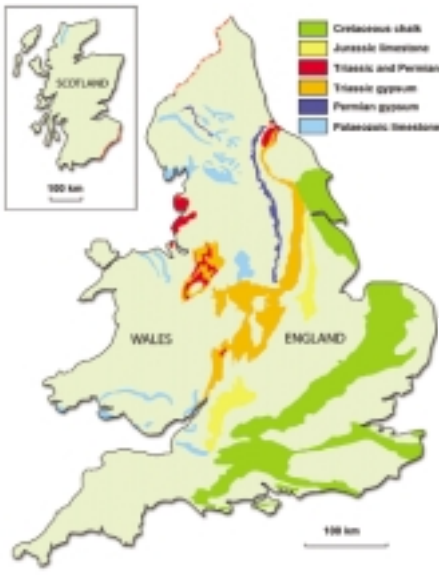
Hazards

Planning for problems with soluble rocks

Defining karstic hazards using GIS

by Anthony Cooper & Andrew Farrant, *Keyworth*



BGS © NERC

Map showing the distribution of soluble (karstic) rocks in the UK.

Britain has four types of soluble (or karstic) rocks: limestone, chalk, gypsum and salt, each with a different character and associated problems. Subsidence, often triggered by anthropogenic disturbance or water abstraction, occurs widely, especially where karstic rocks are overlain by a thin superficial cover. These can cause significant engineering and foundation problems. Aquifer vulnerability and the detection of rapid groundwater and contaminant flow routes are of particular concern in some areas.

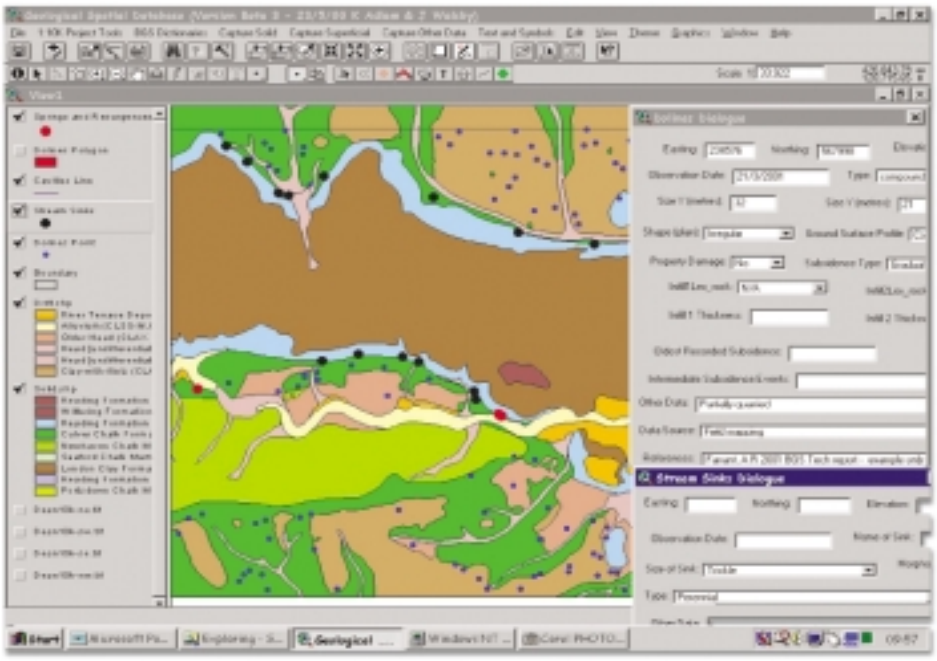
The Carboniferous Limestone hosts the best-developed karst landscapes and the longest cave systems in the country. Although karst features are widespread, they are particularly well-developed in the Yorkshire Dales, the Peak District, the Mendip Hills, and around the margins of the South Wales coalfield. Cambrian and Devonian limestones, together with some Jurassic limestones, also display karstic characteristics. The major problems associated with these karst areas are water supply protection, geological conservation, and engineering problems. Ground movement associated with subsidence hollow (doline) formation does occur, but generally in remote and rural areas with little impact on property and infrastructure. However, these subsidence hollows are often sites for illegal tipping of farm and other refuse or waste which can cause rapid contamination of the groundwater and local drinking supplies.

A H Cooper, BGS © NERC

Distorted railway lines over the salt karst (also affected by brine extraction) near Crewe, Cheshire.

"... the major problems associated with karst areas are water supply protection, subsidence, and engineering problems ..."

The Chalk is the most widespread carbonate rock in the country and forms the UK's most important aquifer. In places, the enlargement of fissures and conduits by dissolution can cause problems by creating rapid contaminant pathways though the aquifer. This is particularly important as the Chalk often underlies major transport corridors and urban areas. Chalk dissolution also generates subsidence hazards and difficult engineering conditions associated with the development of clay-filled



Computer screen showing the Geographic Information System input interface for recording the karstic features including caves, subsidence features, springs, and stream sinks.

pipes and fissures. These problems include irregular rockhead, localised subsidence, increased mass compressibility, and diminished quality of the rock mass.

Gypsum karst is present mainly in a belt three kilometres wide and about 100 kilometres long in the Permian rocks of eastern and north-eastern England. It also locally occurs in the Triassic strata, but the effects of it are much less severe than those in the Permian rocks. The difference is mainly caused by the thickness of gypsum in the Permian sequence, and the fact that it has interbedded dolomite aquifers. In contrast, the Triassic gypsum is present mainly in weakly permeable mudstone sequences. The gypsum karst has formed phreatic cave systems, but the rapid solubility rate of the gypsum means that the karst is evolving on a human timescale. Active subsidence occurs in many places, especially around the town of Ripon. The active nature of the dissolution and the ongoing subsidence features cause difficult conditions for planning and development.

Salt in Great Britain occurs mainly in the Permian and Triassic strata of central and north-eastern England. Many towns on the Triassic strata have 'wich' or 'wych' in their names, indicating that they are sited on former salt springs emanating from actively dissolving salt karst. These places became the focus for shallow mining and near-surface 'wild' brine extraction, a technique that exacerbated the salt karstification. Most extraction of natural brine has ceased. Modern exploitation is mainly in dry mines or by deep, controlled brine extraction leaving brine-filled cavities.

Subsidence crater formed by the dissolution of Permian gypsum in the village of Sutton Howgrave near Ripon, North Yorkshire.

Since the cessation of natural brine pumping, the saline groundwater levels have returned towards their pre-pumping state. Brine springs are becoming re-established and natural karstification and subsidence may be expected to occur. The exact nature of the brine flow, and how it might interact with mined and brined areas, has yet to be studied.

The BGS has completed a comprehensive digitisation scheme of the base 1:50 000 scale geological map information (DigMapGB-50). Alongside this, the recording and assessment of geological hazards, including karst problems, are being undertaken to provide complementary digital information. Digital map capture has been established at 1:10 000 scale using a customised interface with the ESRI ArcView™ Geographical Information System (GIS) application.

For the karst geohazards, this application has been extended to allow the digitisation of the karst features and the population of the associated Oracle™ database tables. Attributes have been defined for each type of karst feature, polygon, or point and there are dictionaries for the appropriate morphological, stratigraphical, or lithological entities. Linked features and databases for springs, stream sinks, and dye tracing are being developed, tied to the existing hydrochemistry tables, where appropriate. Cave survey and plan data derived from published sources are also being incorporated. Hazard areas will be derived from these factual data.

When the GIS is fully established and populated, the system will highlight the presence of karst features to non-specialists, and allow the rapid interpretation of potentially hazardous karst areas by geological, hydrogeological, and engineering geologists. With suitable links to descriptions of polygon features, it will also be feasible to derive basic geological reports by semi-automatic means. Such information will be important to house purchasers, planners, and developers.

For more information, contact:

Dr A H Cooper,
Tel: +44 (0)115 936 3393
e-mail: ahc@bgs.ac.uk