Petroleum System of Evans Shoal Gas Field, northern Bonaparte Basin, Australia

Suliman Ahmed Hamid Fadul[1,2], Ye Jia Ren[1], Cao Qiang [1]and Zhang Yang[1]

[1.] Key Laboratory of Tectonics and Petroleum Resources, China University of Geosciences MOE, Wuhan 430074, China
[2.] Sudan, Ministry of Higher Education and Scientific Research, Technical Education Corporation
marfsud@yahoo.com, jrye@cug.edu.cn and charleycq@163.com

Abstract: Evans Shoal Gas Field comprises the wells Evans Shoal-1and Evans Shoal-2 .Our study aimed to determine the hydrocarbon potential of the main source rock in the study area and analyze the petroleum systems and guide future hydrocarbon exploration and development. The methods used encompass BasinMod techniques using mathematical methods. Analysis of the source rock potential helped to identify the Plover-Plover (!) system. The main source rock and reservoir rock are located in the Plover Formation. The source rock of Plover Formation is currently mature and characterized by OM Type II and Type III. The average TOC of the Plover Formation in well Evans Shoal-1 is 1.78 wt%, whereas in well Evans Shoal-2 it is 1.84 wt%. The reservoir composed predominantly of fine-grained sandstone deposited with marine and estuarine environments. The measured porosity and permeability are reduced with depth and the upper part of the reservoir section is better than lower one. Cleia and Echuca Shoals formations encompass the main Seal. The overburden includes Cleia, Echuca Shoals, Darwin, Jamieson, Wangarlu, Vee, Lynedoch, Turnestone, Hibernia, Oliver, Barracouta and Alaria formations. The traps were developed from Middle Jurassic to Middle Cretaceous, are almost anticline structural traps. The threshold for hydrocarbon generation and expulsion of the Plover Formation occurred during Late cretaceous and reached the peak at Early Paleocene. The intensities of gas generation and expulsion of the Plover Formation source rock are greater than that of oil generation and expulsion. The Plover-Plover (!) System comprises a complete geological elements and processes.

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Keywords: Petroleum System; geological elements; geological processes; Plover Formation; Evans Shoal Gas Field

1. Introduction

Evans Shoal Field is situated on the northern edge of Malita Graben and south of Sahul platform in the northern Bonaparte basin, approximately 320km northwest of Darwin, Australia. The Field comprises two wells, Evans Shoal-1 and Evans Shoal-2 (Figure 1.) The exploration of the Field was started in 1988 with the first well Evans shoal-1, which terminated in Jurassic sediments at a total depth of 3713m. Gas-bearing reservoirs in the Plover Formation were confirmed by the recovery of Repeat Formation Tester (RFT) gas samples. Further evaluation of the Evans Shoal field was conducted by drilling of Evans Shoal-2 in 1998 to determine the gas-water contact, deliverability of the reservoir, and gas volume and composition. The well Evans Shoal-2 encountered approximately 360m of gross Plover Formation sandstone. Test of the upper section of the Plover Formation yielded gas at a maximum stabilized flow rate of 25.5 MMSCF (Million Mega Standard Cubic Feet) showing the presence of a significant gas resource. The Field is the second largest gas accumulation in the Bonaparte Basin, containing an estimated 6.6 TCF (Trillion Cubic Feet) recoverable gas. Our study aimed to determine hydrocarbon potential of the main source rock and to identity the petroleum systems of Evans Shoal Gas Field for guiding the future hydrocarbon exploration and development.

Gondwanan "break-up" along the northwestern margin of Australia. The northeast-southwest trending faults in the Northern Bonaparte Basin lead to rapid subsidence in the Malita and Calder Grabens, which were developed as major Mesozoic depocentres in the basin. The major mappable seismic surfaces associated with "break-up" events are the Callovian Unconformity, intra-Valanginian Unconformity, and Aptian Unconformity (Figure 3).

2. Geological settings

Evans Shoal Field is situated on the northern edge of Malita Graben and south of Sahul platform in the Northern Bonaparte Basin.

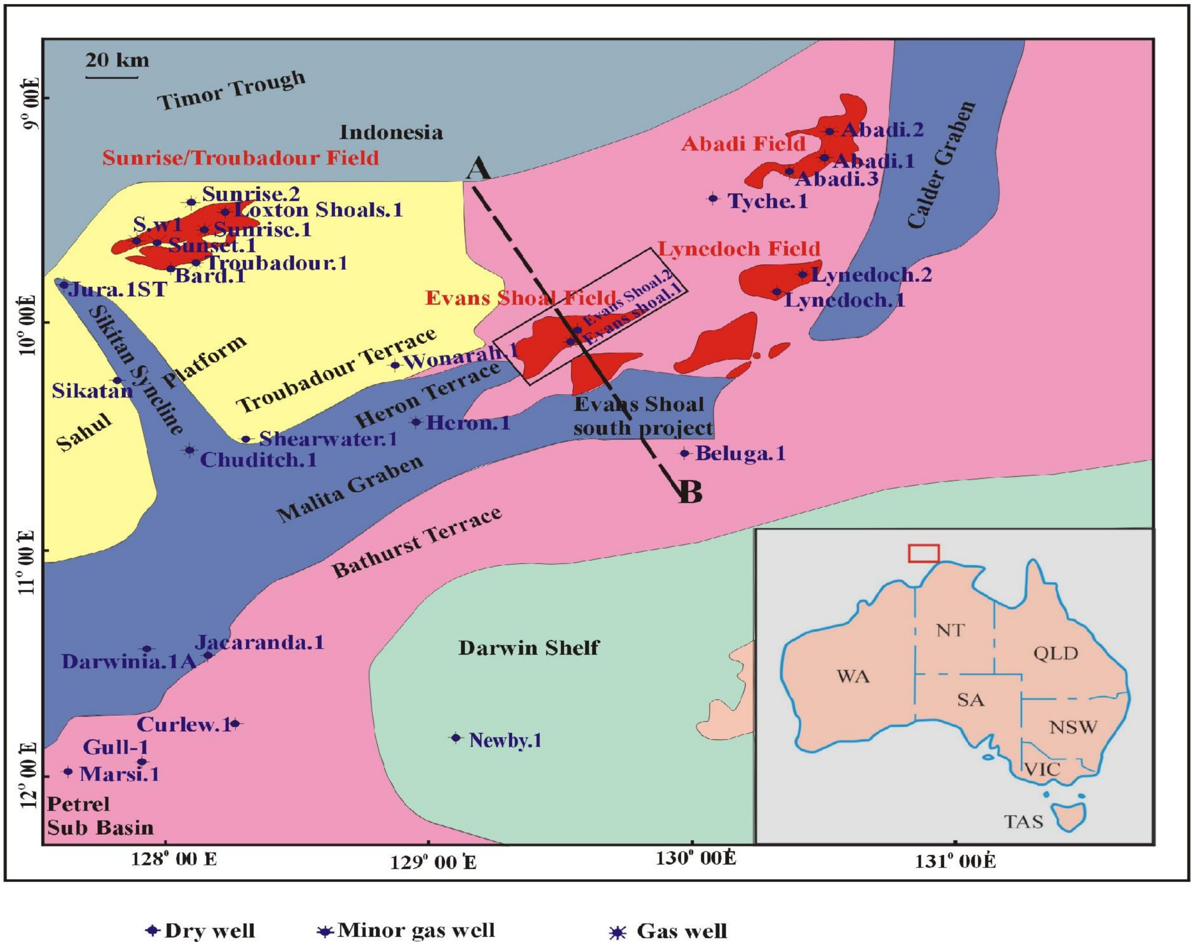

Figure1. Location map of Evans Shoal Gas Field showing Seismic line AB across the Field

The Field is characterized by gas accumulation within a large, elongate, fault-bounded anticlinal structure, trending northeast-southwest along the northern edge of the east Malita Graben. The average water depth in the field area is 100m.

The major tectonic frame work in the Northern Bonaparte Basin were formed by Mesozoic rifting which started at Late Triassic and continued throughout the Jurassic(Figure 2), which may be related to Gondwanan “break-up” along the northwestern margin of Australia. The northeast-southwest trending faults in the Northern Bonaparte Basin lead to rapid subsidence in the Malita and Calder Grabens, which were developed as major Mesozoic depocentres in the basin. The major mappable seismic surfaces associated with “break-up” events are the Callovian Unconformity, intra-Valanginian Unconformity, and Aptian Unconformity (Figure 3).

The structural architecture of the area is illustrated by regional seismic line oriented northeast-southwest across the Evans Shoal area (Figure 3). The thick Mesozoic section within the Malita Graben depocentre is shown on the northwest southeast dip line which extends from the Sahul Platform to the Darwin Shelf. The style of major fault-bounded structures situated along the northern edge of the Malita Graben is demonstrated in the northeast-southwest composite strike line. The Evans Shoal field structures are gas-charged at the Plover Formation level. The main reservoirs in the Northern Bonaparte Basin occur in the Middle-Upper Jurassic Plover Formation. The Plover Formation is a regionally widespread predominantly fluvio-deltaic sequence, which grades into a tidal-estuarine/deltaic and marine shoreface succession towards the Sunrise-Troubadour area in the northern part of the Sahul Platform. In the Evans Shoal area, the Callovian Unconformity defines the top of the Plover Formation. Cliea and Echuca Shoals Formations form the top Seal in the Evans Shoal Field. Post-rift subsidence of the Malita Graben resulted in the deposition of the Upper Jurassic to Lower Cretaceous Flamingo Formation, which varies in thickness across the northern Bonaparte Basin.

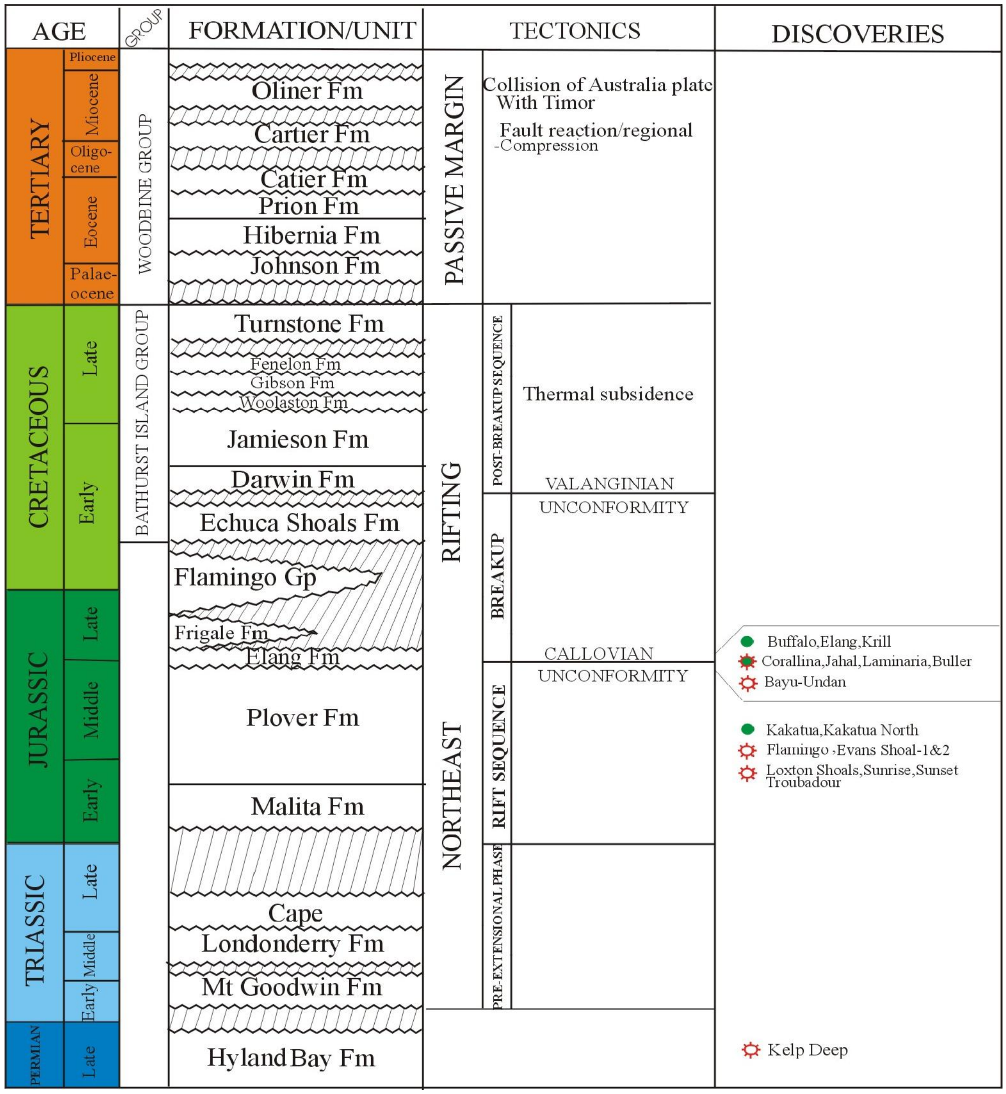

Figure2. Stratigraphy, tectonics, and petroleum discoveries of Northern Bonaparte Basin, Australia

Locally the Flamingo Formation is absent in the Evans Shoals wells and thickens significantly towards the Malita Graben depocentre.The top of the Flamingo Formation occurs at the Intra-Valanginian Unconformity.

The Cretaceous Bathurst Island Group, containing glauconitic claystone Formation is overlying the Intra-Valanginian Unconformity. The Aptian Unconformity marks the top of the Echuca Shoals which is characterized by a condensed radiolarian claystone /calcilutite section. The post-Albian sequence comprises a succession of marine shelf/slope sediments, which is dominated by carbonate deposits throughout the Paleocene to Recent time (Figure 2).

3. Materials and Methods

The study on Petroleum System of Evans Shoal Field is based on the data of well Evans Shoal-1 and well Evans Shoal-2; the materials and methods used are as follows:

3.1. Methods (models) of the study

BasinMod1D technique is used to reconstruct burial history, thermal history and the processes of hydrocarbon generation and expulsion in order to determine the maturation parameters, such as the time of onset, peak and end of oil generation and expulsion. The models used are:

(1) Mathematical method comprises the equations of backstripping and tectonic subsidence (Steckler and Watts, 1978) is used to reconstruct the burial history:

$$Dt=\left[S\frac{(\rho m-\rho s)}{(\rho m-\rho w)}-\Delta SL\frac{\rho w}{(\rho m-\rho w)}\right]+(W_d-\Delta SL) \quad (0)$$

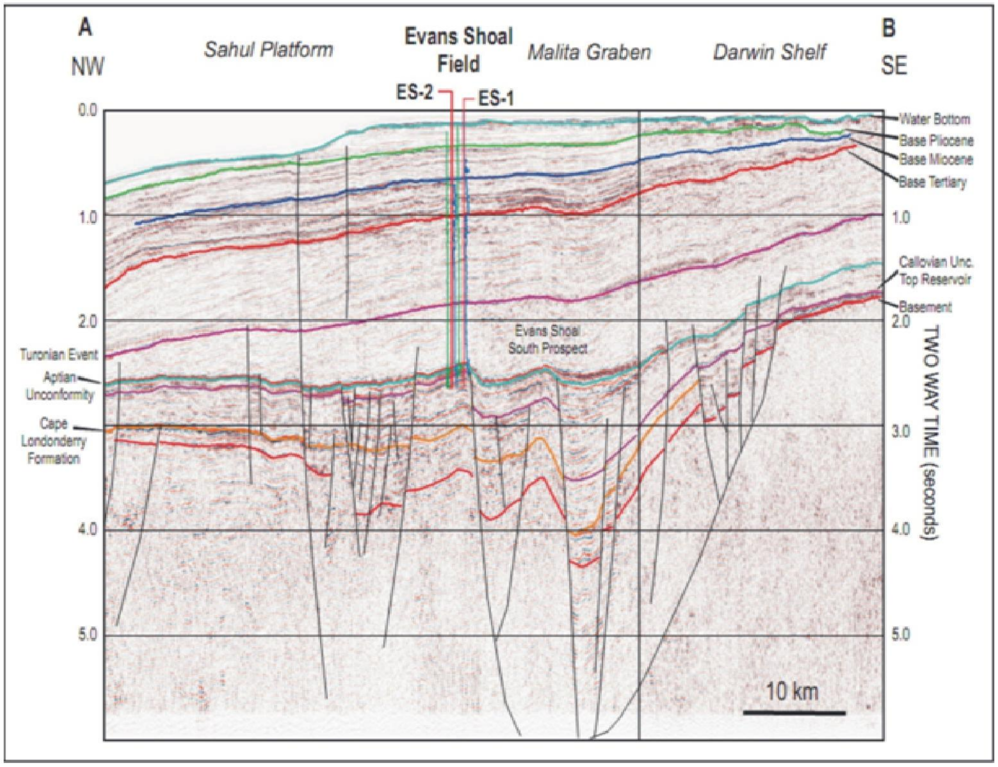

Figure 3. Schematic diagram of Evans Shoal Field showing regional composite seismic dip section **AB** between Sahul Platform and Darwin Shelf

$$\rho s=\frac{\sum_i\left[\Phi_i\rho w+(1-\Phi_i)\rho_{sgi}\right]S_i}{S} \quad (2)$$

Where:

Dt = the amount of tectonic subsidence (water column (m) in past time).

S = the total stratigrapgic thickness of the sediment column corrected for compaction (m).

ρ_s = the average density of the sediment stratigrapgic column (g/cm^3).

W_d = the palaeo-water depth (m).

ΔSL = the relative increment for eustatic sea-level variation (m).

ρ_m = the density of asthenosphere (g/cm^3).

ρ_w = the density of water (g/cm^3).

Φ_i = the porosity of stratigrapgic unit I (dimensionless).

ρ_{sgi} = the grain density of stratigrapgic unit i (g/cm^3).

S_i = the thickness of stratigrapgic unit i after compaction correction.

(2)The exponential equation of Sclater and Christie (1980) for porosity calculation as follows:

$$P = P_0 \exp^{(-kz)} \quad (3)$$

Where: P = porosity (%).

P_o = initial porosity (%).

k = compaction factor adjusted for varying compressibilities of different lithologies (m^{-1}).

z = depth (m).

(3) Modified Kozeny-Carman equation is used to calculate permeability:

$$K = \begin{cases} \dfrac{0.2\Phi^3}{S^2o(1-\Phi)^2} & (\Phi\geq 0.1) \\ \dfrac{20\Phi^5}{S^2o(1-\Phi)^2} & (\Phi<0.1) \end{cases} \quad (4)$$

K = permeability (md).

Φ = porosity (dimensionless).

S_O = specific surface area of the rock (m^2).

(4) The Simple-Ro model of (Suzuki et al., 1993) is used to reconstruct the organic matter maturation history:

$$E_{app} = \alpha \ln(Ro) + \beta \quad (5)$$

Where:

E_{app} = activity energy (kJ/mol).

Ro = vitrinite reflectance (%).

α and β = are empirical constants.

(5) The transient heat flow equation is used to describe thermal conduction and convection

assuming that the heat transfer in 1D is by vertical conduction using the following equation:

$$\frac{dT(x,t)}{dt} = \frac{d}{dx}\left(\alpha(x)\frac{dT}{dx}Q\right) \qquad (6)$$

$\alpha(x) = \frac{k}{\rho c}$ (Thermal diffusivity).

Where: T = temperature (^oK), k = thermal conductivity (W/m*C), c = heat capacity (kJ/m^3*C), t = time (Ma), ρ = density (g/cm^3), Q = heat generation (mg/g TOC) and x = depth (m).

(6)The Expulsion Efficiency VR method is used to correlate percentages of the generated oil/and or gas expelled with Ro% taking the threshold for expulsion (0.2).

3.2. Materials and input parameters

The materials and input parameters of our study comprise the thicknesses of stratigraphic units in the subsurface, absolute ages of stratigraphic units, percentages of lithologies of stratigraphic units, thicknesses of eroded sections during the main uplift events in the subsurface, the extrapolated bottom whole temperatures, the surface temperature, vitrinite Reflectance values, Tmax values, heat flow values, porosities and permeabilities and Rock-Eval pyrolysis parameters, etc. The initial porosity, matrix density, matrix thermal conductivity and matrix heat capacity are adopted from the default values in BasinMod Software package.

4 .Results and Discussions

4.1. Elements of petroleum system

A petroleum system, as defined by Magoon (1992) and Magoon and Dow (1994), includes all the essential elements and processes that are crucial for accumulations of oil and natural gas. The essential elements of petroleum system are considered to include source rock, reservoir, seal and overburden rock (Magoon, 1992; Magoon and Dow, 1994).

Source rock

The Early-Upper Jurassic of Plover Formation is the main source rock for hydrocarbon generation and expulsion in the Evans Shoals Field. The TOC of the source rock in Plover Formation of well Evans Shoal-1 and well Evans Shoal-2 range from 1.3 to 2.26wt% with average of 1.78 wt%, and from 1.4 to 2.28wt% with average of 1.84 wt%, respectively (Table 1). Organic matter analysis indicates that the Plover Formation is a gas-prone source rock with the types II&III kerogens dominantly (Figure 4), and has identified a mature level of source rock in the wells Evans Shoal-1and Evans Shoal-1 (Figure 5).In well Evans Shoal-1 the onset for the oil, wet gas and dry gas are shown by vitrinite reflectance values 0.5%, 1.3% and 2.0%, respectively, which correspond to present-day depths of 1917m, 3025m and 4713m, respectively (Figure 5A). In well Evans Shoal-2, the threshold for the oil, wet gas and dry gas are shown by vitrinite reflectance values 0.5 % , 1.3% and 2.0%, respectively, which correspond to present day depths of 1970m, 3030m and 4803, respectively (Figure 5B). The burial depth of the Plover Formation in the Evans Shoal area revealed by the wells Evans Shoal-1 and Evans Shoal-2 is deeper than 350m, so the Plover Formation source rock has arrived the wet gas generation stage at present day.

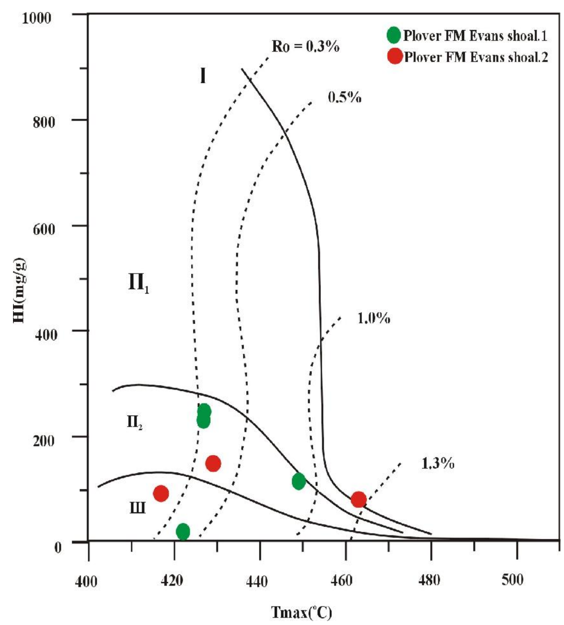

Figure 4. Diagram shows organic matter types of Plover Formation of Evans Shoal Gas Field

Reservoir Rock

In Evans Shoal Gas Field the reservoir is mainly located in the middle-upper Jurassic part of the Plover Formation. The lithology of the reservoir is predominantly fine-grained sandstone. The thicknesses of the sediment in the reservoir section are 169.5m and 360.8m in well Evans Shoal-1 and well Evans Shoal-2 respectively, while sandstone intervals have an average thickness of 84.75m which represents 50% of the total thickness of the reservoir section in well Evans Shoal-1, and in well Evans Shoal-2, sandstone intervals have an average thickness of 216.48m that accounts 60% of the total thickness of the reservoir section. Core samples are used to analyze the characteristics of the middle-upper part of the Jurassic Plover Formation reservoir. In well Evans Shoal-1, the measured porosity values range from 1.70 to 10.70% with average of 6.05 % (Figure 6A) and permeability values range from 0.01 to 581.00 md with average of 46.93 md, both porosity and permeability decrease with depth . In well Evans Shaol-2, the measured porosity values range from 0.9 to 10.30% with average value of 3.88 % (Figure 6B), while the measured permeability ranges from 0.01 to 205md with average of 11.03md**,** porosity and permeability also decrease with depth. Changes in porosity and permeability occurred as sediments compact during the burial. To compare the reservoir quality between lower and upper reservoir sections of well Evans shaol-2, a porosity-permeability relationship was conducted (Figure 7), the interpretation of these two sections indicated that the upper reservoir section is characterized by the marine shoreface facies which shows better reservoir quality than the lower section which is dominated by the Tidal/estuarine facies.

Seal rock

Due to the abundance of claystones in the Cretaceous and Upper Jurassic, both vertical and horizontal seal is likely above the Jurassic sandstone and provided by the Cleia and Echuca Shoals formations claystones. The vertical thicknesses of the seal are 90.5m and 97.9m in well Evans Shoal-1 and well Evans Shoal-2, respectively.

Table 1. Abundance of organic matter in well Evans Shoal-1 and well Evans Shoal-2

Well name	Well depth(m)	Formation	Lithology	TOC (wt.%)	HI(mg/g)	Tmax (°C)	(S_1+S_2) (mg/g)	Abundanc evaluation
Evans Shoal-1	1490-1560	Lynedoch	Lime stone	0.5-1.0	111-243	0.0	0.99-1.56	medium
	1755-3315	Wangarlu	Clay stone	0.5-1.0	21-243	428-483	0.51-1.97	medium
	3339-3495	Echuca Shoals	Clay stone	0.1-0.5	29-50	376-482	0.47-1.07	good
	3510-3525	Cleia	Claystone	1.0-2.33	26-57	360-398	0.4-0.83	poor
	3535.4-3713	Plover	Dark Mudstone	1.3-2.26	14-338	422-449	0.59-21.55	good
Evans Shoal-2	2886-3435	Wangarlu	Caystone	0.5-1.05	209-315	0.0-442	1.7-3.98	medium
	3435-3484.7	Darwin	Claystone	0.5-1.0	95-248	0.0-349	1.5-2.54	medium
	3484.7-3492.5	Echuca Shoals	Claystone	1.0-1.95	95-139	355-428	1.08-2.51	good
	3497-3545	Cleia	Claystone	1.0-2.04	55-174	397-500	1.32-6.74	good
	3563-3857	Plover	Dark Mudstone	1.4-2.28	76-151	417-463	0.88-8.15	good

TOC is total organic content (wt. %).
HI is the hydrogen index (mg/g).
Tmax (°C) measures thermal maturity and corresponds to the Rock-Eval pyrolysis oven temperature (°C) at maximum S_2 generation.
S1+S2 are the total amount of petroleum that might be generated from a rock.
S1is free hydrocarbons (mg/g).
S2 is the hydrocarbon generation potential of the source rock (mg/g).

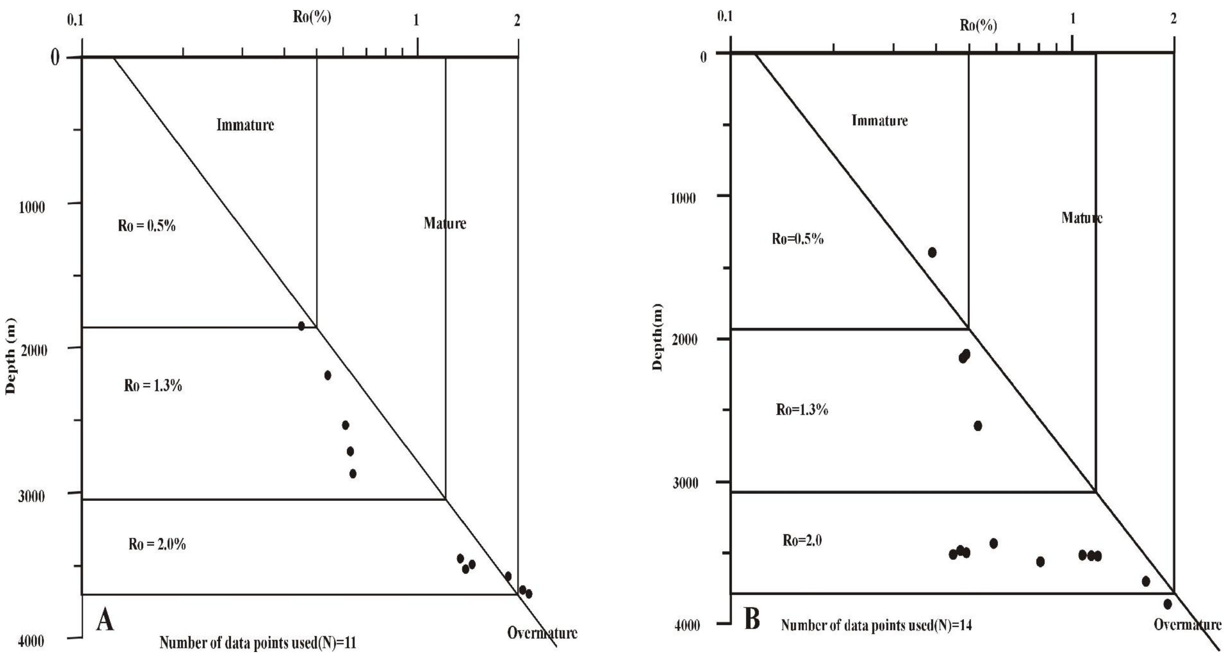

Figure 5. Diagrams showing depth versus vitrinite reflectance plots of Evans shoal Gas Field. (**A)** Well Evans Shoal-1, (**B)** well Evans Shoal-2. The diagrams indicate that source rocks of Plover Formation have entered wet gas zone.

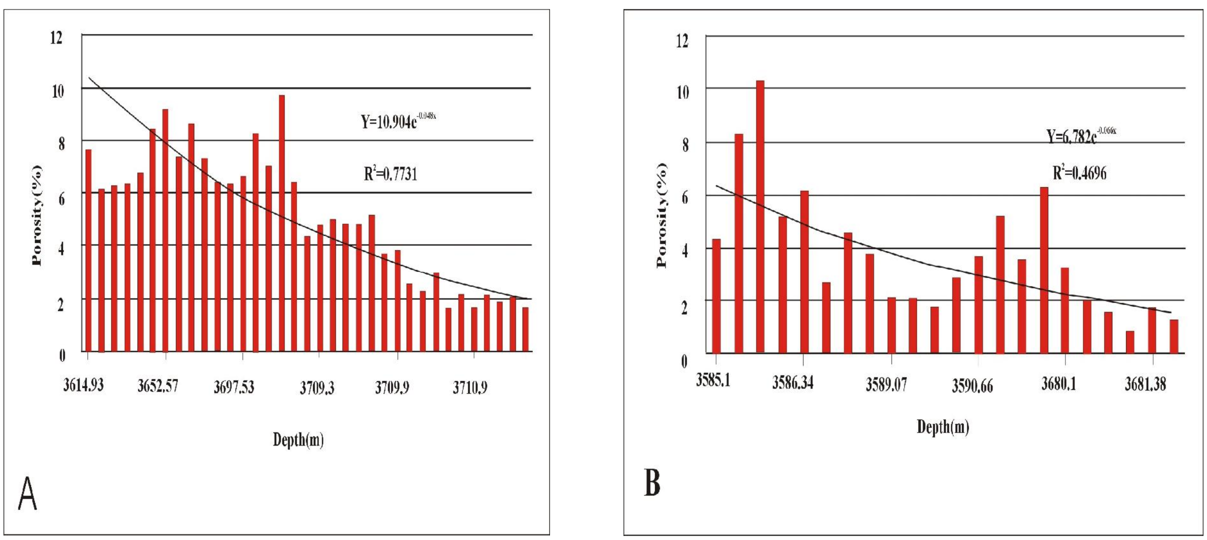

Figure 6. Porosity vs. depth diagrams of Evans Shoal Gas Field.
(A) Well Evans Shoal-1. **(B)** Well Evans Shoal-2

Overburden rock

The overburden rock in the Evans Shoal Field comprises all the formations above the Plover Formation source rock, i.e., Cleia, Echuca Shoals, Darwin, Jamieson, Wangalu, Vee, Lynedoch, Turnstone, Hibernia, Oliver, Barracouta, and Alaria formations with total thicknesses of 3432.5m in well Evans Shoal-1, and 3441.8 in well Evans Shoal-2. The lithology of the overburden rock in Evans Shoal Field wells is variable, for example, in Jamieson and Wangalu formations, the predominant lithology is claystone, the rest of stratigraphic units of the overburden rock, the predominant lithology is limestone, dolomite also occurred in small amounts. Based on corrected BHTs and the surface temperatures, the average geothermal gradient of the overburden rock is 3.93°C/100m in well Evans Shoal-1 and 3.61°C/100m in well Evans Shoal-2, these gradients provide favorable conditions for the source rock maturation and petroleum generation in the study area.

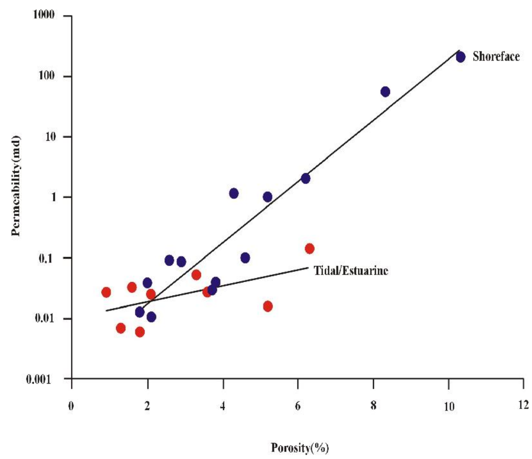

Figure 7. Porosity-permeability cross-plots of reservoir sections in well Evans Shoal-2, upper section was deposited in shoreface and it has better quality of reservoir than lower section which was deposited in tidal/estuarine environment.

4.2. Petroleum System Processes

The petroleum system processes include trap formation and generation-migration, and accumulation of petroleum. A proper evaluation of any petroleum system should also include the processes that are crucial for accumulation of oil and gas, including the timing of trap formation and the timing of hydrocarbon generation and migration (Magoon, 1992; Magoon and Dow, 1994 and Ye et al., 2007). The essential elements and processes must be correctly placed in time and space so that organic matter included in a source rock can be converted to a petroleum accumulation at the appropriate time (Magoon and Dow, 1994). In our study, we analyze trap formation, generation and expulsion processes to identity the petroleum system of Evans Shoal Gas Field.

Hydrocarbon Generation in Evans Shoal Gas Field

The timing of hydrocarbon generation and expulsion of the source rock is assessed by reconstruction of 1D model of burial history of well Evans Shoal-1(Figure 8A) and well Evans Shoal-2 (Figure 9A) using the BasinMod 1D Software. The heat flow values are 56m/Wm^2 in well Evans Shoal-1 and 51m/Wm^2 in well Evans shoal-2. The modeling results are calibrated to measured vitrinite reflectance values in the well Evans Shoal1and well Evans Shoal-2 (Figure 8B and Figure 9 B). The correspondence between simulated and measured values is remarkably good, which indicates that the accuracy is relatively higher for the 1-D modeling. The modeling results also indicated that the Plover Formation source rock in both wells entered oil, and wet-gas windows. In well Evans Shoal-1, the source rock entered the oil window during the late Cretaceous, entered wet-gas window during the end Paleogene and is at present still in the wet-gas window (Figure 8A). In well Evans Shoal-2 the Plover Formation source rock reached the oil window during the middle Cretaceous , reached the wet-gas window during the late Neogene, and is also still in the wet-gas window at present day (Figure 9A). The amount of gas generated from the Plover Formation in well Evans Shoal-1is 41.55 mg/g TOC (Figure 10 A) with generation rate of 3.77 mg/g TOC• Ma (Figure 10B), whereas the amount of generated oil from the Plover Formation in well Evans Shoal-1is 18.39 mg/g TOC with generation rate of 1.72 mg/g TOC• Ma (Figure 10A&B). In well Evans Shoal-2 the amount of gas generated is 42.17 mg/g TOC (Figure 11A) with generation rate of 2.50 mg/g TOC• Ma (Figure 11B). The peak generation in these wells is both in Early Paleocene.

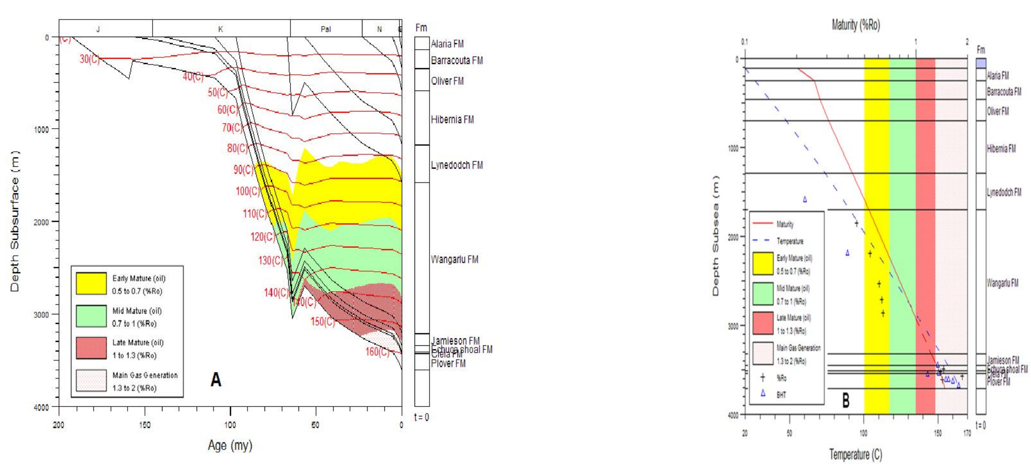

Figure 8. Modeling of burial history and isoclines of Ro (%) of Evans Shoal-1**(A)** Burial history curve. **(B)** The thermal maturity history identifying the fitness of the calculated and measured Ro, temperature

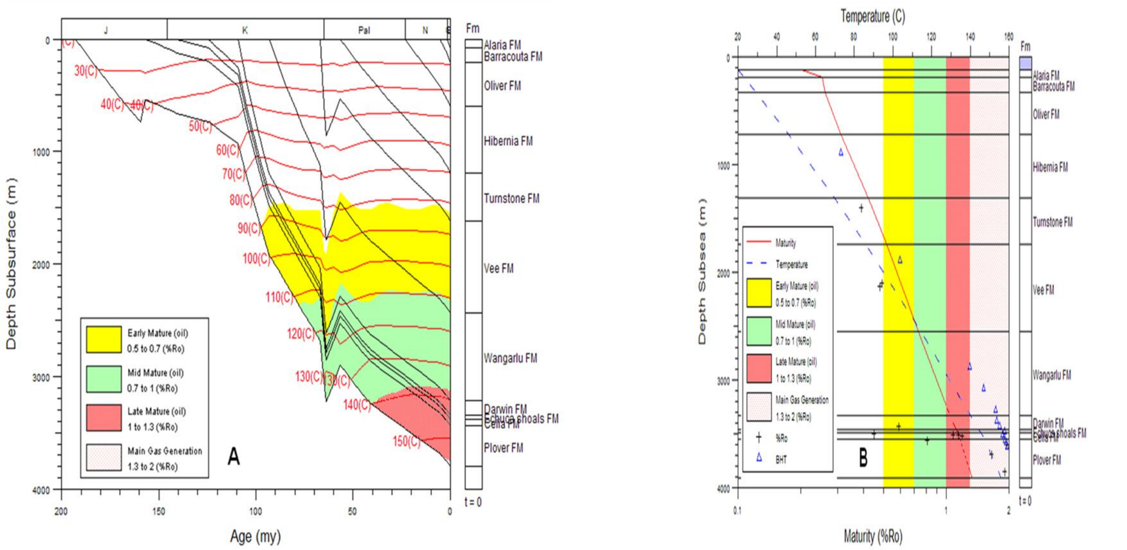

Figure 9. Modeling of burial history and isoclines of Ro (%) of Evans Shoal-2. (**A)** The burial history curve. **(B)** The thermal maturity history identifying the fitness of the calculated and measured Ro, temperature

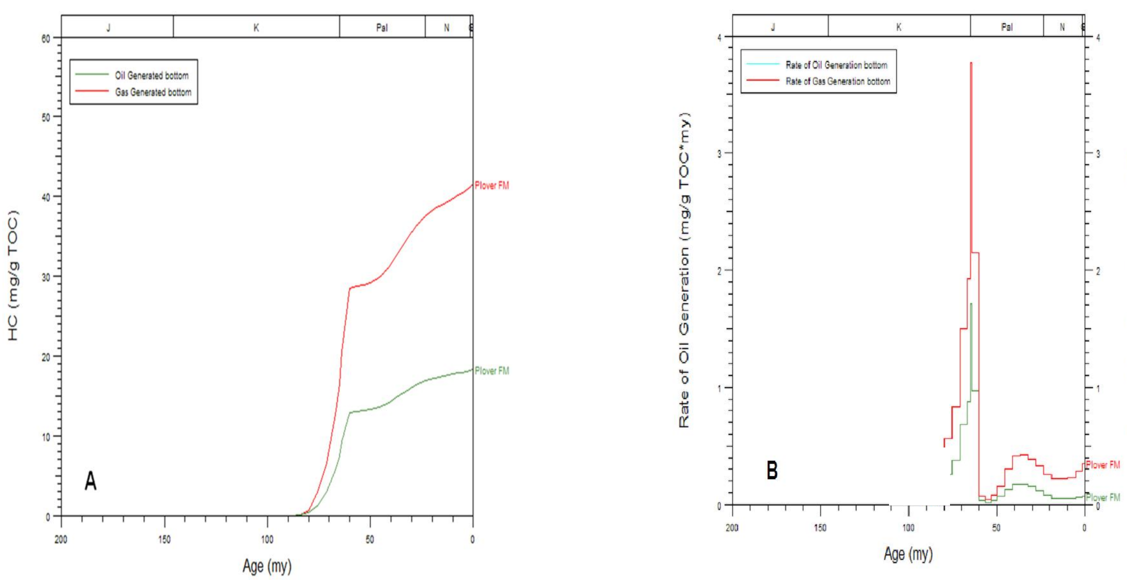

Figure 10. Modeling results of hydrocarbon generation history in well Evans shoal-1. **(A)**Timing of hydrocarbon generation. (**B)** Rates of hydrocarbon generation showing the peak generation at Early Paleocene

Hydrocarbon Expulsion in Evans Shoal Gas Field

Hydrocarbons are expelled from a source rock as discrete phases depending on the hydrocarbon saturation of the source rock, conduits-micro fractures, and overpressure caused by oil and gas generation and fluid expansion on temperature increase and capillary pressure. Hydrocarbon expulsion in Evans Shoal Gas Field started during the late Cretaceous and reached the peak at the Early Paleocene (Figure 12). The expelling efficiencies of gas and oil in well Evans Shoal-1 are 73% and 68%, respectively (Table 2), while in well Evans Shoal-2, the expelling efficiencies of gas and oil are 68% and 62%, respectively (Table 2). Thus the timing of preservation in Evans Shoal Gas Field begins at Early Paleocene at 60.23 Ma and continued up to the present-day. Based on the results (Table 2), the source rock in well Evans Shoal-1 has a greater ability than well Evans Shoal-2 to expel hydrocarbons.

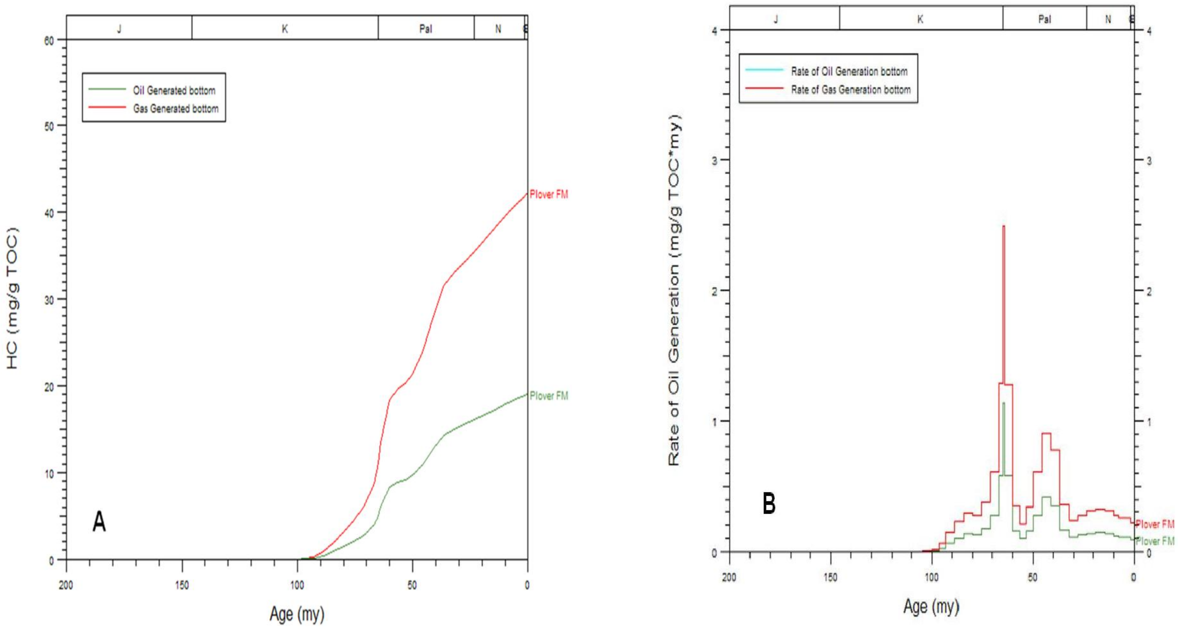

Figure 11. Modeling results of hydrocarbon generation history in Evans shoal-2. **(A)**Timing of hydrocarbon generation. **(B)** Rates of hydrocarbon generation showing the peak generation at Early Paleocene

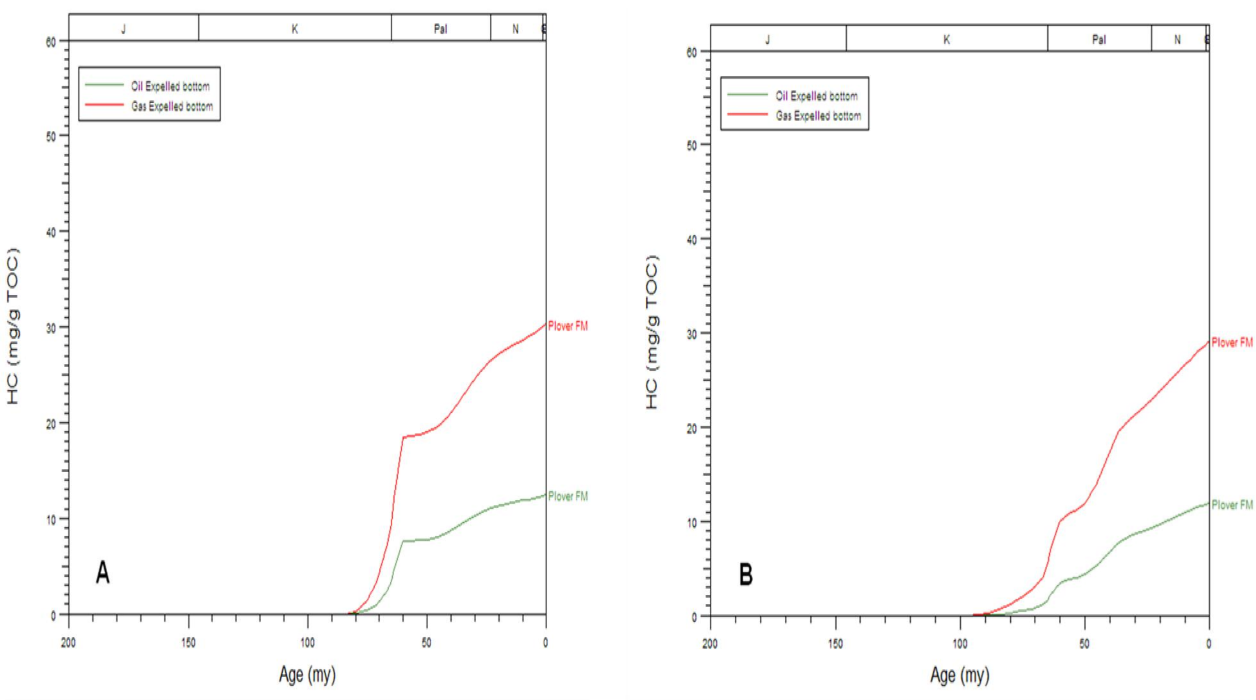

Figure 12. Diagrams showing hydrocarbon expulsion history in Evans Shoal Gas Field**. (A)** Hydrocarbon expelling intensity in well Evans shoal-1. (**B)** Hydrocarbon expelling intensity in well Evans shoal-2

Table 2. Generation and expulsion and their efficiencies from well Evans Shoal-1and well EvansShoal-2

Well Name	Oil				Gas			
	G_{oil}	E_{oil}	Age	Oil_{eff}	G_{gas}	E_{gas}	Age	Gas_{eff}
Evans Shoal1	18.39	12.64	60.23	68	41.55	30.36	60.23	73
Evans Shoal2	19.32	11.217	60.23	62	42.17	29.05	60.23	68

Where:
G_{oil} : oil generating intensity (mg/g TOC).
E_{oil} : oil expelling intensity (mg/g TOC).
Oil_{eff} : oil expelling efficiency (%).
G_{gas} : Gas generating intensity (mg/g TOC).
E_{gas} : Gas expelling intensity ((mg/g TOC).
Gas_{eff} : Gas expelling efficiency (%).

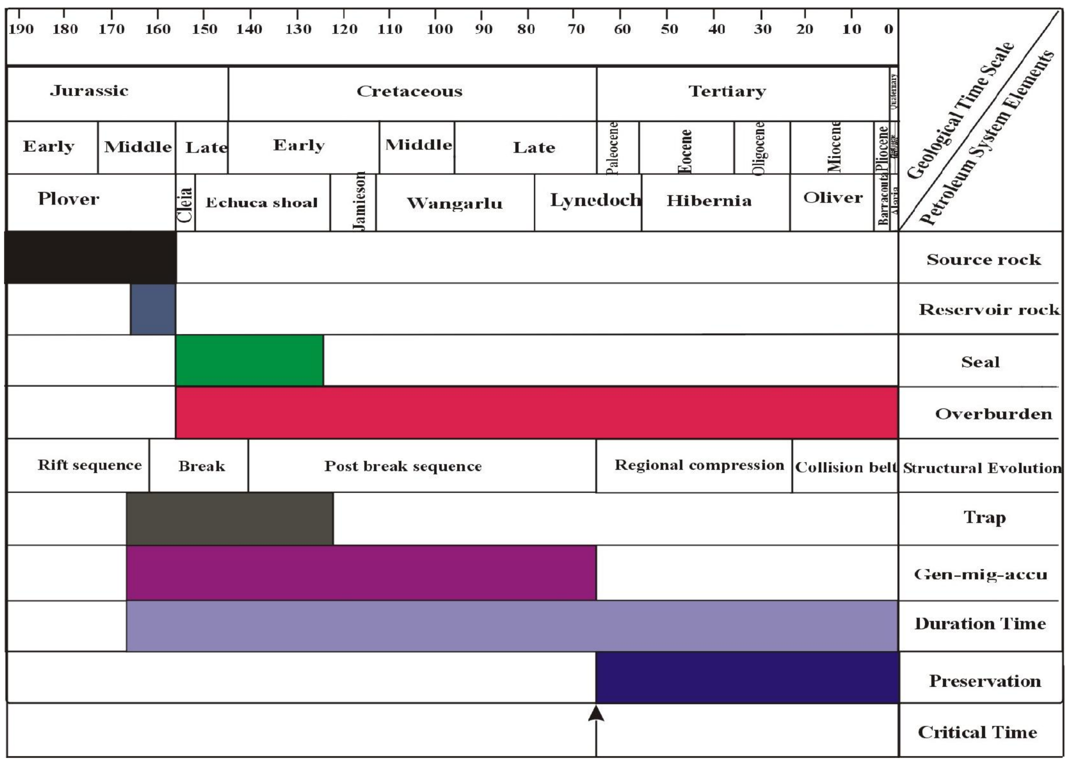

Figure 13. Events Charts of the petroleum systems in Evans Shoal Gas Field

Trap Formation

In Evans Shoal Gas Field the trap formation occurred during Middle Jurassic to Early Cretaceous and its development was associated with tectonic events which are break-up of Callovian, Intra-valangian and Aptian Unconformities. The type of the trap is a large elongate anticlinal structure bounded by a northeast-southwest trending faults and it is an effective trap to explore and drill hydrocarbon which was conformed by the gas discoveries in wells Evans Shoal-1 and Evans Shoal-2.

4.3. Petroleum System

One Petroleum System is identified in the Evans Shoal area, i.e., Plover-Plover (!)System (Figure 13). The source rock is the dark mudstone of the lower Plover Formation, and has reached a high level of thermal maturity (Ro=1.3-2.0%) within most of the area(Figure 8A and Figure 9A).The TOC values of Plover Formation are 1.78wt% and

1.84wt% for wells Evans Shoal-1 and Evans Shoal-2, respectively. The reservoir of Evans Shoal Gas Field is located in middle-upper part of the Plover Formation. The best reservoir was encountered in the top section of Plover Formation. The claystones of Cleia and Echuca Shoals formations represent the seal. The overburden rock comprises Cleia, Echuca Shoals Darwin, Jamieson, Wangarlu, Vee, Lynedoch, Turnstone, Hibernia, Oliver, Barracuda, and Alaria formations. The onset of the hydrocarbon generation-expulsion and accumulation of Plover-Plover (!) System begins at late Cretaceous and reached the peak during Early Paleocene (Figure 10, Figure 11 and Figure 12).The intensities of gas generation and expulsion of the Plover Formation source rock are greater than that of oil generation and expulsion, indicating the system is dominantly natural gas. The timing of preservation begins at 60.23 Ma, continued and ceased at present .The trap type of the Evans Shoal Gas Field is a structural anticline trap and developed during middle Jurassic to middle Cretaceous (Aptian). The Plover-Plover (!) System has complete petroleum system elements and processes, covers almost the entire Evans Shoal area and can serve as the main exploration target in the area.

5. Conclusions

The Plover-Plover (!) System has been identified in Evans Shoal Gas Field. The source rock of Plover Formation entered a mature zone and characterized by a mix of Type II and Type III kerogens showing a gas-prone source rock as a major constituent in the Field. The averages of TOC are 1.78 wt% and 1.84wt% in well Evans Shoal-1and well Evans Shoal-2, respectively.

The Plover Formation reservoir lithology is predominantly sandstone. The average porosity and permeability of well Evans Shoal-1 are 6.05 % and 46.93md, respectively and porosity and permeability measurements of well Evans Shoal-2 are 3.88% and 11.03md respectively. Porosity and permeability in both wells are reducing with increasing depth of burial. The Cleia and Echuca Shoals formations form the seal of the reservoir.

The overburden rock includes Cleia, Echuca Shoals, Darwin, Jamieson, Wangarlu, Vee, Lynedoch, Turnestone, Hibernia, Oliver, Barracouta and Alaria formations. The hydrocarbon trap of Evans Shoal Gas Field was developed during Middle Jurassic to Early Cretaceous in an anticline structural trap. Hydrocarbon generation started Late Cretaceous and reaches the peak during Early Paleocene. Timing of preservation started during Early Paleocene immediately after Critical Time at 60.23Ma, continued and ceased at the present-day. BasinMod techniques and models selected for our study are effective for source rock analysis and identification of The Plover-Plover (!) System in Evans Shoal Gas Field.

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***Correspondence to**
1. Suliman Ahmed Hamid Fadul; Email:marfsud@yahoo.com; Tel:00862765597827
2. Ye Jia Ren;Email:jrye@cug.edu.cn; Tel: 008613971562162
3. Cao Qiang;Email:charleycq@163.com
4. Zhang Yang; Tel: 008615827575155
Key Laboratory of Tectonics and Petroleum Resources, China University of Geosciences, MOE, Wuhan 430074, China

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