Bath Geological Society Presentation

Chris Pullan & John Donato

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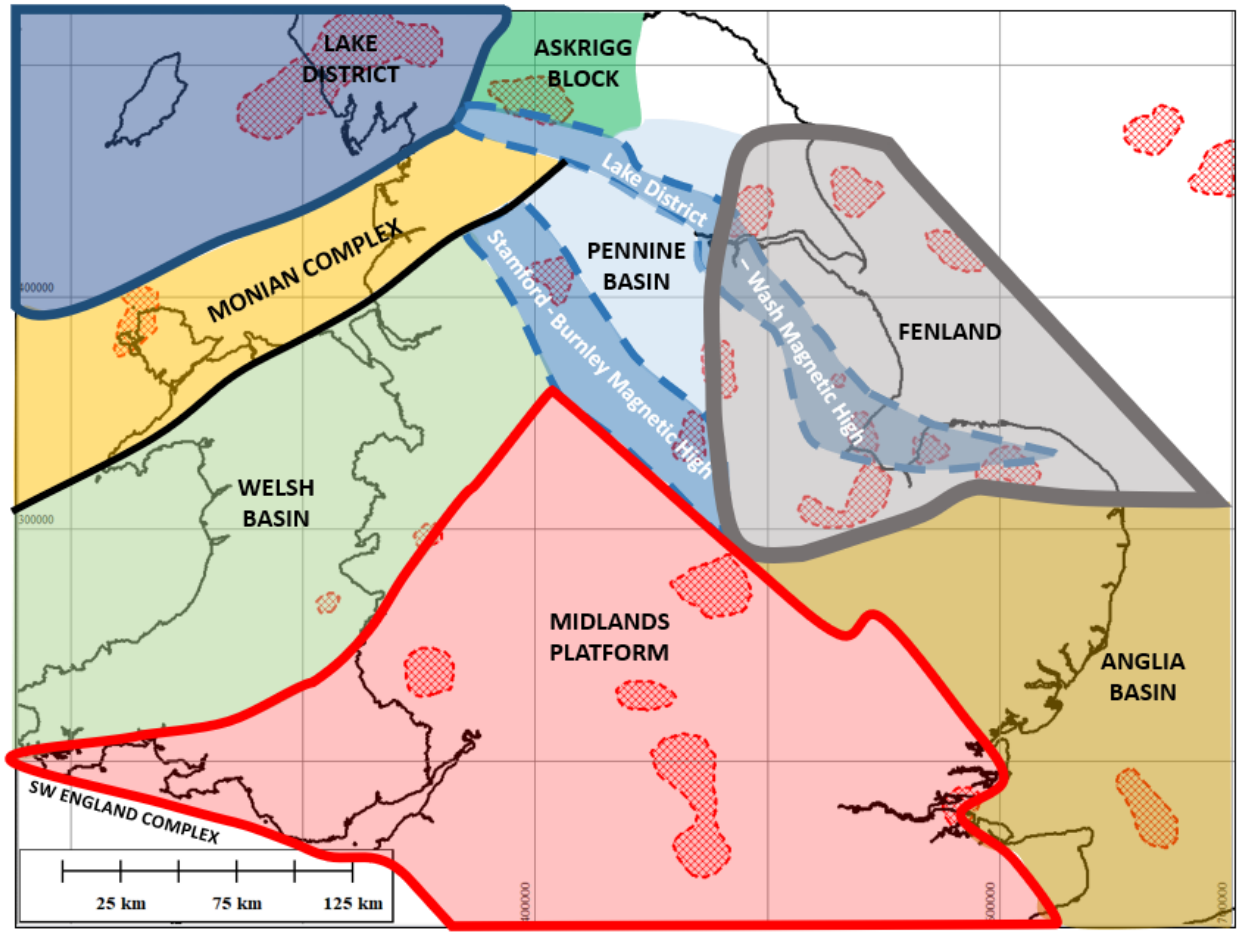
Beneath Britain Study

- Key Objective - Trying to understand gravity and magnetic data and explain the anomalies recognised

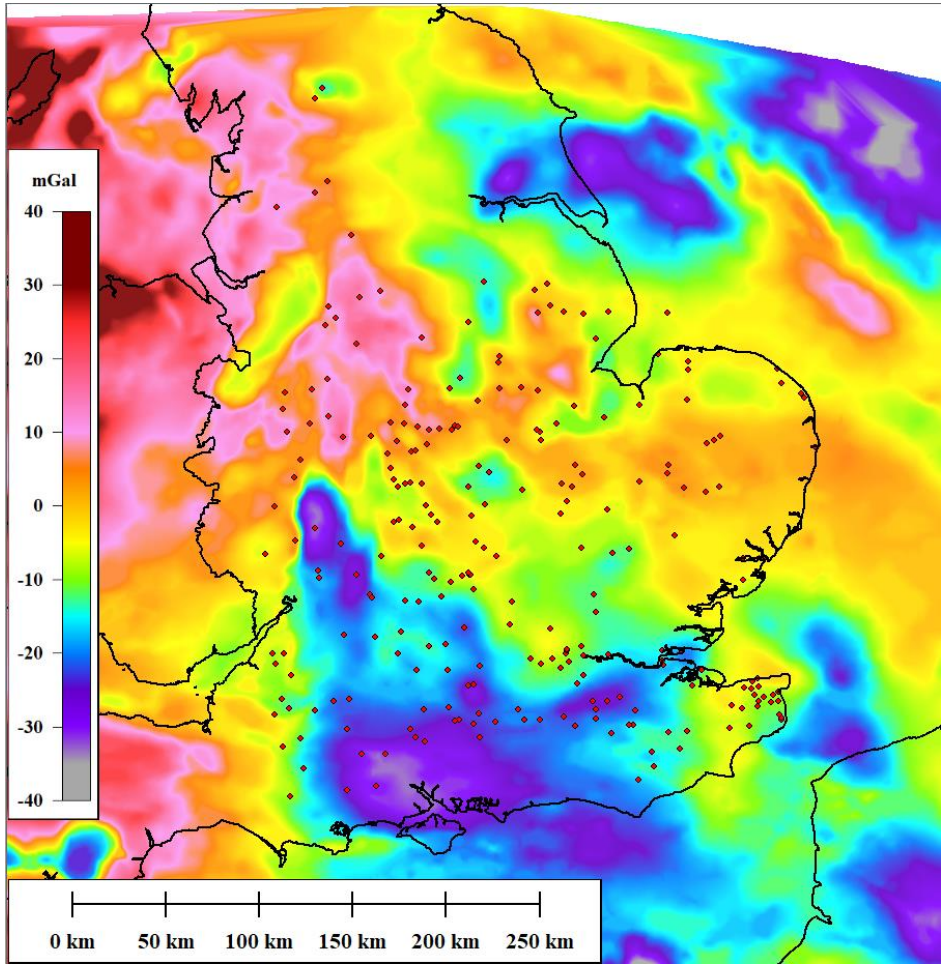
- Collected all available data
- Reviewed stratigraphy in all deep wells
- Constructed Gravity and Magnetic Profiles
  - Strip the effects of known geology along the profiles and identify anomalies
  - Regional stratigraphic stripping – removing effect of post Permian cover
- New Moho Depth Map incorporating results from different branches of geophysics

- Still more anomalies require explanation

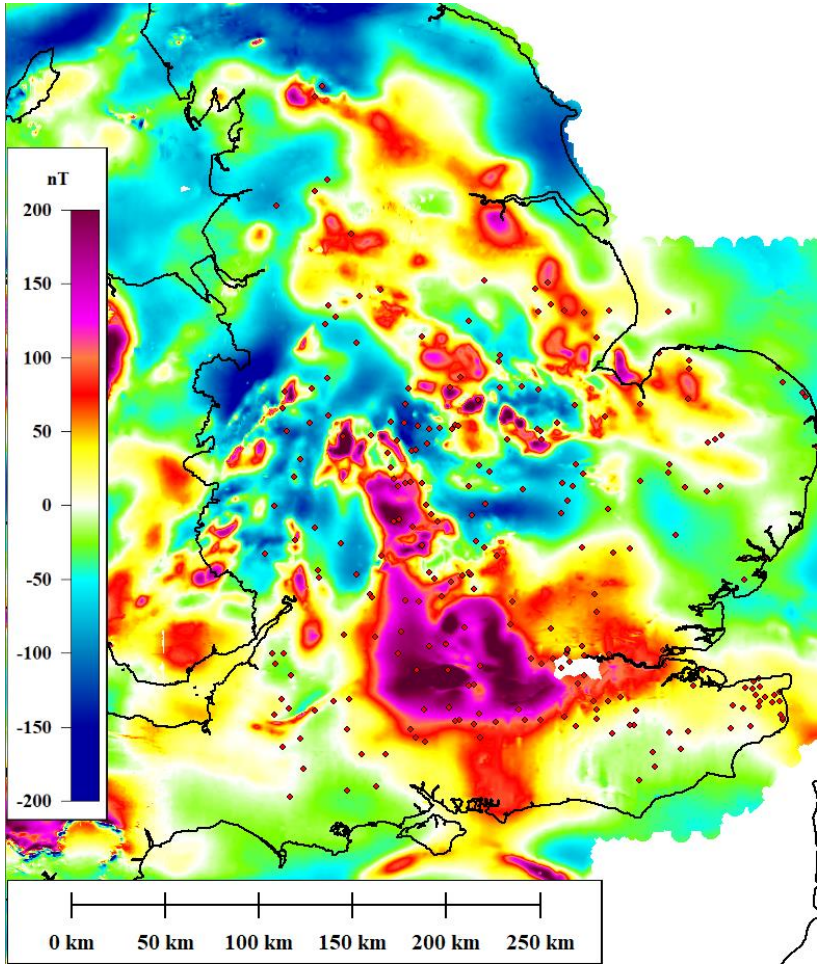


DATA

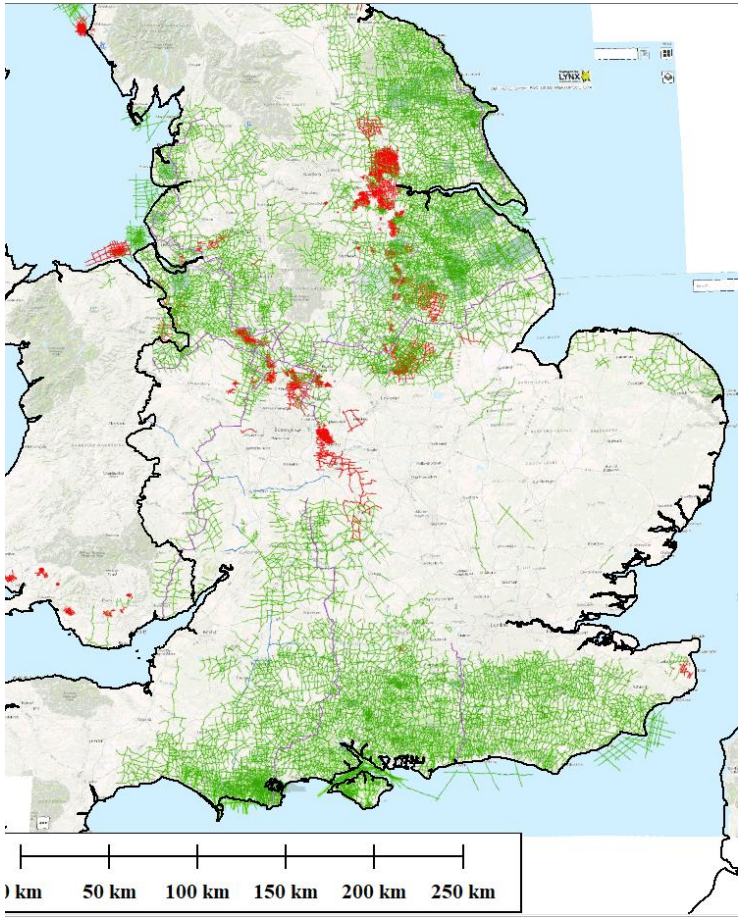
Geophysical Database



Gravity – BGS Bouguer Map*



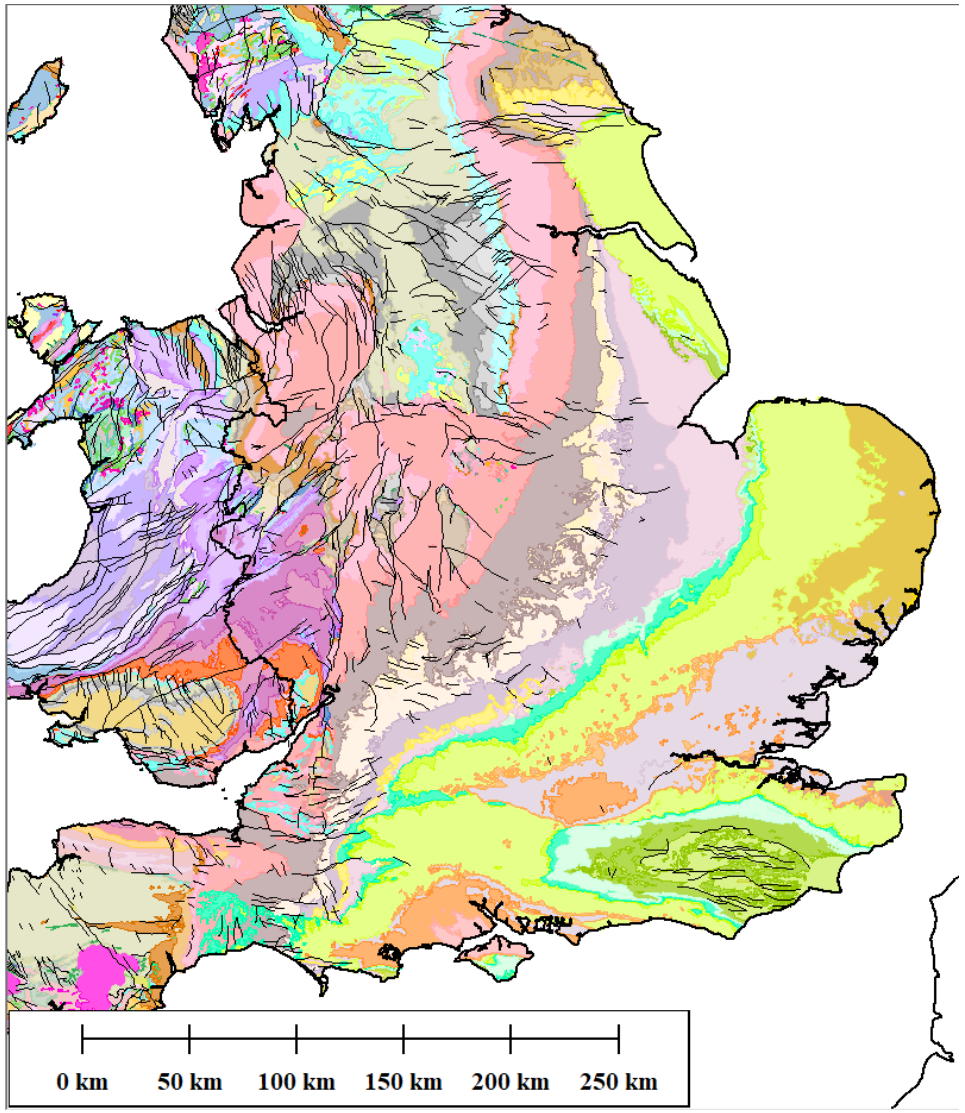
Magnetic – BGS Magnetic Map*



Seismic – UKOGL Database

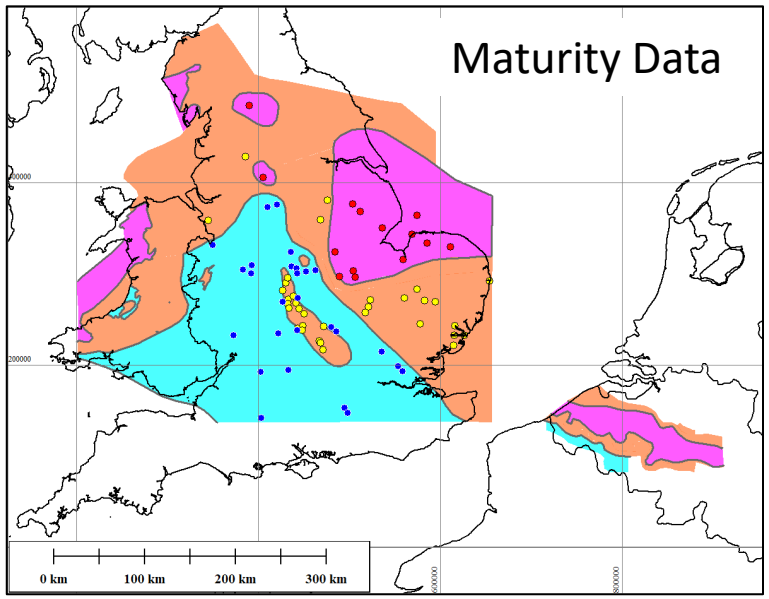
Geological Database

- Outcrop geology and sheet memoirs, as well as regional memoirs from the BGS
- Well data
  - Lithology
  - Stratigraphy
  - Electric Log data
  - Palaeontology
  - Maturity
  - Other borehole data
- Published data

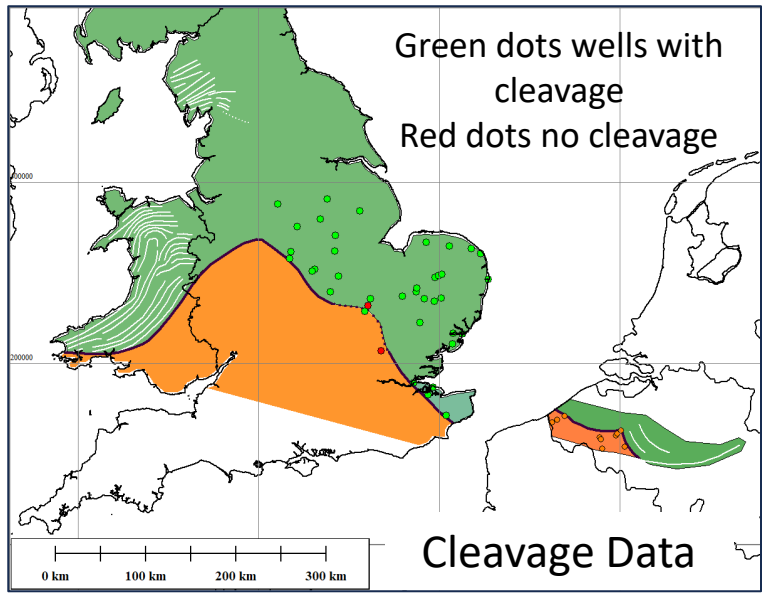


UK- Surface Geology Map*

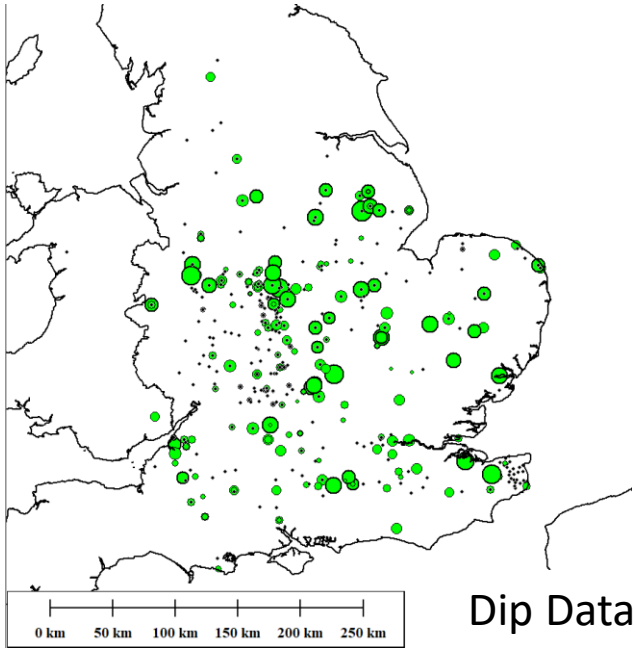
Well Database



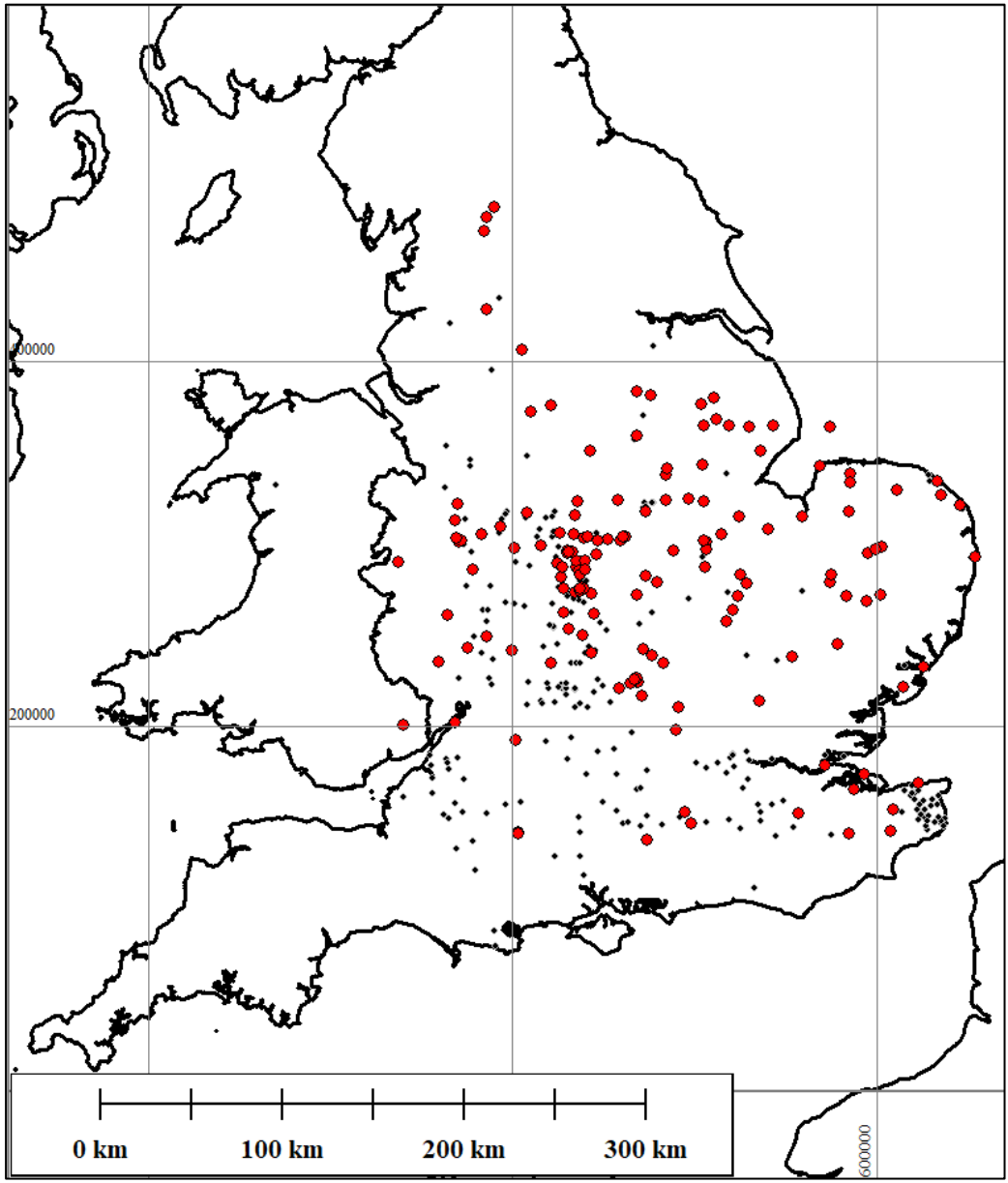
High - Epizone
Moderate - Anchizone
Low - Diagenetic



Circle size shows magnitude of dip
Large circle = steep dip



Dip Data

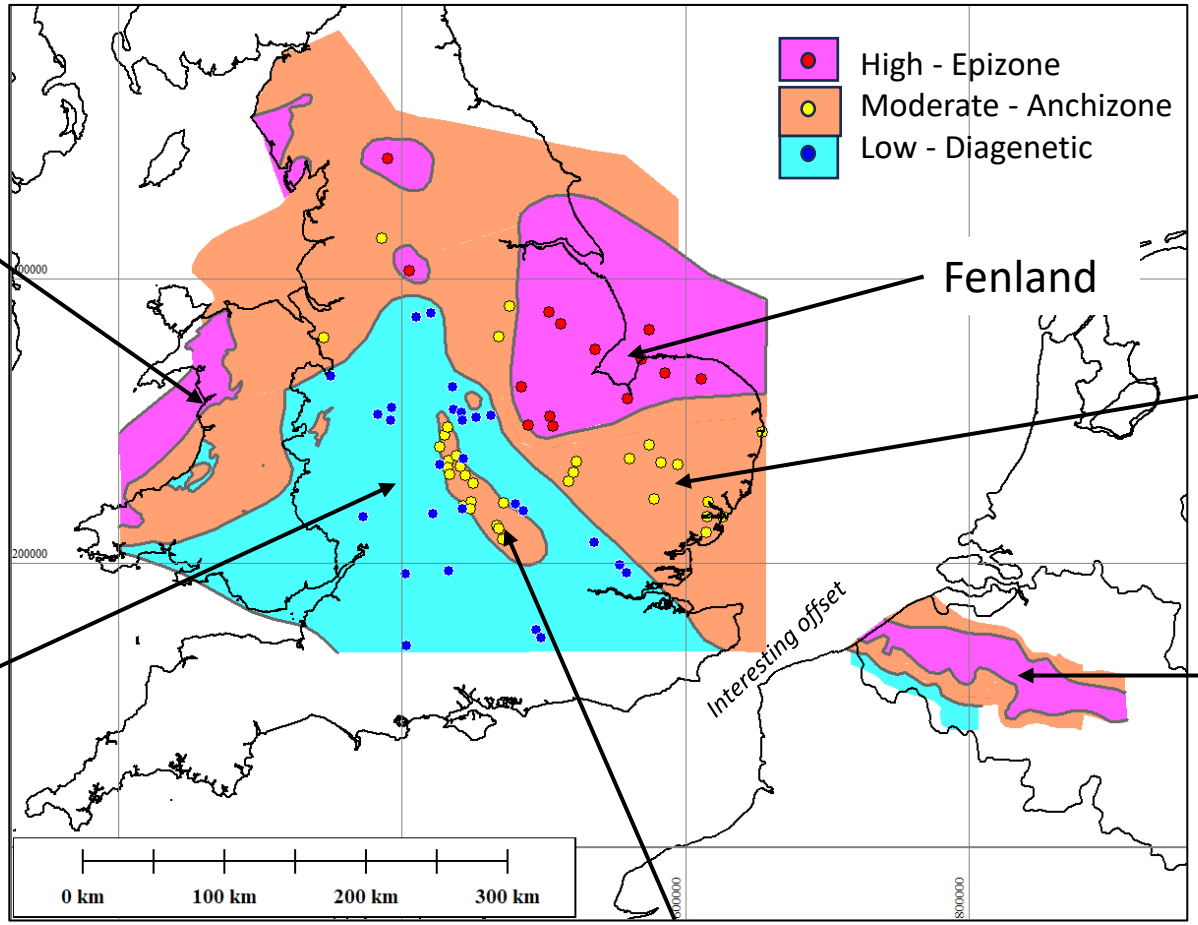


360 Selected Boreholes reaching the Palaeozoic with large dots showing wells reaching the Lower Paleozoic (140)

Geological Database problems

- Sparse sampling vertically and spatially in the Lower Paleozoic
- All rocks are hard and indurated, metamorphosed, and often highly deformed with steep dips, veining and fracturing
- Data availability and the problem of lithological Identification
  - Descriptions - Limited stratigraphic penetrations, with a reliance on cuttings
  - Lithology – often difficult to differentiate sedimentary beds and volcaniclastics. Intrusions easier. Sandstones are generally called quartzites, but based on the lithological descriptions, seem too quartz poor to be considered quartzites
  - Palaeontology – difficulties due to lack of fossil presence, degree of maturity, the reworking of microfossils
  - Radiometric Age dating – problem of widespread resetting of Rb-Sr dates during the Acadian – U-Pb dates more reliable
  - Metamorphism
  - Igneous chemistry – problem that volcaniclastics of Precambrian and Ordovician age have similar chemistry
  - The same stratigraphic relationship exists between quartzites and underlying volcaniclastics at the base of the Cambrian and the base Arenig (Ordovician) –
    - Cambrian Hartshill quartzite unconformably overlies Precambrian Caldecote Volcanic Formation at Nuneaton
    - L.Ordovician Lickey quartzite on Barnt Group volcaniclastics at Lickey

Lower Paleozoic Maturity Data



Welsh Basin

Fenland

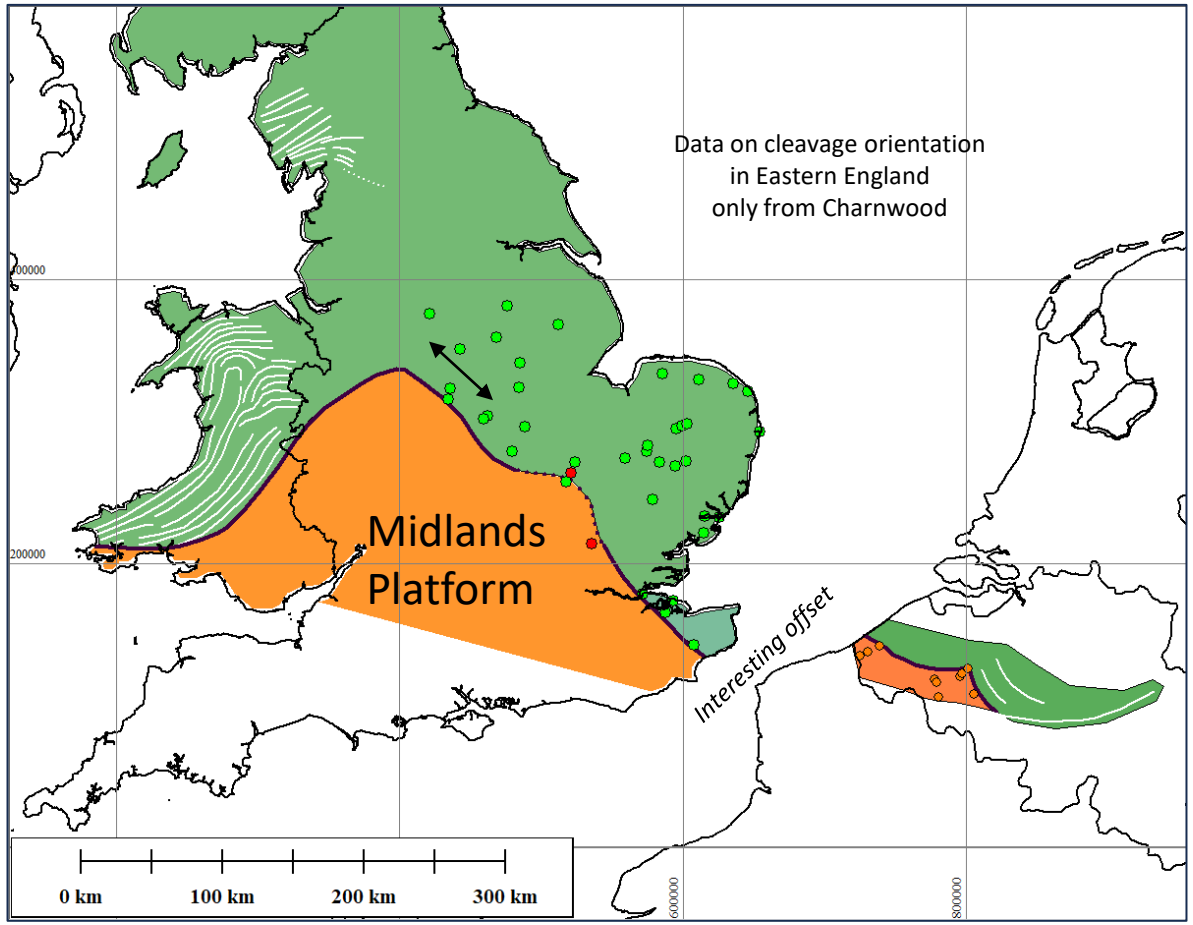
Anglia Basin

Midlands Platform

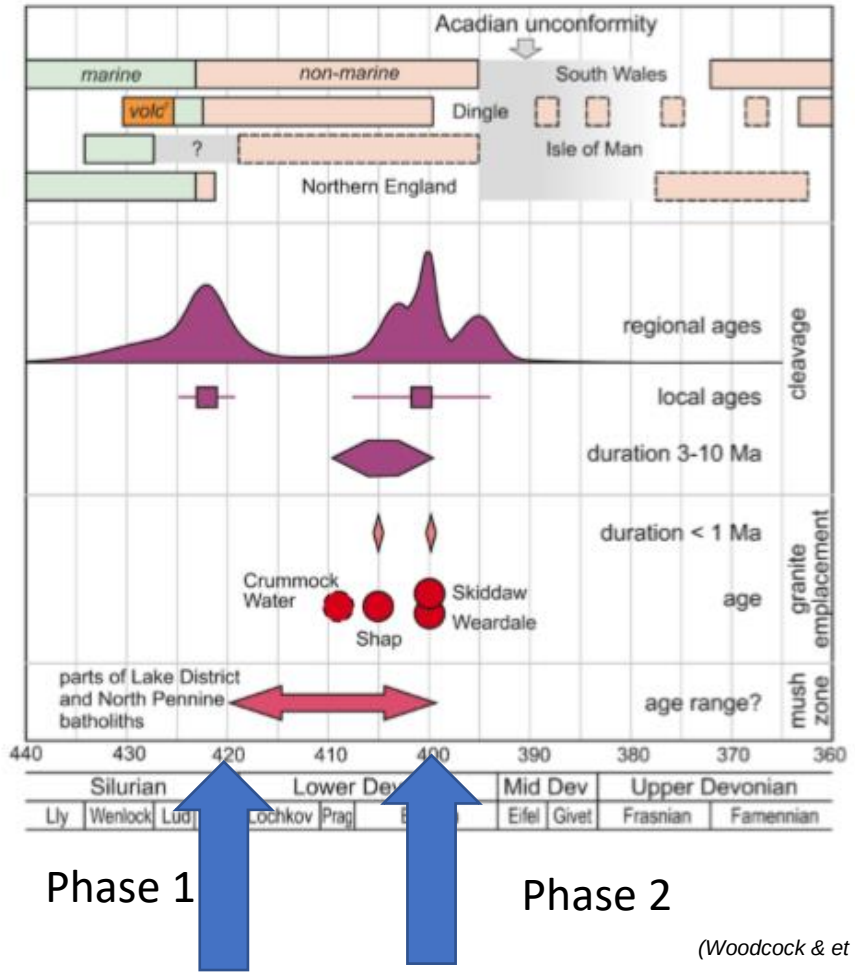
Brabant Basin

Aylesbury – Tamworth High

Acadian Cleavage Data



- No cleavage recognised in wells on the Midlands Platform

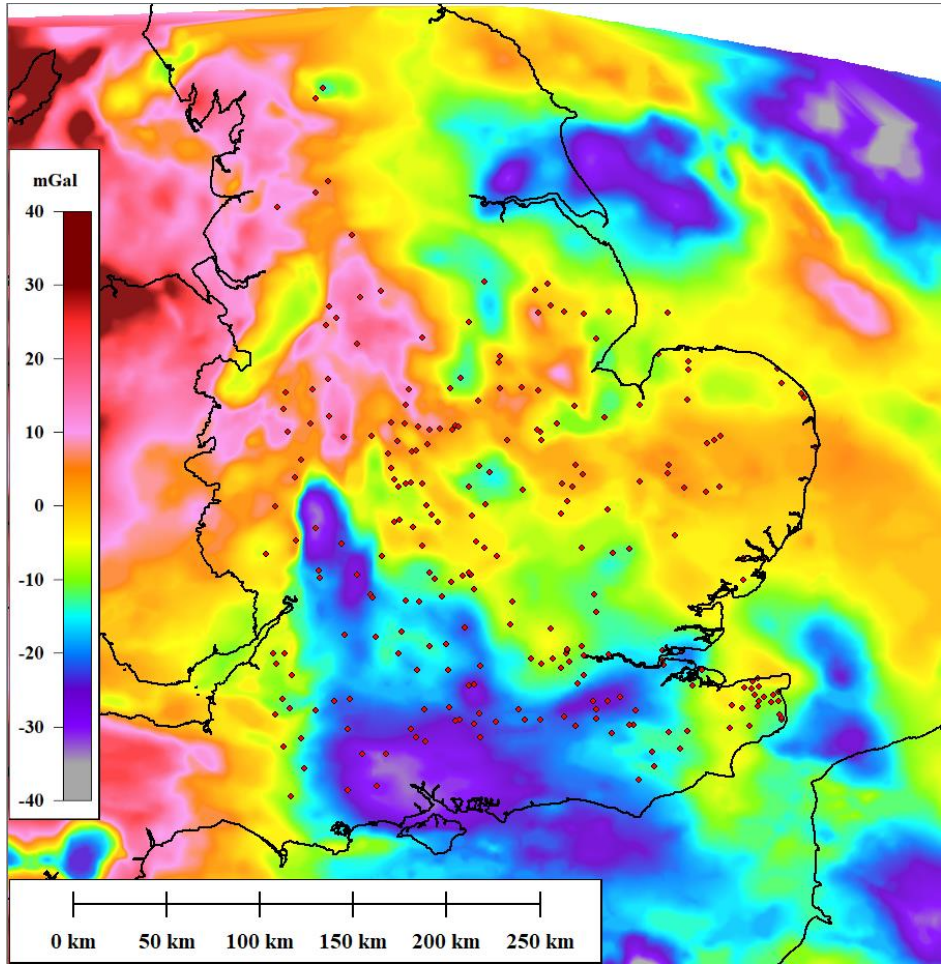


(Woodcock & et al,2019)

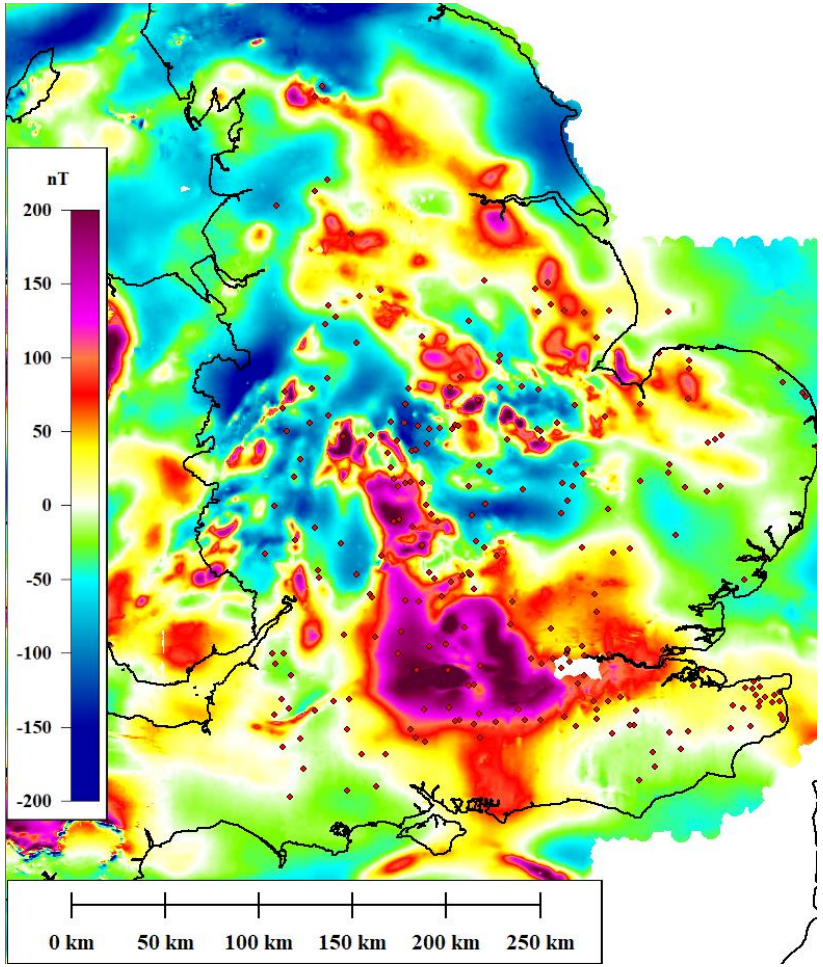
- Two episodes are recognised:
  - Phase 1 432- 418 my (Late Silurian) Folding and faulting of Eastern England and cleavage formation - recognised in Eastern England and Belgium
  - Phase 2 400my (Lower Devonian – Emsian) Cleavage and folding in Wales and Lake District, with the inversion of the Welsh Basin, marked by Middle Devonian unconformity

ANALYSIS OF GEOPHYSICAL DATA

Geophysical Analysis

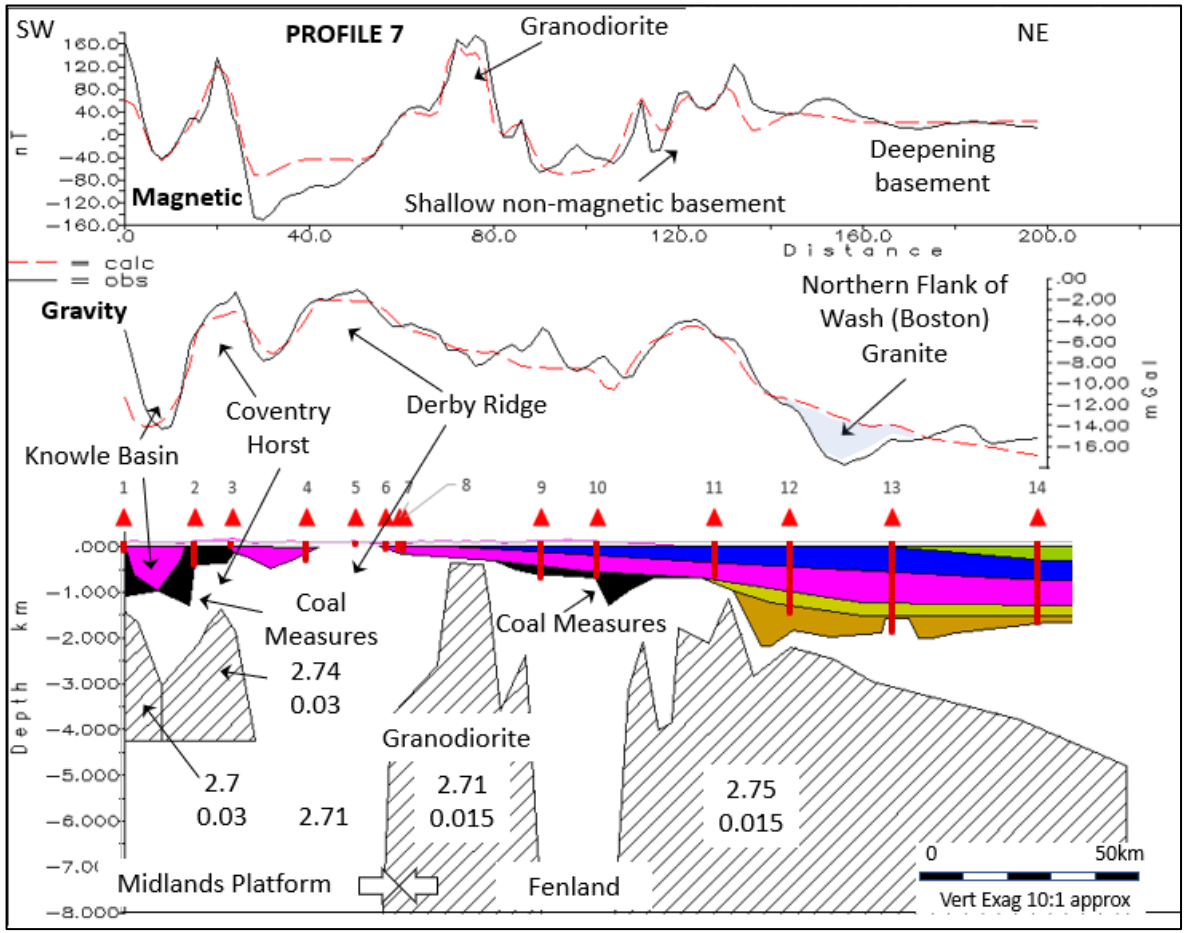


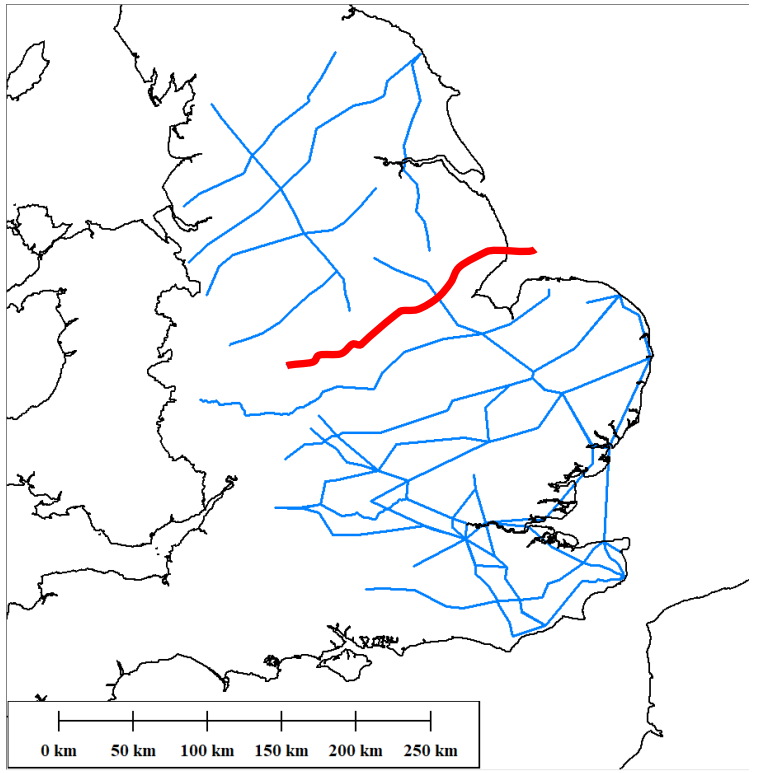
Gravity – BGS Bouguer Map*

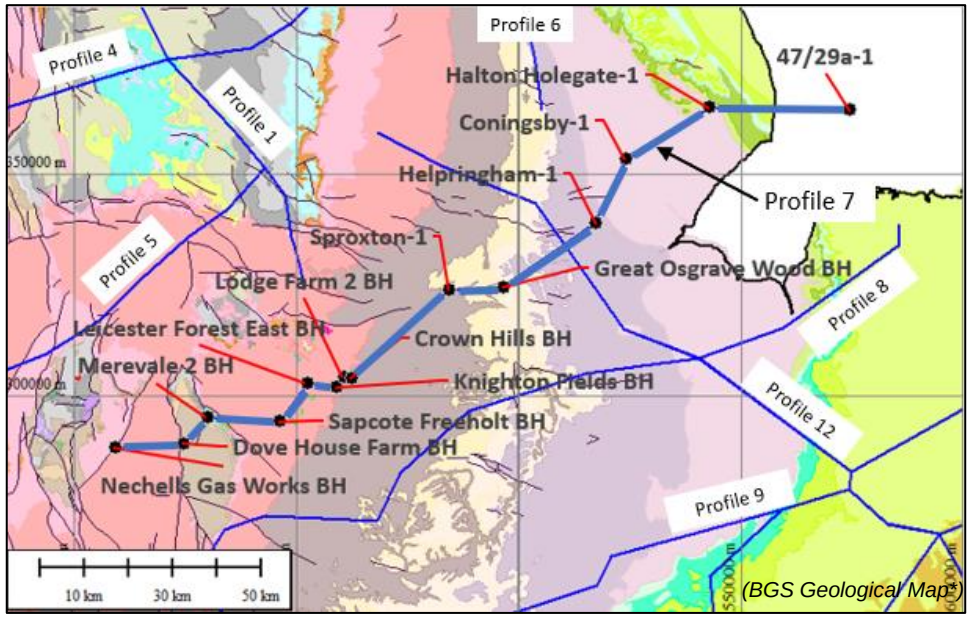


Magnetic – BGS Magnetic Map*

Gravity and Magnetic Profile Work

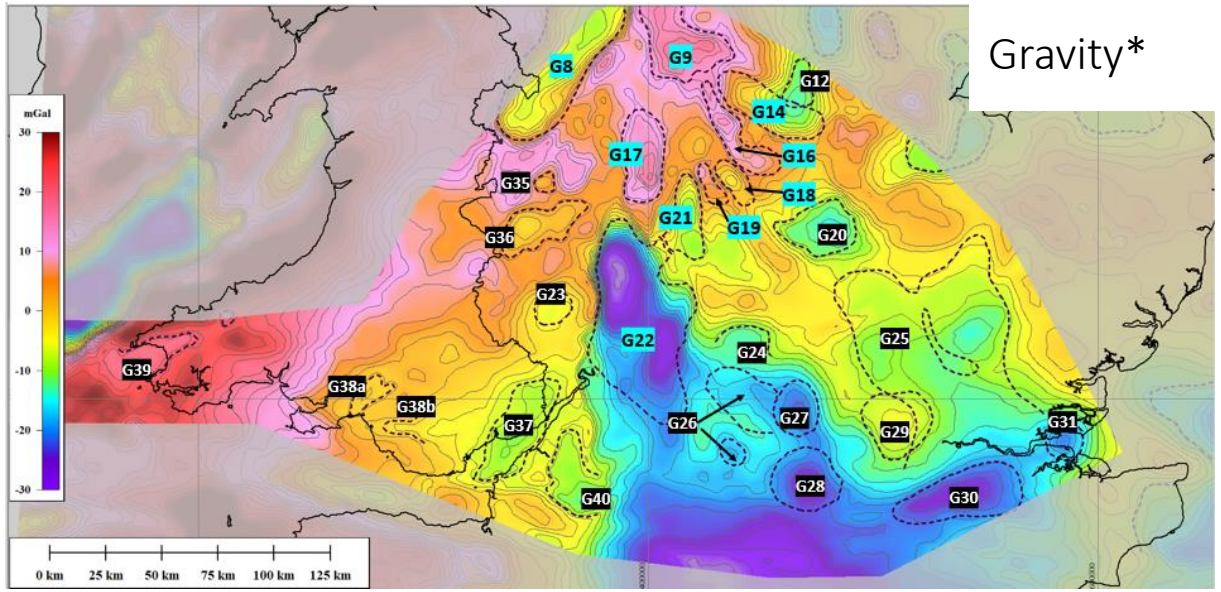




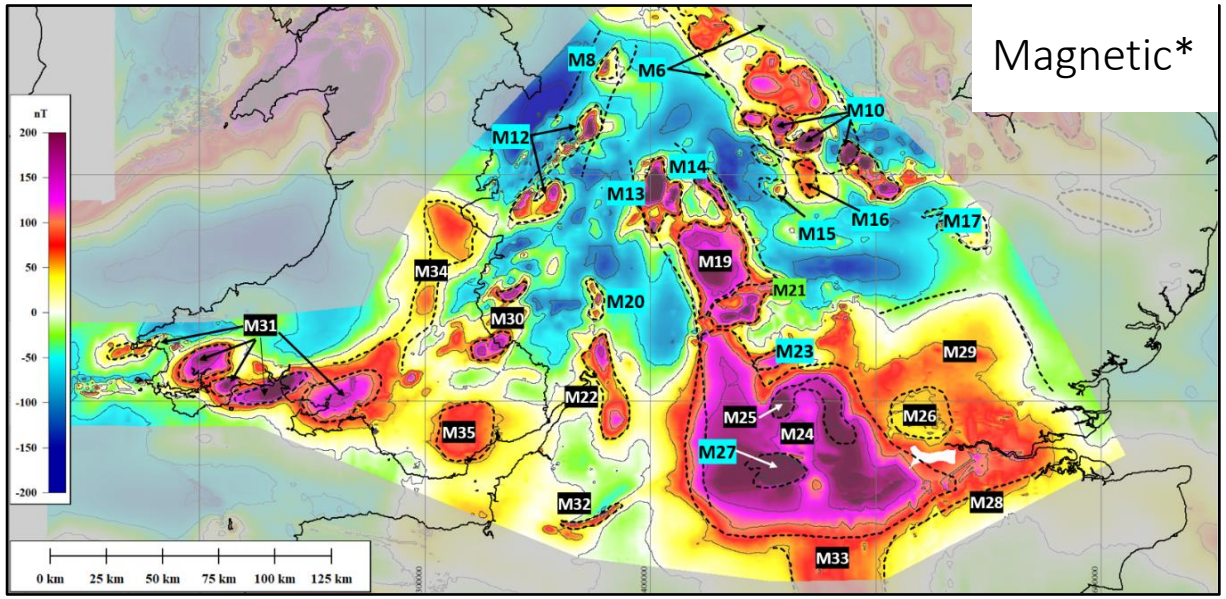


Gravity and Magnetic Anomalies

Bouguer Gravity Anomaly Map (Chacksfield & Edwards, 2006). The highlighted area follows the approximate extent of the Midlands Platform. Labelled gravity anomalies have a prefix ‘G’



Gravity*

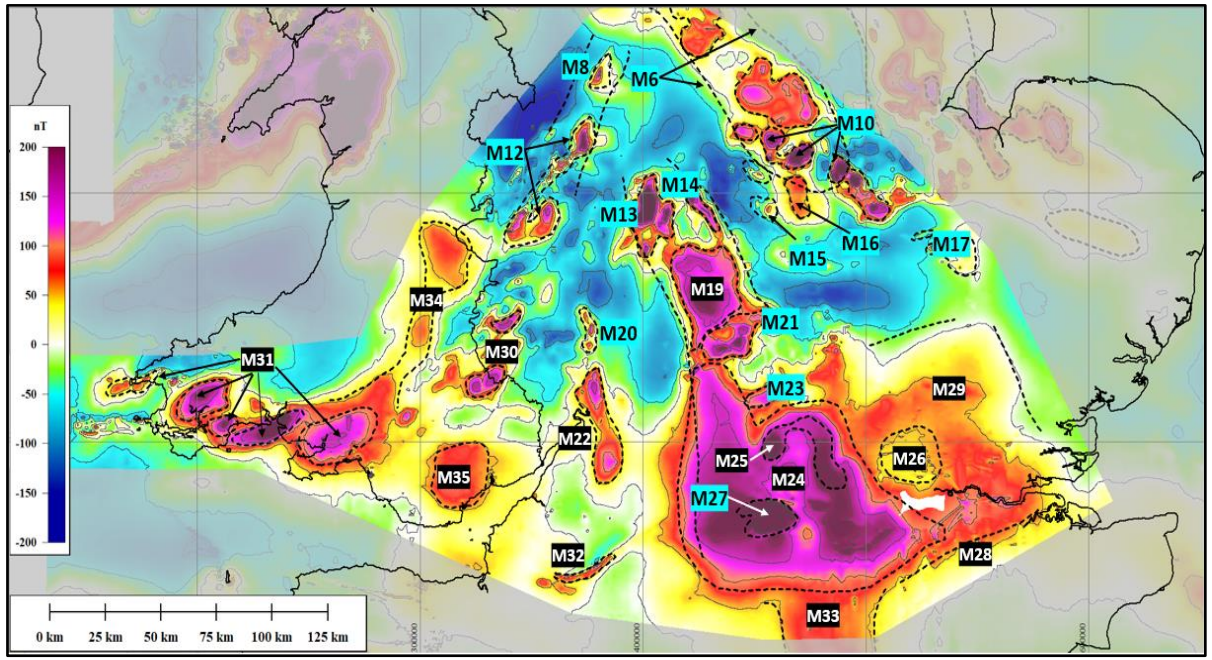


Magnetic*

Total Intensity Magnetic Anomaly Map (Chacksfield, et al., 2006). The highlighted area approximately follows the area of the Midlands Platform. Labelled magnetic anomalies are prefixed ‘M’

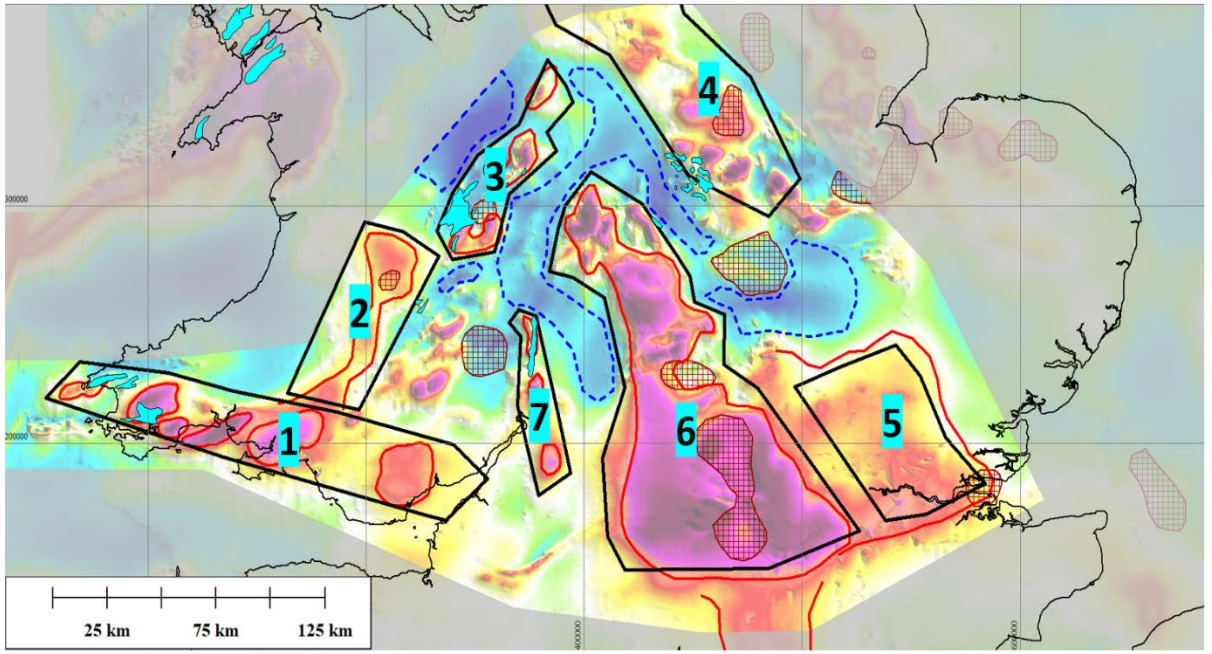
Magnetic Anomaly Analysis – London Platform

Local*



Labelled magnetic anomalies have a prefix 'M' – anomalies with high confidence have labels in blue , those with lower confidence have black labels

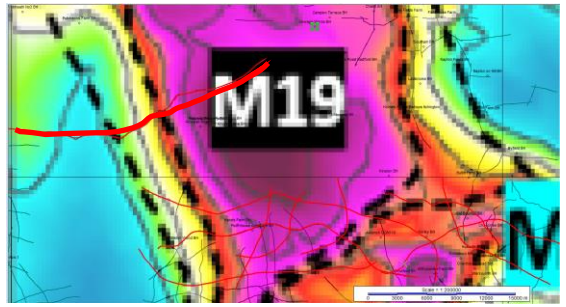
Regional*



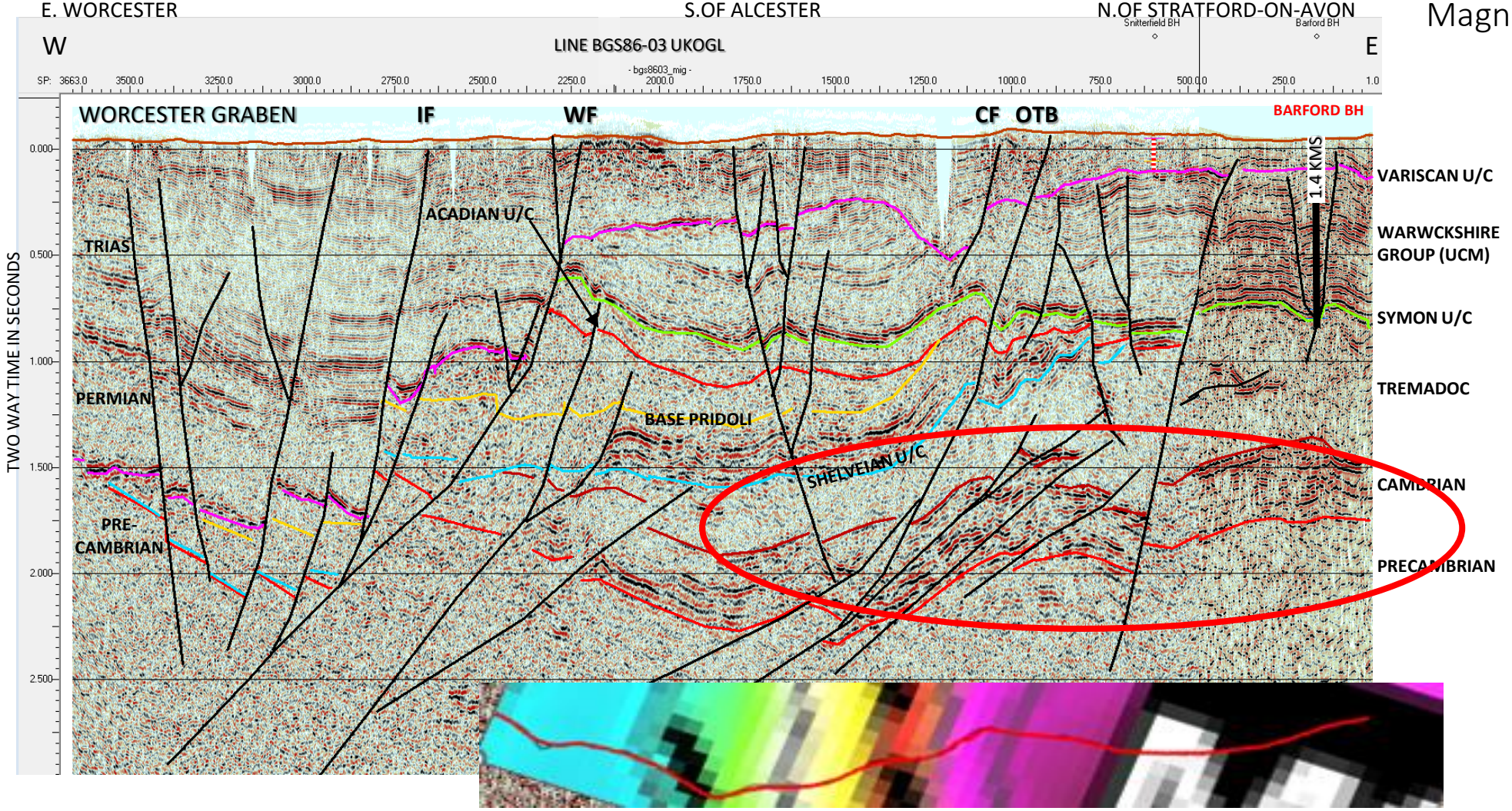
Magnetic data brings out both shallow short wavelength anomalies as well as more regional anomalies as shown in the polygons above

Estimating depths to magnetic anomalies can be fraught with uncertainty

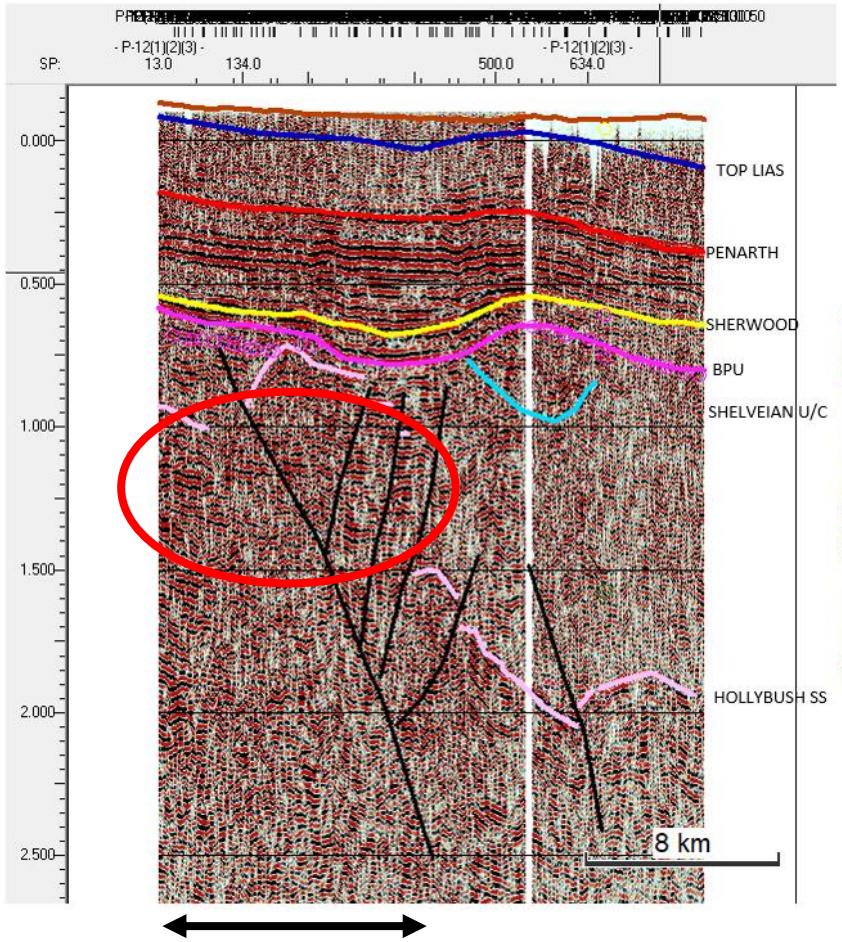
Central England Magnetic Anomaly



Magnetic Map



Bath Axis

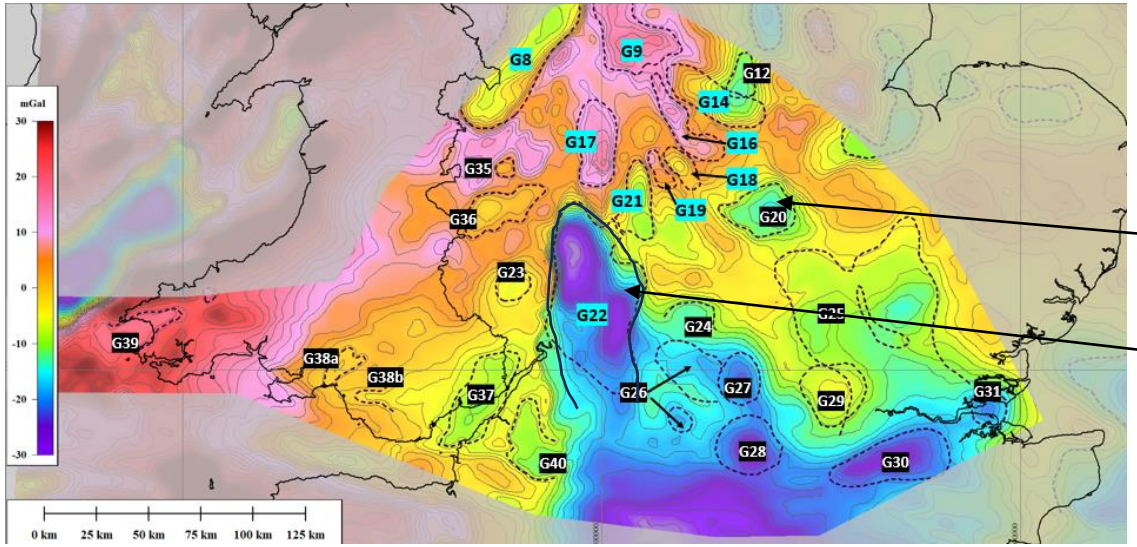


Magnetic anomaly extent

Magnetic Map

Gravity Anomaly Analysis – London Platform

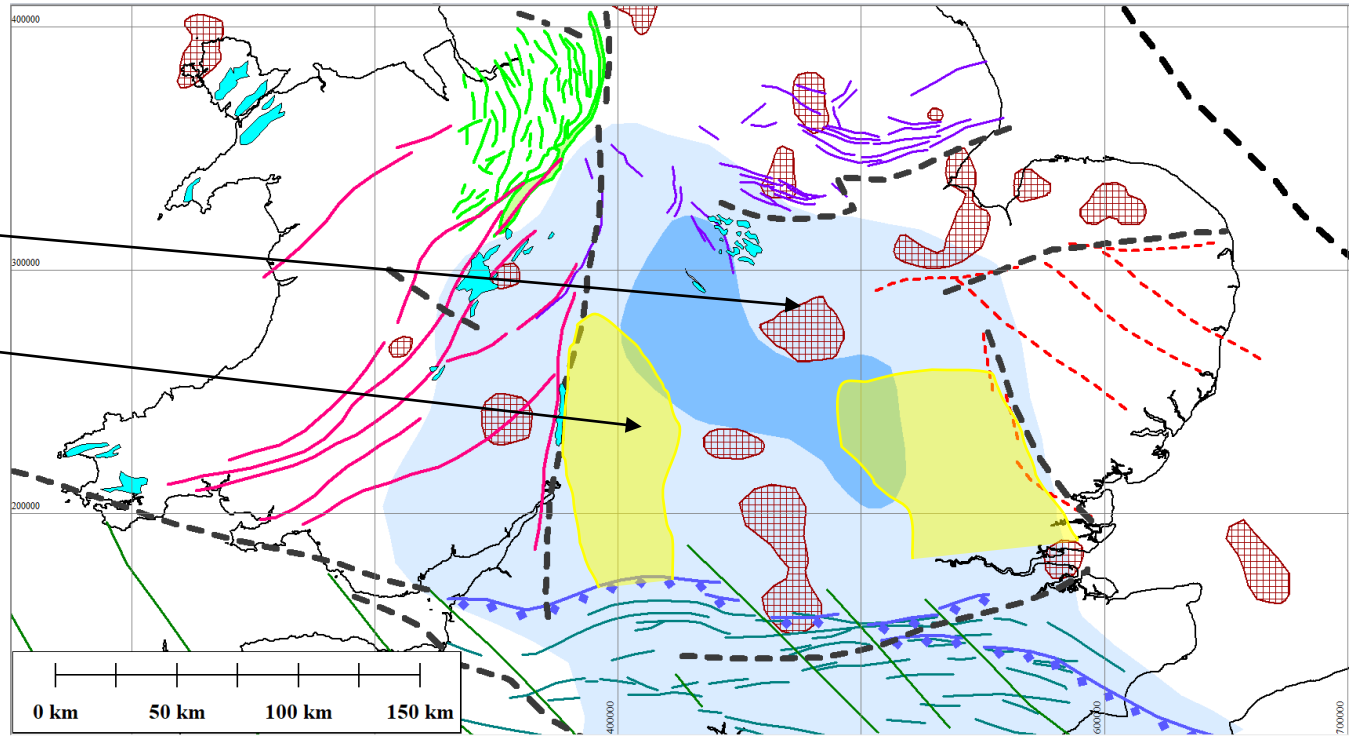
Local*



Labelled gravity anomalies have a prefix ‘G’ – anomalies with high confidence have labels in blue , those with lower confidence have black labels

Gravity data brings out short wavelength anomalies

Regional



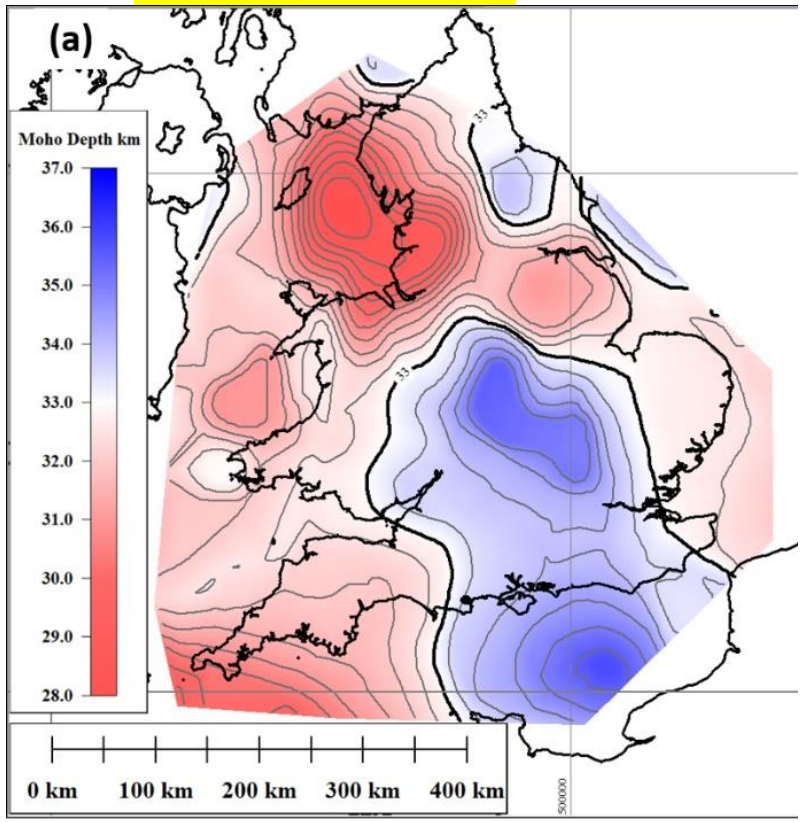
Yellow areas are sedimentary basins – red cross hatched anomalies are interpreted as granites
Moho depth shown in blue

MOHO MAP

Depth to Moho

- Depth to Moho map in conjunction with magnetic anomaly map enable crustal fragments to be identified
- The crustal fragment edges conform approximately to previously mapped geological lineaments and allow the Blocks to be recognised

Depth to Moho



Moho Depth with Structural elements

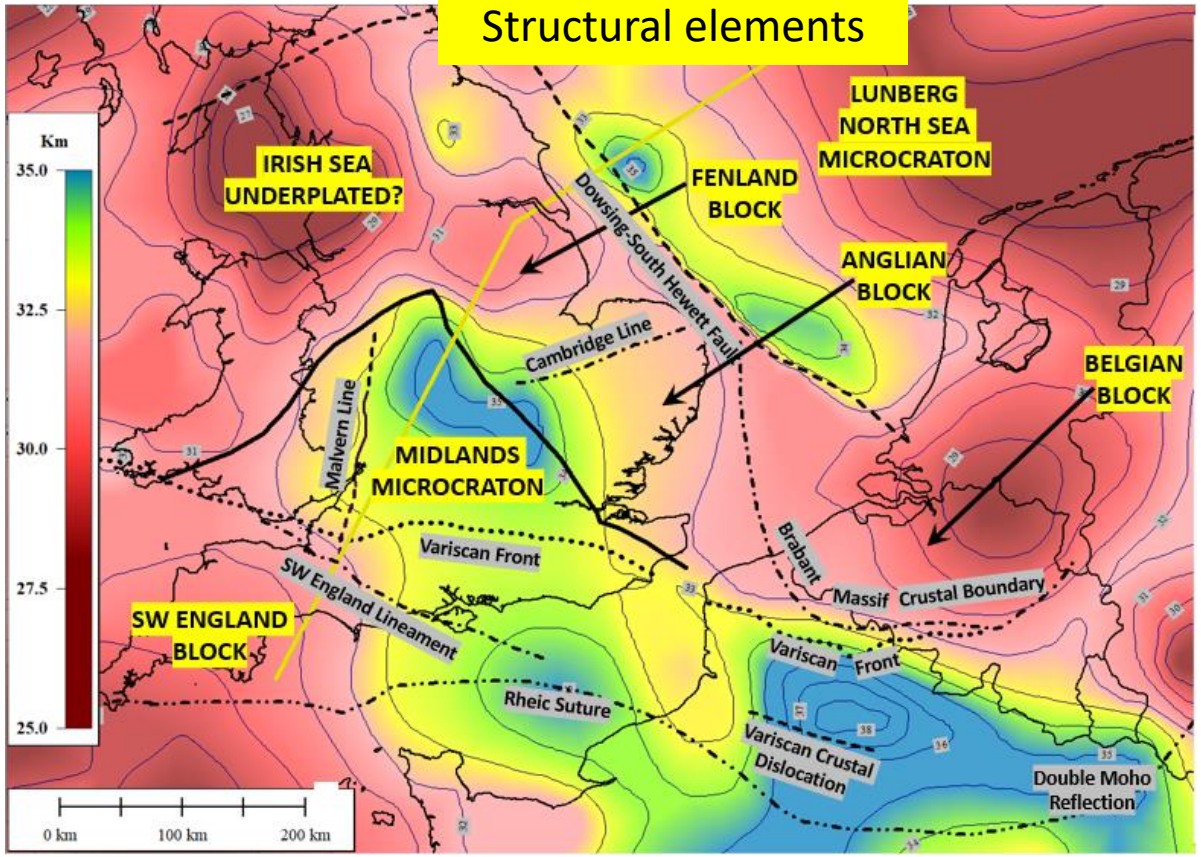
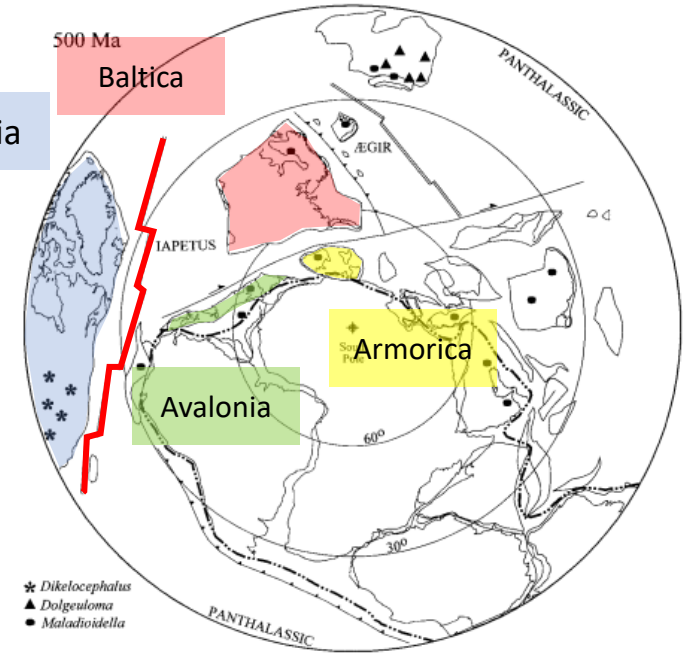


PLATE MODEL

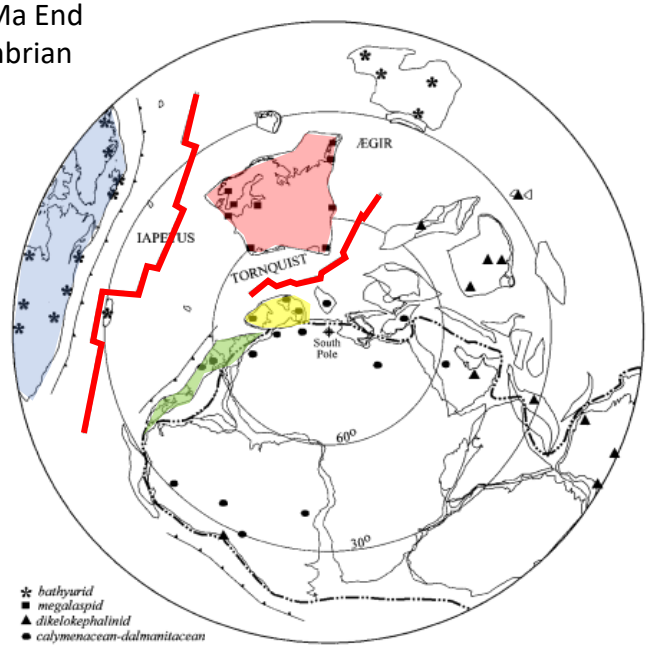
Plate Situation

- A large number of terranes existed on the north side of Gondwanaland which consolidated in the Late Precambrian
- A series of plates – Laurentia, Avalonia, Baltica and Armorica separated from Gondwanaland at different times
- Laurentia separated from South America during Vendian to Lower Cambrian times and rapidly drifted north to Equatorial Regions creating the Iapetus Ocean
- Avalonia and Baltica were discrete plates separated by the Tornquist Ocean
- Avalonia separated from Gondwanaland and drifted north rapidly in the Ordovician. It collided with the Baltica plate in Late Ordovician (Ashgill) times – 450my
- Avalonia/Baltica joined to the Laurentian plate in Mid-Late Silurian times with the closure of the Iapetus Ocean
- The Armorican plate was separated from the other plates by the Rheic Ocean. The closure of this Ocean marks the Variscan Orogenic episode
- Gondwanaland moved north with time and in the Late Paleozoic the amalgamated plates of Laurentia, Avalonia, Baltica and Armorica joined with it to form Pangea

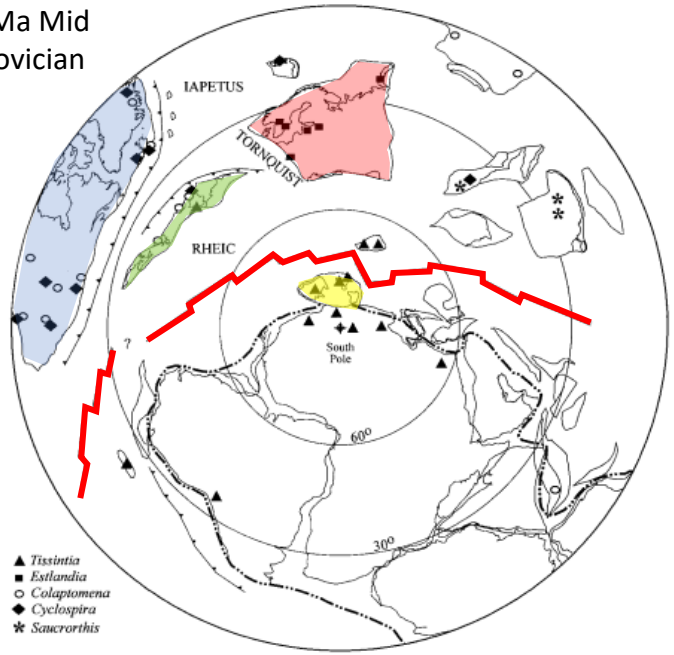
500Ma Mid Cambrian



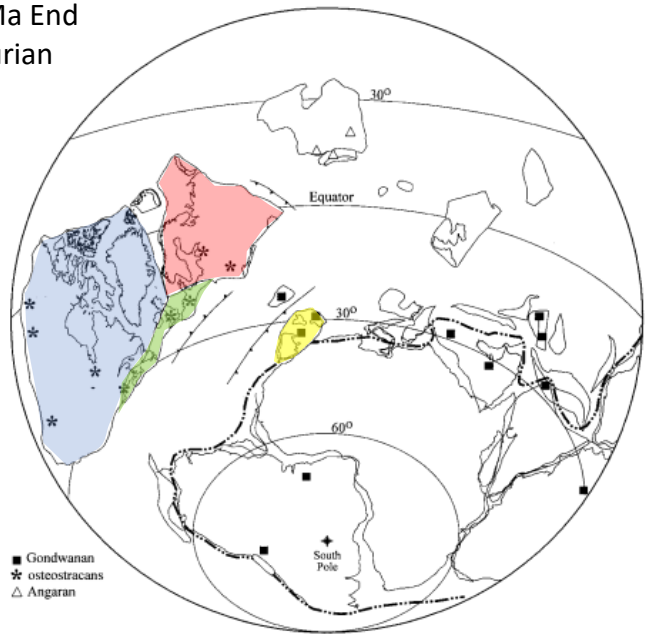
480Ma End Cambrian



460Ma Mid Ordovician

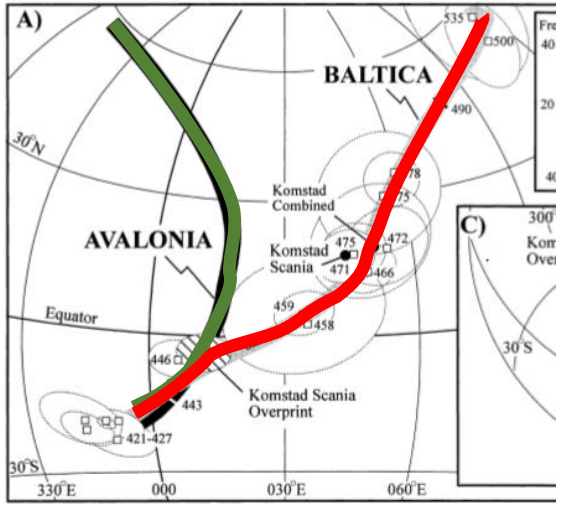


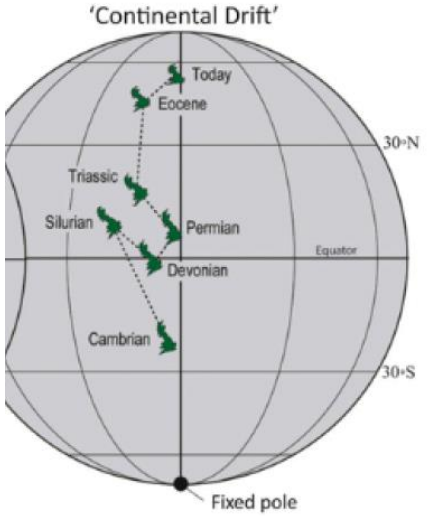
420Ma End Silurian



Palaeomagnetics

- The principal evidence for the plate positions comes from Palaeomagnetics. It gives latitude control but no longitude control. This data is supplemented by faunal studies
- Palaeomagnetic data control for England and Wales comes mainly from the Midlands Microcraton (the Silurian volcanics of Southern England), the Lake District and North Wales
- Palaeomagnetics shows that in the Caradoc to Mid Devonian period the Lake District was rotated 50° anticlockwise with respect to North Wales. Palaeomagnetic data from Nuneaton shows that since the Upper Ordovician it has rotated 160° clockwise
- In the Mendips there is evidence of 80° clockwise rotation post Silurian – assumed to be related to Variscan deformation. At Tortworth there is evidence of 33-63° clockwise rotation.

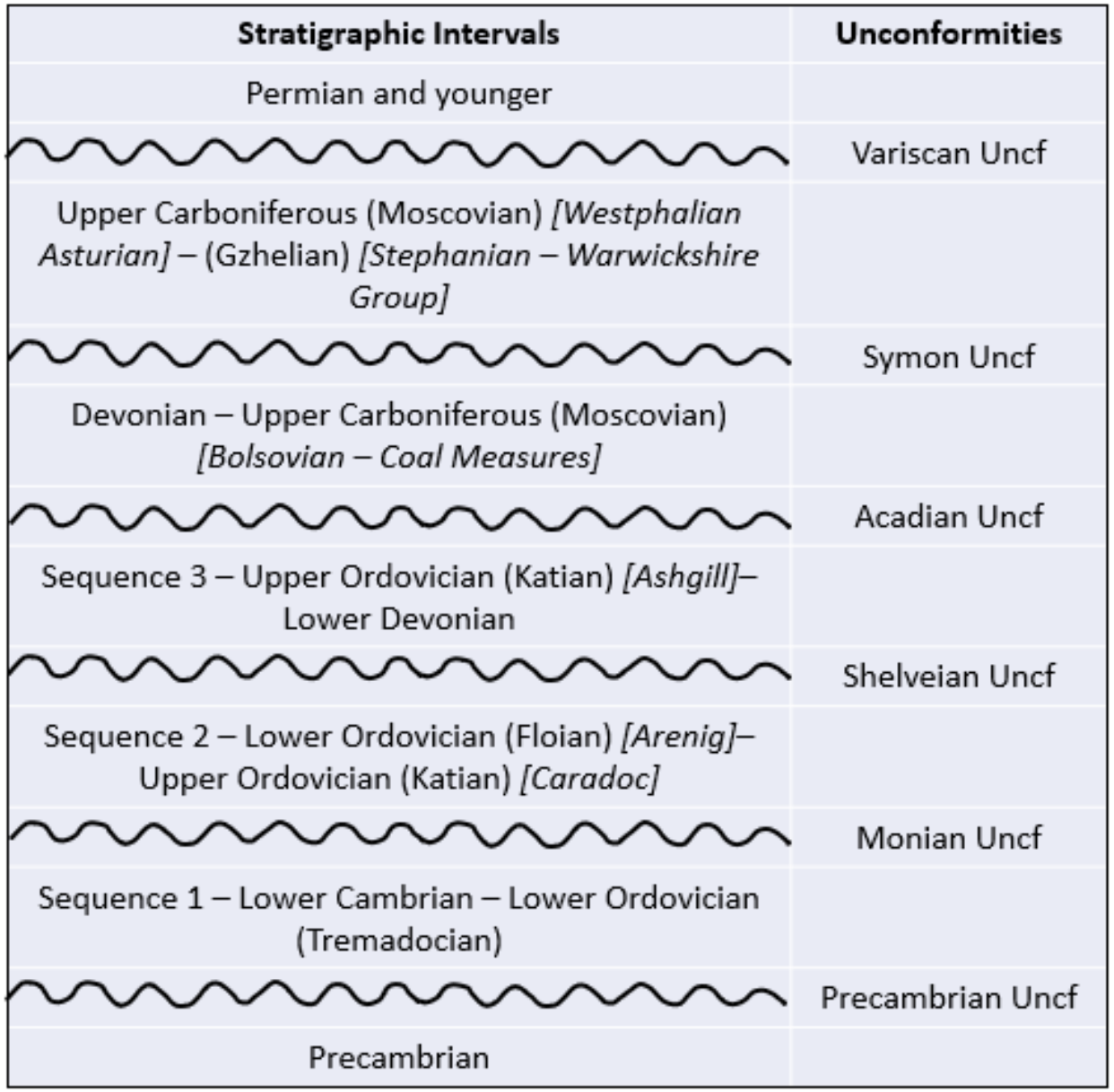




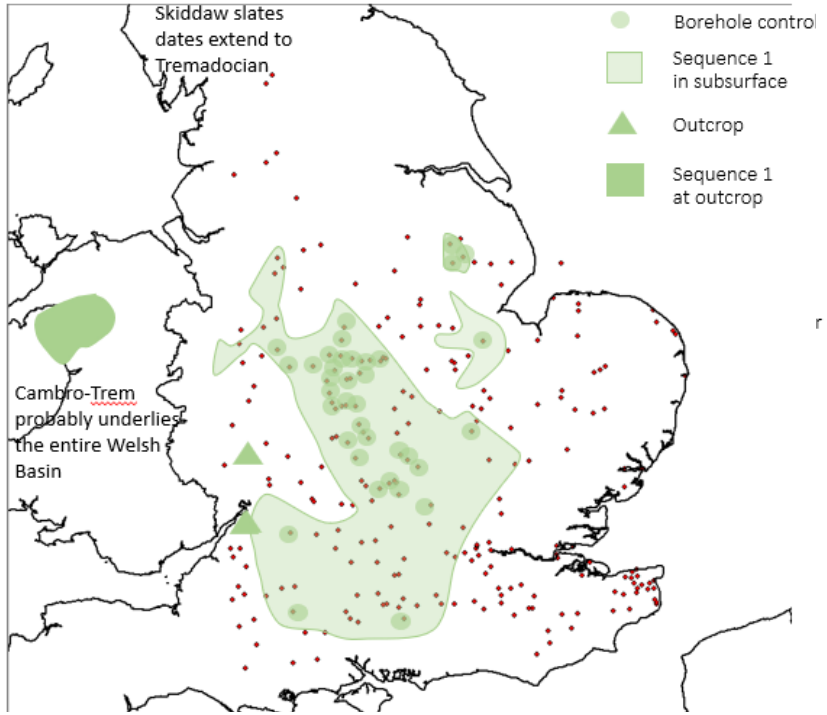
STRATIGRAPHIC ANALYSIS

Paleozoic Stratigraphy

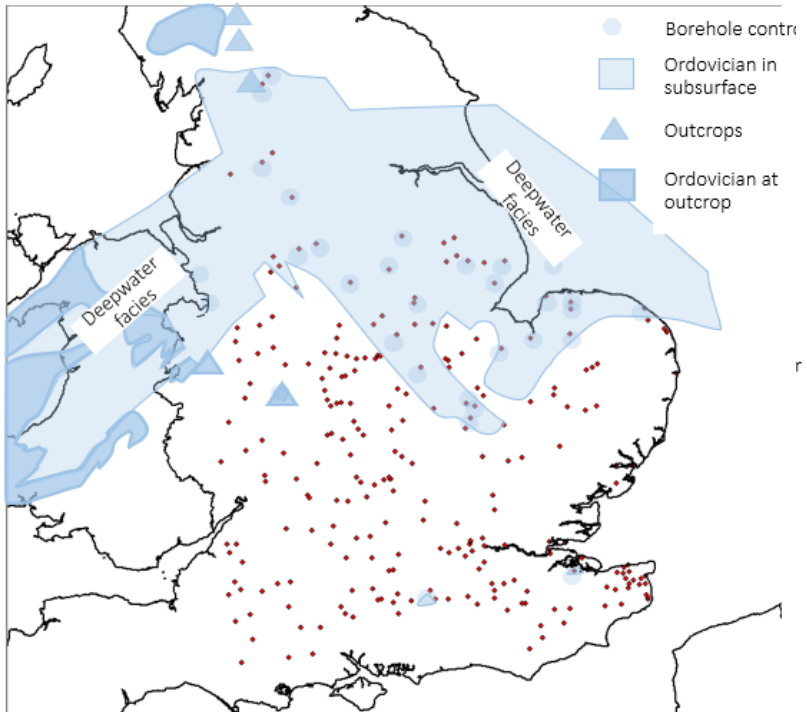
- Unconformity bounded sequences – recognised at outcrop and seismic data. Above Precambrian Basement
- Sequence 5 – Upper Coal Measures – Variscan unconformity at top
- Sequence 4 – Upper Devonian – Upper Carboniferous – Symon unconformity at the top. Non deposition in the Namurian in Southern and Central England
- Sequence 3 – Latest Ordovician – Early Devonian – Acadian unconformity at top
- Sequence 2 – Lower – Upper Ordovician – Shelvian unconformity at top
- Sequence 1 – Cambrian – Lower Ordovician (Tremadocian) – Monian unconformity at top
- Problem of reworking of unconformities



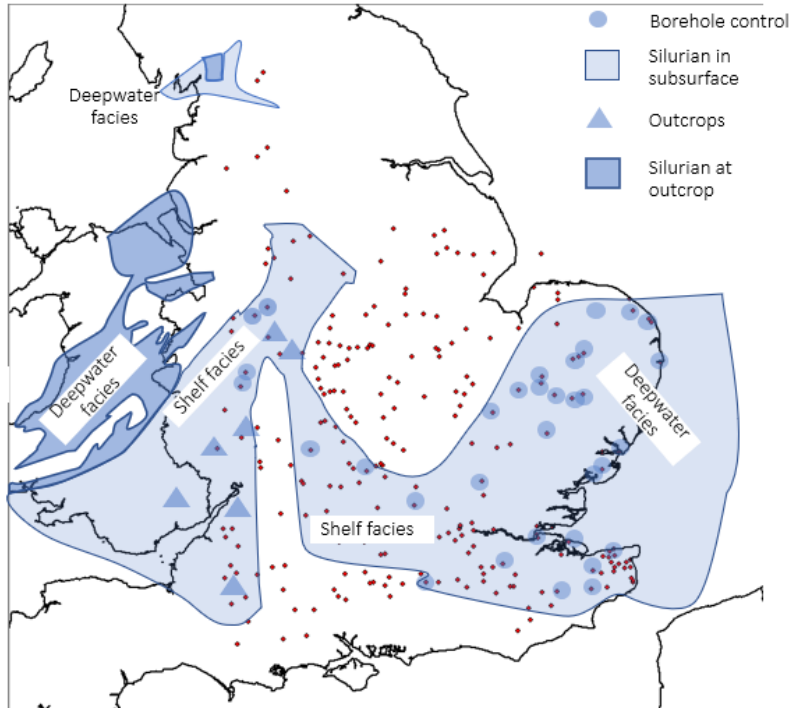
Lower Paleozoic – Outcrop and Well Control



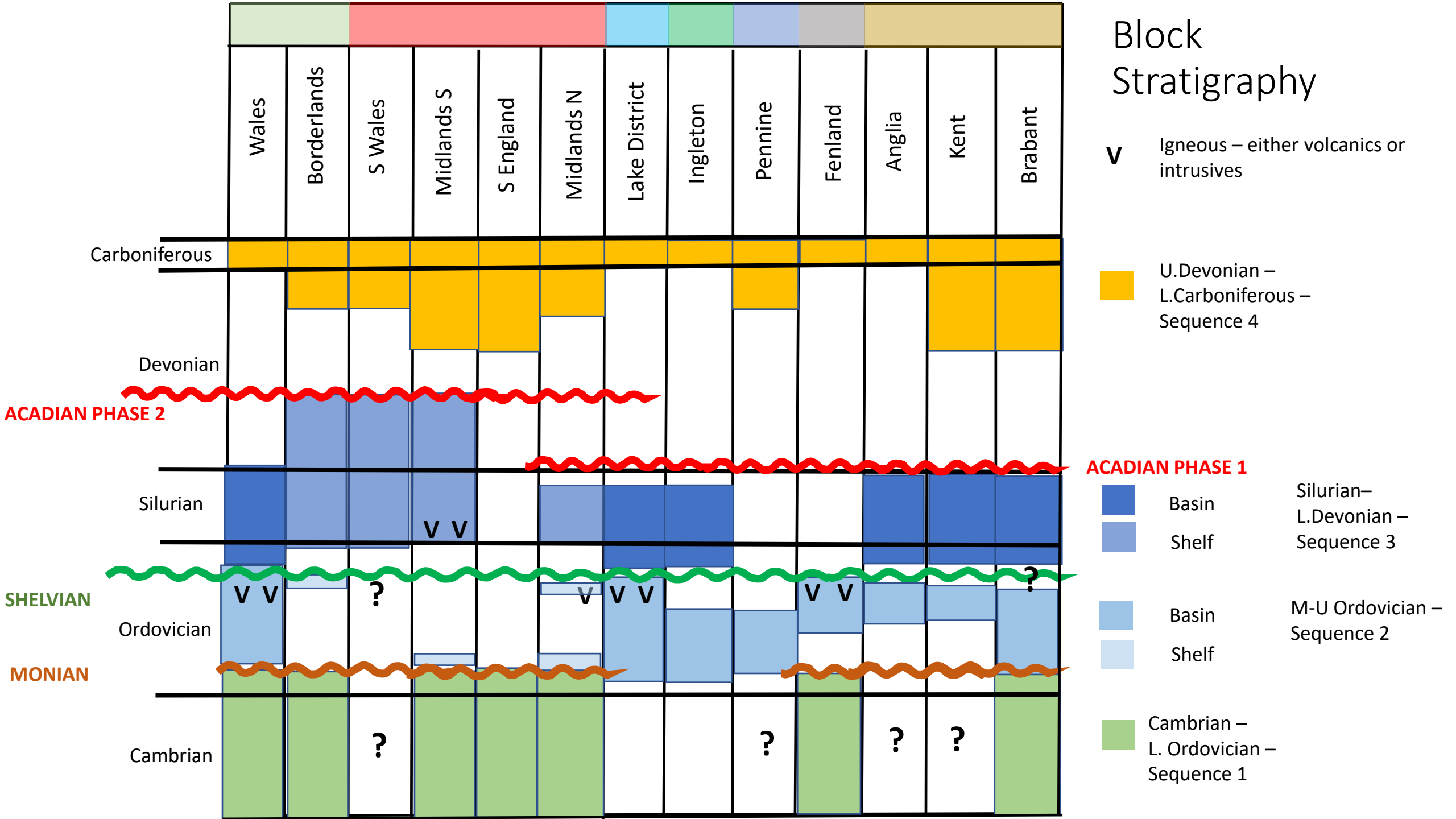
Sequence 1 – Cambrian- Tremadocian



Sequence 2 – M-U Ordovician



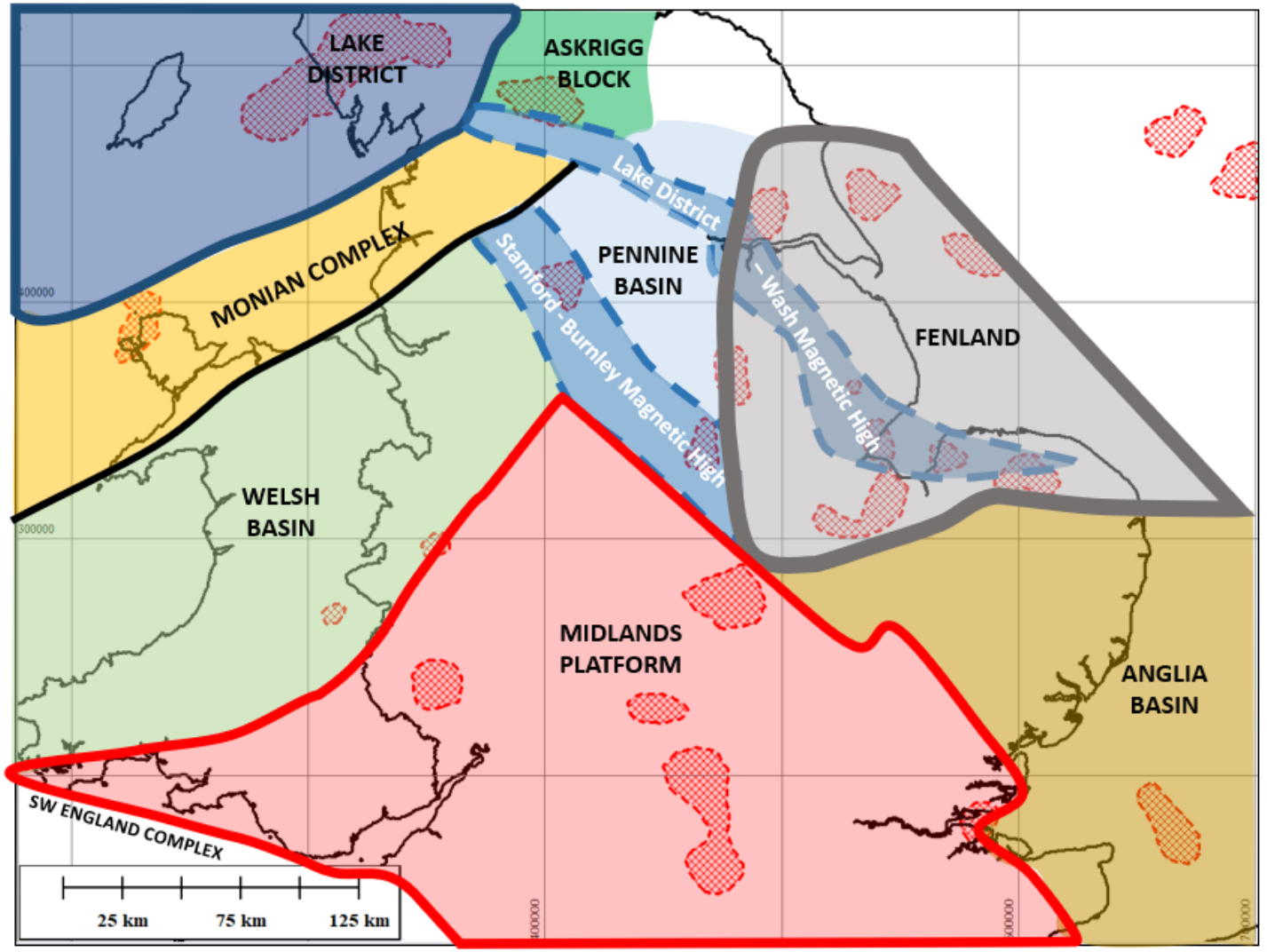
Sequence 3 – Silurian


Block Stratigraphy
Wales
Borderlands
S Wales
Midlands S
S England
Midlands N
Lake District
Ingleton
Pennine
Fenland
Anglia
Kent
Brabant
Carboniferous
Devonian
ACADIAN PHASE 2
Silurian
ACADIAN PHASE 1
SHELVIAN
Ordovician
MONIAN
Cambrian
V
Igneous – either volcanics or intrusives
U.Devonian – L.Carboniferous – Sequence 4
Basin
Shelf
Silurian– L.Devonian – Sequence 3
Basin
Shelf
M-U Ordovician – Sequence 2
Cambrian – L. Ordovician – Sequence 1

BLOCK ANALYSIS

Block Model

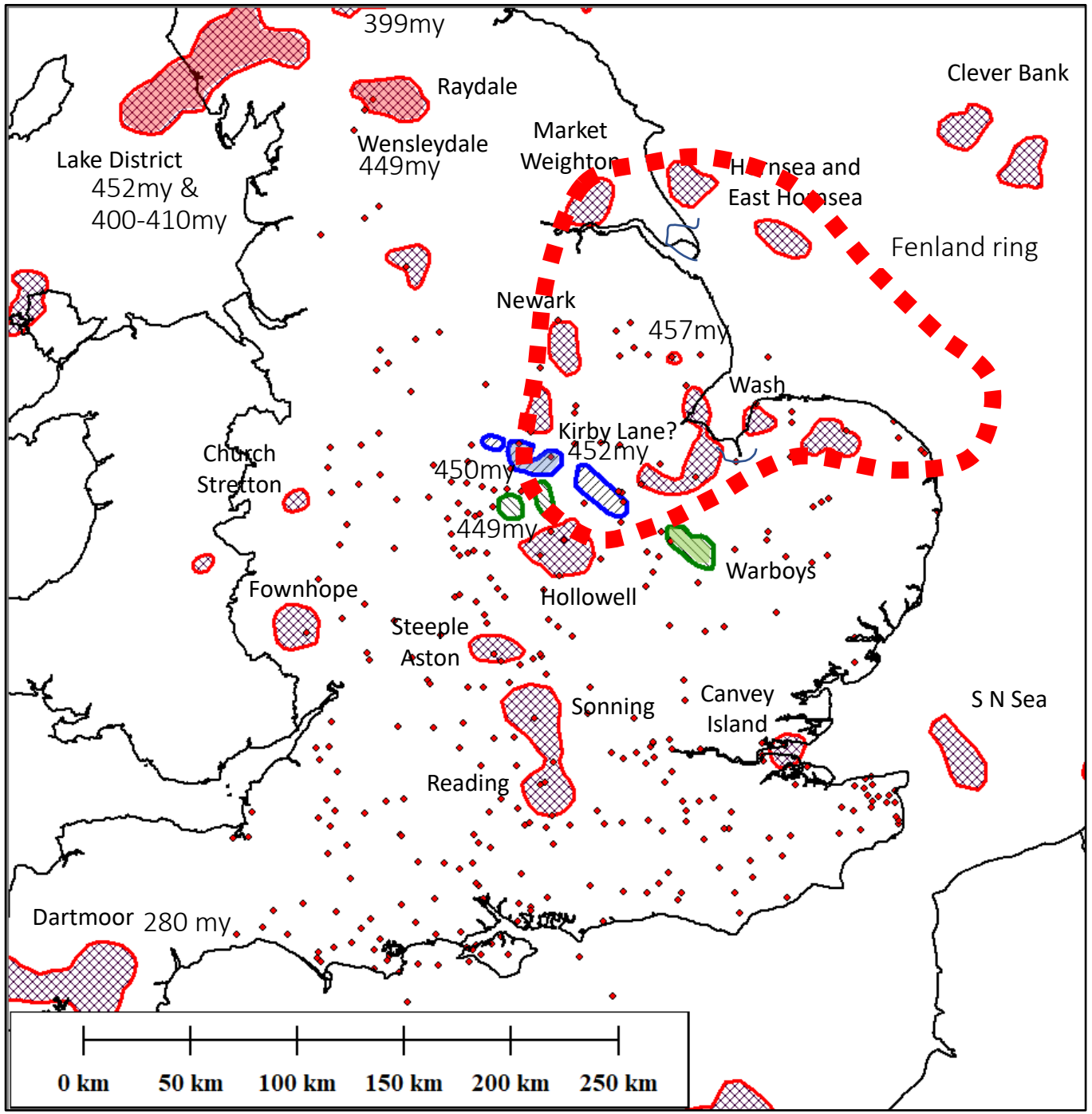
- A series of Blocks can be recognised. They characterised by differing geophysical responses, as well as differences in the geology.
- Different stratigraphic sequences are preserved, with different maturities and degree of deformation
- The geophysical boundaries between the blocks are blurred and unclear but are broadly coincident with geological lineaments.
- These lineaments are ancient, long lived and were reactivated over time with varying sense of throw. Generally not marked by one fault but a zone. Seem to be sites of igneous intrusions
- The blocks are currently juxtaposed despite significantly different geology. We suspect strike slip fault movement are associated with many of these lineaments



Igneous Intrusions

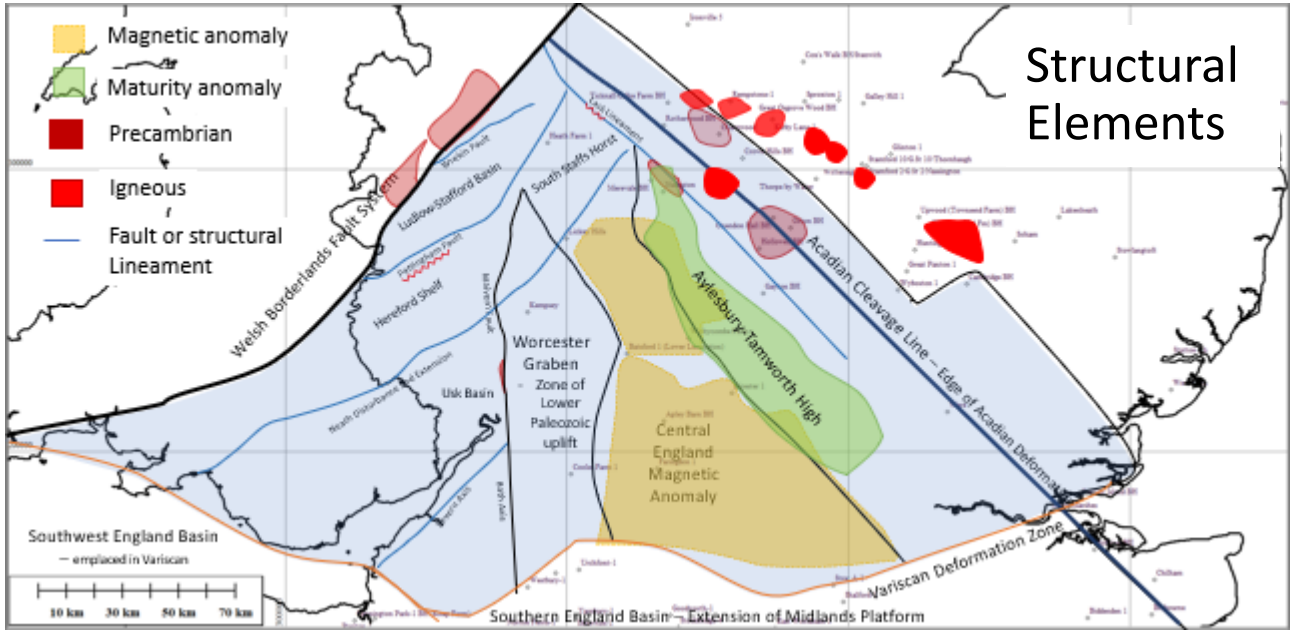
- Most intrusions are geophysically defined and therefore are undated
- Three main phases of intrusion are recognised :
  - Precambrian
  - Ordovician
  - Devonian
- The Ordovician intrusions are thought to associated with the Shelvian tectonic event. Most of the Diorites and Granodiorites appear to have been intruded at this time
- The Devonian igneous intrusion episode appears to be associated with the end of the second phase of the Acadian tectonic event. These granites appear to be of the high heatflow variety
- The granites of SW England are associated with the end of the Variscan tectonic episode. These granites appear to be of the high heatflow variety

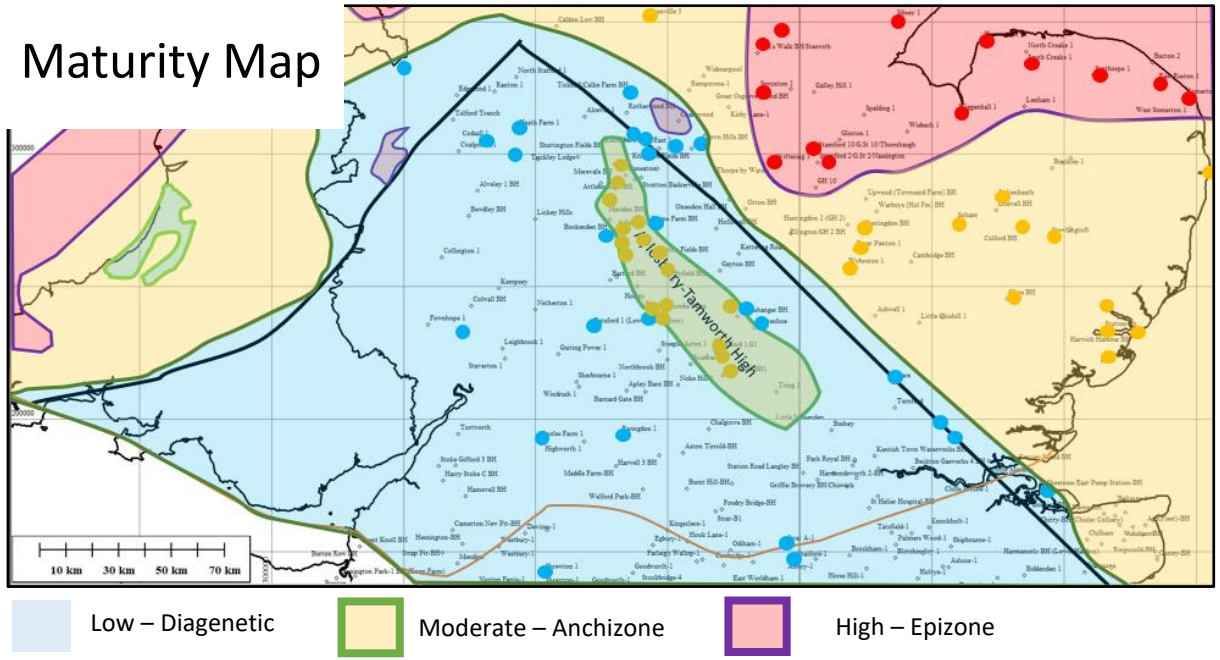
Granites		Granodiorites		Diorites	
	Geophysically defined		Geophysically defined		Geophysically defined
	Outcrop or borehole control		Outcrop or borehole control		Outcrop or borehole control



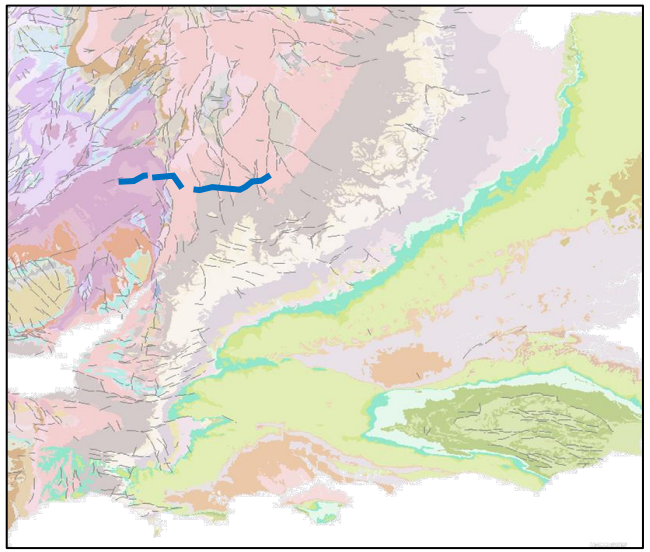
Midlands Platform

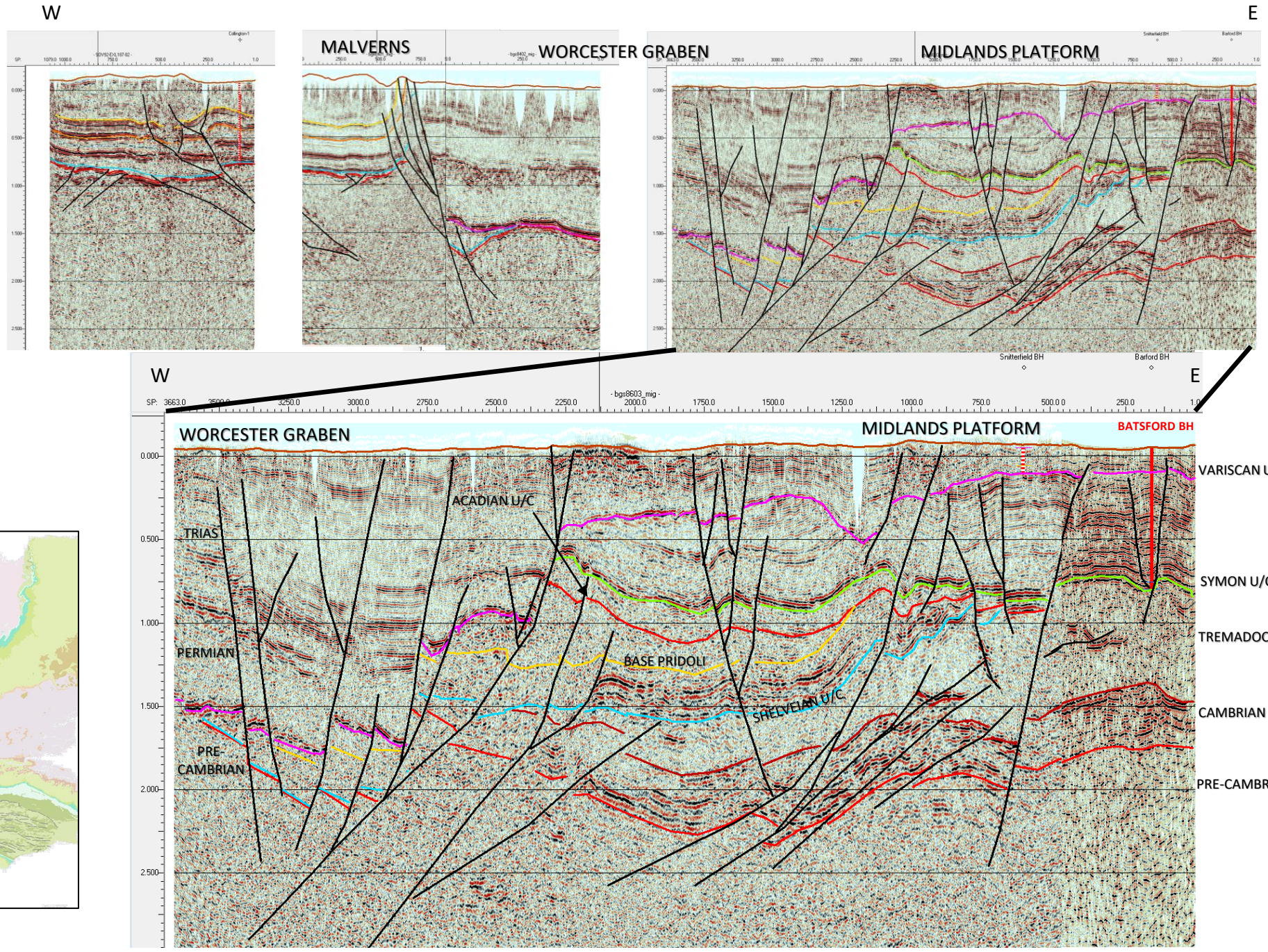
- Known mainly from borehole data with limited outcrop control
- Geophysics: Numerous gravity and magnetic anomalies. Gravity lows associated with Permo-Triassic basins and granites. Magnetic anomalies recognised of unknown source. Data suggests wide deformation zones around the Platform margins
- Stratigraphy:
  - The Precambrian basement is composed of volcaniclastics
  - Thick Cambrian to Lower Ordovician (Tremadocian) shales (Sequence 1)
  - The Lower to Upper Ordovician (Sequence 2) is largely absent
  - The Llandovery to Lower Devonian (Sequence 3) is present with red bed deposition onset in the Pridoli. Very thick L.Devonian is preserved only to the south
  - Sedimentation recommences in the Upper Devonian and continues into the Lower Carboniferous. Upper Carboniferous, Upper Coal Measures (Sequence 5) are widely developed
- Deformation: Sequences not severely deformed except over the Aylesbury-Tamworth High and along the southern Variscan deformation zone
- Cleavage: No cleavage is recognised
- Maturity: All the area is at low maturity stage except over the Aylesbury-Tamworth High
- Ordovician aged igneous intrusions to the northeast. Undated granites to the south and northeast



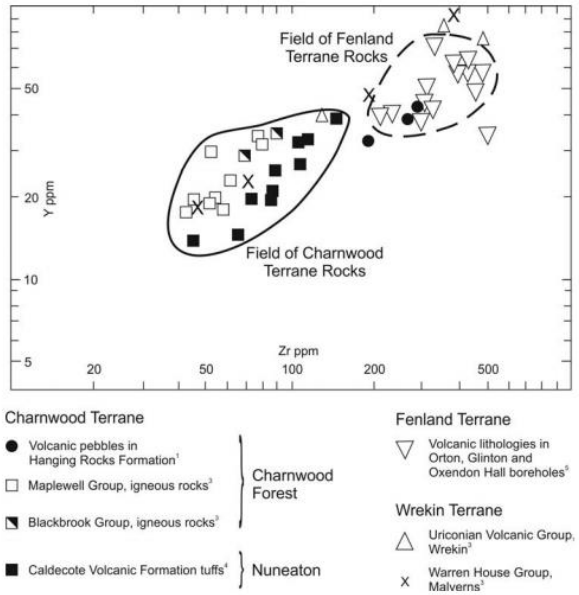


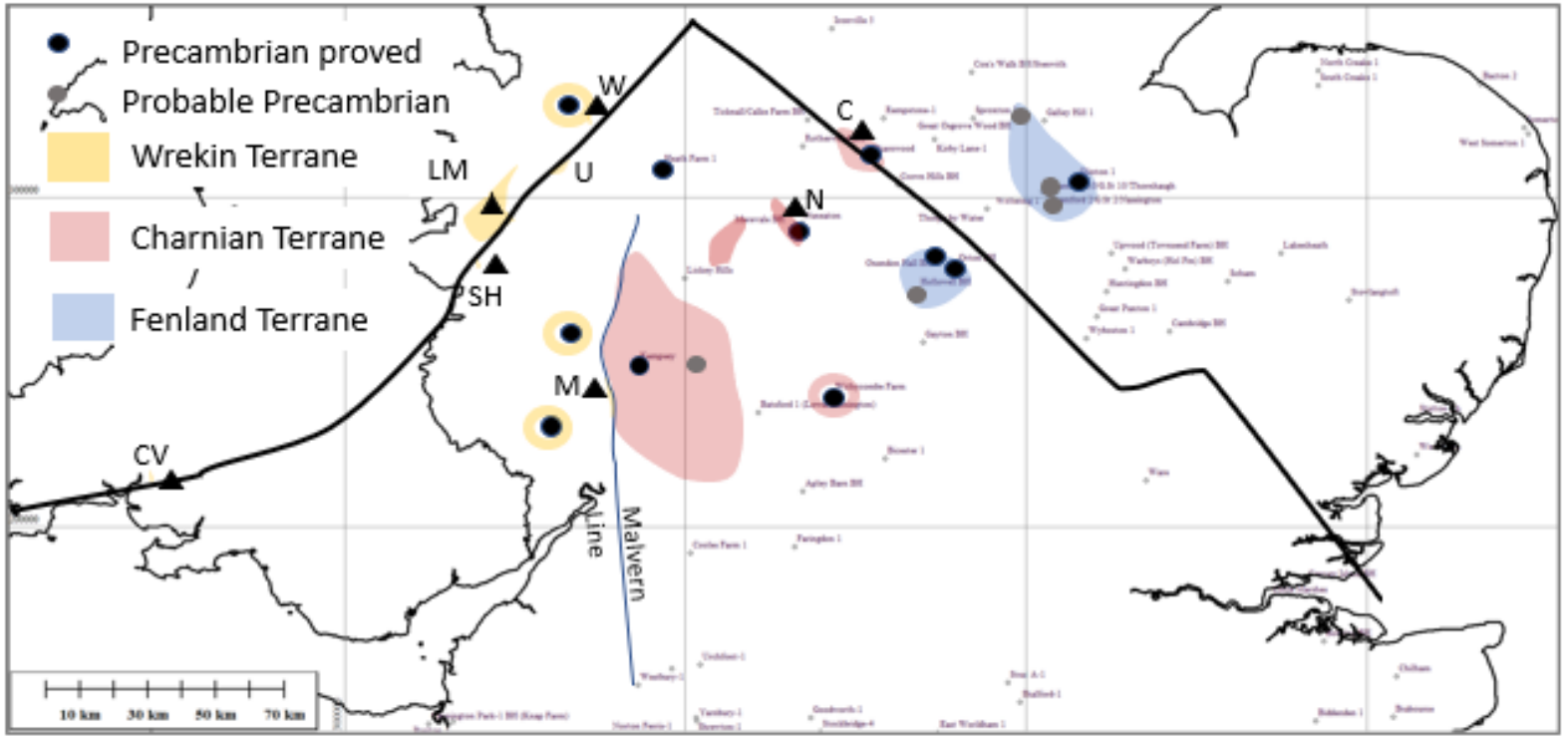
East-West Seismic Line across Midlands Platform





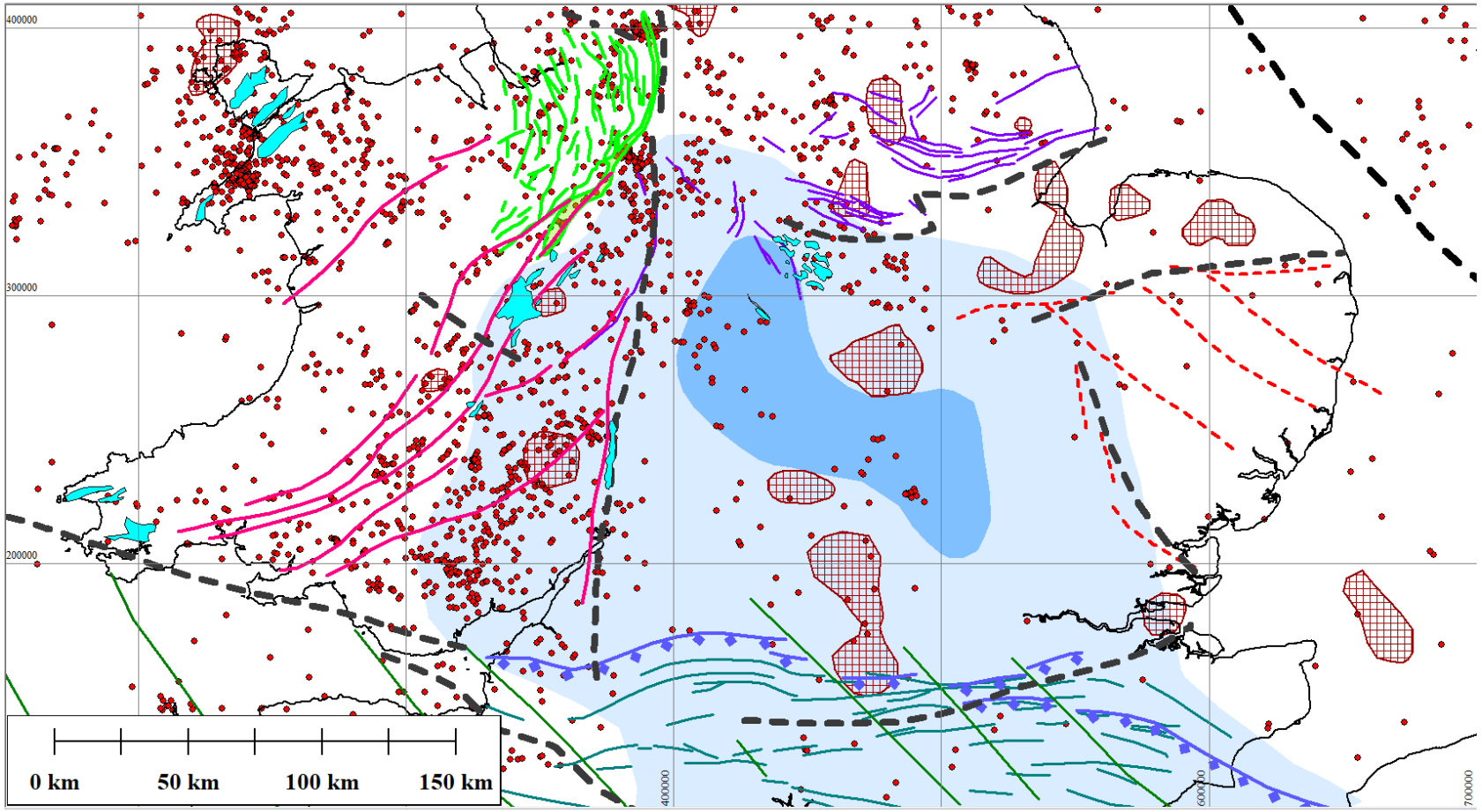
Precambrian





- BGS work shows that the different terranes have different chemical signatures
- The different terranes are thought to have formed in an Island Arc setting on the northern side of Gondwanaland
- The accretion of the terranes is thought to have occurred in the Late Precambrian. The suture lines between the blocks seem to be the major structural lineaments that were subsequently reactivated

Earthquakes



- Dots show earthquakes extracted from the BGS database
- To avoid anthropogenic earthquakes, only those with a focal depth greater than 3km are shown
- Most earthquakes originate from depths less than 25 km, therefore the distribution may be reflecting changes in the character of the upper and middle crust

Welsh Basin

- Known from extensive outcrop
- Geophysics: Data suggest little density discrimination between Lower Paleozoic rocks. Several magnetic anomalies thought to be derived from Precambrian sources. Significant Precambrian ridge interpreted to trend ESE across South Wales and deepen to the east.
- Paleozoic Stratigraphy
  - Sequence 1 – Cambrian to Lower Ordovician (Tremadocian) – deep basinal sequence, locally volcanic – Dyfed supergroup
  - Sequence 2 – Lower to Upper Ordovician – deep basinal sequence, volcanic episode in Caradoc (452my) – Gwynedd supergroup
  - Sequence 3 – Upper Ordovician to Lower Devonian – deep basinal sequence with the Upper Ludlovian marking onset of red bed deposition, non volcanic – Powys supergroup
  - Sequences 4 – Upper Devonian to Upper Carboniferous – originally covered area but preserved to the south and east and northeast
  - Sequence 5 – Upper Coal Measures
- Deformation: All sequences severely deformed during the Acadian tectonism dated to the Mid Devonian (Emsian) with inversion of the Welsh basin. It was the main phase (400my) of cleavage formation. Shelvian deformation recognised in the Welsh Borderland Fault system. Monian deformation is recognised in Anglesey
- Maturity: Maturity increases to the west and north. It is highest where basinal inversion has been greatest

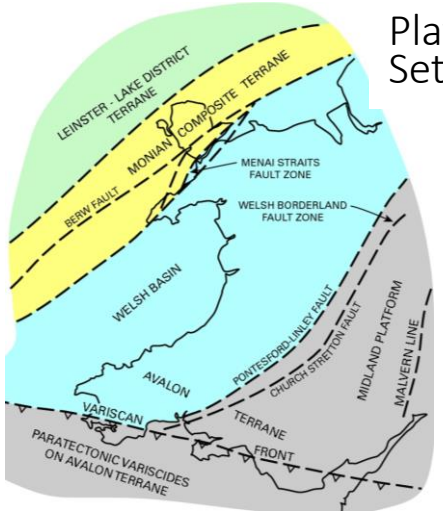
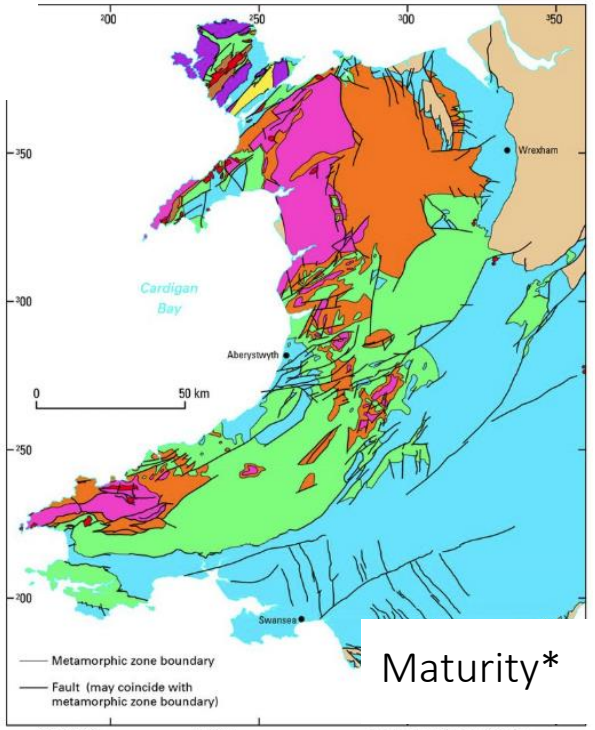
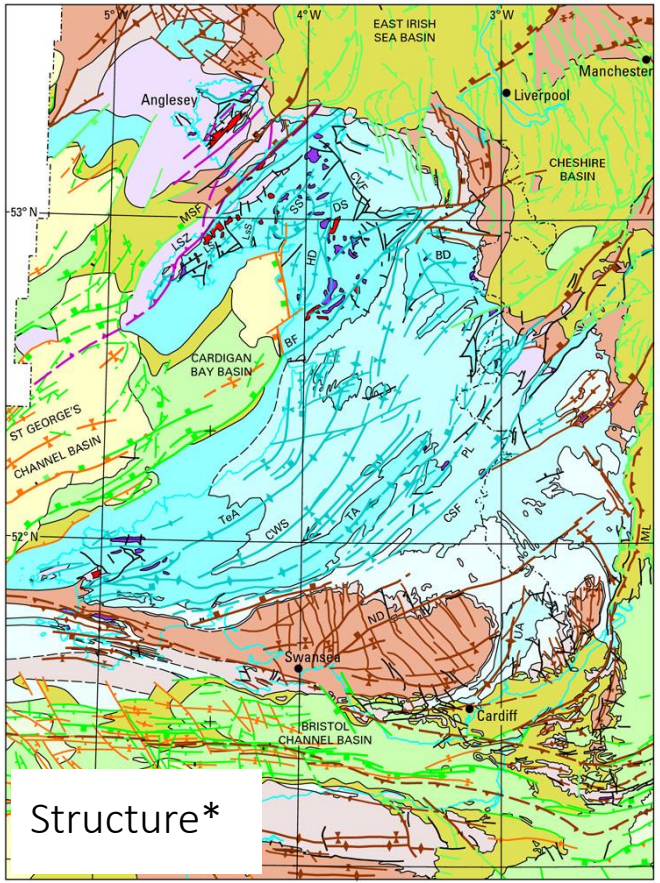


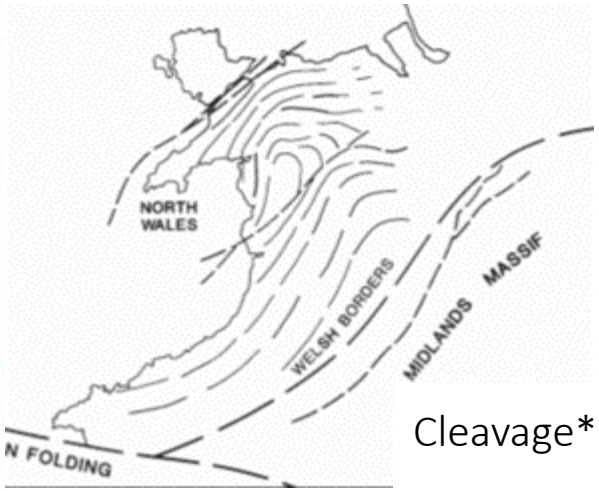
Plate Setting*



Maturity*



Structure*

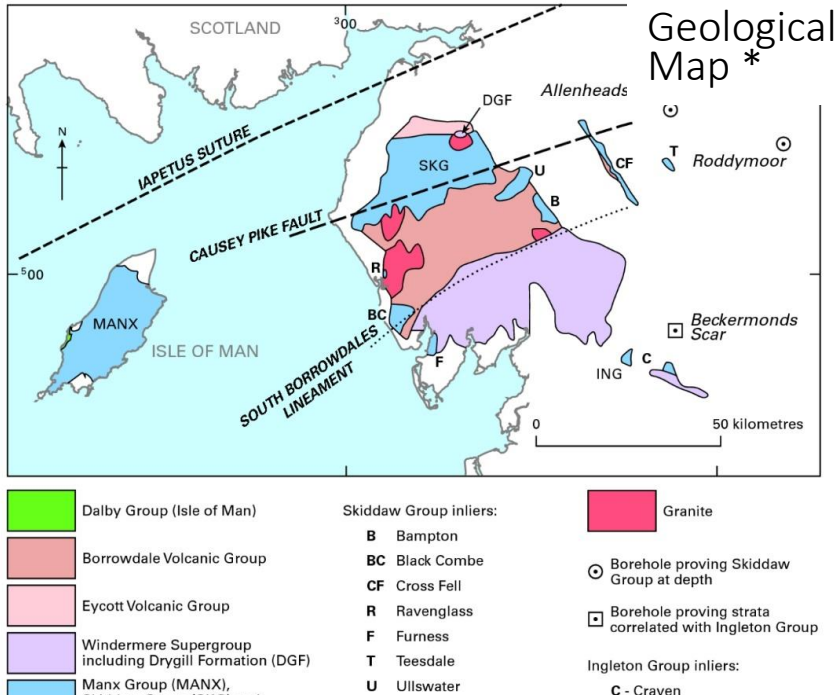


Cleavage*

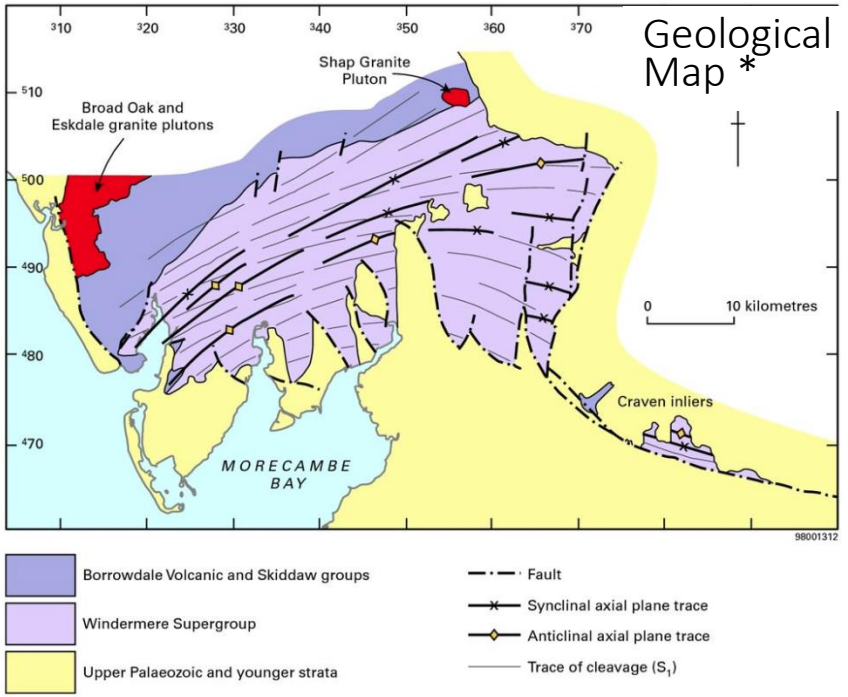
Northern Britain

- Known from outcrop and limited borehole data
- Geophysics: Gravity data show a gravity low associated with the Lake District Batholith and the Weardale Devonian Granite (Alston Block) and the Wensleydale Ordovician Granite (Askrigg Block). Magnetic anomalies are associated with the Borrowdale Volcanic Group
- Stratigraphy:
  - Cambrian not reached. No unconformity in the Tremadocian
  - In Lower to Upper Ordovician (Sequence 2) thick basinal shales (Skiddaw Slates, Ingletonian and Manx Slates) with major volcanic episode in M.Caradoc (452my) – calc-alkaline
  - Upper Ordovician to Silurian (Ludlow) (Sequence 3) – period of rapid subsidence – non volcanic Windermere Group. Broadly regressive sequence
  - Sequence 4 – Lower Carboniferous with Sequence 5 absent
- Deformation: 2 phases recognised - pre and post Silurian
  - Shelvian - Pre Ashgill (U.Ord) aged tight isoclinal folding with associated thermal event
  - Acadian - broad open folding of Silurian beds. The folds in the Ingletonian and Windermere are sub parallel suggesting reactivation of the same basement trends. Cleavage formed during Acadian tectonic phase (422±3 (Ar-Ar) and 401±7 my). Trends from NE-SW to WNW-ESE, from west to east. It is not axial to the folds suggesting some later rotation and strike slip movement along the faults
- Maturity: The area has undergone a polyphase metamorphic history with lateral variations seen. The Ingletonian rocks generally at anchizone grades but higher to the NW. The Acadian has imposed higher metamorphic grades (high anchizone-epizone) but of the type indicative of higher pressures and lower geothermal temperatures, suggesting shear deformation
- Post orogenic Devonian granites (400my) were intruded.
- East-west trending Lamprophyre dykes intrude the sequence and have been dated to 409-420my (K-Ar) [Lower Devonian]
- Variscan aged strike slip faulting on the Dent and Craven Faults is recognised

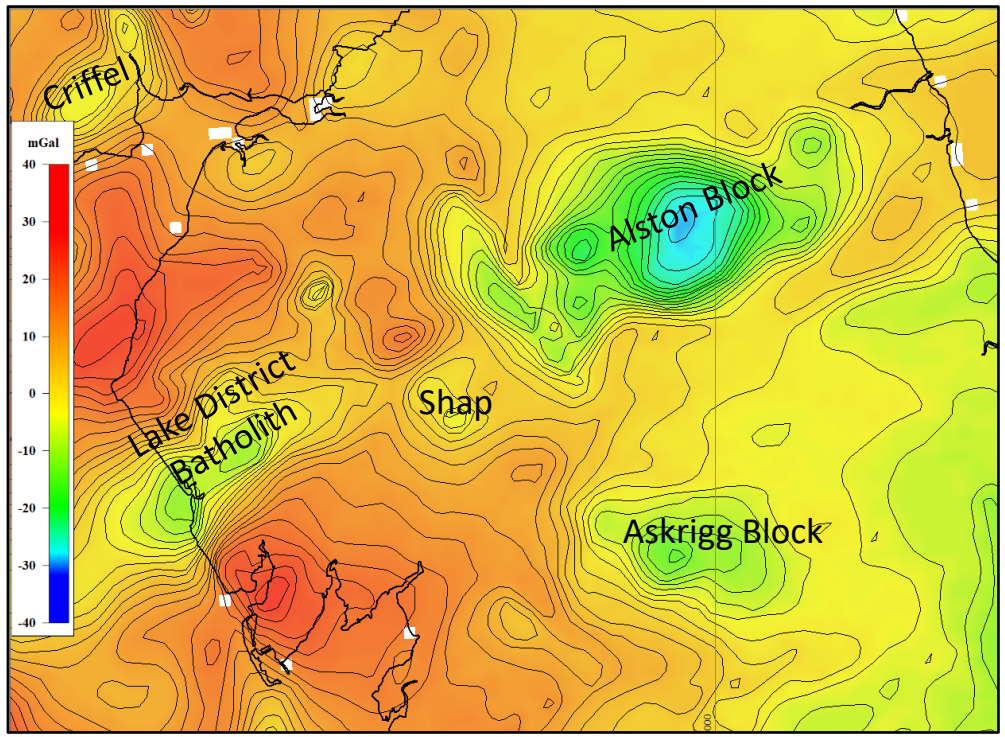
Geological Map *

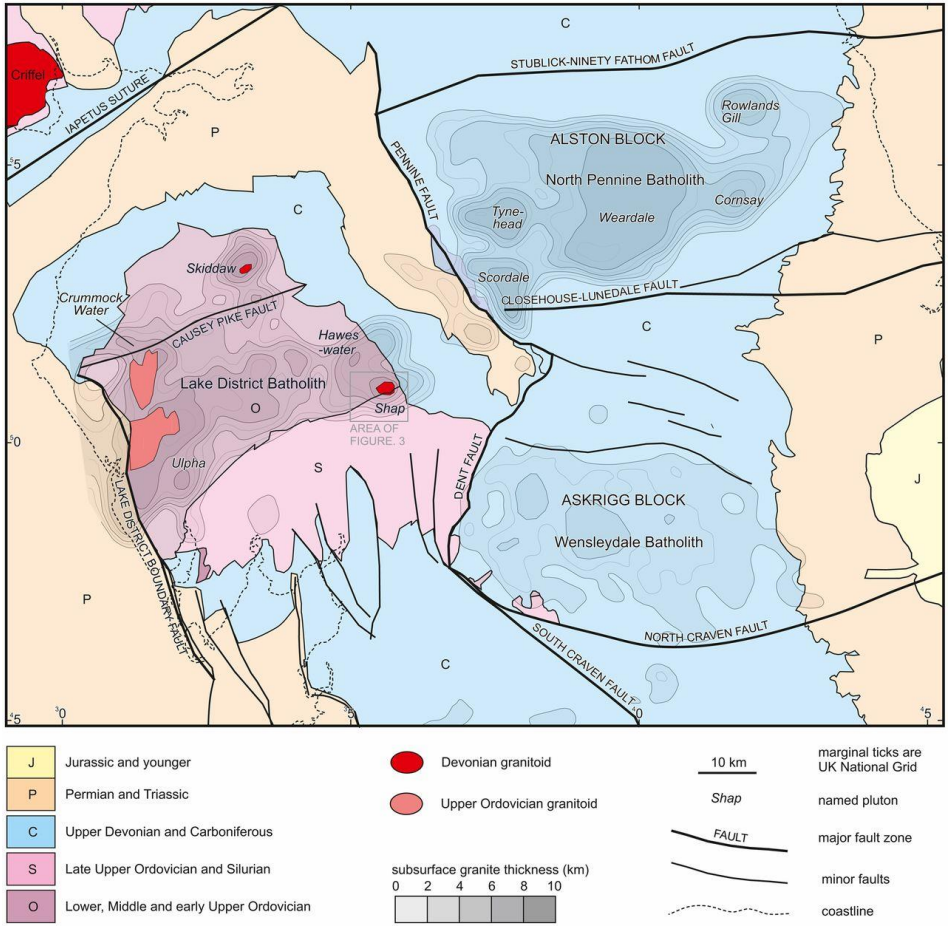


Geological Map *



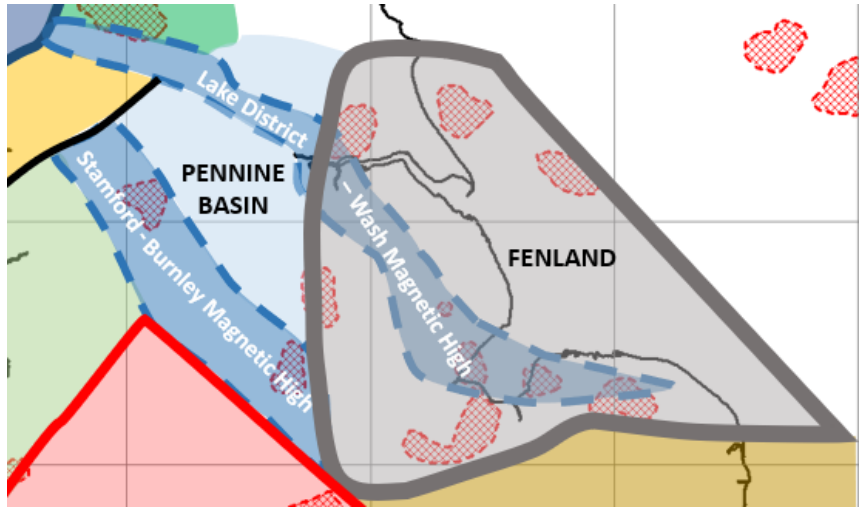
Gravity Data over Northern England*

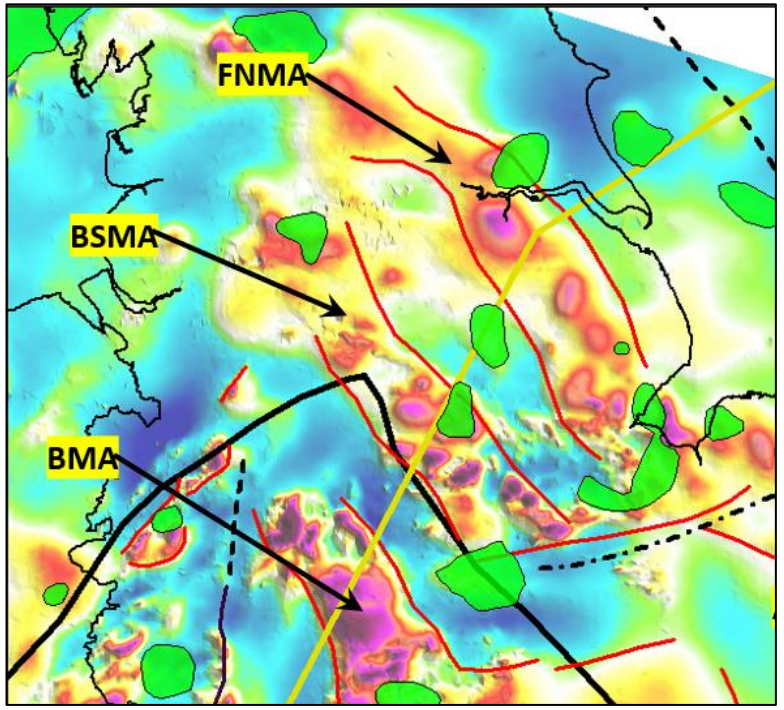




Fenland & Pennine Basin

- No outcrop. Known from few boreholes with limited penetration of the pre Acadian section and poor/limited lithological descriptions only
- Geophysics: Blocks of magnetic and non magnetic character orientated NW-SE in the Pennine Basin extending into the Fenland Block. Shallow magnetic basement over the Fenland Block with numerous intrusions. Undrilled granites appear to surround the Fenland Block. A sharp boundary exists to the south (Cambridge Line). Very limited seismic and due to steep dips the section is not resoled
- Stratigraphy:
  - Basement of Precambrian volcaniclastics overlain by poorly dated Cambrian to L. Ordovician (Tremadocian) sediments. Sequences are thinner and more metamorphosed than on the Midlands Platform
  - Widely developed deepwater Ordovician sediments of Arenig to Llanvirn age (Sequence 2) that are strongly deformed and altered, overlain by volcanic and intrusive sequences of Late Ordovician (Caradoc) age. Geophysical data suggests the intrusions are widely present
  - No Silurian or Lower Devonian sediments are seen. Widespread sedimentation resumes in the Lower Carboniferous and continues into the Late Carboniferous
- Deformation: All sequences encountered are strongly deformed with steep dips, severe alteration, and cleavage. At Charnwood the cleavage is dated to 432-416my (Middle Silurian to Lower Devonian) with a peak at 423my
- Maturity: The Fenland Block high maturity reaching epizone grade. In the Pennine basin intervals are metamorphosed but at a lower grade than in the Fenland area. The maturity data suggests the area was strongly influenced by the Late Ordovician Shelvian event and the magnetic blocks are thought to have amalgamated/docked at that time

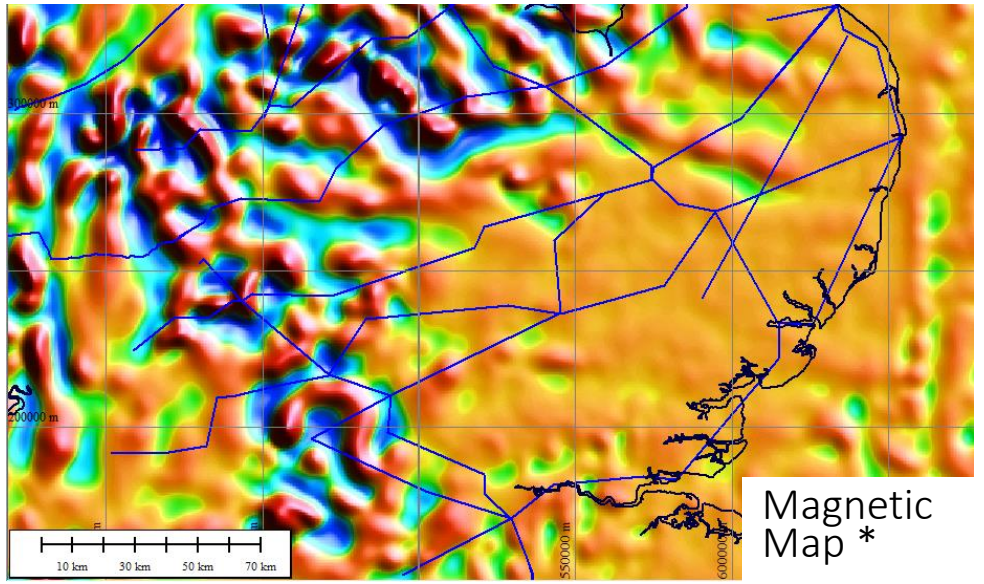




Magnetic Map *

Anglia Basin

- Known from boreholes. No outcrop. Well database has limited penetration of the pre Acadian section with poor/limited lithological descriptions
- Geophysics: The gravity data is featureless and implies a very thick sedimentary sequence preserved above a magnetic basement at 9kms. The magnetics show no evidence of widespread igneous activity and there are no igneous rocks seen in the wells. Very limited seismic.
- Stratigraphy:
  - Lower Ordovician (Tremadocian) beds are possibly present
  - In a few boreholes, sequences of deepwater Ordovician sediments (Arenig to Llanvirn - Sequence 2) are seen
  - Most wells encountered Silurian shelfal sequences of Llandovery to Pridoli age (Sequence 3). No reliably dated Lower Devonian sequences have been encountered.
  - Widespread sedimentation resumes in the Lower Carboniferous and continues into the Late Carboniferous
- Deformation: Beds in boreholes all show steep dip with undated cleavage recognised but with no orientation data
- Cleavage: Maturity – Low Anchizone metamorphic grade suggesting burial during the Late Silurian prior to Devonian uplift and erosion



Magnetic Map *

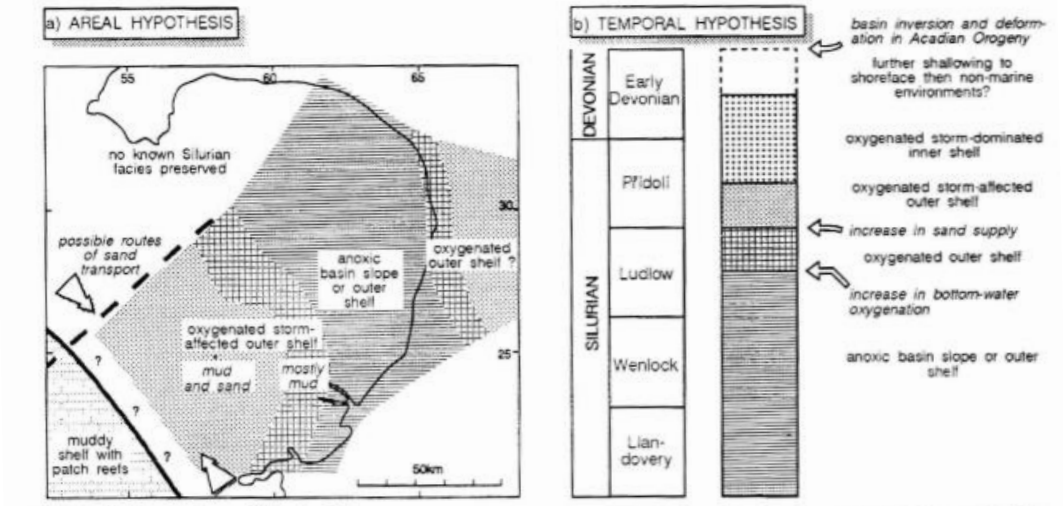
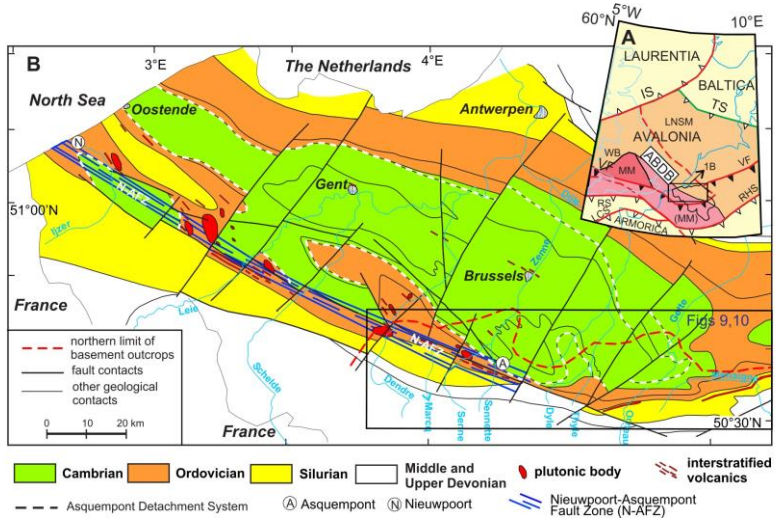


Figure 6. Interpretations of Silurian facies patterns as (a) a variation in space across the basin from shallow in the west to deep in the east, or (b) a variation through time as the basin shallowed by over-supply of sediment and by inversion.

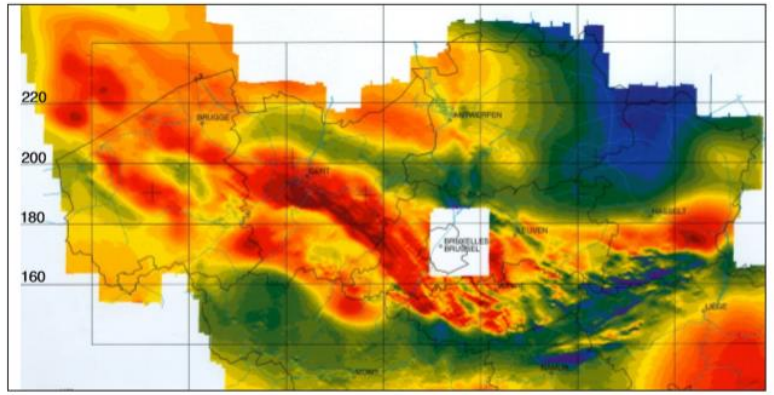
(Woodcock & Pharoah,1993)

Brabant Block

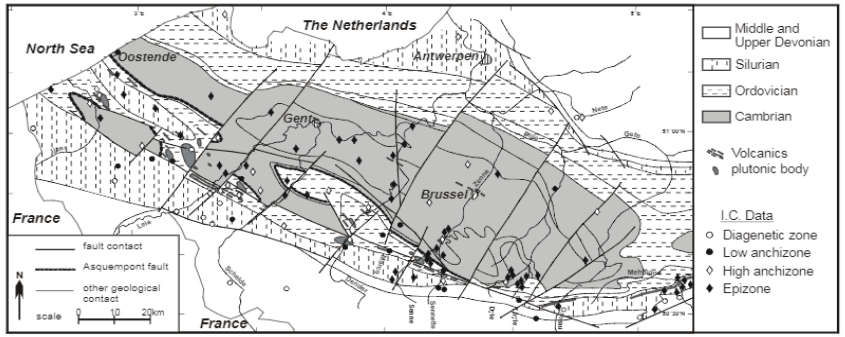
- Known from outcrop. Small well database – appears to lie on trend to Eastern England – but with offset in the Channel
- Geophysics: The basin is dominated by a gravity high. The magnetic response comes from siltstones in the Cambrian aged Tubize Formation. The potential field data shows igneous intrusions along the Nieuwpoort-Asuempont Fault Zone
- Stratigraphy:
  - Thick deepwater shales and sands of the Cambrian to Lower Ordovician (Tremadocian) (Sequence 1) are unconformably overlain by shales of the Late M. Arenig – Middle Caradoc (Sequence 2) with Upper Ordovician to Upper Silurian (Sequence 3) beds at the top
  - A series of intrusions and volcanics of U.Ordovician- M.Silurian (Wenlock) age lie along the Nieuwpoort-Asuempont Fault Zone, which forms the southern margin of the Basin
  - Sedimentation resumed in the Middle Devonian (Givetian) that continued into the Carboniferous
- Deformation: The NW-SE gravity high is thought to indicate the position of an Acadian aged basin inversion. The margin of the uplift is marked by the Nieuwpoort-Asuempont Fault Zone
- Cleavage: Cleavage of Acadian age is recognised throughout the central area of the block
- Maturity – Epizone metamorphic grade is reached over the centre of the area with only diagenetic grade reached on the flanks. To achieve this grade the sediments must have been buried in the Late Silurian to Lower Devonian and removed during the Acadian uplift and erosion event



(Herbosch & Debacker, 2018)



(Sintubin and Everaerts, 2002)



(Debacker et al,2003)

TECTONIC ANALYSIS

Shelvian Deformation

Major unconformity with Silurian sediments unconformably overlie more intensely deformed and heated Ordovician Ingletonian rocks. Ordovician aged intrusions. Two blocks are thought to have joined at this time

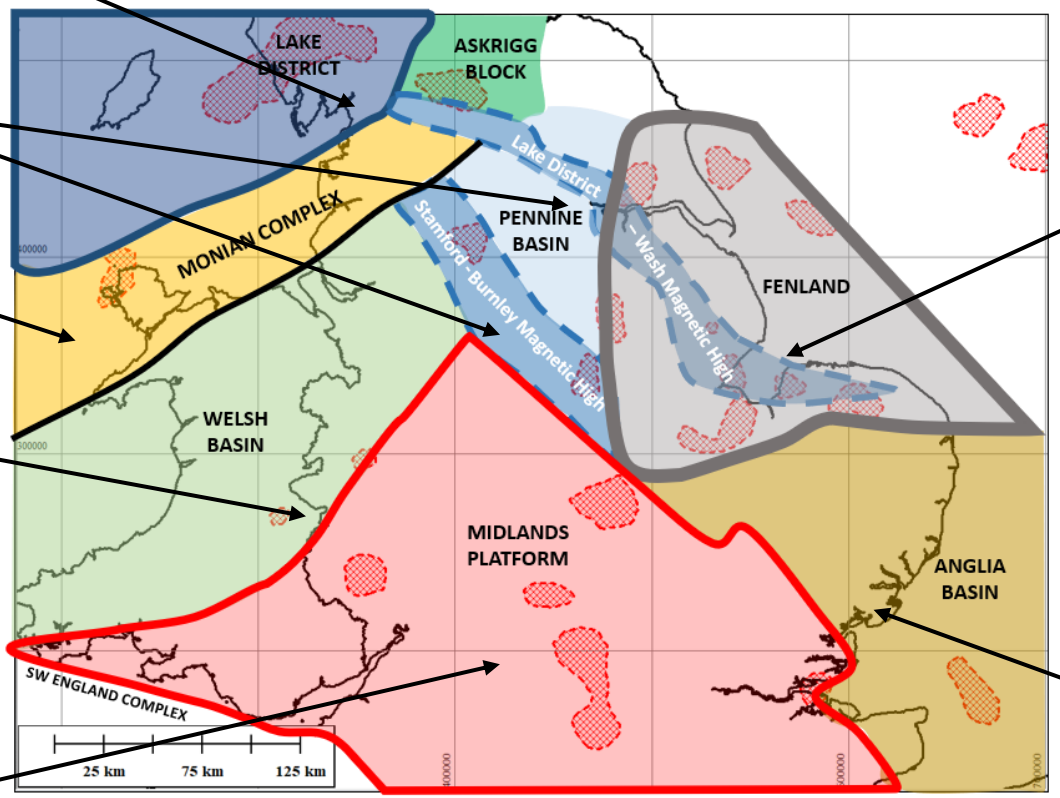
This event is thought to mark the joining of the Baltica and Avalonia plates – Block amalgamation in the UK – the implication is greater deformation in the east

The magnetic blocks are thought to have docked/amalgamated at this time

Lower Silurian Llandovery section unconformably overlies older section

Intra Ashgillian Shelvian unconformity at outcrop in the Borderland fault system. No break is seen in the centre of the Welsh Basin

Pre Silurian unconformity is seen on seismic across the Midlands Platform. The widespread absence of younger Ordovician sediments



The enhanced maturity and greater deformation of the thick Ordovician sequences of the Fenland area with respect to surrounding Blocks and the absence of Silurian sequences would be explained by the area being effected by the Shelvian event. The ring of granites may have been emplaced at this time

No evidence of post orogenic depositional facies

Acadian Deformation

This event is thought to mark the last stage of the Caledonian movements. Deformation and cleavage formation to the east is slightly older than deformation in the west

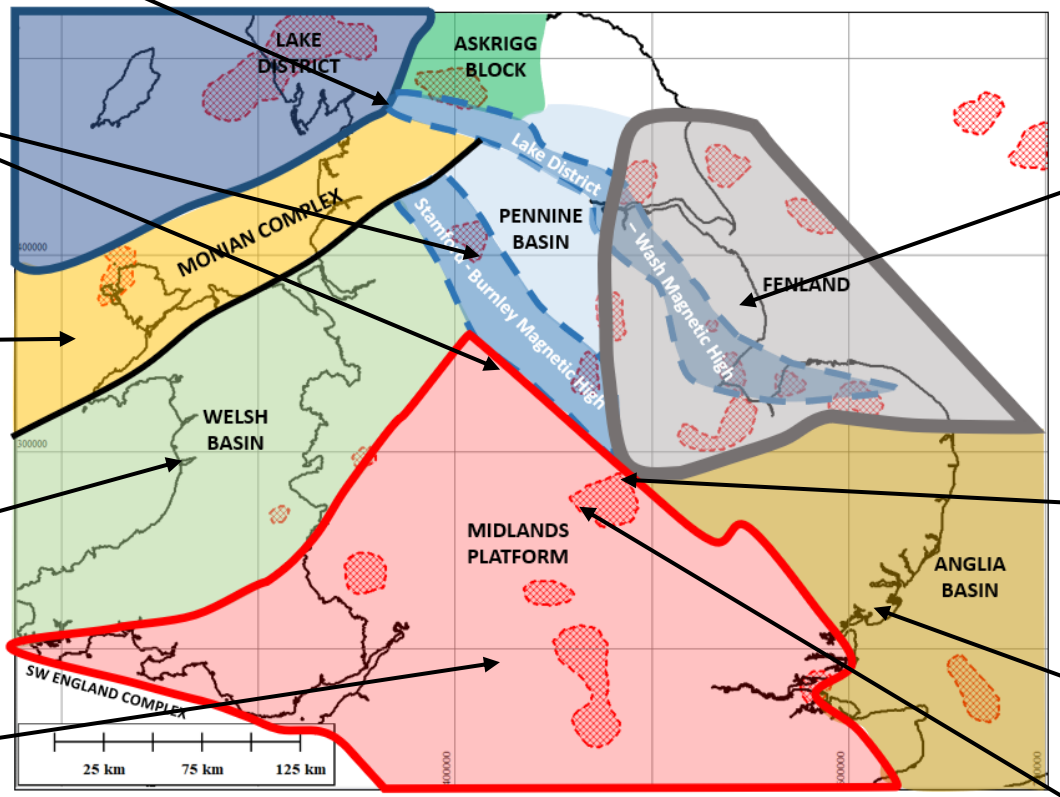
The Silurian is deformed and metamorphosed. Cleavage trends swing from NE-SW to NW-SE – dated in part to Late Silurian. Basin uplift seen. Post orogenic granites emplaced

No Silurian preserved – no post Ludlow sediments seen on the basin flanks. Ordovician section is deformed, cleaved and metamorphosed, partly during the Acadian

Lower Silurian Llandovery section unconformably overlies older section

Main phase of deformation, with folding basin uplift and cleavage formation event – dated to pre Middle Devonian

Sediments are uncleaved, unmetamorphosed and relatively undeformed on the Midlands Platform



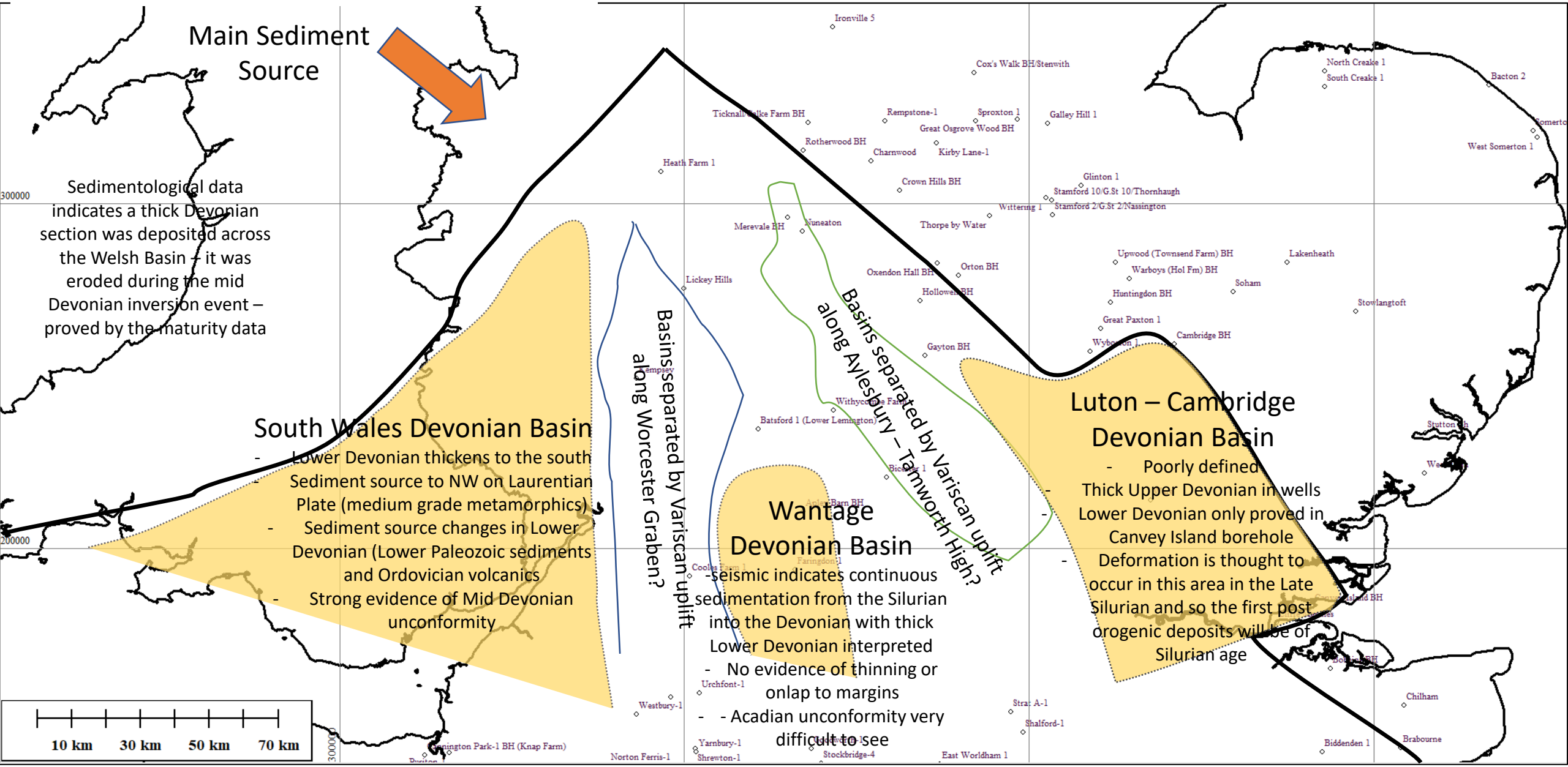
No Silurian preserved. Impossible to separate Shelvian and Acadian deformation phases. The presence of cleavage and the continuity of structural trends from the Anglia Basin northwards is thought to be indicative of Acadian deformation

At Charnwood, the cleavage is orientated NW-SE and is dated to 432-416my (Middle Silurian to Lower Devonian)

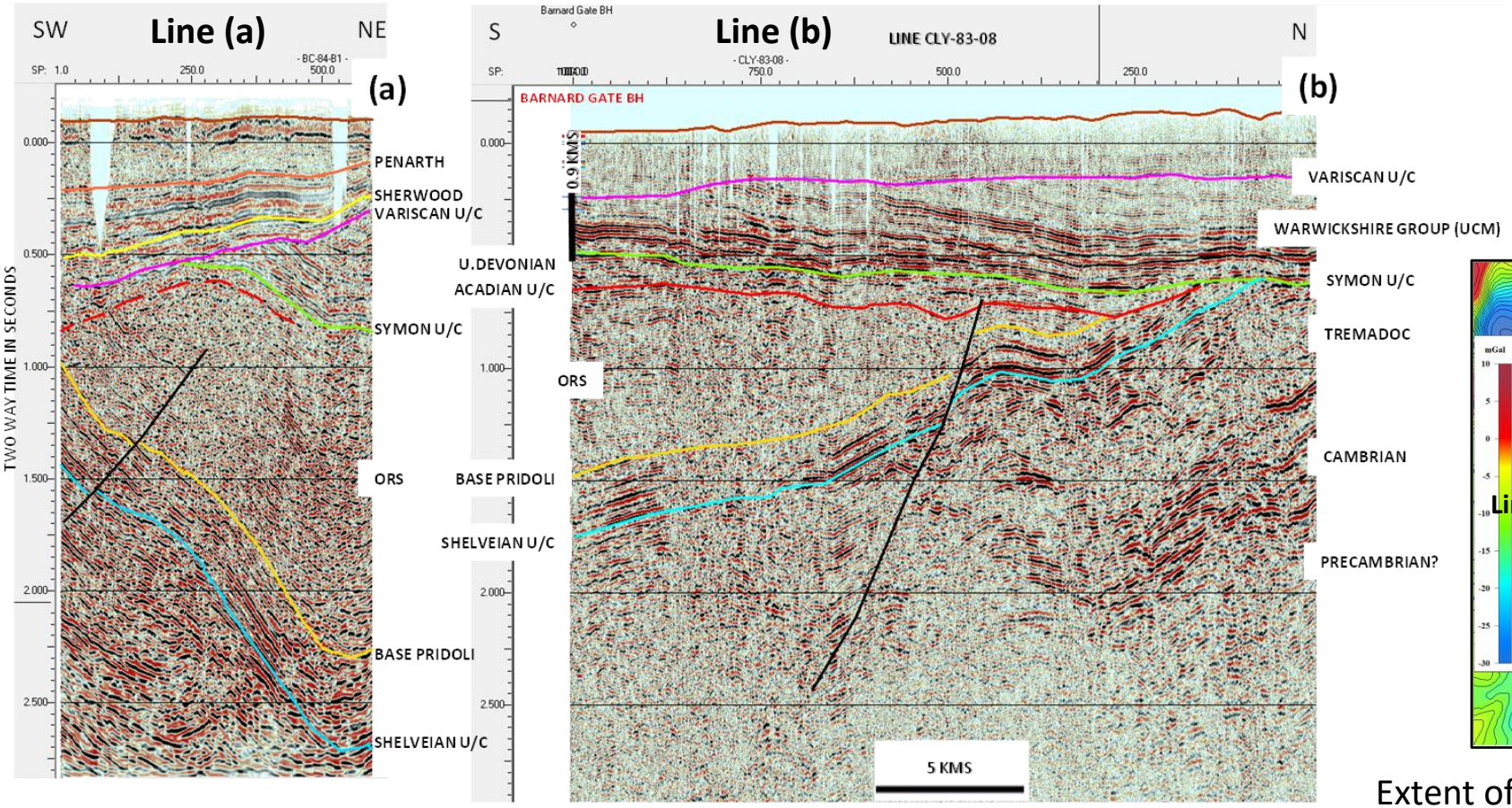
Silurian sediments deformed, cleaved and slightly metamorphosed. Some evidence of basinal inversion

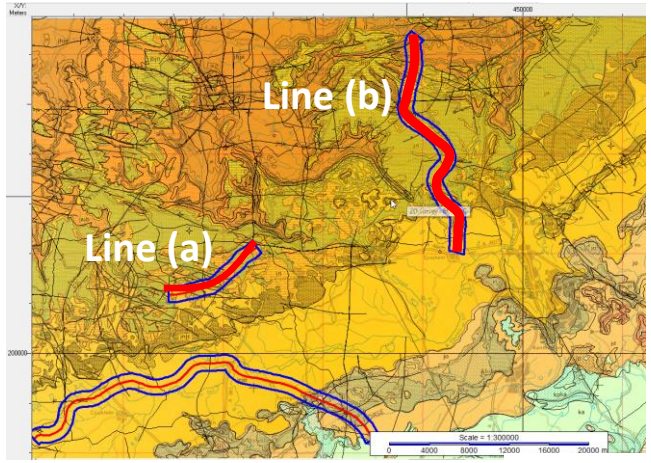
The edge of Acadian deformation along the east flank of the Midlands Platform lies to the west of the Shelvian deformation edge

Post Acadian Deposits – Devonian

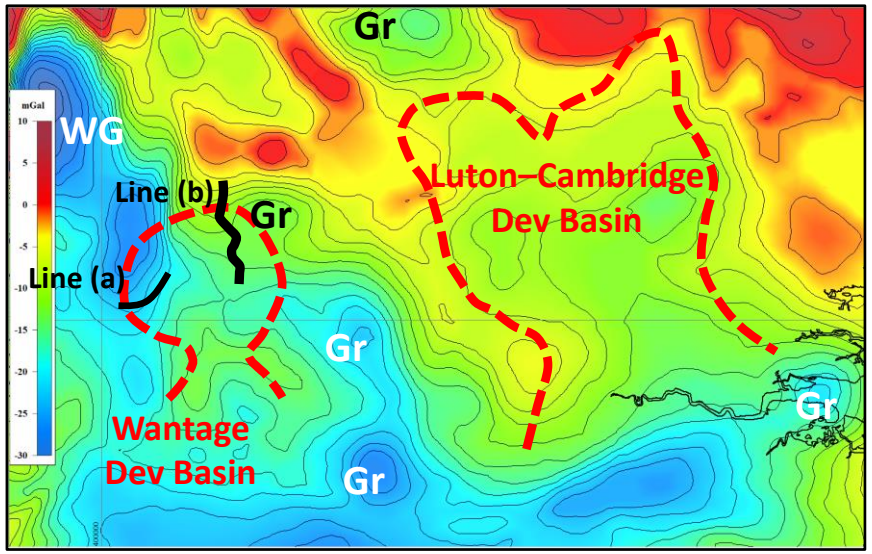


Seismic showing Lower Devonian Depocentre





Geological Map *

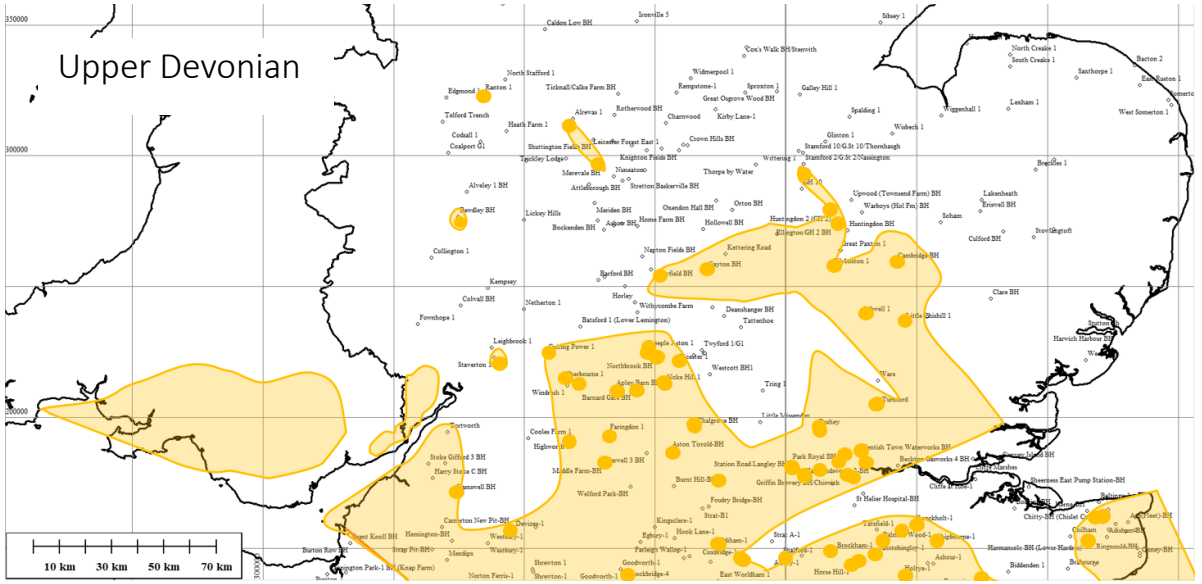


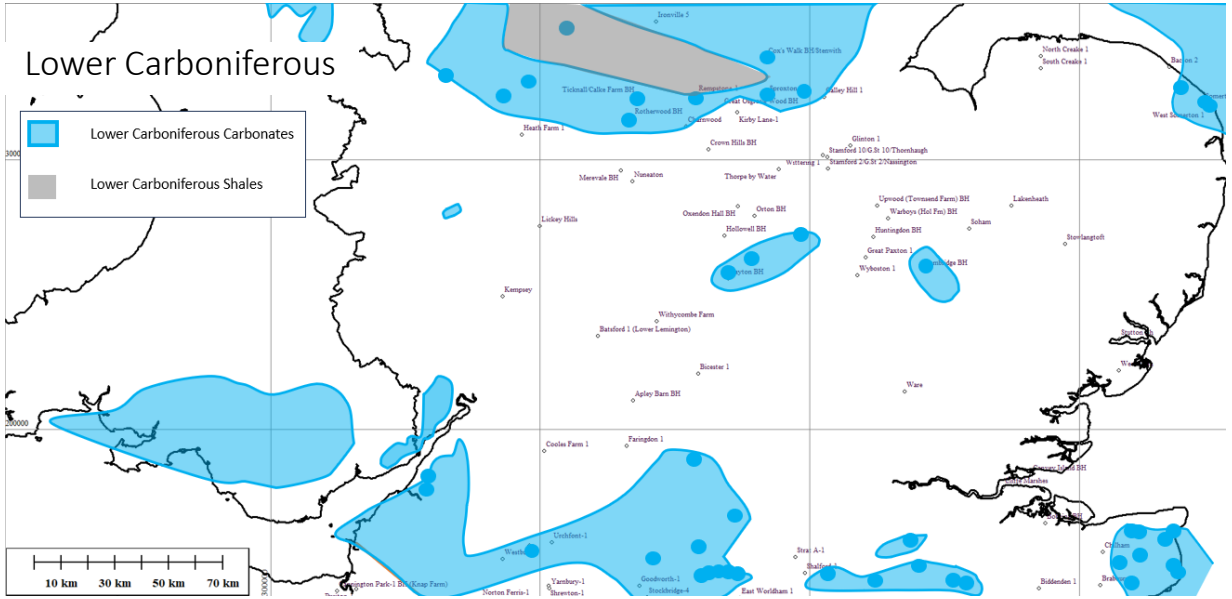
Extent of Wantage Basin from Seismic Interpretation
Extent of Luton-Camb Basin from Gravity Interp
Gr – Granite, WG – Worcester Graben

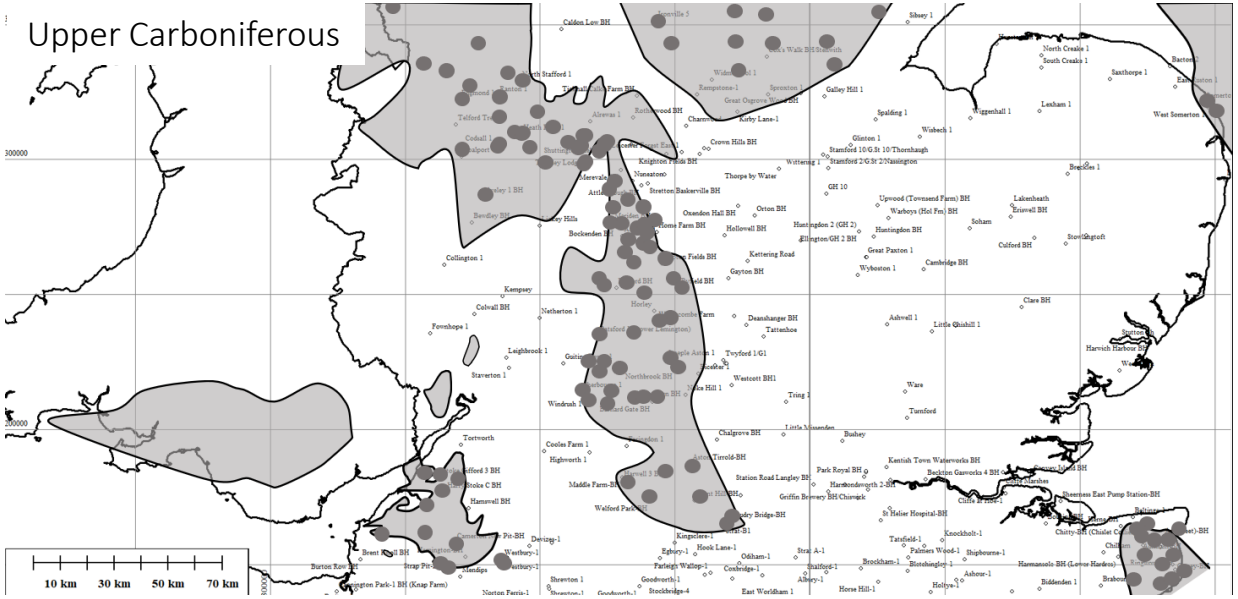
UPPER PALEOZOIC

Upper Paleozoic

- Following the Acadian orogeny the Midlands Platform, Fenland Block and Anglia Basin were consolidated into the London Brabant Massif
- This massif was first flooded in the Devonian from the south and north. The transgression culminated in the deposition of the Lower Carboniferous carbonates
- There was widespread non deposition in the Namurian before the advance of the major delta complex from the north reached the Massif
- Tectonic activity is represented by the Symon unconformity resulted in uplift in the south a northerly flood of coarse clastics represented by the Upper Coal Measures sequences

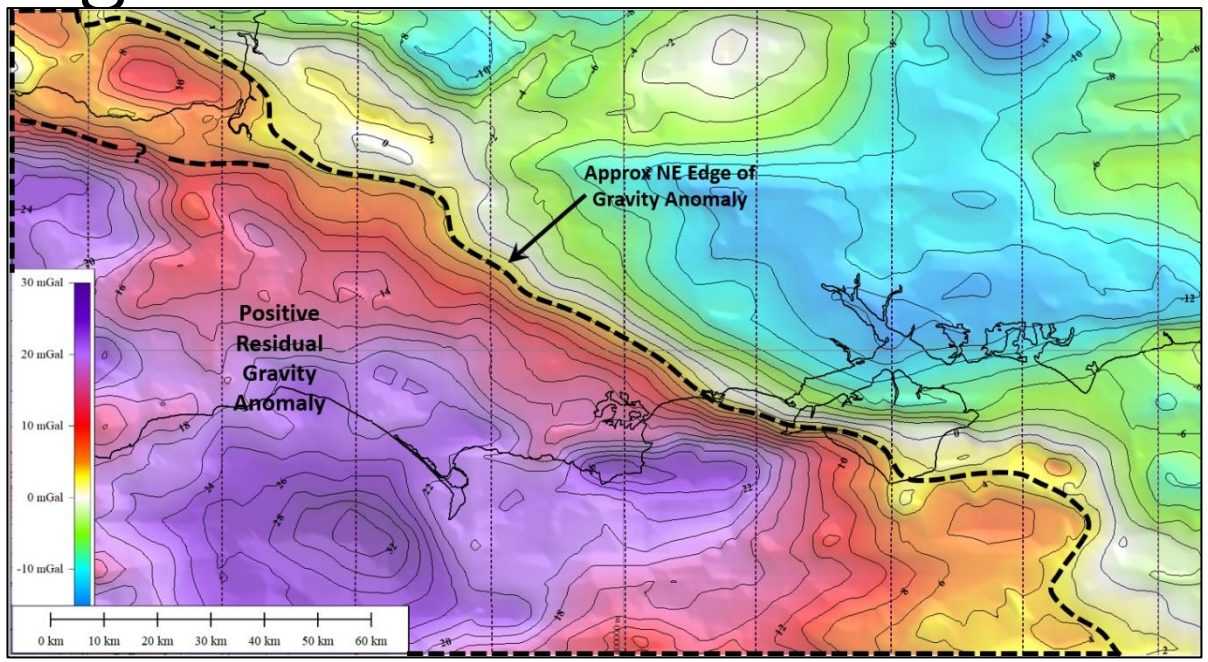


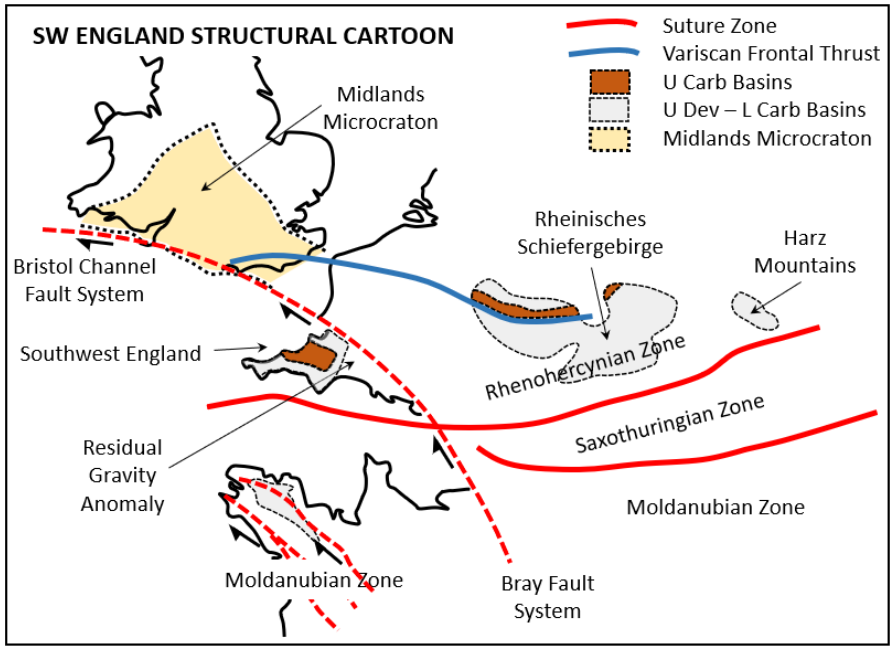


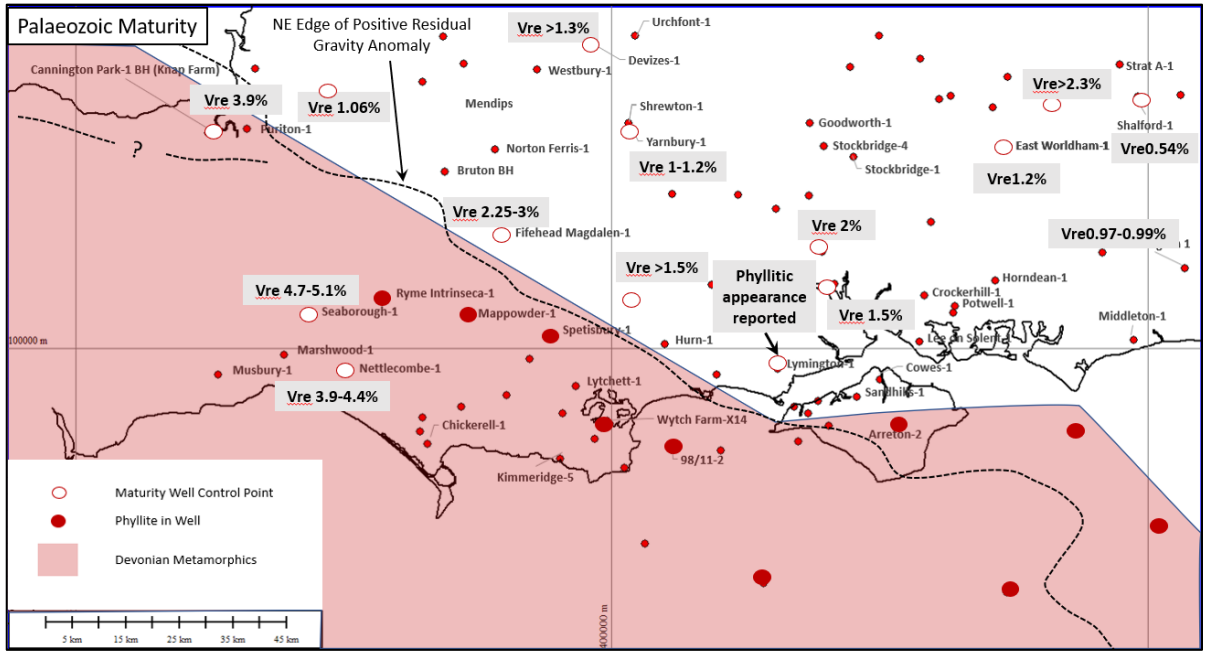


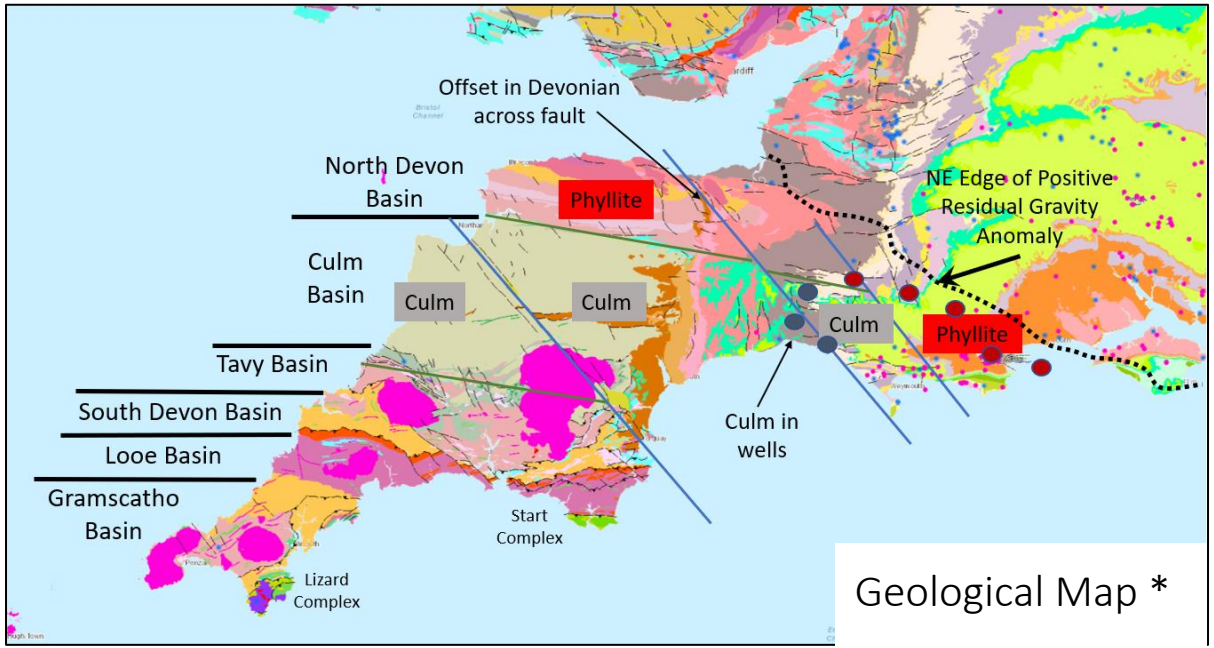
Well/Borehole control points shown as dots

SW England





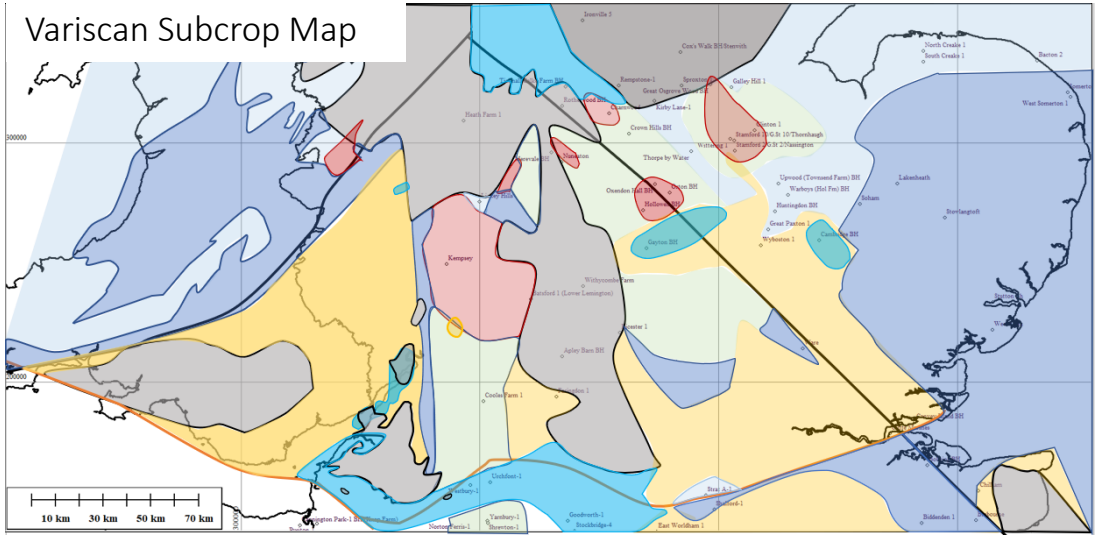


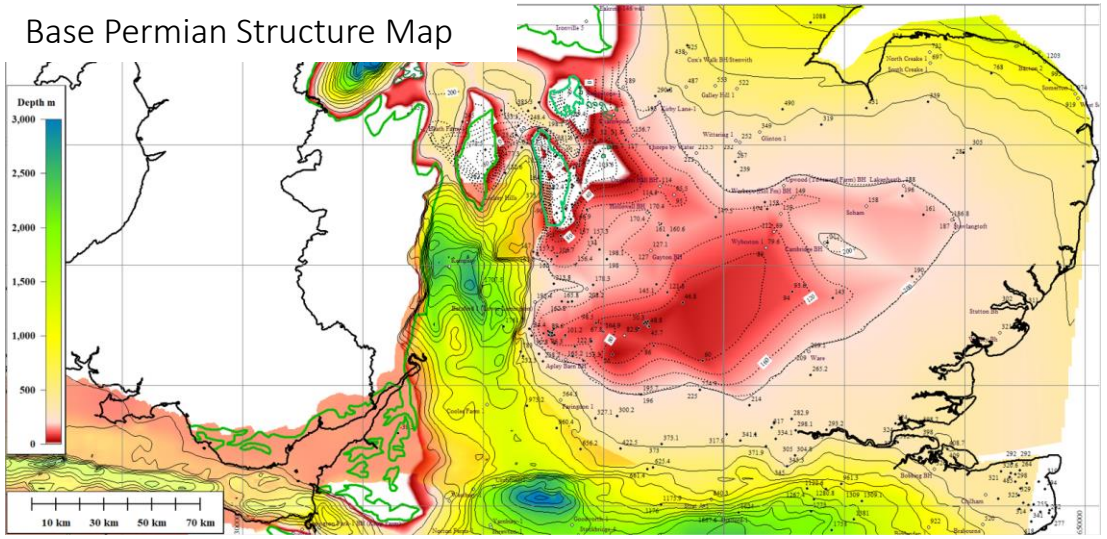


Geological Map *

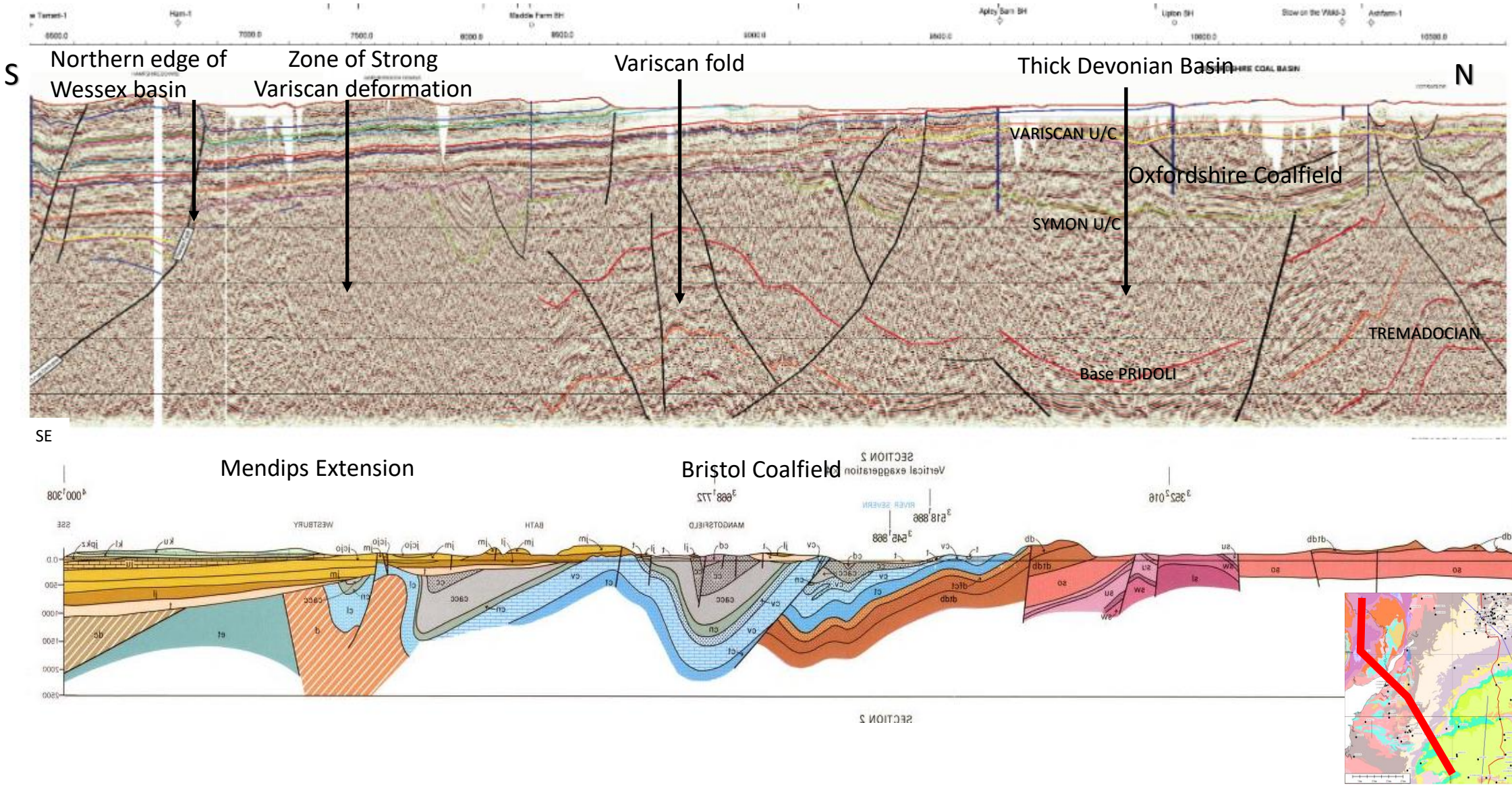
Variscan Deformation

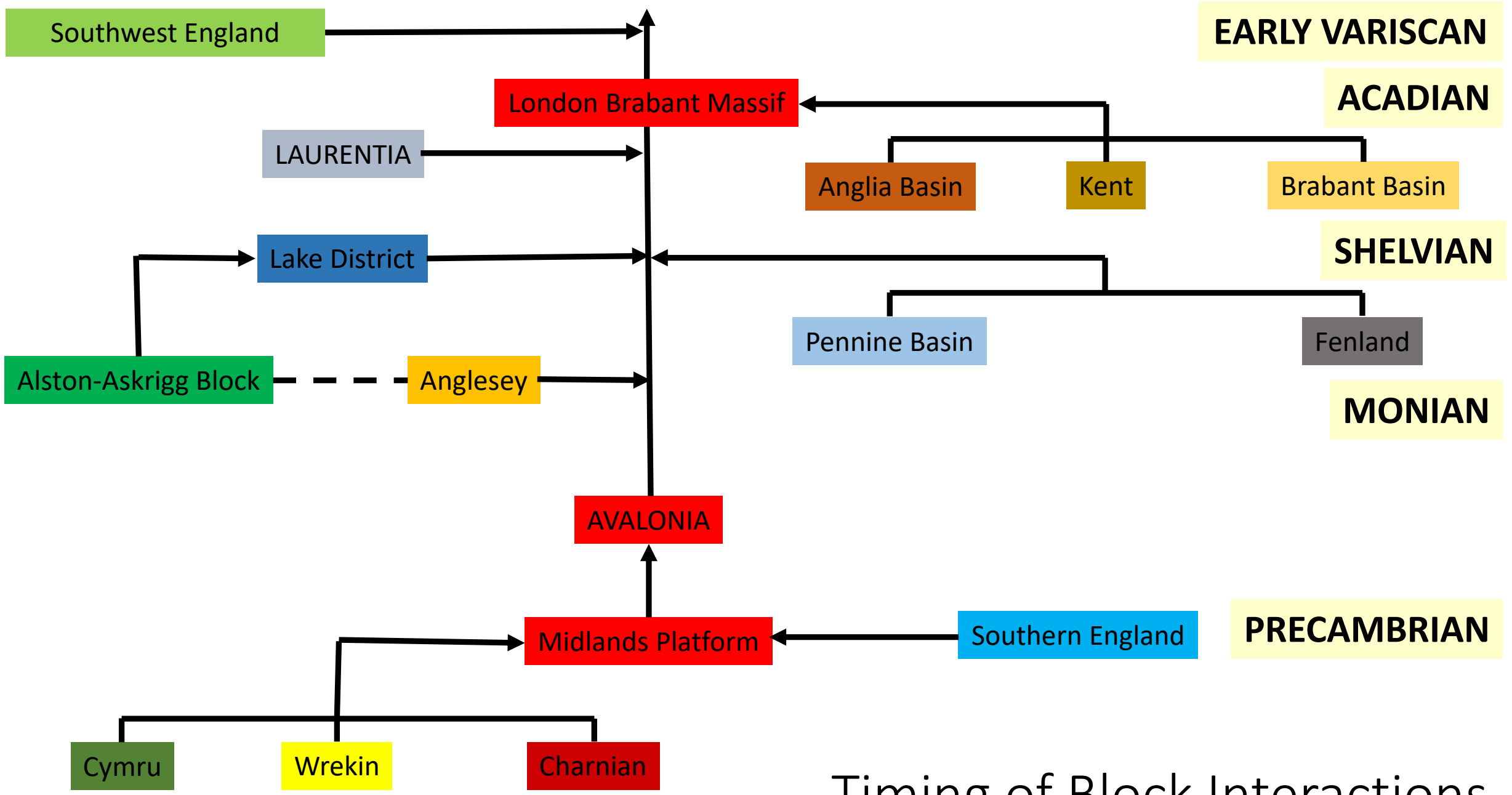
- Several episodes of Variscan deformation can be seen :
  - Namurian - non deposition over the London Platform-Weald Basin areas and emplacement of SW England
  - Intra Westphalian – Symon unconformity - Deformation in the south. Formed a sediment source area for later Carboniferous sands
  - Late Carboniferous-Early Permian times – Variscan unconformity - Deformation widely seen – post orogenic sedimentation is seen in the Southern North Sea and areas north of the London Platform
- The Southwest England block is thought to have been originated to the south and was emplaced along a major northwest-southeast strike slip fault zone
- Along the south coast of Britain an east-west trending unit of mainly Devonian sediments thrust to the north
- An east west zone of deformation along the south flank of the London Platform is recognised. It swings around the south side of the Reading-Sonning granites which are thought to have acted as a structural bulwark. To the east, it bifurcates with one limb on the north side of the Warlingham anomaly and continues into East Anglia whilst a second limb continues running east
- A series of broadly north south trending older lineaments, that cross the London Platform, were reactivated and transmit the stresses to the north
- The Variscan movements were not accompanied by cleavage formation or enhanced regional maturity over the London Platform or Weald Basin areas
- Variscan aged reactivated are characterised by being palaeohighs in the Permo-Triassic – for example: Mendips, Aylesbury-Tamworth High, south side of Anglia Basin, Charnwood. Many of the Variscan structures were reactivated in the Mesozoic and Tertiary





North –South Seismic Line and Cross- section* across Variscan Deformation Zone





Timing of Block Interactions

Conclusions

- The approach of integrating all the geophysical datasets with the geological data and its interpretation through a series of iterations is a very productive methodology – it does not provide unique solutions but it drastically reduces the number of viable geological alternatives and gives very valuable insights
- The Unconformity bounded sequences approach to the stratigraphy can be widely applied
- The area can be subdivided into a series of blocks with similar structural and stratigraphic histories separated by long lived lineaments which have been periodically reactivated, with many originating in the Precambrian
- The Shelvian deformation event determined the form and evolution of northern Britain
- Acadian deformation was the dominant deformation event around the Midlands Platform
- Southern England was joined to the Midlands Platform prior to the Paleozoic. Southwest England was emplaced by strike slip faulting during the Variscan

Future

- Variscan deformation in Southern England and how it links to Northern France/Belgium
- The Shelvian tectonism of Northern and Eastern England
- Anomalies that need further work, for example the Warlingham Hole
- Upper Carboniferous stratigraphy in Southern England wells