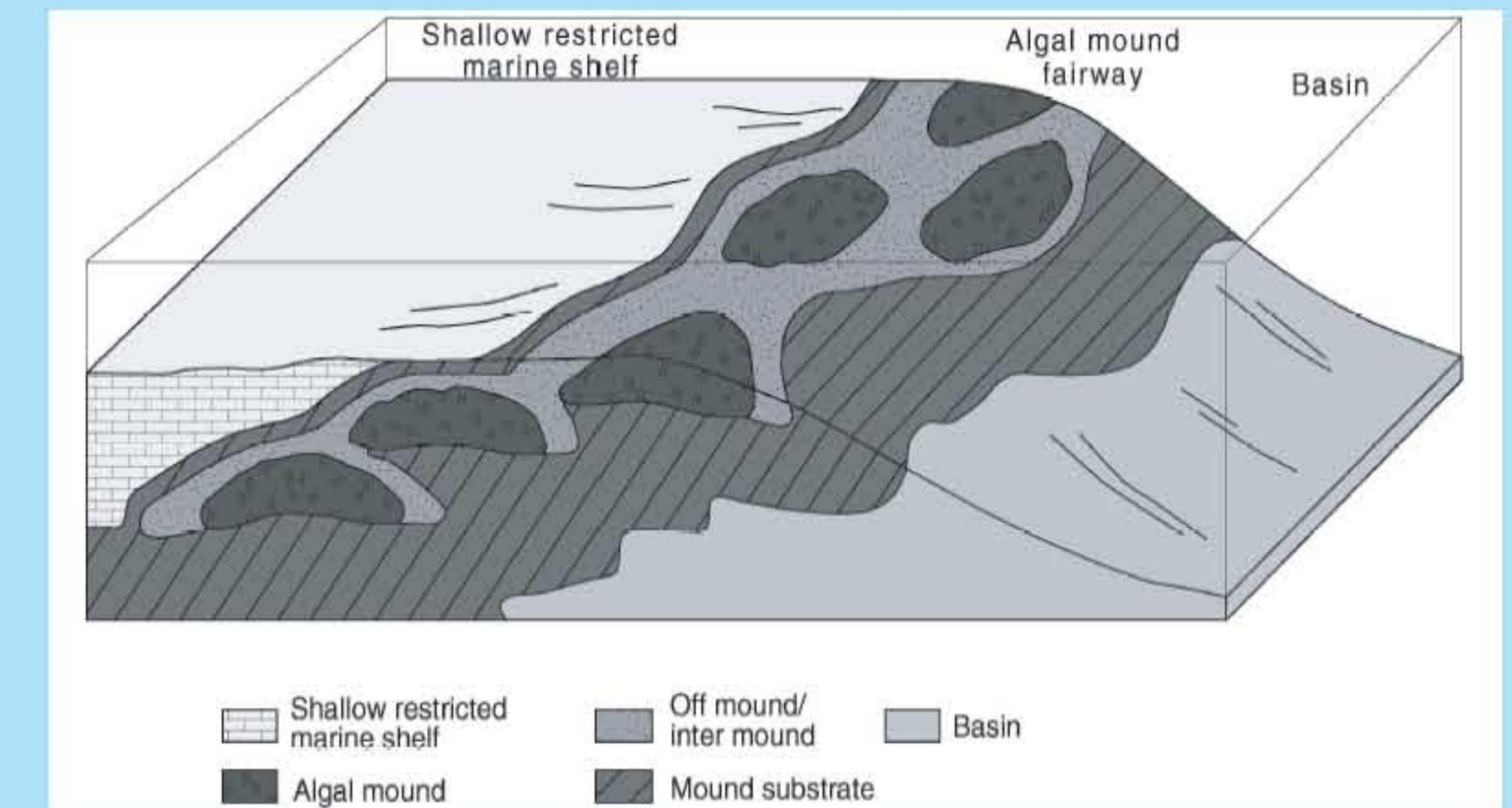


# Northwest Shelf Upper Pennsylvanian Carbonate Play

## Play Geology

Reservoirs in the Northwest Shelf Upper Pennsylvanian Carbonate Play lie on the Northwest Shelf of the Permian Basin. The play trend extends from the shelf edge near Carlsbad in Eddy County to the shelf interior in Chaves and Roosevelt Counties. Reservoirs are limestones and dolostones of Canyon (Upper Pennsylvanian: Missourian) and Cisco (Upper Pennsylvanian: Virgilian) age. Traps are primarily stratigraphic and are formed by phylloid algal mounds and associated grainstones and packstones (Cys, 1986; Speer, 1993; Mazzullo, 1998; Cox et al., 1998). Productive porosity is primarily vugular, intercrystalline, and intergranular. Most reservoirs in this play were initially discovered by drilling structures or by testing shows encountered while drilling to deeper zones. There are almost 400 known discovered reservoirs in this play, 200 of which are currently nonproductive and 35 of which have produced more than 1 MMBO. Cumulative production from these 35 reservoirs was 354 MMBO as of 2000. Many of these reservoirs are characterized by high water cuts; produced water volumes often exceed produced oil volumes.

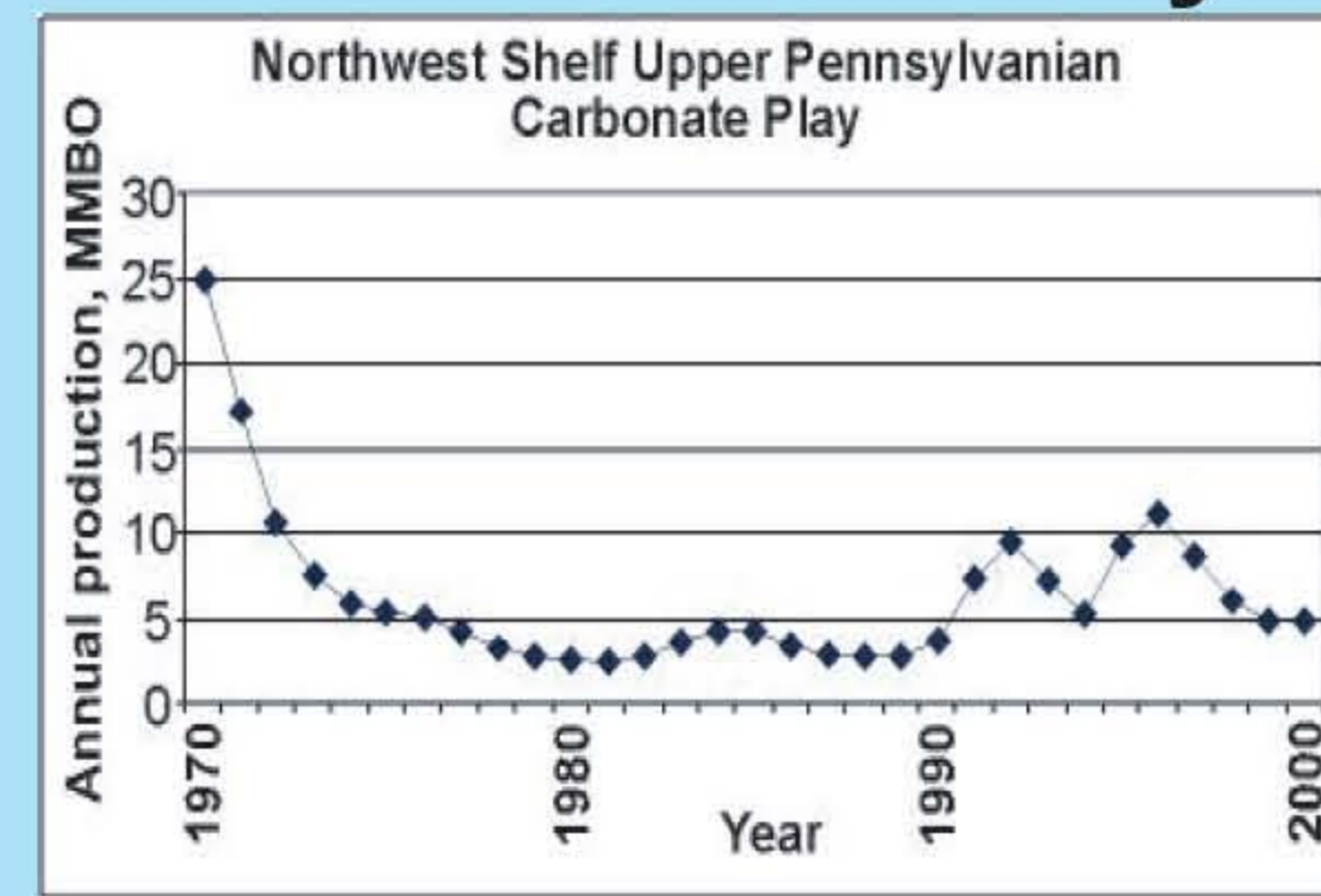
		Shelf		Basin
Permian	Wolfcampian	Wolfcamp	Three Bralcers Member lower Wolfcamp	Wolfcamp Group
	Virgilian	Cisco	Bough A Bough B Bough C Bough D	Cisco
Pennsylvanian	Missourian		Canyon	Canyon
	Des Moinesian		Strawn	Strawn
	Atokan		Atoka	Atoka
	Morrowan		Morrow	Morrow



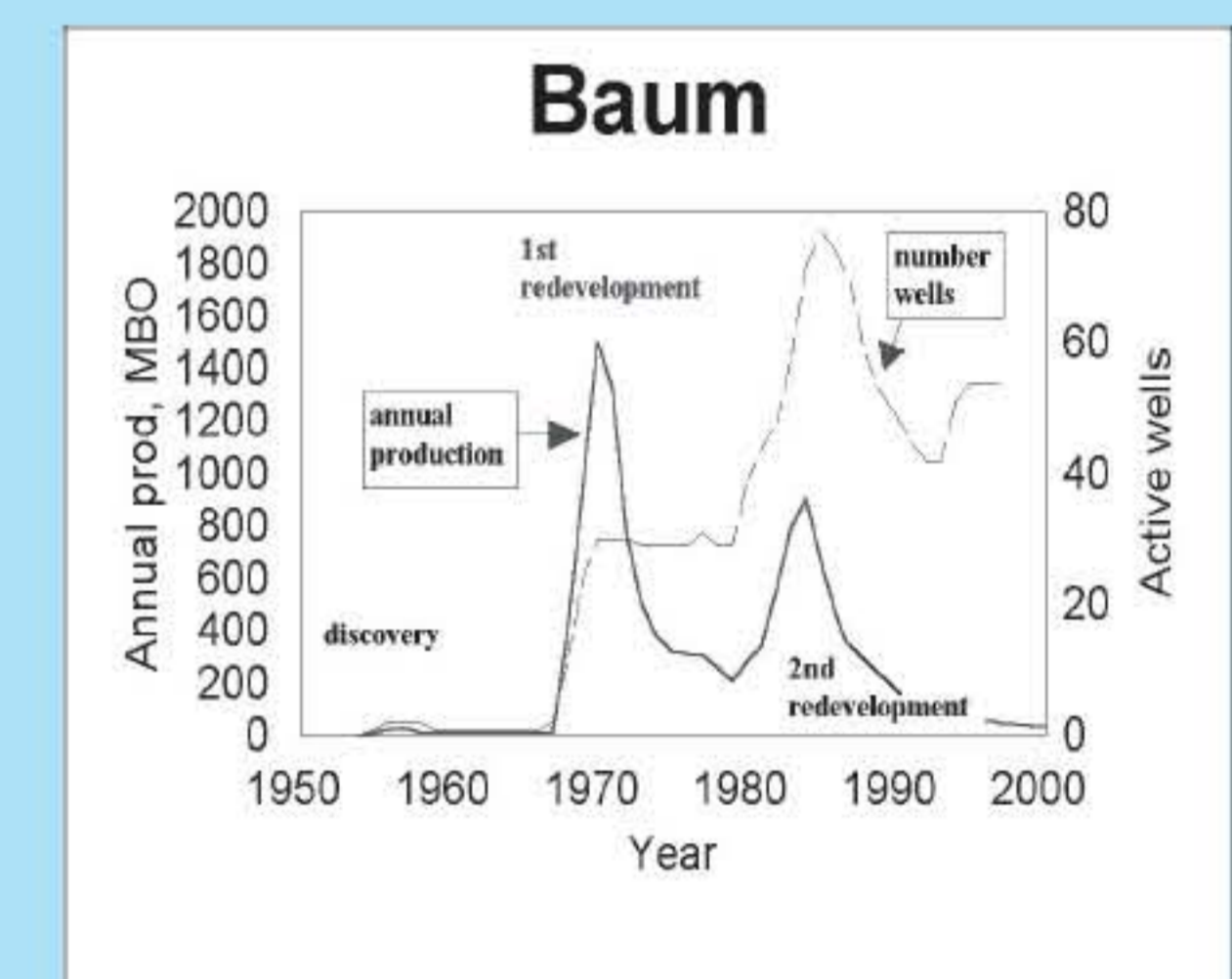
Depositional model for Upper Pennsylvanian algal mound fairway at shelf edge, Dagger Draw South reservoir. From Cox et al. (1998)

Stratigraphic column of Upper Pennsylvanian and Lower Permian strata, southeast New Mexico. Reservoirs in this play are productive primarily from Canyon and Cisco strata of Late Pennsylvanian age and from the Bough zones of earliest Wolfcampian age.

## Production History



Production from this play reached a peak in the 1990's as a result of redevelopment of the Dagger Draw North and Dagger Draw South reservoirs and has been declining since 1997 as redevelopment wells at Dagger Draw have begun to enter depletion stages of the production cycle. The huge decline in the early 1970's resulted from depletion of reservoirs discovered and developed during the 1950's and 1960's.

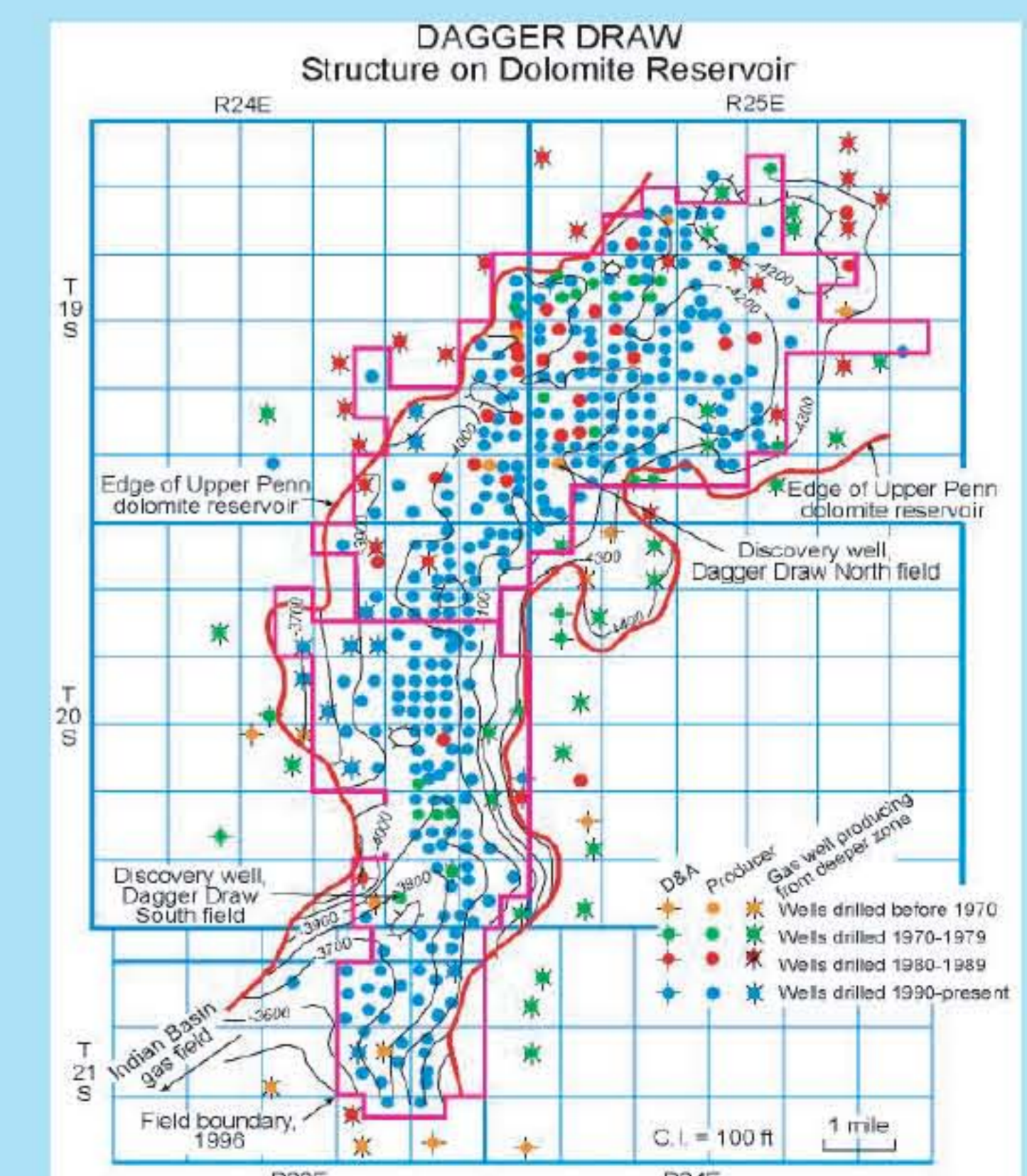


The Baum reservoir was discovered in 1955 but only minimal production was obtained as wells were drilled on structural closures. This reservoir saw a 1st phase of redevelopment in the late 1960's and production increased as new wells were drilled in previously unrecognized parts of the reservoir and the stratigraphic nature of entrapment became apparent. Production again spiked in the early 1980's as yet another wave of wells was drilled in previously unrecognized parts of the reservoir. 99% of oil reserves were brought into production by redevelopment. From Broadhead (1999).

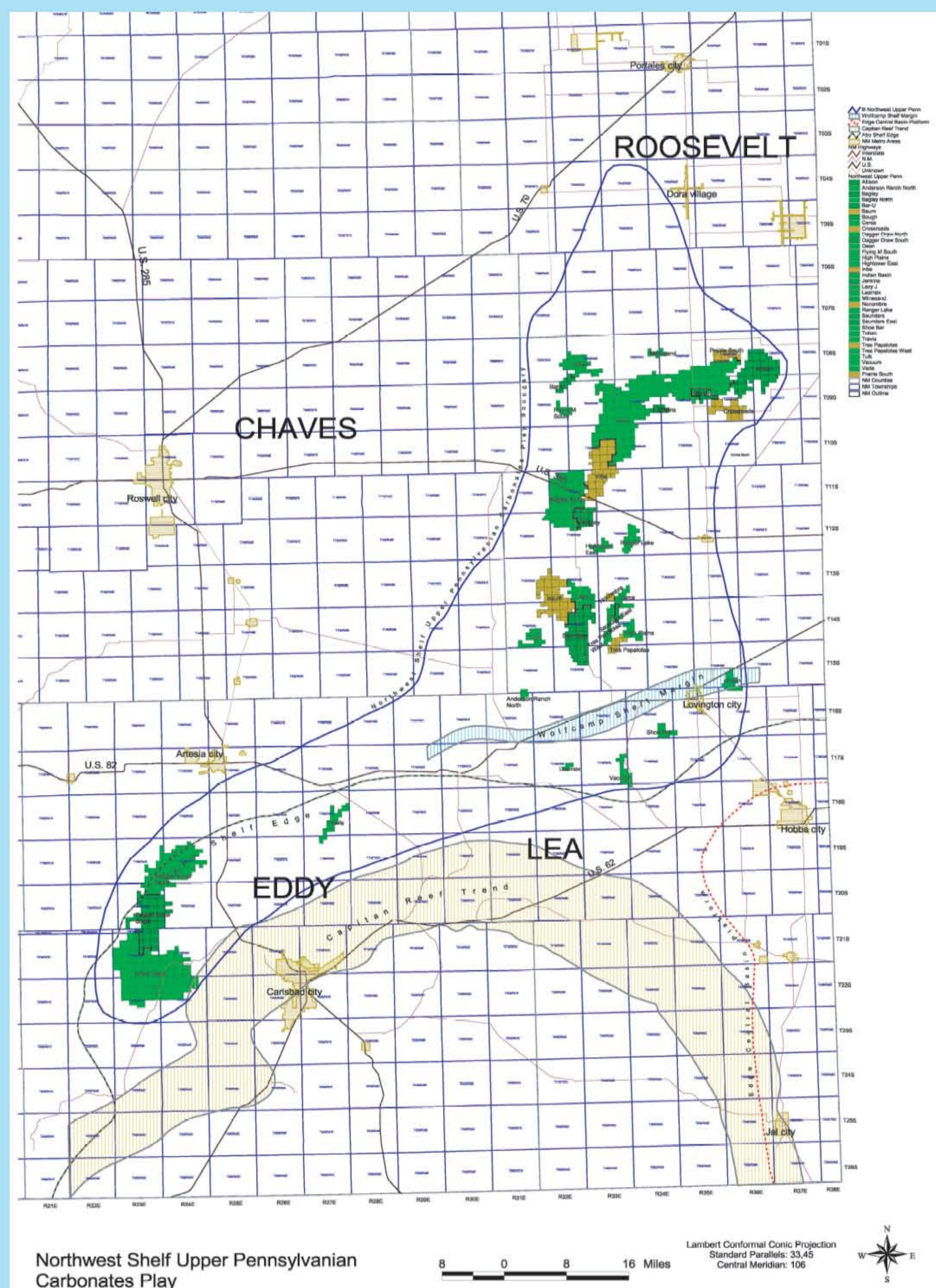
## Reservoir Redevelopment

Upper Pennsylvanian carbonate reservoirs in southeast New Mexico have typically been discovered by drilling small seismically defined anticlines. Initial development has generally been concentrated on the crests of the structures, and in most of the larger reservoirs, generally did not extend into offstructure areas. Subsequent drilling generally proceeded in discrete phases, each with a corresponding increase in production and reserves. The stratigraphic nature of entrapment was often not recognized until most of the reservoir was drilled out. Recognition of the stratigraphic nature of entrapment is essential if the reservoir is to be drilled out efficiently and completely in the years immediately following initial reservoir discovery. Of the 400 reservoirs in this play, 84% have less than 10 producing wells, 57% have less than 3 wells, and almost 200 have no productive wells, having never produced or having been abandoned. It is likely that a number of small reservoirs that have been developed only on structures are underdeveloped. Additional study of carbonate facies is needed to fully delineate traps.

High water cuts often exceed produced oil volumes in a reservoir. Production under these circumstances may be feasible with the use of modern, downhole, high-volume pumps that can move large volumes of fluid economically, as is the case at Dagger Draw (Brent May, personal communication, 1998).



Most wells in the Dagger Draw North and Dagger Draw South reservoirs were drilled in the 1990's as a result of redevelopment. Initial reservoir discovery was in 1963. More than 90% of oil reserves have been brought into production as a result of redevelopment. After Broadhead (1999). Contours after Reddy (1995).



Reservoirs with > 1 MMBO cumulative production in the Northwest Shelf Upper Pennsylvanian Carbonate Play.