dti Minerals Programme

BGS 1835

Mineral exploration methods in Britain

Panned-concentrate drainage sampling

Introduction

Stream sediments are composite products of erosion and weathering which represent the source catchment area of a stream drainage network, including the bedrock geology, overburden cover and any contained mineralisation. Their composition is also influenced by factors such as climatic conditions and sample collection and preparation methods.

Mineral exploration using the concentration of heavy minerals from stream sediments is one of the oldest methods of prospecting for ore. Many ore minerals are dispersed in the surficial environment as chemically and mechanically resistant detrital grains, with greater densities than most common rock-forming minerals. Inspection and analysis of these grains in heavy-mineral concentrates provides valuable information on mineralisation and bedrock geology, complementary to that derived from fine-fraction stream-sediment samples. Traditionally this technique has been applied to precious metals, gems, and tin and tungsten minerals, which can be identified visually in the field. More recently multi-element chemical analysis of heavy-mineral concentrates has become widely used.

The densities of some of the most common heavy minerals found in stream sediments in Britain are listed in the table *(overleaf),* together with selected rock-forming silicates.

Mineral	Density (g cm^{-3})	Mineral	Density (g cm^{-3})
Gold	15.0–19.3	Baryte	4.5
Galena	7.5	Chromite	4.3–4.6
Cassiterite	6.8–7.1	Chalcopyrite	4.1–4.3
Magnetite	5.18	Sphalerite	3.9–4.1
Monazite	5.0–5.3	Amphibole	2.85–3.45
Pyrite	5.02	Plagioclase	2.62–2.76
Zircon	4.68	Quartz	2.65

The role of contamination by human activities is an important consideration when carrying out drainage surveys in heavily populated areas of lowland Britain. Heavy-mineral concentrates can be examined in the field for contaminants, such as metal, glass or pottery, to provide an immediate warning. Unusual geochemical anomalies and element associations not common in nature may also indicate contamination e.g. high values of Sn associated with Sb and Pb may be derived from solder.

In the UK, the BGS has undertaken drainage geochemical surveys involving the collection of stream-sediment and heavy-mineral concentrate samples for more than 30 years. This experience forms the basis for the methods recommended here and ensures collection of high quality samples, thereby enhancing the probability of identifying mineralisation.

Survey planning

The sampling density and approximate locations of individual sites are best determined prior to commencement of field operations. Important factors to consider are the size of the target and the expected downstream dispersion which may be less predictable for heavy minerals than for elements which are transported hydromorphically. In Britain some ore minerals, such as gold, chromite, stibnite and scheelite, may survive for many km, while others, such as sulphides, may have dispersion trains of less than 1 km.

In the BGS regional reconnaissance G-BASE programme samples are collected from low-order streams at a density of about 1 sample per 1.5 km^2. In follow-up surveys higher sampling density is used according to local conditions, the nature of the target and the expected dispersion patterns.

Site selection

Sites are selected with the following factors in mind:

1. Avoid obvious sources of contamination: sample upstream (at least 50 m) from roads and habitation.
2. Where valleys are steeply incised, avoid collapsed bank material by sampling near the centre of the stream.
3. In regional surveys, collect concentrates at the same site as the stream-sediment sample.
4. In follow-up surveys, collect samples from heavy mineral traps such as irregularities in the stream bed, behind boulders and on the inside of bends.

PANNED-CONCENTRATE DRAINAGE SAMPLING

Sample collection

Heavy-mineral concentrates may be prepared from bulk stream sediment using screening, gravity and magnetic techniques in the laboratory. An alternative simpler and quicker method is to concentrate the heavy minerals by panning in the field. Panning is carried out using a flat-bottomed, metal or plastic 'gold pan' or a round-bottomed hardwood 'dulang', similar to the Malaysian tin pan. The gold pan has steep sides, which are commonly riffled, and retains the densest minerals such as gold. The BGS uses dulangs to collect samples that retain most of the heavy mineral suite in the sediment down to very fine grain sizes. Examination of the sample in the field allows identification of the heavy minerals and provides an immediate guide to further work. By standardising the volume of sediment processed and the final volume of concentrate, uniform upgrading is maintained. This permits comparison of geochemical data across the survey area.

The BGS method of collecting panned-concentrate and stream-sediment samples at the same site is summarised below:

1. Wash sieves and pans in stream immediately prior to sampling. The sieve with the 2 mm cloth is placed on top of the other sieve and both are mounted on top of the pan.
2. Dig sediment from several points on the stream bed to produce a representative composite sample. The top 10-20 cm of sediment is discarded to avoid Fe and Mn oxide coatings.

3 Load sediment into the top sieve with minimum input of water. Wearing rubber gloves, rub the material through the top sieve. Remove the top sieve and collect the fine fraction of the sediment in the pan beneath by careful rubbing and shaking.

4 Transfer the -2 mm sediment from the top of the fine mesh into a second pan and place the 2 mm sieve on top of this pan.

5 Dig more sediment from deeper within the profile at each point on the stream bed and load into the sieve.

6 Rub the sediment through the sieve with large quantities of water until the pan is filled to the required starting volume, normally 4 litres.

7 Wash out clays and organic matter by repeated stirring and agitation. Pour away the resulting suspension and repeat until the water remains clear.

8 Start the panning process by shaking the clean sediment vigorously with ample water to promote settling of the heaviest minerals to the bottom of the pan. Panning is accomplished using a near-circular swirling motion, first pushing the pan away and then bringing it back to draw water into the front of the pan **(1)**. As the water enters the pan it sweeps around the pile of sediment on the forward stroke (**2**), removing the uppermost and lightest minerals from the top and discharging them into the stream as the water is expelled from the front of the pan **(3)**. Panning is normally carried out where the water is deep enough to allow the full pan to sink. Facing upstream where the flow is gentle assists the washing process.

9 At regular intervals, especially during the early stages of panning, shake the remaining sediment vigorously to encourage the denser grains to settle to the base.

10 Continue careful panning and shaking until the required final volume (normally to the 120 ml calibration mark on the pan) remains **(4)**.

11 Examine the concentrate with a hand lens to identify the heavy minerals and estimate their abundances. Note any grains of immediate interest or contaminants. These may be removed using a fine brush and stored in a plastic vial for laboratory examination.

12 Carefully wash the concentrate into a numbered Kraft bag using a clean funnel. Place the sealed bag into a thin polythene bag for security.

13 Transfer the -150 μm stream sediment from the other pan into another numbered Kraft bag.

14 Wash all equipment thoroughly in the stream before packing away.

15 Collect duplicate samples to monitor within-site variability. In a regional survey duplicates are normally collected from every 100th site. In detailed surveys duplicates should be collected more frequently, from 4 or 5 sites in every 100.

PANNED-CONCENTRATE DRAINAGE SAMPLING

Field observations

Prenumbered field cards, randomised in blocks of 100 numbers, are issued to the sampling teams. At each site the appropriate number is transferred to the field map and to all sample containers. A wide range of observations is recorded on the field cards while at site. These include:

- site locality description, preferably with regard to a fixed permanent feature or landmark
- grid reference
- identity of collectors
- date
- catchment geology
- clast and bedrock geology at site
- identity and abundance of heavy minerals
- land use
- contamination (visible in the pan and in the stream)
- sediment colour/composition
- precipitates in stream
- weather conditions
- stream flow conditions

In the G-BASE regional programme two-man teams sample about 10 sites per day, collecting panned-concentrate, stream-sediment and water samples. In more detailed surveys 15–20 sites may be sampled per day.

Sample preparation and analysis

Samples can be air dried in the field or, more usually, oven dried in the Kraft bags at a temperature of about 95°C at a field camp or base laboratory. After drying, the sample is divided into two equal parts using a riffle splitter. Half is retained for reference and mineralogical study, while the remainder is milled in an agate planetary ball-mill until 95% is finer than 53 μm. Representative sub-samples of the powder are prepared for analysis by riffling or coning and quartering.

Key points

- *seek landowners permission before entering land*
- *the methods suggested here are guidelines only. An orientation survey is recommended when new targets or new areas are under investigation*
- *be consistent throughout, from site selection, to sample collection, preparation and analysis*
- *do not rely on a single sample type. Collection of both panned concentrates and stream sediments is preferred.*
- *avoid contamination. Samplers should not wear jewellery, lotions/creams, plasters*
- *use trained sampling teams and monitor their work*
- *adopt rigorous quality control procedures at all stages*
- *give a high priority to health and safety matters*

BRITISH GEOLOGICAL SURVEY

PANNED-CONCENTRATE DRAINAGE SAMPLING

Health and safety

Although most hills and mountains in Britain are comparatively low, they are locally precipitous and subject to rapid changes in weather, which can be arctic in winter. Sampling in such areas should only be carried out by suitably equipped and trained pairs of workers.

Equipment needed:

Items required for collection of panned-concentrate and stream-sediment samples from a single site.

- *sieve nest – two circular wooden frames about 45 cm diameter, with nylon sieve cloth, one with 2 mm aperture and the other 150 μm*
- *two wooden pans, calibrated to show volume of concentrate to be collected*
- *mild steel trenching tool, or similar, for digging*
- *polypropylene funnel, at least 15 cm diameter*
- *Kraft paper sample bags, 8 x 13 cm for concentrate, 10 x 20 cm for sediment*
- *polythene bags to protect samples in Kraft bags*
- *heavy duty rubber gloves*
- *waterproof marker pen*
- *hand lens*
- *small plastic tubes or vials*
- *fine paint brush*
- *field cards for data recording*
- *binocular microscope (with reference mineral grains – optional)*
- *topographic and geological maps*
- *first-aid kit*

Further information

Collection, sampling and analysis

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Background, planning and interpretation

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Health and safety

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