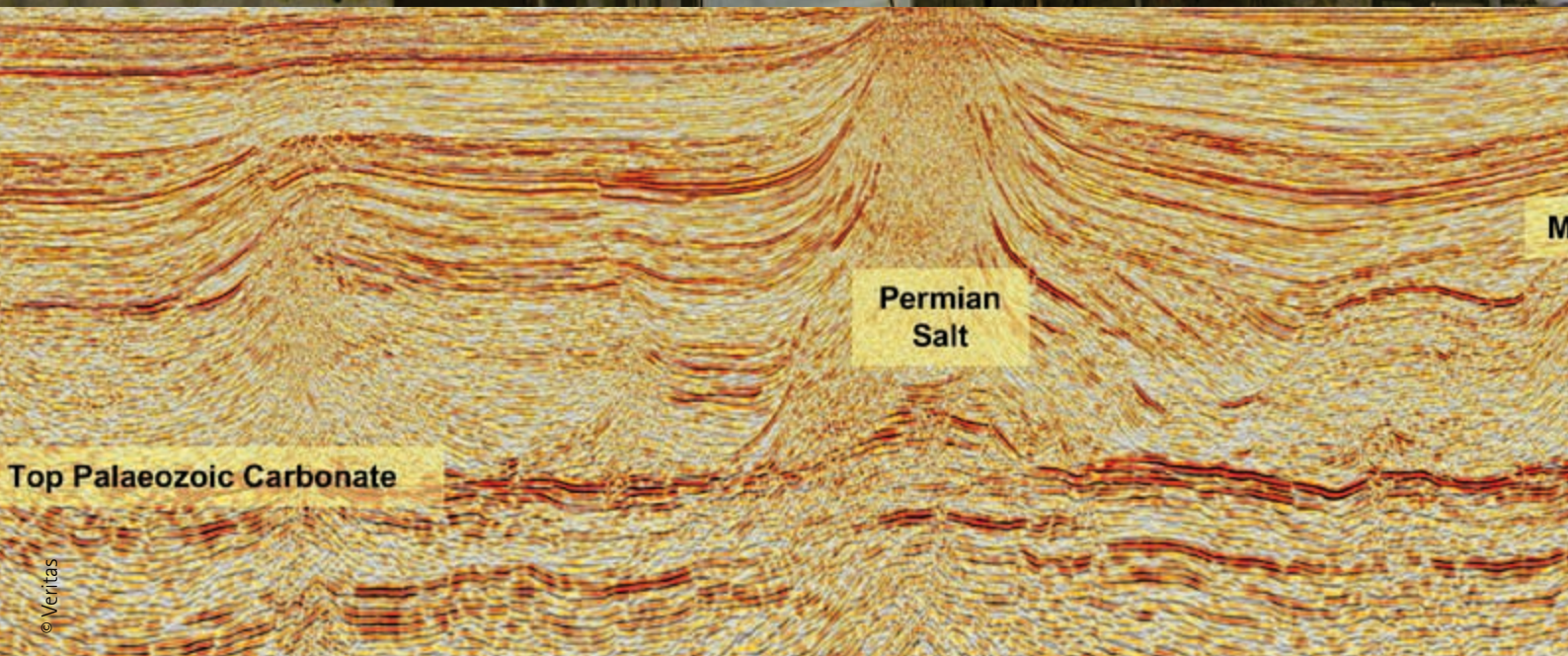


A Sleeping Giant Awakes

Kazakhstan has spent most of its history away from the gaze of the West. But this vast and remote country, the size of Western Europe, is now about to step into the spotlight. With its huge hydrocarbon resources – and a dynamic and forward looking leadership – Kazakhstan is set to become a dominant player in the supply of oil and gas to world markets.

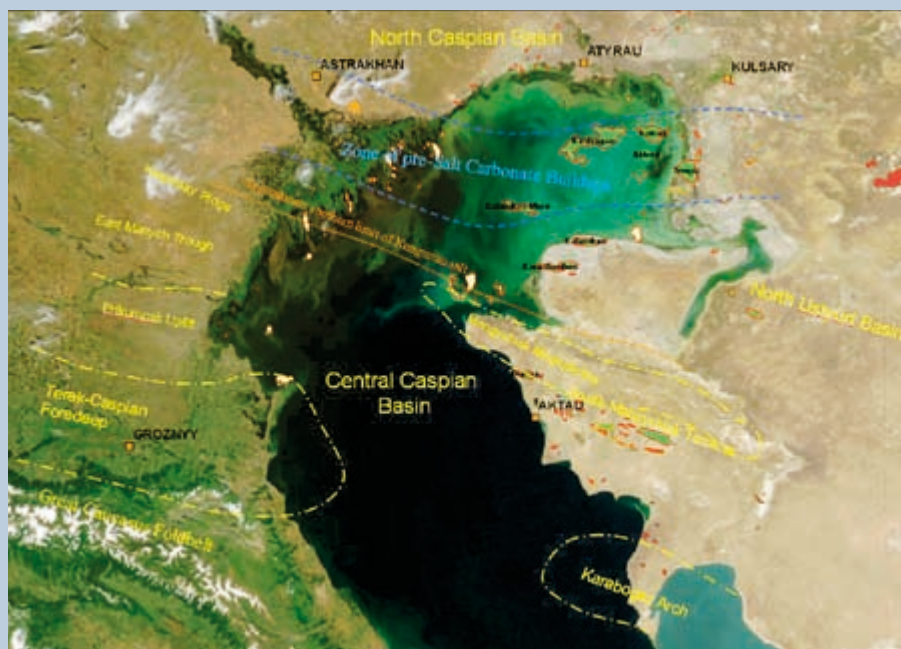
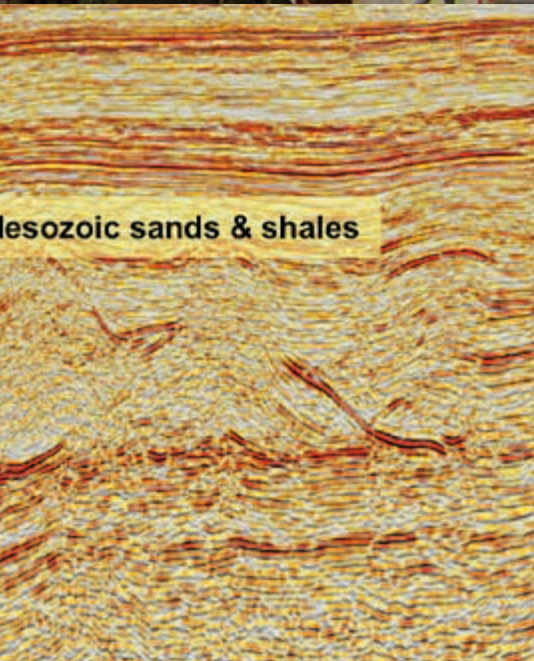


Photo: Brent O'Brian



Permian
Salt

Top Palaeozoic Carbonate



Cartography: Veritas DGC based on NASA image.

The main producing area offshore Kazakhstan (The Caspian Sea) is the North Caspian Basin, which is a part of the much larger Precaspian Basin and includes the supergiant Tengiz and Kashagan oil fields. There is also a fair amount of oil and gas production onshore Kazakhstan. The main producing areas outside the Precaspian Basin are the Ustyurt Basin just to the east of the Caspian Sea and further to the east (outside the map) the significant Turgay Basin which is about 600km long. Then, a bit further east is the Chu Sarysu Basin which includes the Tustin Uplift, the Muyunkum Depression and the Akkum Talassk Terrace and that's over a hundred kilometers long. It's really a hugely unexplored region.

From the aft deck of the accommodation vessel we see the shooting boat to the left and the recording boat to the right. The cable lies on the sea floor between them. In the centre of the picture are two of the four cable boats standing by.

Some 1,000km of long offset 2D data were recorded this year up to November when the northern Caspian Sea freezes over. Last season's acquisition has been in water depths between 2 and 5 metres.

The seismic line shows numerous salt swells and diapirs that are seen together with some structure at the Devonian-Permian carbonate level. Above the salt section there are numerous faulted anticlines induced by the salt movement. Many of the faults reach to the surface but this does not generally compromise the seal quality of the structure as there are many examples of successful fields with faults of this type.

This year Veritas will have three crews operating; two in the northern Caspian acquiring shallow marine and transition zone data and one in the deeper waters of the central Caspian acquiring streamer data.

Steve Toothill, Chief Geologist, Veritas DGC

The history of oil and gas exploration goes back a long way in Kazakhstan. In fact, the Emba-Caspiisk Company produced the first barrel of oil in 1899. This was from a well less than 50m deep on what became the Karachungul oil field. Nobel made the second discovery in the same region (Makat). The oil was transported to the port of Rakushinok in skin bags carried by camels, where it was refined and then shipped to market.

All of the early discoveries were shallow pools draped over salt domes and as such were identified from surface mapping. These were concentrated in the southern part of the Precaspian basin¹ and by 1930 over 300 fields had been discovered. The 1920's saw a change to geological and seismic mapping, which coincided with the introduction of rotary drilling and the need for more qualified workers. Thus a burgeon-

ing industry developed in the Atyrau region, which was further boosted by the surge in demand for oil during the Second World War. At this time two pipelines were built and a steam electricity station was constructed in Kamyskul close to the Kulsary oil refinery.

World Class Discoveries

It was during the Soviet era that many of Kazakhstan's hundreds of oil and gas fields were discovered. These were almost exclusively onshore and shallow, with stacked but relatively thin reservoirs and difficult crudes; often sulfurous, waxy and resinous, thus making it difficult to flow the oil.

Oil exploration and production continued to expand throughout the postwar years. The Emba-Caspiisk Company discovered some very large fields in the 1960's of which Prorva with both oil and gas was the largest. It sits above a salt dome and has nine producing horizons ranging from

Triassic to Jurassic.

After Kazakhstan became independent in 1989 foreign companies were allowed to invest in the oil industry. Chevron then formed a joint venture with Tengizneftgaz to form Tengizchevroil in order to develop the Tengiz oil field, discovered in 1981 but whose potential was not realised until very much later. This is a pre-salt field situated in swamplands just onshore covering an area of approximately 400 km². It has an oil column of 1550m and reserves are estimated between 6 and 9 billion barrels of oil. Production is currently about 270,000 bopd but is set to rise shortly to 450,000 bopd and has the capacity to rise to 700,000 bopd.

Further consortia were formed with foreign companies and as a result the world's largest oil discovery for thirty years was made in the centre of the northern part of the Caspian Sea. Kashagan was discovered in 2000 and has reserves of between 9 and 13 billion barrels, the higher value being dependent on gas re-injection. When fully developed this field alone is expected to produce 900,000 bopd. The consortium is headed by Agip and has KazMunayGas, ExxonMobil, Shell, Total, ConocoPhillips and INPEX as partners.

In recognition of the importance of its oil reserves, Kazakhstan has invested heavily in the infrastructure needed to help manage them. International companies have been involved in pipeline construction with a new route into China and the recently opened Baku-Ceyhan pipeline².

Extremely rich – all over

The Kazakhstan sector of the Caspian Sea falls across two distinct geological provinces, The North Caspian Basin and The Central Caspian Basin. Both provinces, although very different in their geological setting, are extremely rich in hydrocarbon deposits. The USGS in its 2000 review quotes undiscovered resources of around 14 billion barrels of oil and 63 TCF of gas for the offshore areas, of which over 90% is said to be in the North Caspian Basin.

The North Caspian Basin

The North Caspian Basin, to the north of the Karpinsky Ridge – Mangyshlak Meganticline, falls within the southern extent of the Precaspian Basin. This basin covers approximately 500,000 km², roughly comparable



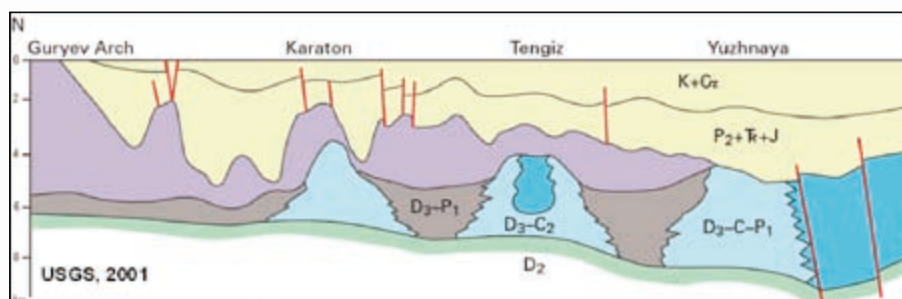
Elwyn Jones and Steve Toothill looking at some data in a hotel in the capital Astana in February of last year.



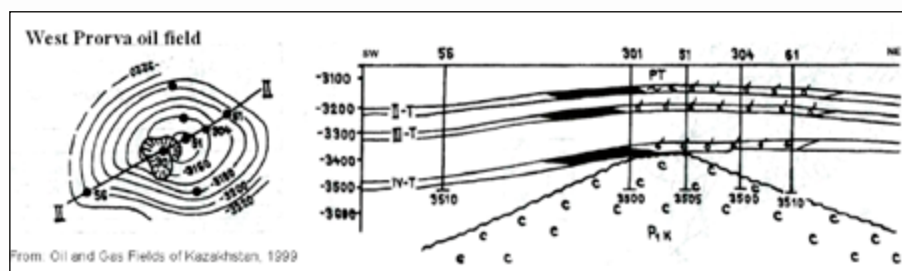
The new headquarters of KazMunayGas, the state oil company in Astana.

1 The Precaspian Basin extends northwards over 400km all the way to the Ural Mountains in Russia and largely covers the westernmost part of Kazakhstan north of the Caspian Sea.

2 The 1700 km long oil pipeline runs from Baku, Azerbaijan, through Georgia to the Turkish seaport of Ceyhan. The pipeline is scheduled to deliver an estimated one million barrels of oil a day.



Schematic cross section across the basin from the Guryev Arch, which lies approximately 100km north of the Caspian Sea, across the Karaton and Tengiz carbonate fields. Lower yellow: Mesozoic clastics; Permian, Triassic and Jurassic, Upper yellow: Cretaceous and Cenozoic sediments. Purple: Permian age Kungurian evaporates, light blue: Devonian to Carboniferous reef carbonates, dark blue: Devonian to Carboniferous shallow shelf and lagoonal carbonates and grey: off-reef deep-water carbonates and clastics



Four-way dip closure map of West Prorva reservoir horizon. Illustration: "Oil and Gas Fields of Kazakhstan", published by the Ministry of Natural Resources

to the whole of the southern, central and northern North Sea, and is bounded by the Volga-Ural carbonate platform of Palaeozoic age to the north and west and by the South Emba and Karpinsky foldbelts to the south and east. It is a highly productive basin ringed by producing fields and discoveries.

In the Caspian Sea area, it is surrounded onshore by producing fields, whilst a number of giant and super-giant fields have been discovered in the shallow waters offshore.

From Devonian to Permian times deposition in the Precaspian was dominated by carbonate followed by salt, resulting in a winning combination of huge carbonate platform reservoirs overlain by an excellent seal. The reefs that have developed over the period of approximately 100 million years achieve a vertical relief up to 1500m. Not surprisingly these are the traps that form the giant and super giant fields such as Tengiz and Kashagan.

Where vertical migration has been made possible through areas of thinned salt, further Mesozoic reservoir fields are found in sandstones draped over the salt highs and sealed by shales to provide stacked pay. Examples of these in and around the north Caspian Sea are Arman, Kalamkas and Prorva. These fields are typified by thin,

stacked pay and, for example, Kalamkas has at least 15 producing intervals throughout the Jurassic and Cretaceous.

Source rocks in this basin are found in Upper Devonian to Lower Carboniferous black shales, Middle Carboniferous black shales and Lower Permian black shales.

Very large fields dominate the Palaeozoic or pre-salt discoveries in the North Caspian Basin. Both Tengiz and Kashagan are reservoirs in pinnacle and barrier reef carbonates of Devonian to Permian age. They are also deep (>4,000m) and the reservoirs are highly overpressured.

The post-salt discoveries in the North Caspian Basin are also associated with salt domes, forming a mixture of structural and stratigraphic traps draped over the domes. The sequence of thin alternating sands and shales found throughout the basin provides massively stacked pay throughout the Mesozoic. Reservoir quality is generally good although oil quality can be highly variable with high sulphur content or waxy or resinous oils. Thus productivity from these fields can be quite low.

Examples of the larger fields of this type are Arman, which has been in production since 1994 and has approximately 11MMbbls of remaining reserves and Prorva which was discovered in 1964 and is still producing.

The Central Caspian Basin

The Central Caspian Basin is underlain by much deeper water than the North, exceeding 500m in the centre of the sea. It is bounded to the south by the Great Caucasus Fold Belt, Karabogaz Arch and Apsheron-Pribalkan uplifts and was formed in Late Permian-Triassic time on Hercynian (or Variscan), Devonian to Carboniferous, accreted rocks.

The Triassic to Tertiary age rocks present in the basin range from 3km thickness in the north to 6km in the south.

There is no Permian salt in the Central Caspian Basin to provide structure and seal but plenty of structure is provided on the flanks of the arches that traverse the basin from northwest to southeast. Traps tend to be four-way dip closures or fault bound closures or combination structural/stratigraphic traps.

Reservoirs in the basin comprise fractured carbonates of Triassic to Upper



Photo: Tahir Zaki

Elwyn Jones, VP Business Development of Veritas DGC, at the signing ceremony with the Minister of Energy & Mineral Resources, Baktykozha Izumkam-betov

Kazakhstan's history

The word Kazakh derives from the Turkic meaning a free and independent nomad although, by the 16th Century, three distinct hordes were established in the region.

In 1602 the Kalmuks and Djungar Mongols invaded the steppes, at the start of a time subsequently referred to by the Kazakhs as the Great Disaster, which lasted, on and off, for over a hundred years. In the 18th Century the Russians began expanding into the territory until, after a local revolt in 1860, the whole country was colonized by them.



Winter ice sculptures look out on the massive building programme in Almaty.

The country was effectively absorbed into the Russian state, suffering Stalin's collectivization of agriculture that led to the death of millions both in Kazakhstan and across Russia as a whole. A number of gulags were established in Kazakhstan for the control of Russian "dissidents" and the country was designated a resettlement area for millions of non-Russians who it was thought might pose a threat to the Russian leadership. Russian nuclear test programmes were also carried out in the country leaving behind a legacy of dangerous pollution.

With the collapse of the Soviet Union Kazakhstan regained its independence. It was a difficult transition, with falling industrial output and unemployment defining the early years. However, a strong government under President Nursultan Nazarbayev, elected in 1991, has turned the country around and now Kazakhstan's 15 million people enjoy the benefits of increased oil and gas production and a sustained growth rate of nearly 10% per annum.

A new capital city called Astana has been established in the centre of the country. Since 1997 its population has grown to over 600,000 and its breathtaking architecture and wide boulevards are emblematic of Kazakhstan's spectacular progress. However, being situated in the High Steppes means that the inhabitants endure extremes of temperature from -35°C in the winter to +40 °C in summer, together with very high winds. Almaty, the previous capital, is now a commercial centre and being situated in the southeast of the country, offers a more benign climate. The city is slowly modernizing and many of the more austere buildings of the communist era are now being replaced.

Oil revenue is Kazakhstan's main source of wealth. In the next five years oil and gas exports are set to more than double, making the country one of the world's top oil producers. The country is also rich in other natural resources. It has vast coal reserves, with the world's largest opencast coalmine at Bogatyr and there are also massive deposits of iron, manganese, bauxite, chromium, tungsten and uranium.

The Tree of Life Monument in the centre of Astana is "a symbol of life, a symbol of the people and a symbol of peace".



The early oil landscape in Kazakhstan.

Cretaceous age and clastic reservoirs of Triassic to Miocene age, sealed by shales.

Source rocks are present in Lower to Middle Triassic shales and possibly in Lower to Middle Jurassic shales. The Oligocene Maykop shales which are an important source rock in the Terek-Caspian Foredeep may also extend in to the Kazakhstan sector of the Central Caspian Basin.

A New Exploration Strategy

Recognising the need to sustain high levels of hydrocarbon production to keep pace with pipeline construction and the region's economic growth, the government has decided to prioritise exploration. It has launched a project entitled *The State Geophysical Survey of the Republic of Kazakhstan* to acquire seismic data over the whole of the Kazakh sector of the Caspian Sea. This survey, which will comprise 2D and 3D data acquisition, is to be carried out over the next five years by Veritas Caspian LLC, a joint venture between Veritas DGC Limited and Kazmorgeophisika CJSC. As the survey progresses, licence blocks will be offered to industry in competitive bidding rounds. This brings a more consistent approach to licensing and will allow a staged exploration strategy for the whole of the Caspian Sea.

The first area to be opened for seismic acquisition is the Shagala permit, which covers an area of 5,800km² in the shallow waters of the northern Caspian Sea. It is surrounded by giant oil fields with Kashagan to the north and northwest, Aktote to the northeast, Tengiz on its eastern boundary, Prorva to the southeast and Kalamkas More to the west. Approximately 1000km of 2D seismic data have been acquired over the permit in 2006, complementing and extending existing good quality seismic data acquired more than 10 years ago.



Photo: Steve Toothill