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Transient hydrodynamics within inter-cratonic sedimentary basins during glacial cycles

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We investigated the hydrodynamic consequences within an idealized inter-cratonic sedimentary basin of a glaciation/de-glaciation cycle using transient hydrogeologic models that incorporate the effects of mechanical ice-sheet loading, permafrost formation, variable-density groundwater flow, solute/isotope transport, groundwater residence times and lithospheric flexure. Results show that steady-state hydrodynamic conditions in the basin are probably never reached during a 32.5 kyr cycle of retreat and advance of a wet-based ice-sheet. We show that present-day hydrogeological conditions in inter-cratonic basins across formerly glaciated areas are likely to still reflect the impact of the last glaciation that ended more than 10 kyr BP. Characteristic combinations of under- and overpressure (up to 1.2 MPa) are expected to occur in aquifers and aquitards respectively, which is roughly consistent with anomalous pressure patterns reported in formerly glaciated basins in North America and Europe. However, additional pressure effects that can be expected from, for example, erosional unloading and microbial gas generation complicates a close comparison with field data. The presence of dense brines confines the emplacement of glacial meltwater to basin margins which is further illustrated by calculated oxygen-isotope concentrations and groundwater age distributions largely confirming field data. Since permafrost is largely melted away during ice-sheet advance subglacial recharge rates are not fundamentally affected by permafrost. However, ahead of the ice-sheet edge where permafrost is present distinct zones of enhanced discharge of subglacial meltwater develop in narrow zones where permafrost becomes discontinuous as a result

of the upwelling of relatively warm groundwater. Through this process it is likely that ice-sheet loading contributes to the development of hydrodynamic collapse structures that are documented in formerly glaciated basins.