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Double-diffusive instabilities in ancient seawater

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Powell Lake, British Columbia, Canada is a geothermally heated lake about 350m deep with a saline lower layer that was isolated from the ocean by coastal uplift about 11000 years ago, after the last ice age. Careful temperature and conductivity profiling measurements show consistent, stable, and spatially/temporally coherent steps resulting from double-diffusive processes in certain ranges of depth, vertically interspersed with other depth ranges where these signatures are not present. These features are quasi-stable for at least several years. Although molecular diffusion has removed about half the salt from the deepest waters and biogeochemical processes have slightly modified the water composition, the lack of tidal processes and shear-driven mixing, as well as an accurate estimate of heat flux from both sediment heat flux measurements and gradient measurements in a region not susceptible to diffusive instabilities, makes this a unique geophysical laboratory to study double diffusion. Here we present a detailed picture of the structure of Powell Lake and its double-diffusive stair cases, and suggest shortcomings with existing parameterizations for fluxes through such staircases.