plications. High spreading rates result in large mid-ocean ridge volumes giving rise to high sea levels, lowered erosion and terrigenous sedimentation rates, extensive shelf carbonate (C_{ox}) deposition, and concomitant mass transfer of calcium from evaporites to carbonates and of sulfur from evaporites to sedimentary sulfides. The observed evidence of elevated global temperatures during such times may result from higher atmospheric CO_2 levels due to an increased rate of production of CO_2 from the decarbonation of limestones and the formation of calc-silicates at subduction zones.

During global low sea levels, higher erosion and terrigenous sedimentation rates restrict carbonates leading to the mass transfer of calcium from carbonates and of sulfur from sulfides to extensive evaporites. Total organic carbon (C_{red}) storage in sediments is greater (although preservation and concentration of organic carbon may also be high during anoxic high CO_2, high sea level times). Lower atmospheric CO_2 levels during these episodes may have been conducive to the observed evidence of epochs of glaciations and lowered world temperatures.

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Sedimentology of Tight Gas Sandstones: Well Log and Core Evaluation

A cooperative study with the Delta Drilling Company (Tyler, Texas) provided a unique correlation of experimental tools (induced gamma-ray spectroscopy, digital sonic) and commercial tools (natural gamma-ray spectroscopy, high-resolution dipmeter) with petrophysical/geologic measurements on a whole rock core from the tight gas sandstones of the Upper Jurassic Cotton Valley Group in east Texas.

For example, a SARABAND suite of logs and dipmeter analyses processed according to the major genetic units of sedimentation (barrier bar, tidal delta) demonstrates the dynamic conditions of fluvial and shallow-marine (tidal) systems. Induced and natural gamma-ray spectroscopy with a SARABAND presentation yields a stratigraphic analysis of the clay/non-clay fractions and the lithology. Of growing economic importance, fracture containment boundaries to hydraulic fracturing can be predicted from a mechanical properties log—a combination of SARABAND and digital sonic.

The tight gas sandstones are characteristically well-laminated and bedded lithic sandstones with low porosities ($<$ 10%) and low permeabilities ($<$ 0.1 md). The intergranular pores are lined with diagenetic minerals—quartz overgrowths and calcite, and are filled, lined, and/or bridged with non-expandable illite, chlorite, and illite/chlorite mixed-layer clay minerals.

The depositional paleoenvironment of the lower section of the Cotton Valley Group is interpreted as a sequence of shallow-marine, organically burrowed, layered, foreshore-shoreface deposits comprising the above-mentioned major genetic sedimentation units, the barrier bar and the tidal delta.

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Diagenetic Trends in Siliceous Facies of Monterey Formation, California

Much of the unique character of the siliceous facies of the Miocene Monterey Formation stems from diagenesis. At localities in California, soft, porous diatomites and diatomaceous mudrocks give way vertically and laterally to hard, dense, and brittle cherts, porcelanites, and siliceous mudrocks. Vertical lithologic transformations typically occur through several tens of meters of section; lateral changes may span several kilometers or more. A well-documented mineralogic progression from highly disordered amorphous silica (opal-A) to microcrystalline quartz through an intermediate cristobalitic stage (opal-CT) commonly accompanies these changes.

X-ray diffraction analyses of surface and subsurface samples define present boundaries of silica zones. Within the cristobalitic silica zone the d-(101) spacing of opal-CT may vary between 4.12 A and 4.04 A. In the Taft and Chico Martinez areas of the Temblor Range, boundaries between silica zones and stratigraphic horizons are generally parallel. In the Santa Maria region and in the Santa Ynez Mountains, silica zones cut obliquely across stratigraphic horizons. Off central Baja California, the opal-A to opal-CT transition in Monterey-equivalent rocks corresponds to a prominent bottom-parallel seismic reflector.

Time, temperature, and sediment composition affect rates of silica transformations. Oxygen isotopes of opal-CT and quartz provide estimates of the temperatures at which these transformations occurred. In nature the thermal history of any sediment is largely a function of the thermal gradient and sedimentation rate. In the Santa Maria region, most silica conversions probably occurred during the last 3 to 4 m.y. in response to accelerated rates of sedimentation and, therefore, to burial heating during the Pliocene. In contrast, rates of silica transormations in the Monterey Shale in the Cholame area probably varied with proximity to hydrothermally altered intrusive serpentine.

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Authigenic Dolomite in Monterey Formation, California, and Related Rocks from Offshore California and Baja California

Authigenic carbonate rocks occur as thin layers and concretionary zones in the Monterey Formation in California and in equivalent strata off southern California and Baja California. Calcium-rich dolomite (49 to 56 mol % $CaCO_3$) is the dominant carbonate although authigenic calcite also occurs. Sedimentary structures, including laminations and burrows, are common in these carbonate rocks and commonly continue across concretion and layer boundaries. Microtextures run the spectrum from sparsely distributed dolomite crystals in dolomitic mudrocks to dolomites composed completely of interlocking 5 to 10 μm crystals. Dolomite cements and impregnates the host lithology. Dolomitization of existing biogenic carbonate also occurs.

Isotopic and chemical data suggest that these dolomites formed in shallow subsurface zones of high alkalinity spawned by abundant carbon dioxide and methane production during progressive microbial decay of organic matter. Oxygen isotopes range from 23 to 34 ppt SMOW (Monterey dolomites) and from 27 to 35 ppt SMOW (offshore dolomites). Approximate ranges in formation temperatures computed from these values are 17 to 72°C and 10 to 50°C, respectively. Highly variable carbon isotopes, -25 to $+21$ ppt PDB (Monterey dolomites) and -30 to $+16$ ppt PDB (offshore dolomites), reflect the isotopic reservoirs in which the carbonates formed. Oxidation of organic matter through microbial reduction of sulfate at shallow burial depths favors light-carbon dolomites; heavy-carbon dolomites probably formed below this zone where $HC^{12}O_3^-$ is preferentially removed by reduction of CO_2 to methane during methanogenesis. A controlling factor in these reactions is the sedimentation rate which dictates both the preservation of organic matter on the sea floor and the depth distribution of subsurface zones of organic matter decay.

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New Eustatic Sea Level Curve from Oceanographic Data

A eustatic sea level curve can be obtained by combining marine geophysical, geologic, and tectonic data. Eustatic sea level variations result from changes in the volume of the world oceans. Volume decreases can be ascribed to increased spreading rates of the mid-ocean ridge system, and of small ocean basins, the presence of hot spots beneath oceanic crust, and an increase in the volume of sediments deposited in the oceans. Orogenic activity results in increased ocean volume as does contraction of the mantle due to increased subduction rates. The formation of major ice sheets offsets eustatic sea level by lowering the volume of water present in the ocean system. A eustatic sea level curve will be obtained, taking into account all of the above effects. This will include an analysis of the error introduced by geologic uncertainties.

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Fluidized-Bed Combustion of Oil Shales

Oil shales from Colorado, Israel, Morocco, and the eastern U.S. Devonian and Mississippian were burned in a fluidized-bed combustion unit. The oil shales are devolatilized or retorted in the fluidized bed; the volatiles are burned over-bed for maximum heat recovery and/or the volatile can be condensed downstream for hydrocarbon fuels production.

An oil shale energy recovery process is proposed wherein pseudo, two-state combustion in a high freeboard fluidized-bed combustion unit is used. In this design, the volatiles are driven off with minimum calcination taking place in the spent shale. The volatiles are burned in the freeboard for maximum heat recovery. The burning fluidized bed will be shielded from the radiation heat generated by the freeboard combustion by a cloud of elutriating dust particles.

Experiments and analytical data leading to the conceptual design will be presented. Some of the oil shales have an inordinate amount of inert material with a high concentration of calcium carbonates. The amount of calcium sulfates exceeds the calcium carbonate required for sulfur retention.

When heating up to the temperature where the calcination of carbonates is taking place, considerable amounts of heat of combustion will be consumed by the heat from calcination. The conceptual design will heat the oil shale to a temperature at which the devolatilization or retorting is taking place without appreciable calcination. The control of calcination will reduce the heat consumption and increase the heat recovery.

The spent shale from fluidized-bed combustion can be used for cement manufacturing, the major component of construction materials. The use of oil shales as a source of cementitious material will help to solve the troublesome solid waste disposal problem.

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Generic Predominance Facies Among Deep-Water Benthic Foraminifera of Gulf of Mexico

A synthesis of published and unpublished records of benthic foraminifera from the continental slope, rise, and the abyssal plains of the Gulf of Mexico reveals environmentally influenced facies of generic predominance. Circum-Gulf facies of predominant *Brizalina, Uvigerina,* and *Bulimina* are present on the continental slope and appear to be associated with water mass patterns or hydrostatic pressure changes. The *Glomospira* facies, which is patchily distributed on the continental slope and rise appears to be a result of geochemical conditions on bottom prominences. In abyssal depths, the *Eponides-Nuttallides* and *Cibicides* facies are associated with contrasting substrates on the Sigsbee Plain and Mississippi fan, respectively. Trends in the diversity of generic predominance facies mimic species diversity trends in other silled basins, and decrease from seven facies on the slope, to two facies on the Sigsbee Plain.

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Chronostratigraphic Sequences Beneath Northeastern United States Continental Margin

Chronostratigraphic sequences of wide areal extent beneath the United States Atlantic margin north of Cape Hatteras have been delineated by: (1) examination of four COST (Continental Offshore Stratigraphic Test) wells, 1 exploratory well (Shell, Blk. 272, No. 1, OCS A 0096), 14 shallow AMCOR (Atlanctic Margin Coring) core holes, and eight ASP (Atlantic Slope Project) core holes; (2) analysis of multichannel seismic reflection profiles collected along several thousand kilometers of track lines; and (3) comparison of these interpretations to the Canadian offshore chronostratigraphy. In the Baltimore Canyon Trough and Georges Bank basin, seismically identified regional unconformities are associated with Lower Jurassic, Middle Jurassic, Upper Jurassic-Lower Cretaceous, upper Hauterivian, Cenomanian, Turonian-Coniacian, Upper Cretaceous-lower Paleocene, Oligocene, and upper Miocene-Pliocene rocks. The Tertiary unconformities are identified best in the Baltimore Canyon Trough where the thickness of Tertiary rocks exceeds 1,400 m. There, seismic profiles near the COST B-3 well reveal several probable unconformities of Miocene to Pliocene age that are not documented in the wells. Across the Georges Bank basin, subtle Jurassic unconformities appear to be present on seismic records within a thick, poorly dated section of interbedded limestone, dolomite, and anhydrite.

Microfossil records from the deep wells and shallow core holes reveal seven unconformities of regional extent, forming chronostratigraphic gaps in the early to middle Cenomanian, late Turonian-early Coniacian, late Maestrichtian-early Paleocene, late Eocene-early Oligocene, early Miocene, late Miocene-early Pliocene, and late Pliocene-early Pleistocene. These gaps in the fossil record are comparable with the gaps found in wells in the Scotian basin, and correspond to unconformities inferred from the seismic profiles.

The chronostratigraphic sequences bounded by these unconformities help to better define the curve of coastal onlap during the Cretaceous and to support the major trends in sea level change during the late Mesozoic and Cenozoic noted by Vail, Pitman, and others.