WHERE ON EARTH ARE WE? (Applications of GPS satellite navigation in Botswana)

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The development of portable and affordable satellite positioning systems has greatly improved navigation in the Kalahari Desert, and is of great interest to all geoscientists working in remote areas.

As a result of rapid develpment of satellite technology since the early 1960s, several satellite navigation systems came into use. TRANSIT of SATNAV was developed by the United States Navy, while ARGOS, SARSAT and STARFIX are examples of civilian and commercial systems. The former Soviet Union also designed its own GLONASS system, the future of which is perhaps uncertain.

The Global Positioning System (GPS or NAVSTAR) has been developed by the US Ministry of Defence in the 1970s to eventually replace the TRANSIT system. The full GPS satellite constellation consists of 21 operational and 3 spare satellites and should be completed in 1993 (Figure 1). As of this date, there are 17 operational satellites in orbit, enàbling 24 hour 2-dimensional position fixing. Until the complete constellation is operational, 3-dimensional positioning may be available only part-time.

Early positioning instruments using the TRANSIT satellites were bulky and required several days of recording to achieve 1 m accuracy. The development of

the GPS technology launched navigation and surveying into a new era. There are

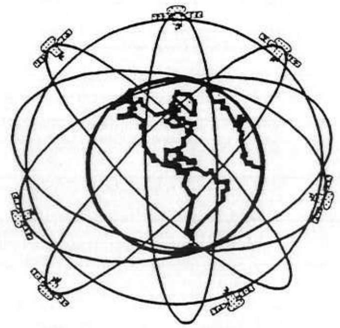

Figure 1 - GPS satellite constellation

two levels of accuracy of GPS instruments: Coarse Acquisition (CA) used primarily for navigation; and Precise Positioning Service (PPS) Systems employed for survey applications.

CA receivers are more common in the earth sciences because of their low cost, portability and real-time positioning capabilities. The standard technology of these CA instruments is easily capable of 100 m in seconds. This accuracy may be improved to perhaps 5 m by recording the data over a period of about 20 minutes and analyzing the statistical variation of position with time (Figure 2).

The new GPS technology is very quickly becoming established in applied earth sciences in Botswana. During recent field work in the Okavango Delta, three different GPS instruments were used for mapping the occurrence of Acacia Spp and Salvinia Molesta (Kariba Weed), borehole surveying, water sampling of the Boro River system, and game tracking. The Geological Survey of Botswana use GPS receivers for navigation in the Kalahari, and point positioning for regional gravity surveys.

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.

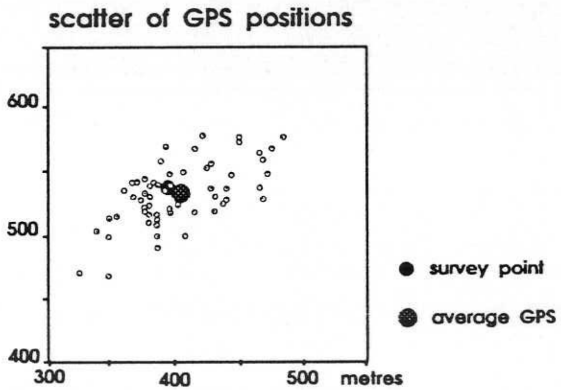

Figure 2 - variation of position with time

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