Some Modern Methods of Prospecting

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IT is probable that the overwhelming majority of ore-deposits with obvious surface indications have already been discovered, but in view of the ever-increasing demand for metals, it is necessary to prospect for deposits which are not characterised by surface indications easily interpretated by the eye alone, or by means of such simple tests as can be carried out by the miner's pan and blow-pipe.

In comparatively recent times a series of new methods has been developed to aid the prospector in his search for the more obscure mineral deposits, and these methods fall into two major groups, namely the geo-physical and geo-chemical.

The following notes are mainly concerned with geo-chemical methods. Because of the complexity of geo-physical methods only a few of the simpler ones have been included.

1. Spectrographic Methods.

By means of the spectrograph, rapid qualitative and quantitative analyses can be made, but unfortunately the apparatus involved is not ideal for field work because it is so bulky. Nevertheless, both the Swedes and Russians use the apparatus in the field for both soil and plant analyses in connection with their searches for ore, and the Russians use a portable spectrograph that can be dismantled and carried by truck or pack animals to the field H.Q. A seven-man Russian crew can turn out a hundred spectrograms of soil per day.

A somewhat specialised spectrographic method with considerable promise and scope for development has been investigated in British Columbia by Warren and Thompson. These workers have shown that if gold from a given area contains traces of mercury or tin, the area may contain these metals in economic quantities ; but if the spectroscope indicates an absence of either of these metals in the gold, then further prospecting for economic deposits of the missing metal or metals will be useless. The same workers showed that the same inference could not be drawn from the presence of traces of all metals in gold.

2. Methods involving soils and plants.

At least sometimes, when an orebody is developed from ascending solutions (or gases), some of the metallic ions concerned tend to migrate for considerable distances from the orebody proper into the country rock. Similarly, during oxidation, metallic ions are liberated and migrate into the covering soil where they are anchored, probably by absorption into soil colloids. Once these dispersion patterns are formed, they are not easily destroyed, e.g., by ground water.

However the dispersion pattern is formed, it possesses a concentration gradient which increases as the orebody is approached. This concentration gradient can be detected in the soil proper, in forest leaf-mould, and in the plants of the area, either by spectrographic methods, or by rapid colorimetric analyses which can often be made fairly easily in a field H.Q.

When looking for such concentration gradients by means of plant analyses, it is necessary to examine the same anatomical parts of the same species of plant, and the specimens must all be collected at the same time.

This method has been shown to be especially suitable for the location of lead, zinc and copper deposits which are hidden by glacial drift, or which are situated in tropical areas where outcrops are obscured by dense vegetation and a heavy laterite covering.

In America, and elsewhere, prospectors are making use of the fact that the vegetation over an orebody is often different from that on barren ground, and plants of special value in this connection have been termed "Indicator Plants." Thus, in the area of the San Manuel copper deposit, Arizona, the California poppy is found growing only on the oxidized outcrop of the orebody.

3. Methods depending on water analyses.

It has long been known that ground-water removes heavy metal ions from oxidizing orebodies and carries these ions into the rivers. A given river draining an area carrying an orebody will have its heavy metal concentration decreased as a result of dilution by water from tributaries draining non-mineralised areas. Therefore, in the simplest case, the nearer one approaches the orebody, the greater will be the heavy metal concentration in the river water.

Variations in copper, lead and zinc concentrations can easily be traced in river water by means of field colorimetric analyses involving the use of dithizone, and deposits of these metals have been located in this way. In due course it may be possible to locate deposits of other metals in the same manner.

The method is suited to areas of mature relief which are subjected to at least a reasonable amount of rain, and may prove specially valuable in tropical regions where dense undergrowth makes other methods of prospecting difficult.

4. Methods utilising ultra-violet light.

Although many minerals fluoresce under certain circumstances, the ultra-violet lamp is only of prime importance to the prospector who is looking for scheelite, uranium minerals, and columbite.

When prospecting for scheelite it is necessary to employ a lamp emitting rays of comparatively short wave-length (c.2537A°). Scheelite, under such rays, may fluoresce a variety of colours ranging from blue, through white, to yellow, depending on the amount of undesirable powellite ($CaMoO_4$) present. Portable lamps enable outcrops of this mineral to be located by night, and also quickly indicate values underground.

Many uranium minerals fluoresce (usually yellow-green) when subjected to the rays of an "ordinary" ultra-violet lamp, but pitchblende, carnotite and some varieties of torbenite do not. However, the presence of uranium in any mineral can be detected by fusing a mixture of twenty parts fusion mixture and one part sodium fluoride on a piece of nickel foil or on the lid of a tobacco tin, then adding small fragments of the mineral under test, cooling, and irradiating with ultra-violet light. Any fragment which contains uranium will be surrounded by an intense lemon-yellow halo.

This same test may be used for the identification of columbite, for when this mineral is present it is surrounded by a very pale yellow halo which could never be mistaken for that due to uranium.

5. Methods involving the Geiger Counter and Scintillation Counter.

The Geiger Counter is a portable piece of electrical apparatus which warns the operator when he is approaching radio-active deposits by an increased clicking in his headset, and/or by the visual indication given by a ratemeter. It is the standard piece of apparatus for the present-day uranium prospector, for not only can he use the apparatus to enable him to discover the ore, but it can also be used for obtaining some idea of the grade of the ore once it has been located. The apparatus will only locate near-surface deposits, and some experience is needed before the variations in the "click intensity" can be truly interpreted, as this intensity varies when passing from one rock contact to another, and when moving from hills down into valleys, etc.

The Scintillation Counter is also a portable piece of electrical apparatus utilised for locating radio-active deposits. It is, however, much more efficient than the Geiger Counter and has located uranium in areas which had previously been investigated by means of a Geiger Counter with negative results.

6. Chemical methods for large-scale identification of minerals in situ.

Minerals disseminated in certain rocks may, by virtue of their size and/or colour similarities with the rock in which they lie, not be easily identified, nor, therefore, their relative quantities easily assessed by visual means. If then, by spraying chemicals on the rock, the valuable mineral will become coloured whilst the parent rock remains uncoloured, a valuable method will be at hand which will serve as a guide to sampling, exploration, development and mining.

Such a method has recently been used to "show up" cerussite ($PbCO_3$) disseminated in arkose lenses in the Sacramento Mountains of New Mexico. One man broke a fresh surface, cleaned it with a broom and sprayed on a five per cent. solution of acetic acid by means of a two-gallon pressure garden spray carried on his back. After about a minute, a second man sprayed on a five per cent. solution of potassium iodide, which caused the cerussite to be coated with yellow lead iodide. This second man also recorded the results.

Conclusion.

These notes by no means exhaust what may be termed by some the "novel" methods of prospecting. It is hoped, however, that they will fire the imagination of some, and cause others to realise that many of the simple experiments carried out in the chemistry, physics and mineralogical laboratories can be turned, by those with initiative, into valuable mining and prospecting aids.