and transmitting light microscope) from the Arctic, Bering Sea, Gulf of Mexico, Southern Atlantic, equatorial Pacific, California continental borderlands, Indian and Antarctic Oceans. Three groups of spongodiscid-type radiolarians were identified. (1) *Spongotrochus glacialis* group (robust spongy matrix, with or without spines, without arms) dominates the polar oceans. The diversity is low and the assemblage can inhabit the waters of the shelf as well as the slope. (2) *Stylochlamydium venustum* group (spongodiscid-type with distinct pores, spongy matrix, with or without spines, without arms) plus *S. glacialis*, dominate subarctic assemblages. (3) *S. glacialis* and spongodiscid-type with arms are found in the equatorial region. The diversity here is much greater than in any of the other areas. These results are plotted on a world map comparing the distribution of recent spongodiscid-type with surface-water temperature, water temperature at depth 200 and 400 m (656 and 1,312 ft), surface salinity, surface and bottom currents and bottom topography of the world ocean.

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A New Model of Succession of Middle and Late Pennsylvanian Fossil Communities in North Texas, Mid-Continent, and Appalachians with Implications on Black Shale Controversy

A new model for the succession of Pennsylvanian fossil communities, preserved in cyclothems, is proposed on the basis of more than 200 fossil localities in the Mid-Continent, Appalachians, and north Texas.

Early models for Mid-Continent cyclothems placed the black shales in shallow water, with maximum transgression at the fusulinid-bearing zone in the overlying limestone. The most recent model proposed that the black phosphatic shales, which commonly occur between two subtidal carbonates, are widespread and laterally continuous over great distances and represent maximum transgression.

The black phosphatic shales contain: ammonoids; inarticulate brachiopods; radiolarians; conularids; shark material and abundant and diverse conodonts. This assemblage represents a pelagic or epipelagic community developed in a stratified water column over an anoxic bottom.

The black shales grade vertically and laterally into dark gray-black shales which contain many of the same pelagic and epipelagic forms found in the phosphatic black shales, plus the following: low diversity of articulate brachiopods; large numbers and diversity of ammonoids together with other cephalopods; hyolithids; blastoids; trilobites; corals; and moderate diversity and numbers of bivalves and gastropods. This facies contains the deepest water benthic community. Most of these forms are immature, pyritized, and generally are preserved as molds. The ammonoids include both nepionic and late juvenile–early mature forms with the body chambers. These ammonoids, along with the other immature invertebrates, suggest mass mortality due to fluctuating low bottom oxygen as the deeper water stratification was breaking up.

The dark gray-black facies grades into a medium gray shale facies which contains a mature molluscan fauna. This assemblage contains many of the same benthics as the dark gray facies, but with greater diversity. The pelagics and epipelagics, including plants, are rare to absent, except for the conodonts, which are diverse and abundant.

The medium gray shale grades into a lighter gray facies, which is dominated by brachiopods, crinoids, and corals, with occasional bivalves and gastropods. Fusulinid and coral communities may also occur in the slightly shallower depths. (These facies are interpreted as being a moderate to shallow depth shelf community.)

The brachiopid-crinoid community is succeeded by shallow water communities which may have occupied shoreline, lagoonal, bay, interdeltaic, or shallow prodeltaic environments. These communities are low to high diversity molluscan assemblages, generally lacking ammonoids, and have a very low diversity conodont assemblage. These shallow water assemblages are discontinuous and occur commonly interbedded with sandstone, in the regressive and early transgressive portions of each cycle. In addition, coals are sometimes present that grade vertically into black carbonaceous shales that are non-phosphatic, lack benthic and pelagic forms, and contain plant compressions. These black shales are interpreted as being marsh deposits.

This model is consistent with the findings of Yancey and Stevens with the Lower Permian fossil communities in the western United States. In addition, this model agrees with Calver's work on the succession of communities associated with the cyclothems in the Westphalian of England.

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Geology and Petroleum Potential of Flathead Region, Flathead County, Montana, and Southeastern British Columbia

Discovery of oil seeps in the Flathead region led to wildcat drilling by 1902. Exploration on the U.S. side stopped by 1910 because of the formation of Glacier Park, and the fact that the oil seeps were in Precambrian sedimentary rocks. Exploration continued through the 1930s on the Canadian side with drilling in the vicinity of major oil seeps. Exploration in Canada from the 1950s to present has included seismic work and six wildcat tests in the Flathead region. A land play has been going on in northwestern Montana for the past several years and recently released seismic data have demonstrated major structures that apparently involve Paleozoic rocks. Plans for drilling have been announced.

The Glacier-Waterton and Flathead region are on the Lewis thrust plate. At the Sage Creek, British Columbia, oil seeps, drilling in 1952 penetrated the Lewis fault after drilling 4,400 ft (1,341 m) of Precambrian sedimentary rocks, and then drilled a strongly faulted sequence of upper Paleozoic carbonates and sandstones with several oil shows. The Precambrian rocks on the Lewis plate in the U.S. thin into Canada, eventually to zero where Paleozoic and Mesozoic rocks are carried by the Lewis fault. An area of hundreds of square miles of Paleozoic and Mesozoic outcrop, including the Fernie basin, is present immediately across the international boundary from areas of Montana which have been mapped as containing great thicknesses of Precambrian sediments. In the northern Whitefish Range of Montana, nearly 40 mi (64 km) from the leading edge of the Lewis thrust, is 30 mi^2 (78 km^2) of Paleozoic and Mesozoic outcrop containing several petroliferous units. This sequence is the only part of the extensive Paleozoic and Mesozoic outcrop of southeastern British Columbia which extends into the U.S., but it is important in understanding the involvement of Paleozoic and Mesozoic rocks in complexly faulted northwestern Montana. The Whitefish Range Paleozoic and Mesozoic sequence is cut by several minor thrust faults as well as having been overthrust by the Hefty plate, present now as klippe on the highest peaks of Paleozoic rocks. The Couldry and Tuchuck faults cut these rocks a few miles to the west.

Between the Whitefish Range and the Livingstone Range of Glacier Park lies the Kishenehn basin, a graben to half-graben formed by the listric normal Flathead fault on the Lewis plate. This basin is filled with Oligocene Kishenehn formation, a fluvial