the crust of the earth as varying laterally in composi­
tion and thickness. Evidence from measurements of the
HETEROGENEITY or THE UPPER MANTLE

In general, Tully deposition occurred in a carbonate
mud-depositing sea with an eastern clastic source that
exerted decreasing influence through time.
The lower part of the Tully Limestone consists of
arenaceous deltaic beds of limited areal extent. On the
east, abundant Choneutes aurora and occasional Lepa-
strophus represent the restricted fauna of the brackish
nearshore environment. Westward, the addition of
other brachiopods, notably Hypothyridina, Atrypa, and Schizocystis, characterizes the more marine facies.

The upper part of the Tully Limestone consists of
carbonate mudstone characterized by the presence of
metriophyllid and auloporid corals, styliolines, trilo-
bites, and pelmatozoans. Toward the middle of this
part, and representing normal marine conditions, is a
diverse fauna developed to the east in dark calcareous
shale and to the west in limestone.

Erosion surfaces with burrows, channels, local car-onate-pebble conglomerates and filled mud cracks are
evidence for the intermittent nature of carbonate mud
deposition and are observed especially in the central
and western regions.

In the upper part of the formation near the town of
Borodino, two elongate mounds of pure carbonate
mudstone, about 15 feet high, contain structures sim-
ilar to stromatactis and grade laterally into much
thinner pelmatozoan calcarenites. These mounds are
overlain by similar calcarenites which locally contain
pebbles of dark siltstone. Deposition was also
from the west, where purer carbonate mudstone is de-
veloped.

The upper part of the Tully Limestone consists of

carbonates in several instances were transported by
interpreted as turbidity current deposits because of
their association with graded beds. The writer offers
evidence to demonstrate that such cross-laminated
sediments in several instances were transported by
turbidity currents to deep-sea bottom and deposited
originally as graded beds, but subsequently were re-
worked and redeposited by the rippling action of deep-
marine bottom currents. Evidence includes these facts:

1) deep-marine bottom currents exist and are occasion-
ally strong enough to ripple deep-sea bottom as indi-
cated by photographs; and

LATE PALEozoIC TECTONICS AND MOUNTAIN RANGES. WESlRN TEXAS TO SOUTHERN COLORADO

Underlying the Permian rocks of the West Texas basin
are the roots of a Paleozoic mountain range. In
direction of strike and structure, the folds of these moun-
tains bear a general resemblance to the mountains of
central Colorado. However, the Permian and younger
rocks of the West Texas basin were not refolded during
the early Tertiary as were the ranges of central Colo-
rado. In this paper, the author attempts to show the
reason for this difference in tectonic history which has
resulted in the absence of a folded front range province
from northern New Mexico as far south as the Sierra
Madre Oriental in the Republic of Mexico. In the course
of the investigation, paleogeologic maps were
constructed of the area from Big Bend of Texas to central
Colorado for the beginning of Pennsylvanian and the
beginning of Permian time. From them a tectonic map
showing elements existing at the beginning of Permian
time was built and compared with a similar map showing
present elements. Cross sections were made comparing
homologous tectonic units of the West Texas basin with
the Cordillera of central Colorado.

In this manner the author has come to the conclusion
that the pre-Permian folds of the West Texas basin are
not tectonically related to the younger folds of central
Colorado although they do have certain characters
in common. The Paleozoic rocks of the two areas were
 laid down in different basins separated by the Pre-
cambrian massifs of the continental backbone through-
out most of Paleozoic time. These massifs, together
with the tightly folded Paleozoic rocks of the Marathon-
Ouachita belt, absorbed and distributed Laramide
stresses and preserved the West Texas Permian basin
from early Tertiary mountain building in spite of the
presence of structural and sedimentational features
favorable to mountain building.

HSU, K. JINGHWA, Shell Development Company
(A Division of Shell Oil Company), Exploration and
Production Research Division, Houston, Texas

CROSS-LAMINATIONS IN GRADED-BED SEQUENCES

Thin units of cross-laminated sandy and silty sedi-
ments are common in graded-bed sequences. One char-
acteristic common to all is that the thickness of the
cross-laminated bed does not exceed 3 inches and rarely
exceeds one inch. These sediments have been commonly
interpreted as turbidity current deposits because of their
association with graded beds. The writer offers
evidence to demonstrate that such cross-laminated
sediments in several instances were transported by
turbidity currents to deep-sea bottom and deposited
originally as graded beds, but subsequently were re-
worked and redeposited by the rippling action of deep-
marine bottom currents. Evidence includes these facts:

1) deep-marine bottom currents exist and are occasion-
ally strong enough to ripple deep-sea bottom as indi-
cated by photographs; and

2) cross-laminated deep-sea
sands are, in places, considerably better sorted than graded-bedded deep-sea sands which were supposedly deposited by turbidity currents; (3) cross-laminated sands, in places, contain a rich deep-sea benthonic fauna, suggesting a rate of deposition slow enough for the establishment of this fauna; (4) presence of parallel ripples and interference ripples on top of some such cross-laminated sediments; (5) the direction of transport shown by cross-lamination is, in places, quite different from that shown by bottom markings which were supposedly scoured by turbidity currents.

The question whether turbidity currents could deposit cross-laminated sediments remains unsolved. The writer points out, however, that an indiscriminate assumption of turbidity current deposition of all deep-marine sandy sediments has led to confusion, inconsistencies, and controversies. The postulate of bottom-current redeposition helps to resolve this paradox.

HURLEY, ROBERT J., Institute of Marine Science, University of Miami, Miami, Florida

EVIDENCE FOR A COUNTERCURRENT BENEATH THE FLORIDA CURRENT

About 60 per cent of the area shown in photographs taken at the axis of Florida Straits exhibit well defined current ripple marks. These ripples indicate a flow of water of at least .23 to .59 kts. from the north. This current is in the opposite direction from the surface currents of 2 to 4 or more knots.

INGLE, JAMES C., JR., Inglewood, California

PALEOECOLOGIC, SEDIMENTARY, AND STRUCTURAL HISTORY OF THE LATE TERTIARY CAPISTRANO EMBAYMENT, CALIFORNIA

The Capistrano Embayment comprises a distinct geologic unit of the southern California area. Paleobathymetry, sediments, and microfaunas within the embayment indicate that it has had a different structural history, different from the Los Angeles Basin on the north. Marine invasion of the trough began in the Paleocene and ceased in the Pleistocene. This report develops a detailed history of the embayment from middle Miocene to late Pliocene time using data from two well exposed sections within the boundaries of the embayment.

Analogies between ecologic niches of living benthonic Foraminifera and fossil forms encountered indicates that middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was tilled to middle bathyal depths were attained by the