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EXPLORATION OF PLACER GOLD DEPOSITS BY GEOMAGNETIC SURVEYS

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ABSTRACT

Past attempts to explore for placer gold deposits by measuring the anomalous magnetic intensities of the magnetite normally found in the ”black sands” fraction of placer gravels were for the most part unsuccessful. Recent improvements in the sensitivity, reliability and portability of magnetometers have made it possible to cheaply and accurately delineate some types of placer gravels if they occur in a geological environment that is ”magnetically hospitable” and does not mask the signal of the overlaying gravels. The main benefit of this technique is that it can accurately delineate targets and thus dramatically reduce the overall cost of an exploration program in a given area.

INTRODUCTION

Whether or not this technique will work in a given area depends on three factors:

1. The amount of magnetite associated with the pay gravels.
2. The depth of the gravel deposit.
3. The nature of the underlying bedrock.

In our work to date in Western Canada and United States, we have not encountered any pay gravels that did not have measurable concentrations of magnetite in the black sands. It is common to find gravel deposits with high concentrations of magnetite and no gold values whatsoever, but our experience and history have shown that gold values rarely occur without associated magnetic black sands; although the concentrates of magnetite do vary tremendously, In this regard it is important to keep two things in mind:

1. When working in an unfamiliar area, always check the magnetite content of the target gravels by hand panning, or if possible, by running a line across a known body of pay gravels.
2. The objective of the geomagnetic survey is to attempt to measure concentrations of magnetite, but a magnetic anomaly does not necessarily indicate an ore body. Only a competent and proper bulk sampling program can establish the grade of a placer deposit.

The depth of a target gravel deposit can vary from a’ few feet to many hundreds of feet. Generally speaking, the deeper the deposit, the easier it is to work with as the gravels tend to mask possible interference from bedrock and thus improve the signal-to-noise ratio. Desert playas and similar formations are usually very well suited to this technique.

In the case of shallower deposits, generally less than 100’ deep, the nature of the underlaying bedrock is usually the all important factor which will determine the success of the survey. The best type of bedrock is a simple metasediment with few igneous intrusions because it provides a uniform background of low magnetic susceptibility and will not mask the signals from the gravels. Many placer deposits in Sierra and Siskiyou Counties in Northern California are of this type and work well with this technique. The worst kind of bedrock would be a complex volcanic formation of high magnetic intensity composed of andesitic, basaltic or ultra mafic type rocks. In this instance the survey will be mapping the magnetic contours of the underlying bedrock and very little, if anything, will be learned about the overlaying gravels.

PROCEDURE

The equipment used is an Geometrics Model 856 Proton Precession Magnetometer which weighs about ten pounds and is mounted on a harness strapped to the operator The sensor is mounted on an 8' collapsible aluminum staff. It has a resolution of 0.25 gammas and is conveniently portable. This particular model is computerized, can function as either an automatic recording base station or a portable unit and has a 1,000 line memory bank. The G-856 can interface with any (RS-232 IBM type*) computer to manipulate raw data in the following manner:

- Perform base station time corrections Remove regional gradient to enhance the local.
- Remove local gradient to enhance the regional.
- Perform complex digital filtering.
- Plot profiles.

These functions are useful when large areas, say a section or more, are to be surveyed; but reconnaissance and smaller survey data can be reduced just as well manually.

In selecting line spacing and station intervals, one must take into consideration the size of the target. Generally speaking, higher grade pay gravels tend to occur as pods or strands which would probably be missed by a widely spaced grid. Lines spaced at 100' with readings taken every 25' will be satisfactory for most work. When attempting to locate ancient channels it is best to run lines perpendicular to the course of the channels, if that course is known.

The instrument can be operated by one or two people. We have found the best method is to have a senior technician carry the instrument and take notes and a helper to carry the staff and locate stations by use of' a compass and hip-chain.

*Editor's note, some references have been changed to reflect current technology

The operator can also be mapping other features at the same time with great accuracy because his position on the ground is always known to within a few feet. In this manner a two man team can survey any- where from 2,000 to 15,000 line feet per day, depending on the terrain. An overall average would be 6,000 to 7,000 L.F./day which would be doubled in desert or other open terrain

(Editors note: Current continuous reading Cesium vapor technology provides 12 to 18 miles/day (60,000 to 90,000 L.F./day))

The most important source of error is diurnal variations which are the background noise created by sunspot activity. In setting up a survey, a central arbitrary reference point should first be established at a convenient central location. Reference readings should then be taken at that exact same spot every 30-60 minutes and all other data corrected for these variations. For larger surveys, an automatic recording base station should be set up which will automatically plot diurnal variations. At the end of the day the field data is ”dumped” into the base station and then automatically corrected for diurnals and profiles plotted. In the event of a solar storm, all work should be abandoned until after the storm subsides.

In the field, the diurnally corrected data can be plotted on an 18” x 22” graph pad and rough contours drawn (Editor’s Note: this is now fully automatic with free MagMap software provided with Geometrics equipment). In this manner gross errors can be detected in a timely manner and features of interest can be examined more closely while still in the field. In the case of an initial reconnaissance of a new area it is essential to plot data immediately because an experienced technician can usually determine if the ground is amenable to a mag survey after running a few lines. If it isn’t going to work, there’s no point wasting money generating useless data.

When reconnaissance work has demonstrated that the data is meaningful and there are a sufficient number of data points, say greater than 100, the magnetic contours should be plotted by computer. There are a number of firms specializing in these services and it has been our experience that they can do the job faster and cheaper and produce a much better product than can be done in-house without a major capital investment in computer hardware. The contour and 3-D maps presented in Case History B were prepared by Whitney 6 Whitney, Reno, Nevada using a Cyber 175 computer and a SACM program which filters the data by means of a bi-cubic spine. The 2-D and 3-D contours are then plotted by a Cal Comp 1039 3-pen plotter. (See above Editor’s note, current technology provides in-field plotting.)

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Choosing the proper contour interval is a matter of experience because a meaningful anomaly could be anywhere from 30-400 gammas depending on the magnetic environment of the gravels and the absolute concentrations of magnetite they contain. Our experience has been that most meaningful anomalies fall within the 50-200 gamma category. This is very comfortably within the limits of current instrumentation It is good practice to reoccupy at least 5% of the stations to determine the reproducibility of the data, and they should be reproducible to within ±1 gamma. By careful work and the use of a recording base station, reproducibility can be brought to within ±0.5 gammas. However, reproducibility of + 5 gammas is adequate for this type of work to the amplitude of the target anomalies.

CASE HISTORIES

Case History A: This property is a large block of claims locate in northern Nevada in typical high-desert sagebrush country featuring 2,000' relief mountains and rolling hills and ridges in the alluvial fans at the base of the mountains. The known deposits were located in the alluvial fans and distributed in an erratic and unpredictable manner in pods and lenses varying in size from a few hundred to several hundred thousand cubic yards. The area has an extensive and fairly well documented history of production and has supported many hundreds of small scale "dry-wash" operations as well as several medium size mechanized ones of about a thousand yards a day. The factors inhibiting large scale development of the area were lack of water and the spotty nature of the deposit. The water problem was solved by deep drilling and it became our task to develop a practical and economic means of locating and delineating the scattered ore bodies.

Desert placers present some unique exploration problems. The terrain, though easy to work and get around in, presents very few clues as to what lies underneath. There are no obvious river benches to use as a starting point, the modern drainage patter can often be misleading and there are miles and miles of gently rolling hills stretching in all directions that look exactly alike. Another problem often overlooked is that unlike a river placer which usually has a well defined bedrock where coarse values tend to concentrate, the desert placer is usually far more complex and only through careful observation and test work can any insight be gained as to where in the vertical column values are likely to occur .

Our task in this case was somewhat simplified by the fact that there were three medium size ore bodies already located. Our first step was to do a geomagnetic survey around the known pay gravels. Lines were spaced at 100' and readings taken every 20'. The data was corrected for diurnal variations and magnetic contour maps were prepared. Distinct anomalies ranging from 50-150 gammas were noted

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around the pay gravels. To establish the grade of the deposit, a Case 980B Excavator with 1¼ cubic yard bucket and an effective digging depth of 22' was brought in and approximately 90 test trenches were dug on grid intervals of 50' and 100'. By digging on the floor of the pit and stripping the overburden at some locations, it was possible to examine a vertical interval of almost 50'. Bulk samples varying in size from 500 – 3,000 pounds were taken and processed through a portable test plant. Through this program, 480,000 c.y. of pay gravels were indicated with a grade of between .012 and .028 oz., Au/c.y. of recoverable +150 mesh values. There was an excellent correlation between the magnetic anomalies, and in general, the higher the anomaly, the better the values.

It was also noted in the initial program that all the pay gravels seemed to occur within a certain 150' contour interval even though they were separated horizontally by a distance of 3,000 feet. Our next step was to conduct magnetic surveys on the surrounding terrain at that contour interval. A number of anomalies were found and approximately 170 additional test pits were dug and sampled. About 70% of the high magnetic anomalies were found to contain economic values and sufficient reserve developed to support a modest sized operation.

It is safe to say that it would not have been possible to develop the subject property without the data generated by the magnetic survey. To accomplish the same results either by drilling or test trenching it would have been necessary to drill 960 acres at 50' intervals for a total of 16,590 holes for a probable cost in excess of $1,000,000 and several years time. The magnetic survey cost under $20,000 (in-house cost) and was completed in about seven weeks.

Case History B: The subject property consists of approximately 300 acres located along the banks of one of the branches of the Yuba River in Northern California. The immediate area has a well documented history of prolific gold production from placer, lode and hydraulic mines of over three million ounces. The subject property probably produced 100,000 ounces from placer and hydraulic mines and an additional amount from lode mines between 1850 and 1890. There are two small scale, but profitable placer mines now in operation in the immediate vicinity. Our objective was to explore the unmined benches to determine if there were sufficient pay gravels to support a modest (500 – 1,000 c.y./day) mining operation.

The terrain is fairly steep and covered with a mixture of conifers and brush. However, unlike a desert placer, the morphology of the terrain indicates the obvious exploration targets The rapid down-cutting and meandering action of the river has left benches along the sides of the valley which were ancient river beds. It is these channels which were mined hydraulically and when the Sawyer decision of 1884

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stopped this type of mining in its tracks there remained a number of unmined and potentially economic deposits. It was also hypothesized that there might be concentrations of black sand tailings left behind by the hydraulic users which might be a secondary target.

Our first step was to determine whether a magnetic survey was a viable tool in this area. Approximately 1,000 line feet were run across a known deposit at a producing mine in the immediate vicinity with poor results. The Calaveras Slate bedrock provided a uniform background of low intensity and it was obvious from the mine tailings that there were high concentrations of black sand in the pay gravels. The next step was to survey the most convenient and promising area within the property, which was an area along the north bank of the river about 1,800’ long and varying in width from 200’ to 400’. Lines were spaced at 100’ intervals perpendicular to the course of the channel and readings taken every 25’. It took a two man team approximately 1.7 days to run 5,700 line feet, correct for diurnals plot the data, and prepare rough contours.

The result of this reconnaissance survey was that a 200 gamma anomaly measuring approximately 10,750 yards was delineated. This area was then very carefully examined on foot. An old flume ditch was found which ran parallel to the river along the southern boundary of the anomaly. Concealed in dense brush in this ditch we found the entrance to several fairly extensive workings which had drifted along bedrock under the pay gravels. The workings were of the room and pillar type and in excellent shape. Physical evidence indicated they had been abandoned prior to 1900. Twenty-two five gallon bucket samples were taken and concentrated. Results indicated high concentrations of magnetite (0.75% by weight) and free gold values in the .010-.023 oz. Au/c.y. range. The workings were in the dead center of the anomaly. There were no indications of similar workings or economic values anywhere else within the survey area. The probability of having been able to locate these gravels in such a short time without the magnetometer would have been small indeed.

Due to the positive results of the initial reconnaissance, a full scale survey was done of the entire claim group. Approximately 750,000 cubic yards of target gravels were delineated. Subsequent sampling work indicated sufficient pay gravels to support a modest operation of approximately 500 c.y./day. Production is scheduled to commence on a pilot scale level by the early spring of 1983. It can be said with certainty that without the geomagnetic survey, it would not have been possible to develop this property because the exploration budget was too small to sustain the massive drilling program which would have been necessary to locate the pay gravels without this type of data.

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CONCLUSIONS

The geomagnetic survey is a highly cost-effective exploration tool for some types of placer gold deposits. In those cases where it will not work, this determination can usually be made at very modest expense. When it does work, it can generate more useful data per exploration dollar than any other geophysical technique now being used in placer exploration.

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*Editor's note, some references have been changed to reflect current technology