# Petroleum Geology of the Black Sea

## 6-7 October 2015

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# PROGRAMME

| Day One | |
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| 08.30 | **Registration** |
| 09.15 | **Welcome** |
| | **Session One:** |
| **09.30** | **Keynote: Aral Okay (Istanbul Technical University)**<br>Black Sea Basin Structure, History and Hydrocarbon Systems: A View from Russian and Turkish Sectors |
| 10.10 | **Rod Graham (Independent Consultant)**<br>The Deep Structure of the Black Sea Basins from Deep Seismic Reflection Data |
| 10.35 | **Nick Kusznir (Badley Geoscience)**<br>Black Sea Crustal Structure and Crustal Type from Integrated Quantitative Analysis of ION-GXT Deep Seismic and Gravity Anomaly Data |
| 11.00 | **Break** |
| 11.30 | **Rose Edwards (National Oceanography Centre)**<br>Wide-Angle Seismic Constraints on the Crustal Structure of the Eastern Black Sea Basin |
| 11.55 | **Neil Hodgson (Spectrum Geo)**<br>An integrated Exploration Model for the Eastern Black Sea. |
| 12.20 | **Aral Okay (Istanbul Technical University)**<br>Cretaceous Development of the Pontides and the Black Sea |
| 12.45 | **Lunch** |
| | **Session Two:** |
| **14.00** | **Keynote: Özgür Sipahioğlu (Turkish Petroleum)**<br>Revealing the Hydrocarbon Potential of the Turkish Western Black Sea: Time to Conclude or Carry on? |
| 14.40 | **Okan Tüysüz (Istanbul Technical University)**<br>Late Cretacous Stratigraphy of the Pontides: Implications for Palaeogeography and Tectonics |
| 15.05 | **Mike Simmons (Neftex)**<br>Syn-Rift Play Concepts for the Western Black Sea |
| 15.30 | **Break** |
| 16.00 | **Gabor Tari (OMV)**<br>Is the Eocene Shallow Water Carbonate Play on the Present-Day Shelf a Valid Play Type in the Deepwater of the Black Sea as well? |
| 16.25 | **Thomas Rainer (OMV)**<br>Thermal Maturity and Hydrocarbon Generation Potential of the Western Black Sea Basin |
| 16.50 | **Reinhard Sachsenhofer (Montanuniversität)**<br>Oligocene and Miocene Source Rocks in the Central and Eastern Parathetys |
| 17.15 | **Finish** |
| 17.15-19.00 | **Wine Reception** |

| Day Two | |
|---|---|
| 08.30 | **Registration** |
| 09.15 | **Welcome** |
| | **Session Three:** |
| **09.30** | **Keynote: Gabriel Ionescu (OMV)**<br>Romanian Black Sea Exploration - From Regional to Local |
| 10.10 | **Alexander Kitchka (Naftogaz of Ukraine)**<br>Hydrocarbon Exploration Offshore Ukraine: Historical Milestones, Prospecting Potential, Geological Challenges. |
| 10.35 | **David Boote**<br>Local Versus Regional Tectonic Controls on 2nd/3rd Order Sequence Architecture, Romanian Black Sea Shelf |
| 11.00 | **Break** |
| 11.30 | **Meghan O'Neill (CGG)**<br>Mesozoic – Cenozoic Palaeogeographic Reconstruction of the Black Sea Region: Implications for Reservoir and Source Rock Distribution |
| 11.55 | **Jan Mayer (OMV)**<br>Source Potential of Oligo-/Miocene Rocks in the Western Black Sea, Offshore Bulgaria |
| 12.20 | **Chris van Baak (Utrecht University)**<br>Revised Chronology for the Successions of the Eastern Paratethys: Towards A Better Understanding of Paleoenvironmental Change |
| 12.45 | **Lunch** |
| | **Session Four:** |
| **14.00** | **Keynote: Stephen Vincent (CASP)**<br>Predicting Siliciclastic Reservoir Presence and Quality in the Black Sea |
| 14.40 | **Arjan de Leeuw (CASP)**<br>Field Insights Into Sediment Delivery to the Northwest Black Sea |
| 15.05 | **Gabor Tari (OMV)**<br>The Importance of Miocene to Recent Mass Transport Complexes in the Western Black Sea |
| 15.30 | **Break** |
| 16.00 | **Iuliana Vasiliev (Utrecht University)**<br>Recurrent Phases of Drought in the Miocene of the Black Sea Region |
| 16.25 | **Chris van Baak (Utrecht University)**<br>A Greigite-Based Magnetostratigraphic Time Frame for the Late Miocene to Recent DSDP Leg 42B Cores from the Black Sea |
| 16.50 | **Csaba Krezsek (OMV)**<br>The Messinian Sea-Level Fall in the Black Sea: Small or Large? Insights from Offshore Romania |
| 17.15 | **Finish** |

# POSTER PROGRAMME

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|---|
| **Keith Richards (KrA Stratigraphic Ltd)**<br>A New High-Resolution Biostratigraphic and Magnetostratigraphic Study of the Akchagylian Stage in Outcrop from the Gobustan Region of Azerbaijan, Western Caspian Sea |
| **Adrian Bestwick (CGG MCNV)**<br>Regional Seismic Datasets: The First Stage in Evaluating the Petroleum Prospectivity of New Frontiers. |

# Oral Presentation Abstracts

## (Presentation order)

# Tuesday 6 October

## Session One

# Keynote Speaker: Black Sea Basin Structure, History and Hydrocarbon Systems: A View from Russian Sector

Anatoly M. Nikishin[1] and **Aral Okay[2]**

*1Geological faculty, Moscow State University*
*2 Istanbul Technical University*

*In cooperation with:* E. Petrov, O. Almendinger, and AMityuov, *Moscow*
Okan Tüysüz, *Istanbul*

Our works are based upon results of interpretation of about 8872 km-long regional seismic lines acquired in 2011 within the international project Geology Without Limits in the Black Sea. The seismic lines cover nearly the entire Black Sea Basins, including Russia, Turkey, Ukraine, Romania and Bulgaria sectors. We have used 2D and 3D seismic data interpretation for Russian and Ukrainian parts of the Black Sea. A new map of acoustic basement relief and a new tectonic structure scheme are constructed for the Black Sea Basins. The basement of the Black Sea includes areas with oceanic crust and areas with highly rifted continental crust. A chain of buried seamounts, which were interpreted as submarine volcanoes of Late Cretaceous (Santonian to Campanian) age, has been identified to the north of the Turkish coast. On the Shatsky Ridge, probable volcanoes of Albian age have also been recognized. Synorogenic turbidite sequences of Paleocene, Eocene and Oligocene ages have been mapped. In the Cenozoic, numerous compressional and transpressional structures were formed in different parts of the Black Sea Basin. During the PleistoceneeQuaternary, turbidites, mass-transport deposits and leveed channels were formed in the distal part of the Danube Delta. A new lithostratigraphy scheme has been compiled for theWestern Black Sea Basin and a new geological history scheme from Middle Jurassic till Neogene is suggested for the entire Black Sea Region. Continental rifting manifested itself from the Late Barremian to the Albian while the time of opening of the basins with oceanic crust was from Cenomanian till mid Santonian; origination of the Western and Eastern Black Sea Basins took place almost simultaneously. During Cenozoic time, numerous compressional and transpressional structures were formed in different part of the Black Sea Basins. It is shown that in Pleistocene-Quaternary time, turbidities, mass-transport deposits and leveed channels were being formed in the distal part of the Danube Delta.

We discuss hydrocarbon systems of the Black Sea Basin for Russian sector of Black Sea.

**NOTES**

## The Deep Structure of the Black Sea Basins from Deep Seismic Reflection Data

Paul Bellingham[1], **Rod Graham[2]** and Nuretdin Kaymakci[3]

[1]*ION Geophysical*
[2]*Independent Consultant*
[3]*Dept of Geological Engineering, Middle East Technical University*

New deep seismic data in the Black Sea have added an important dimension to our understanding of the geometry and evolution of the Black Sea basins. It has been accepted that the two Black Sea basins are back-arc basins which opened at different times (mid and late Cretaceous), in response to the northward subduction of the Neotethys, and that they are both partly floored by oceanic crust. The new data enable us to see something of the nature of the continent-ocean transition of the basin margins and suggest that there might be a need to modify the established plate tectonic model of Western Black Sea opening. We will demonstrate that stretched continental crust exists in the SW corner of the Western Black Sea giving way north-eastwards to oceanic crust and implying 'fan shaped' opening as in the Eastern Basin.

We will show that the nature of the passive margins of the Black Sea oceanic basins fit neither of the magma-rich and magma-poor end members which can normally be clearly imaged and differentiated on deep reflection seismic data. On ideal magma-poor margins the continental Moho can be seen to rise to the base of the sediment pile at the continental edge and the sub-continental mantle must once have been exposed at the sea floor, with well-defined oceanic crust developed some distance ocean-ward. Magma-rich margins are characterised by seaward dipping reflectors (SDRs) which cloak the collapsed continental margins. SDRs are generally easily identifiable on deep reflection seismic data.

Neither of these diagnostic features is visible on the very abrupt continent-ocean transitions of the Black Sea basins, and we speculate on what this might mean for the tectonics of basin opening and the implications for the plate tectonic context and the thermal evolution of the basin.

**NOTES**

# Black Sea Crustal Structure and Crustal Type from Integrated Quantitative Analysis of ION-GXT Deep Seismic and Gravity Anomaly Data

**Nick Kusznir**[1], Leanne Cowie[1] & Alan Roberts[1], Paul Bellingham[2], Rod Graham[2], Nuri Kaymakci[2]

[1]*Badley Geoscience, Hundleby, Lincolnshire, PE23 5NB, UK*
[2]*ION Geophysical / GX Technologies, Egham, Surrey, UK*

The composition and thickness of crustal basement are critical to frontier hydrocarbon exploration in deep-water, rifted-continental-margin settings. For the Black Sea we need to know the distribution of continental and oceanic crust, ocean-continent-transition structure and magmatic type (magma-poor, normal or magma-rich).

We have applied a set a quantitative analytical techniques to interpretations of ION-GXT's deep long-offset seismic-reflection Black Sea SPAN data. These techniques consist of:

(i) gravity inversion, incorporating a lithosphere thermal-gravity-anomaly correction, giving Moho depth, crustal-basement thickness & continental-lithosphere thinning

(ii) residual depth anomaly (RDA) analysis, showing departures from "standard" oceanic bathymetry

(iii) subsidence analysis, using 3D flexural-backstripping, to predict lithosphere thinning.

Application of these quantitative analytical techniques maximises the geological value of the seismic data. Superposition of the 3D Moho-surface, determined from gravity inversion, onto PSDM and PSTM seismic sections provides assistance to, and validation of, deep-seismic-reflection interpretation. The integrated interpretation of the results is used to determine OCT structure and crustal type for each ION seismic line.

The older (~100Ma) Western Basin shows a rim of thin or absent crustal-basement (hyper-extended crust) sitting between thinned continental-crust and oceanic crust. While the ocean-continent-transition of the Western Basin is magma-poor it appears that the mantle was not exhumed, rather it was covered by syn-rift volcano-clastic sediments. In contrast the younger (~60Ma) Eastern Basin is more magma-rich with a typical OCT structure.

The quantitative analysis has been used to produce whole-basin maps of crustal-basement thickness and continental-lithosphere thinning. Continental radiogenic-heat-productivity contributes significantly to hydrocarbon maturation; in contrast oceanic crust or exhumed mantle contributes little. The maps from our analysis are used to predict both the continental-radiogenic and transient-thermal heat-flow contributions. Output from our 3D quantitative analysis of the Black Sea includes grids of lithosphere-thinning , β-factor and heat-flow-history, for input to petroleum systems modelling.

**NOTES**

## Wide-Angle Seismic Constraints on the Crustal Structure of the Eastern Black Sea Basin

T. A. Minshull[1], D. J. Shillington[2], **R. A. Edwards[3]**, C. L. Scott[4] and N. J. White[5]

[1]*University of Southampton*
[2]*Lamont-Doherty Earth Observatory*
[3]*National Oceanography Centre*
[4]*BG Group*
[5]*University of Cambridge*

The Eastern Black Sea Basin was formed by back-arc extension behind subducting Neotethys oceanic lithosphere during Cretaceous to Cenozoic times. The crust beneath the basin is buried beneath up to c. 10 km of sediment and its nature is poorly known. In 2005, we acquired four crustal-scale wide-angle seismic profiles in the eastern Black Sea. Two of these profiles crossed the southern margin of the basin and extended into the central part of the basin; one c. 400 km profile sampled the axis of the basin from Andrusov Ridge in the west to the southeastern coast of the Black Sea; and one profile crossed the Andrusov Ridge and sampled part of the Western Black Sea Basin. The profiles across the basin margin revealed to the east a velocity structure indicating the presence of oceanic crust up to 13 km thick and substantial magmatic addition to the adjacent continental crust; and to the west 7-9 km continental thick continental crust without significant magmatic addition. Crustal thinning profiles are similar to profiles of lithospheric thinning inferred from subsidence analysis, providing evidence for uniform extension. The profile along the basin axis shows an abrupt transition between thick oceanic and thinned continental crust over a distance of c. 20 km. The profile across the Andrusov Ridge shows a crustal thickness of c. 20 km beneath the ridge, reducing to c. 6 km at the edge of the western basin. The profiles also reveal the presence of low-velocity zones at c. 6-8 km depth within the sediments, attributed to overpressure, beneath both basins.

**NOTES**

**An Integrated Exploration Model for the Eastern Black Sea.**

**Dr Neil Hodgson**, Karyna Rodriquez and Jevon Hilder, *Spectrum Geo, Woking, UK.*

The Turkish coast of the East Black Sea is comparable in size to the Gulf of Mexico and displays a working oil generative source, yet only a handful of wells have been drilled off the shelf to date. Partly this is due the narrowness of the shelf and only recently being able to explore in required water depths. However, it also reflects the industry's response to the results from the first wells in the basin.

Well data and basin modelling indicate that the Oligo-Miocene Maykop Formation is a working oil source in the Eastern Black sea. We review the evidence, including provisional data from 2015 2D seismic, for the existence of trapping geometries in the carbonate and Tertiary clastic play. The primary risk for exploration in the Eastern Black Sea would appear to be the presence of an effective reservoir, either carbonate or clastic. Both carbonate and clastic plays are reviewed, and we conclude that the primary potential for exploration lies in the Tertiary clastic play.

Only two wells have been drilled on this play to-date, the Hopa-1 well and the Surmene-1, 1RE well. The results of these wells are reviewed in light of legacy and 2015 seismic. We integrate these results with a model of the structural development of the basin, particularly the northern margin, and the consequent development of the provenance for clastics from the Oligo-Miocene to Recent times. Whilst the Upper Miocene to recent sequence appears dominated by clastic input from the Rioni Delta to the east in Georgia, prior to this, a quartz-rich sediment supply from the north is proposed, and a mechanism to negotiate the basin architecture presented.

Integration of exploration to date, with models for reservoir distribution, basin formation and basin modelling suggest that an untested clastic play exists in the Eastern Black Sea where high quality clastic reservoir is intimate with, or even contained within, the main source rock. This play is therefore very prospective for oil, and has the potential for multiple prospects, with playmaker repeatability.

**NOTES**

## Cretaceous Development of the Pontides and the Black Sea

**Aral I. Okay**, *Istanbul Technical University, Eurasia Institute of Earth Sciences and Department of Geology, Maslak 34469 Istanbul, Turkey*

Cretaceous period in the Black Sea region was a time of subduction, opening of the Black Sea and the inception of continental collision. Cretaceous started inconspicuously with carbonate deposition throughout the Black Sea region. A wide, carbonate platform extended from Crimea to the Pontides and passed south to a continental margin characterized by calciturbidites and pelagic micrites. The carbonate deposition continued from Late Jurassic into Berriasian/Valanginian with no evidence for subduction and for the existence of a Black Sea basin; Crimea was adjacent to the Pontides. Widespread uplift and erosion occurred during the Valanginian/Hauterivian, probably associated with renewed northward subduction. Uplift or nondeposition continued during the Barremian-Albian along most of the Eastern and Western Pontides, whereas a large submarine turbidite fan developed in the Central Pontides. The turbidite fan extended from the East European Platform south into the active continental margin of the Tethys. The distal parts of the turbidite fan were trapped into the trench and were underplated during the Albian. Albian also saw the accretion of a large oceanic crustal subduction complex with eclogites and blueschists to the southern margin of the Pontides. The continuity of the turbidite basin from the East European Platform south to the Tethys and widespread Albian contractional deformation in the southern parts of the Pontides indicate that the Black Sea was not open as a rift basin during the Albian. The Albian orogeny was followed by widespread subsidence during the Santonian. Red pelagic limestones and associated volcanic rocks of Santonian age lie unconformably over a wide range of basement lithologies. The Santonian subsidence of the Pontides marks the creation of oceanic lithosphere in the Black Sea, possibly through the splitting of the magmatic arc. Arc volcanism continued through the Campanian and was replaced by carbonate deposition in the Maastrichtian and Paleocene.

**NOTES**

# Tuesday 6 October
## Session Two

## Keynote Speaker: Revealing the Hydrocarbon Potential of the Turkish Western Black Sea: Time to Conclude or Carry On?

**Özgür Sipahioğlu,** *Turkish Petroleum, Ankara, Turkey*

Since late 1990s, Turkish Petroleum (TP) has been conducting an aggressive exploration campaign in the deep/ultra-deep waters of the Turkish Black Sea that led to acquisition of more than 140,000 km two- and 16,500 km2 three-dimensional seismic data and drilling of 8 wells.

Interpretation of enormous amount of seismic data combined with well data and recent encouraging successes have resulted in evolution and refining of TP's ideas on the prospectivity of the Turkish sector of the Western Black Sea (TWBS) through the years. Currently, there are three provenance-based major exploration concepts that stand out in TP's portfolio and are planned to be tested in the near- and mid-future. The first one dominates the western part of the TWBS and is composed of Oligocene-Lower Miocene turbidites, which are interpreted to have been sourced from the northwest, possibly through Kaliakra Canyon in Bulgaria. Several structural and stratigraphic plays and prospects, which are associated with this concept, have already been identified, evaluated and ranked. If the concept is proven, it is very likely that the area will witness a series of drilling activities in the near-future. The second exploration concept covers the northern part of the TWBS and is characterized by Upper Miocene-Pliocene channel/fan complexes that were sourced from palaeo-Danube and/or Dnieper rivers constituting the downdip equivalents of the turbidites, which have been successfully tested in Neptun Block in the Romanian sector of the Black Sea, recently. The whole system covers an area of more than 10,000 km2 and possesses both stratigraphic and structural leads, which are currently being evaluated using the recently acquired dense two-dimensional seismic data. Being restricted to the eastern part of the TWBS, the third exploration concept is the Lower(?)/Middle Miocene turbidites, which might have been sourced from the north, possibly Ukraine. The concept is composed of multiple structures with four-way closure. However, more data from outside the Turkish sector are needed to mature this concept.

Besides being located in a hard-to-access part of the world for the oil industry (given the difficulties of mobilising appropriate drilling units into this basin), the TWBS is also challenged by water depths that reach up to 2,200 m and has already witnessed a few unsuccessful exploration attempts in the last decade. Yet, having at least these three major play concepts in its portfolio, the area possesses a promising exploration future.

**NOTES**

## Late Cretacous Stratigraphy of the Pontides: Implications for Palaeogeography and Tectonics

**Okan Tüysüz**, *Istanbul Technical University, Eurasia Institute of Earth Sciences and Faculty of Mines, 34469, Maslak, Istanbul, Turkey*

The Pontides consists of two tectonic units, the Istanbul Zone in the west and the Sakarya Zone in the east. Cretaceous sedimentation on the Istanbul Zone started during the late Barremian and lasted until the Aptian. Albian and Cenomanian was a time of uplifting and erosion on this zone. On the Sakarya Zone sedimentation started during the Hauterivian and continued until the Aptian with deepening upward turbidites with abundant debris flows and olistoliths. Deep marine red and black shales and radiolarian cherts deposited during the Cenomanian and Turonian. These regional differences of the stratigraphy of the Lower Cretaceous sediments, together with their sedimentary characteristics, possibly indicate different palaeogeographic positions of both tectonic units during the early Cretaceous.

Turonian to Campanian is characterized by two periods of magmatism and associating sedimentation on both tectonic units. First stage of magmatism accompanying to syn-rift deposits of the Middle Turonian to Lower Santonian represent a magmatic arc developed in response to northward subduction of the Tethys Ocean to the south, and associating extensional tectonic regime. The whole southern Black Sea coast subsided and changed into a deep marine environment during the late Santonian. This period marks the end of the first stage and possibly breaking up the continental lithosphere. Second stage of the magmatism was active during the Campanian, which was derived from both a depleted mantle source enriched by a distinct subduction component, and an enriched asthenospheric mantle source. This stage possibly indicates thinning of the lithosphere and upwelling of the asthenospheric mantle in the mature stages of the rifting.

Based on these stratigraphic, palaeontologic and geochemical data an alternative tectonic model will be discussed in this presentation.

## NOTES

## Syn-Rift Play Concepts for the Western Black Sea

**Mike Simmons**, Andrew Lavender & Owen Sutcliffe, Neftex, *97 Jubilee Avenue, Milton Park, Oxford, OX14 4RW, UK.*

Geodynamic reconstructions of the Black Sea region point to an episode of extension within the Barremian-Aptian period. This extension is expressed as a series of tilted fault blocks visible from regional outcrop mapping and visible on regional seismic data. Associated sedimentation patterns include the transgression of structural highs with clastic and carbonate shelfal sediments, whilst in the basins created during extension, clastic turbidite systems are present along with potential source rocks. Regional seal is created by the pelagic carbonates of the Late Cretaceous post-rift drift succession.

Outcrop analogues in Northern Turkey and Crimea suggest that shelfal sands may have reservoir potential in porous and permeable quartz-rich sands derived from local Pre-Cambrian massifs. Shelfal carbonates are highly cyclic and have multiple phases of exposure within them, possibly creating enhanced reservoir quality in the subsurface.

In the structural lows between the highs, deeper water clastic facies are prevalent and these form a variety of facies types dependent on proximity to uplifted blocks, angle of slope and provenance source. However, relatively clean sands may be present in those rock units derived from the Ukrainian Shield.

In the literature there is much speculation on the presence of syn-rift source rocks in the Western Black Sea. Onshore seeps and relatively lean organic enrichment within Barremian-Aptian sediments offer unconfirmed possibilities of genuine source rock deposition in offshore depocentres.

Play concepts based on these observations will be discussed.

**NOTES**

## Is the Eocene Shallow Water Carbonate Play on the Present-Day Shelf a Valid Play Type in the Deepwater of the Black Sea as Well?

**G. Tari[1]**, M. Fallah[1] , W. Kosi[1], Z. Bati[2], Ö. Sipahioğlu[2], Z. Bega[3] and Cs. Krezsek [3]

[1]*OMV, Vienna, Austria*
[2]*Turkish Petroleum, Ankara, Turkey*
[3]*Petrom, Bucharest, Romania*

Given the very few numbers of deepwater wells drilled in the Black Sea to date, ongoing exploration efforts frequently use reservoir analogs from the well-known coastal and shelf areas of the Black Sea. In particular, the well documented cases of Eocene neritic limestone units with potentially good reservoir characteristics along the coast of the Black Sea, e.g. at Karaburun, NW Turkey, or at Belogorsk, Crimea, highlight the possibility of having the same age rocks targeted in offshore exploration. The age of the shallow water carbonate units range from Middle to Late Eocene and they have locally good reservoir characteristics (e.g. porosity up to 25%).

There are some documented cases of offshore Eocene carbonate reservoirs on the present-day shelf of the Black Sea, e.g. in the Romanian sector. However, even within the paleo-shelf, there is typically a break between potential reservoir facies (mixed carbonate and siliciclastic facies with nummulites), like in the case of the Bulgarian coastal basin and shelf. In this part of the Black Sea, the potential Eocene reservoir rock facies transitions to non-reservoir units with increasingly higher marl content.

In terms of exploration plays, the question then is whether one can expect similar shallow water Eocene carbonate reservoirs in the present-day deepwater of the Black Sea? At least one well (Sinop-1), tested the Eocene sequence in a paleo-deepwater setting, drilling into the Mid-Black Sea High. Whereas the primary exploration targets were prognosed deeper in the well, the Eocene strata turned out to be a deepwater, pelagic non-reservoir marl sequence deposited on the paleo-basin floor.

The Black Sea opened up during the Cretaceous and therefore the Eocene sequence is part of the post-rift basin fill. The deepwater sedimentation was already in place in most parts of the basin by Senonian times and it continued until the Present as the basin floor is still located in about 2,200 m water depth. Therefore the absence of shallow-water, reservoir facies Eocene carbonate units as reservoir targets (either reefal buildups or nummulitic banks) should not be surprising in a drilling location anywhere basinward of the Eocene shelf break.

In conclusion, one cannot extrapolate the neritic carbonate play from the shelf area into the basin center, into the paleo-deepwater basin, as pelagic, non-reservoir marls were deposited there at the basin floor and the slopes. With other words, the Eocene neritic carbonate play over the prominent intra-basin structural highs of the Black Sea Basin, such as the Polshkov, Mid-Black Sea, Tetyaev and Shatsky Highs, should be considered very risky, at best.

## NOTES

## Thermal Maturity and Hydrocarbon Generation Potential of the Western Black Sea Basin

**Rainer, T.**[1], Olaru, R.[2], Kosi, W.[1], Krezsek, C.[2], Ungureanu, C.[2], and Tari, G.[1]

[1]*OMV, Vienna, Austria*
[2]*Petrom, Bucharest, Romania*

The Western Black Sea Basin (WBSB) is a large basin filled with 15+ km thick Cretaceous syn-rift and Cenozoic post-rift sediments. Several hydrocarbon accumulations have been found in the WBSB to date, proving the presence of both thermogenic and biogenic petroleum systems. The main source rock (SR) in the WBSB is the oil/gas-prone Oligocene to Lower Miocene Maykop Formation. Additional oil/gas potential might be provided by the Middle Eocene Kuma Formation. The presence of oleanane biomarker in oil fields on the Romanian shelf proves the existence of a Cenozoic thermogenic petroleum system. A syn-rift Lower Cretaceous SR remains speculative at present. The pre-rift Jurassic (e.g. Etropole Formation) is thought to co-contribute to the oil/gas in the Tjulenovo field located at the Bulgarian coast.

Offshore Bulgarian well data show that the Cenozoic source rocks are thermally immature on the present-day shelf, i.e. no break in coalification between the Mesozoic rocks and the overlying basin fill can be found. In order to unravel the thermal history and the timing of hydrocarbon generation in the undrilled deep water parts of the basin, a 3D basin model was created for the WBSB using PetroMod® software. Paleo-heat flow maps were created using newly acquired and also published data. Heat flow at the shelf is in the range of 40-50 mW/m², decreasing in the deep segments of the basin to <30 mW/m².

The modeling results show the oil window is located at ~3600 m below the sediment surface at present and the top of the wet gas window is expected at ~6500 m. On deepwater the slope of the WBSB, the Maykop Formation and Eocene strata are in the oil window at present. These Cenozoic SRs generated hydrocarbons since Early Miocene. The speculative Lower Cretaceous syn-rift SR entered the oil window during Late Oligocene and is currently at the onset of the wet gas window. The 3D basin modeling results, using thermogenic kinetics, are clearly very encouraging for the unexplored deepwater parts of the WBSB.

## NOTES

## Oligocene and Miocene source rocks in the Central and Eastern Parathetys

**Sachsenhofer R.F.[1]**, Bechtel A.[1], Gratzer, R.[1], Coric S.[3], Hentschke, J.[1], Mayer J.[2], Popov, S.V.[4], Rupprecht B.[1], Samsu, A.[1], Zdravkov, A.[5]

[1]*Department Applied Geosciences and Geophysics, Montanuniversitaet Leoben, Austria*
[2]*OMV Exploration and Production GmbH, Austria*
[3]*Geological Survey of Austria*
[4]*Paleontological Institute RAS, Moscow, Russia*
[5]*Department of Economic Geology, University of Mining and Geology "St. Ivan Rilski", Sofia, Bulgaria*

Oligo-/Miocene deposits are considered the main source rocks in the Black Sea area. However, source rock data exist only from a small region along the western margin of the basin. Within the frame of the present contribution, organic geochemical data from different parts of the Paratethys (Alpine Foreland Basin, Carpathians, Black Sea, Caucasus) are presented In order to reveal regional trends.

Prolific source rocks with high TOC contents (up to >10%) and HI values in the order of 600 mgHC/gTOC exist in the Lower Oligocene succession of the Central Paratethys. The bright colored brackish-water Dynow Formation forms a significant marker horizon. Upper Oligocene and Lower Miocene rocks may contain high TOC contents, but their HI values are generally lower (<420 mgHC/gTOC).

In the western part of the Eastern Paratethys (western Black Sea), Oligocene rocks typically contain ~2% TOC with HI values up to 400 mgHC/gTOC in the Lower Oligocene section (including equivalents of the Dynow Fm.) and with HI values <300 mgHC/gTOC in the Upper Oligocene section. However, HI values are higher in Miocene diatom-rich sediments drilled offshore and onshore Bulgaria.

In the central part of the Eastern Paratethys (south of Maykop) Oligocene sediments contain about 1.5 to 2.0% TOC with HI values <300 mgHC/gTOC. Higher HI values are restricted to a thin interval below and above the Ostracoda Bed, a time-equivalent of the Dynow Marlstone. In Upper Oligocene deposits HI values decrease upwards and remain low (~100 mgHC/gTOC) in Lower Miocene rocks. Oligocene sediments with moderate TOC contents and generally low HI values have also been studied in Georgia and Azerbaijan.

Hence a general trend with eastward decreasing source rock quality can be observed. Apart from that, Lower Oligocene rocks typically host a higher hydrocarbon generation potential than Upper Oligocene rocks. Miocene diatom-rich deposits are locally very good source rocks.

**NOTES**

# Wednesday 7 October

## Session Three

## Keynote Speaker: Romanian Black Sea Exploration – From Regional to Local

G. Ionescu, Cs. Krezsek and Z. Bega, *OMV PETROM SA, Romania*

Recent exploration results of Domino 1 shifted the exploration focus in the Romanian part of the Western Black Sea from the Albian to Eocene oil and gas play located on the shelf, to the deep-water Miocene plays. Despite this focus shift, the classic oil and gas play remains a very attractive target, as shown by the recent exploration results of Marina 1 well. The very extensive seismic acquisition campaigns developed, in the recent years, offshore Romania and in the overall Black Sea Basin have opened the path for new regional geological studies. In our presentation we are going to briefly discuss some examples about how the OMV Petrom geoscientists have used the regional studies in order to support individual exploration projects.

The Albian play is related to inverted extensional faults with Early Cretaceous syn-rift deposits. These syn-rift depocentres represent an area of stretched continental crust of a failed rift arm (Histria basin) that was active during the rifting of the Western Black Sea. The Early Cretaceous extensional faults have been inverted in the Late Cretaceous and Paleogene to form several structural trends with good trapping potential. Several inversion styles have been interpreted and the understanding of these is key for the current exploration in the area.

The 3D basin modelling indicates that the charge kitchen for the Cretaceous play in the Histria basin is located further to the east, requiring tens of kilometers of lateral migration. Expulsion of hydrocarbons started during the Late Miocene and probably followed two main migration paths westward of the fully charged East Lebada High.

Maykop deposition started with a major relative sea level drop by the end Eocene, which exposed the previous shelf areas and carved out a major erosional feature (Histria Canyon). The relative sea-level fall triggered lowstand deposits with deltaic sediments in the basin center, possibly interbedded with highly anoxic black shales. Later, during the Rupelian, transgressive sedimentation resumed on the shelf and buried the inverted syn-rift highs. Locally, good quality shallow-marine sands shed from a quartz rich northern source were deposited at the front of incised valleys. These have a good stratigraphic trapping potential, as tested by the Portita wells.

The Upper Maykop (Chattian to Burdigalian) sedimentation became dominantly progradational, with large-scale clinoforms interpreted on seismic data. Seismic attribute mapping indicates the presence of slope channel-levee systems and basin floor fans. These have not been tested by any wells, but may represent attractive exploration targets for the future.

**NOTES**

## Hydrocarbon Exploration Offshore Ukraine: Historical Milestones, Prospecting Potential and Geological Challenges

**Alexander Kitchka,** Sergii Vakarchuk, and Tetiana Dovzhok, *Naftogaz of Ukraine*

Commercial development of the Black Basin hydrocarbon resources has started with the discovery of the Golitsyn gas condensate field, offshore Ukraine, in 1975. Since that time Ukraine has discovered 14 offshore gas and condensate fields and one oil field (Subbotin). This last discovery underlined the hydrocarbon potential of the East Black Sea being the only offshore discovery in that part of the Black Sea to date. Extensive geologic and geophysical data sets, including 2D/3D reflection seismic and well data, coupled with integrated interpretation including sequence stratigraphy, production hgeology, petroleum systems and formation pressure analysis positioned Ukraine to boost its offshore proved reserves and enter the deepwater exploration frontier. Main targets include the pre-Pliocene Neogene, the Lower Miocene to Oligocene Maykop, the Eocene-Paleocene and Upper Cretaceous clastic and carbonate reservoirs. The Lebada play, proven and well understood in offshore Romania with its Lower Cretaceous reservoirs, is still on the exploration agenda. The Ukrainian sector of the Black Sea possesses the biggest exploration prospect portfolio in an easy-to-develop shallow-water setting in the basin. Moreover, the inner shelf offers even more extensive and practically unexplored areas. Ukraine's Naftogaz subsidiary PJSC ChornomorNaftogaz was recently relocated to Odessa to re-design and re-focus for the time being the exploration programs offshore Ukraine for intrashelf sub-basins within the Odessa Gulf and north of Sea of Azov.

**NOTES**

## Local versus Regional Tectonic Controls on 2nd/3rd Order Sequence Architecture, Romanian Black Sea Shelf

**D.R.D. Boote & A.W. Baird**

The Istria 'Depression' or sub-basin of offshore Romania lies at the intersection of the trans-European Tornquist-Teisseyre 'Zone' and the Black Sea back arc basin, just outboard of the East Carpathian orogenic welt. Its Late Mesozoic-Cenozoic succession records an extraordinary polyphase history of subsidence and sedimentation, interrupted by several quite spectacular 2nd/3rd order erosional unconformities, reflecting the interplay between these tectonic domains. The unconformities divide the succession into a number of stratigraphic sequences.

The sub-basin first developed as a transtensional rift in the Triassic-Early Jurassic, evolving into a narrow oceanized trough in later Jurassic. This was tilted west during the Early Cretaceous by uplift and rifting in the Western Black Sea and the residual Late Jurassic topography was filled and buried by a west-facing clastic-evaporite wedge. Late Aptian-Albian post-rift subsidence and spreading in the Western Black Sea imposed a strong easterly tilt, encouraging the partial evacuation of its Early Cretaceous sedimentary fill by gravity-driven mass wastage. The incised valley topography was subsequently buried in the later Cretaceous and Early Cenozoic. During the mid-Late Cenozoic, the Black Sea basin experienced intermittent periods of partial to complete isolation from the world ocean and significant base-level drawdown. The first major sea level fall occurred in the Eocene when the Istria 'Depression' was deeply incised, to be healed by Oligocene shales during the subsequent rise. Yet another period of drawdown and exposure occurred in mid-Miocene with extensive shelf margin mass wastage and erosion, followed by reflooding and deposition of a transgressive backstepping sequence in mid-late Miocene. Messinian drawdown in the Mediterranean caused a further period of isolation and falling base level. The shelf margin was again exposed and experienced widespread mass wastage and slumping. A marine connection was re-established in late Messinian. Rising sea level eroded the earlier slumped sequence and the margin was healed by a lowstand prograding wedge in late Miocene-early Pliocene. This was followed by shelf sedimentation in the Plio-Pleistocene periodically interrupted by canyon incision events, testifying to continued climatically or tectonically-imposed base level fluctuations.

Several direct and indirect tectonic factors were responsible for valley/canyon incision within the Istria Depression and erosion of the Romanian Black Sea shelf margin. These include: **(1)** ***the local structural framework*** **(2)** ***direct tectonic uplift and tilting*** **and (3)** ***more indirect tectonically imposed isolation encouraging significant base level falls.***

**NOTES**

## Mesozoic – Cenozoic Palaeogeographic Reconstruction of the Black Sea Region: Implications for Reservoir and Source Rock Distribution

**O'Neill, Meghan;** Iwaniw, Eugene and Carrillo, Eduardo, *CGG*

The Black Sea region, located on the southern margin of the East European Craton, has undergone a complex geodynamic history. A new tectonic model for the region has led to the revision of existing palaeogeographic reconstructions.

Eight palaeogeographic maps have been produced using extensive seismic and well data covering the offshore Black Sea region and data from numerous fieldwork seasons from relevant onshore basins. The time slices covered are as follows: Late Triassic - Early Jurassic, Tithonian, Neocomian, Aptian-Albian, Late Cretaceous- Early Paleocene, Eocene, Oligocene – Miocene and Miocene - Pliocene. These include the most important reservoir, seal and source horizons in the Black Sea region. The palaeogeographic maps are presented on palinspastically reconstructed bases underpinned by a proprietary deformable plate model software and illustrate the complex interplay of tectonic processes and eustatic sea level changes.

The Late Triassic – Early Jurassic represents the economic basement in many parts of the Black Sea, with mainly deepwater clastic shelf and deepwater flysch sediments being deformed during the Cimmerian Orogeny. The Tithonian was a time of widespread carbonate sedimentation and contains important reef reservoir facies. Following a period of tectonic quiescence in Neocomian times, the Aptian-Albian and Late Cretaceous – Early Paleocene mark important rifting/drifting events in the Black Sea. The palaeo-topography was created as a response to sinistral transtensional fault movement along the extension of the Tornquist–Teisseyre fault system into the Black Sea area. Coastal, shelf and deepwater sediments that constitute important carbonate and clastic reservoirs, seals and source horizons were laid down at this time along WNW-ESE trending palaeogeographic belts sub-parallel to the main fault system. During the Eocene and Oligocene – Miocene, inversion occurred throughout the Black Sea region (transpressional movements along the NW-SE fault trend) creating a marked submarine topography into which the main clastic source rocks were deposited in the basin and traps were formed; the important Maikop source rock was deposited at this time in widespread deep marine environments. Following collision (uplift?) of the Pontides in the south of the Black Sea and Carpathian closure, the Miocene - Pliocene represents a period of palaeogeographic isolation during which organic-rich source rocks were extensively deposited. Drainage network studies illustrate possible palaeo-sediment input points throughout the basin margin at this time, providing important sandstone reservoir development and stratigraphic targets in the basin.

**NOTES**

## Source Potential of Oligo-/Miocene Rocks in the Western Black Sea, Offshore Bulgaria

**Mayer J.**[1], Sachsenhofer R.F.[2], Tari G. 1, Kosi W.[1], Bechtel A.[2] and Coric S.[3]

[1]*OMV Exploration and Production GmbH*
[2]*Department Applied Geosciences and Geophysics, Montanuniversitaet Leoben, Austria*
[3]*Geological Survey of Austria*

Cuttings and core samples from three wells offshore Bulgaria were studied to quantify their source potential, to detect vertical and lateral changes in their source potential and to correlate them with other source rocks of the Paratethys region.

Based on 2D seismic lines, well logs and considering source rock data from a previous study, carried out on four additional wells, a depositional model was established.

The depositional model includes five depositional units (from bottom to top: I to V). Unit I and represents the Oligocene Ruslar Formation, which overlies Eocene sediments with a major erosional unconformity (Sachsenhofer et al., 2009). Units II to V, separated by erosional surfaces, form the newly introduced Oligocene to Miocene Samotino Group, which represents the fill of a major palaeochannel.

Dysoxic to anoxic conditions with mainly aquatic organic matter alternate with terrestrial dominated oxic to anoxic intervals. During periods with strong anoxia free H2S in the water column existed. A carbonate-rich layer (up to 51 % calciteequiv), Rupelian in age (NP23), forming the upper part of the Unit I has been deposited in a basin with reduced salinity. It is a time equivalent of the Dynow Fm. in the Alpine and Carpathian foreland basins and the Ostracoda Bed in the Caucasus region.

Brackish surface water conditions, combined with an upwelling event, lead to the deposition of the diatom rich source rock interval in the Samotino Gp. (Unit IV). A basin-wide upwelling event in the Paratethys, which migrates from the west to the east over time, is indicated by the occurrence of early Miocene diatoms in Lower Austria (Molasse Basin), middle Miocene diatoms in the study area and middle to late Miocene diatoms in the Southern Caspian Basin.

Organic carbon contents are 1-2 %, locally up to 4.3 %. The allochthonous terrestrial organic matter is dominated by conifers. The autochthonous aquatic matter is made up from algae and is dominated by diatoms (up to 57 % biogenic opal) within the interval of the highest organic matter content.

All samples are immature and the kerogen is mainly of type II-III and reaches up to type II. The maximum hydrogen index is 530 mg HC/g TOC in Unit IV. Using the nomenclature of Peters (1986) Units I, II, III and V are characterized by a good potential to produce oil and gas. Unit IV shows a very good potential to produce oil.

**NOTES**

## Revised Chronology for the Successions of the Eastern Paratethys: Towards A Better Understanding of Paleoenvironmental Change

Wout Krijgsman[1], **Chris van Baak[1]**, Iuliana Vasiliev[1], Liao Chang[2], Dan Palcu[1], Arjen Grothe[1], Marius Stoica[3]

*[1]Utrecht University, Utrecht, The Netherlands*
*[2]Australian National University, Canberra, Australia*
*[3]Bucharest University, Bucharest, Romania*

Paratethys is a large epicontinental sea, stretching from Germany to China at the beginning of the Oligocene (~34 Myr ago), that progressively retreated by a complex combination of basin infill, glacio-eustatic sea-level lowering and tectonic uplift to its present-day remnants: Black Sea, Caspian Sea and Aral Lake. Paratethys experienced major paleoenvironmental changes towards anoxic, hypersaline, and fresh water conditions. An accurate geological time scale (GTS) is crucial to understand the timing and rates of these change and to determine the underlying mechanisms. Geological time scales for the Paratethys region are notoriously controversial and encompass mainly regional stages, which are all defined on the basis of characteristic faunal assemblages (mainly mollusks and ostracods) endemic to the Paratethys Sea.

During the last decade, we have performed numerous integrated magneto-biostratigraphic studies on the sedimentary successions of the Eastern Paratethys, which resulted in revised chronological frameworks for the Dacian, Black Sea and Caspian Sea basins. This allows high-resolution stratigraphic correlations between the individual Paratethys subbasins and with the Mediterranean successions and help to better understand the dramatic paleoenvironmental changes in the region, such as the anoxic Maykop series and the Badenian and Messinian salinity crises.

**NOTES**

# Wednesday 7 October

## Session Four

## Keynote Speaker: Predicting Siliciclastic Reservoir Presence and Quality in the Black Sea

**Stephen J. Vincent**[1], Arjan de Leeuw[1], Fiona Hyden[2], Eduardo Garzanti[3], Giovanni Vezzoli[3], Vladimir A. Lavrishchev[4], Teimuraz G. Barabadze[5], Dian Vangelov[6], Andrei V. Matoshko[7], Marius Stoica[8], Andrew C. Morton[1,9], Mark Fanning[10], Andrew Carter[11] & Mark L. Somin[12]

*[1]CASP, UK*
*[2]Oil Quest, UK*
*[3]Università Milano-Bicocca, Italy*
*[4]Kavkazgeols'emka, Russia*
*[5]Georgian Technical University, Georgia*
*[6]Sofia University, Bulgaria*
*[7]NAS, Ukraine*
*[8]Bucharest University, Romania*
*[9]HM Associates, UK*
*[10]Australian National University, Australia*
*[11]Birkbeck, University of London, UK*
*[12]Schmidt Institute of Physics of the Earth, RAS, Russia*

Siliciclastic reservoir presence and quality are key exploration risks in the Black Sea. These risks can be minimised by understanding the geological framework and evolution of the region and the sediment transport pathways that developed within it. The Black Sea region is an amalgam of arcs and continental fragments that accreted to the southern margin of Laurussia / Laurasia / Eurasia. Plate margin processes resulted in multiple episodes of collision and upper plate extension. Collisional events generated and rejuvenated sediment source areas, including the inversion of earlier extensional basins, and formed flexural successor basins. Extension resulted in basin formation, including the western and eastern Black Sea basins, and the generation of localised areas of footwall uplift and erosion. Identifying and tracking first- and multiple-cycle sediments through these tectonic cycles is highly complex and requires the use of multiple provenance tools.

In this presentation we shall outline the location of siliciclastic packages within the Black Sea and link these via their sediment input points to potential source areas onshore. Where the composition of the upstream, onshore, components of these depositional systems are known, direct predictions of downstream, subsurface reservoir quality can be made. Where these sediments are no longer exposed onshore, inferences can be gained from modern sand compositions and knowledge of the nature and history of the source areas themselves. Ultimately, however, the hypotheses presented in this talk can only be tested through the analysis of well material from the basin itself.

## NOTES

## Field Insights into Sediment Delivery to the Northwest Black Sea

**Arjan de Leeuw**[1], Stephen J. Vincent[1], Andrei Matoshko[2], Anton Matoshko[2], Marius Stoica[3] and Igor Nicoara[4]

[1]*CASP, UK*
[2]*Geoexpert LLC, Ukraine*
[3]*University of Bucharest, Romania*
[4]*Institute of Geology and Seismology, Moldova*

The NW Black Sea contains the basin's largest clastic system, currently dominated by the Danube, and the recent success of the Domino-1 well highlights this region's large exploration potential. Our ongoing research in the area is tailored to provide better constraints on the composition of potential clastic reservoirs in both the Romanian and Ukrainian offshore. Both literature reviews and extensive field investigations provide input for a reconstruction of the palaeogeographic evolution of the circum-NW Black Sea. Special emphasis is placed on an understanding of the spatial, temporal and compositional evolution of the different sediment supply systems. Key elements addressed are the infilling of the Dacian Basin, which controlled timing of the arrival of the Danube to the NW Black Sea, and the significance of the Balta-Porat Delta of Moldova and Ukraine; a largely underappreciated, and frequently overlooked clastic system. Compositional analysis of sands from the precursors of the present-day Danube, Prut, Dniester, South Bug and Dnieper provides a means to predict the characteristics of derived potential reservoirs and recognition of the source area of retrieved well-material. Combined results from outcrop investigations and analysis of regional cross sections furthermore illustrate what the impact of Sarmatian, Meotian, Pontian (Messinian) and Dacian base-level falls were on the onshore part of the depositional systems of the Dacian Basin and the Moldovan and Ukrainian parts of the Scythian Platform. Our research strongly benefits from recent improvements in the bio- and chronostratigraphy of Paratethys that allow for much better regional and global correlations.

## NOTES

# The Importance of Miocene to Recent Mass Transport Complexes in the Western Black Sea

**G. Tari**[1], M. Fallah[1], W. Kosi[1], Z. Bati[2], and Ö. Sipahioğlu[2]

[1]*OMV, Vienna, Austria*
[2]*Turkish Petroleum, Ankara, Turkey*

The first three deepwater wells were drilled during Leg 42 of the Deep Sea Drilling Program in 1975 (DSDP 379, 380 and 381 wells). In the DSDP 380 well there is one particular unit that provided the critical argument for some to claim the signal of the Messinian Salinity Crisis in the Black Sea. A coarse clastic “pebbly breccia” (about 20 m thick), the genesis of which is uncertain, was recovered from a depth of between 864.5 m and 883.5 m. It includes clasts of a stromatolitic dolomite that was considered to have formed in an intertidal, to supratidal environment. This was interpreted by some as the evidence for a very shallow Black Sea at that time.

However, the original ship-board description and interpretation of the “pebbly breccia” and the overlying units suggested something entirely different. They described the clastic part of the “pebbly breccia” as a slump breccia, having largely angular clasts within it, up to cobble size. Our alternative interpretation is that the "pebbly breccia" unit between 864.5-883.5 m below the seafloor represents the base of a large mass transport complex (MTC).

Interpreting modern 2D seismic section data, the well penetrated the updip parts of two large MTCs. The geometry of the MTCs defined by the seismic data is consistent with gravity slides on the paleo-slope. More specifically, the MTCs we were able to map on seismic data can be classified as “slope-attached”, on their cuspate scarp morphology and the location of the headwalls on the slope of the basin.

These gravity-driven detached systems could not be seen on the short-offset and low-fold seismic data which was used to spud the well in 1975. The observation of two major detached gravity slides in the DSDP 380 well is mostly in agreement with the original description and interpretation of the core materials by the shipboard scientific party. In our interpretation, the extent of the allochthonous material in this well is not limited to the "pebbly breccia" interval (i.e. 864.5-883.5 m below the seafloor), but it is the entire 363.5 m thick sequence between 520-883.5 m below the seafloor which resulted from mass movements on the slope.

The DSDP 381 well reportedly also has the “pebbly breccia” in it. Based on seismic reflection and well core data we interpret this unit being as mass transport complex. Here again, the original core description of the pebbly breccia in DSDP well 381 by the shipboard scientific staff of the interval between 465.5-475.0 m refers to it as a “breccia showing abundant evidence of soft sediment deformation. Casts show internal flowage deformation”. The pebbly breccia is clearly not a sequence corresponding to in situ shallow-water “supra- or inter-tidal” deposition, therefore its presence in both DSDP 380 and 381 wells cannot be used as evidence for a 1600 m sea level drop during the Messinian Salinity Crisis as suggested by some.

In conclusion, it is suggested here that the presence of MTCs in the Black Sea has not been fully appreciated in the past, with the exception of a few recent papers. However, the recognition of large mass transport complexes in this basin has very important consequences for ongoing exploration efforts.

**NOTES**

# Recurrent Phases of Drought in the Miocene of the Black Sea Region

**Vasiliev, I.**[1,2], Reichart, G. J.[1,3], Grothe, A.[4], Sangiorgi, F.[4], Krijgsman, W. [2], van Roij, L.[1]

[1]*Organic Geochemistry, Department of Earth Sciences, Utrecht University, Budapestlaan 4, 3584 CD, Utrecht, The Netherlands*
[2]*Paleomagnetic Laboratory 'Fort Hoofddijk', Department of Earth Sciences, Utrecht University, Budapestlaan 17, 3584 CD, Utrecht, The Netherlands*
[3]*Alfred Wegener Institute for Polar and Marine Research, Biogeosciences, Am Handelshafen 12 (E), D-27570 Bremerhaven, Germany*
[4]*Biomarine Sciences, Department of Earth Sciences, Utrecht University, Budapestlaan 4, 3584 CD, Utrecht, The Netherlands*

Keywords: Black Sea, Miocene, hydrogen isotopes, carbon isotopes, alkenones, n-alkanes, TEX86, SST's, palynology

Since the Miocene the Black Sea proved to be highly sensitive to fluctuations in the hydrological cycle because of its recurrent restricted connections with the open ocean and the location between the dry Mediterranean and more humid higher northern latitudes. Although the Black Sea formed one of the foci of the 1975 Deep Sea Drilling Project Leg 42B, robust tools to reconstruct past changes in its hydrological cycle were lacking at that time. Here we revisit the sedimentary succession recovered in 1975 (Hole 380A) and determined compound-specific carbon ($\delta$13C) hydrogen isotope ratios ($\delta$D) of terrestrial and aquatic biomarkers to investigate changes in the hydrological budget of the Black Sea during the late Miocene. The $\delta$13C and $\delta$D isotopic composition of n-alkanes as well as alkenones and palynology indicate large environmental changes in the Black Sea and/or in the sources of the water entering the Black Sea during the late Miocene. The $\delta$D of alkenones, showing an enrichment of more than 80 ‰ at the end of the Miocene, implies a major shift in basin hydrology, possibly resulting in severely increased salinity. These changes in $\delta$D composition of the alkenones concur both with sharp shifts in reconstructed sea surface temperature and palynological assemblages. Two intervals with negative water budget were identified, most likely caused by enhanced evaporation. The older and longer dry/evaporative phase predates the Maeotian/Pontian boundary (regional stages) at ~6.1 Ma. The younger negative water budget phase corresponds to the Messinian salinity crisis. This shift to highly evaporative conditions is related to a similar shift previously observed in a Messinian (Pontian) sedimentary succession from the Taman peninsula (Russia). These recurrent dryer phases were, most likely, the result of hydrological changes over a significantly larger area around the Black Sea area during the upper Miocene.

**NOTES**

## A Greigite-Based Magnetostratigraphic Time Frame for the Late Miocene to Recent DSDP Leg 42B Cores from the Black Sea

**Chris van Baak**[1], Iuliana Vasiliev[1], Arjen Grothe[1], Klaudia Kuiper[2], Isabella Raffi[3], Eleonora Radionova[4], Larisa Golovina[4] and Wout Krijgsman[1]

[1]*Utrecht University, Utrecht, The Netherlands*
[2]*Free University of Amsterdam, Amsterdam, The Netherlands*
[3]*University of Chieti-Pescara, Pescara, Italy*
[4]*Geological Institute, Russian Academy of Sciences (RAS), Moscow, Russia*

In 1975, during DSDP Leg 42B to the Black Sea, three sites were drilled with a total of 2318 m cored and a recovery of 55%. While to modern scientific standards this may not be very impressive, these sites still represent the best record of sedimentation in the basinal part of the Black Sea. The main stratigraphic objectives of DSDP Leg 42B were to 1) obtain a complete Pleistocene litho- and biostratigraphic section and 2) study interactions between the Black Sea and Mediterranean Sea, focusing on glacio-eustatic sea level change, periods of lacustrine sedimentation, periods of anoxia, and to establish a paleoclimatic record. Major problems establishing a timescale emerged after drilling due to a) the general shortage of definitive paleontological age markers and b) the general lack of agreement on correlation and time zonation of sedimentary units.

Magnetostratigraphic dating could have solved these timescale problems but was hindered by the presence of the little understood authigenic iron sulphide mineral greigite (Fe3S4) as main magnetic carrier. In recent years, the understanding of greigite has significantly improved and is considered a reliable magnetic carrier. Especially in the circum-Black Sea region, many Miocene to recent, land-based sections are magnetostratigraphically dated with greigite as magnetic carrier. We therefore resample the cores of DSDP Leg 42B to see whether after 40 years of storage any of the original signal is preserved.

Our results show these cores are surprisingly useful for magnetostratigraphic dating. We create an integrated bio-magnetostratigraphic framework for the sites of Leg 42B, focusing on the Latest Miocene and Plio-Pleistocene. New 40Ar/39Ar dating of an ash-layer in Hole 380A gives additional age constraints. Our age model gives important new insights into the response of the Black Sea to major paleoenvironmental and climatic changes related to the Messinian salinity crisis and throughout the Pleistocene.

**NOTES**

## The Messinian Sea-Level Fall in the Black Sea: Small or Large? Insights from Offshore Romania

**Krezsek[1], C.**, Ionescu[1], G., Bega[1], Z., Schleder[1], Z., Dudus[1], R., Tari[2], G.

[1]*OMV PETROM SA, Romania*
[2]*OMV, Austria*

A number of contrasting interpretations have recently been published about the amount of the relative sea-level fall in the Black Sea during the Messinian salinity crisis in the Mediterranean. Various studies cite values from a few tens of meters to more than a thousand meters of sea level drop. Our scope is to review the Messinian events using data from the Romanian offshore.

In the Romanian offshore, the Messinian relative sea-level fall triggers thin-skinned gravitational collapse of the basin margin above the over-pressured Oligocene Maykop shales. Two different, NE to SW and NW to SE oriented systems can be mapped on seismic data, each consisting of up-dip extension accommodated by down dip compression. The deformation rate on these structures must have been very fast, as practically no syntectonic sediments are recorded in the depocenters. The gravitational collapse is a single catastrophic event controlled by the relative sea-level fall, the thickness of the detachment layer (Maykop) and pre-tectonic Meotian package.

The extensional depocenters are often several hundred meter deep canyons. These are filled with post-tectonic sediments during the Messinian lowstand, which illustrate massive amount of reworking. The sediment sources were entirely captured by these deep depocenters while on the canyon margins subaerial erosion is recorded. These erosional levels suggest several hundreds of meters of sea-level drop during the Messinian.

**NOTES**

# Poster Presentation Abstracts

## A New High-Resolution Biostratigraphic and Magnetostratigraphic Study of the Akchagylian Stage in Outcrop from the Gobustan Region of Azerbaijan, Western Caspian Sea

Keith Richards [1, 2], John Athersuch [3], William E. N. Austin, [4] Christiaan van Baak [5], Antoine A. H. Wonders [3]

[1]*KrA Stratigraphic Ltd., United Kingdom*
[2]*Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, The Netherlands*
[3]*StrataData Ltd., United Kingdom*
[4]*School of Geography and Geosciences, University of St Andrews, United Kingdom*
[5]*Paleomagnetic Laboratory "Fort Hoofddijk", Utrecht University, The Netherlands*.

The Akchagylian (Akchagyl) Stage in the Caspian Sea, and the Kuyalnikian equivalent in the Black Sea, are important stratigraphic units as they form regional seals over the hydrocarbon-rich Productive Series (in the Caspian Sea) and Kimmerian (in the Black Sea). New magnetostratigraphic and biostratigraphic data from an outcrop in the Jeirankechmez river valley, Gobustan, Azerbaijan provide a detailed record of the timing and depositional history for the Akchagyl. Ar/Ar ages from volcanic ashes and magnetostratigraphic calibrations show conclusively that Akchagyl deposition at the Jeirankechmez locality commenced in the latest Pliocene at around 2.7 Ma and continued into the Early Pleistocene. Combined ostracod and palynological data show that the lowermost beds of the Akchagyl contain exclusively freshwater, lacustrine assemblages, consistent with a pro-glacial lake. Reworked (mainly Mesozoic) palynomorphs also occur frequently, including northern Boreal-restricted forms (Aquilapollenites group), eroded by glacial scour and transported by melt-water. The first marine influence is noted about 30m above the base Akchagyl and is evident from the presence of a low-diversity dinocyst and benthonic foraminiferal assemblage. The latter relates to the "Cassidulina Beds", previously described from the region (e.g. Agalarova 1940; Agalarova et al. 1961; Mandelstam et al. 1962). Several cycles of deposition are visible within the Akchagyl unit, with evidence for marine, restricted marine, brackish and freshwater conditions provided by ostracods and palynology. Dinocyst associations indicate several episodes of connection between the Caspian Sea and Black Sea.

**Regional Seismic Datasets: The First Stage in Evaluating the Petroleum Prospectivity of New Frontiers.**

Adrian Bestwick, Daniel Marks and David Spofforth, *CGG MCNV*

The Black Sea is a proven hydrocarbon province which currently offers extremely attractive fiscal terms for exploration and production activities. With less than 100 wells drilled in the region it also represents a highly underexplored area; with the deep water segment remaining an enticing frontier for exploration.

Regional seismic datasets, particularly legacy data, can provide a cost-effective means of evaluating the overall petroleum prospectivity of a region. An extensive, regional seismic and well dataset, un-constrained by political boundaries, can help contextualise the likely petroleum geology of an individual basin of interest. As part of an integrated exploration strategy, regional data thus provides important context for more detailed licence evaluation & exploration, allowing improved understanding of key basin structuring events, regional sediment thickness and how this relates to source rock occurrence, maturity and migration.

This study uses an extensive 2D regional seismic database over the Black Sea to illustrate the benefits of regional-scale analysis to hone exploration efforts. Analysis of long, regional composite lines has helped reveal the gross architecture of the western and eastern Black Sea regions providing a better understanding of potential hydrocarbon migration pathways, particularly from the Maikop source rock in the deep offshore. Deep water lines show the presence of DHIs and untested structures and the greater levels of exploration in near shore areas provide a denser grid of data for understanding sediment input pathways into deeper water. A 2D seismic case study from offshore Bulgaria is used to illustrate the sediment supply conduits and basinal fans, before looking at how features identified in the 2D can be better illuminated in 3D. These results provide new insights into the palaeo-depositional environments for a number of channel systems identified below the Miocene (Messinian) unconformity and how these systems evolved through time, providing greater information on the petroleum potential of the region.

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Leave the building via the nearest and safest exit or the exit that you are advised to by the Fire Marshall on that floor.

**Fire Exits from the Geological Society Conference Rooms**

*Lower Library:*
Exit via Piccadilly entrance or main reception entrance.

*Lecture Theatre*
Exit at front of theatre (by screen) onto Courtyard or via side door out to Piccadilly entrance or via the doors that link to the Lower Library and to the main reception entrance.

*Piccadilly Entrance*
Straight out door and walk around to the Courtyard or via the main reception entrance.

Close the doors when leaving a room. **DO NOT SWITCH OFF THE LIGHTS**.

Assemble in the Courtyard in front of the Royal Academy, outside the Royal Astronomical Society.

Please do not re-enter the building except when you are advised that it is safe to do so by the Fire Brigade.

**First Aid**

All accidents should be reported to Reception and First Aid assistance will be provided if necessary.

**Facilities**

The ladies toilets are situated in the basement at the bottom of the staircase outside the Lecture Theatre.

The Gents toilets are situated on the ground floor in the corridor leading to the Arthur Holmes Room.

The cloakroom is located along the corridor to the Arthur Holmes Room.

# Ground Floor Plan of the Geological Society, Burlington House, Piccadilly