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**REDEFINITION OF THE UPPER PENNSYLVANIAN
VIRGILIAN SERIES IN KANSAS**

by

D.L. Baars
C.G. Maples
S.M. Ritter
C.A. Ross

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Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence, KS 66047-3726

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D.L. Baars and Christopher G. Maples
Kansas Geological Survey
The University of Kansas
1930 Constant Avenue, Campus West
Lawrence, Kansas 66047-2598

Scott M. Ritter
Department of Geology
Oklahoma State University
Stillwater, Oklahoma 74078

Charles A. Ross
Chevron U.S.A., Inc.
P.O. Box 1635
Houston, Texas 77251

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D.L. Baars¹, Scott M. Ritter², C. G. Maples¹, and Charles A. Ross³

ABSTRACT

The Virgilian Series was defined nearly 60 years ago to include those rocks lying between the Missourian Series and the base of the Permian System. In the type area in east-central Kansas the Virgilian Series comprised the Douglas, Shawnee and Wabaunsee Groups. In Kansas, the upper boundary of the Virgilian (Pennsylvanian-Permian boundary) was placed at the top of the Brownsville Limestone on the basis of what was then believed to be a regional disconformity rather than on paleontological criteria. Recent advances in fusulinid and conodont biostratigraphy provide tentative criteria upon which to effect a change in the placement of the Virgilian-Permian boundary. It is now generally agreed that the base of the Permian System is approximated by the first occurrence of Pseudoschwagerina, an inflated schwagerinid. Furthermore, the Subcommittee on Permian Stratigraphy has informally agreed that the base of the Permian should coincide with the first occurrence of the conodont species Streptognathodus barskovi. Inflated schwagerinids (Paraschwagerina kansasensis) first occur along with evolutionary changes in the Conodonta in the Neva Limestone of the Council Grove Group. Consequently, the Virgilian Series is herein redefined to include rocks present between the top of the Missourian Series and the base of the Neva Limestone.

To increase compatibility between chronostratigraphic and lithostratigraphic nomenclature, the following changes are made: (1) the Admire Group is redefined to include rocks between the base of the Onaga Shale and the base of the Neva Limestone; (2) the Admire is reassigned to the upper Virgilian Series; (3) the Neva Limestone is elevated to formational status; (4) the Grenola Limestone is redefined to include strata between the top of the Roca Shale and the base of the Neva Limestone; and (5) the overlying Council Grove Group is redefined to include strata lying between the base of the Neva Limestone and the base of the Chase Group, and (6) regionally the base of the emended Council Grove Group marks the base of the Permian System. The emended Council Grove Group is lower Wolfcampian in age and is time equivalent with the Neal Ranch Formation of the West Texas type Wolfcampian.

¹ Kansas Geological Survey, University of Kansas, 1930 Constant Avenue, Campus West, Lawrence, Kansas 66047-2598

² Department of Geology, Oklahoma State University, Stillwater, Oklahoma 74078

³ Chevron U.S.A., Inc., P.O. Box 1635, Houston, Texas 77251

INTRODUCTION

As originally defined, the Virgilian Series comprised the youngest rocks of Pennsylvanian age in the Midcontinent (Moore, 1932; 1949). Boundaries of the chronostratigraphic unit were defined at regional disconformities, rather than by biostratigraphic zonations. The lower boundary was placed at the disconformity developed at the top of the Missourian Series (base of the Stranger Formation). However, placement of the upper boundary, or base of the Permian System, has been in dispute for decades. After numerous vacillations (Fig. 1), Moore (1940) concluded that the top of the Virgilian sequence (base of the Permian System) should be placed at what he believed to be a major disconformity immediately above the Wood Siding Formation, the uppermost unit in the Wabaunsee Group. Mudge and Yochelson (1962) coordinated an exhaustive study of stratigraphy and paleontology of the Pennsylvanian-Permian boundary in Kansas. However, they did not examine the paleontology in detail above the Americus Limestone Member, thus they eventually reached the conclusion that: "As there is no clear agreement as to what constitutes the Permian, especially in regard to definition on the basis of fossils, any boundary established in Kansas must be regarded as tentative and subject to change when more is known of the type area in Russia or of the standard sequence for North America" (Mudge and Yochelson, 1962, p. 127). That arbitrary stratigraphic position of the Pennsylvanian-Permian boundary at the base of the Admire Group has since been followed by the Kansas Geological Survey (O'Connor and others, 1968).

Much of the early confusion resulted from a lack of agreement by Russian geologists on what rocks were to be included in the type Permian (Baars, 1990). Since Likharev (1959) placed the Carboniferous-Permian boundary at the base of the Asselian in Russia, most stratigraphers have agreed (Waterhouse, 1978; Chuvashov, 1989). There also was confusion regarding critical fusulinid nomenclature that clouded the issue (Ross, 1963). General agreement among fusulinid paleontologists, although not adopted by the International Commission on Stratigraphy, is that the base of the Pseudoschwagerina biozone marks the base of the Permian System (Ross, 1989). Ammonoid (Furnish, 1989) and conodont (Wardlaw, 1989; Ritter, 1989) paleontologists tend to generally concur with that selection. This biozone first occurs in the Neva Limestone in Kansas (Ross, 1963; King, 1988).

Placement of the base of the Permian at the base of the Neva Limestone necessitates repositioning the top of the Pennsylvanian upward stratigraphically to that boundary. A section including the Admire Group and the lower formations of the Council Grove Group necessarily must be reassigned to the upper Pennsylvanian System. This section has traditionally been considered as early Wolfcampian in North America for decades, and includes the Bursum and Pueblo intervals in Texas and New Mexico (Ross, 1963), and the Elephant Canyon Formation of eastern Utah. Microfaunas in this Admire-Bursum-Pueblo interval include the Triticites-Schwagerina biozone that predates the zone of Pseudoschwagerina, and is considered to be latest Carboniferous in Europe. This reassignment makes the top of the Pennsylvanian in North America coincident with the top of the Carboniferous in Europe.

CONODONTS

Conodonts are important index fossils in most systems from the Cambrian to the Triassic, however, they have played only a minor role, subordinate to that of the fusulinids and ammonoids, in determination of the Carboniferous-Permian (C-P) boundary. Latest Carboniferous to Early Permian conodont faunas are low in diversity and consist of elements of two evolutionary cycles. Holdovers from the Late Carboniferous include Idiognathodus, Streptognathodus and Cavugnathus. The Early Permian is ushered in by the inception of Sweetognathus and novel species of Neogondolella. Because conodonts undergo a faunal replacement, two approaches to a conodont-based boundary have been advocated. Some workers have suggested using the first occurrence of uniquely Permian Sweetognathus whitei to define the C-P boundary at the base of the Sakmarian Stage. During the past 15 years Soviet workers have established a reliable biostratigraphic zonation for the Gzhelian and Asselian Series based upon speciation events in the genus Streptognathodus. Conodonts are present and often abundant in at least select lithofacies within the Wabaunsee, Admire and Council Grove Groups. These faunas are dominated by species of Streptognathodus, with modest but significant occurrences of Sweetognathus. Although detailed evaluation is still in progress, these faunas suggest that the beginning of the Sweetognathus-Neogondolella provides a sound conceptual and practical basis for placing the C-P boundary at the level of the Neva Limestone.

The first occurrence of Sweetognathus in the Midcontinent is within the Neva Limestone in both northern Oklahoma and southern Nebraska. The Neva specimens have an adenticulate carina and are assigned to Sweetognathus expansus (Perlmutter), the founding species of the genus. In the Midcontinent this species is joined or succeeded stratigraphically by Sw. merrilli (Kozur), Sw. inornatus (Ritter) and Sw. whitei (Rhodes) in the overlying Council Grove and Chase Groups. Sweetognathus expansus has not been recovered, however, from the Neva Limestone in Kansas nor has it been reported from sections outside of the U.S.A. Hence, this seminal species may have only limited application as an indicator of the C-P boundary.

The appearance of Sw. expansus is preceded and accompanied by important changes in the more widespread holdover genera Idiognathodus and Streptognathodus. Despite persisting taxonomic problems, studies in progress reveal that evolutionary trends within these genera in the Midcontinent are similar to those reported from the type Permian of Russia. Because a full evaluation of Streptognathodus faunas from the Wabaunsee, Admire and Council Grove Groups is not yet completed these zones are not applied at this time to rocks of the Midcontinent. Nevertheless, we recognize four nearly identical conodont faunal intervals in Gzhelian to Asselian rocks of both Russia and the Midcontinent. A straw vote of the Working Group on the C-P Boundary on July 13, 1989 tentatively established the first occurrence of Streptognathodus barskovi accompanied by the base of the Schwagerina moelleri-Pseudofusulina fecunda (Pseudoschwagerina) fusulinid Zone as the base of the Permian System.

In the Midcontinent, the base of this interval is characterized by a sharp decline in the relative abundance of S. wabaunsensis, the appearance and predominance of narrow elongate streptognathodids with extremely short carina, and the appearance of Sweetognathodus expansus. These changes are first noted in the lower part of the Neva Limestone. The exact time of these

changes is obscured by the near absence of conodonts in the Howe Limestone through Salem Point Shale. S. barskovi has its earliest occurrence in the Bennett Shale but constitutes less than 2% of the total fauna. S. barskovi is present in the Neva Limestone where it is slightly more common.

VIRGILIAN SERIES REDEFINED

The Virgilian Series was originally defined to include all rocks from the top of the Missourian Series to the base of the Permian System. As such, the top of the Virgilian must now be placed at the base of the Neva Limestone of the Council Grove Group that contains fusulinids of the Pseudoschwagerina biozone, the first appearance of the conodont genus Sweetognathus (Ritter, 1989) and the ammonoid Subperrinites bakeri (Wardlaw, 1989). The base of the Virgilian remains unchanged at the base of the Stranger Formation.

The reference section of the series is exposures along the Verdegris River in Greenwood County, Kansas. The top is here extended stratigraphically upward to the base of the Neva Limestone. This revised Virgilian section is, in many respects, more in line with Moore's (1932) original definition of the Virgilian, the top of which he placed at the Americus Limestone in Kansas. Thus the Admire Group and lower Council Grove Group as previously defined, are of latest Virgilian age. Regionally, the controversial Bursum-Pueblo-Elephant Canyon intervals, containing the Triticites-Schwagerina biozone, are here included in the latest Virgilian.

Microfaunal studies of the Virgilian Series have not previously been published in sufficient detail to characterize the series. Paleontological samples of the redefined type Virgilian collected by C.G. Maples, R.R. West (Kansas State University) and W. Henry (USGS) are currently being studied. Charles A. Ross is studying the fusulinids, and Scott M. Ritter is studying the conodonts. These investigations are being done in cooperation with the Kansas Geological Survey for a more accurate biostratigraphic definition of the series.

ADMIRE GROUP REDEFINED

To compartmentalize and simplify lithostratigraphic nomenclature accompanying redefinition of the Virgilian Series, the Admire Group is here redefined to include all strata from the base of the Onaga Shale to the base of the Neva Limestone. Thus, the Admire Group now includes (ascending) the Onaga Shale, Falls City Limestone, Janesville Shale, Foraker Limestone, Johnson Shale, Red Eagle Limestone, Roca Shale, and the Sallyards Limestone, Legion Shale, Burr Limestone, and Salem Point Shale members of the Grenola Limestone. The base of the Neva Limestone, as here redefined, will constitute the base of the Council Grove Group and the base of the Wolfcampian Series (Lower Permian) (Fig. 2).

The Admire Group (revised) now comprises a thicker series of cyclical carbonates and fine clastics, but still has approximately the same geographic distribution and significance as the former group. It overlies the Wabaunsee Group and underlies the Council Grove Group as previously used, but is reassigned to the latest Virgilian Series.

O'Connor et al., 1968			This report				Ural Mtns. Russia (Chuvashov, 1989)	
Permian System	Gearyan Stage	Chase Group	Wreford Limestone	Chase Group	Wolfcampian Series	Permian System	Asselian Series	Permian System
		Council Grove Group	Speiser Shale Funston Limestone Blue Rapids Shale Crouse Limestone Easley Creek Shale Bader Limestone Stearns Shale Beattie Limestone Eskridge Shale Neva Limestone	Council Grove Group				
			Admire Group	Grenola Limestone Roca Shale Red Eagle Limestone Johnson Shale Foraker Limestone Janesville Shale	Admire Group			
				Falls City Limestone Onaga Shale				
Pennsylvanian System	Virgilian Stage	Wabaunsee Group	Wood Siding Formation Severy Shale	Wabaunsee Group	Virgilian Series	Pennsylvanian System	Gzhelian Series	Upper Carboniferous
		Shawnee Group	Topeka Limestone Oread Limestone	Shawnee Group				
		Douglas Group	Lawrence Formation Stranger Formation	Douglas Group				
	Missourian Stage	Lansing Group	Stanton Limestone	Lansing Group	Missourian Series			

Figure 2. Stratigraphic column showing previous assignments under the column labelled O'Connor et al., 1968 compared with the proposed usage of this report, relative to generally accepted standard Russian terminology.

COUNCIL GROVE GROUP REDEFINED

To accommodate changes in latest Pennsylvanian nomenclature the Council Grove Group, as here redefined, is proposed to consist of all strata from the base of the Neva Limestone to the base of the Wellington Formation. The Neva Limestone is elevated to formation status to simplify lithostratigraphic terminology and to begin the redefined Permian System and Council Grove Group with a sequence boundary. The Neva Limestone contains the first occurrences of fusulinids of the Pseudoschwagerina biozone.

Thus, the Council Grove Group consists of (ascending) the Neva Limestone, Eskridge Shale, Beattie Limestone, Stearns Shale, Bader Limestone, Easley Creek Shale, Crouse Limestone, Blue Rapids Shale, Funston Limestone, and Speiser Shale (Fig. 2). It is underlain by the Admire Group and overlain by the Chase Group, and is of lower Wolfcampian (Lower Permian) age, biostratigraphically equivalent to the Neal Ranch Formation of the type Wolfcampian (Ross, 1963).

CONCLUSIONS

- 1) The Neva Limestone contains the first occurrences of the Pseudoschwagerina biozone, and thus constitutes the base of the global Permian System. It is here elevated to formation status.
- 2) To accommodate the relocated base of the Permian System, the Virgilian Series is extended stratigraphically upward to include all rocks above the Missourian Series and below the Neva Limestone.
- 3) The Admire Group is here redefined to include strata between the base of the Onaga Shale up to the base of the Neva Limestone. The group is latest Virgilian (latest Pennsylvanian and latest Carboniferous) in age.
- 4) The Council Grove Group is redefined to include all strata between the base of the Neva Limestone and the base of the Chase Group. The group is earliest Wolfcampian (Lower Permian) in age.

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