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Groundwater exploration in the Voltaian system

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Abstract

A large portion of the Voltaian Basin lies within the drought-prone areas of Ghana. A vast majority of the inhabitants of the basin is rural-based farmers who depend mainly on water from ponds with ephemeral streams and depressions for water.

During the dry period these surface supplies are usually exhausted leaving the farmers desperate and highly exposed to water-borne diseases.

Groundwater development offers the best alternative in this area. However, attempts to improve the groundwater situation have been beset with problems associated with exploration and development methodologies, to the point that certain areas have been excluded from groundwater exploration due to their unfavourable morphological and geological setting. This paper attempts to address this teething problem by combining the use of remote sensing techniques, geology and geophysics.

Follow-up field studies have revealed that it is possible to find sustainable groundwater for most of the communities if regional surveys take precedence over local site investigations.

This would involve higher cost in the short term while the long term results would be cost-effective.

Introduction

The Voltaian Basin, largely underlain by argillaceous, fine arenaceous and carbonate rocks occupy about 43% of the land mass of Ghana and it is drought prone. Mean annual rainfall is about 1000 to 1150mm with evaporation as high as 80%.

A vast majority of the inhabitants are rural based and attempts at addressing the perennial water shortage have met with mixed success. Success of drilling depends on secondary porosity in fractured sequences, with yields in most cases being as low as 10 l/min.

Analysis of groundwater availability in the same formation differs from one report to another (Van der Kamp, 1981; NORRIP, Water Sector Report, 1982; Van Ess, 1982; Bouma, 1988; Sommelet, 1990). Reasons for this mix up may be adduced from fast facies changes in the Voltaian, density and extent of tectonic signatures that characterises the Basin from east to west.

Fracture systems are more regional and dense to the east of the basin along with coaser and more arenaceous lithology more ameable to groundwater storage. Towards the centre tectonic features such as fractures, turn to be more localized and sparse and the lithology is more argillaceous and compact.

This picture presents genuine difficulties in locating aquifers for sustainable water supply to these communities. Traditional rule-of-thumb methods of locating aquifers would have to give way to the use of satelite imageries, aerial photographs and geophysics.

This paper seeks to present a more regional approach by combining terrain analysis involving morphotectonics and aerial photographs interpretation, geology and geophysics as the key to improving the success rate in this terrain.

Results of case study

A few centimetres beneath the soil is usually lateritic hardpan which rests on the bedrock. There is practically no percolation below the hardpan resulting in extensive flooding with little run off due to the low relief. Most streams dry up during the dry season. Groundwater recharge is mainly through fractures which have variable laterial extent and densities.

In the study area, out of 38 testholes, the success rate was 13%. All previous drilling operations were not successful. Sixty-one percent of the drill holes intercepted fractures between 15 and 30m depths. Most of these fractures seem localized and of limited extent and cannot sustain any community. The location of the boreholes was done by aerial photographs and terrain features to pick sites for geophysical studies.

The solution seems to be an areal approach in locating sustainable aquifers on the central part of the Voltaian Basin, by wider area of not less than 2 x 2 km per village in order to locate fractures. The area should be demarcated using satellite imagery and/or aerial photographs and geophysics. Using this approach, it is expected that the extent of the fractures, density and degree of water connection would be established.

A follow up geophysical survey using VLF-EM and Electrical Resistivity Methods on a wider 2 x 2km coverage on 3 communities in the West Gonja District (Sheri, Mpaha and Kpalbuso) revealed that:-

At Sheri where a yield of 150 l/min was recorded the borehole was on an extensive fracture at depths of 24m which continued beyond the area of survey.

At Mpaha a yield of 12 l/min was located at the edge of a limited fracture at a depth of 22m, while other extensive fractures like those of Sheri were also found to be present in the area.

At Kpalbuso with a yield of 2 l/min the borehole was located on a minor fracture at the depth of 13m leaving major fractures untapped.

The survey also showed the interconnection between some of these fractures which could have been an added parameter or tool in siting the borehole.

Conclusion

It is obvious from the foregoing study that a combination of satelite imageries, photo interpretation and geophysical study of an extended area rather than a limited site would afford a wider choice of reliable locations for rural water supplies to communities underlain by impermeable and difficult terrain such as the central part of the Voltaian Basin.

References

Banerman, D. 1988. Preliminary note on the groundwater resources in the Voltaian Sedimentary Basin in the Northern Region of Ghana. Rural Water Supply in the Archdioceses of Tamale, Sewa Report 8800.

Sommelet, H. 1990. Hydrogeological assessment of 350 boreholes programme in Yendi and East Mamprusi. NORRIP.

Van der, Kamp 1981. Test drilling programme in the Northern Region - Preliminary appraisal of results to May 1981. NORRIP sectional report.

Van Ess, R.K.D. 1982. Groundwater potential of the sedimentary basin in the Northern Region. Unpublished report.