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Sandia National Laboratories

Albuquerque, New Mexico 87185-1324

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to: Palmer Vaughn, 6849, MS1328

Rick Beauheim

from: Rick Beauheim, 6115, MS1324

subject: Revisions to Castile Brine Reservoir Parameter Packages

I have recently completed revisions to five Castile brine reservoir parameter packages that provide input to PA. In some instances, my revisions have resulted in changes in the individual parameter values used in the CCA. This memo summarizes the revisions I have made and discusses the impacts on the calculations made for the CCA.

The five Castile brine reservoir packages that have been revised are: permeability, porosity, pressure, rock compressibility, and volume. The following table shows the ranges given for these parameters in the previous versions of the packages, which were used for the CCA, and the ranges given in the newly revised packages.

Parameter	CCA Range	Revised Range
Permeability (m^2)	2.0×10^{-15} to 1.58×10^{-10}	2.0×10^{-15} to 6.6×10^{-11}
Porosity	0.001 to 0.02	0.001 to 0.02
Pressure (MPa)	11.1 to 17.0	11.0 to 16.5
Rock Compressibility (Pa^{-1})	5×10^{-12} to 1×10^{-8}	2×10^{-11} to 1×10^{-9}
Volume (m^3)	3.2×10^4 to 1.6×10^5	1.0×10^5 to 1.7×10^6

The high end of the range of permeability has been revised downward for the sake of consistency. The original package failed to recognize that a measured permeability is always correlated with a thickness and, as a result, presented permeabilities that were actually calculated assuming three different thicknesses as if they had been calculated using a consistent thickness. The new range assumes a consistent brine-reservoir thickness of 18.6 m. A statement has been added to the package in Section IX, Correlation with Other Parameters, that if any modeling is done using a thickness other than 18.6 m, the permeabilities presented in the package must be multiplied by the factor (18.6 m/modeled thickness). I believe the modeled thickness in the CCA was 125.8343 m. Therefore, the revised permeabilities would need to be multiplied by 0.148. I do not believe that this was done and, consequently, the permeabilities used were probably too high by a factor of about 6.8. The effect of this should have been to allow the brine reservoirs to flow more readily, which is conservative and therefore not of concern.

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The range for porosity did not change. The constant value of 0.0087 used in the CCA still falls within the recommended range.

The range for pressure contracted slightly due to development of what I consider to be a more defensible rationale. Also, no clear distinction had been made previously between gage and absolute pressures. The revised range is presented in terms of gage pressures. If BRAGFLO operates with absolute pressures, the values should be increased by 0.1 MPa. Furthermore, pressure is now noted to be correlated with depth. The pressure range presented was derived assuming a depth of 918 m. If a different reservoir depth is used in modeling, pressures should be multiplied by (modeled depth/918 m). Use of pressures greater than the maximum recommended value of 16.5 MPa (gage) is clearly conservative and not of concern.

The range for rock compressibility contracted significantly. More site-specific information on Castile anhydrite elastic moduli is available than was recognized in the original package, which relied heavily on generic data from different rock types. Although the high end value of compressibility is now an order of magnitude lower than it was previously, it still contains an order of magnitude of conservatism with respect to literature estimates of the effects of fracturing on compressibility. I believe the new range is completely defensible.

The estimates of reservoir volume increased significantly. The new range relies more heavily on observational data constrained by defensible assumptions about the volume that could be contained under the area protected by PICs. Increasing reservoir volumes while leaving other parameters unchanged would mean that the CCA runs were not conservative. However, both the volume (V) and rock compressibility (C_r) packages now note that they are correlated (with porosity, ϕ) through a lumped parameter I call the productivity ratio (PR) given by:

$$PR = V \frac{C_r}{\phi}$$

Thus, for fixed porosity as is used in the CCA calculations, the product of volume and compressibility is important, not the individual values of either. The new recommended range of values for PR is 7×10^{-4} to 4×10^{-2} m^3/Pa. The calculated range for the 100 vectors in replicate 1 of the CCA is 5.3×10^{-5} to 6.0×10^{-2} m^3/Pa. While some of the CCA values, therefore, fall nonconservatively below the recommended range, we have determined that this is of no consequence (see memo from Swift, Larson, and Beauheim to Shephard and Chu dated October 3, 1996, WPO#41885).

In summary, the revisions to the Castile brine reservoir parameter packages result in the CCA calculations being either conservative or nonconservative with no consequence. The revisions provide a more defensible basis, however, for any future calculations that may be performed. Please contact me if you have any questions.

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cc:
M.S.Y. Chu, MS1335
M.S. Tierney, MS1328
P.B. Davies, MS1324
A.R. Lappin, MS1324
S.M. Howarth, MS1324
M.G. Marietta, MS1395
K.W. Larson, MS1395
SWCF-A:WPO#31070, 31072, 31082, 31083, 31084

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