出國報告（出國類別：開會）

「參加第 18 屆世界石油大會」、查閱及蒐集非洲國家礦區資料

服務機關：中國石油公司探採研究所
姓名職稱：紀文榮　副所長
　　吳榮章　微古生物科學師
派赴國家：南非-約翰尼斯堡
出國期間：94 年 9 月 24 日至 10 月 1 日
報告日期：94 年 12 月 21 日

目　　錄

頁數

摘 要…… 1

壹、 出國目的與任務…… 3

貳、 主要行程…… 4

參、 論文研討會特色及重要內容…… 5

肆、 重要特殊專題與項目研討…… 8

一、深水盆地探勘 8

二、非洲張裂性斷層地塹系統及其油氣儲聚能 14

三、奈及利亞之油氣儲聚潛能 32

四、利比亞之油氣儲聚潛能 36

伍、 結論與建議…… 52

附 圖…… 54

摘　要

職等此次奉派參加每四年一次在南非約翰尼斯堡所舉行之「第 18 屆世界石油大會」國際會議，與世界各地知名油氣探勘及研究學者、不同領域之專家共聚一堂，研討最新之石油探勘科技及探討未來之發展方向，獲益良多。會中利用機會查閱及收集非洲國家礦區資料及相關之探勘資料與資訊，期能爲我公司找尋有利之礦區，提供日後國內、外探勘之參考及應用之需。

非洲爲世界現今之主要油氣生產地區，油氣資源豐富，其原始蘊藏量在現今世界油氣工業，佔有一席之地。其中奈及利亞、利比亞、阿爾及利亞及埃及等之油氣生產量，列入世界二十大產油國之一。最近由於深水探勘之崛起，西非之奈及利亞、安哥拉、剛果等地區之潛能，更引起世界石油工業界之震撼與重視。因此，世界各國莫不積極投入西非陸海域地區之探勘及開發研究，如鄰國日本、中國大陸及印尼早已紛紛派員前往搜集資訊並作深入研究，並已擁有礦區。

中油公司探採事業部，已成立非洲小組進行非洲之評估研究。但由於非洲地區之資源龐大，分佈面積廣汎，同時各地區之油氣礦床之特徵亦區區各異。因此，建議公司強化非洲地區評估小組之組織規模，增加各種領域之專家，以團隊方式大規模展開此非洲地區之探勘評估與開發技術等工作，積極佈署或尋找切入投資之時機，期以爲公司爭取最大之利益。

深水礦區之油氣產量與年俱增，尤以 2006 年以後，產量更大幅成長。西非深水區之探勘，以大西洋岸之安哥拉、剛果及奈及利亞海域最爲顯著，而其油氣產量及蘊藏量快速增加。西非深水礦區以 Block, 14,15,17,18 及 31 五個礦區最具潛能。其中以 Angola 海域之 Block 31 及 32 深水及超深水礦區最具未來探勘開發潛能。而 Nigeria 海域之深水區塊，亦聚探勘潛能，正在加強探勘之中。

由於目前世界上淺水陸棚區容易找尋之油氣構造多已被鑽探，所剩者爲深水部份，深水探勘已成爲目前國際上探勘之主要潮流，世界各大石油公司莫不紛紛

加入該行列。中油公司對於深水探勘接觸較少，但深水探勘實爲目前國際探勘之主流，此方面之探勘趨勢實不可忽略。建議公司組成專案小組積極展開深水礦區資料之搜集與評估工作，期以選取良好及具未來潛能之礦區早日加入。但由於深水探勘之投資金額龐大，建議公司可採取分段式投資策略，先以少許資金投資加入，待有成效後再加碼投入，期爲公司爭取最大商機。

利比亞 Sirte、Ghadames、 Murzuq 及 Tripolitania 等盆地共有 320 個油氣田，其可採收蘊藏量可達 500 億桶油及 40 兆立方呎天然氣以上。利比亞礦區中，以 Murzuq 及 Ghadmes 盆地之低緩構造群、構造與地層聯合封閉最具潛能，而且尚有許多未探勘區域值得重視。建議公司購置 Murzuq 及 Ghadames 之礦區細部資料並作進一步評估，期爲日後投標礦區之參考。

奈及利亞爲非洲最大之產油國，同時也是世界十大產油國之一。該國之巨大型油區-尼日三角洲，其油田大多儲聚於大陸棚上濱及遠濱區內三角洲上之生長構造，尼日三角洲外海地區上已有礦區開放，值得重視。而位於奈及利亞境內之深海沈積變形帶之濁流層砂以及大陸棚楔狀砂體，亦俱潛能，值得未來進一步深入評估，以爲日後標入之參考依據。

最近在中北非之查德及蘇丹等地區已陸續發現超大型油氣田，此區之油氣田之形成，主要係中非大斷裂帶因剪力所形成之深盆地有關，因此，此地區之油氣潛能比預估還大。其中，位於查德南部之 Doba 及 Doseo 盆地，具有良好的陸相生油母岩，而且已有油氣發現，其油氣潛能尚高。而此等盆地現爲各大石油公司所據，但由於此等盆地之構造及地化條件佳，因此建議留意原有經營者擬退出之礦區，或在其周圍尋找機會進入探勘。而 Lake Chad 盆地目前尚未發現具有商業性之油氣，但位於附近之 Termit 地塹內，已有諸多油氣井發現。同時此盆地內尚具生油條件優良之生油岩，而且其探勘密度不高。因此，如找到封閉良好之構造，尚值得進入。

壹、出國目的與任務

本公司爲掌握自產能源及支援建設發展，歷久以來積極在台灣陸海域從事油氣探開發作業。但受限於有限之天然氣資源，且各地區經過多年之開採後，其油氣已日益枯竭，因此，前往國外探勘發展及併購經營，已爲本公司當前之主要探勘策略。

本出國計畫爲配合本年度研究專題，在本公司之年度探勘目標國家中，選擇頗具潛能之非洲張裂盆地，進行石油地質架構特性及石油系統等之評估工作，以做爲日後本公司國外探勘先導性評估之參考依據。非洲地區以張裂構造爲主，諸多盆地富產油氣，例如奈及利亞、利比亞及阿爾及利亞等大油田區，近年來已成爲極熱門之探勘地區。

世界石油大會自 1933 年成立，迄今已有七十二年歷史，爲國際上最大、最重要之石油會議組織，每四年舉辦一次，會中定期邀請石油探勘界各專業領域人員齊聚一堂，共同研討石油探勘之最新科技與未來發展方向，向來爲世界各國及各大油公司所至爲重視之石油專業組織及研討會。尤其難能可貴者爲今年適巧於非洲舉行。本次「第 18 屆世界石油大會（簡稱 18th WPC，下同）」國際會議由南非國營石油公司（PetroSA）主辦，全非洲重要之石油公司，包括 Nation Oil Corporation Libya、 Nigerian National Petroleum Corporation、Alergeria Oil Company、Sonangol Angola、Exxon Mobil、Tatal、Chevron、Woodside、Upstream、Fiuor 等皆爲該會之協辦單位。與會人員共有四千兩百人之多，分別來自六十二個會員國。會中除了針對非洲之油氣探勘及礦區研討及論文發表外，並有許多非洲各主要油氣礦區國家最新之探勘活動展示及推廣，爲一能難得機會能集中進行非洲國家礦區資料之收集及查閱機會。

爲此，職等奉准於九月二十四日至十月一日前往與會，蒐集非洲地區重點礦區之資料，並與來自世界各大石油公司之專家學者，共同探討油氣之最新探勘科技，並瞭解現今之油氣探勘動態與未來發展方向，期爲本公司日後國內、外探勘及投資之參考與應用。

貳、主要行程

職等於九月二十四日起程，由桃園國際機場搭機經香港轉機，於翌日抵達開會地點-南非，約翰尼斯堡。當日早上隨即赴大會開會地點 Santon Convention Center 報到，展開爲期四天之研討會（圖 2-1 及圖 2-2）。茲將主要行程及工作內容列表如下：

預定起迄日期	天數	到 達 地 點	詳 細 工 作 內 容
9/24-9/25	2	台北-香港-約翰尼斯堡	啓程(含轉機)及 9/25 日上午抵達後前往會場註冊。
9/26-9/29	4	約翰尼斯堡	參加第 18 屆世界石油大會，查閱及收集非洲國家礦區資料。
9/30-10/1	2	約翰尼斯堡-香港-台北	返程(含轉機)。

參、論文研討會特色及重要內容

一、石油技術論文發表及研討會：

石油技術論文發表及研討會爲 18WPC 之最主要項目之一，論文研討內容包括（一）**上游探勘**、（二）**下游及石化產業**、（三）**天然氣及再生能源**，以及（**四**）**能源管理** 四大項目。而一般性論文則放在每天的第一場次（圖 2-1 及 2-2）。此次論文宣讀共有 323 篇參加，分屬不同領域及地區，分別於九月二十六~二十九日間之四天在 Santon Convention Center 舉行(圖 3-1~圖 3-13)。大會研討會除了之 323 篇論文發表，在上游之探勘方面，大會尙依其所屬不同之區域及各種探勘技術領域，特別舉辦了十八項圓桌會議研討會（圖 3-14~圖 3-17）。

(一)、 區域性盆地礦區之評估(圖 3-1~圖 3-13)

1.非洲潛能礦區之探勘

此次大會之主題，其所發表之論文包括目前最熱門之奈及利亞，利比亞、阿爾及利亞、埃及、安哥拉、查德、剛果、莫三比克、加彭及南非等國，資料內容豐富，發表者針對具有潛能之區塊，發表見解，並向外國各大油公司招商(圖 3-18)。

2.非洲以外地區之探勘

此專題包括伊拉克、阿爾及利亞印度及中國大陸等地區之探勘進展及風險評估，共有四十篇專題發表。

詳細之礦區探勘評估論文，擬於第肆章詳細報告。

(二)、探勘技術項目（圖 3-1~圖 3-13）

除了區域性之探勘評估外，並有探勘技術論文發表，茲留述於下：

1.油田之開發與管理

共有二篇論文發表，主要針對如何提升原油之採收技術及生產管理爲主。

2.超深水區氣田開發之關鍵技術

主要針對超深水區油氣田之油氣層描述、預測，以及如何降低鑽探成本，提升油氣分離技術，完井及油氣之儲存與管理等議題研討。

3.超重油及天然瀝青油氣田之開發新技術

超重油及油砂之開採，在過去之低油價時代較不受重視，但最近由於油價節節上升，同時重油之開採技術也得到突破性進展，因此，重油及油砂之開採晚近以來受到極大重視，並可能成爲未來之新能源之一。重油之開發技術僅有在加拿大達商業性水準，但重油已知在委內瑞拉、俄羅斯、美國及印尼有相當大的蘊藏量，然因環境污染及操作上問題，未能有效的量產及開發。因此，此次大會亦列有專題會場專門研討重油之開發技術，期以能擔任能源供給之重任。因此職等至爲重視，除了參與與會討論外。並赴其展示場所與加拿大辦事處探勘經理 Dr. Shieh 研討，並廣爲收集資料，以爲日後本公司參與投資之需。

4.裂縫儲集層之探勘與開發

此專題共有十六篇論文發表，主要針對裂縫儲集層之研究，碳酸岩裂縫儲集岩之開發技術;裂縫儲集岩之生產管理應用;震測技術 Side-View Seismic Location Technology(SVSL)技術層在裂縫儲集層之評估與生產上之應用等。

5.碳酸岩成岩作用 (Carbonate Diagenesis)

碳酸岩儲集岩在中東及北非分佈至爲廣泛而且重要，主要以古生代爲主。共有三篇論文專門探討碳酸岩地層之成岩作用，包括白雲化作用與孔隙率之關係，以及成岩過程對油氣儲聚之影響等。

6.構造地質及儲集岩沉積特徵

此項專題共有八篇論文研討，包括應用構造地質之分析技術，斷層之封閉特徵及其預測；構造作用與儲集層特性之關係與影響；根據地層分析觀點，探討淺海相地層之沈積特徵及碳酸岩之卡斯特特徵及其與油氣之聚積關係等；以及深水相地層之形成機制、地層特徵、沈積體系與成岩作用以及區域性評估等。

7.震測技術之研發

共有十一個專題論文發表，主要爲震測資料處理分析技術之改善，及應用震測方法以評估儲集層之特性等。其應用地區除了陸域海域盆地外，尚增加對西非深水海域，如 Angola 之應用與研討，此爲本年度大會研討會之最大特色。

8.地球化學

共有六篇論文參與研討，主要探討石油及天然氣之生成與儲聚及地化模擬等。

9.鑽探技術問題研討

包括六個專題論文及三篇壁報論文發表。主要爲針對當前所面臨之鑽探技術，包括鑽頭之高效能使用；可膨脹轉作套管之鑽桿技術(Drilling-With casing,DWC)， Well Corrosion 以及 Maximum Resevoir Contact(MRC)。

肆、重要特殊專題與項目研討

由於人力及時間所限，職等著重在本公司之目標盆地—利比亞、奈及利亞、查德以及目前最熱門與最具未來潛能之西非深水盆地，參加研討，並取回資料，以供本公司日後探勘之需。茲依將其研討心得描述如下：

一、深水盆地探勘

深水區油氣探勘，爲世界上目前極爲熱門之趨勢(圖 4-1-1)。

(一)、深水探勘之主要特性：

1、探勘井及生產景之水深逐漸加大

在 1975 年以前，不論生產井或探勘井深度，大多在 500-600m 以內，過了此年代，逐次加深，尤以 1985 年以後，各探勘及生產井之水深急遽加大(圖 4-1-2 及 4-1-3)。尤以探勘井在 1990 年以後更深達 2300 公尺以上。而進入所謂之超深水水域(extra deep ＜2000m) (圖 4-1-3)。如以地理之分佈而言，此等深井之探勘及生產大多集中在三個地區：(一)美國墨西哥灣地區、(二)大西洋西岸之巴西外海、(三)非洲及大西洋東岸(圖 4-1-2 及圖 4-1-3)。

2、深水海域之探勘活動史，可分爲以下幾個階段：

(1)1980 年以前，處女地區之試探階段

(2)1980 年-1990 年之大規模進行探勘及佐證

(3)1980 年代以後，確認了巨大蘊藏量

(4)1990 年以後，進入開發及生產階段

油氣之蘊藏量，自 1995 年以後急速增加，並開始有了超過 2000 公尺以上之

超深水礦區加入。自 1996 年以後油氣發現之埋藏量快速增加，以致許多大石油公司紛紛投入大筆資金開發深水礦區（圖 4-1-4）。

3、深水海域之油氣發現

以深度 500 公尺以上之海域油氣發現之而言，則以大西洋西岸最爲突出，其中南美洲佔 55%，西非佔 34%,而墨西哥灣則佔 5%而已(如圖 4-1-3)。

4、深水海域之鑽探成功率

深水海域之鑽探成功率，因水深而不同。在水深 1000 公尺以內者，以巴西外海之成功率較高，高達 40%以上；但在水深 1000 公尺以上者，則以西非之成功率較高，可高達 50%以上(圖 4-1-5)。

5、深水水域之總蘊藏量

深水水域之總蘊藏量，以前雖佔 5%而已此大多產自 Non-Opec 國家。過去深水探勘，開始大型油公司甚少參與，目前大多由大型或中型石油公司所把持(圖 4-1-6)。目前各大型石油公司每年均編列大量預算，進行深水水域之油氣探勘。

如圖 4-1-6 所示， 西非深水礦區之油氣產量與年聚亦增，大以 2006 年以後，產量更大幅成長，同時也顯示，西方之各大公司在西非佔有極重要的角色（圖 4-1-6 及 4-1-7）。

(二)、安哥拉及奈及利亞之深水域探勘

西非之深水探勘，以西菲大西洋之安哥拉及奈及利亞海域最爲顯著（圖 4-1-7），其油氣產量主要爲海域之五個礦區（Block, 14,15,17,18 及 31）(圖 4-1-8)在最近五年，已獲得明顯提升。其中 Block 17, Girassol 之油氣田水深 1350～4429m 深，Total Fina El 爲經營人，而 ExxonMobil, BP, Statoil, Ncrsk Hydro 爲合夥人。氣油田之蘊藏量爲 700 百萬桶（111 百万 M^3）：而 Block 14,15,17 及 18 之

油氣蘊藏量可高達 111 百万 M^3（1.5 billion M^3）。Block 14, Chevron Texaco 爲經營人；Block15, Exxon Mobil 爲經營人；Block 18, BP 爲經營人。在安哥拉最深之發現井位於 Block 31 之 BP Platao 井。

1、安哥拉（Angola）之深水域探勘

安哥拉（Angola）據有四個主要之深水礦區：Block 14,15,17 及 18（圖 4-1-9）其油氣蘊藏佔安哥拉之 80%（圖 4-1-6~圖 4-1-9）。

(1)Block 14(圖 4-1-9 及圖 4-1-14)

Chevron Fxaco 爲經營公司，已有幾個高業價值之油氣田發現。第一個在 Block 14 開發者爲 Kuito 油氣田(圖 4-12)。Chevron Texaco 在 Kuito 地區發現油氣之第三年，即展開開發工作。目前已鑽了 29 口井，每日最高可達 100,000b/d 之原油，流入 135,000b/d 之水。据估價 Kuito 油氣田之生產設施總共約 1.4 bllion 元。

Block 14 之 Bevqula, Belize, Lobito 及 Tomboco(BBLT) 爲第二輪開發之油氣田（圖 4-1-12）。BBLT 距 80km，水深 400m，爲一單一生產平台之巨型油氣田，預估可處理 210,000b/d 之油氣，預定總共可開發生 500 百万 bbl，而此 BBLT 開發設施之約需 2.4 billion 元。

(2)Block 15（圖 3-1-9 及圖 3-1-14、圖 3-1-15）

Block 15 之經營者爲 Exxon Mobil，已有 8 個計畫準備開發之中。

Kizomba 目前最大正在開發之計劃，準備開 Hungo 及 Chocalho 兩油田，生產設施可生產 2.2 百万桶。今年預定可生產 250,000b/a，其可採蘊藏量約 3billion, 整個 Kizomba 之生產設施約需 3.5 billion。

(3) Block 17（圖 3-1-9 及圖 3-1-14、圖 3-1-15）

Block 17 內發現了十個油氣田，其中 Girassol 油田爲 Block 礦區第一個發現

者，已裝置生產設施開發 Jasmin 油田力以及未來準備加開發者有 Rosa, Gravo, 及 Lirio 油氣田等。

Block 17 內 Balia 爲第二個發現者，而 Camelia 油氣於 1999 年發現，亦準備利用 Balia structure 開發生產。此設備約需 4 billion 元，而 Girassol 約需 3 billion。

Rosa 爲 Block 17 第二大生產設備，生產設備約需 1.7 billion。

(4) Block 18（圖 3-1-9、圖 3-1-14 及圖 3-1-15）

Block 18 經營人爲 BP,在 Block 18 內之 Greaten Plutonio，可儲存 2 百万 bbl，預定 2007 年開始生產，此設備約需 4 billion 元，約等於$6.50/bble，較其他 Block 爲高。另外尚有 Cesiol, Chumbo-1 兩個生產設備（圖 4-1-14）。

2、奈及利亞（Nigeria）之深水域探勘（圖 4-1-16~圖 4-1-21）

奈及利亞（Nigeria）深水礦區(圖 4-1-16 及圖 4-1-17)之油氣預定於 2006 年對於奈國之油氣生產會有較大貢獻。奈國之第一個深水油田爲 Abo，雖然規模較小，大油田 Bonge 及 Erha 之開發工作於分列於 2005 年及 2006 年展開，而此 Abo 則可能緊接其後(圖 4-1-18)。

(1) Abo 油氣田（圖 4-1-17、圖 4-1-18 及圖 4-1-21）

迄目前爲止，奈國之深水礦區僅有由 ENI 經營之 Abo 油田，該油田 2004 年之生產量爲 30,000b/d，該油田之生產設備約 2,75 百万美元。

(2) Bonga 深水油氣田（圖 4-1-17、圖 4-1-18 及圖 4-1-21）

Bonga 深水油氣田位於 Niger 三角洲兩側之 Blaock OML 118，距海岸約 75km。此油田爲奈國第一個主要之深水油田，原計劃於 2003 年開始生產，於 2004 年修正，因技術性問題延到 2005 年生產。

此油氣田之原油產量爲 250,000b/d，而天然氣則爲 150 MMcfd。整個 OML Block 之預定於 2010 年產量爲 350,000 b/d；而天然氣爲 250MMcfd。整個生產設備高達 30 億美元（3 billion）以上。

(3)Erha 及 Bosi 深水油田（圖 4-1-17、圖 4-1-18 及圖 4-1-21）

Erha 及 Bosi 深水油田包括 Erha 及 Bosi 兩個油田，位於尼日三角洲之西部，距奈國海岸約 100km。此兩油田預定 2006 年開始生產，其蘊藏量共有 650 百万桶，以 200,000b/d 日產約可生產 20 年。2004 年整個生產及設備費用約爲 28 億美元（2.8 billion）。

(4)Agbami 深水油田（圖 4-1-17、圖 4-1-18 及圖 4-1-21）

Agbami 深水油田於 1998 年發現，其經營者 Chevron Texaco，預定於 2007 年開始生產，於 2008 年之生產量爲 250,000 b/d，主要投入資含迄目前爲止 45 億美元。

(5)Usan 深水油田（圖 4-1-17、圖 4-1-18 及圖 4-1-21）

Usan 深水田水深 700-800m 位爲奈國最東側，於 2001 年發現，爲奈國最大型之深水油田。由於最近鉆探成 3 口估鉆井，其蘊藏量幾達 6 億桶（600 million）。預定於 2008 年第一口井開始生產，日產量爲 185,000 b/d。由於此口井較淺，所以較其他油田區早生產。

(6)Akpo 深水油田（圖 4-1-17、圖 4-1-18 及圖 4-1-21）

Akpo 深水油田位於奈國南界水域（圖 4-1-19、圖 4-1-20 及圖 4-1-21），經營者爲 Total 下之 Sapetro 公司，蘊藏量爲 6 億 2 千万桶（620 million）及 3.5 TCF 之天然氣及凝結油。預定日產量爲 140,000 b/d 之凝結油及 3 億立方公尺（300mmcfd）。天然氣設備以管線運送至 Bonny 之 LNG 廠。

3、深水域探勘之未來展望

深水區油氣探勘之所以再度受到重視，主要受到最近南大西洋西岸被動式大陸邊緣(Passive Continental Margin)盆地之巴西外海盆地、非洲海域以及墨西哥海灣之深水探勘成功獲得相當程度之鼓勵及啓發。不論是墨西哥灣或南大西洋盆地具有極爲相似之盆地演化史、生油岩、岩鹽運動機制及沉積物類型，如碎屑及碳酸岩沉積等（圖 4-1-22、圖 4-1-23 及圖 4-1-24）。因此，兩岸之油氣儲聚條件及油氣潛能應相似。近年來，淺海礦區之油氣已逐漸開發完成，而其生產量亦已達尖峰，尤其近年來，油價高居不下，因此，世界各地之海域油氣之鑽探活動由淺水逐次邁向深水區（圖 4-1-25 及圖 4-1-26））。而其在公司之蘊藏量所佔比例亦急遽升高。

深水地區之鑽探成功率以北美、南美洲及西非海域爲最高，再加上最近以來探勘技術之更新、大量採用 3D 震測(圖 4-1-27)、震測品質之改善（圖 4-1-28）與提升，因而導致鑽探成功率平均高達 30%以上。

因此，晚近以來各大石油公司，莫不以持續在深水區探勘爲持續經營之主要的經營策略。例如 Angola 及 Congo 深水地區之油氣蘊藏，即有明顯增加及成長(圖 4-1-29)。

目前西非海域之深水探勘以 Angola 深水及超深水以 Block 31、32，以及 Congo 外海最具未來潛能（圖 4-1-30~圖 4-1-32）。而位於 Angola 南北側之 Nigeria 深水區塊積極展開探勘工作之中（圖 4-1-33），其未來潛能應可期待。

但由於此深水探勘所費資本甚大，一般小公司無法負荷，我公司亦不例外，但由於深水探勘爲目前世界探勘最主要之趨勢，建議公司開始先投入少量資金，如有成果後，再加重比例。

二、非洲張裂性斷層地塹系統及其油氣儲聚潛能-Doba 盆地、Doseo 盆地、Lake Chad 盆地與 Bongor 盆地

(一)、引言

自從最近在中北非的查德、蘇丹等地區沿 Centre Africa Shear Zone 陸續發現超大型油氣田以後，非洲的裂谷盆地探勘，也如雨後春筍般展開。此地區油氣田之形成與 Shear Zone 內的剪力所造成之深湖相盆地有關，蓋因此深盆具有良好的陸相生油母岩，此等地區的油氣潛能也比預估大。非洲內陸地區含有許多的構造線(lineament)，現今爲沙漠、河流、森林所掩蓋而不易發現，但這些早期張裂性構造帶及其分枝帶均可能具有豐富的油氣潛能，值得注意。

非洲張裂性斷層地塹系統發生於以前的構造高區或是脆弱地殼之下降地區，可分爲三個主要系統(圖 4-2-1 及 4-2-2)。

1、Karoo system

於非洲的南部地塹系統，主要發生二疊紀~三疊紀。

2、Central system

發生於白堊紀早期，持續至白堊紀晚期及第三紀，包括 Gao graben，Sirte 盆地，Anza 地塹，蘇丹 Khartoum 的小地塹群，查德 Ennedi Massif 附近的張盆地沿 Chad shear zone 發育。

3、East African system

發生於漸新世晚期至中新世早期，主要侷限於非洲東部。

(二)、查德南部盆地之張裂構造

中非剪切帶包括有 4,000,000 平方公里的範圍，涵蓋奈及利亞、尼日、查德、喀麥隆以及部份的 Benin 以及中非共和國，緯度從北 4°至 24°，東徑 2°至 24°。其中的裂谷盆地與中非剪切帶有直接的關係，雖然各盆地程度不同，主要還是以扭張作用力爲主。這些因中非剪切帶而開裂生成的扭張盆地，都具有扭動構造的基本特徵（圖 4-2-2 及圖 4-2-3）。

查德南部及中非共和國東北部的裂谷盆地區有四個開裂盆地（圖 4-2-4），其中兩個 Doba 及 Doseo 盆地已經証實生產石油，而另兩個 Bongor 及 Salamat 盆地則僅有極少量的鑽探。查德南部的盆地係因大西洋的開裂、拉張及擴張而形成。依 Genik(1993)之研究，查德南部的盆地開裂主要發生早白堊系(130-96Ma) 及晚白堊系(96-75Ma)（圖 4-2-5）。

查德所屬盆地中可分爲三大部份：有油氣發現的 Doba 及 Doseo 盆地；極少鑽探但有油氣徵兆的 Bongor 及 Salamat（圖 4-2-4）；以及未鑽探且所知甚少的 Bake-Birao 盆地。茲將地質條件、石油系統及石油潛能分述如下：

1、Doba 盆地

(1)區域地質

Doba 盆地位於 Chad 之南邊（圖 4-2-6），Boba 盆地位於 Bongor 盆地之南，與 Cameron 之北界交界附近，長爲 300km，140km 寬，此盆地介於左移之 Benue

Wrench 與右移之 Mbere-Djerem-Borogop 兩大斷裂斷層之間，盆地之形式與特性受此幾乎東西向延長大斷裂之控制（圖 4-2-3 及圖 4-2-7）。此盆地以盆地基盤與其他之盆地包括 Logone-Birni 及 Bongor 盆地隔開。本盆地軸爲東西向，盆地之南邊爲基盤露頭呈向西傾斜，地層在與 Cameron 交界附近爲基盤岩層所截；盆地之東側爲呈 N60°E 走向延伸之 Borogop 右移扭力斷層所切，並於井下爲 1974 年 Conaco 公司之第一口井及 1985 年 Esso 公司之井鑽過（圖 4-2-8）。

如圖 4-2-7 及 4-2-8 顯示，本盆地之合成基盤深度，盆地軸部方向幾乎約爲東西向(N80°E)，沿此方向有一組斷層群，掌控盆地 Barremian 時期的早期開裂。

本盆地之構造演化，甚爲複雜，Barremian-Aptian 期爲盆地張裂期，晚／Aptian－Albian，在 Cenomanian 早期海侵，第三紀及第四紀時爲厚約 1000m 厚之陸棚相沈積所蓋（詳見圖 4-2-7）。

如圖 4-2-7 之剖面圖所示，此盆地爲一半地塹盆地，向北，向南地塹之軸傾沒消失，地塹盆地呈不對稱狀。盆地之外型受晚白堊紀擠壓關係，致使盆地中心靠向右移呈 N120°E～N140°E 方向之 Borogop fault Zone。一般由此形成之褶曲方向爲 N40°～N60°（圖 4-2-9）。由此時期所形成之褶曲構造，對於油氣之儲聚極爲重要。

(2)地層岩相

Doba 之岩相可綜述如下（見圖 4-2-10 及圖 4-2-11）：

－以 Barremian-Early Aptian 期：以陸相之粗粒沉積物爲主，厚可達 2,000-3,000 公尺。

－Late Aptian 至 Albian 期：以陸相之砂岩，頁岩及粉砂岩爲主，夾湖相頁岩，爲本盆地之生油岩。此沉積在東南方可厚至 3,000-4,000 公尺。

－Early Cenomanian 期，爲一海侵之海相頁岩

－Late Cenomanian 期，以陸相砂岩和頁岩爲主，厚度超過 2,000 公尺厚。

－新生代及第四系沉積：以陸相爲主，超過 1,000 公尺厚。

此等地層厚度及其連續性變化極大（見圖 4-2-10 及圖 4-2-11）。

(3)探勘簡史

此盆地已鑽探許多口井(圖 4-2-12)，其中有 5 口井發現油氣，油氣蘊藏量由 5MMb-200MMb，已達經濟規模，並鋪設管線至 Camercon 之海岸出口。

(4)石油系統

Doba 盆地的油氣潛能，屬於單一石油系統，目前已証實的生油岩爲早白堊紀第一開裂階段的湖泊相沉積，另外在晚白堊紀亦有湖泊相沉積，但不具油氣生成潛能，但爲重要的蓋層，上覆於早白堊紀油氣藏之上。早白堊紀的生油岩爲高有機富集度的湖泊相頁岩，它與低有機富集度的頁岩呈互層，總有機碳含量可高達 10%,平均爲 2~3%。有機碳主要爲第三類型（氫指數＜300）及第一類型（氫指數＜600），屬產油型之有機相（圖 4-2-13）。

本區的地溫梯度中等，平均約 2.5~3℃/100 公尺，油窗範圍約在 2,500~5,000 公尺；因此，早白堊系之生油岩應已成熟。圖 4-2-14 爲 Doba 和 Doseo 盆地成熟度(Ro)深度圖，顯示其油窗頂部深度較 Tenere 及 Lake Chad 盆地淺約 200~300 公尺。由於 Doba 盆地內之砂岩比例高，儲集層品質尙可，但儲集層之特性因年代、沉積相和埋深不同而差異很大，其中以晚白堊紀儲集層最佳，孔隙率高達 20~25%，滲透率達數達西，大部份爲河道砂體，早白堊紀儲集層之沉積相較複雜，由湖泊~三角洲到河道相組成。砂岩之顆粒較晚白堊紀儲集層細，且因埋藏較深，儲集品質較差。由於砂岩分佈發達，蓋層成爲重要的問題，尤其在斷層封閉，需要較高比例且較厚之蓋層。但對背斜封閉則問題較小。

目前 Doba 盆地之探勘標的主要爲 Santonian 之背斜構造（圖 4-2-15）。由於

此地層上覆厚層沉積，以及高的熱梯度，足可使早白堊紀之生油岩達到成熟，進而發生油氣移棲，因此，只要儲集層上有合適之蓋層，不論是早白堊紀湖泊相之頁岩，或者晚白堊紀之頁岩發生的構造，均可封閉油氣田。斷層封閉亦爲本盆地之主要封閉類型，尤其受兩大橫移斷層之影響，斷層之角度甚爲陡峭，花狀斷層甚爲發育，形成較好之封閉構造（圖 4-2-16）。

由於構造的發生較晚（相對於油氣生成）及斷層分佈廣，生成的油氣在盆地中心處可能有部分逸散，尤其是晚白堊紀主要頁岩是構造之形成及油氣成熟較早，油氣之封存效果值得考慮。雖然如此，鑽探結果顯示在早白堊紀及晚白堊紀之儲集層中，仍蘊藏相當大量之油氣（圖 4-2-17）。其中，在晚白堊系中已發現油氣，其蘊藏量達 425 百萬桶；而早白堊系亦有一個 7,500 萬桶之油氣蘊藏發現（圖 4-2-18）。

(5)探勘機會

本地區之生油岩爲白堊紀之湖相頁岩，油氣移棲最高峰爲白堊紀早期，有機質屬於 TypeⅢ，TOC 平均約 2-3% (Genik, 1933)。油氣之封閉以構造封閉爲主，構造擠壓之形成時間爲晚白堊紀，較晚於油氣生成時間，爲一相當優良之油氣儲聚條件。

根據鑽探結果顯示，下白堊系及上白堊系之儲集層中，可能蘊藏相當大量之油氣。其中，在上白堊系發現之油氣藏，其蘊藏量約爲 400 百萬桶；而下白堊系僅發現一個油氣藏，其蘊藏量只有 7 百萬桶左右。

此盆地爲 Esso Mobil 公司所擁有，目前盆地內本身，可能尚難有機會取得礦區，但其外圍地區，其油氣儲聚條件與 Doba 盆地應相略，將來可能有讓入機會(圖 4-2-19 及圖 4-2-20)。在 Doba 盆地所發現之油氣，可藉由查德南部至喀麥隆大西洋岸的已完工之輸油管開始運送。

2、Doseo 及 Salamat 盆地

(1)區域地質

Doseo 及 Salamat 盆地位於 Chad 南部（圖 4-2-6 及 4-2-21），此兩個盆地均位於查德南部。其中 Doseo 盆地沿著中非共和國邊界，而 Birao 盆地則跨過中非共和國的國界。Salamat 盆地亦稱爲 Birao 盆地。Doseo 盆地中，目前已知有 30MM 桶及 50MM 桶之可採油量之油氣田發現。

Doseo 及 Salamat 盆地位於中非共和國基盤高區之正北，沿 Mbere-Dferem -Borogop 斷層帶分佈。斷層爲右移，大致走向爲 N70°E。此盆地之形貌因斷層而扭轉成爲菱形盆地。此盆地自從開裂後，持續受到 Borogop 斷層帶之控制，不似其他盆地如 Yola-Garua、Doba、Bongor 及 Logone-Birni 盆地，同時受 Benue 及 Borogo 兩大斷裂帶之控制(圖 4-2-22)。

此兩盆地之構造運動史相當複雜。其早期張裂發生於 Barrernian-Aptian，爲一因張裂而形成之半地塹（圖 4-2-23）。盆地之基盤深 5-6000m，向北傾沒。在 Aptian-Albian 晚期，Borogop 轉移斷層極爲活躍，盆地約呈 N110°-120° E 之走向，後來由於擠壓關係，以致形成了以 N 70° E 方向爲主之褶曲及隆起構造群 (圖 4-2-24)。此二盆地之演化史如下可歸納(見圖 4-2-25)：

-Barren-Aptian 早期，沈積了陸棚相之粗粒砂岩，厚達 4000m 以上。

-晚 Aptian-Albian 期，沈積了陸棚相之砂岩、頁岩、細砂岩及湖相頁岩間挾火山岩，厚達 5,000m 以上。

-在 Cenomanian 早期，沈積了海相頁岩

-晚白堊紀時，沈積厚約 2000m 之陸棚相砂岩及頁岩

-第三紀及第四紀以陸棚相之沈積爲主，厚約 1000m(圖 4-2-25)。

(2)地層岩相

沉積岩層序與 Doba 盆地相似(圖 4-2-26)：

－Barremian-Early Aptian：以陸相之粗砂層爲主，厚度可達 4,000 公尺。

－Late Aptian-Albian：以陸相砂岩、粉砂岩、頁岩及湖相頁岩爲主，厚度可至 5,000 公尺，間夾火山岩夾層。

－Early Cennomanian：以海侵海相頁岩爲主。

－包括 Late Cenomanian：以陸相砂岩爲主，在底層附近間夾頁岩層，厚度在 2,000 公尺以下。

－新生代及第四紀：以陸相爲主，沉積厚達 1,000 公尺。

Doseo 盆地之地層厚度變化可能相當大，例如 Barremian-Early Aptian 層中在 Kedni-1 地壘可能缺失(圖 4-2-26)。

(3)探勘簡史

此其油氣探勘史與 Doba 盆地相似，1977-1979 年 Conoco 在此盆地鉆了 3 口井後，Esso 取而代之。整個盆地共鉆 10 口井，而在中非邊境 Birao(亦稱 Salamat)僅鑽一口井(迄 1996 年止)。其中，二口井有油氣，分別爲 30MMb 及 50MMb。

(4)石油系統

a.地化條件

Doseo 盆地唯一的生油岩爲白堊紀 Barremian-Aptian 湖相頁岩和黏土岩，在盆地中心沉積相當厚。然而有機質含量變化大，一些薄的高有機質頁岩 TOC 可高達 10%，而其餘的則多不超過 3%。

湖相生油岩爲第三類型及第一類型之有機質，最佳的生油岩沉積受斷層控制而產生快速沉積之湖盆中較深處，因而是有還原環境。上白堊系之沉積環境較爲開放，因此生油岩條件較差。

根據地化分析資料，油窗成熟範圍在 2,300 到 5,000 公尺（圖 4-2-27），由於下白堊系的沉積速率大，油氣生成排放早，在構造(如 Senonian Pulse 背斜)形成時即發生（約 8,000 萬年前，Campanian），因此此等構造可以儲聚大部分的油氣（圖 4-2-27）。

b.儲集岩品質

Doseo 盆地中之砂岩比率高，厚度大，儲集特性良好，爲由陸相之河流相及湖泊邊緣沉積組成（圖 4-2-28）。

c.封閉構造

本盆地屬於半地塹盆地，由南北方向之剖面圖可知，盆地由中非共合國向查德方向逐次加深，沉積物並逐次加厚，因此有利之油氣盆地位置應在查德（圖 4-2-29）。

由於此盆地係因二條東北-西南方向之大斷層剪切而成，因而形成了許多菱形集雁行排列、高角度之楔狀構造高區群。由於此等構造高區群呈規則狀分佈（圖 4-2-30 及圖 4-2-31）。因此，如果其中之一構造高區鑽獲油氣，則可循此構造趨勢，找到其它類似構造之油氣。

(5)探勘機會

根據 Doseo 及 Doba 盆地之成熟度圖，可知此盆地之成熟度較 Lake Chad 盆地爲佳，油氣在白堊紀時，大多已儲聚於構造內，同時其生油中心亦較 Lake had 盆地爲淺。

此盆地目前已發現二構造有油氣，其中，Tega 構造已證實有 30 MMBO 之蘊藏量，而在 Maku 構造則有 50MMBO 之蘊藏量(圖 4-2-32)，因此本盆地地區之油氣潛能應相當優異。

Doseo 盆地之所有礦區，目前之經營者爲 ESS0 公司。而位中菲共和國內 Salamat (Birao)盆地，幾年前在鑽探了 Aoukale-1 井後，Esso 公司已釋出，但 Salamat(Birao)盆地在 Chad 境內之部分，則仍保留在 Exso-mobile 公司手上。

3、Lake Chad 盆地

(1)區域地質

Lake Chad 盆地位於 Chad 之南邊 Lake Chad 之東北側(圖 6-26 及圖 4-2-33)

Lake Chad 盆地之面積約 450 km2，以 N140°~145°E 方向延伸，與大地塹之延伸方向一致。此盆地到了北邊，可分爲三個小亞盆：Tefidet、Tenere 及 Bilma-Seguedine。大多沿 Benue 左移轉移斷層之 N60°E 方向分佈(圖 4-2-34)。

由重力圖可知，此盆地之基盤深約 6000m，此經由盆地邊緣之鑽探證實(圖 4-2-35)。

盆地內之構造受白堊紀 N140°~145°E 方向，爲一半地塹，由東向西傾斜，此可由剖面看出(圖 4-2-36)。

盆地之演化：在 Benue 地塹內盆地之沈積，在白堊紀早期爲陸棚相之沈積，在晚白堊紀後產生海侵，而在晚白堊紀~早古新世時則爲海進，爲屬於古地中海(Tethys)海侵之一部份。在始新世結束時，發生橫移運動，因而將晚白堊紀之盆地轉以 N160°E 方向爲主，並有褶曲構造伴生(圖 4-2-37)。

(2)盆地之岩相

此盆地之岩相如圖 4-2-38 所示，茲簡述如下：

晚 Aptian-Albian：此時期以陸棚相沈積爲主，沉積物厚達 2000m 以上，以粗粒及細粒之砂岩爲主，在上部則轉爲頁岩質。此層亦可對比於 Bima 層，此層在 Cameron 及在 Doba-Doseo 盆地內爲以黑色頁岩爲主。

Cenumanian-Turomian-Santonian：此時期產生海侵，沈積了厚約 1000m 之海相頁岩(Donga 層)，在鑽探時常鉆遇高壓層即屬於此層。

Campanian：此時期之沈積，以厚約 600m 之海相頁岩爲主，夾石灰岩及砂岩，此即 Yogou 層。

Paleocene~Oligocene：此時期沈積了厚約 1600m 之 Sokor 層，此層以頁岩、砂岩爲主。

新第三紀~現今：沈積了由頁岩及砂岩所組成。

Lake Chad 盆地與周圍之其他盆地，其沈積史及岩相大致相似，可爲相互對比（圖 4-2-38 及圖 4-2-39）。

(3)探勘簡史

Lake Chad 盆地跨越了 Niger、Chad、Cameron 及 Nigeria 四個國家，但主要在 Niger 及 Chad 境內。

在 Chad 境內 Lake Chad 盆地，原來之經營者爲 Esso、Shell 及 ELF，後來改由 Conoco 經營，共鉆了 24 口探勘井，僅在 Lake Chad 盆地中有油氣發現（圖 4-2-40）。

(4)石油聚積系統

Lake Chad 盆地之石油系統，可簡化成圖 4-2-41。

a.生油岩

本盆地之生油岩，以上部白堊紀 Campanian 之 Yogou 層及 Turonian-Campanian 之 Donga 頁岩爲主。而上部白堊紀 Cenomanian 之 Gongila 層，根據研究屬於 Type II / III(?)，可成爲生油岩。另外，古新世之海相頁岩中亦可能成爲

生油岩。本盆地之碳質物以 Type Ⅲ爲主，TOC 爲 2-3%，油窗深度約爲 2300m，油窗上限之 Ro %爲 0.5-0.65%(圖 4-2-44)，油氣成熟之深度爲介於 2000-2500m 之間，由於古新統及始新統岩層多在 2000m 以下，可能爲生油母岩(圖 4-2-41 及 4-2-42)。

b.儲集岩

此盆地之儲集岩在白堊系上段發見五層儲油岩。其中以上部白堊紀之 Cenomanian-Santonian 砂層最爲重要，其次爲 Campanian 之 Yogou 層。至於下部白堊系 Albian 之河相砂，亦可能成爲儲集層，但仍待證實。

另外，在古新統內亦發現一層砂岩，此砂岩爲陸棚相淺海相之沈積亦可能成爲儲集岩。此儲集岩大多爲以白堊系上部之頁岩及漸新統之許多互層中之頁岩爲主要蓋層(圖 4-2-38、39 及 4-2-41)。

c.封閉構造

此盆地之油氣封閉構造，因兩大斷層以不同方向產生位移，因而形成之雁形正斷層封閉構造。此等雁形構造群所造成之構造高區，在 Lake Chad 盆地甚爲普遍，爲本盆地之主要油氣封閉構造（圖 4-2-43 及圖 4-2-44）。另外新生代之始新世所產生之斷層及褶曲構造亦可爲此盆地重要之油氣封閉構造。

d.蓋 岩

上部白堊系 Santonian- Campanian 內之頁岩，當爲甚佳之蓋層（圖 4-2-38 及圖 4-2-41）。

根據成熟度，盆地之油窗頂部約在 2600m 之附近，而構造之形成時間可分爲二期，一期爲白堊紀，另外一期爲新生代。然而本盆地之油氣移棲由白堊紀晚期即開始生油，但所形成之油氣一直到中新世才大量排出，因此，本盆地內不同

時期所形成之構造均有機會聚積油氣(圖 4-2-42)。

(5)探勘機會

在 Lake Chad 盆地內已有 25 MMb 之油氣發現，因此，在類似之構造封閉中，應有可能再找到油氣(圖 4-2-44~4-2-45)。

此盆地主要經營人有二，一爲尼日 ELF-ESSO 及查德之 ESS0-Shell-ELF 公司(圖 4-2-47)。油氣之輸送主要仰賴 Doha 及 Doseo 油氣田至 Cameron 大西洋岸(長約 1000km)之管線。由於有此管線，使得本地區之探勘活動更爲活躍。

4、Bongor 盆地

(1)區域地質

Bongor 盆地位於 Doba 盆地之北側(圖 4-2-6)，與 Cameron 北側之交界線附近。盆地 300 km 長，81 km 寬，盆地大致呈東西向(圖 4-2-48)。斷層有二組，一組爲 N70°-80° E，另一組爲 N130°-150° E(圖 4-2-59)方向。

由基盤圖顯示，最深可達 6 km，盆地上構造向南傾，爲一半地塹構造(圖 4-2-50)，盆地內之沈積物向斷層處加厚及成長。在下白堊系以後之沈積，具有斷裂所形成之背斜構造，已鉆探 Naramay-1 井。

盆地之演化，與 Doba 盆地相似，可簡化如圖 4-2-51。

(2)盆地之岩相

根據 Bongor 盆地的兩口井 Naramay-1 及 Semegin-1 資料，顯示儲油岩品質，在 2000 公尺附近孔隙率逐漸下降，至 2500 公尺以下則降至 8%，因此，最好的儲油岩品質應淺於 2000 公尺；另外此儲油岩可能爲由湖相及河流相之砂岩組成（圖 4-2-52），砂岩之橫向分佈變化較大。

(3)探勘簡史

此盆地目前已鉆了二口井，Noramay-1 井位北邊，井深約 1500m，而 Semegin-1 井位於南邊，兩口井均已鑽達基盤，Noramay-1 井深約 1500m，鉆遇之地層爲 Barrca~Aptian 之陸棚相砂岩及頁岩，夾火山岩，但在 Cenomarian 地層內並未鑽到海相地層。新生界厚約 500m。

Semegin-1 井岩相，以 1800m 厚之 Albo-Aptian 之陸棚相砂岩及頁岩爲主，其上之上白堊系 Cenomanian 則爲陸棚相。

(4)石油聚積系統

在 Bongor 盆地構造類型甚多，其中以早期盆地受張力作用所形成之斷層封閉；因正斷層所形成反轉背斜(Rollover)構造；以及後期盆地內受扭壓作用所形成之背斜構造及反轉背斜構造最爲重要（圖 4-2-53）。另外，在早期盆地內位於基盤高區上之披覆背斜構造，亦可能扮演相當重要角色。一般言之，早期形成之構造比後期所形成之構造較爲有利，而且探勘風險較低。

以構造形成時間與油氣移棲之關係而言，在早白堊紀所形成之古構造，較有機會儲聚早白堊紀時期所生成及所排放出來之油氣。但由於此構造受到後期運動影響，其中之油氣可能會遭到破壞；而後期運動所形成之新構造，由於地溫梯度較低，因此探勘風險亦相對提高。因此，本盆地之探勘應以尋找早期之封閉構造爲佳。由於本盆地係以湖相及河流相之砂岩體爲儲油岩，但此砂岩層之厚度橫向變化大，增加本盆地之探勘風險。

(5)探勘機會

此盆地爲 Exxo 所經營（圖 4-2-54）。此盆地內所鉆探之二口井，並未有油氣發現。其失敗之原因可能爲，未鑽遇在 Upper Benue、N. Cameron 以及 Doba 盆地所見之 Barremian-Aptian 湖相生油岩。另外，亦可能爲此盆地之生油岩尚未達到成熟階段所致。

5、綜合評估

(1)大地構造特徵

根據已有 Chad 盆地之重力及構造線性等資料分析結果顯示，相似之大地地質構造方向與特徵，此等特徵影響了位於其上之盆地之地質結構與特徵（圖 4-2-55）。其中較顯著者有下列諸項：

a.Lake Chad 西北方之 Benue Wrench 斷層帶(Fault Zone)，爲一左移斷層，主要呈 N60° E 方向。

b.位於 Mugland 盆地附近之另一條 Borogop 斷層帶爲一右移斷層，呈 N 70° E。此二大斷層帶之發生時期，主要始自白堊紀 Aptian 晚期，而止於 Mastrichtian 期。而 Doba-Doseo 及 Bongor 盆地之形成，可能較早些。此等盆地之方向幾乎沿著東－西向之古生代軸線方向發育。

c.查德南部之盆地沉降，屬於熱沉降(Thermic subsidence)，其中 Lake Chad 盆地主要在新生代沉降；而 Doba 及 Doseo 盆地與熱沉降關係較少。

(2)地層沈積與岩相（圖 4-2-56）

a.白堊系下部

白堊系下部之沈積除了 Anamba 盆地外，主要以陸相沉積爲主。據放射性定年，此下白堊系沉積相爲侏儸紀晚期，但 Doba 及 Doseo 及 Bongor 盆地之沉積，據花粉定年爲白堊紀之 Barremian。

b.白堊系中部

白堊系中部之 Cenomanian 地層爲屬於海進之沈積；而在晚白堊紀

Maastrichtian 時，Lake Chad 盆地爲陸棚相沈積。而位於東南邊之 Bongor 及 Doba-Doseo 盆地，整個中白堊系爲陸棚相沈積。

(3)石油系統

a.生油岩

查得南部地區之 Chad 盆地之生油岩，以白堊紀中期及晚期爲最主要之生油岩。而位於其上之古新統及始新統亦可能成爲生油岩。

b.成熟度

以油氣之成熟史而言，Lake Chad 盆地之成熟度尚佳，但可能爲生油岩之古新統－始新統期成熟度可能稍爲不足。

Daba-Doseo 盆地之有機碳成熟度，介於 Lake Chad 與奈及利亞境內之 Anamora 盆地之間，爲一具有較佳成熟度之盆地。

c.蓋層

查德南部之蓋層條件甚佳，白堊系及上覆之新生代地層均可爲蓋層。尤以 Cenmanian 之海進頁岩爲此等盆地之主要蓋層，封存效果甚佳。

d.封閉條件

由於此三盆地之構造高區，大多屬於披覆背斜、斷層封閉以及反轉構造等，因此，封閉性較佳，尤以 Doba 盆地最佳。

4、探勘機會（圖 4-2-56 及圖 4-2-57）

(1)Benue 海槽(Trough)

由奈及利亞沿西南方向進入查德，此盆地內尚有諸多構造尚未探勘，爲一探勘密度不高之地區(圖 4-2-57)。

(2)Doba-Doseo 及 Bongor 盆地

在 Doba-Doseo 及 Bongor 盆地已有油氣發現，其油氣潛能尚高(圖 4-2-58)。而此等盆地現爲各大石油公司所據(圖 4-2-58)，但由於此等盆地之構造條件佳，因此留意原有經營者擬退出之礦區，或其周圍尚有機會進入探勘(圖 4-2-59)。

(3)Lake Chad 盆地

目前尚未發現具有商業性之油氣，但位於附近 Termitf 地塹內，已有諸多油氣井發現。同時此盆地內尚具生油條件優良之生油岩，而且其探勘密度不高。因此，如找到封閉良好之構造，尚值得進入(圖 4-2-58 及圖 4-2-59)。

目前 Doha 及 Doseo 盆地內之油氣已有管線經 Cameron 境內到達大西洋(圖 4-2-60)。因此，在查德南邊之盆地，包括 Dohb-Doseo，Bongor 及 Lake Chad 等附近之盆地，如果再有油氣發現，當可利用此管線運送出口，無形中可節省探勘及開發成本，而增加探勘機會。

三、 奈及利亞

非洲大陸西臨大西洋，東臨印度洋，北與地中海爲界，隔著紅海與阿拉伯半島爲鄰(圖 4-3-1)。因此非洲大陸的地質構造演化與大西洋地中海及印度洋的發育息息相關。在探討非洲大陸及其近海的油氣之前，對於其盆地的發育及形成機制必須加以詳細研究，始能掌握盆地發育的構造特性沈積特性，以及可能儲聚油氣之好景區(Fareway)。由於非洲大陸是一面積相當廣大的地區且有關非洲大陸石油探勘方面相關的文章，散佈於世界雜誌、期刊、書籍等，收集資料本身就是一件非常煩雜的工作；加上有些盆地具有複雜的地質構造史，使得油氣的探勘成功率降低，至少由某些研究已逐漸加強某種程度的基礎工作，有利於國外盆地的認知以及盆地演化模式的模擬等。

非洲及其鄰近海域是非常廣濶的地區，本次由收集岡地瓦納級的板塊運動，分析非洲地區的大張裂盆地特性，進而以非洲大陸級去探討非洲內部的地質架構，接著探討分析盆地級的構造、地層特徵及其演化，得到下列重要心得:

在白堊紀早期之前，非洲與歐洲大陸板塊之間存在著一古地中海，非洲北部是屬於張裂性盆地，此古地中海亦是一重要的前淵盆地，而且延伸至 Palmyra，Zagros，經巴基斯坦至喜馬拉亞山南緣，白堊紀早期之後非洲陸塊往北移動，直至漸新世非洲板塊與歐洲大陸碰撞，北非的 Sahara Atlas 地帶、敍利亞、Zagros、阿曼、印度蘇里門形成造山帶變形前緣，在所謂的 Alpine cycle(白堊紀至漸新世)，由於非洲—阿拉伯板塊與歐亞板塊的碰撞致使古地中海洋的關閉，因此北非地區屬標準的前陸盆地，其油氣潛能可媲美於 Zagros 爲複合盆地，其油氣儲集具有張裂盆地及擠壓盆地之特性，因此值得重視。

在西非的尼日三角洲，加彭，安哥拉、剛果的外海地區，於 110~75 百萬年沿 Walvis Ridge 及 ST. Paul Fracture Zone 形成塩岩盆地，具有極優之生油岩，也是西非地區成爲探勘較成熟的地區的主因，局部具有塩岩盆地、塩下構造、塩下

石油系統等，皆值得注意，其中小型油氣潛能區值得中小型油公司投資。

最近在中北非的查德、蘇丹等地區沿 Centre Africa shear zone 陸續發現超大型油氣田，此區之油氣田與 Center Africa Shear Zone 內的剪力深盆地有關，此深盆具有良好的陸相生油母岩，因此這地區的油氣潛能也比預估大。

東非地區的外海值得注意，最近十年內，巴基斯坦及西印度外海接續發現數個超大油氣田。因爲在白堊紀早期之前，印度半島、巴基斯坦與東非、馬達加斯加島幾乎是相連接在一起，在白堊紀早期之後，此地區開始張裂，形成超大型裂谷盆地，深具油氣潛能。就非洲構造史而言，南非及東非海岸地區，在白堊紀至漸新世之間，是長時間穩定的大陸邊緣，在漸新世之後東非地區開始張裂(圖 4-3-2)，因此東非外海的沈積物缺少白堊紀時期的較深的張裂斷層地塹之深盆沈積物，生油岩的條件普遍較弱，取而代之的是第三紀往海方向前伸的沉積物，油氣潛能可能以天然氣爲主體，此區橫移性的裂谷深盆值得另外考量評估。

由此可知非洲陸地區具有許多的線性構造帶(lineament)及其分支構造帶，可能爲現今之沙漠、河流、森林所掩蓋，而不易被發現，值得注意的是這些早期張裂性構造帶及其分支延伸帶均可能具有豐富的油氣潛能，透過大地架構、盆地地層、盆地演化及力學模式的分析將可瞭解區域性盆地特性，增加探勘人員的信心。

奈及利亞爲世界第七大石油輸出國，每日生產兩百萬桶石油，其石油蘊藏量約有二百四十億桶至三百一十五億桶石油，生產石油的主要儲集層來自沿岸構造單純的尼日三角洲（Niger Delta），但較新發現的儲集層則來自奈及利亞外海深水區。需探討尼日三角洲之構造封閉型態，並藉以了解該型態在探勘上有何風險或助益。

尼日三角洲面積約 200,000 平方公里，奈及利亞的海岸線幾乎由該三角洲所圍繞。尼日三角洲自 1952 年展開以石油爲主的探勘，至 2000 年底在三角洲上至少有 5200 口鑽井，探勘結果發現有 240 個生產礦區，初步估儲集量約 66,100MMBOE，現在產量超過 2 百萬 BOPD，極小的部分在 Camersoons (Riodel

Rey)及在 Equatorial Guinea。在 Camersoons 所發現的 40 開發區（discoveries）含有 1400MMBO，生產量達 100,000BOPD。在 Equatorial Guinea 已發現兩個礦區，包括一個大油田，生產約 94,000 BOPD。深水探勘則於 1995 年開始展開，目前已發現 4 個大油田及其他小油田。一般有關於尼日三角洲的文獻多描述油田盆地，實際上尼日三角洲有很多以天然氣爲主的礦區；根據統計，天然氣在尼日三角洲越來越重要，可能改變成爲最重要的能源來源(圖 4-3-3)。

中西海岸區域（West-Central Coastal Provinces）的許多封閉構造爲鹽丘運動的結果。在此大的三角洲系統中封閉構造大多爲向盆地中心下傾的生長斷層及反傾斷層所形成。在 Guinea 海岸，構造完全爲扭力作用產生的一系列盆地及山脊。大部分儲集層爲砂層，Albian 時期的中西海岸區域碳酸岩儲集層爲主要希望。在 1994 年後深海開採區的儲集層爲濁流層。河流沈積及盆地海床的沖積扇爲目標層（prospective）。此與沿南美洲的大西洋大陸邊緣預估的及所發現的相似。

尼日三角洲由 Camersoon 火山帶、Dahomey 盆地與 4000 公尺（13100 呎）深海等高線所包圍，地形圖與海底圖用灰色調表示（圖 4-3-4）。現今的三角洲可分爲自古新世至全新世的七個沈積中心（圖 4-3-5），該沈積物經由海進作用而覆蓋於南美洲板塊及非洲大陸板塊所分裂的海洋基盤上。在古新世至始新世下部之後的海進，三角洲發展成雙葉特性。其非常明顯的在上濱及遠濱上，以大構造軸部的破裂方式呈現。在此深水沈積變動區，這兩個葉是在不同系統。整個海退的系統由 Evamy 等（1978）、Doust 和 Omatsola(1989)及 Stacher(1995)描述得相當清楚。圖 5 中綠色代表非常豐富的石油（參考圖 4-3-6），主要侵蝕-海進區域以紅色線表示。這些凹陷地區大多在三角洲主要地區，因此對海岸線的改變特別敏感且對砂岩及頁岩（如儲集層、封阻層）較有利。

由此次攜回的資料分析，得知尼日三角洲可分成三個石油系統：白堊紀底部的石油系統以湖相爲生油岩，產於三角洲西北部；白堊紀上部-古新世底部的石油系統，以海相生油岩爲特性，發生於三角洲西北部；第三紀石油系統爲三角洲主要石油來源，生油岩爲局部不同成熟度的陸源有機物（圖 4-3-7）。

尼日三角洲在大陸棚的上濱及遠濱區最大的油氣以封閉於 Agbada 地層的生長構造之近海沈積物。小的儲油層也封閉於其他地層單位及構造。在深水遠濱區最大的油聚集於低水期沈積的的三角洲濁流砂層扇葉及海相頁岩，其他的聚集作用也發生於不同狀況。高水位期的濁流層砂或大陸棚楔狀砂雖發生於深海沈積變形帶也值的加以探勘。

尼日三角洲之發育與陸後（backland）抬升有直接關係，局部地區受到火山活動的抬升影響，因此三角洲沈積物含高砂/頁岩比，自漸新世/中新世早期開始沈積，並持續到第四紀，沈陷作用則與紅海張裂運動同期。尼日三角洲的產氣層爲中新世及古新世的頁岩，產油層則爲白堊紀晚期的石灰岩。

尼日三角洲的北方主要封閉構造爲反傾背斜，其特色爲簡單構造伴隨向南變形嚴重的生長斷層。這些生長斷層面含有頁岩及砂岩互層所以能造成封阻或生產。在此地區有一些油田是以頁岩擦痕與頁岩相抵觸的砂岩造成斷層封閉，而砂岩尖滅與河道切割發生於邊緣的也會造成地層封閉，例如在 Egbema 及 Pologbene 礦區。構造-地層封閉多發現於東南方，尤其是深海遠濱區，而且有新的各種不同混合封閉已被鑽探到。

尼日三角洲爲許多張裂且複雜的大構造所組成，油田多位於該大構造上與三角洲之凹陷上（圖 4-3-8），所以未來探勘應以該地區爲考量。尼日三角洲的封閉型態主要有四種（圖 4-3-9），分別爲：含頁岩充填河谷的反傾構造、多重生長斷層構造、反傾斷層構造及崩塌構造，而以斷層有關之背斜構造之油氣產量最大。

在尼日三角洲深海探勘必須注意區域性構造型態與演化。例如區域性剖面的回復，構造型態的瞭解、逆衝斷層的定年及層序與區域縮短量這些因素對尼日三角洲深海石油的成熟度與改變產生重要影響。另外尼日三角洲的天然氣水合物（gas hydrates）之蘊藏量在世界上也是居於重要地位，在石油價格日益升漲與能源日益匱乏下，若未來能克服探勘上的工安危險，則天然氣水合物探勘投資不失爲重要項目。尼日三角洲的多爲油田盆地，實際上存在很多以天然氣爲基質的礦

區，天然氣在尼日三角洲越來越重要，可能改變結構成爲最重要的能源來源。

尼日三角洲的北方主要封閉構造爲反傾背斜，其特色爲簡單構造伴隨向南變形嚴重的生長斷層。這些生長斷層面含有頁岩及砂岩互層所以能造成封阻或生產。在此地區有一些油田是以頁岩擦痕與頁岩相抵觸的砂岩造成斷層封閉，而砂岩尖滅與河道切割發生於邊緣的也會造成地層封閉，例如在 Egbema 及 Pologbene 礦區。構造-地層封閉多發現於東南方，尤其是深海遠濱區，而且有新的各種不同混合封閉已被鑽探到。在尼日三角洲深海探勘必須注意區域性構造型態與演化。例如區域性剖面的回復，構造型態的瞭解、逆衝斷層的定年及層序與區域縮短量這些因素對尼日三角洲深海石油的成熟度與改變產生重要影響。尼日三角洲爲許多張裂且複雜的大構造所組成，油田多位於該大構造上與三角洲之凹陷上，所以未來探勘應以該地區爲考量。

四、利比亞

非洲張裂地區諸多盆地含大油田，近年來已成爲極熱門之地區，爲各大油公司競相爭取之標的，其潛能自不待言。況且由圖 4-4-1 可知 200 百萬年前板塊重建顯示，古地中海油氣儲聚在非洲北部地區，尤其在 30°範圍內與中東阿拉伯相似，同俱極高之油氣潛能。

利比亞至今發現的油氣生產大都集中於 Sirte 盆地。利比亞沈積盆地主要分爲六個沈積中心：Sirte 盆地、Ghadames 盆地、Murzuq 盆地、Kufra 盆地、Pelagian 盆地及 Cyrenaica 盆地。至今至少有 17 個油田屬於 5 億桶油當量以上之巨大油田。利比亞主要沉積盆地及大地構造圖見圖 4-4-2。

由攜回的有關資料加以分析研究，可獲得下述結果：

(一)Sirte 盆地

古地中海邊緣的 Sirte 盆地及 Pelagian 陸棚，Sirte 盆地爲內陸斷裂盆地，其上部白堊系一中新統地層覆蓋在海西寧基盤和其侵蝕產物(Nubian 砂岩)之上。油氣產自 Cambro-Ordovician 和 Nubian 砂岩，及上部白堊系到中新統石灰岩一般認爲上部白堊系和古新統黑色頁岩是主要的生油岩。

根據鑽井樣品地化分析，主要產油型態之生油岩存在於上部白堊紀地層內，Sirte 盆地內之 Trough 至少含 900 公尺厚之沈積物，這些沈積物富含有機物，是盆地內主要的生油岩。一般而言，在盆地東邊地區其油窗範圍在 2,700-3,400 公尺內，而在西邊則須大於 3,500 公尺深度才達成熟階段，除上述地層外，許多油田的油氣與生油岩對比亦顯示在 Augila Trough 內之古/始新世地層亦爲極佳之生油岩，而先白堊紀地層之生油岩亦提供 Sarir、MessIa 油田之生油來源，Augila Trough 之生油岩成熟度因地層向北傾斜，北部地區如太大深埋則會以產氣爲主，下部古新世一上部古新世生油岩在 Trough 深度可達成熟範圍。上部古新世-始新世生油岩可能不夠成熟，除了在 Trough 北部地區。中部始新世-上部始新世生油岩則僅有少量可達成熟階段。盆地內自前寒武紀含裂縫基盤岩層到中新世地層的砂岩，幾乎每一時期的地層都有儲油岩層。前寒武紀基盤裂隙在某些高區內是良好的儲油岩，在 Augila 油田中，某些井產量高達 18,000　BOPD，其油氣可能是沿著斷層通道由白堊紀或第三紀之成熟生油岩移棲而至。寒武-奧陶紀石英砂岩裂隙亦在某些區域含油氣，如 BahiBeda、Ora 及 Amal。

Sirte 盆地有超過 101 個油氣田，多數油氣田位於隆起或平台高區，少數則在 trough 內被鑽獲。而油氣移棲主要有三種路徑:(1)沿斷層面垂直移至封閉高區內，如 Gialo 及 Amal 油田;(2)生油岩與儲集層同層，油氣生成後直接灌入構造內，如 Bu Atiffel 油田;(3)從遠距離生油區內橫向移聚至構造內，如 Messla　Sarir 油田等。

(二)Ghadames 盆地

油氣產自寒武一泥盆系，上部 Gothlandian 一下部石炭系和上部二疊系-下部三疊系砂岩。Ghadames 盆地的原油比重介於 33。APl~39。APl 之間蠟質含量低，志留紀 Gothlandian 黑色頁岩是主要的生油岩。

Gothlandian(Llandovery)Tanezzuft 頁岩層是封閉環境較深水海相沈積，含腐泥型產油有機質，爲灰色頁岩，部份爲粉砂、含砂岩薄層，厚度 400 公尺，下部爲較好生油岩，埋藏深度 3,000-4,000 公尺，愈南埋藏愈深，地溫梯度 23.5°C/km。

主要生油岩 Tanezzuft 頁岩除了在 Ghadames 盆地北部邊緣受海西期造山運動(Hercynian Orogenic Movement)抬升而被侵蝕外，在盆地大部份地區都有分佈且甚厚。

Husky 公司曾以佳德美斯盆地 NC-162 礦區內各井地溫梯度計算 Tanezzuft 頁岩之溫度，劃出此生油岩分佈圖，礦區內 B1-26 和 01-26 兩井的 TTl 模型顯示該處 Tanezzuft 頁岩於白堊紀中期進入產油初期階段，可生成少量未成熟原油，隨即進入主生油期，可生成大量成熟原油，白堊紀末期以後，因地層不再埋深，成熟度不再快速增加，因此大部份生油岩保持於主生油期至今，而埋藏較深處則漸漸進入晚生油期，產生原油及天然氣。根據盆地內產油構造顯示，原油自生油岩移棲到儲油岩的主要通道是古生代斷層，若斷層近到中生代，則原油有可能順著斷層面漏失，另志留紀的下部 Acacus 砂岩爲主要儲油岩之一，直接覆蓋在 Tanezzuft 頁岩上，其原油研判是由 Tanezzuft 頁岩垂直直接移棲進入儲油岩內。中部 Acacus 頁岩可爲良好蓋層，另外 Gothlandian 下部泥盆系的 Acacus 層亦爲主要生油岩，是淺水沈積環境，含腐泥型產油有機質和混合型有機質，爲黑色有機質頁岩夾砂層，在泥盆系中轉變成中粒砂岩，其中夾有植物殘駭。本層覆蓋在整個撒哈拉地台，厚度達 300 公尺，下部爲較好生油岩， 埋藏深度 3,000-4,000

公尺，愈往南埋藏愈深，地溫梯度爲 23.5。C/km。

Ghadames 盆地陸續發現近十個中、小型油田，油田分佈集中在盆地的南部與西北部區域，盆地中最大油田爲東南邊之 ELHAMRA 油田，油氣產自泥盆紀下部砂岩層。盆地生油岩沈積以志留紀頁岩爲主，在盆地中心屬過成熟-成熟階段沿上傾地層及斷層通道移棲進入儲集層內，移棲方向大體沿東南及西北向進行。儲油岩以古生代地層爲主，在盆地多數地區皆有生產，而中生代地層則以盆地北部爲主，以三疊紀蒸發岩爲蓋層，並向盆地北邊潛能漸增。構造封閉爲多數油田之封閉型態，向盆地邊緣地區則地層封閉型態漸增加，亦爲探勘重點。

(三)Murzuq 盆地

在 Murzuq 盆地生油岩研究中，新購一些資料進行進一步探討：

1、生油岩分析

由過去 Occidental 、Braspetro 及 Bulgarian 油公司等所鑽之 A1-NC34、A1-NC58、C1-NC58、D1-NC58、E1-NC58、H1-NC58、E1-NC101、F1-NC101 井下總有機碳含量 TOC 及熱裂分析結果(見表 4-4-1～表 4-4-5)，可探討各層生油岩潛能：

(1)總有機碳及熱裂分析結果

表 4-4-1 盆地內各井泥盆紀及碳紀生油岩 TOC 及 S_2 地化分析資料

	Pyrolysis (S_2 - mg/g)	TOC %
石炭紀		
A1-NC34	1.40	1.04-2.25
A1-NC58	1.37-3.46	1.00-2.16
H1-NC58	0.32-8.58	0.81-3.37
A1-76	0.87-2.92	0.44-1.61
泥盆紀		
A1-NC34	1.30-2.30	2.30
A1-NC58	0.75-2.60	0.80-2.05
D1-NC58	0.75-2.60	0.80-2.05
E1-NC58	12.05	3.86
H1-NC58	1.11-3.67	1.31-1.41
F1-NC58	2.93-6.04	1.80-3.50
B1-67	0.25-0.62	0.48-1.14
A1-67	<2.92	1.12-1.66

表 4-4-2 盆地內各井志留紀生油岩 TOC 及 S_2 地化分析結果(整理自井下資料)

志留紀		
A1-NC34		<1.0
A1-NC58	0.54-2.73	0.78-3.45
C1-NC58	0.71-4.51	2.3
D1-NC58	1.75-2.93	
E1-NC58	0.52-39.57	0.23-8.42
H1-NC58	0.48-1.27	0.52-1.00
E1-NC101	0.78-0.98	0.55-1.08
F1-NC101	1.25-2.37	0.60-0.84
B1-67	1.32-2.05	0.60-0.78
A1-68	1.90-7.99	1.04-2.25
A2-68		0.12-0.55
A1-76	0.34-2.39	0.61

表 4-4-3 盆地內各井井下岩樣鏡媒素反射率測值 Ro(整理自井下資料)

井	深度（m）	年代	樣品數	RO 範圍	代表性 RO
A1-NC34	2085-2094	Carb.	-	-	0.48
	2268-2271	Carb.	-	-	0.50
	2387-2396	Dev.	-	-	0.49
	2347-2408	Dev.	-	-	0.50
A1-NC58	2286-2316	Carb.	13	0.89-1.39+	1.30
	2316-2334	Carb.	13	0.96-1.39+	1.29
	2408-2438	Carb.	-	-	1.25
C1-NC58	1137	Carb.	11	0.92-1.15	1.03
D1-NC-58	2073	Dev.	3	0.54-0.62	0.54
	2134	Sil.	2	0.50-0.52	0.51
	2179	Sil.	4	0.45-0.57	0.56
	2225	Sil.	4	0.46-0.56	0.55
	2286	Ord.	4	0.62-0.64	0.63
E1-NC58	1372	Carb.	4	0.49-0.54	0.51
	1676	Sil.	17	0.51-0.70	0.61
H1-NC58	1600	Carb.	19	0.50-0.68	0.53
	1676	Carb.	8	0.45-0.68	0.54
	1737	Carb.	16	0.43-0.62	0.55
	1841	Carb.	16	0.46-0.67	0.56
	2073	Dev.	21	0.52-0.77	0.64
	2179	Sil.	6	0.65-0.78	0.65
	2225	Sil.	10	0.63-0.84	0.66
	2332	Sil.	7	0.67-0.88	0.68
B1-67	534	Dev.	4	0.86-0.99	0.95
A1-67	211-244	Carb.	9	0.83-1.10	0.87
	304-335	Dev.	8	0.78-0.99	0.92
	365-396	Dev.	8	0.78-0.99	0.92

(2)時溫指數

表 4-4-4 盆地內各井時溫指數計算值(整理自井下資料)

井	地溫梯度	現今	達各 TTI 值所需年代(My)		
	(ºC/km)	TTI	TTI=15	TTI-75	TTI=160
A1-NC34	23.8	119	-	-	-
A1-NC58	30.9	241	130	83	40
B1-NC58	29.1	161	122	57	0.6
C1-NC58	25.5	10	-	-	-
D1-NC58	28.2	62	5	-	-
E1-NC58	22.8	11	-	-	-
F1-NC58	27.3	21	51	-	-
G1-NC58	28.2	19	34	-	-
H1-NC58	27.3	69	116	-	-
E-NC101	30.9	130	129	55	-
A1-NC115	39.1	51	161	-	-
A1-68	32.8	31	129	-	-
A1-73	26.4	46	129	-	-
A1-76	25.5	22	121	-	-

表 4-4-5 生油岩評估等級

	熱裂(S2)值		
	Kg / Tonne	mg / g	ppm
Poor(貧乏級)	<2.0	<2.0	<2,000
Fair(普通級)	2.0-4.0	2.0-4.0	2,000-4,000
Good(良好級)	4.0-6.0	4.0-6.0	4,000-6,000
Very good(優級)	6.0-10.0	6.0-10.0	6,000-10,000
Rich(豐富級)	10.0-20.0	10.0-20.0	10,000-20,000
Very rich (非常豐富級)	>20.0	>20.0	>20,000

奧陶紀 Melez chograne 層

Murzuq 盆地最老之生油岩地層爲晚奧陶紀 Melez chograne 層頁岩。在 A1-NC34 鑽探結果本段具 good 至 very good 級生油岩(Geochem Labs 1995)；另外由 E1-NC58 井該段 TOC 值介於 0.34%至 0.52%間，D1-NC58 井則超過 1%，盆地內本段相當豐富有機碳富集度之頁岩最厚可達 50M，爲冷溫海相之頁岩，向北及向西增厚，往南則變爲河流相。若與北邊 Ghadames 盆地同樣生油岩相比較其油氣在中生代晚期至第三紀早期生成，沿著 Murzuq 及 Ghadames 盆地東側移棲進入油氣封閉構造。

志留紀 Tanezzuft 層及 Acaus 層

在 Murzuq 盆地存在著志留系下部之生油岩，該生油岩在西撒哈拉(western sahara)之中西部阿爾及利亞(Algeria)及摩洛哥(morocco)屬較低成熟生油岩，但在 Murzuq 盆地則因沉積相變化大，有較佳生油岩之存在，如 A1-68 井熱裂分析 S2 值有 8mg/g，在 E1-NC58 井則達到 29-32 mg/g。

盆地內 Llandoverian 之 Tanezzuft 層，含有富含筆石沉積之連續頁岩沉積，其中含 fair 級至 very good 級生油岩，由於厚度極厚，不可忽視其生油潛能。

Tanezzuft 層沉積在高緯度地帶，當 Ashgillian 冰帽融解，造成淺海及三角洲前緣之沉積，其分佈及生油岩品質在本盆地內之 Murzuq－Djado 及 Dor-el-Gussa 兩個次盆地有所變化，而分隔兩次盆地之古高地區則生油潛能較差。但盆地內 Acaus 層之頁岩被認爲可能如 Tanezzuft 層同具生油潛能。

泥盆及石炭紀之生油岩

Murzuq 盆地之上部泥盆紀亦發展有良好之生油岩，特別是在 Strunian /Tournaisian 時期。局部富含生油潛能之生油岩需配合較高之熱成熟，方能產生較大量油氣。至於盆地內最上部泥盆紀及石炭紀中及下部地層富含頁岩，亦可見

fair 至 good 之生油岩，TOC 值可達 3.5%，熱裂分析 S2 可達 6mg/g，可對比至 Ghadames 盆地已證實上部泥盆紀(Frasnian)之生油岩。

Emsian Ouan Kasa 層及中部～上部泥盆系 Aouinet Quenine 層之頁岩一般較 Tanezzuft 層爲薄，但厚度已足夠成爲生油岩。Ouan Kasa 層厚達 25m 生油岩爲盆地西側及西北側海相及三角洲沉積，於盆地南側及東側則轉爲陸相，較缺乏本層之成油岩。

從 A1-NC34 最上部泥盆系 shati 層中分析，有良好生油岩 TOC 高達 3.2%，主要爲草本型油母質，另有 4.6%者，主要爲生油岩之 amorphous 油母質，由於盆地內泥盆紀及石炭紀之生油岩富含陸生植物物質，以產氣爲主，但 shati 層則具良好產油之生油岩潛能。Murzuq 盆地部份地區，上部泥盆系已進入油窗，並有產油之生油岩存在。

Murzuq 盆地內包含 A1-NC34 井下之傾向紅色頁岩夾暗青色頁岩其爲 good 級～very good 級生油岩屬 Memouniat 層(Melez Chograne 相)，通常其生油岩厚度超過 3m（Geochem Cabs 1995）。該暗青色頁岩含超過 3.1%草本型及木型有機碳，雖然不定型（amorphous）油母質較少，但仍爲富含有機質頁岩，沉積在冰河外緣環境之海相地層。

在 A1-NC34 井薄而粉砂質 Tanezzuft 頁岩爲普通級具分散有機物（夾木型及煤型物質之草本型油母質）。有機碳含量可達 2.5%，但大部份皆小於 1%，該井位於兩盆地間之高脊，頁岩特性較差。Berry and Boucot (1973)認爲此類高緯度頁岩在北非地區常見，較缺乏生物性資源，但 Massa and Jaeger(1971)在 Ghadames 盆地所發現盆地內富含有機物之 Tanezzuft 頁岩正好相反，此厚層普通至良好級生油岩在盆地西側發育較東側爲佳。

至於下部及中部泥盆紀地層之頁岩（Wan Kasa 及 Wanin 層）較 Tanezzuft 層爲薄，但一般被認爲已足夠成爲生油岩。Wan Kasa 層具生油岩潛能頁岩最厚達 13m，在盆地西部及西北部屬海相及三角洲相沉積。這些地層在盆地內包含

A1-NC34 皆受到侵蝕，且在盆地南側及東側受陸相沉積影響，頁岩發展更差。

盆地內普遍存在上部泥盆紀及下部、中部石炭紀頁岩，在 A1-NC34 井內鑽遇 Shati 及 Murar 層下部良好級至非常良好級生油岩(TOC 4.6%)，在 Assedjefar 層上部亦發現普通級至良好級生油岩(TOC 3.2%)，其有機物主要由草本型及木型夾雜孢粉及少數煤型、木質物質，而 Shati 層部份潟湖沉積亦可保持成爲良好生油岩。另外盆地內 A1-NC34 井之西北側將存在更佳之生油岩潛能，在適當之埋壓條件皆可產生大量油氣。

2、地溫梯度與熱成熟

從井下分析資料得知 Murzuq 盆地地溫梯度介於每公里 250c 至 400c 之間，在盆地範圍內之西北側最高。異常地溫梯度將影響油氣之成熟及移棲，其異常區域肇因於流體滙移。

盆地內上部奧陶系普通至良好級生油岩其熱成熟主要產氣階段，位於氣窗範圍內，屬成熟晚期至乾氣之階段。

志留系生油岩在 Ghadames 盆地從盆地邊緣產油高峰期(約 0.72% Ro)至沉積中心晚期成熟(1.3% Ro)階段，其盆地志留系及中生代／第三紀年青地層較厚，故可使志留系及泥盆系之地層埋壓較 Murzuq 盆地稍重，但熱成熟結果相仿，由盆地邊緣的較低成熟至產油高峰(0.55～0.72% Ro)至盆地軸部之成熟晚期(1.3% Ro)階段，此可由 A1-NC58 井得到證實。

然而在盆地內泥盆紀之生油岩熱成熟卻變得相當複雜。如 B1-67、A1-67 及 A1-NC58 諸井之泥盆紀生油岩所測得之 Ro 以達 0.92%以上，有些更高於 1.3%；但 A1-NC34、D1-NC58、H1-NC58 等井泥盆紀生油岩成熟度僅達 0.49%～0.64% 。故泥盆紀之生油岩受有機富集度及有機相所控制，在探勘時要特別注意。

至於石炭紀之生油岩，主要點產氣，在 Ghadames 及 Murzuq 兩盆地皆可發

現，熱成熟程度往上從產氣高峰至成熟邊緣。A1-NC58 井石炭紀沉積物所測 Ro 爲 1.25%～1.3%；但 E1-NC58、H1-NC58 及 A1-NC34 井之石炭紀生油岩僅 0.48%～0.56%，剛要進入油窗；而 Murzuq 盆地之 A1-76 井石炭紀生油岩 Ro 則已達 0.87%。由此看來，本盆地之石炭紀生油岩中產油之油母質正介於適宜之油氣範圍內，而產氣之油母質亦進入產氣之初始階段，皆未達過成熟階段。

3、油岩對比

由 A1-NC58 井泥盆紀儲集岩及 E1-NC101 井奧陶紀儲集岩之油氣可與 E1-NC101 及 F1-NC101 井下志留紀生油岩良好對比，故可證實從志留紀生油岩同時移棲至奧陶紀較老岩層及泥盆紀較年青地層之移棲路徑。

在 IIIizi 盆地氣相層析顯示下部志留系生油岩與儲集岩有良好的對比。Hamyouni(1984)研究指出在西利比亞地區油氣聚集許多來自志留紀及上部泥盆紀生油岩所產生油氣的混合。

在 Ghadames 盆地北側，E1-66 井之油與附近 Tigi 油田 B1-23 井上部奧陶紀生油岩有很好的對比。

在本盆地油氣可歸納出四種類型：

(1)來自奧陶紀生油岩的油，如 E1-66 井。

(2)底部志留紀生油岩產生的油，如 Q1-23 井。

(3)下部泥盆紀儲集岩所封閉的油，如 P6-32 井，爲底部志留紀及上部泥盆紀兩種來源混合油。

上部泥盆紀/下部石炭紀生油岩形成的油，如 H-26, B2-2 及 F-90 井。

4、油氣對比

Geochem Labs 實驗室 1995 年曾分析 Lasmo 之 A1-NC174 井與鄰近周圍井之油氣對比。A1-NC174 井 33°API 之油與 B12-NC115 井 BB family 可對比，而不同於 NC115 及 B12-NC115 之 B family 的油。

5、盆地模擬

據 Nubian Consulting (2004)指出，盆地模擬可顯示底部志留系頁岩在中侏儸紀至早第三紀，特別從井下岩樣分析在白堊紀（Pre Austrian）時期進入主要產油階段。

(四)Kufra 盆地

位於利比亞東南部地區，如同 Ghadames 盆地及 Murzuq 盆地一樣，屬非洲內陸凹陷盆地之一。主要受古生代時期造山運動影響，形成二組構造型態，第一次的隆起運動爲加里東造山運動所造成，整個構造走向呈西北東南向。第二次則爲海西寧運動造成，形成東北一西南走向構造，亦使三疊紀地層缺失。而本區主要含油氣潛能地層則以寒武紀至石炭紀陸相及海相沈積爲主。奧陶紀之薄層頁岩爲生油岩之一，特別是在盆地西部及中部地區，此層在盆地深部可達油窗範圍。而最佳的生油岩是以志留紀地層之頁岩爲主，盆地西部可能比盆地中部具較好的生油岩分佈。現今盆地最深的沈積厚度大約有 3,000 公尺，根據地溫梯度估算古生代之沈積岩能達到不成熟至早期成熟階段。但在第三紀時期發生的火山活動可能加速油氣生成。盆地內至今顯示油氣潛能不佳，原因在於盆地沈積物最厚才 3,000 公尺，生油岩未達油窗範圍。局部地區由火山活動增加生油岩成熟尚可考慮其生油潛能。儲油岩層雖有許多層次可做爲目標，但卻缺乏蓋岩做爲密封岩層，整體而言探勘地層還是以古生代地層爲主。

(五)Pelagian 盆地

位於利比亞西北海域內，面積約爲 55,000 平方公里，主要爲中生代與新生代構造運動所形成之邊緣張裂盆地。本區位於非洲古陸塊邊緣，在中生代及新生代時間因地體構造運動而發生張裂、扭轉及擠壓等。盆地深部地層在古生代早期屬於 Ghadames 盆地向北延伸區域，至中生代時才與 Ghadames 盆地分離，並在三疊紀至侏儸紀形成 Tripolitania Trough。盆地沈降作用始於白堊紀早期 Aptian 張裂活動，且在盆地北部及東部地區造成三疊紀鹽岩穹起之衝頂作用。整個盆地形成西北一東南走向之地塹構造，而古新世至始新世沈積物沈積在地塹內，主要沈積作用則在中新世早期發生，估計此時期的沈積物厚度可達 1,500 公尺。整個沈降作用一直延續至今日。主要生油岩爲白堊紀至古新世的頁岩及碳酸鹽岩，一部份爲中新世地層的頁岩。生油岩的成熟度介於過成熟至成熟範圍。最佳的生油岩是上部白堊紀至古新世內之富集度豐富的頁岩及碳酸岩。白堊紀的生油岩在第三紀進入油窗範圍，而第三紀地層在盆地深部地區可達早-中期成熟階段。

多層次的生油岩分佈在中新世-白堊紀地層內，均已達到油窗範圍產出油氣，可垂直移棲及水平移棲進入儲油構造內。多層次的儲油岩如同生油岩般亦在漸新世至白堊紀地層內，以碳酸鹽岩爲主，除原生孔隙率外，成岩作用產生的次生孔隙也會增加儲油能力。豐富而成熟的生油岩及多層的儲油岩配合構造、地層與組合式的封閉，使此區亦具油氣探勘潛能。

(六)Cyrenaica 盆地

位於利比亞東北部地區，面積大約 I00,000 平方公里，爲古生代非洲內陸凹陷盆地，在中生代後發育成盆地沈積型態。古生代早期，本區北部在 CaIansclo-Anaynat 隆起帶上，僅有薄層沈積物，志留紀中期開始有較厚的沈積物

在北部及東部發育，志留紀末期，Cyrenaica 盆地才開始沈降，從三疊紀期形成準平原陸相沈積環境。侏羅紀時期南部地區形成凹谷地形，白堊紀早期的沈積物大量堆積在此，而北部地區則在白堊紀末期形成凹陷谷地後才開始有沈積物供應。至第三紀時期南部之 Jagbub 隆起後，相對於其他地區型態即稱本區爲地台，此期的沈積以始新世地層爲主。志留紀地層含黑色頁岩，有機物富集度高，尤其在北部地區，幾乎都已達到油窗範圍，而在西部地區則爲中期至初期成熟階段，油氣生成則在石炭紀至新生代時期，油氣靠斷層往上移棲至儲油岩內。上部泥盆紀生油岩型態類似志留紀地層。石炭紀的生油岩以煤層爲主，可能產氣，北部地區進入油窗範圍，但在台地區域內可能未成熟。另在北部的上部白堊紀地層亦爲重要的生油岩，屬成熟初期至未成熟階段。本區至今並無重要的油氣發現。生油岩雖分佈在古生代及中生代的地層內，且均已進入油窗範圍，但在油氣生成時期，正值構造運動作用，許多油氣無法移棲至封閉構造內而散失，且無良好的蓋岩密封都是本區未發現油氣的可能因素。

綜合而言，依盆地以及石油系統觀念綜合探討其高潛能地區有:

(1) Sirte 盆地未探勘高潛能地區　(2) 高潛能 Ghadames 盆地

(3) 高潛能 Murzuq 盆地　　(4) 海域盆地高潛能地區

建議公司派員查閱並購入礦區資料進一步研究的 Ghadames 及 Murzuq 盆地其石油系統見圖 4-4-3～4-4-7。

伍、結論與建議

一、職等此次奉派參加每四年舉辦一次，本次在南非約翰尼斯堡所舉行之「第18屆世界石油大會」國際會議，與世界各地知名油氣探勘及研究學者、不同領域之專家共聚一堂，研討最新之石油探勘科技及探討未來之發展方向，獲益良多。會中利用機會查閱及收集非洲國家礦區資料及相關之探勘資料及地質評估軟體資訊，共同研討非洲之油氣儲聚特徵及潛能，期能找尋最有利之礦區，提供及應用於本公司國外探勘工作上，對於本公司形象之提升以及技術交流相當有助益。

二、非洲爲世界現今之主要油氣生產地區，油氣資源豐富，其原始蘊藏量在現今世界油氣工業，佔有一席之地。尤以奈及利亞、利比亞、阿爾及利亞及埃及等之油氣生產量，列入世界二十大產油國之一。最近由於深水探勘之崛起，西非包括奈及利亞、安哥拉、剛果地區之潛能更引起世界石油工業界之重視。爲此，世界各國莫不積極投入西非陸海域地區之投資及開發研究，如鄰國日本、中國大陸及印尼早已紛紛派員前往搜集資訊並作深入研究，並已擁有礦區，尤以中國大陸更爲積極，派遣專家及作業人員紛紛在各潛能地區進駐。中油公司早年曾派員評估研究，並成立非洲小組專責進行此方面之評估研究。但由於非洲地區之資源龐大，分佈面積廣泛，同時各地區之油氣礦床之特徵亦區區各異。因此，建議公司強化非洲地區評估小組之組織規模，增加各種領域之專家，以團隊方式大規模展開非洲地區之探勘評估與開發技術等工作，積極佈署或尋找切入投資之時機，期以爲公司爭取最大之利益。

三、深水礦區之油氣產量與年俱增，2006年以後，產量更大幅成長，西方之各大油公司皆在西非地區佔有極重要的角色。由於目前世界上淺水陸棚區容易找尋之油氣構造多已被鑽探，所剩者爲深水部份，深水探勘已成爲目前國際上探勘之主要潮流，世界各大石油公司莫不紛紛加入該行列。中油公司對於深水探勘

接觸較少，但深水探勘實爲目前國際探勘之主流，此方面之探勘趨勢實不可忽略。建議公司組成專案小組積極展開深水礦區資料之搜集與評估工作，期以選取良好及具未來潛能之礦區早日加入。但由於深水探勘之投資金額龐大，建議公司可採取分段式投資策略，即先以少許資金投資加入，待有成效後再加碼投入，期爲公司爭取最大商機。

四、最近在中北非的查德、蘇丹等地區沿 Centre Africa Shear Zone 陸續發現超大型油氣田，此區之油氣田與剪力形成之深盆地有關，此深盆具有良好的陸相生油母岩，因此這地區的油氣潛能也比預估大。而查德地區，其 B enue 海槽(Trough)由奈及利亞沿西南方向進入查德境內，此盆地內尚有諸多構造尚未探勘，爲一探勘密度不高之地區。其中，Doba-Doseo 及 Bongor 盆地，已有油氣發現，其油氣潛能尚高。而此等盆地現爲各大石油公司所據，但由於此等盆地之構造條件佳，因此留意原有經營者擬退出之礦區，或其周圍尚有機會進入探勘。而 Lake Chad 盆地目前尚未發現具有商業性之油氣，但位於附近 Termit 地塹內，已有諸多油氣井發現。同時此盆地內尚具生油條件優良之生油岩，而且其探勘密度不高。因此，如找到封閉良好之構造，尚值得進入。

五、利比亞爲世界十大產油國之一，其可採收蘊藏量達 500 億桶油及 40 兆立方呎天然氣以上。利比亞礦區中，以 Murzuq 及 Ghadmes 盆地之低緩構造群、構造與地層聯合封閉最具潛能，而且尚有許多未探勘區域值得重視。建議公司購置 Murzuq 及 Ghadames 之礦區細部資料並作進一步評估，期爲日後投標礦區之參考。

六、奈及利亞爲非洲最大之產油國，同時也是世界十大產油國之一。該國之尼日三角洲爲一巨大型油區，其油田大多儲聚於大陸棚上濱及遠濱區內三角洲上之生長構造，尼日三角洲外海地區上已有礦區開放。而位於奈及利亞境內之深海沈積變形帶之濁流層砂以及大陸棚楔狀砂體，亦俱潛能，值得未來進一步深入評估，以爲日後標入之參考依據。

圖2-1 第18屆世界石油大會國際會議，於九月二十六~二十九日四天在在南非約翰尼斯堡之Santon Convention Center舉行(1)。

圖 **2-2**在南非約翰尼斯堡舉行之第**18**屆世界石油大會會場外觀。

Plenaries & keynote speakers

Sunday, 25th September 2005

Sponsored by: **PetroSA**
In association with: **NOC Libya / NNPC Nigeria / Sonangol Angola / Sonatrach Algeria**

19:00 **Opening Ceremony**
Official Opening Welcome by: **Dr. Eivald Røren,** President, World & Petroleum Council
Ayanda Mjekula, Chairman, South African National Committee of the WPC

Ceremonial element with the Ministers of Energy from the Host and Co-Host countries of the 18th WPC
H.E. Lindiwe Hendricks, Minister of Minerals and Energy, South Africa
H.E. Dr. Chakib Khelil, Minister of Energy and Mines, Algeria
H.E. Desidério da Costa, Minister of Petroleum, Angola
H.E. Dr. Fathi Hamed Ben Shatwan, Secretary of the People's Committee for Energy, Libya
H.E. Dr. Edmund Daukoru, Minister of State for Petroleum Resources, Nigeria

Welcome Address by the President:
H.E. Thabo Mbeki, President of the Republic of South Africa

Monday, 26th September 2005

Sponsored by: **Petrobras**

8:30 Plenary 1: The African Perspective
Keynote Speakers:
Dr. Abdullah Salem El-Badri, Chairman, National Oil Corporation, Libya
Eng. Funsho Kupolokun, Group Managing Director, NNPC, Nigeria
Sipho Mkhize, President & CEO, PetroSA, South Africa /
Mthozami Xiphu, Acting Chief Executive, Petroleum Agency SA, South Africa
Manuel Vicente, President, Sonangol, Angola
Mohamed Meziane, President, Sonatrach, Algeria

Session Chair: **Pat Davies,** CEO, Sasol, South Africa

Tuesday, 27th September 2005

Sponsored by: **National Ports Authority of South Africa**

8:30 Plenary 2: The Global Oil Perspective
Keynote Speakers:
H.E. Ali Al-Naimi, Minister of Petroleum & Mineral Resources, Saudi Arabia
Rex Tillerson, President, ExxonMobil Corporation
Session Chair: **Rafael Ramirez,** Minister of Energy and President, PdVSA, Venezuela

9:30 Plenary 3: Partners for Sustainability
Keynote Speakers:
Christophe De Margerie, President of Exploration & Production, Total
Paul Boateng, British High Commissioner to South Africa
Session Chair: **Aron Cramer,** President & CEO, Business for Social Responsibility (BSR)

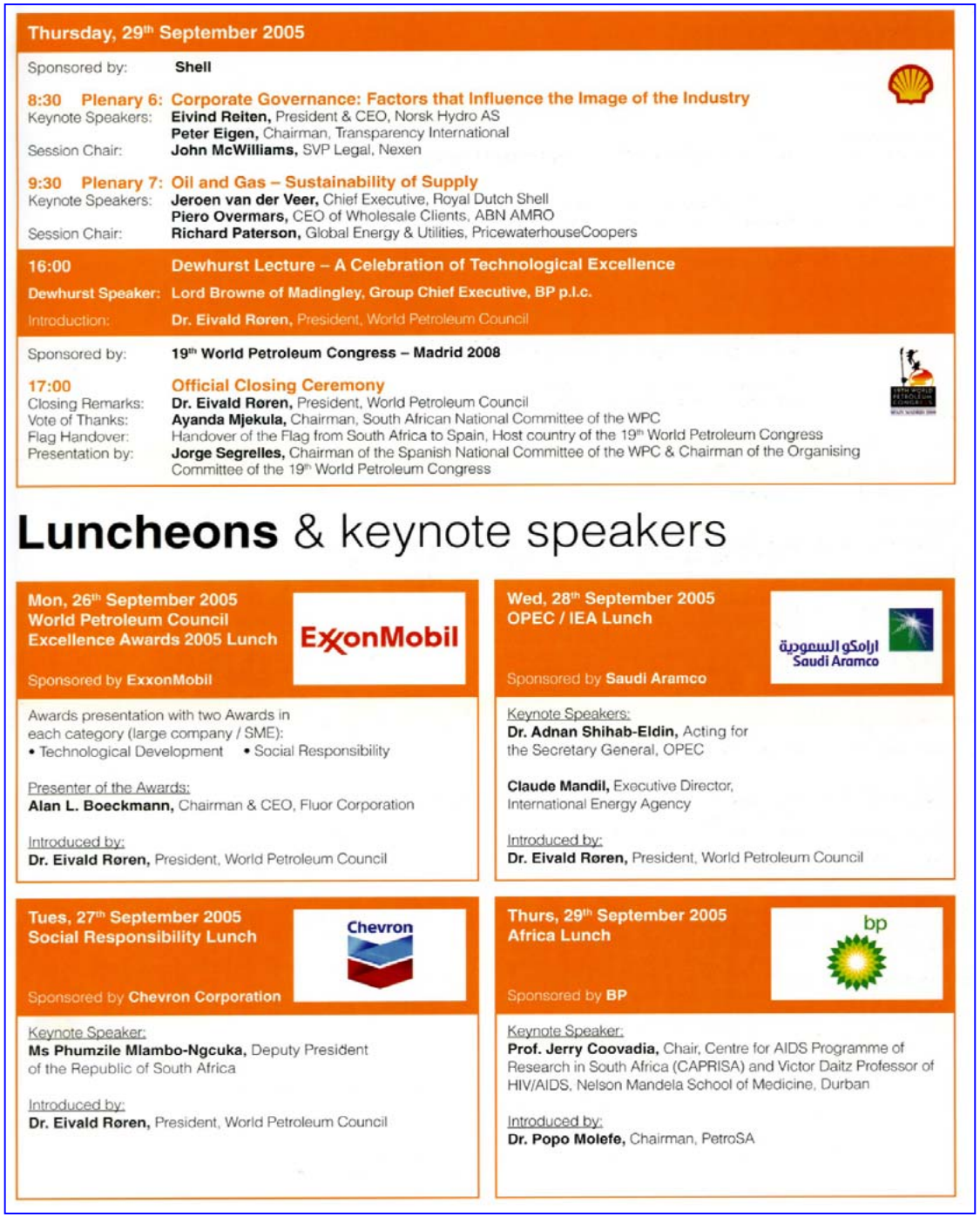
Wednesday, 28th September 2005

Sponsored by: **Statoil**

8:30 Plenary 4: Natural Gas in the Global Energy Picture
Keynote Speakers:
George Verberg, President, IGU
John Gass, President, Chevron Global Gas, USA
Session Chair: **H.E. Abdullah Bin Hamad Al-Attiyah,** Second Deputy Premier, Minister of Energy & Industry, Qatar, Chairman & Managing Director of Qatar Petroleum

9:30 Plenary 5: Renewables: A Significant Part of the Solution
Keynote Speakers:
Christopher Flavin, President, Worldwatch Institute (WWI), USA
Graeme Sweeney, CEO of Shell Renewables & President, Shell Hydrogen
Session Chair: **Antonio Brufau,** Chairman & CEO, Repsol YPF, Spain

圖3-1 第18屆世界石油大會之論文宣讀共有323篇參加，論文研討會內容包括（一）上游探勘產業、（二）下游及石化產業、（三）天然氣及再生能源及（四）能源管理四大項目。重要演講之一



Thursday, 29th September 2005

Sponsored by: **Shell**

8:30 Plenary 6: Corporate Governance: Factors that Influence the Image of the Industry
Keynote Speakers: **Eivind Reiten,** President & CEO, Norsk Hydro AS
Peter Eigen, Chairman, Transparency International
Session Chair: **John McWilliams,** SVP Legal, Nexen

9:30 Plenary 7: Oil and Gas – Sustainability of Supply
Keynote Speakers: **Jeroen van der Veer,** Chief Executive, Royal Dutch Shell
Piero Overmars, CEO of Wholesale Clients, ABN AMRO
Session Chair: **Richard Paterson,** Global Energy & Utilities, PricewaterhouseCoopers

16:00 Dewhurst Lecture – A Celebration of Technological Excellence
Dewhurst Speaker: Lord Browne of Madingley, Group Chief Executive, BP p.l.c.
Introduction: **Dr. Eivald Røren,** President, World Petroleum Council

Sponsored by: **19th World Petroleum Congress – Madrid 2008**

17:00 Official Closing Ceremony
Closing Remarks: **Dr. Eivald Røren,** President, World Petroleum Council
Vote of Thanks: **Ayanda Mjekula,** Chairman, South African National Committee of the WPC
Flag Handover: Handover of the Flag from South Africa to Spain, Host country of the 19th World Petroleum Congress
Presentation by: **Jorge Segrelles,** Chairman of the Spanish National Committee of the WPC & Chairman of the Organising Committee of the 19th World Petroleum Congress

Luncheons & keynote speakers

Mon, 26th September 2005
World Petroleum Council
Excellence Awards 2005 Lunch
Sponsored by **ExxonMobil**

Awards presentation with two Awards in each category (large company / SME):
• Technological Development • Social Responsibility

Presenter of the Awards:
Alan L. Boeckmann, Chairman & CEO, Fluor Corporation

Introduced by:
Dr. Eivald Røren, President, World Petroleum Council

Wed, 28th September 2005
OPEC / IEA Lunch
Sponsored by **Saudi Aramco**

Keynote Speakers:
Dr. Adnan Shihab-Eldin, Acting for the Secretary General, OPEC

Claude Mandil, Executive Director, International Energy Agency

Introduced by:
Dr. Eivald Røren, President, World Petroleum Council

Tues, 27th September 2005
Social Responsibility Lunch
Sponsored by **Chevron Corporation**

Keynote Speaker:
Ms Phumzile Mlambo-Ngcuka, Deputy President of the Republic of South Africa

Introduced by:
Dr. Eivald Røren, President, World Petroleum Council

Thurs, 29th September 2005
Africa Lunch
Sponsored by **BP**

Keynote Speaker:
Prof. Jerry Coovadia, Chair, Centre for AIDS Programme of Research in South Africa (CAPRISA) and Victor Daitz Professor of HIV/AIDS, Nelson Mandela School of Medicine, Durban

Introduced by:
Dr. Popo Molefe, Chairman, PetroSA

圖3-2 第18屆世界石油大會之論文宣讀共有323篇參加，論文研討會重要演講之 2

Technical programme

Block 1 – Upstream

Review and Forecast Papers (RFP)

RFP1 Intelligent Oil fields — **Mon, 26th Sep 11:00 – 12:00**

Advances in downhole monitoring and control will enable managing reservoir production without rig intervention. This has an impact on manpower and costs of field management. Experiences and challenges of field automation and smart wells and surveillance will be invited.

Authors: **Dalton Boutte,** President, Western Geco, UK
Dr. Peter Kapteijn, Manager, Smart Fields, Shell, Netherlands
Chair: **Dr. Abdulaziz Al-Kaabi,** Manager, Reservoir Engineering Technology, Saudi Aramco, Saudi Arabia

RFP2 Breakthrough Technologies for Ultra Deep Water Development — **Wed, 28th Sep 11:00 – 12:00**

New technologies needed to commercially find, develop and produce oil and natural gas reserves from the ultra deep waters: reservoir prediction prior to drilling, low cost drilling of ultra deep wells, flow assurance and natural gas /oil separation, smart well completions, custom mooring and alternatives for storage and exporting.

Author: **Ricardo Luis Beltrao,** Production R&D General Manager, Petrobras, Brazil
Chair: **Eng. Jose Sousa Vicente,** Production Manager, Sonangol, Angola

RFP3 New Technologies in Extra Heavy Crude Oil & Natural Bitumen Field Development — **Thurs, 29th Sep 11:00 – 12:00**

Huge reservoirs of extra heavy crude oil and natural bitumen have been discovered in a variety of operational and climatic conditions. Although produced by various recovery methods in the USA, Russia, Indonesia and Venezuela, new production technologies allowed Canada to commercially produce their tarsands reservoirs. However, major problems remain in developing extra heavy crude oil, natural bitumen and tarsands production schemes in some challenging environments.

Author: **Dave Boone,** President, Escavar Energy, Canada
Gary Bunio, Manager, Heavy Oil, Paramount Resources Ltd., Canada
Chair: **Dr. Rafael Tenreyro,** Senior Specialist, Cuba Petroleo, Cuba

Forums (F)

F1 West Africa Deep Water Exploration, Development and Production — **Mon, 26th Sep 16:00 – 18:00**

Chair: **Joao Carlos Araujo Figueira,** Exec. Manager, International, Petrobras SA, Brazil
Vice Chairs: **Ing. Gaspar Martins,** E&P General Manager, Sonangol, Angola
Gérard Bocquillon, Director Block 17, Total E&P, Angola

F1 - PAPERS:

- **BP Angola, the Growth and Development of a Major New Profit Centre**
  Authors: Bill Schrader, BP Angola, UK
- **Benguela Belize - Lobito Tomboco Development, Block 14: Angola's Next Deep Water Hub**
  Authors: Dr. William Higgs, Chevron, Angola; Fredrico Domingos, and Rosario Isaac, Sonangol E&P, Angola; Ms. Rhonda Redwine, and Paul Benoit, Chevron, USA
- **Optimal Horizontal Wellbore Placement Using New Drilling Technology in the Niger Delta – Bonga Field Case Study**
  Authors: Sola Falodun, Halliburton Energy Services, Nigeria; Kingsley Ehrunmwunsee, Shell Nigeria Exploration & Production Company, Nigeria; Mike Kellas, Andergauge Drilling Systems, Nigeria
- **Petrobras in Nigeria: A Success Case**
  Authors: Samir Awad, and Rudy Ferreira, Petrobras Nigeria, Nigeria
- **Downhole Monitoring and Flow Control in Deep-Offshore Wells - The Girassol and Jasmim Fields Experience**
  Author: Eurico Barber, and Didier Caie, Total E&P Angola, Angola
- **New Technologies for Field Development in 3000 Meters of Water Depth**
  Author: Dr. Jacques Braile Salies, Petrobras, Brazil

F1 - POSTERS:

Advancements in Ultra Deep Water Completions by Use of Vacuum Insulated Tubing; Dr. Jaroslaw Nowinka, C-Fer Technologies, Canada; Manuel Gonzalez, and Rodney Hensley, Chevron, USA

Thermal Insulated Fluid Helps Ensure Flow in West Africa Deep Water Locations; James Cottom, Faustino Conde, David Poole, Don Garrett and David Huynh, Halliburton Energy Services, Angola

Procedure Monitoring of the Pipeline Internal Inspection Robot - G.I.R.I.N.O.; Breno Bonifatti Figueiredo, Rodrigo Carvalho Ferreira, and Auderi Vicente Santos, Pontificia Universidade Católica Do Rio De Janeiro, Brazil; Ney Robinson Salvi Dos Reis, PETROBRAS Research Center (Cenpes), Brazil; Pedro Eduardo Gonzales Panta, Universidade Federal Do Rio De Janeiro, Brazil

圖3-3 第18屆世界石油大會論文 宣讀研討會 之上游論文研討內容 (1)

Exploration to Production: A Near Decade of Success in Block 14, Angola; David Kennedy, and Nelson Pacavira, Cabinda Gulf Oil Company Limited, Angola; Dr. Henrique Lago De Carvalho, Sonangol, Angola
Meeting The Challenge Of Subsea Field Development Offshore Nigeria - The Okwori Oil Field Case; Bruno Stenger, Paul Van Maren, and Jac Blommerde, Addax Petroleum Services, Switzerland; Monday Otabor, Michael Simpson, Mrs. Mercy Okoro, and Tony Ezeukwu, Addax Petroleum Development Nigeria Ltd, Nigeria
Quantitative Lithoseismic Characterization for Reservoir Modelling of Angola Deep Water Case; M.Sc. Francisco Cunha, Sonangol, Angola; Dr. Sylvain Nguyen, Dr. Olivier Voutay, and Pascale Neff, Beicip-Franlab, France

F2 Emerging Technologies for Drilling Challenges — Tues, 27th Sep 13:45 – 15:45

Chair: **Khalid Al-Buraik,** Manager, Drilling, Saudi Aramco, Saudi Arabia
Vice Chairs: **Ing. Daniel Rocha,** President, Chevron Environmental Management Company, USA
Dr. Iskander R. Diyashev, Chief Engineer, Sibneft, Russia

F2 - PAPERS:

- **Application of Azimuth Density Imaging of LWD in Structure Interpretation**
  Author: Jun Zhao, Tarim Oilfield Company, PetroChina, China
- **Unique Bit Performance Predictor Using Specific Energy Coefficients as a Function of Confined Compressive Strength Impacts Drilling Performance**
  Authors: Hector Caicedo, and Russ Ewy, Chevron Corporation Energy Technology Co., USA
- **Implementation of a New Risk Based Well Collision Avoidance Method**
  Authors: Gary McNair, Chevron Corporation Energy Technology Company, USA; Steve Lance, Chevron Corporation, Thailand; Roger Watson, Sperry Sun Drilling Services, Thailand; Jerry Codling, Landmark Graphics, England
- **New Drilling Technologies as Drilling-with-Casing (DWC) Require New Solutions for Tubular's Connections**
  Authors: MSc Gabriel Carcagno, and Eng. Nestor Santi, Tenaris, Argentina
- **Managed Pressure Drilling improves drilling efficiency, economics, recoverables and enhances well site HSE**
  Author: Tom Fuller, Weatherford Underbalanced Systems, UK,
- **First Lateral-Flow-Controlled Maximum Reservoir Contact (MRC) Well in Saudi Arabia: Drilling & Completion - Challenges & Achievements: Case Study**
  Authors: Omar Al-Faraj, and Faisal Al-Nughaimish, Drilling & Workover, Saudi Arabia; Nabeel Al-Faleg, and Uthman Al-Otaibi, Reservoir Management, Saudi Arabia

F2 - POSTERS:

Improving Gas and Gas Condensate Well Construction in the Arctic Regions; Dr Andrey Frolov, and Dr Alexander Ryabokon, GAZPROM Drilling Dept, Russia; Dr Sergey Nadikta, ZAO Kortecservice, Russia; Prof Anatoly Klyusov, VNIIGaz, Russia
Characterizing Cement Sheath Properties for Zonal Isolation; Dr Kris Ravi, Halliburton, USA; Dr Phillip Pattillo, BP, USA
Applications for Formation Testing While Drilling in the Middle East; Ron Deady, Halliburton, USA; Douglas Seifert, Saleh Al-Dossari, Saudi Aramco, Saudi Arabia; Stephen Kellet, Halliburton, Saudi Arabia
New Concept to Evaluate Rheological Behaviour for Deep Hard Rock Drilling into Hotter and More Pressured Formations and Performance of Miscible Gas Injection; Noureddine Benayad, and Mrs Nadia Haddoum-Kherfellah, Sonatrach, Algeria

F3 Exploration and Development of Naturally Fractured Reservoirs — Tues, 27th Sep 16:00 – 18:00

Chair: **Dr. István Bérczi,** Chief Advisor of CEO, MOL Hungarian Oil and Gas Plc., Hungary
Vice Chairs: **Dr. Jean Letouzey,** VP Exp-Res-Eng/Tech., Institut Francais du Pétrole, France
Prof. Jia Chenzao, Chief Geologist, PetroChina, China

F3 - PAPERS:

- **Development of a Large Carbonate Reservoir with Natural Fractures**
  Authors: Dr. Nabeel Al-Afaleg, and Tony Pham, Saudi Aramco, Saudi Arabia
- **Fluid Type Identification in Fractured Reservoir**
  Authors: Dr. Bin Wei, Chengjun Zhang, and Ms. Jiarong Cai, Liaohe Petroleum Exploration, CNPC, China
- **Fractured Reservoir Management - Recent Progress and Promising Perspectives**
  Authors: Bernard Bourbiaux, Dr. Rémy Basquet, Dr. Arnaud Lange, and Dr. Lin-Ying Hu, Institut Français Du Pétrole, France
- **How Will the Naturally Fractured Reservoirs of the World Age?** (With a Special Focus on Carbonates since that is where most of the Reserves Lie)
  Author: William "Bill" Wright, Schlumberger, Reservoir Evaluation Wireline, France
- **Simulation Study of Secondary Water and Gas Injection in a Typical Iranian Naturally Fractured Carbonate Oil Reservoir**
  Authors: Vali Ahmad Sajjadian, Research Institute of Petroleum Industry (RIPI), Iran; Ali Mohammad Emadi, Director of NIOC R&D, Iran; Mrs. Elham Khaghani, Petroleum University of Technology, Iran
- **Seismically Driven Fractured Reservoir Characterization**
  Author: Dr. Ahmed Ouenes, Gary Robinson, Abdel Zelou, Dave Balogh and Udo Araktingi, Prism Seismic, USA

F3 - POSTERS:

Solving the Problems of HC Reserves Production by Applying Side-View Seismic Location Technology (SVSL) to Monitor the Reservoir Fracturing; Prof Oleg Kuznetsov, Dr I.A. Chirkin, and Dr Boris Melchouk, VNII Geosystem, Russia; Dr Yuri Kuryanov, Tyumenneftegeofizika, Russia

(cont.)

圖3-4 第18 屆世界石油大會
論文 宣讀研討會 之
上游論文研討內容 (2)

Technical programme (cont.)

Research on Chemical Shallow Profile Modification Mode of Frontal Facies Reservoir of Daqing Oilfield of China; Sen. Eng. Huaiyou Jiang and Sen. Eng. Xinguang Sui, Geological Institute of No.1 Oil Production Company, Daqing Oil Field Company, China
An Investigation of the Initial and Exploitation Conditions of the Super Giant Akal Offshore Naturally Fractured Reservoir; Alfredo Leon G., PEMEX, Mexico; Fernando Samaniego, UNAM, Mexico; Heber Cinco Ley, and Fernando Rodriguez, PEMEX and UNAM, Mexico
Combining Old and New Techniques for Fracturing Characterization; Dr. Alexander Afanasenkov, and Dr. Vladimir Nozhin, United Oil Group, Russia; Dr. Evgeny Kozlov, and Dr. Nikolai Baransky, Paradigm Geophysical, Russia
Fracture Opening - Key to Well Productivity in Naturally Fractured Reservoirs; Yuqi Du, New Mexico Tech., USA; Linhua Guan, Texas A&M University; Dr. Haiyun Liang, Director, China Petroleum University, China
Formation Evaluation in Dezful Embayment of Iran Using Oil-Base-Mud Imaging Techniques; Principal Geologist Mahmood Akbar, Geologist Zohreh Movahed, and Geologist Zeynalabedin Safarkhanlou, Well Services Of Iran(Schlumberger Methods), Iran; Geologist Abbas Nazaraghaie, National Iranian Oil Company South Fields, Exploration Geology/Geological Studies, Iran
Sarvak Reservoir Characterization and its Pore Geometry Analysis with Emphasis on the Role of Buoyancy Force in Oil Production of the Kupal Oilfield, SW, Iran; Mojtaba Homaie, and Babak Tahmaseby Morady, National Iranian Oil Company, South Fields, Iran; Bahram Alizadeh, Chamran University, Iran
A New Methodology to Estimate Fracture Intensity Index for Naturally Fractured Reservoirs; Sandro Arango Gomez, Ecopetrol S.A, Colombia; Eduardo Alejandro Idrobo Hurtado, Ecopetrol S.A (ICP), Santander; Hector Hugo Perez Vega, Ecopetrol S.A (ICP), Colombia
Discrete Fracture Network Model - a Case History, Dorozsma Field, SE-Hungary; Tamas Vincze, Julia Komlósi, and Peter Zahuczki, MOL Hungarian Oil and Gas, Hungary; James Moffatt, Schlumberger, Russia; Dr. Thomas Doe, Golder Associates, USA
Characterizing Sparsely Fractured Reservoirs through Structural Parameters, Time-Lapse 3-D Seismic, and Production Data; M.Sc. Mehdi Zeidouni, National Iranian Oil Company, Iran; Prof. C.P.J.W. van Kruijsdijk, Delft University of Technology, The Netherlands

F4 Challenges in Seismic Exploration — Wed, 28th Sep 13:45 – 15:45

Chair: **Dr. Craig J. Beasley,** Schlumberger Fellow, Schlumberger, USA
Vice Chairs: **George Smith,** Senior Lecturer in Applied Geophysics, University of Cape Town, South Africa
Dr. Abdulmohsin Y. Al-Dulaijan, Assistant to VP Exploration, Saudi Aramco, Saudi Arabia

F4 – PAPERS:

- **Seismic Acquisition & Processing in Block 0, Offshore Cabinda, Angola - Continuous Evolution in Technology and Applications**
  Author: Ronald M Cupich, Erik Davidsen, Helmut Hsiao, and Dave Dalley, Chevron, Southern Africa Business Unit, USA
- **Optimising Seismic Cost, Quality and Time**
  Authors: Andrew Dippenaar and N J S van Wyk, PetroSA, South Africa
- **Using Seismic to Meet the World's Hunger For Energy: Challenges and Opportunities**
  Author: Dr Kamal Al-Yahya, Saudi Aramco, Saudi Arabia
- **Reducing E&P Risk and Cost in Deep Water Basins with Innovations in Seismic Acquisition Technology**
  Author: Maurice Nessim, Dr. Mark Egan, and Dr. Craig Beasley, WesternGeco, USA
- **Challenges in Seismic Exploration: 3D Seismic - Still Not True 3D**
  Author: Sverre Strandenes, Petroleum Geo-Services, Norway, Per Arild Reksnes, PGS Marine Geophysical, Norway and Andrew Long, PGS Marine Geophysical, Australia

F4 - POSTERS

The Use of Deep Seismic Sounding Data for Hydrocarbon Potential Prediction; Dr N.L. Baransky, Paradigm Geophysical, Russia; Dr G.V. Krasopevtseva, VNIIGeopfizika, Russia; Dr Alexey M. Kuzin, IGIRGI, Russia,
S-Mode Propagation – An Important Factor in Reservoir Characterisation; Prof. Halina Jedrzejowska and Krzysztof Zulawinski, Oil & Gas Institute, Poland
The Application of Thin & Poor Reservoir Predicted Technology to the Punan Oilfield; Sen. Eng. Hong Dong Xu, Eng. Wang Jinrong, Eng. Wang Changsheng; Eng. Jianping Lou; Sen. Eng. Jun Hou and Eng. Zhaogang Wang, No.7 Oil Production Company of Daqing Oilfield, China
Possibility of Optimization of Production Wells' Location by Using New Tools for Statics Correction & Reservoir Characterization; Dr. Alexander Afanasenkov, and Dr. Vladimir Nozhin, Yukos Oil Company, Russia; Dr. Nikolai Baransky, Vladimir Vinikovsky, and Mrs. Tatyana Malyarova, Paradigm Geophysical, Russia
Use of Model Based K-L Filtering to Improve Seismic Imaging of the Devonian Jauf Reservoir, Eastern Saudi Arabia; Douglas Cook, and Ching-Chang J. Tsai, Saudi Aramco Exploration Technical Services, Saudi Arabia
Petrographic, Petrophysics & Seismic Integration: an Approach to Delineation of Diagenetic Trap, Reshadat Oil Field in the Persian Gulf; Dr. Alireza Bashari, Iranian Offshore Oil Company, Iran

圖3- 5 第18 屆世界石油大會 論文宣讀研討會 之上游論文研討內容 (3)

F5 Increasing Yield from Fields — **Thurs, 29th Sep 13:45 – 15:45**

Chair: **Dr. Georg von Hantelmann,** Member of the Board, Gaz de France Produktion, Germany
Vice Chairs: **Dr. Ravil R. Ibatullin,** Director, Tatnipineft Institute, Russia
Dr. Hugo Araujo, Reservoir Eng, Finding, Repsol-YPF, Argentina

F5 – PAPERS:

- **Uncertainty Assessments in Hydrocarbon Forecasts for Mature Fields**
  Author: Dr. Dominique Guerillot, Institut Français Du Petrole, France
- **Role of Chemical IOR/EOR Methods in the XXI Century**
  Authors: Prof. István Lakatos, Research Institute of Applied Chemistry, U. Miskolc, Hungary
- **Resources Valuation Plan - From Resources to Reserves or Promoting Technology to Maximise Hydrocarbon Production & Recovery**
  Authors: Philippe Clovin, Alain Goulois, Michel Maguerez, and Igor Potapieff, Total Exploration & Production, France
- **Infill Drilling-Lessons Learned in the Past 20 Years**
  Authors: Linhua Guan, Texas A&M University, USA, Yuqi Du, New Mexico Tech, USA and Zhiming Wang, Chevron, USA
- **Improved Oil Recovery: Status and Opportunities**
  Authors: Dr. Leonid Surguchev, Rogaland Research, Norway; Dr. Eduardo Manrique, Questa Engineering Corp., USA; Prof. Vladimir Alvarado, University of Rio De Janeiro, Brazil

F5 – POSTERS:

Improved Oil Recovery Technology in China: Status & Outlook; Prof. Ping Ping Shen, Sen. Eng. Jie Song, and Sen. Eng. Bin Zhu, Petrochina Research Institute of Petroleum Exploration & Development (RIPED), China

NCS Technology and Application for Africa; Jan Helge Skogen, Vice President, Hydro ASA, Angola

Mature Field Revitalization Using Horizontal Wells - Case Study Hassi Messaoud Oil Field, Algeria; Aissaoui Karim, Sonatrach / Amont / Ped, Algeria,

Gel Treatment of Injectors: Mechanism, Simulation, and Field Practice; Prof. Konstantin Fedorov, Tyumen State University, Russia; Dr. Yevgeniy Pavlov, JSC Lukoil-West Siberia, Russia; Prof. Vadim Andreev, Prof. Nil Khairetdinov, and Dr. Yury Kotenev, Institute For Enhanced Oil Recovery Bashkortostan Academy Of Sciences, Russia

Driving Value throughout the Upstream Life Cycle; Antonio Sanchez Coullaut and Holger Kisker, SAP AG, Germany

Risk Minimization in a Fully Stochastic Development Plan on a Marginal Field Offshore Angola; Thomas Graf, Schlumberger, France; Joaquim Fernandes, Sonangol, Angola; Herve Henrion, and Robert Bellavance, Schlumberger, Angola

Three Companies in Latin America Collaborate to Execute an Integrated Approach to Achieve Operating Excellence; Luis Bacigalupo, Ziff Energy Group, USA; Nelson Navarrete, Ecopetrol, Colombia; Hubert Borja, Hocol, Colombia,

Microbial Degradation Influences on Heave Oil Characters and MEOR Test; Prof. Zhang Tingshan; Associate Prof. Chen Xiaohei; Prof. Lan Guangzhi; and Assistant Jiang Zhaoyong, SW Petroleum Institute, China

圖3-6 第18屆世界石油大會論文 宣讀研討會 之上游論文研討內容 (4)

Technical programme (cont.)

Block 2 – Downstream and Petrochemicals

Review & Forecast Papers

RFP4 Downstream Supply Chain Optimisation — Mon, 26th Sep 11:00 – 12:00

In the environment of the very volatile crude and product market, there is an increasing need for optimising the downstream supply chain. The basic target is to meet the customers' requirements while running all downstream operations efficiently. These are the key issues for refiners. The question to be answered is: How close are we to a perfect model for optimization of the whole downstream supply chain?

Author: **Mark M. Gainsborough,** Vice President - Supply Strategy, Shell International, Netherlands
Chair: **Prof. Li Dadong,** President, SINOPEC, Research Institute Pet. Process, China

RFP5 Catalytic Distillation — Wed, 28th Sep 11:00 – 12:00

Certain conversion processes can be greatly enhanced by combining catalytic reaction processes and distillation in a single column/reactor. The technique does not only save investment costs, but it also allows to make direct use of the heat of exothermic conversions for the distillation and to shift the thermodynamic equilibrium towards the desired product. The rapidly growing number of commercial gasoline desulphurisation units based on catalytic distillation is proof of the very successful development of this technology and of the economic viability. Benzene hydrogenation is representing another phase in the technical and commercial development of catalytic distillation. Questions to be answered are related to the fundamental process thermodynamics, design of catalytic distillation and other competing technologies, as well as the respective economics. A report on the current status of catalytic distillation in petroleum refining and petrochemistry will be given and future trends in and opportunities of catalytic distillation will be outlined.

Author: **Jan Harmsen,** Principal Process Developer, Shell Global Solutions, Netherlands
Chair: **Prof. M. M. Akbarnejad,** NIOC Research Institute, Iran

RFP6 Non-Conventional Routes to Petrochemicals from Natural Gas – the Future — Thurs, 29th Sep 11:00 – 12:00

Methane is an abundant raw material for a variety of chemicals. Besides the conventional route via synthesis gas, various direct pathways for converting natural gas into valuable chemicals have been envisaged. Examples are the direct oxidation to methanol and other oxygenates, oxidative coupling to C_2+hydrocarbons or the manufacture of aromatics from methane. The recent progress and the perspectives in this area will be reviewed.

Author: **Prof. Anders Holmen,** NTNU, Norway
Chair: **Dr. Ing. Ulrich Graeser,** Director Operations, BP Refining & Petrochemicals, Germany

Forums (F)

F6 Latest Improvements in Refining by Catalyst Development — Mon, 26th Sep 13:45 – 15:45

Chair: **Dr. Ahmad Al-Saadi,** Chief Engineer, Saudi Aramco, Saudi Arabia
Vice Chairs: **Dr. Hans-Gerd Löhr,** General Manager, MiRO Mineralölraffinerie, Germany
Dr. Hong Dingyi, Science and Tech. Director, CPCC, China

F6 - PAPERS

- **Development and Commercial Application of Catalysts for Resid Hydrotreating Technology (RHT)**
  Author: Lishun Dai, Chuanfeng Niu, Qinghe Yang, Xuefen Liu, Hong Nie, Yahua Shi, and Dadong Li, Research Institute of Petroleum Processing, SINOPEC, China,
- **Novel Catalysts Design for Selective Conversion of Alkanes under Mild Conditions**
  Authors: Prof. Vagif Akhmedov, and Prof. Soliman Al-Khowaiter, Petroleum & Petrochemicals Research Institute, Saudi Arabia
- **Leveraging FCCU Benefits with Catalyst & Additives**
  Authors: Ms. Divya Jain and Sriganesh Gandham, HPCL, India
- **PetroSA's Conversion of Olefins to Distillate (COD) Research Program**
  Authors: Cyril Knottenbelt, and Volan Nicholson, PetroSA, South Africa
- **Hydrocracking Catalyst Selection**
  Authors: Dr. Gene Yeh, Walid Al-Naeem and Ali Al-Abdulal, Saudi Aramco, Saudi Arabia
- **New Generation of Isocracking Catalysts**
  Author: Dr. Hye-Kyung Timken; J.F. Mayer; A.J. Dahlberg; M.M. Habib and T. Maesen, Chevron Energy TechnologyCompany, USA

F6 - POSTERS

An Integrated Approach for Oil Industry through Heavy Oil Conversion, Hydrogen Production, CO_2 Sequestration & Enhanced Oil Recovery; Oscar Chamberlain, Petrobras - CENPES R&D Center, Brazil; William Gilbert, and Henrique Cerqueira, Petrobras - CENPES, Brazil; Raul Rawet, Ricardo Pimenta; Gustavo Moure, and Paulo Rocha, Petrobras, Brazil

Commercial Application of a Novel Catalyst for the First-Stage Hydrogenation of Pyrolysis Gasoline; Prof. Zaiku Xie; Prof. Zhongneng Liu; Prof. Weimin Yang; Sen. Eng. Hongyuan Zong; and Prof. Rongwei Wang, SINOPEC Shanghai Research Institute of Petrochemical Technology, China

Role of FCC Catalyst in Chinese Transportation Fuels Production; Prof. Huiping Tian; and Sen. Eng. Jun Long, Research Institute of Petroleum Processing, SINOPEC, China

MIP Process for Clean Gasoline and Propylene; Sen. Eng. Jun Long; and Sen. Eng. Jiushun Zhang, Research Institute of Petroleum Processing, SINOPEC, China

The FHI Diesel Oil Hydroupgrading-Isodewaxing Technology and Commercial Application; Sen. Eng. Minghua Guan; and Sen. Eng. Fenglai Wang, Fushun Research Institute of Petroleum and Petrochemicals, SINOPEC, China

Novel Biphasic Catalytic System and Technology for Olefin Oligomerization: the Difasol process; Dr. Hélène Olivier-Bourbigou; and Dr. Frédéric Favre, Institut Français du Pétrole, France

Vanadium oxide supported on Kieselguhr and MCM-41 for Oxidative Dehydrogenation of Propane into Propene; Dr. Mohammed C. Al-Kinany; Dr. Mohammad Al-Dosari; Dr. Hamid Al-Megren; Dr. Soliman Al-Khowaiter; Dr. Saud Al-Drees and Rasheed Al-Rasheed, King Abdulaziz City for Science and Technology, Saudi Arabia

Fluidized Catalytic Cracking (FCC) Kinetic Model to Support Operation Optimization and Catalyst Development for Fuels and Petrochemical Products; Christopher Dean; Safwan Nugali; and Graham Jones, Saudi Aramco, Saudi Arabia

Perspective Catalysts for Modernization FCC and Catalytic Reforming Processes to Improve Operation and Products' Environmental Quality; Dr. Mikhail Levinbuk, and Alexander Lebedev, Moscow Oil Refinery, Russia; Dr. Eduard Kaminski and Dr. Vsevolod Khavkin, Oil Refining Institute, Russia; Prof. Vladimir Kapustin, Gubkin Russian State Oil & Gas University, Russia

F7 Innovative Ways of Increasing Efficiency in Refinery Utility Processes — Mon, 26th Sep 16:00 – 18:00

Chair: **Dr. Jose Felix Garcia,** Executive Secretary, ARPEL, Uruguay
Vice Chairs: **Abubakar Lawal Yardua,** Group Executive Director, NNPC, Nigeria
Maurice Radebe, Managing Director, AMEF/Exel, South Africa

F7 - PAPERS

- **Optimization Experiences in Refinery Cooling Tower Water Systems - Lessons Learned**
  Author: Arif Jaffer, Baker Hughes, USA
- **Energy Saving in Refinery Plants and its Environmental Impact**
  Authors: Dr. Mohand Amokrane Masri, Sonatrach - IAP CU, Algeria; K. Dali, Aprue, Algeria
- **Sea Cooling Water New Treatment Process**
  Authors: Gandham Sriganesh; Subroto Chaudhuri; and Vijay Kathin, HPCL, India
- **Provision of High Efficiency Utility Boilers in BPCL Refinery, Mumbai, India - A Case Study**
  Authors: P. Padmanabhan, and P.D. Amin, BPCL, India
- **The Refinery of the Future**
  Author: Dr. Ashok Krishna, Chevron Global Refining, USA

F7 - POSTERS

PILOT - Software for Designing Energy Efficient Systems in Refineries and Petrochemical Industries; Dr. Mohammad Hassan Panjeshahi, Petroleum University of Technology, Iran

How to Optimise the Downstream Refinery Sector in Latin America for its Future Viability? Miguel Moyano, ARPEL, Uruguay; Mauro Bria, PETROBRAS, Brazil

Improved Boiler Water Treatment Programme; Vijay Kathin, Sudip K Pal, and Subroto Chaudhuri, HPCL, India

Chemical Characterization of Residue Stream Samples Obtained through Molecular Distillation from Brazilian Vacuum Residues; Paula Sbaite; Claudia Vasconcelos; Dr Cesar Batistella; Dr Prof. Maria Wolf Maciel; and Dr Prof. Rubens Maciel Filho, State University of Campinas, Brazil; Alexandre Gomes; and Researcher Lilian Medina, CENPES/Petrobras, Brazil

Understanding Operational Risk in Petroleum Downstream: A Review of Best Practices to Reduce Operational Risk; Linus Hakimattar, Aspen Technology Inc, Canada

Energy Optimization in Oil Refinery - Case Study: Catalytic Reforming Unit; Dr. Ozren OCIC, NIS-Oil Refinery Pancevo, Serbia

F8 Meeting the Growing Hydrogen Demand in Refining — Tues, 27th Sep 16:00 – 18:00

Chair: **Dr. Klaus Niemann,** Managing Director, PCK Raffinerie GmbH, Germany
Vice Chairs: **Dr. Carlos, Saturnino,** Negotiations Manager, Sonangol, Angola
Ing. Publio Roberto Gomes Bonfadini, Refining & Petrochem., Petrobras, Brazil

F8 – PAPERS

- **New Developments in Steam Reformer Design**
  Authors: Zain Abdin, and Simon Barendregt, Technip Benelux B.V., Netherlands
- **New Development in Hydrocracking Technologies**
  Authors: Sen. Eng. Quanzhu Peng; and Sen. Eng. Minghua Guan, Fushun Research Institute of Petroleum and Petrochemicals, SINOPEC, China
- **Meeting the Growing Hydrogen Demand in Oil Refining**
  Author: Dr Joao Alves, UOP, UK
- **Elevated Temperature Embrittlement in Cast 20Cr32Ni1Nb Alloy**
  Authors: José Claudio Guimarães Teixeira; M.Sc. Guilherme Victor Peixoto Donato; Laudemiro Nogueira Júnior; and Dr Carlos Bruno Eckstein, Petrobras, Brazil

(cont.)

圖3-7 第18 屆世界石油大會論文 宣讀研討會 之下游論文研討內容 (5)

Technical programme (cont.)

- **Hydrogen Purification in Hydro Processing**
  Authors: Yuv Mehra, and Ali Al-Abdulal, Saudi Aramco, Saudi Arabia
- **Cost Effective Production of Near-Pure Hydrogen**
  Authors: Dr Eve Sprunt and Dr James Stevens, Chevron Technology Ventures, USA; Dr Paolina Atanassova; J.P. Shen, Cabot Superior Micropowders, USA and Mark Hamden-Smith, Cabot Superior Micropowders, USA; Ms Julie Cao, Kelly Scientific, USA

F8 – POSTERS

Development of IGCC Technology Taking the Partial Oxidation Process as a Core; Sen. Eng. Dejun Jiang; Sen. Eng. Zhenping Xao; and Sen. Eng. Xiaozhong Yu, Sinopec Ningbo Engineering Co., China

The Canadian Clean Power Coalition: Industry/Government Partnership Program to Produce Power and Hydrogen from Coal and Coke while Capturing, Utilizing and Sequestering CO_2; Dr. Duke du Plessis, Alberta Energy Research Institute, Alberta; Robert Stobbs, Canadian Clean Power Coalition, Canada; Paul Clark; and Jim Dinning, TransAlta Utilities Corporation, Canada

Multi-Feed HDT Reactor High Performance Operation; Dr. Eduardo Coselli Vasco de Toledo; and Dr. Rubens Maciel Filho, School of Chemical Engineering, State University of Campinas (UNICAMP), Brazil

Thermodynamics Study of Reformer in Hydrogen Plants by Minimization of Free Gibbs Energy; Morteza Torabi, Arvand Petrochemical Co., Iran; Dr Mahdi Goharrokhi, Azad University, Iran; Kamran Dehghani, Rahavaran Petrochemical Co., Iran

Impact on Hydrogen Consumption of Different Hydrotreating Technologies and Brazilian Crude Oils; Process Eng. Donizeti Belato; Process Eng. Denise Monteiro; Process Eng. Jorge Duncan; Process Eng. Carlos Monteiro, Petrobras/Cenpes, Brazil

F9 C_4 Chemistry for Fuels and Petrochemicals — **Wed, 28th Sep 13:45 – 15:45**

Chair: **Prof. Eduardo Falabella Sousa Aguiar,** Senior Advisor, Petrobras SA, Brazil
Vice Chairs: **Dr. Martin Rupp,** Technology Integration, BP Refining Technology, Germany
Dr. Abdelhafid Feghouli, General Deputy Manager, Sonatrach, Algeria

F9 - PAPERS

- **MOL TEMPO 99 EVO - Development & Production of a Premium Grade Environmentally Friendly ULSG Using High Quality Isoparaffins & Oxygenates**
  Authors: Dr. Andras Hollo; Dr. Laszlo Szirmai; Dr. Gabriella Szalmas; and Janos Magyar, MOL - Hungarian Oil and Gas Plc., Hungary
- **The Changing World of C_4 and C_5 Refining**
  Author: Jamie Townsend, BP Oil International, UK
- **Advances and Prospects of Isobutane Alkylation on Solid Catalysts**
  Author: Prof. Dr. Johannes A. Lercher, Carsten Sievers and Dr. Roberta Olindo, TU Munchen, Germany
- **Opportunities for Propylene Production from C_4+ Metathesis in Developing Countries**
  Author: Dr. Marcos Sugaya, Petrobras, Brazil
- **Recent Advances in the Oxidative Activation of Isobutane**
  Authors: Dr. Vicente Cortés Corberán, CSIC - Inst. Catalysis and Petroleum Chemistry, Spain; Dr. Vladislav P. Vislovskiy, Azerbaijan National Academy of Sciences, Azerbaijan

F9 - POSTERS

Petrobras MTBE Unit Retrofit to Isoctane Production; D. Sc. Carlos Rene Klotz Rabello; Processing Eng. Marcelo Wolff; Processing Eng. Mauro Silva; and Processing Eng. Rafael Menegassi, Petrobras, Brazil

Production of High Octane Isooctane for Automobile Fuel via Dimerization of Butylenes and Hydrogenation Processes; Jin Zhaosheng; Dr.Yang Weimin and Dr.Xie Zaiku; SINOPEC Shanghai Research Institute of Petrochemical Technology, China

Synthesis and Characterization of Highly Efficient Tungsten-Substituted SBA-15 Catalysts for Olefin Metathesis; Dr. Yangdong Wang; Prof. Weimin Yang; and Prof. Zaiku Xie, Shanghai Research Institute of Petrochemical Technology, China

Mathematical Model and Experimental Testing of a Two-Zone Fluidized Bed Reactor for the Oxidation of Butane to Maleic Anhydride; Jorge Gascón; Dr Carlos Téllez; Dr Javier Herguido; Dr Miguel Menéndez; and Dr Jesús Santamaría, University of Zaragoza, Spain, with Dr Hugo Jakobsen, NTNU, Norway

Laboratory Study of Factors Impacting on Isobutane Yield in FCC; Dr.Ulises Sedran; Ing. Francisco Passamonti; and Dr. Gabriela de la Puente, INCAPE, Argentina

Steamcracking of Naphtha over ZSM-5 Zeolites modified by both Calcium and Magnesium Cations; Eng. Yuanyuan Ji; and Prof. Yuanyi Yang, Beijing Research Institute of Chemical Industry, China Petroleum & Chemical Corp., China

Regularities of Isobutane Dehydrogenation with CO_2 on Oxide Catalysts; Dr. Aggadin Mammadov; Dr. Abdulaziz Aljodai; and Dr. Ijaz Ahmed, Sabic Company, Saudi Arabia

Sulphur and Trace Elements in Fuels by ED-P-XRFS; Mrs Julie Shannon, Spectro Analytical Instruments, South Africa; Mrs M Julising, Spectro Analytical Instruments, Germany

F10 Advances in Olefin Production — **Thurs, 29th Sep 13:45 – 15:45**

Chair: **Jacques Grootjans,** General Manager Base Chemicals R&T, Total Petrochemicals Research, Belgium
Vice Chairs: **Dr. Wilfried Petzny,** Former CEO, EC Erdölchemie GmbH, Germany
Paul D. Clark, VP Research, Nova Chemicals Corp, Canada

F10 - PAPERS

- **Meeting Olefins Demand in a Novel FCC Technology**
  Authors: Dr. Halim Redhwi, and Dr. Mohammad Abul-Hamayel, King Fahd University of Petroleum & Minerals, Saudi Arabia; Dr. Takashi Ino, Nippon Oil Corporation, Japan; Yuichiro Fujiyama, Nippon Oil Corporation, Japan; Karl Kleemeier; Christopher Dean, and Mousa Al-Nemer, Saudi Aramco, Saudi Arabia
- **Clean Fuels and Petrochemicals at SASOL via SUPERFLEX™**
  Authors: Curtis Eng, and Steve Heidenreich, Kellogg Brown & Root (KBR), USA; Sias Swart, and Francois Moeller, Sasol Technology, South Africa
- **Technologies for Filling the Propylene Gap**
  Author: Jim Andersen, UOP LLC, USA
- **Bitumen-derived Heavy Gas Oils as Feedstock for Petrochemicals**
  Authors: Dr. Paul Clark, and Dr. Mike Oballa, NOVA Chemicals Corporation, Canada; Dr. Duke du Plessis, and Dr. Catherine Laureshen, Alberta Energy Research Institute, Canada
- **Production of Olefins and Aromatics from Alberta's Oil Sands Plants**
  Authors: Dr. Duke du Plessis, Alberta Energy Research Institute, Canada; Dr. Paul Clark, Nova Chemicals Corporation, Canada
- **Advances in FCCU Technology for the Production of Olefins**
  Authors: Derek Lawler, and Fakhri Dhaidan, Stone & Webster, UK; Warren Letzsch, Stone & Webster, USA

F10 - POSTERS

Mechanistic Modelling of the Pyrolysis of n-heptane: Development of a Chemical Compiler; Kayode Latinwo, Oladele Bello, and Mrs. Tinuade Afolabi, Ladoke Akintola University of Technology, Nigeria; Dr. Donaldson Aribike, University of Lagos, Nigeria

Technical Development in the Production of Low Carbon by Using Methanol; Dr. Hongxing Liu, and Prof. Zaiku Xie, SINOPEC Shanghai Research Institute of Petrochemical Technology, China

The Use of Ceramic Rods in Reactor Pyrolysis for Steam Cracking Hydrocarbons; Ass. Prof. Ramin Karimzadeh, and Prof. Jafar Towfighi, Tarbiat Modares University, Iran; Dr. Heinz Zimmemann, Linde Co., Germany

Production of Propylene from C4 Olefins by Catalytic Cracking - The Effect of ZSM-5 Zeolite Crystal Sizes; Sen. Eng. Jiawei Teng, Eng. Guoliang Zhao, Prof. Zaiku Xie, and Prof. Qingling Chen, SINOPEC Shanghai Research Institute of Petrochemical Technology, China

Catalytic Pyrolysis of Heavy Oils for Light Olefin Production; Dr. Xianghai Meng, Prof. Chunming Xu, and Prof. Jinsen Gao, State Key Laboratory of Heavy Oil Processing, China

Petrochemicals Industry (Olefins & Aromatics): Opportunities and Challenges in Indonesia for 2007; Surya Armansyah, PT. Pertamina (PERSERO), Indonesia

Direct Conversion of Methane to Higher Hydrocarbons Using a Corona Plasma Discharge: Experimental Studies; Eng. Mohammad Ali Khodagholi, NIOC Research Institute of Petroleum Industry, Iran

The Significance of Upgrading Consumption of Hydrocarbon Sources as Petrochemicals Feed; Mohammad Hassan Peyvandi, National Petrochemical Company, Iran,

Double Riser FCC - An Opportunity for the Petrochemical Industry; Andrea Pinho, José Geraldo Furtado Ramos, José Antonio Moreno Castillero and Pedro Pedrosa Neto, Petrobras, Brazil

Reducing FCC Gasoline Olefin and Enhancing Propylene Yield with FDFCC Process; Dr. Fandong Meng, CTO Longyan Wang, and Prof. Haitao Tang, Luoyang Petrochemical Engineering Corp., SINOPEC, China

(cont.)

圖3-8 第18屆世界石油大會論文 宣讀研討會 之下游論文研討內容 (6)

Technical programme (cont.)

Block 3 - Natural Gas and Renewables

Review and Forecast Papers

RFP7 Natural Gas Supply and Demand: Getting the Balance Right — Mon, 26th Sep 11:00 – 12:00

This paper will present the findings of the natural gas industry on the current status and trends in world natural gas supply and demand, highlighting the main constraints and challenges it faces to match the balance in terms of technology, investments, transport options and regulation.

Authors: **Ms. Melanie Kenderdine,** Vice President, Gas Technology Institute, USA
Philippe Sauquet, VP Strategy Total G&P, Total, France
Chair: **Prof. Zhao Wenzhi,** Vice President, RIPED, PetroChina, China

RFP8 Coal Bed Methane Production & CO_2 Storage: the Win-Win Association? — Wed, 28th Sep 11:00 – 12:00

Of a relatively marginal significance for the conventional oil & natural gas industry, coal bed methane (CMB) has been particularly promoted in some specific coal oriented-countries (USA, China, UK), despite constraints linked to environmental concerns. Papers will concentrate on the technical challenges of projects in countries such as USA, Poland, China and the UK and other former coal production countries utilising CO_2 sequestration to promote gas production whilst gaining credit for carbon storage.

Author: **J. Michael Gatens,** Chairman and CEO, MGV Energy Inc., Canada/USA
Dr. William D. Gunter, Distinguished Scientist, Alberta Research Council, Canada
Chair: **Chris Hopkins,** Manager, Technology Center, Schlumberger Technology, USA

RFP9 Gas To Liquids: A Proven Route for Monetising Gas? — Thurs, 29th Sep 11:00 – 12:00

Being in the GTL Sasol birth place, this paper is naturally dedicated to the GTL experience. Present status and evolution trends will be reviewed with the target to highlight the monetization and environmental concerns behind the technical achievements.

Author: **George Couvaras,** CEO, SasolChevron, South Africa
Chair: **Marcelo E. Rosso,** International Exp and Dev, Pluspetrol SA, Argentina

Forums (F)

F11 Natural Gas and Africa: A Growing Role and Impact — Mon, 26th Sep 13:45 – 15:45

Chair: **Manu Wope,** Manager Southern/Eastern Africa, Tullow Oil, South Africa
Vice Chairs: **Jean Privey,** SVP Africa E&P, Total, France
Said Akretche, General Director of Energy, Ministry of Energy & Petroleum, Algeria

F11 – PAPERS

- **The Angola LNG Project**
  Authors: Antonio Orafo, Sonangol, Angola; Christopher Miller, Chevron - Angola LNG Project, USA
- **Floating Gas to Liquids - A Solution to Offshore Stranded Gas**
  Authors: William John Hutton, Syntroleum Corporation, UK; Lynn Tomlinson, Syntroleum Corporation, USA
- **Africa in the Future Atlantic & Mediterranean Markets**
  Author: Jean Privey, Total, France
- **Raising Finance for African Gas-Related Projects: Lessons from Nigeria**
  Author: Victor E. Eromosele, NNPC-NAPIMS, Nigeria

F11 – POSTERS

Strategy for Energy Infrastructure Development: The Case of Algeria; Mohand Hanouti, and Abdelkrim Ainouche, Sonatrach, Trc / Rti / In Amenas, Algeria
Trans Saharan Gas Pipeline Project: A Vehicle for Progress and Sustained Development; Abdelhakim Ainouche, Sonatrach / Trc / Rth / Haoud El Hamra, Algeria

F12 Renewables: Status and Expected Impact — Mon, 26th Sep 16:00 – 18:00

Chair: **Dr. Steve Westwell,** Group Vice President & Head of BP Solar, BP, UK
Vice Chairs: **Dr. Alexandre Penna Rodrigues,** Energetic Solutions Exec., Petrobras Distribuidora, Brazil
Dr. Wendy Anecke, Gender and Energy Research and Training, South Africa

F12 – PAPERS

- **Critical Energy Issues and Challenges in the Emerging Scenario of a New World Energy Order - A Radical Transition from Carbon Energy to a Sustainable Renewable Energy Portfolio**
  Author: Dr. Jagdish Giri, Oil and Natural Gas Corporation Limited, India
- **Biofuels: Bio-Diesel & Bio-Ethanol**
  Author: Dr. Stephan Reimelt, Lurgi AG, Germany
- **Algeria and the Promotion of Renewable Energies**
  Authors: Boubekeur Malek, Sonatrach / HSE / AMT, Algeria, and Abdelhakim Ainouche, Sonatrach / TRC / RTH / Haoud el Hamra, Algeria
- **Bio Fuels as Blending Components for Transportation Fuels**
  Authors: Sh. B.M. Bansal, R.K. Malhotra, and N.R. Raje, Indian Oil Corporation, R&D Centre, India
- **Solar Power: Ready for take-off!**
  Author: Gilles Cochevelou, Total, France
- **Renewable Hydrogen Energy Systems**
  Authors: Ivar Hexeberg and Ms. Elisabet Fjermestad Hagen, Norsk Hydro ASA, Norway

F12 – POSTERS

Renewables as an Alternative Energy Source to Oil; Dr. Amaziah Walter Otunyo, Shell Petroleum Development Company, Nigeria
Alternative Fuels for Sustainable Mobility; Dr. Ulrich Balfanz, Deutsche BP AG, Germany
How to Save the World: A Roadmap to Maximizing the Social Benefits of R&D Spending for Cleaner Transportation Fuels; Dr. Awwad Alharthi, and Mohammed Alfehaid, Saudi Aramco, Saudi Arabia

F13 Supplying the Natural Gas Demand: A Global Challenge — Tues, 27th Sep 13:45 – 15:45

Chair: **Peder Sortland,** Senior Vice President, Statoil, Norway
Vice Chairs: **Eng. Jose Fernando de Freitas,** Exec. Manager, Int. Gas Power, Petrobras SA, Brazil
Prof. Rudolf M Ter-Sarkisov, General Director, Viniigaz/Gazprom, Russia

F13 - PAPERS

- **Impact on Global LNG Markets of Balancing the North American Natural Gas Market**
  Author: Dr. Lori Smith Schell, Empowered Energy, USA
- **Challenges Facing the Liberalisation of the European Gas Markets: A Seller's Perspective**
  Authors: Abdelhakim Ainouche, Sonatrach / TRC / RTH / Haoud el Hamra, Algeria; and Abdelkrim Ainouche, Sonatrach / TRC / In Amenas, Algeria
- **Meeting the Natural Gas Demand: Global and Regional Challenges**
  Author: Prof. Anatoly Dmitrievsky, Oil & Gas Research Institute, Russia
- **RasGas and the State of Qatar - Developing the LNG Supply Chain**
  Author: Alexander Dodds, RasGas Company Limited, Qatar
- **Global Natural Gas Demand is Set to Continue Increasing**
  Author: Per Lindberg, Statoil, Norway

F13 – POSTERS

Market Development Analysis for the Brazilian Gas Distribution Case: CNG Anticipating Pipeline Network Gas Supply; Eng. Luis Felipe Espírito Basso Poli, Dr. Silvia Cheroto, Dr. Jorge Roberto Abrahão Hijjar and M.Sc. Newton Paterman, Petrobras, Brazil
Oil and Gas Exploration and Development in Tarim Basin and the Resource of West-to-East Pipeline Project; Dr. Long-De Sun, Dr. Wen-Jie Song, and Phd. Tong-Wen Jiang, Chinese National Committee for the WPC, China
Natural Gas Transportation - NGH or LNG?; Dr. Jafar Javanmardi, and Dr Mahmood Moshfeghian, Shiraz University of Technology, Iran; Dr Khashayar Nasrifar, Norwegian University of Science and Technology, Norway; Dr Hesam Najibi, University of Petroleum Industry, Iran
Realizing the Potential of Africa's Gas Reserves & Meeting Global Energy Demand: Challenges & Opportunities; Samuel Igbatayo, Igbinedion University, Okada, Nigeria; Prof. Peter Imoudu, Federal University of Technology, Nigeria
The Resource Potential and the Prospect of Coal Bed Methane (CMB) In Western Guizhou and Eastern Yunnan of China; Prof. Ma Yongsheng; Chen Yuekun; Guo Chiqi; Xu Guoming; Dou Weishan, Southern Exploration and Development Company, SINOPEC, China
An Option for Gas-To-Liquids (GTL) Technology in Sarir Oil Field of Libya; Dr. Iftikhar Ahmad, and Ramadan Mansour, Jowfe Oil Technology, Libya; Dr. A.M. Gerrard, University of Teesside, UK
Yamalo-Nenets Autonomous District's Role in Shaping Russian Energy Balance; Dr. Yuri Neyolov, Administration of Yamalo-Nenets Autonomous District, Russia
Virtual Gas Distribution Investments and the Rise of the Brazilian Natural Gas Market; Alvim Borges da Silva Filho, UFES / CRET-LOG, France; Edmilson Moutinho dos Santos, USP, Brazil
Shipping Compressed Natural Gas from the North Sea Region to the Polish Gas Market; Dr Andrzej Piwowarski, and MSc Stanislas Trzop, Polish Oil and Gas Company, Poland
The Large Genesis - Special Natural Gas Deposits in Deep Volcano and Non-Typical Sedimentary Rocks in the Songlao Basin of China; Master Min-zhi Zhang, Master Cheng Wang, Master Hong-qi Jiang, Dr. Dan Yao, Master Xian-da Sun, Quing-yun Mao, Guang-zheng Shen, Daqing Oil Field E&P Research Institute, China

(cont.)

圖3-9 第18 屆世界石油大會論文 宣讀研討會 之天然氣及資源管理論文研討內容 (1)

18WPC2005
www.18wpc.com
30

Technical programme (cont.)

F14 Evolution of the LNG Market: Between Constraints and Rewards — Tues, 27th Sep 16:00 – 18:00

Chair: **Dr. Ramzi Salman,** Advisor to H.E. the Minister, Qatar Petroleum, Qatar
Vice Chairs: **Didier Holleaux,** Vice President LNG, Gaz de France, France
Prof. Jonathan Stern, Director of Gas Research, OIES, UK

F14 – PAPERS

- **New LNG Receiving Terminal Concepts**
  Authors: Boris Ertl and Isa Mohammed, M.W. Kellogg Limited, USA; David Coyle and Charles Durr, KBR, USA; Stanley Huang, International Process Systems, USA
- **Challenges and Opportunities for LNG Supply in Developing Markets – The Indian Perspective**
  Author: Suresh Chandra Sharma, Petronet LNG, India
- **The Global LNG Industry - Changed Market Dynamics**
  Author: David Small, National Gas Company, Trinidad
- **Algerian LNG - A Central Role in the New International Scene**
  Authors: Abdelaziz Benhamadi, Sonatrach / AVL, Algeria, Abdelkrim Ainouche, Sonatrach / TRC / In Amenas, Algeria; Karim Aissaoui, Sonatrach / AMT, Algeria
- **ChevronTexaco - Turning Partnership into Energy**
  Authors: Audie Setters, Chevron Global Gas, USA
- **Offshore Concrete LNG Import Terminals**
  Author: Svein Bredahl, Aker Kværner ASA, Norway

F14 – POSTERS

Evolution of the LNG Market and its Competition with GTL; Abdelhakim Ainouche, Sonatrach / TRC / RTH / Haoud el Hamra, Algeria; Abdelkrim Ainouche, Sonatrach / TRC / In Amenas, Algeria; Nabil Tiab, Sonatrach / AVL / Business Development, Algeria
The Future of LNG Business - Reality and Perspectives; Benhamadi Abdelaziz, Sonatrach, Algeria

F15 Gas to Chemicals — Thurs, 29th Sep 13:45 – 15:45

Chair: **Dr. Edouard Freund,** Exec. VP, Institut Francais du Petrole, France
Vice Chairs: **Jan Fourie,** Director, Sasol, South Africa
Joseph Naylor, Vice President, Strategy, Planning and Business Support, Chevron Global Gas, USA

F15 – PAPERS

- **Gas to Propylene: Report on Commercialisation by Lurgi**
  Author: Dr. Waldemar Liebner, and Dipl.-Ing. Harald Koempel, Lurgi AG, Germany
- **Production of Olefins and Oxygenated Compounds from Fischer-Tropsch**
  Author: Andy Redman, Sasol Technology, South Africa
- **Methanol Production Technology**
  Author: Terry Fitzpatrick, Johnson Matthey Catalysts, UK
- **Statoil's World Scale Methanol Plant: Technology and Experience**
  Author: Ola Olsvik, and Thomas Sperle, Statoil, Norway

F15 – POSTERS

Technical Development in the Production of Syn-gas and Methanol by Using Natural Gas; Sen. Eng. Zhenping Xiao, Sen. Eng. Dejun Jiang, and Sen. Eng. Mingfeng Zheng, Sinopec Ningbo Eng. Co., China
MtSynfuels and FT: Lurgi's Routes to Synthetic Fuels; Dipl.-Ing. Bernd Ahlers, and Dr. Waldemar Liebner, Lurgi AG, Germany
Methane Conversion to Higher Hydrocarbons by an Electrical Plasma - Experimental Studies; Eng. Mohammad Ali Khodagholi, and Naser Seed Matin, NIOC-Research Institute of Petroleum Industry, Iran
Chemicals Refining from Fischer-Tropsch Synthesis; Arno De Klerk, Luis Dancuart, and Dr Dieter Leckel, Sasol Technology R&D, South Africa
Comparison Between Several GTL Production Processes in Iran; Dr. Ali Vatani, Mahmood Nazeri, and Ismail Alizadeh, Tehran University, Iran; Hadi Rahmani, Amir Kabir University, Iran
Operating the Worlds Largest GTL Facility (Natural Gas-to-Liquids); Ncazane Mabena and Christo Cloete, PetroSA, South Africa

Block 4 - Managing the Industry

Review and Forecast Papers –

RFP10 Shaping the Future Through R&D? — Mon, 26th Sep 11:00 – 12:00

This paper assesses the benefits that R&D brings to the industry, including case studies demonstrating economic returns from scientific advances. Past and future sources of funding and ways of cooperation and partnerships between petroleum and service companies, academia and public research entities will be discussed. Specific research needs now and in the future will be presented.
Author: **Dr. Olivier Appert,** Chairman and CEO, Institut Francais du Petrole, France
Chair: **Prof. Mars Khasanov,** Director of Science, Yukos E&P, Russia

RFP11 Knowledge Management — Wed, 28th Sep 11:00 – 12:00

Technological advances in gathering, processing and storage led to the creation of databases with massive amounts of information. As operations become increasingly driven by the newest technological solutions and the most complete and accurate databases available, it is essential that this knowledge base be readily available to all end users at the right time and the right location. This session will review the latest advances in data handling systems and how companies are ensuring that the knowledge accumulated internally can be disseminated to all users through knowledge networks or similar approaches.
Author: **Antoine Rostand,** Global Managing Director, Schlumberger Business Consulting, France
Mike Bowman, Head of Appraisal, BP Exploration, UK
Chair: **Prof. Francisco Neopomuceno,** EP Corporative Exec., Petrobras SA, Brazil

RFP12 Water Management — Thurs, 29th Sep 11:00 – 12:00

Water management is a major emerging issue for the international petroleum industry and increased focus of regulatory attention. Issues include the utilization of fresh water required to sustain our industry as well as the handling of produced water, waste water treatment and recycle. Current practices and specific areas for improvement will be addressed
Author: **Carlos Guimaraes,** UOP – CEO, Dow Chemical/US BCSD, USA
Dr. Paul Hardisty, MD, Europe, Middle East and Africa, Komex Environmental, Cyprus/Canada
Chair: **Saleh M Al-Dawas,** Manager, Exp., Tech., Services, Saudi Aramco, Saudi Arabia

Forums (F)

F16 Revenue Transparency — Mon, 26th Sep 13:45 – 15:45

Chair: **John Martin,** MD, ABN Amro Bank, UK
Vice Chairs: **Michael Lynch-Bell,** Partner, Ernst & Young, UK
Pierre R. Alvarez, President, Canadian Ass. Of Petroleum, Canada

F16 - PAPERS

- **Transparency Initiatives: Strategies for Energy Companies in West Africa**
  Author: Ms. Monica Enfield, PFC Energy, USA
- **Transparent Tender Systems in the African Oil and Gas Sector: Benefits and Challenges**
  Authors: Alexandre Chequer, Tauil, Chequer e Mello Advogados associated with Thompson & Knight LLP, USA
- **Transparency - a Key to Business Success**
  Author: László Varró, MOL Hungarian Oil and Gas Plc., Hungary
- **Revenue Transparency, National Sovereignty and Authoritative Government: Any Way Out of the Dilemma?**
  Author: Bede Nwete, Centre For Energy, Petroleum and Mineral Law and Policy (CEPMLP), University of Dundee, UK
- **Designing Petroleum Contracts & Emerging Principles of International Law**
  Author: Stéphane Brabant, Partner, Herbert Smith, France
- **Revenue Transparency and the Extractive Industries Transparency Initiative (EITI)**
  Authors: Alexis Majnoni d'Intignano, KPMG France; Michael Levitsky, World Bank, USA

F16 – POSTERS

Valuing Oil and Gas Field Projects with Real Options; Drs. Pieter Jansen, Real-Options, Netherlands
Transparency and Debt Cost Reduction – the Petrobras Case; Roldao de Paula Freitas, PETROBRAS - Petroleo Brasileiro, Brazil

(cont.)

圖3-10 第18 屆世界石油大會論文 宣讀研討會 之天然氣及資源管理論文研討內容 (2)

18WPC2005
www.18wpc.com
32

Technical programme (cont.)

F17 HSE Aspects of Marine Transportation — Mon, 26th Sep 16:00 – 18:00

Chair: **Jean Michel Gires,** Executive VP, Sustainable Development, Total, France
Vice Chairs: **Terje C. Gloersen,** Director, Norwegian Shipowners Association, Norway
Jan M. Kopernicki, Vice President Shipping, Shell International

F17 - PAPERS

- **Prestige Fuel Recovery at 4000 Meters Water Depth**
  Author: Carlos Berenguer, Repsol YPF Upstream, Spain
- **HSE Aspects of Marine Transportation in the Gulf Area**
  Author: Khaled Helal, Aramco Gulf Operation Company, Saudi Arabia
- **Safe Transportation Systems**
  Author: Paul Markides, Oil Companies International Marine Forum, UK
- **Natural Gas and Shipping Development of Transport Concepts**
  Authors: Terje Staalstrøm, and Henrik Madsen, Det Norske Veritas, Norway

F17 – POSTERS

The Middle East Transportation Fuels: Current Development and Future Challenges; Ubaidallah Alghamdi, Arabian Fuels Technology Centre, Saudi Arabia
Emerging Trends in HSE Competence Development in Shell Petroleum Development Company of Nigeria (SPDC); Dr. Virgy-Claire Nwafor, Shell Exploration and Production Africa Ltd (SEPA), Nigeria
Geochemistry of Zn and Ni and the Sedimentation Rate in the Bay of Gorgan, Adjacent to the Caspian Sea; Dr. Ahmad Talebi, Khazar Exploration and Production Company, Iran; Dr. Abdulreza Karbassi, and Eng. Ali Amirnejad, Islamic Azad University, Iran
Impact of Oil Spills on Mosquito Biology in the Utorogu Field of the Western Niger Delta; Dr. Chinyere Ozumba, The Shell Petroleum Development Company Nigeria, Nigeria; Prof. J.K. Udonsi, University of Port Harcourt, Nigeria
Minimising Oil Pollution from Shipping; Terje C. Gloersen, Norwegian Shipowners' Association, Norway
Effective Information Management in Environmental Impact Assessment of Large Pipeline Projects in Remote Environments: Case Studies and Successes; Dave Kerr, Principal, and Robert van Wyngaarden, Associate, Golder Associates Ltd., Canada
Development of Automatic Coating Operations on Corroded Surfaces; Billy Alceu de Abreu, Labsolda - Welding Laboratory, Brazil
Analyzing Oil Pollution of Ships' Ballast Water in the Iranian Shores of the Caspian Sea at Bandar Anzali region; Eng. Afshin Ghorbaninedjad, Iran Maritime Institute (IMI), Iran
HSE Q Challenges & Opportunities; Emad Roayaei, National Iranian Oil Company, Iran

F18 Technology Options to Address Greenhouse Gas Emissions — Tues, 27th Sep 13:45 – 15:45

Chair: **Dr. Haroon Kheshgi,** ExxonMobil Research and Engineering Company, USA
Vice Chairs: **Prof. Jakub Siemek,** AGH University of Science and Technology, Poland
Prof. Michael Grubb, Visiting Professor of Climate Change and Energy Policy, Imperial College, UK

F18 – PAPERS

- **Addressing Green House Gas Emissions Through Co-Generation Technology**
  Author: Eng. Mohammed Dashash, and Dr. Refaat Mahfoudhi, Saudi Aramco, Saudi Arabia
- **Greenhouse Gas Management Through Flaring Reduction**
  Authors: Dr. John H Shinn, Chevron Energy Technology Company, USA; Jonathan Grant, Chevron Energy Technology Company, UK and Andre Peterhans, Sasol Chevron Consultants Ltd, UK
- **Advancing Global Consistency in Estimating Greenhouse Gas Emissions from Oil and Gas Industry Operations**
  Authors: Karin Ritter, American Petroleum Institute, USA; Susann Nordrum, Chevron Energy Research and Technology Co., USA; Michael McMahon, BP Plc, UK; Chris Loreti, Battelle, USA; Theresa M. Shires, URS Corporation, USA; Miriam Lev-On, The LEVON Group, USA
- **GHG Emissions from Road Transport: A European Perspective**
  Author: Jean-Francois Larive, CONCAWE, Belgium
- **Win-Win: Enhanced Oil Recovery and CO_2 Storage at EnCana's Weyburn Oilfield**
  Author: Gerard Protti, EnCana Corporation, Canada
- **Carbon Dioxide Capture and Geological Storage: Contributing to Climate Change Solutions**
  Author: Tim Stileman, IPIECA, UK and Haroon Kheshgi, ExxonMobil Research and Engineering Company, USA, with Frede Cappelen, Statoil, Norway; Steve Crookshank, API, USA; Alain Heilbrunn, CONCAWE, Belgium; Arthur Lee, Chevron, USA; Tom Mikus, Shell, USA; Wishart Robson, Nexen, Canada; Bill Senior, BP, UK

18th World Petroleum Congress 2005 South Africa

18WPC2005
www.18wpc.com
33

F18 – POSTERS

The Impact of Abandoned Hard-Coal Mines Processes in the Silesian Coal Basin (Poland) on Greenhouse Gas Pollution; Dr. Stanislaw Nagy, Prof. Stanislaw Rychlicki, and Prof. Jakub Siemek, AGH University of Science and Technology, Poland
Contribution of the Algerian Experience in the Reduction of Greenhouse Gas Emissions; Abdelhakim Ainouche, Sonatrach / TRC / RTH / Haoud el Hamra, Algeria; Boubekeur Malek, Sonatrach / HSE / AMT, Algeria
The Canadian Clean Power Coalition: Industry/Government Partnership Program to Produce Power and Hydrogen from Coal and Coke while Capturing, Utilizing and Sequestering CO_2; Dr. Duke du Plessis, Alberta Energy Research Institute, Canada; Robert Stobbs, Canadian Clean Power Coalition, Canada; Paul Clark, and Jim Dinning, TransAlta Utilities, Canada
Technology Options to Reduce Greenhouse Gas Emissions in Latin America and the Caribbean; Miguel Moyano, ARPEL, Uruguay; Vicente Schmall, PETROBRAS, Brazil; Ivar Saetre, Statoil, Norway; Arthur Lee, Chevron, USA; Jaime Martin, Repsol, Spain; Javier Bocanegra, PEMEX, Mexico; Leon Velasco, PDVSA, Venezuela
CO_2 Capture Project - Results Phase 1 and Update; Lars Ingolf Eide, Hydro Oil & Energy, Norway
Best Practices for Greenhouse Gas Reduction in Exploration and Production Activities; Robert Sherman, Halliburton, USA
Gas to Liquids Life Cycle Assessment Synthesis Report; Fred Goede, Sasol Limited, South Africa
Petrobras Technological Development for Climate Change Mitigation; Ricardo Castello Branco, Petrobras Research Center - CENPES, Brazil

F19 Sustainability Reporting Initiatives — Tues, 28th Sep 16:00 – 18:00

Chair: **Chris Morris,** Secretary General, IPIECA, UK
Vice Chairs: **Antonio Gomis,** Corporate Director, External, Repsol YPF, Spain
Prof. Manuel Marrero Cuba, Senior Petroleum Advisor, Ministry of Basic Industries, Cuba

F19 – PAPERS

- **International Standards and the Triple Bottom Line: The Contribution of ISO**
  Authors: Alan Bryden, International Organization for Standardization (ISO), Switzerland
- **BP's Approach to Sustainability Reporting - Defining Our Path**
  Author: Bill Boyle, BP International, UK
- **Corporate Sustainability Reporting - Effective Disclosure for the Future**
  Authors: David Shirley, KPMG, UK; Prof. George Molenkamp, KPMG, Netherlands
- **Developing a New Generation of Globally Responsible Leaders**
  Authors: Milton Costa Filho, and Izeusse Dias Braga Jr., Petrobras, Brazil
- **Impact of Sustainability Measures on Halliburton**
  Authors: Pat Cook, and Robert Sherman, Halliburton, Texas, USA
- **Challenges for the Financial Sector - The Limits of Transparency?**
  Author: Richard Burrett, ABN AMRO, UK

F19 – POSTERS

Past & Future Frameworks for Sustainability Regimes; Prof. Michael Dorsey, Dartmouth College, USA
Sustainable Development and the Regulation / Deregulation of the Nigerian Petroleum Sector: Issues and Challenges; Akongbowa Amadasun, Igbinedion University, Nigeria
New Set of International Standards for the Oil and Gas Sector, Delivered by ISO/TC 67; Alain Samne, ISO, International Organization for Standardization, Switzerland; Neil Reeve, Shell Global Solutions Int'l BV, Netherlands
The European Network "TRENDS": QHSE and CSR issues - Identified Challenges and Responses Initiated; Ole Andreas Flagstad, DNV, Norway
Implementing Sustainability - A Contractor's Perspective; Dr. Kent Saugier, KBR, USA
Offsetting Corporate Impact on Biodiversity; Dr. Art Blundell, Dr Raymond Gullison, and Jared Hardner, Biodiversity Offset Initiative, USA; Dr Tormod Burkey, DNV, Norway

F20 The Role of Business in Zones of Conflict through Stakeholder Involvement — Wed, 28th Sep 13:45 – 15:45

Chair: **Mrs. Denise O'Brien,** Director, United Nations Compact
Vice Chairs: **Richard Lanaud,** Chairman of the Ethic Committee, Total, France
Gerard J. Protti, Exec. VP, Corporate Relations EnCana Corporation, Canada

F20 – PAPERS

- **Reducing the Conflict of E&P Operations in the Amazonian Basin through Indigenous Peoples Involvement**
  Authors: Miguel Moyano, ARPEL, Uruguay; Relations with Indigenous Peoples Working Group - ARPEL
- **Practical Options for Getting the Above-Ground Issues Right - Lessons Learned from Working in Zones of Conflict**
  Authors: Luc Zandvliet, and Ms. Mary B. Anderson, Collaborative for Development Action, USA
- **Niger Delta Coastal Development Initiative**
  Author: Bill Knight, Director, Pro-Natura, Nigeria
- **The Case for Transparency: How the Extractive Industries Transparency Initiative (EITI) Can Help Reduce Conflict**
  Author: Ben Mellor, Department for International Development, UK
- **Building Trust in Zones of Conflict: Where Principles and Practice Meet to Create Success**
  Authors: James Shaw, Nexen Inc., Canada; Prof. Errol Mendez, University of Ottawa, Canada

18th World Petroleum Congress 2005 South Africa

圖3-11 第18 屆世界石油大會論文 宣讀研討會 之天然氣及資源管理論文研討內容 (3)

Africa session

Forums

F21 Exploration and Production — **Wed, 28th Sep 16:00 – 18:00**

Chair: **Boumediene Belkacem,** Vice President E&P, Sonatrach, Algeria
Vice Chairs: **Dr. Tarek Hassan-Beck,** Director, NOC, Libya
Amadeu de Azevedo, Director, Sonangol, Angola

F21 – PAPERS

- **Angola: Reservoir Types and Distribution in Atlantic Coastal and Offshore Basins**
  Author: Dr. Murthy Inkollu, and Eng. Mateus de Brito, Sonangol, Angola
- **The Barremian to Aptian Gas Fairway - Bredasdorp Basin, South Africa**
  Authors: N. Grobbler, A. Jawoodien, and J. Malan. PetroSA, South Africa
- **Relations between Stratigraphic Traps and Development of Flooding Surfaces in the Lower Paleozoïc - South Eastern Saharan Platform - Illizi Basin (Algeria)**
  Authors: Dr. Hamid Ait Salem, Sonatrach CRD, Algeria; Zellouf Khemissi, University of Boumerdes, Algeria
- **Sequence Stratigraphy of X Field in the Coastal Swamp Depobelt of the Niger Delta, Nigeria**
  Author: Ademolu O. Richard Balogun, University of Edinburgh, UK
- **The Potential and Prospect of Hydrocarbon Resources in Tanzania;**
  Author: Halfani R. Halfani, Director, Tanzania Petroleum Development Corp., Tanzania

F21 – POSTERS

The Bredasdorp Basin, Offshore South Africa - Three Decades Later; Jean Malan, PetroSA, South Africa
Pre-Salt Petroleum Reservoirs and Trapping Styles in the Southern Gabon Sub-Basin; Ms Answa de Lange, and Robert Noble, PetroSA, South Africa
The Tombua-Landana Development: from Discovery to Development in Angola Block 14; James Swartz, and Nelson Pacavira, Chevron, Angola; John Baillie, Chevron, USA
Palaeogeothermal Study for Basin Dynamic Characterization: Case Study Idjeran M'zab and Amguid El-Biod Ridge (Central Sahara, Algeria); Dr. Kerdjidj Mohammed-Kamel, Sonatrach - IAP CU, Algeria
Reserves Evaluation: Approach and Method; Rabih Lounissi, and Ibrahim Maarouf, Sonatrach, Algeria
Northern Algeria - A General Overview of Hydrocarbon Prospectivity; Mohamed Messaoudi, Sonatrach, Algeria
Nemba Field: A Successful Minimum Flare Phased Development; Manuel Miguel, and Michael Pillow, Chevron Overseas Petroleum Inc, Angola
Clays as Tracer of Climatic Cycles in the Triassic Fluviatile Series of the Central Sahara (Algeria); Dr. Mohamed-Kamel Kerdjidj, Sonatrach / Institut Algerien Du Petrole / Corporate University, Algeria; Eng. Mohamed Sahli, Halliburton HESP, Algeria; Eng. Madani Messaoud, Sonatrach / Production, Algeria

F22 Infrastructure & Refining — **Wed, 28th Sep 16:00 – 18:00**

Chair: **Dr. Chawki Rahal,** CEO, Sonatrach International, Algeria
Vice Chairs: **David Guembhyt,** Ministerial Advisor to the Minister in Charge of Oil Exploration and Production, Gabon
Emmanuel Adokpaye, President NAPE, Chevron, Nigeria

F22 – PAPERS

- **The Challenges of Building a New Refinery in Nigeria with Limited Energy Infrastructure & Regulated Petroleum Products Market**
  Author: Eng. Ubani Nkaginieme, Totalsupport Energy Group, Nigeria
- **Managing Constructive Down-Stream Competition**
  Author: Stephen Floyd, Consultant, South Africa
- **Angola - A Rapidly Changing Operating Environment for the Oil & Gas Industry**
  Author: Paul De Sousa, KPMG, Angola
- **The Public Distribution of Petroleum Products - A Strategic Issue: Algeria's Example**
  Author: Said Akretche, Algerian Ministry of Mines & Energy, Algeria
- **Country Ranking for GTL Projects**
  Author: Reza Kootbodien, PetroSA, South Africa

F22 – POSTERS

Evaluation of Global Subsea Technology Trends and Applicability to Africa; James Tait, FMC Kongsberg Subsea, UK
The Sudan Model of CNPC Business in Africa; Lihua Cao, China National Petroleum Company, China
The Future of Asset Management; Ralph Hedding, Strategic Asset Management Inc., USA
Africa and the Global Energy Scene - A Legal, Economic & Political Analysis; Dr. Adewale Dosunmu, University of Port Harcourt, Nigeria
Using Competency Based Training Systems to Meet the Manpower Challenges Facing African Exploration and Production Projects in the 21st Century; Robert Taylor, Bradford Donohue, Ken Ogle, and Timothy Donohue, IHRDC, USA
The Global Energy Crises and Debt Sustainability in Highly Indebted Sub-Sahara African Countries; Moses Kpughur Tule, Central Bank of Nigeria, Nigeria

圖3-12 第18 屆世界石油大會論文 宣讀研討會 之3-12非洲專題研討論文內容 (1)

F23 World Resources and Reserves – The Role of Africa — Wed, 28th Sep 16:00 – 18:00

Chair: **Dr. Mahmoud El-Batanoney,** Director, EPRI, Egypt
Vice Chairs: **Ms. Joyce Singano,** Head of Biostratigraphy, TPDC, Tanzania
Syanga Abilio, Vice President, Sonangol, Angola

F23 – PAPERS

- **Oil Price Volatility: A Curse or Blessing to the African Economy?**
  Author: Ganiyu Kayode Sanni, Central Bank of Nigeria, Abuja, Nigeria
- **The Role of Petroleum Exploration in Shaping Africa's Energy Future**
  Author: Dr. Philip Stark, IHS Energy, USA
- **Shaping the Energy Future - The African Perspective**
  Author: Eng. Ismaila Haliru Zarma, Energy Commission of Nigeria, Nigeria
- **The Role of Africa in World Resources and Reserves**
  Author: Prof. Segun Ogunbemi, Fivateck, Nigeria

F23 – POSTERS

Deep Water Drilling - Untested Resources of Offshore South Africa; Jacques Roux, Petroleum Agency SA, South Africa
UN Convention on the Law of the Sea, Article 76: An Opportunity to Extend South Africa's Rights to Hydrocarbons and Other Potential Resources Seaward of the Exclusive Economic Zone; Ian McLachlan, and Ms Jennifer Marot, Petroleum Agency SA, South Africa
Africa - New Plays, Old Plays and the Impact of Deep Water; Dr. Mark Cowgill, and Simon Otto, Fugro Robertson, UK; Dr Andrew Latham, Wood Mackenzie, UK
Challenges Facing the Valorisation of the West Mediterranean Offshore Hydrocarbons; Mohamed Messaoudi, Sonatrach, Algeria; Kamel Eddine Chikhi, Sonatrach, Algeria
Harnessing Africa's Crude Oil Reserves and Meeting Rising Global Demand: Emerging Trends and Future Prospects; Prof. Peter Imoudu, Federal University of Technology, Nigeria; Samuel Igbatayo, Igbinedion University, Nigeria
The Takula Field: A History of Angola's First Giant Oil Field; Dr. Gregory King, and Timothy Tokar, Cabinda Gulf Oil Company, Angola; Larry Littlefield, Consultant, USA; Stephen Newton, Chevron International Exploration and Production Co., USA; Ms. Filomena Oliveira, Sonangol, Angola
Challenges of Exploration and Production in Africa; Jean Privey, President EP Afric, Total, France
Transparent Tender Systems in the African Oil and Gas Sector: Benefits and Challenges; Andrew B. Derman, Thompson & Knight, USA; Hassan Yassine, Thompson & Knight, Algeria
Prospectivity of the Northern Orange Basin, Offshore South Africa; David van der Spuy, Petroleum Agency SA, South Africa

F24 Corporate Governance — Wed, 28th Sep 16:00 – 18:00

Chair: **Hammouda El-Aswad,** OPEC Governor, NOC, Libya
Vice Chairs: **Ms. Linda Zama,** CEO, Sanoco, South Africa
Anthony Chukwueke, Director, Department of Petroleum, Nigeria

F24 – PAPERS

- **Environmental and Host Community Issues in African Oil Exploration: The Niger Delta Region of Nigeria**
  Author: Moses Kpughur Tule, Central Bank of Nigeria, Nigeria
- **Frontier Markets: Local Workforce as a Strategic Asset**
  Author: Ms. Claire Markwardt, Accenture, USA
- **Trans-Saharan Gas Pipeline Project (TSGP) - Road Map for Success**
  Author: Mohamed Yousfi, Sonatrach, Algeria
- **International Soft Law and Corporate Governance**
  Author: Stéphane Brabant, Herbert Smith, France
- **Business Reporting and Communications: A Key Corporate Governance Tool in the Global Petroleum Industry**
  Author: Michael Bray, KPMG, Australia

F24 – POSTERS

VSAT Technology for the Oil & Gas Industry; Wayne McDonald, Gilat Satellite Networks Ltd., South Africa
Use of Risk Management, Compliance and Governance by Global Resource Companies to Achieve Risk and Lower Costs in Doing Business; Dr. Avi Eyal, Cura Risk Management Software, South Africa
Impact of Technical and Market Uncertainty on Mean Expected NPV of a Marginal Field, Offshore Angola; Herve Henrion, Schlumberger, France; Paulo Gouveia Jr, Sonangol, Angola; Robert Bellavance, and Thomas Graf, Schlumberger, Angola
Minimise Reputational Risk; Deon Binneman, Repucomm, South Africa
AfricaArray: Specific Research and Training Programmes; Ms. Susan Webb, School of Geosciences, South Africa; Prof. Andy Nyblade, Pennsylvania State University, USA; Dr. Michael Jones, and Prof. Paul Dirks, University of the Witwatersrand, South Africa
Site Optimisation of PetroSA's Gas-to-Liquids Complex; Carel Steyn, Johan Lourens, and Theuns du Toit, PetroSA, South Africa
Partnership Model: the Panacea to Sustainable Development in the Niger Delta Region of Nigeria; Godswill Okiyi, Bowen University, Nigeria
Corporate Governance and Responsibility through Partnerships; Dennis Flemming, Cabinda Gulf Oil Company (Chevron), Angola

圖3-13 第18 屆世界石油大會論文 宣讀研討會 之3-12非洲專題研討論文內容 (2)

Round tables (RT)

RT1 Block 1 – Upstream — **Mon, 26th Sep 13:45 – 15:45**

Advances in Upstream Technology – View from the Top

Presidents of major scientific and technical organizations, such as SPE, SEG and AAPG will discuss their organizations' view of the ever increasing technological advances in the upstream industry, and present their visions of the future.

Moderator: **Prof. Khalid Aziz,** Professor of Petroleum Engineering & Otto N. Miller Professor of Earth Sciences, Stanford University, USA

Panel Members: **Eve Sprunt,** 2006 SPE President
Craig Beasley, President, SEG
Peter R. Rose, President Elect, AAPG
Gareth Williams, President-to-be, EAGE

RT2 Block 1 – Upstream — **Tues, 27th Sep 11:00 – 12:00**

Marginal and Small Field Development

In many petroliferous basins of the world, marginal and small fields were deemed uneconomical and were not developed. Recent technological breakthroughs, economic incentives and the desire to develop an indigenous petroleum industry have resulted in renewed interest in developing these dormant resources.

Moderator: **Dr. Renato Bertani,** President, Petrobras America Inc., USA

Panel Members: **Charles Ekwedike,** Country Manager – Nigeria, Halliburton Digital & Consulting Solutions
Prof. Anatoly B. Zolotukhin, Technical Director, Statoil ASA / Stavanger University, Norway
Charles C. Rubins, Reservoir Manager Western Venezuela, Chevron Global Technology Services
Kleber Galvao de Oliveira Padua, Production Asset Manager, RN-CE Business Unit, Petrobras, Brazil
Prof. Zhao Wenzhi, Deputy President, RIPED, China

RT3 Block 2 – Downstream & Petrochemicals — **Tues, 27th Sep 11:00 – 12:00**

Has Optimisation of Refining Operations Reached Maturity?

Optimisation in refining operations has developed over the past three decades from the very basic electronic data handling and processing, to sophisticated modelling of the main refining processes. Is the end of the road in sight, with limitations presented by data processing and modelling capacity? Or are new breakthroughs underway in further refined modelling and data processing, as well as in linking the individual processes into larger interrelated systems that cover the whole refinery or expand even further into combined refinery and supply systems? This round table offers the opportunity for a discussion between experts from such different and often separated disciplines as refining and supply, and technology and economics.

Moderator: **Jean-Jacques Mosconi,** Senior VP Strategy and Development, Total Refining, France

Panel Members: **Philippe Bonnelle,** Head of Optimization Models, Total Research Center, France
Jean Sentenac, Axens / IFP, France
Mark Gainsborough, Vice President, Supply Strategy, Shell International, UK
Dr. Abdelhafidh Feghouli, Senior Vice President Downstream, Sonatrach, Algeria
A senior representative from ExxonMobil (name to be confirmed)

RT4 Block 2 – Downstream & Petrochemicals — **Tues, 27th Sep 13:45 – 15:45**

The Ultimate Fuel Quality: Car Manufacturers' and Refiners' Views

Today's fuel specifications have reached a level that gives rise to the question: Have the car manufacturers reached the ultimate parameters of combustion engines using the latest spec mogas and diesel fuels? This round table discussion aims at specifying the future requirements from the viewpoints of both petroleum refiners and car manufacturers. While the topic is being widely discussed at various occasions worldwide, this roundtable offers the unique opportunity to bring representatives from the car building industry, refiners and a large audience of experts together to discuss all issues related to the future fuel quality.

Moderator: **Dr. Peter Seifried,** Portfolio Project General Manager, Shell International Petroleum Company, UK

Panel Members: **Dr. Johan Botha,** General Manager Technology, Sasol, South Africa
Sandrine Dixson-Decléve, Director Europe & Africa, International Fuel Quality Center, Belgium
Dr. Hartmut Heinrich, Head of Fuels & Lubricants, Volkswagen AG, Germany
Jean-Jacques Mosconi, Senior VP Strategy and Development, Total Refining, France
Prof. Masayuki Sasanouchi, Project General Manager, Environmental Affairs Division, Toyota Motor Corporation, Japan
Mark Gainsborough, Vice President, Supply Strategy, Shell International, UK

圖3-14 大會 除了論文發表外，尚依其所屬區域及各種不同探勘技術領域，特別舉辦了十八項圓桌會議研討會**(1)**。

RT5 Block 3 – Natural Gas & Renewables — Tues, 27th Sep 11:00 – 12:00

Hydrogen: From Research to Reality

In response to continued concern over climate change, a move toward a hydrogen-based economy is being increasingly discussed. But hydrogen needs to be produced and is more an energy vector than a raw accessible product. The Round Table, grouping advocate and opponents will debate to set the limit between dream and reality of this important question.

Moderator: **Dr. Jeremy Bentham,** CEO Shell Hydrogen BV, Netherlands

Panel Members: **Ivar Hexeberg,** Vice President, Head of Hydrogen, Norsk Hydro, Norway
Christopher Flavin, President, Worldwatch Institute, USA
Claude Mandil, Executive Director, International Energy Agency, France
Plus other senior panel members to be confirmed

RT6 Block 3 – Natural Gas & Renewables — Wed, 28th Sep 13:45 – 15:45

2006 World Gas Congress Preview: Key Success Factors for a Developing Gas Market - West African Gas Pipe Line: A Case for Gas

Under IGU leadership, invited guests will discuss the main changes and challenges the natural gas business is facing in developing gas markets. This subject will also be dealt with extensively during the next World Gas Conference in Amsterdam in 2006. The topic will be illustrated by a discussion of the determining factors of the West African Gas Pipeline project.

Chair: **George Verberg,** President, IGU

Moderator: **Dick de Jong,** Project Advisor, Gas to Power, IGU

Panel Members: **Camillo Gloria,** Executive Director GALP Energia, Portugal
Mourad Belguedj, Lead Energy Specialist Oil & Gas Policy Division, World Bank, USA
Dennis Fahy, Managing Director, West African Pipeline Company (WAPCO), Ghana
Cathy Laing, Corporate Specialist (Energy), Eskom, South Africa
Tony Hanna, Vice President Africa, Shell Gas & Power International BV, Netherlands
Daniel Simmons, Natural Gas Expert, IEA, France

RT7 Block 4 – Managing The Industry — Tues, 27th Sep 11:00 – 12:00

HIV/AIDS

The HIV/AIDS pandemic is creating unprecedented challenges for the international petroleum industry. Companies are faced with the reality of creating awareness within the workplace, and implementing policies and care programmes. In addition, the petroleum industry contributes towards the transmission of the disease through its transportation infrastructure. This roundtable will explore the views of governments, NGO's international institutions and business in seeking effective mechanisms to combat HIV/AIDS.

Moderator: **Dr. Bernard Huisman,** Chief Health Advisor, Shell, Netherlands

Panel Members: **Jay Pryor,** Co Chair, Nigerian Business Coalition against Aids (NIBUCAA) & CE, Chevron, Nigeria
Dr. Peter S. Nmadu, Group General Manager-Medical, NNPC, Nigeria
Catherine Ferrant, Vice-President Diversity and Accountability, Total, France
Solomon Molekwa, BP Coordinator of Employee Wellness in Southern Africa

RT8 Block 4 – Managing The Industry — Thurs, 29th Sep 13:45 – 15:45

Flaring

Regulators worldwide are moving towards eliminating flaring and increasing vent gas recovery. Companies are recognising the increased efficiencies and profitability with these actions. However, there remain considerable challenges in terms of regulations, markets and infrastructure. The roles of business, governments and civil society will be addressed in this roundtable.

Moderator: **Neil McCrank QC,** Chairman, Alberta Energy and Utilities Board, Canada

Panel Members: **Bent R. Svensson,** Program Manager, Oil, Gas, Mining and Chemicals Department, World Bank Group
Basil Omiyi, Managing Director, Shell Petroleum Development Company, Nigeria
Abiodun Ibikunle, Assistant Director, Office of the Presidential Adviser on Petroleum & Energy, Nigeria
Du Weidong, Director, Environmental Monitoring Centre, China National Petroleum Corporation, China
Gunnar Berge, Director General, Norwegian Petroleum Directorate, Norway

RT9 Global Impact of International E&P Standards (ISO/OGP Initiative) — Mon, 26th Sep 13:45 – 15:45

ISO and OGP put together a Round Table to look at "international standardization in support of the petroleum industry and the contribution to sustainable development". The panel of decision makers will discuss a number of key issues: quality management, environmental management, emission rights, reporting, social responsibility, standardization in developing countries and the role of oil companiesIt will also address the most effective ways to develop international standards, particularly technical standards, not only in our industry but in the downstream sector (compared to motor vehicles/industry).

Moderator: **Charles Bowen,** Director, OGP, UK

Panel Members: **Alan Bryden,** Director General, ISO, Switzerland
Jeroen van der Veer, President and CEO, Royal Dutch Shell, Netherlands
Jose Sergio Gabrielli de Azevedo, President, Petrobras, Brazil
Rejane Burton, Director, MMS (Mineral Management Service), USA
Dr. Fabiya Amakiri, Managing Director, NNPC, Nigeria
Mu Shuling, Vice President, Sinopec and Vice Chair, CPSC, China

圖3-15 大會 除了論文發表外，尚依其所屬區域及各種不同探勘技術領域，特別舉辦了十八項圓桌會議研討會**(2)**。

Round tables (RT) (cont.)

RT10 Revenue Transparency Initiatives — **Mon, 26th Sep 16:00 – 18:00**

International energy companies have a responsibility to ensure that investment in all countries (developed and developing) does not contribute to corruption. Revenue transparency can help protect and improve the bottom line and also enhance reputation and the working business environment. This session will highlight some of the best practises around the world and hear from some of the worlds leading players. With over $40billion invested in west and central Africa alone in this decade this is indeed an important topic and one where the petroleum industry is leading the way.

Moderator: **John Martin,** Managing Director, ABN Amro, UK

Panel Members:
The Hon. Greg Melchin, Minister of Energy for Alberta, Canada
Dr Chakib Khelil, Minister of Energy & Mines, Algeria
Karin Lissakers, Head of the Soros Open Society Institute, USA
Stuart Brooks, Head of International Relations, Chevron, USA
Michael Levitsky, Senior Economist, Oil, Gas, Mining & Chemicals, World Bank Group

RT11 Climate Change Initiatives – Dealing with Public Perception — **Mon, 26th Sep 16:00 – 18:00**

There are already many technologies available and demonstrated that can make use of the existing fossil fuel infrastructure whilst emitting virtually zero greenhouse gases and that at a cost much lower than many conventional alternatives. One such example is carbon sequestration. So far very little attention has been paid to the public perception of carbon sequestration and the basic business models for its implementation compared to other methods of reducing carbon emissions. In the media the public sees ice caps melting. This Round Table hopes to widen the debate, demonstrate real case studies and move from just the technical arena to the real issues and people's concerns.

Moderator: **Harry Audus,** Director, IEA Greenhouse Gas R&D Programme

Panel Members:
Gardiner Hill, Head, Carbon Capture Project (CCP), BP
Dr. Stephen Lennon, WEC Representative, and Eskom, South Africa
Rob Cormie, Director, Corporate Finance, Energy & Natural Resources, KPMG UK

RT12 African Energy Co-operation — **Tues, 27th Sep 16:00 – 18:00**

The session aims at examining the existing and potential relationships between Africa's energy suppliers and consumers and looking at greater self-sufficiency and local market development on the continent through closer co-operation between the various stakeholders.

Moderator: **Lamon Rutten,** Chief, Finance and Energy, UNCTAD (invited)

Panel Members:
Reatile Mochebelele, Adviser, Infrastructure, NEPAD Secretariat
Dave Lafiaji, Executive Secretary, African Petroleum Producers Association (APPA)
Hammouda El-Aswad, OPEC Governor for Libya
Mohammed S. Barkindo, National Representative for Nigeria to OPEC
Dr Hussein Elhag, Director, AFREC
Mustapha Haimifi, Director, Ministry of Energy & Mines, Algeria
Atanasio-Ela Ntugu, Minister of Mines, Industry & Energy, Equatorial Guinea (awaiting final conf.)

RT13 Recruiting and Retaining Young People in the Industry — **Wed, 28th Sep 13:45 – 15:45**

Following the oil price spike in 1982 and the oil price collapse in 1986, the oil industry went into a protracted period of downsizing with very little hiring. Thus, the average age in the industry is over 45. To attract young people to the industry, companies must overcome major image issues including public perceptions that it is a sunset industry and that use of petroleum is detrimental to the environment. The industry must also gear up to provide training to the new recruits and capture and transfer the technical knowledge of the older workers, who will be retiring soon.

Moderator: **Eve Sprunt,** 2006 SPE President

Panel Members:
Peter Newman, Global Managing Partner, Oil and Gas, Deloitte, UK
Tony Meggs, Group Vice President for Technology, BP, UK
Alh. Ibrahim Waziri, Group Executive Director, Corporate Services, NNPC, Nigeria
Zhu Weilin, President, Zhanjiang Company, China National Offshore Oil Corporation Ltd., China
Dr. Salah Khebri, Managing Director, Algerian Institute of Petroleum (IAP), Algeria
Carlos Sao Vicente, Risk Management Manager, Sonangol, Angola

圖3-16 大會 除了論文發表外，尚依其所屬區域及各種不同探勘技術領域，特別舉辦了十八項圓桌會議研討會**(3)**。

RT14 Distribution & Transportation of Gas – LNG or Pipeline? — **Wed, 28th Sep 13:45 – 15:45**

Globally, gas reserves are geopolitically more diversified than oil, with around half of them in OPEC countries. One of the interesting dilemmas is whether to send the gas by pipeline or to transport it by ship. If transported by ship, it has to be decided between on shore or off shore terminals. Not only does cost factor into the equation, but also geopolitics. These decisions are being made now with under the perspective that the international gas trade is expected to triple by 2030. To date, economic, safety, environmental and security concerns coupled with some physical constraints have encouraged the development of offshore LNG terminals. This Round Table will discuss all aspects for the advancement of natural gas transport.

Moderator: **Dr. Chawki Rahal,** Director General, Sonatrach LNG, UK

Panel Members: **Anne Quinn,** Group Vice President, BP Gas, Power & Renewables, UK
Randy Curry, President, Chevron Natural Gas, USA
R.T. Chatterjee, Chairman and Managing Director, EMIL (Consultant to the Indian Government)
Alexander Landia, Global Lead for Gas, Accenture, Germany/Russia
Alexander Dodds, Managing Director, RasGas Company, Qatar

RT15 Role of Service Providers as Partners for the Petroleum Industry — **Wed, 28th Sep 16:00 – 18:00**

This Round Table will be dedicated to the discussion of future trends for the service companies, in particular how they intend to develop the technological solutions that will create value for their oil industry clients, to deal with a more and more demanding involvement on the local content – with their consequence in training, know-how transfer, local infrastructure investment – to cope with stronger social responsibilities and, conversely, the issues they envisage on their contractual relations and fair compensation for all their services.

Moderator: **Paul Ziff,** CEO, Ziff Energy Group, Canada

Panel Members: **Lew Watts,** Senior Vice President, Halliburton Energy Services, USA
Robert Storey, Chairman, European Construction Institute & Vice President, CBI Constructors, UK
Dalton Boutte, President of WesternGeco and Executive Vice President of Schlumberger Limited, UK
Khomotso Phihlela, Acting CEO, National Ports Authority, South Africa
Roger Munnings, Global Chairman, Oil, KPMG, Russia
Ali Ferling, Head of Global Oil and Gas, HP, Austria
Steve Davies, Chairman and Chief Executive Officer, Foster Wheeler Energy Limited, UK

RT16 Associations & Institutions — **Wed, 28th Sep 16:00 – 18:00**

The Round Table for institutes and associations is the place for like minded individuals and organisations from a range of countries and cultures to compare and contrast ideas on a number of topics, in particular education resources. Efforts to establish a forum (for closer co-operation) of Petroleum Institutes and Similar Institutions (PISI) have had a long record under the auspices of the World Petroleum Congress. A first meeting was held in Rio de Janeiro within the framework of the 17th WPC. It was followed up in London during IP week and again in Qatar. This is an opportunity for PISIs to establish bi-lateral contacts and exchange thoughts with associations from across all continents.

Moderator: **Prof. Dr. István Bérczi,** Chief Adviser to CEO, MOL Hungarian Oil and Gas Plc, Hungary

Keynote Address: **New Role for NOCs and New Paradigms for NOCs and IOCs**
Vahan Zanoyan, CEO & Chairman, PFC Energy, USA

Co-referates by: **Dr. Samuel E. Ovuru,** Nigeria; **Ms. Manuela Coelho,** Angola; **Dr Bourima A. Belgasem,** Libya

Comments by: **Valery Rusakov,** Russia; **Milton Costa Filho,** Brazil; **Olivier Appert,** France; **Ahmad A. Al-Saadi,** Saudi Arabia
Louise Kingham, UK; **Ed Murphy,** US

RT17 West Africa Deep Water - The Journey So Far — **Thur, 29th Sep 10:30 – 12:00**

Based on lessons from Abuja 2004 NAPE/AAPG Conference.

Moderator: **Nahum Schneiderman,** Director, International Technical Relations, Chevron

Panel Members: **Alek Musa,** General Manager Production, Total Nigeria
Dr. E. O. Ayoola, Group Executive Director E&P, NNPC, Nigeria
Bayo Akinpelu, Special Adviser for Exploration and Technology, Chevron, Nigeria
Rich Sears, VP, Exploration & Deepwater, Shell International E & P, USA
José Manuel Jesus Sardinha de Sousa, Sonangol, Angola
Ruben Costa, Head of Facilities Engineering, Sonangol, Angola

RT18 Reserves & Resources — **Thurs, 29th Sep 13:45 – 15:45**

Quality information on oil and gas reserves and resources is essential in the international society. This round table will illuminate the needs for accurate information in oil and gas resources management and for comparable information in financial reporting. The related challenges of ensuring consistent and reliable estimation and communication of reserves and resources will form the basis for a discussion of how to protect and promote corporate and national integrity in a way that helps secure future oil and gas supplies.

Moderator: **Sigurd Heiberg,** Chairman, UNECE Ad Hoc group of Experts on the Harmonization of Energy Reserves/Resources Terminology, Statoil, Norway

Panel Members: **H.E. Dr. Adnan Shihab-Eldin,** Acting Secretary-General, OPEC
Robert Garnett, Member, International Accounting Standards Board (IASB), South Africa
Ronald Harrell, Chairman and Chief Executive Officer, Ryder Scott Company, USA/Canada
Michael Lynch-Bell, Partner in Charge, EMEA Global Energy, Chemical and Utilities Transaction Advisory Services, Ernst & Young, UK

圖3-17 大會 除了論文發表外，尚依其所屬區域及各種不同探勘技術領域，特別舉辦了十八項圓桌會議研討會**(4)**。

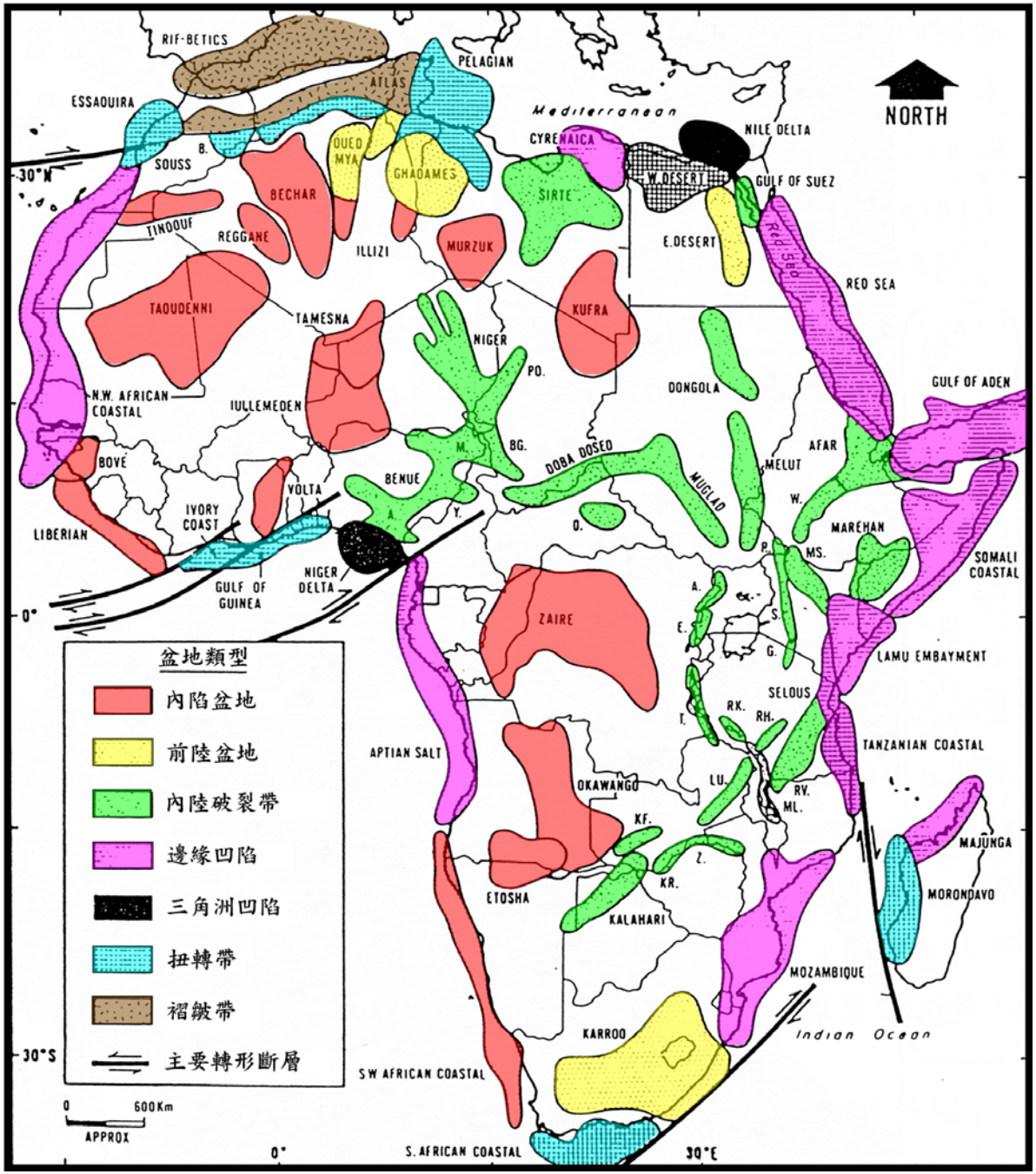


圖3-18 非洲各類型沉積盆地之分佈

(改繪自Clifford，1984)

圖 4-1-1　世界上之巨型深水域油氣田（＞500m）之油田發現及蘊藏量一覽表。此大油田大部分多位於西非及南美，少數在澳洲及北海地區 。

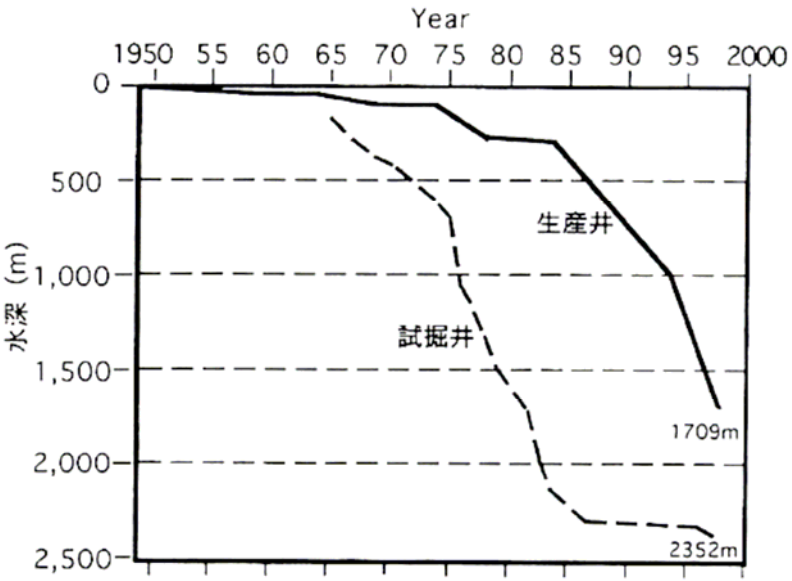
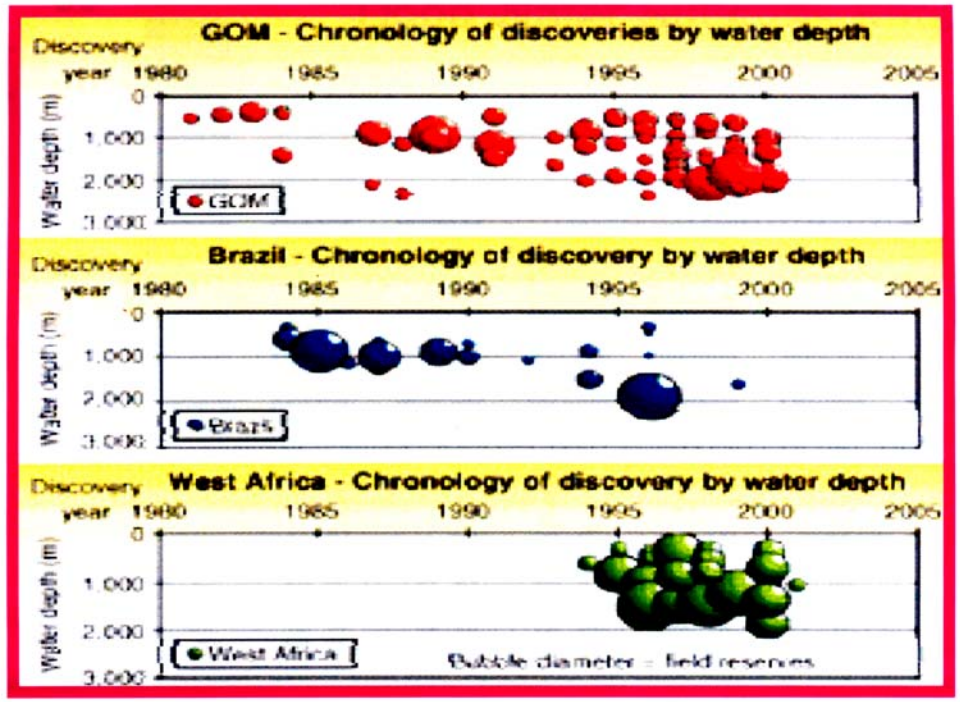


図1　生産井と試掘井の大水深化傾向[1,2)]



各地區探勘活動具有由淺逐次加深之勢，
尤以1985年以後為甚

圖 4-1-2 世界各地之深水礦區，在1975年以前，不論生產井或探勘井深度，大多在500-600m以內，過了此年代，逐次加深，尤以1985年以後，各探勘及生產井之水深急遽加大。

YEAR ON STREAM:	MEAN WATER DEPTH (m):	MAX WATER DEPTH (m):
<1951	13	60
1951-1955	15	45
1956-1960	15	48
1961-1965	20	70
1966-1970	34	114
1971-1975	44	176
1976-1980	51	312
1981-1985	51	423
1986-1990	58	682
1991-1995	74	1,027
1996-2000	126	1,853
2001-2005	188	2,307
2006-2010	260	2,953
>2010	249	2,934

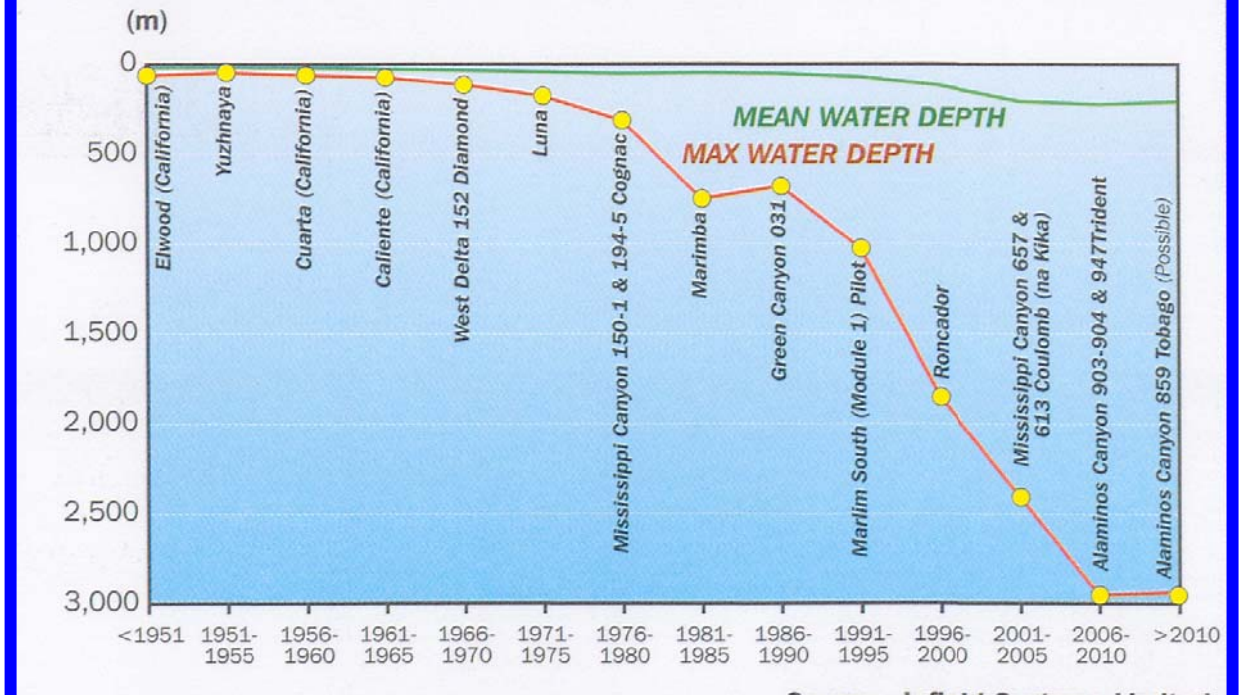
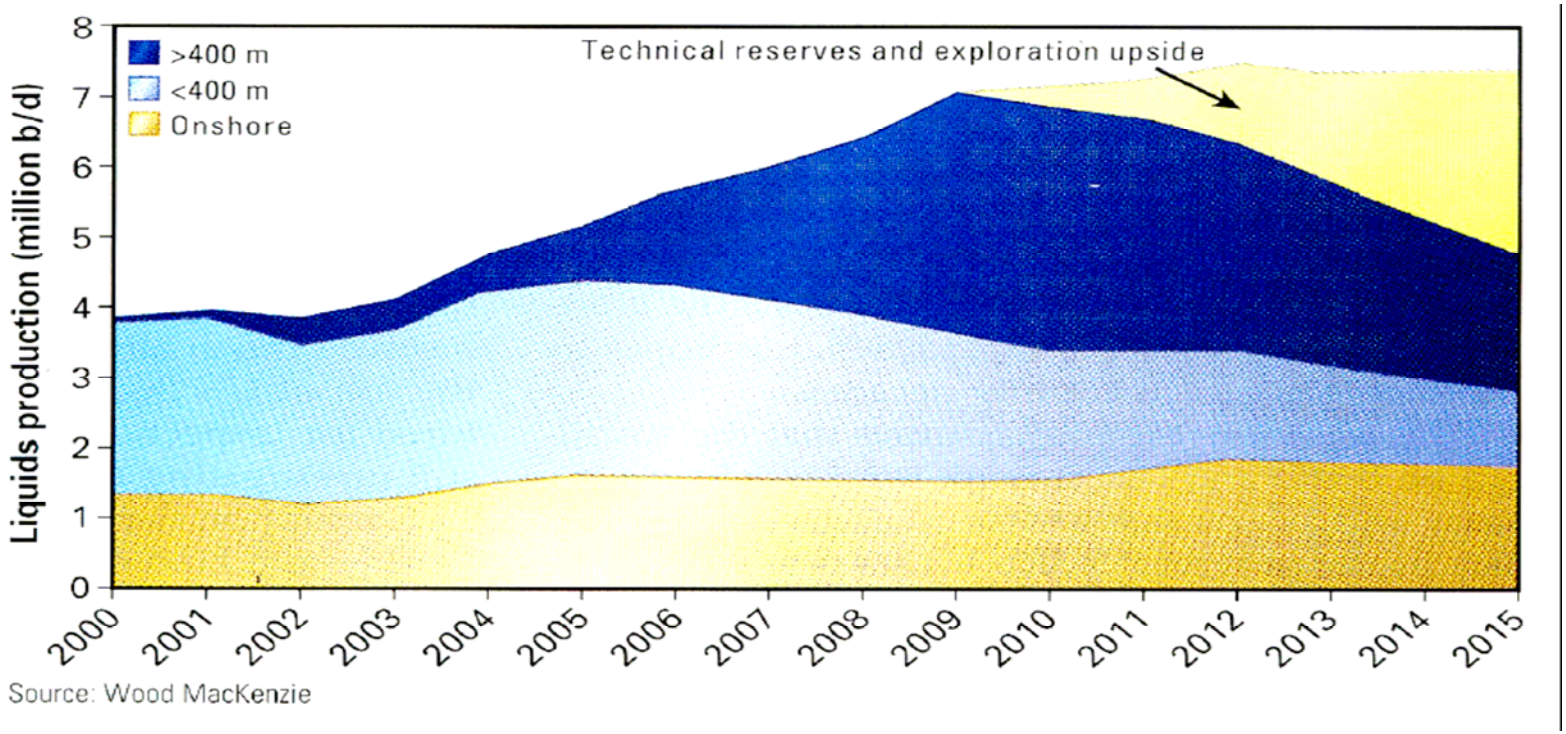


圖 4-1-2-1 世界各地之深水礦區，在**1985**年以後，各探勘及生產井之水 深急遽加大。

圖4-1-3 世界主要之深水及超深水區之盆地，顯示主要集中在大西洋西岸之巴西及西非地區(Pettingill and Weimer，2001)。



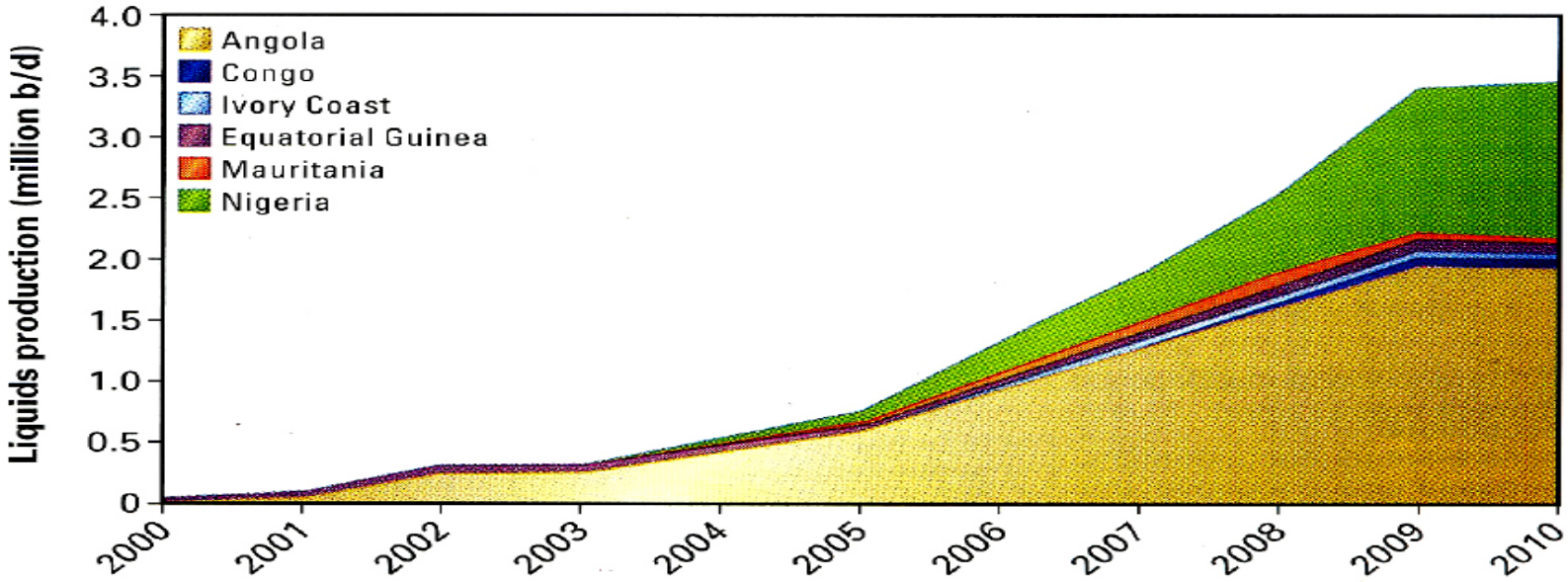
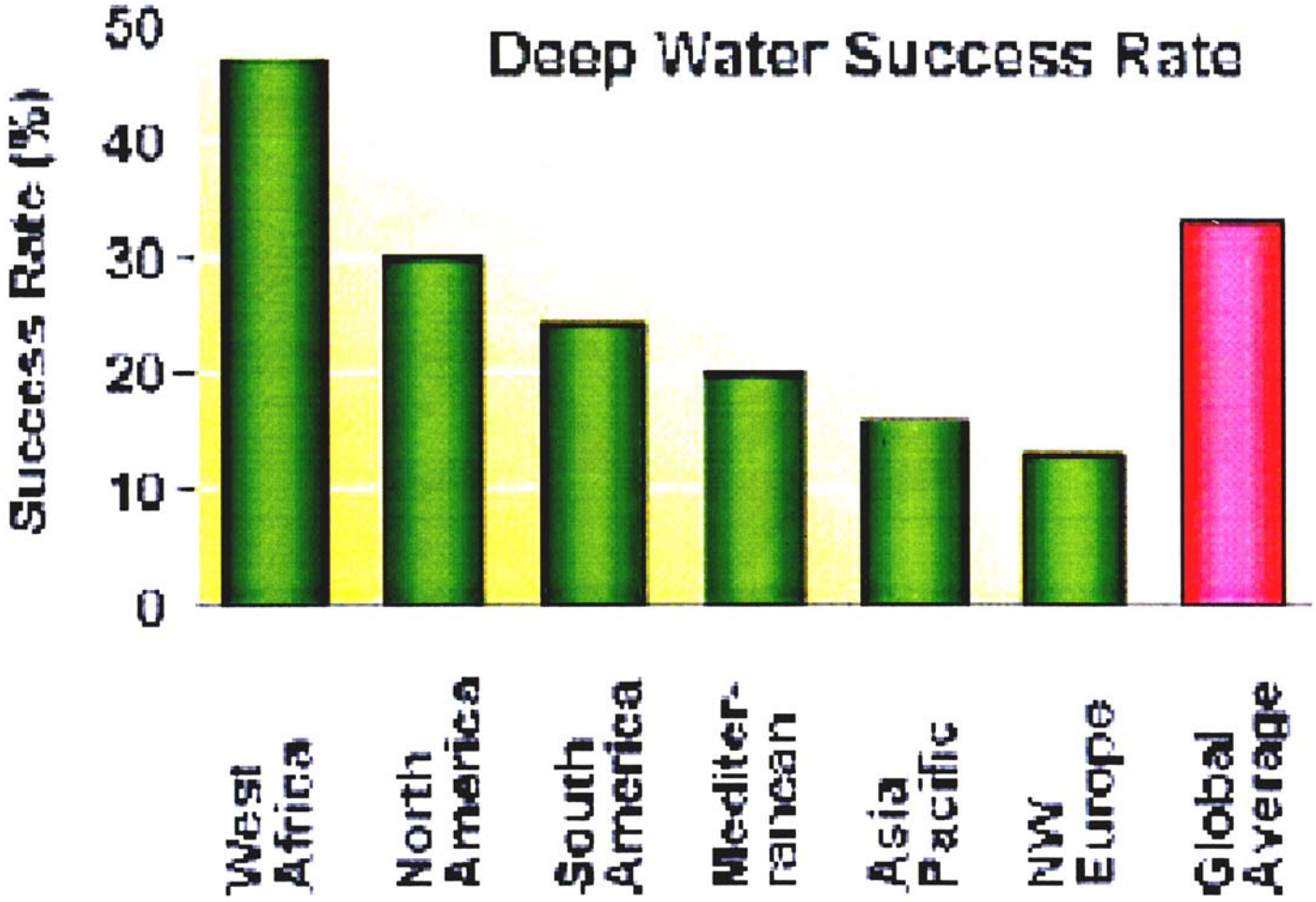
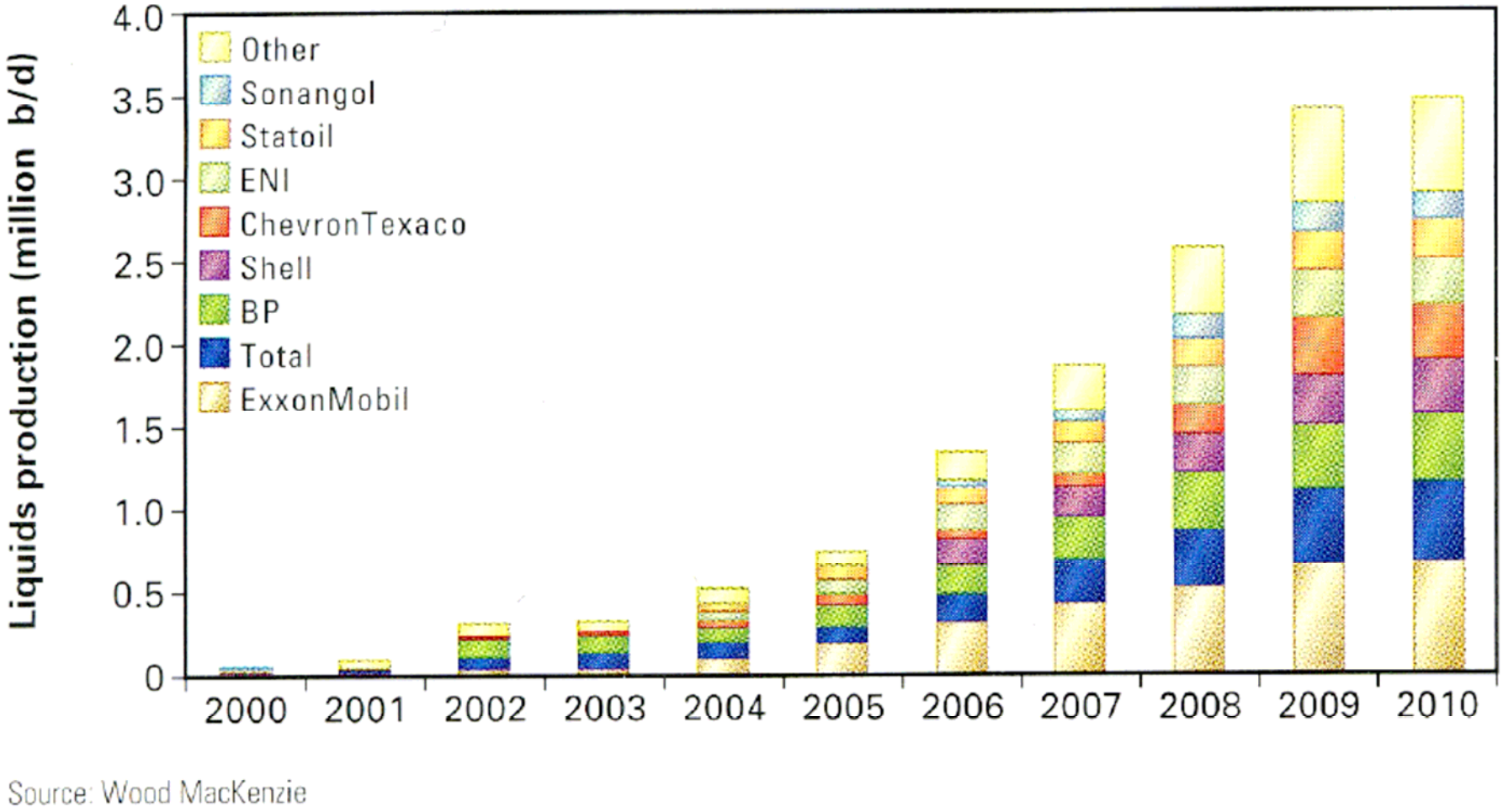


圖4-1-4 全世界原油與天然氣之累積蘊藏量， 與年驟增，尤以**1996**年以後快速增長。



世界各地區深水探勘地區之鑽探成功率

圖4-1-5 各地區深水水域之探勘成功率



Source: Wood MacKenzie

圖4-1-6 全世界原油與天然氣之累積蘊藏量， **1996**年以後快速增長 。

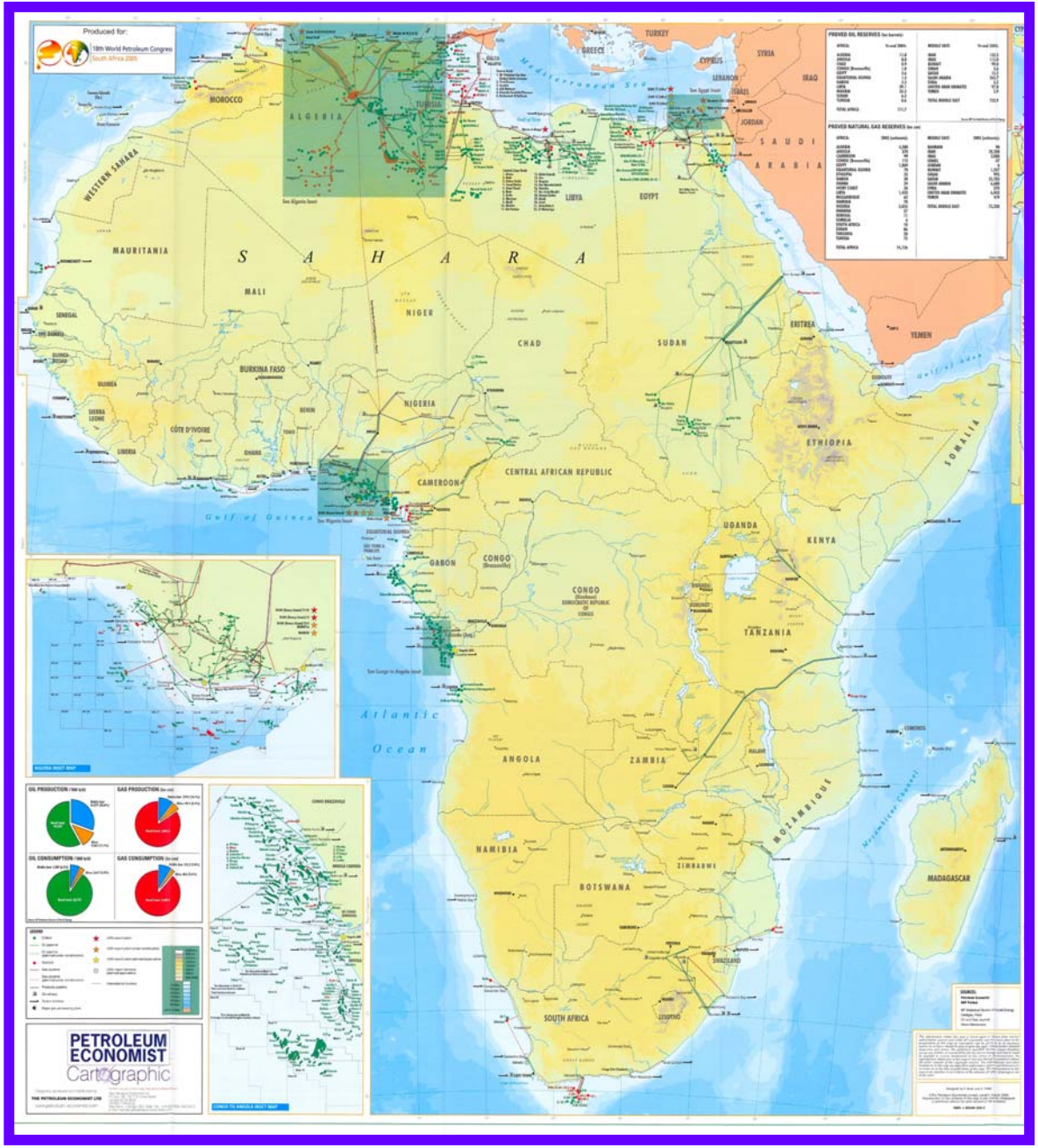


圖4-1-7 西菲之深水探勘(Pertroleum Economics, 2005)

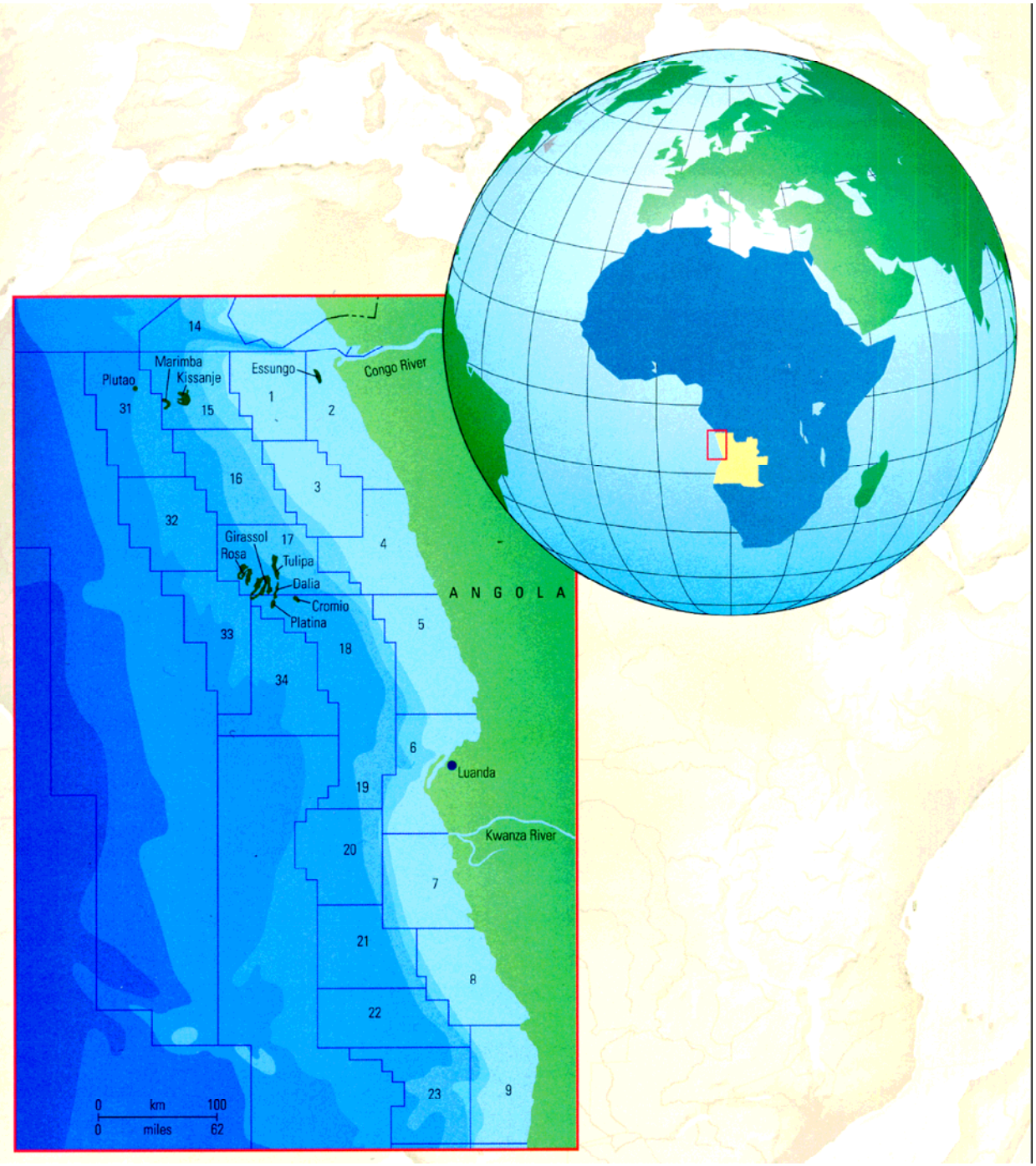
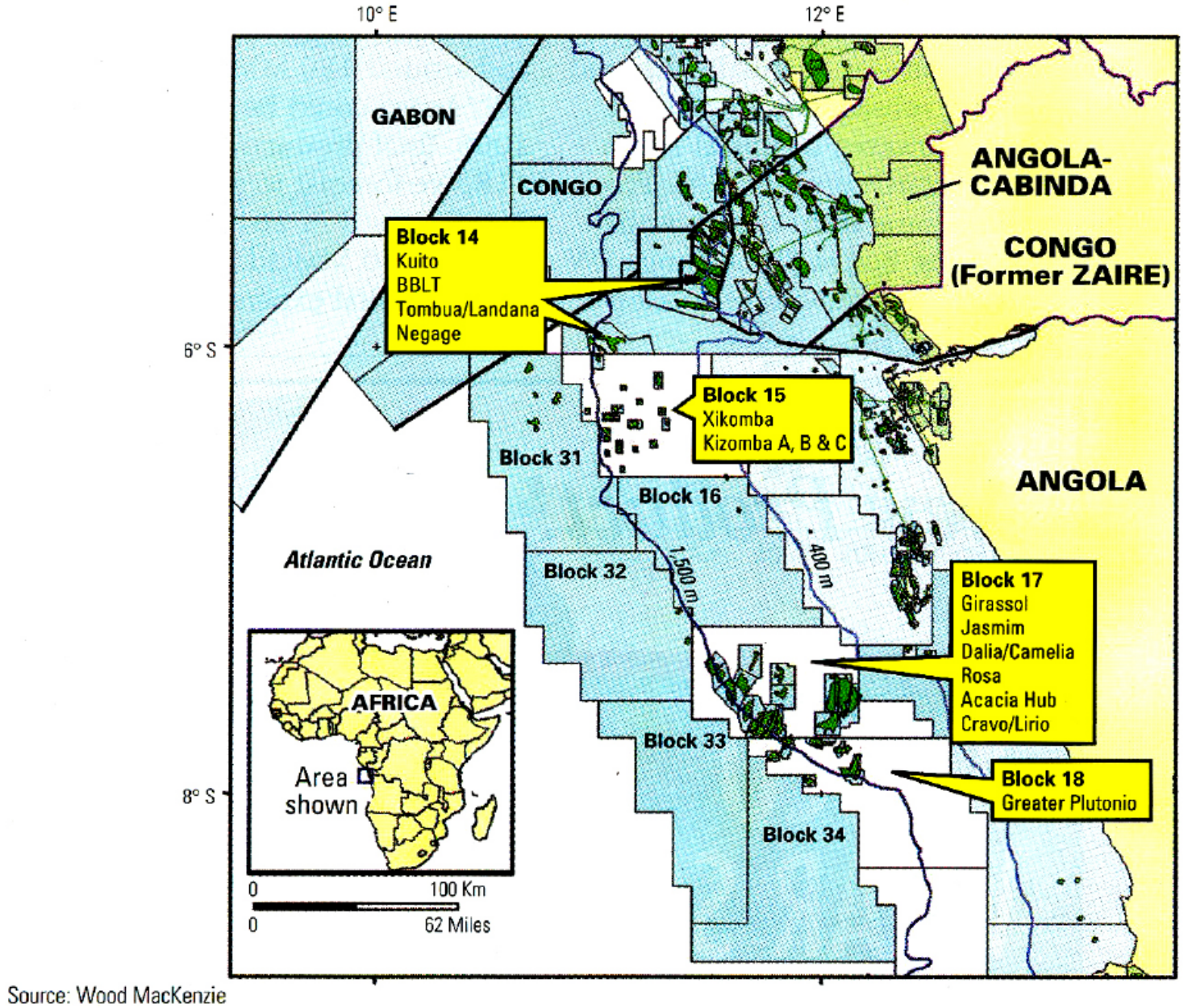


圖4-1-8 西菲之深水探勘，以西菲大西洋之安哥拉及奈及利亞海域最為顯著。
(Pettingill and Weimer(2001)



Source: Wood MacKenzie

圖4-1-9 安哥拉（**Angola**）據有四個主要之深水礦區：
Block 14,15,17及18其油氣蘊藏佔安哥 拉之80%。