ESTIMATED SOIL CHEMISTRY DATA V3

Estimated Soil Chemistry Data for Great Britain (v3)

This document provides information for users of the BGS ESTIMATED SOIL CHEMISTRY DATA V3

1. Introduction

Potentially harmful chemical elements (PHEs), including arsenic (As), cadmium (Cd), chromium (Cr), nickel (Ni) and lead (Pb), occur in the environment and under certain circumstances can be harmful to plants, animals or people. Whether or not a particular PHE constitutes a hazard depends on a variety of factors including its chemical form, concentration, behaviour and the extent to which it may be taken up by living organisms; the size of the mineral particles in which the element occurs; soil or water acidity (pH); the type of vegetation cover; the extent of exposure to the element; and the dose received.

Some chemicals are widely distributed in natural (uncontaminated) soils as well as in range of anthropogenic sources. PHEs exist in a range of inorganic forms which have varying toxicity. The toxicity of the common PHEs and the likely adverse affects of chronic ingestion of low doses are described in DEFRA-EA (2002a).

Ambient background concentrations of PHEs in topsoil from natural and non-natural, diffuse sources are required for: i) risk assessments and, ii) to establish whether elevated local measurements may be the result of significant anthropogenic contamination.

A significant proportion of the landscape in Great Britain has naturally elevated topsoil concentrations of some PHEs which exceed the proposed Soil Screening Value (SSV) for assessing ecological risks (Environment Agency, 2009) and/or the former Soil Guideline Value (SGV), which is a threshold used in the preliminary assessments for land contamination (DEFRA-EA, 2002b-g). New SGVs are expected to be announced by the Environment Agency in 2009 (Environment Agency 2008a,b).

The BGS digital ESTIMATED SOIL CHEMISTRY DATA indicates the estimated geometric mean concentrations (mg kg\(^{-1}\)) of As, Cd, Cr, Ni and Pb in surface soil. It is planned that data for copper (Cu) and zinc (Zn) will be made available by March 2010.

Due to the current lack of suitable geochemical data, the soil chemistry data set does not cover London within the M25. More detailed information on the concentration of PHEs in topsoil of selected urban areas is available from the BGS Urban Soil Chemistry data (BGS 2009).

Public understanding of the effect of ground conditions on the safety of people and property is growing. Local councils and developers are under increasing pressure from central government to provide environmental information. Information about geological and geochemical hazards is...
needed, in particular, for the identification of areas with a potential for land contamination or ground movement.

In response to this, the British Geological Survey initiated a development programme to produce data sets that identified and assessed potential geohazards threatening the human environment in Great Britain. Since 2000, the programme has generated:

- Potentially Harmful Elements soil chemistry data
- Potential radon hazard data
- Six ground stability hazard datasets
- Superficial deposit thickness models
- Scans of onshore borehole logs for Great Britain
- Scans of geology and historic topography maps
- Ground permeability data
- Susceptibility to groundwater flooding data
- Geological indicators of past flooding data
- Environmental sensitivity data
- Non-coal mining hazards data

Further information on these and other digital data provided by the BGS can be found on our website at [www.bgs.ac.uk](http://www.bgs.ac.uk) or by contacting:

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2. **What is the ESTIMATED SOIL CHEMISTRY DATA for?**

1. Risk assessments based on the estimated concentration (mg kg\(^{-1}\)) of As, Cd, Cr, Ni and Pb in topsoil.

2. To help evaluate whether elevated local PHE concentrations in soil may be the result of significant anthropogenic contamination (DEFRA-EA, 2002b).

3. **Creation of the ESTIMATED SOIL CHEMISTRY DATA**

   Regulatory authorities require estimates of ambient background concentrations (ABCs) of potentially harmful elements (PHEs) in topsoil. The BGS ESTIMATED SOIL CHEMISTRY DATA is derived from national, high-resolution geochemical data from the BGS G-BASE (Johnson et al., 2005) and Imperial College Wolfson (Webb et al., 1978) geochemical surveys in combination with maps of soil parent material (PM) derived from the BGS DiGMapGB-50 digital geological data (British Geological Survey, 2006).

   Parent material (PM) is the primary control on soil geochemistry in recently glaciated landscapes such as the British Isles (Rawlins et al., 2003). PM classes are based on the concatenation of separate descriptive codes for the underlying bedrock and any superficial deposits present. The high-resolution PM maps for all of Great Britain (1:50 000 scale) provide a firm spatial basis for mapping estimated soil chemistry concentrations. The geochemical mapping units are delineations of PM coded polygons within each 1-km square of the British National Grid. By using delineations of PM polygons as soil geochemistry mapping units, it is possible to estimate PHE concentrations based on local averages for such units, without significant errors at PM boundaries.

   The ESTIMATED SOIL CHEMISTRY DATA is based on GBASE soil geochemical data where these are available (Figure 1). Elsewhere the stream sediment data are converted to surface soil equivalent PHE concentrations using delineations of PM polygons as the soil geochemistry mapping unit and the statistical relationships between soil and stream sediment data to derive the equivalent soil chemistry concentration from the stream sediment data. Where only Wolfson stream sediment data are available in southern England, these data are first transformed to G-BASE equivalent sediment concentrations, and then to soil equivalent concentrations.

   Geometric mean ambient background concentrations (ABCs) for PHEs in mineral soils are mapped within delineations of PM polygons to produce a seamless data set covering the whole of Great Britain, with the exception of the London area where an inadequate number of geochemical samples are available at the moment.

   PHE concentrations in organic soils (i.e. with more than 15-20% organic carbon) are likely to be significantly lower than those indicated by the ESTIMATED SOIL CHEMISTRY DATA.

   Further information on the method used to develop the ESTIMATED SOIL CHEMISTRY DATA is presented in Appleton et al. (2008).
Figure 1. Location of analysed BGS GBASE soil (red dots), GBASE sediment (black dots) and Wolfson sediment (brown dots) samples used to produce the Estimated Soil Chemistry data.
4. Technical Information

Explanations for the fields in the data table are as follows:

a. **SAMPLETYPE** indicates whether the estimated soil chemistry value is derived from a statistical assessment of rural soil (Soil) or sediment (Sed) data. “London” in this field indicates that no data are available from the London area.

b. **Arsenic** estimated concentration of arsenic (mg kg$^{-1}$) in topsoil
c. **Cadmium** estimated concentration of cadmium (mg kg$^{-1}$) in topsoil
d. **Chromium** estimated concentration of chromium (mg kg$^{-1}$) in topsoil
e. **Nickel** estimated concentration of nickel (mg kg$^{-1}$) in topsoil
f. **Lead** estimated concentration of lead (mg kg$^{-1}$) in topsoil
g. **VERSION** data version number - relates to the BGS DiGMapGB-50 version 3 used to compile the PHE data.

The estimated soil PHE concentrations are classed as follows:

**Arsenic:** <15, 15-25, 25-35, 35-45, 45-60, 60-120, >120 (max. 1004) mg kg$^{-1}$

**Cadmium:** <1.8, 1.8-2.2, 2.2-3.0, 3.0-6.0, >6.0 (max 21.2) mg kg$^{-1}$

**Chromium:** <20, 20-40, 40-60, 60-90, 90-120, 120-180, >180 (max. 611) mg kg$^{-1}$

**Nickel:** <15, 15-30, 30-45, 45-60, 60-100, >100 (max. 178) mg kg$^{-1}$

**Lead:** <150, 150-300, 300-600, 600-900, >900 (max. 5169) mg kg$^{-1}$

5. Data history

The ESTIMATED SOIL CHEMISTRY DATA is based mainly upon the DiGMapGB-50 Version 3 (2006) bedrock, superficial and artificial data sets. Each data layer is rectified to align with British National Grid origin. There are some areas where 1:250 000 scale data is used, for example, in upland areas of Scotland and Wales, because 1:50 000 scale data are not available. BGS is continually surveying and resurveying areas of Britain, improving and updating the geological maps.

Metadata for the GBASE soil and stream sediment data can be found at http://www.bgs.ac.uk/discoverymetadata/13480412.html. The specifications for the Wolfson stream sediment data are detailed in Webb et al. (1978).

The BGS is committed to improving the ESTIMATED SOIL CHEMISTRY DATA as more information becomes available.
6. Limitations

6.1 The ESTIMATED SOIL CHEMISTRY DATA has been developed at 1:50 000 scale and must not be used at larger scales. Spatial searches against the data must be made with a 50m buffer in order to allow for the spatial uncertainty of the data (this should be in addition to any buffer applied to define the extent of a site).

6.2 The ESTIMATED SOIL CHEMISTRY DATA consists of vector polygons and is available in a range of GIS formats, including ArcGIS (.shp), Arc Info Coverages and MapInfo (.tab). More specialised formats may be available but may incur additional processing costs. Due to the differences in precision of different formats and to small changes in precision during translation between formats, the absolute position of features in different GIS systems may vary by a few millimetres on the ground.

6.3 The ESTIMATED SOIL CHEMISTRY DATA is concerned with As, Cd, Cr, Ni and Pb concentrations in mineral soils related mainly to natural geological sources although the influence of some anthropogenic effects, such as mining and mineral processing, will also be represented in the map data.

6.4 PHE concentrations in organic soils (i.e. with more than 15-20% organic carbon) are likely to be significantly lower than those indicated by the ESTIMATED SOIL CHEMISTRY DATA which are estimated concentrations in mineral soils.

6.5 The ESTIMATED SOIL CHEMISTRY DATA is based on, and limited to, an interpretation of the records in the possession of The British Geological Survey at the time the data set was created (March 2009).

6.6 An indication of high estimated PHE concentrations in soil does not necessarily mean that an individual site will have a high PHE concentration. The only way to find out whether a site does in fact have high soil PHE concentrations is to carry out a site investigation that includes the sampling and analysis of soil samples. Guidance on soil sampling and PHE analysis can be obtained from the BGS (BGS Central Enquiries Tel: 0115 9363143).

6.7 All address searches against the data should be made using Ordnance Survey ADDRESS-POINT® coordinates, under the Terms & Conditions described by the Ordnance Survey.

6.8 The ESTIMATED SOIL CHEMISTRY DATA based on DigMapGB-50 does not quite extend to the coastline in some areas; either because reclamation of land has moved the coastline or because the coastline used on the paper map from which the digital geology was captured does not quite reach the actual coastline due to the scale of the mapping.
7. Using the BGS ESTIMATED SOIL CHEMISTRY DATA in site assessment reports

7.1 The data indicate (1) the estimated geometric mean concentration of As, Cd, Cr, Ni and Pb in the soil. This information is relevant for the first stage of any assessment of risks to human health required by regulatory authorities in relation to land-use and also for assessing ecological risks.

7.2 Although an estimated soil PHE concentration above the SSV or SGV does not in itself imply a significant risk, it does highlight the need to consider whether or not one or more PHEs may be a risk.

7.3 The BGS ESTIMATED SOIL CHEMISTRY data can be used to assess whether elevated concentrations of PHEs observed in site investigations may be attributable to geogenic or anthropogenic sources.

8. Model Question and Answers for site assessment reports

Question

What is the estimated ambient background concentration of As, Cd, Cr, Ni and Pb in the search area?

Answer

The British Geological Survey has assessed that the highest estimated geometric mean concentrations in the search area are:

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 - 45 mg/kg</td>
<td>Arsenic (As)</td>
</tr>
<tr>
<td>&lt;1.8 mg/kg</td>
<td>Cadmium (Cd)</td>
</tr>
<tr>
<td>90 - 120 mg/kg</td>
<td>Chromium (Cr)</td>
</tr>
<tr>
<td>45 - 60 mg/kg</td>
<td>Nickel (Ni)</td>
</tr>
<tr>
<td>&lt;150 mg/kg</td>
<td>Lead (Pb)</td>
</tr>
</tbody>
</table>

Please contact the Head of BGS Information Delivery (Keith Westhead rkw@bgs.ac.uk) with any queries on incorporating this information into site reports.
7. References


BGS 2009. Urban soil PHE data v1. BGS Data Information Note.


