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Geodynamic control on Phanerozoic marine carbonate sedimentary systems

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The most prominent factors that control ancient and modern carbonate systems are generally considered as water conditions (temperature, chemistry, nutrients ...), climate, oceanography, eustasy and biology of the carbonate producers. Geodynamic processes are considered secondary factors framing the so-called "tectonic context" or "geodynamic context". This biased approach might result from the significant scale jumps between observed carbonate stratigraphic architectures, sedimentary systems and heterogeneities and geodynamic systems. For example, high wavelength, low frequency, tectonic deformations of the crust or high amplitude vertical movements of the lithosphere are difficult to identified at the scale of the carbonate systems at local and regional scales and are simply not taken into account, unlike high frequency-low amplitude sea level changes. This study that is founded on an exhaustive investigation of representative and well documented cases of carbonate systems during Phanerozoic, proposes to investigate the coupling between stratigraphic architecture and sedimentary organization of marine carbonate systems and geodynamic systems at regional scale. The main objective is to identify, and quantify if possible, the impact of geodynamic processes on the paleogeography, geometry, architecture and dynamics of carbonate systems for the entire Phanerozoic. Each studied carbonate systems are characterized in terms of geometry (thickness, length, width, shape, sedimentary profile...), stratigraphic architecture (aggrading, prograding or retrograding), time duration (Ma), preserved sedimentation rate (m/Ma), paleogeography (isolated or attached platform, rimmed shelf, ramp, epeiric platform), and sedimentary sequences thickness. Geodynamic and tectonic parameters are characterized in terms of basin confinement (epicontinental sea, open sea, confined basin), basement depth and type (i.e. continental upper crust, continental lower crust, transitional crust, oceanic crust, mantle, volcanic edifice, ophiolites), Moho depth, tectonic setting (passive margin; post-rift; foreland basin; rifting-drifting; intracratonic/pericratonic basin; forearc/backarc basin; intra-oceanic ridge; volcano; post-obduction), and subsidence origin (thermic subsidence, tectonic extension, sediment loading, advancing orogenic front).

Eighty cases of well documented marine carbonate systems are studied, from stratigraphic mega-sequence scale to basin scale. The geologic parameters are summarized with tables including qualitative and quantitative parameters that are further analyzed with statistics. Several correlations and trends are tested between carbonates parameters (age system, paleogeography, geometry, thickness, accumulation rate...) and geodynamic characteristics (tectonic system, basement depth and type, origin of the subsidence ...).

Clear broad trends are identified: tectonic setting controls the thickness, platform confinement and size, paleogeography and accumulation rates. For example carbonate system with a thickness over 1300m are always epicontinental and small carbonate platforms (<100km2) are mainly developed in foreland basins. Very large platforms (>10 000km2) mostly developed along passive margins, foreland and cratonic basins. Carbonate platform with areas between 100 km2 and 1000 km2 are common in cratonic basin settings. As expected, carbonate platform with a size over 1000 km2 never develop on top of a volcanic basement. Accumulation rate is also strongly correlated to the age of the system, distance to basement and the origin of the subsidence. But it is not correlated to platform size nor time duration of the carbonate sedimentary system.