British Geological Survey

New exploration techniques

Advanced instruments and information technology

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New search techniques are needed to discover buried mineral deposits in urbanised and highly developed countries with a long history of mining such as Britain. The BGS has been addressing this problem through the development and application of new methods and technologies.

Study of gold grains

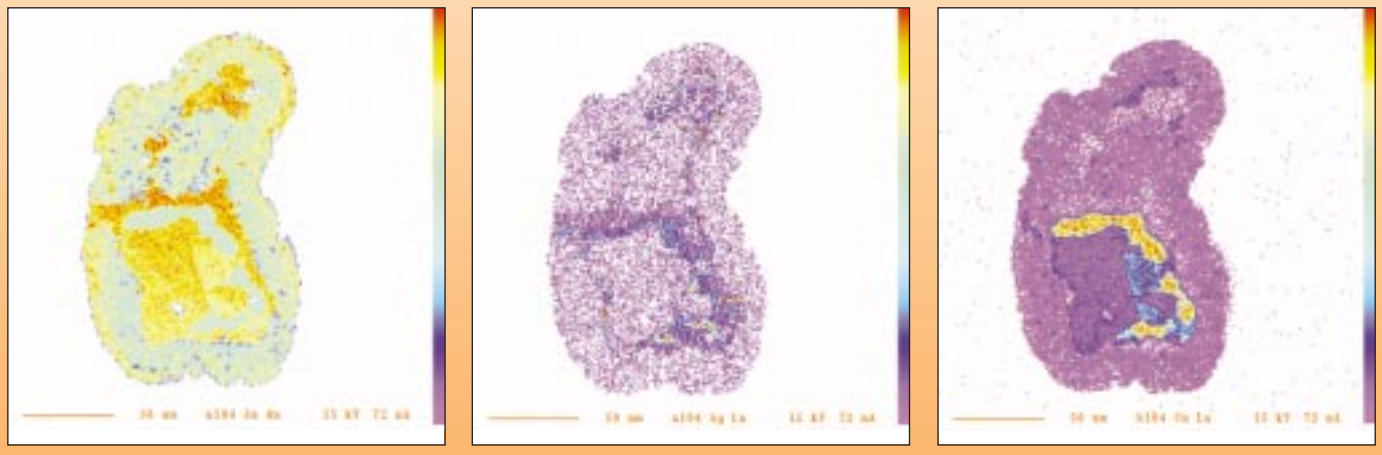
An exciting new tool for gold exploration has been developed at the BGS in recent years. This technique involves the microchemical characterisation of alluvial (river sediment) gold grains using an electron microprobe. Alluvial gold grains frequently show internal chemical heterogeneity, and they also contain minute inclusions of other minerals. These features are usually inherited from the bedrock source and are preserved throughout the processes of weathering and transport. Examination of alluvial grains can thus provide important information which can be used to deduce the geological and structural setting of the source from which the gold was derived. Multiple sources for alluvial gold can be recognised, and the most appropriate pathfinder elements for use in exploration can be identified. This method has attracted considerable interest from mining companies worldwide and has been applied to the study of alluvial gold in various geological environments in South America, southern Africa, south-east Asia and Europe.

Alteration around mineral deposits

Mineral deposits are commonly associated with hydrothermal alteration of the surrounding rocks, the style and extent of the alteration reflecting the type of mineral deposit. Such alteration commonly forms a halo around the mineralisation, providing an exploration target considerably larger than the deposit itself. The delineation and characterisation of hydrothermal alteration can therefore be of great value in mineral exploration, for the identification and assessment of new targets.

Until recently, assessment of alteration assemblages was often very difficult, because of the fine grain-size of the minerals, and could only be accomplished by expensive and time-consuming laboratory techniques such as X-ray diffraction. However, this problem can now be addressed in the field using an instrument known as a Portable Infrared Mineral Analyser (PIMA). The PIMA is a compact, portable, hand-held spectrometer which can provide the field geologist with important mineralogical information on rocks, minerals and soils. The instrument is capable of detecting many of the minerals commonly found in hydrothermal alteration systems, such as clays, carbonates and sulphates.

The PIMA, originally developed in Australia, is increasingly being used worldwide in mineral exploration and in the evaluation of mineral resources. The BGS has used it in studies of ore deposits in the UK and internationally.

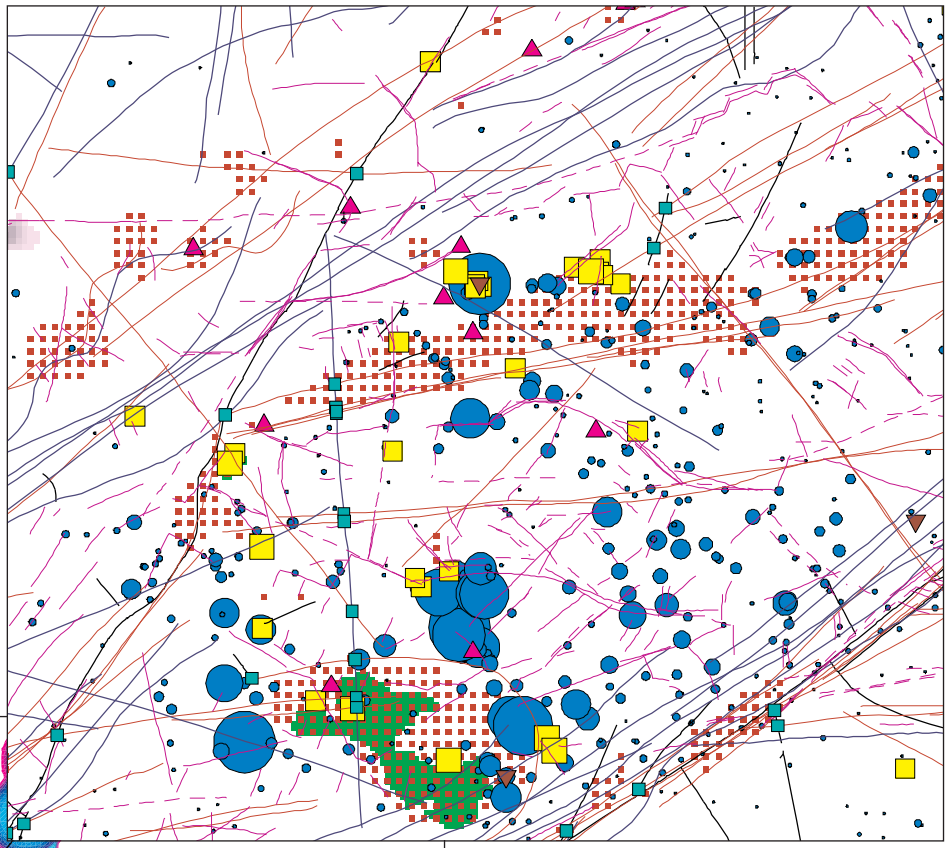


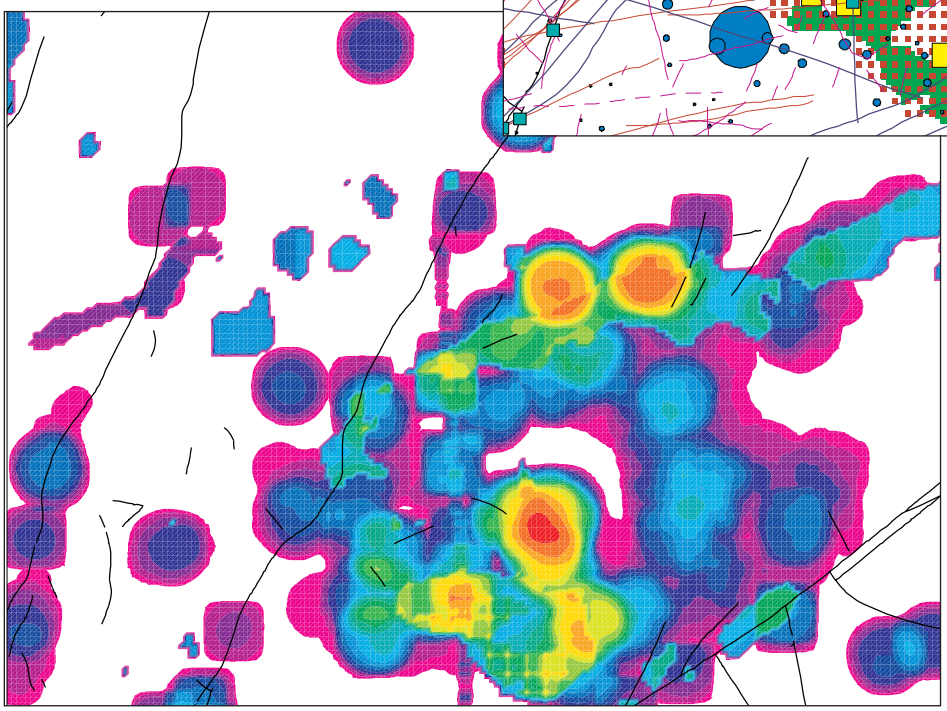
Microchemical maps showing the distribution of gold (Au), silver (Ag) and copper (Cu) in a single gold grain.

A recent project, supported by the Department of Trade and Industry, the BGS and commercial companies, examined the nature and distribution of alteration in the volcanogenic massive sulphide base-metal deposit at Parys Mountain in Anglesey, North Wales. Spectral features derived from PIMA analysis of drillcore were incorporated in a three-dimensional model of the deposit using the VULCAN software package and provided important new insights into the relationship between alteration patterns, geology and mineralisation.

Advanced IT

The increased availability of geoscience information in digital form and major improvements in information technology have had a significant impact on mineral exploration in the last decade.





Above: *Multi-dataset map for the south Loch Tay area of the Grampian Highlands.*

Left: *Derived gold prospectivity map of the same area. Zones of highest prospectivity are coloured red.*

Geographical Information Systems (GIS) are being used to examine datasets of many different types (geology, geochemistry, etc.) in order to identify combinations of key features which are consistently associated with mineralisation. Recognition of these associations, or deposit signatures, allows new targets to be identified and prioritised. This approach of multi-dataset analysis has recently been taken a step further by the BGS, through the development of a prospectivity mapping system in which the datasets are searched for the various components of the deposit signature to produce a prospectivity map showing the potential for a mineral deposit of a particular type within the search area. The system is flexible and allows various models to be tested, by changing the weighting attached to each feature relevant to the targetted deposit type.

The BGS prototype system has been used to map the prospectivity of the Dalradian terrane of the Scottish Highlands for lode gold mineralisation. Regional datasets, including geology, structure, geophysics and geochemistry, were integrated to produce a multi-dataset map for the south Loch Tay area of Perthshire.

The application of advanced information technology using a GIS platform linked to a knowledge-based prospectivity mapping system offers considerable potential for assessing the likelihood of the discovery of new mineral deposits in an area. The use of these methodologies can also assist government departments in land-use planning worldwide.