Proposed Repositioning of the Pennsylvanian–Permian Boundary in Kansas

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Abstract

The Pennsylvanian–Permian boundary in North America has not corresponded with the Carboniferous-Permian boundary in Europe for decades. To facilitate global correlations, an attempt is here made to suggest a possible solution to the dilemma by making the best possible correlation of the Kansas stratigraphic section with the recently proposed boundary location in the Russian type section.

The Virgilian Stage (Upper Pennsylvanian) was defined nearly 60 years ago to include those rocks lying between the Missourian Stage and the base of the Permian System. In the type area in east-central Kansas, the Virgilian Stage comprised the Douglas, Shawnee, and Wabaunsee Groups. In Kansas, the Pennsylvanian–Permian boundary was placed eventually at the top of the Brownville Limestone Member 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 suggest a change in the placement of the Virgilian–Permian boundary.

A Russian delegation formally proposed at the International Congress on the Permian System of the World held in Perm, U.S.S.R. (Russia) in August 1991 that the base of the Permian System be established at the base of the Asselian Stage at the approximate stratigraphic position of the first inflated fusulinids (*Sphaeroschwagerina vulgaris-S. fusiformis*). Inflated schwagerinids (*Paraschwagerina kansasensis*) first occur, along with evolutionary changes in conodonts, in the Neva Limestone Member of the Grenola Limestone (Council Grove Group). Thus, if we assume that inflated schwagerinids arose globally at about the same time, the Neva Limestone Member is the oldest definitive Permian in the United States midcontinent, as related to the newly proposed boundary in Russia and Kazakhstan. Consequently, we propose that the Virgilian Stage in Kansas include rocks between the top of the Missourian Stage and the base of the Neva Limestone Member.

Introduction

The location of the Pennsylvanian–Permian boundary in the stratigraphic section in North America has been under dispute for decades. As such, the upper limits of the Pennsylvanian System have not corresponded with the Carboniferous–Permian boundary in Europe, causing unnecessary confusion and debate on a global basis. With the advent of consensus by Russian geologists on a proposed Carboniferous–Permian boundary in the type Permian section in the Southern Ural Mountains (Davydov et al., 1991), the controversy potentially can be resolved.

As originally defined, the Virgilian Stage comprised the youngest rocks of Pennsylvanian age in the midcontinent (Moore, 1932a, 1932b, 1936, 1949). Stage boundaries were defined at regional disconformities, rather than by biostratigraphic zonations. Placement of the upper boundary, or base of the Permian System, has been in dispute for decades. The Virgilian Stage was first mentioned by Moore (1932a), and formally proposed by Moore (1932b). At that time, Moore (1932b, p. 89) indicated that the base of the Neva Limestone was adopted in Oklahoma as the Pennsylvanian–Permian boundary, but considered the base of the Americus Limestone Member (Foraker Limestone, Council Grove Group) to better represent the systemic boundary stating: ". . . if the Cottonwood and Neva are to be reckoned as Permian, then the beds beneath them down to the Americus seem surely to belong to the same division." He later (Moore, 1936, p. 143) designated the type section as being along the Verdigris River in east-central Kansas. After numerous vascillations, Moore (1940) concluded that the base of the Permian System should be placed at the disconformity between the Wabaunsee and Admire Groups (top of the Brownville Limestone). 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 reached the conclusion that: "... 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). More is now known of the type area in Russia. After reviewing the typical Permian in the southern Ural Mountains, Baars et al. (1991) and Baars et al. (1992) proposed that the base of the Permian System in Kansas is best placed again at the base of the Neva Limestone Member.

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Fusulinids

In writing early drafts of this manuscript, we experienced difficulty in communicating to each other about the taxonomy of inflated schwagerinids and their significance to stratigraphic zonation. Early problems of the taxonomy of inflated schwagerinids have been extensively discussed by Dunbar and Skinner (1936), Dunbar (1958), Rauser-Chernousova (1936, 1956), and Skinner and Wilde (1966b).

The basic problem revolves around the question of the correct concept of the genus *Schwagerina* Möller. Möller (1877, 1878) misidentified specimens that he studied for an earlier species that had been poorly described and illustrated by Ehrenberg (1854) as *Borelis princeps*. Möller (1877), believing the specimens he was studying were the same as Ehrenberg's *B. princeps*, selected Ehrenberg's species (and specimens) as the type of his new genus *Schwagerina*. Much later Dunbar and Skinner (1936) restudied the type specimens of Ehrenberg's *Borelis princeps* and discovered they were significantly different from the highly inflated specimens illustrated under that name by Möller (1878). Dunbar (1958) compared the general morphological feature of *Borelis princeps* Ehrenberg with those in *Schwagerina uralica* Krotow. Both are from the Lower Permian of the Russian Platform.

Based on their restudy of Ehrenberg's specimens of *Borelis princeps*, Dunbar and Skinner (1936) defined two genera of inflated schwagerinids from the midcontinent and southwestern North America. For *Pseudoschwagerina* they selected as type species *Schwagerina uddeni* Beede and Kniker, 1924, and for *Paraschwagerina* they selected *Schwagerina gigantea* White, 1932, both common North America species from the lower part of the Wolfcampian Series.

Beede and Kniker (1924) who had first recognized the worldwide geographical and stratigraphic significance of the "Zone of *Schwagerina*," were at that time using Möller's misidentified illustrations as their concept of *Schwagerina*. Thus, after 1936, the "Zone of *Schwagerina*" became the "Zone of *Pseudoschwagerina*," at least in much of the world.

Rauser-Chernousova (1936) recognizing that the Ehrenberg specimens restudied by Dunbar and Skinner (1936) could not be the same species as the specimens illustrated by Möller (1878) renamed Möller's specimens *Schwagerina mölleri*, then proposed *S. mölleri* as the type species of *Schwagerina* in an attempt to correct the misidentification. The International Commission on Zoological Nomenclature (1954; Opinion 213) upheld Möller's original (1877) designation of *Borelis princeps* Ehrenberg. Rauser-Chernousova (1956) protested on the grounds that Ehrenberg's specimens had only vague locality information and were silicified and sufficiently poorly preserved to be unidentifiable (however, Opinion 213 has not been reversed). Thus, in the former Soviet Union, use of the "Zone of *Schwagerina*" continued unchanged so that the "Zone of *Schwagerina*" and the "Zone of *Pseudoschwagerina*" represent essentially the same zone of inflated schwagerinids. Lower Permian Asselian to Sakmarian (Wolfcampian) genera of inflated schwagerinids that concern us are shown in table 1.

Ozawa et al. (1990) recognized five main lineages in the Asselian inflated schwagerinids in the Akiyoshi Limestone, Southern Honshu, Japan. The *Sphaeroschwagerina* lineage becomes inflated beginning with *Sphaeroschwagerina fusiformis* at the base of the Asselian and evolves through *Sphaeroschwagerina mölleri* (=*Schwagerina mölleri* Rauser-Chernousova) and *Sphaeroschwagerina sphaerica* to become extinct at the end of the Asselian. (These are the "Zone of Schwagerina" species of Rauser-Chernousova and most other "Soviet" studies.) Rauser-Chernousova (1949) suggested that this lineage had its roots in *Schubertella* based on features of the juvenarium, and others (Davydov, 1984) have found additional evidence to support this evolutionary history. (Here we are going to ignore the taxonomic implications that *Sphaeroschwagerina* may not even be a schwagerinid.) This lineage is widespread in the Paleotethys (Japan, South China, Indochina, Central Asia and Carnic Alps, and, with question, from Cache Creek terrane of British Columbia), on the Russian Platform, northeast Greenland, Franklinian region of northern Canada, and as far south on the Euramerican craton as central eastern British Columbia. It has not been recorded from the non-Tethyan accreted terranes of the western Cordillera or from either the western or the southern part of the Paleozoic craton of United States or from South America.

Ozawa et al. (1990) recognized an *Alpinoschwagerina* line that evolved from a species group of *Triticites*, starting with *T. schwageriniformis*, through *T. convexus* and, in the middle Asselian, to the inflated *Alpinoschwagerina turkestanica* (fig. 1). The *Alpinoschwagerina* lineage ranges through the middle and upper Asselian into the lower Sakmarian before becoming extinct. It is apparently widespread, particularly in the Paleotethys, and is even reported from an isolated locality in south-central Texas.

The two southwestern United States lineages of Ozawa et al. (1990), their *Pseudoschwagerina uddeni* and *Pseudoschwagerina texana* lineages (fig. 1), probably both originated from the same *Triticites* ancestor, perhaps *T. subventricosus* or a similar species. *Pseudoschwagerina beedei* and *P. needhami* are among the early species of this group and some specimens are closely similar to *Occidentoschwagerina fusulinoides*, which is one of the zone species to the lowest Asselian. Ozawa et al. (1990) perceived three branches evolving from this earliest species complex of *Pseudoschwagerina*. Their *Pseudoschwagerina muongthensis* lineage leading to *Zellia* and *Robustoschwagerina* in the Sakmarian is predominantly a Paleotethys line, even if one species of *Robustoschwagerina* briefly floated into West Texas in the earliest Leonardian. In the midcontinent and southwestern United States, the *P. uddeni* lineage evolved toward subspherical tests and the *P. texana* lineage evolved toward slightly less inflated tests. If one accepts that the earliest part of these lineages includes *Occidento-schwagerina fusulinoides*-like forms, then during the early Asselian they were cosmopolitan and become geographically separate lineages in the middle and late Asselian. The derived genera, *Zellia* and *Robustoschwagerina*, in the Sakmarian are mainly Paleotethys.

In spite of a complex, and at first glance, a confused taxonomic nomenclature, the inflated schwagerinids are reasonably well studied and may form a very useful group to zone the Asselian and Sakmarian Stages (and the Wolfcampian Series). In the southwestern United States, early Wolfcampian species of *Pseudoschwagerina* are more common and more abundant than those of *Paraschwagerina*; however, they occur in many of the same collections and both are part of the same early Wolfcampian fossil community and stratigraphic zone. The presence of a species of *Paraschwagerina*, such as *Paraschwagerina kansasensis*, in the Neva Limestone Member of Kansas, without accompanying species of *Pseudoschwagerina*, is an example of an incomplete community assemblage. *Pseudoschwagerina* is scarce everywhere in the Kansas lower Permian succession.

Conodonts

Conodont workers note significant faunal changes that coincide with the appearance of *Paraschwagerina kansasensis*, a constituent of the *Pseudoschwagerina uddeni* biozone, in the midcontinent United States (Ritter, 1989; Wardlaw, 1989). These faunal changes occur at the level of the Neva Limestone Member in Kansas, Oklahoma, and Nebraska (Ross, 1963; King, 1988). Conodont faunas from the Late Carboniferous are dominated by *Idiognathodus*, *Streptognathodus*, and *Adetognathus*. The Early Permian is characterized by the inception of *Sweetognathus* and continued evolution of *Streptognathodus*. Conodonts within the Late Pennsylvanian and Early Permian (Wabaunsee, Admire, and Council Grove Groups) reflect the changeover from faunas of Late Carboniferous aspect to typical Permian faunas. *Sweetognathus* first occurs in the basal limestone of the Neva Limestone Member along with the appearance of *Streptognathodus* cf. *S. longissimus* (Ritter, 1991). This horizon also marks a decline in the relative abundance of nodose *Streptognathodus wabaunsensis*. This faunal changeover provides a conceptual and practical basis for correlating the Carboniferous–Permian boundary in the midcontinent at the level of the Neva Limestone Member using conodonts, although correlations are not yet firmly established in the Southern Ural Mountains of Russia and Kazakhstan (Ritter, in preparation). If an ammonoid or some other conodont zonation were to be employed in defining the basal Permian in the type area, the Pennsylvanian–Permian boundary may move eventually somewhat below the Neva Limestone Member. Wherever the boundary is placed officially, the Neva Limestone Member represents the lowest undisputed Permian rocks in the midcontinent.

Discussion

Much of the early confusion resulted from a lack of agreement among Russian geologists as to what constituted the Permian in the type area (Baars, 1990). There also was confusion regarding critical fusulinid nomenclature that clouded the issue (Ross, 1963). Following Likharev (1959), most stratigraphers have placed the Carboniferous–Permian boundary at the base of the Asselian Stage (Ross and Ross, 1979; Waterhouse, 1978; Chuvashov, 1989; Davydov et al., 1991). During the International Congress on the Permian System of the World held in Perm, U.S.S.R. (Russia) in August 1991, a Russian delegation proposed that the historical base of the Asselian, as established by V. E. Ruzhenzev at the first occurrence of *Sphaeroschwagerina vulgaris* and *S. fusiformis*, be accepted by the International Stratigraphic Commission as the base of the Permian System (Davydov et al., 1991). The proposed boundary stratotype was indicated as between Bed 19 and Bed 20 in the Aidaralash section in the southern Ural Mountains of northern Kazakhstan. Bed 20 lies 12 m (36 ft) stratigraphically above the base of the *S. vulgaris–S. fusiformis* fusulinid biozone (Bed 19.6). The *S. vulgaris–S. fusiformis* interval lies immediately stratigraphically below *Pseudoschwagerina* occurrences in the southern Urals and in Japan; however, it is not known to occur in the Glass Mountains of Texas or in Kansas. We therefore interpret the first occurrence of the *Ps. uddeni* biozone to constitute the earliest Permian interval represented in Kansas, and interpret that position as approximately equivalent to the *S. vulgaris–S. fusiformis* biozone as it occurs in the southern Ural Mountains. Fusulinid paleontologists generally agree that the base of the *Pseudoschwagerina* biozone marks the base of the Permian System in the United States (Ross, 1989), because the *S. vulgaris–S. fusiformis* is missing. Our assumption here is that inflated schwagerinids arose penecontemporaneously on a global basis (in low paleolatitudes) irrespective of generic assignment, or that *S. vulgaris-S. fusiformis* are missing due to stratigraphic or paleoenvironmental aberrations. In other words, the base of the Neva Limestone Member is the closest possible correlation between the Kansas section and the type Permian on the basis of the presently known distribution of fusulinids.

If our proposed repositioning of the base of the Permian at the base of the Neva Limestone Member in Kansas is accepted, it would necessitate 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 would be reassigned to the Upper Pennsylvanian Series (Virgilian Stage). 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 parts of the Elephant Canyon Formation of eastern Utah (Baars, 1962). Microfaunas in this Admire–Bursum–Pueblo interval include the *Triticites–Schwagerina* biozone that predates the zone of *Pseudoschwagerina uddeni*. The base of the Permian *Ps. uddeni* biozone is closely constrained at the base of the Neva Limestone Member by the presence of *Triticites creekensis*, a component of the *Schwagerina–Triticites* biozone of Bursum–Pueblo–Admire affinities, in the Burr Limestone Member of the Grenola Limestone, the next underlying limestone below the Neva Limestone Member (King, 1988). This biozone is considered to be latest Carboniferous (Orenburgian/Gzhelian) in Europe. This proposed repositioning would make the top of the Pennsylvanian in North America coincident with the top of the Carboniferous in Europe.

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TABLE 1—LOWER PERMIAN ASSELIAN TO SAKMARIAN (WOLFCAMPIAN) GENERA OF INFLATED SCHWAGERINIDS.

Genera	Type Species
Sphaeroschwagerina Miklukho–Maklai	*Schwagerina sphaerica* var. *karnica* Shcherbovich *in* Rauser–Chernousova and Shcherbovich
Alpinoschwagerina Bensh	*Alpinoschwagernia turkestanica* Bensh
Occidentoschwagerina Miklukho–Maklai	*Schwagerina fusulinoides* Schellwien
Pseudoschwagerina Dunbar and Skinner	*Schwagerina uddeni* Beede and Kniker
Parazellia Rauser–Chernousova	*Fusulina muongthensis* Depart
Paraschwagerina Dunbar and Skinner	*Schwagerina gigantea* White
Zellia Kahler and Kahler	*Pseudoschwagerina* (*Zellia*) *Heritschi* Kahler and Kahler
Eozellia Rozovskaya	*Pseudoschwagerina primigena* Rauser–Chernousova, *in* Rauser–Chernousova and Shcherbovich

(Several of these genera, such as *Pseudoschwagerina*, *Parazellia*, and *Alpinoschwagerina* are similar to one another in certain, but not all, of their morphological features and were subjectively synomonized by Loeblich and Tappan, 1988.)

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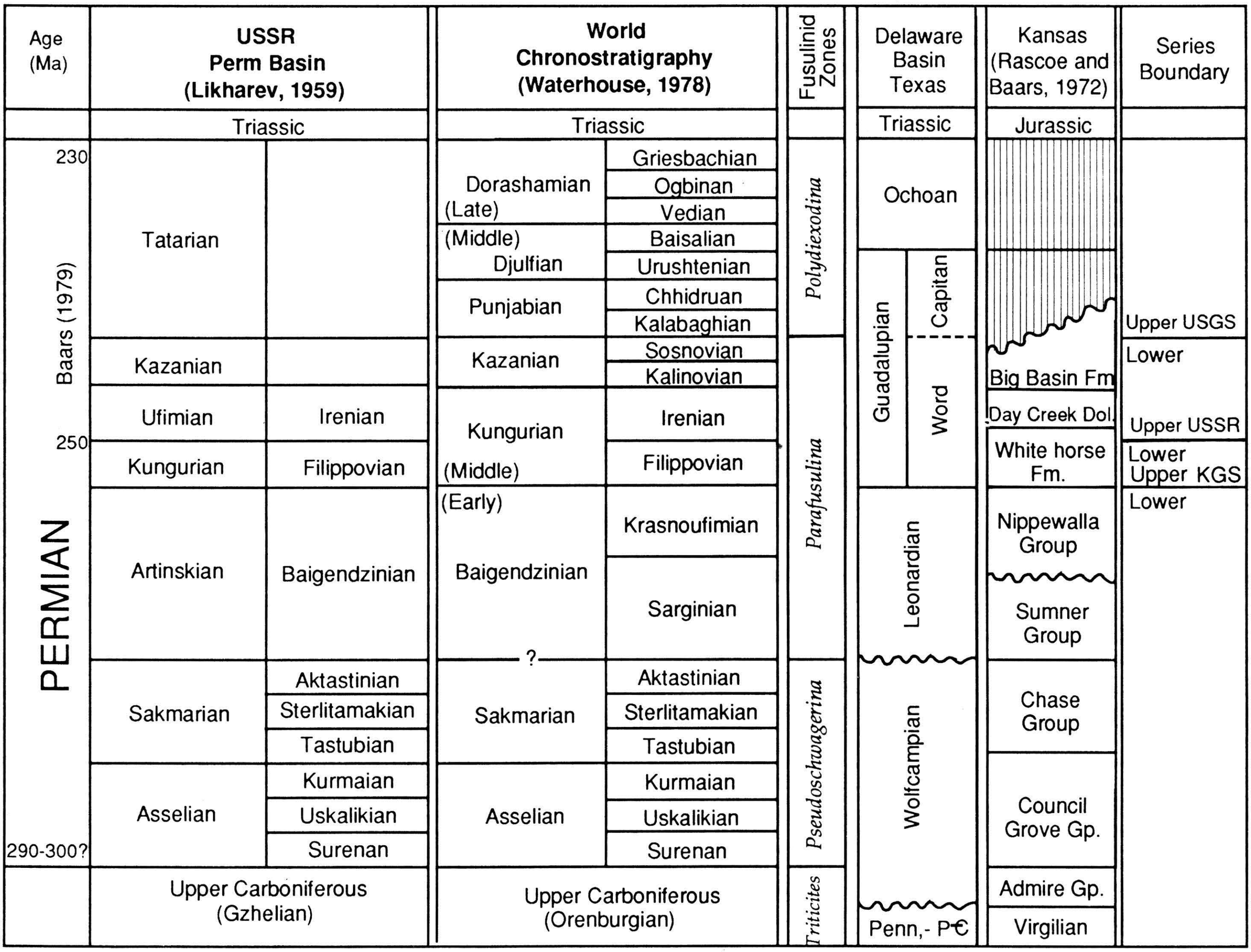

FIGURE 1—Range of characteristic genera and species of inflated schwagerinids and their possible evolutionary and phylogenetic relationship. This is considerably modified from Ozawa et al. (1990), and the southwestern North American column is after Ross and Ross (1987a, b).