

INTEGRATED MINERAL RESOURCE MAPPING AND SAFEGUARDING: A NATIONAL-SCALE EXAMPLE FROM WALES

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ABSTRACT

Information on the spatial location of mineral resources is becoming increasingly important due to a widening gap between supply and demand for resources, competition for land-use, a complex planning regime and increased data requirements from planning departments to deal with minerals issues. In Wales, until now, a lack of widespread mineral resource information has hampered the efforts of Mineral Planning Authorities to 'safeguard' mineral resources. Wording of national policy on safeguarding and a lack of guidance on the subject has also led to debate about the way that mineral safeguarding should be approached.

A consistent and transparent approach to mineral resource delineation has been applied in Wales and, for the first time, has been combined with the process of defining national Mineral Safeguarding Areas, to produce readily accessible spatial datasets for minerals planners. The short term aim of providing such datasets for immediate use by minerals planners has been achieved through the study. However, the true measure of success will be evident in years to come if planning practices today result in continued availability of minerals in the future.

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INTRODUCTION

Across Europe, the realisation of our dependence on mineral resources and the necessity of maintaining secure supplies of minerals is increasing (Tiess, 2010). This is reflected by the European Raw Materials Initiative (European Union, 2008) and, within the UK, separate overarching minerals policies for England, Wales, Scotland and Northern Ireland. Minerals are key in sustaining the economy (British Geological Survey, 2008), but are also finite and can only be worked where they occur (Highley *et al.*, 2004). It is, therefore, essential that society uses minerals in an efficient and sustainable manner. With the increasing awareness of the importance of these resources and the need to maintain access to these resources for future generations (Wrighton *et al.*, 2011), land-use planning systems around the world have a vital role to play in the management and supply of minerals.

Mineral safeguarding

Given the importance of minerals to the economy, 'sterilisation' of a mineral resource by other forms of development taking place on mineral-bearing land, is a serious issue (Bloodworth *et al.*, 2009). Since the introduction of the 1947 Town and Country Planning Act, a theme of the planning process has been to protect mineral resources from unnecessary sterilisation (for example, the Town and Country Planning Act 1947, The Local Government, Planning and Land Act 1980 and the

Town and Country Planning Act 1990). The process by which this outcome is ensured is known as 'mineral safeguarding'. Current national spatial planning policy documents in England, Scotland and Wales refer to the importance of safeguarding minerals for future generations (Department for Communities and Local Government, 2006; The Scottish Government, 2010; Welsh Assembly Government, 2000), and specific guidance is available in England (Wrighton *et al.*, 2011). However, the practical application of safeguarding policy at a local level is by no means universal, resulting in a broad variation of approaches and effectiveness (Bloodworth *et al.*, 2009).

Effective mineral safeguarding requires the location of mineral resources to be known, and areas defined where other proposed development might hinder or prevent exploitation of these mineral resources in the future. These areas should be shown in planning documents and suitable policies adopted to manage development. Areas where these policies apply are known as 'Mineral Safeguarding Areas' (MSAs). In Wales, the requirement to safeguard mineral resources is set out in paragraph 13 of the planning policy document 'Minerals Planning Policy Wales' (MPPW) (Welsh Assembly Government, 2000), which states:

'It is important that access to mineral deposits which society may need is safeguarded. This does not necessarily indicate an acceptance of working, but that the location

and quality of the mineral is known, and that the environmental constraints associated with extraction have been considered. Areas to be safeguarded should be identified on proposals maps and policies should protect potential mineral resources from other types of permanent development which would either sterilise them or hinder extraction, or which may hinder extraction in the future as technology changes'

Although there is no presumption that mineral resources will be worked in MSAs, the process aims to ensure that mineral resources are considered in land-use planning decisions so that they are not unnecessarily sterilised when planning applications for other types of development are determined (Wrighton *et al.*, 2011). Critically, supply options of future generations are, therefore, maintained.

Planning for mineral supply in Wales

Within Great Britain, Wales is a major mineral producer, although it is reliant on imports of some minerals. In 2008 Wales produced 10 per cent of Great Britain's coal (1.7 million tonnes) (The Coal Authority, 2009) and 25 per cent of Great Britain's sandstone (2.3 million tonnes) (Office of National Statistics, 2009), most of which was for high-specification and high PSV (polished stone value) end products.

Approximately 16 per cent of Great Britain's limestone production is sourced from Wales (12.1 million tonnes) (Office of National Statistics, 2009) much of which is suitable for high-grade chemical products. Wales is a major supplier of crushed rock aggregate to England and in 2009 supplied 2.6 million tonnes, 23 per cent of the country's total production (Mankelov *et al.*, 2011). The minerals industry and those industries supported by it generate significant revenue within Wales; over 2500 people were employed by the minerals industry in 2009 (Office of National Statistics, 2009). The management of a steady supply of minerals is, therefore, essential to meet current and future demand from the Welsh economy, and the economies of countries which benefit from receiving exports from Wales.

In England, advice on mineral safeguarding encourages MSAs to be based on the best geological and mineral resource information available. This is principally provided by the British Geological Survey (BGS) in the form of mineral resource maps and digital data that has been prepared for each Mineral Planning Authority (MPA). This resource information shows the geological distribution of all onshore mineral resources for the whole of England, enabling Mineral Planning Authorities to define MSAs in development plans (British Geological Survey, 2010a). In Wales, until now, a lack of comparable, widespread mineral resource information has hampered the efforts of MPAs to delineate such areas. Knowledge of the distribution of mineral resources was restricted to areas where investigation of resources had been commissioned or where the minerals industry could provide information.

Further uncertainty has also arisen due to the wording of national safeguarding policy and the lack of explanatory guidance. In a report produced for Torfaen Borough Council, Blaenau Gwent Borough Council, Newport City Council and Monmouthshire County

Council the point is made that it is not clear from MPPW to what extent environmental constraints need to be taken into account when defining safeguarding areas (Cuesta Consulting Ltd, 2009). This has led to debate about the necessity of safeguarding in areas such as National Parks, where '*minerals development should not take place in these areas save in exceptional circumstances*' (MPPW, para 21).

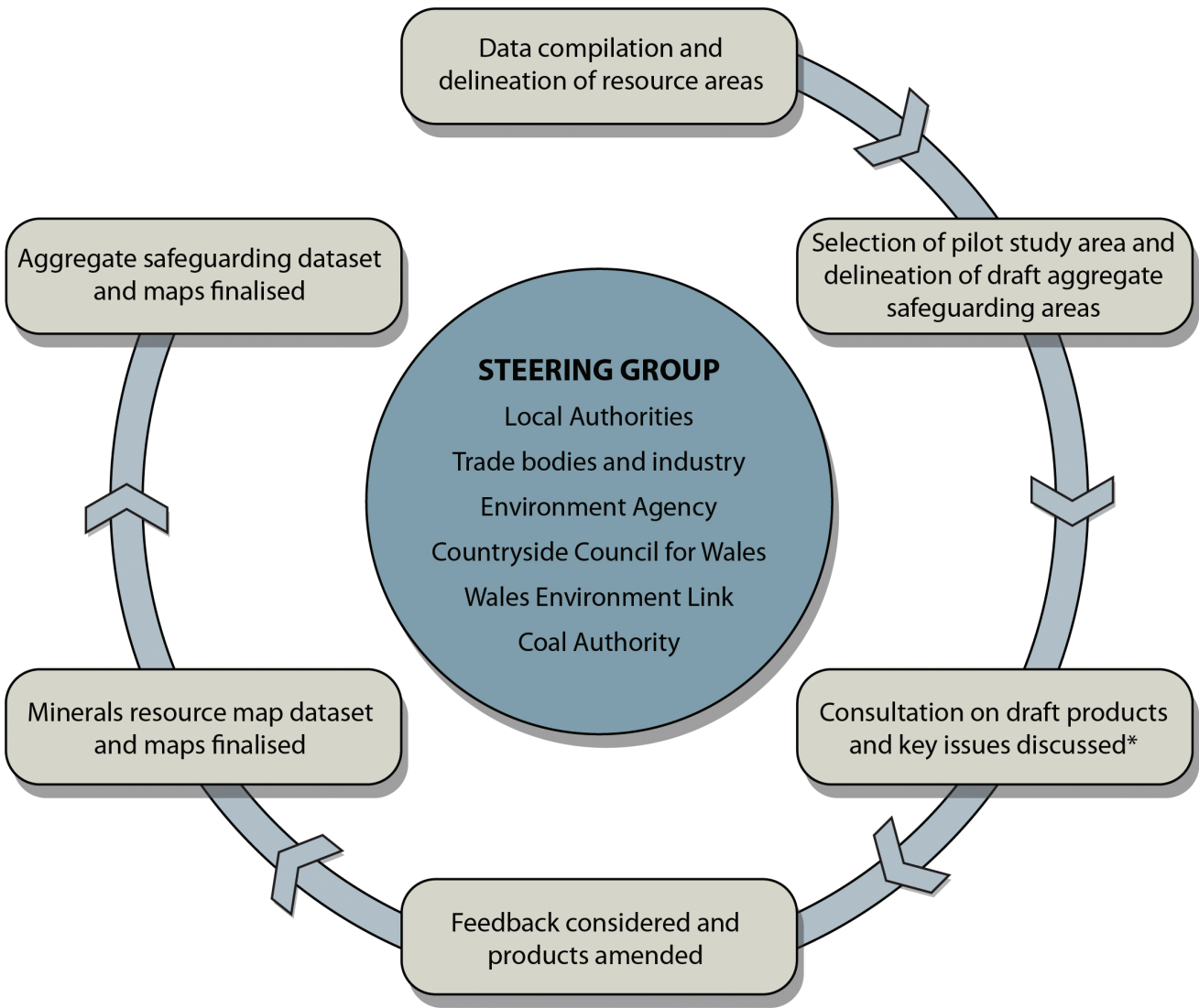
When selected stakeholders were asked for examples which illustrate where mineral sterilisation has occurred, two specific examples were provided. The Felindre to Tirley gas pipeline, which crosses the Brecon Beacons National Park, (National Grid, 2010) has sterilised sand and gravel deposits recently identified on the Mineral Resource Map of Wales (J. Cowley, personal communication, 2010). Also an electronics plant West of Newport which has been built on and thus sterilised sand and gravel resources (S. Bool, and A. Wilcock, personal communications, 2011). In the pipeline example, the mineral resources were considered as part of the Environmental Statement, representing consideration of sterilisation issues. In the electronic plant example, the mineral resources present were not effectively considered as part of the application process (J. Cowley, personal communication, 2008). In circumstances like these, it is important to have accurate mineral resource information and a mechanism by which the presence of a resource is identified and considered in the planning process even if, as the former example showed, sterilisation of minerals was deemed to be acceptable. This will help to prevent unnecessary sterilisation and a situation where access to resources becomes increasingly difficult as a result of planning decisions permitting non-mineral development on mineral bearing land.

Requirement for national-scale mineral resource and safeguarding maps

Recognising these issues, in 2008 the Welsh Government commissioned the British Geological Survey to produce a Mineral Resource Map of Wales and an Aggregates Safeguarding Map of Wales. The Mineral Resource map of Wales was to show the distribution and extent of mineral resources across Wales to improve the availability of information necessary for effective spatial planning. The Aggregates Safeguarding Map was intended to help local authorities with the task of defining MSAs at a local level, in a consistent way. This paper describes the approach to the study and the methodology developed for both maps, discussing key issues and considerations. The study commenced in March 2009 and the Mineral Resource Map of Wales was published in July 2010 (British Geological Survey, 2010b). The aggregate safeguarding maps have been produced in draft format, and are likely to be published in April 2012.

METHODOLOGY

The study comprised several distinct stages, each following on from the other (Figure 1) and all was overseen by a steering group. The role of the Steering Group was to provide technical comments and guide both the methodology being developed by the BGS, and the presentation of the resulting maps.



*With environmental organisations, Local Authorities, trade bodies and industry representatives

Figure 1. Schematic representation of methodology.

Both the Mineral Resource Map and the Aggregate Safeguarding Map have been produced as a set of six sheets covering the whole of Wales at 1:100,000 scale and as seamless digital spatial datasets for use within a Geographical Information System (GIS). This will facilitate integration of the datasets with other planning information held by the 25 Mineral Planning Authorities (MPAs) across Wales.

RESOURCE DEFINITION

A systematic, consistent and transparent methodology for defining mineral resources to be included on the map was devised. This national approach aimed to both aid the end user and provide robust data to the planning system.

The Mineral Resource Map of Wales (MRMW) shows the surface extent of mineral resources that are *inferred* from available geological information, and generally, exist within the boundaries outlined by geological mapping. Mineral resources are, therefore, primarily based on lithologies defined by geological mapping and

supplemented by more detailed geological data where available. In general, areas containing mineral resource have not been evaluated by drilling or by other sampling methods on any systematic basis.

The mineral resources are primarily defined on the basis of geological factors as to what may or may not constitute a mineral resource. Specifically the mineral resources depicted on the map show those areas within which minerals are considered by geological experts to have suitable chemical and physical properties to be potentially workable. Geological criteria that were used in identifying resources include resource quality, variability, extent and suitability for a particular application. Resources have been defined based on the PERC code (Pan-European Reserves Reporting Committee, 2008). The PERC code defines a mineral resource as ‘*a concentration or occurrence of material of intrinsic economic interest in or on the Earth’s crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction.*’

Supplementary information on the location of mineral extraction sites, the location of former slate quarries and

significant areas of slate waste, the location of historic building stone quarries and the recorded occurrences of metallic minerals are also shown. For building stone and metallic minerals, the distribution of historic workings and occurrences was considered to be the most practical way to view these resources.

Non-geological factors, such as anthropogenic sterilisation (largely urban development), relationships to environmental designations and economic factors, such as proximity to markets, end-uses and extraction technology were not considered. This is because although the factors listed above can greatly influence the exploitation of a mineral resource, they are subject to change with changing economic conditions and planning legislation within the 50 year time period the MRMW considers.

The first phase of mineral resource mapping involved a desk-based appraisal of the geology of an area to determine those geological formations with potential for mineral resources. Mineral resources were defined within a GIS environment, using digital geological linework at 1:50 000 scale (BGS 2011) as the basis for all mineral resource areas (Figure 2). The dataset was constructed by identifying those lithological units, from the DiGMap dataset, which were considered as mineral resources. As many sources of information as possible were consulted when considering which geological units constitute a mineral resource, ranging from historic publications to consultation with geologists with specialist knowledge of the local area. The majority of decisions were based on existing BGS publications such as memoirs for geological map sheet areas, the BGS 'BritPits' mines and quarries database, and advice from geologists with area specific knowledge. The location of active or historic extraction sites also formed an important source of information, as the first step in identifying resources involves identifying geological formations that are worked at present or have been historically worked and have the possibility of being worked again.

Following this initial appraisal, the lithologies identified in the DiGMap dataset were assigned to the

relevant mineral resource classification, this was often related to the end use of that rplifications, for example, the lithology, quartz dolerite can be considered equivalent to high specification aggregate (a class of aggregate resource). Once the lithologies from DiGMap were attributed with resource information, GIS was used to further refine and simplify polygons (by removal of geological information not required for the MRMW such as faults for example).

The mineral resource categories shown on the MRMW are shown below and include the onshore (above low water mark) bedrock and superficial mineral resources in Wales, many of which have been exploited for some time:

- Unconsolidated sediments, primarily sand and gravel; river terrace deposits, glaciofluvial deposits, alluvial deposits and wind-blown sand.
- Sedimentary rock resources; limestone, high-purity limestone (>97 per cent CaCO_3) and sandstone including sandstones suitable for high specification aggregate applications.
- Igneous rock resources including those suitable for road surfacing materials with a high PSV.
- Clay resources suitable for brickmaking.
- Energy resources in the coalfields of south and north-east Wales, together with associated brick clay and fireclay.
- Slate and associated slate waste, which occur across Wales and have a range of aggregate and industrial uses.
- Salt resources.
- Historic building stone quarries.
- Metallic mineral occurrences.

Using linework defined by geological mapping is not suitable for all mineral resource types and a different

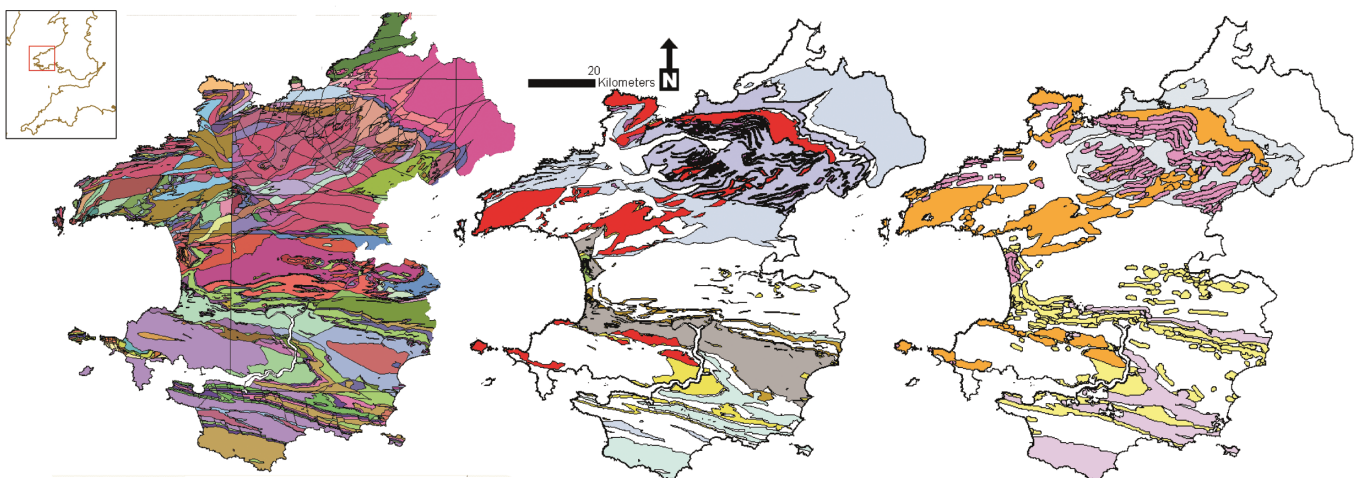


Figure 2. The original geological map of Pembrokeshire (left) the pilot study of the mineral resource map showing Pembrokeshire (middle) and the aggregate safeguarding map on the right. For clarity, the examples provided show only bedrock units. The safeguarding map does not show Category 3 resources which are of local importance in some areas only as described in the section entitled 'criteria for defining mineral safeguarding categories'.

approach was required for some resource categories. The extent of slate resources, for example, corresponds to metamorphic grade rather than lithology, so boundaries of this resource type were not well represented by available data from geological maps. To avoid large areas of un-metamorphosed mudstone being categorised as slate the locations of historic slate mines were used as an indicator of the presence of a slate resource. Another example is for mineral resource categories that cover large areas but have a low prospectivity for extraction, for example, bedrock sands and gravels from Triassic sandstones. This unit is extensive but can comprise locally important, yet low value, resources and is actively worked. To prevent large areas of non-resource from dominating the map the surface extent was reduced by excluding areas buried by >5 metres of drift, as they were considered to be not of sufficient quality to merit working under these depths. For some resource types geological mapping data could not be used at all, for example for building stone or metallic minerals. The location of building stone resources and metallic minerals are dictated by local geological conditions, not represented by regional geological mapping. To overcome this, point data for the location of historic building stone quarries and metallic mineral occurrences have been used to best represent the spatial distribution of these resource types.

AGGREGATES SAFEGUARDING MAP

The mineral resource information prepared for the MRMW was an essential precursor to the development of the Aggregates Safeguarding Map (ASM). The ASM categorises aggregate resources according to their relative broad economic importance, taking account of the sterilisation potential of the resource by proximal development. Furthermore, the areas take into account sterilisation of urban areas and designations.

Criteria for defining mineral safeguarding categories

Stakeholder consultation identified that the safeguarding of all mineral resources requires contextual information about the relative economic importance of mineral resources to aid decision makers when balancing planning considerations. Each aggregate resource type was therefore categorised according to the level of importance (national, regional or local) as indicated by policy documents and resource experts in the BGS. MPPW has yet to be updated to include directions on how to apply this categorised system. Publication of the ASM and user guide will, however, allow MPAs to identify safeguarding areas in Development Plans and develop appropriate protective policies.

The first or highest category, Category 1, includes those resources that have a national importance as inferred to by the information provided in the Regional Technical Statements (NWRAP, 2009, SWRAWP, 2008) and national policies and guidance. This includes those minerals that are specifically referenced in policy as being of limited occurrence and therefore particularly susceptible to sterilisation in the region, and those that have particular economic importance due to their high quality and/or limited occurrence across the UK. For example, the Regional Technical Statement for South

Wales indicates the national importance of high specification aggregates from the region: *‘As South Wales is an important source of these materials [high specification aggregates] at a UK level...’*.

Category 2 resources are those that are considered to be of more than local importance and may have some regional significance, but are of less importance nationally than those identified for Category 1. Category 3 resources are considered to be important for supply locally in some areas. Examples of mineral resources included within the three categories are shown on Table 1. The categorisation of mineral resources was undertaken by mineral resource experts at the BGS and technical experts in the steering group as detailed knowledge of the local industry is necessary to make these judgements.

Category	Definition	Resources
1	Nationally important minerals which have limited occurrence, and those which have particular economic importance due to their high quality and/or limited occurrence	Blown sand, glaciofluvial and river terrace sand and gravel deposits; rocks with potential for high specification aggregate e.g. quartz dolerite, Pennant Sandstone Formation; High purity limestone and other Carboniferous limestones
2	Regionally important minerals which are less important than Category 1	Glacigenic, poorly sorted and locally clayey sand and gravel deposits; limestones, sandstones and igneous rocks not considered as high specification aggregates; slates
3	Minerals with local importance only (shown only in the GIS data – not on face of hardcopy map)	Interbedded sandstones and mudstones and potential slate resource with recorded workings.

Table 1. Mineral safeguarding categories.

‘Safeguarding margins’

Non mineral development over a mineral resource not only has the potential to sterilise mineral that is beneath it, but also that which is adjacent to it as access to the mineral resource would not be permitted in the immediate vicinity of the development (Figure 3). MPPW (para. 40) recognises the conflict between mineral workings and other land-uses due to noise, dust and vibration, suggesting the use of ‘buffer zones’ around permitted and proposed mineral workings. Minerals Technical Advice Note (Wales) 1: Aggregates (MTAN1) (Welsh Assembly Government, 2004) refers to these zones as ‘separation distances’ and states that they should be 100 metres for those resources that do not require blasting and 200 metres for hard rock resources.

Consistent with the separation distances in MTAN1, MSAs were extended beyond that of the mapped mineral resource, generating a safeguarding margin. This not only minimises the risk of sterilisation of mineral on the ‘edges’ of the mapped resource, it also makes allowance for any inaccuracy of mapped geological boundaries and the scale of the data being used (Figure 3). Therefore, MSAs were created by extending superficial aggregate resource boundaries by 100 metres and bedrock resources by 200 metres.

Safeguarding in designated areas

Environmental designations are afforded protection in the planning system due to recognised special qualities that should be protected from inappropriate development. Although development is somewhat restricted in these areas, there are circumstances where development is necessary and does take place. The earlier example of the gas pipeline which crosses the sand and gravel resources of the Brecon Beacons National Park, demonstrates this point. As part of the application for development of the pipeline, mineral resources were considered and action taken to ensure that sterilisation of the resource was minimised. Although it is likely that mineral may not be extracted whilst viable mineral exists outside the designation, society may need access to the mineral in the future if such resources become scarce, inaccessible, or planning priorities change. To account for this, safeguarding areas have been delineated within environmental designations, including National Parks. This provides a consistency in approach to safeguarding across Wales.

Safeguarding in urban areas

Due to high population densities and concentration of services in urban areas, high volumes of development applications are submitted to planning authorities. There is a concern that the definition of MSAs in urban areas would cause an unnecessary and unmanageable administrative burden. One approach is to define a set of development policies to 'filter' out those applications that are unlikely to pose a sterilisation threat. Alternatively, policies that promote the extraction of mineral resources prior to re-development taking place

help prevent significant sterilisation of mineral resources in urban areas. As these 'prior extraction' policies are already applied in some areas of Wales, urban areas were excluded from MSAs using an Ordnance Survey dataset, Vectormap Local.

Safeguarding map compilation

As with the Mineral Resource Map, the Aggregates Safeguarding Map was defined within a GIS environment. Aggregate resources were selected from the Minerals Map dataset and were used as the basis for defining MSAs. Following this initial selection, the aggregates resources dataset was extended by 100 metres and 200 metres for superficial and bedrock deposits respectively in order to create a safeguarding margin. Finally, urban areas were removed from the safeguarding dataset using the OS dataset VectorMap Local.

CONCLUSION

Minerals planning in Wales has been hampered by a lack of suitable and relevant data. Production of both the Mineral Resource Map of Wales and the Aggregates Safeguarding Map has significantly increased the amount of data available to underpin the planning process.

These maps and data fill the broad information gap which existed for mineral resource information in Wales and will enable the consideration of mineral resources in land use planning. The ASMs identify safeguarding areas throughout Wales, including in environmental designations, so that however national policy is interpreted, a comprehensive, relevant and accessible information base is available.

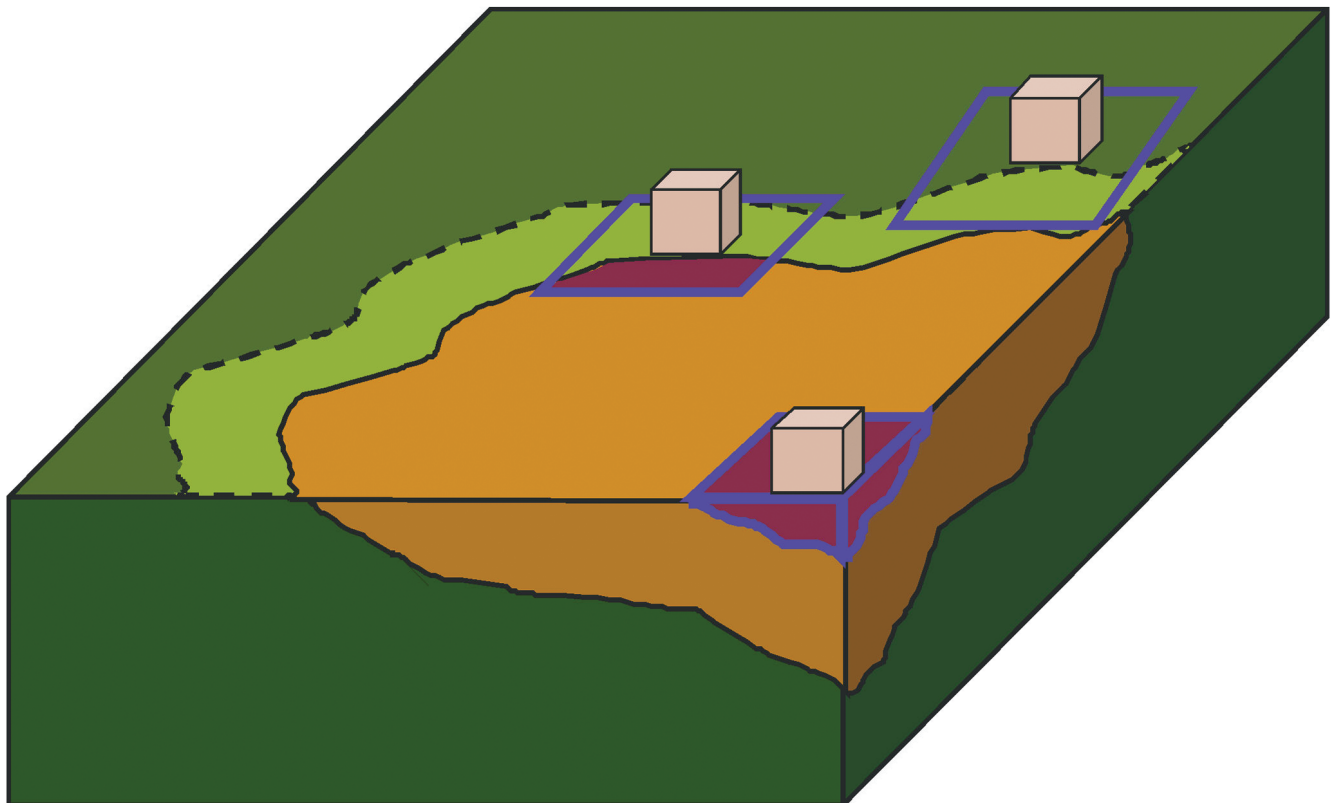


Figure 3. Diagram showing how development in close proximity can sterilise (purple) part of a mineral resource (shown in orange) whereas application of a 'Safeguarding Margin' (pale green) provides for protection of the resource in its entirety.

It is too early to tell whether the MRMWs and ASMs of Wales will be utilised effectively to ensure that secure supplies of minerals are available for the future. The maps in themselves will have little impact if not tied to policies that ensure their use in plan making and development management.

The next, and vital, step is to incorporate the maps into planning policies and procedures. The short term aim of providing the data for use may have been achieved through the study, but the true measure of success will be evident in years to come if planning practices today result in achieving the optimum balance between environmental protection and continued access to minerals in the future.

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