Gulf of Mexico Paleogene "Whopper Sand" Sedimentology: Hypersaline Drawdown Versus Low-Salinity Hyperpycnite Models*

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Abstract

Billions of barrels of oil have been found since 2001 in the Paleocene-Eocene, Wilcox-equivalent "Whopper Sand" turbidites, deposited on the Gulf of Mexico abyssal plain, anomalously far (100s km) from the coeval shelf margin. Major evaporative drawdown (1-2 km), after tectonic damming of the Gulf (Cuban orogeny), has been proposed to explain (1) turbidite deposition so far basinward (shore advance), and (2) deep paleocanyons incising the shelf margin and slope. This model suffers from a lack of associated evaporites and from the unlikelihood of southern Gulf aridity (evaporation) outweighing inflow from humid (peaty) northern deltas.

An alternative, "opposite", low-salinity model is as follows. During three Paleocene-Eocene eustatic superlows, each involving a fall of about 100 m (Haq chart), world sea level fell toward or below the level of the Gulf's lowest inlet/outlet (sill), such that inflow from the ocean was reduced or cut (cf. Quaternary Black Sea). River inflow exceeded evaporation, desalinating the Gulf, turning it brackish or even, at times, fresh ("Lake Mexico" proposed here). Reduced salinity meant that river-fed (hyperpycnal) turbidity currents of long duration (weeks), already known to transport silt far out (100s km) onto modern marine abyssal plains, would have become more frequent and more sustained, carving the canyons and supplying the Whopper. Coriolis turning of unchanneled basin-floor flows impedes prediction of proximality trends, vital for exploration and development. Proper outcrop analogs of the Whopper low-salinity abyssal hyperpycnites may exist only in collisional accretionary complexes, because abyssal plains are ultimately subducted. Partial analogs are Carboniferous and Permian formations interpreted by the author as lacustrine hyperpycnites, but deposited above storm wave base (Brushy Canyon, Bude, Ross, Laingsburg, Skoorsteenberg)
References

Berggren, W.A., D.V. Kent, M.-P. Aubry, and J. Hardenbol, editors, Geochronology, time scales and global stratigraphic correlation: SEPM Special Publication 54, 244 p.


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INTRODUCTION

Billions of barrels discovered since 2001 in Paleogene (Wilcox-equivalent) “Whopper Sand”

GoM major evaporative drawdown (1-2 km) has been proposed to explain (A) turbidite deposition anomalously far (100s km) from coeval shelf edge & (B) deep canyons in paleo-shelf/slope

Drawdown models suffers from (A) lack of Paleogene evaporites in GoM & (B) unlikelihood that Gulf evaporation outweighed river inflow at northern GoM deltas
McDonnell et al. 2008
McDonnell et al. 2008

"sand-rich fan"

present-day Yucatan Strait
Canyon incision & Whopper deposition related to tectonic damming at Yucatan Strait? (also Berman & Rosenfeld 2007)
Canyon incision & Whopper deposition related to eustasy?

**Figure 2.** Generalized stratigraphic column for the Paleogene of the Texas coastal zone; modified from Galloway et al. (2000). The time scale is that of Berggren et al. (1995). E = early; M = middle; L = late.

**McDonnell et al. 2008**

**Haq et al. 1988**
GULF OF MEXICO, NEOGENE: LOW SPILL POINT (SILL); SALINITY MARINE DURING EUSTATIC HIGH OR LOWS

NW

eustatic high

eustatic low

Gulf of Mexico, marine

SE

Caribbean

sill low, Yucatan Strait, depth 2 km
GULF OF MEXICO, PALEOCENE-EOCENE, HIGH SILL, EUSTATIC-LOWSTAND MODELS: OPEN LAKE vs CLOSED LAKE

lowstand water level, "open-lake" model, i.e. inflow exceeds evap'n; lake freshens with time, cf. Quat Black Sea

"Lake Mexico" - sill high, Suwannee Strait (Chen 1965); Yucatan Strait non-existent (Cuban Orogen)

lowstand water level, evaporative drawdown model; implies "closed lake", i.e. evap'n exceeds inflow, lake hypersaline, cf. Miocene Mediterranean
MOST LIKELY MODEL, as (1) GoM Paleogene evaporites absent, & (2) GoM aridity unlikely to outweigh inflow from humid (peaty) deltas in N
Fig. 11.—Hypothetical diagram showing a curve of fluctuating velocity related to a quasi-steady underflow and its consequences for sedimentation at a fixed point in the basin. Three main phases are recognized: Acceleration phase (AP): accumulation of intervals 1 to 7 by an accelerating and fluctuating flow. Erosion-plus-bypass phase (EP): erosion of some of the preceding deposits. Deceleration phase (DP): accumulation of intervals 9 to 15 from a decelerating and fluctuating flow.

potential Whopper hyperpycnite facies
Sustained hyperpycnal flows:

More susceptible to Coriolis turning effect (compared to brief slump-generated flows) due to longer duration

Affects prediction of fan proximality trends, vital for exploration & development.
Skoorsteenberg Fm, South Africa, widely used as analog for passive margin, marine, deep water reservoirs.

probable lacustrine hyperpycnites, i.e. PARTIAL WHOPPER ANALOG?
CONCLUSIONS

-radical “sea-level fall of as much as 6,000 ft” (Berman 2008) in Paleogene GoM not necessary

-facies predictions can be made, using Zavala hyperpycnal model, and making allowance for Coriolis deflection

-biostrat problems likely, due to (A) canyon incision (reworking), and (B) lowered salinity (brackish/fresh microfauna & microflora

THANK YOU