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ANNOTATED BIBLIOGRAPHY OF SELECTED REFERENCES FOR THE OUACHITA-APPALACHIAN STRUCTURAL BELT, AS PERTAINS TO THE BLACK WARRIOR BASIN OF MISSISSIPPI

James L. Coleman, Jr., and Wendy S. Hale-Erlich
Amoco Production Company
Houston, Texas 77253

INTRODUCTION

In an early draft of a recently published article, Hale-Erlich and Coleman (1993) discussed the evolution and variety of interpretational concepts developed by workers on the subsurface structure of the Black Warrior Basin of Mississippi and Alabama. Reviewers of this manuscript suggested that the discussion be significantly reduced in length. Because the sources on which the discussion was based might be of general interest to all workers in the Black Warrior Basin, this annotated bibliography of selected references was compiled as a companion paper to Hale-Erlich and Coleman (1993). For a more complete, but unannotated, bibliography, the reader is referred to Sartwell and Bearden (1983).

SUMMARY OF STUDY AREA

Hale-Erlich et al. (1987) presented a study completed by Amoco Production Company (New Orleans Region) explorationists, which interpreted the confluence of the Appalachian Orogenic Belt and the Ouachita Orogenic Belt as a north-south, transform fault zone, 24 km (15 mi.) west of the Mississippi-Alabama state line in Kemper and Lauderdale counties, Mississippi (Figure 1). Prior to this report, a number of speculative interpretations had been presented (Figures 2, 3).

The interpretation by Hale-Erlich et al. (1987) and Hale-Erlich and Coleman (1993) was developed from seismic structural interpretations of CDP reflection seismic profiles acquired by Western Geophysical Company and Amoco Production Company (Figure 4).

Amoco drilled two wells in this area which assisted this interpretation: No. 1 Lucky and No. 1 Leggett. Integration of these data suggests that the following sequence of deformation transpired (Figure 5):

(1) Appalachian thrust faulting and folding along the Mississippi-Alabama state line area, creating the Pickens-Sumter Anticline (Thomas and Bearce, 1969);

(2) North-south transpressional faulting through the Alabama Promontory, cutting Appalachian transverse ramps and translating frontal ramp folds northward;

(3) Ouachita deformation, closely following (or even contemporaneous with) Step (2), in conjunction with northwestward closure of the Ouachita Basin.

This sequence of deformation events generally contradicts the more widely accepted interpretations of Thomas (1972 and later - see below).

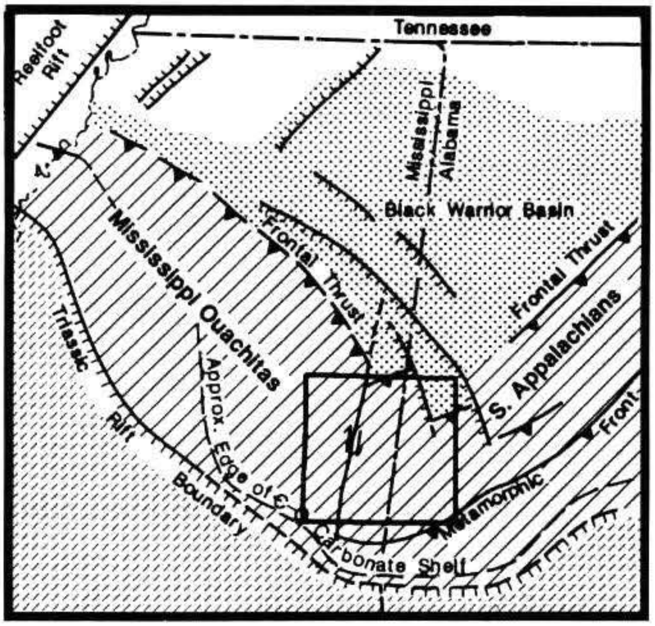

Figure 1. Map of the principal structural elements of the study area. The square outlines the area of detailed study and measures 58.5 mi. (94 km) on a side. Heavy lines with short ticks represent normal fault trends, while subcropping structurally deformed Paleozoic sediments are indicated with diagonal lines. Other structural features are as labeled. From Hale-Erlich and Coleman (1993).

REFERENCES CITED

Hale-Erlich, W. S., and J. L. Coleman, Jr., 1993, The Ouachita-Appalachian juncture: a Paleozoic transpressional zone in the southeastern U.S.A.: American Association of Petroleum Geologists Bulletin, v. 77, p. 552-568.

Hale-Erlich, W. S., J. L. Coleman, J. A. Lopez, and M. S. Lober, 1987, The Ouachita-Appalachian juncture: a Paleozoic transpressional zone (abstract): American Association of Petroleum Geologists Bulletin, v. 71, p. 563.

Sartwell, A., and B. L. Bearden, 1983, Bibliography of the Black Warrior Basin of Alabama and Mississippi: Geological Survey of Alabama, Circular 114, 48 p.

Thomas, W. A., 1972, Regional Paleozoic stratigraphy in Mississippi, between the Ouachita and Appalachian mountains: American Association of Petroleum Geologists Bulletin, v. 56, p. 81-106.

Thomas, W. A., and D. B. Bearce, 1969, Sequatchie Anticline in north-central Alabama, *in* W. G. Hooks, ed., The Appalachian structural front in Alabama: Alabama Geological Society 7th annual field trip guide book, p. 26-43.

SELECTED BIBLIOGRAPHY

Arbentz, J. K., 1989, The Ouachita system, *in* A. W. Bally and A. R. Palmer, eds., The Geology of North America - an overview: Boulder, Colorado, Geological Society of America, The Geology of North America, v. A, p. 371-396.

Arbentz presents a summary article which updates previous publications and points out remaining, unsolved problems. Arbentz prefers Lowe's controversial (1985) model (see below) in which the Ouachita trough formed originally as a rift basin separated from the proto-Atlantic by a microcontinent or ocean plateau located in present-day southeast Texas, Louisiana, and southern Mississippi, which controlled deep basin geometry and sedimentation, while contributing sediment intermittently.

Bayer, K. C., 1983, Generalized structural lithologic and physiographic provinces in the fold and thrust belts of the United States: U. S. Geological Survey Map, 2 sheets, 1:2,500,000.

Bayer presents an annotation of the geologic map of the conterminous United States with general structural trend boundaries. Bayer illustrates the Ouachita structural front in Mississippi as a right lateral, strike-slip fault zone, trending northwest.

Blythe, A. E., A. Sugar, and S. O. Phipps, 1988, Structural profiles of the Ouachita Mountains, western Arkansas: American Association of Petroleum Geologists Bulletin, v. 72, p. 810-819.

These workers from the University of Pennsylvania (supported by ARCO) palinspastically restored interpretations from two north-south seismic lines across the Arkansas Ouachitas (one was the COCORP line illustrated by Lillie et al., 1983, below). They determined that a minimum shortening of 45 to 50 percent occurred in the frontal thrust zone, and regional shortening of 30 to 50 percent is probable for the pre-Carboniferous rocks in the Ouachita core.

Boland, L. F., and E. D. Minihan, 1971, Petroleum potential of the Black Warrior basin: Gulf Coast Association of Geological Societies, Transactions, v. 21, p. 139-158.

These authors interpret the Black Warrior Basin as a small part of the elongated east-west Appalachian-Ouachita geosyncline, rather than a restricted, triangular-shaped basin.

Briggs, G., and D. H. Roeder, 1975, Sedimentation and plate tectonics, Ouachita mountains and Arkoma basin, *in* G. Briggs, E. F. McBride, and R. J. Moiola, eds., Sedimentology of Paleozoic flysch and associated deposits, Ouachita mountains - Arkoma basin: Dallas Geological Society, p. 1-22.

Briggs and Roeder present a plate tectonic model for the Ouachita Mountains of central Arkansas. Their model embraces a south-dipping subduction zone.

Previous Theories

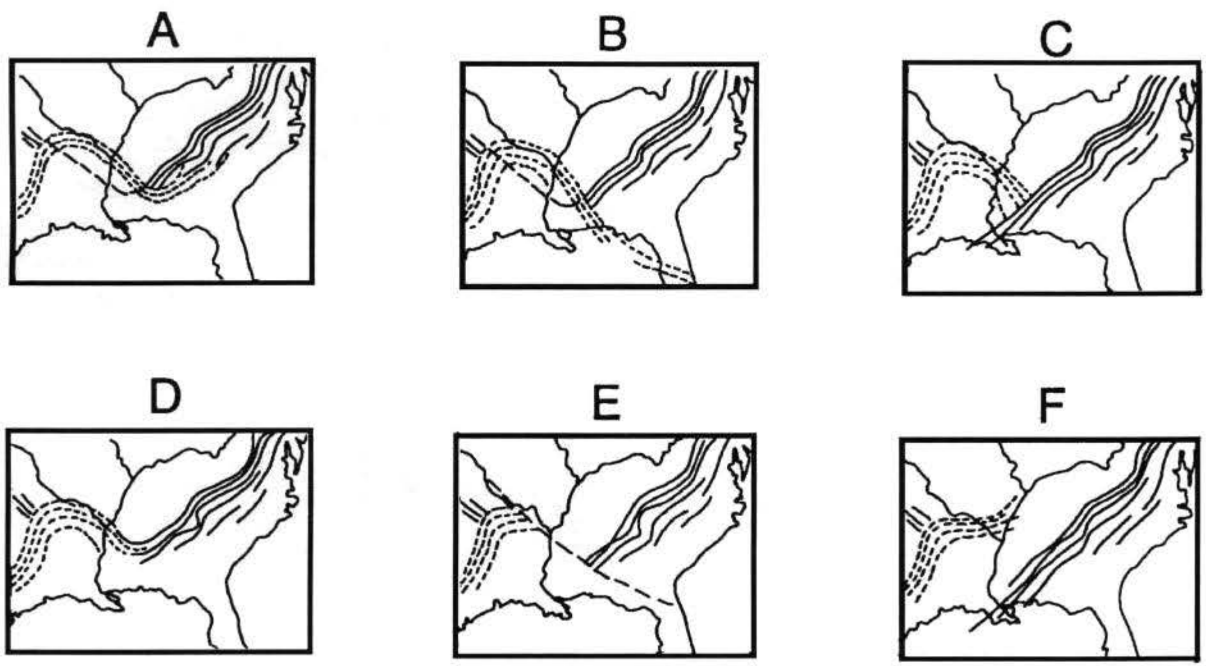

Figure 2. Panel of maps of previous theories of the junction of the Ouachitas and Appalachians. Modified from King (1950).

Cebull, S. E., D. H. Shurbet, G. R. Keller, and L. R. Russell, 1976, Possible role of transform faults in the development of apparent offsets in the Ouachita - southern Appalachian tectonic belt: Journal of Geology, v. 84, p. 107-114.

Based on plate tectonic models, Cebull et al. (1976) interpret the junction between the Ouachita and Appalachian tectonic belts as a "zone of offset." This zone consists of late Paleozoic transform faults along the late Precambrian - early Cambrian rifted continental margin of North America.

Cleaves, A. W., 1983, Carboniferous terrigenous clastic facies, hydrocarbon producing zones, and sandstone provenance, northern shelf of Black Warrior Basin: Gulf Coast Association of Geological Societies, Transactions, v. 33, p. 41-53.

Based on lithofacies mineral assemblages and net sand isoliths, Cleaves illustrates his thesis that Chesterian Mississippian clastics prograded into the Black Warrior Basin from the north-northwest (Illinois Basin/Ozark Uplift) followed by Morrowan Pennsylvanian Pottsville Formation clastics from the south-southwest (Appalachian-Ouachita orogenic belt).

Cleaves, A. W., and M. L. Broussard, 1980, Chester and Pottsville depositional systems, outcrop and subsurface in the Black Warrior basin of Mississippi and Alabama: Gulf Coast Association of Geological Societies, Transactions, v. 30, p. 49-59.

These authors illustrate a northern source for the Mississippian siliciclastics of the Black Warrior Basin, which displace Bangor carbonate deposits in north-central Alabama. These sediments are restricted to the Black Warrior shelf and do not reach the deep basin in east-central Mississippi (their figure 15). The sediment transport direction is then reversed 180 degrees to prograde the Pottsville to the north presumably across the deep, shale basin onto the Black Warrior shelf of northeast Mississippi - northwest Alabama.

Coleman, J. L., Jr., and H. A. Pohn, 1988, CSD's of the eastern United States, *in* J. L. Coleman, Jr., R. H. Groshong, Jr., K. F. Rheams, T. L. Neathery, and L. J. Rheams, Structure of the Wills Valley anticline - Lookout Mountain syncline between the Rising Fawn and Anniston CSD's, northeast Alabama: Alabama Geological Society 25th Annual Field Trip Guidebook, Tuscaloosa, Alabama, Plate 3.

This regional map illustrates, but does not explain the abrupt truncation of the Appalachians in east-central Mississippi along the Ouachita-Appalachian Juncture CSD. The authors infer that this truncation is due to structural changes associated with a deep-seated, basement fault.

Previous Theories

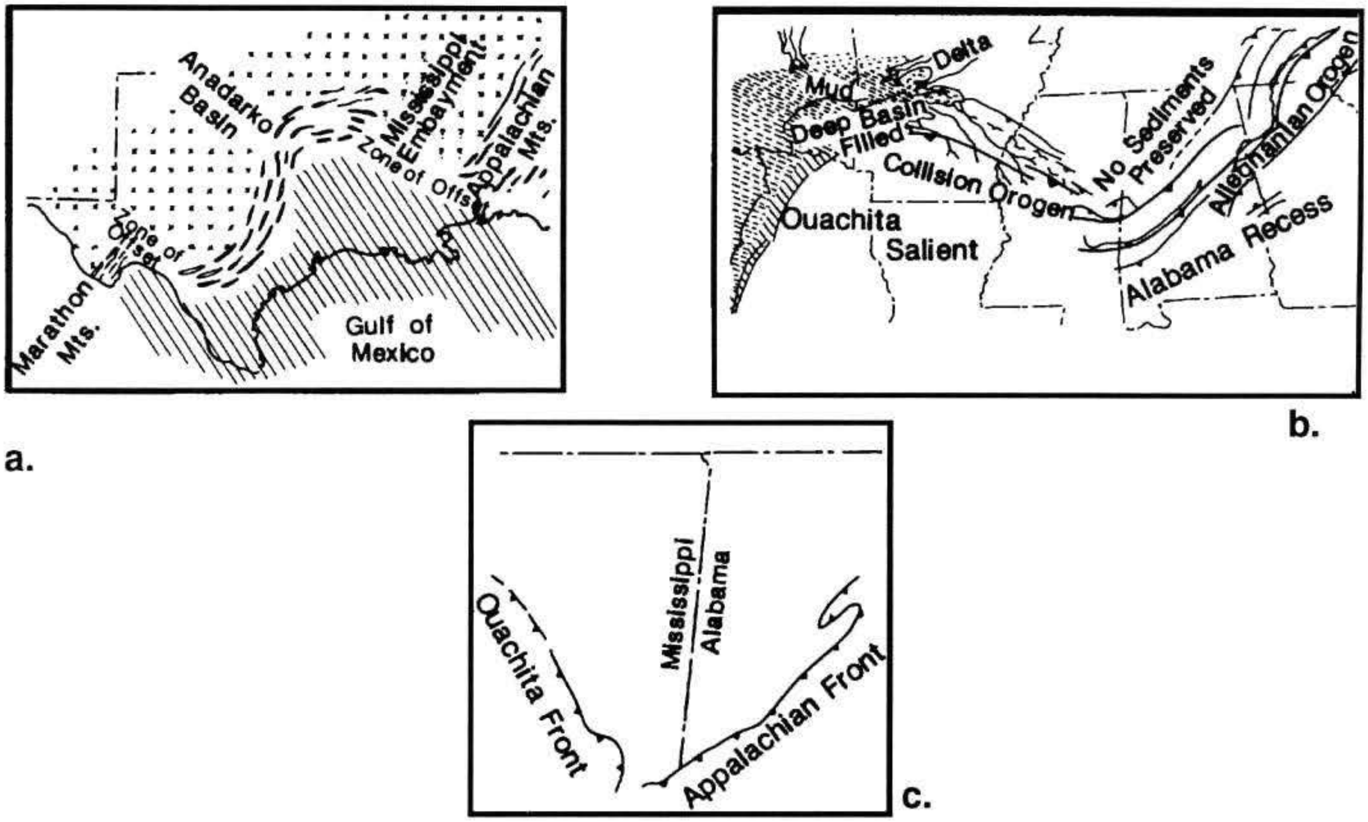

Figure 3. Panel of maps of previous theories of the junction of the Ouachitas and Appalachians. Modified from (a) Cebull et al. (1976), (b) Thomas (1985a), and (c) Welch (1978).

Denison, R. E., 1989, Foreland structure adjacent to the Ouachita foldbelt, *in* R. D. Hatcher, Jr., W. A. Thomas, and G. W. Viele, eds., The Appalachian-Ouachita Orogen in the United States: Boulder, Colorado, Geological Society of America, The Geology of North America, v. F-2, p. 681-688.

Denison (1989) discusses the variety of basins and uplifts peripheral to the Appalachian-Ouachita Orogen in terms of structural timing and parallelism (or lack thereof). Foreland sedimentary evidence indicates major thrusting began in late Pennsylvanian to early Permian time. A slightly older (?) (middle Pennsylvanian) period of down-to-the-south, basement faulting caused the Atoka Formation to thicken significantly on the south side of this trend. The Mississippi Embayment, the Southern Oklahoma aulacogen, and the Permian Basin, three transverse structural areas, have a much older and complex geologic history. Denison closes with a discussion of the difficulty in correlating the transverse foreland deformation directly to the Ouachita collision.

Dewey, J. F., and J. M. Bird, 1970, Mountain belts and the new global tectonics: Journal of Geophysical Research, v. 75, p. 2625-2647.

This is an early, seminal discussion of why mountain belts are the way they are. It accepts plate tectonics as a powerful, invisible, causal mechanism. The authors propose two mechanisms for mountain building: (1) island arc (Cordilleran), and (2) continent-continent or continent-island arc collision.

Ehrlich, R., 1965a, The geologic evolution of the Black Warrior detrital basin: Unpublished Ph.D. Dissertation, Louisiana State University, Baton Rouge, La., 64 p.

Ehrlich's dissertation concluded that sediments deposited in the Black Warrior Basin were derived from Ouachita Orogenic uplift in late Mississippian time in southern Mississippi and southeastern Alabama. This orogenic event extended farther east than obvious today and was cross-cut and offset by later Appalachian thrusting. These tectonic conclusions were based on north to south sedimentary facies changes.

Ehrlich, R., 1965b, Relative chronology of Ouachita and Appalachian tectonism in Alabama, *in* W. A. Thomas, ed., Structural development of the southernmost Appalachians: Alabama Geological Society 3rd annual field trip guide book, p. 29-30.

Based on mineral facies patterns, Ehrlich indicates that the upper Carboniferous was derived from uplift and erosion of a southern source terrane. He further states that the southern uplift was probably cross-cut by later Appalachian folding.

Erickson, P. D., 1986, Lineaments, geomorphology and tectonism in the southern Mississippi Embayment, Arkansas and Mississippi: Bulletin of the South Texas Geological Society, v. 27, p. 11-27.

Using photogeologic mapping, seismic and gravity-magnetic interpretation techniques, Erickson illustrates northwest verging thrust faults and folds in the southern Mississippi Embayment of east Arkansas - northwest Mississippi. He interprets these to be the result of northwestward, right lateral, transpressional faulting across central and northwestern Mississippi during the Ouachita Orogeny.

Ervin, C. P., and L. D. McGinnis, 1975, Reelfoot Rift: reactivated precursor to the Mississippi Embayment: Geological Society of America Bulletin, v. 86, p. 1287-1295.

Ervin and McGinnis discuss the complex history of the Reelfoot Rift, a zone of recurring normal and reverse faulting from latest Precambrian to the present. "The hypothesis presented here is intended to serve as a conceptual framework to guide and inspire the search for additional evidence" (p. 1294).

Feldman, M. I., 1989, Paleozoic framework of the Gulf of Mexico: West Texas Geological Society Publication No. 89-85, p. 199-204.

Feldman illustrates the tectonic deformation of the Mississippi-Alabama area as an area of NW transform faulting and drag folding in the Black Warrior Basin with clockwise, microcontinental plate rotation in (present-day) central Louisiana - southern Mississippi - eastern Texas during the late Atokan Pennsylvanian. Closure was focussed towards the NW into a NW-dipping subduction zone. This rotation adjacent to the transpressional margin may have produced a transtensional graben in (present-day) EC Mississippi and SW Alabama.

Flawn, P. T., A. Goldstein, P. B. King, and C. E. Weaver, 1961, The Ouachita system: Texas Bureau of Economic Geology, Publication 6120, University of Texas, Austin, Texas, 401 p.

Probably the most valuable resource material for Ouachita workers, this book contains abundant well stratigraphic data in the buried Ouachita trend of the ARKLAMISS area. More pertinent annotations are found in King (1961; below).

Graham, S. A., W. R. Dickinson, and R. V. Ingersoll, 1975, Himalayan-Bengal model for flysch dispersal in the Appalachian- Ouachita system: Geological Society of America Bulletin, v. 86, p. 273-286.

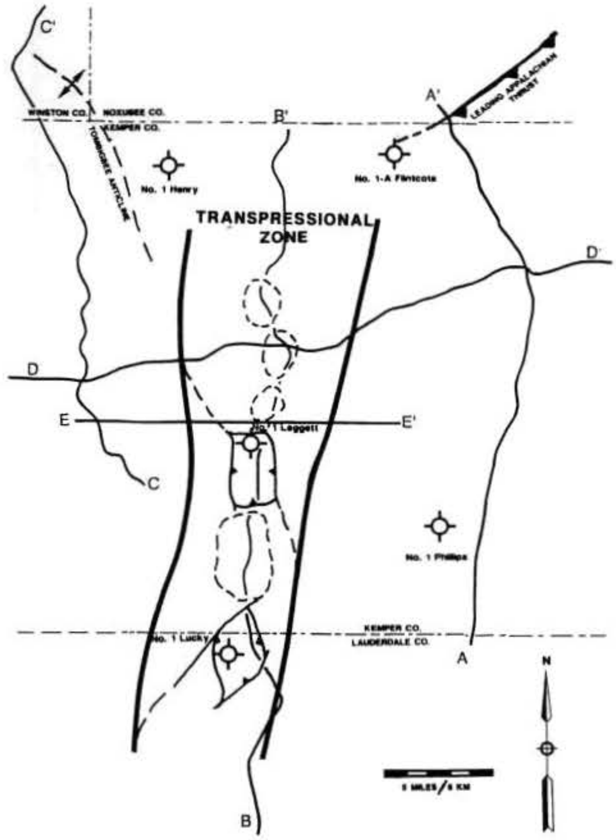

Figure 4. Location map for the study area in Kemper County, Mississippi. Seismic lines are illustrated in Hale-Erlich and Coleman (1993). The dashed or toothed ellipses are the anticlinal structures mapped within the Kemper County transpressional zone, which is outlined in heavy black lines. From Hale-Erlich and Coleman (1993).

Graham et al. compare the Appalachian-Ouachita orogenic belt with that of the Himalayas and associated orogenic systems of the northern Indian Ocean Basin. In this comparison of plate tectonic concepts, the Ouachita trend is shown offsetting the Appalachian structural trends.

Graham, S. A., R. V. Ingersoll, and W. R. Dickinson, 1976, Common provenance for lithic grains in Carboniferous sandstones from the Ouachita mountains and Black Warrior basin: Journal of Sedimentary Petrology, v. 46, p. 620-632.

Graham et al., in a companion paper to Graham et al. (1975; above) conclude that Ouachita and Black Warrior Basin graywackes have a common provenance to the south of these basins.

Hale-Erlich, W. S., J. L. Coleman, J. A. Lopez, and M. S.

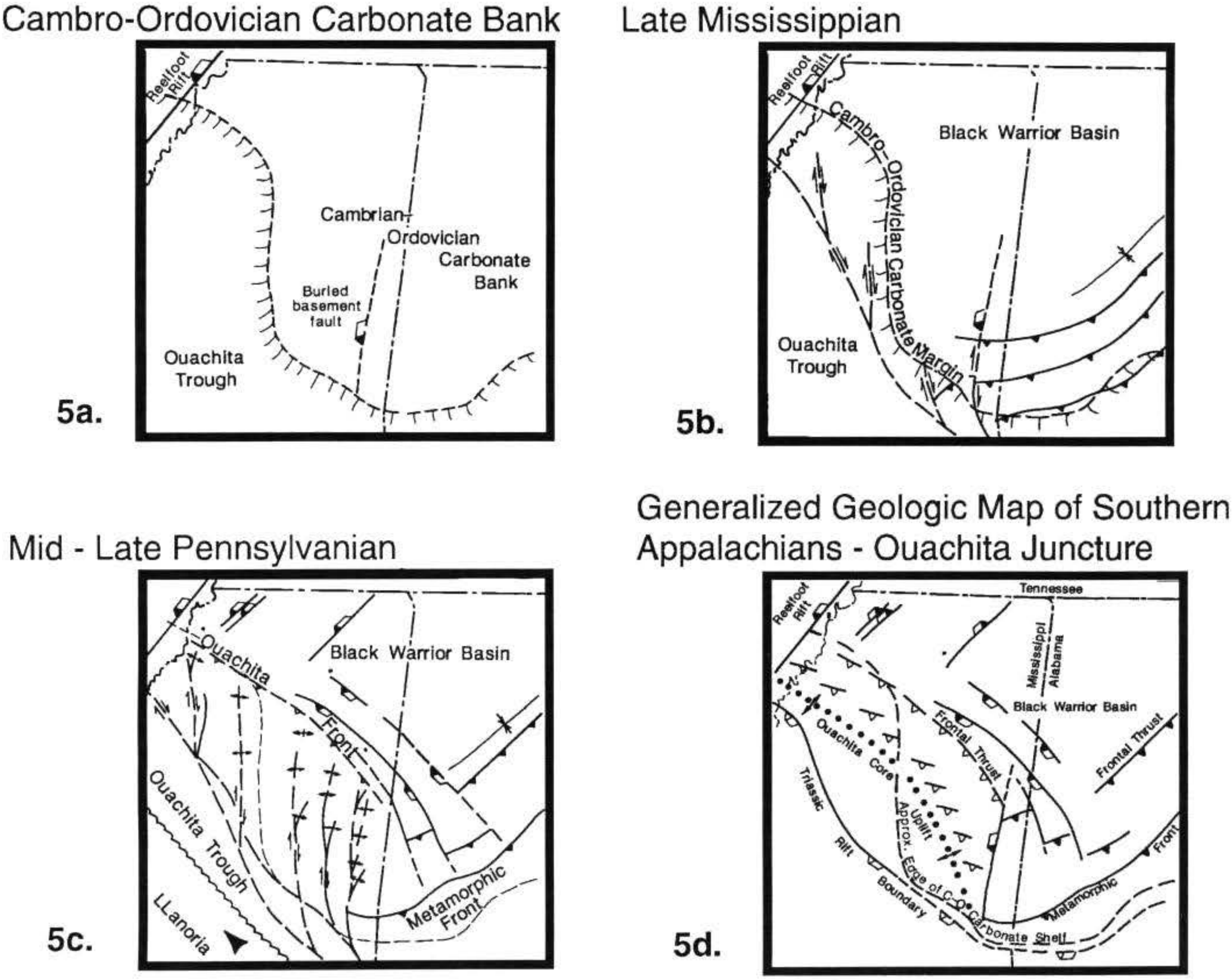

Figure 5. Schematic depiction of the paleotectonic evolution of the Black Warrior Basin. (a) Cambro-Ordovician carbonate bank developed on the Alabama Promontory, itself a product of late Precambrian continental rifting. (b) Onset of tectonic deformation, during late Mississippian; decollement thrusting began in SW Alabama at about the same time transpressional faulting began in central Mississippi, (c) Period of maximum tectonic deformation during middle to late Pennsylvanian. Continued normal faulting in Black Warrior Basin; offset of Appalachian fault trends by continued transpressional faulting; development of positive flower structures and Ouachita structural front. (d) Generalized tectonic map of Black Warrior Basin. Modified from Hale-Erlich et al. (1987).

Lober, 1987, The Ouachita-Appalachian Juncture: a Paleozoic transpressional zone (abs.): American Association of Petroleum Geologists Bulletin, v. 71, p. 563.

Using proprietary well, seismic, and gravity interpretations, Hale-Erlich et al. illustrated the Appalachian-Ouachita juncture as a north-south, right lateral, strike-slip fault zone in east-central Mississippi.

Harris, L. D., and R. C. Milici, 1977, Characteristics of thin-skinned style of deformation in the southern Appalachians, and potential hydrocarbon traps: U. S. Geological Survey, Professional Paper 1018, 40 p.

Harris and Milici present a well-illustrated and outcrop-constrained interpretation of classic Appalachian decollement structural styles in the southern Appalachians.

Hatcher, R. D., Jr., 1972, Developmental model for the southern Appalachians: Geological Society of America Bulletin, v. 83, p. 2735-2760.

This is an early attempt to synthesize the abundant tectono-stratigraphic data of the southern Appalachians into a sequential, evolutionary model. Specific arguments are focussed in E. Tennessee, W. North Carolina, South Carolina, and eastern Georgia.

Hatcher, R. D., Jr., 1989, Tectonic synthesis of the U. S. Appalachians, *in* R. D. Hatcher, W. A. Thomas, and G. W. Viele, eds., The Appalachian-Ouachita orogen in the United States: Boulder, Colorado, Geological Society of America, The Geology of North America, v. F-2, p. 511-535.

Hatcher's summary article interprets a 37 to 54% shortening in the southern Appalachians due to Alleghenian thrusting. This may be coincident with 10 to 50 km of strike-slip displacement in the Piedmont of the southern Appalachians.

Henk, F. H., Jr., 1983, Wrench fault origin of the Central Mississippi Uplift, Benton Uplift, and Black Warrior Basin and the consequential preservation of peninsula Florida (abs.): Geological Society of America, Abstracts with Programs, v. 15, p. 66.

Apparently from studying the structural style of the southern Appalachians and the Ouachitas, Henk (1983) concludes that the southern Appalachians were offset along right-lateral, strike-slip faults in the Black Warrior Basin and that the Central Mississippi and Benton Uplifts of Mississippi and Arkansas, respectively, were created by wrench faults. He cites analogs in the San Andreas system of California, the northern coast of Venezuela, the Sumatra Region of southwest Pacific, and the Val Verde - Devils River Uplift of southwest Texas.

Hines, R. A., Jr., 1988, Carboniferous evolution of the Black Warrior foreland basin, Alabama and Mississippi: Unpublished Ph.D. Dissertation, University of Alabama, Tuscaloosa, Alabama, 231 p.

Hines' study of the Black Warrior Basin, based on well stratigraphic and vitrinite data, concludes that the Black Warrior Basin subsidence was directly the result of Ouachita flexural foreland loading during the late Mississippian to early Pennsylvanian. He documents the presence of a cratonward migrating flexural bulge. This work was summarized by Hines and Thomas (1987; below).

Hines, R. A., and W. A. Thomas, 1987, Foreland basin evolution of the Black Warrior Basin (Carboniferous): Alabama and Mississippi: Proceedings Appalachian Basin Industrial Assoc., v. 13, p. 99-151.

Foreland basin subsidence began in late Mississippian at 4 cm/1000 yrs, increasing to 30 cm/1000 yrs by early Pennsylvanian times. Deepest burial occurred in the southwestern portion where maximum burial of 18,000 feet (at the Mississippian Tuscumbia Limestone level) is indicated by vitrinite reflectance data. This maximum burial was probably the result of thrust sheet emplacement, which ceased by 300 Ma. Regional uplift increased at that time and continued until the end of the Pennsylvanian. Stratigraphic relationships and subsidence history indicate that the Black Warrior Basin subsidence was related to Ouachita, rather than Appalachian, thrust loading. This material is presented also by Hines (1987) in Geological Society of America, Abstracts with Programs, v. 19, p. 89-90.

Horsey, C. A., 1981, Depositional environments of the Pennsylvanian Pottsville formation in the Black Warrior basin of Alabama: Journal of Sedimentary Petrology, v. 51, p. 799-806.

Horsey confirmed previous theses that most of the Pottsville of the Alabama Black Warrior Basin was derived from a southern source. Preliminary mapping indicated an eastern contribution for at least part of the upper Pottsville.

Houseknecht, D. W., 1986, Evolution from passive margin to foreland basin: the Atoka formation of the Arkoma basin, south-central U.S.A.: Special Publication of the International Association of Sedimentology, v. 8, p. 327-345.

Houseknecht discusses the evolution of the Ouachita Basin from a sedimentological point of view. He prefers a south- dipping subduction zone which developed in the early Mississippian and persisted until the Desmoinesian Pennsylvanian. Houseknecht also discusses the syn-depositional normal faults which developed in early Atokan Pennsylvanian time in eastern Oklahoma.

Howe, J. R., 1985, Tectonics, sedimentation, and hydrocarbon potential of the Reelfoot aulacogen: Unpublished Masters Thesis, University of Oklahoma, 109 p.

Howe uses proprietary CDP seismic profiles to interpret the geologic history of the Reelfoot Rift, a deep, early Paleozoic aulacogen (failed rift basin) beneath the modern Mississippi River alluvial plain. His work loosely ties together the local tectonics of the rift with the regional Ouachita compression, suggesting the northwest compression caused formation of new faults or reactivation of older faults. Reverse, wrench(?) faulting along the Axial Fault Zone continued after the Wolfcampian Permian to possibly the Leonardian, based on association with dated faulting in the Rough Creek Graben of western Kentucky. Howe's ideas about the genetic relationship between the tectonics of the Reelfoot Rift and the Ouachitas are not well illustrated.

Howe, J. R., and T. L. Thompson, 1984, Tectonics, sedimentation and hydrocarbon potential of the Reelfoot rift: Oil and Gas Journal, Nov. 12, p. 179-190.

This article is a published summary of Howe (1985; above), including his key seismic lines.

Jurick, D. M., 1989, Basement structure of the north-central Gulf Coastal Plain, Mississippi and Alabama: Unpublished Masters Thesis, University of Texas at El Paso, El Paso, Texas, 177 p.

Jurick used seismic, gravity, magnetic, and well stratigraphic data to analyze the buried Ouachita trend in Mississippi and Alabama. Jurick incorporated Thomas's (1985a)

interpretation into his geophysical interpretation (figure 36) showing truncation of the Ouachita structures by Appalachian structures. He further discusses the difficulty in correlating the Ouachita gravity signature of Arkansas with the gravity response in Mississippi.

Keller, G. R., and S. E. Cebull, 1973, Plate tectonics and the Ouachita system in Texas, Oklahoma, and Arkansas: Geological Society of America Bulletin, v. 83, p. 1659-1666.

Keller and Cebull apply a cordilleran-type plate tectonic model to the Ouachita system. This model implies Paleozoic and possibly Mesozoic spreading centers in the region of the present Gulf of Mexico. This model was consistent with the chronology of events for the area and somewhat suggested by sparse gravity and other geophysical data. Their model suggests that the Ouachitas are a lateral continuation of the Appalachians.

Keller, G. R., E. G. Lidiak, E. G. Hinze, and L. W. Braile, 1983, The role of rifting in the tectonic development of the midcontinent, USA, *in* P. Morgan and B. H. Baker, eds., Processes of continental rifting: Tectonophysics, v. 94, p. 391-412.

Keller et al. indicate that the southern continental margin of North America formed as an Eocambrian rift zone oriented NW-SE (present day).

Kidd, J. T., 1975, Pre-Mississippian subsurface stratigraphy of the Warrior Basin in Alabama: Gulf Coast Association of Geological Societies, Transactions, v. 25, p. 20-39 (reprinted as Geological Survey of Alabama Reprint Series 47).

Kidd's regional structural contour map on the top of the Knox Group illustrates the northwest-verging thrusted nature of the Pickens-Sumter Anticline.

King, P. B., 1950, Tectonic framework of the southeastern United States: American Association of Petroleum Geologists Bulletin, v. 34, p. 635-671.

This work documents the six prevailing theories (in 1950 and since) on the juncture between the Appalachians and the Ouachitas. King prefers a Ouachita overprinting/overthrusting(?) of the Appalachians, with the Ouachita facies continuing on into the Appalachians as the Talledega Group(?). He concludes that the right-lateral offset of the Ouachitas from the Appalachians has "been disproved by drilling" (p. 666).

King, P. B., 1961, The subsurface Ouachita structural belt east of the Ouachita mountains, *in* P. T. Flawn, A. Goldstein, P. B. King, and C. E. Weaver, The Ouachita system: Texas Bureau of Economic Geology, Publication 6120, p. 83-98 and Plate 3.

This section of Flawn et al. (1961; above) contains data and interpretation of the buried Ouachita trend in Mississippi and eastern Arkansas and frequently forms the nucleus of more recent studies. Interpretation of well (point) data is made using a Bouguer gravity anomaly map and shows the Ouachita structural front truncating the Appalachian structural front.

King, P. B., 1975, Ancient southern margin of North America: Geology, v. 3, p. 732-734.

These self-professed speculations, a "Sunday afternoon doodle," record King's summary thoughts on nearly 40 years of work in this area.

King, P. B., 1977, The evolution of North America (revised edition): Princeton University Press, Princeton, 197 p.

Perhaps more appropriately entitled "Memoirs of the Geology of North America," King's seminal work summarizes his concepts on the stratigraphic and tectonic evolution of the Appalachian and Ouachita orogens. King considers the relationship between the Ouachita and Appalachian systems the "greatest puzzle" (p. 73), which remains "uncertain, because of wide spacing of well control in the critical areas" (p. 73). He concludes that either the Appalachians change sedimentary facies into the Ouachitas or the Ouachitas are thrust over the Appalachians.

Kluth, C. F., and P. J. Coney, 1981, Plate tectonics of the ancestral Rocky Mountains: Geology, v. 9, p. 10-15.

These authors interpret the ancestral Rocky Mountains as intracratonic block uplifts that formed as a result of the collision of North America with South America - Africa during the Ouachita-Marathon Orogeny. The focal paths for compression appear to be concentrated through the Southern Oklahoma aulacogen and the Val Verde Basin.

A. G. Goldstein, Kluth and Coney (Geology, v. 9, p. 387-389) present a discussion and reply on this article. Of interest here is the comment of Kluth and Coney (p. 388-389), "We concluded that the present evidence favors a collisional model, and we proceeded with that model as an assumption .... We never intended to show that a collision occurred or to deal with the details of the collision, because our work did not address that problem."

Lefort, J.-P., and R. Van der Voo, 1981, Kinematic model for the collision and complete suturing between Gondwanaland and Laurussia in the Carboniferous: Journal of Geology, v. 89, p. 537-550.

Lefort and Van der Voo compiled tectonic maps of western Europe, northern Africa, and eastern North America from geological and geophysical data to illustrate the major Middle to Late Carboniferous strike-slip fault zones of Gondwana and Laurussia.

Lillie, R. J., K. D. Nelson, B. de Voogd, J. A. Brewer, J. E. Oliver, L. O. Brown, S. Kaufman, and G. W. Viele, 1983, Crustal structure of the Ouachita Mountains, Arkansas: a model based on integration of COCORP reflection profiles and regional geophysical data: American Association of Petroleum Geologists Bulletin, v. 67, p. 907-931.

This COCORP group report illustrates the moderate and deep seismic structure of the western Arkansas Ouachita Mountains. A strong reflector, correlated with the shallow water Cambro-Ordovician Arbuckle carbonate section, dips southward to a point of non-resolution between the Benton Uplift (i.e., Ouachita core) at an estimated depth of 12 to 15 km. The Benton Uplift is interpreted to be a post-thrusting, basement-involved uplift of the North American continental margin, "analogous to other basement uplifts along the Ouachita trend in Texas" (p. 926). Interpretations from magnetic and gravity data are consistent with the seismic interpretation.

Link, M. H., and M. T. Roberts, 1986, Pennsylvanian paleogeography for the Ozarks, Arkoma and Ouachita basins in east-central Arkansas, *in* C. G. Stone and D. B. Haley, eds., Sedimentary and igneous rocks of the Ouachita mountains of Arkansas, Pt. 2: Arkansas Geological Commission, Guidebook 86-3, p. 37-60.

Link and Roberts discuss the Pennsylvanian sedimentation in the Ouachita Basin, primarily in Arkansas. Their paleogeographic reconstructions, in the form of Roberts' exceptional, three- dimensional diagrams, show emergent confluence of the eastern Ouachitas and southern Appalachians in south-central Mississippi. The Morrowan Pennsylvanian thrust belt becomes submergent along the present-day Arkansas-Louisiana border about halfway between Mississippi and Texas, and then completely emergent by Desmoinesian Pennsylvanian time.

Lowe, D. R., 1985, Ouachita trough: part of a Cambrian failed rift system: Geology, v. 13, p. 790-793.

Based on facies successions and lithologic assemblages, Lowe suggests that the incipient Black Warrior Basin was a failed, Cambrian rift, oriented northwest-southeast, separating the north Mississippi-Alabama Black Warrior shelf on the northeast from a distended, continental fragment to the southwest. As such, the true, passive continental margin for southern North America lay south of this microcontinental block, in present-day southern Louisiana. This microcontinent was the potential site for the southerly-derived sediments found throughout the Cambrian to Pennsylvanian section in the Ouachita Basin.

Mack, G. H., W. C. James, and W. A. Thomas, 1981, Orogenic provenance of Mississippian sandstones associated with southern Appalachian-Ouachita orogen: American Association of Petroleum Geologists Bulletin, v. 65, p. 1444-1456.

Mack et al. illustrate a southern provenance for the Mississippian siliciclastics of the Black Warrior Basin.

Mack, G. H., W. A. Thomas, and C. A. Horsey, 1983, Composition of Carboniferous sandstones and tectonic framework of southern Appalachian-Ouachita orogen: Journal of Sedimentary Petrology, v. 53, p. 931-946.

Mack et al. demonstrate that two Carboniferous converging clastic wedges deposited siliciclastics in the Black Warrior Basin. A NE-prograding wedge deposited material from late Meramecian Mississippian to early Pennsylvanian (Pottsville) time, whereas a southwestward prograding wedge was active from latest Chesterian Mississippian to early Pennsylvanian time. Provenance studies suggest that a complex source terrane was produced by a collision of the Alabama promontory with an arc complex or a microcontinent and associated continental-margin arc.

Mellen, F. F., 1947, Black Warrior Basin, Alabama and Mississippi: American Association of Petroleum Geologists Bulletin, v. 31, p. 1801-1816.

This is the initial published report on the Black Warrior Basin of Alabama and Mississippi as a triangular-shaped basin of thick Paleozoic strata. There is little discussion of regional structural geology.

Mellen, F. F., 1974, Possible Ordovician carbonate reservoirs in Mississippi: American Association of Petroleum Geologists Bulletin, v. 58, p. 870-876.

In this discussion, Mellen illustrates the general structure of the Black Warrior Basin and outcrops/subcrops of Ordovician strata peripheral to the basin.

Mellen, F. F., 1977, Cambrian System in Black Warrior Basin: American Association of Petroleum Geologists Bulletin, v. 61, p. 1897-1900.

Mellen discusses three deep wells in the Black Warrior Basin of Mississippi and Alabama which bottom in basement or near basement strata.

Morgan, J. K., 1970, The Central Mississippi Uplift: Gulf Coast Association of Geological Societies, Transactions, v. 20, p. 91-109.

This is apparently the only detailed, published report on the Central Mississippi Uplift (or Neshoba Ridge), a structurally high and complex area, with vertical displacement of at least 10,000 feet. There are few significantly deep penetrations on this uplift, so a complete understanding of its stratigraphic history and structural origins are still uncertain. Four moderately poor seismic lines are presented. Morgan determines that differentiating the stratigraphy of the Devonian to Cambrian carbonate sequence is extremely difficult to do with well cuttings. Morgan concludes that the Central Mississippi Uplift is not related to either the Appalachian or Ouachita structural trends, since it occurred after the thrust belts formed. He also suggests that the Appalachian and Ouachita trends were inactive at the time of the uplift.

Morris, R. C., 1974, Sedimentary and tectonic history of the Ouachita Mountains: Society of Economic Paleontologists and Mineralogists, Special Publication 22, p. 120-142.

Morris presents a thorough summary of Paleozoic sedimentation with a sequential paleotectonic model to explain the development and closure of the Ouachita Basin. He favors a north-dipping subduction zone, which died out about present-day panhandle Florida in middle Mississippian time. This subduction zone ceased completely by early Pennsylvanian time. Initial sea-floor spreading began in early Pennsylvanian time and continued through the Jurassic.

Nicholas, R. L., and R. A. Rozendal, 1975, Subsurface positive elements with the Ouachita foldbelt in Texas and their relation to the Paleozoic cratonic margin: American Association of Petroleum Geologists Bulletin, v. 59, p. 193-216.

This comprehensive report of Shell Oil Company's exploration seismic and drilling data in the buried Ouachita foldbelt of Texas documents the structural nature of the Devil's River and Waco Uplifts. These two uplifts are interpreted to be "external massifs" similar to the Green Mountains - Blue Ridge basement uplifts of the Appalachians. Isotopic data indicate that both uplifts had an early to middle Paleozoic origin. Precambrian age Rb-Sr dates were recovered from the basement rocks coring the Devil's River Uplift (Shell #1 Stewart, Val Verde Co., Texas), whereas the Waco Uplift basement core was dated at approximately 350 m.y. (Rb-Sr) (Shell #1 Barrett, Hill Co., Texas).

Nicholas, R. L., and D. W. Waddell, 1989, The Ouachita system in the subsurface of Texas, Arkansas, and Louisiana, *in* R. D. Hatcher, Jr., W. A. Thomas, and G. W. Viele, eds., The Appalachian-Ouachita orogen in the United States: Boulder, Colorado, Geological Society of America, The Geology of North America, v. F-2, p. 667-672.

Nicholas and Waddell document the presence of early Carboniferous volcanic rocks in northern Louisiana, overlain by undeformed(?) post-Atokan Pennsylvanian to Permian carbonates of an "episutural (successor) basin," now buried beneath Mesozoic and Tertiary rocks of the Gulf Coastal Plain.

Niem, A. R., 1976, Patterns of flysch deposition and deep-sea fans in the lower Stanley Group (Mississippian), Ouachita Mountains, Oklahoma and Arkansas: Journal of Sedimentary Petrology, v. 46, p. 633-646.

Niem's report on the Stanley Group sediments and volcaniclastics of the southern Ouachitas of Arkansas and Oklahoma indicates that the siliciclastic sediments came into the Ouachita Basin from the south or southeast. This unit has not been recognized in the Black Warrior Basin of Mississippi and Alabama.

Niem, A. R., 1977, Mississippian pyroclastic flow and ashfall deposits in the deep-marine Ouachita flysch basin, Oklahoma and Arkansas: Geological Society of America Bulletin, v. 88, p. 49-61.

This companion paper to Niem (1976; above) discusses the volcaniclastic and volcanic deposits of the Stanley Group of Oklahoma and Arkansas. As with the siliciclastic sediments discussed above, the volcanic sediment apparently came from the southeast. No volcanic center of late Mississippian age is known to the southeast of the Ouachitas. The closest possible center for volcanic activity is the Sabine Uplift of northwest Louisiana.

Paulson, O. L., Jr., 1970, Wrench faulting as a trigger mechanism for interior salt ridges of Mississippi, *in* J. L. Rau and L. F. Dellwig, eds., Third Symposium on Salt, v. 1: Northern Ohio Geological Society, Cleveland, p. 283-285.

Paulson suggests that middle to late Pennsylvanian Ouachita wrench faulting constrained Mesozoic salt deposition and later deformation into an apparent wrench-fault structural configuration.

Paulson, O. L., Jr., 1974, Wrench fault forms gulf producing structures: Oil and Gas Journal, Dec. 9, p. 115-116.

Based on a study of salt ridges and associated grabens in SW Alabama and SE Mississippi, Paulson concludes that the best explanation for the left- (northwest) stepping anticlines is they are set up by a right-lateral wrench fault. Paulson does not conclude that this Mesozoic wrench fault might be a reactivation of an older Paleozoic wrench fault, but does suggest that explorationists look at the Paleozoic Wichita megashear where it crosses the Gulf Coastal Plain for possible analogous salt structures.

Pindell, J. L., 1985, Alleghenian reconstruction and subsequent evolution of the Gulf of Mexico, Bahamas, and Proto-Caribbean: Tectonics, v. 4, p. 1-40.

Pindell produces one of the best constrained and detailed models for the evolution of the Gulf of Mexico, Bahamas, and proto-Caribbean from initial Alleghenian suturing to the present day. This reconstruction places a number of small, microcontinental plates within the present Gulf of Mexico basin (i.e., Yucatan, Wiggins Arch, Sabine Uplift, etc.). Pindell identifies all pre-Mesozoic continental crust, restores this crust to near original thickness, and retracts, where possible, post-Permian offsets.

Ross, C. A., 1979, Late Paleozoic collision of North and South America: Geology, v. 7, p. 41-44.

Using paleobiogeographic, stratigraphic, structural, and regional tectonic data, Ross concludes that the classic Wegener fit placing South America opposite the Ouachita-Marathon orogenic belt is valid. Closure was reached during Pennsylvanian and earliest Permian time through a "series of complex events." The collision was completed during latest Pennsyl-

vanian in the Ouachita region and before middle Early Permian in the Marathon region.

Ross, C. A., 1986, Paleozoic evolution of the southern margin of the Permian Basin: Geological Society of America Bulletin, v. 97, p. 536-554.

Ross illustrates the Mississippi Ouachita orogenic belt as a zone of possible transform faulting, with the main (orthogonal) Gondwanan closure against east Texas.

Royden, L. H., B. C. Burchfiel, H. Ye, and M. S. Schuepback, 1990, The Ouachita-Appalachian thrust belt: orogeny without collision (abs.): Geological Society of America, Abstracts with Programs, v. 22, no. 7, p. A112.

Based on its lack of high mountains, thickened crust, or structural and sedimentological features which are typical of "true collisional mountain belts such as the Appalachians, western Alps, and Himalayas," the Ouachita-Marathon thrust belt is interpreted to be "typical of incompletely collided or accreted boundaries" such as the Apennine and East Carpathian orogens of Mediterranean Europe. Based on structural terrane comparative analysis with the Mediterranean belts, the Ouachita-Marathon belt developed as an accretionary wedge during southward subduction of North America coeval with a Permo-Pennsylvanian extensional back-arc basin in east Texas and northern Louisiana.

Ryder, R. T., 1987, Oil and gas resources of the Black Warrior Basin, Alabama and Mississippi: U. S. Geological Survey, Open-File Report 87-450X, 23 p.

Ryder, using nearly 15 to 20 year old data, pictures the Appalachians overthrusting the Ouachita thrust belt.

Sachnik, F. L., and R. D. Moore, 1983, Southern Appalachians folding and faulting, *in* A. W. Bally, ed., Seismic expressions of structural styles: American Association of Petroleum Geologists, Studies in Geology No. 15, v. 3, p. 3.4.1-79.

This paper illustrates the seismic structural style of the southwesternmost Appalachians as well as the inferred seismic stratigraphic character and the depth to Precambrian basement of 28,000 to 29,000 feet along the Mississippi-Alabama border.

Shaw, C. E., 1976, Large-scale recumbent folding in the Valley and Ridge province of Alabama: Geological Society of America Bulletin, v. 87, p. 407-418.

Shaw theorizes that in a large area of the southern Appalachians of Alabama, folding occurred during three stages: (1) NW-directed recumbent folding in early Mississippian time; (2) refolding about upright NE-trending axes in Pennsylvanian or later time; and (3) broad arching and rotation of structures, after event #2. Shaw discusses the style of folding in SC Alabama in terms of nappe tectonics.

Tanner, W. F., 1963, Tetonic [sic] patterns in the Appalachian-Ouachita-Oklahoma mountain complex: Shale Shaker, v. 14, p. 2-6.

This unusual report is based on "several fundamental assumptions, a great deal of scale-model work, and field experience in the areas studied" (p. 2). Tanner concludes that the Appalachians were deformed primarily by left-lateral strike slip (as a result of north-south compression) and the Ouachitas were created during a "sharp, short interval of mountain-making" by a combination of drag-folding and counter-clockwise rotation. These conclusions allow "no room for ... long-distance low-angle thrusting" (p. 6). Tanner abandoned the thrust-sheet hypothesis because of "his inability to produce convincing model thrusts" (p. 6). He does suggest that the southern Appalachians were dextrally offset by strike slip motion along the Central Mississippi Uplift.

Thomas, W. A., 1965, Ouachita influence on Mississippian lithofacies in Alabama, *in* W. A. Thomas, ed., Structural development of the southernmost Appalachians: Alabama Geological Society 3rd annual field trip guide book, p. 23-28.

This is, perhaps, Thomas's first report of the control by an active southern orogenic belt on Mississippian lithofacies distribution in Alabama and Mississippi.

Thomas, W. A., 1972, Regional Paleozoic stratigraphy in Mississippi, between the Ouachita and Appalachian mountains: American Association of Petroleum Geologists Bulletin, v. 56, p. 81-106.

This early synthesis of the stratigraphy of the Ouachita trend in Mississippi contains much of the specific data and interpretations which form the basis for Thomas's later work. Thomas concludes that the lower Paleozoic shallow-water carbonates of the Black Warrior Basin abruptly grade southwestward into a deep-water undifferentiable shale facies along a steep platform edge. The Devonian overlaps the older deep-water facies as well as the shallow-water platform carbonates. The Mississippian-Pennsylvanian is dominantly an eastwardly regressive unit which built out from the southwest. The deep-water Carboniferous is separated from the shallow-water Carboniferous also by an abrupt platform-edge boundary which extended north-northwest from central Mississippi.

Thomas's figure 3 illustrates his thesis that the Appalachian stratigraphic and structural domain is thrust over the Ouachita facies of central Mississippi.

This article provoked a rather invigorating discussion from F. F. Mellen and S. W. Welch (American Association of Petroleum Geologists Bulletin, v. 56, p. 2457-2463). Mellen felt that Thomas had neglected some key individual well data in developing his conclusions. Thomas replied that his arguments were based on a regional pattern which was generally independent of individual well idiosyncracies. Welch reiterated his thesis that the sandstones of the Black Warrior Basin had a northern rather than a southern source and are more

closely related to the similar sequence in the Illinois Basin. Thomas replied with a discussion of the formal stratigraphic confusion in the Carboniferous of the Black Warrior Basin and the evidence for a southwestern source for the Parkwood.

The following articles which discuss the same theme are updated reports which incorporate new data and only slightly refined interpretations.

Thomas, W. A., 1973, Southwestern Appalachian structural system beneath the Gulf Coastal Plain: American Journal of Science, Cooper Volume, v. 273-A, p. 372-390.

In this article, Thomas expands his 1972 structural geologic map of the Paleozoic of the subsurface Gulf Coastal Plain to include Alabama as well as Mississippi. Additional wells are incorporated which only slightly modify Thomas, 1972, figure 3. Of key significance is the depiction of the Pickens-Sumter thrusted anticline trend in northern Sumter County, Alabama, and eastern Kemper and southern Noxubee counties, Mississippi (figure 4). His preferred interpretation (figure 4) shows Appalachian folds overthrusting Ouachita structure. In offering an alternative interpretation, Thomas (figure 6) depicts the Ouachita-Appalachian juncture as a right-lateral strike-slip fault zone striking generally north-south through eastern Newton and Neshoba counties, Mississippi. A "companion" left-lateral fault strikes slightly east of north through eastern Kemper and Lauderdale counties. The two strike-slip fault zones separate eastern and western thrust terranes and pre-Pennsylvanian stratigraphy from a central area of Pennsylvanian strata and no apparent thrusting.

Thomas, W. A., 1974, Converging clastic wedges in the Mississippian of Alabama: Geological Society of America, Special Paper 148, p. 187-207.

Thomas discusses the convergence of Mississippian clastics from the southwest (Ouachitas) and east (Appalachians) into the Black Warrior Basin of Alabama.

Thomas, W. A., 1976, Evolution of the Ouachita-Appalachian continental margin: Journal of Geology, v. 84, p. 323-342.

Thomas discusses a tectonic history of the Appalachian-Ouachita continental margin, inferred from the distribution and succession of Paleozoic sedimentary facies. Original curvature of the Appalachian-Ouachita belt in Mississippi and Arkansas is due to a Precambrian transform faulted, continental margin, rather than a late Paleozoic collision producing the present curvature.

Thomas, W. A., 1977a, Structural and stratigraphic continuity of the Ouachita and Appalachian mountains, *in* C. Stone, ed., Symposium on the Geology of the Ouachita Mountains: Arkansas Geological Commission, v. 1, pt. 2, p. 9-24.

Thomas illustrates a degree of stratigraphic continuity which exists in the outcrops of the Ouachitas of Arkansas and the Appalachians of Alabama, and which persists into the subsurface of Mississippi.

Thomas, W. A., 1977b, Evolution of Ouachita-Appalachian salients and recesses from reentrants and promontories in the continental margin: American Journal of Science, v. 277, p. 1233-1278.

This "monumental" study discusses the stratigraphic evolution of the Appalachians and Ouachitas in a tectono-stratigraphic sense from Precambrian continental rifting to Pennsylvanian-Permian collision and mountain building. Thomas's discussion incorporates the Paleozoic geologic history of eastern United States from Newfoundland to west Texas. In doing so, he develops the concepts of salients (or structural embayments) and recesses (or structural promontories) which controlled initial Precambrian continental breakup, Paleozoic sedimentation, and late Paleozoic collisional structural style. The initiating mechanism for these salients and recesses was probably transform faults which developed during the Late Precambrian rifting episode. Thomas names the "Alabama Promontory."

This report prompted discussions from and replies to H. Williams and B. Doolan (American Journal of Science, v. 279, p. 92-96). In a turnabout, Williams and Doolan offer supporting evidence from Newfoundland and Quebec and a request to cease use of the terms "recess" and "salient." Thomas's reply discusses how reentrants are not necessarily salients and promontories are not necessarily recesses because continental margins are not the same as orogenic belts.

Thomas's interpretation of the Mississippi-Alabama area (figure 9) is generalized from Thomas (1973, figure 4) and illustrates Pennsylvanian depositional patterns and depositional directions.

Thomas, W. A., 1979, Carboniferous tectonic framework of the continental margin of southeastern North America: 9th International Carboniferous Stratigraphic and Geologic Congress, Proc., v. 3, p. 291-302.

Thomas discusses a common provenance for Ouachita and Black Warrior Basin sediments, which existed as an orogenic uplift along a converging continental margin to the south. This common provenance contributed sediment from Meramecian Mississippian to Atokan Pennsylvanian times. Additional sediment, transported southward from the Illinois Basin, reached the Ouachita Basin by the beginning of the Pennsylvanian. Clastic sediment entered the Black Warrior shelf area from the east (present-day Tennessee). The composite suite of clastics resulted from the convergence of clastic wedges.

Thomas, W. A., 1985a, The Appalachian-Ouachita connection: Paleozoic orogenic belt at the southern margin of North America: Annual Reviews of Earth and Planetary Science, v. 13, p. 175-199.

This is an editor-requested summary paper which brings

together the concepts of a structural grain imparted to the continental margin by Precambrian rifting; a southern source area for the Carboniferous sediments of the Black Warrior Basin; and Appalachian overthrusting of Ouachita structures. Regional cross sections (figures 2 and 3) illustrate major down-to-the south (or southeast) basement faults which later focussed basal thrust detachments upward into imbricate sheets.

Thomas, W. A., 1985b, Northern Alabama sections, *in* N. B. Woodward, ed., Valley and Ridge thrust belt: balanced structural sections, Pennsylvania to Alabama: Appalachian Basin Industrial Association/University of Tennessee Department of Geological Sciences Studies in Geology 12, p. 54-61.

This collection of cross sections illustrates best the variation in structural styles of the southern Appalachians of Alabama.

Thomas, W. A., 1986, Evolution of subsurface Appalachian-Ouachita fold-thrust belt beneath Gulf Coastal Plain (abs.): American Association of Petroleum Geologists Bulletin, v. 70, p. 655.

Thomas summarizes the evolution of the Appalachian-Ouachita orogen in subsurface Mississippi as (1) initial thrusting along the Ouachita structural front during the Mississippian, (2) progression of thrusting westward to the Ouachita outcrop area by Pennsylvanian times, and (3) thrusting in the southern Appalachian area during the Pennsylvanian. This sequence is derived from clastic-wedge stratigraphy and structural geometries.

Thomas, W. A., 1988a, The Black Warrior basin, *in* L. L. Sloss, ed., Sedimentary cover - North American craton; U. S.: Boulder, Colorado, Geological Society of America, The Geology of North America, v. D-2, p. 471-491, Plate 8.

In this detailed summary report, Thomas reprises his thesis of a southern source for the Black Warrior Basin Carboniferous clastic section, plus his stratigraphic interpretation for the Cambro-Ordovician carbonate section, citing previously unpublished paleontologic control. This article is an excellent companion to Thomas (1989; below).

Thomas, W. A., 1988b, Stratigraphic framework of the geometry of the basal decollement of the Appalachian-Ouachita fold-thrust belt: Geologische Rundschau, v. 77, p. 183-190.

Thomas examines the geometry of the basal detachment of the Appalachian-Ouachita orogenic belt and finds that five distinct configurations are systematically distributed along the trend. Variations in the geometry reflect changes in lithology as well as changes in regional structural position among promontories and embayments.

Thomas, W. A., 1989, The Appalachian-Ouachita orogen beneath the Gulf coastal plain between the outcrops in the Appalachian and Ouachita Mountains, *in* R. D. Hatcher, W. A. Thomas, and G. W. Viele, eds., The Appalachian-Ouachita orogen in the United States: Boulder, Colorado, Geological Society of America, The Geology of North America, v. F-2, p. 537-553, Plate 8.

This article, modified from Thomas (1985a; above) with accompanying map, "Tectonic map of the Ouachita Orogen" (plate 8), illustrates Thomas's most recent data and interpretation of the Black Warrior Basin and the Ouachita-Appalachian convergence in central Mississippi. By comparing stratigraphic succession, he interprets that east-west Appalachian thrust faults override northwest trending Ouachita thrust faults. This conclusion is based on a number of wells (as depicted in map view), but is illustrated in cross section view with only two wells, one of which is projected into the plane of section from approximately 10 km away.

Thomas, W. A., 1991, The Appalachian-Ouachita rifted margin of southeastern North America: Geological Society of America Bulletin, v. 103, p. 415-431.

In this paper, Thomas discusses the origin of the Precambrian structural grain of the southern United States. In particular the major continental shelf - ocean basin boundary in subsurface Mississippi was formed by right-lateral strike slip faulting along the Alabama-Oklahoma transform.

Thomas, W. A., and D. B. Bearce, 1969, Sequatchie Anticline in north-central Alabama, *in* W. G. Hooks, ed., The Appalachian structural front in Alabama: Alabama Geological Society 7th annual field trip guide book, p. 26-43.

This early report is one of the first discussions of the subsurface extent of the southern Alabama structural trends into easternmost Mississippi. Well data from three deep wells were used to define the Pickens-Sumter Anticline near the Noxubee-Kemper-Sumter counties corner. Based on asymmetrical stratigraphic horizon dip rates, Thomas and Bearce concluded that the Pickens-Sumter Anticline was probably a thrust-cored anticline similar to the exposed Sequatchie Anticline in northeastern Alabama - southeastern Tennessee.

Thomas, W. A., and G. H. Mack, 1982, Paleogeographic relationship of a Mississippian barrier-island and shelf-bar system (Hartselle sandstone) in Alabama to the Appalachian-Ouachita orogenic belt: Geological Society of America Bulletin, v. 93, p. 6-19.

Thomas and Mack interpret south-derived Mississippian clastic sedimentation originating from the area of the conjunction of the Appalachians and Ouachitas in east-central Mississippi.

Thomas, W. A., and T. L. Neathery, 1980, Tectonic framework of the Appalachian orogen in Alabama, *in* R. W. Frey, ed., Excursions in southeastern geology: American Geological Institute, v. 2, p. 465-526.

This is an excellent summary and field guide for the stratigraphy and structure of the southern Appalachian Mountains of Alabama.

Vanarsdale, R. B., and E. S. Schweig, III, 1990, Subsurface structure of the eastern Arkoma Basin: American Association of Petroleum Geologists Bulletin, v. 74, p. 1030-1037.

These authors illustrate with seismic the decollement style of deformation in the Ouachita thrusts overlying basement normal faulting. The thrust faulting is dated as late Pennsylvanian, whereas the basement normal faulting is constrained to the Mississippian-Pennsylvanian boundary (post-Pitkin, pre-Morrowan). Later, listric normal faults formed during the Pennsylvanian and merged with the sub-Morrowan unconformity.

Viele, G. W., 1973, Structure and tectonic history of the Ouachita mountains, Arkansas, *in* K. Dejong and R. Schotten, eds., Gravity and Tectonics: Wiley and Sons, N.Y., p. 361-378.

This summary article discusses Viele's (1973) views on the different styles of Ouachita deformation from "diving nappes" and "chaotic gravity sliding" to "primarily compressional" tectonics. The observations which generated these somewhat controversial conclusions were derived from a few quadrangles in the eastern Ouachitas of Arkansas (west and southwest of Little Rock).

Viele, G. W., 1989, The Ouachita orogenic belt, *in* R. D. Hatcher, W. A. Thomas, and G. W. Viele, eds., The Appalachian-Ouachita orogen in the United States: Boulder, Colorado, Geological Society of America, The Geology of North America, v. F-2, p. 555-561.

The article is a good, modern, summary article which introduces the reader to more detailed discussions within the volume "The Appalachian-Ouachita Orogen in the United States." Viele presents a succinct discussion of previous work in the Ouachita and Marathon fold belts.

Viele, G. W., and W. A. Thomas, 1989, Tectonic synthesis of the Ouachita orogenic belt, *in* R. D. Hatcher, W. A. Thomas, and G. W. Viele, eds., The Appalachian-Ouachita orogen in the United States: Boulder, Colorado, Geological Society of America, The Geology of North America, v. F-2, p. 695-728.

Viele and Thomas present a modern synthesis of the tectonics of the Ouachita orogenic belt from subsurface central Mississippi to the Marathon Uplift of West Texas. Their interpretation of the subsurface Ouachita structural front in Mississippi is derived from analogy to outcrops in Arkansas where the thrust front is a northerly verging fault zone. Based on Thomas's subsurface interpretations and resulting cross-cutting relationships, they conclude "that the frontal thrust faults of the Ouachitas pre-date the Alleghenian thrust faults of the southern Appalachians."

Warren, D. H., J. H. Healy, and W. H. Jackson, 1966, Crustal seismic measurements in southern Mississippi: Journal of Geophysical Research, v. 71, p. 3437-3458.

Based on a 400 km north-south seismic refraction survey across central Mississippi, Warren et al. concluded that the crustal structure of southern Mississippi is fairly complex. Their data revealed the north flank of a deep, major structure south of Tatum Salt Dome. They speculated that this structure might be the southeast extension of the crystalline Appalachian core.

Welch, S. W., 1978, Deposition of the Carter-Sanders Zone of the Black Warrior Basin, Mississippi and Alabama, *in* W. H. Moore, ed., Mississippian rocks of the Black Warrior Basin: Mississippi Geological Society 17th field trip guide book, p. 25-33.

Welch (his figures 4 through 7) illustrates the confluence of the Ouachitas and Appalachians as the near coincidence of a northeast-trending (NW-verging) Appalachian thrust belt and the north-trending (east-verging) Ouachita thrust belt.

Wickham, J., D. Roeder, and G. Briggs, 1976, Plate tectonic model for the Ouachita foldbelt: Geology, v. 4, p. 173-176.

This trio discusses three plate tectonic models for the Ouachitas: Cordilleran, flip, and collision models. They conclude that the collision model best fits the known geologic data. The collision model, with its south- to southeast-dipping subduction, does not specify whether the colliding plate was a southern island arc or a continental mass because of the lack of confining data. This discussion concludes that, with the collision model, dip-slip transport would occur in Arkansas and Texas, whereas right-lateral strike slip would dominate in eastern Arkansas, western Mississippi, and southern Texas.

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Open-File Report 22 is a study of the deeply buried Jurassic rocks beneath coastal Mississippi and the state-owned offshore waters. The report includes color core photographs from Catahoula Creek Field, the only Jurassic producing area of coastal Mississippi; a discussion of Jurassic production of Mississippi; and x-ray powder diffraction patterns and color photomicrographs of Jurassic mudlog show zones from the Chevron #1 Mississippi Sound Block 57 well. A structure map of the Petit Bois Island area and a log correlation section are included. The report, with 102 pages and 2 plates in the back pocket, was completed as a research project funded by a grant from the Minerals Management Service of the U. S. Department of the Interior.

($20.00 for each copy, plus $3.00 postage and handling for the first copy and $1.00 for each additional copy)

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Department of Environmental Quality
Office of Geology
Post Office Box 20307
Jackson, Mississippi 39289-1307

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Editor, Mississippi Geology
Office of Geology
P. O. Box 20307
Jackson, Mississippi 39289-1307

Editors: Michael B. E. Bograd and David Dockery