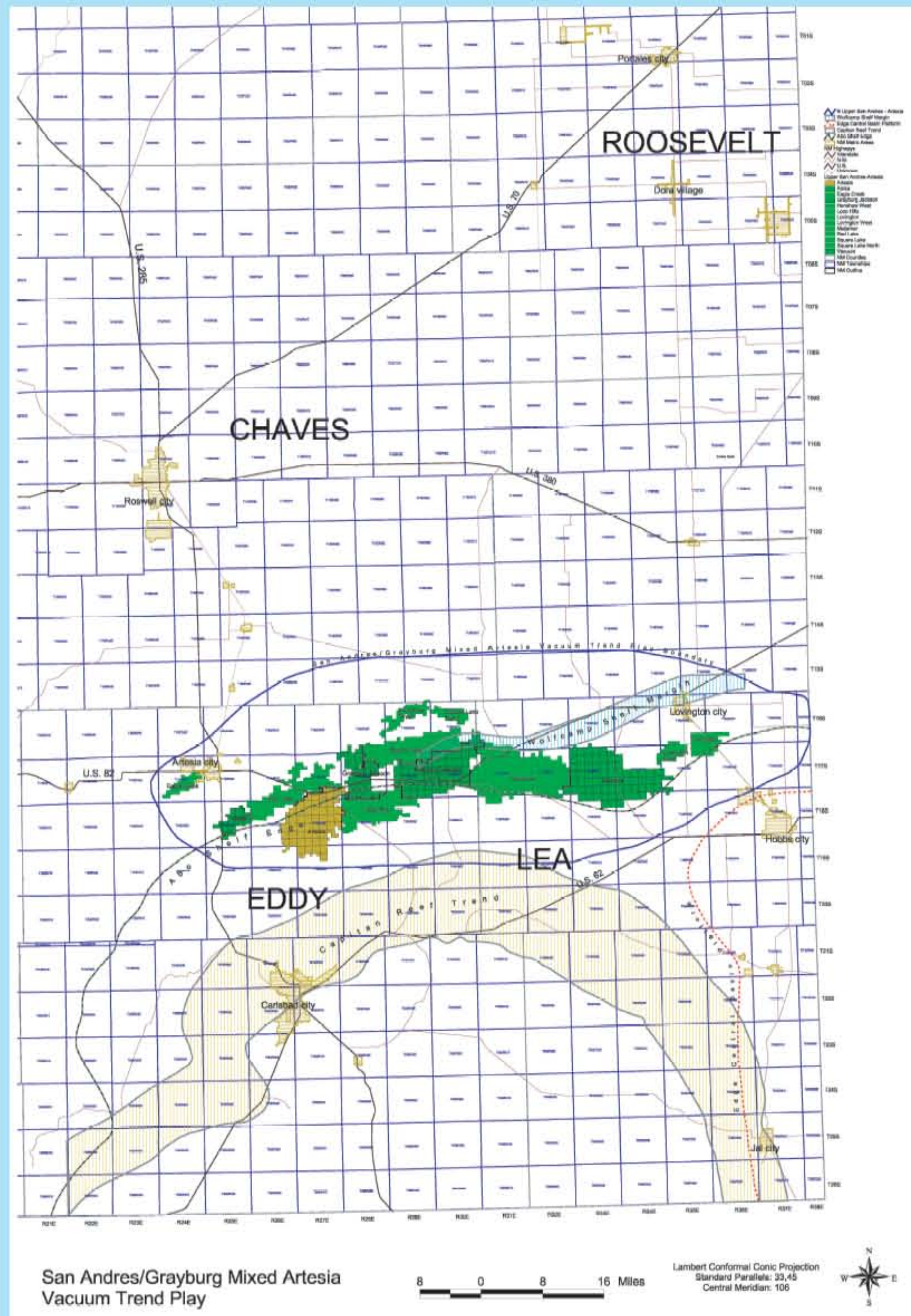


# Upper San Andres and Grayburg Platform - Artesia Vacuum Trend Play Play Geology

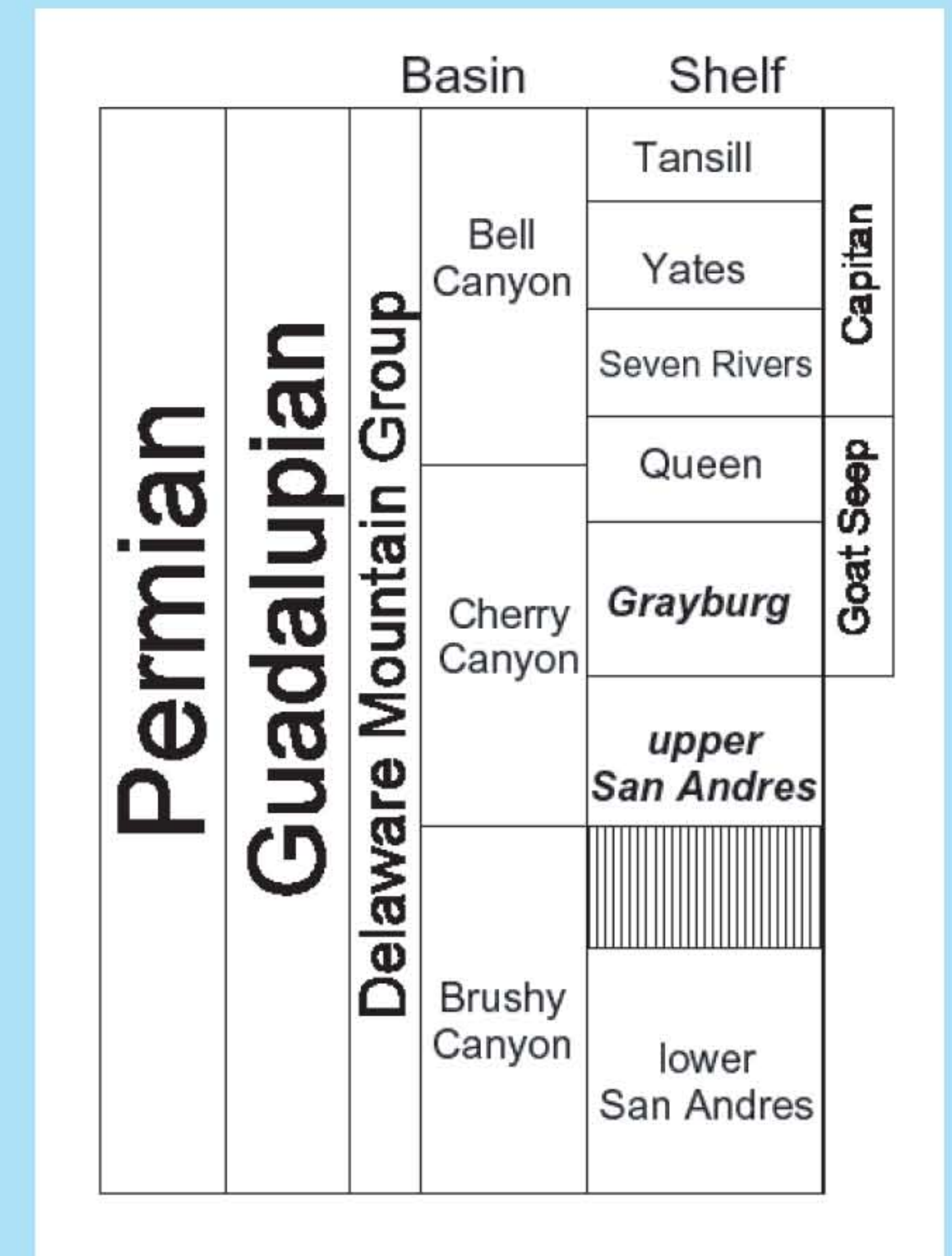


The Upper San Andres and Grayburg Platform - Artesia Vacuum Trend Play extends between the cities of Artesia and Hobbs in Eddy and Lea Counties along the Artesia-Vacuum arch. The play has 13 reservoirs with > 1 MMBO cumulative production. Cumulative production from these 13 reservoirs was 796 MMBO as of 2000. Production is obtained from both the San Andres Formation and the overlying Grayburg Formation.

The upper San Andres Formation was deposited on a restricted carbonate shelf and is a backreef deposit composed of dolowackstones, dolopacktones and dolograinstones. It is composed of high-frequency, upward-shoaling carbonate depositional cycles capped by low-permeability peritidal facies that vertically compartmentalize the reservoir (e.g. Purves, 1986; Modica and Dorobek, 1996; Handford et al., 1996; Stoudt and Raines, 2001; Pranter et al., 2004). Reservoir facies lie between the Guadalupian shelf margin to the south and tight evaporites and dolostones of the inner shelf to the north. In some reservoirs, there is significant permeability and porosity enhancement associated with unconformities and subaerial exposure diagenesis (karsting; Hovorka et al., 1993). In other reservoirs such as Vacuum, karstification has acted to further compartmentalize reservoirs horizontally as well as vertically through development of karst pore systems and subsequent filling of karst pore systems with impermeable sandstones, collapsed carbonates and evaporites (Stoudt and Raines, 2001; Pranter et al., 2004). High-angle, low-displacement (<25 ft) faults have also acted to horizontally compartmentalize reservoirs (Pranter et al., 2004). This vertical and horizontal compartmentalization makes development of reservoirs incomplete with vertical wells drilled on standard 40-acre spacing. The Vacuum reservoir has responded favorably to CO<sub>2</sub> flooding. Horizontal laterals have demonstrated the ability to produce bypassed, unswept, and banked oil.

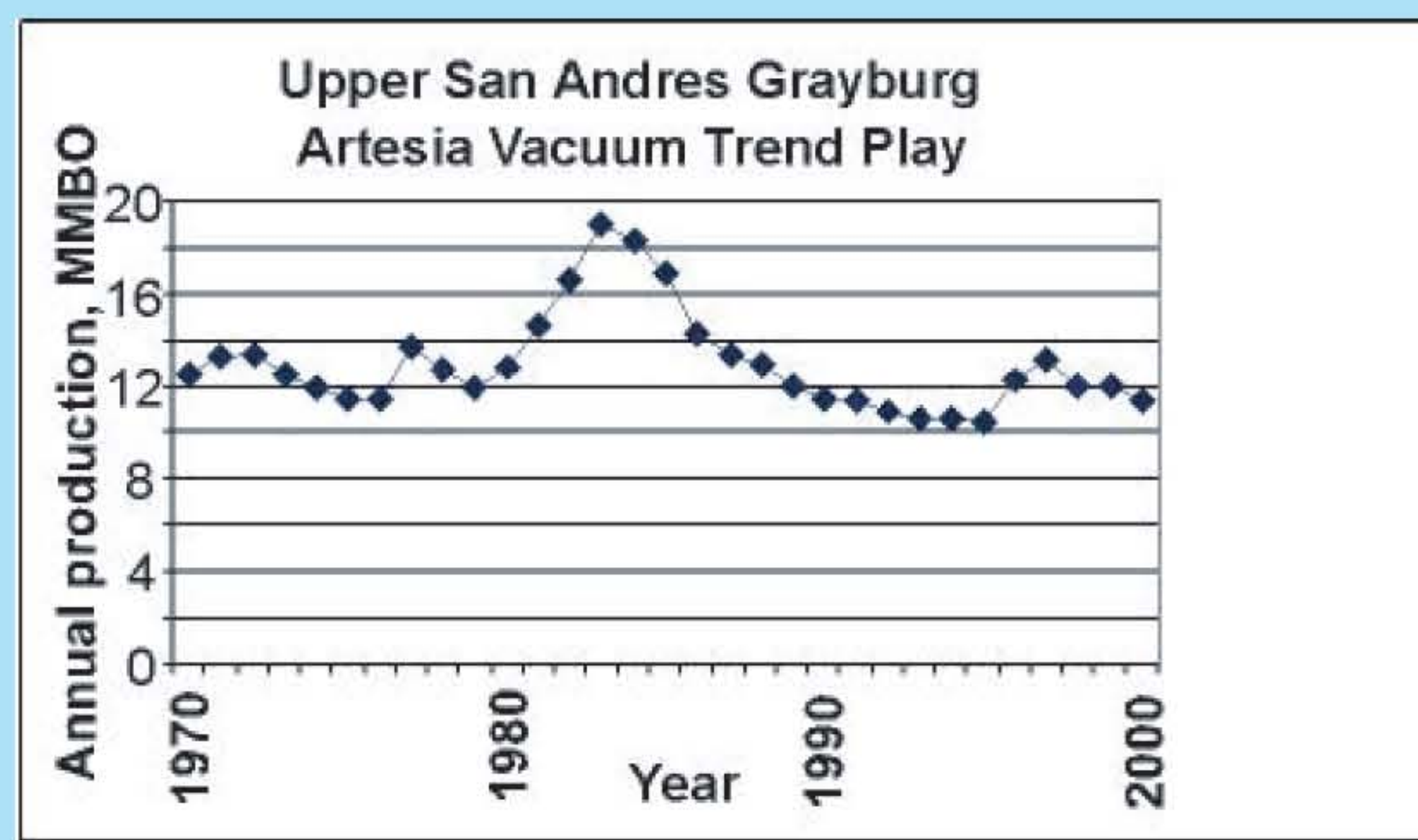
The Grayburg Formation consists of interbedded sandstones, siltstones and dolomitic carbonates (Handford et al., 1996; Modica and Dorobek, 1996). The sandstones are the main Grayburg reservoirs and were deposited in coastal sabka, sandflat and eolian environments. Carbonates are generally impermeable subtidal deposits. Substantial pay may remain behind pipe in Grayburg sandstones.

The Artesia-Vacuum arch is a shallow structure that overlies the deeper Abo shelf edge reef trend and Bone Spring flexure. Reservoir position with respect to the crest of the arch determines whether the San Andres or the Grayburg dominates production in any given field. The fields located in structurally higher positions will have substantial production from the Grayburg as well as the underlying San Andres. Fields occupying a structural position lower on the arch tend to be productive mostly from the Grayburg with the underlying San Andres mostly wet. The regional vertical seals are impermeable facies in the upper Grayburg and Queen Formations.



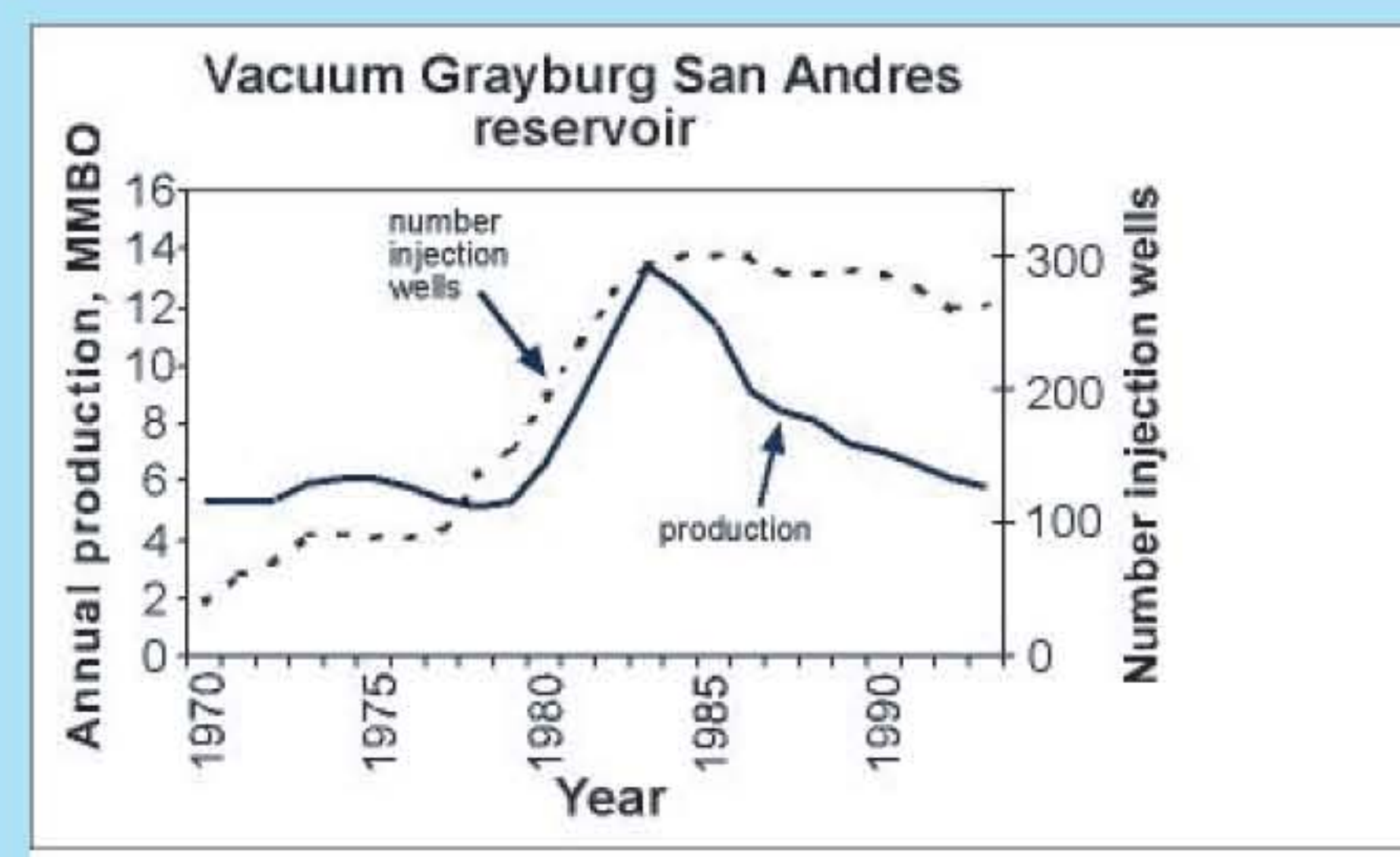
Reservoirs with > 1 MMBO cumulative production in the Upper San Andres and Grayburg Platform - Artesia Vacuum Trend Play.

## Production History

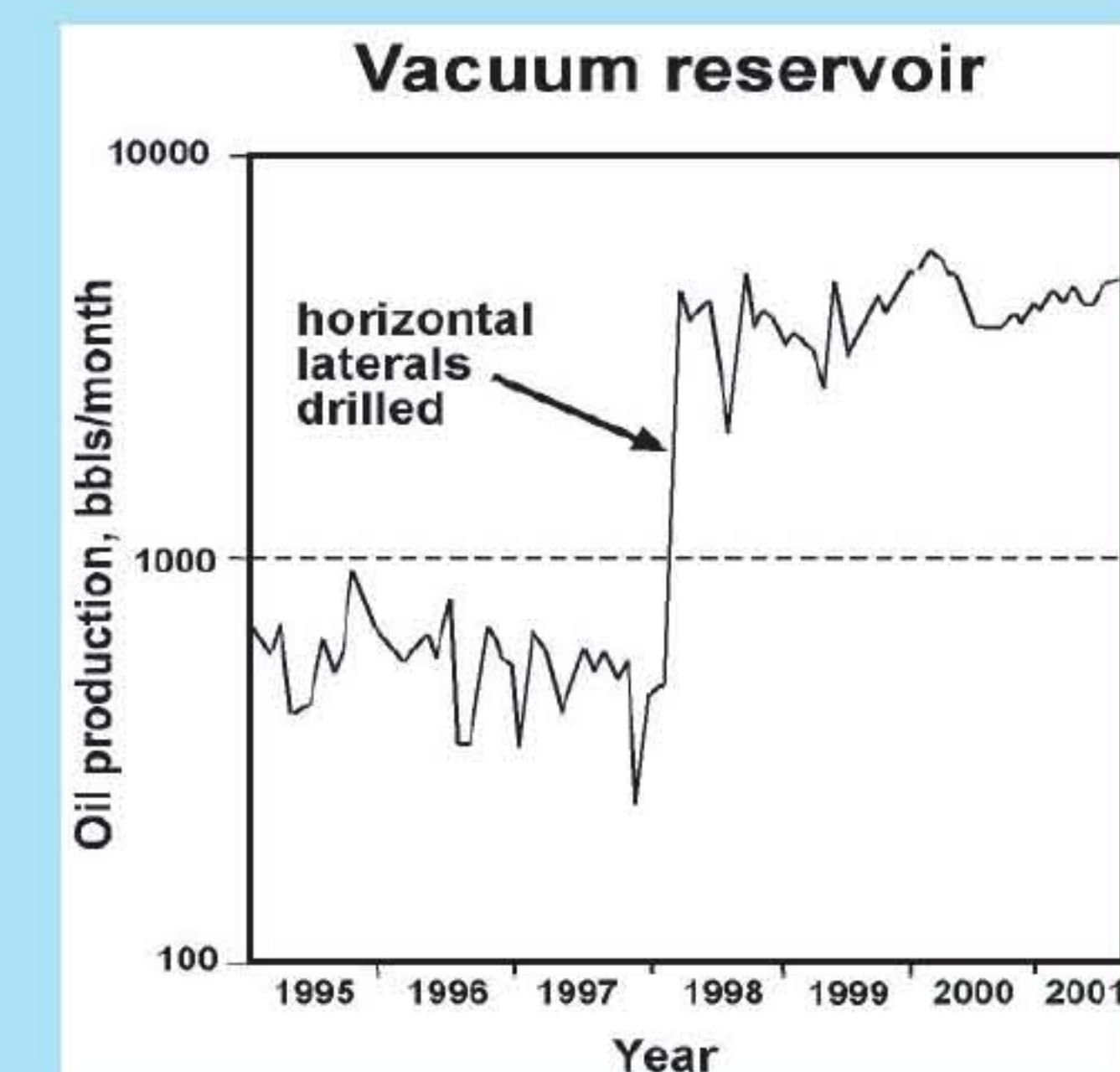


Annual production from 1970 to 2000 for the 13 reservoirs within the Upper San Andres and Grayburg Platform-Artisia Vacuum Trend Play that have produced more than 1 MMBO. The significant increase in production during the mid-1980's was caused by implementation of waterflood/pressure maintenance projects in the Vacuum reservoir.

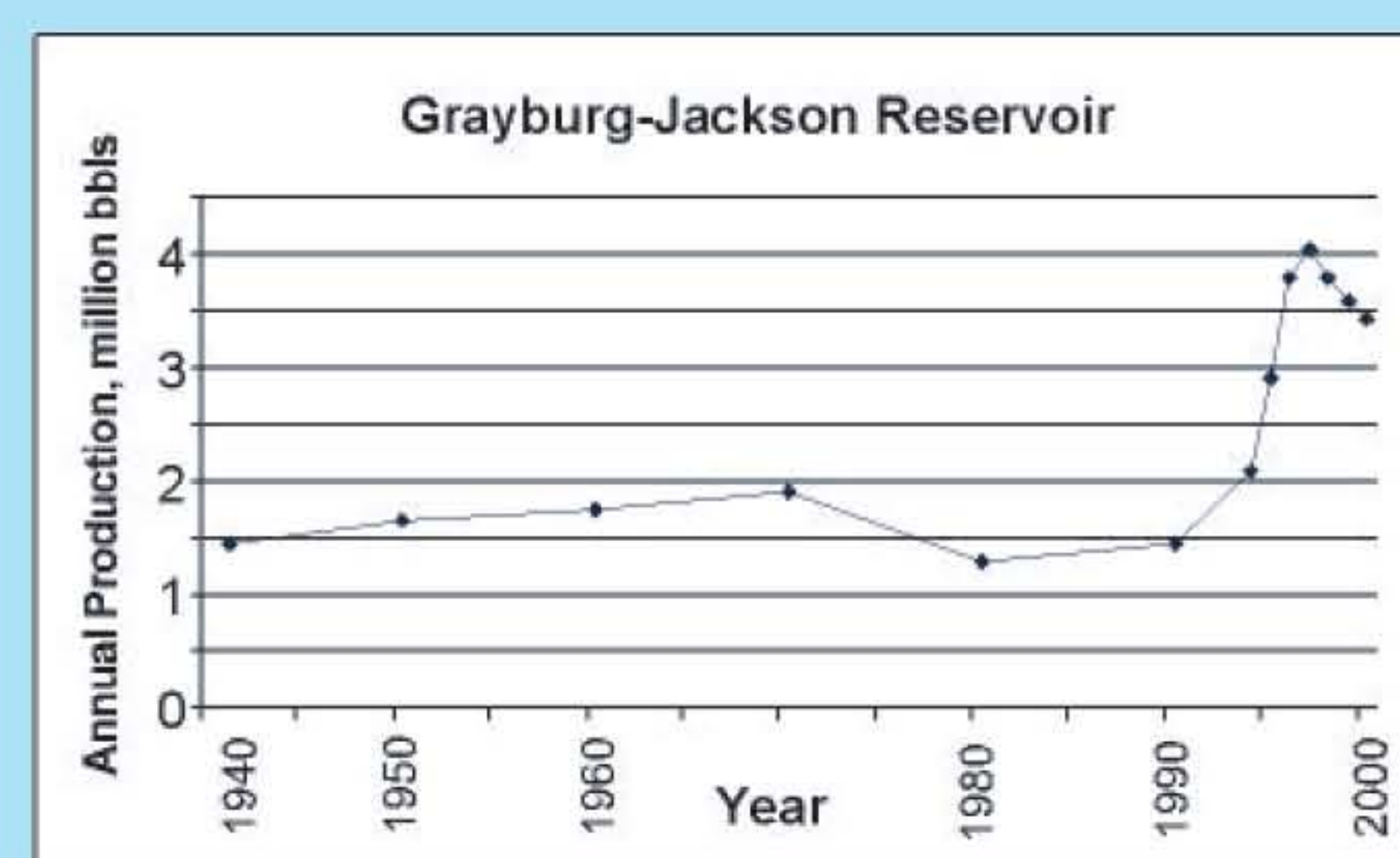
## Enhanced Production Methods



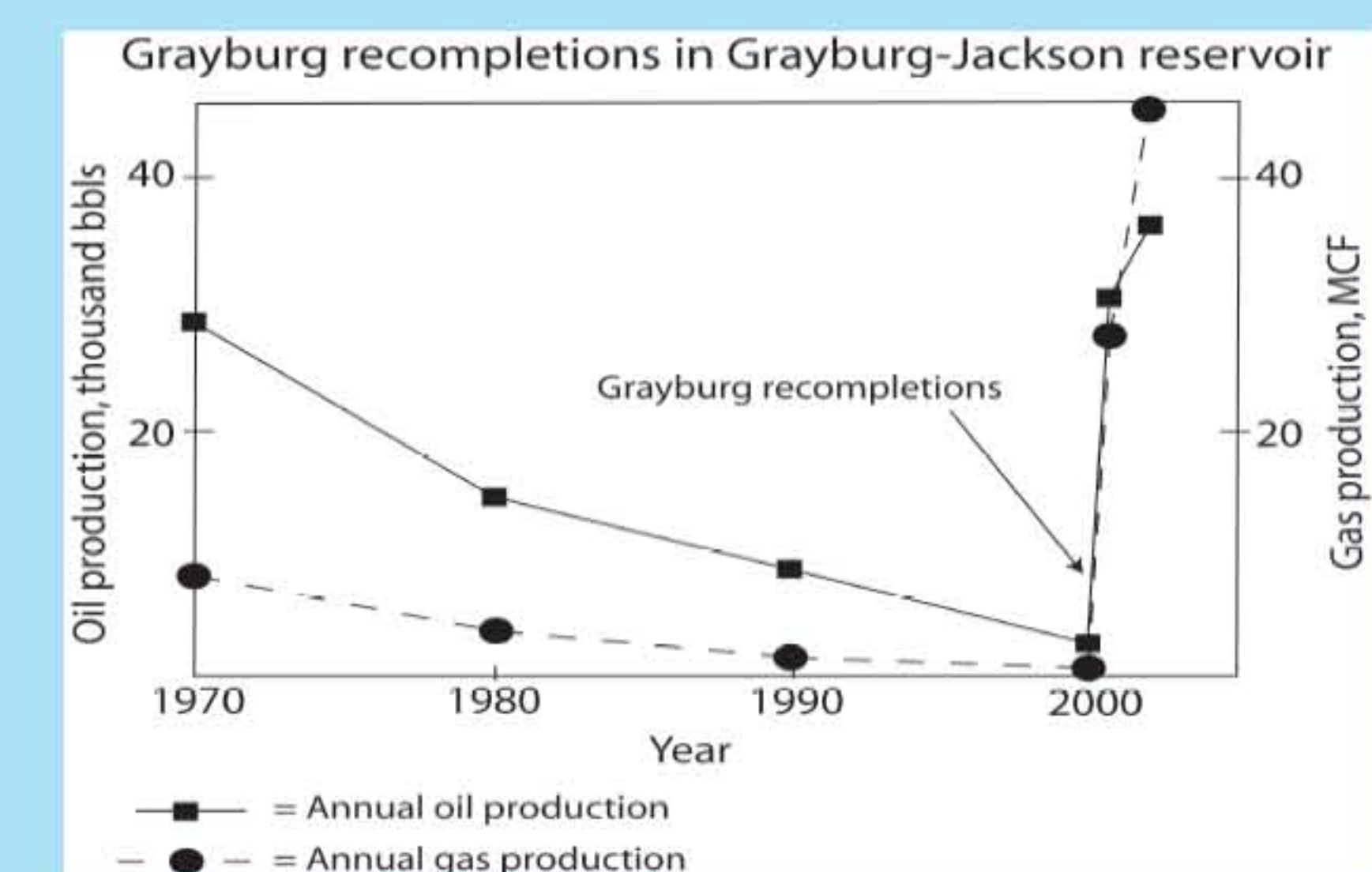
Annual oil production and number of injection wells in the Vacuum reservoir, showing response of reservoirs to pressure maintenance/waterflooding in the 1980's.



Small-displacement normal faults, along with depositional cycles, and sediment- and evaporite-filled karst pore systems have compartmentalized the San Andres in the Vacuum reservoir, leaving behind banked and unswept oil. Two laterals drilled by Texaco from an existing vertical well resulted in this substantial increase in production from a single well. After Pranter et al. (2004).



Annual oil production from Grayburg Jackson reservoir. The large upturn in production during the mid-1990's is due in large part to recompletions in previously bypassed pay of the Grayburg Formation (B. Brister, personal communication, 2003).



Production history of 3 wells in Burnett Oil Co. lease in Grayburg Jackson reservoir, indicating substantial increase in production due to recompleting San Andres wells to behind-pipe pay in Grayburg sandstones.