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WHY IS THE QUIVIRA MARSH IN SOUTH-CENTRAL KANSAS SALTY AND WHY ARE THERE MARCHES IN THAT AREA OF KANSAS

by

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Why is the Quivira Marsh salty and why are there marshes in this area in the first place? To answer these questions, we need to look underground, at the rock layers that lie beneath the surface of the marsh. Underneath the thin veneer of wind-blown dune sand found throughout the Great Bend Prairie lies the Great Bend Prairie alluvial aquifer, which is the major source of water for the region. Beneath this mostly freshwater aquifer lie the bedrock Dakota and Cedar Hills sandstone aquifers. The geology of these bedrock aquifers is shown in aerial view in figure 1A, and in cross-sectional view across northern Stafford County in figure 1B. The rocks in the Cedar Hills sandstone aquifer are from the Permian, that period of geological time from 286 to 245 million years ago. Those in the Dakota aquifer were formed during the Cretaceous (112 to 93 million years ago), and those in the Great Bend Prairie aquifer were formed fairly recently, during the Pleistocene (1.6 million to ten thousand years ago). The Cedar Hills sandstone and the overlying and underlying Permian red beds, labelled as aquitards or low permeability barriers in figure 1, contain salt-cemented sandstone and beds of halite (the mineral name for sodium chloride, common table salt) and anhydrite (a form of gypsum, calcium sulfate). These Permian rocks were formed under shallow seas in a climate so arid that water evaporated rapidly, leaving behind vast quantities of rock salt crystals. (Rock salt is commercially mined further east near Hutchinson in other Permian geologic units.) As a result, the Cedar Hills sandstone aquifer is a saltwater aquifer.

The Quivira Marsh and the surrounding area are a common discharge center, where ground water, recharged from higher elevations in southwest and south-central Kansas, moves upwards towards the surface of the low lying areas of the Quivira Marsh vicinity, and where the separate ground-water flows from the three major aquifers (Cedar Hills sandstone, Dakota, and Great Bend Prairie aquifers) converge (fig. 1B). Beneath the marshes, a bedrock ridge (fig. 1B) with a north-south orientation blocks the prevailing easterly movement of the ground water toward the Arkansas River and causes upward discharge of saltwater into the streams and marshes. These factors account for the existence of the Quivira Marsh here. To understand why it is salty, we have to remember that water is a universal solvent. It can dissolve and chemically react with the rocks it encounters. The longer water remains in the aquifer and the farther it travels, the more mineralized it can become, especially if it encounters such rock salt deposits, as the Cedar Hills sandstone and the red beds.

At the surface of the marsh the water evaporates from the shallow lakes, concentrating salts on the surface and creating the characteristic white salt flats. The average salinity of Little Salt Marsh is approximately 2,500 parts per million (ppm chloride), whereas that of Big Salt Marsh averages from 5,000 to 10,000 ppm (sea water averages 19,000 ppm and drinking water about 250 ppm). As figure 1B shows, the water in the Great Bend Prairie aquifer is fresher west of the Quivira Marsh (west of US Highway 281) where the Dakota aquifer is found in the subsurface under the alluvial deposits of the Great Bend Prairie aquifer, in contrast to the area around the Quivira Marsh where the Cedar Hills sandstone aquifer directly underlies the Great Bend Prairie aquifer. This is because the relatively impervious nature of the Kiowa shale aquitard confines the salt water to the lower Dakota aquifer and the Permian units below (fig. 1B).

I am indebted to numerous colleagues at KGS who reviewed and commended on this write-up.

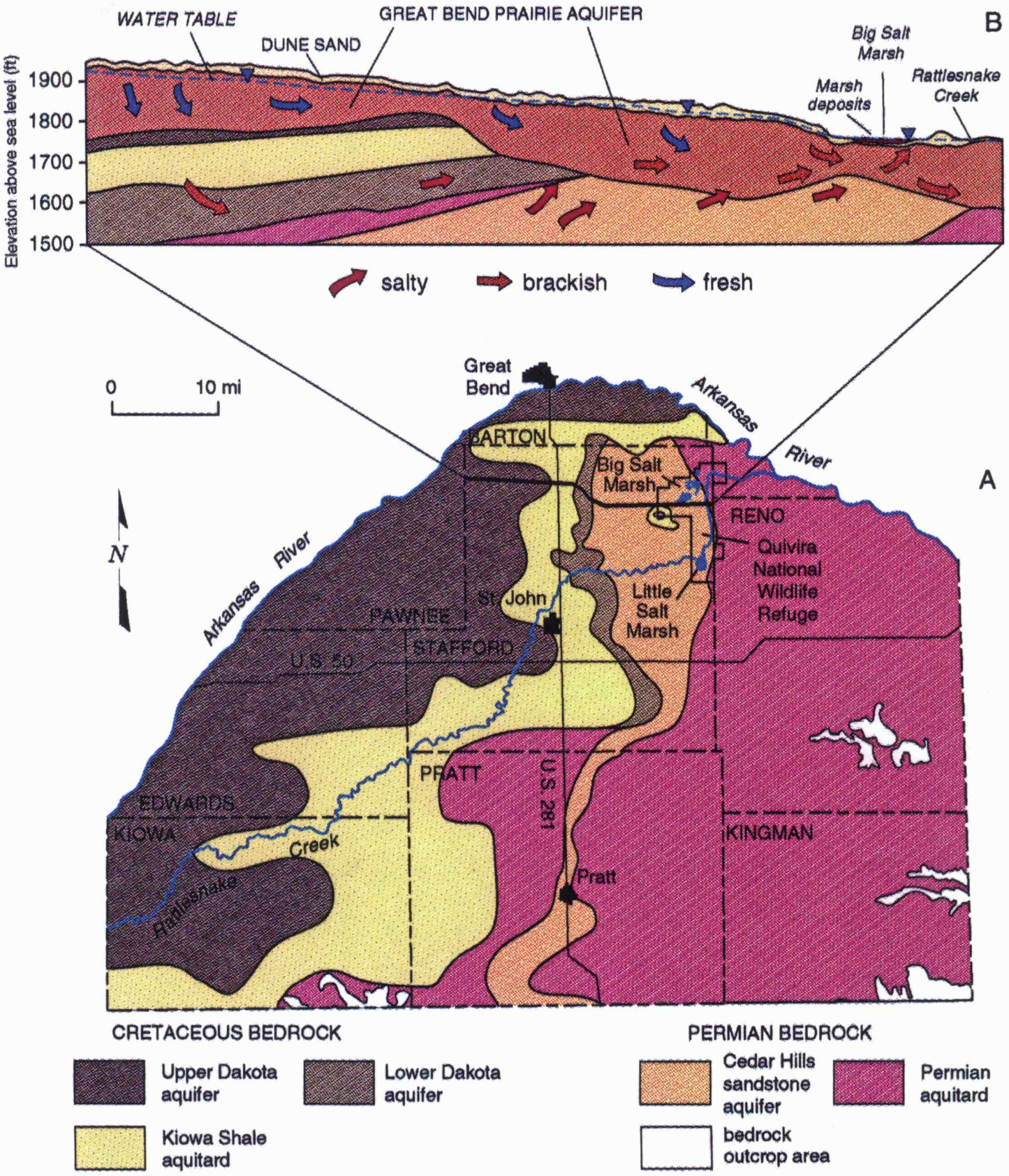

Figure 1. A. Bedrock geology underlying the Great Bend Prairie aquifer (adapted from Fader and Stullken, 1978). B. Vertical section from west to east across the region indicated by the heavy black line, showing the relation of the alluvial Great Bend Prairie aquifer to the underlying Cretaceous and Permian strata (adapted from Latta, 1950). (A and B are further adapted according to more recent results from the KGS Dakota Aquifer Program, Allen Macfarlane, 1996, oral communication).