Regional scale flow in southeastern Alberta

Stephen Anfort and *Larry Bentley*, University of Calgary; *Stefan Bachu* *, Alberta Geological Survey

The hydrological regime for the units between the Clearwater Formation and the Beaverhill Lake Group in southeastern Alberta was examined to test the hypothesis that the Grosmont aquifer, forms a regional-scale drain and that the carbonate units that subcrop at the Sub-Cretaceous Unconformity direct flow northwards towards it. Formation water flow for the area defined by 51.5 to 56°N and 110 to 115°W was studied using freshwater hydraulic heads derived from 8335 good quality drill-stem tests and 6028 formation water analyses.

The flow systems mapped in the study area exhibit characteristics of up-dip, northeastward-directed basin-scale regional flow systems modified by topographically driven local flow systems. The regional flow system originates close to the deformation belt, while local flow systems occur throughout the area, particularly in the south where recharge from the Sweetgrass Hills is observed in aquifers as deep as the Cooking Lake. The flow patterns are strongly influenced by the presence of the Grosmont drain. Formation waters from the Mannville, Mississippian and Upper Devonian units flow into the drain. In the Lower Mannville aquifer, an enclosed hydraulic head low of 400 m covers nearly a third of the study area in the northwest. This low indicates flow of formation water downward, towards the Grosmont aquifer. The Mississippian, Wabamun and Nisku aquifers exhibit a similar trend of flow toward the Grosmont drain. However, these flow systems are controlled by the location of the respective aquifer subcrop edges rather then by an enclosed low. Typically, flow is regional until the aquifer subcrops, where it is redirected northward towards the Grosmont aquifer. The hydraulic head values in the Grosmont Formation are in the 350 m range, the lowest in the study area, showing that it is acting as the regional drain since all the aquifers from the Lower Mannville through the Nisku discharge into it. Flow in the Grosmont aquifer continues northward out of the study area presumably towards the outcrop of the Grosmont formation along the Peace River in northeast Alberta.

The distribution of formation water chemistries is consistent with the flow patterns that were interpreted from the hydraulic head maps. Meteoric water is entering the drain from above the unconformity surface and more saline formation water is entering the drain from below the unconformity surface creating a zone of mixing between fresh and saline waters. This is evident in the Wabamun aquifer past the subcrop boundary and is also reflected in the Lower Mannville aquifer as shown by their respective TDS, chloride and bicarbonate distributions. Recharge from the Sweetgrass Hills, characterized by low TDS and low chloride concentrations that coincide with hydraulic head highs, is evident in all aquifers down to the Cooking Lake. Breaching of the Ireton aquitard in the Wabamun and Nisku aquifers is evidenced by the sharp increase in salinity over the Bashaw Reef complex. The bicarbonate distribution in the south is not consistent with the recharge pattern. While bicarbonate is generally high relative to other areas, there are isolated highs that are above the regional trend. These highs seem to be correlated with an isolated sulfate high that exists in all of the aquifers. This may be due to bacterial sulfate reduction as carbonate buffered formation waters of the Mississippian equilibrate in the clastic environment of Mannville strata.

(1998) Geo-triad '98: Abstracts: Plenary, Oral, Posters, Core Workshop