

Mineral exploration methods in Britain



Stream sediment sampling

Introduction

Geochemical surveys based on the chemical analysis of samples of active stream sediment from drainage courses have long been used as an exploration tool worldwide. The underlying premise is that stream sediments are composite products of erosion and weathering and thus represent the source catchment area of the stream drainage network.

The composition of the stream-sediment samples reflects the bedrock geology of the catchment area, overburden cover and any contained metalliferous mineralisation. The climatic conditions under which weathering and erosion take place also influence the sample compositions, as do a range of other factors related to sample collection, preparation and analysis. Variations in Eh and pH control the mobility of many elements and thus affect sample compositions, especially in upland areas of Britain where such variations are most common. The role of contamination by human activities is also important in Britain, especially in lowland areas where population and industrial activities are concentrated.

The purpose of this leaflet is to provide advice on recommended procedures for the collection of stream-sediment samples in the UK. It is intended to help with answering a number of questions:

- ❖ *where, what and how to sample*
- ❖ *what size fraction to analyse*
- ❖ *which analytical method to use*

Stream sediments comprise clastic and hydromorphic components, including detrital grains, clays, colloids, organic matter and Fe-Mn coatings on clasts. In view of this diversity it is important to collect the most appropriate size fraction consistent with the objectives of the survey. In mineral exploration the objective is to enhance the anomaly contrast (peak/background ratio) in order to increase the chances of identifying a mineralised bedrock source.

In any new geological or physiographic environment the optimum procedures are normally identified by a trial or orientation survey. In the UK the BGS, through its G-BASE programme (Geochemical Baseline Survey of the Environment) and MRP (Mineral Reconnaissance Programme), has undertaken drainage geochemical surveys and associated orientation studies for more than 30 years. This experience forms the basis for the methods described here which have been recommended as international standards for geochemical mapping (Darnley et al., 1995). Panned heavy-mineral concentrates and stream-water samples are often collected at the same time as stream-sediment samples. Collection procedures for these samples are described in other leaflets in the series.

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 element dispersion patterns from it. Practical considerations of resource availability (manpower and finance), logistics and site access must also be taken into account. Permission to sample should be obtained from the landowner at each site.

In the regional reconnaissance G-BASE programme BGS employs a density of about 1 sample per 1.5 km². The sites are selected on as low an order stream as possible (i.e. smallest streams) and upstream from the confluence with a higher order (larger) stream to avoid sampling sediment that is mixed from the two channels during flood flow. In follow-up surveys higher sampling density is commonly used according to local conditions and the nature of the target.

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 Avoid areas of winnowed sediment. Fine-grained material at the margins of the water course may be better.
- 4 Avoid deposits of well-sorted gravel and areas of limited sediment accumulation.
- 5 For consistency, always sample material deposited in the same setting in a stream e.g. do not mix material from heavy mineral traps with fine sediment banks.

Sample collection

- 1 Wash sieves and pans in stream immediately prior to sampling. The sieve with the 2 mm cloth is placed on top of the fine sieve and both are mounted on top of the pan.
- 2 Collect 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 spurious high contents of Fe and Mn in oxide coatings.
- 3 Load coarse sediment into the top sieve with minimum input of water. Remove large clasts by hand and rub the material through the top sieve, wearing rubber gloves. Remove the top sieve, and continue careful rubbing and shaking until adequate fine material (normally about 100 g dry weight) has passed through the lower (fine) sieve into the pan beneath. No coarse particles should be allowed to enter the fine fraction sample.
- 4 Leave sample to settle for a fixed time, typically about 15–20 minutes. During this period panned-concentrate and water samples may be collected and site data are recorded.
- 5 Decant excess water to leave a final volume of 200–250 ml. Homogenise this by gentle agitation with stirring, and carefully decant into a clean numbered Kraft bag using a clean funnel. Place the sealed bag in a thin polythene bag and secure with a loose knot for transportation in an upright position.
- 6 Wash all equipment thoroughly in the stream before packing away.
- 7 Collect duplicate samples at some sites to monitor within-site variability. In a regional survey field duplicates are normally collected from every 100th site. For smaller surveys duplicates should be collected more frequently, from 4 or 5 sites in every 100.





Field observations

Pre-numbered 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:

- ❖ *description of site locality, preferably with regard to a fixed permanent feature or landmark*
- ❖ *grid reference*
- ❖ *identity of collectors*
- ❖ *date*
- ❖ *catchment geology from map*
- ❖ *clast and bedrock geology at site*
- ❖ *heavy minerals seen in concentrate*
- ❖ *land use*
- ❖ *contamination*
- ❖ *sediment colour and composition*
- ❖ *precipitates in stream*
- ❖ *weather conditions*
- ❖ *stream-flow conditions*

Stream-sediment sampling in the UK is normally carried out by teams of two people. In the G-BASE regional programme these teams sample about 10 sites per day, also collecting panned-concentrate and water samples. In more detailed surveys 15–20 sites may be sampled per day, and higher numbers are possible if only sediments are collected and sites are not remote.

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.

Sample preparation and analysis

Wet 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 samples are removed from their original bags and disaggregated by hand using a mortar and pestle. Sample homogenisation is then carried out using an agate planetary ball-mill until 95% is finer than 53 µm.

Representative sub-samples of the powder are prepared for analysis by riffing or coning and quartering. The quantities required will depend on the analytical method used: for XRF about 12 g is needed for preparation of a pressed powder pellet; for ICP-AES an acid leach is normally conducted on about 0.5 g; where precious metals (Au, PGE) are to be determined a 30 g split is normally used.

Various leaches and fusions are available for sample decomposition prior to analysis. The choice is not always easy, but the decision may be critical. Gold, for example, may occur as free grains, occluded in silicates or refractory in sulphides. A fire-assay fusion will normally provide a total gold analysis, whereas strong- or mixed-acid attacks may liberate only part of the contained gold.

Use of laboratory duplicates, certified reference materials and in-house standards is strongly recommended to monitor contamination, systematic errors and instrumental drift. Wherever possible standards should be of a similar composition to the samples being analysed.

Choice of laboratory is another important consideration. Long established laboratories, preferably with ISO 9002 accreditation, are generally the preferred option.

Key points

- ❖ *be consistent throughout, from site selection, to sample collection, preparation and analysis*
- ❖ *avoid contamination. Samplers should not wear jewellery, lotions/creams, plasters*
- ❖ *use trained sampling teams*
- ❖ *adopt rigorous quality-control procedures at all stages*
- ❖ *give a high priority to health and safety matters*

Equipment needed:

- ❖ *sieve nest – two circular wooden frames about 45 cm diameter, with nylon sieve cloth, one with 2 mm aperture and the other 150 µm**
- ❖ *wooden pan, similar to the Malaysian 'dulang'**
- ❖ *mild steel trenching tool, or similar, for digging*
- ❖ *polypropylene funnel, at least 15 cm diameter*
- ❖ *Kraft paper sample bags, 10 x 20 cm*
- ❖ *polythene bags, 15 x 40 cm*
- ❖ *heavy-duty rubber gloves*
- ❖ *waterproof marker pen*
- ❖ *field cards for data recording*
- ❖ *topographic and geological maps*
- ❖ *first-aid kit*

*If panned heavy-mineral concentrates are not being collected, smaller sieves and a simple collecting vessel can be used.



Further information

Collection, sampling and analysis

Darnley, A G et al., 1995. A global geochemical database for environmental and resource management. UNESCO Publishing.

Background, planning and interpretation

Hale, M and Plant, J A (editors). 1994. Handbook of Exploration Geochemistry: volume 6, Drainage Geochemistry.

Health and safety

Guidance Note: safety in fieldwork. 1997. Natural Environment Research Council, Swindon.

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