COLLECTION AND TREATMENT OF DIAMOND EXPLORATION SAMPLES

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INTRODUCTION

Exploration for primary diamond deposits in many areas is based on the results obtained from drainage or loam samples. Because macrodiamonds (diamonds plus 0.5mm in size) are very rare, even in economic deposits, search is often made for more common pathfinder minerals, typically picroilmenite, pyrope garnet, microdiamonds (diamonds less than 0.5mm size), magnesiochromite and chrome diopside though other minerals may be important in some areas. However, even these pathfinder minerals usually occur in very low concentrations, perhaps only one or two grains per sample, and thus collection and treatment of samples must be meticulous if success in exploration is to be achieved.

This paper outlines the drainage sampling and treatment procedure used by BP minerals australia / Seltrust Mining during their Australian diamond exploration programme from 1978 to 1983. Two main sampling methods are used viz. "Diamond Sampling" and "Pathfinder Sampling". The former is mainly used in the search for diamondiferous olivine lamproites where typical pathfinder minerals are rare or absent and the latter mainly used to explore for diamondiferous kimberlites.

DIAMOND SAMPLING

Collection Of Samples

The purpose of diamond sampling is to detect whether or not a drainage catchment, or part of a catchment, contains macrodiamonds. In this regard a single macrodiamond could constitute an anomaly and would be investigated. Samples are collected at a density of 100 tonnes of unscreened sediment per 1000 square kilometres of drainage catchment, with a minimum size of 15 tonnes (one truck load). A theoretical sample site is first chosen based on the size of catchment, drainage characteristics, geology, topography, access and logistics. This general site, and possible alternatives, is then field checked for suitablity and an actual sample position identified. The best sample positions are:- large potholes; near the base of large waterfalls; in the lee of rock bars; gravel filled depressions in drainage channels. Boulder bars are taken as a last resort. Excavation of the sample is achieved using a back hoe and the sample is then trucked to a field treatment plant established nearby. Considerable effort is made to clean out the bottom of the sample site. Where bedrock is soft approximately 150 mm depth of this is excavated and forms part of the sample. Where bedrock is hard, it is cleaned mechanically as best as possible. Dry sample sites are finished using a broom and a shovel.

Treatment Of Samples

Diamond samples are first concentrated in the field. Where water is plentiful, access easy and logistical parameters acceptable, samples are treated using a Mitchell Cotts Mk3 heavy media plant. Where water is scarce, access difficult and sites scattered, a portable, trommel-quadruple yuba jig plant is used. The size range of the concentrate obtained from the heavy media plant is minus 12 mm plus 0.5 mm whilst the trommel - jig plant yields concentrate of minus 6 mm plus 0.5 mm size. Test markers at SG 3.5 are added routinely to both circuits and the usual recovery is 100%.

Ongoing treatment of the concentrate is carried out in the laboratory. Field concentrate is first dried using a gas fired rotary drier of 0.5 tph capacity which discharges directly onto a 4 deck Kason screen. The plus 4 mm fraction is observed without further treatment. The minus 4 plus 2.5 mm fraction and the minus 2.5 mm fraction is further upgraded using a Pleitz jig and then observed. The minus 1 mm plus 0.5 mm fraction is batch fed through a scalper to remove highly magnetic minerals and then to a custom made high intensity Mecal induced roll magnetic separator. Diamonds are concentrated in the non magnetic fraction whilst weakly magnetic minerals, including most of the laterite, are removed in the magnetic fraction. Two passes may be necessary. The non magnetic fractions are upgraded using tetrabromoethane at SG 2.95. The sink fraction is treated on a Readings pilot roll magnetic separator to remove any weakly magnetic minerals remaining and then observed. This circuit will not separate magnetic diamonds minus 1.0 mm in size and where these are suspected, or important, a grease table can be used in lieu of magnetic separation.

PATHFINDER SAMPLING

Collection Of Samples

The purpose of pathfinder sampling is to detect pathfinder minerals dispersed from kimberlitic rocks. The main pathfinder minerals have been listed above and often a single grain of any one of them could constitute an anomaly. On a reconnaissance survey, pathfinder drainage samples are collected at a density of about 6 kg of minus 2.5 mm sediment per square kilometre with a minimum size of 25kg and a normal range of 25 to 200 kg. It is critical that samples be collected from good trap sites. The best sites are crevices or open joints trending near normal to the drainage. Boulder bars, basal gravel accumulations, the lee of rock bars, under tree roots and in the lee of islands vary from good to moderate sites generally in the order listed. Pot holes are not good trap sites as pathfinder minerals may be destroyed by attrition. Only in very special circumstances is it worth taking a sample from the well sorted sand choked streams so common in many parts of Australia.

Samples are screened in the field at 2.5 mm, the minus 2.5 mm fraction being stored in ultraviolet resistant polythene bags for despatch to the laboratory. Damp or wet samples, and samples over 100 kg, are generally wet screened in the field. This is achieved using a Cheers hanging screen suspended over a polythene dustbin; water is pumped from a nearby source and sprayed over the sample with a garden hose. Excess water is decanted from the sample. The main advantage of wet screening is that it provides a much cleaner sample and removes unwanted salt and gypsum.

Treatment Of Samples

Treatment of pathfinder samples in the laboratory is based on jigging, tableing, heavy media separation, magnetic separation, alkali fusion and observation. The general circuit is described below but may be modified in detail depending on the size, composition and purpose of individual samples.

All samples are dried and screened at 1.0 mm, 0.5 mm and 0.25 mm on arrival at the laboratory using a Cheers hanging screen. The minus 2.5 mm plus 1.0 mm fraction is treated using a Pleitz jig and the jig "eye" observed for diamonds and pathfinder minerals. The eye is subsequently upgraded using tetrabromoethane (TBE) at SG 2.95 and the concentrate observed again. The minus 1 mm plus 0. 5 mm and minus 0.5 mm plus 0.25 mm fractions are soaked for 24 hours in water containing Calgon. The wet sample is fed to a conical hopper containing a compressed air driven stirrer where it is mixed with water laced with Calgon. The resulting slurry, at a pulp density of about 50%, is discharged directly onto a laboratory sized Wilfley table with a fibreglass sand deck. Middlings are recirculated and tails are discharged to waste.

Wilfley concentrate is dried and upgraded using tetrabromoethane at SG 2.95. The finer fraction being left overnight to reach equilibrium.

Coarse (plus 0.5 mm) TBE concentrate is scalped using a Readings pilot roll magnetic separator to remove highly magnetic minerals and then passed several times through a Rapid rotary disc magnetic separator. This produces a magnetic fraction containing any picroilmenite and magnesiochromite, a non magnetic fraction containing any pyrope and macrodiamonds and a middle fraction (the greatest bulk) which is of no interest.

Both the magnetic and non magnetic fractions obtained above are further upgraded using a Readings high tension separator, if necessary, before being observed. As a final check for small diamonds, the observed minus 1mm plus 0.5 mm fraction is sent to the alkali fusion circuit described below.

Fine TBE concentrate (minus 0.5 mm plus 0.25 mm) is mixed with approximately 6 times its own volume of sodium peroxide and fused in a zirconia crucible at 600'C for 20 minutes in a muffle furnace. The fused product is digested in dilute HCl and the residue observed for microdiamonds.

Observing consists of examining every single grain of the appropriate concentrate usually under a binocular microscope. It is a slow tedious job and one that can neither be hurried or circumvented. It represents the final stage in the analytical process and whilst checks can, and are, carried out it is impractical to do this with every sample. In consequence the correct choice of personnel to carry out this work is critical.

The composition of pathfinder minerals is determined using electron probe microanalysis and microdiamonds are confirmed using a scanning electron microscope.

PROBLEM AREAS

Whilst it is important that all the work be carried out meticulously, some areas are more prone to problems than others. Attention is particularly drawn to the following points:

All equipment must be cleaned between samples. Especial attention must be paid to screens, cabinets and brushes which are all difficult to clean and may contain mineral grains from previous samples.

Microdiamonds are hydrophobic and tend to float on the surface of water. The circuit described has been developed following a variety of tests and obtained a normal microdiamond recovery of 85 to 100%. Short circuiting the described procedure may result in loss of microdiamonds. For example tests on dry samples fed directly to the Wilfley table gave recoveries of 0 to 46% whilst tests on Calgon soaked samples which had not been passed through the stirrer gave recoveries of 50 to 80%.

Diamonds work down crevices in rock. It is essential that, during collection of the field samples, crevices and joints be thoroughly cleaned out.

Because of the need to carry out all aspects of the work accurately, and because errors may be difficult to identify and check, it is essential that only competent and trusted staff be used for collection and treatment of samples.

Accurate labelling of samples is essential to avoid mix up of sample numbers. This potential problem can be minimised by using a numbered aluminum tag at the collection stage and which accompanies the sample throughout treatment.

CONCLUDING REMARK

The circuit described above has been developed and found effective in Australia. Whilst it is probably applicable in other areas, orientation tests should be carried out to ensure this is the case.

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