

Why West Cumbria is unsuitable for a deep geological nuclear waste facility

International aspects

Guidelines

What other countries do

History of search in Britain

Up to watershed of 1997 Inquiry

West Cumbria

Geology of **Sellafield (Longlands Farm)**

Geology of **Eskdale & Ennerdale granites**

Political/scientific manipulation

**Some progress made during MRWS
consultation:**

Geology put centre-stage of agenda

Arguments reduced to two rock types:

- **Eskdale / Ennerdale granites (Copeland)**
- **Mercia Mudstone Group (Allerdale)**

Sellafield now implicitly ruled out

Evolution of international search criteria

The following organisations agree or have agreed on the same set of broad principles:

- IAEA (pre Nirex 1995 Inquiry guidelines)
- British Nuclear Fuels Ltd
- IAEA – new guidelines 2011
- European Union
- British Geological Survey
- Finnish Geological Survey

None of them put voluntarism ahead of a systematic geological search.

Search practice abroad

Geological search for a waste repository

Abroad:

Geology sorted before community involvement :

- Belgium
- Canada
- Finland
- France
- Sweden
- Switzerland
- USA

The 2008 White Paper misleads on:

Sweden and Finland

Summary of fundamental criteria

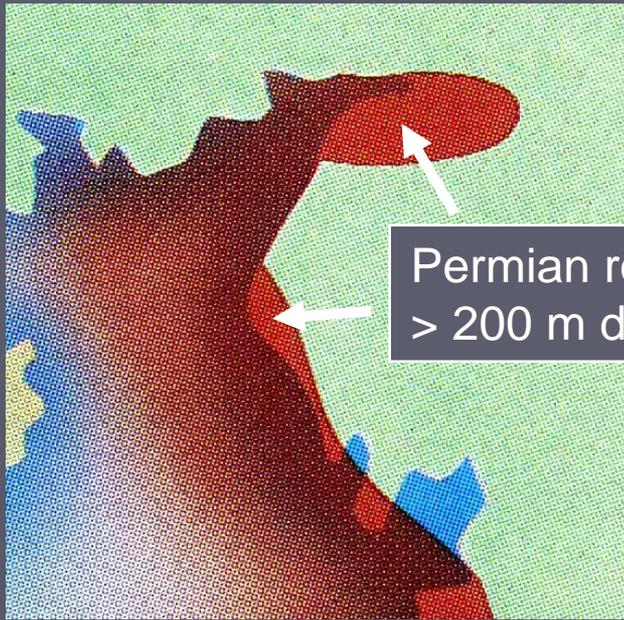
Drawn from research, experience and recommendations here and abroad since the early 1990s:

- The host rock is NOT so important at the first stage.
- The regional setting of the site IS most important.
- Long geological stability.
- Low hydraulic gradients.
- Simple geology.
- Suitable geology precedes community assent / veto.

Every locality in West Cumbria has a problem with several of these.

History of UK site search up to 1997

Nirex 1987: *The Way Forward*



Permian rocks at > 200 m depth

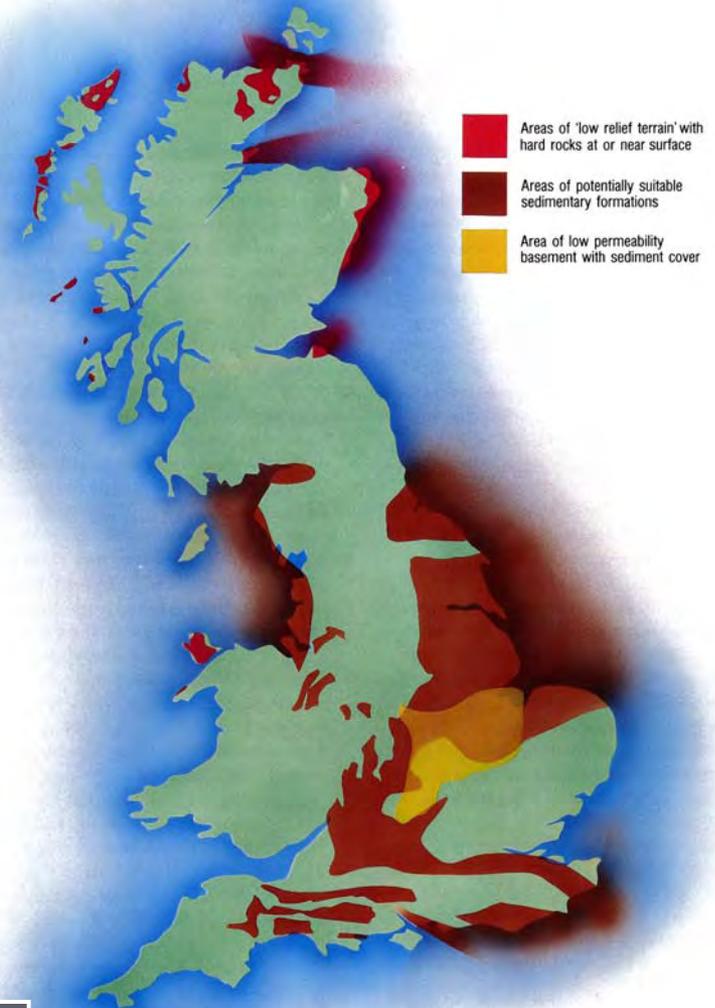
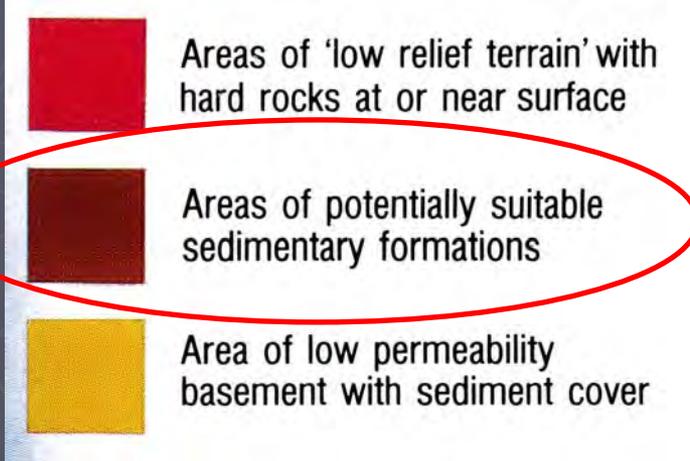


Figure 5.4 Base map showing geological environments considered to have potential for repository development.

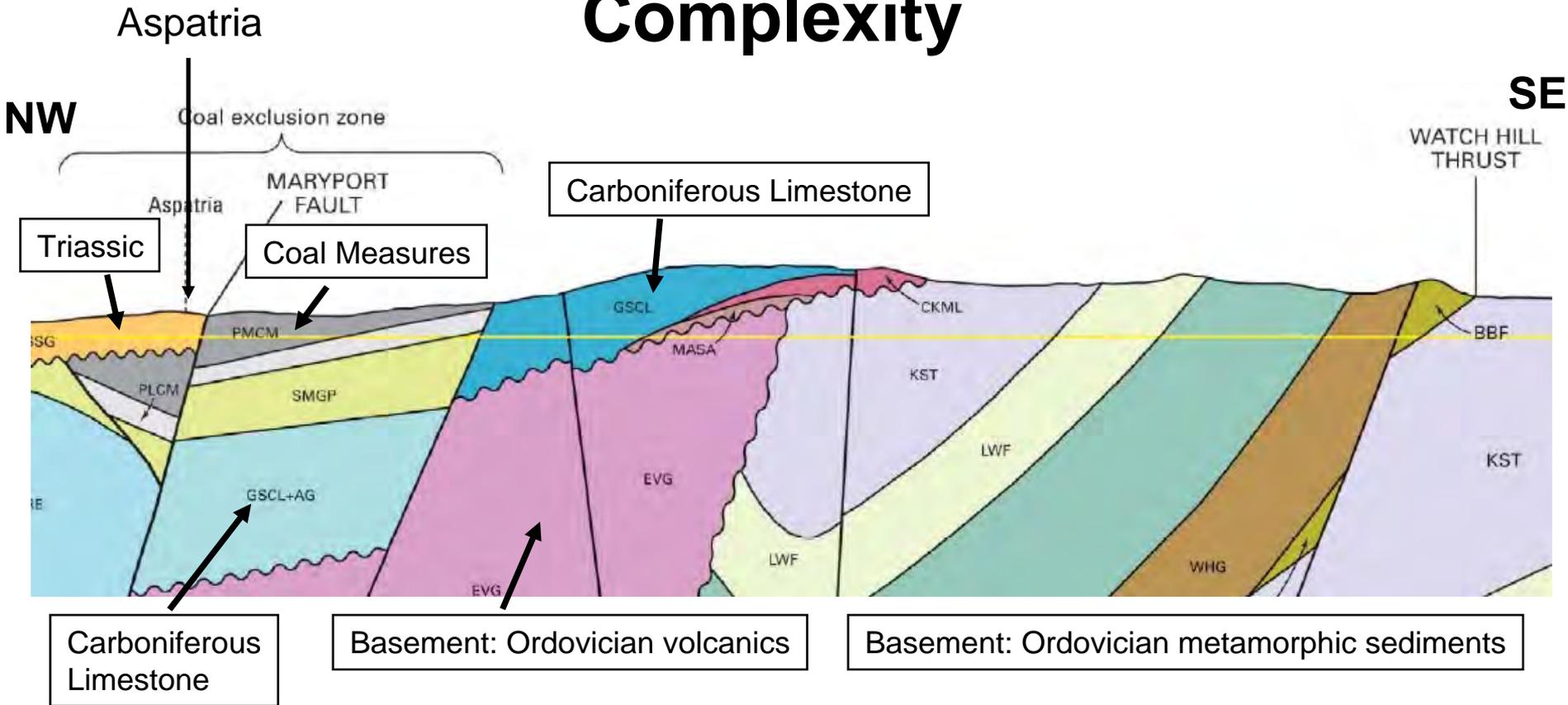
Sediments were the only suitable formation identified in Cumbria

What does complexity mean ?

in the context of a potential repository:

- Variety of lithologies
- Folding
- Angular unconformities
- Faults cutting both basement and cover rocks
- Faults intersecting the ground surface
- Faults intersecting each other at shallow depth
- Three-dimensionality

Complexity



Cross-section through Allerdale from BGS screening report.

Vertical scale 3x horizontal.

Sea level – yellow line; base of section at 1500 m.

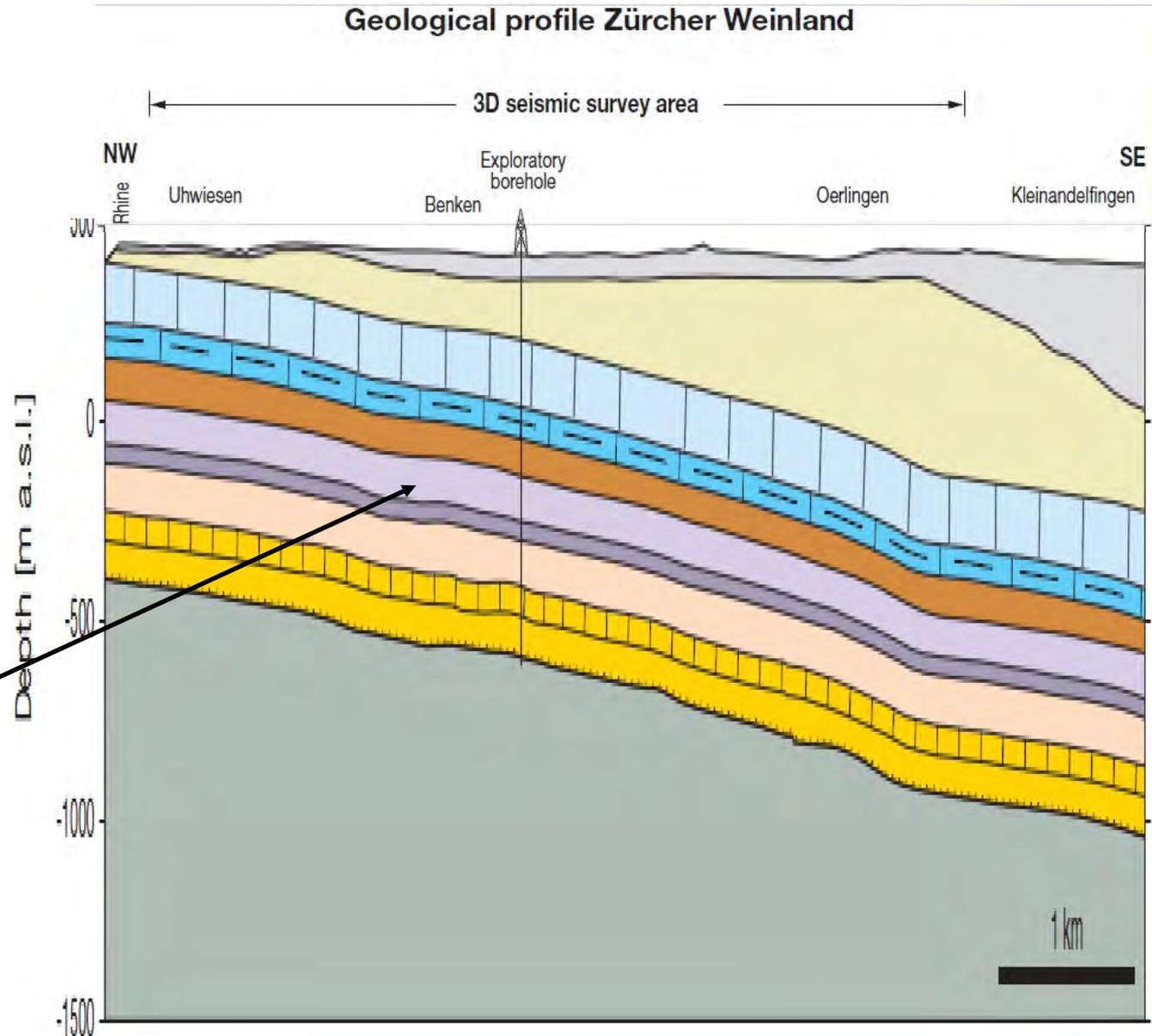
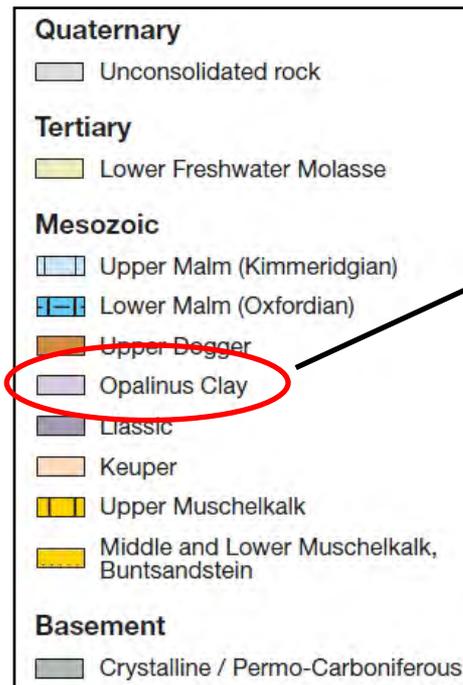
Faults are denoted by solid lines, unconformities by wavy lines.

- a good Final Year Honours Geology exam question !

Simplicity: the clay layer site in Switzerland

Cross-section from the Swiss HLW site.

Vertical scale 3x horizontal.

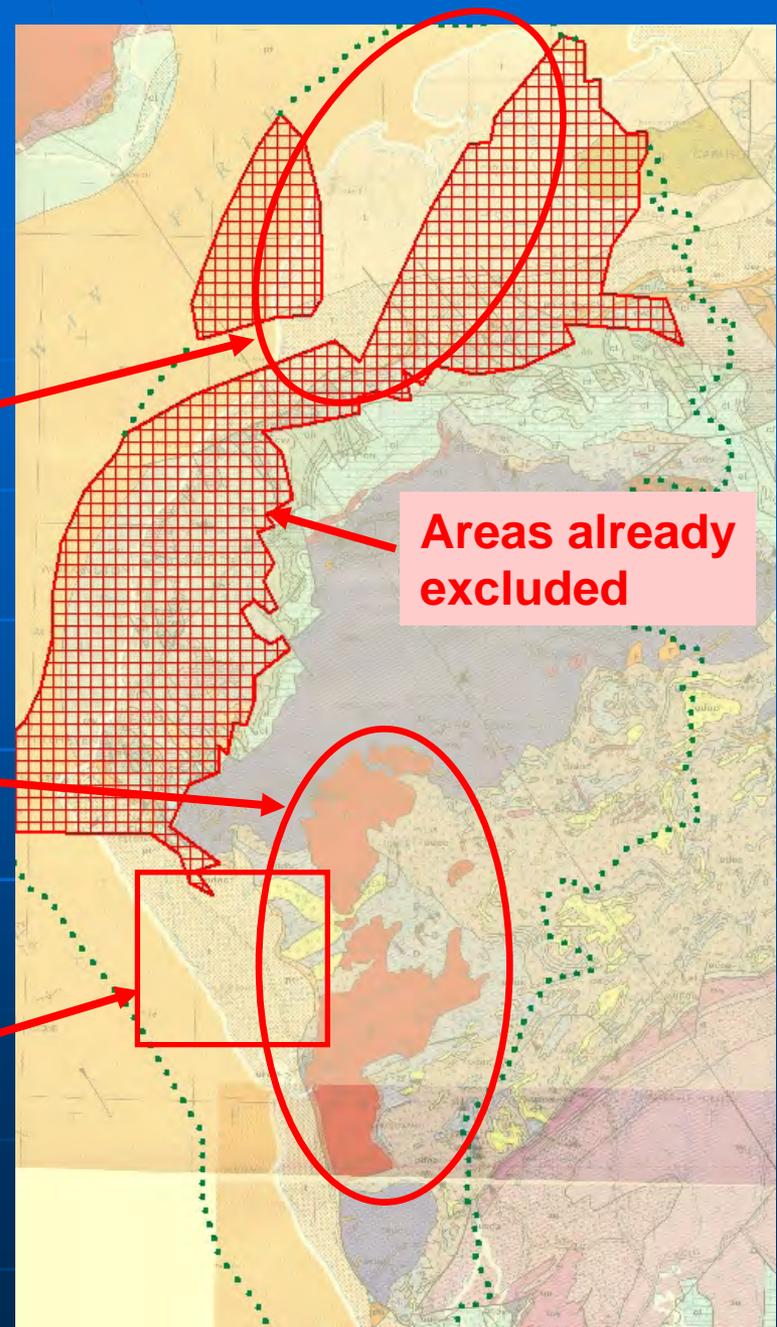


Geology of the areas left in play

Northern Allerdale –
the Mercia Mudstone
Group

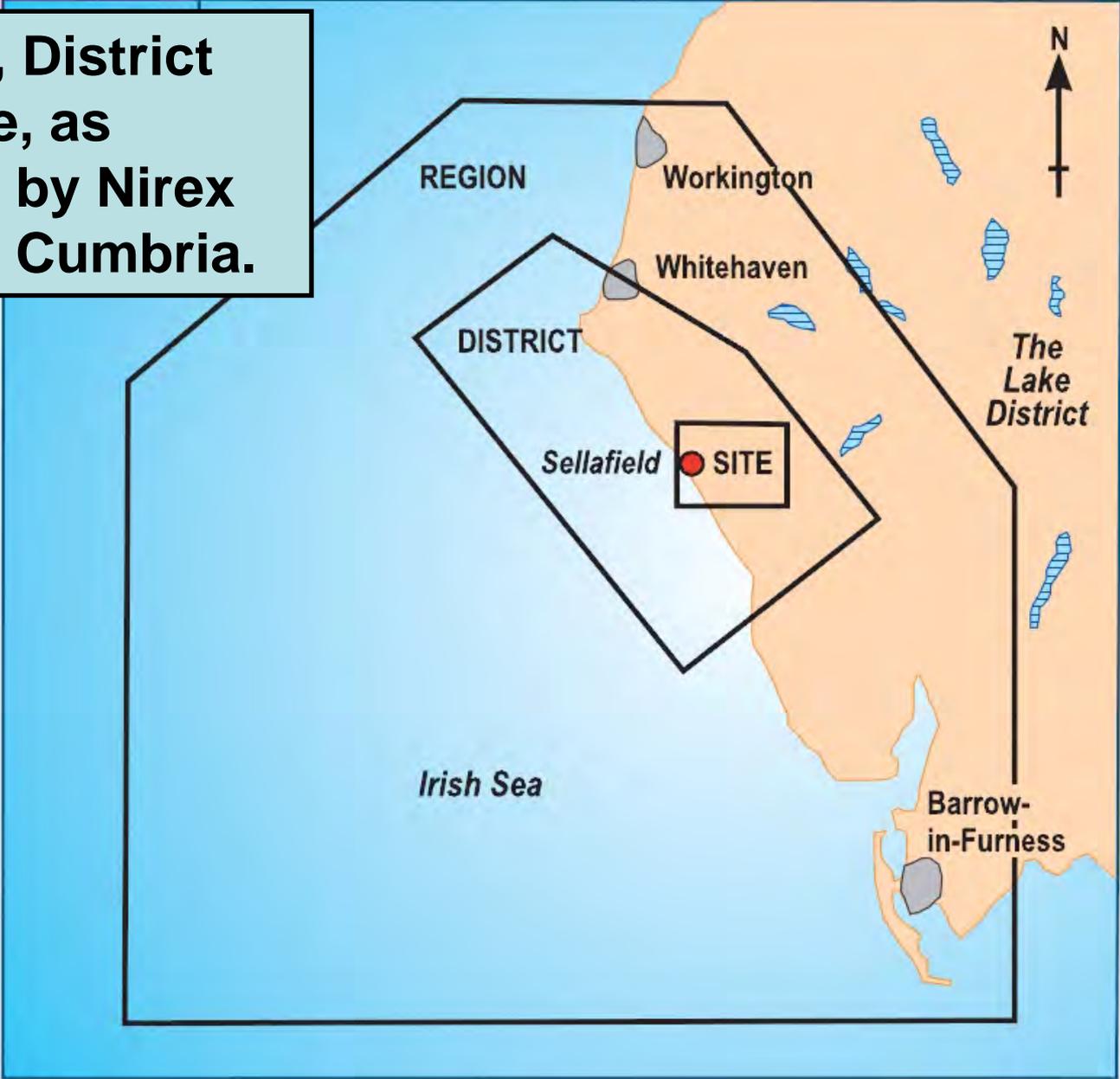
Eskdale and Ennerdale
granites (red areas)

Sellafield / Longlands Farm
(ancient history or not?)



Region, District and Site, as defined by Nirex in West Cumbria.

Site and repository pre-selected - but whole region now very well-understood



Key

-  Town
-  Lake

**Systematic search
(international search guidance)**



CUMBRIA

North of Workington to south of Barrow - inland to Ulverston.



NIREX 1
REGION

Whitehaven to Ravensglass and offshore 10km.



NIREX 2
DISTRICT

Sellafield Worthy - Seascale and Gosforth.



NIREX 3
SITE

Longlands Farm, Gosforth.



NIREX 4
PROPOSED
REPOSITORY
ZONE



Directions of Nirex studies

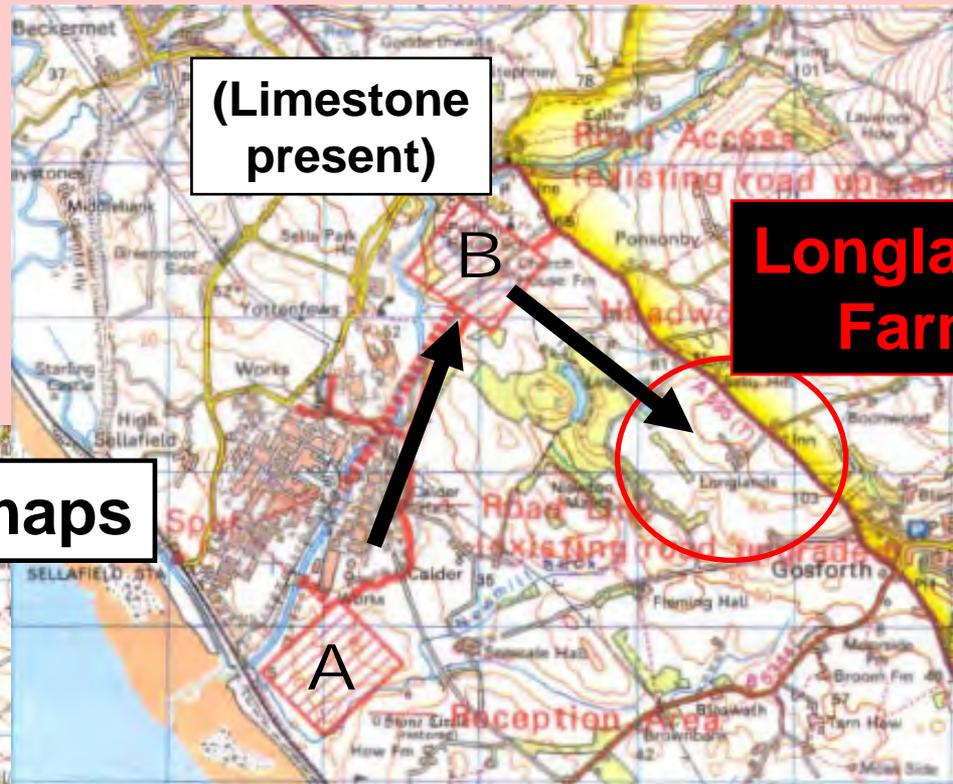
Thanks to Marianne Birkby

**Sellafield
Longlands Farm
Host rock:
Borrowdale Volcanic Group**

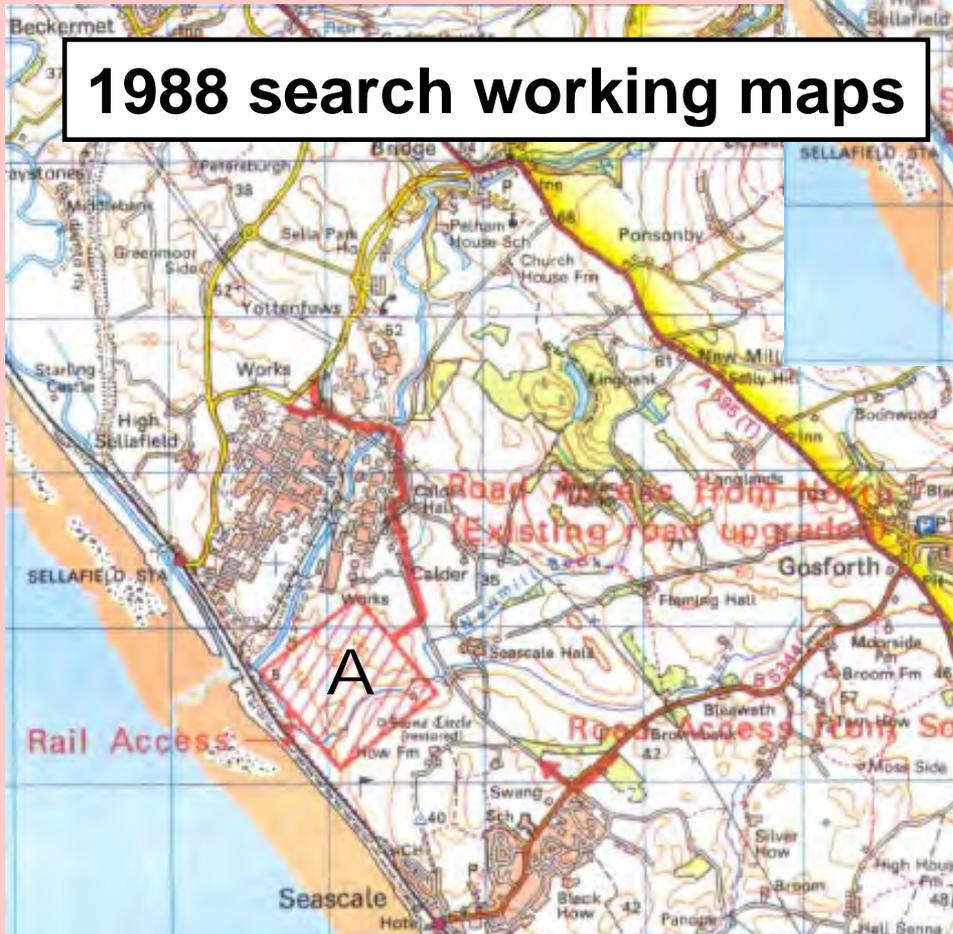
- **£400M spent**
- **Rejected by Inquiry**

**Can it be revived?
What lessons can be learned?**

Site search:
 'Coastal sediments'
 at Sellafield
 morphed into a
 'BUSC variant'.



1988 search working maps



361	North Rona	Small island	A	420	Salisbury Farm	Ex-AOS inland	D
362	Norton Barracks	Inland	A	421	Samphrey	Small island	B
363	Norton Manor Camp	Inland	A	422	Sanda	Small island	B
364	Nuneaton	Inland	A	423	Sandhurst	Inland	A
365	Oakington	Inland	A	424	Sandray	Small island	G
366	Odiham RAF	Inland	A	425	Scalpay	Small island	B
367	Ogborne St George	Inland	A	426	Scampton RAF	Sedim. inland	C
368	Oigh Sgeir	Small island	F	427	Scarba	Small island	A
369	Old Dalby	Inland	A	428	Scarp	Small island	A
370	Old Park Barracks	Inland	A	429	Scor	Ex-AOS coastal	D
371	Old Sarum	Inland	A	430	Seathorpe USAF	Sedim. inland	E
372	Oldbury	Ex-AOS coastal	D	431	Sealand Range	Coastal	A
373	Ollerton	Sedim. inland	C	432	Seighford	Inland	A
374	Orfordness	Coastal	A	433	Sellafield (-A)	Sedim. coastal	H
375	Ornsay	Small island	A	434	Sennybridge	Ex-AOS inland	D
376	Ornsay	Small island	B	435	Shawbury	Inland	A
377	Osgodby Moor	Sedim. inland	F	436	Shellingford Afd	Inland	A
378	Ossington Afd	Sedim. inland	B	437	Shiant Islands	Small island	B
379	Otmoor	Inland	A	438	Shoeburyness	BUSC coastal	F
380	Otterburn	Ex-AOS inland	D	439	Shrivenham	Ex-AOS inland	C

List of 437 UK potential sites

What's wrong with the Sellafield site (Longlands Farm)

- Not in the list of 437 sites
- Not BUSC (nor any other suitable type)
- Regional topography too severe
- BVG not true hard rock
- Highly complex volcanics
- Highly faulted
- Three-dimensional
- Overlain by aquifers

- Fast, unpredictable flow
- Therefore **unsafe**

**After £400M spent in West Cumbria
+ £10M at the Inquiry itself in 1995-96**

The Inquiry Inspector

FINAL CONCLUSIONS

“8.53 The indications are, in my judgement, still overwhelmingly that this site is not suitable for the proposed repository, and that **investigations should now be moved to one of the more promising sites elsewhere.**”

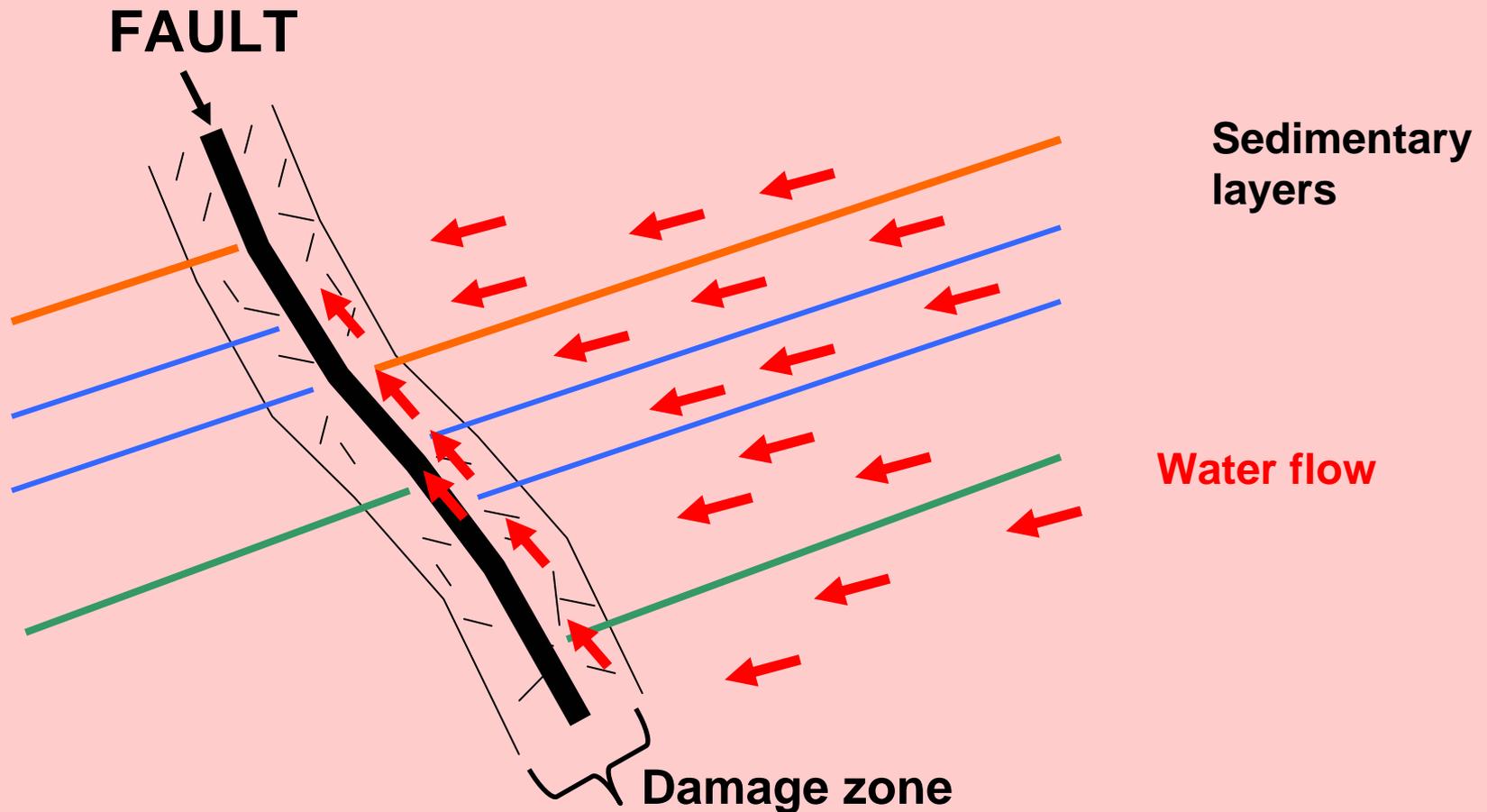
... the end for Sellafield, one might reasonably think.

In denial

Nirex discussed Sellafield in 2005, asserting:

“It has been argued that the rejection of the RCF planning application indicates that Sellafield was unsuitable as a repository site.

However, we believe that this was never a conclusion from the RCF Local Planning Inquiry Inspector's report.”



**Fault core – could be a barrier; could be a conduit.
Damage zone – a conduit.**

**But fault zones have been assigned permeabilities similar to,
or the same as, the unfaulted rock.**

Nirex work at Longlands Farm completed after end of Inquiry

REPOSITORY

WEST

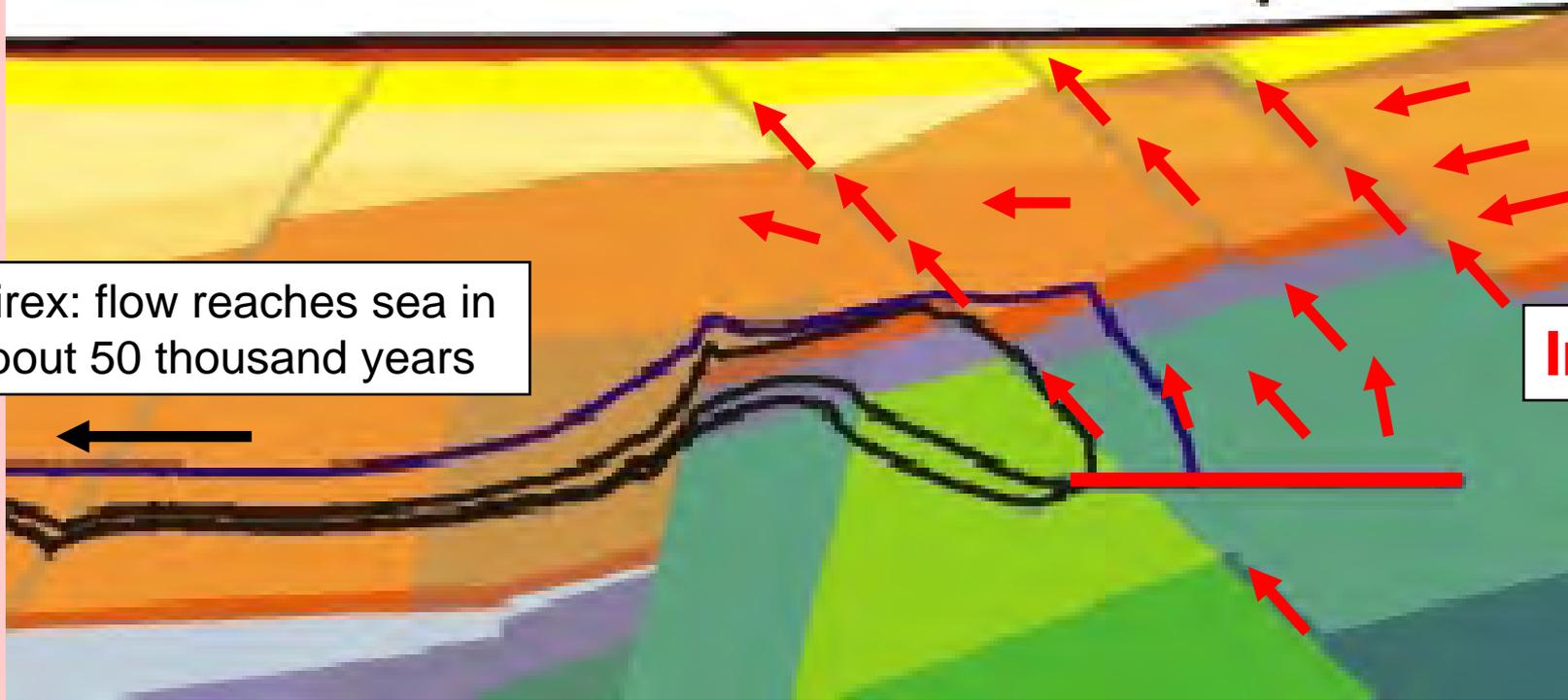
EAST

Outflow



Nirex: flow reaches sea in about 50 thousand years

Inflow



Red arrows show more realistic flow directions. Why not test this by drilling the faults?

Drilling for water in west Cumbria

- ▶ [Pay Your Bill](#)
- ▶ [Emergencies](#)
- ▶ [My Account](#)
- ▶ [About United Utilities](#)
- ▶ [Our Services](#)

Drilling for water in west Cumbria

03 February 2011

We are using drilling Cumbria's most prec

Our specialist teams 120m deep in fields for a potential new g

It's all part of a uniqu help us maintain wat protecting the enviro

Phil Merrin, groundw most people in White drink water that com

"The European Habi the amount of water protect important pro River Ehen which ha of Conservation," he

People in Whitehav their drinking water f



"However, this is the start of a long-term project to re-evaluate the way we del Cumbria so that we maintain excellent services to our customers while minimis

United Utilities, 2011

"Our specialist teams have plunged four boreholes up to 120m deep in fields south of Egremont ...

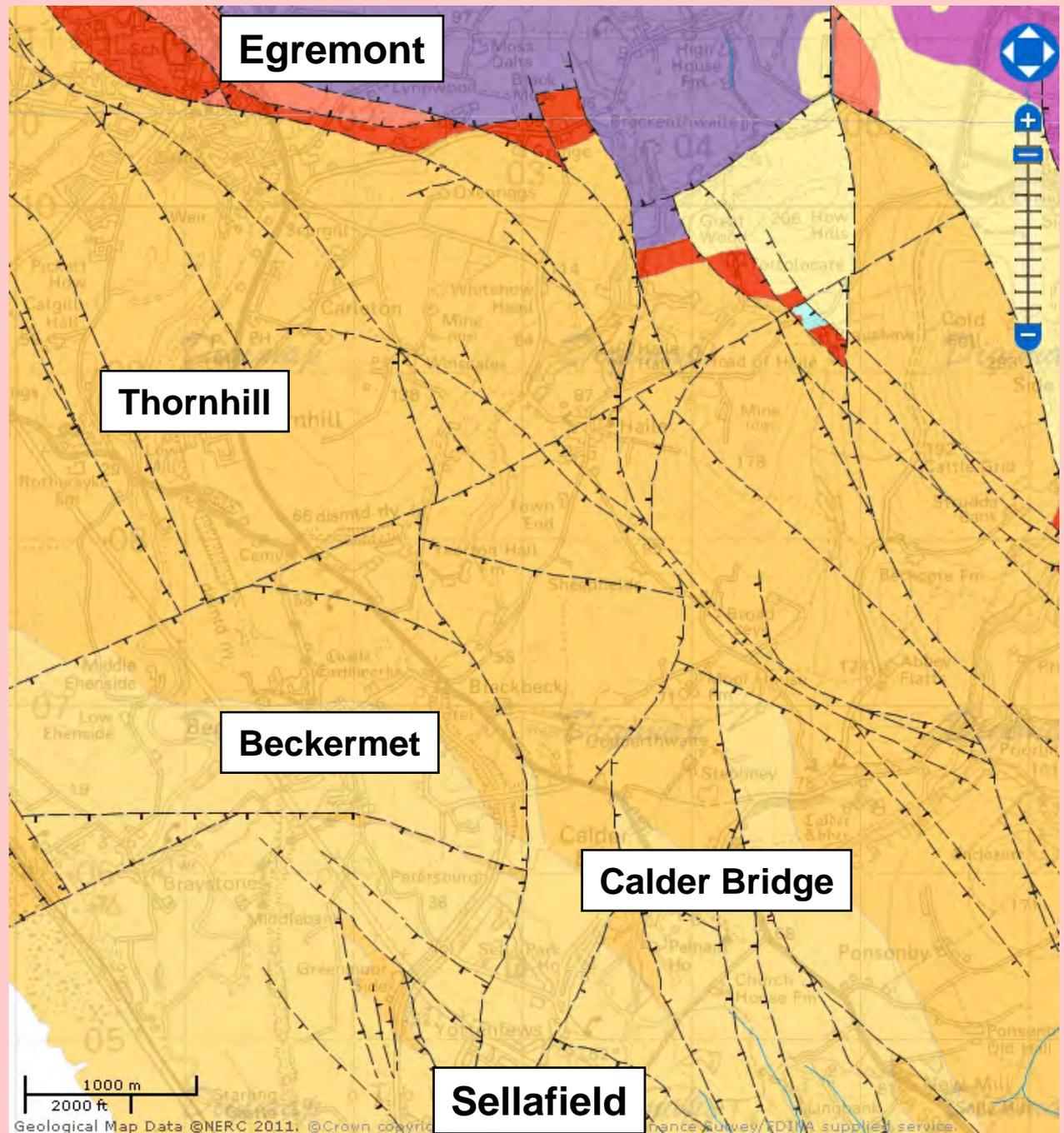
*The boreholes have been sited to **target geological faults to give the best access to the yields.**"*

Geology map

Red / orange / buff colours are aquifer sediments

NB locations of water wells are secret ...

-Possibility of terrorist contamination



Conclusions

on Nirex 97 hydrogeological modelling:

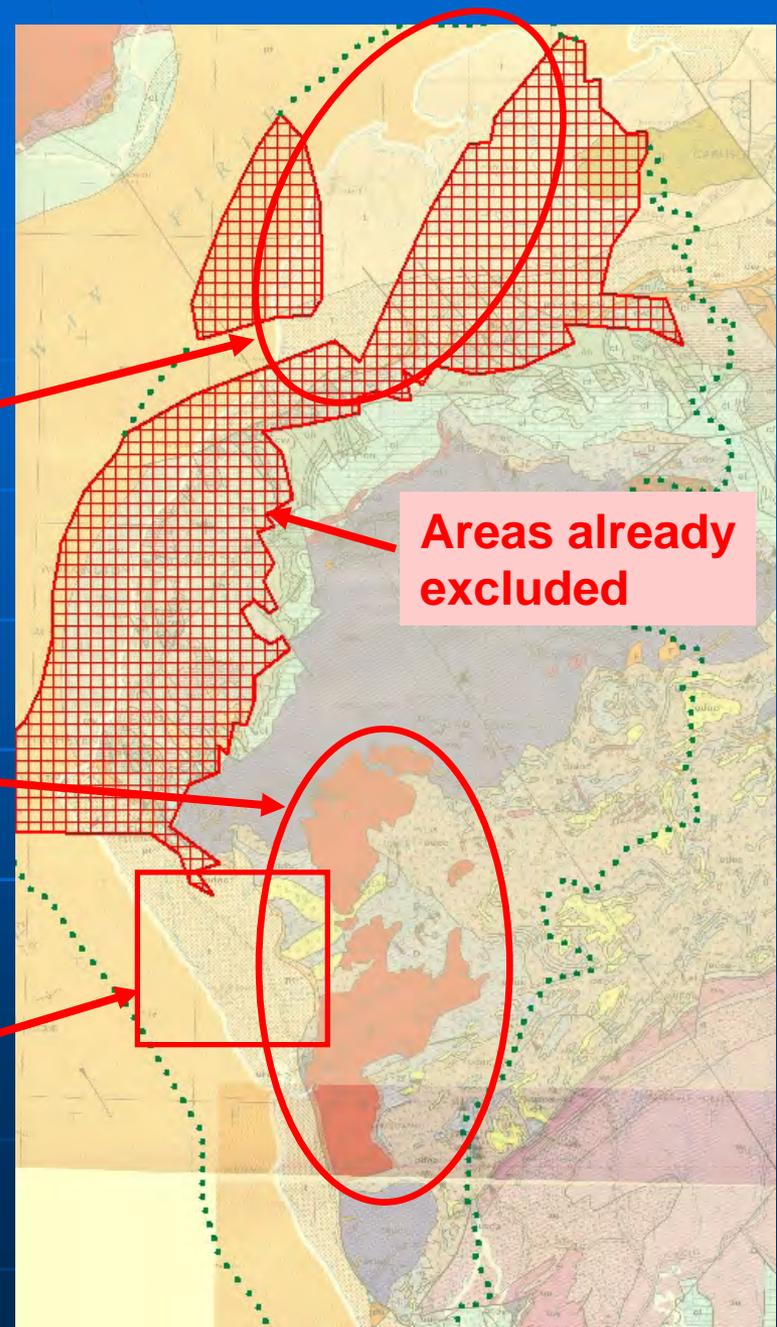
- Values are **fiddled** to keep flow lines underground.
 - Many values are just **made up** ('data elicitation').
 - **Mean values** picked – not the worst case.
 - Faults **airbrushed out of** the model.
-
- We should not claim to know something just because the computer models tells us.
 - Faster computers since 1996 will simply make the same mistakes faster.
 - Go where the geology and hydrogeology is simple and predictable.

Geology of the areas left in play

Northern Allerdale –
the Mercia Mudstone
Group

Eskdale and Ennerdale
granites (red areas)

Sellafield / Longlands Farm

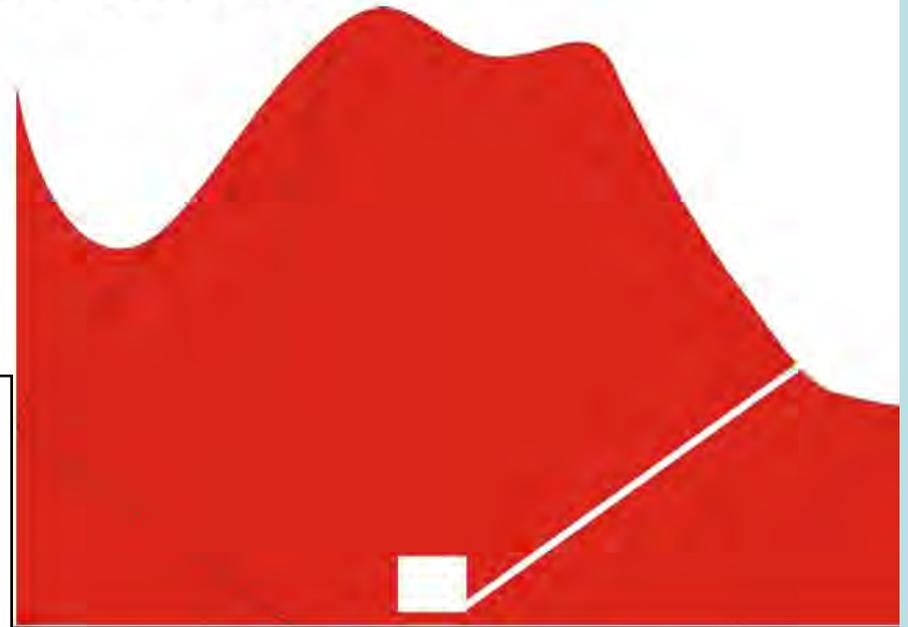


Favourable Geological Situations

Low permeability basement ('hard') rocks

Rocks with low bulk rock permeability rocks at surface, regardless of surface relief

Potential problems of complex geology (sometimes) and short return pathways



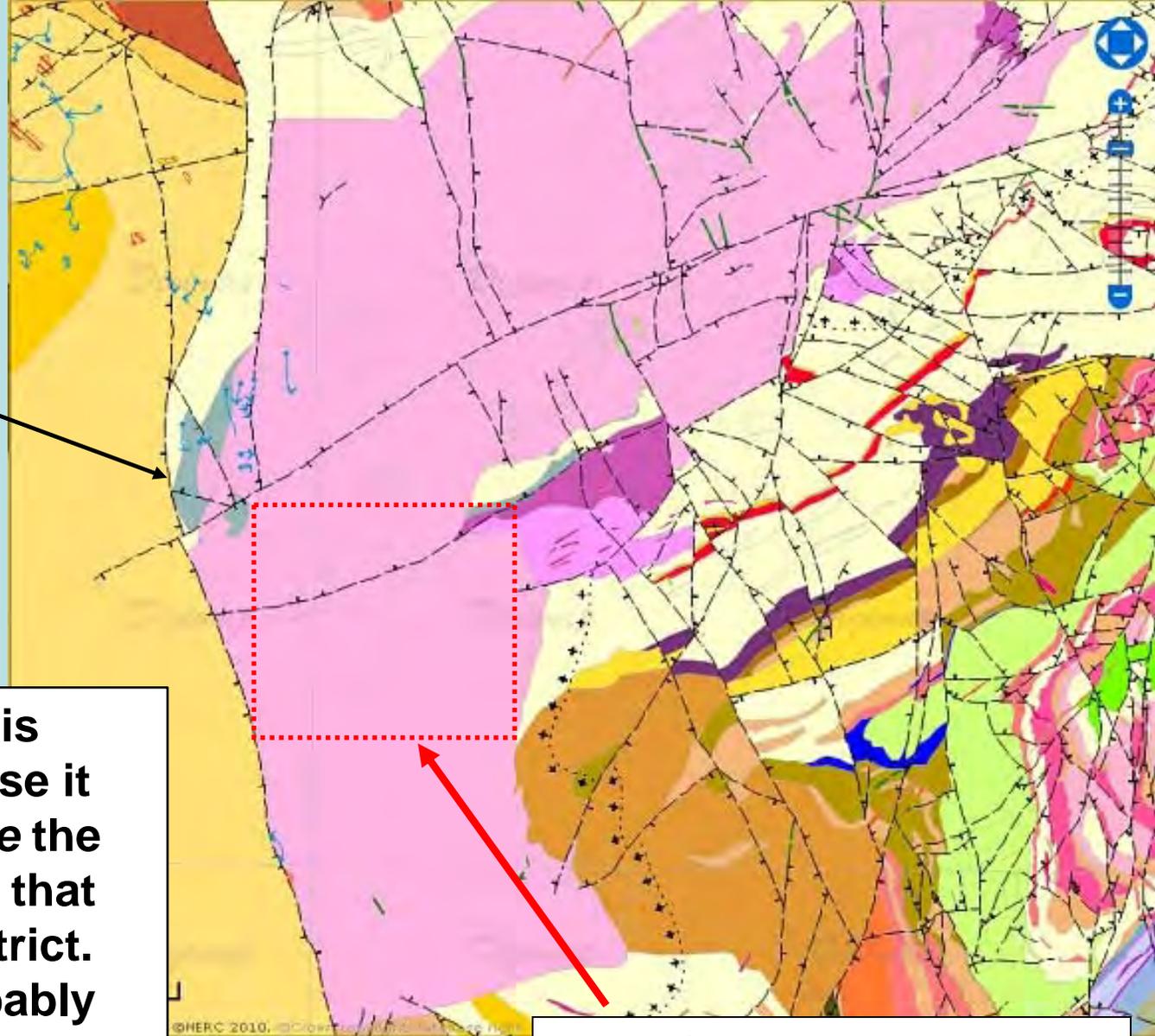
**BGS 2006 and 2010:
Purports to show high-relief
mountains as 'favourable'.
But no GDF search
guidance supports this
concept.**

Eskdale

**Lake District
Boundary Fault**

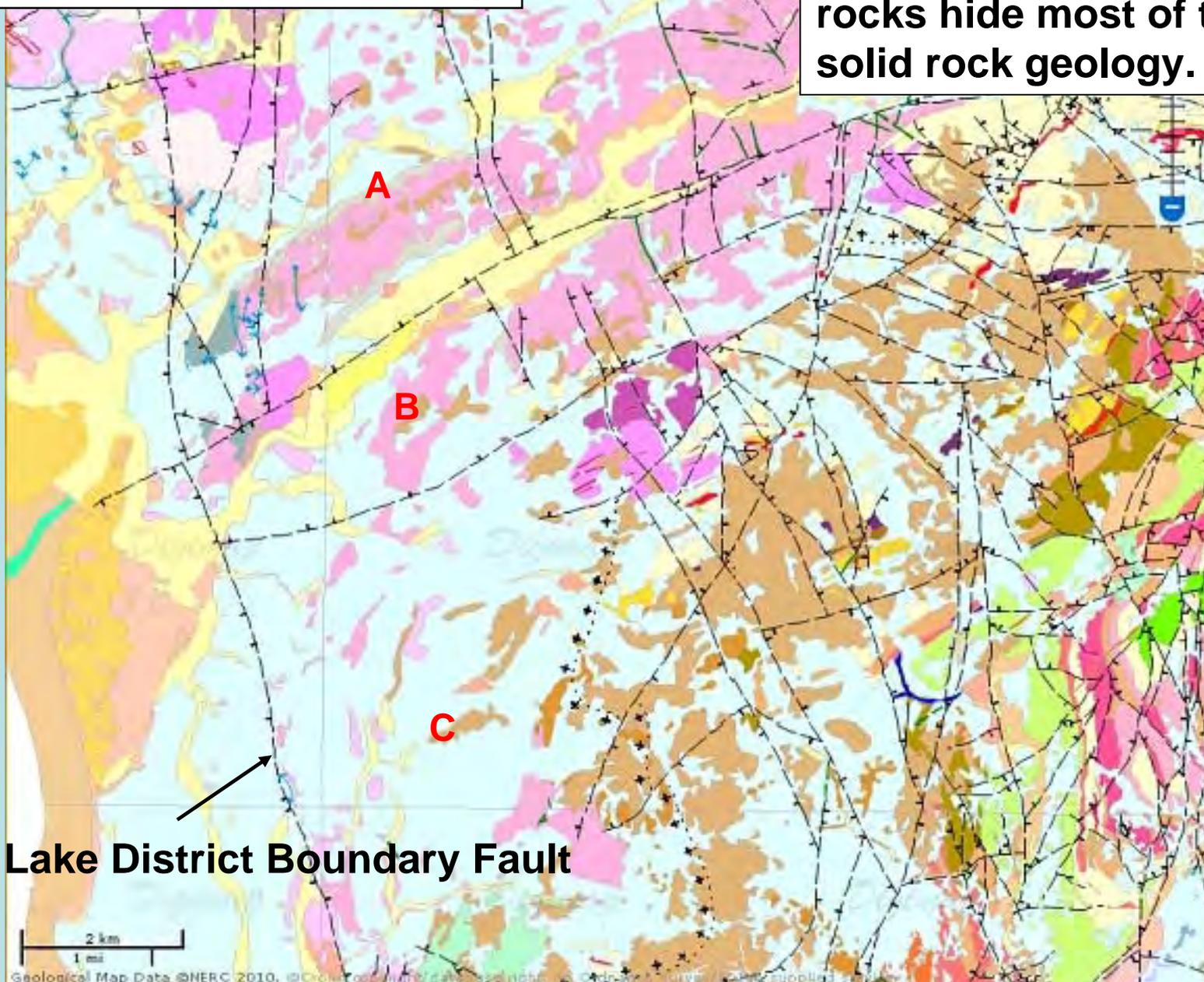
The Eskdale granite is highly faulted because it was emplaced *before* the continental collision that formed the Lake District. Fault density is probably much higher than can be mapped, due to poor exposure.

10 km², the underground area required for a repository.



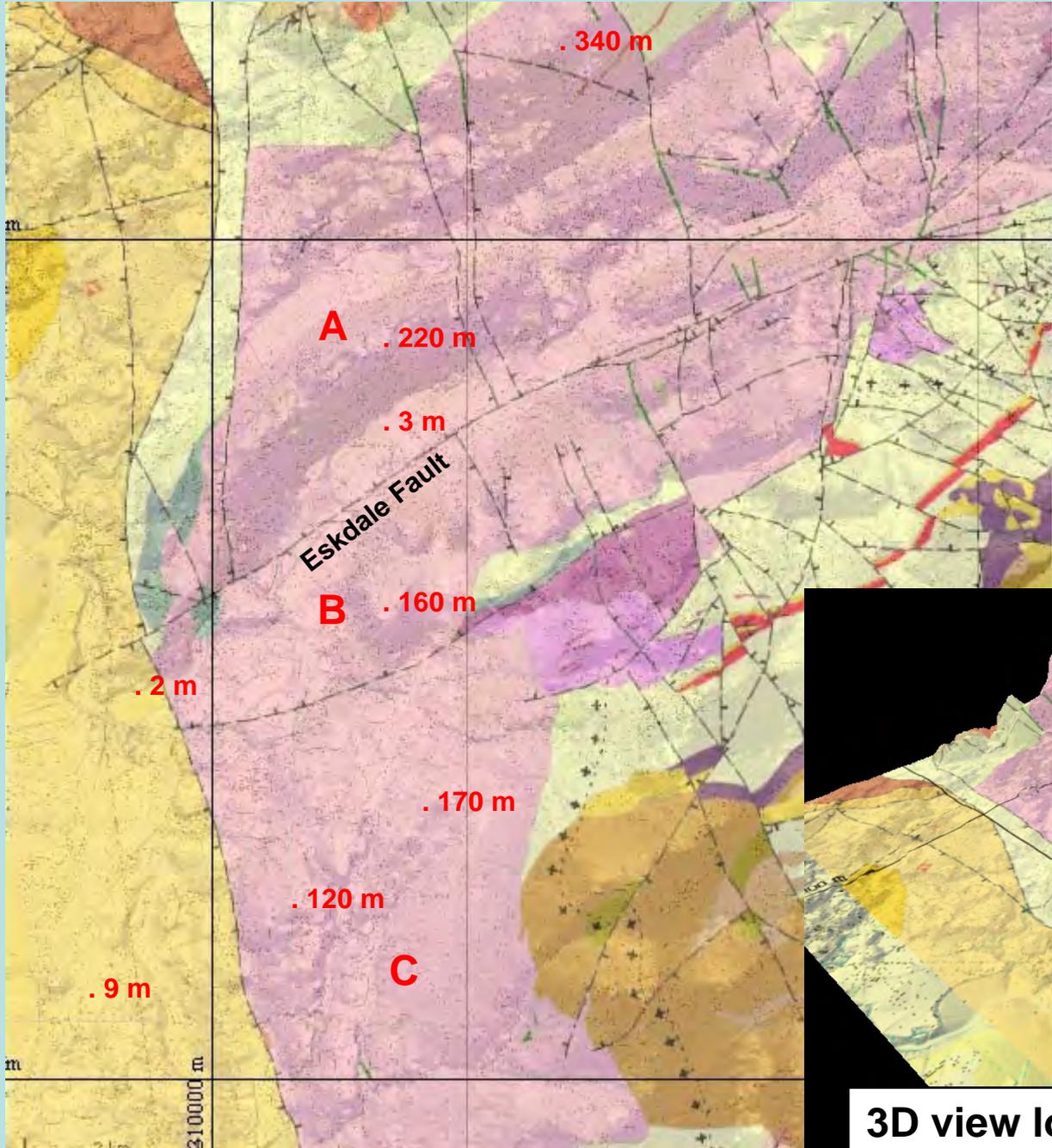
**Eskdale granite:
Superficial and solid geology map.**

**The superficial ('cover')
rocks hide most of the
solid rock geology.**

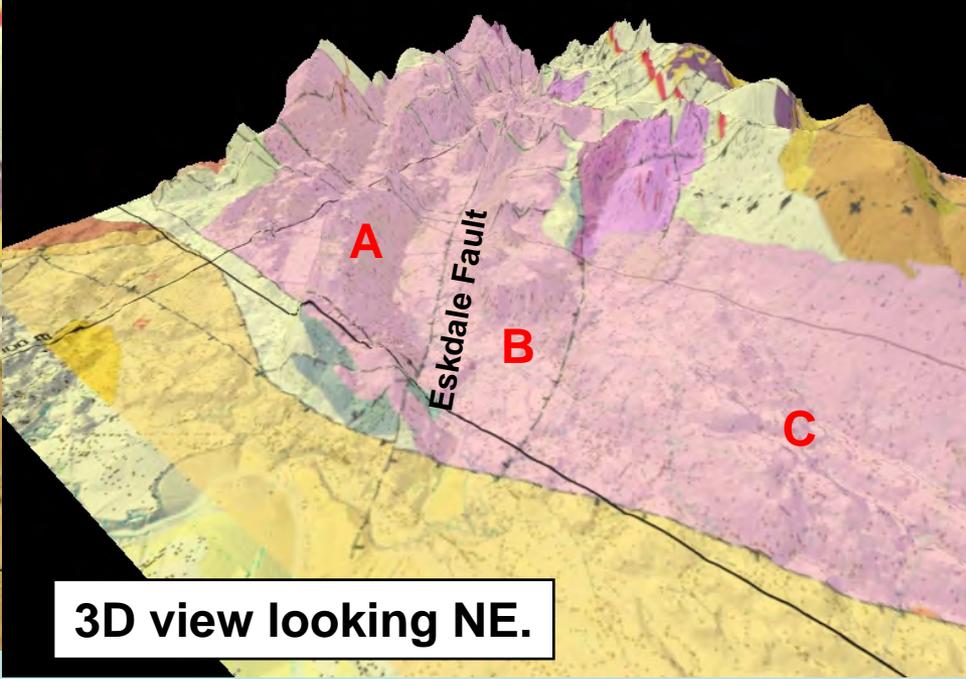


Lake District Boundary Fault

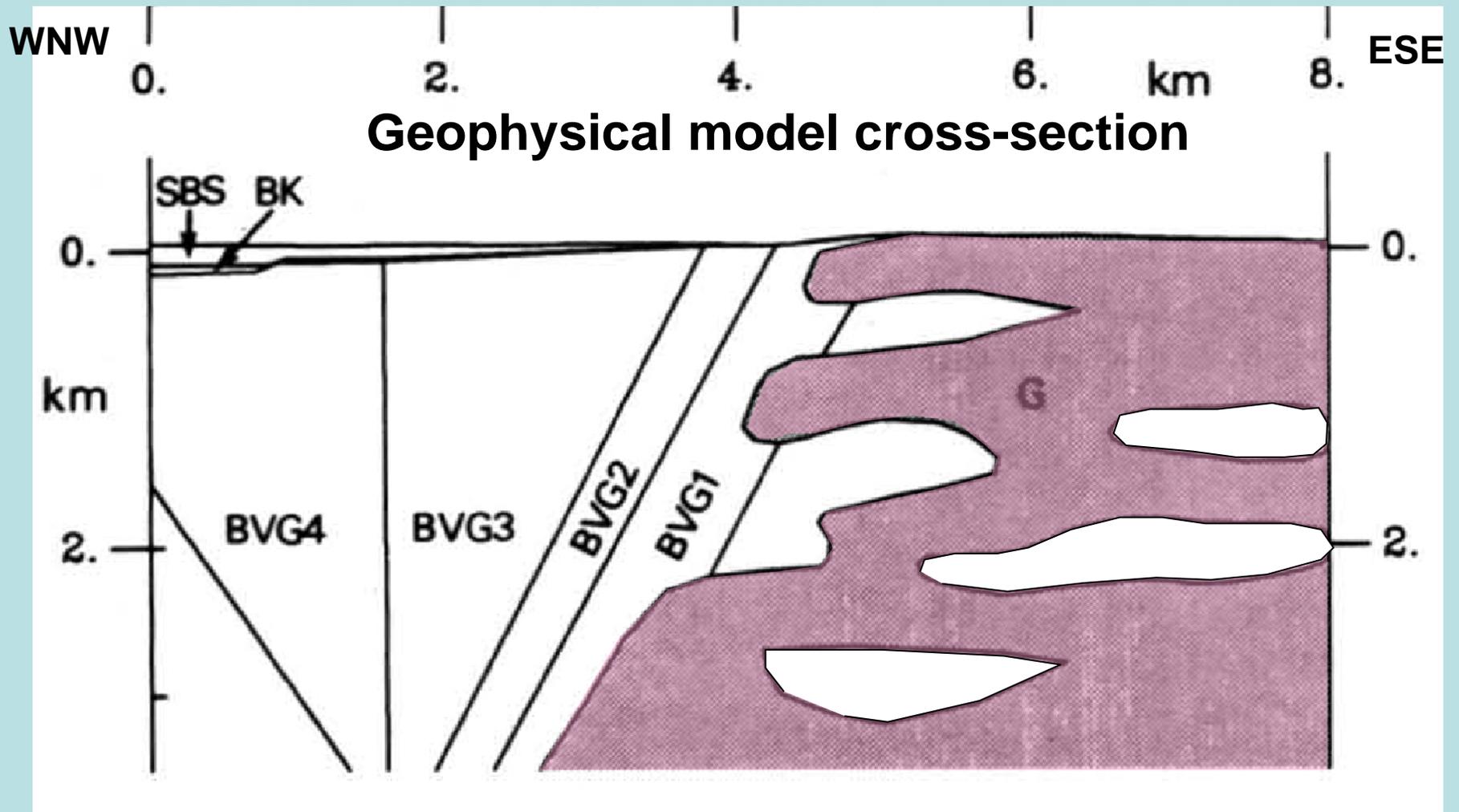
2 km
1 mi



Shaded relief of the Eskdale granite, with spot heights in meters.



3D view looking NE.



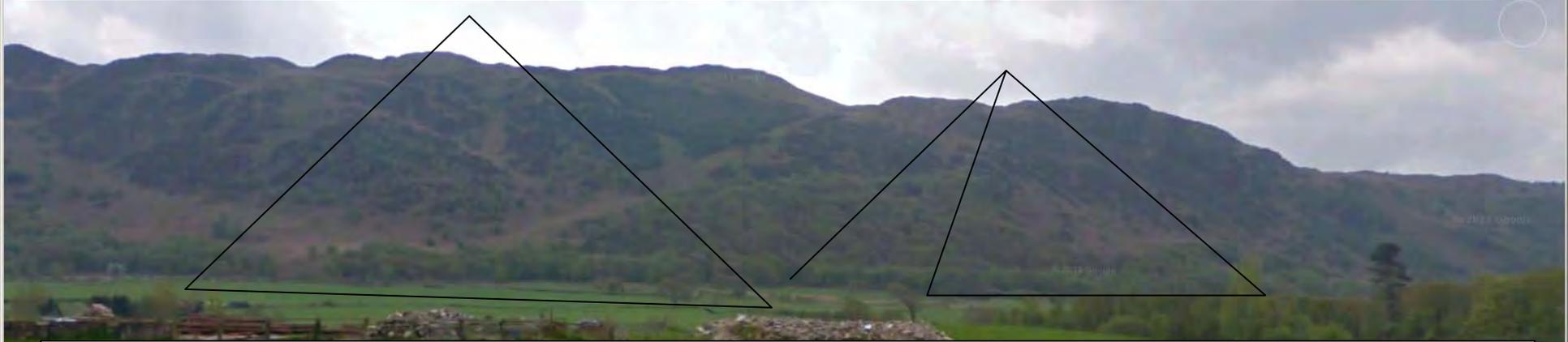
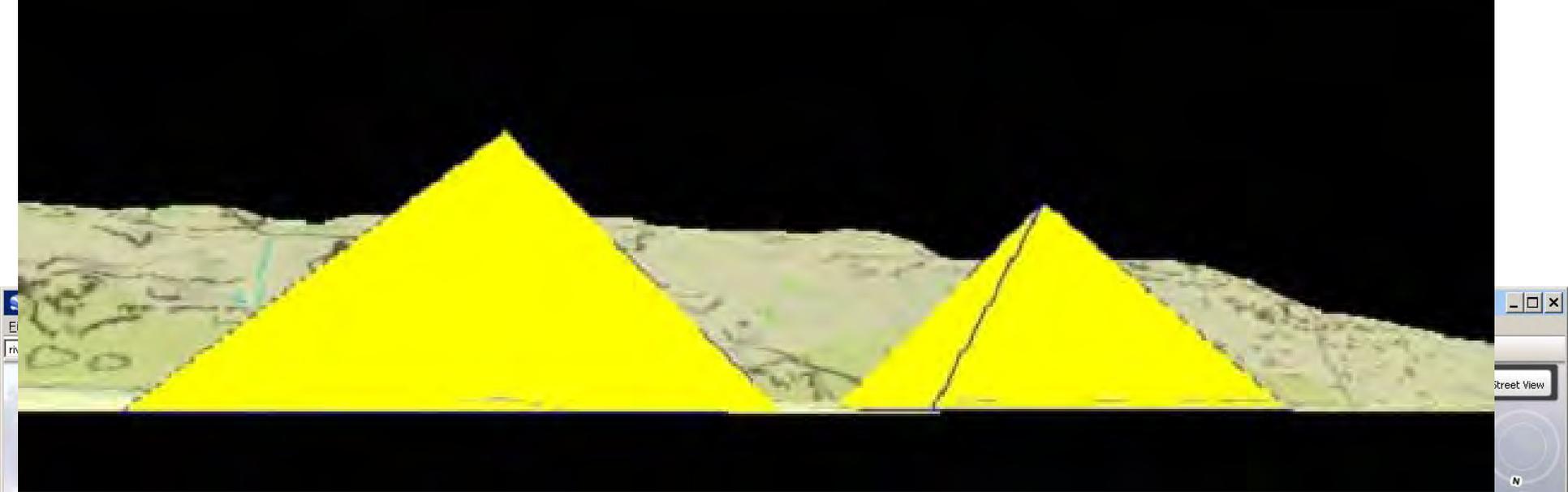
The western edge of the Eskdale granite has an interfingering 'cedar tree' structure, not a clean break. BVG1-4 are Borrowdale Volcanic Group volumes with slightly different densities.

**The
construction
waste
problem**

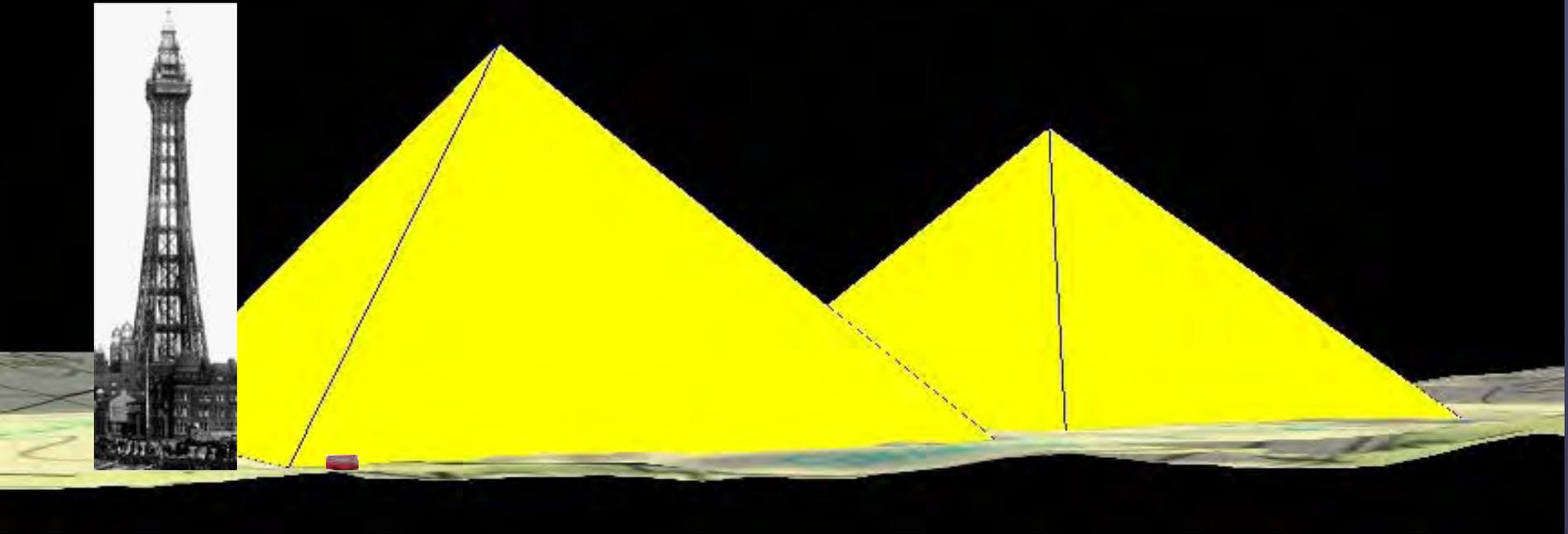


**The Great Pyramid of Cheops (or Kheops) at Giza, Egypt
volume 2,500,000 cu. m., 140 m high.
London Routemaster bus is shown for scale.**

**Spoil heaps will not in fact be built to that shape, but rather
in the form of low flat-topped mounds called *bunds*.**



Assuming site works in the Irt Valley. The spoil which has to be **stored for final use as backfill is equivalent to 2 pyramids**. The upper view is a 3D GIS view of the valley, on which I have superimposed the two 'backfill' pyramids. Both views are looking south from Sandbank.



The two pyramids seen from about 50 m uphill on Muncaster Fell to the south. They are 140 m high. The Blackpool Tower, shown for scale, is 158 m high. The Routemaster bus (4.4 m high) is also shown for scale near the nearest corner of the nearer pyramid.

Eskdale:

**Transport off-site
of **excess spoil****



Ravenglass & Eskdale Railway

Granite spoil does have a commercial value as an aggregate. It would have to be shipped out by rail or road.

One possibility would be (compulsory) purchase of the **existing miniature railway line**

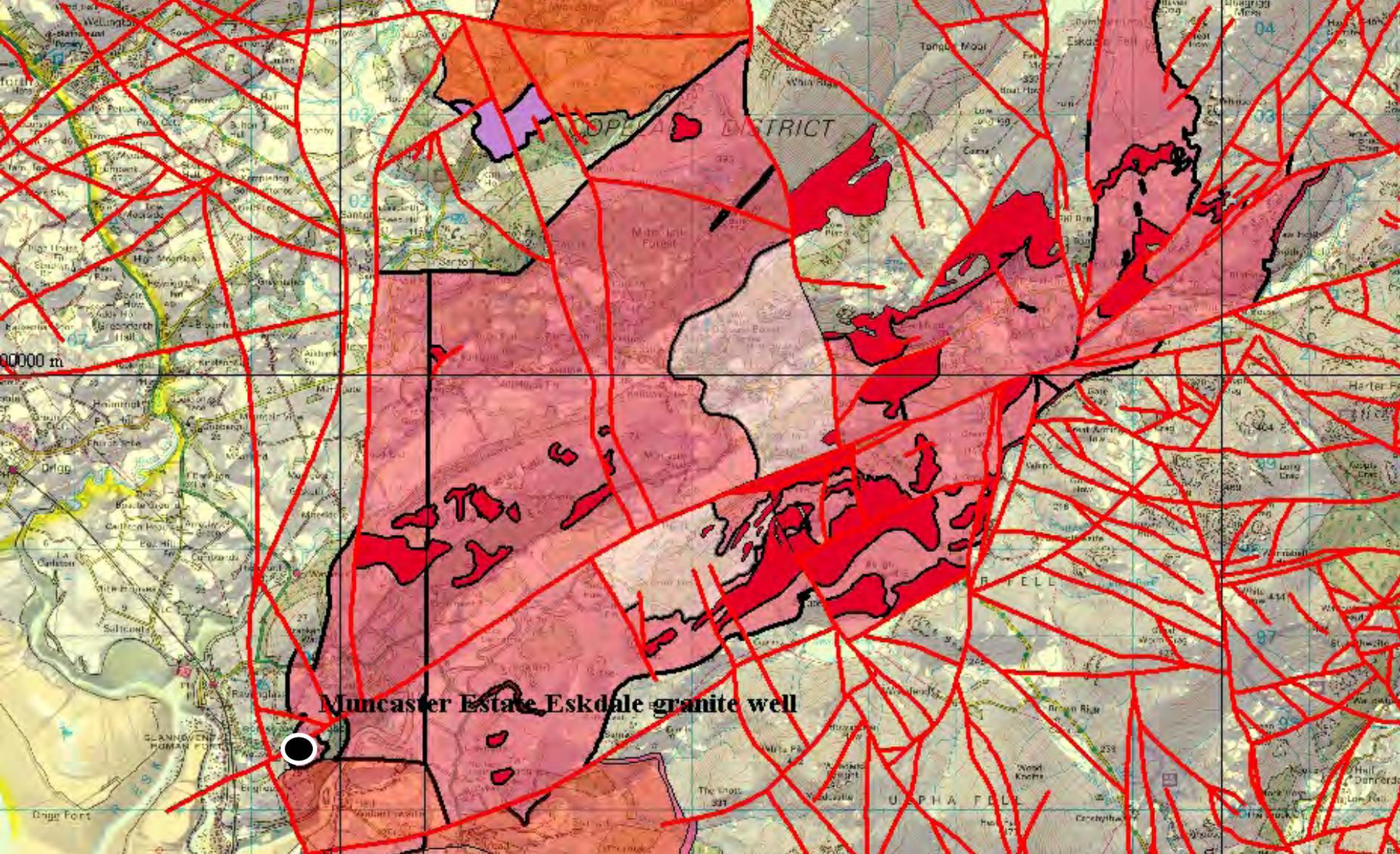
Pyramids or bunds?

So the NDA can 'solve' the problem of unused and commercially valuable **excess spoil** in Eskdale – ship it out by rail and/or road and sell it.

Of course, the two pyramids-worth of **backfill spoil** to be retained for up to a century will not actually be stored in pyramids. Realistically, it will be stored in flat-topped mounds called bunds.

If the bunds are 5 m high, we need 1 sq km to store the spoil. This is the same area as the Drigg low-level waste repository.

The problem with the coastal strip of West Cumbria, between Workington and Barrow, is that it is too narrow. Where is such an area to be found?



The Eskdale granite is classed as a minor aquifer. The EA has a monitoring well on the Muncaster Estate. So the granite should have been excluded.

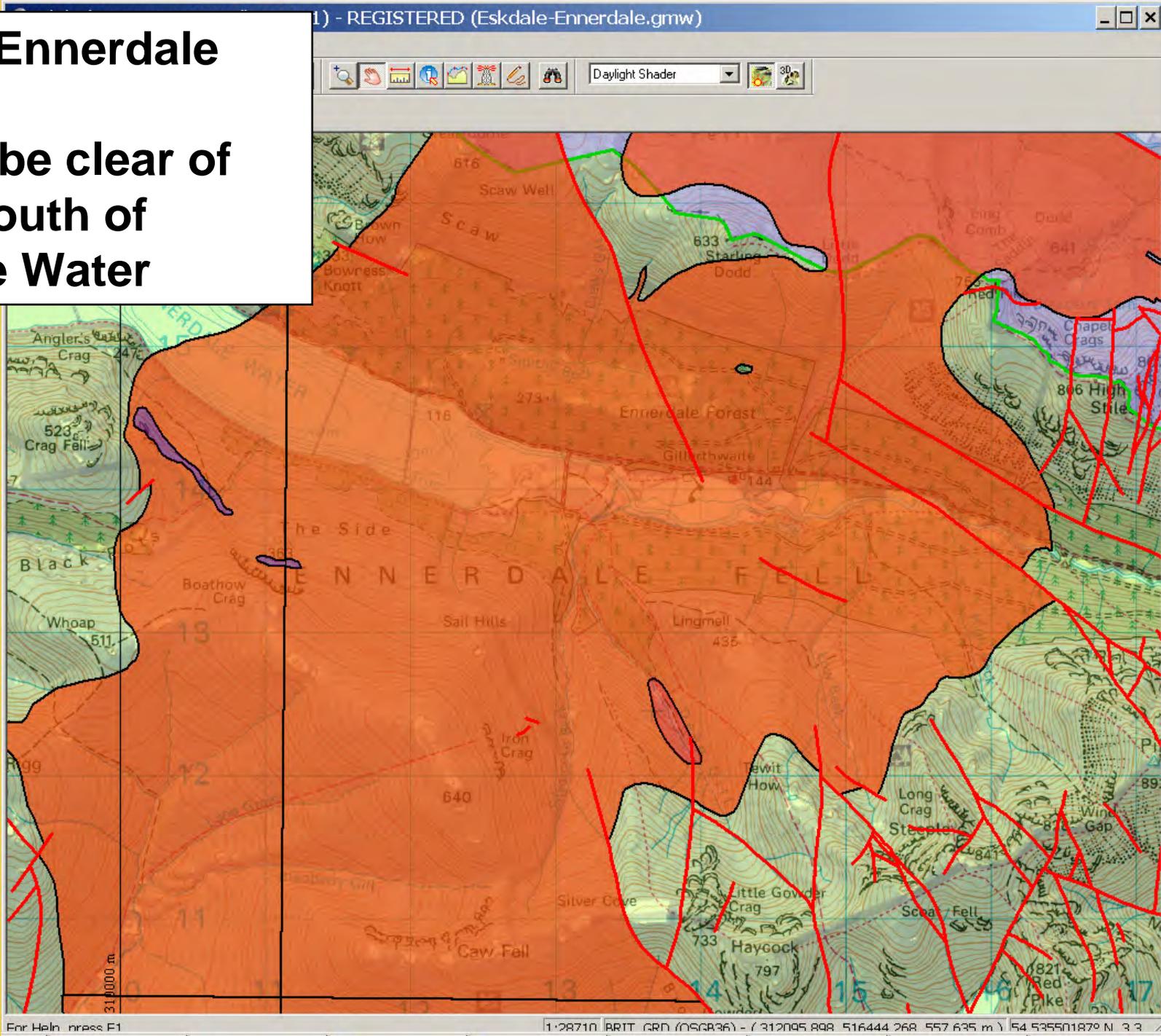
Eskdale granite: summary

Unsuitable because of:

1. Extreme topography
2. Adjacent to Lake District Boundary Fault
3. Oxidising groundwater (old haematite mines, present-day leaching of uranium)
4. Heavily faulted internally
5. Complex internal structure
6. Possible 'hyperpermeable' fracture zones
7. Minor aquifer
8. Potential for geothermal energy

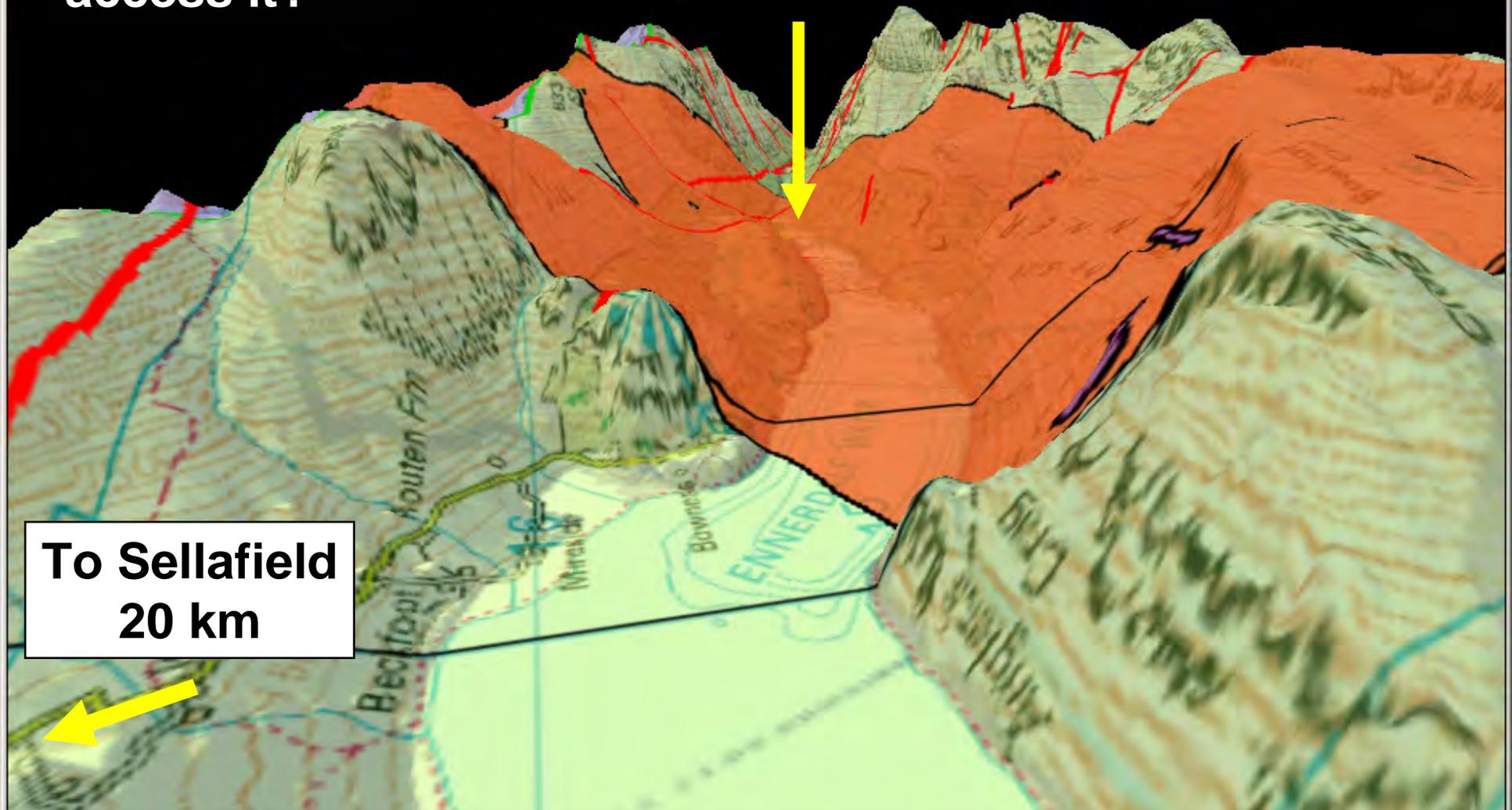
Ennerdale granite

**Northern Ennerdale
granite:
seems to be clear of
faulting south of
Ennerdale Water**



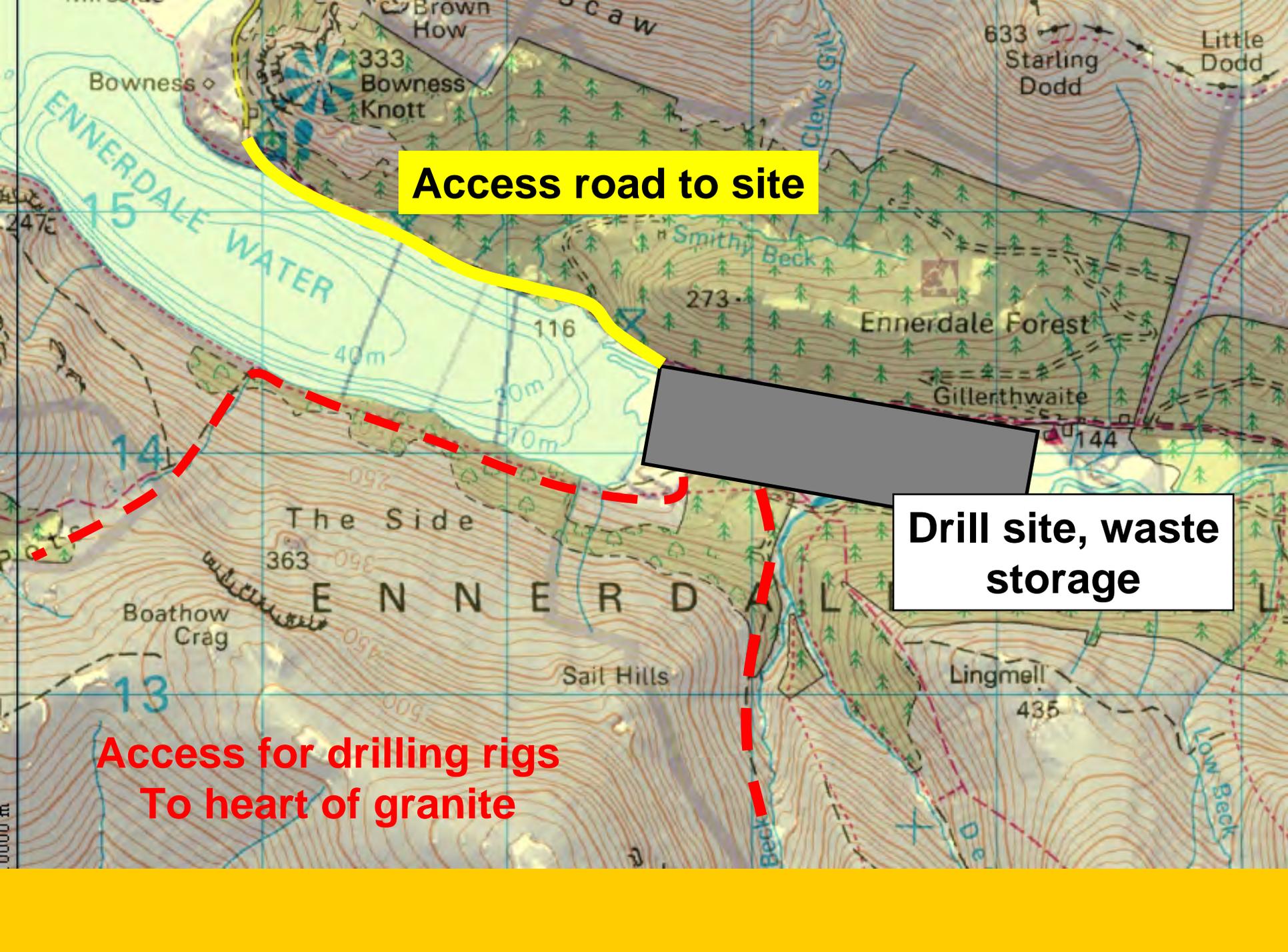
But how to access it?

Drilling site, storage of waste



To Sellafield
20 km

Perspective view looking east to head of Ennerdale Water



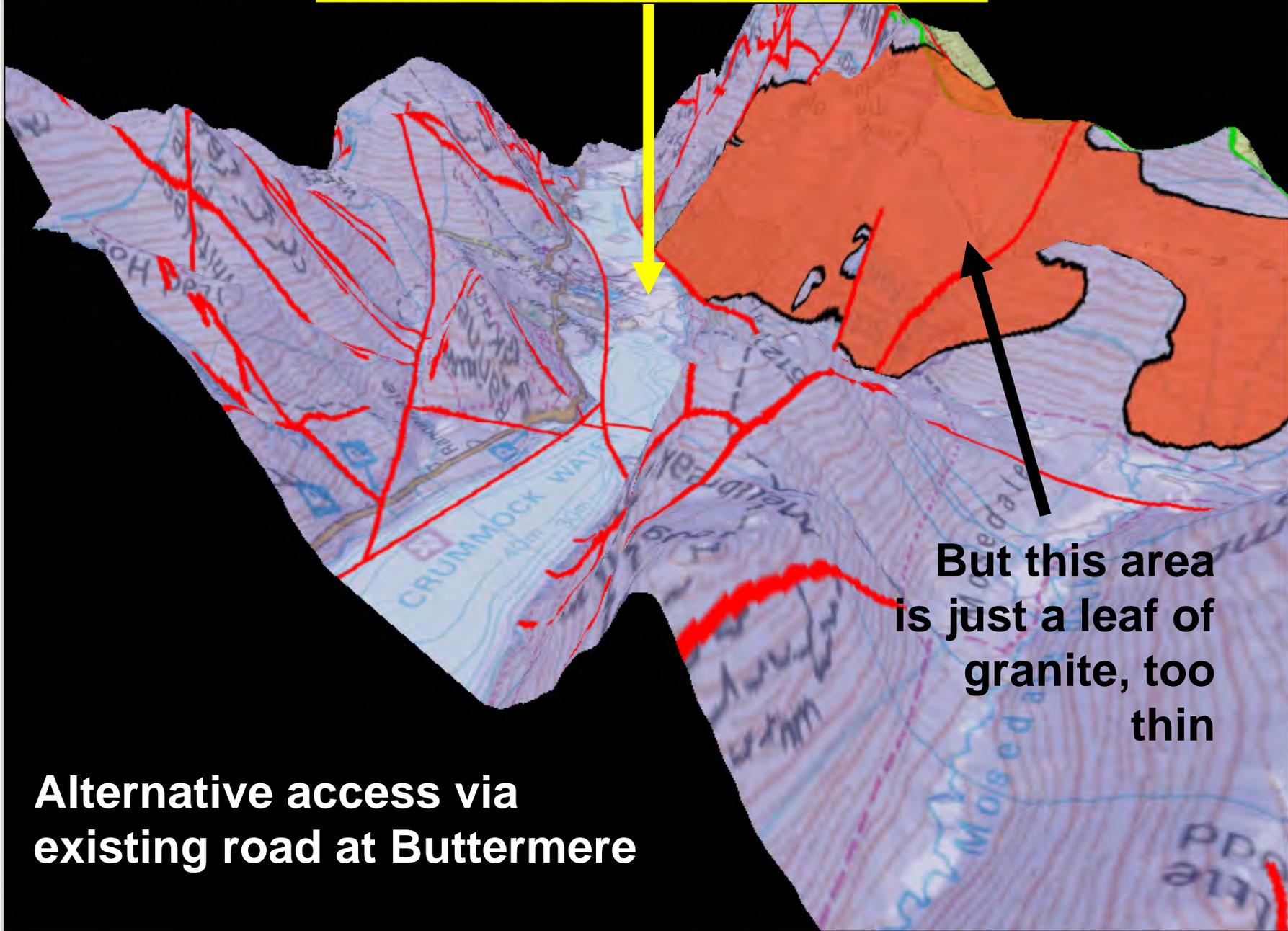
Access road to site

Drill site, waste storage

**Access for drilling rigs
To heart of granite**



Drilling site, storage of waste



**But this area
is just a leaf of
granite, too
thin**

**Alternative access via
existing road at Buttermere**

Ennerdale granite: summary

Unsuitable because of:

- 1. Extreme topography**
- 2. Near-impossible access**
- 3. Complex internal structure**
- 4. Minor aquifer (water well at Nether Wasdale)**

**Misinformation
or
Non-information?**

British Geological Survey (BGS) - advocacy by subterfuge



British
Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

2002: (Hearsay) BGS director supports return to Sellafield.

2006: BGS: 'rather more than 30%' of the UK is potentially suitable.

2006: BGS: high hard-rock mountains are a 'favourable' location.

2010: Crucial screening criteria (oil, water) removed.

2011: (Hearsay) MMG now considered a potential host rock by BGS.

2012: 'Geological Society of London' support for MRWS process actually emanates from one BGS board member + two employees.

2012: Richard Shaw (BGS) states on BBC radio that West Cumbria "*offers potential*".

If Stage 4 goes ahead: Can we trust the BGS ?

Scrutiny of the process?

**Committee on Radioactive Waste Management
(CoRWM)**

Letter to Colin Wales, March 2012

**Response to question about voluntarism before
geology:**

***“It could be argued that the British process has
also screened out unsuitable geology before
asking communities to volunteer.***

...

Your sincerely, Robert Pickard, Chair of CoRWM”

Committee on Radioactive Waste Management (CoRWM)

“ ... no credible scientific case to support the contention that all of West Cumbria is geologically unsuitable.”

This is NOT TRUE :

- We DO know – it's a highly studied area
- No stone has been left unturned
- NOWHERE is suitable
- MRWS stage 4 has been done

Memo to Councils: once you're in, you're in

Councils locked in
from here on

Govt. to BGS:
“Within the Partnership area,
where are the most promising
localities?”

2. Unsuitability screening

3. Decision to participate

4. Desk studies

5. Surface research

6. Underground

Point of no return -
BGS starts drilling

A site is
selected

Decision points – the slippery slope

Each step postpones the real decision: Is the area suitable?

NOMINATED SITES FOR NEW NUCLEAR POWER STATIONS



Sellafield:
National centre for encapsulation of waste before burial?
So no transport of HLW/ILW?

*Shut-down site known as Calder Hall

C u m b r i a CC

Copeland BC Allerdale BC

Volunteering is not enough

Justification

Unsuitable geology

Still time to reconsider !

Fin