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Saline water disposal into the Birds Nest aquifer in Uintah County, Utah: Implications for potential oil shale development

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The Birds Nest aquifer formed from the dissolution of saline minerals in the upper Green River Formation and is mostly restricted to Uintah County. This aquifer, ranging in thickness from 150 to 300 feet, is targeted by natural gas operators as a potential saline water disposal zone. Understanding the aquifer's areal extent, thickness, water chemistry, and zones of differential dissolution will help determine how saline water disposal into the aquifer might impact future oil shale development, especially in-situ-type processes. During the late Eocene, Utah's Lake Uinta transitioned from a balanced-filled basin dominated by organic-rich, laminated marlstone, to an underfilled restricted basin. During this time, the saline mineral nahcolite was deposited in the form of nodules and thin beds. This evaporite interval is in the middle of the R-8 oil shale zone of the Green River Formation, roughly 300 feet above the potentially developable kerogen-rich Mahogany zone. A similar evaporite sequence in Colorado's Piceance Basin occurs in the stratigraphically lower R-3 to R-6 zones, Colorado's main oil shale-rich economic interval. Preliminary research shows the Birds Nest's water chemistry in the north is distinct (averaging >10,000 ppm TDS and as high as 100,000 ppm TDS) from that in the south (averaging <10,000 ppm TDS and down to near 1000 ppm TDS). This abrupt change in water chemistry is most likely due to the differing amounts of saline mineral dissolution in the two areas; the southern portion may have been flushed clean, whereas saline minerals in the northern area are still actively dissolving. The presence of intact nahcolite in the Utah State 1 core (section 26, T. 9 S., R. 21 E.) demonstrates that there are still zones of no dissolution north of the 10,000 ppm TDS line. Anadarko Corp. has reported a "zone of lost circulation" (very high porosity and permeability consistent with near-complete saline mineral dissolution) in other wells in T. 9 S., R. 21 E. This dissolution zone is also seen in the Utah State 42-34 core (section 34, T. 9 S., R. 21 E.). Separating these two areas is a prominent gilsonite vein that originates in the Mahogany zone and continues up to the surface, cross-cutting the Birds Nest aquifer. It seems that these northwest-trending gilsonite veins influence groundwater flow patterns in the Birds Nest by creating "channels" of dissolution and impermeable barriers to flow.