Concentration levels of the elements in a suspended load, when compared to average reported values for shales, show iron and manganese to be low. The other elements are higher. Values for these elements in the dissolved part are variable, possibly reflecting lithologic differences. Correlation coefficients indicate little relation between trace element content and season in most Kansas streams. X-ray diffraction study of the mineralogic content of the suspended load indicated that montmorillonite was the clay mineral present in all cases. Other minerals present in almost all samples were calcite and quartz. Gypsum, dolomite, feldspar, illite, and kaolinite were present in lesser amounts in some samples. Some question of the source of specific trace elements in these stream waters exists. For nickel and lead, however, pollution is considered the most likely source. Some evidence is present to suggest that the major source of lead is fallout from the atmosphere. The data for partition coefficients suggest that nickel, lead, copper, and zinc are being strongly adsorbed onto the suspended load. The data are less certain for iron and manganese. The iron and manganese levels in the suspended loads of all streams are not unusual. Copper, nickel, lead, and zinc clearly are being concentrated by the suspended load. One source of copper and zinc may be from trace-element nutrient fertilizers.

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OLIGOCENE BIOSTRATIGRAPHY OF LINCOLN CREEK FORMATION, SOUTHWESTERN WASHINGTON

Molluscan faunas of the Lincoln Creek Formation, southwestern Washington, represent 6 provincial invertebrate Opellian zones. Continuous late Eocene to early Miocene sequences have been studied in 6 sections where both mollusks and benthonic foraminifers are abundant. The stratigraphic control on both faunas in these and 7 other partial sections allows for detailed biostratigraphic analysis and the synthesis of superpositionally controlled megainvertebrate zones. These zones, moreover, are correlatable in the same sections with the standard Californian benthonic foraminiferal zones and stages.

The molluscan sequence includes faunas previously assigned by Weaver *et al.* to the Keasey, Lincoln, and Blakeley "Stages." These faunal assignments were made from geographically isolated sections. Durham defined 7 Oligocene megafaunal zones for northwestern Washington on the basis of 7 partial sections and other fossiliferous localities. The lack of superpositional control on boundaries for both these studies suggested the need for further biostratigraphic refinement of the Oligocene of western Washington.

The foraminiferal sequence includes faunas previously assigned by Rau to the Narizian Stage of Mallory, the Refugian Stage of Schenck and Kleinpell, and the Zemorrian and lower Saucesian Stages of Kleinpell.

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CARBONIFEROUS COLONIAL RUGOSE CORALS, BIOSTRATIGRAPHY, AND PALEOECOLOGY, LISBURNE GROUP, ARCTIC ALASKA

The Lisburne Group of arctic Alaska contains coral faunas of Osagian (Early Mississippian) to Atokan (Middle Pennsylvanian) age. Beds of Osagian age have a small fauna of solitary and tabulate corals. Beds of Meramecian and very earliest Chesterian ages contain a large fauna of *Ekvasophyllum* spp., *Faberophyllum* spp., *Diphyphyllum klawockensis* Armstrong, *D. nasorakensis* Armstrong, *Lithostrotion* (*Siphonodendron*) *dutroi* Armstrong, *L.* (*S.*) *sinuosum* (Kelly), *L.* (*S.*) *warreni* Nelson, *L.* (*S.*) *lisburnensis* Armstrong, *Lithostrotion reiseri* Armstrong, *Lithostrotionella niakensis* Armstrong, *L. banffensis* (Warren), *L. mclareni* (Sutherland), *L. birdi* Armstrong, *L. pennsylvanica* (Shimer), *Thysanophyllum astraeiforme* (Warren), *T. orientale* Thomson, *Sciophyllum lambarti* Harker and McLaren, and *S. alaskaensis* Armstrong. Corals are rare in beds of younger Chesterian age; they include *Lithostrotionella* aff. *L. mclareni* (Sutherland), *Lithostrotion* (*S.*) *ignekensis* Armstrong, *Syringopora* spp., and a few solitary corals. Pennsylvanian (Atokan) beds of the Lisburne Group contain *Lithostrotionella wahooensis* Armstrong, *Corwenia jagoensis* Armstrong, a thick-welled syringoporoid, and *Michelinia* sp.

The Lisburne Group limestones are cyclic and were deposited on a slowly subsiding carbonate platform. Colonial corals of Meramecian and Atokan ages are present in carbonate rocks associated with shallow-water shoaling facies. The scarcity of corals in carbonate rocks of Osagian, Chesterian, and Morrowan ages is attributed to regional temperature or salinity changes that inhibited their growth. Beds of Atokan age contain more calcareous algae and Foraminifera, indicating warmer waters. Paleoecologic analysis of the carbonate beds associated with the colonial corals of Atokan age indicates that the corals lived in clear, agitated water between oolitic tidal flats. Carboniferous corals are not known to have formed reef-like masses in arctic Alaska.

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BALDWIN HILLS, LOS ANGELES, CALIFORNIA—RATES OF LATE CENOZOIC UPLIFT

Planktonic foraminiferal biostratigraphy and paleomagnetic stratigraphy of late Cenozoic cores of the North Pacific suggest that the major polar planktonic foraminiferal invasions in southern California occurred in the last 800,000 years. In the Baldwin Hills of the Los Angeles basin, relations of the base of these polar planktonic assemblages and probable water depths at that time, on the basis of associated benthic assemblages, indicate an average rate of uplift of about 0.075 m/100 years.

On the basis of relation of radiocarbon dates with environments of deposition for the late Cenozoic, rates of uplift have increased to about 0.63 m/100 years for the past 36,000 years. Marine waters, approximately 100 m in depth 36,000 years ago, gave way gradually, through sedimentation and uplift, to nonmarine deposition in this area of the basin about 28,000 years ago. These early nonmarine deposits have been uplifted since then to elevations of 145 m atop the Baldwin Hills. Localized uplifts along the Newport-Inglewood fault trend may have formed recently, representing actively rising modern structural features along this trend in the Los Angeles basin.

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LATE PLEISTOCENE DEFORMATION OF CASCADIA BASIN TURBIDITES ALONG WASHINGTON CONTINENTAL MARGIN

A minimum rate of underthrusting of the Juan de Fuca plate beneath North America for the late Pleistocene has been calculated to be approximately 0.7 ± 0.3 cm/yr. This estimate was determined in each of 18 CSP crossings of the continental slope off the coast of Washington by dividing the amount of shortening within the westernmost anticlinal ridge by an approximation of the time elapsed since the beginning of the ridge deformation. The latter estimate was obtained by tracing the late Pleistocene discontinuity as described by Leg 18 of the Deep Sea Drilling Project from site 174 on Astoria fan into the deformed Cascadia basin turbidites of the continental slope. Recent plate-tectonics theories predicting northwesterly movement of the Pacific plate parallel with the San Andreas fault at 6 cm/yr, and the spreading of the Juan de Fuca plate away from the Pacific plate at 6 cm/yr, require an underthrusting rate of 2 cm/yr measured perpendicular to the trend of the Washington continental margin. If the age of the late Pleistocene discontinuity is assumed to be a half-million years, the defor-