A PLANT BEARING-HORIZON IN THE PERMIAN OF WEST TEXAS

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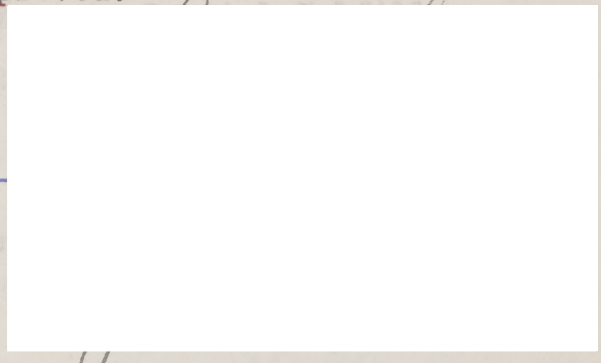

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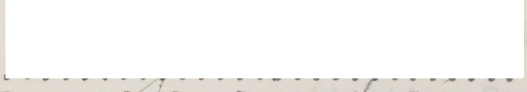

Dean of the Graduate School

May 27, 1932.

A PLANT-BEARING HORIZON IN THE PERMIAN OF WEST TEXAS

THESIS

Presented to the Faculty of the Graduate School of
The University of Texas in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

By

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(Austin, Texas)

Austin, Texas

June, 1932

PREFACE

The study to which this paper is devoted was sug- by Dr. E. H. Sellards of the Bureau of Economic Geology, and the writer wishes to thank him for his suggestions and advice, his encouragement and constructive criticism during the preparation of it.

Free use has been made of the published material pertaining to this subject and the writer wishes to give due credit in each case. The writer is especially indebted to Dr. Philip B. King whose excellent publication and map on the Glass Mountains were followed and referred to frequently.

The writer appreciates the practical experience gained under the instruction of Dr. F. L. Whitney, and thanks him for his kind assistance.

The University of Texas,
May, 1932

Leo W. Kosz

CONTENTS

THE DISCOVERY OF THE PLANT-BEARING HORIZON

In the northwest part of the Glass Mountains of West Texas there is a formation named and described by Philip B. King as the Bissett formation.[1] This formation lies upon marine deposits of known Permian age, and is overlaid by known Cretaceous rocks.

Up to September, 1927, the time of publication of the first description of this formation, no fossils had been found in it. In a more complete and detailed description published in October, 1930,[2] mention is made of a few fossils, ostracods, gastropods, and pelecypods, found in the formation; but they gave no clue as to its age. In December, 1930, a few fossils were obtained by M. B. Arick, Sidney Powers, and R. D. Reed from an exposure of this formation in Hess Canyon. These fossils also were indeterminate as to the age of the formation. Subsequently additional fossils including identifiable plants were obtained by E. H. Sellards, C. L. Baker, and M. B. Arick. These plants were determined by David White and found to be Permian in age.[3]

1 King, Philip B., "The Bissett Formation, A New Stratigraphic Unit in the Permian of West Texas," Amer. Jour. Sci. (5), Vol. 14, pp. 212-221, 1927.

2 King, Philip B., "The Geology of the Glass Mountains," University of Texas Bulletin No. 3038, Part I, pp.84-89.

3 News Letter From the Bureau of Economic Geology of the University of Texas, September, 1931.

THE BISSETT FORMATION

General Character

The Bissett formation was named by Philip B. King in 1927. Its type locality is Bissett Mountain, six miles north-northeast of Altuda, on whose north slopes the formation outcrops in a belt along the northwest flanks of the Glass Mountains extending from the Southern Pacific railroad on the west to a point 13 miles west southwest of Sierra Madera on the east. In this belt its exposures are in many places widely separated by strips of wash.

The Bissett formation is characterized by conglomerate,[4] the conglomerate members ranging in thickness from about 10 to 500 feet. The pebbles and boulders of the conglomerates are sub-angular to rounded and are for the most part made up of dolomite derived from the beds immediately beneath, although there are a few of chert, quartz, and quartzite. The matrix is a sandy limestone or sandy marl. In the upper part, red shales alternate with the conglomerate and in addition a few layers of limestone and dolomite appear. The formation weathers in slopes as shown in Plate 1. The maximum observed thickness is 720 feet.

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[4] King, Philip B. and King, Robert E., "The Pennsylvanian and Permian Stratigraphy of the Glass Mountains," University of Texas Bulletin No. 2801, pp. 140-142.

The Bissett formation is separated from the Cretaceous above by an angular unconformity and contains coarser sediments. Plate 2 is a photograph of the conglomerate characteristic of the Bissett formation, and Plate 3 shows a sandstone ledge in the conglomerate. The Bissett is distinguishable from the beds below by the abrupt change from pure limestone into conglomerate. In at least one locality, the underlying Tessey is made up of angular limestone and dolomite cobbles scattered rather abundantly in a dolomitic matrix, but these fragments are fewer and more angular than those of the Bissett. The pebbles of the Bissett are always distinguishable from those of the normal slope wash deposits because they are much more rounded.

Local Features

The outcrops of the Bissett formation extend from near Altuda in the southwest to 4 miles northeast of the Sibley Ranch house in the northeast. A description of each locality follows, beginning at the southwest end.

About five miles west of north of Altuda section house and a mile off the Marathon-Alpine road is a small hill with an outcrop of Bissett on the west side. This westernmost outcrop consists of about 30 feet of conglomerate resting on the Upper Massive member of the Capitan; above this is 10 feet of pink sandstone followed by 20 feet of conglomerate. The conglomerate is composed of

small well-rounded pebbles in a limestone matrix. This outcrop is represented by Section 8 of the vertical sections.

The next outcrop is found on the slopes of Bissett Mountain, the type locality. Here the lower part of the formation, resting on the Upper Massive member of the Capitan, is composed of red shales interbedded with conglomerate, and overlain by 200 feet of conglomerate made up of well-rounded limestone and dolomite pebbles several inches in diameter in a sandy calcareous matrix of varying hardness and color. The conglomerates weather with smooth or slightly knobby surfaces and in some places show well-developed bedding planes. Where the matrix is of soft material the pebbles weather free and lie on the slopes in great abundance.

The conglomerates have been removed by erosion on the crest of the dome and the Edwards limestone rests on the Upper Massive member of the Capitan. On the flanks of the mountain, the Bissett conglomerates wedge in between and pitch off the sides at angles as great as 35 degrees. King observes that the Bissett mountain dome, a post-Cretaceous structural feature , had been previously uplifted in pre-Comanchean and post-Bissett time, a conclusion also suggested by a comparison of structure contours on the base of the Bissett formation, and on horizons in the Edwards limestone. King measured the following section north of Bissett Mountain.

Section 9

Feet

One and one-quarter miles northwest of summitt of Bissett Mountain.

Edwards Limestone of the lower Cretaceous at top of section.

Calcareous conglomerate in which the fragments are rounded to sub-rounded pebbles and cobbles of limestone and the matrix is a hard limestone in which the fragments are closely packed. One pebble of pink quartzite, very similar to the quartzites of the Word formation, was noted in the upper part. Near the top some thin layers of yellow sandstone are interbedded.....200

Yellow-brown, fine-grained friable sandstone with a few disseminated limestone pebbles. Bedding poorly developed..... 15

Thinly-bedded vermilion-red to maroon-red shale containing scattered limestone pebbles... 60

Calcareous conglomerate with a moderately soft limestone matrix. Pebbles are of limestone, of all sorts, thinly laminated, massive, dense, and finely crystalline gray and brown limestone. This bed is of lenticular character, and thins out to the west..... 15

Red shale like that above..... 30

Conglomerate..... 12

Red shale; contains a few lenses of conglomerate in a red matrix..... 45

Conglomerate consisting of angular blocks of limestone of similar composition those in conglomerate bed above. These are closely packed together, so that the matrix, which is of red calcareous material, is of small amount..... 55

Massive gray dolomitic limestone below.

Total thickness 432

On the hill two miles south of Bissett Mountain the formation is much thinner, consisting of about 100 feet of calcareous conglomerate.

On the northeastern slope of a hill two miles south of Bissett Mountain the formation consists of about 75 feet of calcareous conglomerate.

In the mesas three miles east of Bissett Mountain King

records about 40 feet of conglomerate. The writer noted about 100 feet with some brown limestone in the southwest portion and marly limestone in the northeast. In these mesas the angular divergence between the Bissett and Comanchean is 10 degrees. The basal Edwards limestone rests on the upturned and eroded edges of the Bissett conglomerate to the north, but overlap across them to lie on the Gilliam and Upper Massive member of the Capitan on the south end of the mesa.

Northwest of these mesas is a hill with Bissett outcropping below the Edwards limestone. Here the following section was measured:

Section 20

	Feet
Section measured on east slope of hill three and one-half miles northeast of Bissett Mountain. Edwards limestone of the Comanche series overlying the Bissett formation.	
Yellow clays (Fredricksburg?)	10
Red shale	33
Calcareous conglomerate	6
Remainder covered.	

On the long ridge one-half mile north of the latter locality the outcrop is almost entirely covered with loose rounded pebbles. The Bissett is evidently a calcareous conglomerate with a soft matrix, and is about 50 feet thick where exposed.

East of the Old Edwards Place are several northeast-southwest trending ridges on whose slopes the Bissett formation outcrops. The easternmost ridge, three-quarter miles east of the Old Edwards Place, contains an exposed thickness of Bissett of about 75 feet. Most of this is

calcareous conglomerate with matrix of various colors, mostly gray and pink. There are layers of brown marly limestone and some lighter colored rock interbedded in the conglomerate which also contains some sandstone lenses.

The ridge one-half mile east of the Old Edwards Place consists of a similar series. There is about 70 feet of conglomerate with a red calcareous matrix near the base. A little higher there are red shaley lenses, and above these comes alternate conglomerate and brown sandy limestone ledges. The conglomerate ledges are about 4 feet thick alternating with limestone beds 2 feet thick. The upper part consists of 30 feet of calcareous comglomerate with a pink matrix.

The ridge one-half mile north of the Old Edwards Place also consists of conglomerate and brown limestone. The following section was measured on this ridge:

Section 22

	Feet
Section made on ridge one-half mile north of Old Edwards Place.	
Edwards limestone at top of section.	
Calcareous conglomerate	25
Brown conglomerate of small pebbles	2
Calcareous conglomerate	15
Brown sandy limestone	2
Calcareous conglomerate	40
Base of formation not exposed.	

The ridge one-quarter mile east of the Old Edwards Place also contains an exposure of Bissett formation consisting principally of conglomerate and brown sandy limestone. It is very similar to Section 49 of the next locality.

Two and one-half miles north of the summitt of Bissett Mountain the Bissett formation outcrops on a hill, and here the formation is resistant enough to weather in steeper slopes than is usually seen. The formation consists mostly of conglomerate.Interbedded with brown limestone. King's Section 49 was measured here and is as follows:

Section 49

	Feet
Two and one-half miles north of summitt of Bissett Mountain.	
Edwards limestone at top of section.	
Massive ledges of calcareous conglomerate...	30
Brown limestone with few thin layers of calcareous conglomerate.....	8
Calcareous conglomerate.....	26
Brown limestone.....	11
Calcareous conglomerate.....	3
Brown limestone.....	10
Calcareous conglomerate.....	15
Dense brown limestone with a conchoidal fracture; containing a few scattered pebbles	6
Massive ledges of gray calcareous conglomerate.....	43
Gray calcareous conglomerate, interbedded with brown calcareous sandstone, the former in 3-foot and the latter in 1-foot layers...	8
Massive ledges of gray calcareous conglomwrate. Pebbles reach 3 inches in diameter and are well rounded.....	48
Brown sandy limestone, gray calcareous sandstone, and gray calcareous conglomerate	10
Gray and buff limestone containing well rounded limestone pebbles up to 2 inches in diameter.....	45
Red indurated shale containing a few well rounded and polished limestone pebbles.....	20
Base of formation not exposed.	
Total thickness.....	283

About four miles northwest of the line of outcrops on the Stroud Ranch, about 150 feet of red and yellow marl underlying a thin Cretaceous conglomerate, which is in

turn succeeded by fossiliferous marls and rudistid limestones of Fredricksburg age. These outcrops which lie in several hills are mapped and described by King as Bissett on basis of the red color of some of the strata, and the apparent divergence in dip between them and the Fredricksburg at the south end of the hills. King reports that Miliolina and Chara seeds occur in identical strata in a well two miles to the north, so that a Cretaceous age for these beds is not unlikely. The following section was measure in this region:

Section 23

Feet

Section measured on hills about one mile east of Stroud Place.
Edwards limestone of Cretaceous at top of section.
Covered, but probably is conglomerate. One block was seen with sandy matrix and about 2 feet of yellow marly limestone.....6
Ledge of hard conglomerate with siliceous matrix.....1
Yellow marly limestone weathering in pits.... 12
Conglomerate with matrix gray, red, or yellow Matrix is sandy. One layer of sandstone 6 feet thick is interbedded.....20
Hard red limestone.....20
Ledge of white limestone.....2
Base of section covered.

On the highest hill in this vicinity about 150 feet of similar sediments are exposed.

Almost on the line of outcrops are some hills four miles west of the mouth of Gilliland Canyon. A non-conglomeratic facies of the formation is exposed here. On the largest butte an angular divergence of 5 degrees between the Basement sands and a resistant bed of the Bissett is admirably

shown on the east side of the butte. The section on this butte is as follows:

Section 34

	Feet
On a small butte about four miles northwest of the mouth of Gilliland Canyon.	
Basement sands of Comanche series, resting on Bissett formation with angular unconformity.	
Dense, dark gray limestone, with a peculiar lumpy weathering surface. In places its weathered surface is covered with an ash-like powder	4
Bluish and reddish clays, poorly exposed	21
Limestone, full of rounded and polished quartz grits. An abraded and silicified crinoid step noted	1.5
Brick-red, indurated shale, with some lavender shale	16
Hard dense dolomitic limestone, of light gray and dark gray color, in thin and thick beds	15
Base of formation not exposed.	

On the butte one mile south of the latter about 50 feet of calcareous conglomerate with a red or yellow matrix outcrops.

The next outcrops are those on the hills lying 2 to 4 miles north of the mouth of Gilliland Canyon. These hills are called the Tessey Buttes. Here the formation consists of thick beds of calcareous conglomerate near the middle of which are conspicous red-bed layers. There are also some limestones. Plate 1 is a photograph of the southern end of these hills, showing typical topography of the Bissett. The limestones of the Comanchean cap the hills and stand in ledges, while the Bissett conglomerate weathers in a fairly gentle slope below them. King records the following section from this area:

Section 17

Feet

Section measured along the western edge of the hills lying from 2 to 4 miles north of the mouth of Gilliland Canyon.

Basement sands of Comanche series at north end of section.

White nodular limestone..... 10
Red shale..... 10
Yellow limestone..... 10
Calcareous conglomerate..... 5
Red shale, with some purplish shale.....140
Calcareous conglomerate, like lowest bed..... 66
Red shale, with several interbedded 5 foot layers of calcareous conglomerate..... 42
Calcareous conglomerate, forming massive gray ledges. The conglomerate consists of rounded pebbles of limestone, with rarer ones of chert and quartz. The contact with the Tessey below is determined by the fact that the fragments of the Tessey are fewer and more angular.....250

Tessey dolomites beneath.

Total thickness.....533

The writer spent considerable time at this locality, especially at the extreme southern end of the outcrop. Near the contact with the Tessey, gray and brown dolomitic limestone was found interbedded in the conglomerate. In many places there is evidence of slump in the conglomerate as shown by the steep dips of certain blocks, and at least one place the dolomitic limestone is tilted and apparently folded by the slumping conglomerate. This relation is shown in Plate 4. In most outcrops, however, the limestone rests horizontally on the conglomerate with the bedding parallel to that of the conglomerate, and is overlain by more conglomerate with bedding horizontal. Plate 5 shows a considerable thickness of limestone resting on conglomerate with perfectly conformable relationship.

This limestone, reaching 42 feet in thickness in one outcrop, lies in the basal 100-150 feet of the conglomerate bed in the lower part of the preceding section, section 17. The limestone is evidently of lensing character for it cannot be traced far laterally; even the 42 foot outcrop could not be followed more than 150 feet without losing considerable thickness.

Numerous ledges of this limestone contained poorly preserved fragments of fossil plants. A few layers contained fragments of fairly well preserved fossil plants. These limestones are poor, both in number and preservation of the fossils, compared to those of Hess Canyon which will be discussed later. The limestone containing the plants is, as already stated, gray and dolomitic. It is compact and breaks with conchoidal fracture. Some of the beds are sandy; but most are not and are usually thin-bedded breaking into slabs or plates. In association with the plants and almost invariably found with then are small gastropods. Pelecypod casts were also found but these were less abundant. This fauna, considered both separately and as a group is similar to that found in Hess Canyon, and is probably identical with that fauna.

The limestone described above seems to be confined in this area almost entirely to the ridge running south from Tessey Buttes proper. However, on the northeastern part a six-foot ledge of limestone was found to contain very few fossil plants, but a good many gastropods and pelecypods.

The Basement sands of the Comanchean overlie the Bissett formation in the Tessey Buttes, and the sands successively overlap all the members of the Bissett here. A mile or so to the south outliers of the Basement sands rest on the Tessey member.

A hill just east of the northeastern edge of the Tessey Buttes is on a downfaulted block. The Bissett outcrops here and consists of about 100 feet of calcareous conglomerate. There are two sandstone lenses on the south slopes and a small amount of sandstone on the outcrop nearer the Parker Place. The matrix is calcareous but sandy; the lower portion is red, the middle is yellow, and the upper part is gray.

The next outcrop is about one and three-quarters miles north of the Parker Place. Here the Bissett outcrops on a prominent mesa and on low hills east of it, but they are mapped as a continous outcrop. The formation here consists mostly of calcareous conglomerate, as usual, with some sandstone and limestone. The limestone outcrops on the mesa proper. Most of the section was difficult to measure because of wash, but the following section was made:

Section 11

	Feet
Section beginning at southeastern edge of low hills 1¾ miles north of Parker Place and extending northwest up the mesa.	
Basement sands of the Comanchean on mesa.	
Covered; probably Basement sands.....	12
Conglomerate, fairly well-bedded with rounded pebbles. Lies almost horizontal as do the Basement sands above it.....	5
Yellow nodular limestone with one dolomitic ledge near the base and numerous thin conglomeratic layers.....	7
Mostly covered, but probably yellow shale..	15
Gray, weathered yellow, conglomerate of small irregular pebbles and a calcareous	

Gray, weathered yellow, conglomerate of small irregular pebbles and calcareous matrix	2
White and yellow caliche-like shale	10
Covered	18
Hard dolomitic limestone	2.5
Soft nodular sandy limestone	1.5
Hard dolomitic dark gray limestone containing few casts of pelecypods	2
Partly covered but mostly soft nodular limestone, marly and yellowish and containing many pelecypods	10
Brown limestone, dense, and containing few gastropods	18
Gray dolomitic limestone with doubtful plant fragments	6
Conglomerate with large and small dolomite pebbles	12
Conglomerate, typically Bissett, calcareous with well-rounded fairly even sized pebbles containing few layers of hard sandstone	80
Alternating hard and soft yellow to brown sandstone, well-bedded with some platy layers	18
Nodular sandy limestone	6
Hard brown sandstone in three ledges	6
Covered; probably red and yellow platy sandstone	12
Red and pink sandstone containing very doubtful plant fragments	4
Covered; with occasional hard strata of sandstone projecting above wash	10
Conglomerate, capped with limy sandstone	10
Conglomerate with pink sandy and calcareous matrix	24
Base of formation not exposed	
Total thickness	281

A few doubtful plant fragments were found here in limestone similar litholigically to that in the Tessey Buttes. Gastropods similar to those of the Tessey Buttes were also found here, and one bed contained many well-preserved pelecypods.

The next outcrop is to the east; a series of hills on the west side of Hess Canyon north from the Warren Ranch. It was at this locality that the fossil plants were discovered by E. H. Sellards, C. L. Baker, and M. B. Arick, as previously stated.

The formation here consists of calcareous conglomerate, limestone, shale, and sandstone. The conglomerate is of rounded dolomite and limestone pebbles in a calcareous matrix usually gray in color, and in some places sandy.

Most of the limestone is gray, dense to finely crystalline dolomitic, and cleaves regularly into plates or splinters. It occurs in layers from 2 inches to 2 feet and sometimes more in thickness alternating with soft sandy buff shale.

The sandstone is brown to buff, rather hard and calcareous, as are most of the sandstones interbedded in the conglomerate. Some of the beds are fairly persistent, while others thin rapidly.

King measured this outcrop and although there is considerable wash between the separate hills of the section he records it as a continous sequence from south to north with the exception of 160 feet covered near the middle of the section. The following section is that of King's measured in this area:

Section 24

	Feet
Section measured along the west side of Hess Canyon north from the Warren Ranch.	
Basement sands of Comanche series overlying north end of section.	
Calcareous conglomerate of limestone and dolomite pebbles, with a few of quartz, quartzite and chert.....	100
Gray and brown, dense to finely crystalline dolomitic limestone, with platy or splintery fracture, in 2-inch to 2-foot beds, interbedded with buff shale. The limestone contains the casts of pelecypods and gastropods, and also very abundant well preserved ostracods, including the genus Bairdia.....	50
Calcareous conglomerate.....	10
Covered, probably calcareous conglomerate Similar to lowest member. In some beds the matrix is very sandy, and there are several layers of fine-grained, calcareous sandstone and sandy dolomite.....	160 240
Calcareous conglomerate, consisting of rounded dolomite pebbles, in a calcareous matrix. There are also rather abundant well rounded pebbles of quartz and chert, some of which reach 2 inches in diameter. Some of the chert is fossiliferous and is probably derived from the Word formation.....	240
Tessey dolomites beneath.	
Total thickness.....	800

The writer measured the outcrops on each hill separately, and found them to conform in general to parts of King's section. Their total thickness almost equals that of the above section.

The southernmost hill is composed almost entirely of calcareous conglomerate about 240 feet thick. On the north slopes of the prominent hill are two lesser hills. These hills are also mostly conglomerate, but contain ledges of sandstone scattered throughout. One of these ledges is shown as Plate 3. Here the variation in size of the pebbles is shown; the pebbles directly above the sand are

much larger than those only a few inches above.

The next hill to the north is somewhat isolated from the others. It is composed mostly of dolomitic limestone interbedded with buff shale. The limestone is regularly bedded, breaks evenly along the bedding plane, and fossil plants are abundant. (The writer is using the term abundant as compared to the occurance in other localities). Toward the top the limestone becomes somewhat massive and marly; plants were not found in this bed. The hill is capped by a bed of conglomerate about 7 feet thick; there is also some conglomerate below the massive limestone and at the base of the hill below the thinly bedded limestone.

The northernmost hill of the outcrop is mostly dolomitic limestone and conglomerate with some shale. The limestone cleaves readily and the slopes are covered with thin plates of this limestone. There is the same interbedded buff shale as in the other hill.

Fossil plants are rather plentyful here, but not in such abundance as on the hill south. A ledge of conglomerate caps the southern extremity of the hill and its thickness increases as it dips under the Basement sands of the Comanchean on the western part. The unconformity is not so apparent here; the Comanchean sediments having apparently the same dip as the underlying Bissett.

The dolomitic limestone outcropping in these hills is identified as that of the Tessey Buttes'. The limestone is gray, dense and breaks readily along the bedding planes

into plates. Besides the plants it also contains casts of pelecypods apparently identical with those of the limestone in the hill to the west and in the Tessey Buttes. Abundant well-preserved ostracods, including the genus Bairdia, are present.

The next Bissett locality to the east is across the draw which forms the mouth of Hess Canyon. This is called Cave Mesa, and is near the Sibley Ranch house. Most of the Bissett on the mesa proper is covered, but about 100 feet of calcareous conglomerate, 5 feet of yellow sandy conglomerate, and 4 feet of red marly shale were observed in this locality. This is Section 29 of the vertical sections.

About a mile and a half east of Cave Mesa is Pyramid Mesa with an outcrop of Bissett on its slope directly overlooking the Elsinore West Camp. The following section was measured on this outcrop:

Section 28

	Feet
Section measured on hill south of Elsinore West Camp.	
Basement sands of Cretaceous at top.	
Conglomerate , same as lower bed.....	24
Sandstone.....	6
Conglomerate, calcareous and of rounded pebbles.....	100
Base of formation not exposed.	

In this northeast region the Bissett is almost entirely conglomerate with very little sandstone. The usual matrix is mainly calcareous, but may be somewhat sandy. Arenaceous material is prominent in the matrix of many of the beds of conglomerate. There is apparently very little or no divergence in dip between the Bissett and the Comanchean in this region.

On Panther Mesa about 30 feet of conglomerate is exposed.

On the isolated hill one-half mile south of Panther Mesa the exposed Bissett consists of about 75 feet of calcareous conglomerate. A sand lens 4 feet thick was found on the north slope.

The exposure to the southeast of the hill also consists of calcareous conglomerate and sandstone; the following section was measured on this outcrop:

Section 13

	Feet
Measured on the east slope of hill one and one-half miles east of south of Panther Mesa.	
Basement sands of Cretaceous at top of section.	
Conglomerate with calcareous matrix.....	14
Soft nodular limestone, buff and yellow, with occasional conglomerate layers.....	21
Tessey dolomites beneath.	
Total thickness.....	35

East of the preceding exposure is the easternmost outcrop of the Bissett formation, and is composed almost entirely of conglomerate. The following section was measured at this locality:

Section 14

	Feet
Section measured on hill one and one-half miles southeast of Panther Mesa.	
Basement sands of Cretaceous on top of section.	
Conglomerate with yellow sandy matrix....	6
Conglomerate with gray calcareous matrix.	60
Tessey dolomite below.	
Total thickness.....	66

Stratigraphic Relations

Relations to Underlying Beds: The Bissett rests unconformably on Permian dolomites. Most of its conglomerates are of dolomite pebbles from the immediately subjacent Capitan rocks. These underlying formations are characterized by an interfingering of facies resulting in laterial variation from northeast to southwest in the mountains so that stratigraphic units which are recognizable in one locality lose their identity a short distance away. In the eastern part of the mountains this part of the Permian section consists of three units: below, massive dolomite called the Vidrio; in the middle, Fusilina-bearing, thinly-bedded, dolomite named the Gilliam; and above, a massive dolomite called the Tessey. The Vidrio west of Hess Canyon thickens, becomes more massive, and nearly all bedding planes disappear. The Gilliam formation, at a point a short distance to the west of the mouth of Gilliland Canyon, changes over into massive dolomite, and is not traceable much further toward the west.

At about the same point where the Gilliam loses its identity, another thin-bedded series appears at a lower level. This series has been termed Altuda by King because of its good exposures in the vicinity of Altuda section house. Overlying the Altuda member is a series of massive dolomites, making up the upper beds of the series; they are the probable equivalent of the Gilliam in their type locality. Thin-bedded strata of probable Gilliam age lie near the top of the upper massive beds.

The Tessey formation is well exposed at its type locality north of the mouth of Gilliland Canyon, but west of this point it disappears under alluvial deposits and seems to have no equivalents in the southwestern part of the mountains.

The Bissett formation appears to rest on these beds with a considerable erosion unconformity. The character of the fragments of which it is composed clearly indicates the uplift and erosion of the beds beneath, and in addition it apparently overlaps these strata, with the beds of the underlying series absent toward the southwest as though removed by erosion.

King states that the Bissett formation rests on the Tessey member of the Capitan east of Gilliland Canyon. Four miles east of Bissett Mountain it overlies a few hundred feet of thin-bedded strata at the top of the Upper Massive member, but four miles west of the mountain only 215 feet of this member intervene between the Bissett formation and the Altuda member. This appears to represent a downward overlap across nearly 1800 feet of strata in a distance of 17 miles, or an angular divergence of 100 feet per mile.

The interfingering of facies and relations of the Bissett to the adjacent formations is shown graphically by the diagram on the following page.

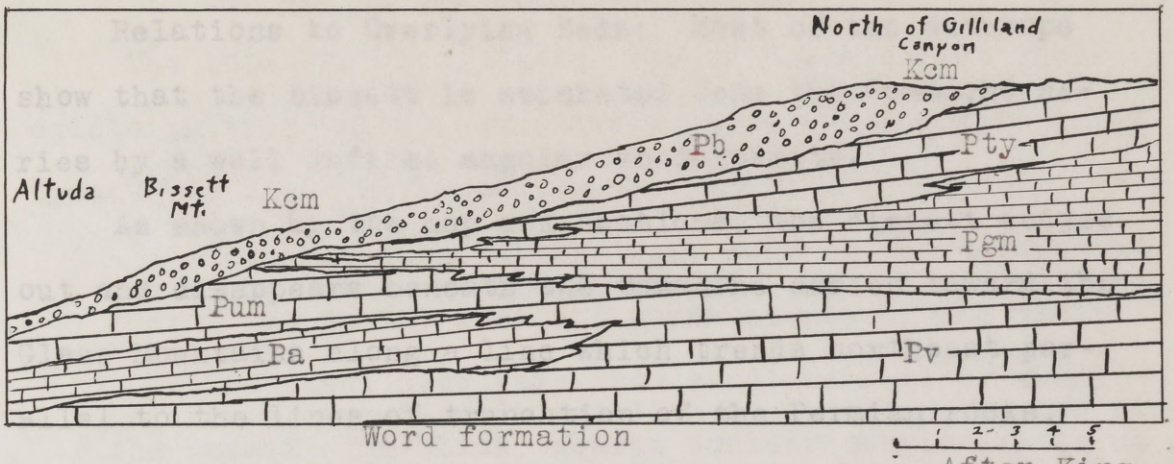

Diagram showing the relation of the Bissett to adjacent formations. Kcm = Comanchean, sands and limestones. Pb = Bissett conglomerate. Pty = Tessey member, massive dolomite. Pgm = Gilliam, thin-bedded dolomite. Pum = Upper Massive member, massive dolomite. Pa = Altuda member, thin-bedded dolomite. Pv = Vidrio massive dolomite.

As mentioned previously, however, in many places the uppermost beds of the dolomite series contain angular pebbles and even cobbles of dolomite rather widely scattered in the matrix, but in increasing abundance as the upper contact is approached. According to King this situation is true not only in the upper Tessey to the east, but in beds presumably at a stratigraphically lower position toward the west. This seems to suggest a gradational relationship, but may be wholly unrelated to the conglomerates above, having its source as a breccia, an intraformational conglomerate, or as a structure related to reef deposition.

Although there is evidently an angular divergence with the underlying beds, this is not evident at the local exposures of the contacts. The contacts with the underlying formations are apparently conformable. A typical example of this is shown in Plate 6.

Relations to Overlying Beds: Most of the outcrops show that the Bissett is separated from the Comanche series by a well defined angular unconformity.

As shown by the map and sections, the Bissett wedges out and disappears beneath the Comanche series toward the Glass Mountains along a line which trends northeast parallel to the lines of truncation of the Permian rocks.

The Basement sands, the basal clastics of the Comanche, also disappear toward the mountains; but this is because of overlap rather than truncation.

The Comanchean overlap and the truncation of the Bissett is evident. At the mouths of Gilliland and Hess Canyons the Bissett is overlaid by the Basement sands while in the southwest these disappear and the overlying sediments are Fredricksburg marls and limestones. Identical sections of Fredricksburg strata with very little conglomerate are found resting indiscriminately on Bissett and older Permian rocks in the western part of the mountains. In the eastern part of the mountains the Basement sands overlie formations from Bissett to Haymond in age.

The Bissett, therefore, is separated from the Comanche by an unconformity as shown by the divergence in dip in several localities, and by the Comanchean overlap across the beveled edges of the formation upon the older rocks of the region.

The Age of the Bissett Formation

The late Dr. J. A. Udden, one of the earliest geologists in this region, considered these sediments to be of Comanchean age. He stated that:

> "But few observations were made on the Comanchean sediments, which generally overlie the Paleozoics fartherst out on the west and north slopes of the Glass Mountains.....
>
> The basal beds vary from sand and marl of small thickness, immediately overlain by limestone on one of the summits, to thick, coarse boulder conglomerates at the mouth of Gilliam Canyon. In some buttes near this place, the Comanchean contains thick beds of bright red sandy marls.
>
> This variation in the nature of the material as well as the different fossil content of the Comanchean at different points, shows, I believe, that there is here a local overlap of the Comanchean caused by the existance of considerable relief at the time of the transgression of the Comanchean sea."

According to King the age of the Bissett formation is not certainly known. When King wrote his description he had meager fossils from this formation. The ostracod Bairdia is a long range form and shows too few evolutionary changes to be of any use in correlation. He considered the gastropods and pelecypods probably not generically determinable.

Lithlogically the marine fossiliferous dolomitic limestones of the Bissett closely resemble those of the undoubted Permian below and are unlike any rocks known from Triassic Dockum group of the Staked Plains. The Bissett red beds are rather similar to red beds of

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4 Udden, J. A."Notes on the Geology of the Glass Mountains," University of Texas Bulletin No. 1753, p.54.

various ages to the northwest, and the conglomerates are obviously of such local character as to furnish no evidence for comparison with rocks of other regions.

King continues in stating that perhaps the strongest argument for the Permian age of the Bissett formation lies in the nature and magnitude of the various periods of diastrophism in the region. It will be seen from the foregoing discussion that the unconformity at the base of the formation represents a gradual overlap upon the older formations, with little apparent divergence in dip, thus suggesting a broad uplift. On the other hand, it has been shown that the unconformity at the top of the formation shows a decided tilting of the Bissett and earlier formations before the deposition of the Comanche series, resulting in an angular unconformity, usually several degrees, but occasionally more. Thus it is evident that the greatest pre-Cretaceous orogeny of the Glass Mountains is post-Bissett. In nearby areas toward the northwest, and for some hundreds of miles beyond in the same direction, it is found that the Triassic is folded somewhat more than the overlying Cretaceous, but that the greatest folding is consistently pre-Triassic and post-Permian, thus suggesting a correlation of the post-Bissett movement with the pre-Triassic disturbance of the Staked Plains.

The character of the erosion surfaces above and below the formation tends to confirm this reasoning. The Bissett conglomerates are derived from the immediate erosion of a gently upraised land mass, on which they overlap irregularly. The erosion surface at their base is in striking contrast to that at the base of the Comanche series, which is a peneplain produced by long-continued erosion of a stable plain.

There is a certain amount of evidence accumulating which would suggest correlation of the Bissett formation with the Dockum group, as has been suggested by Adams.[5] Rocks of this age are known in the Fort Stockton district, not more than 60 miles northeast of the Glass Mountains, and well log correlation suggest the possibility that these are laterally continous. The marine dolomites are, however, quite unlike that of the Dockum.

In a footnote King mentions the fossil plants obtained from the Bissett formation by E. H. Sellards, C. L. Baker, and M. B. Arick in December, 1930. These plants are regarded tentatively as Upper Permian by David White and E. H. Sellards.

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5 Adams, J. E., "Triassic of West Texas," Bulletin American Association of Petroleum Geologists, Vol. 13, p. 1047, 1929

Robert Willis, from compiled data,[6] states that:

> "The uplift which accompanied the folding of the Marathon Region began prior to the deposition of the upper Gaptank from the established land mass southeast of the Glass Mountains which must have persisted until the end of the Word at least, and reappeared during Bissett time if it did not remain throughout the Permian."

In his correlation table, he places the Bissett questionably in the Upper Permian.

Keyte correlates the Vidrio, Gilliam, Tessey, and Bissett as equivalent at least in part to the Capitan, Castile, and Rustler of the Deleware section.[7]

CONCLUSIONS

The purpose of this study was to prove, if possible, that the fossil plants of determined Upper Permian age found below the conglomerate in Hess Canyon are actually in Bissett strata. The plants have been shown to lie between the conglomerates at the locality at Hess Canyon. Moreover another series of limestone strata containing fossil plants was found interbedded in Bissett conglomerate outcropping in the Tessey Buttes. These fossil

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6 Willis, Robert, "Correlation of the Texas and New Mexico Permian," Bull. Amer. Assoc. Petrol. Geol. Vol. 13, pp. 1016-1017, 1929.

7 Keyte, I. A., "Correlation of Pennsylvanian-Permian of Glass Mountains and Deleware Mountains," Bull. Amer. Assoc. Petrol. Geol., Vol. 13, pp. 603-609, 1929.

plants and associated fossils are similar to those found in Hess Canyon. Therefore the age of the Bissett formation can be determined from these plants if their age can be determined.

The Upper Permian age for the Bissett is therefore certain from the determination of the fossil plants collected at Hess Canyon, combined with the stratigraphic relations. Determination of the age of the plants from the Tessey Butte outcrop will determine the age of the formation, and this determination will undoubtly agree with that of the Hess Canyon fossils.

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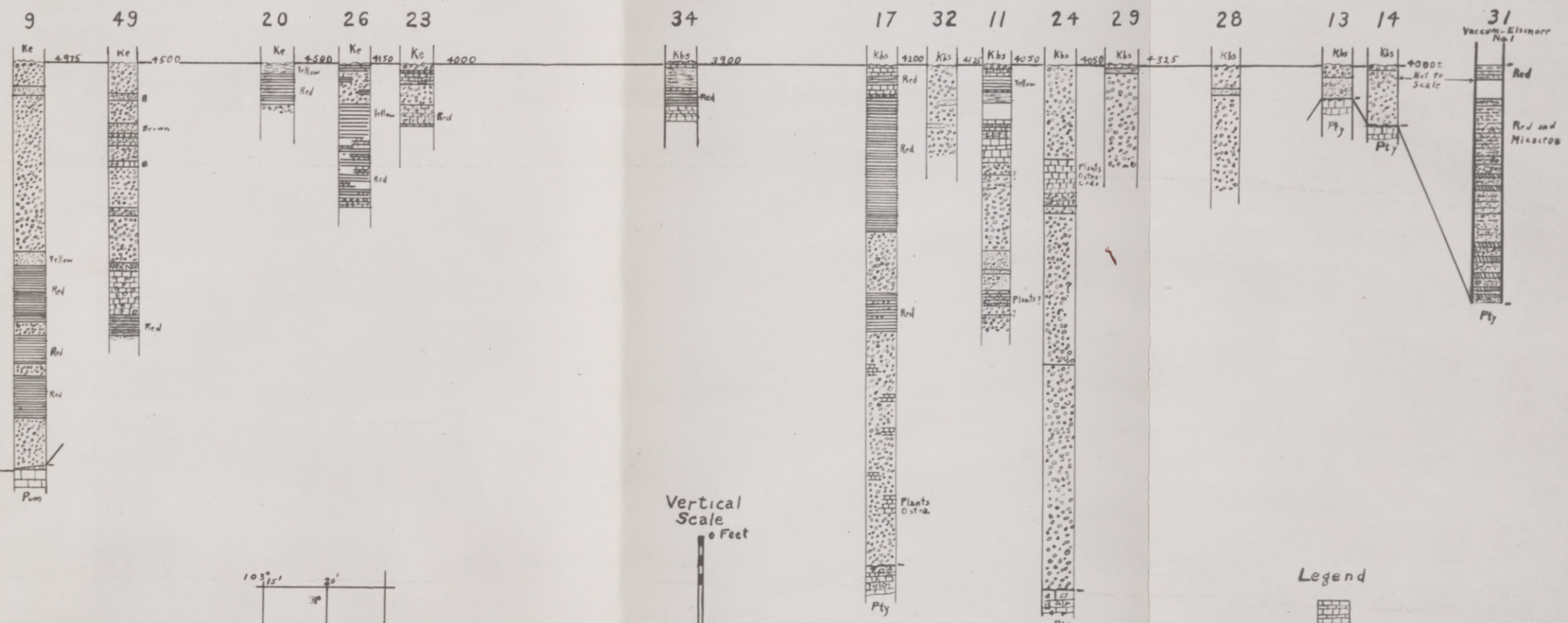
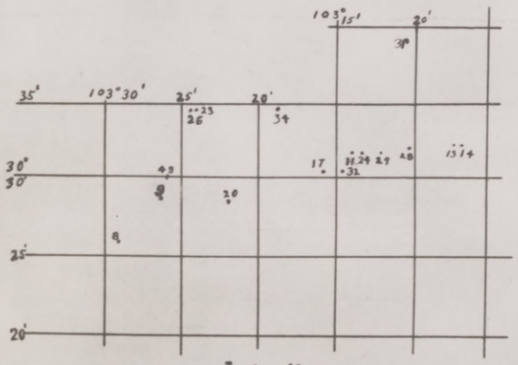
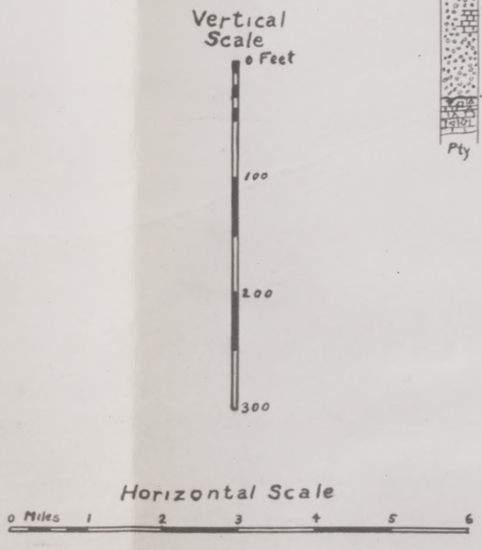
VERTICAL SECTIONS OF THE BISSETT FORMATION OF THE GLASS MOUNTAINS







Legend

- Limestone and Dolomite
- Sandy Limestone
- Conglomerate
- Red Beds
- Anhydrite and Gypsum
- Sandstone

Ke – Edwards limestone, Kbs – Basement sands } Cretaceous

Pty – Tessey formation, Pum – Upper Massive member } Permian

4325 – Elevation (Approximate)

PLATES

West side of the southernmost Tessey Buttes. The prominent ledge is the Basement sand of the Comanchean and the slope below is the Bissett.

Typical Bissett conglomerate on a hill of the west side of Hess Canyon.

Sandstone ledge in Bissett conglomerate on the east hill of Bissett exposures in Hess Canyon.

Dolomitic limestone bent and tilted due to slump of Bissett conglomerate in the Tessey Buttes.

Dolomitic limestone interbedded in conglomerate on Tessey Buttes. (Lower end of rod on top of conglomerate).

Apparently conformable contact between Bissett and Gilliam on hill three miles east of Bissett Mountain.

GEOLOGIC MAP OF PART OF THE GLASS MOUNTAINS SHOWING OUTCROPS OF THE BISSETT AND ADJACENT FORMATIONS

AFTER P. B. KING AND R. B. KING

SCALE

1 ½ 0 Miles 1 2 3 4 5

LEGEND

Sedimentary Rocks

- Wash and rocks not adjacent
- Cretaceous, Comanchean — Kyt — Georgetown
- Cretaceous, Comanchean — Ke — Edwards limestone with Comanche Peak and Walnut formations locally at base
- Cretaceous, Comanchean — Kbs — Basement Sands
- Angular Unconformity
- Permian, Capitan — Pb — Bissett formation
- Unconformity
- Permian, Capitan — Ptv — Tessey formation, West
- Permian, Capitan — Pum — Upper Massive Member, West
- Permian, Capitan — Pm — Altuda member
- Permian, Capitan — Pgm — Gilliam member, East

Special Symbols

- OT — Tank
- x4618 — Heights (in feet)
- D / U — Fault

Pecos County / Brewster County

Middle Cap Rock · North Mtn · Number Three Peak · Pentagon Mtn · Eleanore West Camp · Sibley Ranch · Panther Place · Warmen Ranch · Hord Ranch · Old Stroud Place · Nichols Ranch · Esterwood Ranch · Old Edwards Place · Old Emerson Place · Old Young Place · Spring Canyon · Old Blue Mtn · Gilliland Canyon · Southern Pacific

103° 30' 25' 20' 15' 10' 5'

35' 30' 25' 20'