

4. GEOLOGY

4.1. Pre-Spud Geological Well Prognosis

Well Name: GLYDE #1
 Target Formation: Reward Dolomite, Barney Creek Formation and Coxco Dolomite

Table 3: Geologic description of the Formations:

Formation	Top [m]	Probable Content
Bukulara Sandstone	Surface	The Bukulara Sandstone is a medium to coarse quartzlithic sandstone with subordinate green and red mottled clay. The green colour increases towards the base. The basal 5 m becomes very gritty and almost conglomeratic.
Barney Creek Formation	61	Thin bedded to laminated, dolomitic, carbonaceous, bituminous and pyritic shale and siltstone, dolomite, tuff beds and breccia and sandstone; occasional gypsum casts; talus slope breccia adjacent to Emu Fault.
Teena Dolomite - (Coxco Dolomite Member)	501	Grey to pink crystalline massive to laminated dolomite with upward radiating, needle-like gypsum crystal pseudomorphs (normal to bedding); rare conical stromatolites; thin intervals of dolomitic shale and siltstone. Bitumen and hydrocarbon clots with common collapse breccias

4.2. Along Hole and True Vertical Depth of Seismic Marker and Reservoir Horizons

Table 4: Well Log formation tops for GLYDE #1, TD = 697.5 m.

Geologic Tops	Drilling Depth [m]	Structural Tops [m]
Bukulara Sandstone	57	Surface
Barney Creek Formation	605	57
Teena Dolomite - (Coxco Dolomite Member)	675	605
Emmerugga Dolomite (Mitchell Yard Member)	697.5 (TD)	675

4.3. Geological Interpretation of the Well Data

4.3.1. Log Adjusted Lithology Description

Bukulara Sandstone

The Bukulara Sandstone unconformably overlies the Umbolooga Subgroup of the McArthur Group. The Bukulara Sandstone is a medium to coarse quartzlithic sandstone with subordinate green and red mottled clay. The green colour increases towards the base. The basal 5m becomes very gritty and almost conglomeratic.

In GLYDE #1 - The Bukulara Sandstone is cream to white becoming light green towards the base. It is moderately weathered, fine to medium grained, quartzose sandstone, with minor feldspar grains which have been weathered to clay. The sandstone contains minor porosity and has no visible fluorescence under ultraviolet light. The basal 5m becomes very gritty with common Pyritic bands and infill between a quartz groundmass.

Umbolooga Subgroup

The top of the Umbolooga Subgroup consists of the Reward Dolomite, Barney Creek Formation (HYC Pyritic Shale Member, W-Fold Shale Member), Coxco Dolomite and Teena Dolomite progressing down stratigraphy, respectively.

Reward Dolomite

The Reward Dolomite is a widespread, highly variable dolostone unit which marks the top of the Umbolooga Subgroup. The thickness ranges from a few tens of metres in the west to several hundred metres in the vicinity of the McArthur River mine. The contact with the Barney Creek Formation is generally conformable and often gradational. The lower part of the formation consists of pink, buff and grey, laminated and thin bedded dololite with interbeds of dolomitic siltstone and sandstone, sandy dolarenite and sandy intraclast breccia. Dolomitic beds often contain small chert spheroids. Thin beds of potassium-rich, pink, siliceous, possibly tuffaceous material occur at some levels. The upper part of the formation is marked by a zone of intense silicification. In the west it is deeply weathered, silicified, chaotic breccia containing large, unsorted, angular dolostone clasts in a coarse, poorly sorted sandstone matrix with thin interbeds of dololite and dolomitic sandstone. The Reward Dolomite often contains minor base metal mineralisation along the disconformity where the dololite is black and has a bitumous odour when broken. The Reward Dolomite was deposited in an environment similar to the Barney Creek Formation, very shallow water to emergent conditions under which sediments accumulated in small bodies of standing water.

In GLYDE #1 – The Reward Dolomite was not expected to be encountered in this well, based on previous drill results, and this was found to be the case.

Barney Creek Formation

The Barney Creek Formation is a unit of dolomitic shale, siltstone and dololite which is usually only poorly exposed in low, discontinuous rubbly ridges in the west, northeast and

southeast of the McArthur River Region. The formation is usually less than 150 m thick but thickens to about 700 m near the Emu Fault Zone near the McArthur River deposits. The formation is divided into three members: the HYC Pyritic Shale Member, W-Fold Shale Member and the Cooley Dolomite Member. The Cooley Dolomite is restricted to the HYC Sub-basin to the west of the Western Fault, and 20 km north, near the Caranbirini Waterhole so is unlikely to be found in this well.

HYC Pyritic Shale Member: The HYC Pyritic Shale Member mainly consists of very thin-bedded to laminated dolomitic siltstone characterised by high carbonaceous content. Pyrite is the major sulphide component with galena and sphalerite present in the HYC deposit. Sedimentary structures include scour marks, flame structures, soft sediment slumping and graded bedding. Sedimentary breccias are recognised in the areas around the HYC deposit in close proximity to the Emu Fault Zone.

W-Fold Shale Member: The lowermost member, W-Fold Shale Member, consists of green and red, dolomitic siltstone and shale with interbeds of green vitric tuff. The proportion of tuffaceous material increases toward the top of the member.

In GLYDE #1 - Barney Creek Formation was found to contain dark grey to dark brown to black microcrystalline, blocky, interbedded dolomitic siltstones and sandstones. It was markedly carbonaceous, containing bitumen blebs and fine grained disseminated pyrite up to +5% with minor galena and possible Sphalerite. The sediments exhibited variable weak to strong orange to brown residual fluorescence with a milky white acetone cut and no visible porosity. Increased carbon content with depth was associated with increased pyrite content. The W-Fold Shale was not recognised at this site.

Teena Dolomite

The Teena Dolomite is a recessive dolostone unit with the upper part of the formation called the Coxco Dolomite Member. The Formation is up to 70 m thick in the southern McArthur River Region.

Coxco Dolomite Member: The Coxco Dolomite Member is almost certainly evaporitic and is a massive, dark grey, sometimes vaguely bedded dolomite unit. It contains numerous interbeds of pink, buff or orange-weathering, potassium rich, possibly tuffaceous, and mudstones in the area adjacent to the McArthur River deposits. The Coxco Dolomite Member is characterised by the presence of acicular crystal casts which typically take the form of radiating aggregates of needles, rarely more than 2 mm in diameter and up to 6cm long. Minor disseminated sphalerite, galena and chalcopyrite have been noted at several localities in the Coxco Dolomite Member.

In GLYDE #1 - The Coxco Dolomite Member is a light grey-brown to light pink cream, microcrystalline DOLOMITE. It is hard, blocky with no visible porosity with minor grey chert and occasionally a milky-white cut, dull yellow fluorescence and is in part calcitic.

Lower Teena Dolomite: It consists of very thin bedded, massive, dark pink and grey dolomite. To the east near the McArthur River, the unit has greater sand and silt content and contains beds of ooids and intraclast breccia including flake breccia. Some of the sandy intervals contain cross-beds and ripple marks. Thin beds of stromatolites including conical, domal, columnar and stratiform types are often present near the top and bottom of the unit. Thin beds of pink, cryptocrystalline, possibly tuffaceous siliceous rock are present at some levels. The lower Teena Dolomite was probably deposited in a hyper saline lacustrine environment in which very shallow water and emergent conditions alternated.

In GLYDE #1 - The lower Teena Dolomite units were not found.

Emmerugga Dolomite

- **Mitchell Yard Member**
- **Mara Dolomite Member**

The Emmerugga Dolomite is a unit of dolostone, minor breccia, siltstone and sandstone. It reaches a maximum thickness of 620 m. Considerable thickness variations occur due to post-depositional erosion. The Mitchell Yard Dolomite is commonly not present and erosion has in many places removed the upper part of the Mara Dolomite Member.

In GLYDE #1 - The Mitchell Yard Member is present as a light grey to cream-white massive Dolomite. It is microcrystalline, very hard and very fine grained. Calcitic in part with up to 10% interbedded grey-green tuffaceous siltstone. It exhibits minor brecciated dolomites with traces of pyrite and galena in the breccia.

4.3.2. Reservoir Quality

The reservoir quality in the Coxco Dolomite is considered poor at this location based on mud-log shows and electric-logs.

4.3.3. Source Rock Quality

Not determined.

4.3.4. Hydrocarbon Indications

The chromatograph recorded a steady background of ~100ppm while drilling. There were no significant gas shows. A slight increase in connection gases was observed when the Coxco Dolomite had been penetrated.

4.3.5. Trap integrity

The well was not designed to drill a definable subsurface trap.

4.4. Discussion of the relevance of the Well Data to the Evaluation of the Hydrocarbon Potential of the Area

The well was primarily drilled as a pilot for a later side track from the same wellbore, Glyde #1 ST1.

The Glyde Sub-Basin is an excellent area for exploring the hydrocarbon potential of the unconventional algal-organic rich Barney Creek Shale. At this location the Barney Creek was 530 meters thick. Mudlog data suggests the well is likely in the oil window based upon a background gas that contained C1-C5 and cuttings with a consistent residual oil ring and blooming cut. Previous drill holes in the area by Amoco recorded similar results and it is likely there are unidentified sweet-spots yet to be discovered in the area.

The conventional hydrocarbon potential remains high due to the surrounding Barney Creek source rock. A number of anticlines, fault controlled negative & positive flower structures, stratigraphic traps and various types of breccia plays including solution collapse, hydrothermal and talus debris like those of the Cooley Dolomite are ideal for hydrocarbon accumulations.