Environmental Research &
Information Consortium Pty Ltd
(ABN) ACN (81) 055 194 771
Ph 02 4842 8182
Fax 02 4842 8183
info@eric.com.au
www.eric.com.au

# Groundwater Bore Location

## Application

Water is now identified as limiting for most developments. Surface water resources are largely committed and in some regions have negative growth potential. Groundwater resources provide an alternative but there are many uncertainties, particularly relating to the probability of obtaining water when drilling.

The surface structure by way of topography controls the distribution of surface water. Groundwater distribution is similarly controlled by subsurface structure and is strongly three dimensional. Knowledge of the subsurface structure is a basic requirement when exploring for groundwater.

Broadly, surface water is associated with lakes or streams where each has its own characteristics. Lakes represent reservoirs where the water issues relate to rates of supply and loss, and water quality. With streams the main issue is the flow rate which is largely determined by the catchment characteristics and rainfall.

Groundwater can be similarly classified to surface water. Underground basins or aquifers are similar to lakes where layers of porous material contain water that can be extracted by pumping. Drilling records provide information on the depth, extent and water quality of such aquifers so that the key development issue is the sustainable rate of extraction.

Locating a bore is simple where the basins are known. However, the water in basins can have low quality because of the often long period of storage of water and the mineral characteristics of the geology.

Geology determines the existence of basins with their occurrence limited to particular structural formations. However, extractable groundwater also exists in other subsurface structures such as fractures and fault lines, and these have more general occurrence. Such structural features represent preferred pathways for the subsurface flow of water and so can be regarded as being equivalent to streams.

Fractures and fault lines are difficult to locate due to their sub-surface occurrence and localised nature. Historically their identification has depended on visual interpretation of the terrain (surface topography). Several electronic instruments now exist that provide information on their location and nature where most respond to small variations in the earth’s magnetic field caused by structural anomalies. The occurrence of water in fractures accentuates the magnitude of alteration to the magnetic field.

The main limitation in Australia to the instruments designed specifically for groundwater location is the reliance on a network of low frequency communication towers. The location and distribution of the nearest towers, one on the west coast of Australia, the others in Asia, Japan and Hawaii, is limiting. Another instrument that can provide similar results is expensive to purchase and operate. Other instruments that can be used to explore for near surface basin type aquifers do not have the resolution needed to locate fractures.

## ERIC Approach

The ERIC implementation of groundwater bore location is based on traditional mineral exploration methods of combining interpretation of imagery that provides information on subsurface structure. The developments relate to the range of imagery and image processing techniques used to obtain information relevant to groundwater location.

Geological fracturing and faulting often has surface expression, particularly as linear features (lineaments). While aerial photography only images the very surface of the earth it contains information on subsurface structure. This surface expression of subsurface structure also occurs in detailed topographic data such as provided by radar imagery. Airborne and satellite radar is particularly sensitive to surface structure and can be interpreted to identify subsurface structures.

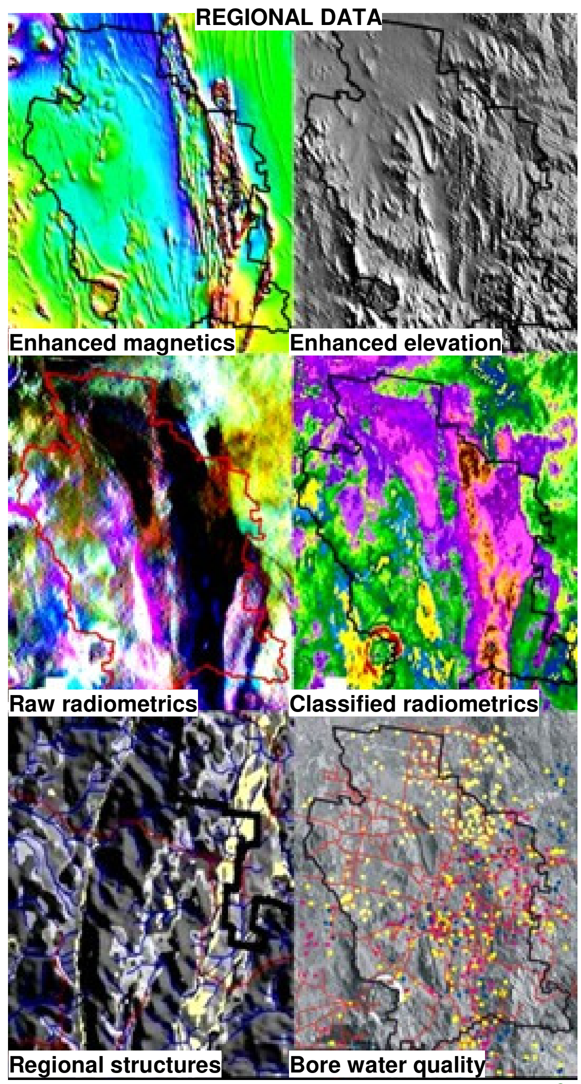
Airborne geophysical imagery responds to conditions under the surface and so provides information on subsurface structure. A number of different measurements can be obtained but only two forms of data are generally available. Airborne gamma radiation data (radiometrics) reflect the mineralogical nature of the material surficial conditions to around 0.5 m. Magnetics measure the deformation in the earth's magnetic field by materials down to around 150 m.

The radiometrics measurement is surficial but, as with aerial photography, it provides information on the occurrence of much deeper structures. As the radiometric measurement responds to the mineralogy it provides information not contained in optical imagery. Airborne magnetics effectively only provides deep structural information. Airborne magnetic data is most suitable for groundwater exploration in highly resistive geologies such as sand dunes.

While no method exists that identifies the occurrence of groundwater other than drilling there is information that can be used to increase the chances of success.

### Data Analysis

The analysis of all imagery ultimately depends on visual analysis but different image processing techniques are used to enhance the features of interest. The main analytical method enhances the structural information in the image and this can be applied to all forms of data. However, the radiometrics are often noisy and such analyses tend to accentuate the noise. Other procedures are used with radiometrics to clearly define differences in mineralogy and thereby aid the identification of unconformities such as fractures.



Maps are produced that provide information on subsurface structures. These maps examine the region surrounding a landholding as extensive fractures are of most consequence. As with surface water, the water supply depends on the size of the catchment area. Locating groundwater in paddocks involves identifying the local occurrence of general features having regional expression.

The regional data identify the general constraints and this is readily apparent in regional elevation and magnetics data. The relevant information is seldom apparent in raw radiometric data but the classified radiometrics provide a clearer picture, particularly when highlighting the most significant classes. Structural features identified in the 'regional structures' image include fault lines that represent pathways for subsurface water movement that extend across the boundary of the Lauchlan and Murrumbidgee river basins.

The regional information can be related to records for bores. While many records do not identify water quality and/or flows, the information identifies considerable local variability.

## Implementations on land holdings

Large regions contain many opportunities for locating groundwater but most requirements relate to obtaining groundwater on individual landholdings. On localised areas there may be little opportunity to obtain groundwater as the number of prospective sites decreases with the size of the survey area. Where there are opportunities, which is usual, the issues relate to identifying the main structures and to achieving the accurate location of the bore hole needed for success.

The example images for lineament analysis are for Yass. The regional images allow identification of the major lineaments having regional expression. These allow identification of prospective locations, as illustrated in the 'zoom in images' for the area of interest.

With structural analysis major features are often evident in several forms of data even though the different forms of data contain different information. For example, the lineaments identified in the radiometric analysis are also apparent in the magnetics and this indicates that they are major features. The point of intersection between major lineaments, as in the radiometric image, is always highly prospective.

Good water quality is a key advantage with obtaining groundwater from fractures. Groundwater obtained from fractures can have high quality even in areas with saline materials where groundwater from basin type aquifers is saline.