Brine Formation and Entrapment in the Eastern Mediterranean Coastal Plain Aquifer

M. Caspi[1], *E. Shalev*[2] and *H. Gvirtzman*[1]
[1]Inst. of Earth Sciences, the Hebrew University of Jerusalem, Jerusalem, Israel
[2]Geological Survey of Israel, Jerusalem, Israel

ABSTRACT

The coastal plain aquifer of Israel, Gaza strip and Sinai Peninsula is located along the Mediterranean coast and includes a transition zone between fresh groundwater originated inland and Mediterranean seawater. The geometry of this interface depends on the specific density of both water bodies.

Throughout geological history, ocean sea level fluctuates many times due to glacial-interglacial cycles. At glacial periods the sea retreats, the coastal shelf is exposed, rain permeates the land and creates a freshwater aquifer in an area that previously was saturated with seawater. During interglacial periods, the sea floods the land and seawater penetrates the fresh-water aquifer. In both cases, during glacial or interglacial periods, the fresh-saline water interface moves inland or seaward.

This theory predicts that salinity of groundwater in the coastal plain aquifer would range from freshwater to seawater. Yet, the saline water pumped through some wells in the Gaza strip aquifer deviates from the expected saltwater-freshwater mixture. The most noticeable deviation is found in Cl concentrations, reaching up to 67,000 mg/l, i.e. 3 times the Cl content of sea water. These high levels of Cl concentrations are also found in the waters of the Bardawill lagoon and sabkhas in northern Sinai.

In view of the geochemical composition of the Gaza aquifer with the water encountered in the Bardawill region, we suggest that brine formed in an ancient lagoon or beach sabkha in the Gaza region had immersed into the aquifer, and efficiently trapped at the sediments beneath. This efficient entrapment was possible due to layers of clay that are interbedded in the aquifer and due to the impermeable Saqiye group which restrict the aquifer at its bottom.

This study aims to examine the physical and chemical feasibility of the suggested mechanism using a numerical simulation. The simulation reconstructs the aquifer migration inland or seaward, the submergence of lagoon water and their entrapment between clay layers in the aquifer as a result of sea level changes. The simulation uses the Bardawill lagoon as a current model which represents an actual process of brine formation and submergence, and uses the coastal plain aquifer of Gaza as a model for brine entrapment.

So far, the model has revealed the formation of two interfaces, one facing land and the other facing the sea, and the lagoon brine situated in-between (Figure 1a). Figures 1b, 1c and 1d display the diminish of the lagoon due to sea level rising and the dilution of the aquifer brine by seawater. We are currently repeating the same simulations using an anisotropic heterogeneous aquifer with clay layers to simulate the brine entrapment. Further analysis of this model will reveal rates and locations of brine formation and migration as well as the latent salinization potential of the entrapped brine.

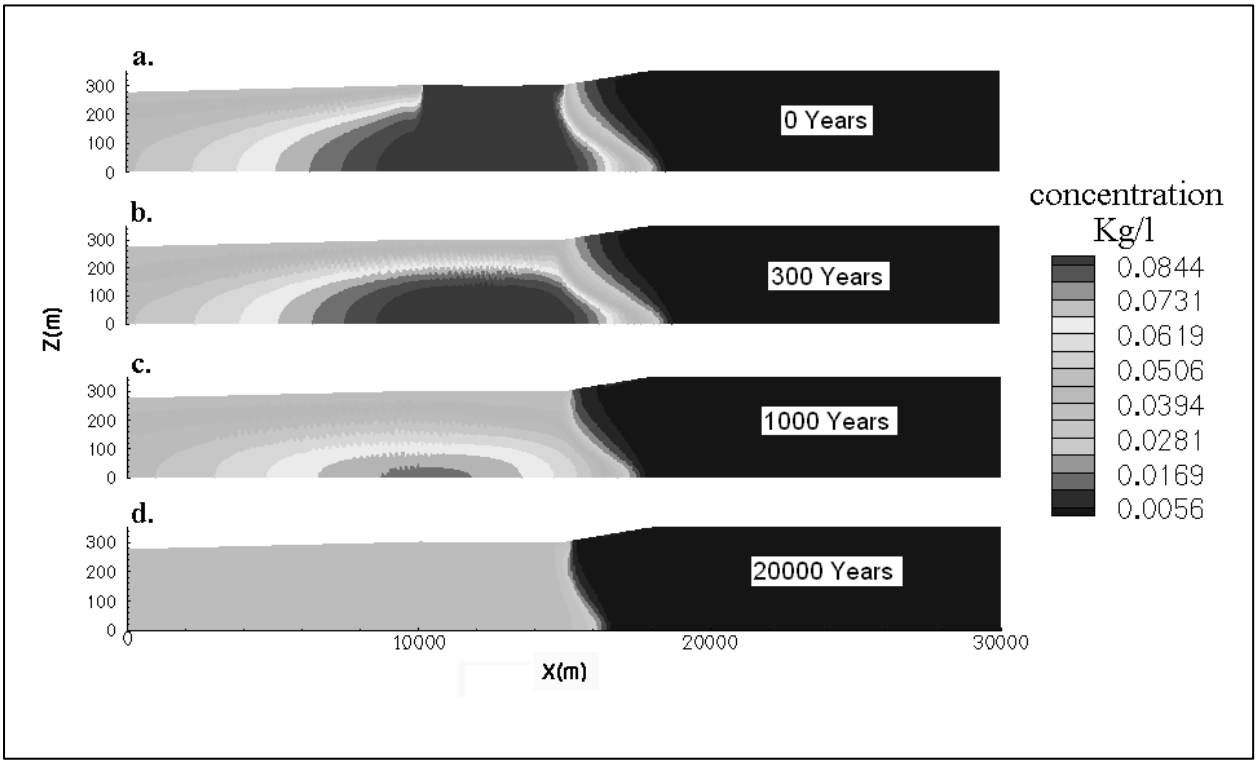

Figure 1. Four stages of lagoon diminish and infiltration of seawater into the aquifer.
a - The lagoon recharges the aquifer with brine. One interface is between seawater (Green) and brine (Red) and the other separate brine from freshwater (Blue).
b and **c** – When the sea level rises the lagoon disappears and seawater submerges into the aquifer and dilutes the brine.
d - New steady state. One interface between seawater and freshwater.

Contact Information: Mati Caspi, Inst. of Earth Sciences, The Hebrew University of Jerusalem, Jerusalem 91904, ISRAEL, Phone: 972-2-6584839, Mobile: 972-54-5366134, Fax: 972-2-5668581, Email: mataniash@gmail.com