DHIs and Flat Spots: The Miocene Levant Basin within a Global Perspective

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ABSTRACT

Direct hydrocarbon indicators ("DHI's"), including 'flat spots,' have been a very effective de-risking tool for oil and gas exploration for almost 50 years, and particularly effective in establishing working petroleum systems in deepwater frontiers such as the Levant Basin. Roughly half of ca. 79 BBOE discovered to date in deepwater giant fields come from DHI discoveries. A large portion of that total is from flat spots, including the giant Miocene fields and discoveries of the Levant Basin, which have announced discovered resources exceeding 40 TCF.

Despite this success, there are several pitfalls that have caused flat spots to result in dry holes. These pitfalls were well-documented before the drilling of Tamar in 2008, however in the last ten years both the pitfalls and common ingredients of successful flat spots have become better understood. That said, except for a spike in 2008–2010 due to a string of discoveries in the deepwater Levant and East Africa, the global success seems to have remained constant at 80%. Furthermore, there does not seem to be a large deviation from this success rate based on reservoir age, trap type, basin type, or AVO class.

We combine data from several sources to make this comparative study and document some key ingredients to success: global deepwater studies (Weimer and Pettingill, 2007; Faroppa and Pettingill, 2017), the Rose and Associates DHI Consortium (Forrest et al., 2010; Roden et al., 2012), and publicly available information. Based on these data, flat spots occur in si-

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liciclastic reservoirs and within all common trap types, however for large discoveries, are more prevalent in structural traps (four-ways or fault-dependent three-ways). This appears to be mostly a consequence of the predominant trap type in a basin, and in plays where stratigraphic trapping is more common, large fields have been found with flat spots. The DHI Consortium database has 40 wildcats that had a high-quality flat spot, and has recognized three basic characteristics that can dramatically increase the chance of success: (1) the flat event itself (a planar event which is flat in depth), (2) an amplitude anomaly at the top reservoir event (most commonly AVO classes II or III), and (3) a change in character of that event at the common elevation of the water contact and flat event (e.g., phase reversal, amplitude dimming). In addition, many also have either an amplitude tuning ring at the reservoir level, and/or a gas cloud or chimney above the trap, and an AVO response indicative of hydrocarbon. Finally, the coincidence of sand depositional indicators with the trap, as interpreted by seismic, well and other regional data, has been recognized as a key ingredient to success.

The Tamar discovery in 2009 and its subsequent successful follow-ons coincided roughly with this increased recognition of key characteristics of successful flat spots. The Tamar sand discoveries display most of the aforementioned characteristics, and hence is an important analog in the global context of DHIs.