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Semi-automated interpretation of aeromagnetic data as a means of determining the geometry of the Kalahari Sands aquifer below the Okavango Delta, Botswana.

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A recently published integrated hydrogeological model of the Okavango Delta in the northwest corner of Botswana is based on the overly simplistic assumption that the important Kalahari Sands aquifer has a uniform thickness. Since the hydraulic conductivity is assumed constant as well, the transmissivity of the aquifer is also constant. Our current work represents an attempt to determine aquifer thickness beneath a large portion of the approximately 30,000 km^2 delta using semi-automated interpretations of aeromagnetic data suitably constrained by deep drillhole data. The high quality aeromagnetic data, which were collected along flight lines separated by an average of 250m, mostly record the magnetic effects of metamorphic and igneous basement rocks and dykes immediately underlying the generally non-magnetic sedimentary cover, including the Kalahari Sands aquifer. From drillholes and rare outcrops, we know that the basement is dominated by metamorphic and igneous rocks of the Ghanzi-Chobe Belt in the south and the Damara Belt in the north. At some places in the south, the low magnetic sedimentary rocks of the Karoo Supergroup and other rock formations are intruded by highly magnetic northwest-southeast trending hypabyssal dykes. Since erosion resulted in a relatively smooth surface prior to deposition of the unconsolidated sedimentary cover, the depth to the top of magnetic rock at any location is likely to be a good estimate of sedimentary cover thickness.

Our semi-automated estimates of depth-to-magnetic sources are based on the 3D Euler deconvolution technique, which requires knowledge of the magnetic field spatial derivatives and the so-called structural index term. The structural index is an indication of the power to which a magnetic anomaly decays as the inverse of distance

from its source. It varies for different types of source. In our computations, we assume that the majority of sources can be adequately represented by dyke-like models. This is clearly valid for the hypabyssal dykes, but it is also a good approximation for those regions where the magnetic anomalies are caused by moderate- to steep-dipping faults or the limbs of peneplained folds. A good correlation is found between the depth-to-magnetic source estimates and the sediment cover thicknesses observed in drillholes. To interpolate depth/thickness estimates, we employ an anisotropic kriging method. The resulting depth-to-magnetic source map reveals a series of graben and horst structures, with one particularly prominent northeast-southwest trending graben. We conclude that aquifer thickness is structurally controlled, being thickest (>300m) in the grabens and thinnest on the horsts. This map will be used as an input to the next phase of improving the existing hydrological model.

Other data sources from remote sensing will be used for further spatial differentiation of model parameters. These are electrical conductivities of the ground from an airborne electromagnetic survey and radar images. Previous studies in the delta seem to indicate that low conductivities are associated with clay free sands thus the leakage coefficient between the surface water and groundwater can be mapped. Radar images allow to map the flooding patterns independent of cloud cover.

The main application of the model will be to evaluate management scenarios and hence help in decision making for any envisaged developments in the river basin.