causes; (2) steep slopes (>10°), especially those covered by sediment, and steep-walled submarine channels; (3) faults that intersect or offset the seafloor or Holocene sediments; and (4) areas of high seismic activity. Geologic features considered hazardous in their present state but whose effects can be economically lessened through existing technology and design are referred to as constraints. Constraints identified in offshore central and northern California are: (1) filled or shallow buried channels where load-bearing capacity differs from surrounding sediments; (2) gas seeps, mounds, and craters; (3) zones of unconsolidated to semiconsolidated sediments (3 to 50 m beneath the sea floor) saturated with interstitial gas under normal to near-normal pressures; and (4) possible pressurized shallow gas identified as bright spots or amplitude anomalies.

These geologic hazards and constraints were evaluated for each of the 243 tracts as a basis for recommendation of withdrawal or stipulation prior to the formal announcement of the sale. Further data acquisition and analysis on a more detailed grid will be required of lessees or operators before drilling will be permitted on leases resulting from the sale.

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Miocene Phosphorite Sedimentation on Atlantic Continental Shelf, Onslow Bay, North Carolina

An extensive sequence of phosphorites outcropping on the Atlantic continental shelf of Onslow Bay, North Carolina, has been delineated by utilizing a series of vibracores and high resolution subbottom profiles (3.5 kHz, uniboom, and sparker). This broad outcrop belt extends 100 km from western Bogue Banks, southwestward across the shelf toward the outer part of Frying Pan Shoals off Cape Fear, North Carolina. Along the outcrop zone the Tertiary phosphorites have been and are presently being eroded, supplying reworked phosphate grains in diluted concentrations to the associated thin Pleistocene to recent sediment and rock blanket. The Tertiary phosphorites are primarily an interbedded sequence of muddy, quartzose phosphorite sands; phosphatic dolosilts; and fossiliferous, dolomitic, phosphatic, quartz sands. The sediment sequence closely resembles that found in the Aurora area of the North Carolina Pungo River basin, a major mining district, and is presently considered to be the Pungo River Formation of middle Miocene age. These phosphorites unconformably overlie the slightly glauconitic, calcareous, fine quartz sands, calcarenites, and sandy, moldic limestones of lower Miocene and/or Oligocene age. Small parts of the updip outcrop belt of the Tertiary phosphorites, as well as the downdip section to the southeast, are covered by a thickening sequence of fossiliferous, clayey, quartz sands of the Yorktown Formation (Pliocene). The distribution of the Tertiary phosphorites is primarily related to the Cape Fear arch, a major coastal plain structural element, and is locally controlled within Onslow Bay by several second order structural features and associated entrapment basins.

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Cyclic Deposition of Upper Tertiary Phosphorites of North Carolina Coastal Plain and Their Relation to Global Sea Level Curves

The upper Tertiary phosphorites in the Aurora area occur within the Miocene Pungo River Formation (units A, B, C, and D) and the Pliocene Yorktown Formation (lower and upper units). These units are characterized by the following features of sedimentation. (1) Three major erosional unconformities and five diastemic surfaces mark the boundaries between consecutive units. (2) Indurated carbonate sediments, which usually contain either a weathered fossil assemblage or are completely moldic, cap each unit. The carbonate surfaces locally contain a rock-boring infauna and are commonly phosphatized. (3) Phosphate sedimentation began in unit A and increased to a maximum through unit C, was negligible in unit D, was reinitiated in the lower Yorktown, and was nonexistent in the upper Yorktown. (4) Phosphate concentration generally increases upward within each unit until carbonate sediments become important, then the phosphate decreases. (5) The dominant carbonate within each unit is as follows: unit A and B, dolosilt; unit C, calcitic micrite; unit D, dolosilt with abundant calcite shell material; and both Yorktown units, calcitic micrite with abundant calcite shells.

This sequence of upper Tertiary sediment units suggests a cyclical pattern controlled by global eustatic sea level fluctuations. Each depositional unit, its carbonate cap, and the associated diastemic surfaces correlate with established third order sea level cycles. Units A, B, and C appear to represent the maximum transgressive part of the second order Miocene supercycle. Phosphate sedimentation was coincident with the transgression; the maximum deposition occurred during the highest level of the sea. Unit D was deposited only over the eastern area as a regressive facies of the supercycle. The Pliocene Yorktown sediments were deposited during the next supercycle. The lower Yorktown phosphorites coincided with the maximum transgression while the nonphosphatic upper Yorktown was deposited during the subsequent regressive phase.

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Ichnology of Neritic Turbidite: Silurian Red Mountain Formation, Georgia and Tennessee

It has recently been shown by others that two thousand units in the Red Mountain Formation are relatively shallow-water turbidites, water depth roughly 100 to 300 ft (30 to 91 m). The turbidites, probably storm-generated, consist of alternating sandstones and shales in fining-upward sequences with scoured bases; the lower turbidite grades upward into hummocky bedded alternating sandstones and shales. Biogenic structures are dominated by *Chondrites gracilis, C. flexuosus,* and *Trichophycus striatus,* which occur through most of the units. Others include *Dictyodora, Asterosoma, Planolites* spp., *?Megagrapton,* as yet unnamed radiating grazing trails, and rare *Fraena, Aulichnites, Monocraterion, Halopoa,* and *?Bifungites.* The traces are preserved largely as sandstone hypichnia, hence most were the work of mud-dwellers. Deposit-feeding evidently predominated over suspension-feeding; *?Megagrapton* is an example of a bacteria-farming network. The ethology of *Trichophycus* is uncertain; the burrow was partly a dwelling structure but may have been the work of a deposit-feeder, suspension-feeder, or carnivore. Stellate forms of *Trichophycus* are perhaps analogous to circular patterns of burrow apertures seen in deep-sea photographs. The assemblage is a mixture of genera from *Cruziana* (shelf) and *Zoophycos* (slope) ichnofacies, as might be expected in a neritic turbidite. Without recently published stratigraphic evidence, the units could be misinterpreted as bathyal turbidites.