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RECENT ADVANCES IN ATOKAN BIOSTRATIGRAPHY

Compiled for discussion following the symposium:
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INTRODUCTION

In this summary we have attempted to identify significant recent contributions to Atokan biostratigraphy. Items included are foraminiferal and conodont studies published after the 1984 OGS symposium volume "The Atokan Series (Pennsylvanian) and its Boundaries," as well as a few studies currently nearing completion.

We did not deliberately exclude contributions on other fossil groups; on the contrary, we sought input from specialists on plant microfossils (L. E. Eames), cephalopods (W. L. Manger; L. L. Lambert), corals and brachiopods (P. K. Sutherland), but no significant papers were identified. Items are keyed numerically to localities on the accompanying Atokan paleogeographic reconstruction.

I. FORAMINIFERIDA

1. Douglass, R. C., 1987, Fusulinid biostratigraphy and correlations between the Appalachian and Eastern Interior basins: U. S. Geological Survey Professional Paper 1451, 95 p., 20 pls. This volume documents fusulinid occurrences from 88 surface and subsurface localities across the Illinois and Appalachian basins. The faunal succession includes all or portions of the zones of *Millerella*, *Profusulinella*, *Fusulinella*, *Beedeina*, and *Triticites*, with the latter two zones subdivided into five and three subzones, respectively. Atokan faunas are documented from the Seville Limestone Member in Illinois; the Finnie Sandstone Member through Curlew Limestone Member in western Kentucky; the Magoffin Limestone Member through Stoney Fork Member in eastern Kentucky; and the lower Mercer through Homewood Sandstone Member in Ohio and western Pennsylvania.

2. Verville, G. J., Sanderson, G. A., and Madsen, M. E., 1986, Pennsylvanian fusulinids from the Fra Cristobal Range, Sierra County, New Mexico: New Mexico Geological Society Guidebook, 37th Field Conference, Truth or Consequences, p. 215-223, 7 figs. (including 5 columnar

sections with illustrated fusulinids). This report contains the first documented biostratigraphic evidence for subdividing Pennsylvanian carbonates in the Fra Critobal Range. Important fusulinid genera are *Fusulinella*, *Fusulina*, *Wedekindellina*, *Eowaeringella*, *Triticites*, and *Dunbarinella* from rocks of the upper Atokan through Virgilian Series. Upper Atokan strata directly overlie the Cambrian Bliss Sandstone and yield *Fusulinella juncea*. Lower Desmoinesian strata are identified by the appearance of *Fusulina insolita*.

3. Verville, G. J., and Sanderson, G. A., 1988, Early Atokan fusulinids from the lower Antler Overlap sequence, Lander and Humboldt counties, Nevada: Journal of Paleontology, v. 62, no. 4, p. 520-529, 5 figs. (2 pls.). Species of *Profusulinella* are employed to correlate the Highway Limestone, lower Etchart Formation and Battle Formation in Lander and Humboldt counties to portions of the Moleen Formation and Ely Formation near Elko and Ely, respectively. Representatives of four genera are systematically described and illustrated.

4a. Groves, J. R., *in press*, Fusulinacean biostratigraphy of the Marble Falls Limestone (Pennsylvanian), western Llano region, central Texas: Journal of Foraminiferal Research, 78 ms. pp., 4

figs., 9 pls. Fusulinid correlations permit interpretation of the local depositional history of the Marble Falls Limestone and superjacent Smithwick Formation. The upper member of the Marble Falls is shown to be highly time-transgressive as a consequence of westward migration across an irregular pre-Atokan paleotopographic surface. The upper Marble Falls in most of the western Llano area is equivalent to the Smithwick along the northern and eastern flanks of the uplift. Species in the following genera are systematically described and illustrated: *Mediocris*, *Millerella*, *Eostaffella*, *Pseudostaffella*, *Eoschubertella*, *Profusulinella*, *Fusulinella*, *Fusulina*, *Wedekindellina*, and *Staffella*.

4b. Groves, J. R., *in review*, Stratigraphic distribution of non-fusulinacean foraminifers in the Marble Falls Limestone (Lower-Middle Pennsylvanian), western Llano region, central Texas: Oklahoma Geological Survey Circular, 20 ms. pp., 3 figs., 4 pls. This short contribution is prepared as a companion article to that in 4a, above. Twenty-two genus- and species-level taxa of smaller foraminifers are illustrated and their occurrences related to the independently established fusulinacean zonation. Assemblages from the middle and upper Atokan portion of the section are remarkably similar to ones reported from the Moscovian of the Eurasian-Arctic faunal realm, suggesting a greater degree of Middle Carboniferous cosmopolitanism than has been previously recognized.

5. Clopine, W. W., (Ph.D. dissertation nearing completion). This study involves detailed taxonomic and stratigraphic analysis of fusulinacean successions from four measured sections in south-central New Mexico and extreme west Texas (Mud Springs Mountains, Sierra County, NM; type Derryan, Derry Hills, Sierra County, NM; Organ Mountains, Donna Anna County, NM; and Franklin Mountains, El Paso County, TX). Species in the genera *Profusulinella*, *Fusulinella*, *Beedeina*, and *Wedekindellina* are used to evaluate the Middle Pennsylvanian lithostratigraphic framework proposed by M. L. Thompson. Fusulinid assemblages bracketing the Atokan-Desmoinesian boundary are best developed at Wiskey Canyon (Mud Springs Mtns.) and Vinton Canyon (Franklin Mtns.).

6. Groves, J. R., 1984, Foraminifers and biostratigraphy of the Arco Hills, Bluebird Mountain,

and lower Snaky Canyon Formations (Mid-Carboniferous) of east-central Idaho: *Journal of Foraminiferal Research*, v. 14, no. 4, p. 282-302, 7 figs., 8 pls. Integrated microfossil biostratigraphy involving smaller foraminifers, fusulinaceans, and conodonts (identified by J. F. Baesemann) enabled subdivision of the upper Chesterian through middle Atokan portions of these recently named formations. Detailed foram and conodont occurrence data are presented from two measured sections in the southern Lemhi Range, Butte County. Forams are illustrated on eight plates. (The systematics and stratigraphic distribution of calcareous algae from coincident samples are documented in: Groves, J. R., 1986, *Calcareous algae and associated microfossils from mid-Carboniferous rocks in east-central Idaho*: *Journal of Paleontology*, v. 60, no. 2, p. 476-496, 9 figs.)

Other. Groves, J. R., 1986, Foraminiferal characterization of the Morrowan-Atokan (lower Middle Pennsylvanian) boundary: *Geological Society of America Bulletin*, v. 97, p. 346-353, 2 figs. This article reiterates the need for establishing a lower Atokan boundary stratotype in light of inadequacies of the traditional type Atokan reference area. Foraminiferal successions from 12 areas throughout the midcontinental and western U. S. and Alaska are reviewed with respect to their suitability as potential stratotype candidates. The appearances of the primitive fusulinids *Pseudostaffella* and *Eoschubertella*, and possibly staffellids, are recommended as the most useful for identifying the base of the Atokan. Documented, sedimentologically continuous sequences containing these appearances are best developed in southern New Mexico, southeastern Arizona, southern Nevada, and east-central Idaho.

Groves, J. R., 1988, Calcareous foraminifers from the Bashkirian stratotype (Middle Carboniferous, south Urals) and their significance for intercontinental correlation and the evolution of the Fusulinidae: *Journal of Paleontology*, v. 62, no. 3, p. 368-399, 18 figs. (9 pls.). This report contains the first documentation of foraminifers from the type Bashkirian, including a sequence of species judged to represent the evolutionary origination and early diversification of the Fusulinidae. Intercontinental correlations based on the fusulinid phylogeny, conodonts, and ammonoids suggest the Morrowan-Atokan boundary to fall slightly above the

base of the Akavassky Horizon of the Early Bashkirian Substage. This contrasts markedly with previous interpretations which equated most of the Bashkirian with the Morrowan.

Groves, J. R., and Sanderson, G. A., *in press*, Systematics of the North American species of *Profusulinella* (Middle Pennsylvanian Fusulinidae): Micropaleontology, 66 ms. pp., 10 figs., 21 tables, 7 pls. The type series of 17 species in *Profusulinella* were re-studied to enable clarification of species concepts. All holotypes and most paratypes are re-illustrated at uniform magnification. Detailed morphometric analysis resulted in identification of statistically significant diagnostic characters for 10 species. The remaining seven species (or approximately 40%) are judged taxonomically deficient as a consequence of inadequacies of their type specimens and/or failure by original authors to properly identify acceptable limits of intraspecific morphologic variation.

II. CONODONTA

7. Grayson, R. C., Jr., Merrill, G. K., Lambert, L. L., and Turner, J., 1989, Phylogenetic basis for species recognition within the conodont genus *Idiognathodus*: applicability to correlation and boundary placement, p. 75-94. In D. R. Boardman II, and others, (eds.), Middle and Late Pennsylvanian chronostratigraphic boundaries in north-central Texas: glacial-eustatic events, biostratigraphy, and paleoecology, Pt. II, Contributed Papers: Texas Tech University Studies in Geology 2. The authors identified previously overlooked morphologic character states of probable evolutionary significance to serve as a basis for discriminating taxa within the *Idiognathodus*-*Streptognathodus* transition series. The resulting taxonomy proves useful in recognition and correlation of the Desmoinesian-Missourian boundary in north-central Texas, and also affects the systematics of several Atokan species.

8. Whiteside, J. R., and Grayson, R. C., Jr., 1989, Carboniferous conodont faunas, northern Ouachita Mountains, Oklahoma: Society of Economic Paleontologists and Mineralogists, Mid-year Meeting, Oklahoma City. Six conodont assemblages from the Caney through Atoka Formations of the Ouachita Mountains are identified and interpreted with respect to their biostratigraphic and chronostratigraphic significance. The Atokan Series

in the northern Ouachitas includes the "Spiro" and Atoka Formations, with the base of the series identified by the appearance of *Diplognathodus coloradoensis* and, in places, the fusulinid *Eoschubertella*. In more southerly exposures, however, paleoenvironments were inimical to these indices and boundary recognition is less certain. An arbitrary placement in the middle portion of the range of *Idiognathodus klapperi* results in the Morrowan-Atokan boundary falling within the "Springer," Atoka, and Johns Valley Formations. Upper Atokan strata failed to yield biostratigraphically diagnostic conodonts.

9. Grayson, R. C., Jr., *in press* (1990), Canyon Creek: a significant exposure of a predominantly mudrock succession recording essentially continuous deposition from the Late Devonian through the Middle Pennsylvanian: Oklahoma Geological Survey Guidebook (South-central Section, GSA, 24th Annual Meeting; Guidebook to Field Trip No. 2: Early to Middle Paleozoic conodont biostratigraphy of the Arbuckle Mountains, Oklahoma, March 3-4, 1990). The Mississippian-Pennsylvanian boundary at Canyon Creek is equated with the internationally defined Mid-Carboniferous boundary at the transition from the "*Adetognathus unicornis* Zone to Higgins' *Idiognathoides noduliferus*-*Streptognathodus lateralis* Zone. The Morrowan-Atokan boundary is less easily located because: 1) paleoenvironmental conditions excluded certain conodonts; and 2) there is no consensus as to precise faunal definition of the boundary. A boundary at the base of the Atoka Formation would separate occurrences of *Idiognathodus klapperi* (below) and *I. incurvus*.

Other. Grayson, R. C., Jr., Merrill, G. K., and Lambert, L. L., *in press* (1990), Carboniferous gnathodontid conodont apparatuses: evidence of a dual origin for Pennsylvanian taxa: Courier Forschungsinstitut Senckenberg, v. 118. Reconstruction of multielement apparatuses permits identification of two major mid-Carboniferous gnathodontid clades. In clade 1, *Gnathodus bilineatus* gave rise to the Pennsylvanian genera "*Declinognathodus*," *Idiognathoides*, and *Idiognathodus* (*Streptognathodus*). Clade 2 taxa stemmed from "*Gnathodus girtyi*" and include *Neognathodus higginsii*, *N. symmetricus*, and *N. bassleri*.

