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GPS Application for Groundwater Resource Assessment, Hermanus, South Africa

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TrigNet (http://www.trignet.co.za/footprint/home.jsp) is a network of permanent continuously operating GPS (cGPS) base stations distributed throughout South Africa at approximately 200 – 300 km spacing. Data from 21 of the stations is continuously streamed to the TrigNet control centre in the offices of the Chief Directorate: Surveys and Mapping, from where it is made available within 30 minutes after each hour for 24 hours a day. All stations record 1-second epoch data on both GPS frequencies (L1 and L2) through geodetic-standard choke ring antennas.

The real-time Trignet station HERM is situated in the grounds of the Hermanus Magnetic Observatory (HMO), in a coastal town about 100 km SW of the City of Cape Town. The Overstrand Municipality of the Greater Hermanus Area has embarked on a major groundwater development to augment the water supply. As a foundation for sustainable management of the groundwater resource, a detailed monitoring programme was developed for a better understanding of the hydraulic system, and of the interconnections between surface water, the shallow primary aquifer and the remarkable, deep, fractured-rock (FR) aquifer of the Table Mountain Group (TMG), which underlies a large part of the Western Cape province in South Africa.

A thick, extensive FR aquifer system like the $\sim$1 km thick Peninsula Aquifer in the TMG provides an opportunity for fundamental advances in understanding interactions between fluid flow and mechanical deformation, through analysis of the "hydro-mechanical" coupling in FR permeability, fluid transport and deep storage in FR porosity. Present knowledge of skeletal-framework compressibility, the main factor in specific storage, is based on published data from similar rocks elsewhere. Up-scaling from dry-sample laboratory measurements of elastic properties of borehole-core samples at $\sim$10-cm scale to saturated rock volumes on 100- to 1000-m scale, is methodologically problematic. Measuring directly the compaction of, and corresponding surface subsidence above, the pumped aquifer, and using these field-experimental measurements to determine the framework compressibility and the specific storage, can obviate such problems. Historically, such aquifer-deformation measurements have used costly devices (borehole extensometers), but recent advances in GNSS technology (e.g., GPS), and also Interferometric Synthetic Aperture Radar (InSAR), now provide noninvasive methods of geospatial data collection, which can be used in conjunction with borehole hydrograph information to estimate the specific storage and hydraulic conductivity of the aquifers.

We have now established a local network of three new cGPS stations on the borehole infrastructure of the Gateway Wellfield at Hermanus, for the purpose of quantifying the vertical and horizontal surface deformations related to groundwater abstraction, prior to a phase of aquifer test-pumping that will begin early in 2009. This African project contributes to the IGCP Project 565 effort to develop the Global Geodetic Observation System (GGOS) towards a global-to-regional-scale monitoring of the full hydrological cycle. It supports capacity-building in space-geodetic data-processing, modeling of the hydrological cycle, and interpretation of observations in terms of terrestrial water storage.