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Application of remote sensing and environmental tracers in modeling a fractured aquifer in the semi-arid environment of south east Botswana.

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Construction of hydrogeological models is a difficult task due to the notorious lack of spatially distributed data. This leads to the problem of non-uniqueness in aquifer parameter estimation and models without predictive power. Here we make use of remotely sensed data to improve the situation, especially in regions of weak infrastructure as it is often the case in developing countries. These data sets include high resolution airborne geomagnetics and multi-spectral satellite data. Geomagnetics allows us to map faults and intrusions which play a major role in influencing flow regimes in hardrock aquifers while multi-spectral data can be correlated to recharge information.

The Kanye Dolomitic Aquifer located in the south-eastern part of semi-arid Botswana offered us the opportunity to use these data sets. The aquifer is the sole source of water supply to an estimated 50,000 inhabitants. Previous investigations carried out in 1995 to 2000 culminated in a hydrogeological model which was used as a predictive tool for water abstraction scheme. This model totally neglected the influence of faults and intrusions on groundwater flow, nonetheless an abstraction scheme was built based on the recommendations of this model. Major abstraction started in 1997 and hardly two years later wells started drying up. Environmental tracer studies showed that the hydraulic flow model as established in the previous study contradicted the tracer analysis in most of the area. This contradiction manifests itself in an increase of water age up a hydraulic gradient.

Processing of high resolution geomagnetic data clearly shows that the aquifer is di-

vided by faults and intrusions into compartments with possibly very little hydraulic communication between the different compartments. The exchange is rather mainly between any individual compartment and the atmosphere within the evapotranspiration extinction depth. This can explain the existence of old age water on a groundwater mound which is generally unexpected. We have taken into account the effect of these features in the new model and used multi-spectral satellite data to estimate the recharge distribution. A calibrated steady state model for the situation prior to the commencement of intensified abstraction in 1997 was followed by a calibrated transient model using well hydrographs. The model allows a consistent interpretation of all observations and will be the basis for a correction of the extraction pattern.