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A GIS of the extent of historical mining activities in Scotland: explanatory notes

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BRITISH GEOLOGICAL SURVEY

COMMISSIONED REPORT CR/03/331N

A GIS of the extent of historical mining activities in Scotland: explanatory notes

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Abandoned mine workings
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1 Introduction

As part of the secondment of BGS staff to SEPA to help implement the Water Framework Directive (WFD) in Scotland, BGS have been asked to provide an approximate outline of the extent of historical mining in Scotland. This will be used to help characterize pressures on Scottish groundwater as part of the initial characterization of groundwater bodies for the WFD. Initial characterization has to be completed by December 2004; for bodies deemed to be at risk there will be further characterization after 2004. A team of BGS geologists carried out the work during September 2003.

The aim of the study was:

“To delineate the extent of known and inferred historical and current shallow and deep mining in Scotland as an aid to characterizing the pressures to Scottish groundwater.”

2 Approach

The most obvious method of identifying historical mining in Scotland is to look at the mine abandonment plans. Mine abandonment plans for coal mining are kept digitally by the Coal Authority. This database is large and expensive to access. Other mine abandonment plans are held by BGS, but are not all held digitally. Many undocumented mines also exist across Scotland. The scale and resources of this project did not allow access to abandonment plans (held either at BGS or by the Coal Authority), therefore, a different approach had to be taken.

The approach used in this project was to consider the *potential* for mining to have taken place. Areas that could potentially have been mined in Scotland can be divided into three categories.

1. Shallow mining constrained by geological formations, such as mining for coal, oil shale or limestone.
2. Metaliferous and other mineral mining, not necessarily constrained by geological formations (e.g. mining for barytes)
3. Deep coal mining (>200 m) constrained by geological formations, but not able to be predicted using maps of the geology at the surface.

For category one, DiGMap50 (the 1:50 000 digital geological map of Scotland) was interpreted by regional geologists at BGS with reference to published Environmental Geology Maps (e.g. Forsyth 1983) and Geological Memoirs. For category two, the mineral occurrence database developed by BGS (<http://www.bgs.ac.uk/mineralsUK/data/mineocc/home.html>) was interrogated and interpreted by a senior BGS mineral geologist. For category 3, the coal resources map of the UK (BGS 1999) was used in conjunction with isopachytes for the Carboniferous rocks of Central Scotland (Browne et al. 1985) to estimate areas where coal reserves (and therefore mining) are found at depth.

The three resulting datasets were combined using Arc 8 GIS and displayed along with information on the location of quarries in Scotland from the BGS dataset Britpits (<http://www.bgs.ac.uk/mineralsUK/data/britpits/home.html>). A summary of the GIS files is given in Appendix 1. Further information on the development of the individual components is given below.

2.1 AREAS OF SIGNIFICANT HISTORIC SHALLOW MINING (CATEGORY 1)

Figure 1 shows a summary of the information available on the GIS. Scotland falls into four classes: areas where historically mining was extensive, important, localised, and the rest of Scotland where mining rarely occurred. The shape file was created primarily using DiGMapGB50, interpreted by regional geologists. Table 1 lists the geological formations where mining has concentrated and the commodity mined. Added to this are areas of significant metaliferous mining (e.g. around Leadhills and the Ochils) interpreted from the mineral occurrence database held at BGS.

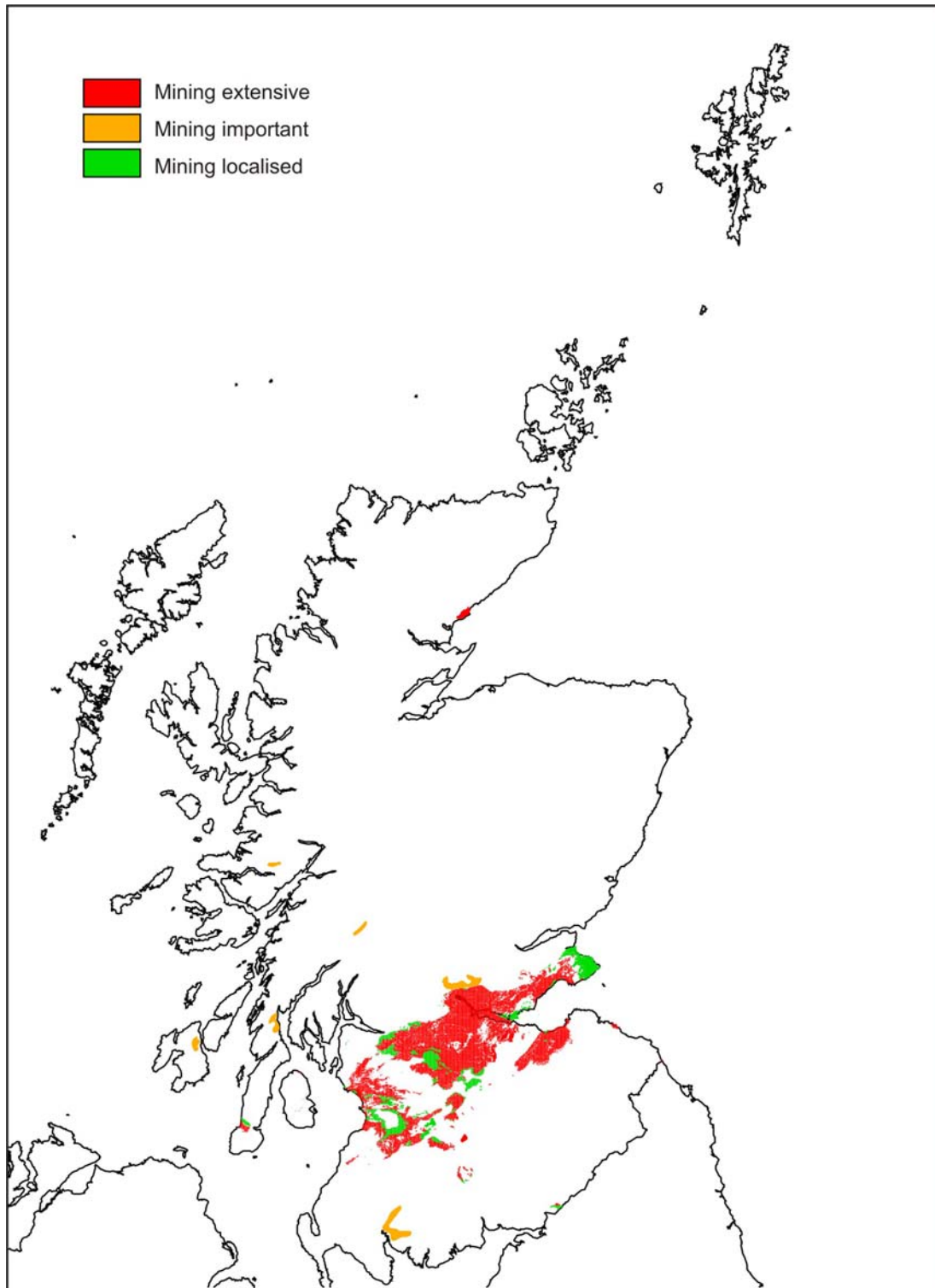


Figure 1 Areas of Scotland that have been extensively mined, estimated from the outcrop of various geological formations and data from the mineral occurrences database.

The map should be interpreted as the *potential* for mining to have occurred in certain areas. More detailed information on actual mine occurrence at a local level can only be gained from using actual mine plans. Coalmine details are available (mostly digitally) from the Coal Authority; other mine abandonment plans are held at BGS (only some are digital). However, there will not be records of all historical mining. Shallow mines in particular, which are extensive in central Scotland, may be completely unrecorded.

Table 1 Geological formations or members where mining activity has historically occurred.

Geological Formation or Member	Historical mining activity		
	Extensive	Important	Localised
Anstruther Formation			Oil-shale mining
Calders Member	Oil-shale mining	Limestone mining	Coal mining
Close Burn Limestone Formation			Limestone mining
Hopetoun Member	Oil-shale mining	Limestone mining	Coal mining
Kinnesswood Formation			Limestone mining
Lower Coal Measures	Coal mining	Ironstone mining	Fireclay, shale, sandstone and ochre mining
Lower Limestone Formation	Limestone mining	Coal mining	Oil-shale and ironstone mining
Limestone Coal Formation	Coal and ironstone mining		Fireclay, shale and sandstone mining
Lawmuir Formation			Coal, fireclay and limestone mining
Middle Coal Measures	Coal mining	Ironstone mining	Fireclay, shale, sandstone and ochre mining
Passage Formation	Fireclay and ironstone mining		Oil-shale and sandstone mining
Pittenweem Formation			Sandstone mining
Sandy Craig Formation			Oil-shale, coal and sandstone mining
Upper Coal Measures			Ochre and terracotta clay mining
Upper Limestone Formation	Coal mining	Limestone mining	Sandstone and ironstone mining
West Lothian Oil Formation	Oil-shale mining	Limestone mining	Coal mining
Jurassic - Brora area	Coal mining		

2.2 METALIFEROUS MINING (CATEGORY 2)

Metals have been mined across Scotland. Although little mining is ongoing, the legacy can give rise to local water contamination. There is no database currently available showing historic mineral mines for Scotland. BGS are planning to develop a database using the available records – but this will not be available for some time. Therefore to estimate the areas that are likely to have been mined, maps of available metaliferous mineral *resources* were examined. A comprehensive database of metaliferous mineral occurrences exists for Scotland (MinOcc). This has been interrogated to indicate the major resources – which are likely to have undergone some mining in the past (Figure 2).

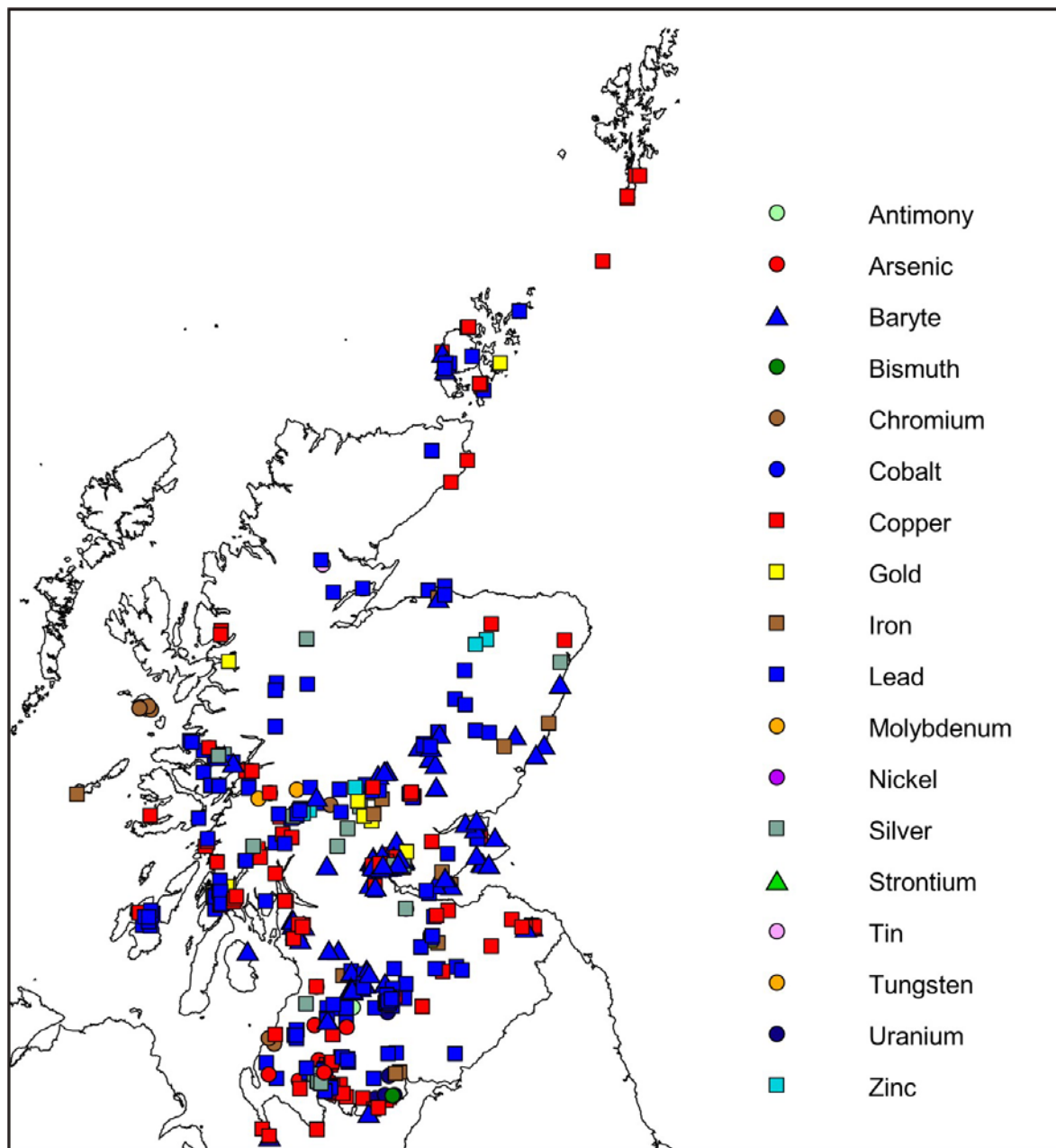


Figure 2 Major metaliferous occurrences in Scotland. Most will have undergone some degree of mining.

2.3 AREAS OF DEEP MINING (CATEGORY 3)

Central Scotland has a long history of deep coal mining. Groundwater contamination from the flooding of these mines is a major threat to the water environment in central Scotland. Areas that are potentially affected by deep mining are outlined in Figure 3. Deep mining has been defined as mining below 200 m. Much of the coal resources in Scotland are within the Limestone Coal Formation and Middle and Lower Coal Measures. Areas where these units are greater than 200 m below ground surface have been mapped using isopachytes generated from previous geothermal studies by BGS.

The map should be interpreted as showing only the potential for deep mining to have occurred and not the actual extent of mining. Again mine plans held at the Coal Authority would need to be accessed to get any more detailed information.

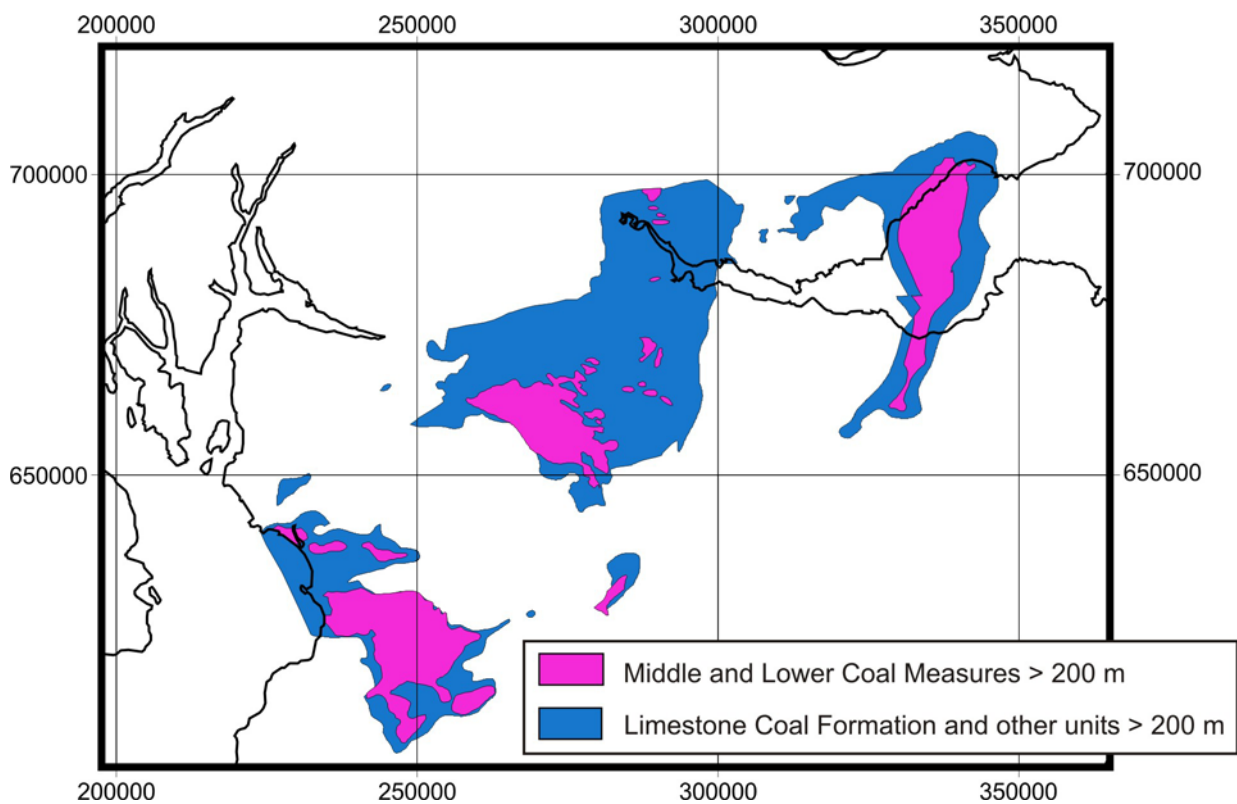


Figure 3 Areas of central Scotland where deep mining is likely to have occurred.

2.4 QUARRIES IN SCOTLAND

BGS have developed a database for Great Britain of known quarries. Although accurate for active quarries, it is not exhaustive for historic quarries. Many of the quarries are for sand and gravel, igneous and metamorphic rocks or hardcore and open cast coal (see Figure 4). The quarries have been included in the GIS to help identify areas where shallow mining may have been intersected by quarries.

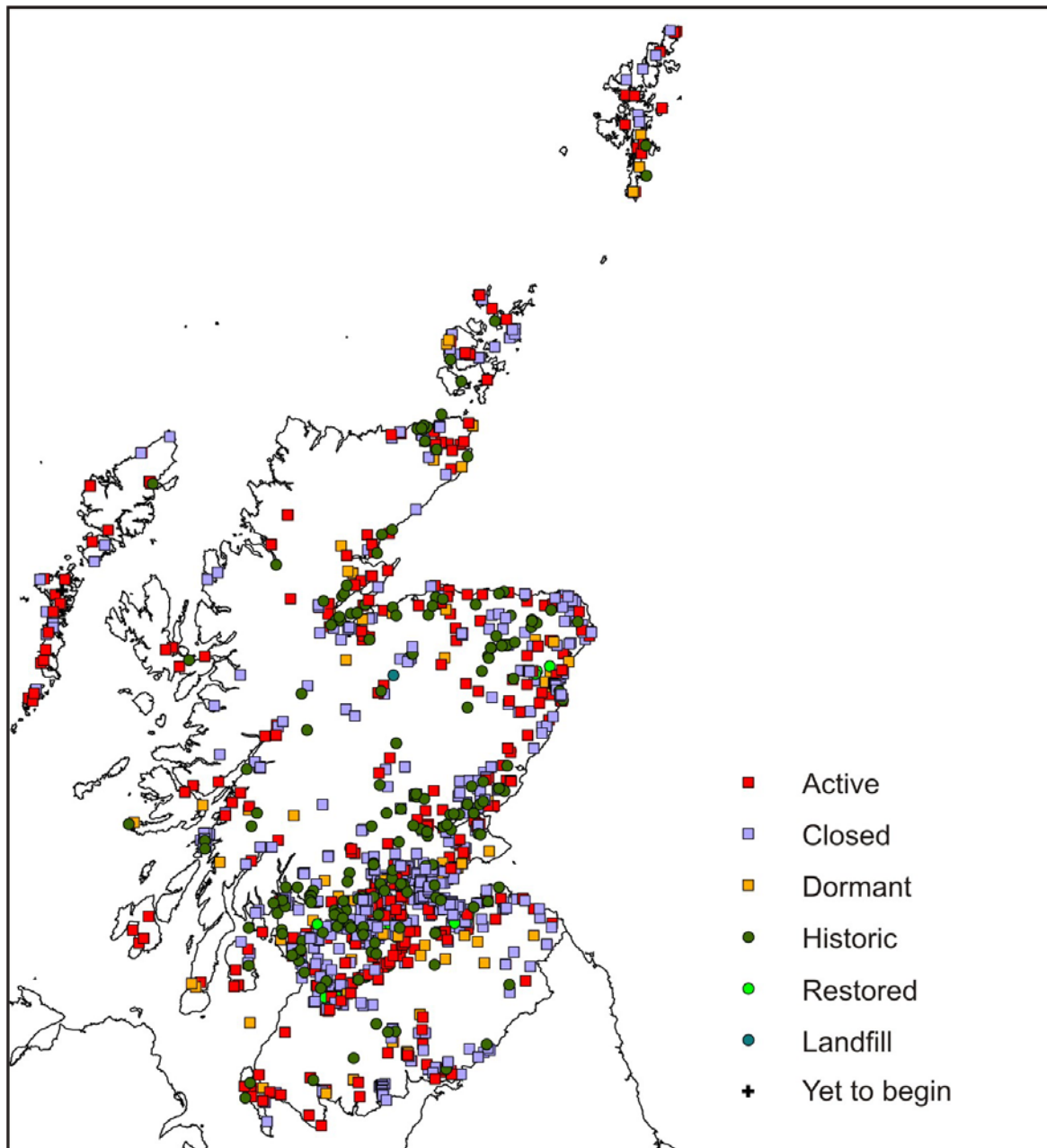


Figure 4 Active and historic quarries for Scotland from the BGS BritPits database.

3 Where to get more detailed information

The information provided in the GIS is primarily to help the initial characterisation of pressures on groundwater bodies, to help meet the requirements of the EU Water Framework Directive. The information is designed to give an indication of the *potential* for shallow or deep mines to be present in an area.

Information on actual mine occurrence exists for most parts of Scotland. The various sources of available information are described below.

1. Environmental Geology Maps (EGMs). These applied geology maps have been produced for much of central Scotland at 1:25 000 scale. They include detailed information on where shallow mining is known to exist from mine plans.
2. Mining Instability Reports. As part of a major project, Arup Geotechnics developed mining instability maps for Great Britain on a 1 km grid (Department of the Environment 1991). These combine some information from mine plans with geological information of where mining is likely to have taken place (as done in this project using DigMap).
3. Database of coal plans. The Coal Authority mining records office houses the collection of coal abandonment plans, covering both opencast and deep mining operations, these plans have been required to be deposited since 1872, and now number in excess of 100,000 plans. The plans have been captured digitally.
4. Other Mine Abandonment Plans. BGS holds abandonment plans for minerals other than coal. The plans are spatially indexed and many have been captured digitally.

Finally, it should be noted that there are many historical mines that are completely unrecorded. Understanding the geology and the mineral resources available is an excellent way of filling in gaps where there are no recorded mines.

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MINERAL OCCURRENCES DATABASE <http://www.bgs.ac.uk/mineralsUK/data/mineocc/home.html>

Appendix 1 Files on the GIS

Below is a description of the files provided in the GIS. Please note that a license from BGS is required to use these files.

- mined_geology Based on DiGMapGB 50, this shapefile indicates areas where there is potential for shallow mining to have taken place.
- deep_lmstcoal Based on isopachytes of the Carboniferous rocks this shape file shows areas where deep mining (> 200 m) may have occurred within the Limestone Coal Formation.
- deep_coalmeasures Based on isopachytes of the Carboniferous rocks this shape file shows areas where deep mining (> 200 m) may have occurred within the Coal Measures.
- mineral_occ Based on the mineral occurrence database for GB, this shapefile shows significant metaliferous mineral occurrences in Scotland, many of which will have been worked to some degree.
- quarries_mines Based on BritPits, this shapefile shows the location and commodity of active (and some historic) quarries and mines, including bulk minerals..