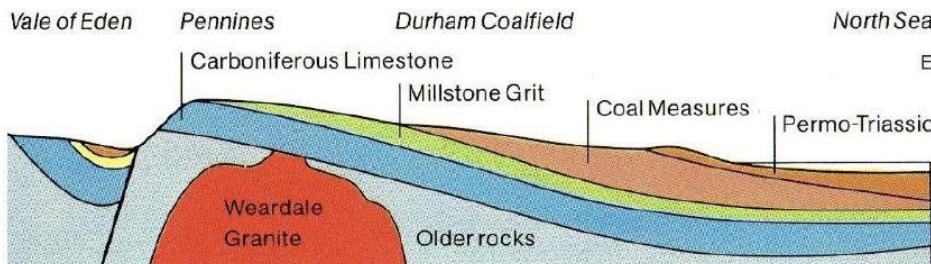
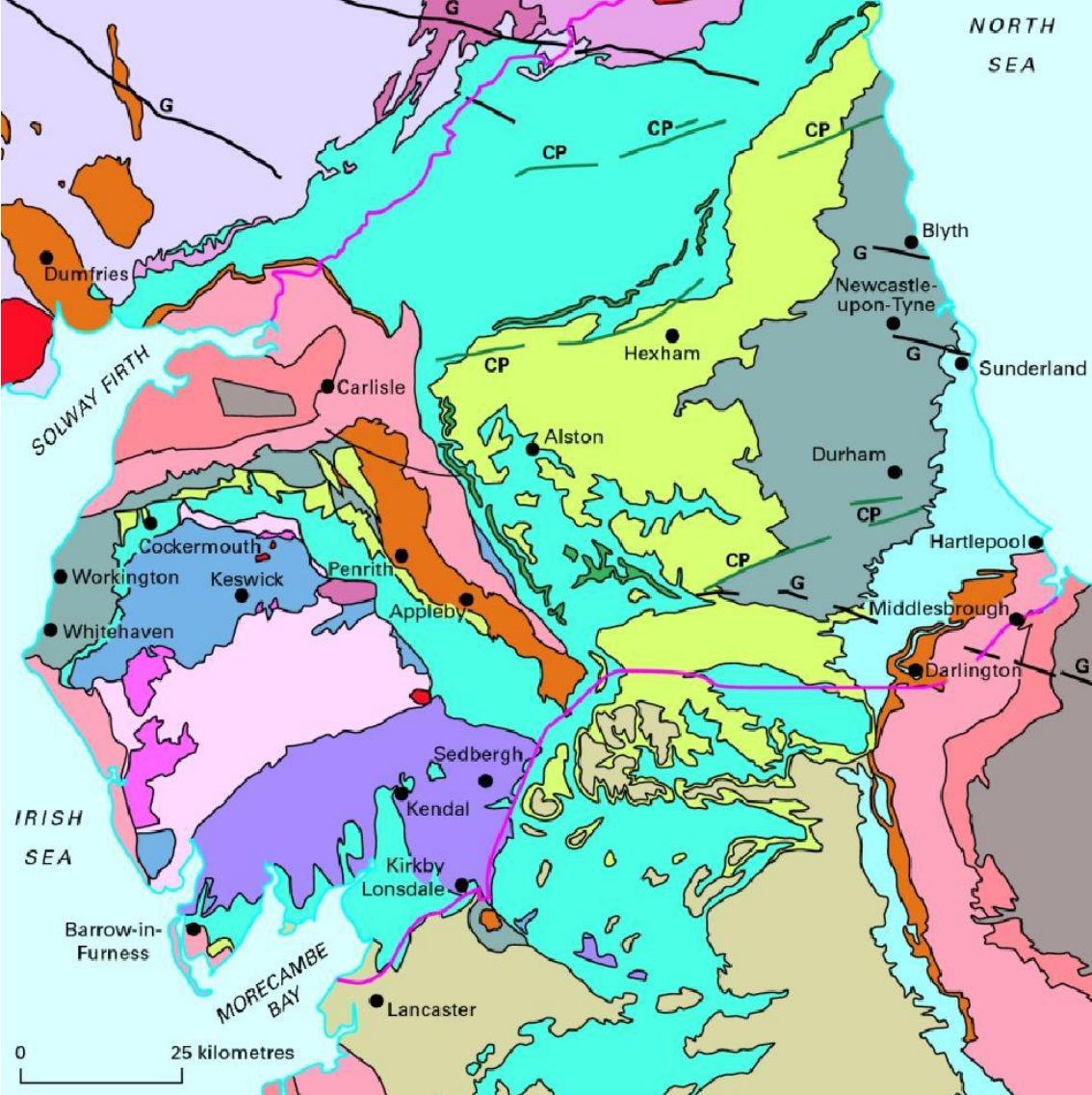


Geology of the Alston Block Northern England





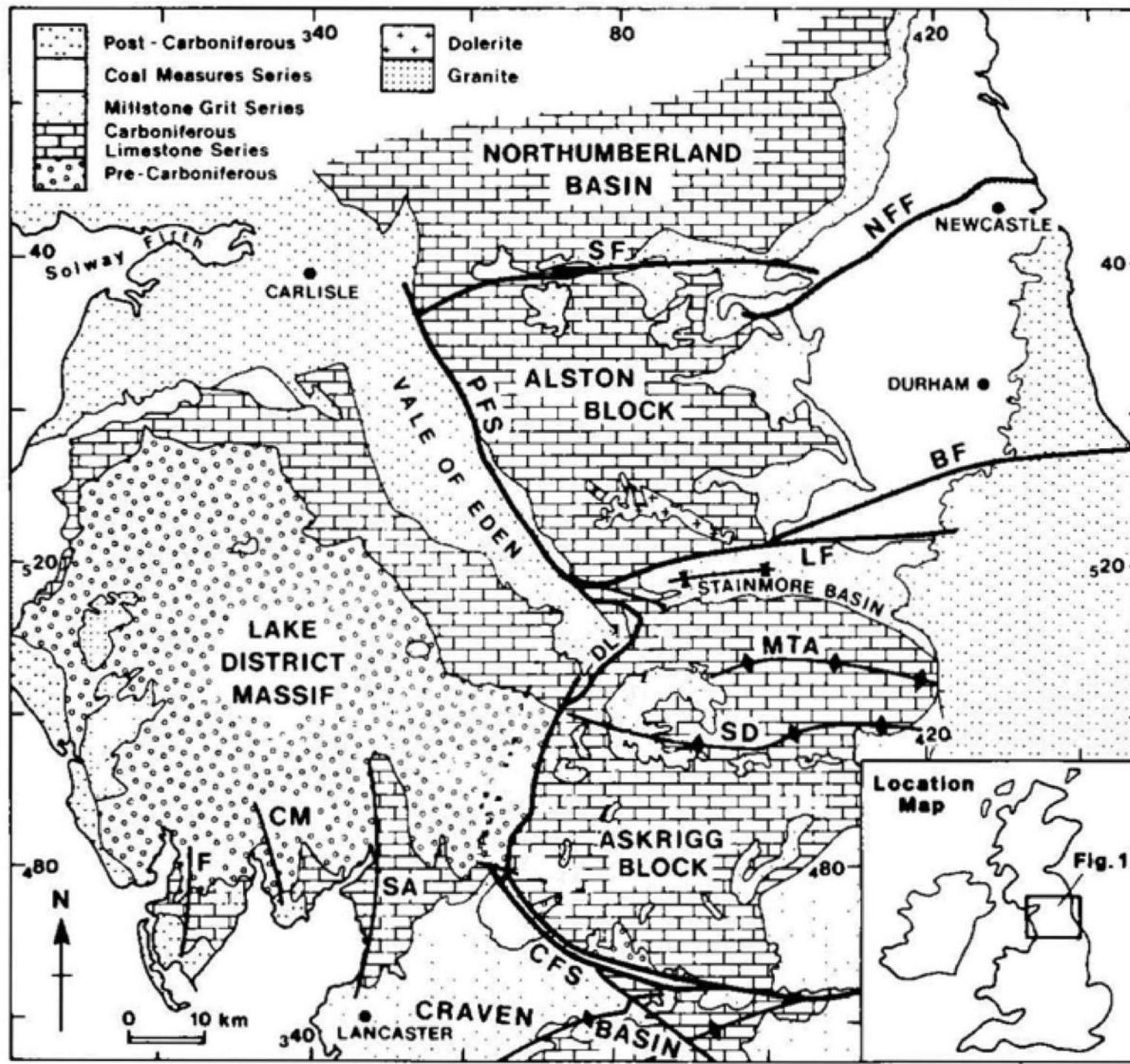
480 – 440 Ma

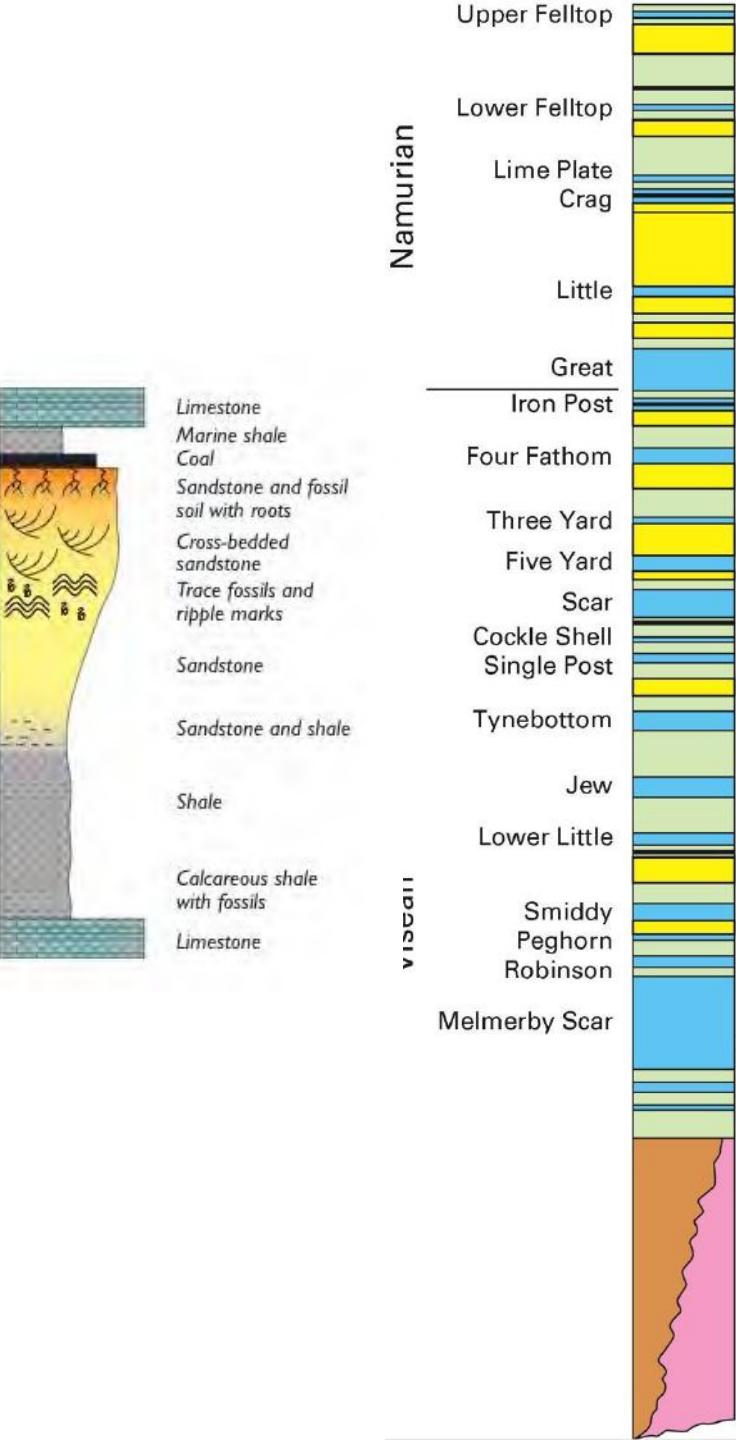


360 – 300 Ma

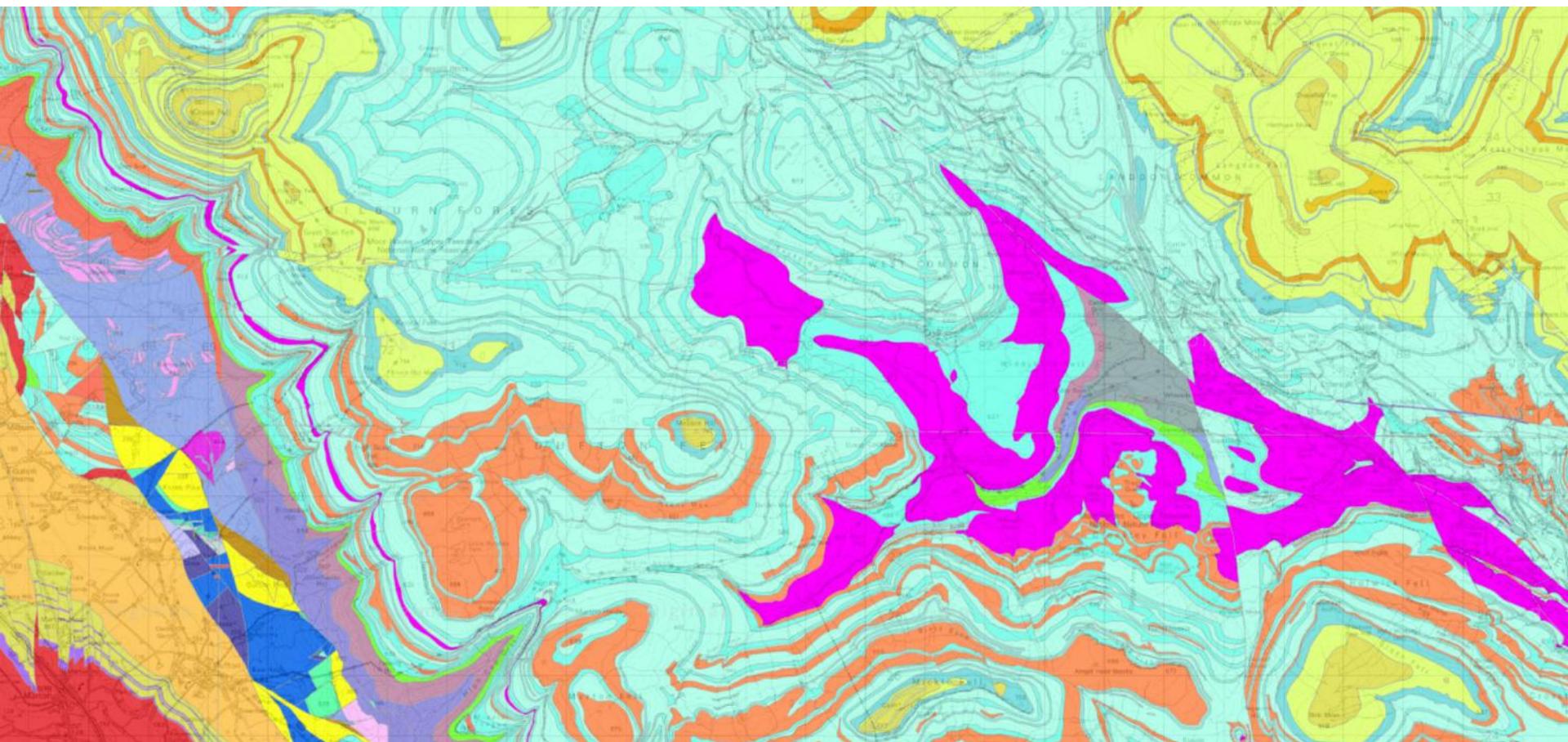


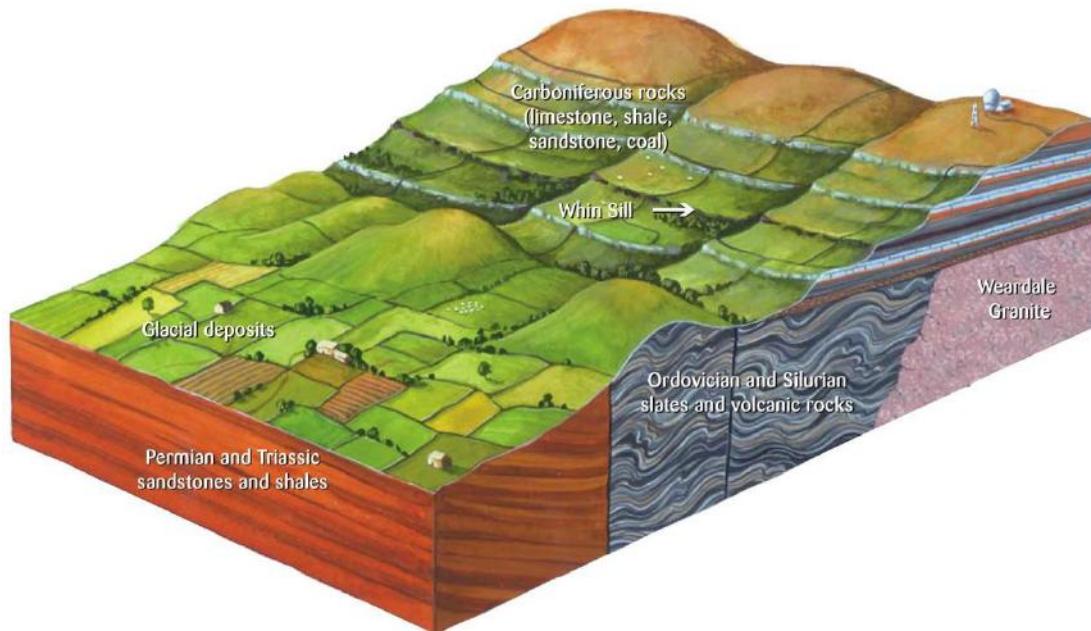
265 – 200 Ma











Dun Fell

835 m

2782 '

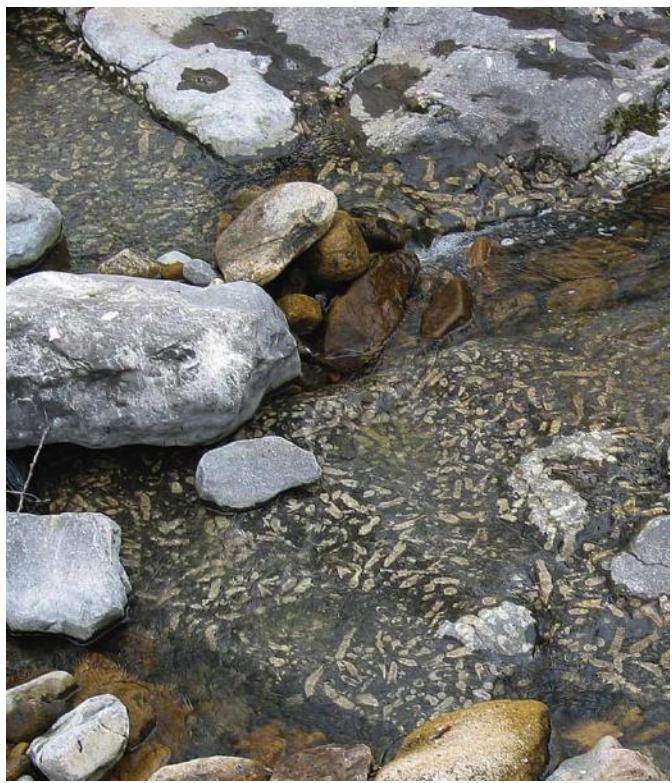


Between 1939 and 1963, 215,000 tons of dressed barytes ore was produced at Silverband and then it closed. The mine reopened in the 1970s and an ore processing mill was built adjacent.

Cross Fell inlier

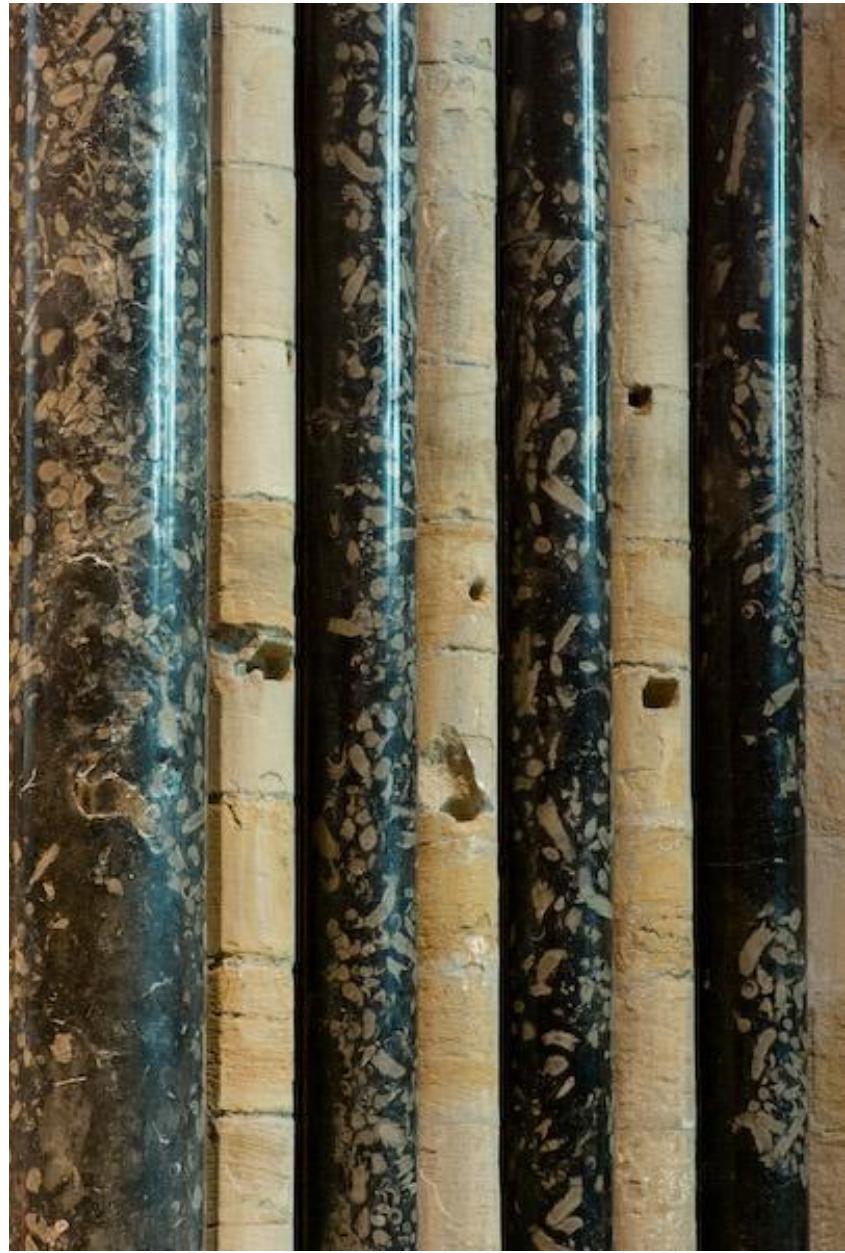
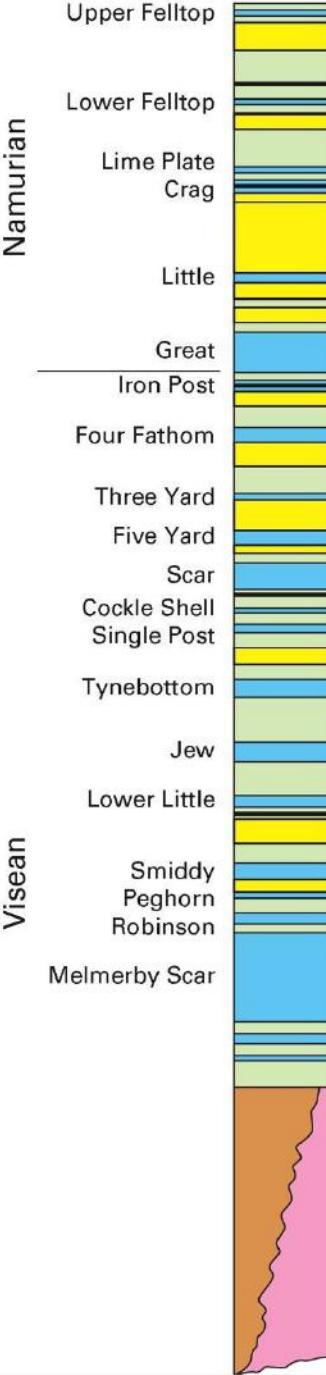




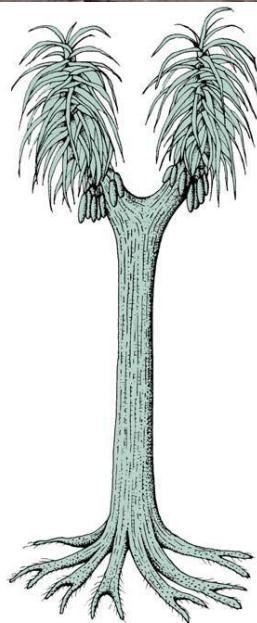


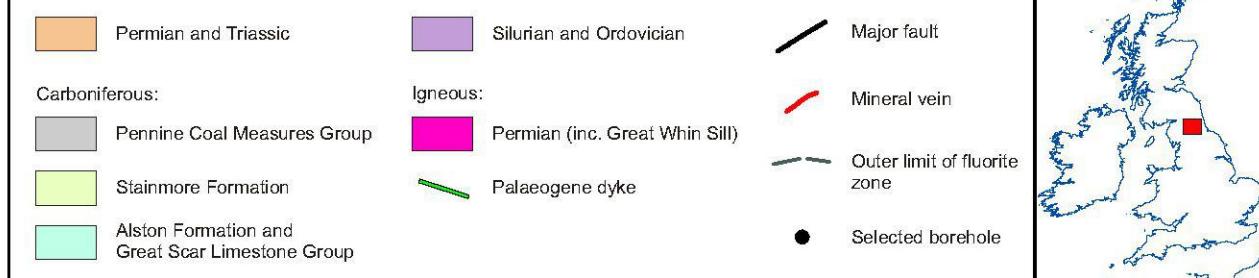
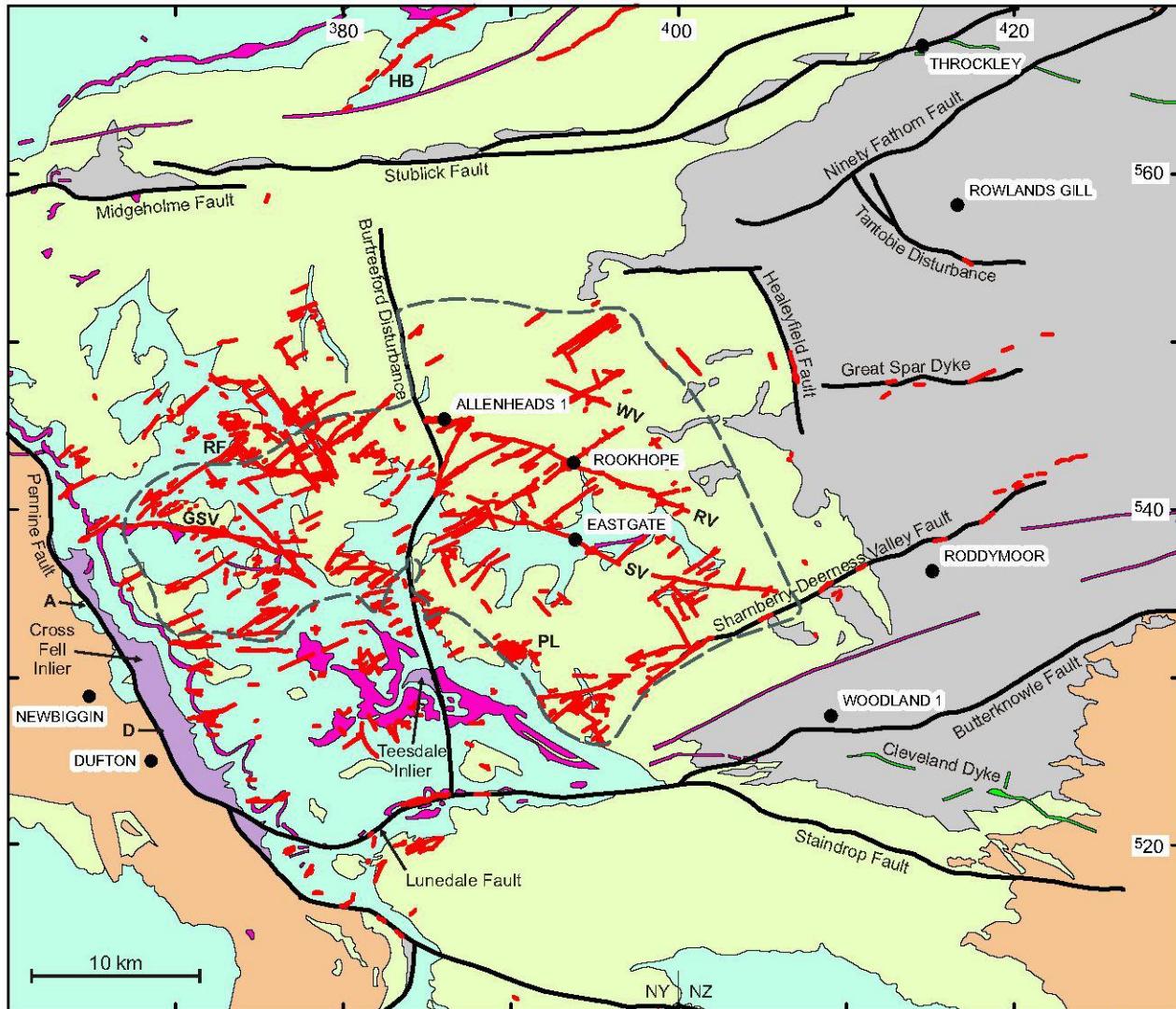
Frosterley Marble

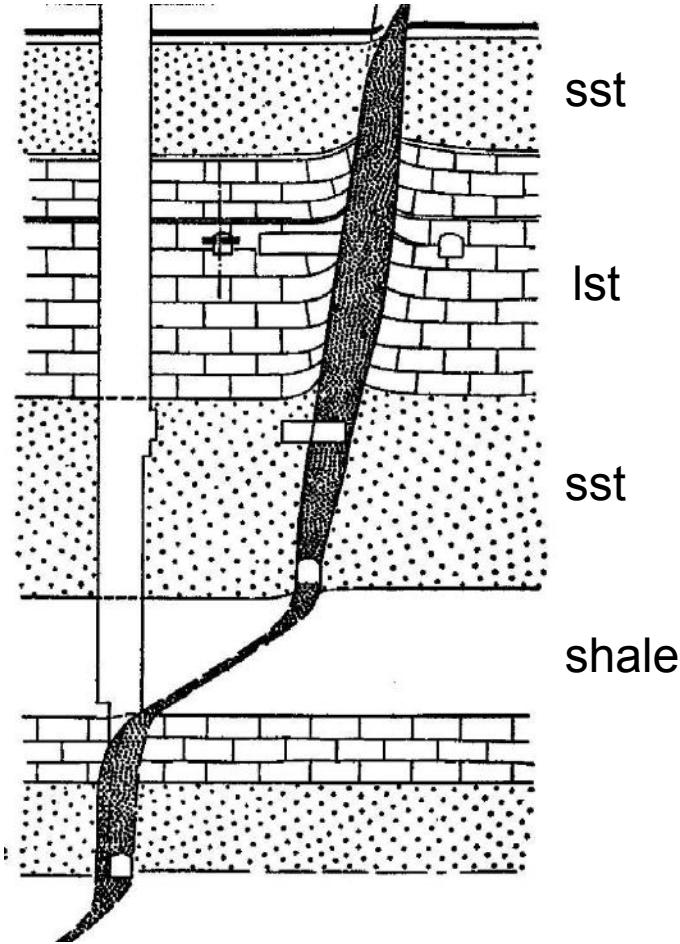
Rogerley Quarry worked for more than 700 years; the decorative columns found in Durham Cathedral date from about 1350.



Stanhope, Weardale



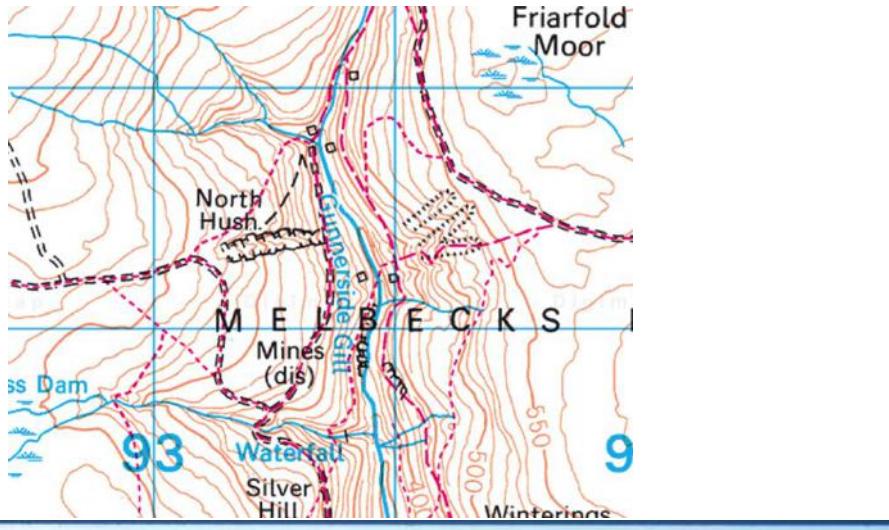




Romans mined Pb in Swaledale

12C record of Pb & Fe mine at Rookhope

17C hushing came into use



Pennines produced

4 Mt Pb – galena PbS with 0.02 % Ag

0.3 Mt Zn – sphalerite ZnS

2.1 Mt - fluorite CaF_2

1.5 Mt - barite BaSO_4

England's largest producer of lead and silver by the nineteenth century, but largely finished by 1920s

Ore minerals



Gangue minerals



2.1 Mt fluorite CaF_2

From 1800s fluorspar mined for use as flux in iron & steel industry, with about 1 - 3 % by weight needed for each ton of metal produced.

Largely finished in 1980 as national steel industry was privatised

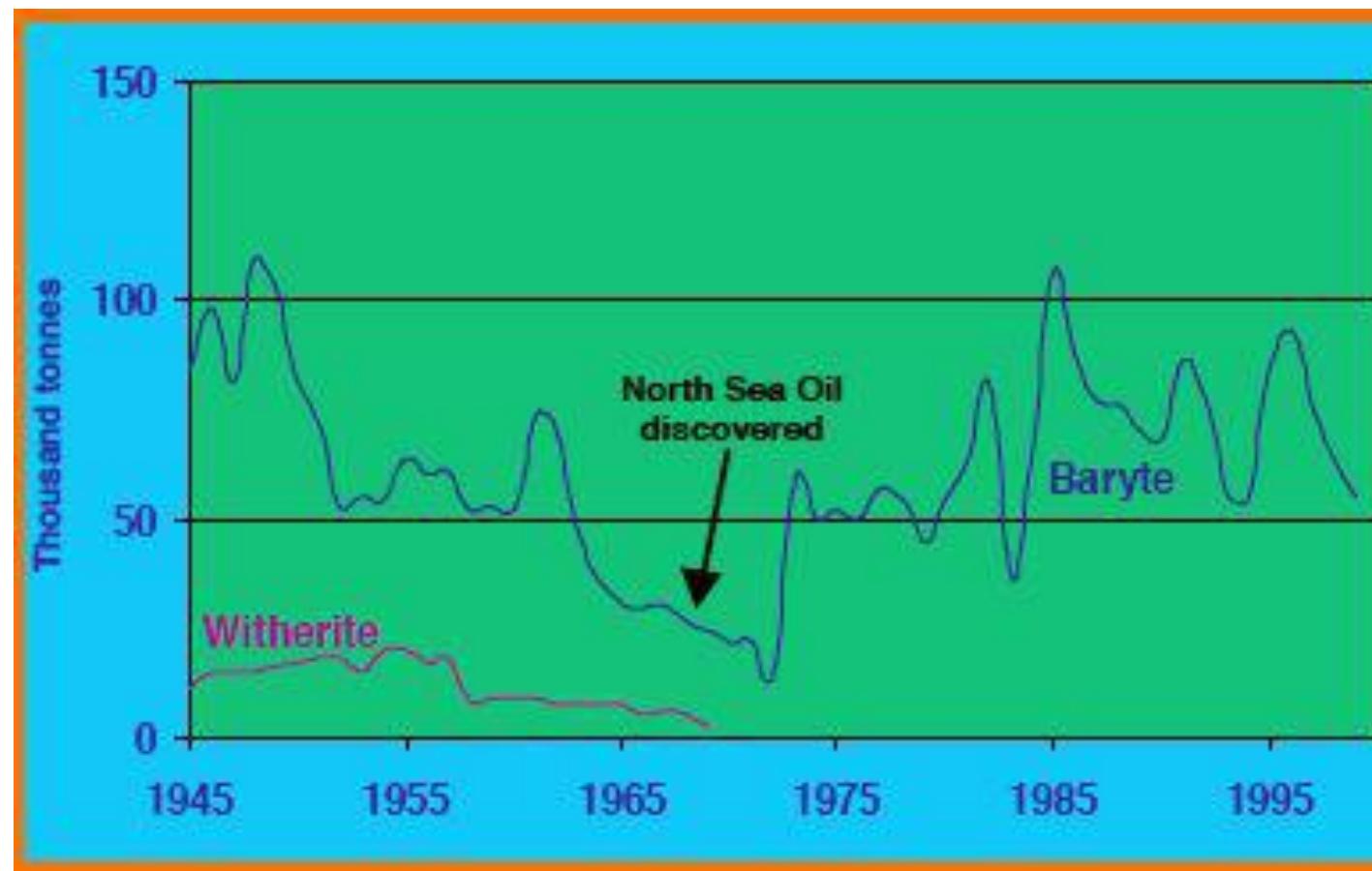
Highest purity used in manufacture of HF acid.
Glazes and hard glossy surfaces and non stick Teflon



No present mining except for small scale activity seeking specimens for mineral trade

1.5 Mt barite BaSO_4

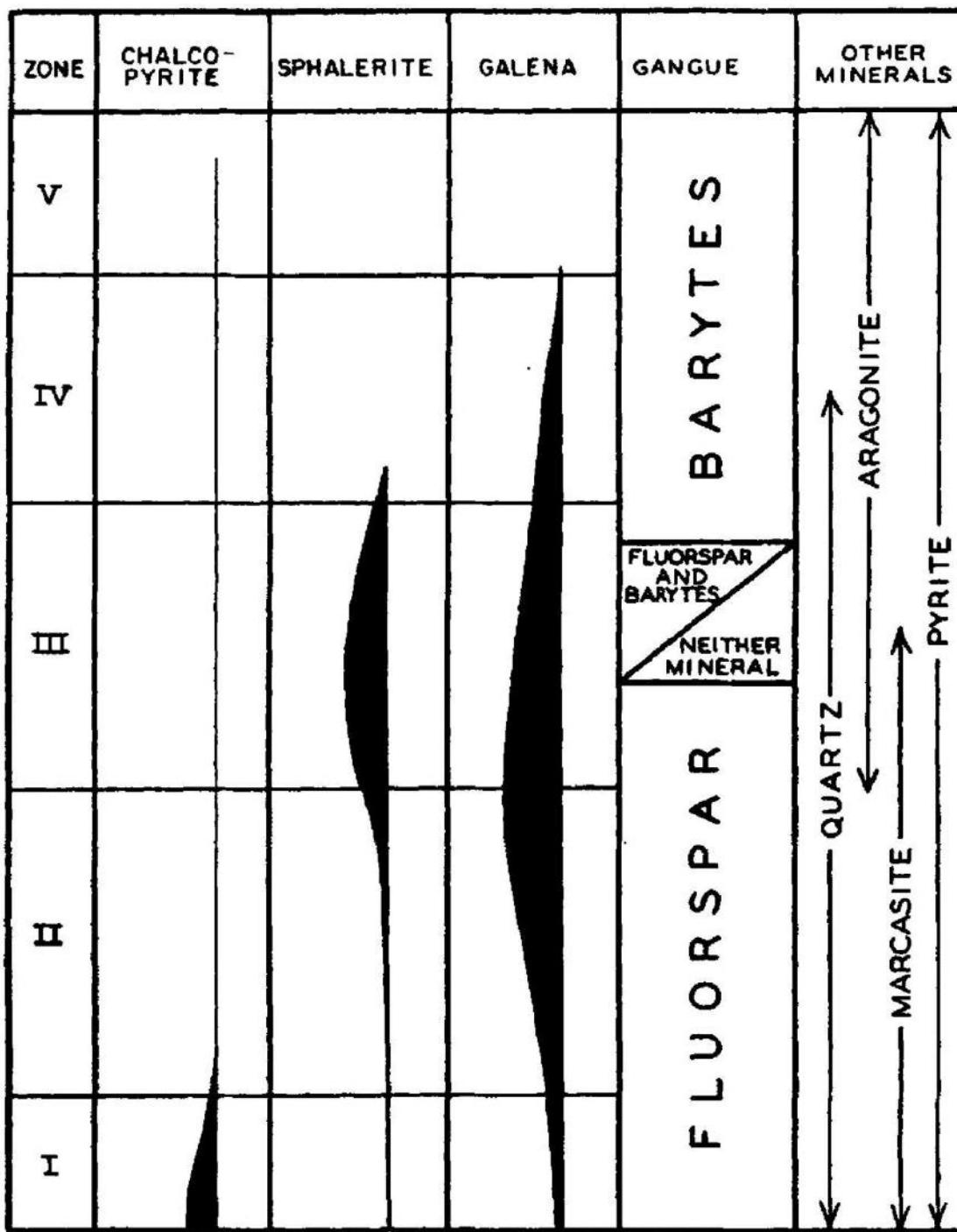
Pigment in paints and as a weighted filler for paper, cloth and rubber. Playing cards have barite between the paper fibers, giving a very high density that allows the cards to be "dealt" more easily.



North Sea used $\sim 200,000$ t per year

Barite (4.5 gm/cm^3 ; quartz 2.6g/cm^3) mixed with drilling mud to prevent "blowouts". Low hardness (~ 3 ; quartz 7) doesn't damage drilling equipment and acts as a lubricant.

Formation of deposits



Dunham 1934



Dunham 1934

From Whin Sill

The zonal arrangement provides definite evidence of derivation from a magmatic source beneath the Pennines.

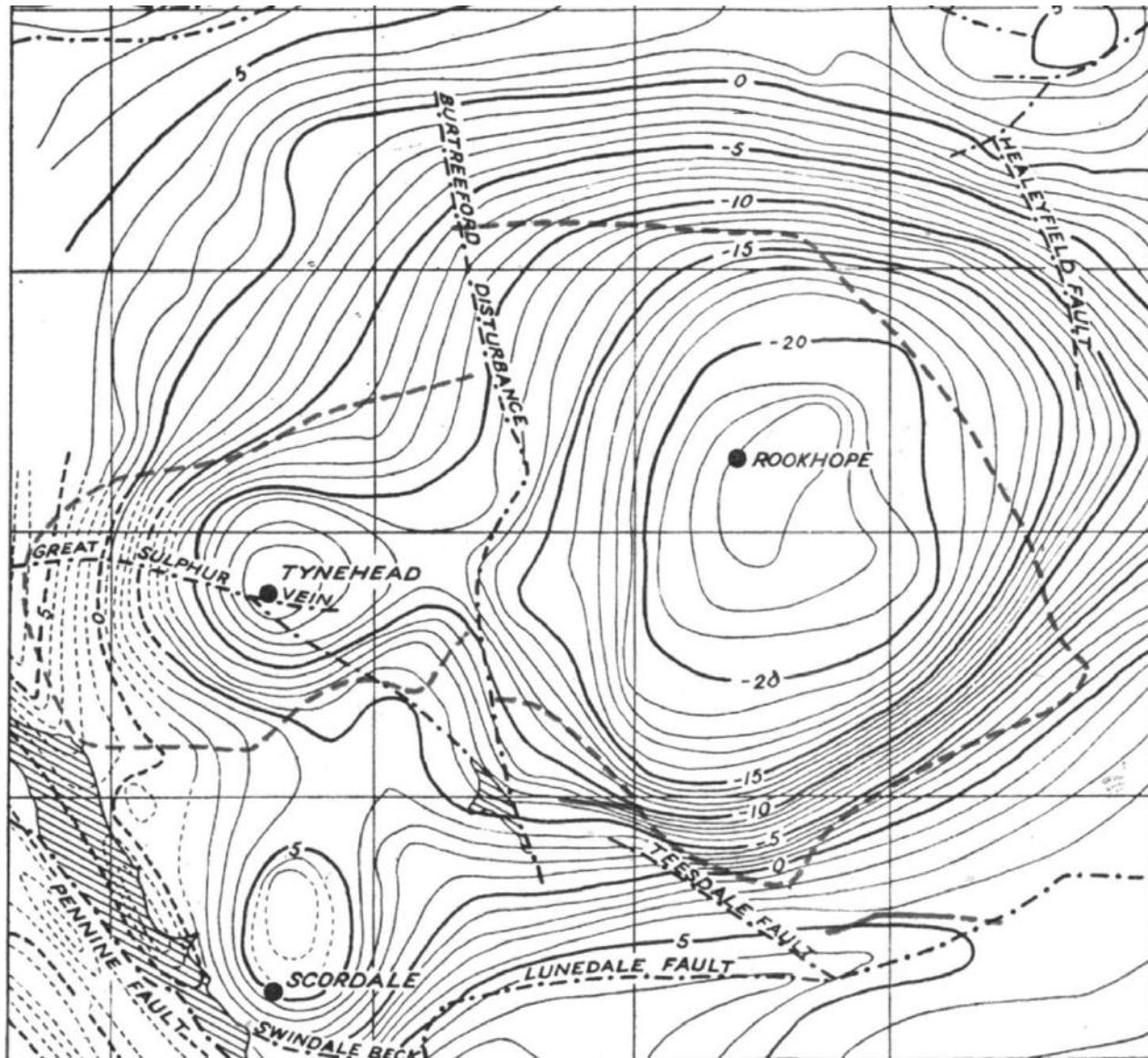


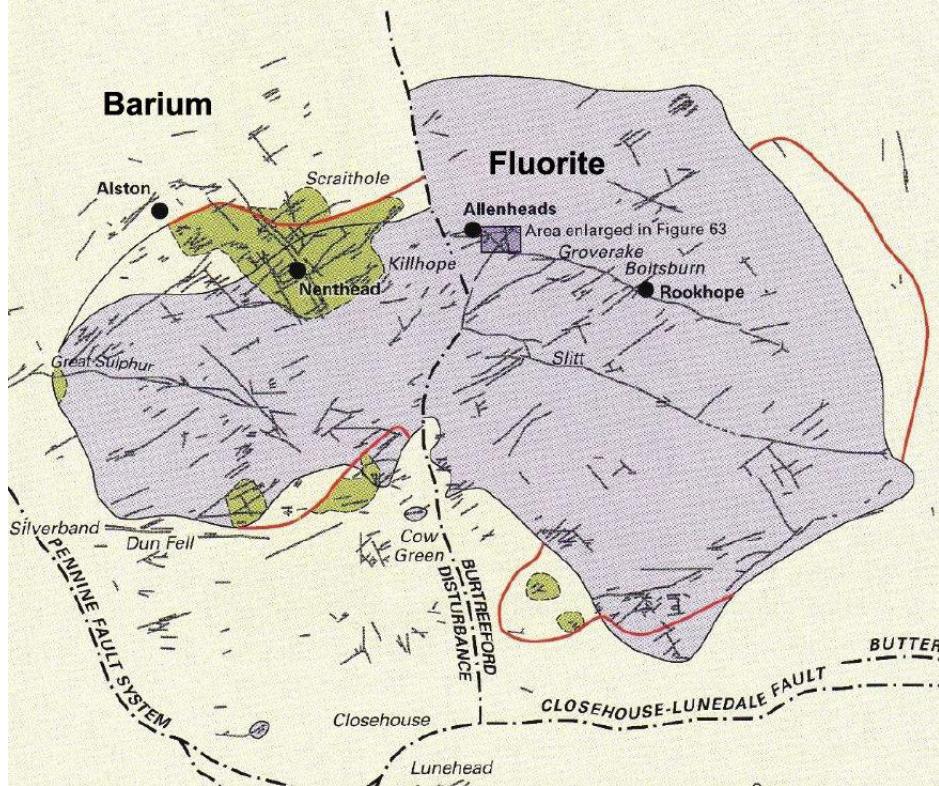
The association of fluorspar with the Cornish granites in hydrothermal and pegmatitic veins are significant facts. Similarly, barytes frequently accompanies mineralization due to hydrothermal solutions from granitic magmas.

Bott 1957

BVS – S Slates	2.74 – 2.77g/cm ³
Lst	2.68
Shale	2.56
Sst	2.42
Granite	2.63

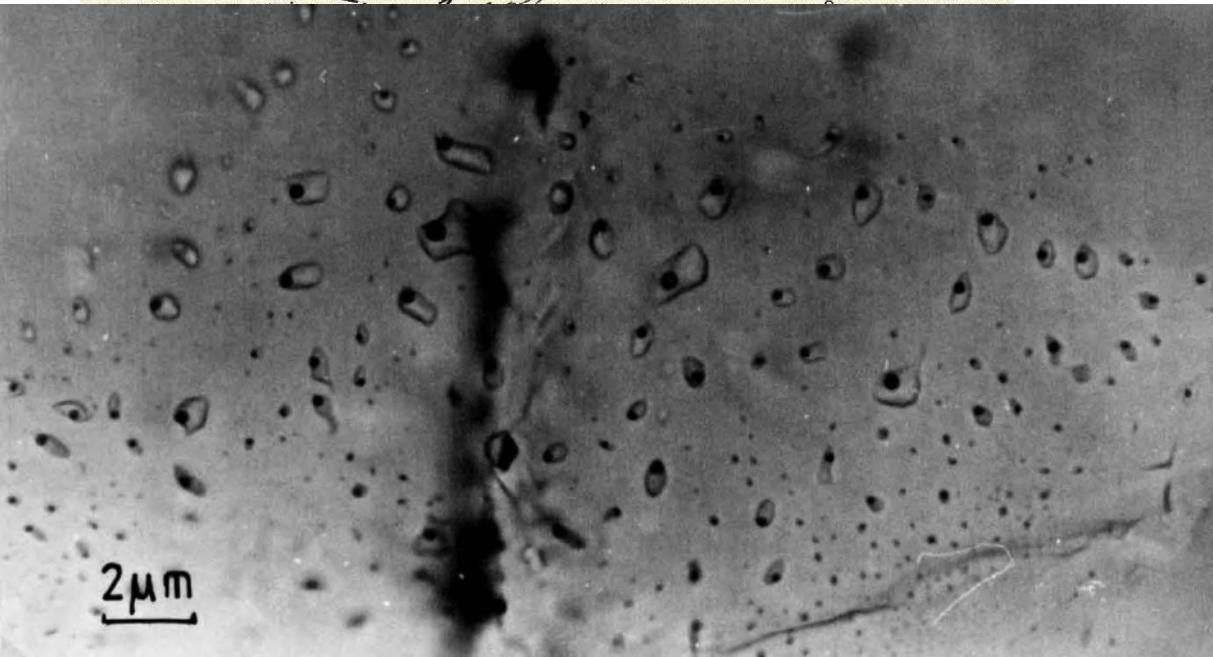
It is concluded that the Alston Block and part of the Durham Coalfield is underlain by an unexposed acid or near-acid intrusion, which is named the "Weardale granite".





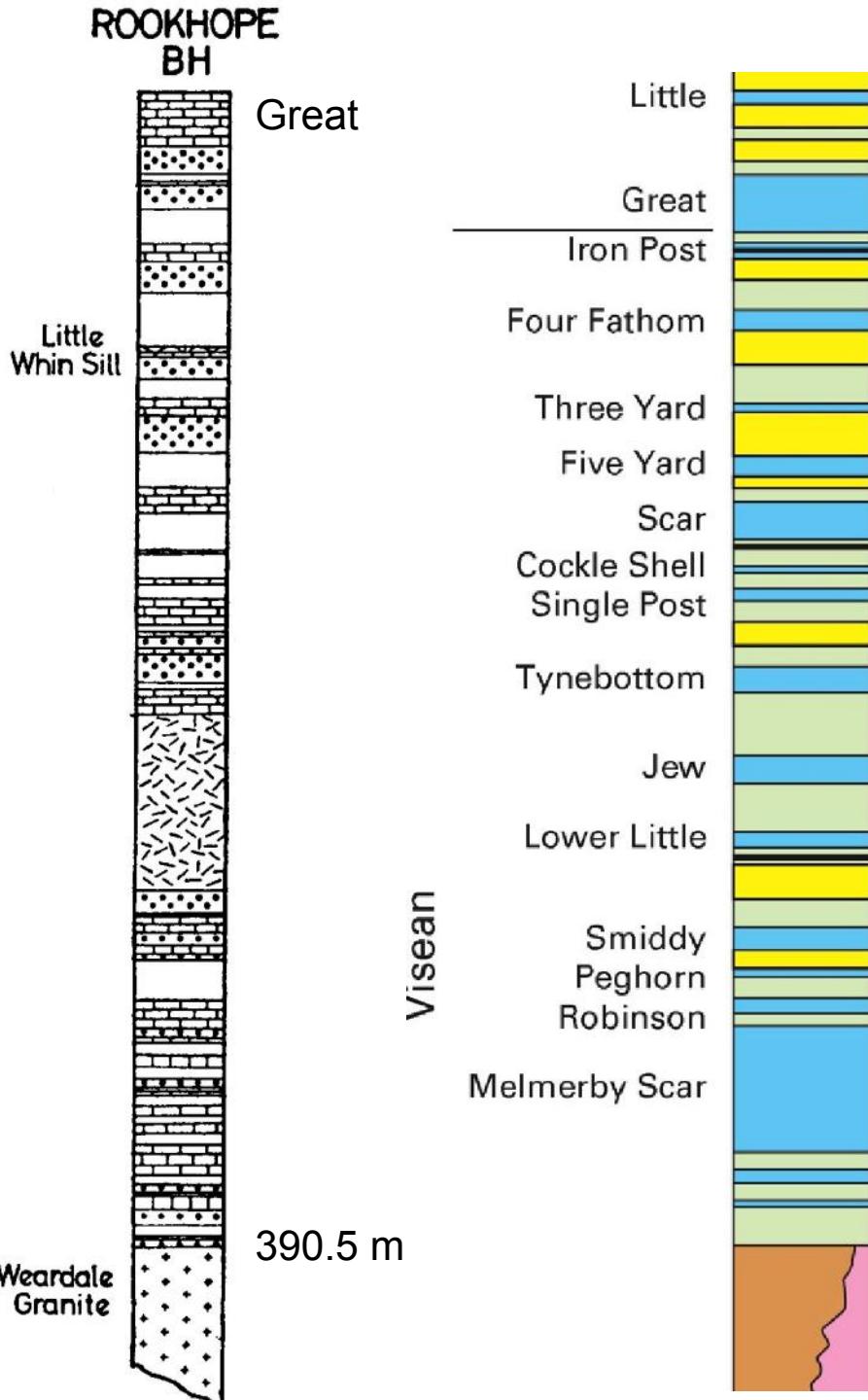
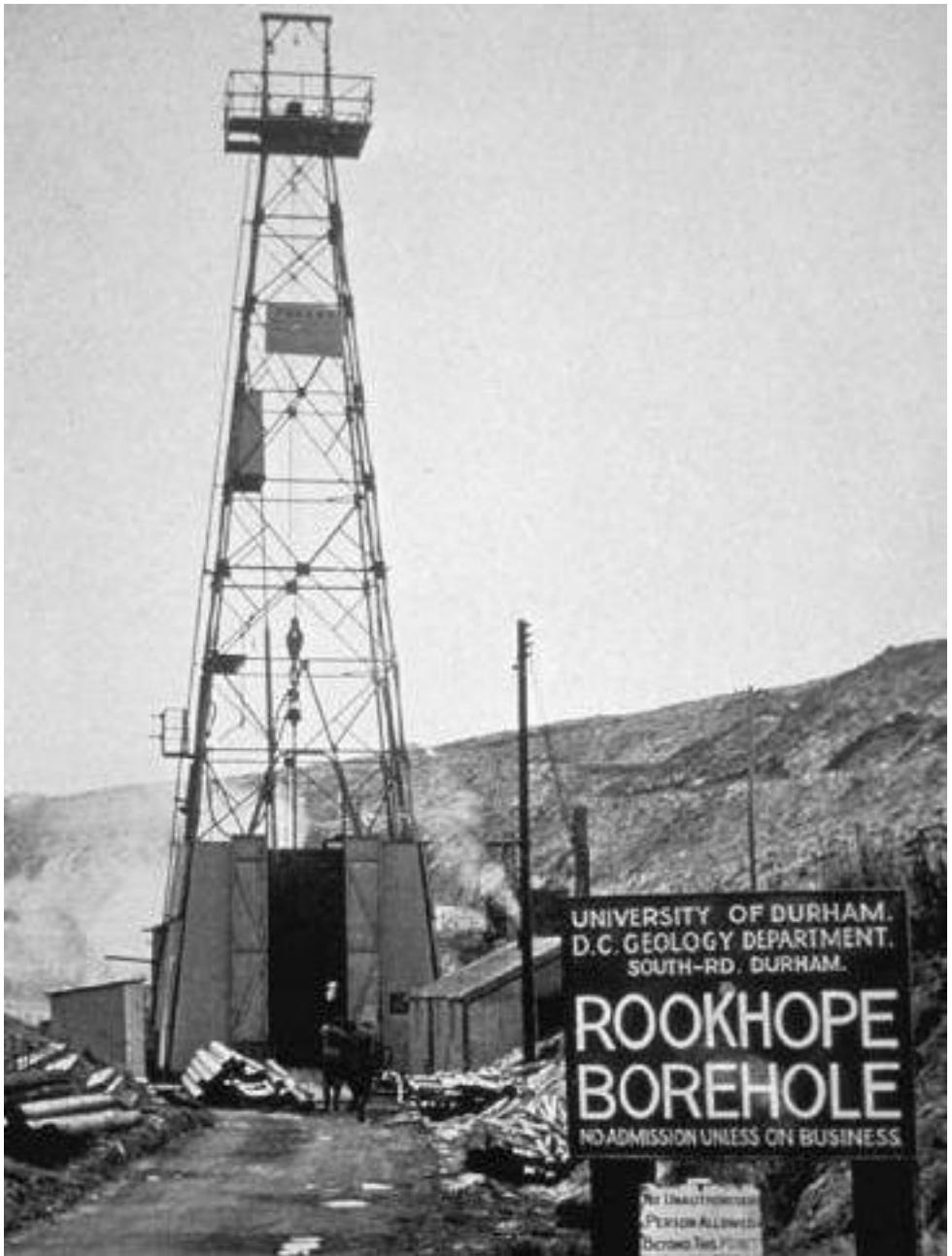
Fluorite zone $> 200^{\circ}\text{C}$

Barite zone $\sim 120^{\circ}\text{C}$



Fluid inclusions

1960-61

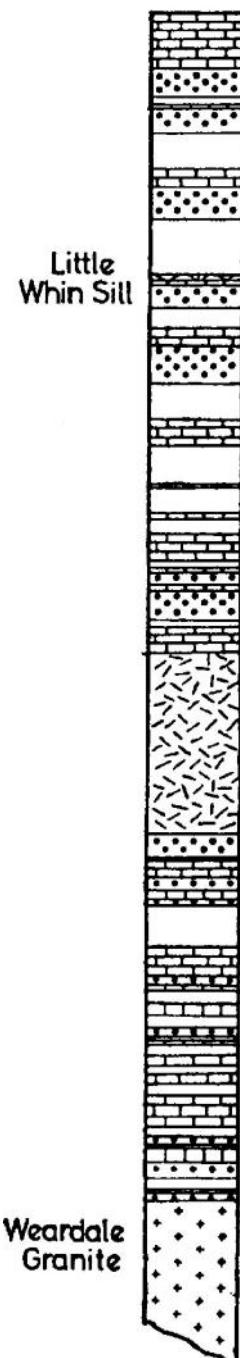


1961

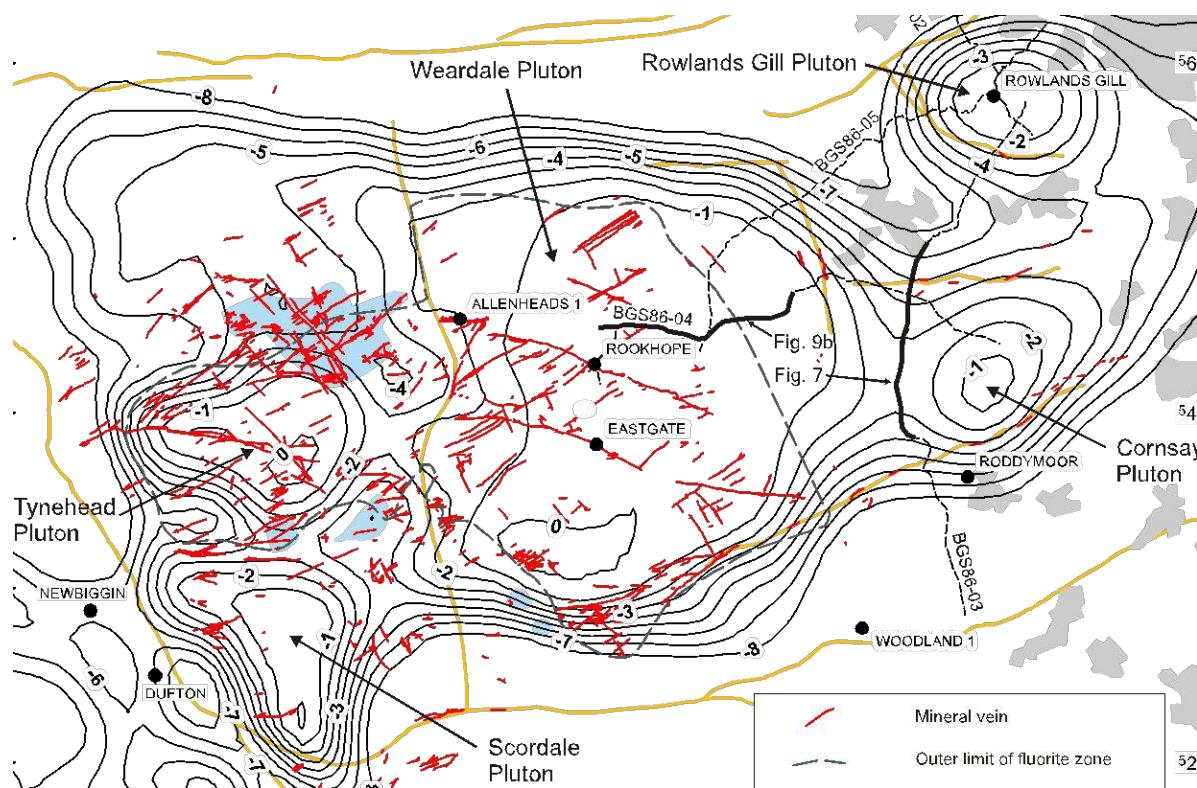
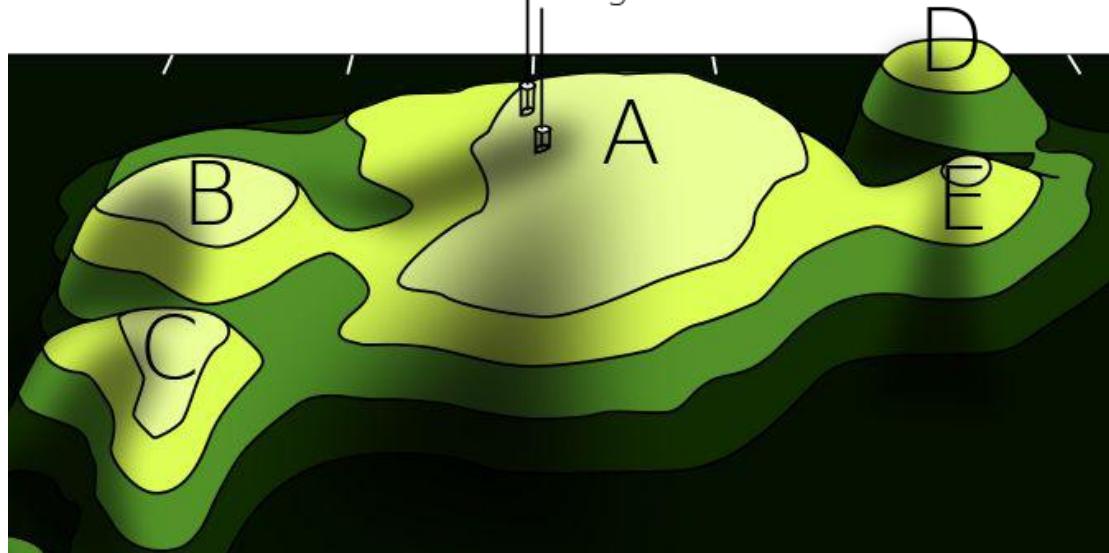
Limestones, black shale with
very thin quartz- and
feldspar-bearing conglomerate
beds rest directly on weathered
granite

Age 399 Ma – early Devonian

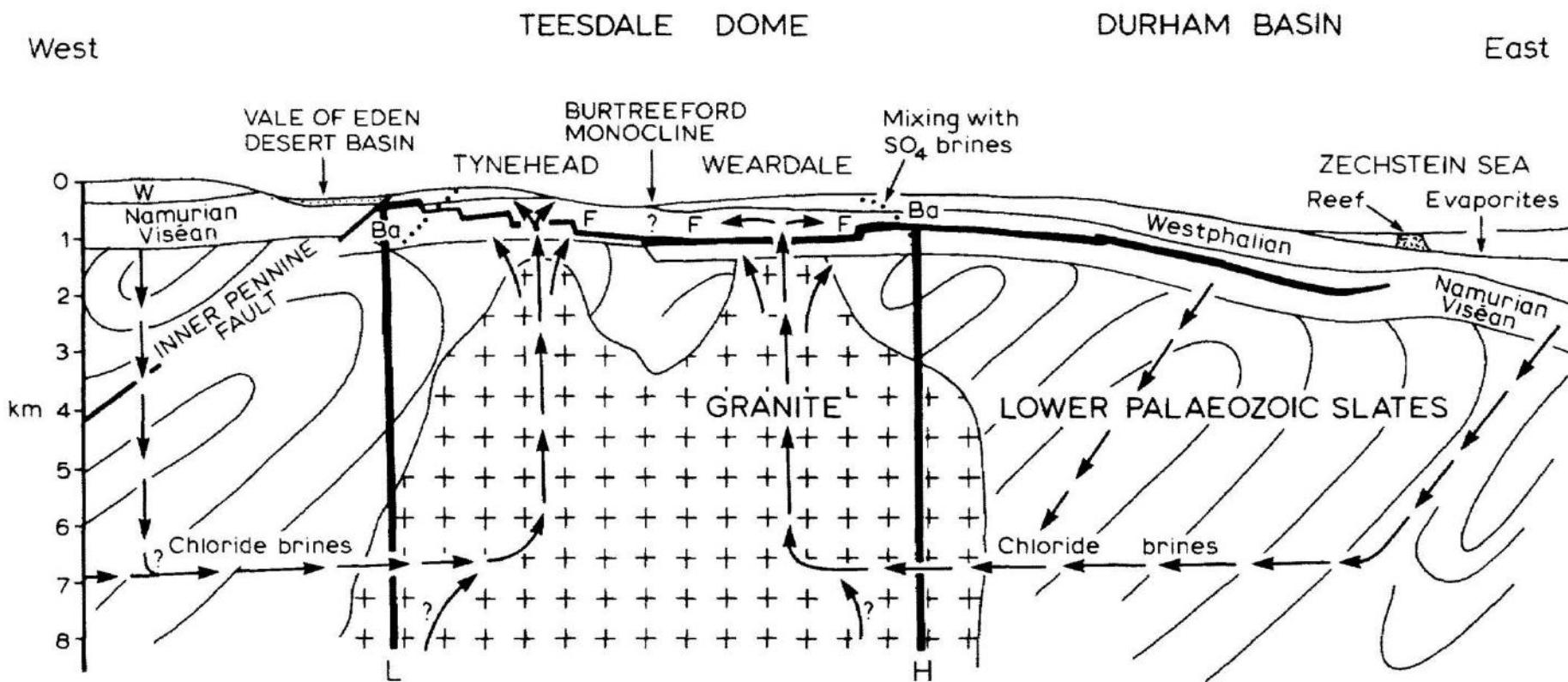
ROOKHOPE
BH



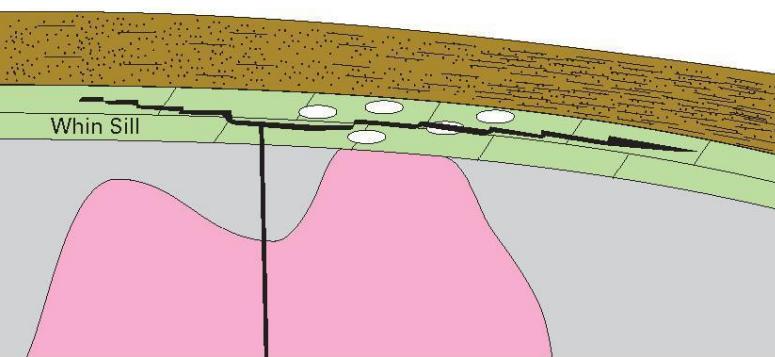
- A – Weardale
- B – Tynehead
- C – Scordale
- D – Rowlands Gill
- E - Cornsay



1970s model

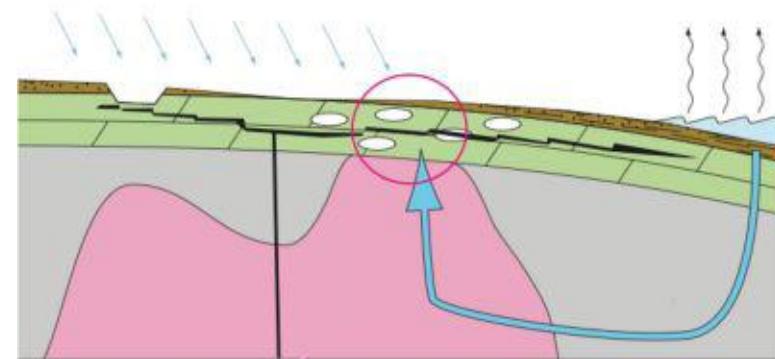


2000 model – Mississippi Valley type



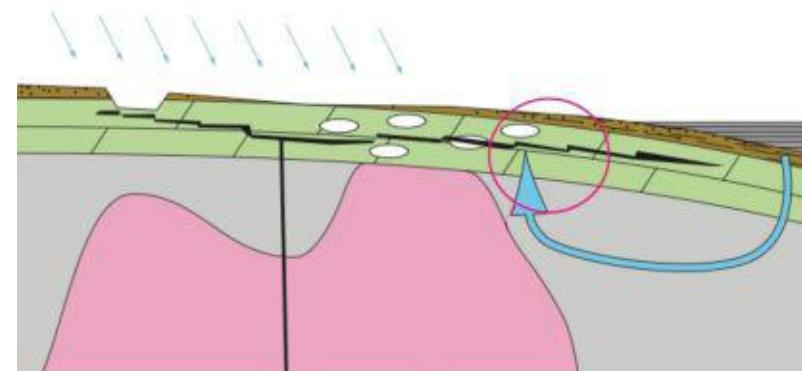
Late Carboniferous extension, fracturing

Whin Sill intrusion



Late Permian

Main Pb-Zn-Fluorite mineralisation from high salinity brines derived from evaporitic Zechstein Sea, then deep circulation to add heat + metals



Triassic

Period of barite mineralisation from brine, but reduced salinity representing waning circulation with reduced metal content and temperature

2015 model: A reappraisal of the age, origin and structural setting of sulphide mineralisation in the UK North Pennines Orefield

The orefield has long been considered to be a classic example of a Mississippi Valley Type (MVT) deposit where the source of the metals and sulphur are derived by hydrothermal leaching of the host sedimentary (carbonate-rich) rocks.

New Rhenium-Osmium (Re-Os) isotope geochemical analysis of the ***pyrite*** mineralization suggests that:

- (i) the metalliferous ores of the NPO formed c. 294 Ma (earliest Permian)
- (ii) they carry an initial Os ratio indicative of a mantle source similar to that indicated by the initial Os ratio of the Whin Sill dolerite suite (emplacement ages ca. 297-294 Ma).

We conclude that mineralization is genetically linked to a mantle source associated with Whin Sill intrusion and deformation in the early Permian.

Previous models suggesting that the NPO is a classic example of a MVT mineral deposit or that the mineralizing fluids are related to the influx of Mesozoic brines are largely incorrect.

2019 model

Alston fluorites have neodymium isotopes indicate a crustal source from Lower Carboniferous shales

Mineralization of the Mississippi-Valley Type usually lack association with igneous activity. We show that some of the fluids responsible for the NPO mineralization were influenced by magmatic sources.

The RE systematics in Alston fluorites may be linked to an interaction of the Permian-age Whin Sill dolerite with the basement granite, which heated fluids and focussed fluid flow into the overlying sedimentary rocks.

?

