New insights on brine dynamics and source in Don Juan Pond, Antarctica

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Don Juan Pond (DJP), located within the Antarctic Dry Valleys (ADVs), is unique due to its concentrated $CaCl_2$ composition. Because of the low eutectic temperature and hygroscopicity of this brine, DJP never freezes or evaporates completely, despite arid conditions and wintertime lows near -50°C. DJP has generated ongoing interest since its discovery in 1961 because of the potential for extremophiles, as an analog site for potential aqueous flows on Mars, and due to the enduring enigma of its unique geochemistry.

Shallow and deep groundwater theories have been proposed to explain the source and dynamics of the brine in DJP. **Shallow groundwater** theories propose that salts in surface soils deliquesce and migrate into DJP. This is based on observations of deliquescence and shallow groundwater flow above DJP. **Deep groundwater** theories propose that deep groundwater regularly discharges into DJP, which is supported observations of upwelling groundwater from drill-holes. We resolve the source of salts to DJP by modeling closed-basin evaporation assuming deep/shallow groundwater inputs using a new model in the Na-K-Ca-Mg-Cl system [1].

Our model results, as well as ionic ratios in DJP, indicate that a deep groundwater source best explains the chemistry of DJP (Fig. 1). Furthermore, we find that less than a year of closed-basin evaporation is needed to form DJP, which implies a flow-through groundwater system. This system may continue towards Lake Vanda (10 km from DJP), and be responsible for its $CaCl_2$ composition. The existence of regional flow-through groundwater systems in the ADVs implies a dynamic subsurface environment and may provide clues for the formation of aqueous flows on Mars.

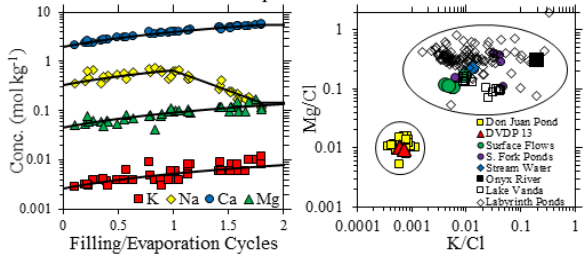

Fig. 1. Left: measured (symbols) and modeled (lines) concentrations in DJP assuming deep groundwater inputs. Right: ionic ratios in DJP and ADV surface waters.

Ref: [1] Toner and Catling 2017, *Journal of Chemical and Engineering Data*, 62, 3, 995–1010.