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Understanding wormhole formation in evaporitic aquifer systems: an intermediate-scale laboratory experiment.

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The desert of south America is characterized by some of the greatest thicknesses of evaporates currently accumulating in the world. In this arid region, the presence of salt-crusted pans (Salars) characterized by evaporitic brine filled aquifer systems has a considerable economical influence and environmental value. In fact, Salars are exploited for a variety of minerals, including dissolved phases extracted from the brine (mobile resource) as Lithium and Potassium, motivating a wide range of research fields. In this context, the nucleus of a Salar aquifer system has been investigated. In order to understand its structure, heterogeneities and hydraulic properties at different scales, a long-term hydraulic test with several intermittent pumping rates and cross information over numerous observations has been carried out at field scale. Data have been used to develop an inverse stochastic numerical flow model capable to identify the presence of preferential flow paths (Wormholes), leading to relevant hydraulic connections in the halite aquifer system. In addition, to better understand the governing spatiotemporal processes occurring at this site between hydrodynamics and dissolution processes, a laboratory intermediate-scale tank experiment has been designed and performed under controlled conditions. Halite extracted from the evaporitic basin has been used to reproduce the aquifer. The aquifer heterogeneous system is controlled by different grain sizes and different boundary and chemical conditions have been taken into consideration. Fluorescent tracer coupled with an image processing analysis allowed to highlight wormhole generation and shape at different times of the experiment, considering different injection rates and brine aggressivity (saturation degree). Results show new insights on the evolution of wormhole formations.