

Optimizing Basement Fracture Exploration in a Mature Basin: Lessons from the South Sumatra Basin's Success and Failures

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Basement fracture reservoir is an unconventional play that still exhibits significant knowledge gaps in exploration and development. There are few fields that have successfully identified reserves in the basement, and one of the basins that has successfully developed it is the South Sumatra Basin, Indonesia. The South Sumatra Basin is highly prolific for basement fracture plays, experiencing multiphase tectonic events conducive to the formation of basement reservoirs. Despite the cumulative reserves of basement fracture reservoir in this basin reaching 1.4 BBOE, hydrocarbon production has been realized only in three fields: Suban, Sumpal, and Dayung. Pertamina has undertaken exploration efforts over the past decade to identify other potential structures surrounding these fields. Six exploration well drillings targeting the basement were conducted during this period, but only two wells succeeded in encountering hydrocarbons.

This paper aims to evaluate the exploration wells targeting basement fracture plays in the South Sumatra Basin, comprehending the reasons for their failures and providing lessons learned to enhance basement fracture exploration. Utilizing data from six exploration wells, advanced logging tools, three volumes of 3D seismic data, and over 20 regional 2D seismic lines, the methodology involves well post-mortem analysis, integrating petroleum system aspects with drilling operational considerations. The petroleum system aspect encompasses reservoir assessment using image logs, cores, geomechanics, multi-attribute seismic for fracture identification, and 3D basin modeling for hydrocarbon migration. The drilling operational aspect includes evaluating mud compatibility, Drill Stem Test (DST) analysis, and pore pressure analysis.

Evaluation results reveal that the KA-1 well failed due to an inverted basement high, while the PA-1 well failed due to oil leakage through a thief zone in the sandstone reservoir above it. MA-1 well successfully flowed oil, but MA-2 delineation well failed to identify a favourable fracture intensity. BA-1 well successfully obtained gas, but BA-2 delineation well failed to find good fracture porosity. From these six wells, several requirements for basement success are identified, including the presence of paleohigh structures instead of inverted highs, proximity to suture zones for reactivating old faults through multiphase tectonics, better deliverability from fractures with critically stressed conditions, a preference for basements below the oil window, and higher chances of success in well operation aspect with underbalanced and directional drilling perpendicular to the fracture trend.

Keywords: basement fracture reservoir, South Sumatera Basin, exploration, mature basin