

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 nickel 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.

Nickel (Ni)

Technical Guidance Sheet TGS05, July 2012.

Nickel (Ni) is a metallic element with an affinity for iron (Fe) and sulphur (S) and has a reported abundance in the Earth's crust of about 20 mg/kg and so it is referred to as a trace element. The rocks with the highest Ni contents are those with a very "mafic" composition (i.e. rich in Fe and Mg minerals) such as serpentinites (1400 - 2000 mg/kg). Rocks with the lowest Ni contents are granites, sandstones and limestones (5 - 15 mg/kg). This element is considered as a contaminant because some Ni compounds are carcinogenic and Ni can cause allergic skin reactions in some individuals.

Nickel concentration in soils is both dependent on the Ni content of parent rocks and soil forming processes. Serpentine soils are well known for high Ni concentrations throughout the world. During chemical weathering Ni is easily mobilised and then co-precipitated with Fe and Manganese (Mn) oxides. However, varying environmental conditions can influence the ability of the soil to retain Ni. Under

acid conditions, significant remobilisation of Ni within the soil profile and into other media (e.g. groundwater) is likely to occur. Nickel is also strongly adsorbed by organic matter. As a result Ni is likely to be concentrated in coal and oil.

Sources of Ni in soils arising from human activity include metallurgical industries, combustion of hydrocarbons (particularly petrol and diesel) and the associated fuel ash, incinerators, sewage sludge spreading, and phosphate fertilisers.

Domain	Area (km ²)	Area (%)	NBC (mg/kg)	n
Basic	300	<1	*	23
Ultrabasic	50	<1	*	4
Ironstone (Ni)	200	<1	230	117
Peak District	450	<1	120	221
Principal	131,900	99	42	41,768

Table 1: NBCs for the nickel domains (cited to 2 significant figures, n is number of samples used in the calculation). Nickel is determined by laboratory-based X-ray fluorescence spectrometry (XRFS), i.e. total Ni 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). *Basic and ultrabasic domains could be identified but NBCs have not been calculated due to insufficient samples.

NORMAL BACKGROUND CONCENTRATIONS (NBCs)

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. Nickel shows variability across England which is primarily controlled by the underlying geology (Figure 2). These soils have also been subjected to a long history of diffuse pollution from urbanisation though, relative to the geogenic control, the impact of human activity on English soils is not as great or significant as seen with some other contaminants.

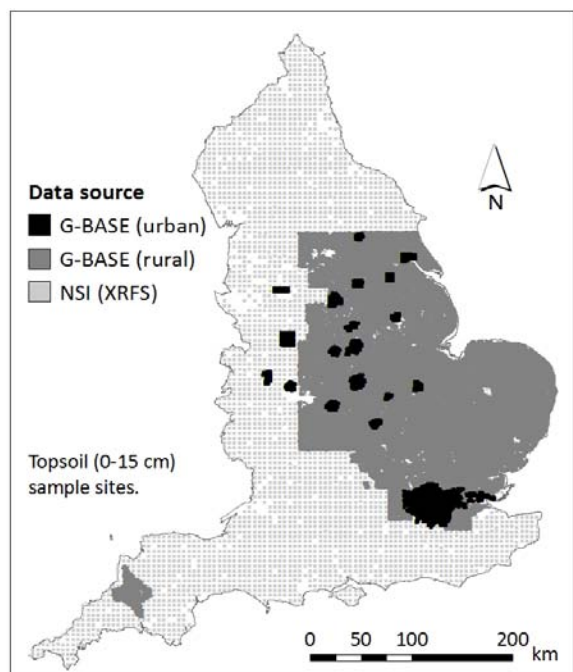


Figure 1: Map showing the distribution of samples used in the Ni NBC determination. NSI (XRFS) covers the whole of England at a sample density of 1:25 km². G-BASE sampling densities for rural and urban areas are 1:2 km² and 4:1 km², respectively.

Results for Ni in topsoils have a relatively narrow range from 1- 506 mg/kg with a mean and median of 26 and 24 mg/kg, respectively.

In order to establish meaningful NBCs, soils are grouped in domains, defined by the most significant controls on a contaminant's concentration 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 results 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.

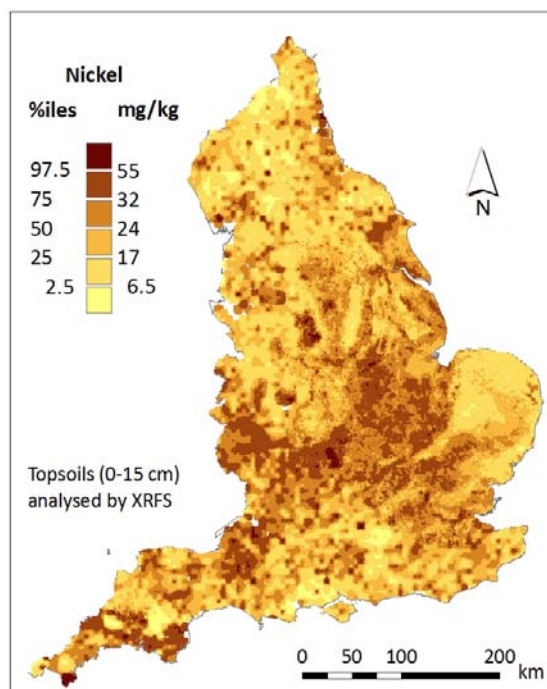


Figure 2: Map showing Ni in topsoil as a percentile classified interpolated image (all data are total concentrations by XRFS).

Results

Exploration of the soil data shows the single most important influence on the concentrations and distribution of Ni in soils is the underlying parent material. Two small but significantly high areas relating to geology are identified, namely an area at the southern tip of Cornwall (Lizard serpentinites) and a specific area of Ironstone rocks predominantly in Oxfordshire. Two further geologically controlled domains are also identified – in the Peak District

where Ni is related to a combination of both mineralisation and Ni-rich parent material, and in several small areas of England underlain by basic rocks. NBCs for the Ultrabasic and Basic Domains could not be calculated because of insufficient sample numbers. The area not covered by the identified domains is referred to as the Principal Domain (Figure 3 and Table 1).

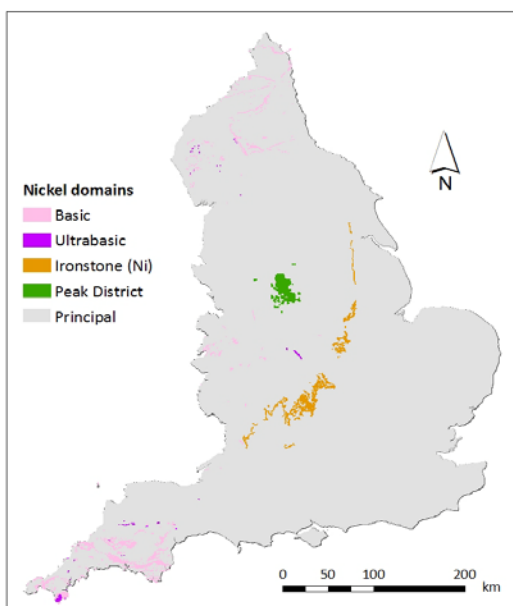


Figure 3: Nickel domain map.

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:

- I. A soil sample under investigation for Ni concentration should be spatially located in one of the five domains described. This should be part of a preliminary step in which the scenario and conceptual site model are considered.
2. If the Ni 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 Ni (SG, Sections 5.2 – 5.4), that is, the land lies outside Categories 1 or 2.
4. If the Ni 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 Ni, 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 Ni 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 SPI008 [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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sampled and analysed to consistent and high standards of quality that have enabled the NBCs for many inorganic contaminants to be calculated with a high level of confidence.

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: Nickel. Technical Guidance Sheet No. TGS05, July 2012. Department for Environment, Food and Rural Affairs (Defra), Soils R&D Project SPI008. Available on-line from Defra project SPI008 [web page](#).

The accompanying supplementary information for the Nickel Technical Guidance Sheet:

Defra, 2012. Technical Guidance Sheet on normal levels of contaminants in English soils: Nickel – supplementary information. Technical Guidance Sheet No. TGS05s, July 2012. Department for Environment, Food and Rural Affairs (Defra), Soils R&D Project SPI008. Available on-line from Defra project SPI008 [web page](#).



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