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Geology and Regional Geophysics Programme

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Mineral Resources of North West Herefordshire

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Mineral Resources of Herefordshire in the Knighton District

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Terrace, Melrose, north of Presteigne

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1 Foreword

This report is prepared for Herefordshire Council as part of contract DRA 25/8/16, awarded on 25th August 2016 and managed by R S Kendall (BGS Cardiff). It defines the distribution of inferred mineral resources present in that part of Herefordshire which lies within the Knighton District (British Geological Survey England and Wales sheet 180), and outlines the methodologies used in making that assessment. It is accompanied by maps (appendix 1 and 2), and should be read with reference to them. Detailed descriptions of the resources, variations in their thickness, and assessments of their quality are beyond the scope of this work. New data and information resulting from this study will be incorporated into the Mineral Resource Maps for England and Wales (BGS 2012).

2 Acknowledgements

P R Wilby (BGS Keyworth) provided field assistance and edited this report and the accompanying maps; T Bide (BGS Keyworth) compiled the map data and updated the National Mineral Resource Maps for England and Wales; and A Bloodworth (Science Director, Minerals, Waste & BGS Wales) provided Quality Assurance. The co-operation of landowners and tenants in permitting access to their land is kindly acknowledged.

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3 Summary

Herefordshire Council commissioned the British Geological Survey to extend the National Mineral Maps Dataset to cover the whole of the county of Herefordshire. The gap in the dataset was the result of there being no modern geological mapping for the part of Herefordshire which lies within the Knighton District (British Geological Survey England and Wales sheet 180). Interpretation of aerial photography and digital terrain models as well as literature review and field study has shown that a number of crushed-rock aggregate and sand and gravel resources identified in the rest of the county, extend into this area. These are sand and gravel, associated with glaciofluvial deposits and sub-alluvial river terrace deposits and limestones of the Woolhope Limestone and Much Wenlock Limestone Formations. The Folly Sandstone, which does not occur elsewhere in the county, has also been identified as a resource in this area.

The geology of this area is poorly known. The mineral resource data presented are based on the best available information, but are not comprehensive and their quality is variable. The inferred boundaries shown are, therefore, approximate. These areas are not of uniform potential, nor do they take account of planning constraints which may limit their working. The economic potential of specific sites can only be proved by a detailed evaluation programme. Such an investigation is an essential precursor to submitting a planning application for mineral working.

4 Introduction

The mineral resource maps for England and Wales, produced by the British Geological Survey from its National Mineral Resources Dataset, are principally derived from its 1:50,000 scale geological survey data. Where such data is not available, as in the northwest part of Herefordshire (the contract area, highlighted in red in Figure 1), 1:250,000 scale information has been used instead (Bloodworth *et al*., 1999). Herefordshire Council consider such data to be of insufficient resolution to develop a new Minerals and Waste Development Plan for the county. Consequently, they commissioned BGS to undertake a rapid geological survey to more precisely define the distribution of potential mineral resources in this area. The results are provided in the form of an updated National Mineral Map dataset, a set of MapInfo polygons for the county of Herefordshire, and this report which includes maps illustrating the updated mineral resources. This report, compiled as part of contract DRA 25/8/16 (awarded on 25th August 2016), describes the methodologies used in the survey and summarises the distribution and nature of the resources present. It completes the 1:50,000 scale mineral resource dataset for the county of Herefordshire.

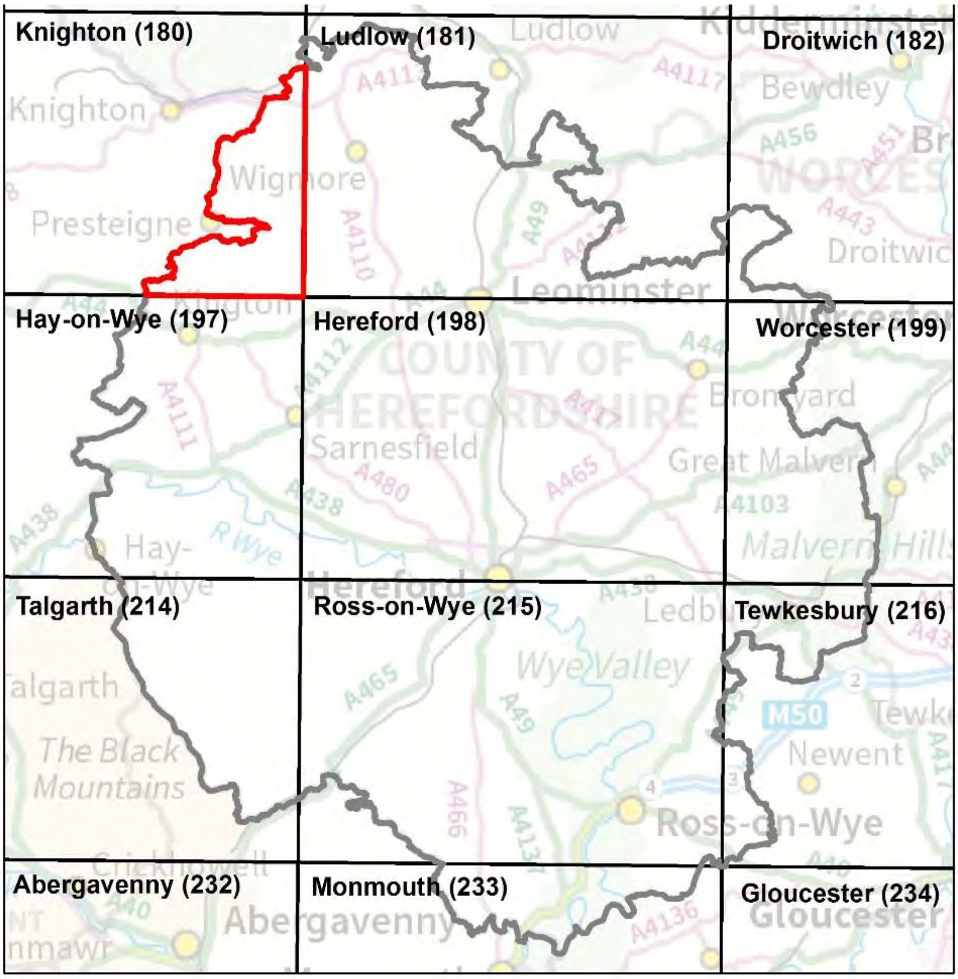


Figure 1 Location map, illustrating the contract area (outlined in red) and the BGS 1:50,000 map sheets that encompass Herefordshire.

5 Methodology

5.1 INTRODUCTION

Mineral resources are natural concentrations of mineral, or bodies of rock, that are or may become of potential economic interest as a basis for the extraction of a commodity. They will exhibit physical and/or chemical properties that make them suitable for specific uses and be present in sufficient quantity to be of intrinsic economic interest (Bloodworth *et al.,* 1999). Definitions of resource terminology is given in Appendix 3.

Assessment of the mineral resources that are present within the contract area (Figure 1) was performed in two stages: 1) desk-based, and 2) field-based. The desk-based survey comprised a thorough literature review, a compilation of available map data into a project GIS, and a provisional geological interpretation of the area using remotely sensed data. This informed the subsequent field-based stage and highlighted those areas in which greatest fieldwork effort should be concentrated.

Five units are considered to have resource potential. The Woolhope Limestone Formation and the Folly Sandstone are highlighted because they have been quarried locally in the past. The Much Wenlock Limestone Formation, glaciofluvial deposits and sub-alluvial river terrace deposits are highlighted because they have been identified as resources in earlier studies and are known to be present in adjacent areas (see Bloodworth *et al*., 1999). The limestones and sandstones have crushed rock aggregate resource potential. Glaciofluvial deposits and sub-alluvial river terrace deposits have sand and gravel resource potential.

5.2 LITERATURE REVIEW

Comparatively few geological studies have been conducted in the contract area. There is no recent mapping and no survey of superficial ("Drift") deposits. No published 1:50,000 scale BGS map is currently available for the Knighton District (England and Wales sheet 180). Nevertheless, a range of published and unpublished data (of varying age and relevance) exists (see Thomas and Kendall, 2011) and was used to inform the present investigation. The key sources are listed below with summaries of their contents:

BGS (1850) Old Series One-inch Geological Sheet Number 56NE: although this map does not subdivide the majority of the bedrock or record most of the superficial deposits that are present, it does provide some useful guidance. It delineates the extent of alluvium in the Redlake-, Teme- and Lugg valleys; it notes areas that are "much obscured by gravel", such as to the northwest of Staunton and near Lower Pedwardine, or where "much gravel" is present, such as in the vicinity of Nash; and it gives an interpretation of the distribution of the Woolhope Limestone Formation and Folly Sandstone to the south of Presteigne, and the Much Wenlock Limestone Formation near Lingen. It also defines the potential positions of major faults and provides some dip directional data.

Dwerryhouse and Miller (1928, 1930), Cross (1968), Luckman (1970), Cross and Hodgson (1975), Richards (1999), Jansson and Glasser (2005), Richards (2005): these papers describe the glacial history of the contract area and surrounding ground, documenting the general distribution and typical succession of the resulting superficial deposits, including glaciofluvial deposits.

Kirk (1947): Unpublished field slips and fair copy maps: these maps indicate areas of outcrop and formation boundaries in the southern part of the contact area, and provide associated point-based structural- (dip and fault) and lithological information. The point-based structural and lithological information has been utilised in the present study of the mineral resources of Herefordshire.

BGS (1960s) Unpublished fieldslips: these are the product of an earlier limestone survey in the area and provide valuable outcrop information, including lithofacies descriptions and dip directions and amounts, some from sites that are no longer available.

Holland *et al* (1963), Bassett *et al*. (1975), Bassett *et al*. (1979), Holland and Bassett (1989), Siveter *et al*. (1989): a series of key papers defining the Silurian stratigraphy, some which has been superseded but also some that is adopted in the current investigation. The papers provide details of regional variations in lithofacies and thickness of the units.

Garwood and Goodyear (1918), Pocock (1940), Scoffin (1971), Hurst (1978), Ray and Thomas (2007), Ray and Butcher (2010), Ray et al. (2010) Ray (2013): a series of papers documenting the distribution and lithological variability of the Much Wenlock Limestone Formation.

BGS (1973) Leintwardine-Ludlow 1:25,000 scale Special Sheet: this provides geological control for the eastern margin of the contract area, especially the bedrock structure, the distribution of the Much Wenlock Limestone Formation, and the nature and distribution of superficial deposits.

Woodcock (1984a, 1984b 1988) and Woodcock and Gibbons (1988): a series of papers describing the gross geological structure of the region, including the contract area.

Woodcock (1993), Cantrill (1917), Ziegler et al (1968): include descriptions and a geological maps of the Folly Sandstone and Woolhope Limestone Formation in the vicinity of Nash Scar Quarry, south of Presteigne. The geological boundaries in the map presented in Woodcock (1993) have been accepted as the extent of the Folly Sandstone and Woolhope Limestone Formation.

Bloodworth *et al*. (1999): this BGS technical report (WF/99/4) and accompanying map (BGS 1999) delineate and briefly describe the mineral resources of potential economic interest in Herefordshire and Worcestershire, and relate them to national planning designations. Some of the resources identified are likely to extend into the current contract area.

BGS (2000) Ludlow, England and Wales 1:50,000 scale sheet 181: this desktop compilation provides geological control for the eastern margin of the contract area, especially the bedrock structure, the distribution of the Much Wenlock Limestone Formation, and the nature and distribution of superficial deposits.

BGS (2004) Hay-on-Wye, England and Wales 1:50,000 scale sheet 197: this map is mainly the result of a desktop compilation, and provides geological control for the southern margin of the contract area, particularly for the nature and distribution of superficial deposits.

Other sources of information that were consulted include:

Environment Agency (2016) / Natural Resources Wales (2016) online flood risk maps: these provide an indication of the potential distribution of alluvium:
http://apps.environment-agency.gov.uk/wiyby/37837.aspx
https://naturalresources.wales/our-evidence-and-reports/maps/flood-risk-map/?lang=en

Ordnance Survey 1:50,000, 1:25,000 and 1 inch to 1 mile scale maps (between 1900 and 2015): these show the locations of former pits and quarries, and other relevant topographical information.

5.3 PROJECT GIS

Available survey data and accompanying spatial datasets were assembled into an ESRI ARC GIS (version 10.1) project, held corporately. This was used to display and interrogate the existing datasets, and underpinned the capture of new data in the field (see 5.5). The datasets used include: current Ordnance Survey spatial sets (OS Explorer and OS Landranger series), historical Ordnance Survey maps, BGS fieldslips, published BGS maps (1:50,000 and 1:25,000 scale), borehole records (Figure 2), non-BGS maps published in journals, DigMap250 (a simplified 1:250,000 scale digital BGS geological map of UK bedrock) and Britpits (a digital BGS database of UK quarries and pits).

5.4 REMOTE SENSING

Relevant geomorphological information (e.g. breaks of slope, benches, etc) and preliminary geological linework were digitised from airphotos in GeoVisionary. This is a stereographic software system developed by BGS and Virtalis. It enables the user to conduct a virtual reconnaissance prior to fieldwork by combining various high resolution spatial datasets (e.g. maps, aerial photography, topographic models) simultaneously in a 3D roaming environment. Results were incorporated into the project GIS and tested during fieldwork.

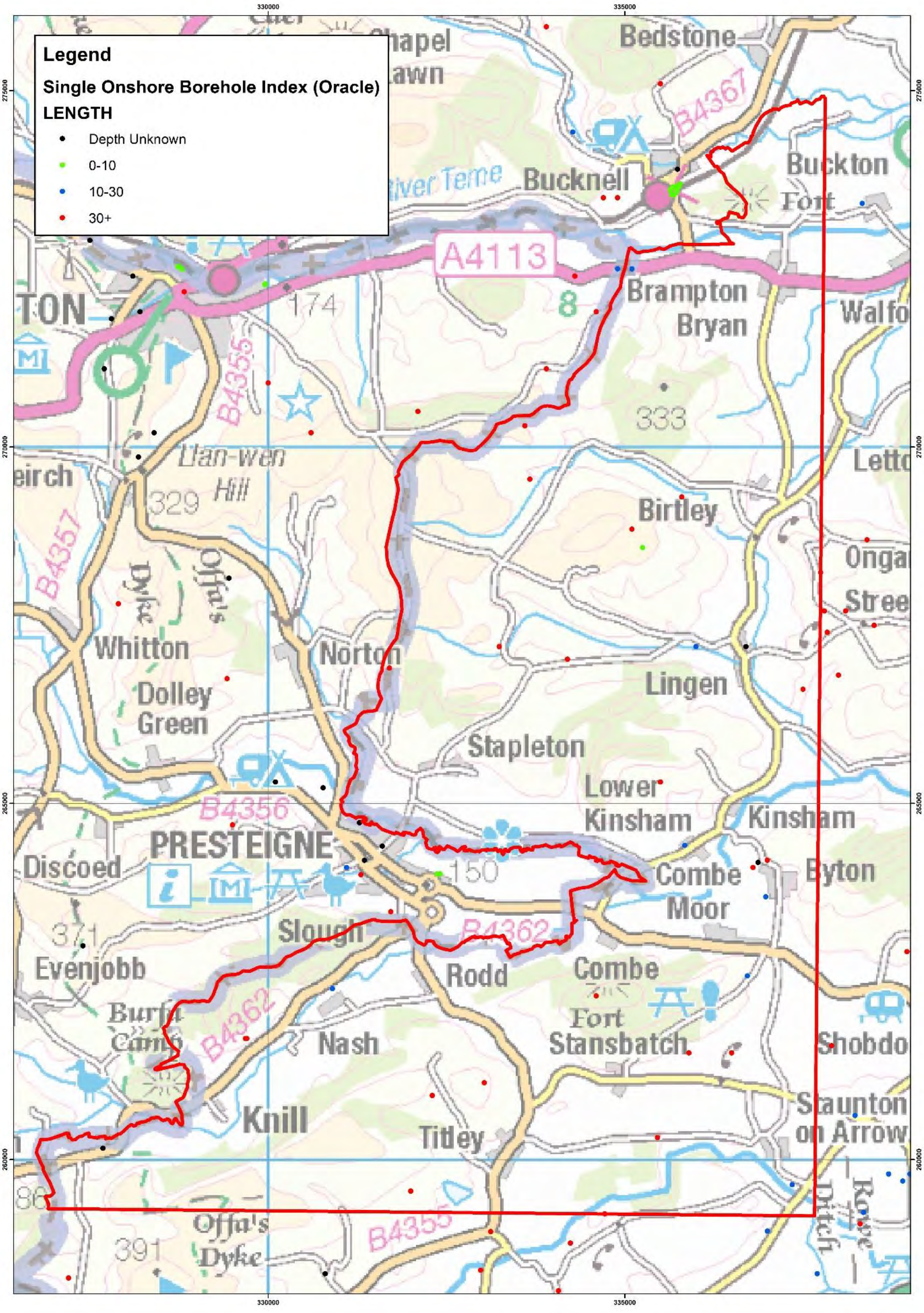


Figure 2 Distribution of boreholes of various lengths within the contract area (denoted by red line)

5.5 FIELDWORK

Fieldwork was conducted in four sessions, totalling three weeks, during August to November 2016. Field observations, geomorphological features and geological boundaries were captured digitally in the project GIS (see section 5.3) using a ruggedized tablet running SIGMA (System for Integrated Geoscience Mapping), a proprietary ARC tool kit developed by BGS for geological surveying. Most fieldwork was carried out on foot along the dense network of roads and foot paths; private land was accessed only where necessary. Augering, to verify the nature of superficial deposits, was limited to a couple of sites (at Byton Moor [336332, 263333] and at the Butts [335907, 260474]).

5.6 INTEGRATION OF NEW DATA INTO EXISTING UK MINERAL RESOURCE DATASET

The newly determined geological boundaries for bedrock and superficial deposits were redrawn as polygons and attributed in a GIS environment. Units that were considered prospective for mineral resources (see Section 7) were then separated from non-prospective geological formations. Areas of alluvium that were considered too small to constitute a resource were removed in order to be consistent with the methodology followed in the acquisition of the UK Mineral Resources Dataset (British Geological Survey 2012). The remaining polygons, representing the identified resources, were then merged with the existing mineral resource data for Herefordshire.

In the case of the sand and gravel resources, the new data replaces the 1:250,000 scale BGS geological data that had been previously used. For the limestone resources, no data was previously available and so entirely new resource polygons have been created; importantly, this has also allowed some polygons to be continued across geological map sheet boundaries where they had previously been artificially terminated. Two new sandstone resource polygons are also delineated. These polygons are relatively small (0.8km^2), but are included in order to be consistent with the approach taken elsewhere in England and Wales.

6 Aggregate resources: bedrock resources

6.1 FOLLY SANDSTONE

The Folly Sandstone comprises dark grey, coarse-grained, poorly sorted, fossiliferous, pebbly sandstone organised in to beds up to approximately 1m thick. The cement is in part quartzitic and partly ?limonitic (Kirk 1947, Cantrill, 1917, Woodcock, 1993). Its total thickness is unknown because its base is nowhere seen, but it is estimated to be in excess of 30m thick (Ziegler *et al.* 1968).

The Folly Sandstone is limited to the area around Nash Rocks Quarry [330216,262315], and Nash Wood, to the south of Presteigne, where it is folded (together with the succeeding Woolhope Limestone Formation, see section 6.2) into a southwest-plunging antiform (Woodcock, 1993). The sandstone on the southeast limb of the antiform dips at up to approximately 45 degrees to the southeast, whereas on the northwest limb it dips at approximately 35 degrees to the northwest. Along the southern margin of the antiform the nature of the contact is uncertain; the Folly Sandstone may dip below or be faulted against the Woolhope Limestone Formation. Along the eastern margin of the antiform, the sandstone is obscured by drift deposits, and along the western margin it is truncated by a splay of the regional Church Stretton Fault (Ziegler *et al.* 1968). A small inlier (approximately 230m long and 60m wide) of the Folly Sandstone was also exposed by quarrying in Nash Scar Quarry where it occurs within the core of an anticline. Its contact is faulted on the southeast limb and shows no angular discordance on the northwest limb (Woodcock, 1993).

The Folly Sandstone has formerly been worked for aggregate at Nash Rock Quarry (Bloodworth *et al.,* 1999), which is presently inactive. The unit has also been locally used as a building stone (Shipton, 2012).

The Folly Sandstone is early Silurian (latest Aeronian to earliest Telychian) in age.

6.2 WOOLHOPE LIMESTONE FORMATION

The Woolhope Limestone Formation typically comprises nodular, argillaceous limestones and rubbly siltstones; massive limestone intervals occur in the middle of the sequence (Squirrel and Tucker 1960). However, at Nash Scar, the Woolhope Limestone Formation comprises massive, dark grey to white, crystalline algal and bryzoan limestone (Garwood and Goodyear, 1918 and Bassett, 1974). Within the contract area, the formation is restricted to the vicinity of Nash Scar Quarry, south of Presteigne, where it is thought to be approximately 60m thick (Kirk, 1947, Ziegler *et al*. 1968).

At Nash Scar Quarry, the Woolhope Limestone outcrops on the southeast limb of an antiform that plunges gently towards the southwest (Woodcock, 1993). The dip of the strata is variable, but is up to approximately 37 degrees (see description of anticline in 6.1). The nature of the contact with the underlying Folly Sandstone is uncertain; the Folly Sandstone may dip below or be faulted against the Woolhope Limestone Formation (Ziegler *et al.* 1968). The Woolhope Limestone Formation is seen to be conformably overlain by the Coalbrookdale Formation in the southeast of Nash Scar Quarry (Woodcock, 1993). Along the eastern margin of the antiform, the limestone is obscured by drift deposits, and along the western margin it is truncated by a splay of the regional Church Stretton Fault.

The Woolhope Limestone Formation was formerly worked (together with the Folly Sandstone, see Section 6.1) for aggregate at Nash Rocks Quarry [330216,262315] (Bloodworth *et al.,* 1999), where it is locally known as the Nash Scar Limestone Formation (Garwood and Goodyear, 1918, Kirk,1947, Woodcock, 1993). The quarry is currently inactive.

The Woolhope Limestone formation is Silurian (early Wenlock) in age (Hurst et al., 1978, Pocock *et al.,* 1940).

6.3 MUCH WENLOCK LIMESTONE FORMATION

Typically, the Much Wenlock Limestone Formation comprises hard, irregularly bedded, light olive-grey to pale olive, silty limestones, alternating with beds of siltstones on a centimetre to metre scale. Regionally, the proportion of limestone varies considerably, but it can form up to 40% of the unit, and its uppermost approximately 15m may consist of hard nodular limestone, arranged in irregular flaggy units. The limestones are finely crystalline and often shelly (Holland *et al.,* 1963).

The maximum regional thickness of the Much Wenlock Limestone Formation is thought to be 29m; in the contract area it is approximately 21m thick (Bassett 1989) and the proportion of limestone within the formation is low (Ray *et al.,* 2010, Scoffin, 1971). Nevertheless, the formation is included here because it has been identified as resource in adjacent areas where it has been extensively quarried for aggregate and agricultural lime, as for example on Wenlock Edge in Shropshire (Bloodwork *et al.,* 1999). However, its usefulness as an aggregate in the contract area is questionable due to the high proportion of non-calcareous siltstones (Bloodworth *et al.,* 1999). Additionally, it is repeatedly offset by faults and its crop is therefore highly discontinuous (see Figure 3).

The Woolhope Limestone formation is Silurian (early Wenlock) in age.

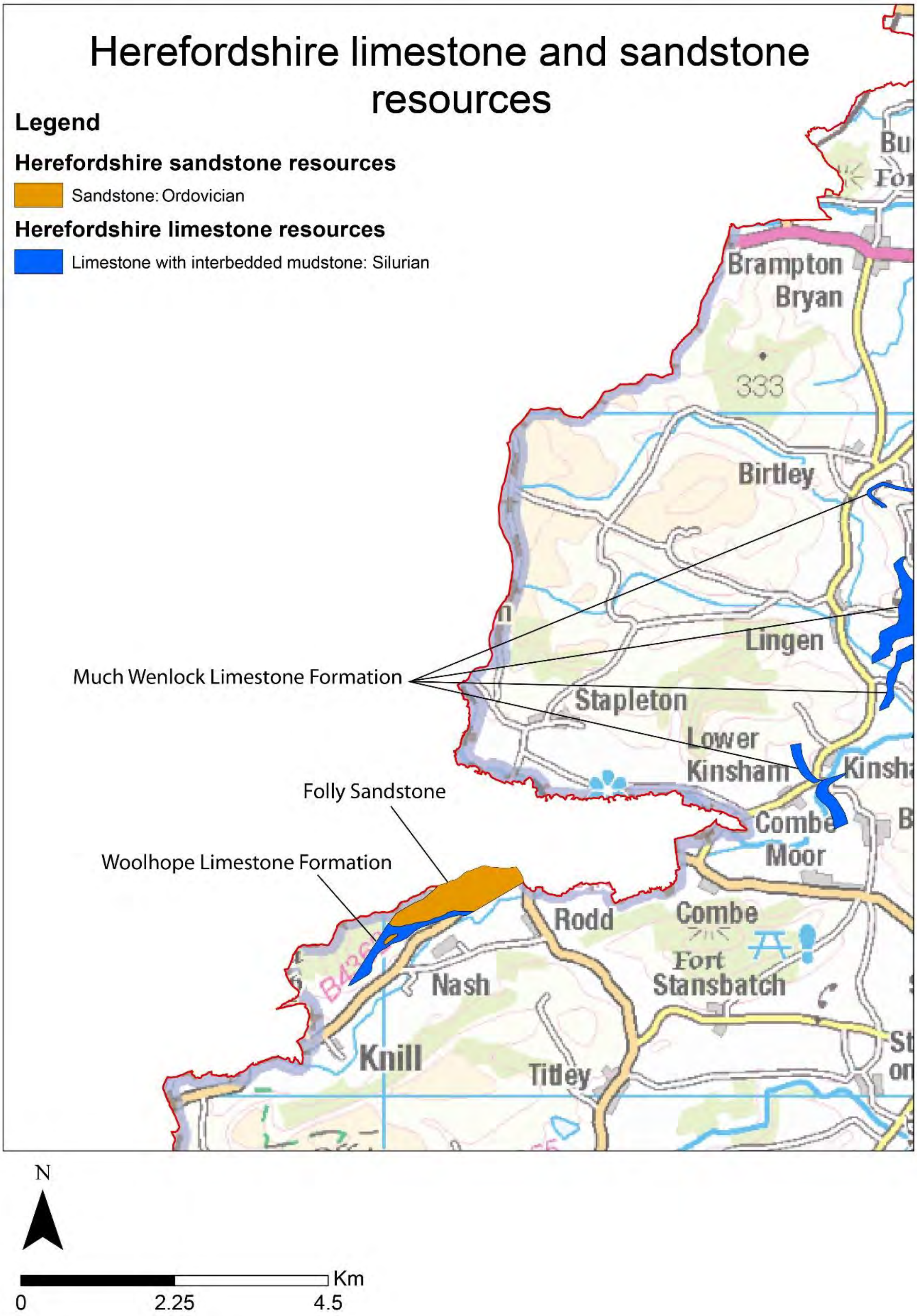


Figure 3 Limestone and sandstone resources in the contract area.

7 Aggregate resources: sand and gravel

During the ice age, which ended approximately 12 000 years ago (Cohen and Gibbard, 2016), the Teme and Lugg valleys were filled and scoured by glaciers fed by ice from the west (Luckman, 1970). These deposited a range of materials, including till, moraines, and glaciofluvial deposits (see section 7.1). Following withdrawal of the ice, the region's drainage was re-established and river terrace deposits (see section 7.2) accumulated in the valley bottoms. These, and the earlier glacial deposits, were subsequently incised by the modern drainage system and locally concealed beneath associated alluvial deposits. Two superficial ("drift") deposits represent resources in the contract area, based on field survey data, borehole information and comparisons with BGS geological maps and BGS mineral maps in adjacent areas. Both are dominated by sand and gravel, and are summarised in ascending stratigraphical order below:

7.1 GLACIOFLUVIAL DEPOSITS

Glaciofluvial deposits comprise unconsolidated, moderately well-sorted and bedded, pebble-cobble gravels and sands with subordinate thin beds of laminated silt and clay. They typically form flat-toped, steep-fronted benches on the sides of valleys, sometimes arranged into flights, or low-relief spreads in the bottom of valleys (Wilby 2009). Benches in glaciofluvial deposits at Nash and to the north of Presteigne, between the B4355 and Kinsham Cross, rise to approximately 20m above the modern floodplain, suggesting that here, at least, they are in excess of 20m thick.

Mapping suggests that the glaciofluvial deposits are underlain, at least in part, by glacial till, and those in the Lugg and Hindwell Brook valleys are confined by bedrock slopes. The spreads in the middle of the Lugg valley, immediately to the east of Presteigne, appear to be progressively buried eastwards by the modern alluvium, suggesting that concealed deposits may exist at depth further east in the vicinity of Melrose. By extension, glaciofluvial deposits may be present below the alluvium elsewhere in the Lugg, as well as in Hindwell Brook and the Teme Valley. The thickness of any such deposits, if present, is uncertain and will be partly controlled by irregularities in the surface(s) of the underlying glacial till and/or bedrock. Boreholes (SO36SW18, SO36W15 and SO36SW21) close to Presteigne record sand and gravel deposits up to approximately 6m thick, overlying possible weathered bedrock or till.

7.2 SUB-RIVER TERRACE DEPOSITS – INFERRED RESOURCES

Mapped extents of alluvium, associated with modern fluvial systems occur within the contract area. The National Mineral Map dataset assumes that sand and gravel resources are likely occur beneath the alluvium and refers to them as sub-river terrace deposits – inferred resources on its maps (Bide and Hannis, 2012).

Alluvium generally comprises a variable suite of deposits, but often can be divided into two units. The upper unit typically consists of yellow and grey silty clays and clayey silts, and the basal unit generally consists of unconsolidated, cross-bedded, pebble gravels and well-sorted, coarse- to fine-grained sands with subsidiary beds and lenses of silt and clay (e.g. Wilby 2009).

Other sand and gravel rich deposits which can occur beneath alluvium include the terraces of earlier rivers and glaciofluvial deposits (See Section 7.1). Distinguishing the likely origin of the sand and gravel can be difficult and deposits could comprise a component of all of these. The variability of sand and gravel deposits mean that in comparison with other bulk minerals, it is more difficult to infer the location and the likely extent of potentially workable resources from geological maps. These deposits have not been assessed by drilling and not all areas are likely to be of commercial value where they are of limited lateral extent or vertical thickness, (Bloodworth *et al.,* 1999).

Sub-river terrace deposits are inferred to be present beneath the alluvium in the Redlake-, Teme-, Hindwell Brook and Lugg valleys. Sub-river terrace deposits, in general, rarely exceed 10m in thickness (Bloodworth *et al,* 1999) although their thickness or presence in the contract area is not proven. In the contract area, the upper clay and silt rich unit of alluvium is recorded as part of this study to be at least 1.5m thick in all of the major river valleys.

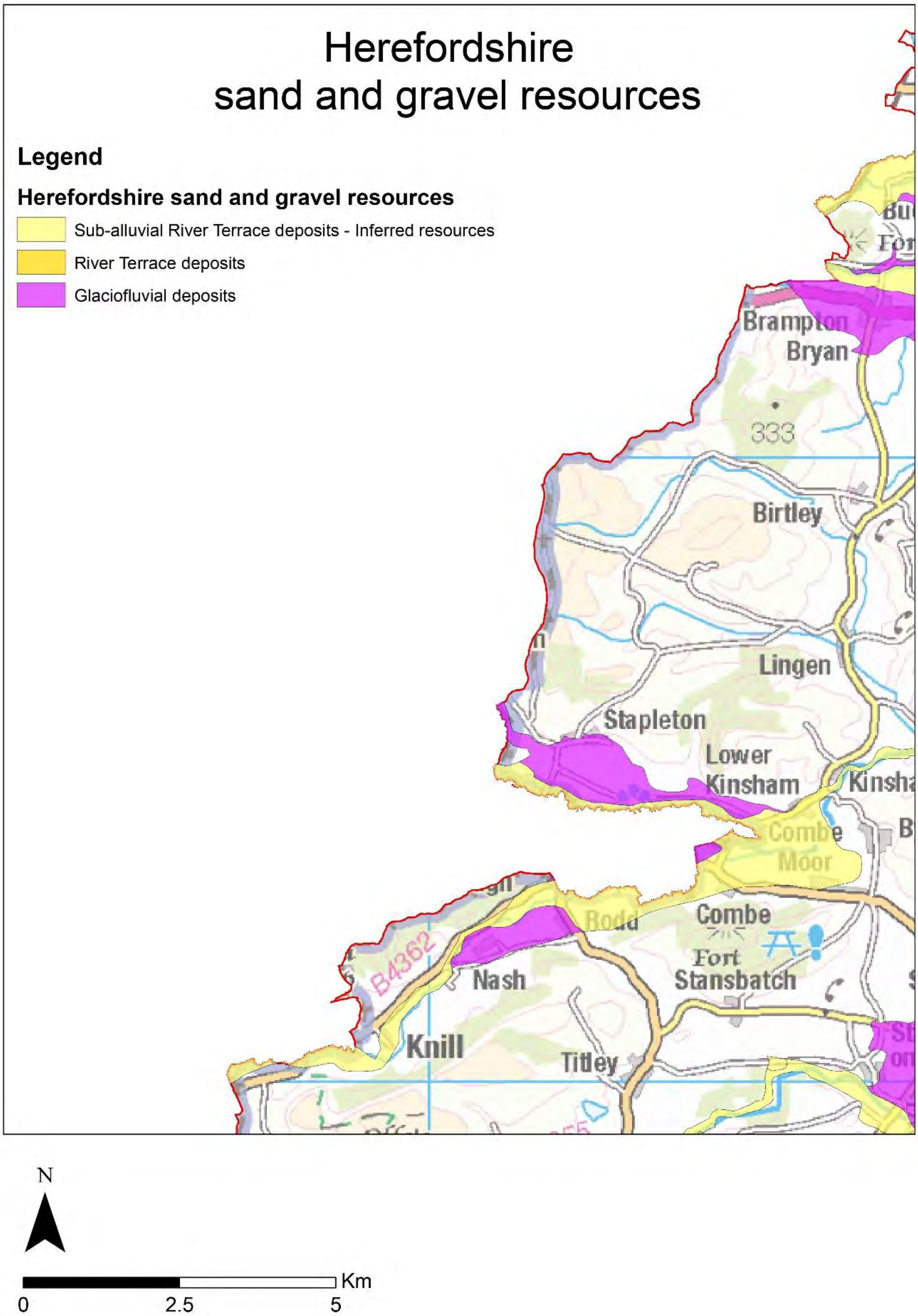
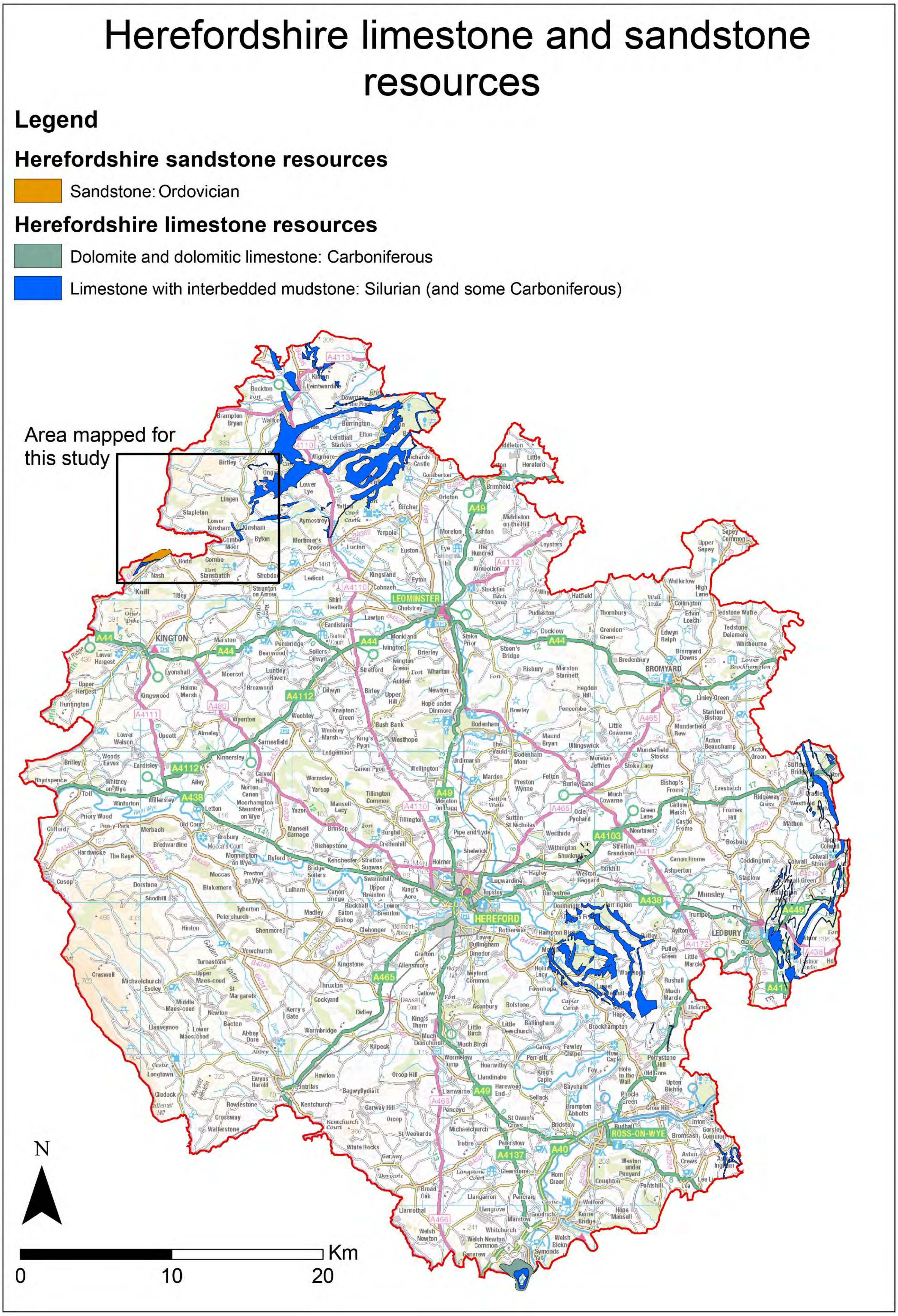
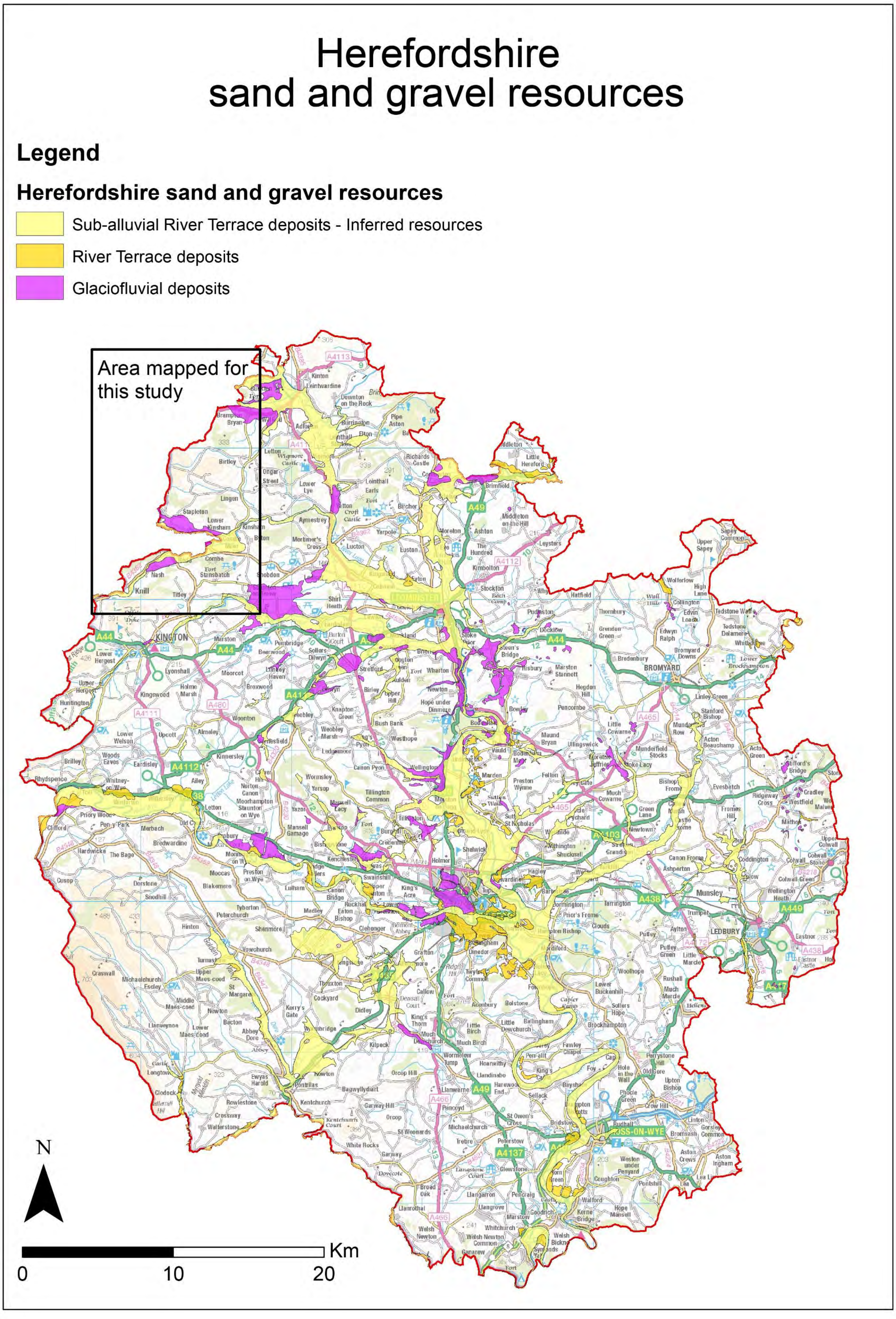


Figure 4 sand and gravel resources in the contract area

Appendix 1 Map of limestone and sandstone resources


Herefordshire limestone and sandstone resources
Legend
Herefordshire sandstone resources
Sandstone: Ordovician
Herefordshire limestone resources
Dolomite and dolomitic limestone: Carboniferous
Limestone with interbedded mudstone: Silurian (and some Carboniferous)
Area mapped for this study
HEREFORD
LEOMINSTER
KINGTON
BROMYARD
LEDBURY
ROSS-ON-WYE
N
0
10
20
Km

Appendix 2 Map of sand and gravel resources


Herefordshire
sand and gravel resources
Legend
Herefordshire sand and gravel resources
Sub-alluvial River Terrace deposits - Inferred resources
River Terrace deposits
Glaciofluvial deposits
Area mapped for this study
N
Km
0
10
20

Appendix 3 Definitions of resources and reserves

A **'Mineral Resource'** is a concentration or occurrence of material of economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are subdivided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories.

An **'Inferred Mineral Resource'** is that part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which is limited or of uncertain quality and reliability.

An **'Indicated Mineral Resource'** is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed.

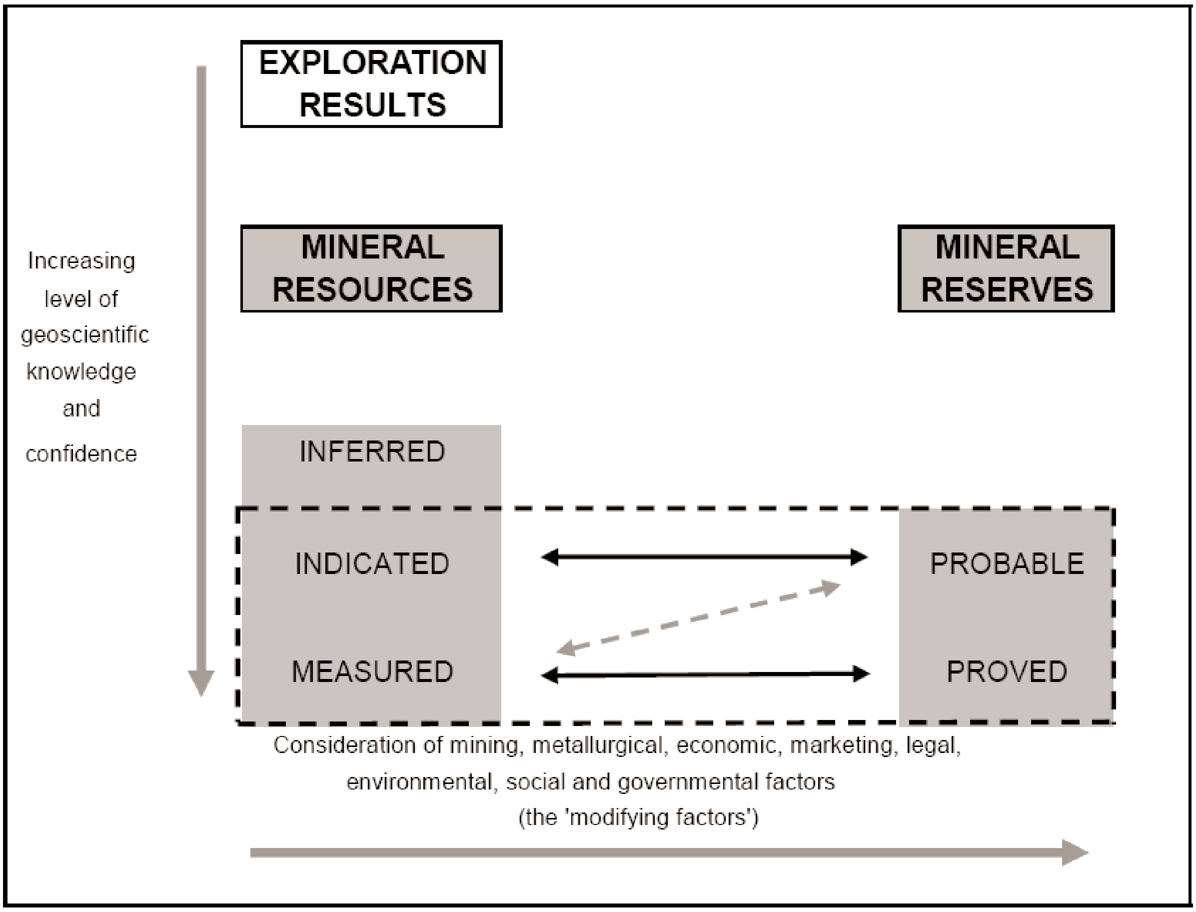
A **'Measured Mineral Resource'** is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity.

A **'Mineral Reserve'** is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out, and include consideration of and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified. Mineral Reserves are sub-divided in order of increasing confidence into Probable Mineral Reserves and Proved Mineral Reserves.

A **'Probable Mineral Reserve'** is the economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Studies to at least Pre-Feasibility level will have been carried out, including consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. The results of the studies demonstrate at the time of reporting that extraction could reasonably be justified.

A **'Proved Mineral Reserve'** is the economically mineable part of a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Studies to at least Pre-Feasibility level will have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These studies demonstrate at the time of reporting that extraction is justified.

The relationship between resources and reserves



*Extracts from the Pan-European code for reporting of exploration results, mineral resources and reserves ('The PERC reporting code'), 2008. The full document is available at: http://www.vmine.net/percreserves/documents/PERC_REPORTING_CODE_jan2009.pdf

Note: In the context of UK land-use planning, the term mineral reserve should strictly be further limited to those minerals for which a valid planning permission for extraction exists (i.e. permitted reserves). Without a valid planning consent, no mineral working can take place and consequently the inherent economic value of the mineral resource cannot be released and resulting wealth created. The ultimate fate of a mineral reserve is to be either physically worked out or to be made non-viable by changing economic circumstances.

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British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: https://envirolib.apps.nerc.ac.uk/olibcgi.

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