effective wave base in modern seas. Supporting evidence comes from the lack of bottom-dwelling metazoans in Phanerozoic examples indicating anaerobic conditions.

In the examples, laminated to thickly bedded sulfides are interstratified with shales, siliciclastic or carbonate-sediment gravity-flow deposits, and some cherts. Where not obscured by deformation and metamorphism, sandstones show grading, flutes and grooves, load casts, and Bouma sequences. Submarine mudflow units may be common. Lacking are hummocky cross-stratification, wave ripples, mudcracks, abundant medium-scale cross-stratification, or other evidence in ore zones of shallow-marine processes or of subaerial exposure. Thicknesses of clastics point to basin depths much greater than 200 m.

These deposits apparently formed in extensional tectonic regimes. Stratigraphic thickness variations, facies changes (especially the presence of local, fault-derived slumps), or geophysical evidence suggest the presence in many of active faults during ore genesis. These faults formed the basins or formed local traps, provided conduits for hydrothermal fluids, and positioned convective cells.

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Reservoir Diagenesis and Convective Fluid Flow

Pore fluids in reservoir rocks are unstable under normal geologic conditions and, in the absence of forced flow, convective fluid flow can be expected as a general rule. Calculations suggest that fluid velocities on the order of 10^{-8} m-sec^{-1} should be typical scale velocities for convective rolls due to normal geothermal gradients (25°C - km^{-1}). Velocities of this magnitude are shown to be sufficient to reduce porosity significantly in less than 5 million years if quartz is the pore-filling cement. If exsolved hydrocarbons are pore-filling materials, the time to complete fill decreases to about 2 million years, while pore filling with both exsolved hydrocarbons and quartz (72% HC) requires about 1.43 million years.

Mass transfer by convective fluid flow alone appears to be sufficient to account for the bulk of diagenesis in the deep subsurface. However, it can also be argued that many diagenetic reactions occur solely as a consequence of moving fluids maintaining chemical equilibrium with their dissolved load as the fluids cycle through temperature and pressure gradients. Phases are precipitated or dissolved during the cycle depending on the sign of the solubility coefficients of a mineral with respect to temperature or pressure. Quartz solubility, for example, increases with T and P under normal reservoir conditions and can be expected to move from hot to cold zones while calcite would be expected to show the opposite behavior. In particular, it is shown that the diagenesis in a convecting system is not a function of mineral solubilities, but rather the temperature and pressure coefficients only. This observation may be of considerable importance in assessing the significance of hydrocarbon transport and accumulation by molecular solution in the aqueous phase because it appears that the components of a petroleum phase exhibit similar temperature and pressure behavior.

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Petrologic Controls of Reservoir Properties of Mid-Continent Pennsylvanian Sandstones

Petrographic analyses of Middle Pennsylvanian (Desmoinesian) Cherokee Group sandstones in the Mid-Continent show that effective liquid porosities, liquid permeabilities, and pore-size distributions are controlled by sedimentologically influenced petrologic parameters and subsequent diagenetic alterations. Deltaic complexes contain two distinct sandstone-bearing lithologies: (1) subarkosic-quartzarenitic channel sandstones, and (2) sublitharenitic sandstones interstratified with shales representing overbank and interdistributary deposits. The sandstones in these two settings underwent different diagenetic histories, which enhanced original differences in their reservoir properties.

Overbank deposits commonly contain soft, argillaceous rock fragments which underwent plastic deformation during compaction, causing the clogging of some pore-throats and pores. In addition, extensive silica cementation, perhaps due to diagenetic clay mineral conversions, caused further destruction of primary pores. In channel sandstones, porosity reduction was less extensive and apparently proceeded at a slower rate. Chlorite coatings on many grains prevented destruction of original pore spaces by inhibiting further silica cementation. Individual sandstone bodies with abundant coatings fall within a porosity range of 20 to 25%, whereas bodies with uncoated grains rarely exceed 18%. Permeabilities in clay-coated reservoir rocks fall within a 100 to 200 md range, whereas uncoated or sparsely coated rocks are in the 1 to 30 md range. The diagenetic histories of these rocks are further complicated by the development of secondary porosity caused mainly by dissolution of the feldspathic grains and carbonate cements.

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Cenozoic Calcareous Nannofossils from Klamath, Southern Oregon

All four reconnaissance samples, from west to east, of almost vertically dipping turbidites exposed in road cuts along the Rogue River of southern Oregon between Gold Beach and the crest of the Coast Range, contain Tertiary calcareous nannofossils. The first assemblage, taken nearest the Pacific Ocean and located near Tom East Creek, includes *Coccolithus pelagicus, Coronocyclus nitiscens, Cyclocargolithus floridanus, Dictyoccoccites abisectus, Discoaster deflandrei, D.* cf. *druggi, Sphenolithus belemnos, S. capricornutus, S. heteromorphus, S. conicus, S.* n. sp., and *Triquetrorhabdulus carinatus,* indicating NN 2-3 zone. The second sample, from west of the first between Tom East Creek and the town of Agnes is sparser, but contains *Coccolithus pelagicus, Cyclocargolithus floridanus, Discoaster deflandrei, D.* cf. *druggi, Sphenolithus belemnos, s. capricornutus, S. heteromorphus,* and *Triquetrorhabdulus carinatus,* also indicative of NN 2-3. Eastward, the third sample, taken at the bridge across the river near Agnes, is sparse but contains *Coccolithus pelagicus, Cyclocargolithus floridanus,* and *Sphenolithus heteromorphus,* indicating an early to mid-Miocene age. The fourth sample, from near the crest of the Coast Range, probably represents the Tyee Formation and contains *Discoasteroides keupperi, Helicosphaera seminulum, Lanternithus minutus, S. radians, Zygolithus dubius,* and *Zygrhablithus bijugatus,* suggesting mid-Eocene NP 12-15.

These samples represent the first reported occurrence of calcareous nannofossils from the Klamath melange, and more important, the youngest strata yet dated from within the Klamath. Detailed collecting, which will commence shortly, should greatly enhance understanding of the Cenozoic and perhaps Mesozoic history of this tectonically complex area.

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