AL HAJAR

Geological Society of Oman
Quarterly Newsletter

Third Edition July 2004

President's message

Shaping the Future

It is with great pleasure that I address you in this issue of **AL HAJAR** on behalf of the new GSO executive committee. We would like to warmly welcome all our valuable members, sponsors, and affiliated associations and on their behalf, we extend a sincere thanks to the previous president and his committee for their dedication and hard work in transforming the GSO vision into reality.

The future is bright for GSO, and in addition to affirming our professional position locally and internationally, we aim to promote the Geo-tourism Industry by lending our expertise to the Ministries, consult with various regional and international geo-tourism companies to adequately and sustainably promote geo-tourism in the Sultanate.

Geological Conservation is another important topic close to our hearts. Oman's geology records the history of hundreds of millions of years, and the coastlines, majestic mountains, caves and the numerous wadis provide windows through which we can look to the past. Unfortunately our rich geological heritage if not conserved will eventually be eroded, not only by natural processes but by the naivety of us. In its pro-activeness the GSO will in the coming months launch a campaign entitled "The past is the key to the future" in the hope of promoting awareness of the numerous unrivalled geological sites to the geoscience community and the public as a whole. Your society together with other associations hopes to work with the Ministry of Heritage and Culture to identify important geological sites that are at risk of destruction. The GSO also believes that a stand alone Geological Museum housing several geological samples will serve to promote geological awareness to the youth of the Sultanate, act as an attraction for tourists and safe heaven for irreplaceable geological specimens.

My fellow members and colleagues: the new executive committee would like to invite and request your participation in achieving our aim and adding yet another chapter of the never ending success story of our geological society "THE GEOLOGICAL SOCIETY OF OMAN".

Omar Al Ja'adi

Note from the Editor

AL HAJAR is proud to publish its third publication, and we are well on our way to meeting our goals of four newsletters per year. With a new executive committee in place we will be looking to build your society on the solid foundations already established. The **AL HAJAR** newsletter will continue to be an important vehicle for informing and communicating with the Geo community.

We are very keen to encourage and promote Geosciences not only within Oman but within the region. One important element is to maintain the profile of Earth Science for the youth of Oman. A great many high caliber students are attracted to Earth Science and we want this to continue. In the next few months we will be approaching and encouraging many of these students to use **AL HAJAR** and GSO to share many of the research projects they are involved in, in there respective Universities, in Oman and from around the world. There is an article in this publication written by Riffa Al Harthy, which captures some of the interest and fascination Geology holds when she discovers that Oman has been covered by ice, not once but twice from evidence in different rocky outcrops of the Oman.

As you have probably noticed the summer has definitely arrived. Many of our members will be heading of on vacation and I want to wish them a safe and happy holiday. Please be careful on the roads and don't forget your seat belts.

John S Willoughby

What's inside

OFFSHORE OMAN 'GIANT FIELD' POTENTIAL

2003 CONCESSION ROUND BLOCKS 18A, 18B AND 41

HUSSAIN AHMED AL LAWATI
MINISTRY OF OIL AND GAS, OMAN

ADIL RABIA JAMIN
MINISTRY OF OIL AND GAS, OMAN

MARK SPENCER JONES
PGS GEOPHYSICAL AS.

DR. BJORN WYGRALA
IES

The Gulf of Oman License Round 2003 incoporates 3 deepwater blocks from the offshore area which covers 45,240 sq km's (**Figure.1**). Two wells BMA-1 and BMB-1 have been drilled on the shelf and give only an indication of the regional prospectivity down-dip, in the Sohar Basin. Both wells containing gas and oil shows. In 2002 PGS acquired 5839 line-km of seismic and gravity data

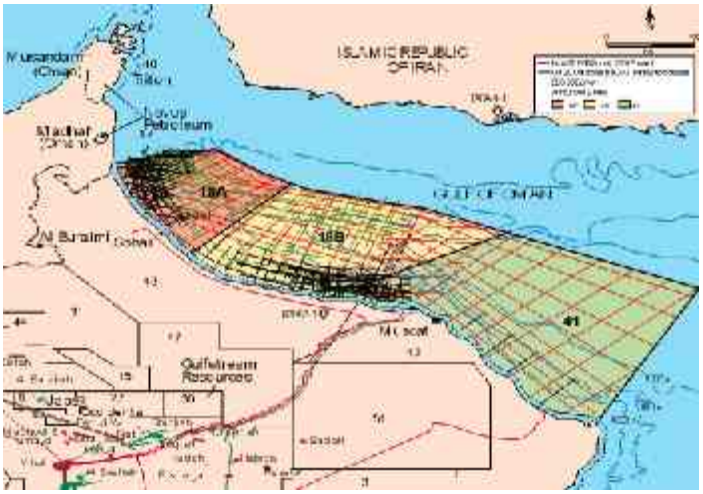


FIGURE 1: THIS MAP SHOWS THE BLOCKS ON OFFER IN THE 2003 OMAN BIDDING ROUND 2003.

Geological History of the Sohar Basin

The area is dominated by the Sohar Basin which is a Cretaceous-Tertiary deepwater basin confined between the Omani continental shelf and the Makran Accretionary Prism, with its associated thrust belt (**Figure. 2**). In the Early Cretaceous the Sohar Basin (**Figure. 3**) formed on the outboard edge of the Oman mountains. During the Middle-Late Cretaceous the basin appears to be in a deep marine setting. A major unconformity separates the Cretaceous from the Tertiary and during the Early Tertiary, in the shelf area, shallow marine carbonates and fine clastics were deposited. Subduction recommenced during the Eocene on the northern side of the Gulf of Oman, in the Makran and Baluchistan. Transpressional and transtensional forces affected the Sohar basin resulting in structuring which shows extensional and compressional features.

During the Miocene, uplift and erosion of the Arabian Plate margin resulted in major sediment input into the Sohar basin. As a result of sedimentary loading, major growth faults with their associated toe thrusts became active. From the Miocene to the Present there was continuous sedimentary input into the basin.

Petroleum Systems

Transpressional structures have been created by the Oman Mountain uplift. Four main plays are thought to exist in the Batinah/Sohar Basin. Firstly Oligocene- Pliocene turbidites which drap over the underlying structures of the Eocene (provenance area to the NW/NE of Block 18). Secondly, the Palaeogene Carbonate play (primarily Jafnayn Formation reservoir) sourced by Eocene or Maastrichtian claystones and sealed by Eocene claystones. In nearby onshore Barka #1 (drilled by Amoco in 1985), this formation demonstrated porosities of up to 17%. Eocene Seeb Formation, above the Rusayl Formation, may be a potential reservoir, which in Barka #1 showed porosities of 15-17%. The Seeb would be sealed by the Diba Formation claystones. Thirdly, the Oligocene Reef play, analogous to reefs known in onshore outcrops and inferred from seismic to occur on thrust anticline crests. Source potential is provided by Rusayl and Thaqab Formations, sealed by Oligocene marls. Lastly, a Maastrichtian sandstone play with a provenance area of Palaeozoic coarse clastics and crystalline basement; proven by the results of Batinah Marine #B1 in which oil and gas shows were encountered. Source and seal is presumably provided by Upper Cretaceous claystones interbedded with the reservoir. The presence of an active petroleum system in the Sohar basin is substantiated by numerous direct hydrocarbon indicators and live oil seeps detected by Infoterra from satellite images.

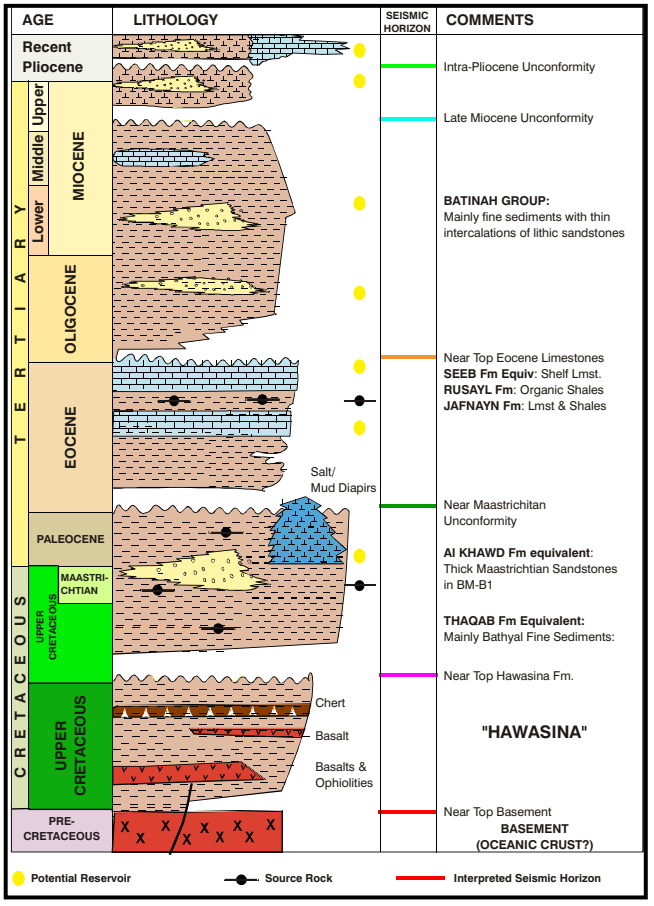


FIGURE 2: CONCEPTUAL CHRONOSTRATIGRAPHY

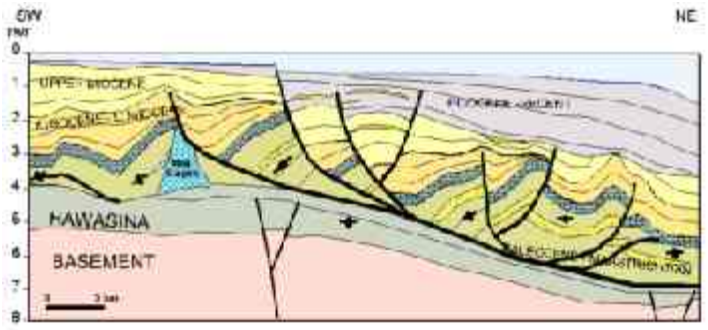


FIGURE 3: SCHEMATIC SECTION OVER THE SOHAR BASIN, OFFSHORE OMAN.

Reservoirs

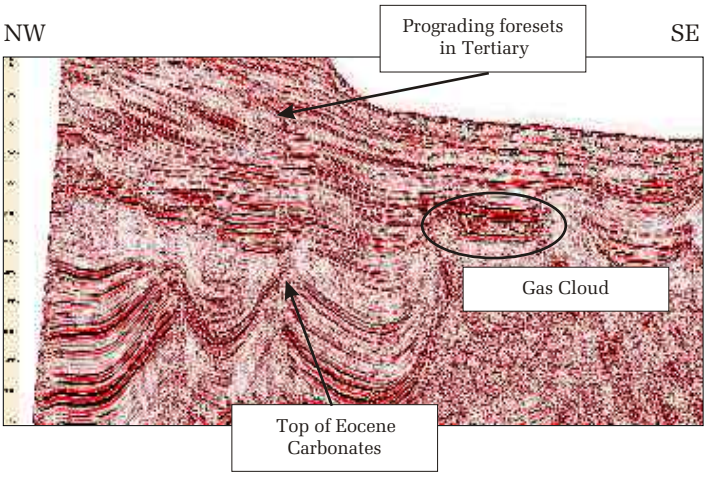
Potential sandstone reservoirs of Upper Cretaceous Campanian to Maastrichtian and Tertiary age are present.The sands are deposited as marine turbidites and sub-marine channel sands. Potential shallow marine limestone reservoirs are also known from Tertiary outcrops, onshore. Reservoir-seal pairs exist in the offshore setting where the reservoirs are sealed by deep marine shales. Oligocene to Miocene marine turbidties are also apparent. Large prograding foresets are evident within Blocks 18 and 41 and indicate changes in sea-level/tectonics within the area. As well as giving indications of the down-dip 'lowstand' equivalent leads in the form of basin floor fans and 'back-stepping' sand traps.

Traps

Structures of various styles are well developed in this concession. Most relate to Tertiary gravity tectonics, induced by a combination of a gentle basinward slope, a ductile substrate shale (and perhaps salt) and a thick cover sequence of semi-brittle marine sediments (**Figure 4**). Super-imposed on the gravity tectonics are signatures of wrench faulting. Closures are of the order of tens to hundreds of square kilometers and reservoirs are potentially stacked in growth-fault roll-over anticlines and collapsed-crest listric fault blocks. Diapir flanks and flower structures provide additional structural closures. Stratigraphic pinchouts are additionally evident in seismic sections.

Charge

Two wells within the region have good indications of the charge potential within the Sohar Basin. Both wells had gas shows within the Turonian-Cenomanian, which is well known as a world class source interval. Additionally, the Batinah-B1 well had oil shows within the Maastrichtian dark marine shales (approx 1000m's thick). Source rocks are also identified in outcrop and within well Barka-1from the Eocene Rusayl Formation. They represent Type II/III source rocks with av TOC values of 6-10%. Burial modelling on these source rocks suggests that in the key prospect areas a Maastrichtian source would be at peak gas generation and an Eocene source would be mature for oil. Gas chimneys are apparent within the blocks, and oil seeps are associated with the growth faults and fold belt within the area .



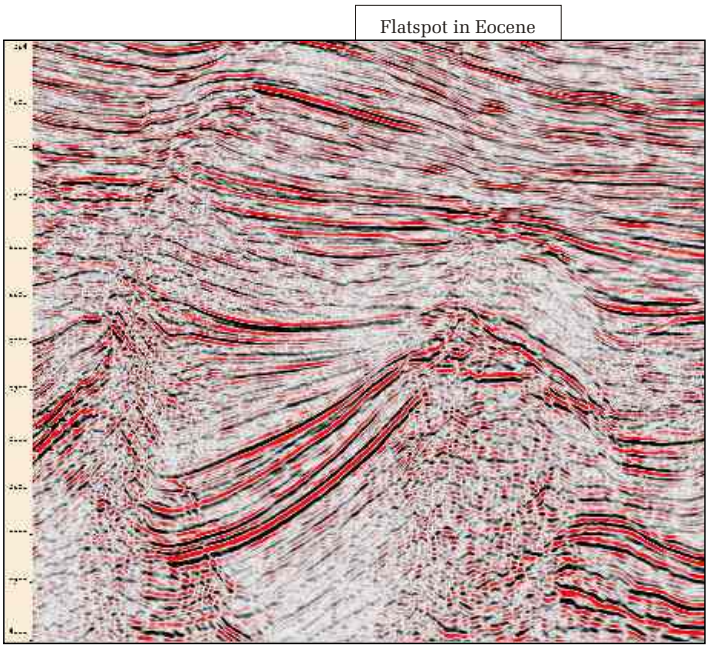


FIGURE 4: SEISMIC EXAMPLES OVER THE TOE OF THRUST SYSTEM

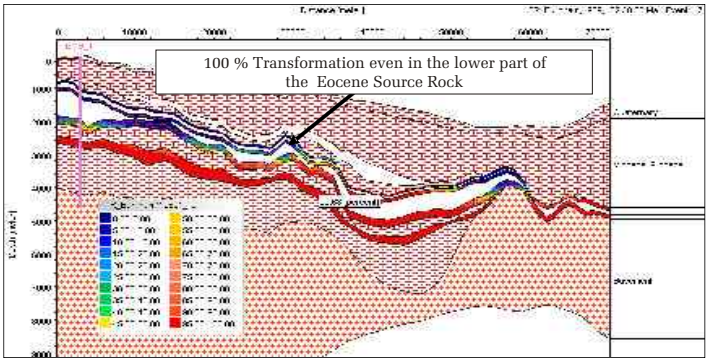


FIGURE 5: OMAN MODELS: RESULTS ("BEST CASE" – TRANSFORMATION POTENTIAL)

TRANSFORMATION RATIO ACCORDING TO BURNHAM (1989) AT A TIME-INVARIANT HEAT FLOW OF 80 MW/M2

Concession round

The Gulf of Oman License round 2003 was announced by the Ministry of Oil and Gas on the 15th January 2003. This first offshore license round will close on the 1st September 2004 . Blocks on offer, range in size from 7,920 km^2 for Block 18A and 13 520 km^2 Block 18B (these 2 blocks were merged

into one Block numbered Block 18) to 23,800 km^2 (Block 41). The main elements of the Exploration and Sharing agreement (EPSA) are an initial exploration term with one/two possible extensions, a 30 year Production agreement in case of commercial discovery which could be extended for an additional 10 years. Companies are exempt from paying taxes . A number of the terms within the EPSA are negotiable, making Oman a flexible and competitive environment to invest. Details of the bidding procedures and the Exploration and Production Sharing agreement can be obtained from PGS Geophysical AS or on PGS's website at www.pgs.com

Conclusion

The Sohar Basin is under explored with only two wells from 1968/72 (one drilled off structure) barely giving an indication of the regional prospectivity. The area consists of large structural closures which has giant hydrocarbon potential. Utilising the available seismic with its DHI's and amplitude anomalies, is the key to unlocking the potential reserves.

OMAN LNG: FUELLING THE FUTURE

BY DR AGNUS CASSENS
GSO ANNUAL MEETING 2004.

The annual meeting was entertained with an interesting talk by Dr. Agnus Cassens, General Manager and Chief Executive of Oman LNG. The talk reviewed the Oman's growing gas business and took us on a journey from production at the well head, to transportation to the LNG plant at Sur, liquefaction processes and transport to market. The seeds of Oman's gas business were sown in 1989 with the discovery of substantial volumes of Gas in Oman's interior. The company was formed in 1994 to market the gas, and in a very short period of 9 years only, it was exporting its first cargo.

The global LNG market is currently growing at 8% per annum, and Oman LNG are currently expanding there business to ensure they maintain market share. Currently a third train (pipeline) is being built from the interior to Sur.

Oman LNG prides itself on its social responsibilities within the local communities. It has run a number of programs to ensure that the benefits of the LNG business are felt by all. Fresh water has been supplied to local villages, and funds have been donated to local schools, hospitals and scholarship funds.

Oman LNG has established itself as a reliable supplier of gas to market. The main customers are found in the growing economies of Korea and Japan. The future looks very exciting for the company and Oman, and we wish Dr. Cassens and Oman LNG the very best of success.

GHAWAR: ANATOMY OF THE WORLD'S LARGEST OIL FIELD

GSO LECTURE BY AAPG DISTINGUISED LECTURER

DR ABDULKADER M AFFI (SAUDI ARAMCO)
MAY 4TH 2004

Aramco initially discovered oil in Ghawar in 1948 based on surface mapping and shallow structure drilling. Ghawar is a large north trending anticlinal structure some 250 kilometres long and 30 kilometres wide. It is a drape fold over a basement horst, which grew initially during the Carboniferous Hercynian deformation, and was reactivated episodically, particularly during the Late Cretaceous. In detail, the deep structure consists of several en echelon horst blocks that probably formed in response to right lateral transpression. The bounding faults have throws exceeding 3000' at the Silurian level, but terminate within the Triassic section. The episodic structural growth influenced sedimentation of the Permo-Carboniferous sandstone reservoirs, which onlap the structure, and the Jurassic and Permian carbonate reservoirs, which accumulated in shoals above structural culminations.

The main oil reservoir is the Arab-D limestone of Late Jurassic age, which improves upwards from mudstone to skeletal-oolitic grainstone, reflecting successive upward shoaling cycles. The excellent reservoir quality is due to the preservation of the primary porosity, the enhancement of permeability, and the presence of fractures in the deeper and tighter parts. The oil was sourced exclusively from Jurassic organic rich mudstones, and is effectively sealed beneath massive anhydrite. The general absence of faults at the Arab-D level maintained seal integrity. Current production is almost 5 million barrels per day under peripheral water injection. The southernmost part of the field remains under development, with a final increment of 300,000 barrels per day on stream in 2006.

In addition to oil, Ghawar contains large reserves of non-associated gas in the deeper Paleozoic reservoirs, sourced from Silurian shales, and trapped in Permian, Permo-Carboniferous and Devonian reservoirs at depths of 10,000-14,000 feet.

The main gas reservoirs are in the Khuff A, B, and C carbonates of late Permian age. Each consists of transgressive grainstones & packstones, sealed by regressive supra- and intertidal mudstone and anhydrite. The Khuff carbonates are highly cyclical and have undergone

extensive diagenesis, resulting in variable reservoir and gas quality. The migration of gas into the Khuff probably occurred along the western bounding fault of Ghawar, which propagated upward through the Khuff during the Cretaceous reactivation.

In addition, sweet gas is trapped structurally and stratigraphically in the Permo-Carboniferous Unayzah sandstones, which onlap the ancestral Ghawar highlands from the south. The Unayzah consists of eolian, fluvial and lacustrine clastics whose reservoir quality is highly variable due to facies changes and quartz cementation. In 1994, an exploration well drilled on the east flank of Ghawar discovered sweet gas in Devonian sandstones in a fault-unconformity truncation trap. Since then, exploration of Paleozoic targets has added 15 new discoveries in and around Ghawar. Development has increased daily Ghawar production capacity to 8 billion cubic feet. The key challenge to gas exploration and development has been the prediction of porosity using geologic models and 3D seismic data.

Dr Afifi is currently a Senior Geological Consultant for Saudi Aramco and Distinguished Lecturer for the AAPG.. He has studied at the Colorado School of Mines and the University of Michigan.

FIELD TRIP REVIEW

SOUTHERN HUQF (21-23 APRIL 2004).

BY MARTIN ROBERTS

This weekend field trip organized by GSO, was to view Permian-NeoProterozoic rocks of the Southern Huqf in Central Oman.

A group of 15 signed up to take part, with a plan to use participants own 4WD to minimize costs. The trip involved two nights camping with meals provided by a designated 'camp boss' on a rota basis. The late April searing heat was countered with adequate water supplies, loaded into two of the accompanying vehicles.

The rocks of the Southern Huqf are a must for anyone wanting to develop their interest or knowledge of Geology in Oman. Under Alan Heward's leadership, the group was shown a whole series of wonderful sections over a wide geographical area. Of particular interest were cliffs and hidden wadis which provided access to well exposed features of glacial and fluvial sediments.

Of particular geological interest were the magnificent algal stromatolite mounds and hollows observed in asymmetric groups on large exposed stratal surfaces (**Photo.1**). Features were interpreted, amongst other things, in terms of paleogeographic setting, possible current directions and time span.

The Wildlife Sanctuary status of the Huqf area was underlined by two opportune sightings of male Arabian Oryx (long horns), fleeting glimpses of gazelle and a close encounter with a dab (1m sized lizard-like creature). These animal viewings, and varied tracks in the desert sands, added to the overall experience of visiting this remote area.

The excellent Khufai exposures visited in the Southern Huqf represent sediments formed cf 600 mya. These rocks are time equivalent to the new Ediacaran Period; the first new geological period added to the geological calendar for over 120 years. The Ediacaran begins at the end of a Snowball Earth ice age; part of a series of ice ages spanning 850-600 mya. Certainly there is scope for further study of Omani rocks to add knowledge to this topical subject.

Glacial grooves and striations preserved in Oman rocks of the Huqf are world class, (**Photo. 2**)no one in the group had seen such magnificent examples. The associated glacial pavements are visible on satellite images – a fact which conveys the magnitude of these glacial relics.

PHOTO 1: ALGAL STROMATOLITES EXPOSED ON LARGE STRATAL SURFACES.

PHOTO 2: ICE GOUGED GROOVES AND STRIATIONS, OMAN SOUTHERN HUQF.

KEEP AN EYE OUT FOR THE NEXT WEEKEND FIELD TRIP. MORE EXCURSIONS ARE PLANNED BY YOUR GSO FIELD TRIP COMMITTEE IN 2004/05……

Occidental of Oman Inc.

Occidental is the second largest producer of oil in Oman, successfully producing more than 200 MMBO to date.

Occidental is the target private sector crude oil producer in Oman. It is a subsidiary of Occidental Oil and Gas Corporation (OOGC), an International oil and gas exploration and production company based in the United States and headquartered in Los Angeles, California. Occidental of Oman acquired initial interest in the Suneinah Concession (Block 9) in 1979 (**Figure.1**). The Suneinah Concession is managed by Occidental (65%), as operator and its partner, Mitsui E&P Middle East B.V (35%), under a Petroleum Sharing Agreement with the Government of Oman. Block 9 is located in the interior portion of northern Oman and produces a high quality crude oil (40° API). The oil is transported via Occidental and Petroleum Development Oman (PDO) pipelines from the Safah & Wadi Latham Trend Fields to the PDO Mina Al Fahal terminal near Muscat where it is loaded on tankers for delivery to market.

The first and most important discovery for Occidental of Oman in Block 9 came after five years of exploration, when oil was found on the western portion of the acreage at Safah. Though Safah continues to contain the bulk of the oil reserves on Block 9, a series of smaller finds in the southern portion of Occidental's acreage were made between 1992 and 2003. These discoveries delineated accumulations on seperate features at Al Barakah, Wadi Latham, Madiq, Salmah, Rayyan, Badr, Rawdah, Saqr, Jalal, Ghadeer, Haseel, Habeh, Salmah, Salmah south and Jadwat. Following completion of a pipeline to tie into PDO processing facilities, production was initiated in 1984 from Safah, with most of the other oil fields coming on line by the end of 1996. Reservoired within Cretaceous aged carbonates, Block 9 reserves have grown significantly over the years as the true potential of the Safah field became known and additional discoveries were made. From a mid-eighties estimate of only around 20 million barrels of oil(MMBO) recoverable at Safah, total reserves in the block had jumped to just over 70 MMBO by 1989, to 145 MMBO in 1994, and are currently estimated to be over 600 MMBO (ultimate recovery). The block's production has kept pace with its reserve growth to reach a present day (December 2003) sustainable rate of approximately 49,200 barrels of oil per day, with about two thirds of this flow coming from the main accumulation at Safah.

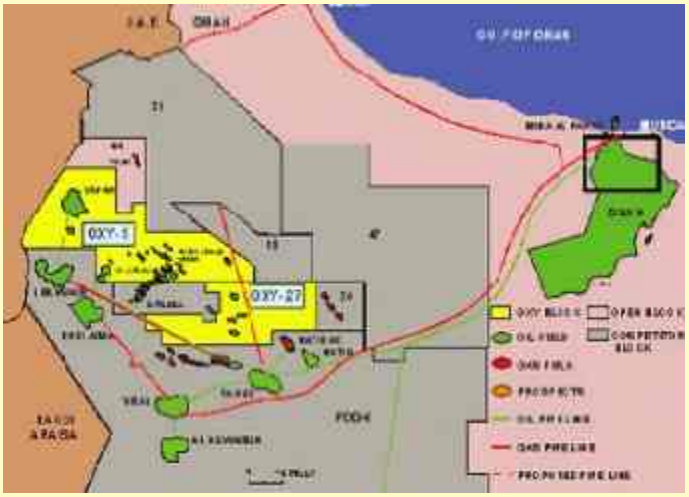


Figure 1: Occidental EPSA - Northern Oman

Additional exploratory acreage was gained for the Oman project with Occidental's signing of a contract on block 27 in June 1998. The new tract (Occidental 65% & Mitsui 35%) has already been the site of an extensive three-dimensional (3D) seismic program and initial exploratory drilling (including one small discovery to date). The new production sharing acquisition has potential not only for oil, but also for gas, which is poised to become an increasingly valuable commodity in Oman for both industrial and domestic use.

The many significant increases in reserve estimates recorded over the years reflect a greatly increased understanding of the nature and potential of the area reservoirs, as well as Occidental of Oman's application of a remarkably high level of oil recovery technology. This high-tech approach begins with the use of 3D seismic and sophisticated computer processing to enable project geoscientists to correctly decipher the area's complex depositional and structural history for optimization of both development and step-out exploratory well sites. Some 2,500 square kilometers of 3D data has been collected over the Oman asset, which has played a key role in supporting the operation's outstanding rate of 80% success in exploratory drilling.

The drilling process itself has been made more effective through the employment of the latest horizontal drilling and completion techniques, which allow maximum exposure of the reservoir in the resulting boreholes to greatly boost production rates and minimize well costs. Though horizontal drilling was not initiated in Oman until 1990, wells completed using this highly effective methodology now account for the majority of the daily production from the operation. Additional advanced multi-lateral drilling techniques were introduced in 1998. Once on-line producing wells benefit from the employment of advanced pumping equipment and procedures while a program of injecting recovered solution gas through a series of dedicated wells serves to energize and push greater quantities of oil from the reservoir carbonates.

Production volumes are further maximized through use of a gas plant and stabilization process that recovers natural gas liquids and then blends them with the produced crude oil. Since 1999 a water-flooding project initiated in Safah Field, where separate wells are used to inject water and flush even more oil from the subsurface. It has been estimated that this water flood innovation alone may add some 100 MMBO to the project's ultimate recovery. When combined with the most diligent efforts at work efficiency, Occidental of Oman's application of modern petroleum technology has created a highly effective operation in Oman, with low production costs.

Health, Environment & Safety (HES)

In addition to its pursuit of optimum commerciality, Occidental's operation in Oman is committed to safeguarding the environment as well as minimizing the health and safety risks to its employees, contractors, and all of the citizens of the communities in which the company does business. the protection of health, environment and safety ranks equally with Occidental of Oman's primary business objectives. As a result a number of vital environmental and safety programs have been implemented in Oman. These include the establishment of critical emergency procedures within the operation;
provision of effective training in the health, environment and safety practices: and the supply of properly designed, operated and controlled equipment to ensure a reduction in overall risk to people and the environment. Emissions for the project are reduced by returning a maximum of produced gas to the underground reservoir, while waste materials are treated and properly disposed of to protect the local desert and its vulnerable water table. Handling of waste materials includes extensive use of lined pits to isolate contaminating fluids, utilization of a sanitary landfill, the building of a modern sewage treatment facility, and the recycling of produced water through an associated plant to generate high grade salt for both industrial and domestic use.

In all of these efforts, Occidental of Oman works closely with the proper governmental authorities to ensure compliance with all applicable regulations. In this regard, Occidental was the first operator in omanto secure an environmental permits for its concession from the Ministry of Regional Muncipalities and Environment (MRME), as well as the first to develop a permited sanitary waste site.

Occidental Oman was also successful in receiving 2 internationallly recognized certificates issued by Bureau of Veritas the ISO 14001 for environmental managment systems and the OHSAS 18001 for health and safety managment systems.

Omanization to reach 88% by the end of 2004

Omanization

Occidental's multinational workforce in Oman consists of 170 employees 75 in the headquarters operation and 95 in the field. A high priority has been placed on significantly increasing the native Omani composition of its staff in order to maximize technology transfer for the benefit of the host country. Thus the company has largely filled its manpower needs from a talented local labor pool and worked diligently to increase the proportional share of Omani workers by 25% since 1998. Representation by national personel on the staff is expected to reach 88% at the end of 2004. As part Occidental's effort to fully integrate national staff at all levels within the organization, the company is currently following a plan of moving top Omani candidates into supervisory and managerial positions. To further boost the certifiable capabilities of this national workforce, Occidental of Oman is currently implementing recognized Competency Assessment Program.

OMAN AAPG-SEG STUDENT GROUP

Brothers and Sisters,
It gives me a great pleasure to write in **AL HAJAR** on behalf of GeoGroup's member. It has been a very busy year for the executive committee. The integration with international associations (AAPG and SEG) enabled GeoGroup to develop management skills and build strong relationships with the industry.

It has been very fruitful experience for me as a president. I tried to build the basis of an organized and scientific group. I was very proud to see GeoGroup members working under the standing committees of OMAN AAPG-SEG Student Group. I can see the future of GeoGroup will be very bright towards a scientific, administrative and leading Group not only in SQU but all over OMAN.

At the end I would like to thank the executive committee members for their hard work that helped to let GeoGroup win the First prize in Science Festival at College of Science, GSO for sponsoring the projects, PDO for sponsoring the Inauguration Meeting and GeoGroup's members for participating in all activities.

Issa Al-Mahroqi
GeoGroup's leader

INAUGURATION MEETING
16th October 2003

- Place: Crown Plaza (Sponsored by PDO).
- Guests of honours, Dr. Abdulazizi Al-Kindi, Dean College of Science & Mrs. Lynda Armstrong, Exploration Manager PDO.
- Geoscientists (All Members of AAPG or SEG in OMAN) and Non-Members (the number of attendees reached to about 150 People)
- Mission & vision of GeoGroup were highlighted by Issa Al-Mahroqi.

VGP
10th February 2004

VGP "Visiting Geologists Program".
By Mr. Peter Lioyd
Business Manager Middle East Asia Pacific.

The title was " The Quest for energy " at College of Science conference room. Comprehensive introductory treatment of the Oil & Gas industry starts off by looking at world energy needs, worldwide oil and gas reserves and the challenging careers that are offered as those reserves are found and developed. The importance of technology advances is highlighted

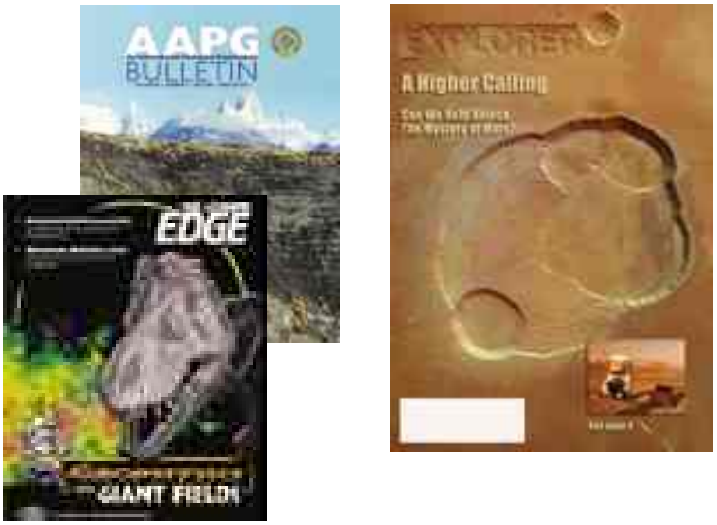
SCHOOL FIELD TRIPS
18th February, 24th March-2004

GeoGroup runs field trips for primary and secondary schools to Al-Khoud Area. This field trip organized with the help of Ministry of Education. The program of the trip is as followed:

- Safety in the field .
- The science of Earth Sciences and the role they play in the country.
- Where do Geologists and Geophysicists work?
- Sedimentary rocks at Al-Khoud Road Cut.
- Pillow lava, sheeted dykes and igneous rocks.
- Overview of Jabal Akhdar Mountain.
- Fossils Locality (Nummelits).

GEO GROUP'S LIBRARY

21st February 2004



Opening new GeoGroup's Library, contain journals:

- The Leading Edge TLE (SEG).
- Explorer (AAPG).
- First Break (EAGE).
- Al-Hajar (GSO).
- GeoArabia (Middle East Petroleum Geosciences).
- Journal of Petroleum Technology JPT (SPE).
- AAPG Bulletin on CD-Rom.

FIRST PRIZE SCIENCE COMPETITION

27th April 2004

27th of April considered to be one of the happiest days for GeoGroup. It was announced that GeoGroup got the First Prize in the Science Competition. The winner project was Aeolian Ripple Mark Simulator. Special thanks goes to: **GSO** for sponsoring the project, Projects Committee members lead by Rashid Al-Kiyomi, Mr. Steven Fryberger PDO and Mr. Ahmed Al-Khausibi, Dr. Abdulrahman Al Harthy and Dr. Omar Al-Ja'aidi from SQU for their advices.

SNOWBALL EARTH

The following is an article written by Rifaa Al Harthy, an Omani student in Australia. She attended a GSO lecture on the theory of the snowball Earth presented by Professor Paul Hoffman earlier this year. This is her account, and illustrates the fascination that Geology can have for Omans youth. Rifaa is now looking forward to being able to pursue her dream and study Geology.

It was the evening of the 14th of May 2004 when I sat on my everyday seat at the front window of the tram, on my way home after a long day at Trinity College. The weather was cold and the skies turned grey. Not long before entering the tram, I experienced a sudden shiver. At that very instant, a picture of my father, Paul Hoffman and I, walking up the mountains of Jabal Al-Akhdar raced through my mind. I quickly opened my bag and removed the new book I bought, "Snowball Earth".

On my last visit to Oman, I had attended a GSO lecture by Professor Paul Hoffman, which was organized by the Geological Society of Oman. I can honestly say I found it rather difficult to understand the theory behind the "Snowball Earth". As I was in a critical stage of deciding on a university major, I decided to read a couple of pages from "Snowball Earth".

After completing the book, I can proudly and confidently say that I currently understand approximately 50% of the theory. Following is a brief summary on the facts and reasons I learnt after reading "Snowball Earth" by Gabriel Walker, based on the theories of various geologists, particularly Professor Paul Hoffman.

The Precambrian period, also known as the Dark Ages, is one of the longest periods in the geological time scale. It is

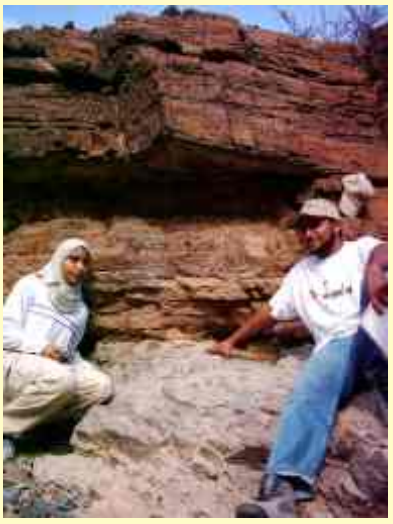
called the Dark Ages since; no signs of life were apparent during that era. Evidence of life such as fossils, only started appearing in the Cambrian. Geologists are trying to find out why. One of the reasons may be that during the Precambrian, the Earth was a ball of ice, which resulted in the extinction of living creatures.

Evidence of Pre Cambrian glacial deposits is seen all over the world. Surprisingly, countries near the equator such as Namibia and Oman show evidence of glacial deposits. This fact has caused a lot of discussion amongst Geologists, many believing it was "impossible" for glaciers

to form near the equator. This has resulted in the rejection of the "Snowball" theory by a number of geologists.

Although geologists were divided, one geologist did an experiment with ice and proved that it can form into a ball. This is because as ice forms in the caps (poles), it gets larger and larger. As a result of the snow's property of reflecting most of the suns rays (energy) back into the atmosphere, the inner surface of the earth gradually becomes cooler. That meant that the entire earth's surface was covered in ice!
That again puzzled the geologists, since if the earth was covered in ice it would never heat up again, and so the ice would never melt.

However, geologists came to realize that volcanic activities still took place under the earths crust, regardless of the atmospheric temperature. That way lava would contribute to the melting of ice. At the same time, gaseous emissions (CO_2) also played an important role, in that it acted as a green house gas. Consequently, as millions of years passed by, earth warmed up again. That was when signs of life appeared again in the Cambrian period. This was the basic idea why the geologists first came to think of the theory. I was surprised that I could understand the way they were thinking, in putting complex evidences together. The book also introduced many geologists who played a role in the theory. I found some facts about Paul Hoffman's discoveries interesting and humorous.



CGG is a leading provider of seismic services and products to the worldwide oil and gas exploration and production industry. Headquartered in France, CGG has over 3,100 employees of more than 20 different nationalities located at over 50 sites around the globe. The company provides a wide range of seismic data acquisition, processing and reservoir services, and is also a manufacturer of geophysical equipment

CGG has worked in Oman for 30 years. In 1974 a CGG crew conducted an electrical campaign on behalf of a French-Italian office for water prospecting. Since 1978 CGG has regularly acquired seismic surveys for oil & gas exploration purposes on behalf of PDO and other foreign operators including Elf, Phillips, Japex and BP. CGG shot its first 3D seismic survey in Oman in 1987.

A large dedicated seismic processing centre was established in Muscat in 1994 and CGG has since operated as an exclusive processing services provider to PDO. Typical volumes processed/reprocessed annually are 2,000-5,000 km of 2D data and 8,000-10,000 sq km of 3D data. Processing projects are characterized by high-density data sets that require the implementation of high-tech state-of-the-art processing techniques and tools to resolve the very difficult geophysical problems prevalent in this region.

The processing centre currently employs 19 Omani nationals, including 13 professional seismologists and some IT personnel, with significant emphasis placed on training and personal development.

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GSO INTERNATIONAL NEWS

INDIA

Two down-dip appraisal wells drilled by Cairn Energy in its Mangala oil field in north-western India's northern Rajastan have led to an upward revision in reserve estimates. Mangala 2 and Mangala 3 encountered "excellent" Fatehgarh sands, establishing reservoir and aquifer continuity across the field. They are located 3km north-east and 2.5km south south-west, respectively, of Cairn's Mangala 1 discovery. Cairn says three additional Mangala updip wells are to be drilled, the first of which is expected to reach total depth before the end of May 2004. Mangala 4 was spudded between Mangala 1 and Mangala 2. The Mangala 5 and Mangala 6 wells, to be sited between the field opener and Mangala 3, are expected to spud before month's end. Cairn says in-place reserves have been revised from 650 MMbo to 1.1 billion barrels, while current recoverable reserve expectations are between 100 and 275 MMbo. The company is planning two 3D seismic surveys, one over the Mangala and N-A discoveries and another over the southern portion of the N-C discovery. The Mangala/N-A survey is expected to get underway in June 2004.

IRAN

Various licensing initiatives introduced at the beginning of 2004 at a seminar in The Netherlands have now been approved by Parliament and await ratification by the Guardian Council. The authorities seek to make oil and gas related projects more attractive to foreign players and

the main initiative is the new Exploration and Development Contract (EDC). Subject to all necessary consents, this will allow companies to continue into the development phase after having made a discovery. This is quite a departure from the existing system where both exploration and development phases are distinct, each requiring appropriate authorization and the issuing of permits. The move is part of Iran's 2005-2010 business plan in which there is a drive to shift exploration away from the lucrative south-west Zagros region. Separately, Hojjatollah Ghanimifard, director of international affairs at the National Iranian Oil Company, has announced that Iran's hydrocarbon reserves have been proven at 130 billion barrels and that they are expected to rise further. The total is known to include gas and gas liquids but no distinction has been made as to the proportions within this total.

With the spud of Band-E-Karkheh 2 (BKH 2), on 3rd May 2004 in the south of the Mehr Block, OMV enters a new phase in its expansion into what it describes as one of the world's richest oil and gas plays. The award of this 2,500 sq km exploration permit marked OMV's operational entry into Iran and, as it contains only two wells drilled in 1967 and sparse seismic coverage, it is deemed to have very significant exploration potential. The well has a planned total depth of 4,300m and will test a primary objective in the Middle to Upper Cretaceous Bangestan Group. OMV completed the acquisition of a 980km 2D seismic survey over the license in January 2003. The start of this survey was significantly delayed due to mine clearance operations in the area by the army that dealt with over 400 items of live ordnance. The Mehr Block is located in the north-western portion of the Khuzestan Province, some 30km north of the city of Ahwaz. The giant Ahwaz field, a 1958 discovery with ultimate recoverable reserves of 13.8 billion barrels, is immediately adjacent to the Mehr Block.

IRAQ

California-based Sonoran Energy has joined Irish independent Petrel Resources and an unnamed Polish company in bidding for the development of the Khurmala Dome of Kirkuk and the Hamrin oil field in Iraq. In the former, production is to be increased to 100,000 bo/d with a maximum associated gas rate of 100 MMcf/d from three degassing stations. In Hamrin, targeted production is 160,000 bo/d and 60 MMcf/d. Bids were submitted to Iraq's Ministry of Oil through the State Company for Oil Projects (SCOP).

PAKISTAN

Both BP and Shell have secured license extensions to complete their respective evaluations. BP was granted an additional extension to the initial exploration phase of the Mehran EL (Lower Indus Basin) that takes the validity of the permit to 30 June 2004. The licence, which covers an area of 5,777.42 sq km, was awarded in November 2000 for the initial three-year exploration phase. Shell has been granted an additional eight month extension to the initial three year exploration phase of its Offshore Indus-E EL (Indus Delta) license taking the period of validity up to 31 December 2004. The licence, which covers an area of 7,389.95 sq km, was awarded to Shell on 16 April 1998 and is located in water depths of between 50m to 1,500m. It represented the first ever deepwater acreage granted for exploration in Pakistan.

QATAR

Anadarko Petroleum has strengthened its acreage position in Qatar with the acquisition of a 3,132 sq km offshore block. On 18 May 2004, the company signed an oil and gas Exploration and Production Sharing Agreement with Qatar Petroleum for Block 4. The tract is located about 40km off the northern coast of Qatar, adjoining Anadarko's Block 12 and the Al Rayyan field, which produces about 17,000 bo/d. During the initial five-year exploration phase, work commitments include seismic reprocessing, acquisition of 2D and 3D data and exploratory drilling. Anadarko, which holds a 100% interest in the block, will undertake exploration via a newly created subsidiary, Anadarko Qatar Block-4, rather than by Anadarko Qatar Energy, which operates blocks 12 and 13. Kufpec recently farmed in for a 37% interest in Block 13, which is probably the reason a separate operating company has been created for Block 4. Anadarko has operated in Qatar since its acquisition of Gulfstream Resources in 2001.

SAUDI ARABIA

Saudi Aramco has signed a comprehensive Memorandum of Understanding with Sumitomo Chemical Company for the planned development of a large, integrated refining and petrochemical complex in the Red Sea town of Rabigh. If progressed, this will create one of the largest integrated refining and petrochemical projects ever to be built at one time. The cost for the direct project investment is currently estimated to be US$ 4.3 billion; however, this estimate is subject to change based on the results of a joint feasibility study to be undertaken by Saudi Aramco and Sumitomo. Saudi Aramco currently owns and operates a topping refinery at Rabigh with a nominal crude distillation capacity of 400,000 bo/d. The existing site and infrastructure will serve as the base platform for the development of the proposed Rabigh Project. Saudi Aramco will supply the Rabigh Project with 400,000 bo/d, 95 MMcf/d of ethane and 10,000 to 15,000 b/d of butane. The project is targeted for start up in late 2008.

SYRIA

Tanganyika Oil Company Ltd's wholly owned subsidiary Dublin International spudded the company's first horizontal Shiranish reservoir well in the Oudeh Block on 21 April 2004. The well, Oudeh 136 (OD 136), has a planned total measured depth of 3,025m and is to be completed as an oil producer using Adwoc (Arab Drilling and Workover Company) L/R "1". It will be drilled to a vertical depth of 1,100m and then kicked off horizontally for up to 1,500m. The company advises that its initial program schedules two such wells into the top section of the Shiranish reservoir but that it has constructed a multiple well drilling pad that could accommodate six wells. Dublin's Production Sharing Agreement over the Oudeh field was ratified by the Syrian Parliament and President on 24 July 2003. The block, which covers an area of 192 sq km, also includes the Kotba and Kahtaniyeh fields located in the North Syrian Platform (Western Arabian Province), and has estimated proven and probable oil reserves of around 84 MMb. Depending on

results, the company has targeted first revenue by 2004. Oudeh was discovered by SPC in 1978 and according to Tanganyika it was brought onstream in 1982, peaked the following year and has been in decline ever since. A total of 41 wells have been drilled on the field, 17 of which are currently producing approximately 600 bo/d plus 27 MMcfg/d. The program aims to increase oil production to at least 30,000 bo/d.

TURKEY

Amity Oil suspended the Adatepe 4 deeper-pool wildcat as a gas producer on 17 May 2004 at a total depth of 1,700m. The well flowed gas at a rate of 2.65 MMcf/d from the Danisman Formation from the interval 1,113 - 1,118.5m. A small frac treatment may be tried on the Danisman section to improve the flow rates and overcome some near well bore damage, which was evident by a reduced flow rate. Very good gas shows were encountered from 1,556m to 1,570m in the Osmancik Formation channel sands, but this unit is considered too tight to be commercial. The well was understood to be evaluating a new and untested play concept that may have potential in other areas of the Thrace Basin. Initial production of 5-8 MMcfg/d from the Adatepe field began on 26 February 2004 but once the plant is fully operational and additional wells are tied in, peak production of around 20 MMcf/d is expected by June 2004.

YEMEN

Despite the encouraging signs in the Neheb 1 wildcat being drilled by the DNO-led group on South Hoowarime, Block 43, testing has failed producing only water, a result that suggests the hydrocarbons encountered are not movable. The initial production test (DST 1A) was in the interval 2,007 to 2,016m in Lower Cretaceous Qishn S2 sandstones while a second test (DST 1B) also in Qishn sandstones was over the interval 2000.5 to 2016m. This was considered an important well as it was the first of two additional tests planned following the March 2004 Nabrajah 1 oil discovery. It is located approximately 17km east-north-east of Nabrajah 1,now regarded as an significant new find, and was drilled to evaluate a four-way dip closed structure in the hanging wall immediately south of the Nabrajah fault block. It was drilled to a total depth of 2,227m and encountered oil shows over a 15m gross interval in the primary objective Qishn S2 Sandstone. Oil shows have also been found over a 4m gross interval in the Lower Qishn Sandstone. DNO advise the well is to be suspended pending further evaluation and that the rig will move to drill a new production well on the Tasour field.

EVENTS CALENDAR

2004

September

1st GSO talk "Exploration Opportunities in Oman"
Mr. Hussain Al-Lawati, Ministry of Oil & Gas

2nd GSO talk "Upper Cretaceous tectonics of North Oman"
Dr. Jean Paul Breton, BRGM

1st GSO Field trip "Tectonics of the Jebel Akhdar"
Dr. Jean Paul Breton, BRGM

October

3rd GSO talk "The Ara equivalent in Siberia"
Dr. Shane Pelechaty, Petroleum Development Oman

2nd GSO Field trip "The Saiq Plateau"
Dr. Gordon Coy Badley Ashton

November

4th GSO talk "Mars Exploration"
Dr John Grotzinger, Massachusetts Institute of Technology

December

5th GSO talk "Carbonate facies through Oman's geological history"
Mr. Mohamed Al-Harthy, Petroleum Development Oman

3rd GSO Field trip "Geology of the Ordovician Amdeh Formation"
Dr. John Aitken Badley Ashton

2005

January

6th GSO talk
Dr. Salah Khirbash, Sultan Qaboos University

Feburary

7th GSO talk "Fluid characterization using 4D seismic amplitude and coherence analysis"
Dr. Mohammed Al-Mazrui, Petroleum Development Oman

4th GSO Field trip "Salt domes of North Oman"
Dr. Hisham Al-Siyabi & Dr. Mark Newell,
Petroleum Development Oman

March

8th GSO talk "Exploration History in Oman"
Dr. Alan Heward, Petroleum Development Oman

5th GSO Field trip "Geology of the Siwan Area, Northern Huqf"
Dr. Alan Heward, Petroleum Development Oman

April

9th GSO talk "General aspects of the main structural units in the norhtern part of the Arabian plate (Syria)".
Dr. AbdulNasser Darkal, Sultan Qaboos University

6th GSO Field trip "The Seeb Formation & Palaeogene succession of the Al-Khod area."
Dr. Abdulrahman Al-Harthy, Sultan Qaboos University

May

10th GSO talk A GSO-SPE Joint Talk

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