# New Insights Regarding Aquifers in the Uinta Basin, Utah: Implications for Saline Water Disposal DNR

## ABSTRACT

As Uinta Basin petroleum production has increased – natural gas alone has more than doubled in the past 8 years - so has saline water production, increasing the need for economic and environmentally responsible disposal plans. Current water disposal wells are near capacity and permitting for new wells is delayed because of insufficient technical data regarding potential disposal aquifers and questions concerning contamination of fresh water sources. Many Uinta Basin operators claim that crude oil and natural gas production cannot reach its full potential until a suitable, long-term saline water disposal solution is determined.

Part one of our effort involves re-mapping the base of the moderately saline aquifer (BMSA) within the Uinta Basin using more robust data and more sophisticated GIS techniques than previous work. Regulators agree that below this boundary, saline water can be injected without damage to the overlying fresh water aquifers. Thus far we have compiled downhole water chemistry data from over 1400 wells, mainly clustered in oil and gas fields. For areas where water quality information is not available, we have used refined techniques for determining the BMSA using geophysical logs from about 260 wells.

Part two of our project includes a detailed study of the Birds Nest aquifer, which is recognized as a possible largevolume saline water disposal zone. During the terminal stage of Eocene Lake Uinta, the saline mineral nahcolite formed within the deep-lake sediments (depocenter in central Uintah County) as isolated crystals, nodules up to one foot in diameter, and beds ranging from less than an inch to 2 feet thick. Post-deposition, the saline mineral shortite formed in fracture zones several feet thick. Examination of several cores reveals that the total thickness of the saline zone ranges from <100 feet on the basin margins to >300 feet in the basin's depocenter. More recently, the Birds Nest aquifer formed from the dissolution of the saline minerals. Core analysis reveals that in the basin's depocenter, the aquifer is divided into two or three stratigraphic zones of dissolution, each roughly 40 feet thick. Near the margins of the basin, the dissolution occurs in one zone about 60-80 feet thick. Ongoing research seeks to determine how these zones correlate throughout the basin and if the Birds Nest as a whole is vertically connected via fractures/joints (possibly gilsonite veins) to other water-bearing horizons.

## **PROJECT TASKS**

- Task 1 Re-map the base of the moderately saline aquifer in the Uinta Basin, Utah (poster panel 1)
- Task 2 Geologic examination of the Birds Nest aquifer, Uintah County, Utah (poster panels 2 and 3)
- Task 3 Baseline water quality and quantity GIS database for lands with oil shale development potential (not discussed on this poster)





## More than 25,000 oil and gas wells are currently proposed for drilling in the Uinta Basin

This future drilling will greatly increase the amount of produced water needing proper disposal

- Greater Monument Butte Project 5570 new wells proposed, EIS in process
- Bureau of Indian Affairs 4899 new wells proposed, EIS in process

- River Bend Field Development Project 484 new wells proposed, EA in process

Source: U.S. Bureau of Land Management

• West Tavaputs Natural Gas Full Field Development Project - 626 new wells - approved • Uinta Basin Natural Gas Development Project (Gasco) - 1491 new wells - proposed, draft EIS • Greater Natural Buttes Area Gas Development Project - 3675 new wells - proposed, draft EIS • South Unit Oil and Gas Development Project - 400 new wells - proposed, draft EIS • Greater Chapita Wells Natural Gas Infill Project - 7028 new wells - proposed, EIS in process

• Big Pack Natural Gas Development Project - 664 new wells - proposed, EA in process • Southam Canyon Field Development Project - 249 new wells - proposed, EA in process

## TASK 1: RE-MAPPING THE BASE OF THE MODERATELY SALINE AQUIFER (BMSA)

**Problem:** A lack of saline water disposal options is a significant limiting factor with regard to increases in oil and gas production in the Uinta Basin, Utah.

- Current disposal wells are at or near capacity
- Evaporation ponds can not handle the increase in saline water and pose several environmental challenges, including increased ozone emissions
- New disposal well permits are being delayed as these problems are addressed

Currently, the agencies responsible for regulating the disposal of produced water use 20year-old data amassed in a publication titled "Base of the Moderately Saline Ground Water in the Uinta Basin, Utah" to try and determine zones suitable for water disposal (Howells and others, 1987). This hard copy publication provides a paper map showing the depth of the transition between moderately saline and very saline water (10,000 mg/L TDS), below this depth it is believed saline water can be injected without damage to overlying fresh-water aquifers. Several oil and gas operators working in the basin believe this dated study needs substantial revision. The original map was based solely on calculations of water quality from geophysical logs, a method with several limitations (e.g., tar sands were misidentified as fresh water aquifers).

UGS has digitized the well locations and the contours of the base of the moderately saline aquifer as reported in Utah Department of Natural Resources Technical Publication 92. published in 1987. This project aims to remap this interface with more accurate and up-to-



## Michael D. Vanden Berg<sup>1</sup>, Paul B. Anderson<sup>2</sup>, **Craig D. Morgan<sup>1</sup>, and Stephanie Carney<sup>1</sup>**

<sup>1</sup>Utah Geological Survey, Salt Lake City, Utah <sup>2</sup>Consulting Geologist, Salt Lake City, Utah

## **Project Web site:** http://geology.utah.gov/emp/UBwater\_study

#### **Solution:**

• Determine new underground zones suitable for saline water disposal

#### **Research/Deliverables:**

• Re-map the base of the moderately saline aquifer in the Uinta Basin using: - Actual downhole water chemistry data

(as of March 2011, UGS has collected 2554 water chemistry analyses from 1407 wells) - Geophysical log analyses

(as of March 2011, UGS has determined the BMSA in 246 of 261 selected wells)

- Create geologic cross sections relating the saline water transition with regional geology and identify potential seals and disposal zones
- Create a comprehensive well database for data storage and manipulation

## **Estimated project completion date:** Fall 2011





### **Donated digital log files**

Company	# of LAS files	Company	<b># of LAS files</b>
Questar	317	Forest	3
Newfield	102	Flying J	2
Enduring	75	Royale	2
Anadarko	52	Anschutz	1
El Paso	24	Bayless	1
Wind River	22	Pendragon	1
Bill Barrett	18	BT Operating	1
EOG	17	JW Operating	1
Berry	15	Elk Resources	1
Gasco	15	McElvain	1
Rosewood	7	Summit Operating	1
FIML	6		
Devon	5		
Mustang Fuel	4	Purchased	60
Whiting Petroleum	3	Digitized by UGS	14



#### UGS is also using geophysical log data to determine the base of the moderately saline aqui-

**Geophysical Log Analyses**