Why West Cumbria is not Switzerland

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It has been suggested that although Switzerland is a mountainous country, this has not prevented Nagra, their national nuclear waste disposal authority, from finding potentially promising sites for high-level nuclear waste (HLW) disposal. So, runs the argument, what is the problem with West Cumbria?

Here is the Nagra map of the north of Switzerland, showing the three potential sites in buff colour. The wiggly line is the border with Germany. First we compare the topographic relief – the mountains; then we consider the geology.
Topographic relief maps
West Cumbria (left) and Northern Switzerland (right) at the same scale
Grid squares are 10 km. The dogleg profile shown on the Cumbrian map runs from 5 km offshore through the former Sellafield potential repository zone, then turns NW to run along the BGS line of section through Cockermouth, finishing 5 km offshore.
The NW-SE profile on the Swiss map runs through the middle of the three potential high-level waste repository sites identified here (red circles mark the centre of each area).
The relief is of the same order in both maps – about 500 m. However all three Swiss sites are 30-50 km distant from the high ground, whereas potential Cumbrian sites onshore cannot be more than 30 km (maximum) from the same relatively high ground.
Putting it another way, the >500 m of relief variation in West Cumbria is concentrated in the available area (the Council's boundary shown by the dotted blue line) of approximately 2000 sq km, but in the Swiss case one has to consider the whole map area of about 7000 sq km to observe the same variation in relief.
Putting it in yet another way, the 2000 sq km of available West Cumbria land, represented as an ellipse of around the same area on the Swiss map enclosing the three potential sites there, shows that the relief variation within that ellipse is under 200 m, taken from any one of the three sites. This relief variation is a half or a quarter of the Cumbrian equivalent.

Note that the region outlined by the ellipse has similar topography to eastern England.
The regional relief profiles show that potential sites in West Cumbria are much nearer the mountainous area than are the potential sites in Switzerland.

The West Cumbria dog-leg profile does not run through the highest peaks, which would add a further 300 m to the profile vertically, but is laid out to follow published Nirex geological profiles through Longlands Farm, the 1995 Potential Repository Zone, then to run NW along the cross-section published by the BGS.

So in Switzerland Nagra appears to have found three suitable sites within a strip of relatively gentle terrain about 50 km wide. In contrast, the lower flanks of the Cumbrian mountains available for a repository are only 10-15 km wide.
Geological cross-sections through the central proposed Swiss site (right) and detail from BGS section AB (below; from fig. 9 of the screening report). Both are at the same scale and have a vertical exaggeration of x 3.
The Swiss propose constructing a repository here, within a flat-lying layer of clay about 100 m thick. The geology is simple, and therefore predictable.

In contrast, the geology of West Cumbria around the National Park is complex. The great variety of hard and soft rocks is folded and cut by faults with large displacements. The structure is very 3-dimensional – that is, the picture changes rapidly if one moves into or out of the plane of this section.
If a repository were to be sited in geology like that shown for West Cumbria, it will be impossible to predict the flow of contaminated fluids, how escaping gas will behave, or how the heating effect of the radioactive waste will change the surroundings.

A reliable safety assessment can therefore never be achieved.

In contrast, the Swiss are choosing one of three sites where the geology is extremely simple. Mountains, which ultimately provide the driving force for fluid flow (the hydraulic head) are much further away than in West Cumbria. The hydraulic gradient (height divided by distance) in Switzerland is less than half of that in West Cumbria.

A thick layer of impervious clay has been chosen to host the repository. There are no thick, flat-lying clay layers in West Cumbria that resemble in any way the Swiss example.
In addition, the Swiss search started with the geology. Here is the current Nagra webpage showing this:

**Disposal - where?**

The question of where to dispose of radioactive waste will be answered conclusively in the coming years. The selection of repository sites will be made in accordance with the conceptual part of the sectoral plan for deep geological repositories, which was approved by the Federal Council on 2nd April 2008. The site selection process, which is divided into three stages, is under the lead of the federal authorities.

At the beginning of the sectoral plan process, Nagra’s task is to identify siting areas in Switzerland where, from a scientific and technical perspective, safe geological repositories could be constructed. Scientists have investigated the geological situation in Switzerland and proposed areas that are suitable from the point of view of safety.

[http://www.nagra.ch/g3.cms/s_page/77780/s_name/locationareas]
Conclusions

• In Switzerland the search for suitable geological sites came first

• Agreement of the local communities has come afterwards

• Despite Switzerland being a mountainous country, the effect of the mountains at their sites is less than half of that in West Cumbria

• Their potential sites all have extremely simple geology

• The Swiss experience could be followed by the UK, if we drop the focus on West Cumbria