

G E O L O G Y

PREVIOUS WORK

Geological:

Surface geological mapping on a regional scale has been carried out in the Amadeus Basin by the Bureau of Mineral Resources, Frome Broken Hill Co. Pty. Ltd. and Magellan Petroleum Corporation. A history of geological investigation of Gosse's Bluff has been given by Brunnschweiler et al (1959) and Moss (1964).

Geophysical:

The first geophysical investigation of Gosse's Bluff was made on behalf of Frome Broken Hill Co. Pty. Ltd. in 1958. Both magnetic and gravity surveys were conducted.

Between March and July, 1962, the Bureau of Mineral Resources conducted a seismic survey consisting of a main north-south reflection traverse and several short supplementary reflection and refraction traverses in the Gosse's Bluff area.

In 1962, the Bureau of Mineral Resources also conducted a semi-detailed gravity survey along seismic traverses, and also on a grid inside Gosse's Bluff. Results of geophysical surveys are discussed briefly on page 10.

Drilling:

The closest deep exploratory well is the Magellan Palm Valley No. 1 well, approximately 25 miles south-east, which was drilling concurrently with Gosse's Bluff No. 1.

Regional Geology:

Gosse's Bluff is located in the Missionary Plain midway between the Gardiner-Krichauff-James Range anticlinal trend and the Macdonnell Range marking the northern boundary of the Amadeus Basin.

Good quality seismic data from work conducted by the Bureau of Mineral Resources across the Mission Plain

indicates a rather conformable sedimentary section in excess of 30,000 feet. The deposits consist of Upper Proterozoic, Cambrian, Ordovician and undifferentiated Upper Palaeozoic beds overlain by a thin veneer of recent deposits.

The type section for the Amadeus Basin is at Ellery Creek about 45 miles from the Bluff. This section has been measured and described by a number of geologists and their results are recorded in various government and private company reports.

Much of the same section is exposed in the core of the deeply eroded Gardiner Range, 15 miles south of the Bluff.

Geology of Gosse's Bluff:

Gosse's Bluff is a circular ridge of steeply dipping and partially over-turned strata projecting 600 to 700 feet above the Missionary Plain. The plain consists of sandstone and conglomerate of the Pertnjara Formation. The steep rim of the Bluff is formed by a highly resistant Lower Pertnjara member and the Mereenie Sandstone. The latter was found by Hopkins (1964) to be 1,130 feet thick which, when compared with 2,300 feet at Stokes Pass in the Macdonnell Range to the north and 2,600 feet in the Gardiner Range to the south-east, indicates considerable thinning across the structure. Inside the Bluff, Hopkins measured 1,275 feet of Stokes and 619 feet of Stairway. This also supports postulated thinning across the dome.

Some workers have reported a small exposure of Horn Valley beds in the centre of the Bluff, but exposure is poor and identification doubtful. The strongly imbricated nature and extreme dips of the beds within the Bluff form a complex picture, and accurate estimates to formation tops were impossible.

Several origins have been suggested for Gosse's Bluff. Among them salt intrusion, igneous intrusion and meteorite crater.

Geophysical and geological work in recent years support a salt dome theory. The following observations support this:-

- (i) A slight negative gravity anomaly across the bluff, with a small positive anomaly superimposed on this. The positive anomaly is thought to represent a cap rock over salt.
- (ii) A small magnetic anomaly imposed on a strong westerly gradient. A portion of the gradient could be caused by an increased thickness of sediments, but the absence of any marked anomaly strongly suggests that the intrusive mass is not igneous (Richards and Brunnschweiler 1958).
- (iii) The presence of a peripheral syncline surrounding the Bluff was established by photo and seismic work. This is a feature common to salt domes of the gulf coast of the United States, caused by the flow of salt into the diapir and subsequent slumping of overlying sediments surrounding it (Levorsen, page 280).
- (iv) The discovery by drilling of substantial salt horizons in Proterozoic and Cambrian rocks of the basin by Exoil in the Ooraminna and Alice wells, and by Transoil in the Mt. Charlotte well.

STRATIGRAPHIC TABLE

Age	Lithologic Unit	Formation Top		Penetrated Thickness
		Depth	Sub-sea	
Ordovician	Stokes Shale	Surface	+2439.5'	1032.5'
Ordovician	Stairway Sandstone	1046'	+1407	3489'+

Stratigraphy:

No attempt has been made to calculate true stratigraphic thicknesses in the well due to varying high dips.

Surface - 1046' (penetrated thickness 1032.5 feet)

Stokes Shale

Age: Palaeozoic - Ordovician

The Stokes is composed of alternating red and green Shales with thinly scattered thin carbonate beds. Shales are variably slightly calcareous and micaceous. Red and green colours are locally mottled together. Fossil remains including bryozoa, brachiopods, and crinoid stems occur in isolated beds. Pseudomorphs of salt were observed in green shale in an outcrop inside the bluff. Thin limestone breaks occur throughout, becoming more numerous towards the base of the interval. The limestone is white, cryptocrystalline to very finely crystalline, dense, rarely containing small amounts of pyrite and gypsum. One thin dolomite zone, ten feet from the base, is white, very fine crystalline, sandy, silty and dense, and contains minor gypsum and galena.

1046' - 4535' (penetrated thickness 3489 feet)

Stairway Sandstone

Age: Palaeozoic - Ordovician

Top of the Stairway was picked at the first Sandstone below Stokes Shales. No attempt has been made to sub-divide the Stairway due to varying steep dips and the possibility of overturning of part of the section.

The Stairway consists of predominately sandstones and minor siltstones with several shale interbeds. Sandstones are generally white to light grey, occasionally becoming light green and brown. Cementing material is invariably white, argillaceous, slightly silty material at times slightly calcareous, rarely siliceous and carbonaceous. Grain size is usually very fine to fine, occasionally becoming medium, generally with good sorting, sub-rounded to sub-angular. A distinctive feature, also

clearly seen in outcrop in the Bluff, is the presence of patches of very coarse to granular, rounded, frosted milky quartz grains in a fine grained matrix. Locally the sands grade to very light grey Siltstones. Shales are very dark grey to black, carbonaceous, partly silty, sandy and micaceous, grading to Siltstone locally. Shale often occurs as irregular wavy, lenticular streaks and argillaceous zones in Sandstone. The interval 3,525 feet to 3,555 feet is predominately red and green Shale. Worm burrowings are present in some cores.

Structure:

Gosse's Bluff is characterised by very steeply dipping beds. Pertnjara and Mereenie rocks forming the Bluff are often vertical, and in some cases overturned. Vertical ridges of Stairway Sandstone ridges crop out within the Bluff. Likewise, dips encountered in the well were generally very steep.

A comparison between hole deviation and measured dips (figure 3) suggests the possibility of overturning of beds between 2,500 feet and 3,000 feet. In general, deviation increases with increasing dip of beds down to 2,500 to 3,000 feet, then begins coming back as dips flatten out. Presuming that the bit would tend to follow the bedding in steep sediments, overturning would seem possible.

3,489 feet, or over four times the anticipated thickness of Stairway, was drilled. This can be accounted for by the steep dips. Other possibilities are either overturning or thrust faulting.

RELEVANCE TO OCCURRENCE OF PETROLEUM

A very small flow of gas from the Stairway was recorded after a trip at 3,092 feet. This flow died out when the hole was 3,300 feet deep. The induction log indicates the gas came from a permeable zone between 3,076' and 3,088'. The Stairway is a known gas horizon in the Mereenie field, and gas was reported from the Stairway in the Magellan Palm Valley No. 1 well.

POROSITY AND PERMEABILITY OF SEDIMENTS

Porosity and permeability of strata were estimated by visual examination of cores and cuttings under the binocular microscope, and inferred from hole conditions. No permeability or porosity logs were run as the hole was essentially empty. Although some porosity was observed in cores and cuttings, no appreciable amount of fluid was encountered to total depth, indicating very limited permeabilities.

CONTRIBUTIONS TO GEOLOGICAL CONCEPTS

The lower estimate by Richards (1958) to salt at 4,000 feet was proved too shallow, as a considerable thickness of contorted sediments overlying presumed salt was encountered with an unknown amount still to be penetrated before reaching salt.

As the well terminated in steeply dipping sediments, no new information concerning the nature of the caprock or salt was gained.

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