GRAVITY SURVEYING FOR A POTABLE WATER SUPPLY, CENTRAL MASSACHUSETTS

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Gravity surveying for potable water supplies has been done successfully since the 1970s, but with limitations on accuracy in complex hydrogeologic settings, time required to complete deliverables, and cost associated with labor and computationally intensive procedures. We re-introduce the gravity method, augmented by GPR, for groundwater prospecting in a small central Massachusetts City, incorporating the latest advances in GPS determination of positioning and elevation, and digital elevation maps, important for terrain corrections, and a 3D gravity inversion of the data to produce a more accurate picture of the subsurface.

Analysis of the gravity data consists of Standard Bouguer data reduction and relevant anomaly isolation applied to field measurements with the aid of macros and a computer program. A best-fit polynomial regression, constrained by known bedrock depths from borings and GPR data, was used to convert over 100 complete Bouguer Anomaly values to bedrock depths. A polynomial regression model provides reasonable fits where groundwater depth is shallow. Limitations to the regression approach include that upper and lower boundaries of CBA values must be constrained, and assumes a 2D layer model.

A 3D bedrock tomographic inversion was also performed, allowing for the inversion of an initial model with four layers, comprising of air, unsaturated and saturated granular soil, and bedrock. The 3D Gravity inversion program takes our initial, assumed model of the site, converts it into a 3D grid comprising of different density layers, then iteratively computes a model to minimize the misfit between the model and the Complete Bouguer Anomaly values observed in areas where no cores are present. Lastly, based on assumed densities, a depth layer model is then output as an ASCII file, where contoured results help us assess the areas deepest to bedrock and greatest saturated thickness for groundwater supply exploration.