THE LADINIAN-CARNIAN BOUNDARY SUCCESSION AT SOUTH CANYON (NEW PASS RANGE, CENTRAL NEVADA)

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Abstract—During the past few years, an extensive bed-by-bed sampling program for ammonoids, pelagic bivalves and conodonts was conducted at the classic South Canyon (central Nevada) locality. This area, recognized as the best site for the study of the earliest Carnian in North America, has never before been examined with such an approach. Preliminary data, which are of interest for the discussion of the GSSP of the Carnian Stage (Upper Triassic Series), are herein presented. The Middle Member of the Augusta Mountain Formation (Star Peak Group) contains an unusually rich ammonoid, conodont and pelagic bivalve record. Furthermore, sampling data yielded by these three biostratigraphic tools indicate that a revision in age is necessary for a portion of the studied sections. The occurrence of the ammonoids *Daxatina* and *Frankites sutherlandi* along with the composition of the conodont assemblages and the presence of bivalves closely related to *Daonella elegans* all combine to form the basis for the suggested change in attribution of the lower part of the Middle Member from the Desatoyense Zone to the Sutherlandi Zone.

INTRODUCTION

South Canyon, in the New Pass Range (central Nevada: Fig. 1), is the most important fossiliferous site in North America for the investigation of the boundary between the Middle and Upper Triassic Series (Fig. 2). This site, together with Prati di Stuores (Dolomites, Italy) and Spiti (Tethys Himalaya, India), is one of the three best sites in the world for the definition of the GSSP of the base of the Carnian Stage. The aims of the field excursion to South Canyon (Lucas et al., this volume) are: (a) to examine the sedimentary succession, (b) to visit the best outcrops, and (c) to test the rich and unique fossil record. New preliminary data will be presented on ammonoids, bivalves and conodonts collected during a joint cooperative program begun in 2002.

SOUTH CANYON: HISTORY OF PALEONTOLOGICAL INVESTIGATIONS

Early-day prospectors discovered gold in the New Pass Range in 1864 or 65 near a diorite intrusion located on the west side of the range (Johnston, 1930). This find soon attracted the attention of professional mining geologists, and their subsequent geological reports (Raymond, 1869; White, 1869) included references to the existence of fossiliferous limestone beds in the area. Recognition of these beds as being of marine origin and of Triassic age was first noted in reports of the Fortieth Parallel Survey by Emmons (1877) and King (1878) (see also MacMillan, 1972). They correlated these rocks, which are primarily exposed along the west flank of the range, with the Star Peak Group, a thick unit of largely marine pre-Tertiary strata exposed in the Humboldt Range and...
recognized as a natural subdivision by the Fortieth Parallel Survey (Nichols and Silberling, 1977). Emmons (1877) included a list of the fossils collected from the limestone beds in his report, and Smith, upon examination of these fossils, recognized their age as Middle Triassic (Daltonella dubia Zone) and listed them in his 1914 monograph on the Middle Triassic of North America. The paleontology of the New Pass Range was then largely ignored until Francis N. Johnston, at the suggestion of Smith, visited the area twice in 1929 to collect fossils and study the geology of the area (Johnston, 1930).

During this early reconnaissance, Johnston collected a new and younger ammonoid fauna from shaly limestone beds in South Canyon. These beds, positioned a considerable stratigraphic distance above the Middle Triassic Daltonella dubia Zone and marked at the base by a distinct brachiopod bed, contained a diverse fauna including Halobia and trachyceratid ammonoids, which he somewhat questionably correlated with the Trachyceras aon Zone of the European Alps (Johnston, 1930).

Johnston summarized his findings in his 1930 Stanford University MA thesis, in which he recognized, among various other ammonoids, several species of Trachyceras. Interestingly, he recognized that this new fauna was older than the Late Carnian Tropites subbullatus Zone of California, but was unsure if it was of Late Ladinian or Early Carnian age (Johnston, 1930).

The second paleontologist to visit South Canyon was Muller, in 1936. He briefly described the extensive coral beds of Ladinian age, which occur above the “Daltonella dubia” Zone and below Johnston’s new Trachyceras beds. A few years later Johnston (1941) authored an extensive paper in which he not only formally described several new species of ammonoids from his Trachyceras beds in South Canyon, but he also definitely established the new fauna’s age as Early Carnian and with considerable confidence, correlated it with the Ladinian zones of the European Alps.

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The entire Triassic section of the north side of South Canyon was measured by Silberling (1956), who reported the occurrence of the typical Upper Ladinian ammonoids Protrachyceras aff. P. archelaus and Protrachyceras cf. P. meeki above the coral beds and below the Trachyceras beds. He also demonstrated that the northern California Upper Carnian ammonoids, for which Smith named his “Trachyceras subzone,” are morphologically distinct from true Trachyceras, and he subsequently assigned them to the new genus, Spirotrachyceras. Afterwards, during a visit to South Canyon in 1964, Silberling and Tozer found Paratrachyceras cf. P. sutherlandi McLearn (now Frankites sutherlandi [McLearn]) together with Protrachyceras cf. P. archelaus (Laube) and Hungarites sp. several hundred feet stratigraphically below the Trachyceras beds on the south side of the canyon (Silberling and Tozer, 1968). In the same publication, Silberling and Tozer formally introduced the Trachyceras desatoyense Zone to replace Johnston’s Joannites Zone.

Conodonts were discovered at South Canyon in the same year by Mosher (1968), who described a fauna from the Trachyceras Zone, which included the new species Neospathodus newpassensis (now attributed to Mosherella) and Paragondolella polygonaliformis (presently attributed to Metapolygnathus). Additional conodonts collected by L. Krystyn in 1989 and sent to Orchard also form part of this report.

Further investigations of the Upper Ladinian part of the succession were mostly carried out by Stanley, who reported foraminifers (Gazdzicki and Stanley, 1983), cnidarians (Roniewicz and Stanley, 1998) and bivalves (Waller and Stanley, 2005).

**SIGNIFICANCE OF SOUTH CANYON FOR THE TRIASSIC OF NORTH AMERICA**

The Triassic succession at South Canyon yields ammonoids, cnidarians, bivalves, foraminifers, conodonts, and brachiopods. However, most of its paleontologic and stratigraphic importance relies on the rich ammonoid fauna, on which Silberling and Tozer (1968) based their definition of the Trachyceras desatoyense Zone of the North American Standard Scale (Fig. 2). This zone is well documented by the 13 genera and 17 species described by Johnston (1941). A significant contribution made by Silberling and Tozer was the discovery of ammonoids of the Upper Ladinian Frankites sutherlandi Zone several hundreds of feet below the Trachyceras desatoyense Zone. On the basis of this discovery, Silberling and Tozer were able to demonstrate the position of the

![FIGURE 2. The North American Upper Ladinian–Carnian ammonoid Standard Scale (Tozer, 1994). The Trachyceras desatoyense Zone (shaded area) is the only zone of the Upper Ladinian-Lower Carnian that is not defined in British Columbia (BC). CA: California.](image)

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The range belongs to the Golconda allochthon (see Speed and Silberling, 1989) and exhibits a rather typical lithostratigraphic succession for this terrane. The oldest rocks are cherts and quartzites of the Ordovician Valmy Formation overlain by Middle Pennsylvanian Battle Formation conglomerates, which are overthrusted by the Pennsylvanian to Permian Havallah sequence, which, in turn, is depositionaly overlain by rocks of the Triassic Koipato and Star Peak groups (Stewart and McKee, 1977). Most of the range is formed by the Havallah sequence and Triassic units.

The Havallah sequence consists of shales, siltstones, cherts and greenstones, while the Triassic is comprised of two types of lithologic assemblages. The Early Triassic Koipato Group consists of conglomerates and siltstones containing various amounts of volcanic and tuffaceous rocks, whereas the Middle to Late Triassic Star Peak Group is made up of shelf limestones.

Generally, these sedimentary rocks strike north and dip steeply to the west in a west-dipping homocline. Rocks of volcanic origin, mainly ash-flow tuffs with some local units of Tertiary age tuffaceous sedimentary rocks, overlie the sedimentary rocks in the northern, eastern and southern parts of the area (Stewart and McKee, 1977). Numerous faults have formed a series of gently east-dipping fault blocks. Gold and manganese mineralization mainly occur along or near faults that cut rocks of the Havallah sequence (Stager, 1977).

THE MIDDLE-LATE TRIASSIC SUCCESSION

South Canyon is roughly oriented W-E and cuts the Triassic succession, which strikes 120°-140°SE and dips 40°-60° SW. Beds dip with the slope on the northern side of the canyon, whereas they dip against the slope on the southern side.

The Triassic succession was briefly described by Johnston (1941), but Silberling (1956) provided a detailed stratigraphic section. Additional stratigraphic remarks regarding the correlations of the lithostratigraphic subdivisions were provided by Nichols and Silberling (1977). The Star Peak Group is subdivided as follows (from bottom to top, Fig. 4):

Favret Formation

Alternation of thin bedded limestones with calcareous shales or siltstones. Fossil content: ammonoids (Bucher, 1988), daonellids (gr. of Daonella dubia). Average thickness 700 feet (210 m).

Augusta Mountain Formation

Lower Member

Approximately the lower half of the member consists of massive gray limestones with some intercalations of siltstones (lower part) and conglomerates (upper part), while the upper half consists of massive gray limestones, often bioclastic, sometimes oolitic, with rare intercalations of shales to siltstones. The limestones are locally rich in cnidarians, but also yield algae and foraminifers (Gazdzicki and Stanley, 1983; Roniewicz and Stanley, 1998; Waller and Stanley, 2005), whereas the shales and siltstones contain bivalves and rare ammonoids (Silberling and Tozer, 1968; Waller and Stanley, 2005). The topmost part of the member is rich in brachiopods, which occur in coquina-like layers. The member is best exposed along the crest of the southern side of the canyon, west from the New Pass Mine. Silberling (1956) estimated a thickness of about 1600 feet (480 m).

Middle Member

This member consists of an alternation of gray marls and gray to dark gray marly limestones, in which the marl/limestone ratio is not constant, and may change from 2:1 to 4:5:1, or even more. On average, the marly limestones are usually 10 to 20 cm thick, while the marl
intervals are 40-80 cm thick. The member is rich in fossils, in particular ammonoids, bivalves and brachiopods (Johnston, 1941; Silberling, 1956; Silberling and Tozer, 1968), especially in the lowermost part (Silberling and Tozer, 1968, p. 35). However, due to its soft-weathering lithology, the member is not very well exposed. The best outcrops are located on the north side of South Canyon, while on the southern side the unit is almost completely covered by debris from the Upper Member. Its total thickness is not easy to estimate. Johnston reported 500 feet (152 m), while in Silberling’s section (1956) it is about 660-680 feet (201-207 m). According to compass and GPS measurements, the thickness is about 280-290 m.

Upper Member

This member consists of massive gray limestones, some tens of meters thick. It is well exposed and forms a cliff on both sides of South Canyon.

THE STRATIGRAPHIC SECTIONS

The lowermost part of the Middle Member of the Augusta Mountain Formation, which contains the Trachyceras destoyense Zone according to the literature, is usually rather poorly exposed, even on the northern side of the canyon. The soft weathering lithology, the structural setting with bedding dipping with the slope, the rather gentle topography of the northern side of the canyon (slope dip between 14° and 25°), and the exposure higher on the slope of the weather-resistant, debris-producing Lower Member, all combine to create unfavorable conditions for well-exposed, laterally continuous, stratigraphically wide outcrops. However, the debris cover is not very thick, and small, fossiliferous outcrops are quite common. Five fossiliferous sites, distributed over a distance of less than 500 m along strike, were selected for bed-by-bed sampling (WGS84 coordinates 39°36’N, 117°30’W: sites A, B, D, E and F) based on the amount and quality of the fossil-bearing bed. The natural outcrops were enlarged by excavating and trenching, especially at sites A, B and D. Figure 5 shows the synthetic section of the interval of the uppermost part of the Lower Member and the lowest 70 m of the Middle Member, with the position of the stratigraphic intervals exposed at the 5 sites. The lithology of the 4 intervals is as follows:

1) Lower Member—Gray crinoidal packstones in 20 to 50 cm thick beds.
2) Lower Member—Gray bioclastic packstones in 10 to 20 cm thick beds, with rare marly interbeds. Packstones are rich in brachiopods, often disarticulated. Sometimes true coquinas exist, which are rich in articulated brachiopods. Thickness about 7 m.
3) Middle Member—Monotonous alternation of light gray to dark gray bioclastic marly mudstones and wackestones with gray marls. The mudstones-wackestones usually contain various amounts of ammonoids, sometimes also brachiopods and bivalves. Brachiopods are more common in the lowermost part. Estimated thickness about 65 m.
4) Middle Member—Interval dominated by gray mudstones in 30 to 50 cm thick beds, with some intercalations of up to 60 cm thick intervals consisting of marly mudstones/calcareous marls in 1 cm thick beds, and with marls. This interval, about 5 m thick, is much better exposed than the rest of the Middle Member.

SITE D(1)

Section

The best natural outcrop of lithologic interval 2 (Fig. 5; gray bioclastic packstones with brachiopods) is located at site D(1). This section (Fig. 6) was not sampled in detail. Brachiopods are very common, but extraction is rather difficult. Sample D31 yielded the conodonts Budurovignathus mungoensis, Neogondolella liardensis, and Paragondolella inclinata, an association typical of the Sutherlandi Zone in British Columbia.

SITES A AND B

Sections

Site A is almost equivalent to USGS Mesozoic locality M2560 (N.J. Silberling, personal commun., 2001), where Silberling and Tozer (1968) found the best record of Johnston’s Desatoyense fauna. Site B is a new site located about 230 m along strike to the east. At both sites (Fig.
Fossil distribution

Ammonoids (Preliminary Remarks)

Ammonoids are rather common in both sections. The majority of the specimens belong to taxa already described by Johnston (1941), and it is only natural to say that Johnston’s “fauna” is recorded from the top level of the Lower Member to the Middle Member. Since the Trachyceratidae have such great biostatigraphical and biochronological importance, it is fortunate that they are so common. However, it is unfortunate that the South Canyon Trachyceratidae are very difficult to classify at the present time (Balini and Jenks, in press).

Johnston (1941) attributed all Trachyceratidae in his collection to Trachyceras Laube, and grouped his specimens into three new species (Trachyceras desatoyense, T. bispinosum, and T. trispinosum), two new varieties of T. desatoyense, and two groups referred by confrontia to T. aon Münster and T. aonoides Mojsisovics. Unfortunately, Johnston’s taxonomy was based on specimens with retained test; therefore, the suture line for most of his new taxa is unknown. This lack of knowledge makes the definite generic attribution of Johnston’s species uncertain, since the suture line is actually the most significant feature for the separation of Trachyceras Laube from the very similar genus Daxatina Strand. Trachyceras has an ammonitic suture line, whereas the suture of Daxatina is ceratitic.

The study of the Trachyceratidae in the large bed-by-bed collection from South Canyon (more than 2,000 specimens) reveals that ceratitic to slightly frilled sutures are rather common (Balini and Jenks, in press). The taxonomic revision of Trachyceratidae is in progress, and hence, the data presented are preliminary.

More than 60-70% of the beds yield ammonoids, and some beds are very rich in specimens. The composition of the ammonoid assemblages is dominated by Trachyceratidae, which normally represent 45 to 90% of the total number of ammonoids. Other groups include Joannitidae, Clionitidae, Lobitidae and Noritidae, which are mainly represented by Joannites Mojsisovics, Clionites Strand, Lobites Mojsisovics and Neocyptites Spath, respectively. Arcestidae (Proarcestes Mojsisovics and Anisarchestes Kittil) and Hungaritidae (Perrinoceras Johnston) are rare. Faunal diversity is rather low in the lower part of site A (Fig. 7), levels A1.1 to A19, but then it increases from level Scan 3 (=A21).

At the present stage in the taxonomic revision of the Trachyceratidae, the following points are rather well established:

1) Trachyceras sensu Johnston (Fig. 8D-H) is very common from the uppermost bed of the brachiopod packstones (interval 2, Fig. 5) to the top of the section at sites A and B. However, several specimens have ceratitic suture lines and are better included in Daxatina Strand (Fig. 8A-C).

2) Trachyceratids commonly possess a thick preseptal layer (Tozer, 1972; Balini and Jenks, in press). This feature makes the morphological analysis of the internal mold vs the outer surface of the test very complex.

3) At site B, Frankties sutherlandi has been found in the levels SCAN 14 and SCAN 15 (Balini, in press; Fig. 7).

Pelagic Bivalves

The collection of bivalves from sites A and B contains a variety of bivalves (Fig. 9) including several species (e.g., Oxytoma gransvillensis) that were recently described by Waller (in Waller and Stanley, 2005).

Most of these bivalves, however, are only known from one or two localities and are largely from older, clearly Ladinian strata, including the Lower Member of the Augusta Formation at South Canyon (Unit E of Waller and Stanley, 2005) and the Grantsville Formation in the Shoshone Mountains.

The most abundant, and biochronologically useful bivalves in the collection are forms here referred to as Daonella ? cf. D. elegans McLearn (Fig. 9A-E). These are moderately large daonelliform bivalves with rather uniform and unbundled ribbing across most of the valve, including the anterodorsal region. In the early growth stages, the ribbing is broadly curved until a kink or sharp break (growth stop of some workers), which occurs about 5-10 mm from the beak. A narrow, flattened and smooth flange occurs along the dorsal margin in well-preserved specimens. Interestingly, a few individuals within the single sample populations show a clear, but poorly-developed though differentiated flattened tube lacking radial ribs in anterodorsal region. Accordingly, these variants conform with the concept of Halobia (see Polubotko, 1984; Campbell, 1994; McRoberts, 2000; Waller in Waller and Stanley, 2005). However, as a clear majority of individuals within sampled populations lack this differentiated region, they are tentatively placed within “Daonella?” until they are properly studied.

The “Daonellas” from both sites A and B are most closely related to Daonella elegans McLearn. They are conspecific with those origi-
nally referred to by Silberling (1956) as “Halobia.” In a subsequent paper, Silberling and Tozer (1968) referred to the same specimens as *Daonella elegans* McLearn and described their position (USGS loc. M2560) as co-occurring with *Trachyceras deysatoynense* in the “lower tens of feet of Middle Member” of the Augusta Mountain and above typical “Protrachyceras cf. *P. sutherlandi*” (now *Frankites cf. F. sutherlandi*). Silberling and Tozer (1968) further note, as discussed below, these appear to be somewhat younger than those found in British Columbia. Additional undescribed material in the USGS collections from a slightly higher level at South Canyon (USGS loc. M2561) include “daonellas” with clearly bundled ribbing and a poorly-developed, differentiated anterodorsal region.
The precise locality and age of the holotype of *Daonella elegans* is not well constrained. McLearn (1947) originally described this species as part of his “Nathrostites Fauna” from the so-called “dark siltstones” beds at the Sikanni Chief River area, northeast B.C. Canada. According to McLearn (1947, p. 8), *Daonella elegans* (presumably the holotype) and associated fauna were collected by “geologists of an oil company” from a locality simply described as “West of Mount Withrow.” In the same collection, McLearn (1947) lists an associated fauna of “Dawsonites?” and “Asklepioceras.” Subsequently, Tozer (1967) reports this species at several levels within the type locality for the Sutherlandi Zone (Boiler Canyon along the Liard River): a lower level (GSC loc. 68234) with *Frankites glaber*, an intermediate level (GSC locs. 68232 and 68233) with *Frankites sutherlandi*, and an upper level (GSC loc. 68231) with *Daxatina canadensis*. The best Canadian examples come from undescribed material from the Toad Formation of the Halfway River area (GSC loc. 15998, collected by P.K. Sutherland in 1948). Presumably, these Canadian localities were the same as were commented on by Silberling and Tozer (1968) in their discussion of the Sutherlandi Zone.

**Conodonts**

Conodont collections from both sections A and B at South Canyon show a tripartite division spanning the uppermost Lower and lower Middle members of the Augusta Mountain Formation. Samples from about 1 m below the top of the Lower Member are virtually monospecific *Budurovignathus mungoensis* faunas and, although this species continues into the Middle Member, it becomes subordinate to species of *Metapolygnathus*, *Neogondolella*, and *Paragondolella* (M-N-P) around the lithological boundary. Higher still, from ~6 m (A) to 9 m (B) above the base of the Middle Member, M-N-P in turn suddenly become subordinate to *Mosherella newpassensis*, which also forms virtually monospecific faunas in higher beds. The pattern of these biofacies shifts can be used to correlate between the two sections.

Site A (Fig. 10) contains the most complete conodont record for the Ladinian-Carnian boundary (LCB) interval at South Canyon. Above monospecific *B. mungoensis* collections (#SCAN8bis, #B2), the fauna consists of that species plus *Paragondolella inclinata*, *P. sulcata* n. sp., *Neogondolella liardensis* n. sp., *Metapolygnathus acuminatus* n. sp., *M. intermedius* n. sp., *M. lobatus* n. sp., and *M. polygnathiformis* sensu
Figure 10. Reconstructed multielement apparatuses of Budurovignathus and Mosherella (adapted from Orchard, 2005), and specimens of Paragondolella inclinata (#SCAN4), Metapolygnathus polygnathiformis (#105 of Krystyn, and #A11), M. intermedius (#105 of Krystyn), and M. tadpole (SCAN3). All x80.
stricto (#SCAN8 and up). None of these species are common compared with those of *Budurovignathus* and *Mosherella*, but they may have greater value in biochronology: all are known from LCB strata in British Columbia (Orchard, in press), where they are associated with Sutherlandi Zone faunas containing both *Frankites* and *Daxatina*. In section A, many of the species range up through the lower ~5 m of the Middle Member where *Misikella longidentata* also occurs sporadically (#SCAN6 thru #SCAN4). *Budurovignathus mungoensis* is very rare at these levels, too. Faunas above the level of the incoming of *Mosherella newpassensis* (#A19, #B5E) are rather poor in other species and appear less diverse, although *Mosherella* itself is extremely abundant. The taxon overlaps with the range of *Frankites* in B.C., as is the case in section B (#SCAN14,15), but it is more commonly associated with *Daxatina*.

Higher strata in both sections A and B are dominated by *M. newpassensis*, but also contain *Metapolygnathus tadpole* in section A (SCAN3) and a form transitional to that species in section B (SCAN15): this association is typical of the youngest *Daxatina* faunas in British Columbia. Rare *Budurovignathus* sp. A also occurs in these higher strata (SCAN3, B11), above the range of *B. mungoensis*.

**FIGURE 11.** Sites D(2), E and F. Stratigraphic sections with the correlation of the most important ammonoid-bearing levels.

**SITES D(2), E AND F**

**Sections**

Sites D(2), E and F are new and have a higher stratigraphic position than sites A and B (Fig. 5). They are located about 40 m above the base of the Middle Member, and their relative position is also calibrated by using the distance from the rather well-exposed, thick gray mudstones of lithologic unit 4.

**Fossil Distribution**

**Ammonoids**

The stratigraphic interval sampled at sites D(2), E, and F is limited to a very few meters (Fig. 11). Ammonoid distribution is very similar, especially at sites D(2) and E. Although ammonoids can be found in several beds, two sites are especially rich. Level D4 at site D(2) provides very common involute, compressed and densely ribbed Trachyceratidae, which also can be found at site E in level E14 (=E4 and
ornamented in ammonoids that it is similar to a coquina. This bed yields coarsely peculiar is the second fossil-bearing level. At site D(2), bed D10 is so rich in ammonoids that it is similar to a coquina. This bed yields coarsely ribbed Trachyceratidae similar to those from bed D4 are also found. An almost identical fauna (2nd marker bed in Fig. 11) is recorded at site E in beds E15 (=E3, E11, E12 and E13, all laterally equivalent to E15), while faunal composition at site F, bed F1 is slightly different with the compressed and densely-ribbed Trachycerataceae being more abundant. Site F was discovered in October, 2006, and faunal analysis is still in progress. It is noteworthy that in level F1 the compressed Trachyceratidae display more indented saddles than specimens from the other levels of the underlying part of the Middle Member of the Augusta Mountain Formation. Therefore they are referred, with doubt, to *Trachyceras* (Fig. 8H-O). Two specimens conspecific with the specimens classified as *Trachyceras* cf. *T. desatoyense* by Silberling (1956: fig. 2B) were also found. These specimens are not actually conspecific with *T. desatoyense* Johnston, but they clearly have an ammonitic suture that resembles the suture of *Trachyceras sensu strictu*.

**Conodonts**

At site D(2), conodont faunas recovered from 5 levels are all dominated by *Mosherella newpassensis*. This forms monospecific faunas in D1, D2, and D4, whereas in D9 and D10 it is far more abundant than *Paragondolella inclinata*, the only other taxon recovered. The absence of metapolygnathids, presumably reflecting inhospitable biofacies, precludes comparison with the conodont zonal scheme developed in British Columbia (Orchard, in press). However, the absence of *Mosherella* n. sp. A, originally collected from higher strata at South Canyon by L. Krystyn and known also from the Lower Carnian Nanseni Zone, suggests that these levels are still within the Desatoyense Zone.

**CONCLUSION**

New data from the South Canyon sections suggest that a revision is required of the chronostratigraphic attribution of the succession encompassing the lithological boundary of the Lower and Middle members of the Augusta Mountain Formation. The attribution of at least 20 m of the Middle Member to the Sutherlandi Zone is supported by:

1. The occurrence of *Daxatina* and *Frankites sutherlandi* McLearn, the latter being the index species of the Sutherlandi Zone.

2. The composition of conodont associations that suggest, in comparison with British Columbia, a position within the Sutherlandi Zone at about the first appearance of *Daxatina*. In particular, the occurrence of *Metapolygnathus intermedius* supports this view. Similarly, the appearance of *Mosherella newpassensis* and *M. tadpole* at ~8 m above the base of the Middle Member at site A argues for a position, in relation to the B.C. faunas, at and above the highest occurrence of *Frankites*.

3. The occurrence of bivalves closely related to *Daonella elegans* McLearn, which is known from the Sutherlandi Zone of British Columbia.

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