UNIVERSITY OF ILLINOIS

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

GEORGE STEWART ROADCAP

ENTITLED ANTHRACOSPIRIFER OPIMUS HALL, ANTHRACOSPIRIFER CURVILATERALIS ALATUS MOFFET, AND NEOSPIRIFER ALATUS DUNBAR AND CONDRA IN THE BIRD SPRING GROUP AT ARROW CANYON, CLARK COUNTY, NEVADA

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF BACHELOR OF SCIENCE

Instructor in Charge

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ANTHRACOSPIRIFER OPIMUS HALL, *ANTHRACOSPIRIFER CURVILATERALIS ALATUS* MOFFET, AND *NEOSPIRIFER ALATUS* DUNBAR AND CONDRA IN THE BIRD SPRING GROUP AT ARROW CANYON, CLARK COUNTY, NEVADA

BY

GEORGE STEWART ROADCAP

THESIS

for the

DEGREE OF BACHELOR OF SCIENCE

IN

GEOLOGY

College of Liberal Arts and Sciences

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1986

Abstract

Anthracospirifer opimus Hall, *Anthracospirifer curvilateralis alatus* Moffet and *Neospirifer alatus* Dunbar and Condra occur near the Atokan-Desmoinesian boundary in the Bird Spring Group at Arrow Canyon, Clark County, Nevada. The ranges of both *A. curvilateralis alatus* Hall and *N. alatus* have been extended down to this point from younger Desmoinesian occurrances.

Acknowledgements

The author would like to thank Dr. R. L. Langenheim, Jr. for suggesting the thesis topic, for supervision and for advice. Special thanks go to co-worker Jack Yarnold for his partership in the field and in the labaratory. Additional thanks are due Cynthia Shroba and C. Pius Weibel for their greatly appreciated help and advice during all phases of this project's completion.

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Introduction

This study was undertaken to examine the brachiopod fauna in a 75 foot section of Upper Atokan-Lower Desmoinesian limestone in the Bird Spring Group at Arrow Canyon, Clark County, Nevada. Three species noted in this section; Anthracospirifer opimus Hall, Anthracospirifer curvilateralis alatus Moffet, and Neospirifer alatus Dunbar and Condra. This report is part of a continuing study of Pennslyvanian brachiopods at Arrow Canyon. The Bird Spring Group in Arrow Canyon has been selected for intensive study because it is abundantly fossiliferous, well exposed, and is an apparently uninterrupted depositional sequence. For these reasons it is under active consideration as a potential Atokan-Desmoinesian boundary stratotype.

Prior Investigations

The many investigations of Atokan and Desmoinesian strata at Arrow Canyon include: section measurements and descriptions by Langenheim and Langenheim (1965), Webster (1969), and Bhagat (1983); road logs and stop descriptions by Langenheim and Webster (1979), Webster and Langenheim (1979), and Webster (1984); microfacies descriptions by Heath, Lumsden, and Carozzi (1967); and biostratigraphic analyses of brachiopds (Huff, 1984; Moffet 1986); corals (Weibel, 1982; Nelson, 1973; and Lumsden, 1965); fusulinids (Welsh, 1959; Coogan, 1962; and Cassity, 1965); and conodonts (Webster, 1969).

Geologists from the Amoco Oil Co. have surveyed the canyon and placed numbered brass tags at stratigraphic intervals of 1.5m. These measurements have been used by subsequent works.

All three of the species discussed in this report also occur in Desmoinesian strata directly above the measured section (Moffet, 1986). In addition, A. opimus was noted by Huff (1984) in Atokan strata directly below.

Location

Arrow Canyon is located at the northern end of the Arrow Canyon Range, $E^1/_2$ section 11, $S^1/_2$ section 12, T14S, R64E, and $SE^1/_4$ section 7, T14S, R65E, Clark County, Nevada. Arrow Canyon is about 50 miles northeast of Las Vegas, Nevada, and can be reached by exiting Interstate 15 at Glendale, Nevada and heading northwest on Nevada Route 168, then turning left on a paved secondary road. After 200 yards turn right on a jeep trial and follow it up the canyon about 2 miles to the collection site on the north wall. This site is approximately 0.5 miles from the mouth of the narrow gorge.

Figure 1, location map of collecting site in Arrow Canyon

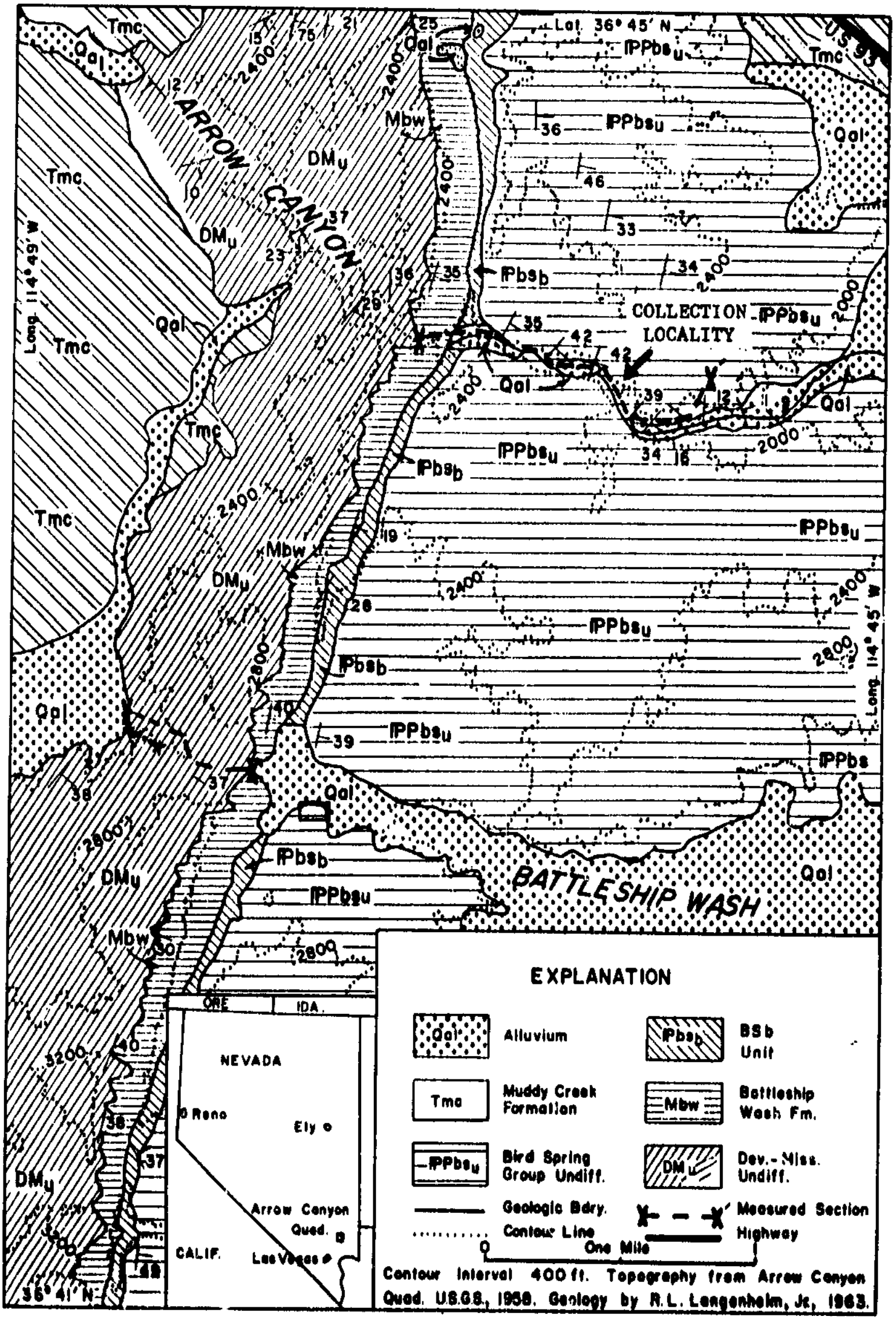
Lat. 36° 45' N.
Long. 114° 49' W.
Long. 114° 45' W.
ARROW CANYON
BATTLESHIP WASH
COLLECTION LOCALITY
Tmc
Qal
Mbw
DMu
IPPbsu
IPbsb
IPPbs
Qpl
ORE
IDA.
NEVADA
CALIF.
Reno
Ely
Las Vegas
Arrow Canyon Quad.
36° 41' N.
EXPLANATION
Alluvium
BSb Unit
Muddy Creek Formation
Battleship Wash Fm.
Bird Spring Group Undiff.
Dev.-Miss. Undiff.
Geologic Bdry.
Measured Section
Contour Line
Highway
One Mile
Contour interval 400 ft. Topography from Arrow Canyon Quad. U.S.G.S., 1958. Geology by R.L. Langenheim, Jr., 1963.

Figure 2, photograph of measured section


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Methods

The field work for this study was done during the first two weeks of January, 1986. The section was divided into units which were described and measured with a Jacob's staff. Fossils then were collected in each unit and samples were taken for thin sectioning. Rocks which contained silicified brachiopod shells were dissolved in 10% hydrochloric acid. The specimens were then sprayed with Krylon acrylic for protection. Selected specimens were stained with Alizarin red dye, coated with aluminum chloride powder, and photographed.

Stratigraphy

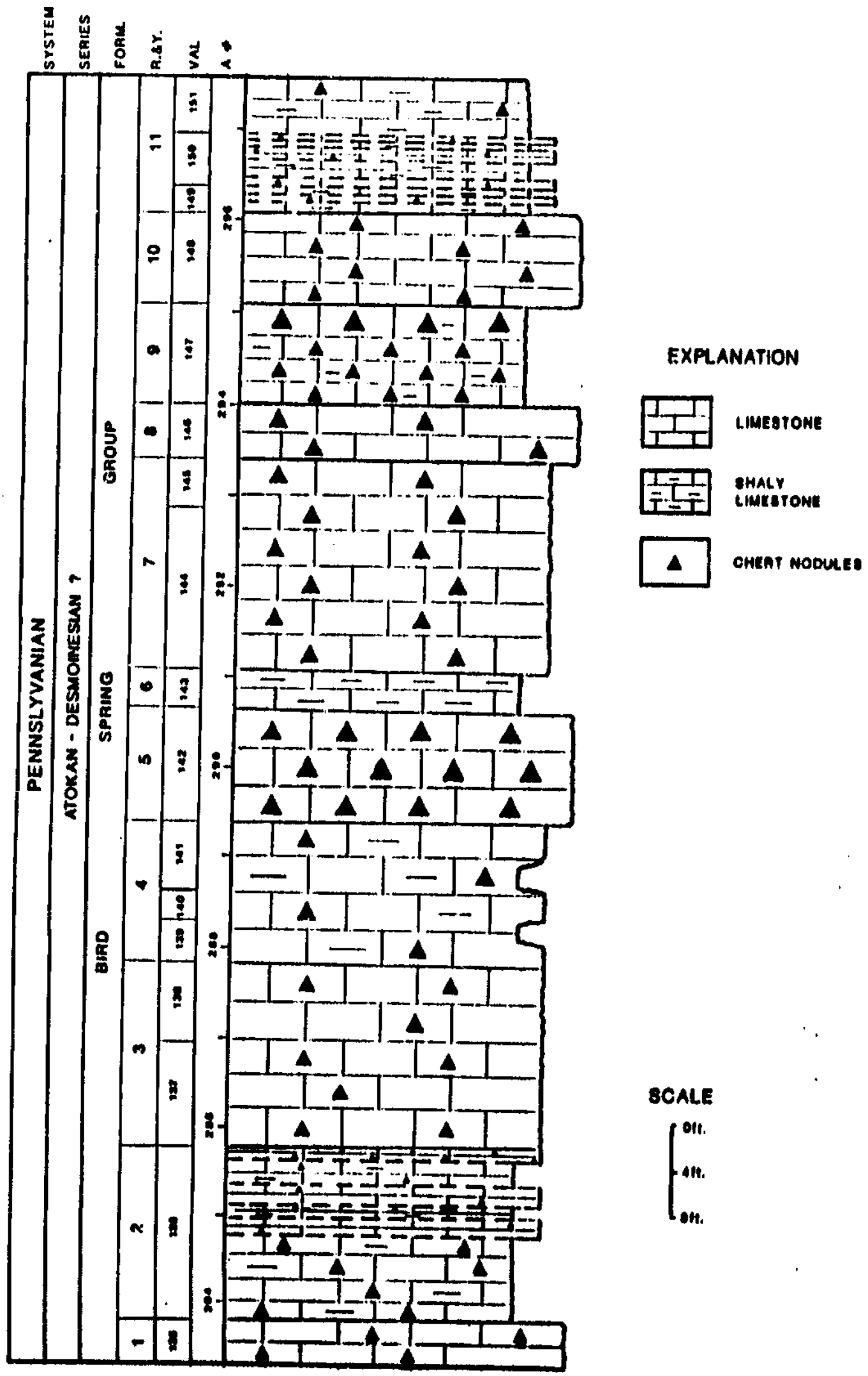
The Bird Spring Group is a cyclic limestone sequence of Late Mississippian through Wolfcampian about 2110 feet thick at Arrow Canyon (Langenheim, 1985). The Bird Spring Group rests on the Monte Cristo Group but succeeding rocks have been eroded at Arrow Canyon. The Bird Spring Group at Arrow Canyon is divided into five formations; the Battleship Wash Fm, the Indian Spring Fm, and the informal units BSc, BSd, and BSe.

The rocks described in this report are within the BSc unit and consist primarily of units of fossiliferous, well indurated calcilutitic to calcisiltitic limestone with abundant chert concretions. These units alternate with more shaly calcisiltitic limestones which generally contain fewer chert concretions. A complete description of the units in hand specimen and thin section (appendices 1,2) and a columnar section (figure 3) are included.

The boundary between the Atokan and Desmoinesian at Arrow Canyon has been subject to several interpretations. Cassity and Langenheim (1966) placed the contact at the top of unit 11 (VAL 151). Later, Langenheim and Webster (1979) placed the top of the Atokan at the base of unit 1 (VAL 135). This lower boundary has become the accepted contact in subsequent works by Webster and Langenheim. Huff, in his study of brachiopods of the late Atokan, ended at the lower boundary. Moffet, on the other hand, started his study of Desmoinesian brachiopods at the upper boundary. Thus the brachiopods between the base of unit 1 and the top of unit 11 were not collected and described.

Figure 3, Columnar section of units 1-11.

COLUMNAR SECTION OF UNITS 1 - 11 BORDERING ATOKAN - DESMOINESIAN BOUNDARY



Systematic Descriptions

The suprageneric classification followed herein is that of the Treatise on Invertebrate Paleontology, part H, Brachiopoda (Moore, 1969).

Phylum Brachiopoda Dumeril, 1806
Class Articulata Huxley,1869
Order Spiriferida Waagen,1883
Suborder Spiriferidina Waagen, 1883
Superfamily Spiriferacea King, 1846
Family Spiriferidae King, 1846
Genus Anthracospirifer Lane, 1963
Species A. opimus Hall, 1858
Plate 1, figs. 1,2

Spirifer opimus Hall and Whitney, 1858, p. 711, pl. 28, figs. 1a-b.
Dunbar and Condra, 1932, p. 320-322, pl. 41, figs. 10-11c.
Hoare and Burgess, 1960, p. 713-714, pl. 91, figs. 4-5.
Spencer, 1967, p.16-18, pl. 9, figs. 1a-f.
Anthracospirifer opimus Sturgeon and Hoare, 1968, p. 62, pl. 19, figs.30-32.
Moffet, 1986, p. 102-104, pl. 16, figs. 11-12.
Huff, 1984, p.122-126, pl. 7, figs. K-N.
Anthracospirifer "opimus" Sutherland and Harlow, 1973, p. 85-86, pl. 16, figs. 17-19.

Description: The medium-sized shells are strongly biconvex. Average dimensions are 20.5mm wide, 17mm long, and 13.2mm thick. The anterior margin is semicircular and the shell is widest at the hinge line. The umbo is inflated and overhangs the hingeline 3.1mm.

The pedicle sulcus is bounded by two primary costae originating at the beak. It is moderately deep and contains three costae of which the outer two arise from the primary costae. The lateral slope is convex and bears 9-10 simple costae. The inner 6-7 origi-

nate from the beak but the outer 3-4 start from the hinge line.

The fold is deformed on the only preserved brachial valve (GSR-1), but the lateral slopes have costae similar to those on the pedicle valve. The beak on this valve overhangs the hingeline about 1.8mm.

Valve interiors are unknown.

Discussion: A. opimus was first described by Hall (1858) as Spirifer opimus. Hall's specimens had a rotund shell of nearly equal length and width, a highly arched umbo, and a strongly incurved beak. The sulcus contains three simple costae and the lateral flanks have 8-10. This description closely matches that of the Arrow Canyon specimens.

The Arrow Canyon specimens also closely resemble A. rocky- [illegible], A. [illegible] Sutherland and Harlow, and A. [illegible] Sutherland and Harlow, but these species all have five costae in the sulcus. A. occiduus Sadlick and A. [illegible] Dunbar and Condra have more than five costae in the sulcus. A. [illegible] tenuicosta Sutherland and Harlow is similar in ventral view, but is much thinner, having a width that is slightly more than twice the thickness. A. newberryi Sutherland and Harlow, has a much lower and less well developed fold and sulcus. A. [illegible] has a greater width to length ratio than that of the specimens.

Occurence: Unit 7. Moffet (1986) reports this species in VAL units 158, 177, and 1823 of Arrow Canyon which are above unit 7. Huff (1984) identified the species in VAL unit 124 which is below unit 7.

Materials: There are two moderately good shells. GSR-1 is complete, but slightly deformed, while GSR-2 is incomplete and not deformed.

Genus: Anthracospirifer Lane, 1963
Species: A. curvilateralis alatus Moffet, 1986
Plate 1, fig 3

Anthracospirifer curvilateralis alatus Moffet, 1986, p. 101-102, pl. 15 figs. 9-10

Description: The medium-sized shell is biconvex with distinctive, greatly extended, cardinal margins giving it an alate outline. The shell is 30.4mm wide, 12.1mm long, and approximately 6.5mm high. The umbo is inflated and the beak overhangs the hinge line by 2.5mm.

The sulcus contains five costae, all of which, excepting the middle, arise from the primary costae. The lateral slope is gently concave with 11 costae, all of which are simple, excepting the first which arise from the primary costae.

Preserved interiors or brachial valves were not found.

Discussion: Moffet, 1986 distinguishes A. curvilateralis alatus from all other Anthracospirifer spp. by its alate (wing-like) outline. A. newberryi Sutherland and Harlow and A. birdspringensis Lane are alate, but their width to length ratios are much less than that of the specimen.

Occurence: Unit 7. Moffet's holotype was found in VAL unit 166 at Arrow Canyon, approximately 50m above unit 7 in Lower Desmoinesian strata. The occurrence in unit 7 extends the range of this species down towards Atokan-Desmoinesian boundary.

Materials: GSR-3, a well preserved pedicle valve.

Genus Neospirifer Fredericks, 1919
Species N alatus Dunbar and Condra,, 1932
Plate 1, figs. 4,5

Neospirifer tripicatus var. alatus Dunbar and Condra, 1932, p. 332, pl. 38, figs. 11-12.

Neospirifer latus Dunbar and Condra, 1932, p. 336, pl. 40, figs. 1-5.

Neospirifer latus latus Spencer, 1967, p. 26-28, fig. 18.

Neospirifer alatus Sutherland and Harlow, 1973, p.75-76, pl. 17, figs. 1-5.

Neospirifer alatus Moffet, 1986, p. 106-108, pl. 17, figs. 3-5.

Description: The very large shells average about 75mm wide, 45mm long, and 22mm thick. The shells are alate and are widest at the hingeline. The pedicle valve is convex in both directions, but flattens close to the anterior margin.

The sulcus is moderately deep and contains 11 costae. These costae, which are poorly preserved, include: a median costae, four costae arising from the primary costae on each side, and two more arising from the two costae adjacent to the median. The lateral slopes bear 25-28 costae that show slight fasciculation which is more noticable near the beak.

One brachial valve is available for study but it is deformed, obscuring any detail. No interiors were collected.

Discussion: Sutherland and Harlow (1973) synonymized Dunbar and Condra's N. triplicatus var. alatus and N. latus in N. alatus, concluding that the two taxa actually were different growth stages of the same species.

The Arrow Canyon specimens are distinguished by their much larger size and higher degree of fasciculation from N. camaratus Morton, N. dunbari King, and N. tasmaniae Sutherland and Harlow.

Dimensions of the Arrow Canyon specimens closely match those reported by Spencer (1967) and Moffet (1986) for N. alatus. Their specimens averaged 81mm wide, 46mm long, and 21mm thick.

Spencer (1967) carefully defined each species of Neospirifer by a specific bifurcation pattern on the fold or sulcus. By his rigid definitions, the specimens in question most closely match the patterns of N. cameratus then that of N. alatus. Sutherland and Harlow (1973), however, do not use, or even mention, Spencer's identification system, but describe several different bifurcation patterns for each species. They recognize 8 different patterns in N. alatus, the most common of which closely resembles that of the Arrow Canyon specimens.

Occurence: Unit 2 and unit 4. Moffet (1986) reports of N. alatus in the Upper Desmoinesian at Arrow Canyon. Sutherland and Harlow (1973) and Dunbar and Condra (1932) both report Missourian occurrences while Spencer (1967) documents a Virgilian occurrence. The occurrences in units 2 and 4 extend the range of this species down towards the Atokan-Desmoinesian boundary.

Material: Several good pedicle valves, only one of which, GSR-4, has moderately well preserved costae. GSR-5 also has the only brachial valve, but it is deformed.

Figure 4, Plate 1 Photograph of brachiopod specimens.

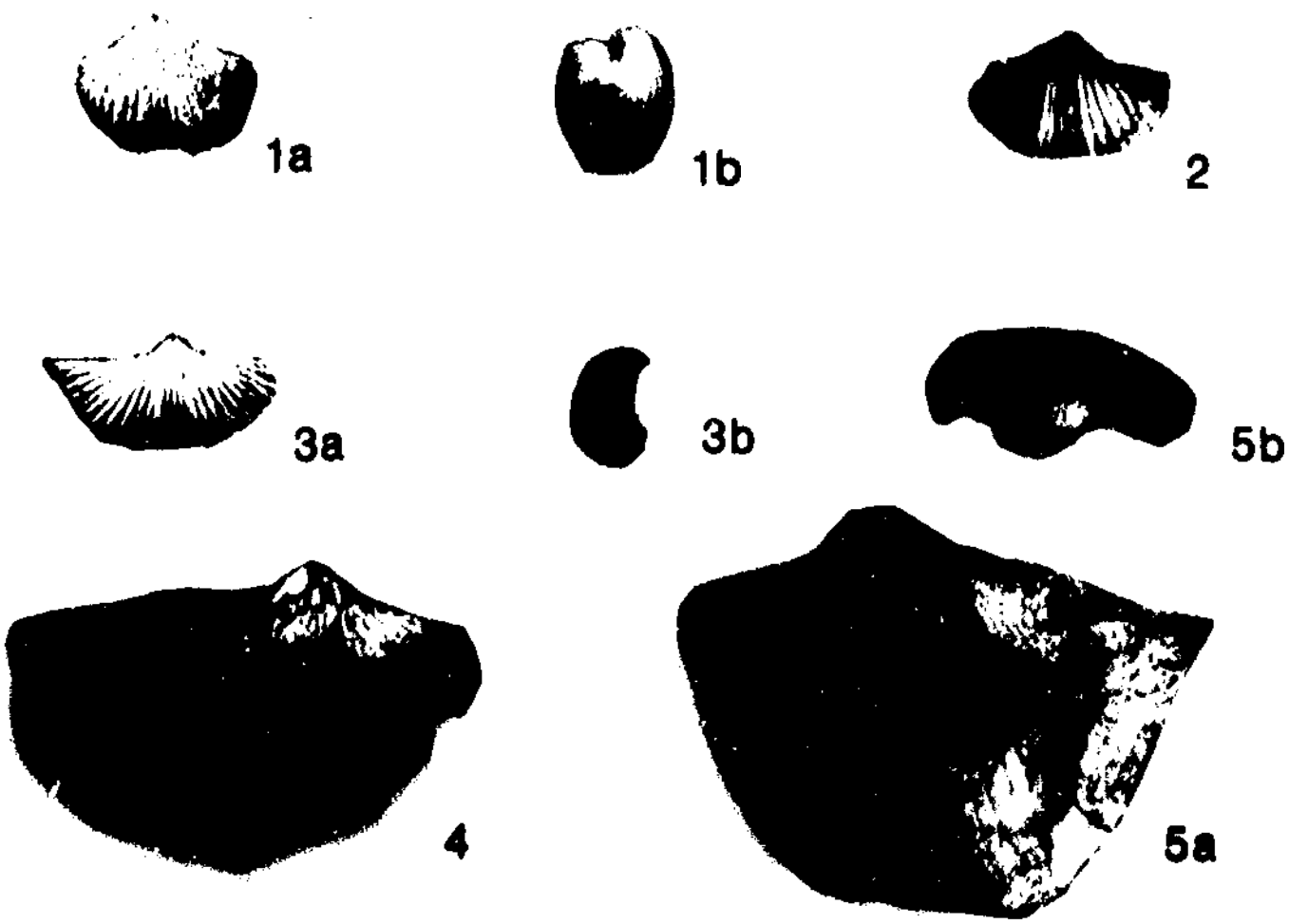


Plate 1 Brachiopods

All figures natural size, X1

Figure		Specimen	View
1a.	GSR-1	Anthracospirifer opimus	Pedicle
1b.	GSR-2	Anthracospirifer opimus	Lateral
2.	GSR-2	Anthracospirifer opimus	Pedicle
3a.	GSR-3	A. curvilateralis alatus	Pedicle
3b.	GSR-3	A. curvilateralis alatus	Lateral
4.	GSR-4	Neospirifer alatus	Pedicle
5a.	GSR-5	Neospirifer alatus	Pedicle
5b.	GSR-5	Neospirifer alatus	Lateral

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Appendix 1

Description of Measured Section

Unit — Description

1) Equivalent to unit VAL 135
Massive, resistant, fine-grained limestone; few chert nodules; moderately to sparsely fossiliferous; gray weathing to brownish gray with rusty brown chert; moderate white calcite veining; bench former; 2' 3" thick.

2) Equivalent to unit VAL 136
Interbedded, fine- to very-fine grained limestone comprised of 3 massive beds alternating with 3 shaly layers; brown to black cobble size chert nodules in massive layers; moderately fossiliferous; abundant fusulinids in the second massive layer from the top; dark gray weathering gray; forms reentrant; 9' 10" thick.

3) Equivalent to units VAL 137, 138
Resistant, fine-grained limestone with few chert nodules; thick bedded near base, thin bedded towards top; abundant fossil fragments; dark gray weathering to gray with buff patches; 9' 8" thick.

4) Equivalent to units VAL 139, 140, 141
Nodular massive to shaly, fine-grained, argillacious limestone; discontinuous layering of cobble to smaller size, orange brown chert; complete fossils are scarce; gray weathering tannish gray; less resistant near base; irregular bench former; partially covered at base; 7' 8" thick.

5) Equivalent to unit VAL 142
Massive, very resistant, fine-grained limestone containing intermittent, distinctive, very large black chert nodules up to 3 feet in diameter; fossiliferous with abundant fusulinids; gray weathering dark gray; abundant white calcite veining; bench former; 6' 2" thick.

6) Equivalent to unit VAL 143
Very friable silty limestone containing a few small chert nodules; moderately to abundantly fossiliferous; gray weathering gray; forms reentrant; gradational upper contact with unit 7; 2' 2" thick.

7) Equivalent to units VAL 144, 145
Thin bedded, fine-grained limestone containing very abundant cobble size to smaller dark chert nodules; moderately fossiliferous; gray weathering to tan; scattered white calcite veins and vugs; bench former, but less resistant than unit 8; 11' 6" thick.

8) Equivalent to unit VAL 146
Massive, very resistant, medium- to fine-grained limestone; abundant cobble size to larger chert nodules; abundantly fossiliferous; dark gray weathering to dark gray; scattered calcite veins; bench former; 3' 0" thick.

9) Equivalent to unit VAL 147
Very friable silty limestone unit containing very abundant cobble size chert nodules;

moderately to sparsely fossiliferous; whitish gray weathering whitish gray; forms reentrant; lower half of unit partially covered; 5' 4" thick.

10) Equivalent to unit VAL 148

Massive, very resistant, fine-grained limestone; intermittent rusty to gray, cobble size chert nodules; abundantly fossiliferous in uppermost 12", generally less fossiliferous in lower parts; light gray weathering to dark gray; moderately abundant white calcite veins; bench former; 5' 0" thick.

11) Equivalent to units VAL 149, 150, 151

Interbedded, fine- to very-fine grained limestone comprised of four massive layers alternating with 5 shaly layers; massive layers contain rusty gray chert nodules; moderately to sparsely fossiliferous; light gray weathering to light tan; forms reentrant; 7' 5" thick.

Appendix 2

Thin Section Descriptions

Unit	Description
2)	**Slide A** Biocalcisiltite with moderately abundant detrital quartz fragments; matrix supported; authigenic quartz crystals; sparsely fossiliferous; bioclasts are partially infilled with microspar calcite; moderately abundant echinoderm fragments and scattered brachiopod fragments, spines, sponge spicules, arthropod fragments and fusulinids; faintly mottled appearance. **Slide B** Biocalcisiltite with sparse detrital quartz fragments; matrix supported with patchy hematitic cement; authigenic quartz crystals; abundantly fossiliferous; bioclasts are partially to largely infilled with microspar calcite; very abundant fusulinids; moderately abundant partially recrystalized brachiopod fragments and spines; scattered arthropod fragments and foraminifera.
4)	Biocalcisiltite with moderately abundant detrital quartz fragments; matrix supported; authigenic quartz crystals; sparsely fossiliferous; bioclasts are partially infilled with microspar calcite and chert; moderately abundant echinoderm fragments; scattered trilobite fragments; isolated "ghosts" of brachiopod fragments; moderate [illegible] and mottling.
6)	Biocalcisiltite with sparse detrital quartz fragments; grain supported with patchy matrix support; authigenic quartz crystals; abundantly fossiliferous; bioclasts are [illegible] recrystallized by microspar calcite; some chert infilling; abundant brachiopod fragments and spines, many showing pseudopunctae; moderately abundant echinoderm fragments; scattered foraminifera.
7)	Biocalcisiltite with sparse detrital quartz fragments; matrix supported; laminated; sparsely fossiliferous; bioclasts are partially infilled with microspar calcite; sparse echinoderm fragments; scattered clumps of sponge spicules; recrystallized pelecypod fragments; light to moderate bioturbation and mottling.
8)	Biocalcisiltite with sparse detrital quartz fragments; matrix supported; authigenic quartz crystals; abundantly fossiliferous; bioclasts are largely infilled with microspar calcite and chert; some bioclasts show evidence of [illegible]; abundant brachiopod fragments and spines that are partially silicified, some have [illegible] quartz [illegible]; [illegible] attached to one brachiopod with a spine [illegible] in [illegible]; moderately abundant echinoderm fragments; scattered foraminifera and sponge spicules.
9)	Biocalcisiltite with abundant detrital quartz fragments; matrix supported; abundantly fossiliferous; bioclasts are partially infilled with microspar calcite and chert; abundant brachiopod fragments, many showing pseudopunctae; abundant echinoderm fragments; sparse trilobite fragments.
10)	Biocalcisiltite with moderately abundant detrital quartz fragments; grain supported with patchy matrix support; some pelletoids or pseudo-pelletoids; abundantly fossiliferous; many bioclasts partially infilled with microspar to spar calcite; abundant fusulinids; abundant recrystallized echinoderm fragments; scattered silicified brachiopod fragments and spines; several arthropod fragments and and forams with micritized tests.

11) Slide A

Biocalcilutite with abundant scattered detrital quartz fragments; some chert crystalization present; matrix supported with patchy hematitic cement; sparsely fossiliferous; bioclasts are predominantly echinoderm fragments; scattered sponge spicules.

Slide B

Biocalcilutite with moderately to sparsely abundant detrital quartz fragments; grain supported with matrix supported patches; well developed authigenic quartz crystals and residual phosphates present; iron cementation occurs locally; abundantly fossiliferous; bioclasts are partially infilled with microspar calcite and include silicified brachiopods, scattered foraminifera, moderatly abundant echinoderm fragments, and micritized fusulinids.

Slide C

Biocalcilutite with moderately to sparsely abundant detrital quartz fragments; matrix supported; some phosphates present; moderately fossiliferous with the brachiopod bioclasts being mostly fragmentary; recrystallization has occured in the sponge spicules, bryozoan fragments and pelecypod fragments present.