Hydrogeological factors affecting seasonal fluctuations of groundwater levels in a heterogeneous bedrock aquifer

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ABSTRACT
The water level fluctuation method is a simple and straightforward way to estimate recharge since the hydraulic head rise is a direct indicator of change in groundwater storage. Its application in Alberta is particularly attractive because of the availability of a long-term water level records from an extensive observation well network. The challenge of using water level fluctuation method for estimation of the actual water storage changes lies in the complex nature of the piezometric head signal. Hydraulic head changes, measured in wells are a superposition of recharge and discharge rate variations, barometric pressure fluctuations, earth tides, surface moisture loading and groundwater withdrawals. The conceptual model of a groundwater system considers bedrock recharge occurring through the leakage from overlying overburden. Water level changes in a bedrock well due to a recharge event can vary depending on a geometry of the bedrock-overburden contact, the thickness of the overburden, the type of sediment and bedrock geology. Observations have shown, that nearby wells, screened at the same depth and with same general lithology can have very different groundwater level dynamics. Sparse geological data does not allow explicitly accounting for the high heterogeneity inherent to the aquifer in the study area. Multiple synthetic 2-D groundwater models simulating different scenarios of subsurface architecture were constructed to evaluate its influence, as well as the role of the boundary conditions. The results of modeling were combined with comprehensive analysis of the water level fluctuations in multiple bedrock wells to explain different patterns of the groundwater level dynamics.