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The future for geology in the Marches: a BGS perspective

David Schofield[1]

SCHOFIELD, D.I. (2008). The future for geology in the Marches: a BGS perspective. *Proceedings of the Shropshire Geological Society*, **13**, 114–120. The British Geological Survey has a long history of geological study in the Marches starting in the 1830's and led by Sir Henry de la Beche who oversaw the original one-inch geological survey of the area.

The current phase of work by the BGS started in the mid 1980's and has largely been driven by the requirement to complete 1:50,000 scale geological map coverage of Wales and the Borders. High quality academic studies had been conducted in the area and the results needed to be integrated with the Survey's mapping. This new phase commenced with a transect across the central part of the Welsh Basin in the Rhayader and Llanilar districts, aiming to establish a workable stratigraphy for the turbidite sequences within the basin informed by new concepts on deep marine sedimentology, sequence stratigraphy and the relationship between depositional facies, eustacy and tectonics.

Plans for the future will build on the earlier work while carrying out studies of Ordovician to Silurian basin to shelf transitions including the Knighton area, and it is hoped to use this as a basis for reappraising the geology of the adjacent Ludlow Anticline, to further the pioneering studies which the Survey instigated in the region during the 19th and early part of the 20th centuries.

[1]*Keyworth, Nottinghamshire, UK. E-mail: dis@bgs.ac.uk*

BACKGROUND

The Marches comprise a diverse geological collage spanning at least 700 million years of Earth history that underlies a varied scenery extending between the Cotswolds to the south and the margins of Snowdonia to the north. It includes the upland regions of Wyre Forest and Clun Forest, the Clee Hills, the Wrekin, the Longmynd, Caer Caradoc, Corndon, the Black Mountains, Mynydd Eppynt and Radnor Forest and includes the North Shropshire Plain, the valleys of the Severn and Wye, and the Wigmore and Leominster basins.

Our understanding of geology has a considerable impact on the lives of those who live in the area. Mineral extraction is still important to local development, groundwater is a major concern for both domestic consumption and commercial use, the landscape attracts tourism and its configuration determines the potential for sustainable development of the region. It is the responsibility of the British Geological Survey (BGS) to maintain and develop the nation's understanding of its geology to improve policymaking, enhance national wealth and reduce risk.

THE ROLE

The BGS' programme seeks to supply relevant geological data to enable local and regional planning authorities, and other public and private sector organizations, to make evidence-based decisions and to carry out research directed towards the central themes of our parent body, the Natural Environment Research Council (NERC). These include the sustainable use of resources and the understanding of natural hazards which the Survey attempts to deliver through their systematic mapping and 3D modelling programme, specialist studies and collaborative work.

Geological knowledge is the essential foundation for a diverse range of services that the BGS now provides to fulfil its remit as the national geological survey. Geoscience information is an essential aid to the decision-making process and it is required by government and statutory bodies alike in order to underpin their obligations to produce mineral development, waste management, water resources and environmental plans and strategies. Industry and the private sector also needs similar information to underpin sustainable resource exploitation and the production of environmental impact assessments.

A modern geoscience knowledge base may include up-to-date information on superficial (including man-made) deposits and bedrock geology. From these, various derived thematic layers and 3D models can be compiled, for example relating to metallic and non-metallic mineral resources, contaminated land, engineering properties, land-slip susceptibility, flood risk and baseline environmental geochemistry.

GEOLOGICAL SURVEYING

The BGS has a long history of geological study in the Marches starting in the 1830's originally led by Sir Henry de la Beche who oversaw the first, one-inch survey of the area. This included survey of the Ludlow Anticline carried out by W.T. Aveline and W.W. Smyth (Geological Survey of Great Britain, 1855), based on the original work of Sir Roderick Murchison, published in 1839.

The BGS instigated pioneering studies of the Quaternary succession of the area in the early part of the 20th century, but the Great War intervened and it was some years before the results entered the public domain (Pocock & Wray, 1925). One of the Survey officers affected, W.B.R. King, had gained trenching experience whilst studying the Quaternary for the Wem Sheet, resulting in a commendation from the Survey after he had been called up which led to the Army redeploying him to undertake geological work on the Western Front, the first geologist to serve as such in any modern army (Rose & Rosenbaum, 1993).

The current phase of activity by the BGS started in the mid 1980's and has largely been driven by the requirement to improve provision of geoscience data and complete 1:50,000 scale geological map coverage of Central Wales and the Borders. In this region the Survey mapping was over a century old, providing the level of detail considered insufficient for modern use. This new phase commenced with a transect across the central part of the Welsh Basin in the Rhayader and Llanilar districts (BGS, 1993; 1994), aiming to integrate existing academic studies (summarised in Part 4 of volume 95 of the *Proceedings of the Geologists' Association*, for 1984, e.g. the papers by M G Bassett and by N H Woodcock) and establish a workable stratigraphy within the basinal turbidite succession informed by new concepts on deep marine sedimentology and basin dynamics (Figure 1; Davies *et al*., 1997).

Careful surveying at the 1:10,000 scale combined with detailed graptolite biostratigraphy and interpretation of remote sensing images has provided new insights controls on the development of the Welsh Basin. These include the influence of a Late Ordovician glaciation, centred on the palaeocontinent of Gondwana, that strongly affected sea-level and ocean circulation at that time, and the gradual progress of Caledonian plate collision that brought about changes in the geometry of the Welsh Basin seen through migration of clastic facies through time and space (e.g. Davies *et al*., 1997).

This approach was developed further during subsequent work in the Builth Wells, Brecon and Llandovery districts (BGS, 2004; 2005; in prep) where important relationships between depositional processes in the basin and those of the adjacent shelf succession in the Borderlands were investigated (Figure 4; Schofield *et al*., 2004). This has led to substantial revision of the stratigraphy in the type area of the Llandovery Series and the Wenlock to Ludlow succession of Mynydd Eppynt and the Myddfai Steep Belt, the new stratigraphy of which was presented by Drs. R.A. Waters, R.D. Hillier, J.R. Davies, M. Williams and D.I. Schofield at the 2007 field meeting of the Ludlow Research Group (LRG). Incidentally, this was the field area studied by Stephen Straw, the inspirational supervisor of the founder members of the LRG (Straw, 1937).

Current work in the Dinas Mawddwy district aims to produce the first 1:50,000 scale geological map of this area and build on research into palaeoenvironmental controls on Llandovery-Wenlock sedimentation. Parts of this district were originally surveyed by W.J. Pugh (1928) and D.A. Bassett (1955) and include the northern margin of the southern Welsh Basin.

THE FUTURE

The mapping programme as set out by the Lithoframe Project (Figure 2) does not identify the Marches as a survey priority, much of the area being covered by 1:50 000 scale mapping dating from the 1960's. However the BGS also recognises the requirement to maintain and build on expertise in the region. During the near future the BGS intends to build on the earlier work in the Welsh Basin by commencing survey in the Knighton district, and to use this as a basis for reappraising the geology of the adjacent Ludlow Anticline.

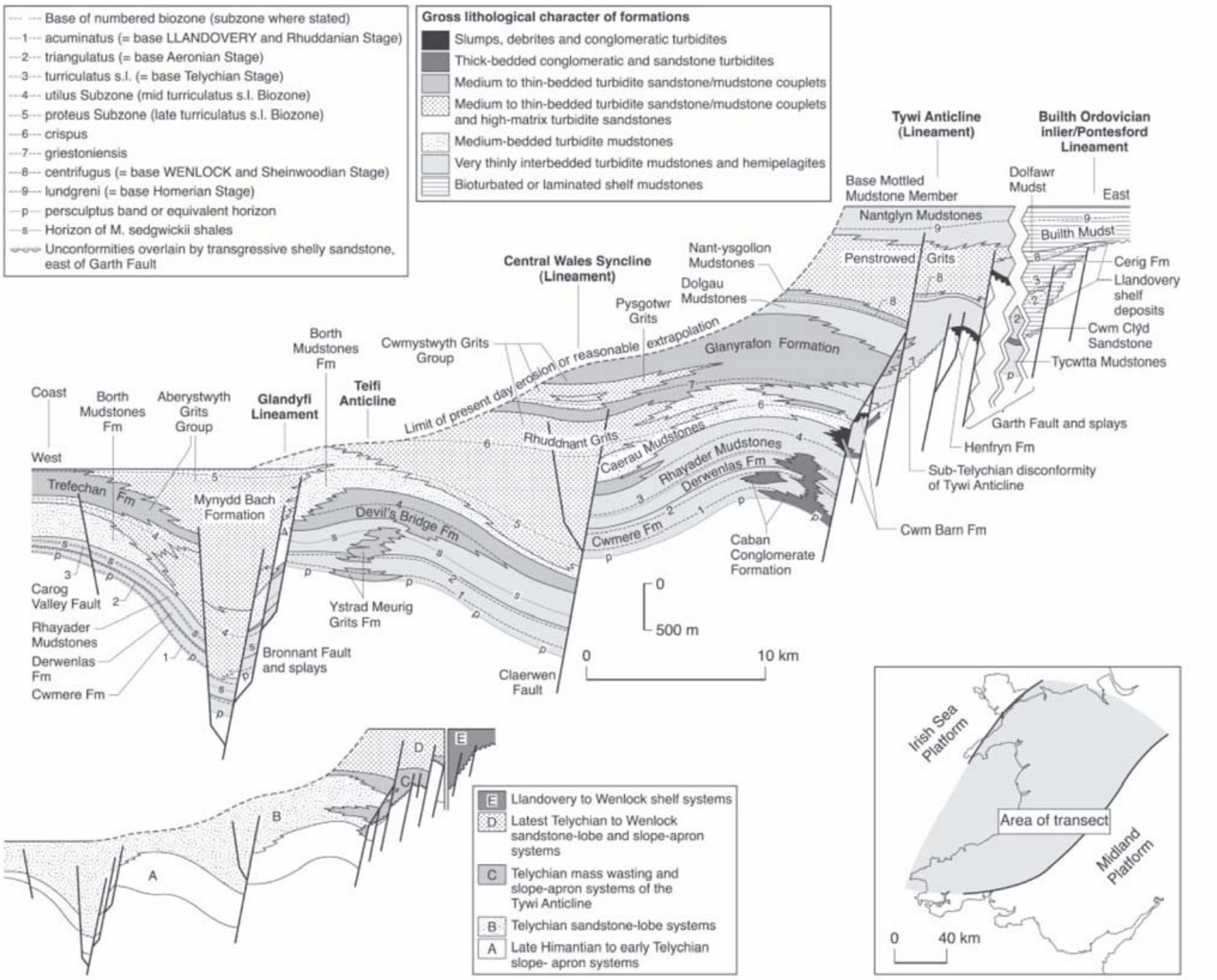

Figure 1. Schematic lithostratigraphic architecture established by mapping across the central part of the Welsh Basin in the Rhayader and Llanilar districts. The relationships are shown here in their disposition prior to the end-Caledonian folding. Such detail is essential as a basis for understanding how the sequence has been deposited but can only be acquired by painstaking surveying and supporting research over many years. After Davies *et al.*, 1997. © NERC, all rights reserved.

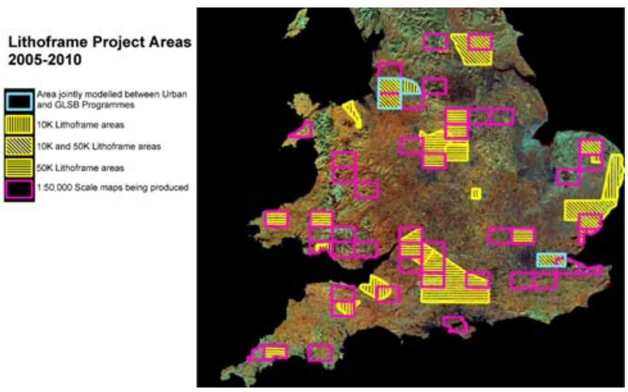

Figure 2. Distribution surveys currently being undertaken by the British Geological Survey. © NERC, all rights reserved.

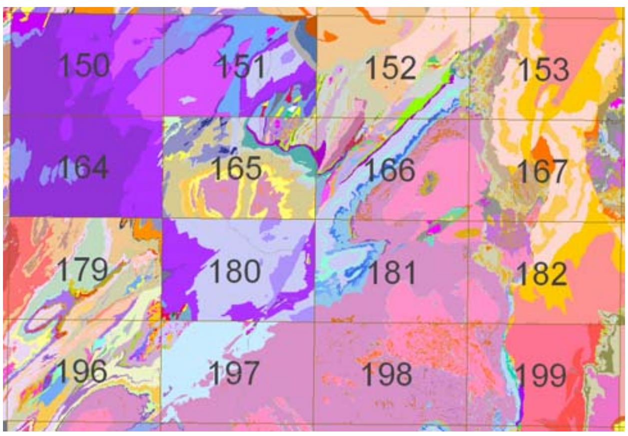

Figure 3. Outline Bedrock Geology map of the Welsh Marches and adjoining areas prepared by the British Geological Survey. Numbers refer to 1:50,000 map sheets (Sheet 181 is Ludlow). © NERC, all rights reserved.

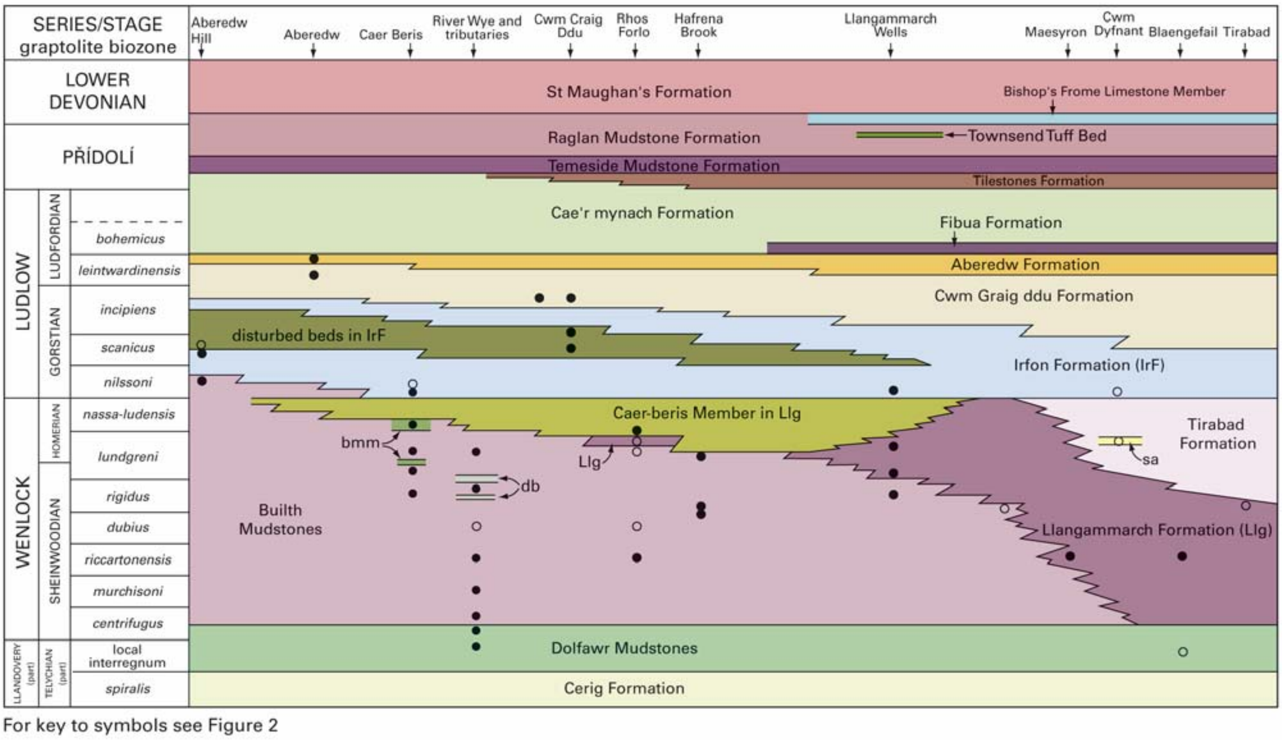

Figure 4. Facies and biostratigraphic variation with time and space, revealed during mapping of the Eppynt escarpment in Builth Wells district. It also shows progradation of nearshore facies from the south. After Schofield *et al.*, 2004. © NERC, all rights reserved.

The outline Bedrock Geology map of the Welsh Marches and adjoining areas prepared by the British Geological Survey is portrayed as Figure 3. Numbers refer to 1:50,000 map sheets (Sheet 181 is Ludlow). The discontinuities in colours between Sheets reflect their age and the classification employed at the time.

The paucity of detail in Sheets 150 (Dinas Mawddwy), 151 (Welshpool), 164 (Llanidloes) and 180 (Knighton) reflects the antiquity of their surveying. Most of these sheets are currently in production, with the last, Sheet 180 (Knighton), high on the list of priorities. The detailed knowledge gained while mapping the sheets to the south and west of Knighton leads to anticipation that there will be changes needed to the interpretation of the stratigraphic concepts evolved through earlier mapping, notably concerning palaeoenvironments and basin evolution of the area during the Silurian and its subsequent tectonic deformation in the Devonian, and later. The Quaternary story also needs to be radically updated too, in order to incorporate the concepts evolved by Peter Cross and Mike Hodgson (Cross & Hodgson, 1975), and others, and are likely to build on the recent work of G.S.P. Thomas (1989). This would focus on developing sediment/landform assemblage models aimed at elucidating ice marginal processes and the history of deglaciation after the last (Late Devensian) glacial maximum. The studies will need to be underpinned by fieldwork, undertaken in the winter months when the ground is not so obscured by vegetation, water stands in the hollows, and long shadows are cast by the low azimuth of the winter sun, helping bring the landscape alive.

Such studies will enable the full advantages of the digital mapping programme to be realised. The superposition of selected sets of information for a specific area, using Geographical Information Systems (GIS) facilitates appreciation of the subsurface.

Portrayal of the depth dimension on a 2D screen or sheet if paper is challenging to non-geologists, and a number of visualisation techniques are being developed in order to deal with this effectively. Examples include the use of digital surface models (Figure 5) and isometric views with vertical relief exaggerated and draped with thematic information (Figures 6 and 7). Applied geological information can be selectively extracted too, as shown in Figures 8 and 9 for the recently mapped Builth Wells Sheet, and combined to highlight areas having a more favourable combination of properties (Figure 10).

CONCLUSIONS

The British Geological Survey is actively surveying and collating geoscientific information to underpin economic growth at a national scale. It also provides the ground-related information needed for the decision-making processes required by government, statutory bodies and other organisations; these include strategic plans for mineral development, waste management, water resources and environmental studies. Industry also needs similar information to underpin sustainable resource exploitation, the production of environmental impact assessments, and site investigation for construction. Furthermore, educational establishments need up-to-date information to support the education of the next generation of geoscientists and to underpin new research.

Examples of current mapping have been presented together with plans for the future. The classic 1:25,000 scale geological special sheet of the Leintwardine - Ludlow district (IGS, 1973), which includes the world stratotype of the Ludlow Series in Mortimer Forest, prepared by the survey in collaboration with the founder members of the LRG, provides a model of collaborative research which could be applied to the revised mapping of other areas (Figure 11). This could enable invaluable local knowledge to be integrated, with the advantage of increasing the number of stakeholders in the endeavour.

The Marches continues to attract and fascinate geoscientists, together releasing the secrets locked within "the ground beneath our feet".

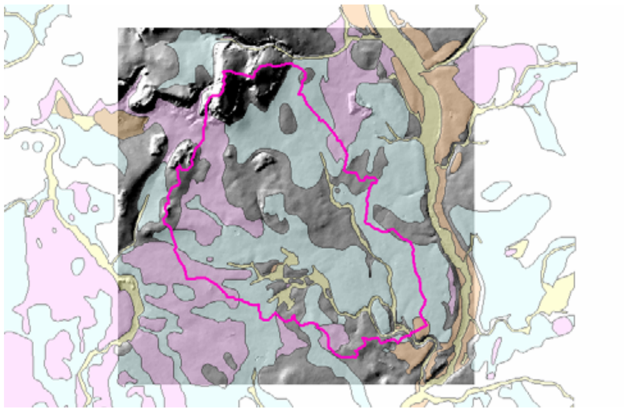

Figure 5. An illustration of how superposition of the Superficial Deposits over a digital surface model can facilitate interpretation of Quaternary deposits. This map is from the catchment of the River Tern in the Wem district and was compiled as part of a collaborative project with Birmingham University. The pale blue is Glacial Till, the buff is modern river Alluvium and the orange are River Terrace Deposits. The digital surface model was extracted from the NEXTMap Britain™ dataset from Intermap Technologies. © NERC, all rights reserved.

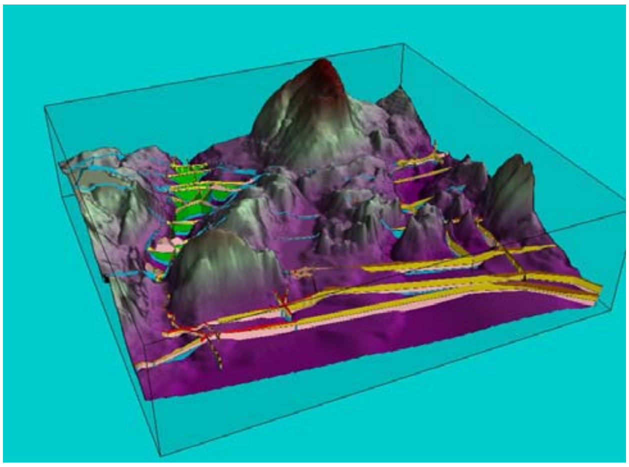

Figure 6. Geological mapping displayed using GIS, here providing a 3D representation of the Quaternary deposits in Swansea. © NERC, all rights reserved.

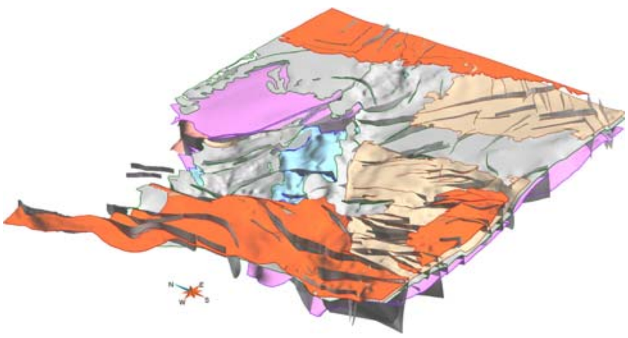

Figure 7. Geological mapping displayed using GIS by staff of the British Geological Survey, here providing an isometric view of an area supplemented by vertical cross-sections to reveal the underlying structure. This model shows an oblique view from the south-west of the Craven Basin GOCAD model, showing the base Permo-Triassic (orange) and the 3D faults (here shown as translucent grey surfaces). © NERC, all rights reserved.

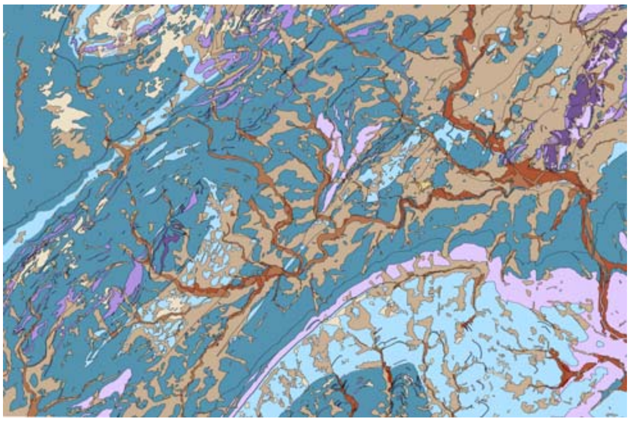

Figure 8. Thematic Layers, in this case for the Builth Wells district generated through a co-funding arrangement with the Welsh Assembly Government, highlighting deposits with comparable suites of engineering properties. © NERC, all rights reserved.

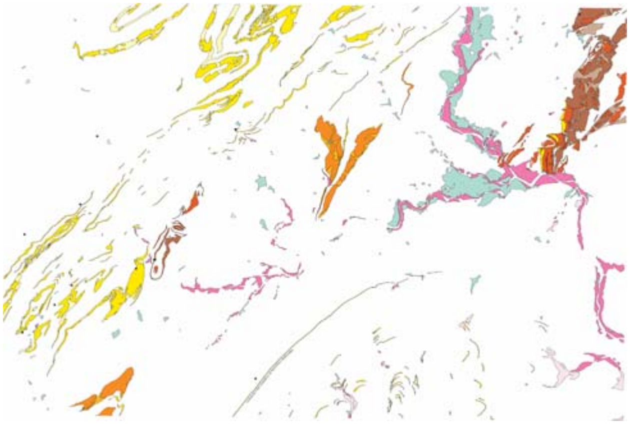

Figure 9. Thematic Layers, in this case the inferred non-metallic and metallic mineral resources for the Builth Wells district, generated through a co-funding arrangement with the Welsh Assembly Government. © NERC, all rights reserved.

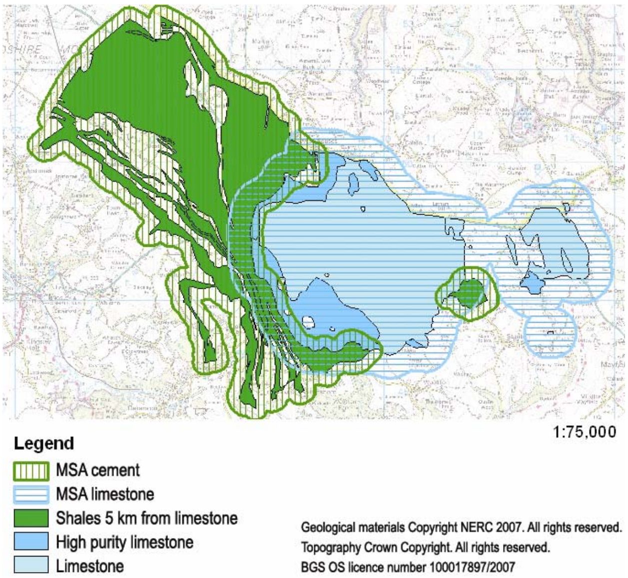

Figure 10. Map illustrating Minerals Safeguarding Areas (McEvoy *et al*., 2007). Buffers around limestone and cement resource areas from Staffordshire were designed to protect residents from the noise and dust created by quarrying whilst safeguarding the mineral resource. © NERC, all rights reserved.

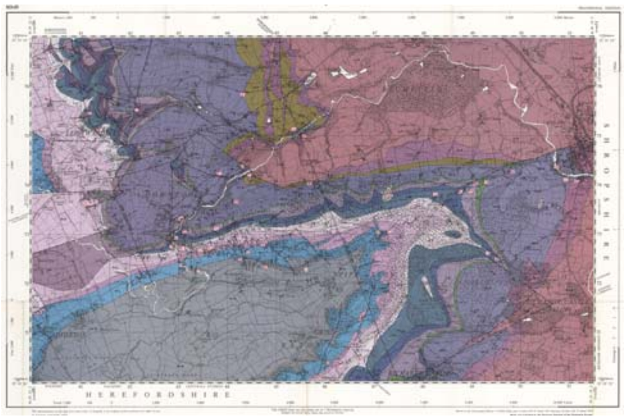

Figure 11. A classic example of a map prepared by the Survey in collaboration with an academic research team, in this case members of the Ludlow Research Group (Whitaker, Lawson, Walmsley, Holland), for the 1:25,000 map covering Mortimer Forest, between Leintwardine and Ludlow (right), published by IGS (as it was then) in 1973. The dots are numbered localities, facilitating personal fieldwork or training; descriptions were printed in the margins of the sheet (out of view). Reproduced with permission of the BGS. © NERC, all rights reserved.

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