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New fusulinid data and multiple episodes of ancestral Rocky Mountain deformation in the Joyita Hills, Socorro County, New Mexico

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Abstract

Previously unmapped exposures of the syntectonic Bursum Formation in the Joyita Hills contain fusulinid-bearing limestone beds. Specimens belonging to the genera *Schwagerina* and *Triticites* document the dominant phase of ancestral Rocky Mountain tectonism associated with the Joyita uplift as an early Wolfcampian event. An earlier episode of deformation has also been recognized but is less well understood. Offset strata of the Sandia Formation are overlain by unfaulted strata of the basal Madera Formation. Fusulinid identifications in both formations bracket this early episode of faulting as an Atokan event.

Introduction

The Joyita Hills (Los Cañoncitos) are in north-central Socorro County, New Mexico (Fig. 1). Previous stratigraphic and paleontologic investigations (Read and Wood, 1947; Kottlowski, 1960; Kottlowski and Stewart, 1970; Stewart, 1970; Siemers, 1978, 1983; Baars, 1982; Altares, 1990) have interpreted the modern-day Joyita Hills area to have been the location of an ancestral Rocky Mountain uplift (the late Paleozoic Joyita uplift). Arkosic sedimentary rocks of the Bursum Formation (Kottlowski and Stewart, 1970; Altares, 1990) represent syntectonic detritus shed from this and other late Paleozoic uplifts (e.g., the Pedernal, Uncompahgre, and Zuni uplifts to the east, north, and northwest, respectively). On a more regional scale, interpretations of late Paleozoic sedimentation and tectonism have been provided by Armstrong (1962), Armstrong and Mamet (1988), Peterson (1980), Kluth and Coney (1981), and Kluth (1986).

The purpose of this paper is to present new fusulinid data and new structural data relevant to the timing and tectonic development of the Joyita uplift. Earlier biostratigraphic (fusulinid) analyses in the Joyita Hills were conducted by Kottlowski and Stewart (1970) and Stewart (1970). However, the fusulinids used in their analyses were recovered exclusively from Pennsylvanian strata on the west side of the Proterozoic core, and no fusulinids had been recovered from the overlying syntectonic Bursum Formation. On the basis of both local and regional stratigraphic relationships, Kottlowski and Stewart (1970) inferred that late Paleozoic uplift in the Joyita Hills area was dominantly a Wolfcampian event. Recent mapping of the Joyita Hills by the senior author has revealed additional exposures of Bursum strata along the east side of the Proterozoic core. Fusulinid-bearing limestone horizons yield *Schwagerina* and *Triticites* fauna (fusulinid identifications courtesy of D. A. Myers, written comm. 1990, 1991). This assemblage establishes the Bursum deposits as early Wolfcampian and confirms the interpretations of Kottlowski and Stewart (1970).

Structural and tectonic interpretations of Wolfcampian tectonism in central New Mexico have been discussed previously by Beck and Chapin (1991). However, additional structures in the Joyita Hills are indicative of an older deformational episode. Fusulinid analyses (Kottlowski and Stewart, 1970; herein) indicate that this early tectonism occurred during the Atokan.

Accordingly, the data presented herein are intended to supplement earlier interpretations of Kottlowski and Stewart (1970) and Beck and Chapin (1991).

General stratigraphic relationships

Pennsylvanian strata in the Joyita Hills range in thickness from 0 to 416 ft (0 to

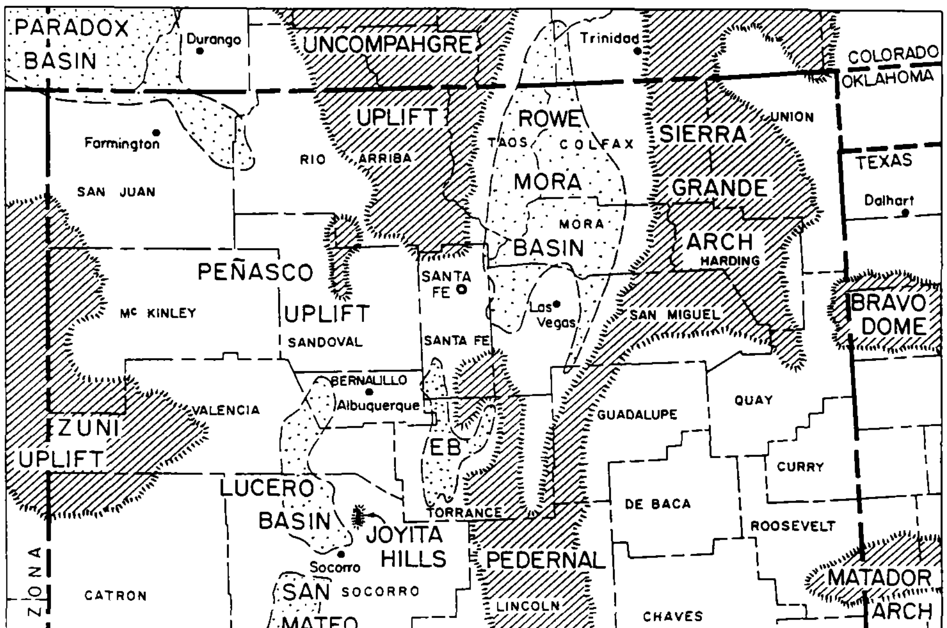

FIGURE 1—Pennsylvanian paleogeographic index map with major uplifts and depositional basins. The modern-day Joyita Hills (late Paleozoic Joyita uplift) are in north-central Socorro County. From Kottlowski and Stewart (1970).

127 m) (Kottlowski and Stewart, 1970; 0 to 112 m, Siemers, 1983). Measured sections and petrologic and biostratigraphic analyses of these rocks have been presented in detail by Kottlowski and Stewart (1970), Stewart (1970), and Siemers (1978, 1983). What follows is a general discussion of Pennsylvanian and early Permian stratigraphy (Fig. 2) in the Joyita Hills based on the work of Kottlowski and Stewart (1970), Siemers (1983), and observations of the authors. Permian strata in the Joyita Hills have received much less attention, and a regional analysis of the Permian system by Peterson (1980) has been used to supplement the personal observations and interpretations presented herein.

Pennsylvanian strata

Proterozoic rocks (augen gneiss) exposed in the core of the Joyita Hills are nonconformably overlain by strata of the Sandia Formation (0 to 161 ft (0 to 49 m), Kottlowski and Stewart, 1970; 0 to 48 m, Siemers, 1983). The age of the basal Sandia is uncertain due to an absence of diagnostic fossils. However, the Sandia Formation is thought to be exclusively early Atokan, the underlying Proterozoic rocks having formed a subaerially exposed upland of low topographic relief during Morrowan time. Lenticular, quartzitic sandstones of the basal Sandia filled shallow topographic depressions on this erosional surface. Overlying strata are dominantly dark-gray to black carbonaceous shales with lesser, interstratified bone coal, sandstone, and limestone horizons. Paleoenvironments have been interpreted (Kottlowski and Stewart, 1970; Siemers, 1983) as shallow, restricted to euxinic lagoon, marsh, and intertidal settings (clastics) interrupted by short periods of subaerial exposure and occasional deepening to shallow, less restricted marine shelf settings (carbonates).

The overlying Madera Formation (0 to 255 ft (0 to 78 m), Kottlowski and Stewart, 1970; 0 to 64 m, Siemers, 1983) is composed of limestones and subordinate fine-grained clastics. The Madera is broadly subdivided into a lower sequence of massive, cliff-forming limestones and an upper sequence of interbedded limestones and fine-grained clastics. Limestones in the lower sequence span late Atokan to early Desmoinesian time and consist of gray cherty mudstones and wackestones, indicative of deposition in normal, open marine, inner to outer shelf settings.

The overlying, interbedded limestone and clastic sequences range in age from early Desmoinesian to Missourian. Interbedded argillaceous marine limestones and calcareous fossiliferous shales and micrites are in turn interstratified with red arkosic shales and mudstones. The clastics represent episodic influx of terrigenous debris shed from Pennsylvanian uplifts. The fine-grained character of the detritus is indicative of distal source areas, which are inferred to have been the Pedernal uplift to the east and the Zuni uplift to the northwest (Fig. 1). Both Kottlowski and Stewart (1970) and Siemers (1983) indicate that the influx of arkosic debris occurred during Missourian time.

Strata deposited during the foregoing stages of the Pennsylvanian are significantly thinner in the Joyita Hills than those deposited in adjacent basins (typically 610 to 820 m; Kottlowski, 1960, fig. 25; Siemers, 1983, fig. 3, tables 1 and 2). Therefore, the anomalously thin section can be attributed to tectonic adjustments during sedimentation rather than uplift and erosion of an initially thick Pennsylvanian section. These adjustments served to elevate the Joyita uplift as a structurally positive block throughout the Pennsylvanian. Kottlowski and Stewart (1970, p. 29) note that late Desmoinesian strata are absent in the Joyita Hills, which has been attributed to middle Desmoinesian uplift and erosion (see also Kluth, 1986, p. 356). Virgilian strata are also absent in the Joyita Hills. On the basis of regional relationships, Kottlowski and Stewart (1970) inferred that a thin Virgilian section may have been deposited in the Joyita Hills but subsequently was removed by late Pennsylvanian and early Permian uplift and erosion. In addition to these unconformities, Kottlowski and Stewart (1970) report several diastems in the lower Pennsylvanian section of the Joyita Hills. These occur in early and late Atokan strata,

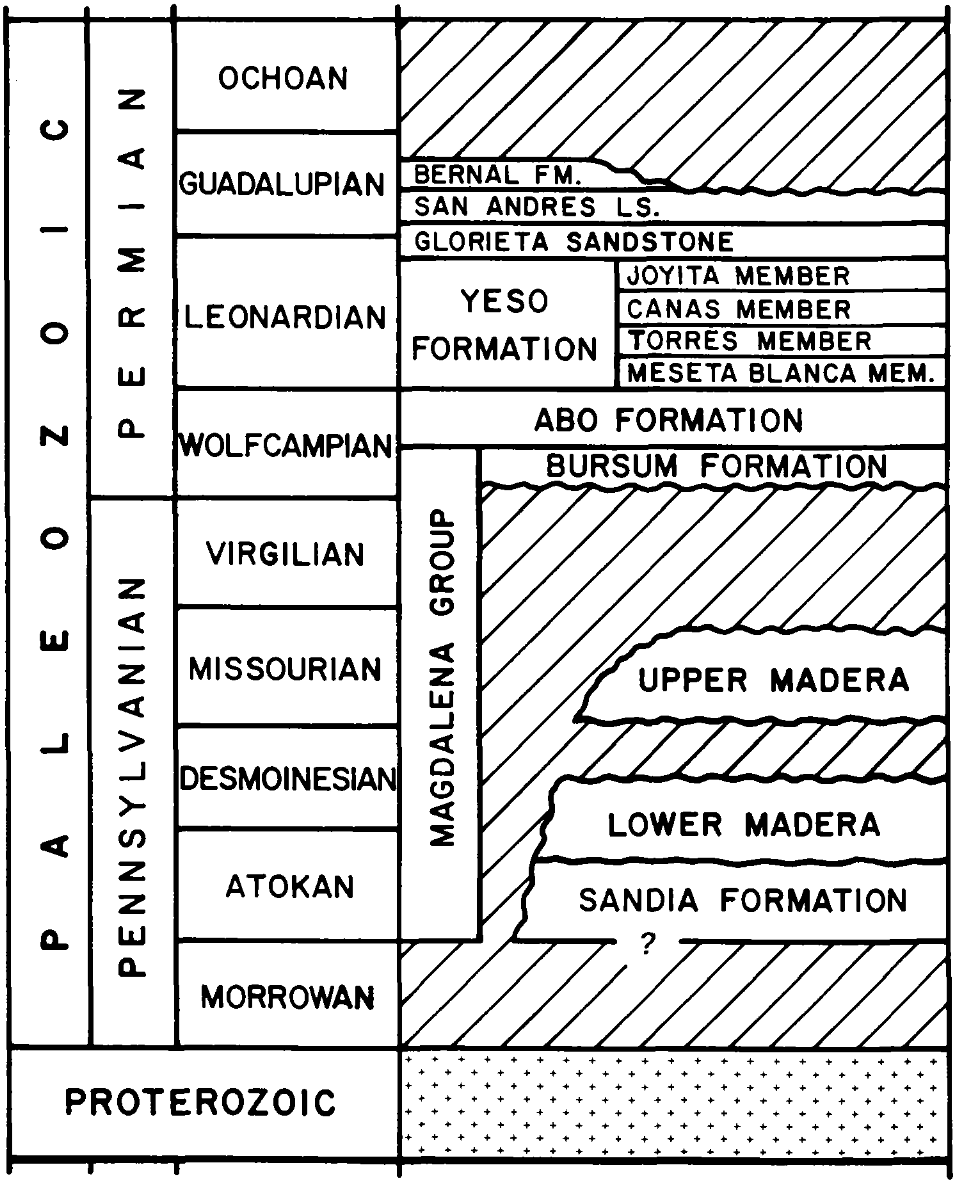

FIGURE 2—Generalized Paleozoic stratigraphic section in the Joyita Hills. Mesozoic and Cenozoic stratigraphic units (not shown) are also exposed in the Joyita Hills and adjacent areas (El Valle de La Joya) to the east and south. Modified from Osburn and Lochman-Balk (1983), Kottlowski and Stewart (1970), and Beck and Chapin (1991) with permission from the New Mexico Geological Society.

along the Atokan/Desmoinesian contact, and in early Desmoinesian strata. The latter two are indicative of localized uplift and erosion as evidenced by clasts of quartz, feldspar, augen gneiss, and reworked limestone.

It is important to note that Kottlowski (1960, p. 152) indicates the term basin may be misleading, in that depocenters probably were not much deeper than nearby uplifts. Therefore, sedimentation in the basins must have kept pace with subsidence. In contrast to the continuous sedimentation in depocenters, episodes of intermittent subaerial exposure, uplift, and erosion recorded in the Joyita Hills section indicate that the Joyita uplift remained as a structurally positive element amid rapidly subsiding basins. The foregoing unconformities, diastems, and general thinness of the Pennsylvanian section in the Joyita Hills, relative to the thickness of comparably aged strata in adjacent depositional basins, attest to the persistent, weakly positive nature of the Joyita uplift throughout the Pennsylvanian.

Permian strata

Pennsylvanian strata in the Joyita Hills are unconformably overlain by strata of the syntectonic Bursum Formation. The unconformity is angular, as Bursum strata successively truncate the Missourian, Desmoinesian, and Atokan sequences from north to south until they lie in depositional contact on the Proterozoic augen gneiss in the southern Joyita Hills (Fig. 3a; Kottlowski and Stewart, 1970, fig. 2; Beck and Chapin, 1991, fig. 5). Restoration of average bedding orientations in the Sandia, Madera, and Bursum Formations (using the regional bedding orientation determined from overlying strata exposed in the Joyita Hills) indicates that these strata were gently inclined (5°–10°) to the east and northeast as a result of late Paleozoic tectonism.

Strata of the Bursum Formation are texturally and compositionally immature, typically 9 m thick, and composed of interstratified, red and less commonly greenish-gray, arkosic shales, mudstones, and breccias (Fig. 3b), with lesser, discontinuous limestone horizons. The clastics are indicative of proximal deposits shed from a local uplift. Breccias typically contain a sand matrix with pebble- to cobble- and occasionally boulder-sized clasts of limestone (typically silicified), vein quartz, pink feldspar, and augen gneiss derived from the underlying Pennsylvanian and Proterozoic rocks. In the vicinity of Central Canyon (Fig. 4; Central Canyon is an informal name adopted from Kottlowski and Stewart, 1970), Bursum sequences stratigraphically overlie the Madera Formation. Both are in fault contact with older Pennsylvanian and Proterozoic rocks (Fig. 5). This fault has been interpreted by Beck and Chapin (1991, fig. 6) as an ancestral Rocky Mountain fault. Here, the Bursum strata are anomalously thick and coarse grained in the hanging wall (west block; downthrown) and were apparently deposited against the exposed fault scarp. In the footwall (east block; upthrown), both Madera and Bursum strata are thinned (the former erosionally, and the latter depositionally and/or erosionally). Both the fault and offset strata are overlain by anomalously thin, unfaulted strata of the Abo Formation. Clearly, the Bursum strata are syntectonic deposits derived from local uplift. On the basis of regional relationships, Kottlowski and Stewart (1970; see also Altares, 1990) inferred that the Bursum deposits were early Wolfcampian.

In general, strata of the Wolfcampian Abo Formation conformably overlie and are intertongued with the Bursum For- ☞

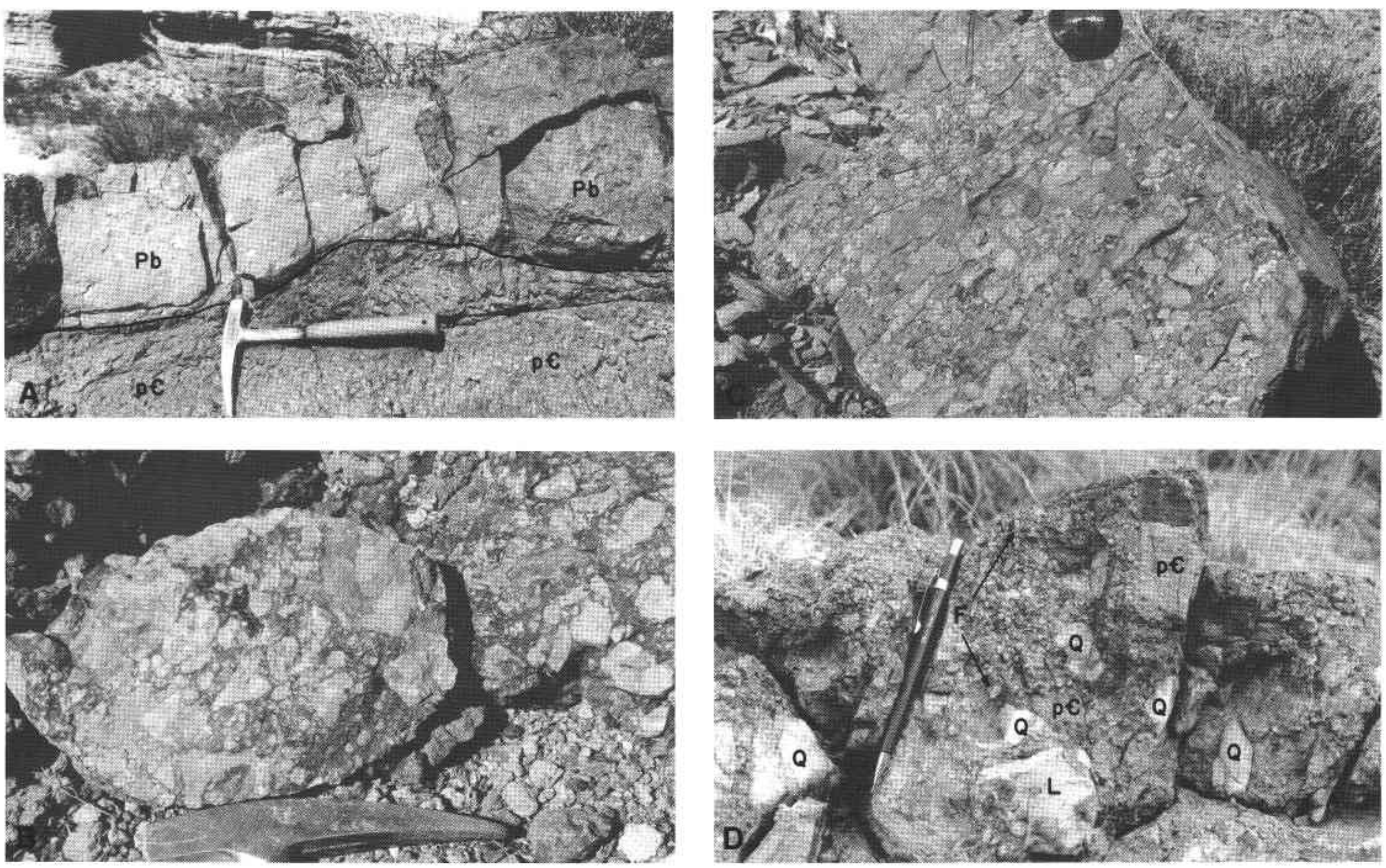

FIGURE 3—Lithologies and features in the Bursum and Abo Formations. **A**, Coarse, arkosic Bursum (**Pb**) in depositional contact with foliated Proterozoic augen gneiss (**p-Є**) in the southern Joyita Hills; **B**, silicified limestone-pebble arkose at the base of the Bursum (interpreted as early Wolfcampian colluvium) in depositional contact on erosionally thinned limestones of the Madera Formation in the southern Joyita Hills, pick head for scale; **C**, limestone-pebble conglomerate in the Wolfcampian Abo Formation, lens cap for scale; and **D**, arkosic breccia in the Bursum Formation (east of the Proterozoic core) with lithic clasts of Proterozoic augen gneiss (**p-Є**), vein quartz (**Q**), silicified limestone (**L**), and pink feldspar (**F**).

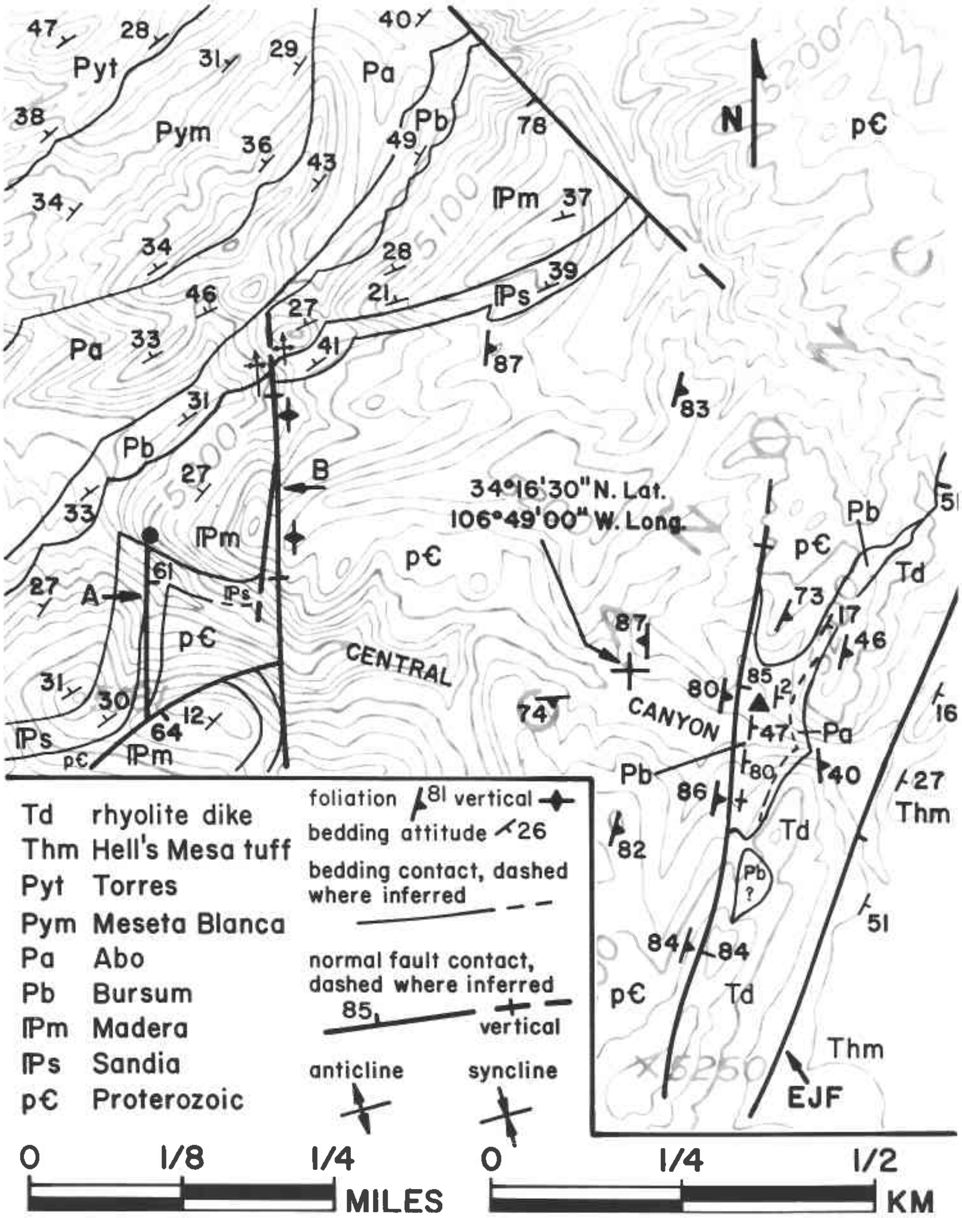

FIGURE 4—Generalized geologic map of the Central Canyon area of the Joyita Hills. Only the East Joyita fault (**EJF**) is named; the Atokan (**A**) and Wolfcampian (**B**) faults are described in the text. Fusulinid sample localities are Atokan (●) and Wolfcampian (▲). **Pb?** is interpreted as a Bursum megalith incorporated into the Tertiary dike.

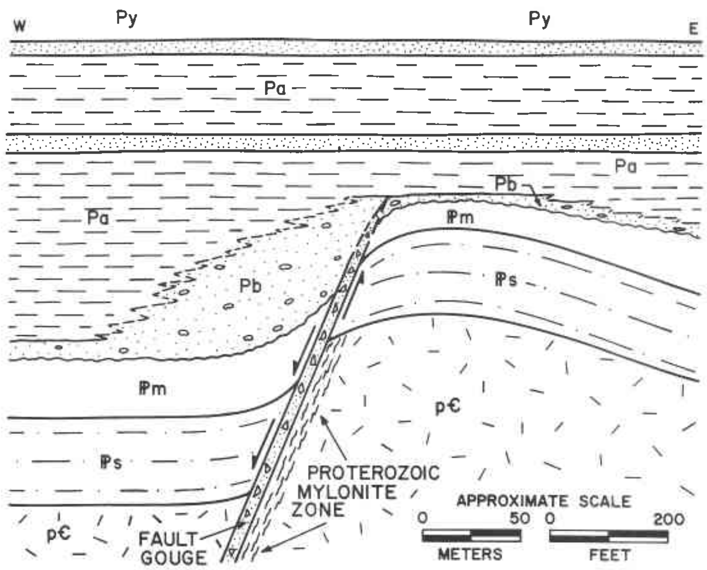

FIGURE 5—Generalized cross section along the early Wolfcampian normal fault (**B**, Fig. 4). Cross section has been restored to its post-ancestral Rocky Mountain orientation by removing 30° of down-to-the-west rotation about a N35°E horizontal axis. Fault and contacts dashed where obscured; formation symbols same as Fig. 4. From Beck and Chapin (1991) with permission from the New Mexico Geological Society.

mation. A potential exception occurs in the southernmost Joyita Hills where depositionally thinned Abo sequences are separated from underlying Proterozoic rocks by an anomalously thin (1 to 2 m) unit of Bursum-like strata (Fig. 3a). This unit of Bursum-like strata may be interpreted alternatively as a thin deposit of the Bursum Formation, or as a Bursum-like lithology at the base of (and in) the Abo Formation. Typically, Abo sequences are red arkosic mudstones and shales with lesser channel sandstone horizons. The majority of these sediments were most likely derived from the larger Pedernal, Uncompahgre, and Zuni uplifts (to the east, north, and northwest, respectively; Fig. 1) that eventually covered the comparatively small Joyita uplift. The fine-grained arkosic sediments of the Abo (typically 110 m thick in the Joyita Hills) are indicative of subaerial sedimentation during the waning stages of ancestral Rocky Mountain tectonism. Occasional limestone-pebble conglomerates (Fig. 3c) have been observed in the lower 75% of the Abo section. These beds are interpreted to indicate that episodic tectonic adjustments occurred during Abo deposition, and/or that local remnant exposures of limestone uplands persisted well into Wolfcampian time.

Peterson (1980) indicated that the late Paleozoic basins in New Mexico were largely filled with sediment during Wolfcampian time and that most of the late Paleozoic uplifts were completely buried by Leonardian/Guadalupian sedimentation. In the Joyita Hills and surrounding areas, Leonardian and Guadalupian strata formed extensive sheet-like layers of compositionally mature, well-sorted clastics and clean carbonates of the Yeso, Glorieta, and San Andres Formations (Fig. 2). These lithologies are indicative of relative tectonic quiescence and a cessation of ancestral Rocky Mountain tectonism in central New Mexico.

Atokan deformation

Several (6–8) north-striking faults offset the Sandia Formation and underlying Proterozoic rocks. Most of these faults are poorly exposed and can only be mapped as surface traces. All appear to be of comparable orientation in that they have a consistent surface trend and exhibit down-to-the-east displacement. Offsets are on the order of a few tens of meters. Cross-sectional exposure of one of these faults (Fig. 6) has been observed in Central Canyon (Fig. 4). Although partially obscured by colluvium, offset strata of the Sandia are overlain by unfaulted strata of the Madera Formation. Down-to-the-east displacement (as evidenced by fault drag and correlation of a sandstone marker horizon in both eastern and western fault blocks) has been measured at approximately 23 m. Restoration of the fault and contained fault striae (using bedding orientations in the Madera) indicates that the original fault orientation was subvertical, striking N12°E. Restored fault striae indicate subvertical displacement. Strata in both formations are comparably oriented indicating that the episode of faulting was nonrotational (excluding fault drag). Although Holocene colluvium obscures the basal Madera and the uppermost extent of the fault, it is considered unlikely that approximately 23 m of displacement would die out in the remaining 9 m of covered slope.

Specimens of *Fusulinella famula* Thompson and *F. devexa* Thompson have been recovered from the lower limestones of the Madera Formation in the vicinity of Central Canyon by Kottlowski and Stewart (1970; figs. 4, 5 and 8, section JH 3). Similarly, *Fusulinella* aff. *F. juncea* Thompson has been recovered (Table 1) from the lowermost Madera limestones exposed above the aforementioned fault (Fig. 6). The *Fusulinella* biozone dates these lower Madera limestone horizons as late Atokan (Kottlowski and Stewart, 1970, p. 22). Offset strata of the underlying Sandia Formation have been established as early Atokan (Kottlowski and Stewart, 1970; Siemers, 1983), and therefore this faulting episode can be constrained as an Atokan event.

Wolfcampian fusulinids

Recent structural investigations and detailed mapping in the Joyita Hills have found previously unmapped exposures of the Bursum Formation in the vicinity of Central Canyon (Fig. 4). These rocks are exposed between the East Joyita fault and an unnamed, north-striking fault of ancestral Rocky Mountain origin. Both faults exhibit a down-to-the-east displacement, which is attributed to Oligocene–Miocene extension (the original, late Paleozoic displacement on the unnamed fault was down-to-the-west; Beck and Chapin, 1991). Relationships are further obscured by an intrusive mid-Tertiary rhyolite dike (31.3 ± 1.2 Ma, Aldrich et al., 1986). Consequently, the base and top of the Bursum are only locally exposed. Where the base of the Bursum is exposed, the Bursum appears to be in depositional contact with Proterozoic rocks. Where the top is exposed, the Bursum strata are overlain by strata of the Abo Formation. However, the combination of known fault contacts, intrusive dike contacts, much vegetation, and Holocene colluvium and alluvium prohibits an accurate determination of the true thickness of the Bursum.

These outcrops of the Bursum Formation are comparable to those on the west side of the Proterozoic core. Reddish-brown and less commonly greenish-gray, coarse-grained sandstones, gravels, and breccias predominate. Arkosic mudstones and shales are also present. The sandstones and gravels are poorly to moderately sorted and predominantly composed of subangular quartz and potassium feldspar grains. Breccias (Fig. 3d) contain a sand matrix and gravel- to pebble-sized lithic clasts of augen gneiss (similar to the augen gneiss in the Proterozoic core), vein quartz, pink feldspar, and silicified limestone.

Occasional limestone beds are interstratified with the arkosic clastic sequences and are thought to represent lack of detrital influx resulting from episodic tectonic quiescence and/or rapid sea level rise caused by eustacy. The limestones ap-

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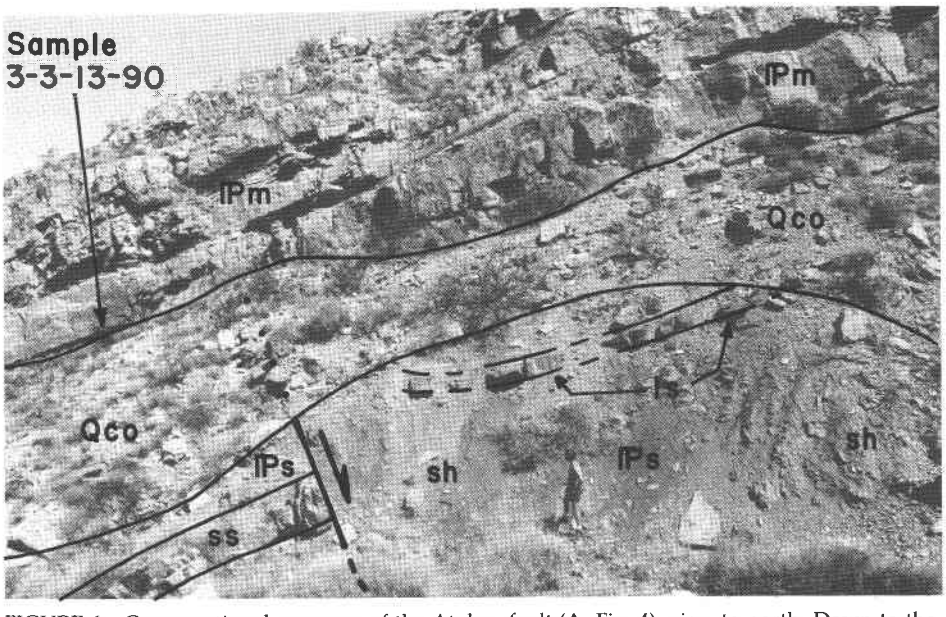

FIGURE 6—Cross-sectional exposure of the Atokan fault (**A**, Fig. 4); view to north. Down-to-the-east displacement approximates 23 m. Fusulinid sample 3–3–13–90 collected from lowermost limestone exposed above colluvium (arrow). **ℙs**, Sandia Formation; **ℙm**, Madera Formation; **Qco**, colluvium; **ss**, sandstone; **ls**, limestone; **sh**, shale. M. D. Boryta for scale.

pear to be discontinuous lenticular (maximum 1 m thick) horizons that are composed of light- to medium-gray calcareous grainstones and packstones, and less commonly, calcareous mudstones. Specimens of the genera *Schwagerina* and *Triticites* have been recovered and identified (Table 1), including *Schwagerina* cf. *S. pinosensis* Thompson (Fig. 7a) and *Triticites* aff. *T. creekensis* Thompson (Fig. 7b). These fusulinids date the syntectonic Bursum Formation as early Wolfcampian and indicate that the dominant phase of tectonism associated with the Joyita uplift was an early Wolfcampian event.

Summary

The new fusulinid data and new structural data presented herein are intended to supplement earlier interpretations of late Paleozoic sedimentation and tectonism (Kottlowski and Stewart, 1970; Beck and Chapin, 1991). Fusulinid analyses of Kottlowski and Stewart (1970) and Stewart (1970) were presented in more detail. However, they did not recover fusulinids from the syntectonic Bursum Formation. Limestones in Bursum outcrops west of the Proterozoic core, where Kottlowski and Stewart (1970) conducted their analyses, apparently contain no fusulinids. Newly recognized outcrops of Bursum strata east of the Proterozoic core, however, do contain fusulinid-bearing limestones. The *Schwagerina* and *Triticites* fauna recovered from these newly sampled outcrops establish the syntectonic Bursum sediments as early Wolfcampian and confirm the earlier interpretations of Kottlowski and Stewart (1970).

Similarly, the analyses and discussion of Atokan tectonism are hindered by the limited number of faults and poor exposure. Although constrained as an Atokan event, this episode of structural deformation is poorly understood. Restoration indicates down-to-the-east, subvertical displacement occurred along subvertical, north-striking faults. The limited displacements observed along these faults suggest that this event was comparatively minor.

The structural trends that were to control late Paleozoic uplift and sedimentation began to develop during Chesterian time (late Mississippian; Armstrong, 1962; Armstrong and Mamet, 1988; Kluth, 1986). These trends persisted throughout the Pennsylvanian (Kottlowski, 1960) and into the Permian (Peterson, 1980). The persistent, weakly positive nature of the Joyita uplift (Kottlowski and Stewart, 1970; Siemers, 1983) throughout the Pennsylvanian indicates that tectonic adjustments must have occurred during Pennsylvanian sedimentation. The unconformities and diastems observed in the Pennsylvanian section of the Joyita Hills (Kottlowski and Stewart, 1970), observed Atokan structures, and inferred middle Desmoinesian uplift and erosion (Kottlowski and Stewart, 1970) are thought to reflect these adjustments. However, they were apparently minor events during the tectonic development of the Joyita uplift and only precursors to the major orogenic episode during the early Wolfcampian (Kottlowski and Stewart, 1970; Beck and Chapin, 1991).

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TABLE 1—Fusulinid identifications (D. A. Myers, written communication 1990, 1991). * read as "sample #3, collected on March 13, 1990."

Sample	Identification	Interpretation	Figure
3–3–13–90*	*Fusulinella* aff. *F. juncea* Thompson	Atokan	
4–3–13–90	*Schwagerina* cf. *S. pinosensis* Thompson	Wolfcampian–Bursum	7a
	Triticites aff. *T. creekensis* Thompson	Wolfcampian–Bursum	
8–10–29–90	*Triticites* aff. *T. creekensis* Thompson	Wolfcampian–Bursum	
10–10–29–90	*Triticites* aff. *T. creekensis* Thompson	Wolfcampian–Bursum	
11–10–29–90	*Triticites* aff. *T. creekensis* Thompson	Wolfcampian–Bursum	7b
12–10–29–90	*Triticites* aff. *T. creekensis* Thompson	Wolfcampian–Bursum	

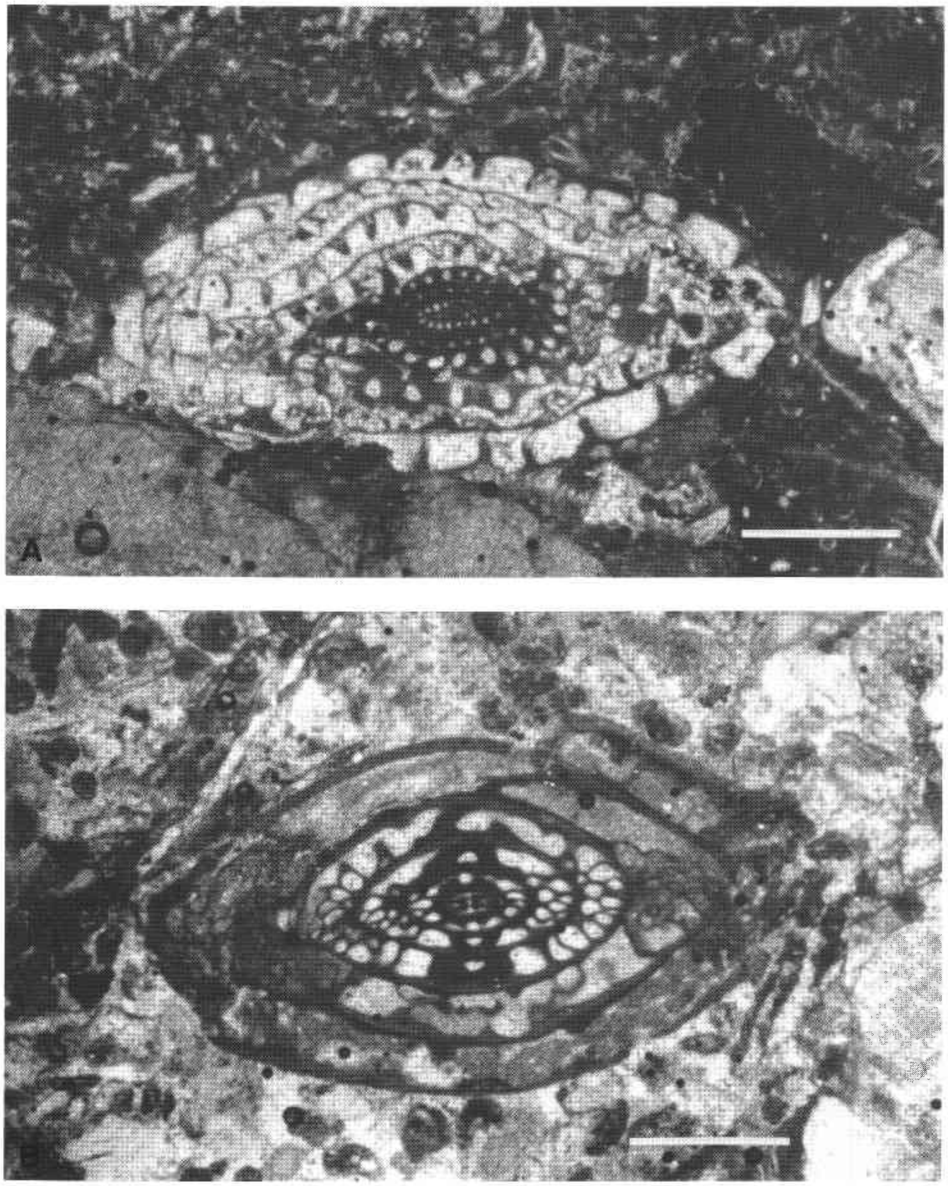

FIGURE 7—Fusulinids recovered from limestones in the Bursum Formation on the east side of the Proterozoic core of the Joyita Hills (Fig. 4). **A**, *Schwagerina* cf. *S. pinosensis* Thompson; **B**, *Triticites* aff. *T. creekensis* Thompson. Scale bars equivalent to 1 mm.

represents part of the senior author's dissertation, and he would like to thank the New Mexico Bureau of Mines and Mineral Resources (C. E. Chapin, Director) and the New Mexico Geological Society for their continued financial support throughout this project.

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Upcoming geologic meetings

Conference title	Dates	Location	Contact for more information
Mesozoic of the Western Interior	Aug. 17–19	Ft. Collins, CO	SEPM P.O. Box 4756 Tulsa, OK 74159–0756
New Mexico Conference on the Environment	Sept. 13–15	Convention Center Albuquerque, NM	NM Environment Dept. 1190 St. Francis Drive P.O. Box 26110 Santa Fe, NM 87502
Rediscover the Rockies	Sept. 13–16	Casper, WY	AAPG 1992 RMS Mtg. P.O. Box 979 Tulsa, OK 74101–0979
New Mexico Mining Association annual meeting	Sept. 16–18	Farmington, NM	NMMA 6020 Academy NE Suite 201 Albuquerque, NM 87109–3315
Denver Gem and Mineral Show	Sept. 18–20	Merchandise Mart Denver, CO	Denver Council Box 621444 Littleton, CO 80162 (303) 978–9926
El Paso Geological Society Field Conference	Sept. 18–21	Mexico	Ms. Marty Brown Econ. Geol. Pub. Co. 101 Vowell Hall, UTEP El Paso, TX 79968 (915) 533–1965
Southwest ARC/INFO User Group Conference	Sept. 23–25	Santa Fe, NM	Ted Talmon, GSD/ISD P.O. Box 26110 Santa Fe, NM 87502
New Mexico Geological Society Field Conference	Sept. 30–Oct. 3	San Juan Basin	Orin J. Anderson NMBMMR Socorro, NM 87801 (505) 835–5122
Chaparral Rockhounds Gem & Mineral Show	Oct. 17–18	Yucca Center Roswell, NM	Bill Gay Roswell, NM (505) 623–2769
New Mexico Mineral Symposium	Nov. 14–15	Macey Center Socorro, NM	Judy Vaiza NMBMMR Socorro, NM 87801 (505) 835–5302
New Mexico Geographic Information Council, Inc. Fall Meeting	Nov. 20	Albuquerque, NM	Amy Budge, TAC 2808 Central SE Albuquerque, NM 87131 (505) 277–3622

New Mexico Geological Society

1993 Field Conference
Call for papers

The 44th New Mexico Geological Society Field Conference will be held in the Carlsbad area of southeastern New Mexico and western Texas on October 6–9, 1993. Field conference planning is being coordinated with the West Texas Geological Society and the Roswell Geological Society. The conference will focus on the geologic evolution of the Pecos Valley–Guadalupe Mountains–Salt Basin region. The broad scope of papers and roadlog contributions being solicited includes reviews of: the Permian geology of the Delaware Basin–Guadalupe Mountains–Northwest shelf region; advances in sequence stratigraphy; regional structural setting; mineral resources (oil, gas, potash, sulfur, water); carbonate and gypsum karst and related cave resources and environmental concerns; and radioactive-waste management (Waste Isolation Pilot Project–WIPP).

Articles for inclusion in the 1993 guidebook (Barry Kues, Managing Editor) must be submitted by **February 15, 1993.** If you would like to contribute an article, please send a tentative title and estimate of manuscript length to: **NMGS—1993,** John W. Hawley, David W. Love, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801, (505) 835–5420.