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# Effective Models of Flow in Vuggy Carbonate Reservoirs

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Carbonate reservoirs hold almost half of the world's oil and gas reserves. Many giants carbonate fields are rather mature, been producing for 50 or even 100 years; these are ready for some form of gas-flooding, EOR. More precise reservoir characterization can lead to better modeling of EOR schemes for these giant/mature fields.
Characterization of carbonate reservoirs is a complicated task mainly because of the complex texture and pore network. Heterogeneities are present in all the scales as well as anisotropy in vertical and horizontal directions. The presence of vugs and fractures in carbonate rock can significantly affect pressure and flow behavior of the fluid. A vug is a cavity (usually a void space, occasionally filled with sediments), and its pore volume is much larger than the intergranular pore volume. Current laboratory techniques may not be capable of quantifying the vuggy heterogeneities in carbonate reservoirs and interpret the effect of the presence of vugs on the permeability of porous media.

This is mainly because of the practical limits of core samples preparation and the variety in size of heterogeneities in carbonate rock. The vug size can be larger than core samples, and consequently, no lab technique can capture the effect of vug on the petrophysical parameters of the carbonate rock. The core sample analysis usually underestimates the carbonate rock's permeability.

We use the analytical models for flow in heterogeneous porous media, including a random distribution of fluid-filled vugs and karsted zones (we address them all as the vuggy inclusions). The flow in vugs at the microscopic level does not obey Darcy's law; rather it is governed by Stokes flow. The coupling of Stokes flow and Darcy's law is implemented through a no-jump condition on normal velocities, a jump condition on pressures, and generalized Beavers–Joseph–Saffman condition on the interface of the porous matrix and vug or fracture. The spheroidal geometry is used because of its flexibility to represent many different geometrical shapes. A spheroid reduces to a sphere when the focal length of the spheroid approaches zero. A prolate spheroid degenerates to an elongated rod to represent the connected vug geometry (a tunnel geometry) when the focal length of the spheroid approaches infinity. An oblate spheroid degenerates to a flat spheroidal disk to represent the fracture geometry. The effective permeability of a porous medium including random distribution and size of vuggs as well as a binary porous medium with a uniform distribution of vugs is obtained.

## References

Arbogast, T., Brunson, D.S., A computational method for approximating a Darcy–Stokes system governing a vuggy porous medium. Comput. Geosci. (2007)11(3), 207–218
Beavers, G.S., Joseph, D.D., Boundary conditions at a naturally permeable wall. J. Fluid Mech., (1967), 30, 197–207.
Carslaw, H.S. and Jaeger, J.C., Conduction of heat in solids. 1960. Clarendon Press.
Happel, J., Brenner, H., Low Reynolds Number Hydrodynamics: With Special Applications to Particulate Media. (1983) Mechanics of Fluids and Transport Processes. Springer, Berlin
Lucia, F. Jerry, Carbonate reservoir characterization: an integrated approach, 2007, Springer Science & Business Media.
Saffman, P.G., On the boundary condition at the surface of a porous medium. Stud. Appl.Math. 1971, 50(2),

93–101.
Yao J, Huang ZQ, Fractured Vuggy Carbonate Reservoir Simulation; 2016 Jul 28, Springer.

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**Primary authors:** Dr RASOULZADEH, Mojdeh (University of Alabama); Dr KUCHUK, Fikri (Schlumberger)

**Presenter:** Dr RASOULZADEH, Mojdeh (University of Alabama)

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