



TECHNICAL MEMORANDUM

To: Alex Campbell and Greg Olson, Enduring Resources
 From: John Shomaker
 Date: August 14, 2023
 Subject: hydraulic relation between Entrada Sandstone and Chinle Formation

This memorandum will address the potential for hydraulic connection between the Entrada Sandstone and the underlying Chinle Formation. The upper part of the Chinle consists largely of low-permeability claystones and mudstones. It is not an aquifer. Flow between the Entrada and the Chinle would be governed by the vertical conductivity and thickness of each unit expressed as a leakance value (the variable VCONT in the USGS MODFLOW groundwater model), calculated as:

$$VCONT = \frac{2}{\frac{\Delta v_k}{(K_z)_{k,i,j}} + \frac{\Delta v_{k+1}}{(K_z)_{k+1,i,j}}} \quad (2.1)$$

where: v_k and v_{k+1} are the thicknesses of two adjacent model layers, and $(K_z)_k$ and $(K_z)_{k+1}$ are the corresponding vertical hydraulic conductivities.

Values of VCONT were calculated from available estimates of vertical conductivity for several formation couplets in the San Juan Basin: the Pictured Cliffs Sandstone and Lewis Shale, the Dakota Sandstone and Mancos Shale, and the Entrada Sandstone and Chinle Formation, as shown in the table below. Of the three, the lowest value appears to be for the Entrada-Chinle couplet, indicating that leakage between those two zones would be the least. Only over very large areas, measured in hundreds or thousands of square miles, would significant flow occur in response to pressure difference between the zones.

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	Horizontal hydraulic conductivity, ft/day	Vertical anisotropy (bold if calculated from Kh/Kv)		Vertical hydraulic conductivity, ft/day	Thickness near well SJ-4301 POD4, ft	Leakance (VCONT), 1/day	Source of vertical conductivity data
Pictured Cliffs Ss.	0.007	100		0.000070	134	1.27296E-08	Kernodle, 1996 (San Juan Basin model)
Lewis Sh.	0.00005	10		0.000005	776		Kernodle, 1996 (San Juan Basin model)
Pictured Cliffs Ss.	0.300	300		0.001000	134	6.44052E-09	INTERA, 2012 (Roca Honda model)
Lewis Sh.	0.00005	20		0.000003	776		INTERA, 2012 (Roca Honda model)
L. Mancos Sh.	0.00005	20		0.000003	582	8.54372E-09	INTERA, 2012 (Roca Honda model)
Dakota Ss.	0.100	1,000		0.000100	129		INTERA, 2012 (Roca Honda model)
L. Mancos Sh.	0.00005	20		0.000003	582	8.58869E-09	INTERA, 2012 (Roca Honda model)
Dakota Ss.	0.250	125		0.002000	129		Kernodle, 1996 (San Juan Basin model)
Entrada Ss.	0.263	300 ?		0.000876	194		Kh, SJ-4301 POD4 test; Kv from est. anisotropy
Chinle Fm.	0.00001	20 ?		0.000001	750	1.33314E-09	upper end of range for unfractured shale, from Heath, 1983, p. 13

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CONDITIONS

Action 300695

CONDITIONS

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