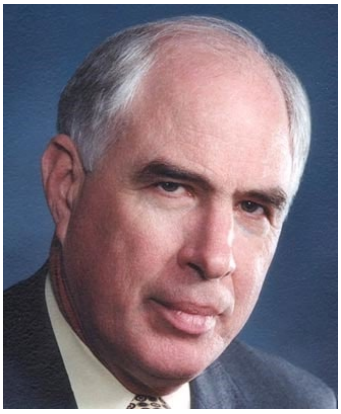
4D Seismic Interpretation: A Logical Error in Gassmann Poroelasticity



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Wednesday, January 12th, 2022 – 12:00 PM MST
WEBINAR

Abstract

The well-known "Biot-Gassmann" formula for the difference between "undrained" and "frame" compressibilities of rocks is in error. The error was introduced by Gassmann (implicitly revising earlier work by Biot), and results in an expression which is simpler than Biot's corresponding expression, containing only one material parameter (KS) in place of Biot's two (H and R). The error occurred when Gassmann applied a hydraulically-open theorem to a hydraulically-closed system, violating the assumptions of the undrained compressibility. The inconsistency between Gassmann and Biot (and equivalent results of Brown/Korringa, and Rice/Cleary) is caused by Gassmann's logical error, rather than by the issue of solid micro-homogeneity. The additional parameter may be experimentally determined via the "Skempton B-coefficient" (the ratio of fluid pressure to external pressure in an undrained quasi-static compression test). The additional parameter enables the resolution of a long-known inconsistency between Gassmann's result and effective medium theory. The correct expression, with its additional parameter, is required to analyze the fluid-dependence of rock incompressibility for all macro-isotropic rocks with uniform fluid pressure, with or without solid micro-homogeneity. A new generation of experimentation is required to determine the systematics of the magnitude of thecorrection to the Gassmann formula.

Biography

Leon Thomsen holds degrees in geophysics from Caltech (1964) and Columbia (1969). Following academic appointments at CNRS (Paris, 1969-70), Caltech (1970-72), and SUNY Binghamton (1972-80), he held industrial appointments at Amoco (1972-1999) and BP (1999-2008). Currently he serves as Chief Scientist of Delta Geophysics (http://DeltaGeophysics.net), as Research Professor at the University of Houston, and as Visiting Scientist at LBNL

Thomsen has led technical development in applied geophysics through innovation in vector seismics (polar anisotropy, azimuthal anisotropy, azimuthal AVO, converted waves, and Life-of-Field-Seismics); in pore-pressure prediction; in ISEM and rock physics, through numerous SEG publications and presentations, and many patents.

Thomsen was an early recipient (1960-64) of an SEG Scholarship. He received SEG's Fessenden Award in 1994, and its Maurice Ewing Medal in 2020. He is a Foreign Member of the Russian Academy of Natural Sciences, and holder of their Kapitsa Medal. He served SEG as Vice President, as President-Elect, as President (2006-07) and as BoD Chair (2018-19) of SEAM.