Information about local hydrogeologic conditions derived from time-series microgravity monitoring in the western USA

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ABSTRACT

The USGS Arizona Water Science Center has monitored gravity for more than two decades across a range of hydrogeologic conditions in the western US. Many of the investigations have used a network of stations to establish the storage change component of groundwater budgets. Estimation of storage change using gravity methods has allowed the estimation of recharge as a residual groundwater budget calculation. The occurrence of significant aquifer storage change is documented by large variations in gravity, which typically occur in or near areas of focused recharge or groundwater withdrawal. Gravity variations equivalent to 1 to 15 feet of water storage have been observed. While estimation of groundwater storage change has been useful, gravity records at individual stations have also produced valuable information about local hydrogeologic conditions, especially when co-incident water-level records are collected.

Correlation of significant variations in gravity—a foot or more of water—and water levels—a few feet of water-level variation—results in a range of relations that reveal important characteristics of the local aquifers. Good correlation of gravity and water levels result from a single unconfined aquifer that is monitored by a representative well. The specific yield can be estimated from the slope of the correlation. Large gravity variations may be poorly correlated with water levels where large storage change occurs in thick unsaturated zones or from a multiple aquifer system where the water level in a well does not represent hydraulic head variations in all of the aquifers. Large unsaturated zone storage change is common at locations of infiltration in ephemeral channels. A confined aquifer is revealed by large water-level variations and no detectable gravity change.

Gravity monitoring has helped reveal basic hydrogeologic conditions that were unobtainable by other methods. Specifically, gravity monitoring establishes whether storage change is occurring. Additionally, when complimented with water-level monitoring, gravity monitoring helps determine hydrogeologic conditions, aquifer storage properties, and helps evaluate the significance of water-level variations.