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The Roles of Tectonics and Climate Change on The Carbonate Facies Architecture Development of an Active Foreland Ramp Margin: Evidence from The Madison Group, Southwest Montana

The Antler Orogeny of the Late Devonian-Early Mississippian changed the western US from a passive margin to an active foredeep basin. As subduction impinged on the shelf, the Madison carbonate ramp's depositional styles were markedly altered. In the Meramecian, tectonically induced relative sea level fall caused exposure and karsting of the system, while sediment production was forced basinward. Contemporaneous growth of continental ice sheets led to sea-level fluctuations of increasing frequency and amplitude. Ramp uplift, basin deepening, and changing eustatic conditions developed a margin that rapidly prograded into the foredeep during falling relative sea level events and backstepped in response to sea level rises.

The Madison ramp of Wyoming is composed of a five-fold hierarchy of sequences and cycles, which has been subdivided into six third-order sequences that nest into a single second-order supersequence. The ramp margin, exposed in southwestern Montana, displays this sequence architecture but lies in a high accommodation setting where the sequences are expanded and are bounded by the correlative conformities of updip exposure surfaces. Here, dramatic shifts in facies belts are observed in the vertical facies successions, illustrating the basinward shift in carbonate production and margin progradation in response to changing relative sea level conditions. Deep-water slope deposits are overlain by tempestites that shoal upward into tidally-influenced skeletal grainstone packages, at both the cycle and sequence scale. In contrast to the karsted updip ramp, the top of the Madison here is marked by the deposition of peritidal facies marking the seaward shift of carbonate production onto the ramp margin and the foredeep basin.