Cretaceous Carbonate Reservoir Facies as a Function of Seawater Composition, Paleoclimate, and Evolution of Major Carbonate Producing Biota

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The Cretaceous was a unique period in the evolution of Earth's biosedimentary systems. While there is evidence for polar ice in the early Cretaceous, the probably highest temperatures of the Phanerozoic were recorded during the mid-Cretaceous. Seawater composition was considerably different to the modern ocean, favoring calcite over aragonite as the dominant marine carbonate mineral. Rudist bivalves evolved into major carbonate producers on carbonate platforms and were able to adjust the mineralogy of their shells to the changing seawater composition. The evolution of seawater composition and climate in concert with biological evolution controlled the aragonite versus calcite dominance of platform carbonates. At the same time pelagic carbonate production by coccoliths and planktonic foraminifers for the first time in Earth history became an important sink in the global carbon cycle.

The mid-Cretaceous sedimentary record is characterized by episodes of oceanic anoxia, drowning of carbonate platforms, and extinction of aragonite-dominated carbonate producing biota. These events are related to significant perturbations of the global carbon cycle that are recorded in the carbon isotopic composition of the ocean-atmosphere system. Carbon isotope chemostratigrapy can be used for a precise global correlation that is important for the prediction of reservoir quality in sequence stratigraphic models.

Major reservoirs are found in originally aragonite dominated deposits of the lower Aptian and Albian-Cenomanian of the Middle East and the Gulf of Mexico and both, the diagenetic reactivity of aragonite and the original porosity of rudist shells are important for the characteristics of these reservoir.

The interaction between seawater composition, climate, and the long-term evolution of Cretaceous carbonate platform and pelagic deposits will be summarized, and the Aptian Shu'aiba Formation of the Middle East is discussed as an example of abrupt changes in reservoir facies related to oceanic anoxia and the extinction of aragonite-dominated rudist bivalves.