sylvania, and New York is price-driven and tax shelter related. With the designation of almost all of the Clinton reservoir sands as "tight sands" for gas pricing, payout can be expected in many, but not all Clinton wells despite the nearly 90% or higher drilling success ratio.

New regional studies show the upward, deltaic progradation to the west as previously documented, but they also demonstrate new stratigraphic relationships between the upper Cabot Head shales, the sandstone reservoirs of the Clinton, and the overlying Packer Shell Limestone. The upper Cabot Head lies only landward of the progradational edge and the transition westward is from reservoir sands into calcareous sands and carbonate rocks. Within this deltaic system, one which covered much of eastern Ohio, Clinton wells have produced oil and gas from these fluvial, fluvial delta-margin and delta-margin bars, and beach sands for over 50 years.

Both regional and local patterns indicate better areas of Clinton development drilling at various depths. In the fluvial sequences, total sand maps, clean sand maps, porosity maps, and water, oil, and gas saturation maps point to locations of higher oil and gas deliverability. In the delta margin system, sand mapping, cross sections, and porosity maps show multiple bar systems at the edges of deltaic plains and tidal flats where there is higher gas and oil production from the Clinton reservoirs.

Local structural highs and faults affect production in this mainly stratigraphic trap. Locally, structure segregates oil and gas in the same reservoir body, but separate, though laterally equivalent, reservoir sands act differently on the same structure in adjacent wells.

COOK, ERNEST E., NORMAN S. NEIDELL, and JOHN H. BEARD, Zenith Exploration Co., Inc., Houston, TX

Precision Measurements of Interval Velocity Differences from Seismic Data

A new seismic technique, the DIVA (Differential Interformational Velocity Analysis) (trademark, Copyright Zenith Exploration Co., patents pending), which makes use of ultra refined seismic velocity analysis has been developed to identify and localize low velocity anomalies in the subsurface. Reservoir quality porous rock formations will always be distinguished by reduced seismic velocities whether or not hydrocarbons are present. In favorable settings, however, low velocities correlate well with hydrocarbon reservoirs. Where gas is present, the velocity reductions can be spectacular making the DIVA display an indicator with as much visual impact as the "bright spot" offshore. Color acoustic impedance sections further corroborate the reality of DIVA detection anomalies and assist in localizing them in reflection time. In addition, the color display, which in fact represents the essential information content of the seismic amplitudes, though very imprecise, is a vital monitor of the detailed changes in lithology. Fourteen wells to date have tested the concept ranging in depths from 7,00 to 15,000 ft (2,133 to 4,572 m) and targeting both carbonate and sandstone reservoirs. Several of these results are reviewed to illustrate the power of the approach. The technology has not only been proven by the drill but has also initiated new and exciting exploration plays which can not even be detected with usual seismic approaches. An east Texas reef bank sequence illustrates such a circumstance.

[redacted]U.S. Geol. Survey, Menlo Park, CA

Sedimentology of Some Allochthonous Deep-Water Carbonate Reservoirs, Lower Permian, West Texas: Carbonate Debris Sheets, Aprons, or Submarine Fans?

During the Wolfcampian, sediment gravity flows were common events at some shelf margins in the Permian basin. These mass flows transported large volumes of shoal-water bank and reef carbonates downslope into the Midland and Delaware basins, forming a wide variety of redeposited lithofacies. For example, along a segment of the Eastern shelf margin at least 40 km (25 mi) long, redeposited carbonates extend into the Midland basin 25 km (16 mi) or more. Within this basin margin setting, several petroleum pay zones occur in mass-transported debris.

In designing exploration strategies for these types of frontier deep-water reservoirs, whether within the Permian basin or elsewhere, one must develop appropriate depositional models. Some questions come to mind. Do these deposits represent episodic, widespread, single-pulse debris sheets, debris aprons dominated by numerous but rather random pulses of areally extensive sheet-flow calcarenites, or more systematically developed submarine fan facies having both channelized deposits in inner and mid-fan settings as well as sheet-flow calcarenites deposited as outer-fan lobes?

Redeposited Wolfcampian carbonates are subdivided into three major lithofacies. (1) Limestone and dolomite conglomerate debris flows and turbidites with dark interstitial micrite. Individual beds are as much as 8 m (26 ft) thick, normal to massively graded, and some beds are arranged by thinning-upward sequences. These carbonates form on of the reservoir facies with intercrystalline, solution interparticle, fracture, and vuggy porosity. (2) Wackestone to packstone calcarenite turbidites consisting largely of biotic grains. This lithofacies forms the most abundant type of redeposited sediment. The calcarenites occur in beds a few cm to 2.5 m (8 ft) thick that exhibit a variety of Bouma turbidite divisions and in some localities are arranged in thickening-upward units. Calcarenite turbidite locally form petroleum reservoirs with solution interparticle, intrabiotic, biomoldic, and fracture porosity. (3) Wackestone to packstone calcisiltite and calcarenite turbidites that occur in less than 2 cm (1 in.) thick beds. This facies does not exhibit vertical cycles of bed thickness nor good reservoir qualities.

Analyses of cores from 12 wells both within and outside the petroleum fields suggest that these redeposited carbonates may represent a combination of debris sheet and submarine fan depositional processes. The conglomerates could be genetically unrelated to the calcarenites and represent episodic debris sheet pulses; or alternatively, these conglomerates may be channelized deposits in inner fan to mid-fan positions near the basin margin. Some of the thick-bedded calcarenites possibly represent mid-fan channelized deposits whereas the more basinward thickening-upward calcarenites resemble unchannelized outer-fan calcarenite lobes. Thin-bedded calcisiltite turbidites appear to occupy basin plain, outer-fan fringe, and interchannel settings. If these reservoirs are developed within one or more fan facies, the size and spatial arrangement of the individual fans still remain to be determined. A better knowledge of appropriate depositional models should enhance future exploration efficiency.

COOPER, S. D., K. A. MCGILLIS*, C. H. MOORE, S. K. STEWART, and S. E. WILKINSON, Louisiana State Univ., Baton Rouge, LA

Upper Jurassic Carbonate Deposition, Smackover and Buckner Formations, East Texas

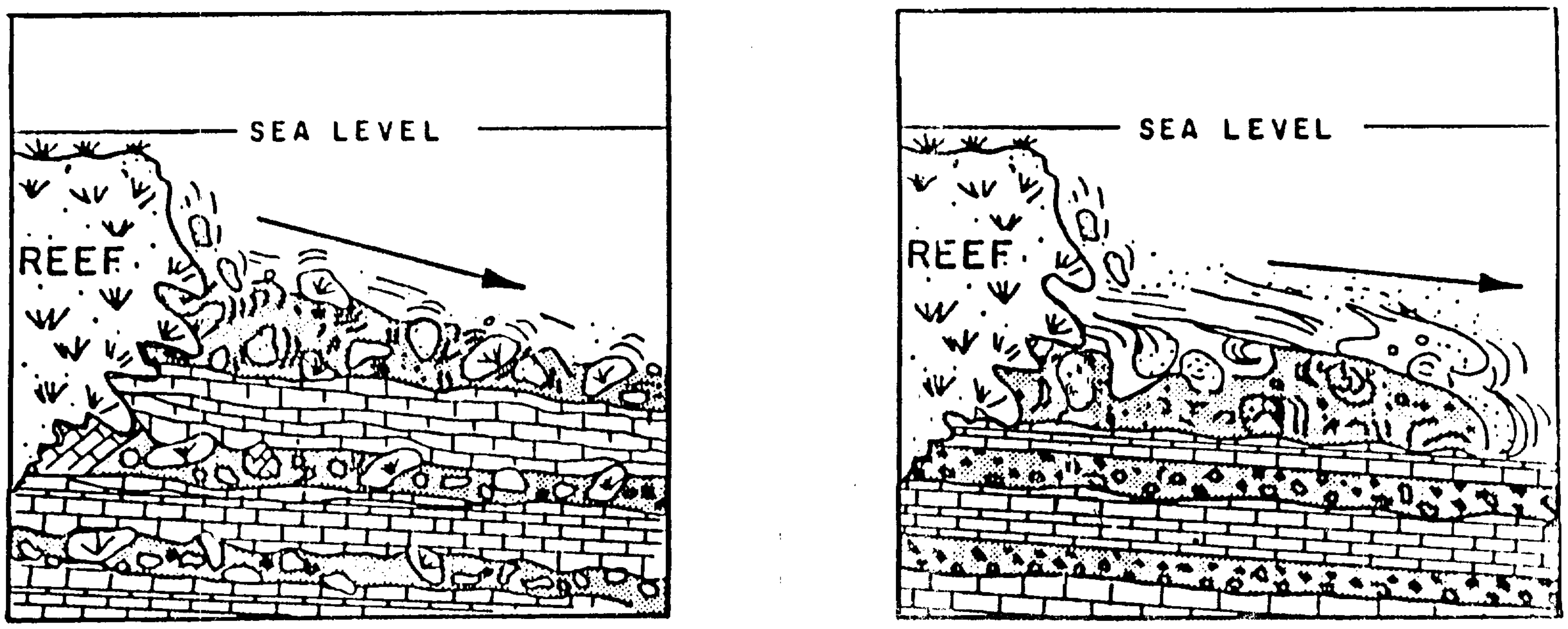
Examination of cores from the upper Smackover Formation from 30 wells in east Texas confirms the presence of a belt of blanket high-energy ooid sandstone throughout much of the area. Pockets of lower energy deposits within this ooid grainstone belt are characterized by pellet-*Favreina* packstones and

Before the
~~OIL CONSERVATION~~ COMMISSION
Santa Fe, New Mexico
Case No. 10211, 10219 Exhibit No. 3
Submitted By: HANLEY
Hearing Date: 5-9-91

BULLETIN OF CANADIAN PETROLEUM GEOLOGY
VOL. 20, NO. 3 (SEPTEMBER, 1972), P. 439-497

ALLOCHTHONOUS CARBONATE DEBRIS FLOWS AT DEVONIAN BANK ('REEF') MARGINS ALBERTA, CANADA[1]

H. E. COOK[2], P. N. MCDANIEL[3], E. W. MOUNTJOY[4] and L. C. PRAY[5]



SUBMARINE MASS FLOW

- Depositional units show distinct boundaries.
- Planar base and top, or pla ar base and hummocky top.
- Poor sorting; normal grading rare.
- Usually has a mud matrix.
- Clasts jumbled together during movement and supported by some type of non-turbulent mechanism.
- Transport distance intermediate across low angle slopes.

SUBMARINE TURBIDITY FLOW

- Depositional units usually show distinct boundaries.
- Planar base and top, or channeled base and planar top.
- Variable sorting; normal grading and other Bouma sequences common
- May or may not have a mud matrix
- Clasts jumbled together during movement and supported by turbulent suspension.
- Transport distance far across low angle slopes.

Fig. 11. Major types of submarine gravity transport mechanisms and some descriptive and interpretive characteristics (modified after R. H. Dott, Jr., 1963).

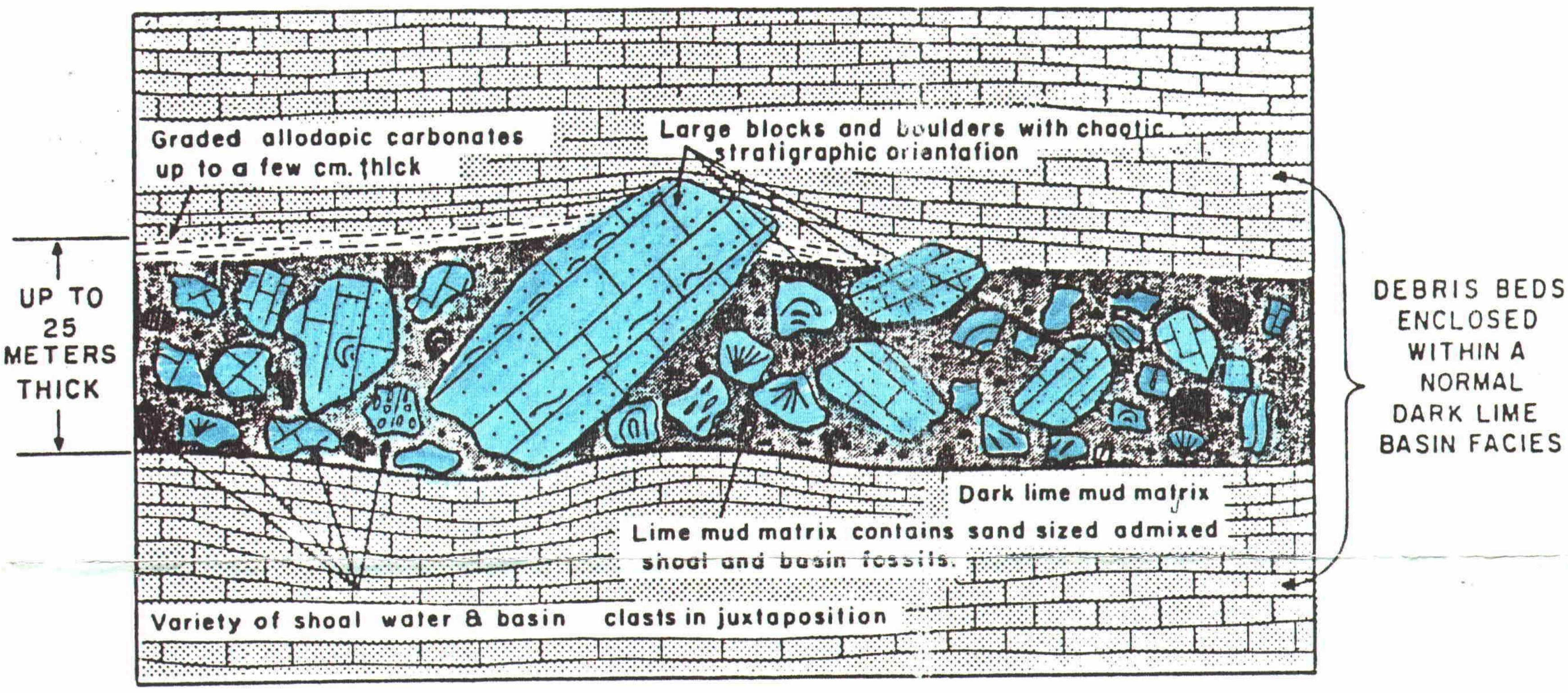


Fig. 9. Generalized sketch of the major features of allochthonous debris-flow deposits.

BULLETIN OF CANADIAN PETROLEUM GEOLOGY
VOL. 20, NO. 3 (SEPTEMBER, 1972), P. 439-497

ALLOCHTHONOUS CARBONATE DEBRIS FLOWS AT DEVONIAN BANK ('REEF') MARGINS ALBERTA, CANADA[1]

H. E. COOK[2], P. N. McDANIEL[3], E. W. MOUNTJOY[4] and L. C. PRAY[5]