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# Emerging contaminants in groundwater

BGS is helping to protect groundwater by studying recently identified contaminants

## What are emerging contaminants?

Emerging contaminants are compounds previously not considered or known to be significant to groundwater (in terms of distribution and/or concentration) which are now being more widely detected. More organic micropollutants are being detected in the aqueous environment due to improved laboratory techniques and monitoring.

## How do they enter groundwater?

There is a wide variety of sources and pathways for these compounds to enter the environment, including agriculture and urban areas. Some emerging contaminants can have human or ecological health effects and we need to improve our understanding of their occurrence and fate in the environment.

## What types of compound?

Various types of organic micropollutants can be found in the aqueous environment. These include nanomaterials, pesticides, pharmaceuticals, industrial additives and by-products, personal care products and fragrances, water treatment by-products, flame/fire retardants and surfactants, hormones, engineered nanomaterials, and caffeine and nicotine and their metabolites.

## Are these compounds regulated?

Pesticides and some industrial compounds are presently covered by the Water Framework Directive, the Groundwater Regulations and the Drinking Water Directive. Additional parameters, such as bisphenol A, are likely to be covered by revisions to the Drinking Water Directive. Other emerging contaminants will be regulated in future.

## Will pesticides leach into groundwater?

BGS scientists have estimated how likely it is that potential contaminants will enter groundwater, and considered how persistent they could be.

Our hazard assessment for currently approved pesticides uses available information on UK usage, persistence, sorption to soil carbon and published leaching indices. The compounds assessed as having the greatest potential for leaching to water included bentazone, clopyralid, MCPA, metribuzin and triclopyr. Nineteen of these leachable compounds had a low octanol/water partition coefficient (Kow), suggesting that they may not be completely removed by water treatment.

“The breakdown products of pesticides can pose a greater risk to groundwater than the original compound.”

Marianne Stuart, BGS

## What about pesticide metabolites?

Data on pesticide metabolites (breakdown products) are sparse in comparison with their parents, so we simplified our assessment for these compounds. Based on organic carbon/water partition coefficient (Koc) and persistence data, our results agreed in principle with other studies.

The metabolites of chlorothalonil, cyanazine, diflufenican, flufenacet, iodosulfuron-methyl, metolaldehyde, metazachlor and metsulfuron-methyl are likely to pose the greatest risk to drinking water. In many cases these metabolites have a higher risk than the original parent compound.

## Emerging urban pollutants

Even fewer data are available to assess the mobility of other organic micropollutants in the aqueous environment.

A range of organic micropollutants from urban settings, including pharmaceuticals, have been detected in groundwater and surface water worldwide. Commonly detected compounds include: bisphenol A, carbamazepine, galaxolide, ibuprofen, phthalates and caffeine.

## How often are these compounds detected?

Data interpreted by BGS from the Environment Agency's monitoring programme for organic pollutants indicates that the 30 most frequently

## Factfile

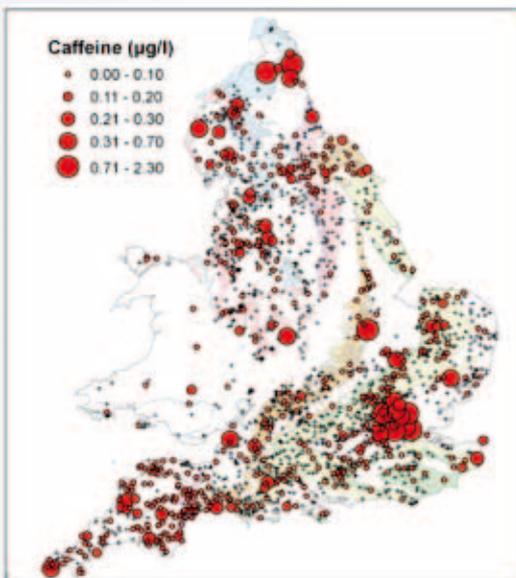
- Medications found in groundwater include ibuprofen (painkiller and anti-inflammatory) and carbamazepine (an epilepsy treatment).
- Recreational drugs such as cocaine and amphetamines have also been detected in groundwater.
- There is concern that tamiflu could reduce the effectiveness of sewage treatment plants and be persistent in the aqueous environment.
- Metaldehyde, used in many slug pellets, was found to be present in many UK groundwaters after an improved laboratory method was developed in 2007. Its physical and chemical properties make it difficult to remove in water treatment plants.

detected compounds include a number of polyaromatic hydrocarbons, petroleum compounds, triazine herbicides, chlorinated solvents, degradation products and THMs, caffeine, DEET and industrial compounds such as bisphenol A. Specific determinands include a range of currently licensed and phased out pesticides with a few metabolites, pharmaceuticals including carbamazepine and triclosan, caffeine, nicotine and food additives.

Caffeine is detected across much of England and Wales (see map), with higher concentrations in some urban locations such as London and Newcastle. Caffeine is not often thought of as a pollutant, but we don't know what effects high caffeine concentrations may have on the environment.

## What can BGS do next to help protect groundwater?

The next phase of our research is likely to focus on a particular compound, such as caffeine or metaldehyde, that has been widely detected in UK groundwater. A possible topic could be a study of migration through the unsaturated zone. In many cases the mechanism for migration of emerging contaminants from the surface to groundwater is very unclear.



Distribution of caffeine in groundwater of England and Wales



More information:  
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