frozen oil-water contact, further preventing re-ad-
in the oil-water transition zone; this seal effected a
ic waters jpercolating basinvward from Tensleep out-
tune of paleoaccumulations into crestal positions.
Subsurface data presently available indicate a loss
of porosity with increased depth in the Tensleep Sandstone. It is suggested that possibilities for locating adequate porosity at greater depths will be enhanced
by exploration in those areas favorable to the ac-
cumulation of oil in primary traps which have not
been modified greatly by Laramide folding.

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FABRIC OF A MIDDLE ORDOVICIAN LIMESTONE AT COlBORNE, ONTARIO

The limestone of the Middle Ordovician Cobourg Limestone at Cobourg, Ontario, occurs, in decreasing order of occurrence, as sparse biomicrite, fossiliferous micrite, biosparite, micrite, and packed biomicrite.

Individual beds display a sequence composed of graded bedding at the base, over lain by a zone of lamination, and structureless micrite. This resembles the sequence in terrigenous turbidites of the Alps and other places. Most disarticulated brachiopod and os-
tracid shells are convex upward in biosparite and convex downward in biomicrite and fossiliferous micrite. The percentage of brachiopod shells increases to-
ward the bottom of the quarry; a variation in the percentage across the quarry has been found. The per-
centages of echinoderm, bryozaon, and ostracard frag-
ments have a high positive correlation with the quan-
tity of quartz grains, whereas the percentages of bra-
chiopod shells and trilobite fragments do not. Orienta-
tion patterns of elongate fossils show two dominant
trends, northeast-southwest and northwest-southeast.

Sedimentation of the Cobourg Limestone was char-
acterized by weak currents. Strong currents were in-
trduced sporadically to form graded and non-graded biosparites, which are suggested tentatively as prod-
ucts of turbidity currents.

All relations between geological entities were calcu-
lated by computer.

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Patagium and Some Spumellarian (Radiolaria)
Genera

Patagium is a unique structure found in some spumellarian Radiolaria and has been considered to be a diagnostic criterion at the generic level in the gener-
ally accepted scheme of classification. A continuous
variation in degree of preservation and (or) develop-
mental stages of this structure from complete to ab-
sent has been found in genera such as Hy meniastrum-
Dictystrum, and Euchitonio-Rohipaphstrum from
northeast Pacific Ocean bottom sediments. The study
of a rich radiolarian fauna in core samples from Java,
Mindinao, and Mariana trenches reveals similar fea-
tures and indicates that such a complete sequence of
variation is neither a rare phenomenon nor biogeo-
graphically significant.

The taxonomic value of Patagium, therefore, needs
critical reconsideration. The degree of development or
preservation of Patagium found in a specimen seems
to be unrelated to radiolarian ontogeny, although its rea-
significance can not now be determined.

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Planktonic Foraminiferal Zonation of Cal-
ifornia "Miocene"

Planktonic Foraminifera occur abundantly in most California "Miocene" strata, but have not been studied previously in detail. By using these planktonic forms, 11 zones are recognized and are related to the existing "Miocene" stages which are based on ben-
thonic species. Correlation of these zones with the standard reference sections of tropical regions is com-
plicated by paleoecologic factors, which probably in-
clude regional variation in water temperature between the tropics and California. Stratigraphically lower zones correspond more closely than do higher ones, indicating a general cooling of the California seas throughout middle Cenozoic time.

Species of Globigerina and Eoglobo~erina are abun-
dant in the California "Miocene," whereas species of Tarborotalia, Globoquadrina, Globo~erinoides, Glo-
borotalioides, Protentella, and Candorbultina are less
common but provide bases for tentative correlation with the tropical zones. The "lower Miocene" Zemor-
rian and Saucesian stages are correlated with the Glo-
bigerina sellii through Tarborotalia kugleri zones (Oli-
gocene to Aquitanian); the "middle Miocene" Relizi-
an and Luision stages correlate with the Catap-
sydax dissimilis through Tarborotalia joki zones (Aquitanian to Burdigalian); and the "upper Mi-
ocene" Mohnia and Delmonian stages correlate with the Globorotalia lobata through Sphaeroidinella semiuluza zones (Burdigalian to Sarmatian).

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Ostracodes and Siluro-Devonian Boundary in South-Central Oklahoma

Detailed studies of the morphology, ontogeny, vari-
ation, and stratigraphic distribution of the ostracodes in the Henryhouse (Silurian) and superjacent Har-
gan (Devonian) Shales indicate the presence of an un-
conformity at the Siluro-Devonian boundary in the Arbuckle Mountains of Oklahoma. The ostracodes in-
dicate a late Niagaran (early Ludlovian) age for the
Henryhouse Shale and Helderbergian age for the Haragan Shale.

The ostracode faunas of both stratigraphic units are
large and diversified. The Henryhouse Shale contains
46 species representing 28 genera and 17 families. The Haragan ostracode fauna consists of 53 species, 27
genera, and 16 families. These taxa are distinctive and readily identifiable. Biostatigraphic evidence for the unconformity be-
between the Henryhouse and Haragan follows. (1) At the specific level the two faunas are completely distinct; no species are common to both units. (2) Of the 28 genera in the Henryhouse, 13 are restricted to it. Twelve of the 27 Haragan genera are not present in the Henryhouse. (3) The two faunas are nowhere known to occur together or interfinger with one another. (4) The faunal change is abrupt. There is no evidence for an intermediate (gradational) fauna between the two distinct faunas recognized.

The stratigraphic distribution of ostracodes within the Henryhouse and Haragan Shales indicates no definite biostratigraphic zonation within either unit. Each species which is significantly abundant ranges definitively within either unit. The ostracode faunas obtained are distinctive and discrete. Therefore, the Siluro-Devonian formations, in descending order: Bois d'Arc Limestone, Haragan Shale, Henryhouse Shale, and Chimneyhill Limestone. The ostracode faunas obtained are distinctive and readily identifiable. Eleven ostracode species previously described as Haragan species are distinctive and discrete. Therefore, the Siluro-Divenonian contact in south-central Oklahoma is unconformable.

Detailed sampling of the Henryhouse and Haragan formations has been carried out in all the outcrop areas of the Hunton Group, which consists of four formations, in descending order: Bois d'Arc Limestone, Haragan Shale, Henryhouse Shale, and Chimneyhill Limestone. The ostracode faunas obtained are distinctive and readily identifiable. Eleven ostracode species previously described as Haragan species are now known to have come from, and to be restricted to, the Henryhouse Shale. The ostracode faunas are distinct and discrete. Therefore, the Siluro-Divenonian contact in south-central Oklahoma is unconformable.

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TEXTURES AND STRUCTURES IN CATAHOULA (GUEYDAN) TUFF, SOUTH-CENTRAL TEXAS

The Catahoula Tuff of Oligocene to early Miocene (?) age is composed almost entirely of volcanic rock debris or its alteration products. Pastel-colored tuffaceous clay predominates, but sandstone, conglomerate, bentonite, vitric tuff, and ash also are present. The rocks studied in outcrop have a maximum thickness of approximately 900 feet, and were deposited largely on a coastal plain not far from shore. Bed geometry and sedimentary textures and structures provide evidence that the coarse clastic sediments and some tuffaceous clay beds were deposited as mudflows. One bed of air-fall ash has been recognized by its geopetal fabric: conical piles of glass dust rest on flat shards.

Vitric tuff and tuffaceous clay beds deposited as mud flows are characterized by massive (structureless) beds 1-4 feet thick, lack of sorting in beds that have partially undergone horizontal laminae and cross-bedding, and by moderate sorting and sub-parallel orientation of elongate shards and tuff intraclasts. These tuffs are now reduced in size or filled by clay skins of montmorillonite that coat framework grains. Bentonite is free of crystal fragments, has no relic texture, and has a random orientation of montmorillonite particles. The lack of orientation of clay particles suggests that they crystallized during the in situ argillation of beds of glass dust rather than by sedimentation of clay particles in quiet water.

Clay dikes from 1 mm to 2 cm wide trend vertically through tuff and sandstone at some localities. Montmorillonite grains are well-oriented parallel with the dike walls, suggesting particle-by-particle deposition from injected slurries.

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EXPLORATION OBJECTIVES IN THE CAMBRO-ORDOVICIAN OF KENTUCKY

The Cambro-Ordovician of Kentucky is a new frontier for petroleum exploration. Dolomite, limestone, and sandstone reservoirs, both proved and potential, provide the oil-seeker with a large number of objectives ranging in age from Early Cambrian to Middle Ordovician and are present at drilling depths of 1,000-14,000 feet.

Dolomite reservoirs associated with the pre-Chattanooga unconformity have produced more than 150 million barrels of oil in Kentucky. Present activity, directed toward the testing of the Knox Dolomite, is a logical extension of exploratory effort downward to the next major unconformity.

The pre-Devonian unconformity in Kentucky was developed on dolomite beds of the Beekmantown. Traps below the unconformity are associated with pre-Chazy structures—faulting, erosional remnants, and truncated porous zones. Vuggy, intercrystalline, and fracture porosity zones occur throughout the Knox Dolomite section, and in many instances appear to be related to specific stratigraphic zones.

The predominantly clastic Conasauga-Rome section below the Knox Dolomite includes potential, but unproved, sandstone and carbonate reservoirs of wide geographic extent. Thickness variations and structural relief in the order of several thousands of feet, coupled with facies changes and known shows of oil and gas, provide the incentive for exploration.

The best guide to exploration will be the reconstruction of Cambro-Ordovician tectonic frameworks and depositional environments. Large structural surface features must be evaluated on the bases of age and structural history. All types of exploratory techniques, from surface geology to geophysics, are applicable to the search for Cambro-Ordovician oil in Kentucky.

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COCCOLITHOPHORID AS ECLOGIC INDICATORS IN OCEANIC SEDIMENTS

The minute, calcitic, skeletal elements (cocoliths) of the Coccolithophoridae constitute 5-20 per cent or