Fluid Flow Across Basement-Cover Interfaces During Mineralization of Unconformity-Related Uranium Deposits

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Oxygen and hydrogen isotopic and fluid inclusion studies have shown that basinal brines have interacted with basement rocks and basement-derived fluids in Proterozoic basins hosting unconformity-related uranium deposits. Numerical modeling was conducted to investigate the potential mechanisms driving fluid flow across a basement-cover unconformity. The results show that thermohaline convection may penetrate into the basement for up to1-2 km below the unconformity, given typical hydrological parameters. Fluid flow velocities in the sandstone are four orders of magnitude larger than those in the basement. If a uranium source is assumed to be located in the center of the basin below the unconformity, uranium gradually spreads into the sandstone aquifer. If the uranium source is initially located at the centre of the aquifer, a uranium plume develops and percolates down to 2 km below the unconformity after 5 m.y.. The location of the uranium source also affects solute transport efficiency. A uranium source located around the sloping basal unconformity close to the basin margin, leads to a wider uranium plume than if it is located near the center of the basin. Therefore, buoyancy-driven convection could have caused widespread interactions of basinal brines with basement rocks or basement-derived fluids in the Proterozoic basins, and that enough uranium could have been extracted from the basement to form giant uranium deposits.