ancestor-descendant relations and conveys important stratigraphic and paleoecologic information.

Most Cenozoic species, for example, are usually assigned to either *Globorotalia* or *Globigerina*. Used in this way, these taxa are over-inclusive and provide no information beyond a mnemonic clue to apertural position. As appropriately modified, *Globorotalia* is exclusively a Neogene genus, and Paleogene species are assigned to *Acarinina, Morozovella,* and *Planorotalites. Globigerina* is largely a middle Tertiary taxon, containing only a few cool-water modern species; most late Neogene globigeriniforms belong in *Neogloboquadrina* or *Globoturborotalita.* An emphasis on phyletic species-grups is requisite for the development of multiple-phyletic zonations.

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Bioclastic Carbonate Facies of Great Barrier Reef, Australia

The variations which can be observed in the component compositions of the reefal sediments result from differences in the percentage contributions made by five dominant skeletal types, namely: coral, coralline algae, "Halimeda," foraminiferids, and mollusks. The distribution within the reef top environment is controlled partly by the nature of the reefal communities and partly by the production of specific skeletal size modes which are preferentially transported to different depositional environments under a variety of high-energy and/or low-energy hydraulic regimes.

The changing nature of the skeletal component composition of the reefal sediments associated with reefs at varying stages of their morphologic evolution is clearly discernible. This allows relations which exist between reef morphology, depositional environments, sediment types, sedimentary facies, and depositional processes to be qualitatively and quantitatively assessed, thereby, providing insight into the behavior of reefal sediments in both a temporal and a spatial context.

The commonly occurring sedimentary facies are illustrated and described. They provide an extremely useful basis for paleoenvironmental reconstructions of pre-Holocene reefs or ancient analogs, especially considering the Great Barrier Reef is one of the few modern carbonate terranes which has exact counterparts in the rock record (e.g., the Devonian "Great Barrier Reef" of the Canning basin; the Permian Texas reef; the Jurassic-Cretaceous buried reef off the Atlantic Coast; Devonian reef complexes of Canada).

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Fluvial Facies Associations—Guide to Tertiary Coal Development and Exploration in Powder River Basin, Wyoming and Montana

The Paleocene Tongue River Member of the Fort Union Formation supports widespread coal-mining activity and contains most of the recoverable coals in the Powder River basin. Coals are well-developed in eastern and northern Powder River basin, but the best exposures are in the northern part. Most mining is from the very thick (as much as 125 ft or 38 m) coals; however, as these coal reserves are depleted, future exploration will focus on moderately thick coals. Exploration guides for the moderately thick coals may be their facies associations. In the northern Powder River basin, 175 mi (280 km) of cross sections, constructed from closely spaced outcrop sections and drill holes, provide detailed facies associations of the coals.

One facies association is dominated by thick fluvial-channel sandstones and coals as much as 40 ft (12 m) thick and 12 mi (19 km) in extent. The coals formed in poorly drained backswamps in which uniformly thick peat bogs accumulated, subparallel to meandering channels and opposite their migration and avulsion directions. A second facies association is characterized by abundant crevasse sandstones, subordinate thin channel sandstones, and lacustrine limestones, shales, and siltstones. Facies-associated coals, as much as 8.5 ft (17 m) thick and 5 mi (8 km) in extent, formed in well-drained backswamps frequently interrupted by crevasse splays that debouched into flood-plain lakes. The best development of economic coals of the fluvial-channel dominated facies is in the lower part of the Tongue River Member, and that of the flood-plain–lacustrine coal-facies association is in the upper part.

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Depositional Environments and Reservoir Properties of Sandstones of Lower Cretaceous Nanushuk and Upper Cretaceous Colville Groups, Umiat Test Well 11, National Petroleum Reserve, Alaska

Delta-front sandstones of the Grandstand Formation, Killik Tongue of the Chandler Formation, and the Ninuluk Formation (Nanushuk Group) are moderately well to well-sorted, very fine to fine-grained, angular to subangular chert-arenite and phyllarenite. A source terrane of low-grade metamorphic rocks, sandstones, and cherty limestone was southwest of Umiat and the delta prograded northeasterly. Weighted average porosity and permeability of cored sandstones are 15.6% and 167 md for the Grandstand Formation, 16.4% and 96.2 md for the Killik Tongue of the Chandler Formation, and 12.6% and 10.7 md for the Ninuluk Formation.

The Seabee Formation (Colville Group) is predominantly marine shale, interbedded with several sandstone units. These marine sandstones are moderately well to well-sorted, very fine to medium-grained, angular to subangular phyllarenite, metarenite, and volcanic litharenite. Volcanic rock fragments and volcanic plagioclase feldspar are abundant. Abundant chlorite and smectite reduce permeability; weighted average permeability is 3.1 md and weighted average porosity is 11.5%.

The Tuluvak Tongue of the Prince Creek Formation (Colville Group) is composed of interbedded delta-plain and delta-front facies of a northeasterly prograding delta. Sandstones from the Tuluvak Tongue are moderately well to well-sorted, very fine to medium-grained, angular to subangular phyllarenite, feldspathin phyllarenite, and volcanic litharenite. Abundant authigenic smectite reduces permeability; weighted average permeability is 3.9 md and weighted average porosity is 14.6%.

Composition of the sandstones has a major effect on porosity and permeability. Sandstones that have a higher content of compressible grains (mainly phyllite), and sandstones that have greater matrix and cement content generally have lower porosity and permeability. Expandable clay matrix is essentially absent in the Nanushuk Group sandstones. Porous and permeable Nanushuk Group sandstones should exist in those depositional areas that received only sparse amounts of metamorphic rock debris and in areas where energy conditions at the site of deposition facilitated sorting and winnowing of the sediment.