Common Exploration Methods.

The following list contains the most common methods which a company with a mineral prospecting licence in Northern Ireland might use to carry out a mineral prospecting programme. The aim of the license holder is to detect subsurface ore-bodies of economic value by identifying anomalous traces of surface mineralisation, through the use of geochemical and/or geophysical prospecting methods. Methods used will vary depending on the different stages of the exploration. Brief descriptions of the methods are presented for information.

DESK STUDY

An initial period of data review, collation and analysis is usually carried out. All available historic and public data which are freely available or available for licence are collated and studied for potential information on target areas. This initial period is used to highlight areas of interest to the company, if no specific target has already been identified. Desk studies have no environmental impact.

In Northern Ireland, GSNI holds historic prospecting information and archive material which are available under licence along with the regional Tellus datasets. Stream sediment, stream water, soil geochemistry, airborne electromagnetic, airborne magnetic and airborne radiometric geophysical data sets are available.
Geology maps are also used as information sources.

FIELD BASED DATA ACQUISITION

Field Mapping
Additional geological field mapping is used to augment the information presented on geological maps. Rock types, geological structures, rock at surface locations and other notable features are recorded by walk-over surveys, normally by one or two people. Rocks may be sampled with a geological hammer to reveal fresh rock faces for clearer identification. Samples may be collected for laboratory analysis. Sample size may vary depending on analysis, but chips/fist-sized lumps to larger amounts may be collected (especially when looking for precious and base metals). This technique is generally considered low impact, but where necessary restrictions on land access will be imposed to protect areas with environmental designations.

Field Prospecting
Very similar to field mapping, but mineralisation and associated changes in host-rock (alteration) is specifically being sought. Rock units identified in the

mapping process are studied and sampled. The same seasonal restrictions will be applied where necessary.

Geochemistry Methods.

The main aim of carrying out geochemical sampling is to identify areas where there appears to be an anomalous amount of the target mineral being sought, or of minerals which are known to be associated with the target. Large areas can be covered at an initial stage by a regional sampling programme which would then be followed up by a more localised survey over anomalous areas. In all instances where geochemical surveying is proposed, the locations of the samples are supplied to the Geological Survey prior to the survey being carried out. If any of the locations are within a designated area or considered likely to have a detrimental impact on a designated area, restrictions may be placed on the timing of the activity or permission to carry out the activity can be refused.

1. Soil sampling.
   Carried out by individual or teams of people. Samples of a few hundred grams up to 5 – 10kg are collected using hand held auger for the small samples and spade for the larger ones. Auger method is low impact and the ground can be left with no visible signs of disturbance. Larger samples are collected from a dug pit.
   Surveys are usually carried out over a rectangular grid which will vary in density depending on the confidence of the target location, or along a transect. The area covered could be very large for regional work or down to less than a few km^2 for detailed/follow-up surveys.

Soil sample collected with a hand auger

Soil sample collection

2. Stream sediment sampling
   Samples are collected from 1st and/or 2nd order streams[i] as near the middle of the stream as possible. Approximately 50 grams of material is normally taken but larger samples may be required dependant on method used and target. Where heavy metal[ii] mineralisation is being targeted, samples are collected as close to the bedrock as possible. This may require digging down through the overlying material. The sediment is wet sieved through mesh screens to the required size and put in paper sample bags for drying. Sample density is low (1 per Km^2 or less) for regional surveys, increasing in density for reconnaissance and follow-up studies.

Sediment sample collection

Site selection for stream sediment sampling has the potential to be disruptive. Access is required to the stream bed and the sediment must be disturbed to collect the samples. However sampling is very short term and generally only carried out in low order streams. Sampling is not permitted in streams where it is considered that it will have a significant detrimental effect on protected species.

3. Water sampling.
   Less commonly used. Approximately 100ml of stream water is collected in plastic bottles with three or four bottles per site.
4. Panning.
   The concentrated heavy mineral residue from a stream sediment sample is panned (in a plastic, steel or wooden shallow dish) using water from the stream where the sediment sample is collected.

Stream sediment panning

The size of the concentrate sample may vary in size from a few grams to one or two hundred grams.

5. Deep overburden[iii] sampling.
   A petrol driven hand held device is used to dig deeper (up to a few metres) into the overburden (the soil and gravel deposits which sit on the rocks underneath) where spade digging and hand auguring will not get to the bedrock to collect soil samples.

Pionjar deep overburden sampling device

Generally operated by a small team walking to sites this process can be noisy and cause surface disruption at the site.

Geophysical Methods

1. Magnetics
2. Electromagnetic Methods including VLF[iv]
3. Gravity
4. Radiometrics[v]

Magnetic, electromagnetic, radiometric and gravity methods can all be carried out rapidly by teams of one or two people as a walk over survey using hand-held instruments.

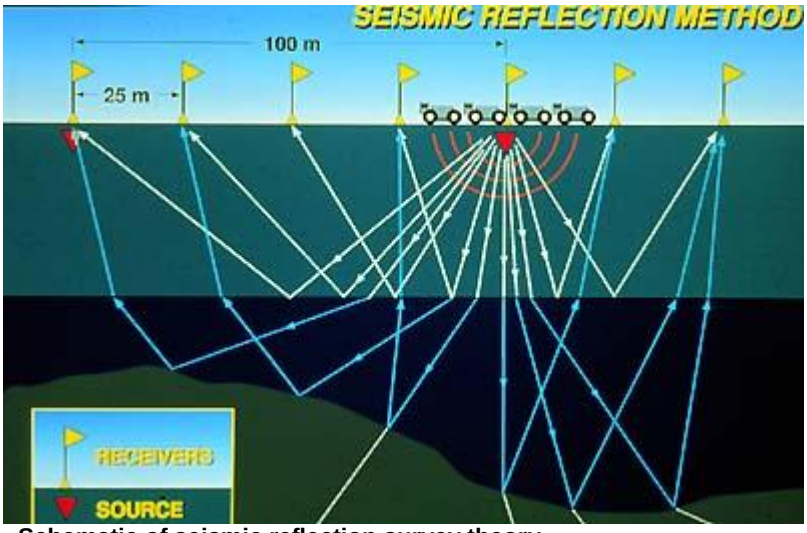
One example of hand held magnetometer equipment

The measurements are recorded without the need to disturb the ground other than by foot fall. In some cases a grid may be marked out with pegs driven into the ground. These are used as survey points at which measurements are taken.

5. Induced Polarisation.
6. Resistivity.
   Both these methods require passing an electrical current into the earth through ground electrodes, pushed into the soils, laid out along a single line traverse. The process is carried out by hand, electrodes are metallic, thin and up to 30cm long. Little other ground disturbance is required other than foot fall and possibly survey pegs marking out line positions. However these methods may use high currents, which can cause a potential risk to livestock.

Two probe resistivity survey equipment

7. Seismic
   Seismic surveys record energy waves reflected from different rock layers in the earth. An input energy source is required. This may be from a series of controlled explosions creating a single frequency source or from a vibrating source onboard a truck (Vibroseis) which sweeps a range of frequencies. Long lines of cables with recording devices (geophones) are laid out and a series of energy bursts are provided either through explosions or vibration.



Schematic of seismic reflection survey theory

Vibroseis Survey at Larne

In the case of explosions, these will be set off in sequence at a series of surveyed locations. The charges are set at depth and cause little disturbance outside the immediate vicinity. A Vibroseis truck will drive along a road stopping at surveyed location marks and vibrate at each

location. The energy which is reflected from the underground rock formations is recorded as ground movements at the surface by the geophones. In land surveys carried out in Northern Ireland, lines of geophones have been laid along road verges, rather than in straight lines across fields. Where water is in the way, the lines of geophones can be anchored to the bed of the water body.
Seismic surveying is more common in petroleum exploration.

Drilling

Mineral exploration drilling operations require a drill rig to carry out the process, which aims to recover cores of rock from depths of up to 1000m. Typically drill holes will be of the order of less than 200m (for reconnaissance drilling, though specific targets may be deeper) with rock core collected and placed in prefabricated core boxes. The drill core comprises cylinders of solid rock with a diameter normally in the range 5-10 cm. A drill rig will typically have a footprint of less than 10 x 10 metres and a height of 4 metres, though some rigs, which can acquire greater depths, will occupy a larger area. Associated with the rig are a stable drill platform (wooden boards used to level the operating area and storage area) fuel stores, drill fluid management systems, equipment stores etc.
All rigs require some sort of lubrication at the drill bit with water being most commonly used. The water is circulated from the surface to flush the area of the drill bit and carry the pulverised rocks and chips back to the surface. Settling sumps may be used to improve the water for re-use or reintroduction to the local water system.

Exploration drill rig

In environmentally sensitive areas, or close to them, it is possible for all drill fluids to be captured in a closed system with no discharge to the local environment. Closed drill systems are used in some areas of Northern Ireland. Exploration drilling operations will generally be over a matter of days or weeks, depending on the type of rock being drilled (harder rock takes longer to drill through) and the target depth of the hole. Where permitted, operations may take place over extended time periods, occasionally up to 24 hours a day.

Additional emissions from rigs include noise and fumes. Exploration drilling for metallic and industrial minerals does not use hydraulic fracturing as a technique.

Trenching

Mineral exploration trenching is carried out by mechanical excavator with a back hoe, with the aim of exposing a section of mineralised bedrock. Trenches can be over 100 metres long and a few metres wide. Depth is controlled by the depth of the overburden in the area being worked. A geologist would require access to the trench in order to log and sample the soil and bedrock profile exposed. Such activities are governed by Health and Safety regulations.

AIRBORNE SURVEYS

Magnetic, electromagnetic, radiometric and gravity measurements can all be made from an aircraft. The lower the flight height of the aircraft, the stronger the signal. Data are collected along parallel flight lines with the aircraft maintaining as level an altitude as possible.

Tellus survey plane at rural survey height

In Northern Ireland the Civil Aviation Authority authorised the Tellus survey to fly at 56m in rural areas, rising to 250m over population centres. Planes can operate at any time of the year provided flying conditions are suitable. Airborne surveys are inevitably associated with short lived noise disturbance that may affect humans, livestock and wildlife.

MARINE ACQUISITION

Marine Seismic Surveying

This is similar to land base seismic but uses a series of airgun explosions as the energy source and floating hydrophones as the recording device. Operations can be carried out from one vessel setting the charges and towing the hydrophone stringers, or two separate vessels, one towing the energy source and the other the recording devices.

[i] A first order stream is a stream which does not have any other streams feeding into it. When two first order streams come together they form a second order stream.
[ii] The term heavy metal is used to loosely define a subset of elements which exhibit metallic properties.
[iii] Overburden is the rock or soil overlying the underground target.
[iv] Very Low Frequency electromagnetic radiation.
[v] Radiometrics surveys target the naturally occurring radioactive elements found in rocks. The gamma radiation resulting from the decay of the elements is recorded.