

# **Seafloor Broaching Prevention After an Offshore-Well Blowout**

In the aftermath of a blowout, the well undergoes a period of unrestricted fluid discharge (*de facto* primary recovery), followed by pressure buildup after its shut-in, which can adversely impact wellbore integrity. The quintessential example is Union Oil's 1969 "A-21" well blowout in California's Santa Barbara Channel, where seafloor broaching kept taking place from the sides of the well following several failed well-capping attempts, until reservoir depletion eventually allowed a successful shut-in, many days later.

The general thrust of this talk revolves around using a hybrid data-driven/physics-based modeling approach to facilitate selecting the appropriate well-capping strategy in such complex offshore-blowout scenarios. This is achieved by creating a physics-based core, complemented by data-driven (computationally-obtained) correction factors that combine the effectiveness of numerical models with the simplicity of analytical (closed-form) expressions.

Reservoir depletion models are coupled with near-well geomechanics to derive closed-form expressions for "critical-discharge flowrates" used to indicate dangers for underground blowouts, in the form of tensile failures on the borehole walls, occurring after well capping. Following the MC 252-1 "Macondo Well" blowout in 2010, as part of blowout-contingency planning, U.S. laws mandate "worst-case-discharge" (WCD) flowrate calculations to be performed, before an offshore well is spudded. Predictive tools can assist blowout-contingency planning through comparisons between these critical-discharge flowrates and WCD estimates to select an appropriate well-capping strategy.



Andreas Michael is an Assistant Professor of Petroleum Engineering at the University of North Dakota (UND), serving also as the faculty advisor of the local ARMA Student Chapter. His research interests include hydraulic-fracture-initiation modeling, underground-blowout prevention, wellbore integrity, improved oil recovery, and petroleum economics. At UND he teaches courses on geomechanics, drilling engineering, well completions, and advanced stimulation techniques. He previously was a Postdoctoral Research Fellow at Colorado School of Mines researching the stability of underground tunnel intersections.

A Greek Cypriot, Dr. Michael holds bachelor's and master's degrees from the University of Texas at Austin and a doctorate from Louisiana State University (LSU), all in petroleum engineering. His PhD dissertation titled, "Fluid-Driven Fracture Initiation from Oil and Gas Wells Considering Lifetime Stresses" received LSU's Distinguished Dissertation of the Year Award for STEM in 2020. He has authored 15 peer-reviewed journal articles (7 first-authored, 4 single-authored), 33 conference papers, and 18 magazine articles. In 2020-21 he served as the Managing Editor (*de facto* Editor-in-Chief) of *The Way Ahead*, the Society of Petroleum Engineers' magazine for young professionals.