. © B. Young, BGS, NERC.

(Figure 19) Hilton Mines, Scordale. Craggs of Whin Sill overlying Melmerby Scar Limestone. © B. Young, BGS, NERC.

(Figure 20) Outcrop of Namurian rocks

(Figure 21) Chaetetes Band, River Nent, Nenthead Mines. © D. Millward, BGS, NERC.

(Figure 22) Characteristic terraced hillside, Blagill, Nent Valley. S. Clarke © BGS, NERC

(Figure 23) Middleton Common. Heather moorland on outcrop of Namurian Rocks. © Charlie Hedley, Countryside Agency.

(Figure 24) Outcrop of Westphalian rocks

(Figure 25) Carboniferous swamp. © Elizabeth Pickett

(Figure 26) Plenmeller Opencast Coal Site in 1980's. © B. Young, BGS, NERC.

(Figure 27) Outcrop of Permo-Triassic rocks

(Figure 28) St Bees sandstone in Croglin Quarry Charlie Hedley © Countryside Agency

(Figure 29) Outcrop of intrusive igneous rocks

(Figure 30) Photomicrograph of thin section of Weardale Granite © H. Emeleus, Durham University.

(Figure 31) High Force, Whin Sill overlying Tynebottom Limestone — NPAP.

(Figure 32) The Little Whin Sill exposed in the abandoned Greenfoot Quarry, Weardale. © B. Young, BGS, NERC

(Figure 33) Crag of columnar jointed Whin Sill, Holwick Scar, Teesdale © BGS, NERC.

(Figure 34) Raft of altered sandstone in Whin Sill, Wynch Bridge, Teesdale. © S. Clarke, BGS, NERC

(Figure 35) Outcrops of 'Sugar Limestone' Widdybank Fell © B. Young, BGS, NERC.

(Figure 36) Major geological structures

(Figure 37) Normal fault in Great Limestone and overlying beds, Heights Quarry, Eastgate, Weardale © B. Young, BGS, NERC.

(Figure 38) Folded limestones adjoining the barites deposit, Closehouse Mine, Lunedale in 1984. © B. Young, BGS, NERC

(Figure 39) Outcrop of mineral veins

(Figure 40) Witherite vein, Scraithole Vein, Scraithole Mine, Carr Shield © BGS P601083.

(Figure 41) Slitt Vein and worked — out ironstone flats, West Rigg, Westgate, Weardale © B. Young, BGS, NERC.

(Figure 42) Miner-farmer landscape, upper Weardale. © Elizabeth Pickett/NPAP

(Figure 43) Spring Sandwort © B. Young, BGS, NERC

(Figure 44) Discharge of brown iron-rich minewater entering Rookhope Burn near Ripsey Mine, 2007. © B. Young, BGS, NERC

(Figure 45) Lady's Rake Mine, an extremely important mineralogical site with mining history interest. © B. Young, BGS, NERC.

(Figure 46) Diagram showing the maximum extent of ice in the British Isles during the Devensian glaciation.

(Figure 47) Boulder clay in river bank, Haugh Hill, Harwood Beck, Teesdale © B. Young, BGS, NERC.

(Figure 48) Large limestone erratic, Herdship Fell, Teesdale © B. Young, BGS, NERC.

(Figure 49) Pre-glacial channel of the River Tees (in background) Cauldron Snout © B. Young, BGS, NERC.

(Figure 50) Peat overlying boulder clay, Plenmeller Opencast Coal Site © BGS, NERC

(Figure 51) The Great Whin Sill at High Cup Nick above Dufton on the Pennine Way © Countryside Agency.

(Figure 52) Stone Stripes, Knock Fell. © C. Vye, BGS, NERC.

(Figure 53) The large landslip at Mason's Holes, Scordale. © B. Young, BGS, NERC

(Figure 54) Limestone pavement, Stainmore. © Elizabeth Pickett/NPAP

(Figure 55) God's Bridge, a natural limestone bridge over the River Greta. © Elizabeth Pickett/NPAP

(Figure 56) Fossilised stump of a Namurian tree, preserved in Stanhope Churchyard © B. Young, BGS, NERC.

(Figure 57) Trace fossils found at Scordale, probably formed small molluscs or worms around 320 million years ago. ([See PDF](#))

(Figure 58) Barytocalcite crystals, Clargill Mine, Alston © BGS, NERC.

(Figure 59) Fluorite crystals, Weardale. [Rob Lavinsky, iRocks.com – CC-BY-SA-3.0, CC BY-SA 3.0](#), via Wikimedia Commons

(Figure 60) The Rookhope Borehole, 1960-61. Image courtesy of © Durham University.

(Figure 61) "Ancient Ironstone Workings, Cowshill, Weardale" © B. Young, BGS, NERC.

(Figure 62) Old Quarry in the Great Limestone, Bollihope Common — Charlie Hedley © Countryside Agency.

(Figure 63) Surface plant, Groverake Mine (now disused), Rookhope © B. Young, BGS, NERC.

(Figure 64) The original stone-arched entrance to Cambokeels Mine, Weardale, driven in the mid-19th Century. © B. Young, BGS, NERC

(Figure 65) Spoil Heaps, Coalcleugh Mine © B. Young, BGS, NERC.

(Figure 66) Croglin. Use of local sandstone including St. Bees sandstone from the village quarry. Charlie Hedley © Countryside Agency

(Figure 67) Blanchland — use of locally worked sandstones as building and roofing stone' © B. Young, BGS, NERC

(Figure 68) Pillars of polished Shap Granite, St Augustine's Parish Church, Alston. © B. Young, BGS, NERC.

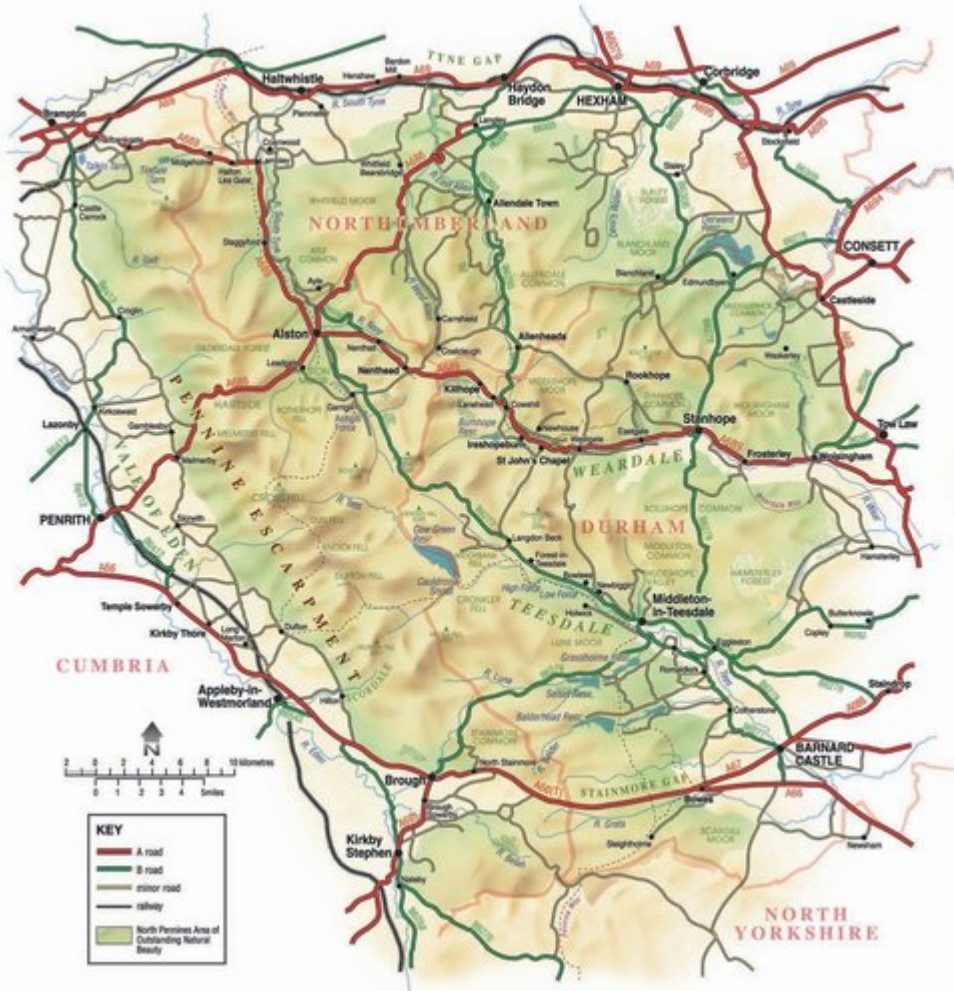
(Figure 69) Frosterly Marble, polished surface © BGS, NERC

(Figure 70) Font in Frosterly Church © B. Young, BGS, NERC

(Figure 71) Spar box with North Pennines minerals ([See PDF](#))

(Figure 72) Thomas Sopwith with a selection of his wooden geological models © BGS, NERC.

(Figure 73) British Steel's mine model for Allenheads. © Elizabeth Pickett/NPAP



Map of the North Pennines Area of Outstanding Beauty.



Jeffrey's chimney above Ramshaw Elizabeth Pickett/NPAP.

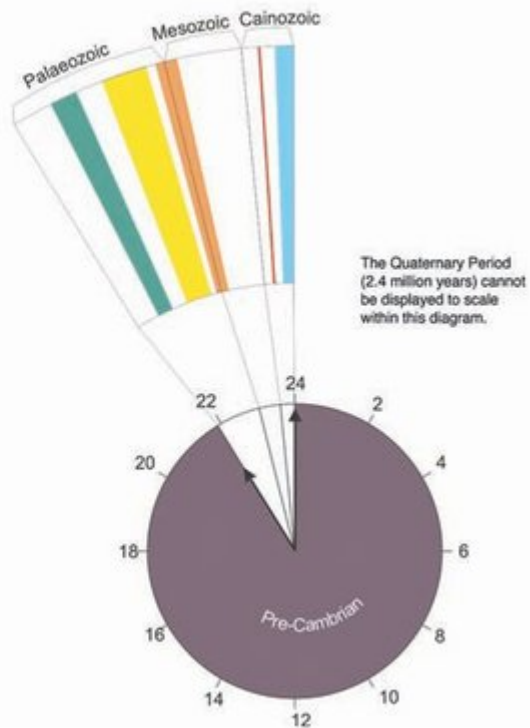


North of Nenthead – Charlie Hedley © Countryside Agency.

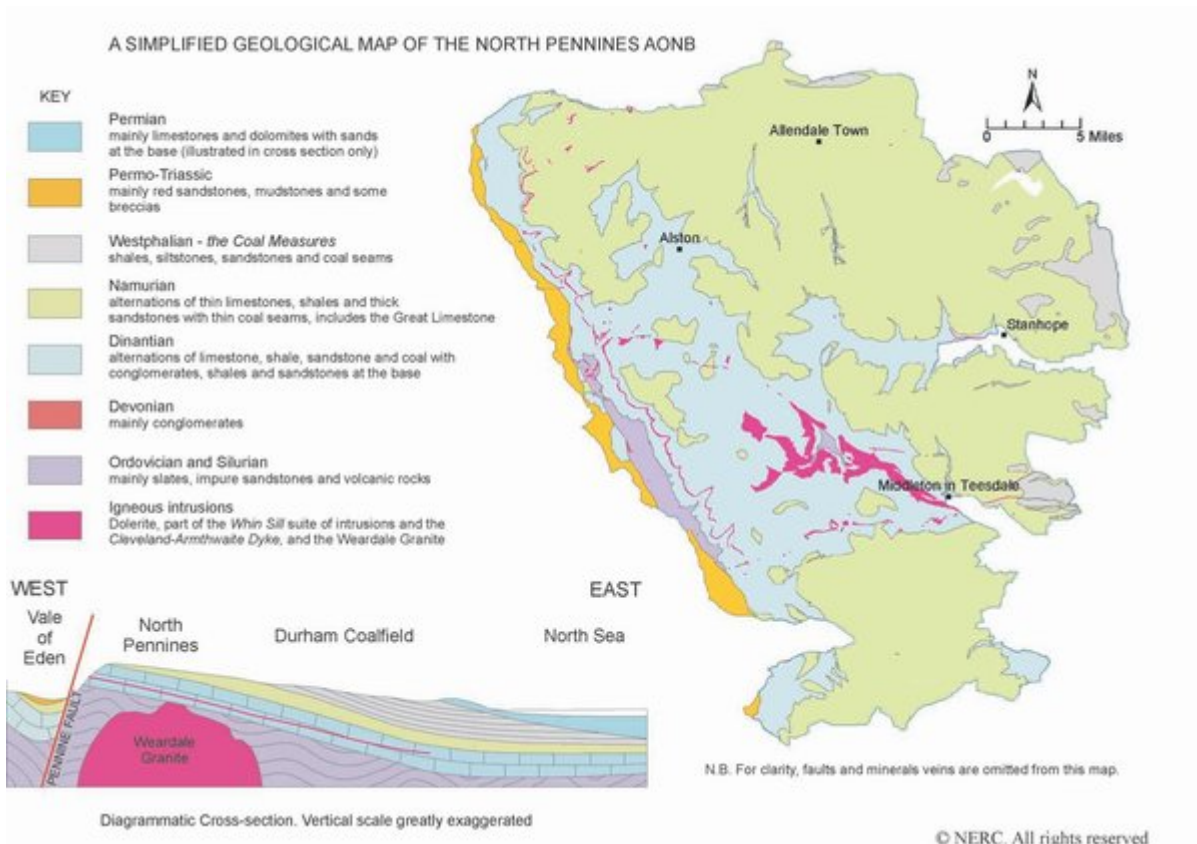


Dufton Pike (left), Knock Pike (right) and Dufton Fell – Charlie Hedley © Countryside Agency.

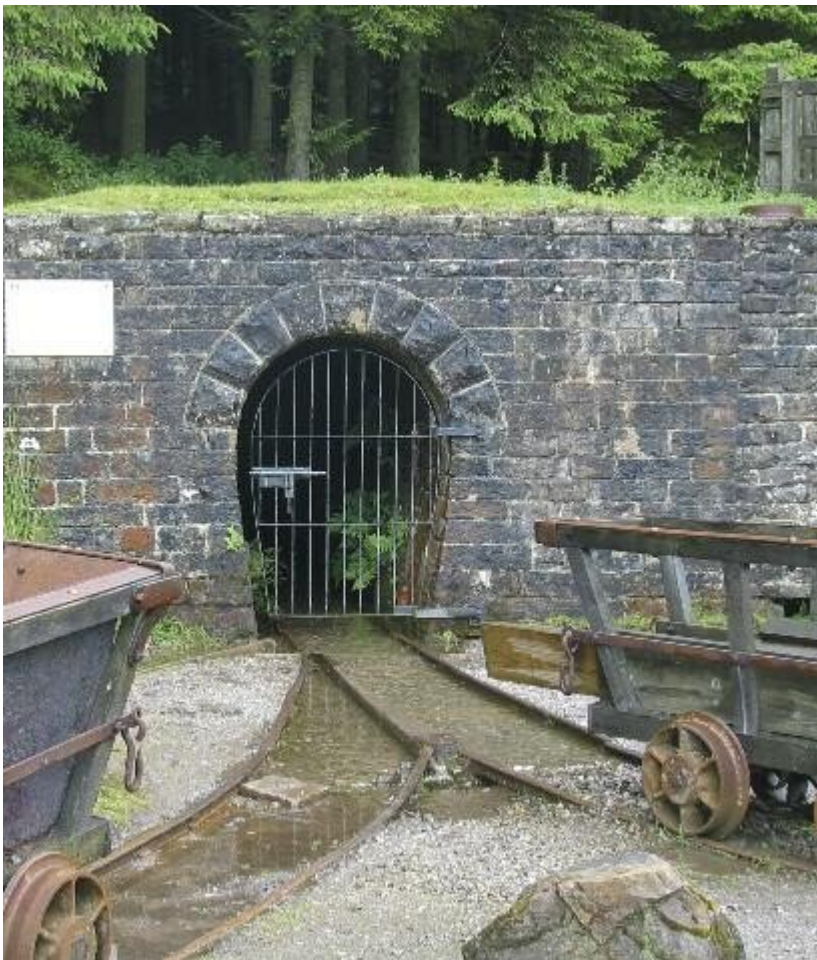
Era	Geological Period	Age (millions of years)	Events
Cainozoic	Quaternary	0	
	Pleistocene	2.4	
	Neogene	24	Tertiary dykes intruded
Mesozoic	Palaeogene	6.5	
	Cretaceous	142	
	Jurassic	205	
	Triassic	248	Formation of mineral veins
	Permian	290	Whin Sill intruded
Palaeozoic	Carboniferous		
	Namurian	362	Wearside Granite intruded
	Dinantian	418	
Neo-proterozoic	Devonian	443	
	Silurian	495	
	Ordovician	543	
	Cambrian	543	
	Pre-Cambrian	c. 4200	



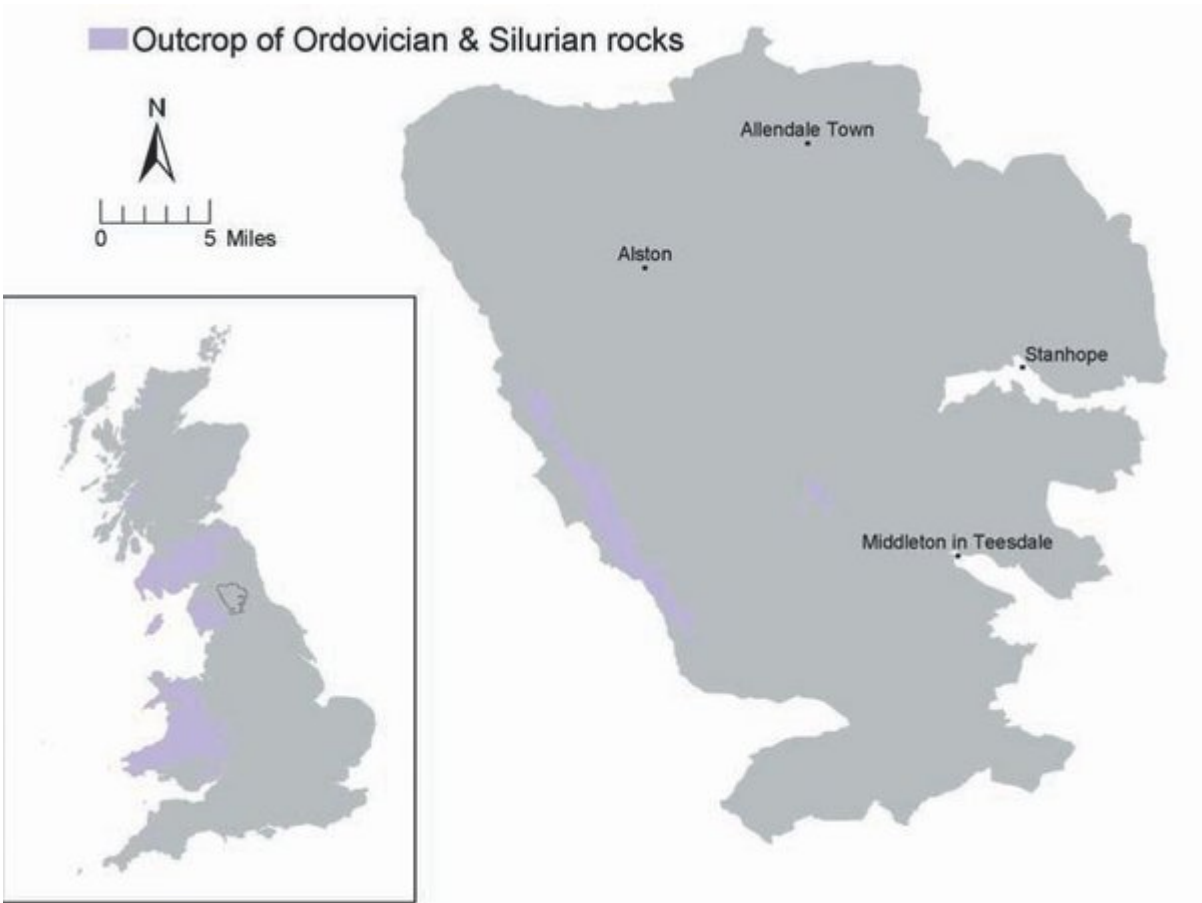
Geological time. Stratigraphic column.



A simplified geological map of the North Pennines AONB



Park Level, Killhope © Elizabeth Pickett/NPAP



Outcrop of Ordovician and Silurian rocks

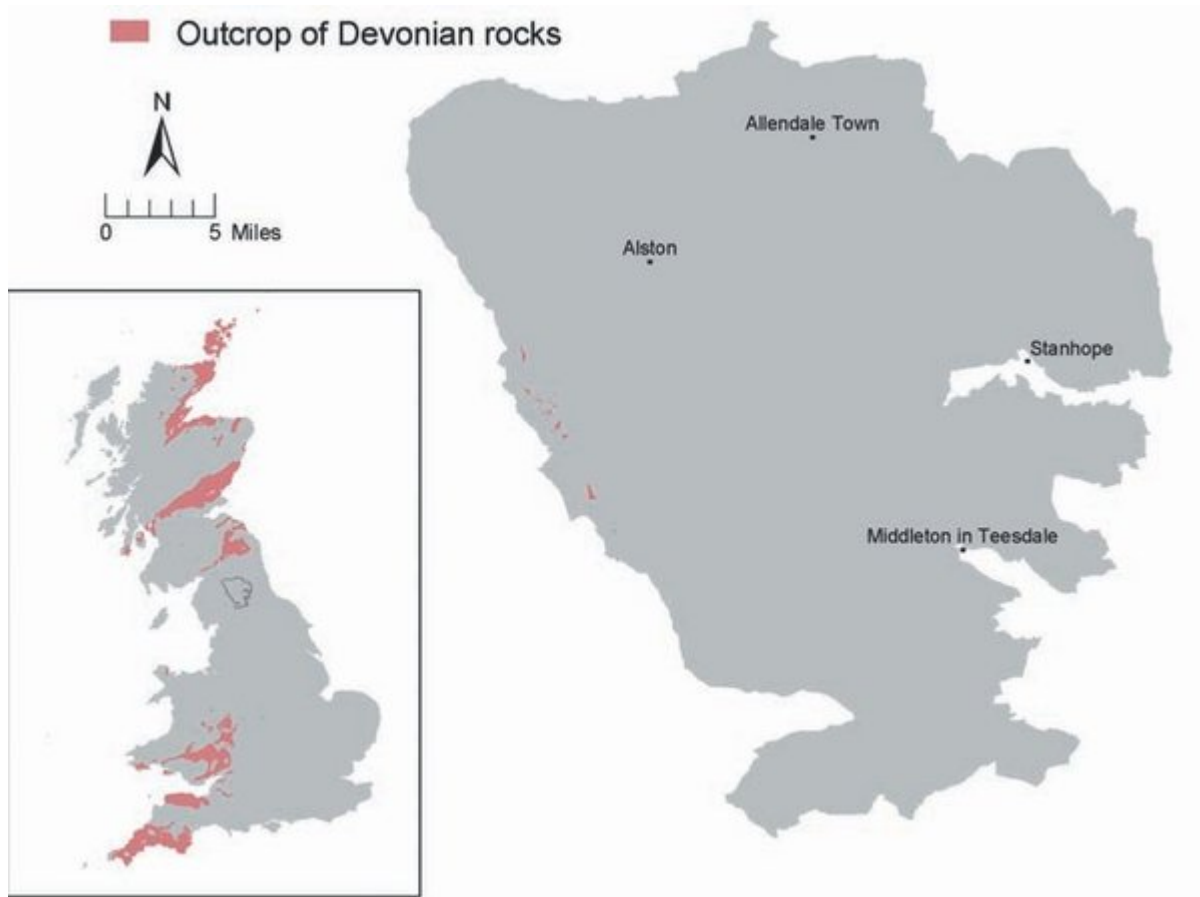
Period	Group		Formation	Main Rock Types
SILURIAN	WINDERMERE SUPERGROUP	Stockdale	Brathay	Dark bluish grey, laminated graptolitic mudstones and siltstones with sporadic calcareous nodules
			Browgill	Pale greenish grey unfossiliferous mudstone with a few thin black graptolitic mudstone beds, succeeded by red mudstone
			Skelgill	Dark brown to black shaly or blocky mudstones
ORDOVICIAN		Dent	Ashgill Formation	Calcareous mudstone with beds and lenses of decalcified limestone; shelly fauna
			Swindale	Mid-grey calcareous mudstones, with bands and lenses of greenish grey fine grained limestone commonly decalcified at outcrop to brown rottenstone
			Dufton Shale	Dark grey, partly calcareous siltstones and mudstones, with thin bands or lenses of silty limestone
		Borrowdale Volcanic	Harthwaite	Volcanic sandstone and siltstones and tuffs
			Knock Pike	Lapilli-tuff and tuff
			Studgill	Lapilli-tuff and volcanoclastic sandstone
Skiddaw	Kirkland	Mudstones interbedded with many thick bands of tuff (volcanic ash) and lavas		
	Murton	Siltstones and mudstones with some sandstones		
	Catterpallot	Siltstones and interbedded sandstones		

The currently accepted classification of the Ordovician and Silurian rocks of the AONB is shown in the table above.



Keisley Limestone Quarry, Dufton. © S. Clarke, BGS, NERC.





Outcrop of Devonian rocks.



Exposure of the 'polygenetic Conglomerate' near Melmerby. © B. Young, BGS, NERC.

Old-fashioned terms	Modern Chronostratigraphical divisions		Divisions used on existing 50k geological maps and this document	Divisions likely to be used on maps and descriptions of the area in the future	
Coal Measures	Upper Carboniferous	Westphalian	Coal Measures	Coal Measures	
Millstone Grit		Namurian	Stainmore Group	Stainmore Formation	Yoredale Group
Carboniferous (or Mountain) Limestone	Lower Carboniferous	Dinantian	Great Limestone	Alston Formation	
			Alston Group	Robinson Limestone	Great Scar Limestone Group
			Melmerby Scar Limestone	Melmerby Scar Limestone Formation	
			Orton Group		
			Basement Group		

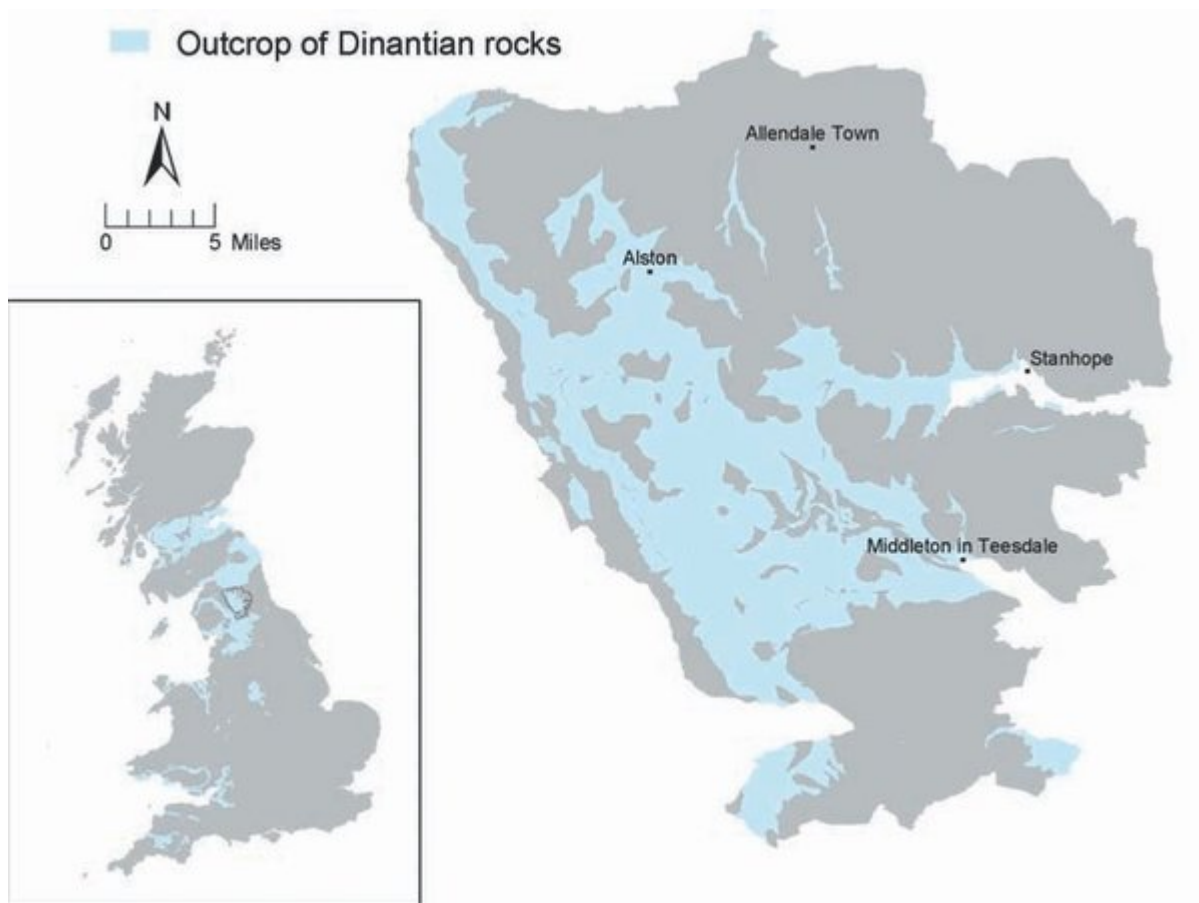
Stratigraphy of the Carboniferous table.



The formation of Yoredale Cyclothems. © Elizabeth Pickett/NPAP



Namurian shales in old ironstone workings © B. Young, BGS, NERC.



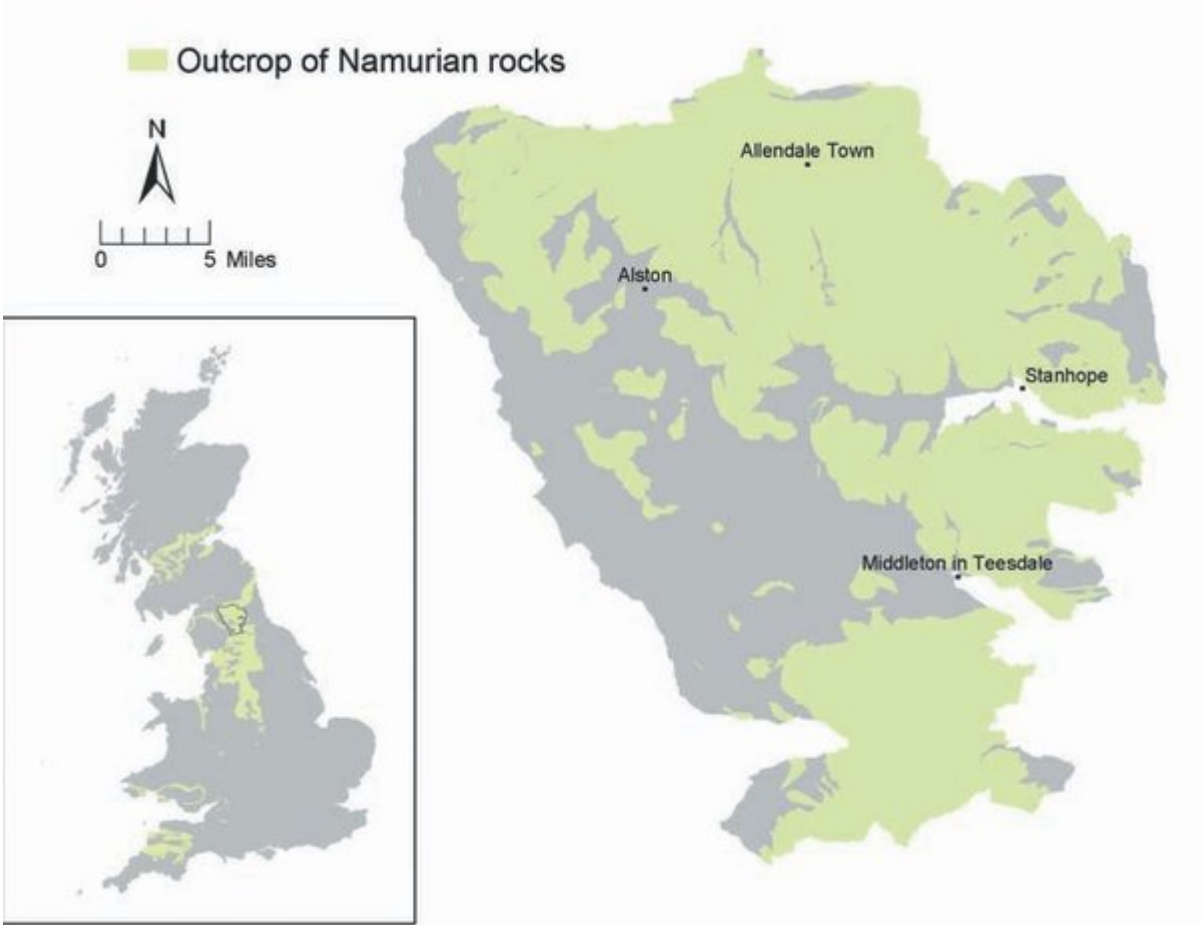
Outcrop of Dinantian rocks.



Falcon Clints, Teesdale. Conglomerates and shales of the Orton Group. © B. Young, BGS, NERC.



Hilton Mines, Scordale. Crags of Whin Sill overlying Melmerby Scar Limestone. © B.Young, BGS, NERC.



Outcrop of Namurian rocks



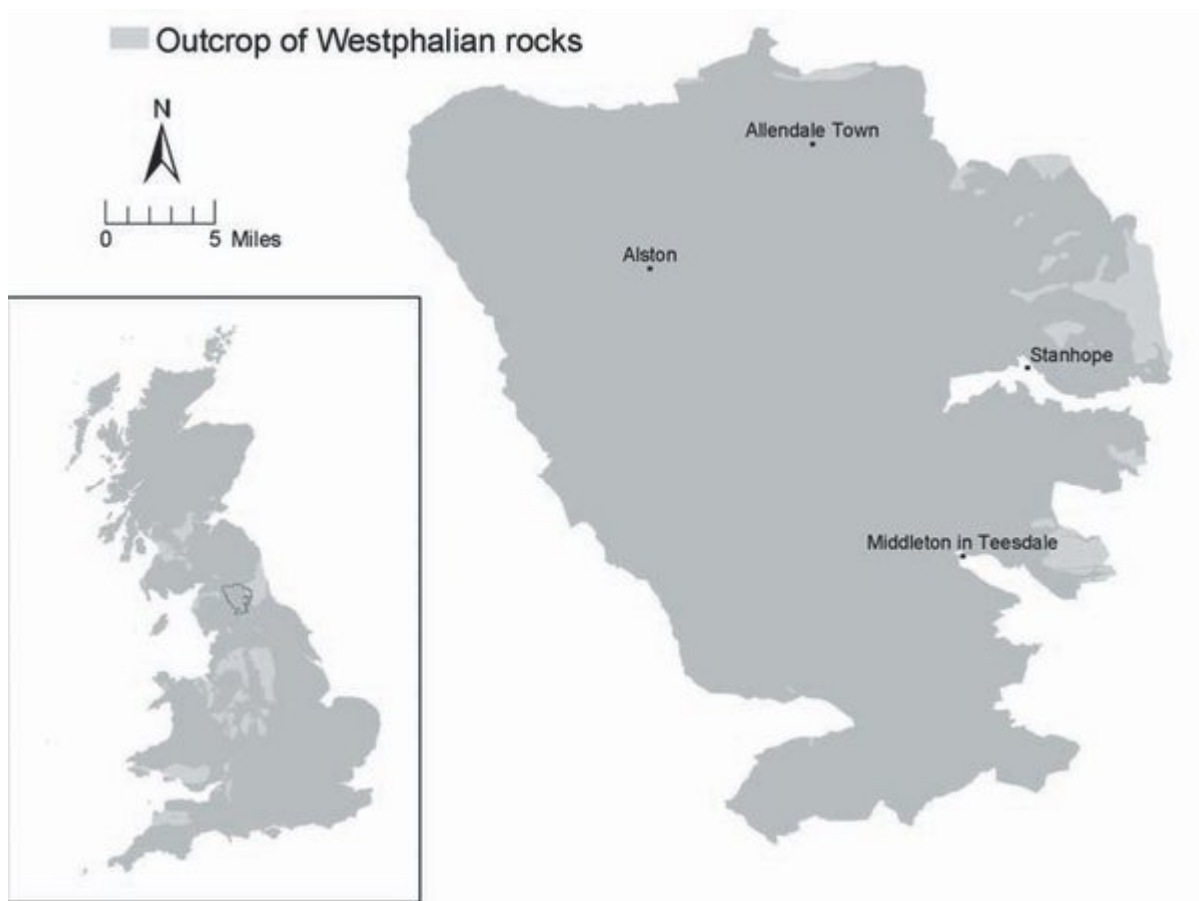
Chaetetes Band, River Nent, Nenthead Mines. © D. Millward, BGS, NERC.



Characteristic terraced hillside, Blagill, Nent Valley. S.Clarke © BGS, NERC.



Middleton Common. Heather moorland on outcrop of Namurian Rocks. © Charlie Hedley, Countryside Agency.



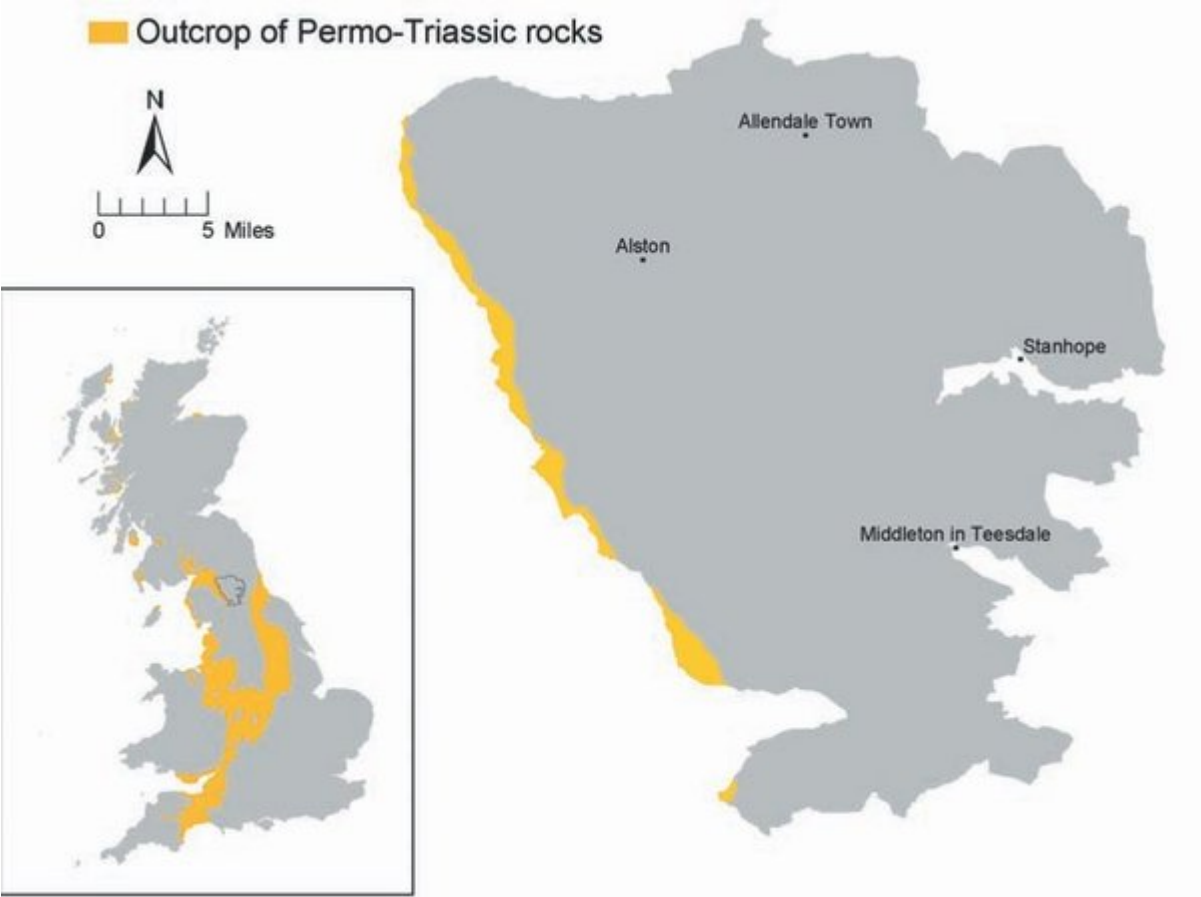
Outcrop of Westphalian rocks.



Carboniferous swamp. © Elizabeth Pickett.



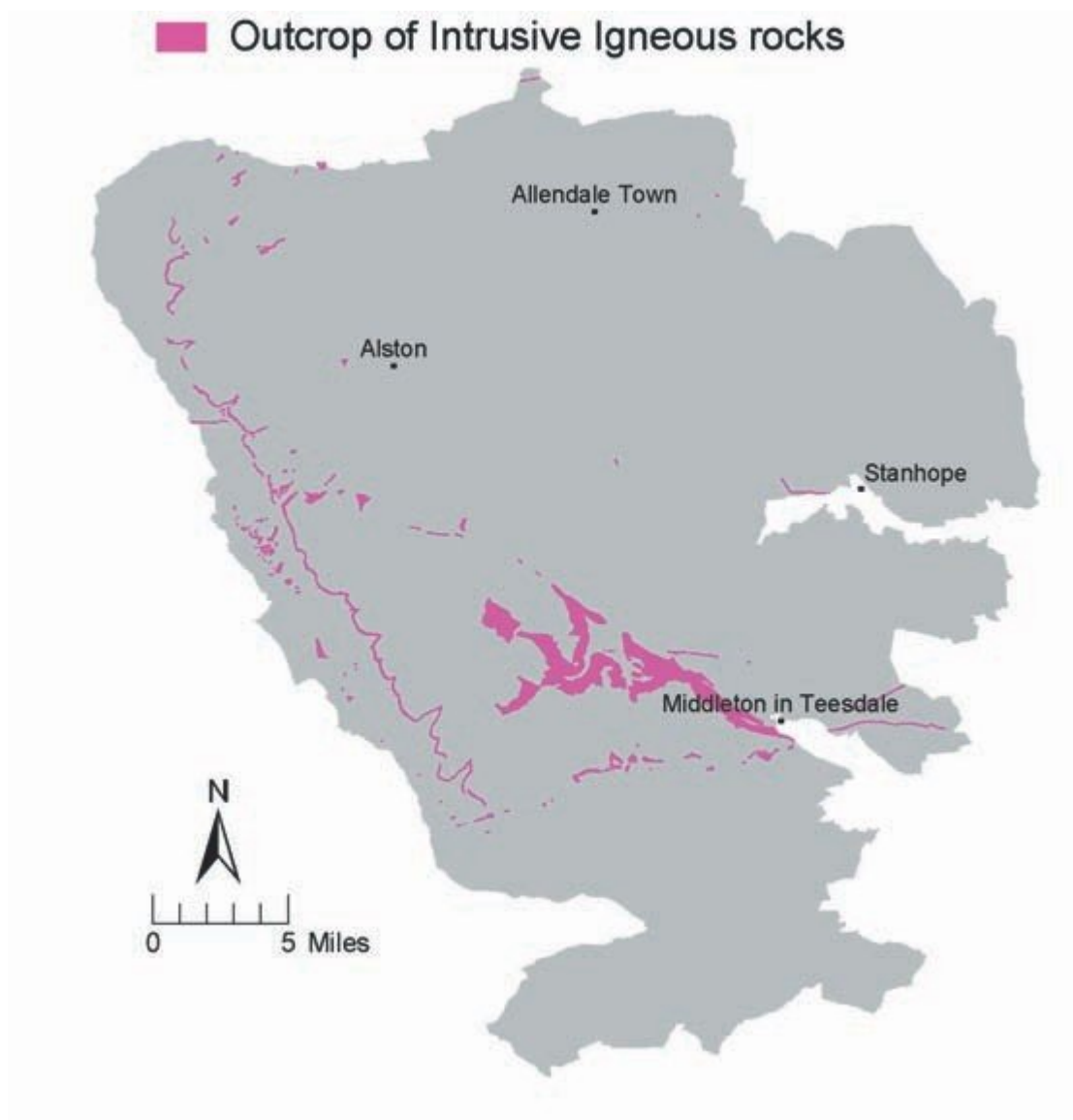
Plenmeller Opencast Coal Site in 1980's. © B. Young, BGS, NERC.



Outcrop of Permo-Triassic rocks.



St Bees sandstone in Croglin Quarry Charlie Hedley © Countryside Agency.



Outcrop of intrusive igneous rocks.



Photomicrograph of thin section of Weardale Granite © H. Emeleus, Durham University.



High Force, Whin Sill overlying Tynebottom Limestone. © NPAP.



The Little Whin Sill exposed in the abandoned Greenfoot Quarry, Weardale. © B. Young, BGS, NERC.



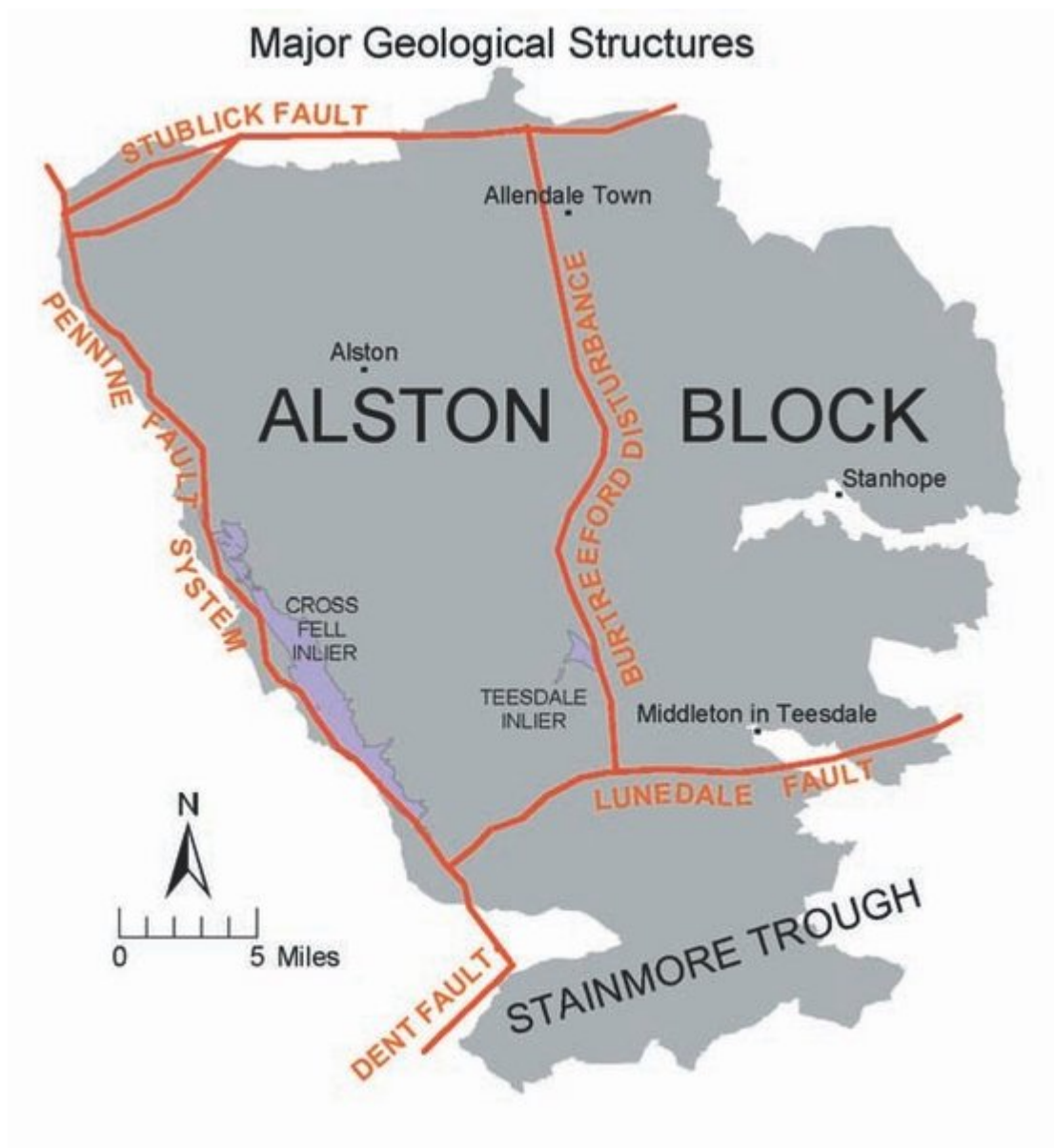
Crags of columnar jointed Whin Sill, Holwick Scar, Teesdale © BGS, NERC.



Raft of altered sandstone in Whin Sill, Wynch Bridge, Teesdale. © S. Clarke, BGS, NERC.



Outcrops of 'Sugar Limestone' Widdybank Fell © B. Young, BGS, NERC.



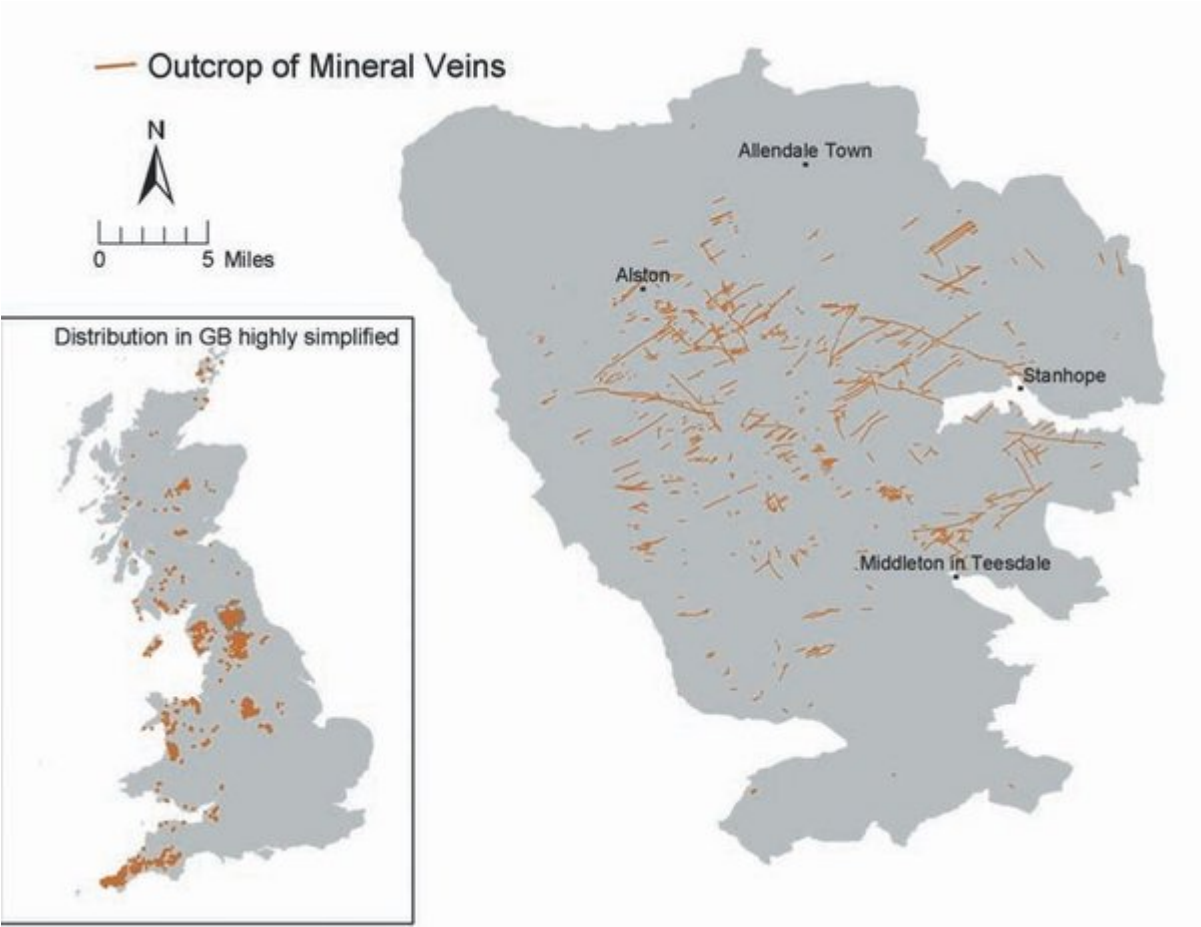
Major geological structures.



Normal fault in Great Limestone and overlying beds, Heights Quarry, Eastgate, Weardale © B. Young, BGS, NERC.



Folded limestones adjoining the barites deposit, Closehouse Mine, Lunedale in 1984. © B. Young, BGS, NERC



Outcrop of mineral veins



Witherite vein, Scraithole Vein, Scraithole Mine, Carr Shield © P601083. BGS.



Slitt Vein and worked – out ironstone flats, West Rigg, Westgate, Weardale © B. Young, BGS, NERC.



Miner-farmer landscape, upper Weardale. © Elizabeth Pickett/NPAP.



Spring Sandwort © B. Young, BGS, NERC.



Discharge of brown iron-rich minewater entering Rookhope Burn near Ripsey Mine, 2007. © B. Young, BGS, NERC.



Lady's Rake Mine, an extremely important mineralogical site with mining history interest. © B. Young, BGS, NERC.



Diagram showing the maximum extent of ice in the British Isles during the Devensian glaciation.



Boulder clay in river bank, Haugh Hill, Harwood Beck, Teesdale © B. Young, BGS, NERC.



Large limestone erratic, Herdship Fell, Teesdale © B. Young, BGS, NERC.



Pre-glacial channel of the River Tees (in background) Cauldron Snout © B. Young, BGS, NERC.



Peat overlying boulder clay, Plenmeller Opencast Coal Site © BGS, NERC.



The Great Whin Sill at High Cup Nick above Dufton on the Pennine Way © Countryside Agency.



Stone Stripes, Knock Fell. © C. Vye, BGS, NERC.



The large landslide at Mason's Holes, Scordale. © B. Young, BGS, NERC.



Limestone pavement, Stainmore. © Elizabeth Pickett/NPAP



God's Bridge, a natural limestone bridge over the River Greta. © Elizabeth Pickett/NPAP.



Fossilised stump of a Namurian tree, preserved in Stanhope Churchyard © B. Young, BGS, NERC.

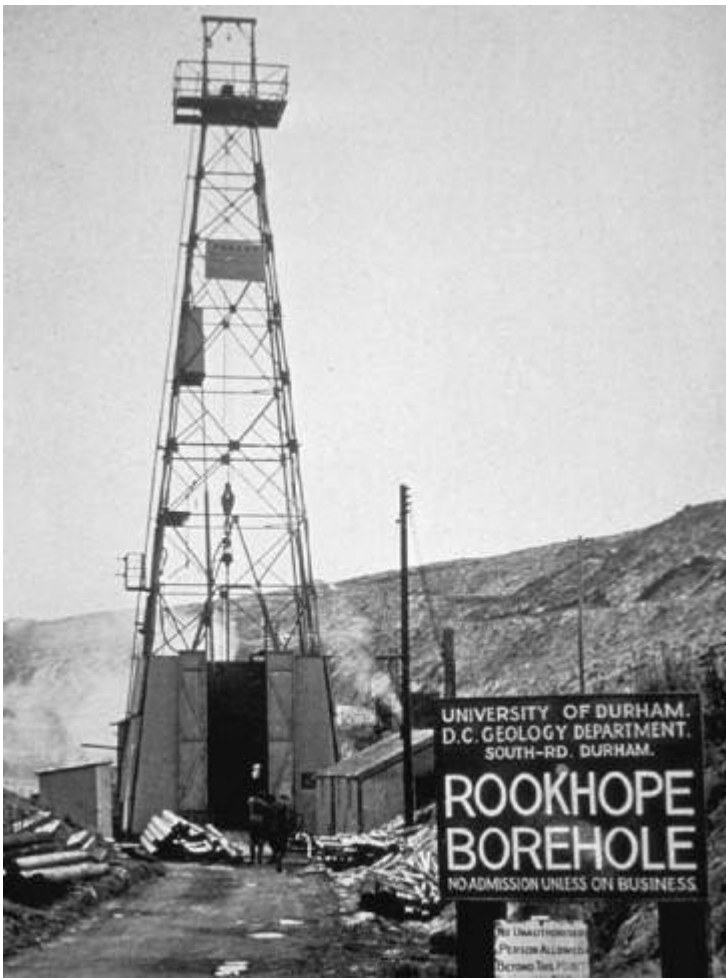


Barytocalcite crystals, Clargill Mine, Alston © BGS, NERC.



Fluorite crystals, Weardale.

(Figure 59) Fluorite crystals, Weardale. [Rob Lavinsky, iRocks.com – CC-BY-SA-3.0](#), [CC BY-SA 3.0](#), via Wikimedia Commons.



The Rookhope Borehole, 1960-61. Image courtesy of © Durham University.



Ancient Ironstone Workings, Cowshill, Weardale © B. Young, BGS, NERC.



Old Quarry in the Great Limestone, Bollilhope Common – Charlie Hedley © Countryside Agency.



Surface plant, Groverake Mine (now disused), Rookhope © B. Young, BGS, NERC.



The original stone-arched entrance to Cambokeels Mine, Weardale, driven in the mid-19th Century. © B. Young, BGS, NERC.



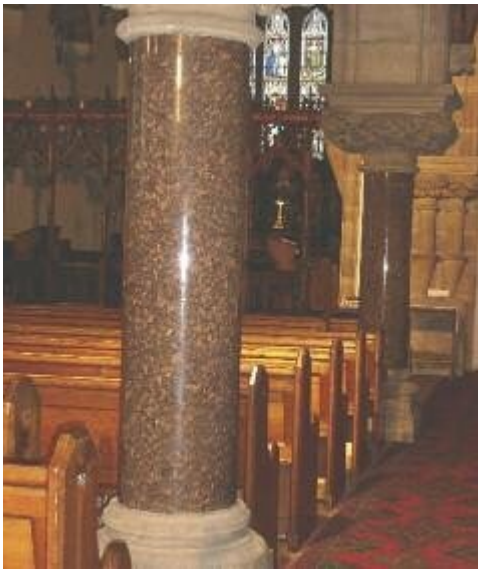
Spoil Heaps, Coalcleugh Mine © B. Young, BGS, NERC.



Croglin. Use of local sandstone including St. Bees sandstone from the village quarry. Charlie Hedley © Countryside Agency.



Blanchland – use of locally worked sandstones as building and roofing stone' © B. Young, BGS, NERC.



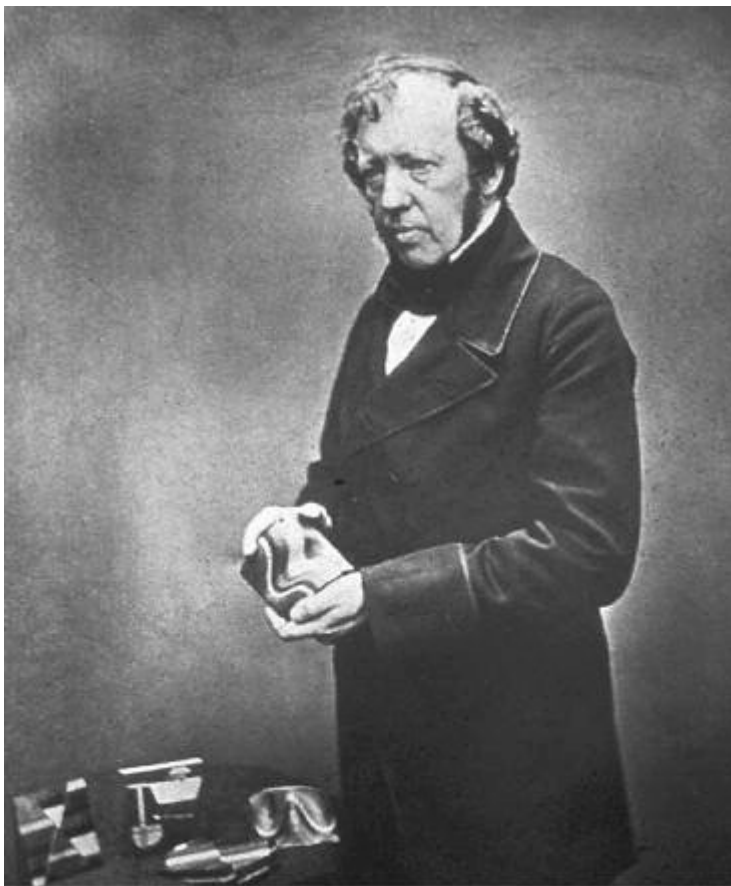
Pillars of polished Shap Granite, St Augustine's Parish Church, Alston. © B. Young, BGS, NERC.



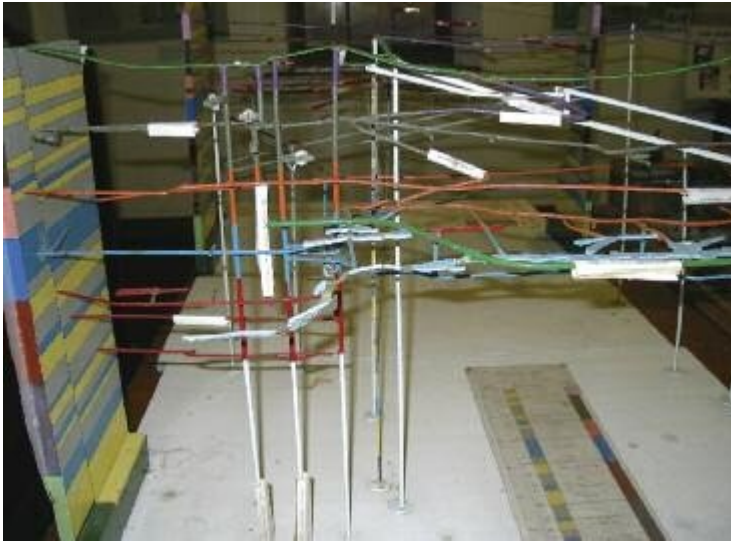
Frosterly Marble, polished surface © BGS, NERC.



Font in Frosterly Church © B. Young, BGS, NERC.



Thomas Sopwith with a selection of his wooden geological models © BGS, NERC.



British Steel's mine model for Allenheads. © Elizabeth Pickett.