Contaminated land

Baseline urban geochemistry

A tool for assessing the potential risks of contaminated soils to health

by Alex Ferguson, *Keyworth*

The importance of soil as a resource has not always been recognised. Recently, however, organisations such as the European Environment Agency are becoming increasingly aware of the fragility of this finite resource. In the industrialised areas of the world, especially in the densely populated countries such as the UK, contamination of soil is limiting the development of land, particularly in urban areas.

Contamination of soil can pose risks to both plant and animal health. Human and animal health is potentially at risk, both through direct contact with soil and through consumption of food plants grown on contaminated soils. Heavy metals, such as copper, lead and zinc, are one of the major groups of contaminants present in soil in industrialised areas. These have been used in a wide range of industries, for example in the manufacture of metal products and in the metal-plating industry, as well as being components of other materials such as paints and plastics. This range of uses has led to their widespread distribution throughout the environment.

Recent changes to the legislation of the UK with regard to contaminated land have placed the responsibility for assessing the extent of contaminated land on local authorities. One of the tools for carrying out this assessment is the use of geochemical baseline data. The BGS has been collecting both regional and urban geochemical data under the Geochemical Baseline Survey of the Environment (G-BASE) programme. These data can fulfil several roles in assessing the extent of soil contamination.

The concentrations of trace elements vary widely over different rock types. Baseline geochemical data enable these natural concentrations to be determined, providing a benchmark with which to compare the levels of contaminants in industrialised and urban areas. The BGS holds urban geochemical baseline data, at a density of four soil samples per square kilometre, for over twenty urban centres, including Stoke-on-Trent, Swansea, Cardiff, Nottingham, and Sheffield.

Urban geochemical data can be used for two major roles in determining the significance of soil contamination. An urban baseline provides a more specific and detailed baseline than that of the regional data. In addition, this type of data can be used to identify broad areas of contamination, particularly those associated with made ground. In many industrial districts, bulk waste such as coal spoil and foundry or kiln waste has been used to level or build up land over wide areas. The results of systematic geochemical sampling can be presented in such a way as to highlight these anomalous concentrations. The proportional symbol plot of zinc *(above right)* in the surface soils of Swansea identifies the docks area of the city as having broad areas of elevated levels of this element.

Zinc is a phytotoxic element, this means that it can be toxic to plants and can inhibit their growth. In many urban areas vegetables are grown in private and allotment gardens. In some cases these gardens may be situated in areas with elevated concentrations of heavy metals such as zinc. The use of geo-

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Geochemical baseline data are useful in assessing sites in urban or industrialised areas such as gardens and allotments where fruit and vegetables may be grown for human consumption.

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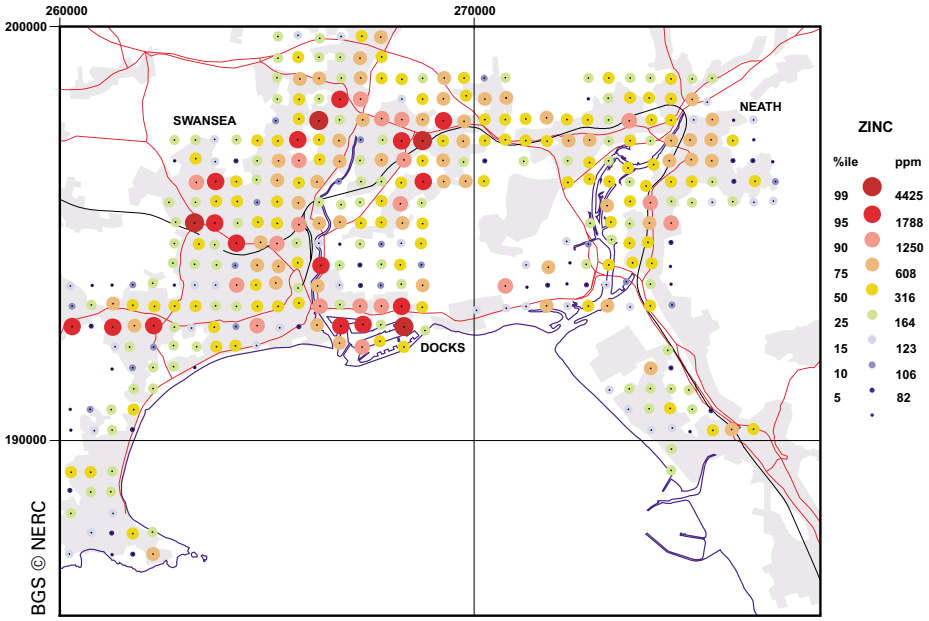

Proportional symbol plot of zinc in the surface soils of Swansea. Elevated levels of this element are indicated in the docks area, amongst others.

chemical baseline data is of particular importance when considering areas which may be suitable for siting new garden areas.

It is not only the elements that may be harmful to plants which need to be considered. Some heavy metals are toxic to humans and animals when consumed at high concentrations. However, while many heavy metals can cause harm and excess, some are essential for human health in low concentrations. The essential nature of these elements means that there are natural mechanisms for uptake into the human or animal body. In most cases this is through plants, the plant takes up the metals and then the human or animal consumes the plants. The existence of this mechanism means that, where metals are present at high levels, they can be taken up in excess by humans and animals.

In some cases there is also concern due to the practice of geophagy, the deliberate consumption of soil (see pages 24 and 25). In the UK this is a habit practised by many children, often for only a short period in their childhood. Soil is, however, consumed in small amounts by people with certain habits involving hand-to-mouth contact, particularly those who bite their nails. Grazing animals also consume soil in the action of cropping plants close to the ground.

These circumstances provide a more direct route for the elements in soil to affect the health of humans and animals.

The presence of heavy metals in soil also provides another potential route for ingestion by humans. Under certain circumstances metals can be carried in a soluble form into groundwater reserves. In many places groundwater is an important source of drinking-water. Contamination of groundwater can lead to potential health risks for those consuming the water. A more frequent concern in the developed world is that this contamination may place additional demands on water treatment works.

The various potential routes for heavy metals to affect the health of plants, animals and humans have made the study of heavy metal behaviour in soil an important branch of scientific research. Many studies have been undertaken to consider the mobility of metals through the soil profile and into organisms. The study of bioavailability — the uptake of metals by plants, animals and humans, and the likely effects of this uptake — is wide ranging. Geochemical baseline data, in conjunction with other data such as the underlying geology, the depth to groundwater, the population density, and many other data-sets, provide a useful tool for focusing these studies. The elemental concentrations of heavy metals are used in the context of other important data, such as the soil pH (acidity) and estimates of soil organic content, to provide a background for further study. The availability of these data enables the most appropriate sites to be identified and allows researchers to focus their work to areas suited to their specific requirements.

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Former chemical processing site requiring site investigation and land reclamation