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Effects of glacial topography and sedimentology on palaeohydrology, Kananaskis, Canadian Rockies: A numerical modelling exercise

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Glacial processes occurring during the Quaternary are a major factor affecting the topography and sedimentology in Kananaskis, Canadian Rocky Mountains. Glaciation resulted in oversteepened hillslopes and deposition of glacial sediments, including glacial till and glaciofluvial deposits. The deepened troughs and steep valley sides associated with glacial erosion influence hydrological functioning, while glacially derived sediments provide a secondary reservoir through which precipitation can be stored and transmitted. A previously glaciated mountain drainage basin with a covering of glacial till or other glacigenic deposit, such as glaciofluvial material, may experience reduced base flow and increased recharge to groundwater systems compared to a basin composed only of bedrock. While numerical modelling of basin-scale hydrology in mountain landscapes has been undertaken in published studies, such studies have not tended to focus explicitly on the role of glacially-influenced topography and glacial sediments in affecting surface and groundwater dynamics. The present study investigates the effects of topography and sediments conditioned by glaciation on basin-scale palaeohydrology for mountain drainage basins in the years immediately following the last glaciation ($\sim$ 10 ka BP) in Kananaskis, Canadian Rockies. The numerical modelling software HydroGeoSphere is used to model surface and groundwater flow in the present study. Digital elevation models (DEMs) of tributary drainage basins of the Kananaskis River are analyzed to guide the definition of a prototypical low-order drainage basin for use in the numerical modelling exercise. The prototype basin width is 1 500 m, length is 4 000 m and drainage area is $\sim$ 6 square kilometers. Values for the coefficient and exponent for a power-law equation to describe the cross-sectional shape of the prototype drainage basin are defined based on DEM analysis. Results of field work and past studies are used to define hydrogeological variables for glacigenic deposits (glaciofluvial deposits, glacial till) and bedrock in Kananaskis. Model runs using HydroGeoSphere are undertaken for a variety of topographic and sedimentological configurations. The subsurface domain discharge is consistently a minor component in the routing of water through the drainage basin for all model scenarios. The surface domain discharge is consistently the primary means by which water is discharged from the study basin. The common factor for model scenarios with somewhat higher values of subsurface discharge is the inclusion of deposits with higher values of hydraulic conductivity (e.g., glaciofluvial sediments). Results show that landscape morphology associated with previously glaciated mountains and glacigenic sediments are important controls on surface and groundwater dynamics in low-order drainage basins located in Kananaskis, Canadian Rockies.