The possible users of GPS are myriad. The civilian uses of this technology are perhaps more imaginative and diverse than those foreseen by the original military designers. In the future, GPS may be used for navigation of automobiles through city streets, or may be available in wristwatch sized versions for the weekend camper. Instrument manufacturers predict a US$6 billion market for GPS by 1996.

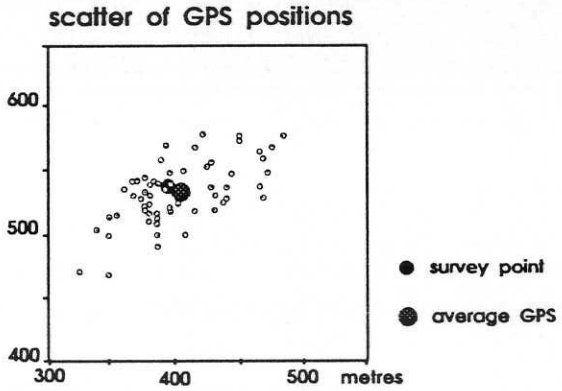

Figure 2 - variation of position with time

THE USE AND MISUSE OF GEOPHYSICS FOR BOREHOLE SITING IN THE KALAHARI

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In the last two decades, geophysics has played an increasingly important role in the siting of boreholes for groundwater. In areas with extensive alluvial cover such as parts of the Kalahari, this increase appears to have been more prolific. Both consultants and contractors continuously search for the perfect modern day "black box" that will replace more traditional techniques that perhaps may operate on a slightly less scientific basis.

With this increase in the use of geophysics for borehole siting, there has been a steady increase in the number of non-geophysicists utilising these methods. While often this does not pose a problem if these individuals have a suitable background in science to understand the physics of the problem at hand, there have been numerous instances of the wrong geophysical method being utilised to measure the wrong physical parameter in the search for groundwater. When proper data has been collected, it has often been incorrectly interpreted. Both non-geophysicists and geophysicists have been guilty of this transgression.

This talk serves to outline the different geophysical techniques available for siting boreholes in various aquifer types and the proper manner in which they should be employed. The discussion is primarily confined to the more conventional techniques currently employed in Botswana (magnetics, VES, EM and gravity) under the assumption that more sophisticated and expensive methods such as controlled source audio-magneto tellurics (CSAMT), reflection seismic and time-domain EM would not be employed in siting bores.

Potential field methods such as magnetics and gravity, are only effective if there is a sufficient lateral contrast in the respective physical properties of the various units within the survey area. Ground surveys with these methods are

generally best suited in defining structure, which in turn tend to be the best drill targets in fractures and fractured-porous aquifers. The resolution of structural features with these methods is primarily a function of survey quality and choosing of the appropriate station interval for the anticipated target. Given the high cost of detailed gravity surveys, this method is less appropriate for siting individual boreholes; however, it is generally very applicable in regional scale work for defining prospective areas for more detailed follow-up, especially in the Karoo.

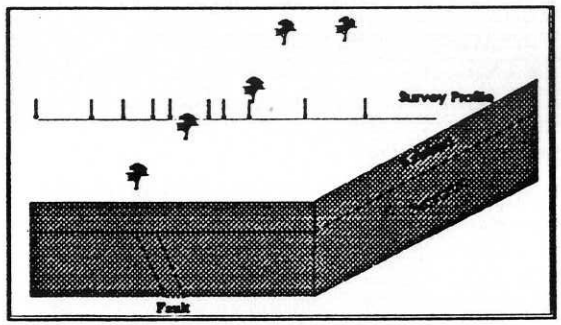

Figure 1 Common Mistake
Siting VES on a fault

Electromagnetic profiling has proven itself to be one of the most effective and successful methods for the siting of boreholes in Botswana. Although the equipment is relatively straightforward to operate, the choice of the proper cable length and operating frequencies is critical to the success of a survey. Typically the cable length chosen is either too short to allow the signal to penetrate to the anticipated target depth, or, the longest cable available is used. This latter configuration decreases resolution and further increases an already conductive background response which in turn dominates and masks the anomalous response. With the exception of porous aquifers, EM profiling is generally effective in all aquifer types in Botswana, provided the survey is properly designed.

VES is perhaps the most widely used geophysical technique in groundwater work and borehole siting, and not surprisingly is the most abused. Interpretation of this data is based on the assumption that the area being surveyed is void of any lateral discontinuities; however, these soundings are quite often sited on interpreted faults, thus invalidating the very basis of the technique. With the exception of work in porous aquifers, this method is generally inappropriate for use in siting individual bores. It is, however, useful in regional scale work in virtually all aquifer types in Botswana.