Discussion on ‘An investigation of the basement complex aquifer system in Lofa county, Liberia, for the purpose of siting boreholes’ *Quarterly Journal of Engineering Geology and Hydrogeology*, Vol. 47, 2014, pp. 159–167

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The Authors (Elster et al. 2014) raise the important issue of knowledge loss contributing to the difficulty of effective borehole siting for water supplies in Liberia and are to be commended for publishing their investigations leading to verification of the standard conceptual model of basement complex weathering in Lofa county.

It is unfortunate that the Authors probably have no awareness of the DANIDA funded project in Maryland county, Liberia carried out in 1986/1987 before the civil war. A team of staff were trained by us to use ABEM resistivity equipment for traversing with Schlumberger spreads to locate fractures in basement complex rocks for village water supplies although the actual drilling work took place in a later phase.

Where knowledge loss is a likely issue, as in Liberia, an important step would be to contact aid agencies and non-governmental organizations other than the immediate project sponsors (in this case Action Contre la Faim) to collate previous experiences. The Authors highlight the issue of long-term knowledge sharing and data storage which we suggest is set against a backdrop of short term inputs by consultants, institutional re-organisations and the inherent difficulties of storing data electronically over extended periods.

The Authors note that 19 boreholes (26%) in Lofa failed to produce 1 m³ h⁻¹ of which 15 had less than 4 m thickness of saprolite. If the median specific capacity of the successful boreholes was 280 l h⁻¹ m⁻¹, we infer from their figure 5 that the median of all boreholes was close to 230 l h⁻¹ m⁻¹. Cumulative frequency curves for specific capacity in figure 7 of Hazell et al (1992) show that granites with pink (orthoclase) feldspar had higher specific capacities than other types of basement complex rocks in Kano State Nigeria when sited using the combined electromagnetic traversing (EMT) and vertical electric sounding (VES) method of geophysical exploration (this method has been described in detail by Beeson & Jones 1988). The higher success rate of combined methods is also clear from figure 19 of Barker et al. (1992). Did the Authors have the opportunity to determine the types of granite in Lofa county or the types of geophysical investigation that had been used for siting?

It is our experience that traversing can usually reveal significant variations in the subsurface over distances of 50 m or more, so it is worthwhile to carry out a reconnaissance survey even in areas of good aquifer potential. It is noted that this is evident in the pseudo-section at Halipo (Elster et al. 2014, fig. 7), which is 128 m long (about 30 m wide at the maximum penetration depth of 24 m at the centre of the section) and where the borehole was sited within an area of relatively low resistivity about 32 m from the start of the section. We suggest that EMT would have been as effective a tool, and more appropriate if greater distances had required investigation. Did the Authors have the opportunity to benchmark a 2D pseudo-section against other methods in use in Lofa county?

We suggest that the Authors did not provide sufficient detail in their conclusions on the standard techniques used elsewhere. It is, in fact, vital that the techniques should be rapid and effective (for example, distances of more than 1 km per day can be traversed with EM equipment yet water-filled fractures less than 20 m wide and up to 60 m below ground can be identified), flexible in terms of negotiating obstructions, and easy to use and interpret by non-specialists whilst accounting for depth to water and groundwater resistivity. It is important not to ignore the considerable efforts both current and in the past to report rapid and reliable investigation methods based on relatively simple equipment. We note, for example, that across Ghana the combined EMT/VES method is the standard geophysical tool that is used by hydrogeologists at the Community Water and Sanitation Agency to site boreholes in basement complex aquifers for small town supplies.

Finally, it is our experience that the most effective approach to achieving a successful result when siting boreholes in basement complex rocks is that the person who chooses the site on the basis of the geophysical survey must also understand the particular hydrogeological environment of the site and should also be the person who shows the driller the site and supervises drilling of the borehole. Most countries we have worked in now have indigenous staff with this expertise. However, given Liberia’s recent troubles, it might be an exception.

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Reply to Discussion on ‘An investigation of the basement complex aquifer system in Lofa county, Liberia, for the purpose of siting boreholes’ Quarterly Journal of Engineering Geology and Hydrogeology, Vol. 47, 2014, pp. 159–167

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Hydrogeological knowledge is vital for developing sustainable groundwater supplies globally. This is particularly true for the underpinning data from basement complex areas, such as those in Liberia, with complex hydrogeology and where past political instability has led to information and knowledge loss. The Authors are therefore appreciative of the attention paid to their paper (Elster et al. 2014) by the Discussers (Beeson & Jones) and welcome the opportunity it provides for discussion on this important topic.

In Liberia, Action Contre la Faim (ACF) works in a consortium with Concern Worldwide, Oxfam GB, Solidarités and Tearfund. As intimated by Beeson & Jones, these organizations were not able to provide details of any previous work they or others had conducted on the basement complex aquifer system in Lofa county. There was also no information available on any geophysical methods used for siting boreholes previously in this area.

We agree that electrical resistivity traversing does indeed enable investigators to detect significant changes in subsurface resistivity along large section distances, assuming that surface vegetation does not hinder access. However, such an approach was not seen as a potential advantage in this case, as the boreholes needed to be sited close to the specific villages and the study looked to understand local groundwater occurrence in a range of key features, including deep weathering zones, fracture zones, weathered dykes and seasonal wetlands. In our study, we considered that the advantage of the improved hydrogeological interpretation gained from the depth information provided by 2D electrical tomography and the greater ease of laying out the cables, given the dense local vegetation, outweighed the shorter lateral distances covered.

We recognize that electromagnetic induction (EMI) systems, such as the EM-34 which can give variable depths of exploration down to 60m, are commonly used for groundwater exploration. However, the only functioning equipment available to the researchers at the time of the study was for 2D geo-electrical surveying, so no comparisons were possible with other types of surveys. However, one of our recommendations at the time was that ACF should consider the purchase of electromagnetic equipment to use in the future, given the faster surveying over larger areas and the relative ease of use in densely vegetated areas.

The hydrogeological and geomorphological mapping and borehole siting was conducted in collaboration with the local drilling team who did understand the particular hydrogeology of each site. Also, the study concluded with a 4-day lecture and practical workshop on improving borehole siting with geophysical and hydrogeological methods, attended by 18 participants from ACF partners (non-governmental organizations, governmental institutions and the UN). Beeson & Jones are correct to highlight this need, as building local capacity is a vital step in achieving safe water supplies.

Our search for previous studies that might inform the research focused on Lofa county and the geographically and geologically similar Nimba county in north eastern Liberia, although discussions were also had with the Liberian Geological Survey, Liberian Hydrological Survey and the University of Liberia. Unfortunately this resulted in the details of the DANIDA funded project mentioned by Beeson & Jones being overlooked as it was based in Maryland which is 1000km away in the far south of the country. However, a broader search of the British Geological Survey’s online library catalogue and DANIDA’s Research Portal failed to identify the DANIDA study referred to by Beeson & Jones. We agree with Beeson & Jones that this demonstrates the need for information sharing between agencies but it also highlights the importance of archiving and retaining research and consultancy outputs in accessible and maintained repositories for possible future use by the hydrogeological community.

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Reference

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