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Evaporation from porous media as influenced by osmotic potential

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Introduction

- Solute transport in soil and water continuum is influenced by both components of soil water potential i.e. matric potential and osmotic potential.

- Effect of the osmotic potential on evaporation from porous media is investigated by a few researchers unlike matric potential.

- Our hypothesis is that both potential components affect the two stages of evaporation and that the osmotic potential in direct vicinity of the soil surface is a controlling variable.

Methodologies

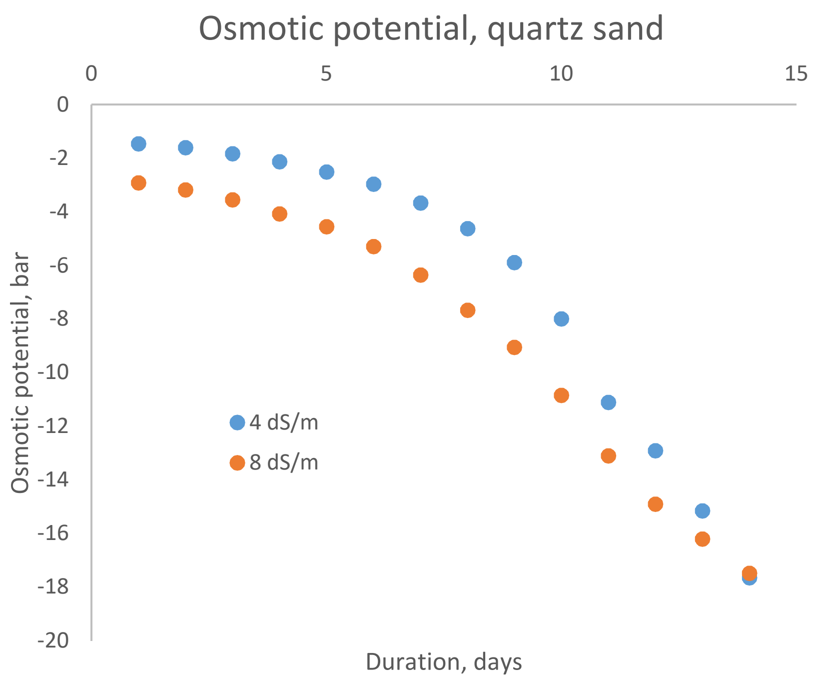
- Quartz sand, sandy, and sandy loam soils were used for the evaporation experiment.
- Disturbed soil samples of each soil in triplicate were packed in small cylinders (L: 5 cm; ∅: 8 cm)
- Saturation was performed with different NaCl concentrations (0 (distilled water), 4 and 8 dS/m).
- Daily evaporation rates were measured manually.
- Evaporation measurements were conducted under climate-controlled laboratory conditions (air temperature,$T = 21 \pm 0.5℃$ and relative humidity,$RH = 55\%$).
- Daily osmotic potential was obtained using the USDA (1954) as following:-

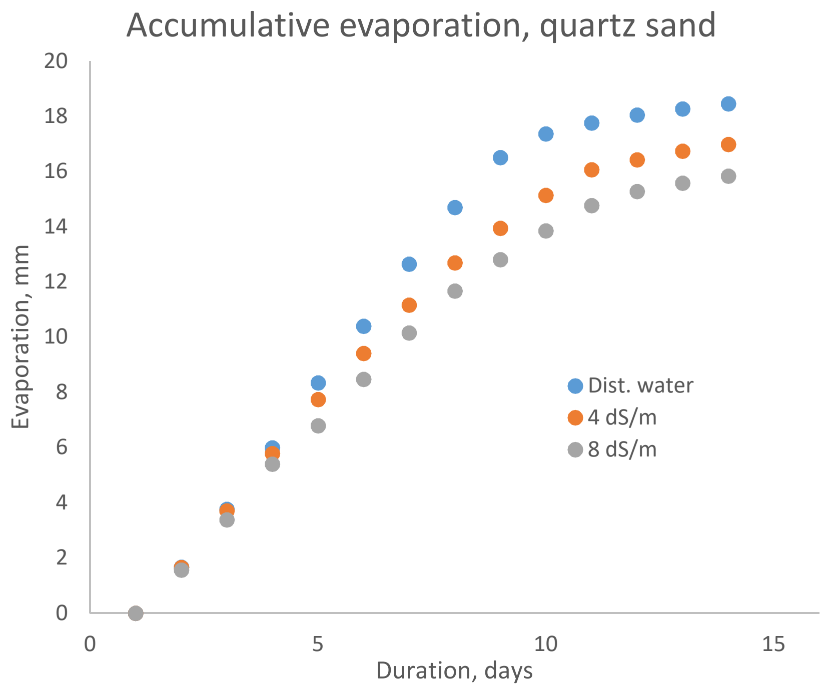
  - Osmotic potential (at.) = EC (dS/m) x 0.36

  - Electric conductivity was calculated from the changes in moisture saturation percentages due to evaporation.
- Salt distribution (EC, 1:3 extract) measured in four layers (A, B, C and D from top to bottom) for each sample at the end of the experiment.

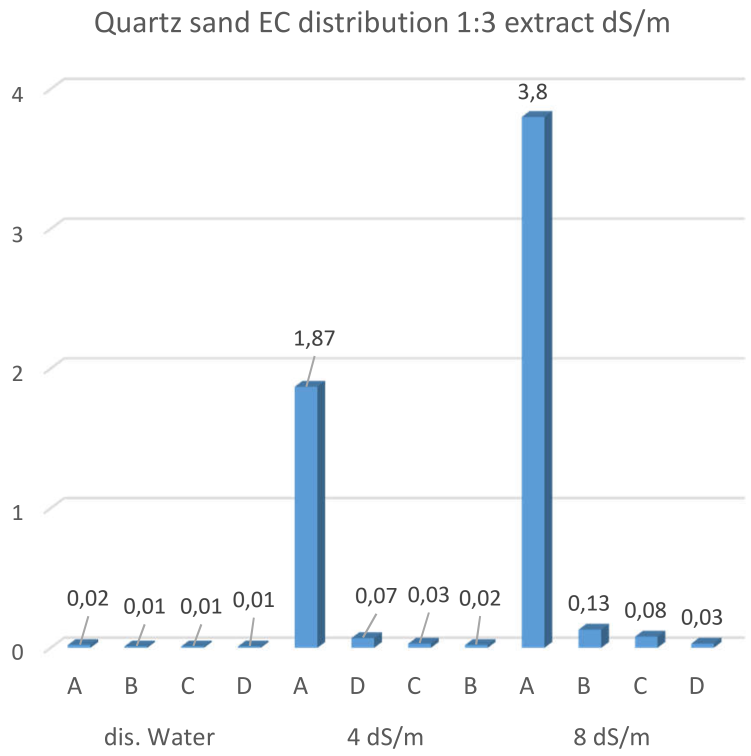
material	texture	Sand kg.kg^{-1}	Silt kg.kg^{-1}	clay kg.kg^{-1}	Bulk density Kg. m^{3}	EC 1:1 dS/m
Quartz sand	Sand (0,1-0,3 mm)	1.00	-	-	1.6	-
SAU soil	Sand	0.985	0.01	0.005	1.6	0.12
JKI soil	Sandy loam	0.65	0.29	0.06	1.32	0.59

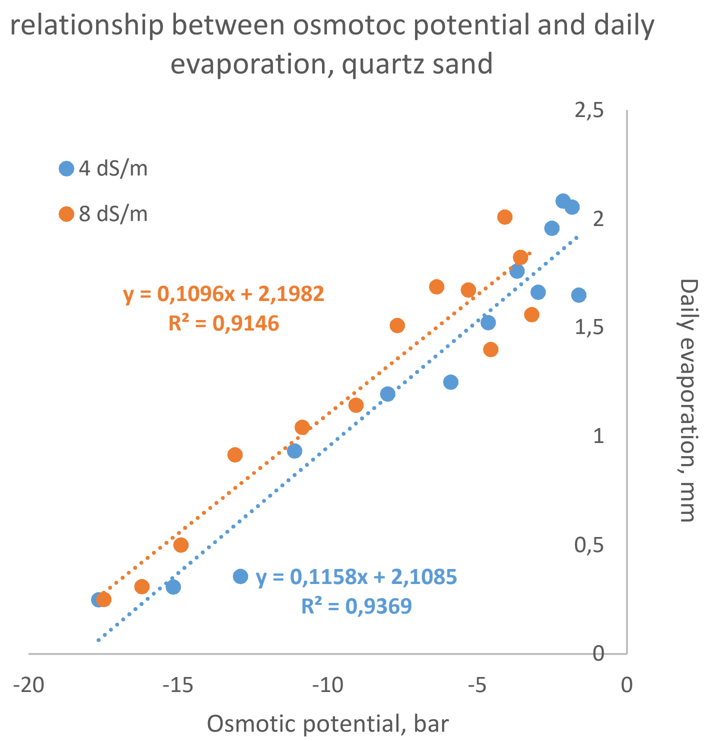
Results Quartz Sand



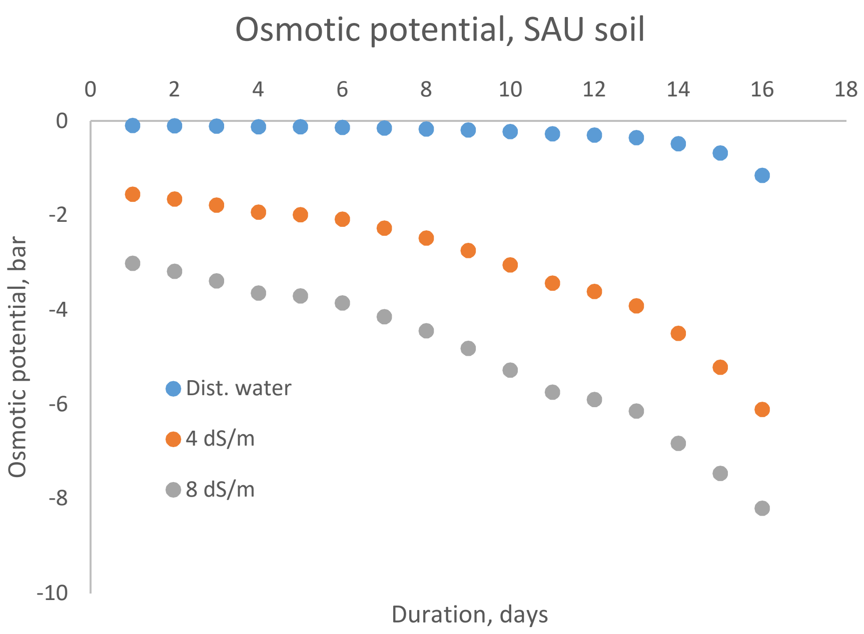


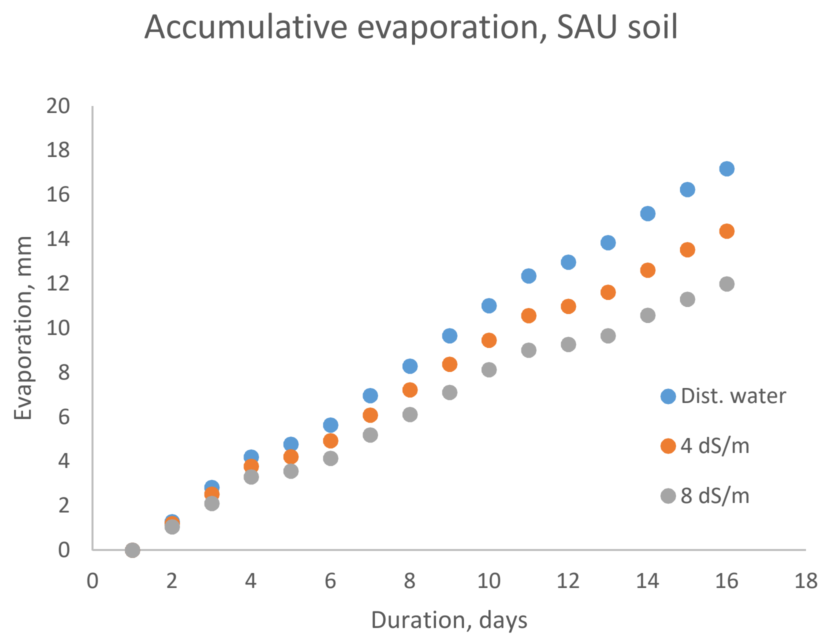
Results Quartz sand



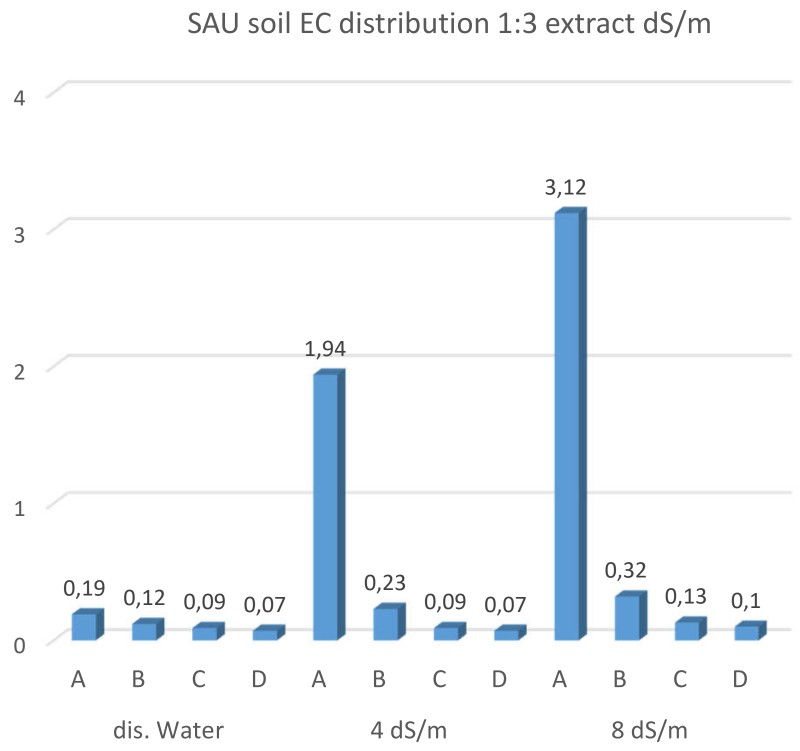


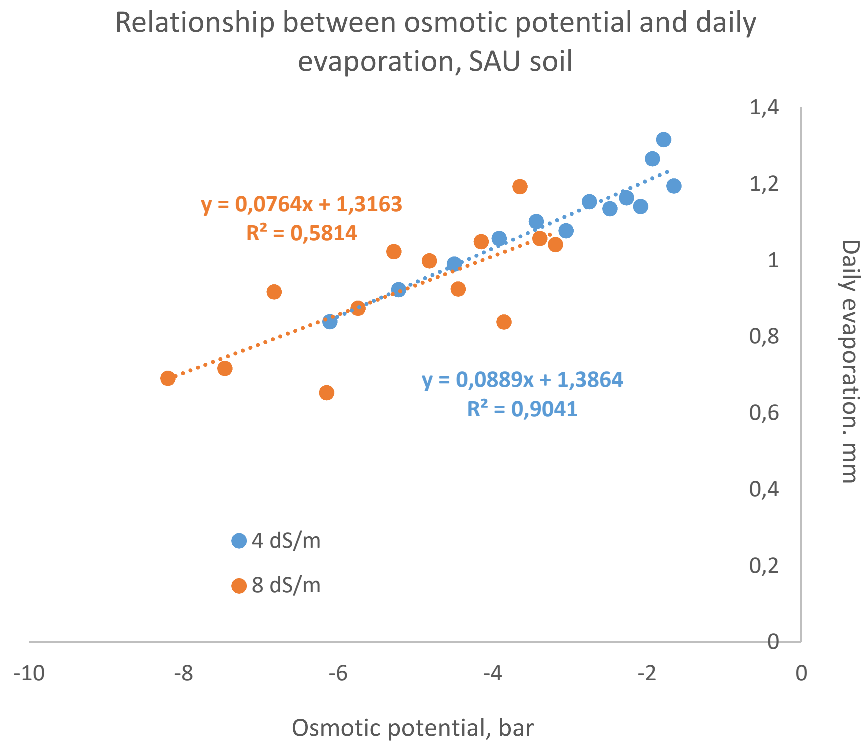
Results SAU Soil



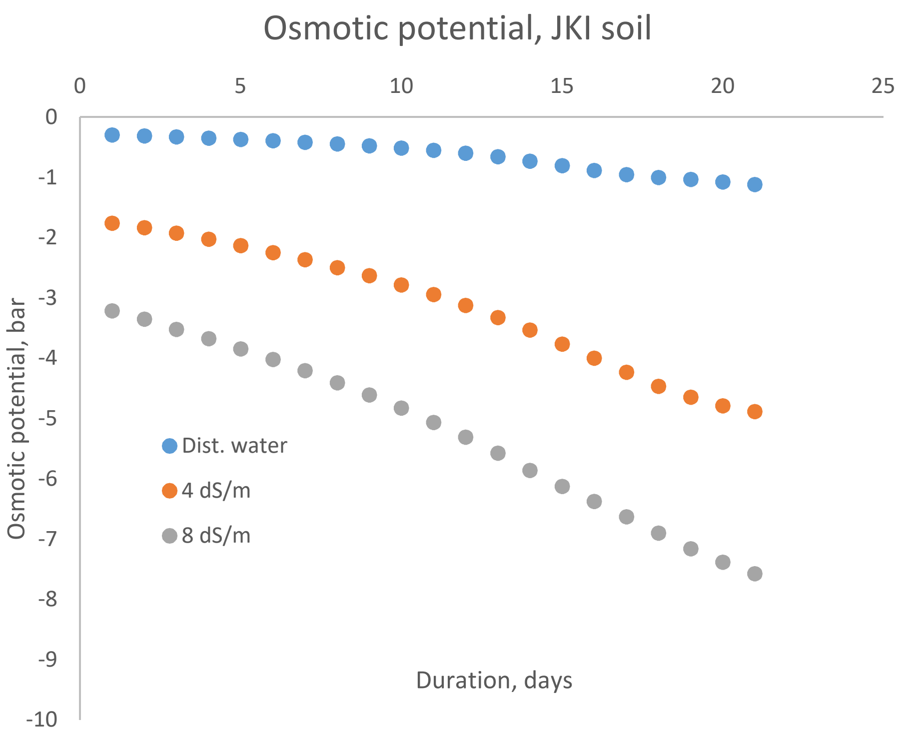


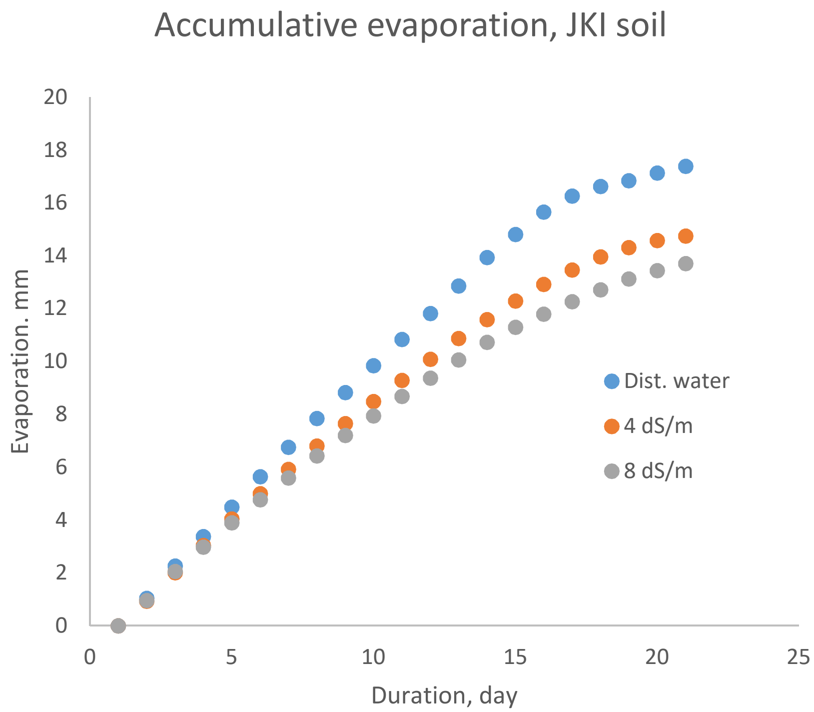
Results SAU Soil



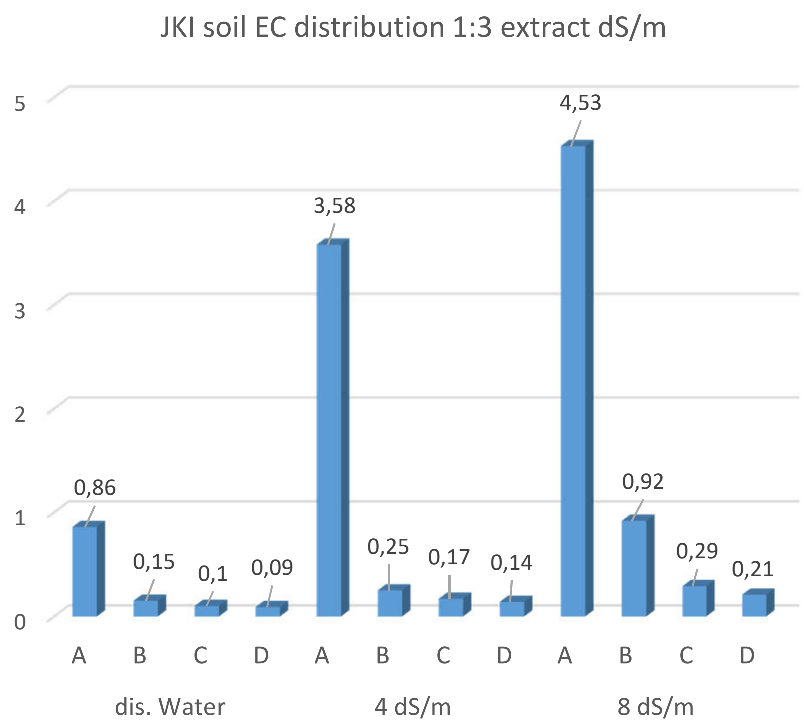


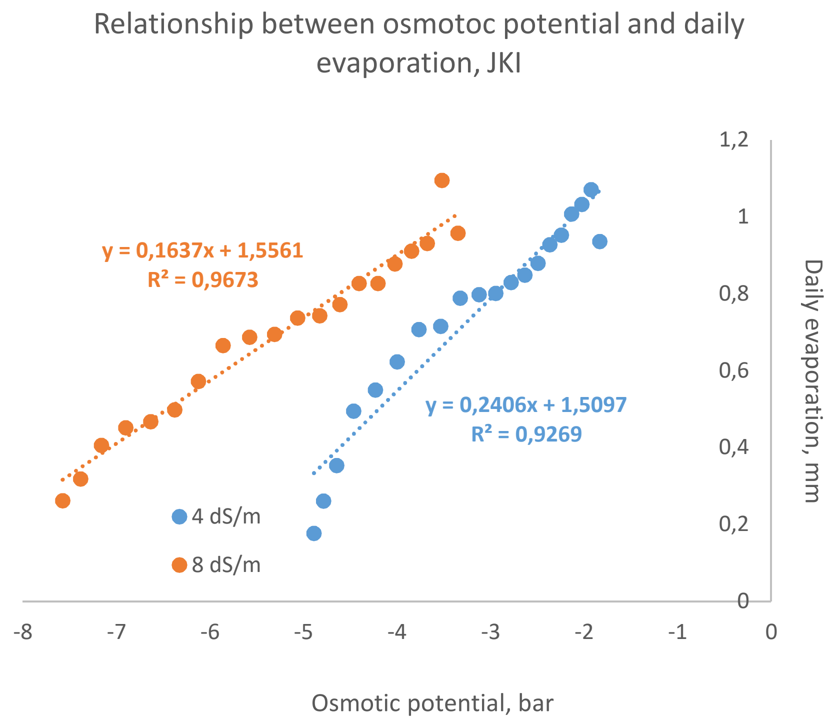
Results JKI Soil





Results JKI Soil





Conclusion

- Increasing of osmotic potential led to reduce the evaporation rate for all the soil textures. A significant relationships between osmotic potential and daily evaporation rates were observed.
- Due to the reduction in evaporation rates, the volumetric water content in the materials which saturated with saline solutions were higher (provided same time and conditions) than the other materials which saturated with lower salinity levels.
- Because of evaporation process, soluble salts moved from soil profile and accumulated in soil surface layer, this produced a driving force at soil surface which apply changes in soil hydraulic properties.

Abstract

The measurement of the water potential is important to characterize solute transport in soil and water uptake by plants. Many researchers have characterized the matric potential and its impact on evaporation from porous media. However, only few studies have been carried out to characterize the effect of the osmotic potential. In this study, we investigated the simultaneous influences of the osmotic and matric potentials on the evaporation from soil. Our hypothesis was that both potential components affect the two stages of evaporation and that the osmotic potential in direct vicinity of the soil surface is a controlling variable. To meet our objective, we performed evaporation experiments on columns filled with pure quartz sand and natural soil materials with different textures, under climate-controlled laboratory conditions. The soils were initially saturated with different concentrations of saline solutions and evaporation from each column was measured daily. Our results show that the osmotic potential reduced the amount of evaporated water from the investigated porous media. The amount of reduction due to the osmotic potential is compared with model calculations that consider the total water potential at the soil surface.