Palaeo-climatic and Hydraulic control on Saline Groundwater in Holocene Delta Plains

Flemming Larsen[1], Long Vu Tran[2], Hoan Hoang[2], Luu Thi Tran[2], and Nhan Quy Pham[2]

[1]Geological Survey of Denmark and Greenland (GEUS),

[2]Hanoi University of Mining and Geology

Abstract

Eustatic sea-level changes during the Quaternary period, with water levels drops down to 130 m below current during periods with glaciations, have had a paramount impact on the sedimentlogical development of geologically young delta systems and the distribution of fresh and salty groundwater in their aquifers. In delta systems, gravels, sands, silts and clays are deposited and form multi-aquifer systems, but early studies of the Mississippi delta have documented erosion of deep entrenched valley systems in these systems during low sea-level stages. These erosional structures are subsequently filled up with low-permeable clay-rich formations during high sea-level, and these geological units appear to control the distribution of palaeo saltwater in the delta systems. We have conducted a study focused on the past climatic and hydraulic controls on the presence of palaeo saltwater in the Red River delta plain (RRDP) in Vietnam. Saltwater in aquifers in the RRDP was studied using: field geophysical methods, including TEM and borehole logging, measurements of saltwater intrusion in the Red River, exploratory drilling, groundwater sampling and determination of major ions and water stable isotope content, hydraulic laboratory experiments, chemical analysis of interstitial clay pore water, and groundwater flow modelling with the SEAWAT code.

The geophysical result reveals that remains of palaeo saltwater is present in deep, incised valleys, filled up with fine grained, marine deposits during Holocene transgressions. The controlling mechanisms of the leaching of the trapped marine pore water are the thickness and permeability of the marine sediments and the leaching time of the pore water. In sediments with a permeability below 10^{-14} m^2 ($K < 10^{-7}$ m/s), transport of marine pore water is controlled by diffusion, and in a sequence of sediments with a thickness of 60 m, leaching of salty water takes more than 10.000 years. With larger permeability of the sediments, transport of salty pore will be controlled by a faster, density driven process, and palaeo saltwater is leached out within few hundred years. Similar results, with so-called inverted saltwater profiles, with dense, salty groundwater overlying less dense fresh groundwater, has been reported by others in the literature, and we therefore suggest that these findings have a general application in the understanding of the occurrence of palaeo saltwater in Holocene delta plains worldwide.

C**ontact information**: Flemming Larsen, Geological Survey of Denmark and Greenland, Department of Geochemistry, O. Voldgade 10, 1350 Copenhagen, Denmark, tel.: +45 91 333 561, e-mail: flar@geus.dk