ingly bimodal, recording deposition in low-relief coastal settings. Overlying nonmarine units are lithologically intermediate between typical Gannett Group lithologies which occur to the west and typical Morrison-Cloverly lithologies which occur to the east. These consist predominantly of numerous fining-upward sandstone channels isolated in variegated siltstone and mudstone. These were deposited in low-gradient meandering fluvial channel and related flood-plain settings, respectively. The Draney Limestone in the upper part of Gannett Group extends eastward across this area into the top of the "Lilac Beds" of the Cloverly Formation, demonstrating synchroniety of deposition across the foreland basin. Nonmarine units are overlain by rippled, crossbedded, and burrowed transgressive nearshore sands of the "Rusty Beds," which are in turn overlain by the normal marine dark shales of the Thermopolis Formation.

Paleoflow directions in nonmarine axial foreland basin units are predominantly to the north, ranging from northwest to northeast. As such, these fine-grained meanderbelt facies demonstrate that while synorogenic rivers of the tectonically active basin margin carried sediment of the Gannett Group eastward toward the basin axis, rates of axial basin subsidence exceeded rates of fluvial input, even during the earliest stages of deformation. Synorogenic rivers, bounded on the west by the rising orogen and the east by the stable craton were constrained to flow northward, parallel to the belt of orogenic deformation. As such, major fluvial systems of the Western Interior were analogous to those of other foreland basin settings such as the Paleozoic Michigan River system which paralleled and flowed to the west of the rising Appalachians, and the east-flowing Quaternary Indogangetic system south of and parallel with the rising Himalayas.

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Evidence for Post-Cementation Migration of High-Temperature, High-Pressure Fluids—Siluro-Devonian Helderberg Group, Central Appalachians

Fluid inclusion data and fracture-filling cements in carbonate and siliciclastic rocks of the Siluro-Devonian Helderberg Group, central Appalachians, indicate post-cementation, late Paleozoic migration of high-pressure, high-temperature fluids.

Void-filling quartz and calcite cements contain secondary, 2-phase fluid inclusions that give freezing temperatures of -20 to -25° C (-4 to -13°F) (salinity > 22 wt.% NaCl). Homogenization temperatures are 200 to 300 + °C (392 to 572°F) (temperatures calibrated and pressure corrected) and greatly exceed maximum paleotemperatures (120 to 160°C; 248 to 320°F) given by conodont color-alteration index values or calculated from known sedimentary overburden. High homogenization temperatures suggest rapid movement of metamorphic fluids so that ambient burial temperature was not raised for long enough periods of time to affect conodont CAI values. These fluids probably came from Blue Ridge–Piedmont thrust sheets that were undergoing metamorphism during late Paleozoic deformation. These fluids migrated more than 75 km (47 mi) during thrusting.

Well-cemented sandstone and limestone have multiple crosscutting trains of secondary hydrocarbon inclusions. Some trains crosscut cement-filled fractures. Hydrocarbons also occur as thin films along cement crystal boundaries and as secondary inclusions trapped along calcite deformation twins. These inclusions indicate geopressured fluids moved along intercrystalline boundaries and along deformation twin planes in calcite under deep burial conditions either during or after deformation.

Rare fractures contain transported skeletal grains, "exotic" clasts, recemented clasts of fracture-filling cement, and mud. Cement clasts contain included mud and skeletal grains, and indicate several episodes of particle transport, cementation, and refracturing prior to final fracture filling. Primary(?) 2-phase fluid inclusions in vein-filling calcite give homogenization temperatures of 120 to 150°C (248 to 302°F). Coarse-grained "clastic" fracture fills indicate migration of rapidly moving fluids capable of transporting clasts through fracture conduits under deep burial conditions.

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Paradox of Great Thicknesses of Carbonate Turbidites—Some Synergistic Observations from French Western Pyrenees and Upper West Florida Continental Slope

By the end of the Turonian, a westward-trending flysch trough was well established in what is now the western French Pyrenees. Over the next 22 m.y., to the end of the Maestrichtian, up to 5 km (16,000 ft) of carbonate flysch were deposited, uninterrupted by major silicoclastic sedimentation. Individual carbonate turbidites vary from a few centimeters to occasional massive deposits tens of meters thick. One carbonate megaturbidite can be traced 90 km (56 mi) and is still 10 m (33 ft) thick at its most distal exposure. Carbonate constituents lack shallow water indicators, suggesting that deposition and mass movement initiation occurred on continental slopes. Carbonate sediments were fed into the trough from both north and south.

Are there modern carbonate depositional environments we can turn to that will help us understand how such great thicknesses of carbonate flysch can build up without major clastic input? We believe that the west Florida upper continental slope is one such environment. It is part of a system which has been a carbonate depocenter since Jurassic time. A lime mud slope facies has accumulated at the rate of about 30 cm/1,000 years (12 in./1,000 years) for the last 25,000 years. At that rate (and allowing for a 50% reduction due to compaction) about 3.3 km (11,000 ft) of carbonate could accumulate in 22 m.y. A large variety of structures show that mass movement is continually displacing sediment downslope. If a second carbonate margin were close, accumulation of 5 km (16,000 ft) of carbonate flysch in 22 m.y. in a subsiding trough need not be extraordinary, even in an orogenically quiescent system.

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Shallow Structure and Carbonate Sedimentation of West Florida Upper Continental Slope

An extensive mini-sparker (3.5 kHz) and piston-coring survey of the continental slope above the West Florida Escarpment has revealed a Pleistocene sequence up to 160-msec (2-way travel time) thick overlying a second strong reflector of either Pliocene or Miocene age. South of 27°20′ N, the contact between the two is clearly erosional and includes a band of karst features. The Pleistocene drape thins to a minimum, in some places exposing the second layer, at about 525 m (1,725 ft) water depth, and then thickens dramatically downslope. We attribute this thinning to the north-south-flowing Loop Current blocking deposition and scouring the bottom. Present depth of the erosional surface suggests as much as 400 m (1,300 ft) of subsidence after its formation.

Two parallel reefs mark the upper slope from its southern limit to 26°40′ N. Sediments on the upper slope are a foraminifera-coccolith ooze, the compositional equivalent of a chalk deposit. Radiocarbon dating indicates that ooze below the erosional minimum accumulated at more than 60 cm/1,000 years (24 in./1,000 years) for at least the last 25,000 years, a surprisingly high rate. High sedimentation rates are also reflected in a wide variety of mass-wasting features from creep to massive slides to gravity-induced folds tens of kilometers long.

Fan deposits have formed at the foot of the continental slope off the southwestern corner of the west Florida margin. Orientation of sand-wave fields on the outermost shelf suggests that offbank transport combined with high slope sedimentation rates and subsequent mass wasting have provided material for these deposits.

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Basement Faults and Cover Tectonics in Southernmost Appalachians

Stratigraphic and seismic data indicate that basement faults occur beneath the Appalachian foreland fold and thrust belt in Alabama. Some of the high-relief basement faults control the locations of thrust-related