Part 2A, Environmental Protection Act 1990

Technical Guidance Sheet (TGS) on normal levels of contaminants in English soils

Normal levels of contaminant concentrations in soils are referred to in the contaminated land Statutory Guidance for the Part 2A regime Defra 2012. This Technical Guidance Sheet (TGS) gives an indication as to what arsenic concentrations can be expected in soils based on results from samples systematically collected across England. Normal Background Concentrations (NBCs) can be used along with other criteria (e.g. site investigation data and risk assessments) to help decide whether land is contaminated land as defined by Part 2A, on a site-by-site basis.

The NBCs are not intended to be a tool to be utilised when undertaking works via the planning regime. *They are contaminant concentrations that are seen as typical and widespread in topsoils (depth 0 – 15 cm) and include contributions from both natural and diffuse anthropogenic sources.*

When using this Guidance Sheet, please refer to the section on 'Using Normal Background Concentrations' at the end, the Supplementary Information, and the revised Part 2A Statutory Guidance.

ARSENIC (As)

Technical Guidance Sheet TGS01, July 2012.

Arsenic (As) is a chemical element that is naturally found in trace amounts in our environment, so in addition to being referred to as a metalloid it is also a trace element. It is the 20th most abundant element in rocks (1-2 mg/kg) and, due to its reputation as the Victorian's poison of choice, awareness of the harmful aspects of this element to human health is high.

It occurs in many geological materials with the highest concentrations found in arsenic sulphide minerals such as arsenopyrite (FeAsS) as well as an accessory element in other sulphides such as iron pyrites (FeS_2). A significant source of As released into the surface environment is as a result of oxidation of sulphide minerals. Phosphate-rich rocks, ironstones and coal-bearing strata can also contain high levels of As. Overall, As minerals and compounds are generally soluble but the mobility of As can be limited by strong sorption by clays, hydroxides and organic matter. Under normal oxidising conditions the most common form of As in solution is the arsenate oxyanion (containing As^{5+}), under more reducing conditions (e.g. waterlogging) the arsenite oxyanion (containing As^{3+}) is more stable.

General diffuse anthropogenic sources of As are from dust particles and waste materials from historical metalliferous mining and smelting processes and coal burning. In the built environment increased levels of As may be related to specific historical land use especially metallurgical industries. Chromium-copper-arsenate (CCA) was developed in 1933 as a wood preservative and, although restricted by regulation from 2004, is a potential source of widespread contamination.

NORMAL BACKGROUND CONCENTRATIONS (NBCs)

Domain	Area (km^2)	Area (%)	NBC (mg/kg)	n
Ironstone	1,300	1	**220**	437
Mineralisation	2,300	2	**290**	187
Principal	129,300	97	**32**	41,509

Table 1: NBCs for the arsenic domains (cited to 2 significant figures, n is number of samples used in the calculation). Arsenic is determined by laboratory-based X-ray fluorescence spectrometry (XRFS), *i.e.* total As in soils sampled from a depth 0 – 15 cm. The NBC is the upper 95% confidence limit of the 95th percentile of the domain data (see supplementary information).

Methods

NBCs are calculated using contaminant data, with demonstrably high levels of quality assurance, for English topsoils systematically collected from a variety of land uses and analysed using certified methods. For this purpose the primary data sets used are the British Geological Survey's G-BASE results and samples collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales (now the National Soil Resources Institute (NSRI), Cranfield University, UK) (see Figure 1). The G-BASE samples cover both urban and rural locations and all data used are total concentrations, measured by X-ray fluorescence spectrometry (XRFS). Soils used to calculate NBCs are from a consistent depth (0 – 15 cm) and are based on aggregating sub-samples collected from within a 20 m square.

England's soils have developed on a diverse range of parent materials, which are inherently variable in their

chemical composition. These soils have also been subjected to a long history of diffuse pollution from urbanisation. This causes a significant variability in the As distribution across the country (Figure 2).

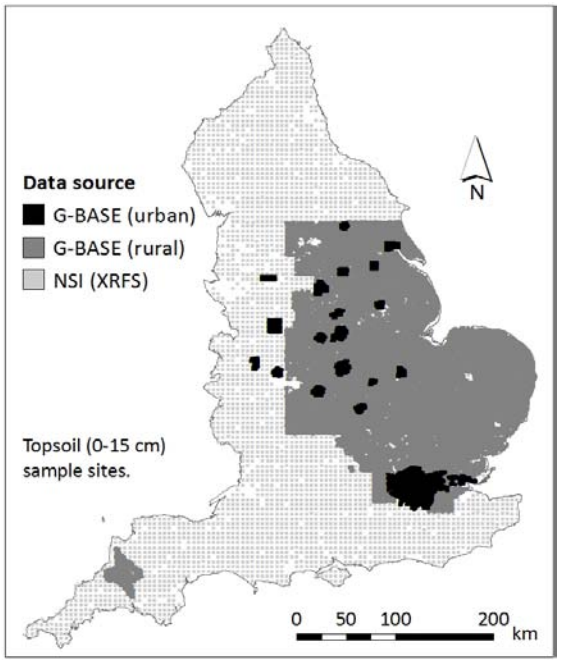

Figure 1: Map showing the distribution of samples used in the As NBC determination. NSI (XRFS) covers the whole of England at a sample density of 1:25 km^2. G-BASE sampling densities for rural and urban areas are 1:2 km^2 and 4:1 km^2, respectively.

Results for As in topsoils range from <0.5 – 15,000 mg/kg with a mean of 18 mg/kg and a median of 14 mg/kg. In order to establish meaningful NBCs, soils are grouped in domains, defined by the most significant controls on a contaminant's high concentrations and distribution.

NBCs are determined for each domain using robust statistical analysis that investigates the distribution of results and, by a process of iteration, takes into account the concentrations that may be associated with point source contamination. "Normal" levels of contaminants are referred to in the Statutory Guidance (Sections 3.21-3.26 and 4.21(b)). They are represented here by the 95th percentile upper confidence interval, *i.e.* the NBC value is the upper limit at or below which contaminant levels can be considered to be normal for the defined domain. Levels at or below the NBC may not be naturally occurring.

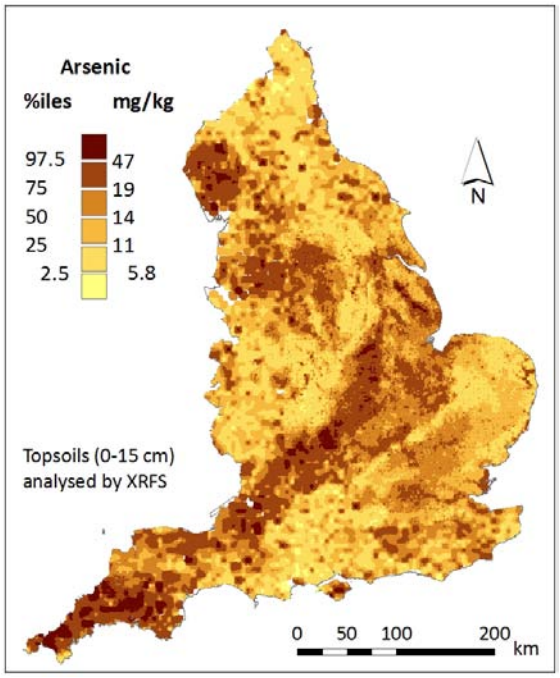

Figure 2: Map showing As in topsoil as a percentile classified interpolated image (all data are total concentrations by XRFS).

Results

Exploration of the soil data shows two significant controls on the distribution of higher As concentrations in England. These are soils where the parent material is an ironstone and some areas where mineralisation and historical mining activity have resulted in significantly elevated levels of As in the soil environment. Therefore, two domains associated with high As soils are identified, the Ironstone Domain and the Mineralisation Domain. The area not covered by these two domains is referred to as the Principal Domain (Figure 3 and Table 1).

In the NBC attribution, only the most significant areas at the national scale with the highest concentration range are classified as domains. Although three domains have been distinguished, further spatial variability will occur within these domains. The Principal Domain, for example, will contain urban areas where common historical land uses (*e.g.*

metallurgical industries) may have caused diffuse increase of As in the area's soil. Coal mining areas may also contain soils enriched in As due to the spreading of pyrite-bearing coal mine spoils. Similarly, peaty areas may contain organic matter-rich soils with high As concentrations.

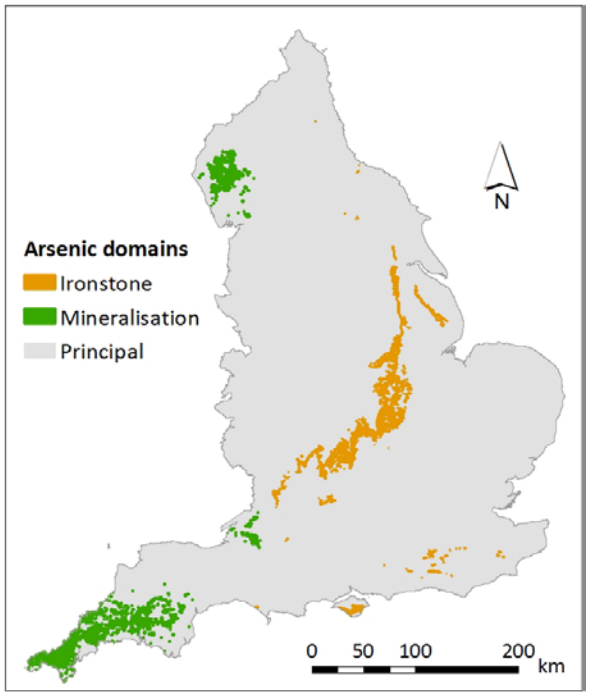

Figure 3: Arsenic domain map.

USING NORMAL BACKGROUND CONCENTRATIONS

The NBCs are produced to support the Part 2A contaminated land Statutory Guidance (SG) and help inform as to what are normal levels of contaminants. Using this TGS, along with the further information and resources provided, a NBC test can be carried out:

1. A soil sample under investigation for As concentration should be spatially located in one of the three domains described. This should be part of a preliminary step in which the scenario and conceptual site model are considered.
2. If the As concentration is at or below the NBC for the specified domain then "*the result should not be considered to cause the land to qualify as contaminated land, **unless** there is a particular reason to consider otherwise*" (SG, Section 3.22). If the latter applies, then proceed to the use of other screening tools or further site investigation as necessary and appropriate.
3. If there is no reason "*to consider otherwise*" then the decision can be made that there is no evidence that the land is contaminated under Part 2A with respect to arsenic (SG, Sections 5.2 – 5.4), that is, the land lies outside Categories 1 or 2.
4. If the As concentration is above the domain NBC then using the additional resources, including those provided with this technical guidance, a more detailed investigation at a local scale should be carried out or the use of other screening tools considered as appropriate. This is to determine whether the concentrations reflect "*levels of contaminants in the soil that are commonplace and widespread....and for which....there is no reason to consider that there is an unacceptable risk*" (SG, Section 3.21). If this is so, then step 3 applies. In the case of As, for example, this may be an urban area within the Principal Domain where a particular land use has caused widespread low level diffuse pollution.
5. If the concentration of As in the soil is not considered to be commonplace and widespread then further testing is required (apply quantitative risk assessment (QRA)).

FURTHER RESOURCES

Additional resources on NBCs are available from the BGS project website and the more detailed supplementary information provided with this guidance sheet. Additional on-line resources include: project reports; a database of essential information about relevant soil data sets; technical guidance sheets for other contaminants; polygons defining domain boundaries in various GIS formats; and a project bibliography.

THIS TGS SHOULD BE READ IN CONJUNCTION WITH THE FOLLOWING:

Part 2 A documents:

Available from the Defra Contaminated land web site at: http://www.defra.gov.uk/environment/quality/land/

Part 2A of the Environmental Protection Act 1990, as amended. The Contaminated Land (England) (Amendment) Regulations 2012 (Statutory Instrument 2012 No 263) (Amends Contaminated Land (England) Regulations 2006 ("the 2006 Regulations") (S.I. 2006/1380).)
Defra. 2012. Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance. Department for Environment, Food and Rural Affairs. April 2012

Project Reports:

Available from the Defra Project SP1008 web page and the British Geological Survey at:
http://www.bgs.ac.uk/gbase/NBCDefraProject.html

Ander, E.L., Cave, M.R., Johnson, C.C. and Palumbo-Roe, B. 2011. Normal background concentrations of contaminants in the soils of England. Available data and data exploration. *British Geological Survey Commissioned Report*, CR/11/145. 124pp.

Ander, E.L., Cave, M.R., Johnson, C.C. and Palumbo-Roe, B. 2012. Normal background concentrations of contaminants in the soils of England. Results of the data exploration for Cu, Ni, Cd and Hg. *British Geological Survey Commissioned Report*, CR/12/041. 88pp.

Cave, M.R., Johnson, C.C., Ander, E.L. and Palumbo-Roe, B. 2012. Methodology for the determination of normal background contaminant concentrations in English soils. *British Geological Survey Commissioned Report*, CR/12/003. 56pp.

Johnson, C.C., Ander, E.L., Cave, M.R. and Palumbo-Roe, B. 2012. Normal Background Concentrations of contaminants in English soil: Final project report. *British Geological Survey Commissioned Report*, CR/12/035. 40pp.

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BIBLIOGRAPHIC REFERENCE

When referring to this document the following bibliographic reference should be made:

Defra, 2012. Technical Guidance Sheet on normal levels of contaminants in English soils: Arsenic. Technical Guidance Sheet No. TGS01, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SP1008. Available on-line from Defra project SP1008 web page.

The accompanying supplementary information for the Arsenic Technical Guidance Sheet:

Defra, 2012. Technical Guidance Sheet on normal levels of contaminants in English soils: Arsenic – supplementary information. Technical Guidance Sheet No. TGS01s, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SP1008. Available on-line from Defra project SP1008 web page.

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