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Tests of piezoelectric methods, Lefroy goldfield

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Introduction

The Lefroy goldfield has been described in detail by Groves (1965). Gold was dispersed in the ubiquitous quartz vein systems to be found in the slates and quartzites of the area, with post-emplacement activity having sheared many of the veins. In order to fully assess the 'reef' content of the area some means for the particular location of the quartz veins was required. Various electrical geophysical methods had already been applied in trial programmes but appeared to yield information of a structural nature. While zones with many veins have been found, mapping of the veins or direct location of position was not possible. Indeed the orientation was uncertain (see Leaman, 1974).

As quartz is a peculiarly sensitive piezoelectric material it was considered that attempts could be made to evaluate the goldfield using piezoelectric methods. Unfortunately neither commercially designed or built equipment nor developed field techniques were available. Only the Russians have attempted experiments in this field and most of these have been laboratory trials. In addition much of the literature is inaccessible, with the notable exception of such summaries as Parkhomenko (1971).

Laboratory trials (e.g. Parkhomenko, 1971) have been relatively small scale and have used two small electrodes and an energy source. Field trials have been of larger scale but have used explosives as an energy source. Seismic records are kept in addition and comparison of the arrival times for both seismic and piezoelectric effects have been used to pinpoint the piezoelectric material. Such a field technique requires good position control and is not economic, as it requires a number of charges for each ground sample examined and may produce records difficult to analyse. No firm procedures are available for the interpretation of such records.

The tests described here included explosive charges and hammer blows as energy sources but unlike the Russian work the vibration source was moved around the area occupied by the electrodes for any given time. Thus a form of traversing was undertaken.

Effect of method and energy source

Figure 1 shows the type of response achieved with different types of energy source. Also shown for comparison purposes is the nature of a seismoelectric effect. In general 'seismoelectric' effects have a greater amplitude and a larger decay time and are due to motion of the pot electrodes. Piezoelectric effects can be related to the impulse imparted by the energy source (note the form from a single blow as compared to motion of the vibrating source).

In each case explosive charges produced a band response, usually of about five seconds duration, irrespective of the shot location with respect to the electrode layout. This could be due to either repeated vibration from the shot producing several responses from a single vein or, more likely, interference from several veins. It is thus nearly impossible in a situation like Lefroy to use the Russian field technique and obtain useful results on vein location as there is a multiplicity of small veins and there is no way to separate the response from any one vein due to time overlaps from nearby veins. The shot band width was more pronounced with increasing shot depth.

Direct percussive actions, such as jumping or tamping with a crowbar, produced much clearer and unambiguous results. With this form of source it was found possible to examine an area with a radius about that of the spread separation, where the centre for such an area is the midpoint of the electrode line. The crowbar was found to be the most effective energy source. In these tests it was not consistently dropped from a uniform height so did not probe to the same depth. It was dropped at a large number of points along a line through the electrodes and where a response was evoked the drop was repeated and the immediate area was similarly tested. In this way it was possible to delineate sensitive zones. By moving the bar sideways whilst embedded in the ground the effect could be enhanced in certain conditions. By systematic tapping it was found possible to trace each vein laterally for several metres.

Factors causing variation of responses

The following discussion applies only to crowbar drops as, already mentioned, explosive sources were neither selective enough nor capable of infinite variation of site.

Strength of the blow. The more energy that could be applied in the region of a vein the greater the response.

Placement of the blow. Most response was observed where drops were over dipping veins or beside nearly vertical veins. In each case more compaction and squeezing of the response resulted. It must be noted that in the

Lefroy area, the veins remain as massive residual accumulations in totally decomposed host rock. Therefore, for good energy transmission and piezoelectric voltage production, the vein or residual quartz must be very close to the 'strike' position. Displacement of 30-50 mm may be sufficient to prevent any voltage being generated.

Depth of blow stroke. The deeper the bar was sunk, the greater the response, due to better energy propagation and greater section of influence.

Number of blows. If the bar is moved whilst seated in the ground a great increase in voltage will be noted when the compressive direction is perpendicular to the vein strike. No response is evoked with motions parallel to the vein. As suggested in Figure 1, motion of the bar will give confirmation of vein presence, imply direction and magnify the response by about three times over the effect from vertical dropping. It is therefore good practice to move the bar at each observation point.

Vein size has not been shown to be a factor although only veins 30-100 mm in thickness were tested.

Results

Wherever a markedly sensitive area was found which could be traced laterally for at least two metres, it was pegged and then excavated. In every case, with one exception, a quartz vein was found. In the exception the test hole was not dug to a great enough depth to encounter the vein. The veins located all trended ENE–WSW, had dips of between 30° and 90°, were between 30 and 100 mm in thickness, and occurred as coherent masses at depths of less than 500–600 mm.

Summary

In regions where there are large numbers of veins, unless it can be shown that larger veins (say several metres wide) have different responses, explosive sources do not provide easy means of vein location. A bar or dropped source moved along a traverse line or the line of the electrodes provides better results and definitely locates veins. In cases where larger veins are present, or where veins are at greater depth, more energy will be required, perhaps more than can be applied with such a source. Examples of this type need to be found and tested.

The equipment required is simple, easily moved and robust. Care must be taken to use water with a salinity approaching that of the local groundwater around the electrodes or bias balance will not be possible on the voltmeter at the sensitivity required.

The types of response noted are characteristic, being derived from impulsive sources, and cannot be confused with telluric effects.

Surface or coherent vein quartz can be distinguished by the form of the response; the former produces broad swells with high frequency effects superimposed. The high frequencies are directly related to the piezoelectric effect and the broader swells (still of high frequency compared to telluric effects) are due to interference from many detached pieces of quartz.

Seismoelectric effects are normally only observed, in the conditions at Lefroy, within 200 mm of the electrodes and are of much greater magnitude than the piezoelectric effect. The seismoelectric effect can be virtually overcome by seating the electrodes well and by providing good contact conditions. The seismoelectric effect discussed here refers to the direct motions of the electrode itself, which is possible because porous pots are used.

References

GROVES, D. I. 1965. Geology of the Lefroy goldfield. *Tech. Rep. Dep. Mines Tasm.* 9:59-76.

LEAMAN, D. E. 1974. Geophysics of the Lefroy goldfield. *Tech. Rep. Dep. Mines Tasm*. 17:79–87.

PARKHOMENKO, E. I. 1971. *Electrification phenomena in rocks*. Monographs in Geoscience, Plenum Press : New York.

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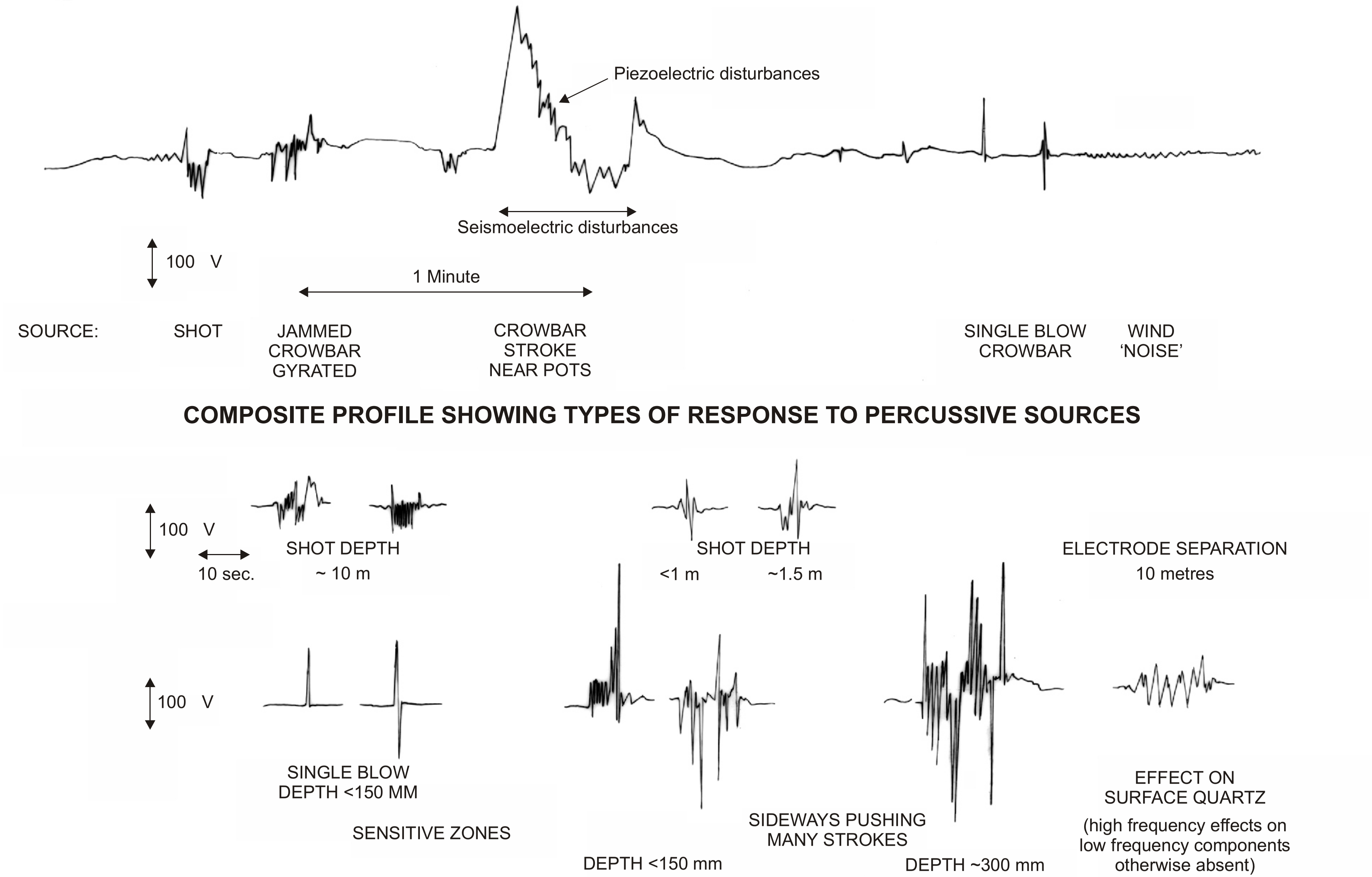
Piezoelectric disturbances
Seismoelectric disturbances
100 V
1 Minute
SOURCE:
SHOT
JAMMED CROWBAR GYRATED
CROWBAR STROKE NEAR POTS
SINGLE BLOW CROWBAR
WIND 'NOISE'
COMPOSITE PROFILE SHOWING TYPES OF RESPONSE TO PERCUSSIVE SOURCES
100 V
10 sec.
SHOT DEPTH
~ 10 m
SHOT DEPTH
<1 m
~1.5 m
ELECTRODE SEPARATION
10 metres
100 V
SINGLE BLOW
DEPTH <150 MM
SENSITIVE ZONES
DEPTH <150 mm
SIDEWAYS PUSHING
MANY STROKES
DEPTH ~300 mm
EFFECT ON
SURFACE QUARTZ
(high frequency effects on low frequency components otherwise absent)

Figure 1