

In the Middle East, where scarce water resources are a potential focus for conflict, an accurate description of the aquifer system can be an essential instrument of the political debate, as Nick Robins explains.

A new map for the West Bank

The *Hydrogeological Map of the West Bank* has recently been published by the BGS on behalf of the Palestinian Water Authority (PWA) through the Sustainable Management of West Bank and Gaza Aquifers (SUSMAQ) project. The map is at 1:250 000 scale and fully conforms with standard UNESCO legend for hydrogeological maps. It includes a number of inset diagrams portraying various aspects of the geological framework, hydrogeology, hydrochemistry, climate and other details. The project was funded by the UK Department for International Development.

The map is of significant and widespread interest. It describes an aquifer system which is the focus of political debate regarding the equitable apportionment of groundwater on both sides of the Green Line separating Palestine and Israel. As such it is intended to inform those involved in the discussions. Work on the creation of the GIS format database began in 1996 as a means of increasing access to the many and diverse data then held by the PWA. The first layers to be created were catchment boundaries and wadi bottoms, followed by borehole and spring locations. This enabled borehole and springflow monitoring data to be accessed using spatial criteria as well as source name and date. Over the ensuing eight years, not only has the database

expanded but so too has the understanding of the hydraulics of the Mountain Aquifer System. A number of comprehensive aquifer evaluations and groundwater flow models have been made as components of bilateral aid, and these have added to the overall knowledge base. In addition, new mapping and remotely sensed data have enabled the geological map to be considerably enhanced. Many of these findings have been incorporated into the GIS so that a comprehensive data holding was created using ArcView™ as the core software.

An important element of the work was a remote sensing geological and hydrogeological interpretation of the West Bank aquifers, which the BGS

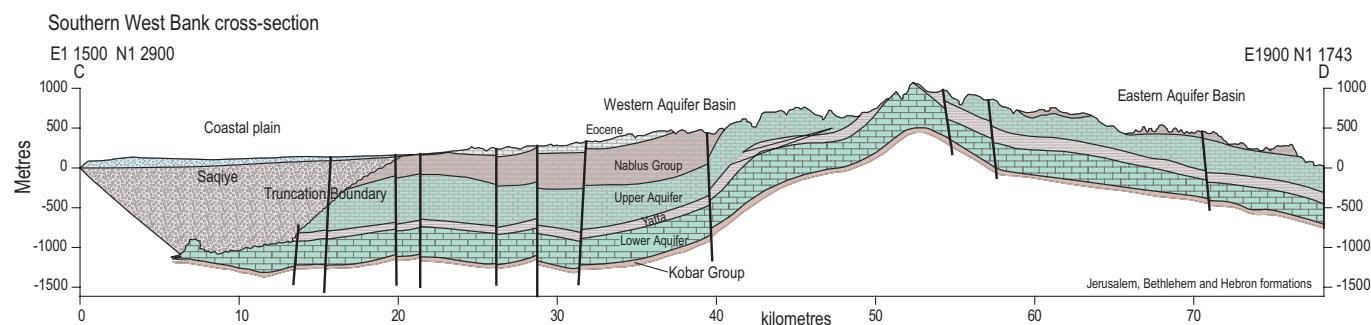
carried out in 1997. It was the intention of the BGS and the PWA that this would be used as the basis for further hydrogeological map development. It was also intended that the hydrogeological map would be a GIS product.

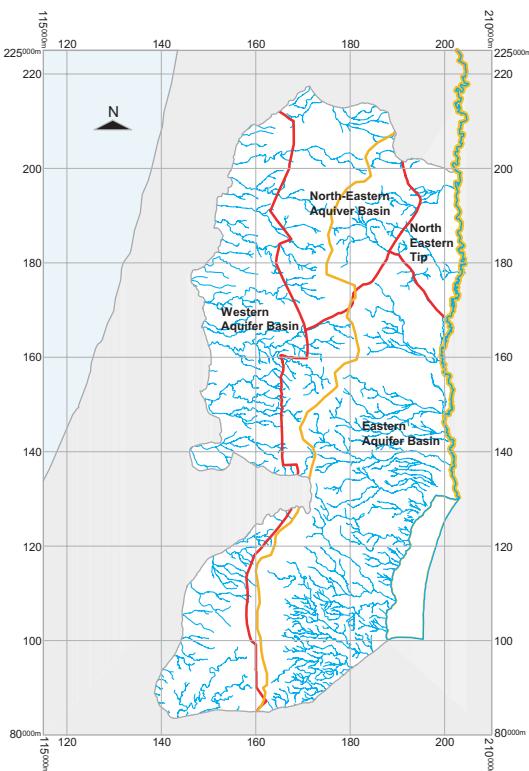
The Mountain Aquifer System

The West Bank contains the core of the limestone Mountain Aquifer System. It is divided into four parts and is a complex anticline system in which the older rocks are exposed at the core, the younger at the margins. A broad subdivision of the Mountain Aquifer includes:

- First Aquifer = the Shallow Aquifer.
- Second Aquifer = the Upper Aquifer.
- Third Aquifer = the Lower Aquifer.
- Fourth Aquifer = the Deep Aquifer.

The traditional view of the Mountain Aquifer comprises three basins: the Western Aquifer, Eastern Aquifer and the North-Eastern Aquifer basins. The piezometry and geological structure indicate a defined groundwater divide





The West Bank aquifer basins.

between the Western Aquifer and the Eastern Aquifer basins, and between the Western and North-Eastern Aquifer basins. These divides run parallel to the surface water divides although there is a considerable offset of the groundwater divide to the west towards the crest of the anticline. The divide between the North-Eastern and the Eastern Aquifer basins is less certain, and although the Upper Aquifer is separated between the two the Lower Aquifer may be in continuum. However, the Eocene component of the First Aquifer is entirely contained within the North-Eastern Aquifer Basin.

Preparation of the map

The sources of data were diverse. The geological base map is a composite

derived from available mapping and remotely sensed data. There is a stratigraphical table with the map that shows both the Palestinian and Israeli terminology for reference.

The data for the map were compiled in ArcView 3.1, ArcMap™ not being available for use at the time. Data were received in a variety of formats, including shape files, drawing files (CAD) and text files. The ArcView compilation was maintained as a single entity in order that a mock-up of the final printed map could be generated at any time.

Initially the cartographers' remit was to take the original draft data and to arrange it in such a way as to produce a

high-quality lithographically printed map. It became apparent that rearranging would not deliver the desired result and a more thorough redesign would be necessary. Normal quality assurance procedures were followed where the final digital file was printed as a single full colour plot plus cyan, magenta, yellow, black and spot purple separations. Once approved the file was sent to the printers, Victoria Litho in London and the map was produced.

The Hydrogeological Map of the West Bank is available from BGS price £10.

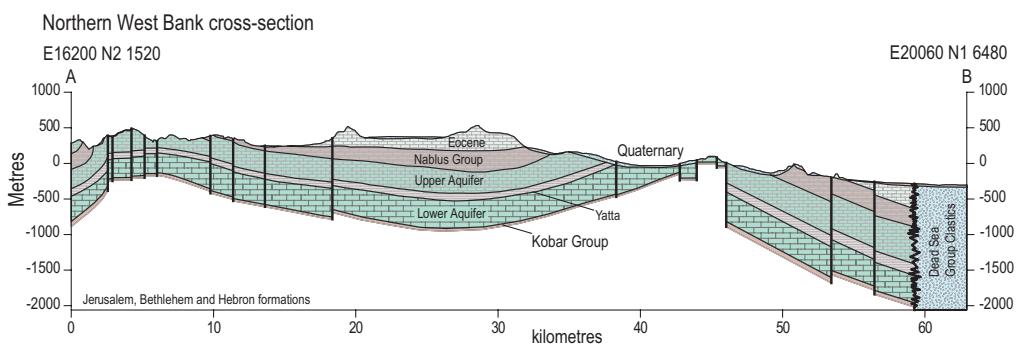
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The SUSMAQ website can be found at: www.ncl.ac.uk/susmaq



Public water supply pumping station near Hebron-Beit Fajjar Borehole.



Cross-sections through the Mountain Aquifer (inset diagrams from the map).