An overview of the exploration and development history of the northern deep-water Gulf of Mexico (GOM) Superbasin.

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An analysis of the 226 known fields and discoveries[1] in the northern deep-water GOM indicates a complex, interrelationship in the timing of reservoir deposition and development of traps (Figure 1). In many of the fields, sediment was deposited overlying thick autochthonous and allochthonous salt bodies of different ages. The sediment loading, in turn, caused the salt to deform, creating a variety of trap styles. The timing of trap formation varies considerably among the major four exploration provinces (Basins, Sub-salt, Fold belt, and Abyssal) and play types (Figure 1). These regional differences were ultimately controlled by the shifting shallow marine depocenters, which delivered the sediment for the deep-water reservoirs.

A three-fold trap classification was used to define eight categories (Figure 2). Four–way closures include contractional traps (30 fields), extensional anticlines (turtles, 7 fields), fault-bounded (4 fields), and compactional drape (13 fields). Three-way combined structural-stratigraphic traps include: faulted-bounded (51), along flank of salt (26), and against salt (sub-salt; 23 fields). The twenty-eight fields with stratigraphic traps are found primarily in the northeastern part of the area (Mississippi Canyon, Viosca Knoll) and include pinchouts due to onlap, erosional truncation, and facies change. Of particular significance for the stratigraphic traps is that they are all associated with seismic amplitude anomalies.

The most active play currently in development is the lower Oxfordian eolian Norphlet play (six discoveries) in the northeastern deep GOM. Traps developed associated with the emplacement of late Oxfordian salt rafts associated with gravity gliding along the flanks of the Middle Ground Arch (Figure 1).

The reservoirs in the rest of the fields were deposited in intra- or base-of-slope turbidite systems. Reservoirs are typically in channel-fill, depositional lobes (sheet), and levee (thin bed) settings. Thirty fields-discoveries are upper Paleocene to lower Eocene (deep-water Wilcox) in age in the northern and northwestern area (including five from Mexico). Fields represent sediment input from the north and northwest. Most of the sediment was derived from the southern Rocky Mountain region. The traps in the subsalt Wilcox play (26 fields) associated with the Keathley–Walker Foldbelt developed between 24 and 15 Ma. The traps in the Perdido foldbelt formed between 27 and 29 Ma, which includes reservoirs in both the Wilcox (8 fields-discoveries, including five in Mexico) and Oligocene Frio (three fields, including Supremus in Mexico).

At the beginning of the Miocene, the significant eastward shift in the shallow-marine depocenter to central Louisiana is clearly seen in the distribution of the deepwater reservoirs. Trap styles and their timing vary considerably. Fourteen lower Miocene fields are primarily in southeastern Green Canyon in subsalt Province or MS Fan Foldbelt.

For the middle Miocene, the slight eastward shift in the shallow-marine depocenter is indicated by the 46 fields that are primarily in Mississippi Canyon, eastern Viosca Knoll, and southeastern

Green Canyon. Sixty-one upper Miocene fields have a similar distribution as middle Miocene fields, with a few fields in central Green Canyon and eastern Garden Banks.

A westward shift during the early Pliocene depocenter to western LA is seen in the distribution of deepwater fields; forty-three fields are primarily in northeast Mississippi Canyon, Green Canyon, and central Garden Banks. A continued westward shift in depocenter to eastern TX/western LA during the late Pliocene resulted in 36 fields in East Breaks, Garden Banks, and Green Canyon, and thirty-three fields in lower Pleistocene reservoirs. In contrast, five fields with upper Pleistocene reservoirs are found across the area, indicating the abrupt shifting of the shallow-marine depocenter.

The timing of trap development during the Neogene in the central to eastern GOM is highly variable. Traps for the 7 of 8 fields in the Mississippi Fan foldbelt developed between 15 and 5.5 Ma. The timing of trap formation in the upper to middle slope (Basins Province) is quite variable, both in duration and the absolute age. Both turtle structures and compactional drape traps develop within 1 to 3 Myrs after reservoir deposition. The timing of three-way and four-way fault bounded traps are variable and depend upon the cessation of fault movement. Three-way closures with sands lapping out against salt take between 1 to 5 mys to develop. Subsalt truncation traps generally formed 2 to 4 Myrs after reservoir deposition. Finally, stratigraphic traps develop shortly after reservoir deposition, typically 1 to 2 myrs later.

Source rocks in the northern deep-water GOM are primarily Tithonian (Cotton Valley equivalent), with some contributions from the Oxfordian Smackover equivalent in the Norphlet play area. Source intervals have only been penetrated in 22 wells (primarily in the Norphlet play), so oil-to-source typing is done through oils in reservoirs and extensive seafloor seeps. In most fields, the source rocks are 5000-20,000 feet deeper than the reservoirs. The GOM has had (a) relatively young generation of oil (last 10 Ma or less), and (b) a complex vertical migration history and charge to its reservoirs.

[1] Note: all statistics current through the summer of 2016.