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Bryce Canyon National Park Stratigraphic Research Report-1998

DETAILED STRATIGRAPHY OF THE INFERRED OLIGOCENE AGE  
CONGLOMERATE AT BOAT MESA  
BRYCE CANYON NATIONAL PARK, UTAH

by  
Jared R. Baker  
B.S. Geology  
Department of Geology  
Southern Utah University  
Cedar City, Utah 84720

## **BRYCE CANYON STRATIGRAPHIC RESEARCH REPORT-1998**

by Jared R. Baker

### **PROJECT TITLE**

DETAILED STRATIGRAPHY OF THE INFERRED OLIGOCENE CONGLOMERATE AT BOAT MESA IN BRYCE CANYON NATIONAL PARK, UTAH.

### **INTRODUCTION**

This study is a further step of the multi-phase geological study started by Stonnie Pollock on the conglomerate at Boat Mesa. Step one of this geological study was to get an initial overview of the conglomerate at Boat Mesa; i.e. aerial distribution and rough stratigraphic section of the conglomerate.

Step two on the geological study of the conglomerate at Boat Mesa has been to take a further and more detailed look into the conglomerate with a more detailed stratigraphic section. The three main focuses for this additional study and the stratigraphic section are paleocurrent direction, lithostratigraphy, and biostratigraphy.

The Conglomerate at Boat Mesa (Bowers 1972) is a seemingly isolated conglomerate in/near Bryce Canyon National Park. The clasts in the conglomerate consist mostly of differing amounts and sizes of dominantly tan and black chert and quartzite, with other minor colors. The matrix of the Conglomerate at Boat Mesa consists of silts, sands, shales, and limestones; becoming more limestone as one rises through the strata. The age deduced/inferred for the Conglomerate at Boat Mesa is Oligocene (37-24 million years ago).

The Conglomerate at Boat Mesa sits on a gradational unconformity (disconformity) upon the upper white limestone member of the Claron Formation.

### **METHODS**

Geologic Map of Bryce Canyon National Park and Vicinity, Southwestern Utah by William E. Bowers (1991), Aerial Distribution and Stratigraphy of the Conglomerate at Boat Mesa Bryce Canyon National Park, Utah by Stonnie L. Pollock (1997) were used to begin this detailed study of Boat Mesa. Data was taken and described on site while measuring with a measuring tape. Detail of each section was taken like rock type, color, grain size, sedimentary structures, topographic expression, and thickness of the measured unit including lateral variations. All data was compiled to produce a detailed stratigraphic column of Boat Mesa in hopes to attain information on paleocurrent direction, lithostratigraphy, and biostratigraphy.

The stratigraphic section results were measured on the south side of Boat Mesa because bed unit exposures are more easily observed. The south side of Boat Mesa has a more gentle slope and measurements could be taken without serious danger of injury. There are a greater number of exposed bed units on the south side of the mesa with less cover of float and/or overgrowth.

## **RESULTS**

Important data from the detailed measuring of Boat Mesa is recorded below; BM # is an abbreviated name for each bed unit measured (i.e. BM 1 = Boat Mesa unit one).

### **Stratigraphic Unit Descriptions**

#### **BM 1** Interbedded Shale beds.

Slope forming shale dominates with a weathered color of white to light gray and a light gray with yellow bits when fresh. The fragments get more angular and larger in size as one digs further into the outcrop. Minor constituent included are the bits of yellow and the calcareous nature of the shale.

The secondary shale bed is yellow in color weathered and yellow-brown when fresh. The yellow shale beds have a platy orientation with distinct horizontal bedding. Each yellow shale bed has slight pinch and swell from one to two inches. The yellow shale is well indurated while the gray is not, thus making the yellow shale bed a cliff former.

The lower contact is gradational with the Claron formation.

Total thickness of BM 1 is approximately 20 feet.

#### **BM 2** Interbedded siltstone and mudstone.

The siltstone is a slope former. This non-resistant bed is interrupted by a well-indurated lime-mudstone that is gray in color. There is a stucco type coating of yellow silt from the above beds.

There is some lateral differentiation in the bed thickness. Near the top of BM 2 the beds pinch and swell. The lateral variation in the mudstone ranges in thickness from 2 inches to 1 foot, while the siltstone has a less drastic range of 4 to 8 inches.

There are 15-17 interbeds.

The lower contact is gradational from shale to silt in size. The shale is yellow in color and grades into a yellow-gray silt. As one rises in the silt bed the gray color diminishes until the yellow dominates approximately two feet into the bed.

Total bed thickness of BM 2 is 23 feet.

#### **BM 3** Conglomerate.

This is the first sighting of the conglomerate as we rise up Boat Mesa. The conglomerate is matrix supported and has visible paleo-river channels that have a 50/50 matrix/clast combination. The channels are poorly sorted in that the grain size ranges from silt to granule in size. Outside of the channels within the conglomerate the ratio of granules increases with more pebbles. BM 3 becomes covered by float laterally along the mesa.

The total thickness of BM 3 is 4 feet 5 inches.

#### **BM 4** Bed BM 4 is dominated by float and debris from above.

Within BM 4 there are 3 exposures of a muddy siltstone. The bedding is cleaved within the muddy siltstone exposures. The exposures of the muddy siltstone are brief at 1', 1', and 1'6". BM 4 is capped with lense of medium grained sandstone. The sandy lense is poor to fairly indurated making BM 4 a slope former.

The lower and upper contacts are inferred as gradational because of the float that is so abundant in BM 4. Total thickness of BM 4 is 40 feet.

#### BM 5 Limestone.

BM 5 is a dirty limestone with some silt mixed within the bed. There is red-yellow color to BM 5 both fresh and weathered. Spheroidal fracturing and weathering dominated the topographic orientation of this cliff forming bed. BM 5 is well indurated and has visible horizontal bedding planes. There is a stucco type coating of medium to coarse sand tan is color that is easily wiped away. The lower contact is undefined due to that amount of float and cover. Note that BM 5 is the base of the cliff/steep sides of Boat Mesa where this stratigraphic section was measured.

Total thickness exposed of BM 5 is 10 feet.

#### BM 6 Interbedded Lithic Sandstone and Limestone.

BM 6 has a sharp lower contact, in fact all contacts within BM 6 are sharp. The sandstone within BM 6 is consistent in that it is medium to coarse grained with some lateral variation of pinch and swell; a purple-red-gray color with a tan stucco type coating; and all are cliff former. The main difference between the sandstones in BM 6 are the weathering characteristics. The range is appearance alters from spheroidal weathering to blocky looking. The sandstone is well-indurated in all exposures within BM 6. In the top sandstone layer of BM 6 paleo river channels are present and the layer changes from well indurated to poor to fairly indurated.

The limestone interbeds within BM 6 are also quite similar in that the color is reddish throughout and gets more yellow in color up the bed. The weathering in each exposure of the limestone is spheroidal. Each limestone layer within BM 6 has some lateral pinch and swell variation. One distinguishing characteristic of the cap limestone of BM 6 is that the weathering becomes angular but nodules are present and the yellow color is more prevalent. Also the upper contact of BM 6 is a gradational one.

The total thickness of BM 6 is 7'-11'3".

#### BM 7 Sandstone.

BM 7 is a fine to medium grained sandstone with sub-rounded grains and moderate sorting. There are lithics within the sandstone but less than 25%. The induration is fair and the sandstone has blocky weathering patterns and is a cliff former. The lower contact of BM 7 is gradational and the lateral variation changes approximately one foot due to pinch and swell. There is a stucco type covering of mud to sand sized material on parts of BM 7.

Total thickness of BM 7 is 2-3 feet.

#### BM 8 Conglomerate split by an interfingering coarse sand and a siltstone.

BM 8 is a matrix supported conglomerate of boat mesa. BM 8 is the second exposure of the conglomerate. The matrix is composed of medium to coarse sized sand and the clasts consist of tan and black chert pebble. The pebbles are angular to rounded with rounded pebbles dominating. The lower contact is sharp and the conglomerate is fair to poorly indurated and has some lateral pinch and swell variation of 1 to 4 inches. BM 8 matrix is a source of some stucco type covering below.

The interfingering center of BM 8 is composed of a coarse sandstone and a siltstone. The sandstone is cleaved with good horizontal bedding with poor sorting. The siltstone has a blocky/massive appearance with an absence of noticeable bedding. The thickness of the

interfingering portion of BM 8 is 2'3".

The cap conglomerate of BM 8 is composed of very coarse to pebble size grains. The grains decrease in size up the layer into a lime-mud absent of any sand sized grains. The lime-mud is blocky in appearance with no visible bedding. The color of the lime-mud is red grading upward into yellow.

The total thickness of BM 8 is 4'-5'.

#### BM 9 Sandstone.

BM 9 is a medium to coarse grained sandstone with moderate sorting. This sandstone is massive and trough cross-beds are abundant. There is a paleo-river channel in BM 9 that is unique to the other channels in that the channel is clast supported by tan and black chert. BM 9 is a cliff former and fair induration. The lower contact is gradational.

The total thickness of BM 9 is 17'.

#### BM 10 Silty Limestone.

BM 10 is a mixed silty limestone. The color is tan both fresh and weathered with some small lenses of interbeds. The interbeds are composed of silty limestone and limestone but are mostly mixed. There are limestone rip-ups in the mixed silty limestone up to cobble in size. BM 10 is a cliff former and has poor to moderate induration. The lower contact is gradational from BM 9.

Total thickness of BM 10 is 8'-11'.

#### BM 11 Lithic Sandstone.

BM 11 is a medium to coarse, sub-rounded grain lithic sandstone. The color of the bed is tan to dirty tan depending on the concentration of the lithics. There are limestone inclusions in the bottom 2' of BM 11. BM 11 is a resistant, blocky, massive, cliff forming bed of sandstone with a sharp lower contact. Paleo-river channels composed of sandstone are obvious but have no visible bedding. BM 11 is laterally continuous with no pinch and swell variations.

Total thickness of BM 11 is 21 feet.

#### BM 12 Lithic Sandstone.

BM 12 is a lithic sandstone composed of coarse sub-rounded grains. The color is dirty tan to gray with tough cross-bedding visible. BM 12 is a well indurated cliff former with a sharp lower contact.

BM 12 has a large conglomerate paleo-stream channel composed of tan and black chert pebbles. The black pebbles dominate but the slope forming conglomerate is still matrix supported by coarse sand.

The total thickness of BM 12 is 8 feet.

#### BM 13 Conglomerate.

BM 13 is a dirty tan color with tan, black, gray, reddish, and banded, chert and quartzite pebbles. The bed is poorly sorted with sub-rounded grains. BM 13 has numerous shallow but wide paleo-stream channels. The channels are no more than 12" deep and up to 8' wide. The channels are medium to coarse sand in size and the deeper channels are up to 11" deep and 2' wide while the more shallow channels are 6" deep and 8' wide. Some of the channels have

trough cross-bedding and the flow of water was traveling North-South with deposition on the East side of the channel.

The conglomerate is loose with poor induration held up as a cliff former by the clasts/aggregate. The lower contact is sharp and there is no noticeable pinch and swell characteristics.

BM 13 had one very unique characteristic in that a fossil was found within the bed. The fossil is a horn coral but is a poor age dating fossil because the horn coral has wide distribution, long lived, and is still a living species. BM 13 has the only embedded fossil found.

The total thickness of BM 13 is 15'8".

#### BM 14          Lithic Sandstone.

BM 14 is a medium to coarse grained, moderately sorted dirty sandstone. The color both fresh and weathered is tan to dirty tan. BM 14 has some very sparse pebbles within and has lateral pinch and swell variation. In fact BM 14 pinches out to nothing in places and then re-appears. There is noticeable horizontal bedding and fracture. BM 14 is a blocky, resistant, cliff former.

BM 14 has a total thickness of 0"-9".

#### BM 15          Interbedded Sandstone and Conglomerate.

BM 15 is composed of a dominate conglomerate with interbedded sandstone. The color of the conglomerate matrix is cream to white with tan and black chert gravel. The sandstone is tan both fresh and weathered. The beds are both interbedded and mixed with gradational and sharp contacts that get more sharply defined up BM 15. The beds range in thickness with no noticeable pattern. Each layer has a slight degree of induration change but the overall induration increases up the bed, i.e. the beds get more resistant up BM 15.

BM 15 has a total thickness of 12'2".

#### BM 16          Conglomerate.

BM 16 is composed of tan, black, dominated chert pebbles with gray and red quartzite pebbles too. BM 16 is a very limey, matrix supported bed and is tan to white in color. BM 16 has a sharp lower contact and is a resistant, well-indurated, blocky, cliff forming bed. After the bottom one foot limestone rip-ups appear in the conglomerate. The conglomerate also has secondary calcite stringers and has botryoidal weathering with the increased lime mud.

Total thickness of BM 16 is 3'4".

#### BM 17          Interbedded Lime-mud and Sandstone.

BM 17 is composed of interbedded lime-mud and medium to coarse grain sandstone. The lower beds are poorly indurated and have secondary calcite stringers and intraclasts of pure white lime mud within. The induration becomes moderate up the bed.

The sandstone is also poorly indurated below and increases up the bed. The sandstone is tan in color both weathered and fresh and also gets a more blocky look up the bed.

The upper foot of BM 17 shows an occasional conglomerate paleo-stream channel. The stream channel shows the same North-South flow as all the other channels have and channel lag with the inside of the stream on the East.

BM 17 has a total thickness of 6'5".

#### BM 18 Conglomerate.

BM 18 is composed of a pure white limey base with sparse pebbles the first foot and with an increase in pebble abundance and darkening to tan after the first foot. The pebbles are tan and mostly black in color. Along with the increase in pebbles the weathering characteristics also change up the bed. The bottom foot of BM 18 has a rounded fracture and weathering characteristic that becomes more blocky up the bed. BM 18 grains get more coarse up the bed.

BM 18 has a sharp lower contact, and some covered exposures due to the above float. The total thickness of BM 18 is 8'.

#### BM 19 Float and unconsolidated sediment.

BM 19 is the uppermost layer of boat mesa and is composed of float, debris, and unconsolidated sediment. One unique characteristic of BM 19 is that on top of the mesa there are fossils that can be found. The fossils are small and also not imbedded so as float the fossils cannot help date the conglomerate with any credibility.

The total thickness of BM 19 is 15'-18'.

### DISCUSSION

The three main focuses of this study were describing each unit at Boat Mesa for a lithostratigraphic description, determining paleocurrent direction of the sediment that are Boat Mesa, and finally use of any fossil found for possible correlation and biostratigraphy.

Lithostratigraphy was the first focus of the study. The detailed stratigraphic section is the result of inch by inch measurement on the mesa. The inspection of Boat Mesa shows us rock types which are diagnostic of the local environment, but not of age. While measuring the section the determination from data was that the paleo-environment was one of a braided river system and/or meandering river system. Perhaps future studies of the surrounding area will be able to precisely correlate the units at Boat Mesa with those that will show a definite source land.

The measurement of sedimentary structures in each bed unit were used to determine paleocurrent direction. Bed unit thickness along with cross-beds within units of boat mesa were recorded to see from where the sediment possibly came. The paleo-river/stream channels found and the channel lag within each unit show that paleo-environment was a braided river system and/or meandering river system. The channel lag and cross-beds, (when present), between units have the same character and show the same direction. (See units BM 11, BM 12, BM 13, and BM 17).

Few measurements were taken from the north side of Boat Mesa due to the amount of cover, pinch and swell of the bed units, and difficulty of getting to the outcrop. The few measurements that were taken from the north side of the mesa show similar to less bed thickness than the south side of the mesa. The channel evidence and bed thickness data show that the sediment most likely came from a South to Southwest direction. Perhaps a direct study/log of the units that obtain cross-bedding and channel lag only will supply increasing evidence for a definite source land.

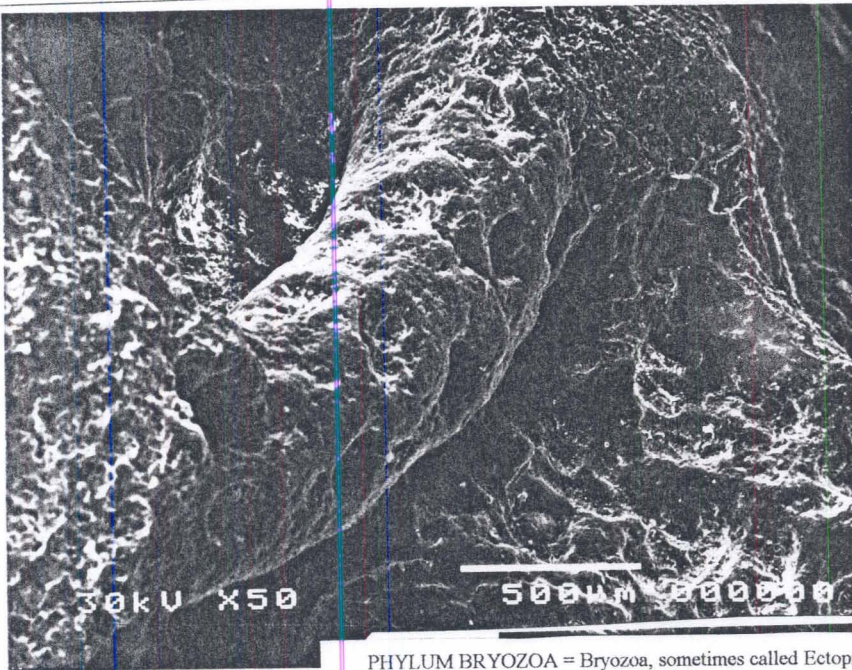
The final focus of this study was biostratigraphy. Biostratigraphy can give a "near" exact age of a rock. There were micro-fossils found on Boat Mesa but the fossils were on top of Boat Mesa unconsolidated, (but isolated), along with the float of BM 19. In BM 13 a fossil was found imbedded and identified as a horn coral. For a fossil to be a good indicator of age it must be

both short lived and have a wide distribution. Horn coral has wide distribution but is not short lived, in fact there are horn coral around today. The evidence for a link by using biostratigraphy have thus far been uneventful and inconclusive.

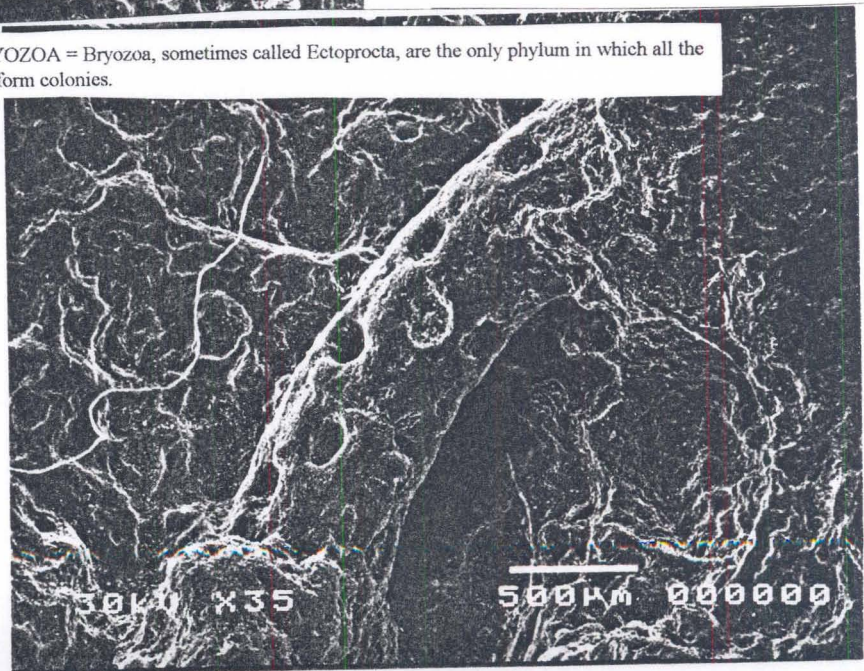
The conglomerate at Boat Mesa is a unique and interesting feature not only in Bryce Canyon but in the region. Many more studies would help further the understanding of the conglomerate. Future studies could include a detailed gravel count study, a detailed log analysis of the cross-bedding and channel lag features within the conglomerate, a regional exploratory study of pebble clasts and/or inclusions, (even oxygen isotopic evidence), present at Boat Mesa. In making the photo log there are two slides that show the Fairyland fault cutting Boat Mesa only partly. If a study was done to date the fault, then the mesa could be dated also.

### SCANNING ELECTRON MICROSCOPE PHOTOS

Scanning electron microscope photo of a micro-fossil found in bed BM 19 on top of Boat Mesa as unconsolidated float. Very few fossils were collected but all were destroyed in analysis.



PHYLUM BRYOZOA = Bryozoa, sometimes called Ectoprocta, are the only phylum in which all the known species form colonies.



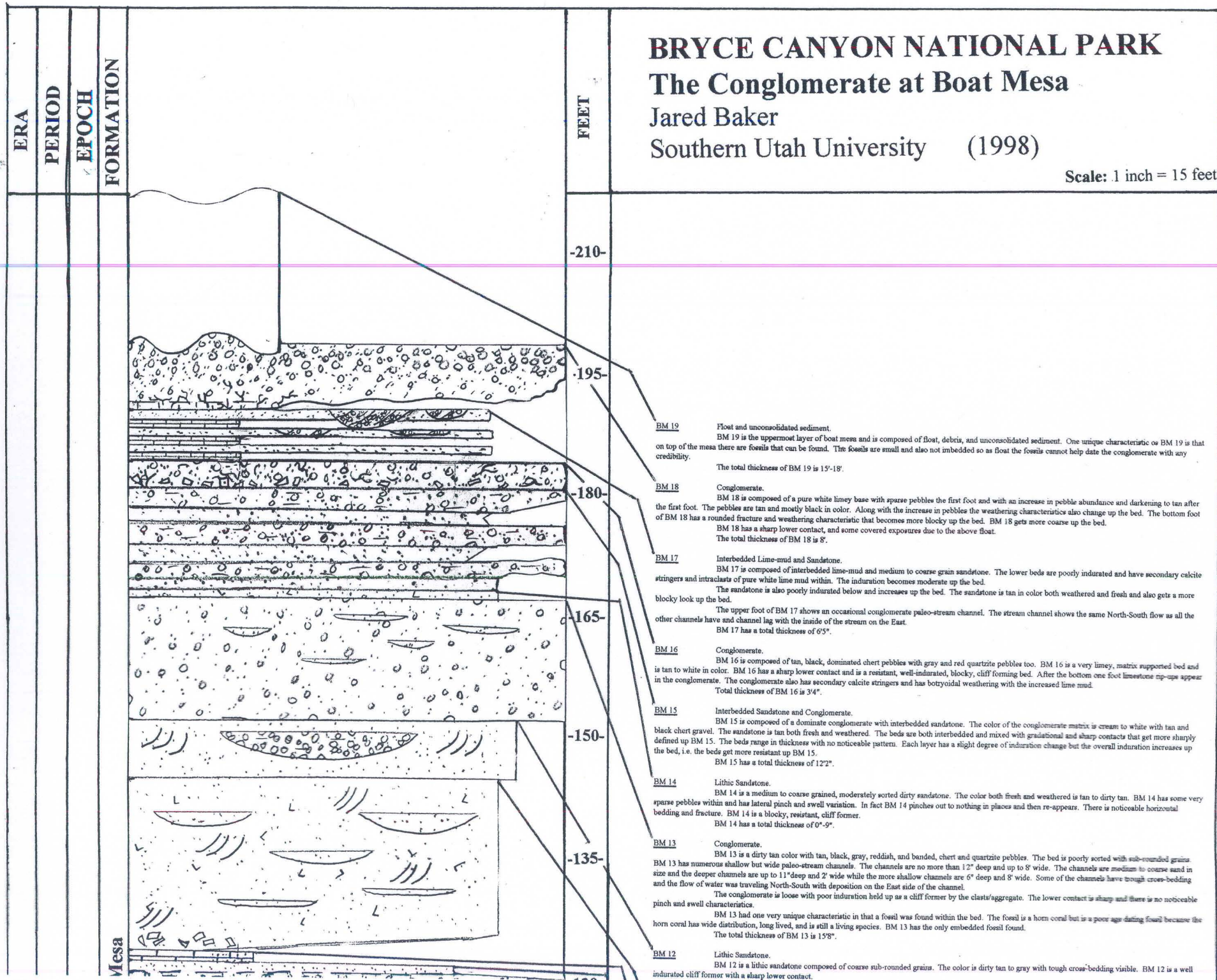
### PHOTO LOG

- 1- Fairyland fault on north side of Boat Mesa. Fault only offsets part of Boat Mesa, so age the fault and age the mesa.
- 2- Mass wasting making the high angle slope float. North side to Boat Mesa.
- 3- Fairyland fault from below. North side of Boat Mesa.
- 4- South side of Boat Mesa with large conglomeratic channel visible.
- 5- South side of Boat Mesa with large conglomeratic channel visible.
- 6- North side of Boat Mesa with Fairyland fault visible.
- 7- North side of Boat Mesa with Fairyland fault visible.
- 8- South side conglomerate with cross-beds in small layers. BM 18.
- 9- South side conglomerate with cross-beds in small layers. BM 18.
- 10- Conglomerate bed, BM 15 with slight thinning upward.
- 11- Conglomerate bed, BM 15 with slight thinning upward.
- 12- Thick conglomerate layer. BM 13.
- 13- Thick conglomerate layer. BM 13.
- 14- Mass wasting of sandy layer. BM 11.
- 15- Mass wasting of sandy layer. BM 11.
- 16- BM 13 and BM 12 divided by a ledge and large tree.
- 17- BM 13 and BM 12 divided by a ledge and large tree.
- 18- BM 5 limestone layer.
- 19- Poor exposure of BM 5.
- 20- BM 12 has a large conglomerate paleo-river channel.
- 21- BM 12 has a large conglomerate paleo-river channel.
- 22- BM 12 has a large conglomerate paleo-river channel.
- 23- BM 11 has interesting wasp holes in it. The poor induration of BM 11 make it easy for the wasp to make a home here.
- 24- BM 6 with large sandstone channels that cut into BM 5.
- 25- BM 6 with large sandstone channels that cut into BM 5.
- 26- Cross-bedding with rare pebble size of chert.
- 27- Cross-bedding with rare pebble size of chert.
- 28- Stucco covering from overlying beds weathering.
- 29- One square foot photo of conglomerate.
- 30- One square foot photo of conglomerate.
- 31- Sunset at Bryce Canyon from Boat Mesas south side.
- 32-38 Photos of Cedar Breaks National Monument showing no conglomerate above the Claron Formation as in Bryce Canyon. Some photos did not turn out.

### REFERENCES CITED

Bowers, W.E., 1991, GEOLOGIC MAP OF BRYCE CANYON NATIONAL PARK AND VICINITY, SOUTHWESTERN UTAH.

Pollock, S.L., 1997, AERIAL DISTRIBUTION AND STRATIGRAPHY OF THE CONGLOMERATE AT BOAT MESA BRYCE CANYON NATIONAL PARK, UTAH

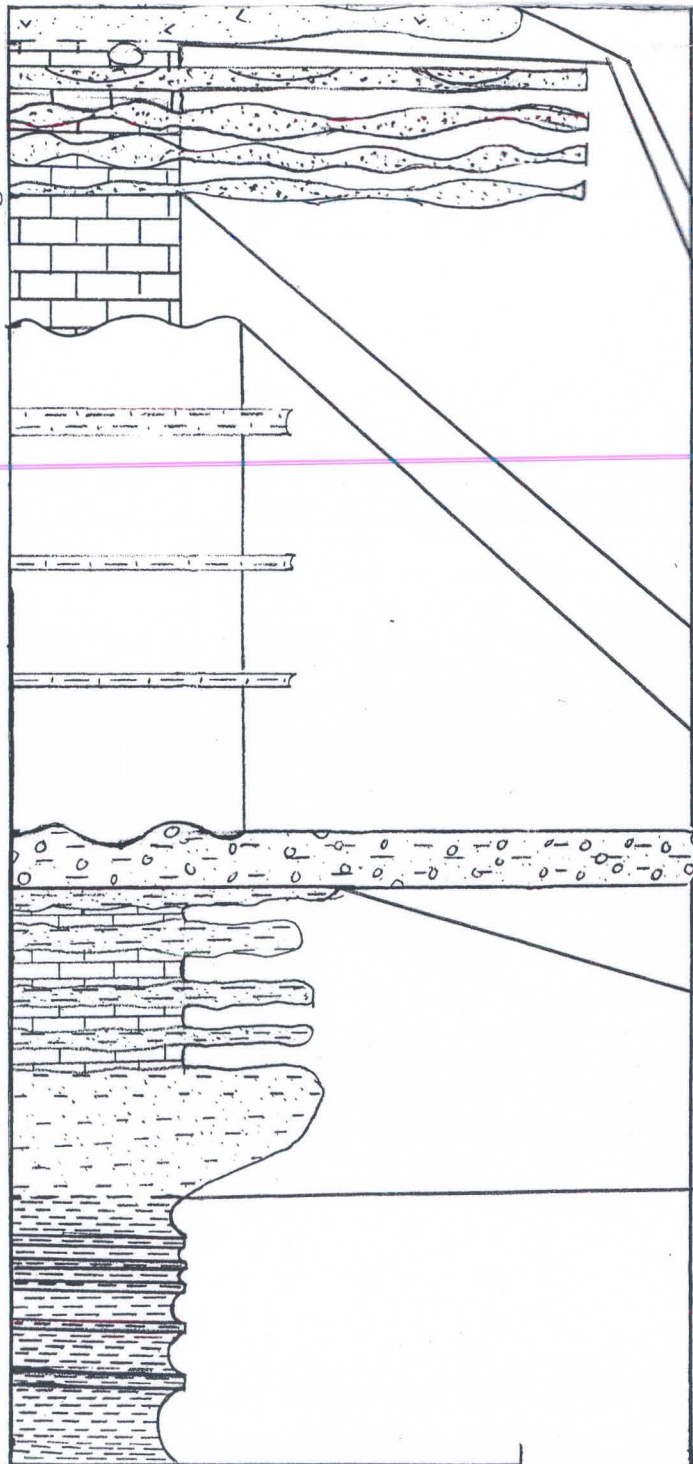


## CENOZOIC

## TERTIARY

## Oligocene (inferred)

## The Conglomerate at Best



BM 11

Lithic Sandstone.

BM 11 is a medium to coarse, sub-rounded grain lithic sandstone. The color of the bed is tan to dirty tan depending on the concentration of the lithics. There are limestone inclusions in the bottom 2' of BM 11. BM 11 is a resistant, blocky, massive, cliff forming bed of sandstone with a sharp lower contact. Paleo-river channels composed of sandstone are obvious but have no visible bedding. BM 11 is laterally continuous with no pinch and swell variations. Total thickness of BM 11 is 21 feet.

BM 10

Silty Limestone.

BM 10 is a mixed silty limestone. The color is tan both fresh and weathered with some small lenses of interbeds. The interbeds are composed of silty limestone and limestone but are mostly mixed. There are limestone rip-ups in the mixed silty limestone up to cobble in size. BM 10 is a cliff former and has poor to moderate induration. The lower contact is gradational from BM 9.

Total thickness of BM 10 is 8'-11'.

BM 9

Sandstone.

BM 9 is a medium to coarse grained sandstone with moderate sorting. This sandstone is massive and trough cross-beds are abundant. There is a paleo-river channel in BM 9 that is unique to the other channels in that the channel is clay supported by tan and black chert. BM 9 is a cliff former and fair induration. The lower contact is gradational.

The total thickness of BM 9 is 17'.

BM 8

Conglomerate split by an interfingered coarse sand and a siltstone.

BM 8 is a matrix supported conglomerate of boat mounds. BM 8 is the second exposure of the conglomerate. The matrix is composed of medium to coarse sized sand and the clasts consist of tan and black chert pebble. The pebbles are angular to rounded with rounded pebbles dominating. The lower contact is sharp and the conglomerate is fair to poorly indurated and has some lateral pinch and swell variation of 1 to 4 inches. BM 8 matrix is a source of some stucco type covering below.

The interfingered center of BM 8 is composed of a coarse sandstone and a siltstone. The sandstone is cleaved with good horizontal bedding with poor sorting. The siltstone has a blocky/massive appearance with an absence of noticeable bedding. The thickness of the interfingered portion of BM 8 is 23'.

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The total thickness of BM 8 is 4'-5'.

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Sandstone.

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Total thickness of BM 7 is 2-3 feet.

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Interbedded Lithic Sandstone and Limestone.

BM 6 has a sharp lower contact, in fact all contacts within BM 6 are sharp. The sandstone within BM 6 is consistent in that it is medium to coarse grained with some lateral variation of pinch and swell; a purple-red-gray color with a tan stucco type coating, and all are cliff former. The main difference between the sandstones in BM 6 are the weathering characteristics. The range is appearance alters from spheroidal weathering to blocky looking. The sandstone is well-indurated in all exposures within BM 6. In the top sandstone layer of BM 6 paleo river channels are present and the layer changes from well indurated to poor to fairly indurated.

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Limestone.

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Total thickness exposed of BM 5 is 10 feet.

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Within BM 4 there are 3 exposures of a muddy siltstone. The bedding is cleaved within the muddy siltstone exposures. The exposures of the muddy siltstone are brief at 1', 1', and 1'6". BM 4 is capped with lenses of medium grained sandstone. The sandy lenses are poor to fairly indurated making BM 4 a slope former. The lower and upper contacts are inferred as gradational because of the float that is so abundant in BM 4. Total thickness of BM 4 is 40 feet.

BM 3

Conglomerate.

This is the first sighting of the conglomerate as we rise up Best Mesa. The conglomerate is matrix supported and has visible paleo-river channels that have a 50/50 matrix/clast combination. The channels are poorly sorted in that the grain size ranges from silt to granule in size. Outside of the channels within the conglomerate the matrix of granules increases with more pebbles. BM 3 becomes covered by float laterally along the mesa.

The total thickness of BM 3 is 4 feet 5 inches.

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Interbedded siltstone and mudstone.

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There are 15-17 interbeds.

The lower contact is gradational from shale to silt in size. The shale is yellow in color and grades into a yellow-gray silt. As one rises in the silt bed the gray color diminishes until the yellow dominates approximately two feet into the bed.

Total bed thickness of BM 2 is 23 feet.

BM 1

Interbedded Shale beds.

Slope forming shale dominates with a weathered color of white to light gray and a light gray with yellow bits when fresh. The fragments get more angular and larger in size as one digs further into the outcrop. Minor constituent included are the bits of yellow and the calcareous nature of the shale.

The secondary shale bed is yellow in color weathered and yellow-brown when fresh. The yellow shale beds have a platy orientation with distinct horizontal bedding. Each yellow shale bed has slight pinch and swell from one to two inches. The yellow shale is well indurated while the gray is not, thus making the yellow shale bed a cliff former.

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SHALE

FINE SAND

MEDIUM SAND

CONGLOMERATE