Tools for visualising data

The South Downs aquifer

Visualisation and 3D modelling using Vulcan

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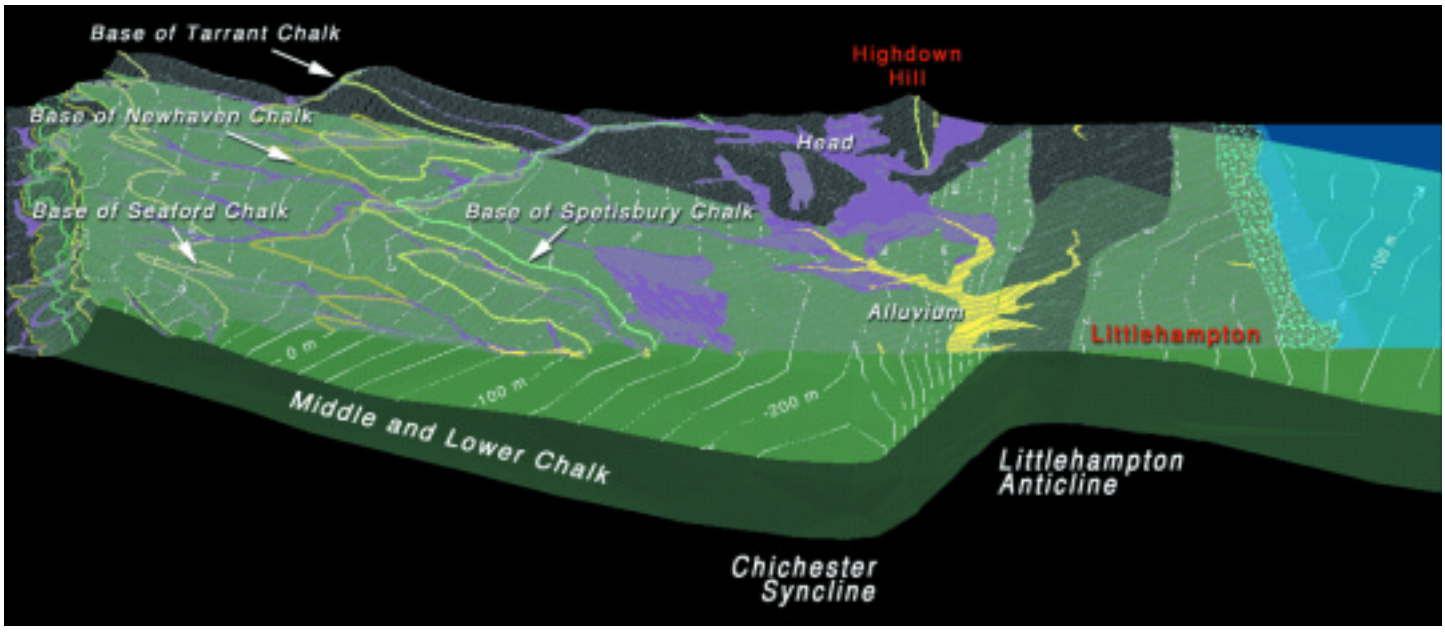
The BGS's National Groundwater Survey is an ongoing project investigating the major aquifers of England and Wales in which the first study area was the South Downs. This work brought together the available data on this important Chalk aquifer, and presented it within the context of modern geological interpretation. The product was the BGS Hydrogeological Report *The Chalk Aquifer of the South Downs*. This has now become the foundation for a new project in collaboration with the Water Resources Team at Southern Water.

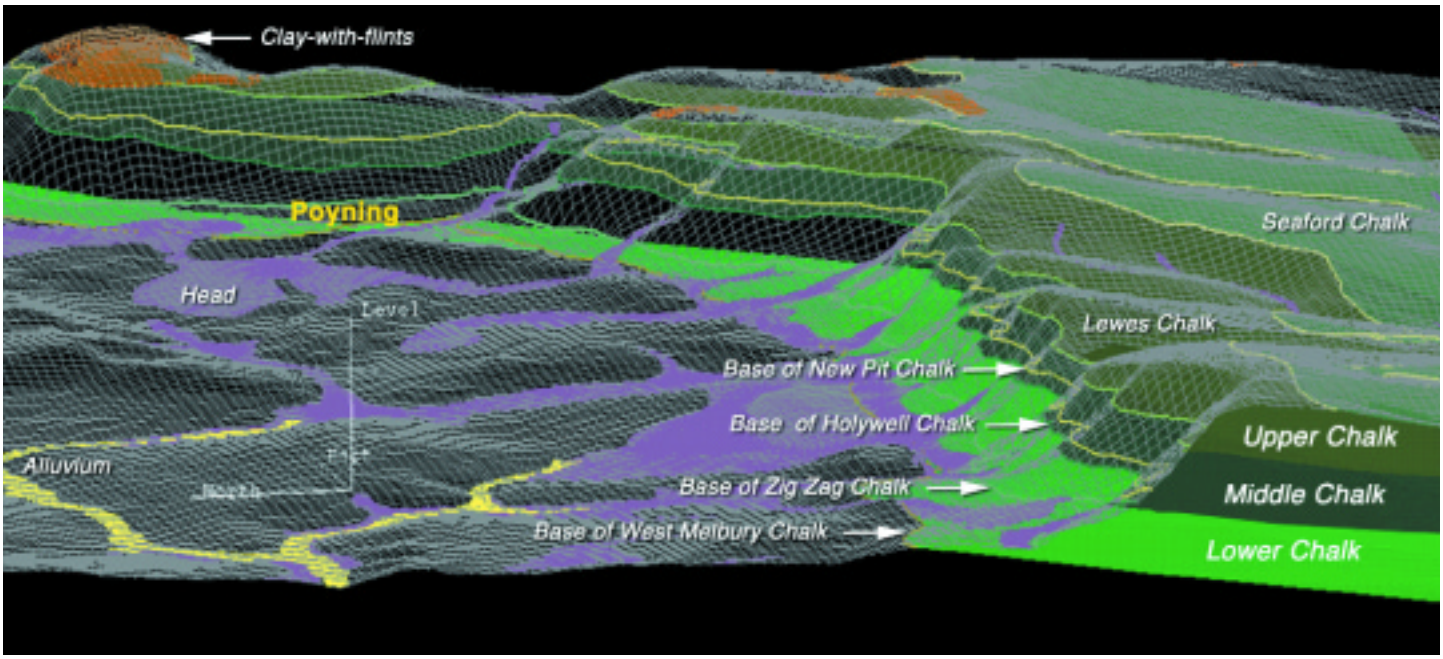
This new project concentrates on the central area of the South Downs, between Arundel in the west and Seaford in the east. It assimilates all available data, including new and reinterpreted data, in order to develop an understanding of the aquifer sufficient to develop a conceptual model of the groundwater flow patterns. The core of the study is a three dimensional geological and structural model of the area which has now been constructed using the sophisticated Vulcan® 3D modelling and visualisation software.

The traditional threefold classification of Lower, Middle and Upper Chalk has recently been subdivided into ten formations based on a reinterpretation of the lithostratigraphy. Originally established in the Wessex Basin, this new interpretation has now been continued into the Brighton and Worthing district and forms the basis for the model. The digital linework of the new mapping has been overlaid on to an Ordnance Survey digital topographical surface, instantly creating a 3D geological map. Interactive manipulation of the model within Vulcan® allows viewing and design work to be carried out at any angle, orientation and scale, including cross section slices (see the sample screen shots). This enables the construction of true 3D representations of the geological surfaces from outcrop lines extending down-dip into the subsurface.

A great deal of historical data has been fed into the model. Existing logs of boreholes are generally classified only as Upper, Middle and Lower Chalk, and therefore were not immediately useful for constructing the model. However, down-hole geophysical logs have been re-examined to identify the



An oblique view of the South Downs from the Vulcan® model, looking east to illustrate the geological structure from the northern escarpment to the English Channel. The contours on the base of the Upper Chalk are at 20 m intervals.



An oblique view of the South Downs from the Vulcan® model, looking west along the northern escarpment.

new lithostratigraphical Chalk formations. Also, reinterpretation of an extensive series of seismic lines (originally for hydrocarbon exploration) has provided detail of the structure of the base of the Chalk extending from the northern escarpment of the Downs to some 15 kilometres offshore.

Although still under construction, the Vulcan® 3D model has already been of value in highlighting uncertainties in some areas of sparse data. The model also demonstrates the geological structure of the area and has been of assistance to the field geologists in their own interpretations.

Other primary data collection has included hydrogeochemical sampling, borehole geophysics, survey of karstic features, surface geophysics, and evaluation of hydraulic data in the south-western corner of the project area. The last two of these studies are student projects at the University of Birmingham. Many of these data will be incorporated into the 3D model.

The earlier project on the South Downs suggested that some of the lithostratigraphical Chalk formations were hydrogeologically more important than others due to their different fracture patterns and hydraulic properties. As most of the boreholes had been drilled before the new classification of the Chalk was introduced, there was no means of testing this. However, the Vulcan® 3D model now makes it possible to assign the new lithostratigraphy to these existing water boreholes, and so test this hypothesis.

The productivity of the Chalk aquifer is also influenced by:

- solution-enhanced bedding plane features and discontinuities. Even though certain horizons are more likely to be fractured than others, dissolution needs to have taken place for the fractures to contribute to groundwater flow
- whether or not the higher permeability horizons are within the saturated zone of the aquifer
- whether or not a borehole actually intersects a yielding fracture or fracture system, and
- whether there is lateral continuity and hydraulic connectivity between fractures

The Vulcan® model has highlighted areas of anomalous dips and discontinuous bedding planes which may be associated with previously unidentified faulting and fracturing. Visualisation of the folded unconformity beneath the Palaeogene (Reading Beds and London Clay) in the axis of the Chichester syncline reveals it to be a highly irregular surface. These deposits are significant because they restrict Chalk groundwater flow across the syncline.

The next stage in the project is to overlay the conceptual groundwater flow paths on to the 3D model. Maximum and minimum elevations of the groundwater table (March and September 1993) are being used to define which Chalk formations are likely to be saturated and whether these horizons appear to be contributing to high transmissivity and to borehole yields. The model will then be used to determine productive aquifer volumes for any given configuration of the water table.

The end result will be a digital compilation of much of the hydrogeological data pertaining to the central area of the South Downs. On top of this will be the conceptualisation of the prevailing groundwater flow systems. This model may then become the foundation for a digital operational groundwater model for the area, which could be developed to analyse any specific problems in the aquifer that may arise in the future.

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