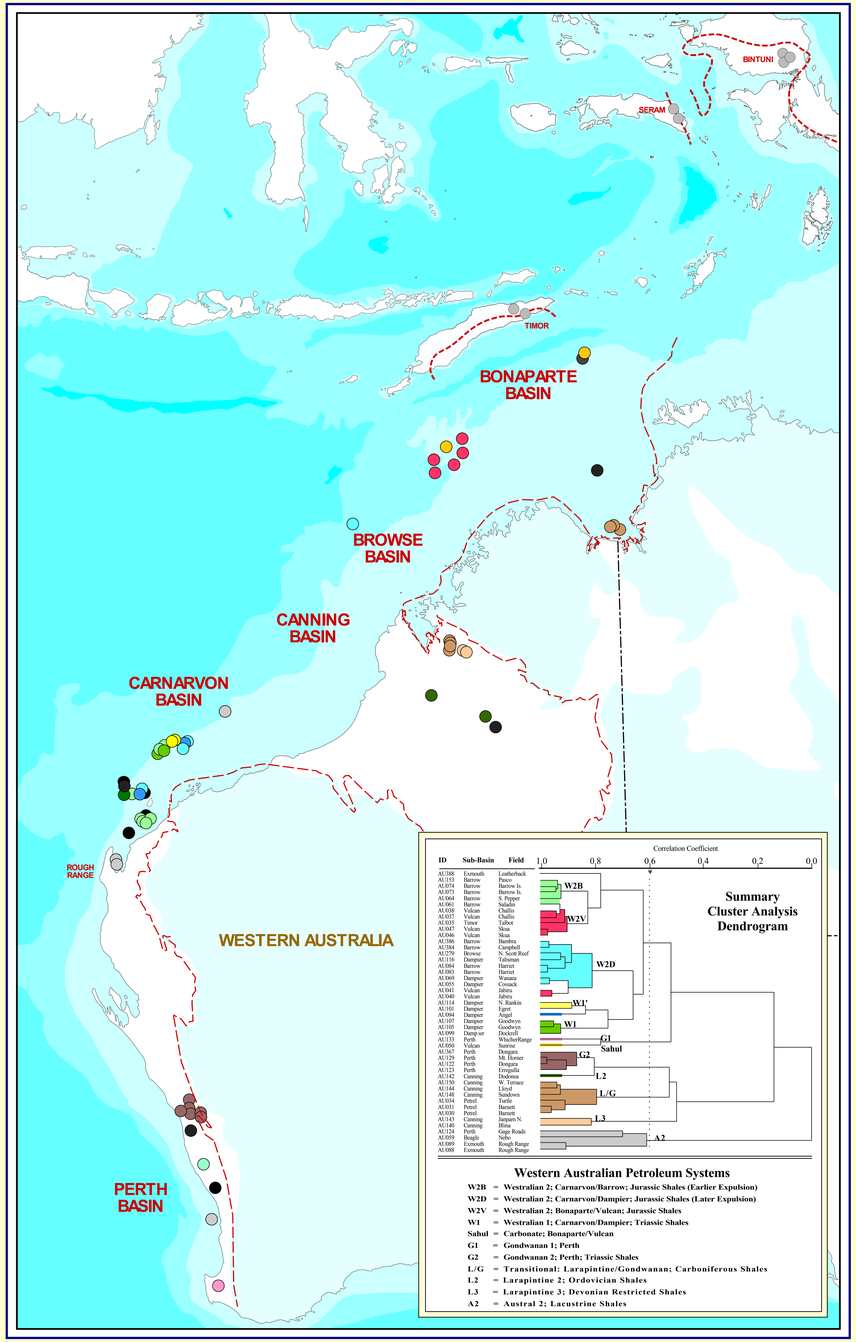


Summary Cluster Analysis Dendrogram

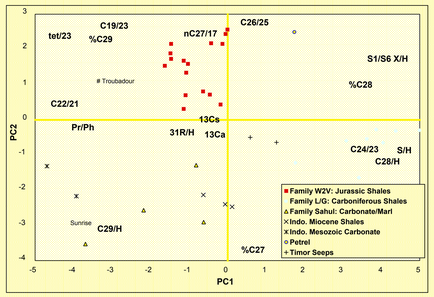
Western Australian Petroleum Systems

- **W2B** = Westralian 2; Carnarvon/Barrow; Jurassic Shales (Earlier Expulsion)
- **W2D** = Westralian 2; Carnarvon/Dampier; Jurassic Shales (Later Expulsion)
- **W2V** = Westralian 2; Bonaparte/Vulcan; Jurassic Shales
- **W1** = Westralian 1; Carnarvon/Dampier; Triassic Shales
- **Sahul** = Carbonate; Bonaparte/Vulcan
- **G1** = Gondwanan 1; Perth
- **G2** = Gondwanan 2; Perth; Triassic Shales
- **L/G** = Transitional; Larapintine/Gondwanan; Carboniferous Shales
- **L.2** = Larapintine 2; Ordovician Shales
- **L.3** = Larapintine 3; Devonian Restricted Shales
- **A2** = Austral 2; Lacustrine Shales

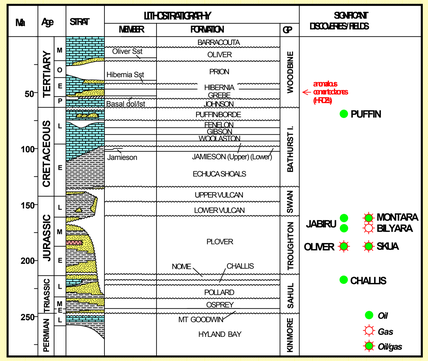
Summary Table

Field	Depth(m)	FC1	FC2	FC3	13Ca	13Cb	St/S6	Ts/Tm	28DH	DM/H
Rng4/W										
AU035 Talbot	1540	-1.14	0.00	-0.05	-27.39	-27.16	1.09	1.62	0.61	0.01
AU046 Skua	2381	-0.45	0.00	0.00	-27.44	-26.64	1.89	1.64	0.60	0.01
AU048 Skua	2339	-0.62	0.00	-0.10	-27.42	-26.60	1.93	1.68	0.62	0.01
AU047 Skua	2340	-0.77	-0.42	-0.23	-27.42	-26.57	1.92	1.71	0.59	0.01
AU045 Skua	2337	-0.23	-0.69	-0.23	-27.43	-26.60	1.83	1.72	0.59	0.02
AU043 Puffin	2357	-1.69	1.52	1.33	-25.40	-24.01	1.26	1.83	0.62	0.03
AU032 Puffin	2335	-1.31	1.57	0.85	-25.97	-25.28	2.05	1.91	0.67	0.01
AU044 Puffin	2332	-1.15	1.67	0.94	-25.68	-25.35	1.80	1.92	0.65	0.01
AU039 Challis	1410	-1.46	1.72	-0.23	-27.68	-26.49	1.75	2.09	0.80	0.01
AU037 Challis	1387	-1.46	2.15	0.24	-27.69	-26.54	1.91	2.13	0.80	0.01
AU038 Challis	1390	-1.37	1.31	-0.02	-27.67	-26.51	1.97	2.17	0.68	0.01
AU036 Challis	1404	-1.46	1.88	-0.22	-27.67	-26.53	1.74	2.19	0.80	0.01
AU001 Jabiru		-0.03	2.44	0.17	-27.29	-26.59	4.37	2.76	0.94	0.01
AU041 Jabiru	1780	-0.41	2.17	-0.27	-27.25	-26.67	3.80	2.80	1.03	0.01
AU040 Jabiru	1828	-0.12	2.15	0.29	-27.23	-26.68	3.60	2.87	1.01	0.01
AU042 Jabiru	1894	0.03	2.28	0.49	-27.17	-26.65	3.98	3.00	0.98	0.01
Rng/LG/										
AU032 Turtle	1921	5.00	0.00	-0.33	-28.02	-27.25	3.20	1.49	**0.89**	2.03
AU033 Turtle	1927	3.97	-0.29	-1.14	-27.97	-27.37	2.66	1.58	**0.85**	1.53
AU030 Barrett	1497	4.23	-0.25	-0.32	-26.41	-27.28	3.03	1.83	**0.80**	0.76
AU031 Barrett	1507	3.94	-0.25	-0.32	-26.35	-27.30	3.45	2.05	0.60	0.64
AU051 Barrett		3.10	-0.60	-0.40	-26.38	-27.24	3.49	2.34	**0.75**	0.68
AU054 Turtle	2721	1.18	-1.22	-0.74	-28.02	-27.03	2.41	3.04	0.71	0.02
AU052 Barrett		3.40	-0.85	-0.22	-26.34	-27.59	3.02	3.68	0.50	0.11
AU029 Barrett	2408	4.39	-0.33	-1.22	-26.28	-27.26	3.30	5.04	1.11	0.00
Rng/SH/										
AU049 Sunrise	2205	-0.16	-2.82	-0.68	-27.51	-25.60	1.52	1.11	0.34	0.04
AU052 Swan	2300	-0.60	-1.32	-0.05	-27.32	-27.18	1.64	1.35	0.34	0.04
AU050 Sunrise	2205	-3.69	-3.64	0.22	-27.70	-26.03	0.80	1.37	0.27	0.03
AU051 Swan	2364	0.68	-2.94	0.71	-27.40	-25.21	1.85	1.81	0.42	0.03
TriasSlope										
ID102 Rakula		1.37	-0.64	-1.98	-30.01	-28.65	2.61	1.04	0.34	0.01
ID103 Akinkala		0.60	-0.83	-1.77	-29.62	-28.78	2.03	0.82	0.35	0.01
BhutuWatershedSource										
ID120 Jagjo	215	-0.93	-2.13	3.42	-25.94	-21.12	1.92	0.75	0.39	0.02
ID119 Mcgri		-0.05	-2.42	3.75	-22.57	-20.42	1.97	0.88	0.40	0.01
ID118 Wasian	1035	0.13	-2.47	3.72	-22.28	-20.43	1.85	1.05	0.36	0.03
SteepMesozoicCarbonateSource										
ID139 Nef East	1755	-4.89	-1.32	-4.17	-29.02	-25.27	0.10	0.15	0.03	0.01
ID106 Bula		-3.93	-2.17	-3.09	-29.12	-28.76	0.21	0.28	0.12	0.01
Vagrants										
ID157 Wiegar					-25.71	-23.84	2.00	0.59	0.21	0.01
AU053 Troubadour	2384	-3.23	1.10	-0.77	-27.92	-25.68	3.57	0.72	0.15	0.01
AU053 Petrel		1.75	2.46	2.54	-24.57	-23.12	4.69	2.04	0.59	0.05

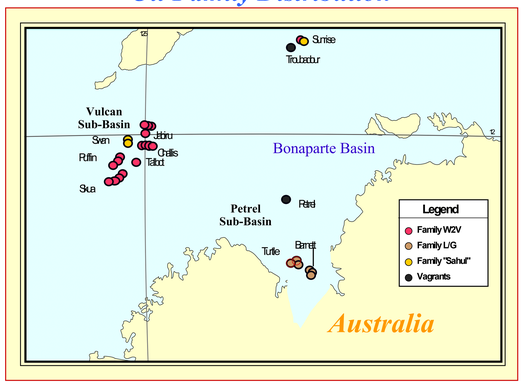
Principal Component Scores and Loads



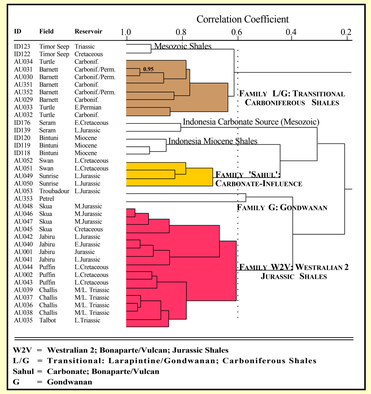
Stratigraphic Chart



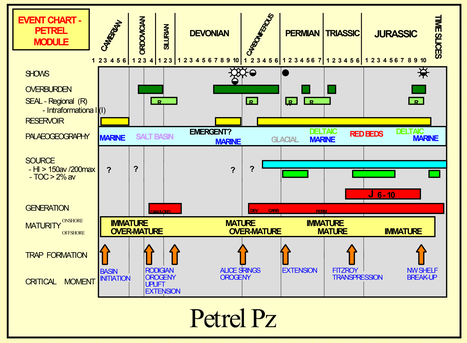
Oil Family Distribution



Cluster Analysis Dendrogram

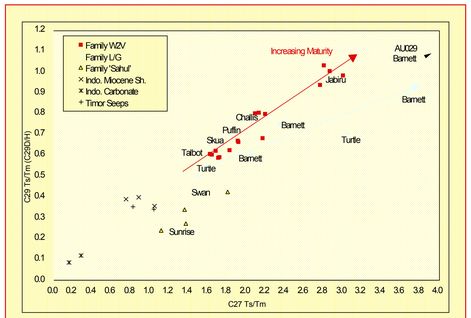


Event Chart



Petrel Pz

Terpane Thermal Maturity



Abstract

Three major petroleum families are evident in the Bonaparte Basin. Oils of the Petrel sub-basin from the Turtle and Barnett fields are distinctly different from Vulcan sub-basin oils of the Jabiru, Challis, Puffin, Skua, and Talbot fields. These families are labeled L/G: Transitional Carboniferous Shales and W2V: Westralian 2 Jurassic Shales on the **Dendrogram** and PCA plots. Members of the third oil family (ÓSahulÓ) are from the Sunrise-1 well and perhaps the Swan and Troubadour tests. The **PCA** plot also indicates which geochemical variables are responsible for the separations of the various oil families. Petrel sub-basin Family L/G contain relatively high values for steranes/hopanes (S/H), C24/C23 tricyclic terpane ratio, and bisnorhopane (C28/H) while Vulcan Family W2V has higher values of terrigenous markers such as C19/C23 tricyclic terpane ratio, %C29 sterane and are more waxy (higher n-C27/n-C17 ratio). As expected, the carbonate/marl-sourced Sunrise oil has a high norhopane/hopane (C29/H) ratio and low diasteranes (S1/S6) and diahopanes (X/H). The **Summary Table** lists the oil samples and field names within each family as determined by the various cluster and principal component analyses. In addition, the oils are listed in order of increasing thermal maturity based on C27 terpane Ts/Tm ratios within each sub family. DM/H is a measure of the relative amount of demethylated hopane and indicates severe paleobiodegradation; Family L/G (Petrel Barnett and Turtle fields) contains high values for this marker. Examining the carbon isotope data of Family W2V, it becomes apparent that the three Puffin oils have anomalous heavy values compared to the other W2V oils. Therefore, the Puffin oil Cretaceous reservoirs have been charged with oil from at least two different sources. The primary source is that which generated the rest of the W2V oils (e.g., Challis and Jabiru oils) containing the biomarkers which grouped the Puffin oils within Family W2V. In addition, a mature oil, containing very low concentrations of biomarkers, but isotopically heavy in the bulk hydrocarbon fractions, mixed with the W2V oil source. A more mature Petrel oil (AU353), of likely Permian origin, with its heavy isotope composition, may be the other source. The **Terpane Maturity** plot illustrates thermal maturity trends within the different oil families by plotting the C27 and C29 terpane maturity parameters Ts/Tm. These parameters can also be source dependent, and it is not usually valid to compare maturities between different families. Jabiru oils are much more mature than the other members of Family W2V. Talbot and Skua oils are the least mature with Challis intermediate. Family L/G oils show another maturity trend consistent with a different source. The large size of the Tern and Petrel (Gondwanan) gas and condensate fields, together with the nearby occurrence of Turtle/Barnett (L/G Transitional) oil family show that the Paleozoic petroleum systems of the region are effective. The isotopic anomaly detected in the Puffin oils also suggests that older rocks may have contributed hydrocarbons to some Mesozoic accumulations. For these reasons, Paleozoic sources should not be discounted in Bonaparte Basin play evaluation.

GeoMark Research, Inc.

AGSO Australian Geological Survey Organisation

Petroleum Systems of Western Australia

Bonaparte Basin Montage

March 1996