AAPG Europe Region

AAPG GTW: Exploration and Production in the Black Sea, Caucasus, and Caspian Region

18–19 SEPTEMBER 2019 | BATUMI, GEORGIA

Georgia Oil and Gas Limited

OMV Petrom

Georgian Oil & Gas Corporation

Block Energy PLC

Schlumberger

ExxonMobil

WELCOME

On behalf of the Organizing and Advisory Committees, it gives us great pleasure to invite you to join us in Batumi, Georgia, for the Geoscience Technical Workshop organized AAPG Europe on September 18-19, 2019. This meeting organized by AAPG Europe is only the second one in Georgia after the first one held in Tbilisi, on September 26-27, 2013. So after a six-year break, we return to Georgia with the theme "Exploration and Production in the Black Sea, Caucasus and Caspian Region".

The theme refers to the hydrocarbon exploration understanding in a very unique and quite complicated collage of basins and folded belts located in the central segment of the Paratethys region stretching from the Alps to the Himalayas. In this workshop special emphasis is placed on the Caucasus region located between the Black Sea and the Caspian Sea as recent years have seen a rise in E&P activities in this region. In particular, Georgian Ministry of Energy had announced the tender results for several onshore blocks earlier this year. Moreover, the very first international offshore Georgia bid round will also be announced this fall. It is to be noted that the Georgian segment of the Black Sea has not seen a single exploration well drilled yet!

This workshop offers a unique opportunity to learn more about ongoing exploration, development and production projects in the broader region. Moreover, this event offers a chance for networking with colleagues, E&P companies, and various academic institutions engaged in research in the Exploration and Production in the Black Sea, Caucasus, and Caspian Region. The GTW program also includes two one-day field trips from Batumi to the nearby Rioni Basin and to the foothills of the Great Caucasus.

Our Advisory Committee members used their networks efficiently and therefore an exceptional technical programme was put together addressing various aspects of our collective understanding of the geology and geophysics in this large geographic area. We are proud to line up solid technical presentations in a very strong technical programme organized into two parallel sessions. We have also put an emphasis on having a healthy mix of both industry and academic professionals presenting their ideas and results.

We hope that all the explorers and geoscientists working on projects in the Paratethyan realm will not only enjoy this conference but also find the time to explore the wonderful city of Batumi at the Black Sea coast. The Georgian hospitality is legendary and we both look forward to seeing you in Batumi!

Gabor Tari and Giorgi Tatishvili

AT A GLANCE

September 18, 2019

09:00 Conference Starts
09:30 Coffee Break
12:30 Lunch
15:20 Coffee Break
18:30 Dinner at Skybar

September 19, 2019

08:40 Conference Starts
10:20 Coffee Break
12:20 Lunch
15:20 Coffee Break
16:00 Closing Remarks

FIELD TRIPS

17 September 2019

STRATIGRAPHY, STRUCTURE AND PETROLEUM EXPLORATION PLAY TYPES OF THE ACHARA-TRIALET FOLDED BELT, WESTERN GEORGIA

The southern onshore Rioni basin in western Georgia is both stratigraphically and structurally akin to the offshore Gurian folded belt in the Eastern Black Sea. Along the onshore north-vergent Achara-Trialet thrust-fold belt, Eocene volcanics and volcanoclastics predominate at outcrop However, the fill of the Rioni foreland basin is Late Miocene to Quaternary in age, all units thickening southwards toward the Achara-Trialet folds. The Middle/Late Miocene to Quaternary strata is a molasse basin sequence, with an overall coarsening upward trend in an overfilled foredeep basin. In the Upper Miocene sequence, some of the shallow-marine sandstones are proven reservoirs, such as the sandstones in the Maeotian and Sarmatian of the Supsa and Shromisubani Fields.

20 September 2019

STRATIGRAPHY AND STRUCTURE OF THE IMERETI ZONE IN THE FOOTHILLS OF THE GREATER CAUCASUS, WESTERN GEORGIA

The Imereti Zone is a segment of the foothills of the Greater Caucasus to the NE of the Rioni Basin. The overall area forms a relatively uplifted promontory of the Caucasus folded belt, located to the NW of the Dziruli basement high. As opposed to the Rioni Basin, there are no commercial hydrocarbon discoveries made in the Imereti Zone to date despite numerous oil seeps reported in the area. The outcrops of this underexplored area are dominated by a variety of Jurassic to Cretaceous sediments ranging from deepwater, shallow-marine and lacustrine-lagoonal siliciclastics and neritic carbonates. Jurassic volcanics, well-known in the broader Black Sea and Caucasus region, have also outcrops in this area. Structures within this foothill zone are represented by SW-vergent fault-related folds (i.e. fault-propagation and fault-bend folds).

ADVISORY COMMITTEE

Piotr Krzywiec
Institute of Geological Sciences, Polish Academy of Sciences, Poland

Reinhard Sachsenhofer
Montanuniversitaet Leoben, Austria

Niko Tevzadze
Georgia Oil & Gas Ltd., Georgia

Sierd Cloetingh
Free Univ of Amsterdam, Netherlands (Holland)

Marc Sosson
France

Alexander Kitchka
Ukraine

Yevgeniya Sheremet
France

Marie-Francoise Brunet
Sorbonne Universite-CNRS, France

Akif Narimanov
Chairperson EAGE Azerbaijan, SOCAR, Azerbaijan

Elshan Abdullayev
Germany

Nazim Abdullayev
BP, England (U.K.)

Csaba Krezsek
OMV Petrom, Romania

Helena Dobrova
IHS Inc, Switzerland

Bogdan Popescu
Zeta Petroleum Romania, Romania

Dmitri Tsaplin
Schlumberger

Jon Mosar
University of Fribourg, Switzerland

Shota Adamia
Tbilisi State University, Rep. of Georgia

Baltabek Kuandykov
President, Meridian Petroleum, Kazakhstan

George Georgiev
University of Sofia, Bulgaria

Bernhard Krainer
Exp. Manager, OMV Exploration & Production, Austria

Richard Jakeman
Advisory Counselor IONGEo, England (U.K.)

Edward Blunt
Managing Director / Geologist, Terroleum Limited, Bulgaria

Olaru Radu
Petrom, Romania

Ozgur Sipahioglu
Technical Advisor at Turkish Petroleum, Türkiye Petrolleri A.O. (TPAO), Turkey

Zuhtu Bati
TPAO Turkish Petroleum Corp., Turkey

Mohammad Fallah
OMV, Austria

Christiaan van Baak
Netherlands (Holland)

Konstantin Sobornov
Dr., Nord-West Ltd, Russia

Aral Okay
Istanbul Technical University, Turkey

Liviu Matenco
Dr., Utrecht University, Netherlands (Holland)

Earl O'Callaghan
Anadarko, UK

Cristina Ungureanu
OMV Petrom, Romania
Onise Enukidze
Georgia

Victor Alania
Georgia

Mahmoud Hajian Barzi
Head of Research and Technology, NIOC Exploration Directorate, Iran

Andrew Robinson
Allied Resources, UK

Flavia Allache
Total

Catherine Kelly
Business Development Advisor for Europe/ Russia/Caspian/Middle East/ North Africa, ExxonMobil, UK

Kevin Meyer
Exploration Manager Europe & Russia, Repsol, Spain

Dian Vangelov
Sofia University

Randell Stephenson
Professor, University of Aberdeen, Scotland (U.K.)

Eugenia Oteleanu
Petrom

Tea Godoladze
Director at Institute of Earth Science and NSMC, Ilia State University, Georgia

Nino Tsereteli
Tbilisi University

David Boote
England (U.K.)

Michael Simmons
NEFTEX Petroleum Consultants Ltd, England (U.K.)

WEDNESDAY, September 18, 2019

08:00-09:00	REGISTRATION	
09:00-09:05	Welcome by Conference co-chairs	
09:05-09:10	Welcome on behalf of the Georgian Ministry of Economy and sustainable development	
09:10-09:30	Tatishvili: Overview of E&P activities in Georgia and update regarding upcoming tender on Georgian offshore	
09:30-10:00	COFFEE BREAK AND POSTERS	
	Room A	Room B
	PLATE TECTONICS AND PALEOGEOGRAPHY **Chairs: Barrier and Sosson**	**NEOTECTONICS AND GEOHAZARDS** **Chairs: Adamia and Tsereteli**
10:00-10:20	Reappraisal of the main Black Sea rifting phase in the Cretaceous and implications for the pre-rift history of the Black Sea lithosphere - Randell Stephenson	Geodynamics and Seismicity of the Lithosphere of the Black Sea – Caspian Sea Region - SNino Sadzadze
10:20-10:40	Geodynamic evolution of the Black Sea Basin: Constraints from structural data and fault kinematic analyses along the Black Sea coasts (Pontides and Crimean Mountains) - Jean-Claude Hippolyte	Seismic hazard estimation based on active faults data for Georgia (Sakartvelo) - Nino Tsereteli
10:40-11:00	The Black Sea, A Tertiary Basin: Observations and Insights - James Maynard	Active tectonics of the eastern and south-eastern Caucasus (within Azerbaijan) - Talat Kangarli
11:00-11:20	Palaeogeographic reconstruction of the Black Sea region; implications for reservoir and source rock distribution. - Eugene Iwaniw	Structural analysis of Earth`s crust GPS horizontal velocities and seismic hazard in Azerbaijan - Rafig Safarov
11:20-11:40	The Eastern Pontides and Somkheto-Karabagh Arcs: Jurassic-Early Cretaceous and Late Cretaceous-Cenozoic magmatism in relation to Eastern Black Sea Basin evolution - Marc Hässig	Level drop – hydrates decay – avalancheous slump – quake-triggered tsumani – chaotic deformation – sedimentary brecciation: Origin of MTDs in the Black sea basin - Alexander Kitchka
11:40-12:00	Slip-Sense Inversion in Iran: Implications for Eurasian Tectonics and Petroleum Systems across the Region - Bernard Guest	Probable Tsunami in the South Caspian Sea by a Large Earthquake! - Hamid Nazari
12:00-12:20	The Caucasus realm since the Mesozoic - Marc Sosson	Integration of petroleum industry and academic data sets in Georgia to mitigate geohazards in the broader Caucasus area - Gabor Tari
12:20-13:40	LUNCH AND POSTERS	
	FOLDED BELTS **Chairs: Sheremet and Robinson**	**EXPLORATION, DEVELOPMENT AND PRODUCTION CASE STUDIES** **Chairs: Kuandykov and Tevzadze**
13:40-14:00	The Greater Caucasus: a Multiphase Inverted Mesozoic Basin - Eric Barrier	Hydrocarbon potential of Kazakhstan and ways to search for new fields - Baltabek Kuandykov
14:00-14:20	The Greater Caucasus Fold-and-Thrust Belt: Paleotectonic inheritance vs. Cenozoic mountain building - Jon Mosar	Oil seeps as indicator of hydrocarbon potential in the Kura and Gabyrry interfluvial area, Western Azerbaijan - Arzu Javadova
14:20-14:40	An overview of the structural evolution of Central Georgia: restoration of a regional transect through the Lesser Caucasus, the Kura Basin and the southern border of the Greater Caucasus - Mélanie Louterbach	Geo-challenges of Studying and Exploring the Structure and Petroleum Potential of the Odessa Gulf - Alexander Kitchka
14:40-15:00	Renewed Hydrocarbon Prospectivity in the Kura-Kartli Foreland Basin, Onshore Central Georgia - Paolo Pace	Middle Eocene Fracture Analysis for Block XIB: Case Study from Patardzeuli Field, Georgia - Tabiat Tan Yildiz
15:00-15:20	The role of inherited structures in the structural frame of the Eastern Black Sea and Western Caucasus (Rioni, Georgia): a tectonostratigraphic approach - Zoé Candaux	Block XIB Lower Eocene, Paleocene, Upper Cretaceous formation characteristics and hydrocarbon potential - Tabiat Tan Yildiz
15:20-16:00	COFFEE BREAK AND POSTERS	
	FOLDED BELTS **Chairs: Mosar and Stephenson**	**EXPLORATION, DEVELOPMENT AND PRODUCTION CASE STUDIES** **Chairs: Alania and Javadova**
16:00-16:20	New And Old Plays – Integration Of Gravity, Seismic And Surface Geology In Central Georgia - Andrew Robinson	Basin Architecture and Hydrocarbon Play Concepts in the Turkish Eastern Black Sea - Anongporn Intawong
16:20-16:40	Structure and development of wedge-shaped thrusts in the southern flank of the Terek-Caspian foredeep, Russia - Konstantin Sobornov	Geological challenges and exploration lessons of the Subbotin oilfield discovery offshore Ukraine - Alexander Kitchka
16:40-17:00	Evolution of the crust of southern Crimea and adjacent northern Black Sea from seismic studies - Tamara Yegorova	Petroleum systems analysis based on simulation results of a 2D numerical model, eastern Pannonian Basin - Zsófia Harold
17:00-17:20	Northern Black Sea reconstruction: what if we change an approach? - Yevgeniya Sheremet	Innovative and cost effective well testing solution for a tight oil and gas reservoirs - Ivan Kukva
17:20-17:40	Jon Mosar	Integration of Conventional Logs and Novel Preprocessing Methods for Identification of Fracture Parameters in the Carbonate Reservoirs (case study, carbonate Asmari Formation, SW Iran) - Ghasem Aghli
	DINNER AT THE SKYBAR	
08:00-08:40	COFFEE BREAK AND POSTERS	

THURSDAY, September 19, 2019

08:00-08:40	COFFEE BREAK AND POSTERS	
	Room A	Room B
	PETROLEUM SYSTEM ANALYSIS **Chairs: Enukidze and Sachsenhofer**	**STRATIGRAPHY AND SEQUENCE STRATIGRAPHY** **Chairs: Abdullayev and Van Baak**
08:40-09:00	Petroleum Systems in Georgia - Reinhard F. Sachsenhofer	Distribution and volume of sedimentary rocks in World's basins - unusual case of the South Caspian Basin - Nazim Abdullayev
09:00-09:20	The Geological Evolution of West Georgia and the Petroleum Potential of the easternmost Black Sea - Stephen Vincent	A multi-proxy stratigraphic reference outcrop record for Oligo-Miocene marine sediments of eastern Azerbaijan - Christiaan G.C. van Baak
09:20-09:40	Rioni Basin, Georgia: Jurassic Potential Petroleum Systems. - Christian Blanpied	Environmental trends and taphonomic pitfalls in the palynology of the Productive Series and Akchagylian of Azerbaijan - Thomas Hoyle
09:40-10:00	New insights into Middle Eocene sedimentary basin and hydrocarbon reservoir architecture in the eastern Achara-Trialeti Fold and Thrust belt, Georgia - Onise Enukidze	Petrography and Geochemistry of clastic sediments as an evidence for Provenance of upper Pliocene and Pleistocene deposits, Central part of South Caspian Basin - Ramez Yousefi
10:00-10:20	Lower Oligocene fossil flora and fauna assemblages together with the hydrocarbon source rock potential at Karadere (Ruslar Formation) in Kamchia Basin, Bulgaria - Emilia Tulan	Combining of regional G&G data from Black Sea to Caspian for identifying new potential HC plays - Alexander Janiashvili
10:20-10:40	COFFEE BREAK AND POSTERS	
	BASIN MODELLING **Chairs: Harold and Yukler**	**EXPLORATION IN THE SOUTHERN CASPIAN REGION** **Chairs: Fallah and Hajian**
10:40-11:00	Evolution of the Mesozoic-Cenozoic Basins of the Caucasian region - Alexander Chabukiani	An overview on the exploration efforts in the southern Caspian region - Mohammad Fallah
11:00-11:20	Variations in geothermal gradient and understanding crustal structure and evolution of Kura Basin, onshore Azerbaijan - Nazim Abdullayev	Petrophysical evaluation of Natural Gas Hydrate in Caspian deepsea as an existence geohazard - Mohammad Saeed Hosseizad Takantapa
11:20-11:40	Untapped world class natural gas potential of Central Georgia - Mehmet Arif Yukler	The geochemistry of mud volcano in South of Caspian Basin - Hossein Mohajer Soltani
11:40-12:00	Tectonic development of the Ararat Basin Lesser Caucasus, Armenia - Ara Avagyan	The South Caspian Basin subsidence and its bearing on depositional environment of Upper Barremian-Lower Aptian successions (Tirgan Formation), Western Koppet-Dagh (NE Iran) - Mahmoud Hajian Barzi
12:00-12:20	3D basin and petroleum system modeling of the Pre-Dobrogea foredeep in the NW Black Sea region of Ukraine - Ivan Karpenko	Research on Cretaceous volcanic activities in the Southern Caspian Sea (Alborz structural zone) - Monireh Kheirkhah
12:20-13:40	LUNCH AND POSTERS / GROUP PHOTO	
	MARINE CONNECTIONS THROUGH TIME **Chairs: Vincent and Temel**	
13:40-14:00	Another potential connection between the Mediterranean and the Black Sea during the Messinian Salinity Crisis: the Sakarya Bosporus - Gabor Tari	
14:00-14:20	Fingerprints of the isolation of Eastern Paratethys in the Early Oligocene (Solenovian) in Thrace, Western Black Sea and South Caspian basins - Recep Hayrettin Sancay	
14:20-14:40	Oligocene – Lower Miocene climate and sea level changes in the South-Caspian basin: integration of lithofacies and diatom analyses - Elmira Aliyeva	
14:40-15:00	Heavy metals in aquatic fresh water, coastal zones and their relation with sediment characteristics of south west of Caspian Sea - Razyeh Lak	
15:00-15:20	COFFEE BREAK AND POSTERS	
15:20-16:00	CLOSING WORDS	

POSTERS

PLATE TECTONICS AND PALEOGEOGRAPHY
Chairs: Barrier and Sosson

Prospectivity of the Kartli-Kura Basin: Insights From Analyses of Gravity and Magnetic Data and Regional Palaeogeographies - David Tierney

New age, structural, and petrological data of metamorphic zones of the Tsaghkuniats Massif, Lesser Caucasus: reinterpretation of the signification of regional metamorphism - Marc Hässig

Transcaucasus Palaeogeography and Prospectivity: Elements of Petroleum Systems from the Black Sea to the Caspian - Graham Blackbourn

FOLDED BELTS
Chairs: Sheremet and Robinson

Some problems of Caucasus tectonics: new insight and data from the structural cross-sections - Victor Alania

Fold growth in the South Caspian Sea Basin: Mechanisms and interaction with deep-water lacustrine sediments - Andrew Procter

Palaeomagnetism and magnetic fabric of flysch sequences in eastern Crimea Mountains - Vladimir Bakhmutov

Collisional processes in the Crimean seismic zone - Anna Murovskaya

Deformation styles at the contact between convergent thrust-belts, central Georgia - Alexander Lapadat

NEOTECTONICS AND GEOHAZARDS
Chairs: Adamia and Tsereteli

Geodynamic analysis of gravity model - Gunel Sadigova

Characteristics of focal mechanisms in South Caspian subduction zone - Aynur Zamanova

EXPLORATION, DEVELOPMENT AND PRODUCTION CASE STUDIES
Chairs:

Defining Independent Sandbodies:Good Reservoirs in a Complex Environment With Many Challenges to Solve - Rachid Chedid Sablit

PETROLEUM SYSTEMS ANALYSIS
Chairs: Enukidze and Sachsenhofer

Hydrocarbon system modelling of Akchagyl Formation In South Caspian Region - Hossein Mohajer Soltani

Hydrocarbon potential of Eocene and Oligocene rocks in Azerbaijan (Perikushkul Section). - Vusala Aghayeva

Upper Devonian and lover Permian reefs in the Cis-Caspian basin framing and their petroliferous - Liliya Zhuravleva

BASIN MODELLING
Chairs: Avagyan and Yukler

3D modeling of the NW Black Sea basin as a new insight from seismic and well data - Andrii Tyshchenko

STRATIGRAPHY AND SEQUENCE STRATIGRAPHY
Chairs: Maynard and van Baak

The Samgori-Patardzeuli Field Middle Eocene Petrophysical Properties And Reservoir Mineralogy Composition Based On Open Hole Logging Formation Evaluation And Cuttings Xrd – Xrf Analysis - Tabiat Tan Yildiz

Stratigraphy and depositional settings of the Cretaceous sediments in the South of Ukraine - Ihor Ischchenko

Heraclites as products of carbonate synthesis of Prokaryotes fed by deep hydrocarbon-bearing fluids in Miocene time, SW Crimea - Dr Vitaliy Lysenko

EXPLORATION IN THE SOUTHERN CASPIAN REGION
Chairs: Fallah and Hajian

Fluid flow simulation and flow assurance investigation in production and transportation pipelines with Olga software in one of the Caspian oilfields - Ali Barati-Harooni

Identification of electrical and petrophysical rock types based on core and well logs: utilizing the results to delineate prolific zones in a deep water sandy package, South Caspian Sea basin - Najmeh Jafarzadeh

Reappraisal of the main Black Sea rifting phase in the Cretaceous and implications for the pre-rift history of the Black Sea lithosphere

Stovba, Sergiy – stovbasm@gmail.com – SPK-GEO LLC, Kyiv

Stephenson Randell – r.stephenson@abdn.ac.uk – School of Geosciences, University of Aberdeen, Scotland

A detailed study based mainly on the interpretation of 30.000 km of regional seismic reflection lines uniformly covering the Ukrainian sector of the Black Sea; this sector comprises about one-quarter of its entire area. Well data from marine boreholes as well as geological data from the offshore area and surrounding onshore have also been used. The results of the study have implications for the entire tectonic history of the initiation and evolution of the Black Sea and its constituent sedimentary basins, including the Eocene and younger compressional tectonic phases that have formed their present-day architecture. Here, we focus only on some kinematic observations related to the Cretaceous (Albian-Cenomanian) rifting phase, generally considered to be the main cause of the Black Sea sedimentary basins as expressed today, as well as the immediate post-rift sedimentation and stratigraphy. From these we go on to make inferences regarding the generally poorly understood – and rarely considered – pre-rift history of the Black Sea basement.
A system of grabens and half-grabens developed in Albian-Cenomanian time throughout the study area. Individual rift blocks were separated from each other by faults with vertical offsets ranging from several tens of metres to 2-3 km and more. One-dimensional subsidence modelling of this event on the Odesa Shelf suggests a "stretching factor" of continental lithosphere of 1.08-1.13, or some ~10% extensional strain. The general characteristics of the main rift structures, including the thickness of the syn-rift sequence, lithofacies distribution and offsets of normal faults bounding these rift structures, are similar throughout the study area including the preserved deep water basin of the Black Sea. This suggests that the rate and magnitude of Cretaceous extension was perhaps only slightly higher in the latter than on the Odesa shelf. This suggestion is supported by the observation that Late Cretaceous-Middle Eocene post-rift sedimentation was essentially uniform and of similar magnitude whether on the shelf or in deep water in areas where these sequences are preserved from post-depositional erosion. The stratigraphic evidence from the study area implies that the degree of extension during the "main" Cretaceous Black Sea rifting phase was moderate at most. It follows that any geodynamic model suggesting the formation of the Western and Eastern Black Sea basins as deep oceanic or sub-oceanic basins in the Cretaceous is untenable and that paleo-tectonic reconstructions that use such a concept are unreliable.

We conclude by considering the implications of the above, including the probable imprint of one or more significant extensional tectonic phases – with concomitant sedimentary basin formation – affecting the Black Sea lithosphere prior to the Cretaceous and what this means for plate reconstructions in the area as far back as the Late Palaeozoic.

Keywords: Black Sea, rifting, lithosphere, seismic reflection profiles, Ukraine

Geodynamic evolution of the Black Sea Basin: Constraints from structural data and fault kinematic analyses along the Black Sea coasts (Pontides and Crimean Mountains)

Hippolyte, Jean-Claude - hippolyte@cerege.fr – Aix Marseille Univ, CNRS, IRD, INRA, Coll France, CEREGE, Aix-en-Provence, France

Kaymakci, Nuretdin- kaymakci@metu.edu.tr – Dept. of Geol. Engineering ODTU-METU, Ankara, Turkey

Sangu, Ercan- esangu@kocaeli.edu.tr – Department of Geological Engineering, Kocaeli University, Turkey

Murovskaya, Anna- murovskaya@gmail.com – National Academy of sciences of Ukraine, Kiev, Ukraine.

Volfman, Yuri- seism.volf@gmail.com – Vernadskii Crimean Federal University, Simferopol, Russia.

Yegorova, Tamara- egorova@igph.kiev.ua – National Academy of sciences of Ukraine, Kiev, Ukraine.

Espurt, Nicolas- espurt@cerege.fr –CEREGE, Aix-en-Provence, France

Gintov, Oleg- oleg.gintov@gmail.com – National Academy of sciences of Ukraine, Kiev, Ukraine

The geodynamic evolution of the Black Sea Basin can be unravelled by structural and kinematic analyses along its inverted margins. In the frame of the Darius Programme we acquired structural data in the Pontides and in the Crimean Mountains. In the Western Pontides intense extensional faulting occurred during the Early Cretaceous and controlled the deposition of the siliciclastic sediments dated as Hauterivian to Albian (Hippolyte et al., 2010). Development of horst and graben structures resulted in the gravitational sliding of limestone olistoliths. The early Cretaceous fault blocks are unconformably overlain by a Late Cretaceous sequence that generally begins with Coniacian red pelagic limestones.

Similar to the Western Pontides, in the Central Pontides intense extensional deformation took place during the Early Cretaceous when sedimentation was characterized by olistoliths and debris flows. Tectonic subsidence locally reached 3600 m. During the Cenozoic, inversion of normal faults created a doubly vergent orogenic wedge (Espurt et al., 2014).

On the conjugate margin of the Black Sea, we mapped an array of collinear normal faults in the western part of the Crimean Mountains (Hippolyte et al, 2018). These faults trend parallel to the crustal-scale structures of the Black Sea Basin. Similar to the Pontides, extensional block faulting occurred during the deposition of debris flow and olistoliths, and the extension direction was NE-SW. The syn-rift sequence is dated as Valanginian-Late Albian. The post-rift sequence, that unconformably overlies the graben structures, starts in the Cenomanian. It is devoid of any normal faults or olistoliths. In the eastern Pontides we studied the onshore extension of the transfer faults of the eastern Black Sea Basin. From the Early Campanian to the Late Paleocene they only move with normal slip, possibly related to thermal subsidence in the Black Sea Basin (Hippolyte et al., 2017). Therefore, their strike-slip displacement, related to the opening of the Eastern Black Sea Basin, must predate the Campanian.

Given the fact that extensional structures are presents on the two conjugate margins of the Black Sea, and that the directions of extension are normal to the crustal structures (mid-Black Sea High and Black Sea margins), we infer that the Early Cretaceous extension is related to the rifting phase of the Black Sea Basin. We conclude that rifting occurred from the Valanginian to the Late Albian. The age of the breakup unconformity in Crimea, and the Late Cretaceous evolution of the transfer faults, suggest a drifting period from the Cenomanian to the Santonian, a period of intense volcanic activity and weak extensional deformation along the southern margin of the Black Sea. Based on the directions of rifting we propose that the Black Sea Basin opened with rotations accommodated by transform faults at its western and eastern margins, as a consequence of two asymmetric rollbacks of the northward subducted Neo-Tethyan slab. The inversion of the Black Sea margins results from several shortening events related to the continental collisions that occurred to the south. We characterize these events by distinct compressional stress fields from the Eocene to the Quaternary.

Keywords: rifting, collisions, stress field, Pontides, Crimea

The Black Sea, A Tertiary Basin: Observations and Insights

Maynard, James R. Email: james.r.maynard@exxonmobil.com ExxonMobil International Ltd

Erratt, Duncan ExxonMobil International Ltd (Retired)

There has been a longstanding debate on the age and kinematics of the opening of the Black Sea Basin. Previous estimates of timing of opening have included the Middle Jurassic (Hossack, 2004, Derman and Vincent, 2010 and Veincent and Rice, 2010), the Cretaceous, Cenomanian to Mid Santonian (Nikishin et al, 2015), Paleocene (Robinson et al 1995) and Eocene (Lordkinpanidze, 1980, Kazmin et al. 2000, Yilmaz et al, 2000 and Vincent et al. 2005).

This paper presents observations and insights from seismic and a key deep water well-tie (Nikishin et al, 2015) that constrain the age of the opening. Seismic stratigraphic principles are used to define a basin wide discordance, here termed a 'base passive fill unconformity' that separates the pre kinematic (Black Sea rifting) from the post kinematic (Figure 1). This surface can be dated to later than the Paleocene-Eocene interval. The surface can be traced regionally throughout the Black Sea, and as such demonstrates that the Western and Eastern Black Sea Basins opened simultaneously.

Recognition of the base passive fill unconformity in the Black Sea and in other rift basins and passive margins around the world is critical for mapping the distribution of pre-kinematic strata in the basin and constraining age models of basin formation.

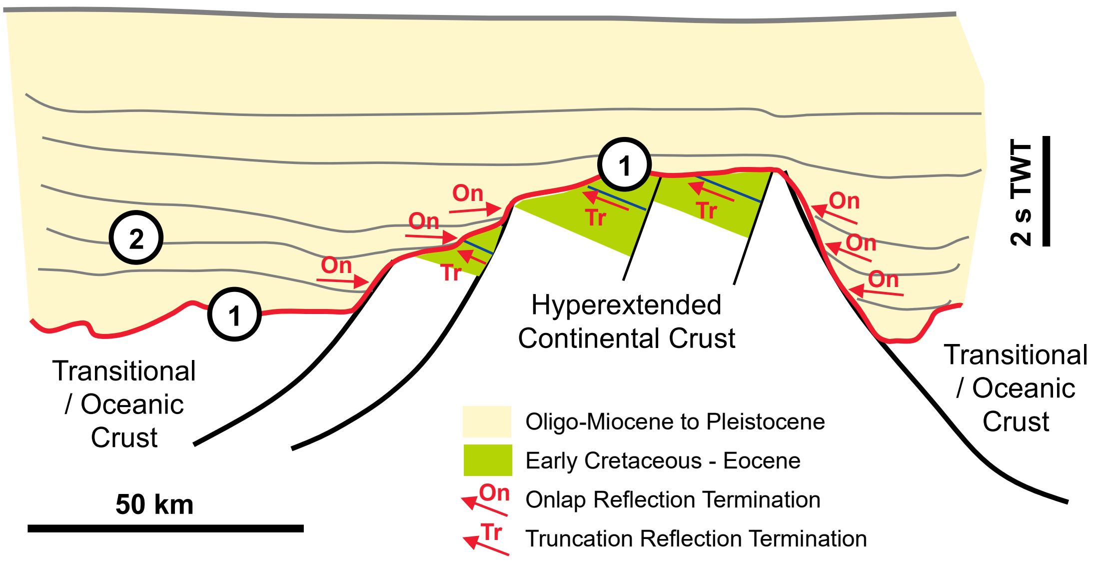


Figure 1. Conceptual sketch West to East through the Mid Black Sea High illustrating the interpretation of the age and stratal relationships observed on seismic within the Black Sea Basins. A well drilled on the high calibrates the age model here. An interpretation that is consistent with the principles seismic stratigraphic interpretation shows that the surface numbered 1 is the key base passive fill unconformity shown in red with onlapping strata above (2) and rotated truncated strata preserved in earlier phase rift basins preserved on hyperextended crust below.

PLATE TECTONICS AND PALEOGEOGRAPHY

Palaeogeographic reconstruction of the Black Sea region; implications for reservoir and source rock distribution.

Iwaniw, Eugene - eugene.iwaniw@cgg.com – CGG Robertson, North Wales, UK

Davies, Meghan - meghan.davies@cgg.com – CGG Robertson, North Wales, UK

The Black Sea is a key area for hydrocarbon exploration. Recent successful oil and gas discoveries have highlighted this significant potential. Over 20 years of knowledge of the regions petroleum geology combined with new fieldwork data, sedimentological, geochemical analysis and biostratigraphic analysis as well as legacy geophysical, geological and satellite data have allowed a re-interpretation of the geology and a "fresh look" at the prospectivity of the area. A new tectonic model has improved existing palaeogeographic reconstructions of the Black Sea.

Eight palaeogeographic maps have been produced covering the offshore Black Sea region using extensive seismic, well and other data from numerous fieldwork seasons covering the offshore Black Sea region and the relevant onshore basins. The aim was to produce a picture of the paleogeographic evolution of the area. They are consistent with the tectonic model and they can ultimately assist with the prediction of most important reservoir, seal and source horizons. The maps span the Late Triassic to Pliocene and were drawn on palinspastically reconstructed plate tectonic base maps. They illustrate the complex interplay of tectonic processes and eustatic sea level changes.

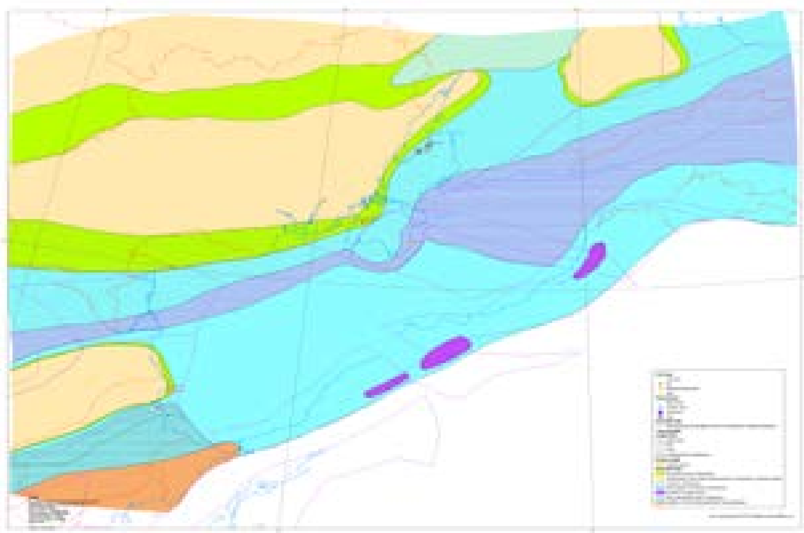


Figure 1 Upper Triassic – Lower Jurassic Palaeogeography

The Late Triassic – Early Jurassic represents the economic basement in many parts of the Black Sea, with mainly deepwater clastic shelf and flysch sediments deformed during the Cimmerian Orogeny. The Tithonian was a time of widespread carbonate sedimentation and contains important reef reservoirs 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. Coastal, shelf and deepwater sediments comprising 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 creating a marked submarine topography into which the main clastic source rocks were deposited in the basin and traps were formed, whereas the important Maikop source rock was deposited at this time in widespread deep marine environments. Following uplift of the Pontides to the south of the Black Sea and Carpathian closure, the Miocene - Pliocene represents a period of palaeogeographic isolation. 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.

Keywords: Black Sea, Palaeogeography, Reservoir, Source

The Eastern Pontides and Somkheto-Karabagh Arcs: Jurassic-Early Cretaceous and Late Cretaceous-Cenozoic magmatism in relation to the Eastern Black Sea Basin

Hässig, Marc - marchassig@gmail.com - Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Moritz, Robert - Robert.Moritz@unige.ch - Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Ulyanov, Alexey - alexey.ulyanov@unil.ch - Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland

Chiaradia, Massimo - Massimo.Chiaradia@unige.ch - Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Popkhadze, Nino - nino_popkhadze@yahoo.com - Al. Jalenidze Institute of Geology, I. Javakhishvili Tbilisi State University, Tbilisi Georgia

Galoyan, Ghazar - ghazar.galoyan@gmail.com - Institute of Geological Sciences, National Academy of Sciences of Armenia, Yerevan, Armenia

Enukidze, Onise - onise2000@yahoo.com - M. Nodia Institute of Geophysics, I. Javakhishvili Tbilisi State University, Tbilisi, Georgia

From the Jurassic to the Eocene the NE Anatolia-Lesser Caucasus regions recorded subduction, obduction, micro-plate accretion, as well as final Eurasia-Arabia collision and closure of Neotethyan oceans. It is accepted that both the Eastern Pontides and the Somkheto-Karabagh Arcs' geology result from subduction of the Neotethyan realm towards the north below the South Eurasian Margin. These arcs are limited to the south by the consecutive Izmir-Ankara-Erzincan and Amasia-Sevan-Akera Suture Zones running along northern Turkey to Armenia, and Eastern Azerbaijan. Yet, despite these geographic and structural analogies a comparison of the magmatic rocks outcropping throughout this portion of the Northern Neotethyan Belt exhibits geochonological disparities differentiating the Eastern Pontides from the Somkheto-Karabagh belt. It appears that the Somkheto-Karabagh belt preserves Jurassic to Early Cretaceous and Late Cretaceous to Eocene ages while the Eastern Pontides preserve mainly Late Cretaceous and Eocene ages.

New radiometric ages and geochemical characterisations of magmatic rocks along with structural observations of the Alaverdi and Bolnisi Districts of the northern Lesser Caucasus region, respectively, in Armenia and Georgia, complement the magmatic history of this portion of the Alpine orogeny. Subduction-related calc-alkaline magmatism in the Alaverdi District is Late Jurassic (158-146 Ma), and in the Bolnisi District it is Campanian (85-81 Ma) and Eocene (53-52 Ma). Similar Late Cretaceous and Eocene magmatism within the Eastern Pontides is identified in the Bolnisi District of Georgia. Jurassic to Early Cretaceous ages determined within the Alaverdi district match other ages found throughout the Somkheto-Karabagh Arc and limited occurrence in the Eastern Pontides. This reinforces interrogations concerning a continuous common subduction history leading the current NE Anatolia-Lesser Caucasus regions.

We propose that marginal basin opening within a continuous Eastern Pontides/Somkheto-Karabagh arc displaced older potions of the Eastern Pontides away from the active supra-subduction zone. This model is supported by the presence of Jurassic subduction-related magmatic rocks in the Sochi-Ritsa Region, Greater Caucasus, across the Eastern Black Sea from the Eastern Pontides. The current position and structure of the subduction related magmatic rocks of the Sochi-Ritsa region, the Eastern Pontides and the Somkheto-Karabagh result from opening of the Eastern Black Sea and Transcaucasian Basin Basins as back- to intra-arc settings. The Jurassic to Early Cretaceous potion of the arc runs from the Sochi-Ritsa region to the Alaverdi district continuing as the Somkheto-Karabagh Arc, cut by the Transcaucasian Basin. The Late Cretaceous to Eocene portion of the arc stretches from the Eastern Pontides to the Bolnisi district, which is located immediately north of the Somkheto-Karabagh Arc of the Lesser Caucasus.

Keywords: Lesser Caucasus, NE Anatolia, subduction, magmatism, U-Pb geochronology, geochemistry

Slip-sense inversion in Iran: Implications for Eurasian tectonics and petroleum systems across the region

Bernard Guest, bernard.guest@yahoo.com, Dept. of Geoscience, University of Calgary, Calgary, AB T2N 1N4, Canada,

Hamid Javadi, hr.javadi.k@gmail.com, Geological Survey of Iran, Tarbiat Modares University, Meraj Blvd., Azadi Sq., P. O. Box: 13185, Tehran, 13185-1494, Iran

The left-lateral Doruneh Fault System (DFS) bounds the north margin of the Central Iranian microplate, and has played an important role in the structural evolution of the Turkish-Iranian Plateau and of Afghanistan. The western termination of the DFS is a sinistral synthetic branch fault array that shows clear kinematic evidence of having undergone recent slip sense inversion from a dextral array to a sinistral array in the latest Neogene or earliest Quaternary. Similarly, kinematic evidence from the Anarak Metamorphic complex at the southwestern most branch of the DFS terminal fault array suggests that this core complex formed at a transpressive left stepping termination and that it was inverted in the latest Neogene to a transtensional fault termination. The recognition that the DFS and possibly other faults in NE Iran were inverted from dextral to sinistral strike slip in the latest Neogene, and the likely connection between the DFS and the Herat Fault of Afghanistan suggests that the evolutions of Afghanistan and the Indo-Asian collisional system are linked to the tectonic evolution of the Turkish-Iranian Plateau. We present a new model that explains the Late Neogene tectonic realignment of the Arabia-Eurasia collision zone in terms of the interaction between the Afghan blocks that were extruding west from the Indo-Asian collision and the Turkish Iranian collision zone that was evolving to the east as Arabia sutured diachronously with Eurasia. The collision of the Afghan blocks with East Iran effectively locked the respective eastern and western free boundaries for the Arabia-Eurasia, and Indo-Asian collisional belts and forced them to diverge away from one another. This unified model, if confirmed, explains the Late Miocene to Pliocene tectonic reorganization that is recognized across the Middle East and has implications for petroleum system models across the region. Regional tectonic reorganization and/or inversion may (1) invert and possibly breach older Cenozoic structures while forming a younger generation of post Miocene structures, (2) reorganize drainage and sediment supply networks, and sealing and obscuring older structural and stratigraphic traps under younger sediments, (3) rejuvenate existing structural traps and trigger secondary migration, and (4) increase exhumation, sediment supply, and subsidence leading to the formation of young reservoirs and increasing the maturation of source rock intervals.

The Caucasus realm since the Mesozoic

Sosson Marc, sosson@geoazur.unice.fr Université Côte d›Azur, UNS CNRS, Obs. de la Côte d'Azur, IRD, UMR Géoazur, 06560, Valbonne, France

Sheremet (Korniyenko) Yevgeniya, sheremet@geoazur.unice.fr Université Côte d›Azur, UNS, CNRS, Obs. de la Côte d'Azur, IRD, UMR Géoazur, 06560, Valbonne, France

Shota Adamia, shota25adamia@gmail.com, Tbilisi State university, Georgia

Ara Avagyan, avagn1064@gmail.com, Institute of Geological Sciences, Armenia

Eric Barrier, eric.barrier@upmc.fr Sorbonne Université, Institut des Sciences de la Terre de Paris (ISTeP) UMR 7193, Paris, France

Since the Triassic, the Caucasus domain has experienced a long and complex tectonic history related to the Tethys subduction beneath the Eurasian plate which originated opening of Back Arc Basins (BAB). The history of Tethys closure can be traced by the geological history of the Greater and Lesser Caucasus. The development of the Triassic trough using the variscan suture zone served the structural patterns for a back-arc opening of the Greater Caucasus basin. In the Lesser Caucasus evidences of the Tethys oceanic plate obducted over a Gondwanian microplate are the consequence of the Tethys ocean closure by a long-lived subduction zone.

The stratigraphic and structural investigations in these two parts including the Black Sea region of the Caucasus "realm", have revealed for ten years that the tectonic evolution is controlled by several main parameters:

1) the structural framework within the Laurasian-European continental crust.

2) the duration of the Tethys subduction process

3) the subduction of spreading centers, magmatic plateau (LIP) and sea mounts

4) the occurrence of several decollement levels in the sedimentary basins

According to these parameters the tectonic inversion of the BABs (Greater Caucasus, Black Sea basins) has not the same structural characteristics everywhere in the Caucasus domain and around the Black Sea.

We present some cross sections of keys zones in the Greater Caucasus (in Georgia) and Lesser Caucasus (in Georgia and Armenia) in order to illustrate and demonstrated the effects of the parameters presented above on the distribution of the compressional structures due to the action of the two collision stages during 1) the Late Cretaceous to Eocene and then 2) during the Oligo-Miocene to recent. Also, with help of the Darius maps we present the reconstruction of the Caucasus realm since the Late Permian.

Keywords: Caucasus, Black Sea, Back-arc-basins, Tethys

Poster presentation

Prospectivity of the Kartli-Kura Basin: Insights From Analyses of Gravity and Magnetic Data and Regional Palaeogeographies

Tierney, David – david.tierney@getech.com – Getech Group plc, Leeds, UK

Sevastjanova, Inga – inga.sevastjanova@getech.com – Getech Group plc, Leeds, UK; Redmile, Abigail – abigail.redmile@getech.com – Getech Group plc, Leeds, UK; Gardner, Kaxia – kaxia.gardner@getech.com – Getech Group plc, Leeds, UK; Tevzadze, Nikoloz – niko@noc.ge – Georgia Oil & Gas Limited, Tbilisi, Georgia; Janiashvili, Alexander – alexander@noc.ge – Georgia Oil & Gas Limited, Tbilisi, Georgia

The Kartli-Kura Basin (which is separated into the Kartli and Kura Depressions in the northwest and southeast, respectively, by the eastern extent of the Adjara-Trialeti Fold-Thrust Belt) is located onshore in eastern Georgia, within the convergence zone between the Eurasian and Africa-Arabian lithospheric plates. Originally located within a system of island arcs, intra-arc rifts and back-arc basins, this region experienced Late Alpine continental collision that inverted the back-arc basins to form the fold-thrust belts of the Great and Lesser Caucasus and, in between these, the Transcaucasian Depression, which contains the Kartli-Kura Basin and the nearby Rioni and Alazani Basins to the west and northeast, respectively. At the Present Day, the Kartli-Kura Basin is bounded by the Lesser Caucasus (south), the Adjara-Trialeti Fold-Thrust Belt (west), the Dziruli Massif (northwest) and the Great Caucasus (northeast). High-resolution gravity, magnetic and topographic data have allowed for precise mapping of the regional structures (primarily NW–SE to W–E thrust faults) to be undertaken. We observe that the strike of these thrusts varies slightly between the Kartli and Kura Depressions: from WNW–ESE to NW–SE, respectively. Four 2D gravity and magnetic models were used to validate the structural configuration and depth-to-basement interpretations based on magnetotelluric (MT) survey line data. The 2D models extended further to the north and south from the MT constraint and, once complete, were used as constraint within a wider depth-to-basement inversion. The inversion results suggest that the deepest sections of the Kartli-Kura Basin lie towards the central region (i.e. up to 12 km in the eastern Kartli Depression and ~10 km in the western Kura Depression), close to the Adjara-Trialeti Fold-Thrust Belt.

We have used palaeogeographic reconstructions to gather insights into depositional settings, potential provenance and the likely grade of the clastic reservoirs in the basin: Aalenian sandstones, upper Eocene silty sandstones and Oligo-Miocene (Maikop Group) sandstones. Significant provenance and reservoir grade variations are expected across the Kartli-Kura Basin for the Aalenian deposits due to the complex geological and tectonic setting in place at that time. Areas adjacent to the Lesser Caucasus (e.g. Present Day Tbilisi), where Aalenian palaeodrainage systems were dominated by short rivers draining inactive volcanic arcs, were starved of abundant clastic sediment input, creating the potential for the development of carbonate build-ups around the relic volcanic arcs. Northward movement of the African Plate towards the Eurasian Plate in the Cenozoic and the resultant Alpine Orogeny caused the inversion of the Greater Caucasus and Adjara-Trialeti Fold-Thrust Belt, making them major sediment source areas during the Eocene and Oligo-Miocene. Published sedimentary provenance studies from nearby regions (e.g. the eastern Black Sea) show that this hinterland was capable of generating sedimentary lithic arenites and volcanic lithic arenites that locally, can have good reservoir potential but which could also have been degraded by the presence of volcanic and volcaniclastic clasts (e.g. Vincent et al., 2013). Contribution (such as clastic sedimentary and metamorphic successions intruded by granitoids) from more distal sediment source areas (e.g. the Turkish Pontides) is also likely. The greatest clastic reservoir risks in the study area are interpreted to result from the input of ferromagnesian mineral-bearing volcanic and ophiolitic detritus that is likely to have degraded the quality of clastic reservoirs by creating chlorite coatings and cement. Using palaeoreconstructions of bathymetry and palaeogeographies, we are able to predict spatial variations in depositional marine total organic carbon (TOC) for the region from the Jurassic to the Miocene; thereby, gaining an insight into potential source rock presence and quality. Initial results from organic facies predictive models show good potential for marine source rocks at multiple stages of the basin's history.

Keywords: Kartli-Kura Basin, potential fields analyses, structural mapping, potential provenance and source rock predictions

New age, structural, and petrological data of metamorphic zones of the Tsaghkuniats Massif, Lesser Caucasus: reinterpretation of the signification of regional metamorphism

Hässig, Marc - marchassig@gmail.com - Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Moritz, Robert - Robert.Moritz@unige.ch - Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Spikings, Richard - Richard.Spikings@unige.ch - Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Galoyan, Ghazar - ghazar.galoyan@gmail.com - Institute of Geological Sciences, National Academy of Sciences of Armenia, Yerevan, Armenia

The South Armenian Block Crystalline Basement (SABCB) outcrops solely in a narrow tectonic window forming the Tsaghkuniats Massif, NW of Yerevan. The southern portion of the massif is comprised of presumed Proterozoic orthogneiss overlain by metamorphosed pelitic rocks, as well as granodiorite and leucogranite emplaced during the Late Jurassic and Early Cretaceous. Past structural, geochronological and petrological observations of this zone have shown a multiphase evolution during Late Jurassic and Early Cretaceous times. Within this reconstruction, a medium pressure–medium temperature metamorphic stage at c. 157–160 Ma, coincided with the emplacement of diorite at c. 150–156 Ma, and leucogranite formed by partial melting through near-adiabatic decompression at c. 153 Ma, was followed by high temperature–low pressure metamorphic conditions, with doming and general exhumation at c. 130–150 Ma, and cooling at 400 °C by c. 123 Ma.

The northern portion of the Tsaghkuniats Massif has been traditionally interpreted to have been marked by Proterozoic metamorphism. Yet, new, much younger $^{40}Ar/^{39}Ar$ ages have been obtained for the metamorphism of these rocks. The Hankavan metamorphic body, which is composed of metabasaltic amphibole and chlorite schist, yielded an age of c. 200 Ma. Mylonitic deformation along the major fault thrusting the Tsaghkuniats Massif to the east is constrained to than 120 Ma. Metapelite and amphibole and chlorite schist along the strike of the Meghradzor valley are dated to c. 38–40 Ma, coeval with onset of dextral strike-slip post-collisional faults parallel to the said valley. These latter ages may either reflect the age of metamorphism, of resetting by later thermal events linked to fault onset or activity, or emplacement of magmatic rocks in close proximity belonging to the Tezhsar intrusion.

Considering this new data, a revised interpretation of the signification of the metamorphic rocks of this region is proposed within the framework of the evolution of the northern margin of the South Armenian Block (SAB).

Keywords: Lesser Caucasus, South Armenian Block, metamorphism, $^{40}Ar/^{39}Ar$ geochronology, geochemistry

Transcaucasus Palaeogeography and Prospectivity: Elements of Petroleum Systems from the Black Sea to the Caspian

Graham Blackbourn, Niko Tevzadze, Alexander Janiashvili[2], Onise Enukidze[1] and Viktor Alania[3]

[1] Blackbourn Geoconsulting, 26 East Pier Street, Bo'ness, West Lothian. EH51 9AB. Scotland, United Kingdom.
[2] Georgia Oil and Gas Ltd., 4a Freedom Square, Entrance 2, Floor 5, Tbilisi 0105. Georgia.
[3] Tbilisi State University, 1 Alexidze str., Tbilisi 0193. Georgia.

The Transcaucasus region lies between the Black Sea and Caspian Sea to west and east respectively, and the Great and Lesser Caucasus to north and south. It is a single geological province which continues westwards into the Eastern Black Sea Basin and eastwards into the South Caspian and beyond. However, for a variety of reasons the eastern Transcaucasus, largely within Azerbaijan, has often been treated merely as a westerly extension of the South Caspian Basin; and the western Transcaucasus, mostly Georgian, has often been considered as a separate onshore province, although its geological continuity with the Eastern Black Sea has been more widely recognised in recent years.

As a result, the Middle and Upper Kura and other onshore basins of western Azerbaijan have usually been considered separately from the Kartli and Rioni basins of Georgia, and these in turn are not generally examined in relation to the geological development of the Caucasus region as a whole. Nonetheless, from the earliest Jurassic until around the late Palaeocene, the Transcaucasus area formed part of an extensive platformal area bounded in the south by the Lesser Caucasus volcanic arc. With the onset of thrusting associated with Tethyan closure, and uplift of the Great Caucasus, the Eastern Black Sea—Transcaucasus—South Caspian belt emerged as a distinct geological unit, the different sectors of which underwent closely-linked geological development which can only be properly understood when examined as a single province.

The aim of the study reported here is to view the petroleum prospectivity of the whole of the Transcaucasus region from a fresh perspective. A series of palaeogeographic maps are being compiled centred on the Transcaucasus, but also including adjacent areas of Turkey, Armenia and the Russian Federation. Their ages range from the Jurassic to the Miocene, focussed on those time horizons which are considered most prospective in terms of both reservoir and source rocks.

Numerous oil and gas accumulations have been discovered within the Transcaucasus over many years, although commercial success has been limited. Re-examining the region from a fresh perspective as a single integrated petroleum province emphasises its overall petroleum prospectivity, and reinvigorates the quest for increased commercial success. As a work in progress, comments from other workers familiar with the region which may help to improve or add detail to our palaeogeographic maps would be welcomed.

The Greater Caucasus: a Multiphase Inverted Mesozoic Basin

Eric Barrier – eric.barrier@sorbonne-universite.fr

Camille Raulin, Alexandre Boutoux, Christian Blanpied, Marie-Françoise Brunet

Sorbonne Université, CNRS-INSU, Institut des Sciences de la Terre de Paris (ISTEP), France.

The Greater Caucasus (GC) results from the Late Cenozoic inversion of a Mesozoic back-arc basin, characterized by a series of extensional and compressional tectonic events. We aim at reconstructing this complex tectonic evolution, conducting field investigations in GC in Russian Federation, Azerbaijan, and Georgia.

The opening of the GC basin initiated in the Sinemurian-Pliensbachian times. The rifting developed during the Early Jurassic. Syndepositional normal faults are common in the whole Liassic clastic sequence. In the basin margins, coastal-deltaic environments prevailed, while in the basin, a thick distal sequence deposited until the Aalenian. The dominant E-W trending Liassic rifting was associated with effusive magmatism, including MOR-basalts pillows suggesting a significant lithospheric thinning. The Liassic rifting was coeval with similar rifting episodes reported in the Pontides and Northern Iran.

The first major inversion of the GC basin is Middle Jurassic in age. The regional angular unconformity between the Bathonian and the Callovian sequences (Callovian unconformity) is interpreted as being related to a Bathonian folding resulting in the inversion of the margins of the GC basin. This Mid-Cimmerian event, also described to the east in Central Iran, may have resulted from changes in the Neo-Tethys subduction zone.

Above the unconformity, the subsidence resumes from the Callovian to the Kimmeridgian, characterized by an increasing of carbonate production leading to the deposition of a thick Late Jurassic carbonate platform. During the Tithonian, a sea-level drop together with aridification led to the deposition of evaporites. The Late Jurassic is a period of tectonic quiescence corresponding to the thermal subsidence in the GC basin. The Late Jurassic sequence is topped by an unconformity (Berriasian unconformity), corresponding to the Neo-Cimmerian event reported all along the north-dipping Neo-Tethys subduction.

A major extensional tectonic event has been evidenced during the Valanginian-Aptian times, characterized by E-W oriented normal faults. In the Central GC Basin deep-water deposited. This extensional tectonic event is contemporary to the rifting of the Black Sea basins. During the Early Cretaceous, back-arc extensions were developing all along the southern active Laurasian margin. The following thick Late Cretaceous sequence is predominately composed of deep water carbonates, marls and turbidites.

A major inversion phase of the GC Basin occurred in the uppermost Cretaceous – Early Paleocene period. In eastern GC Paleocene continental red beds unconformably overlay folded Maastrichtian-Danian strata. This Laramian phase originated reliefs partly lasting in the Paleocene. At regional scale, many basin inversions have been assigned to this phase.

The Cenozoic deposits are rare in central GC, mainly due to the Neogene uplift and erosion. Paleogene deposits are preserved around GC, comprising shales, and turbiditic sandstones. Some moderate emerged highs constituted a proto-Caucasus belt, probably related to the Anatolia-Eurasia collision. In the Oligocene to Early Miocene times a significant thickening developed all around the proto-Greater Caucasus range corresponding to the deposition of the Maykop Series in sag basins. During the Late Miocene-Pliocene, thick coarse molassic sequences deposited all around GC, dating the major orogenic phase of GC in connection with the Arabia-Eurasia collision.

Two main sedimentary successions have been recognized in the Jurassic, in the Sinemurian-Bathonian and the Callovian-Tithonian times respectively, separated by a major regional unconformity.

This Mid-Cimmerian event, also described to the east in Central Iran, may have resulted from changes in the Neo-Tethys subduction such as in slab dip, convergence rate, or structure and age of the subducted oceanic floor.

The Greater Caucasus Fold-and-Thrust Belt: Paleotectonic inheritance vs. Cenozoic mountain building

Jon Mosar, Department. of Geosciences, Univ. of Fribourg, Ch. du Musée 6, CH-1700 Fribourg, Switzerland (jon.mosar@unifr.ch)

Jeremiah Mauvilly, swisstopo , Wabern, Switzerland.

Nikolay Enna, Kavkazgeolsyemka, Fed. state Unitary geol. enterprise; 4A Sadoviy alley, Yessentuki, Russia.

Irakli Gamkrelidze, A. Janelidze Inst. of Geology of Tbilisi State Univ., 31 Politkovskaia str., Tbilisi, Georgia.

Talat Kangarli, Inst. of Geology & Geophysics, Azerbaijan Nat. Acad. of Sci., H. Javid av. 119, Baku, Azerbaijan.

Kakhaber Koiava, A. Janelidze Inst. of Geology of Tbilisi State Univ., 31 Politkovskaia str., Tbilisi, Georgia.

Fuad Aliyev, Inst. of Geology & Geophysics, Azerbaijan Nat. Acad. of Sci., H. Javid av. 119, Baku, Azerbaijan.

Vladimir Lavrischev, Kavkazgeolsyemka, Fed. state Unitary geol. enterprise; 4A Sadoviy alley, Yessentuki, Russia;

The Greater Caucasus Mountain range evolved from an intracontinental basin in the southern margin of the Eurasian (Scythian) plate. This Greater Caucasus Basin initiated as a backarc rift basin to the northward subduction of the Neothythyan s.l. ocean beneath the Lesser Caucasus -Transcaucasus volcanic arc. Hyperextension of the crust is associated with the emplacement of numerous intrusives on both margins and inside the rift. The many dikes intruded in the thinnest part of the stretched crust are located in the central part of the rift system. Despite an important supra-subduction magmatic activity, no oceanic lithosphere appears to be present.

Following the initial rifting in Early Jurassic and the development of a tilted block paleogeography with rift shoulders, the basin evolved as a thermally subsiding post-rift basin. The Mid- and Late-Cimmerian events, which are associated with important erosional unconformities, are associated to farfield geodynamic events due to plate tectonic reoganization. The initiation in early Oligocene times of the collisional orogenic processes and the intra-continental closure of the rifted basin led to the development of flexural foreland basins. Overall, the Greater Caucasus develops as a doubly vergant orogenic wedge, with important changes in geometry along strike of the mountain range. The mountain Range can be subdivided into structural domains reflecting the paleogeographic inheritance. Thus, the Main Caucasus Thrust is initiated in the most stretched central part of the rift basin. Both, thin- and thick-skinned nappe development can be observed. To the north the broad Dagestan fold and thrust belt appears to be still actively growing as suggested by the important seismic activity. Similarly, recent thrusting is documented by the growth structures on fault-bend and fault-propagation type fold in the Tertiary foreland basins. The mountain belt is propagation outwards, to the S and the N, into its own flexural foreland basins. To the N of the western lobe, steep south-dipping thrust in the Fore Range give way to the important monoclinal Laba-Malka Zone and Stavropol High, suggesting the involvement of a large basement nappe, thrusting towards the North.

The Main Caucasus Thrust is a major north-dipping thrust, that runs through the central part of the Main Range, and separates in the western Greater Caucasus lobe, the basement units from the folded and thrusted sediments of the Southern Slope. Most of the Present horizontal displacement and deformation is accommodated to the South of the Main Caucasus Thrust, as documented by active seismicity and GPS data. North of it displacement decreases almost to zero and deformation is accommodated by uplift.

The fact that the original rift basin axis is oblique to the present orogenic trend, combined with modulation of the feedback processes of erosion and topographic development, and the rotational convergence of the Arabian plate may help explain the differences in the tectonics setting along strike of the mountain belt.

An overview of the structural evolution of Central Georgia: restoration of a regional transect through the Lesser Caucasus, the Kura Basin and the southern border of the Greater Caucasus.

Louterbach Mélanie, Repsol Exploración, Madrid, Spain

Rocca Riccardo and Mantilla Pimiento Adriana, Repsol Exploración, Madrid, Spain

The Rioni-Kura foreland basin lies between the Greater Caucasus to the north and the Achara-Trialet Belt and Lesser Caucasus to the south. Active tectonic of the area is due to the late-cenozoic continent-continent collision between the Eurasian and the Africa-Arabia plates. Two thirds of this convergence are thought to be taken up by the southern part of the Lesser Caucasian ophiolite suture. Crustal shortening and deformation within the Lesser Caucasus and the adjacent foreland basin have likely accommodated the rest of the convergence. However, the youngest evidences of deformation are compressive south-verging structures documented in the Kura basin and linked to the active deformation of the Greater Caucasus transferring shortening to the south from the converging Eurasian plates. In order to better understand the geological evolution of the central part of Georgia, we interpreted and restored through time a regional structural cross-section crossing through the Lesser Caucasus, the Kura Basin (near Tbilisi) and the southern border of the Greater Caucasus. The section is based on various 2D seismic sections converted in depth and some wells data from the industry. The section has been calibrated on surface thanks to a set of geological maps and is supported by gravimetric and magnetic modeling.

In our reconstruction, the Greater Caucasus is thought to deform from Eocene times, transferring more and more shortening towards the newly created Kura foreland basin to the south. Based on seismic evidences, stratigraphic and geometric relationships, and according to previous study, we confirm that compressional deformation in the Kura Basin began in the Middle Miocene and reached its maximum rate at the end of the Miocene (c. 5 Ma, Alania et al., 2017). In addition to the establishment of the flexural basin settings and the inversion of mesozoic and paleogene extensive structures in the Kura Basin (formerly part of the extensive Caucasus basin), Miocene times are also characterized by the inversion and northward deformation of the Lesser Caucasus. Duplex structures involving mainly Jurassic, Cretaceous and Eocene strata are also forming in the southern border of the Greater Caucasus. In Pliocene times, there is an increase in the exhumation rate of the GC, and the maximum deformation rate is reached in the Kura Basin (structures are almost completely inverted). In our section, we propose the reactivation of an important fault plane rooting below the Greater Caucasus and outcropping in the Kura Basin where it deforms Pliocene sediments. The shallowest part of this thrust sheet is well-depicted in seismic in the center of the Kura Basin, where it overrides the inverted structures and appears to be connected to the present-day front of the deformation in the basin and linked to recent thin-skinned deformation. Finally, we propose a very last period of Pliocene to Pleistocene re-activation in the center of the Kura Basin where this important detachment appears to be slightly folded.

Accurate timing of structuration help defining precisely the petroleum systems of Central Georgia. The restored section has been furtherly used for 2D basin modelling.

Renewed Hydrocarbon Prospectivity in the Kura-Kartli Foreland Basin, Onshore Central Georgia

Pace, Paolo - paolo.pace@geplan.it - G.E. Plan Consulting, Petroleum Geosciences, Italy

Ricciato, Angelo - angelo.ricciato@geplan.it - G.E. Plan Consulting, Petroleum Geosciences, Italy

Riva, Alberto - alberto.riva@geplan.it - G.E. Plan Consulting, Petroleum Geosciences, Italy

Tevzadze, Prof. Revaz - Georgia Oil & Gas Limited, Georgia

Tevzadze, Nikoloz - niko@noc.ge - Georgia Oil & Gas Limited, Georgia

Janiashvili, Alexander - alexander@noc.ge - Georgia Oil & Gas Limited, Georgia

Sanishvili, Artem - artem@noc.ge - Georgia Oil & Gas Limited, Georgia

Alania, Victor - victor.alania@tsu.ge - M. Nodia Institute of Geophysics, Tbilisi State University, Georgia

Enukidze, Onise - onise.enukidze@tsu.ge - M. Nodia Institute of Geophysics, Tbilisi State University, Georgia

Hydrocarbon occurrence and exploitation onshore Georgia is known since historical times. Pioneering oil exploration and production dates back to the early 19th century with a recorded production existing since 1930. Commercial fields were discovered mainly during the exploration in the 90s around the region surrounding Tbilisi in the Kura-Kartli basin (e.g., Norio in 1939; Satskhenisi in 1956). In 1967, the first commercial production of gas was achieved in the Teleti field at 2712 m of depth in well #11 producing a strong gas flow of 250 000 m^3/d. During the early 70s, exploration targeting the Cretaceous reservoir in the Samgori-Patardzeuli area resulted in the discovery of the biggest oil field onshore Georgia. The first commercial well #7 flowed 7000 bopd from the Middle Eocene fractured volcanogenic reservoir, opening a completely new play in Georgia. Then, about 200 wells were drilled reaching peak production rates of almost 70 000 b/d and a total production of 203 MMbbl between the end of the 70s and beginning of the 80s. Several oil seeps and leaks in the region along with the great results from the Samgori-Patardzeuli-Ninotsminda field reveal a very active petroleum system. The main source rocks are represented by the Maikop and Upper Eocene shales. Reservoirs span from the Maikop-Upper Eocene sandstones, fractured Middle Eocene volcaniclastics, Upper Cretaceous fractured carbonates and tuffs and potential Middle Jurassic sandstones. Trapping is mostly structural related to the thin-/thick-skinned contractional tectonics and mixed structural-stratigraphic.

Currently, Georgia Oil & Gas Ltd. is running an intense exploration activity focussing in the Kura-Kartli basin by recovering, acquiring and integrating old and new geologic, seismic, gravity, magneto-telluric and geochemical data. The interpretation of reprocessed post-stack time- and depth-migrated 2D seismic further constrained by newly acquired magneto-telluric sections reveals the occurrence of several leads and prospects. These prospective structures mainly belong to the north-directed contractional foreland deformation of the Adjara-Trialeti thrust belt. The traps are represented by north-verging inversion-related anticlines and pop-up-like structures riding over high-angle reverse faults with closures involving different reservoir units: Upper, Middle and Lower Eocene (Norio Deep); Middle and Upper Cretaceous (Kavtiskhevi); Lower Cretaceous and (Didgori, Bitsminda). Most of these prospects are in sub-thrust position with respect to the shallow detached low-angle thrusting related to the Greater Caucasus. Oils seeps and small discoveries around confirm the working petroleum system with generation form the Tertiary kitchen. Additional potential is also identified in some structural-stratigraphic leads within the Oligocene-Lower Miocene sandstones. Preliminary results from both deterministic and probabilistic assessments reveal attractive resource potentials.

Keywords: Kura Foreland Thrust Belt, Hydrocarbon Prospectivity, Central Georgia

The role of inherited structures in the structural frame of the Eastern Black Sea and Western Caucasus (Rioni, Georgia): a tectonostratigraphic approach

Candaux Zoé - candaux@geoazur.unice.fr – Université Côte d›Azur, CNRS, Obs. de la Côte d'Azur, IRD, Géoazur, 06560, Valbonne, France

Sosson Marc - sosson@geoazur.unice.fr – Université Côte d›Azur, CNRS, Obs. de la Côte d'Azur, IRD, Géoazur, 06560, Valbonne, France

Adamia Shota - shota25adamia@gmail.com - Javakhishvili State University, Institute of Geophysics, Alexidze str. 1, 0171, Tbilisi, Georgia

Sadradze Nino - ninosadradze@gmail.com - Javakhishvili State University, Institute of Geophysics, Alexidze str. 1, 0171, Tbilisi, Georgia

Enukidze Onise - onise.enukidze@tsu.ge - Javakhishvili State University, Institute of Geophysics, Alexidze str. 1, 0171, Tbilisi, Georgia

Alania Victor - victor.alania@tsu.ge - Javakhishvili State University, Institute of Geophysics, Alexidze str. 1, 0171, Tbilisi, Georgia

Chabukiani Alexandre - alecocha@gmail.com - Javakhishvili State University, Institute of Geophysics, Alexidze str. 1, 0171, Tbilisi, Georgia

Sheremet (Korniyenko) Yevgeniya - sheremet@geoazur.unice.fr – University Côte d'Azur, UNS, CNRS, Obs. de la Côte d'Azur, IRD, UMR Géoazur, 06560, Valbonne, France

Eric Barrier - eric.barrier@upmc.fr - Sorbonne Université, Institut des sciences de la Terre de Paris (ISTeP) - UMR 7193, Paris, France

Christian Blanpied - kris.blanpied@wanadoo.fr - Sorbonne Université, Institut des Sciences de la Terre Paris (iSTeP), Institut des sciences de la Terre de Paris (ISTeP) - UMR 7193, Paris, France

The Greater Caucasus is a great geological laboratory that gave birth to many models attempting to reconstruct the tectonic evolution of the Black Sea-Greater Caucasus domain as a part of the Alpine belt formed in a complex geodynamic setting of the long-lived subduction of the Tethys ocean (e.g. Adamia et al., 1981; Zonenshain and Le Pichon, 1986; Robertson et al., 1996; Stephenson & Schellart, 2010, among others). However, some questions remain concerning the timing of deformations, and the mechanism of their origin.

Previous models (e.g. Banks et al., 1997; Ershov et al., 1999; Tibaldi et al., 2017) interpret the majority of structures as those occurred during the Cenozoic post collisional compression and did not pay enough attention to multi-stage tectonic development of this area. Not all of those structures occurred at the same time: some of them are reactivated normal faults formed not only during the Cretaceous rifting of the Black Sea but originated during the Greater Caucasus back-arc basin formation in the Early-Middle Jurassic or even during earlier extension in the Triassic. Thus, the structural patterns of this area evolved significantly since the Late Paleozoic when the Tethyan plate started its subduction beneath Eurasia.

Some difficulties in reconstructing the tectonic stages and in clarifying their timing come from the approaches using tectono-stratigraphic formations, which, from place to place, do not always coincide with the age of the rocks they include.

Based on new detailed field observations and structural analyses of the Meso-Cenozoic rocks in keys areas of the Transcaucasus region we traced out the major deformation zones, and the structures from the Eastern Black Sea to the Rioni Foreland basin.

Using a "Move geometric model", which we improve with seismic lines, data from wells and field observations of unconformities and growing strata, we built several balanced cross-sections, allowing to precise the timing of deformations since the Early Middle Jurassic.

According to our analyses, the compressional deformations in the Transcaucasus linked to reactivation of normal faults beneath the Rioni Basin during the Cenozoic, representing the thick-skinned tectonics. However, the occurrence of "horse structures", as evidence of the thin-skinned tectonics, could be explained by evaporite's rheology of the Upper Jurassic sediments. Some thin-skinned tectonic deformations take place near reactivated normal faults, as well. The occurrence of such deformations depends on the detachment capacity of the lithologies near the reactivated normal faults. We propose that the nature and thickness of the Upper Jurassic and Lower Cretaceous sediments are keys since lithology can be in some places evaporites, argillites and marls which can particularly well localize the decollements levels.

Keywords: Greater Caucasus, Rioni Basin, reactivated normal faults, evaporites, decollement level.

Inverted Palaeogene Rifts In Central Georgia: A Link Between The Eastern Black Sea And South Caspian

Andrew Robinson, Georgia Oil and Gas

This paper presents a new interpretation of the Palaeogene basins which outcrop in Central Georgia, based upon 2D seismic and potential field data. The seismic lines indicate the presence of a Palaeogene wedge that thickens from north to south. The thickening is of Early Eocene to possibly Late Palaeocene age.

To the north, this sequence is thrust over the Neogene sedime3nts in a Greater Caucasus foreland basin. To the south where the Palaeogene is thickest, the basin is bounded by a blind thrust which does not outcrop. South of the thrust, Palaeozoic basement is near or at the surface.

We interpret the blind thrust as the inverted bounding fault of a rift approximately 100x30km in dimension and striking east-west. The inferred age of rifting – Late Palaeocene – corresponds to that of the Eastern Black Sea. The Central Georgian rifts may thus be considered as a link between the Eastern Black Sea and South Caspian.

Structure and development of wedge-shaped thrusts in the southern flank of the Terek-Caspian foredeep, Russia

Konstantin Sobornov

North Uralian Petroleum Company, Moscow, Russia

Wedge-shaped thin-skinned thrust configurations comprising linked thrusts of opposite vergence are recognized in the frontal zone of the Terek-Caspian foredeep flanking the Greater Caucasus on the north. Geological mapping and drilling provided evidence that the upper detachment of the wedge-shaped thrust sheets is situated mainly in the Maykop shales are by Seismic data collected over the last decade constrained regional structural setting of this area. Integrated interpretation of geological and geophysical data showed considerable lateral structural variations within the thrust belt. Three structural segments are recognized including the Terek-Sunzha zone, Dagestan salient, and Maritime zone. It is interpreted that the prominent structural changes are primarily related to variations in the mechanical stratigraphy of the sedimentary column, geodynamic setting and tectonic grain of the pre-Jurassic section.

The western segment of the thrust belt corresponds to the Terek-Sunzha fold zone. Seismic data show that folding and thrusting in this zone is controlled by the Upper Jurassic (Tithonian) evaporites. This mechanically weak stratigraphic unit provided an efficient detachment level which facilitated the structural delamination of the sedimentary section. Stacked thrust sheets of the Dagestan salient are detached along the Lower-Middle Jurassic shales. Linear folds of the Maritime zone are interpreted to be shaped largely by transpressional displacement. In addition folding in this zone was likely influenced by high-relief folding in the underlying pre-Jurassic section.

The major compressional folding in the study area has started in the Late Miocene and is still active. Due to the structural complexity the fold belt has significant untapped hydrocarbon potential.

Evolution of the crust of southern Crimea and adjacent northern Black Sea from seismic studies

Yegorova Tamara[1]., Baranova Ekaterina[1], Gobarenko Valentina[2]

1 - Institute of Geophysics, National Academy of Sciences of Ukraine, Pr. Palladina 32, Kiev, Ukraine, 03680

2 - Institute of Seismology and Geodynamics, Crimea Federal University, Simferopol, Crimea, 295001

The Crimean Mountains (CM) is a western branch of the Crimean-Caucasus fold-and-thrust belt that formed in a peri-cratonic setting in the Cenozoic in the collisional zone between East Europe and Arabian Plates. The Main Caucasus Thrust, which marks the southern boundary of the Greater Caucasus orogen, can be traced westward along the northern margin of the Black Sea and southern Crimea and coincides with a zone of seismicity called the Crimea Seismic Zone (CSZ) with the earthquakes of M=3-5 with foci in the crust and uppermost mantle and abundant weak seismicity (M≤3). Strong recent and on-going seismicity is indicative of active tectonic processes occurring in an environment of regional compression and transpression. Recent reinterpretation of seismic data on existing DSS profile Sevastopol-Kerch running along the southern Crimea provided construction of a velocity model for the crust of Crimean Mountains. During last years, in the area of southern Crimea and adjacent Black Sea a local seismic tomography study was performed. The study uses data from weak (M≤3) earthquakes in the CSZ, recorded during 1970-2014 by nine stations installed on the Crimean Peninsula. Interpretation of seismic data along the Sevastopol–Kerch profile and seismic tomography led us at the following conclusions.

• The present-day crust of the Crimean Mountains formed on the mature continental crust of the East European Plate (Scythian Plate) and inherited the main features of its Precambrian–Early Paleozoic stage of evolution, which are reflected in the Sevastopol–Kerch profile as thick crust (~ 43 km).

• The Mesozoic closing of the Paleotethys and its subduction beneath the southern margin of the East European Plate could cause intensive crustal magmatism manifested in the seismic tomography model by high-velocity bodies within the crust, which spatially fit the magmatic intrusions of Middle Jurassic (and partly Early Cretaceous) age exposed in southern Crimea.

• At the stage of Alpine compression, the Crimean Mountains were evolving as a collision zone

where the East Black Sea microplate and Central Black Sea Rise thrust under the continental margin of the Scythian Plate. In southern Crimea and on the shelf zone the ancient tectonic faults were reactivated. The compresional regimes of the Alpine stage are probably responsible for formation of a second (lower) Moho interface at a depth of about 55 km.

• The on-going continuation of collisional processes is evidenced by significant seismicity within the CSZ and reactivation of older zones of weaknesses and inhomogeneities in the crust.

Keywords: Crimea, earthquakes, Earth’s crust, velocity structure

Northern Black Sea's regions: structural patterns and timing of deformations

Sheremet (Korniyenko) Yevgeniya - sheremet@geoazur.unice.fr – University Côte d'Azur, UNS, CNRS, Obs. de la Côte d'Azur, IRD, UMR Géoazur, 06560, Valbonne, France

Sosson Marc - sosson@geoazur.unice.fr – University Côte d'Azur, UNS, CNRS, Obs. de la Côte d'Azur, IRD, UMR Géoazur, 06560, Valbonne, France

Stephenson Randell - r.stephenson@abdn.ac.uk - School of Geosciences, University of Aberdeen, King's College, Aberdeen AB24 3UE, UK

Murovska Anna - murovskaya@gmail.com - Institute of Geophysics, National Academy of Sciences of Ukraine, Pr. Palladina 32, Kiev, Ukraine, 03680

Antoneta Seghedi - seghedi@geoecomar.ro - National Institute for Research and Development of Marine Geology and Geoecology (GeoEcoMar), RO-024053, Romania, Bucharest

Eric Barrier - eric.barrier@upmc.fr - Sorbonne Université, Institut des sciences de la Terre de Paris (ISTeP) - UMR 7193, Paris, France

Christian Blanpied - kris.blanpied@wanadoo.fr - Sorbonne Université, Institut des Sciences de la Terre Paris (iSTeP), Institut des sciences de la Terre de Paris (ISTeP) - UMR 7193, Paris, France

It seems it is well established now that both sub-basins of the Black Sea (BS) back-arc basin (BAB) were opened during the Cretaceous, within the strong European continental lithosphere lying over a long-lived subduction zone (duration of 100-120 My). Then why the prevailing NW-SE direction of major tectonic structures and units of the Eastern European Plate (EEP) (e.g. the Dniepr-Donetsk basin, the Ukrainian craton, the Trans European Suture Zone (TESZ, also known as Tornquist-Teisseire Lineament, TTL), which is typical also to major strike of the Mid BS Ridge and the Shatskiy Ridge (the Eastern BS sub-basin, EBS), is not reflected in strike of structures of the Western sub-basin (WBS) of the BS BAB and appear oblique to this main direction?

The results of our recent geological investigations in the following Northern BS mountain provinces such as: the Northern Dobrogea, the Crimean Mountains and the Georgian part of the Greater Caucasus show a strong binding of further deformations to ancient deep tectonic structures developed in the Paleozoic and the Early Mesozoic. Precising of timing of their formation and their reactivation during pre-BS-tectonic evolution is a key-way to reconstruct the BS rifting during the Cretaceous.

We present here the similarities and differences in stratigraphic compositions and structural patterns of northern BSs' mountain regions based on their Paleozoic and Mesozoic outcrops. Reconsidering the tectonic evolution of these areas concerning the timing of formation and reactivation of deep fault zones gives better understanding why there are differences in structural features of both BS sub-basins. Taking into account a mosaic composition of southern margin of Eurasian lithosphere, its stretching and compressing in the complex subduction settings and precising the timing of deformations along the main fault zones around the BS will exclude certain controversies and gups that exist in the tectonic reconstructions of the BS proposed by different models.

Keywords: Black Sea, Crimean Mountains, Northern Dobrogea, Greater Caucasus, back-arc-basin

Tectonic development of the Cretaceous Northern Accretionary Wedge during the post-Triassic-pre-Miocene northward subduction of Neotethyan oceanic crust in the Pontides

Rojay, Bora. brojay@metu.edu.tr, Middle East Technical University

Erroneously named "Ankara Mélange belt" (Bailey and McCallein 1950; 1953), which is a Cretaceous continuous deformational accretionary wedge belt, is situated on tremendous Alpine-Himalayan mountain chain along extensively segmented İzmir-Ankara-Erzican Suture belt and cross-cut by the branches of North Anatolian Fault Zone within northern Anatolia (Turkey). The suture belt, located between the Cenomanian to Late Cretaceous-Paleogene Black Sea Magmatic Arc in north and Anatolide-Tauride Belt in south, links Vardar-Vourinos Zone in Balkans (Macedonia-Greece) to Sevan-Akera Zone in the Lesser Caucasus of Armenia.

The belt is differentiated into tectonic subbelts structurally being on top of each other as; i) Paleozoic metamorphics that are unconformably overlain by Triassic clastics and all later by Liassic to Cenomanian Atlantic-type margin sequences, ii) Triassic Mélange with calcareous blocks and iii) Cretaceous Mélange with ophiolitic blocks (Ankara Ophiolitic Mélange). On top of the Cretaceous ophiolitic mélange belt, various Turonian to Maastrichtian tectonic basins like accretionary forearcs and trench parallel deep-sea basins evolved where all basins regressed and turned into peripheral to foreland and piggyback basins during post-Maastrichtian.

On the other hand, the Cretaceous Ankara Ophiolitic mélanges closely associated with bedded Turonian to Santonian deep-sea basinal sequences, strongly sheared Cenomanian-Turonian marls and Cenomanian sedimentary mélanges with Oxfordian(?)-Berriasian cherty limestone blocks and Late Valanginian-Barremian atolls.

The chaotic mass- the mélanges- overthrusted on to typical Atlantic type margin sequences of Liassic siliciclastics to Callovian-Valanginian platform carbonates to Barremian –Cenomanian pelagic carbonates from Bilecik (Western Pontides; NW Central Anatolia) to Ankara (Central Anatolia) to Amasya (NE of Central Anatolia) to Berdiga and Gümüşhane (Eastern Pontides) onto pre-Miocene units from north to south during the Late Cretaceous. Moreover, lately backthrusted from south to north during post-Lutetian–pre-Miocene period.

To sum up, the Cretaceous continuous deformational accretionary belt limits the Pontides from south evolved in a northward dipping subduction zone operated during Late Cretaceous where Late Cretaceous-Paleogene Black Sea magmatic arc situated to the north and Anatolide-Tauride platform to the south.

Keywords: Ankara ophiolitic mélange, IAES belt, Vardar-Vaurinos Zone, Sevan-Akera Zone, Cenomanian-Turonian, Anatolia

Some problems of Caucasus tectonics: new insight and data from the structural cross-sections

Victor Alania – victor.alania@tsu.ge – Tbilisi State University, Georgia

Onise Enukidze – onise.enukidze@tsu.ge – Tbilisi State University, Georgia

Niko Tevzadze – niko@noc.ge - Georgia Oil & Gas Ltd., Georgia

The Lesser Caucasus and Greater Caucasus orogens are one of the best examples of the collision-driven far-field deformation associated with Arabia-Eurasia convergence. Despite the longterm history of geological investigations, the structure of the Lesser Caucasus and Greater Caucasus and their Cenozoic tectonic history associated with the mountain building process still requires more detailed studies. Currently available tectonic models considerably differ from each other (Adamia et al., 1977, 2011; Alania, 2010; Banks et al., 1997; Cowgill et al., 2016; Khain, 1975; Kocyigit et al. 2003; Mosar et al., 2010; Nemcok et al. 2013; Phillip et al. 1989; Sosson et al., 2010, 2016; Tari et al., 2018; Tibaldi et al., 2017, 2018; Yilmaz et al., 2016). The following questions about the geometry and deformation structural style have motivated our research: (1) What is the present structural architecture of western Greater Caucasus? (2) What has caused the oroclinal bending in the central part of Greater Caucasus retro-wedge? (3) Is the Lesser Caucasus a single- or double-vergent orogen?

We present four S-N trending structural cross-sections which illustrate the present geometry of the Lesser Caucasus and Greater Caucasus. Our study is mainly focused on the interpretation of seismic reflection profiles across the frontal part of the orogens and their foreland basins. In the construction of structural cross-sections seismic reflection profiles, borehole and surface geological data have been used. On the basis of structural cross-sections and previous studies, we assume that: (1) Western part of the Greater Caucasus is double vergent orogen; (2) Basement uplift (Dzirula massif) in the central Caucasus is mainly controlled by south-vergent crustal thrust and formation of oroclinal bending in northern part of Greater Caucasus is related southward propagation of frontal basement structural wedge(s). Formation of south-vergent basement wedge of thick-skinned sector of Dzirula-Imereti uplift zone might be induced by the reactivation of pre-existing normal faults; (3) The Lesser Caucasus is a typical doubly vergent orogenic wedge represented by pro- and retro-wedges actively propagating into the Kura foreland sedimentary basin to the North and the Lesser Caucasus foreland basin to the South.

Keywords: Caucasus tectonics, Seismic reflection profile, Structural cross-section, Double vergent orogen

Fold growth in the South Caspian Sea Basin: Mechanisms and interaction with deep-water lacustrine sediments

Procter, Andrew, andrew.procter16@imperial.ac.uk, Imperial College London

Lonergan, Lidia, L.Lonergan@imperial.ac.uk, Imperial College London

Mayall, Mike, M.Mayall@imperial.ac.uk, Imperial College London

Grant, Simon, simon.grant@uk.bp.com, BP, England

Although the South Caspian Basin (SCB) is one of the oldest hydrocarbon provinces in the world, exploration is continuing to venture into the deeper water. It has therefore become vital to now understand the relatively unknown structural aspects of the basin in these areas. The SCB is a unique basin in which 10 km of sediment has accumulated within the last 6 million years, overlying a thick, organic rich overpressurised shale. Shale cored anticlines and associated mud volcanoes have formed within the basin most likely due to Arabian-Eurasian plate convergence and rapid sediment loading, with the over pressurised shale (>10 km deep) acting as the detachment. By examining a 3D seismic cube, we investigate the mechanisms of mobile shale tectonics and fold growth through time within the South Caspian Sea Basin (SCB). Understanding the timing and mechanisms of fold growth is important for both exploration in the region as well as understanding the fundamental effects of shale tectonics on fold growth. Additionally, the growth of the folds will have impacted the development of topography or differential subsidence at the sea-floor and will control the distribution of potential reservoir facies.

A 1600km^2 3D seismic cube is used for this study and includes two anticlines (Shafag-Asiman fold structure) and three mud volcanoes. There are no well data and therefore horizons were interpreted based on seismic character and stratigraphic relationships. We interpret 20 horizons from five stratigraphic sequences. Isopachs were created to evaluate the growth of the folds both spatially and temporally. Initial results show that whilst both folds appear to show similar growth patterns, growth varies both across each individual fold and between the two folds.

Results also show that fold growth may not initiate in the Late-Pliocene Post-Productive Series, as initially thought, but earlier, in the Early-Pliocene Productive Series. Our results show that although fold growth development principally occurred during the Late-Pliocene, older, underlying structures appear to control the orientation and growth of the folds during Lower Productive Series times. This result is critical in understanding the timing and mechanisms of fold growth in the basin and the controls on the distribution of potential reservoir facies.

Regional tectonics suggest that N-S shortening produced the folding, however, results show that a strike slip component is also present, causing a fold axis rotation through time. The complex nature of the fold growth may be due to a combination of complex tectonic processes as well as sediment loading and mobile shale withdrawal, creating accommodation space, similar to that seen in areas of salt tectonics.

Palaeomagnetism and magnetic fabric of flysch sequences in eastern Crimea Mountains

Bakhmutov Vladimir, Poliachenko Ievgen, Yegorova Tamara., Murovskaya Anna.
Institute of Geophysiscs, National Academy of Sciences of Ukraine. bakhmutovvg@gmail.com

We present a palaeomagnetic study of Mesozoic sedimentary rocks from the eastern part of Crimea Mountains represented by widespread Tavric flysch complex and flish formation near Theodosia area. The new dating of this rocks (Sheremet et al., 2016) requires independent age determination of Crimea flysch sequences. It has been proposed to use the paleomagnetic method taking into account that recent paleomagnetic data from Crimea had been successfully applied both for tectonics (Çinku et al., 2013) and magnetostratigraphy (Guzhikov et al., 2012; Bakhmutov et al., 2018).

Standard palaeomagnetic experiments were performed for sandstones and argillites samples from 13 sites. The directions of more stable characteristic remanent magnetization component (ChRM) was isolated both by thermal and alternating field demagnetization. The analyses of ChRM results, negative conglomerate test and failed fold tests show a widespread remagnetization of Tavric flysh formation in Crimea occurred in post-Berriasian, whereas the flish around the Theodosia area shows no remagnetization. Interpretations of palaeolatitudes with the expected reference apparent polar wander path (APWP) of Eurasia suggest that the remagnetization occurred in the Early Cretaceous (Çinku et al., 2013).

In Theodosia area the flisch section exceeding 160 meters in thickness was studied by micropaleontological and magnetic methods. In different parts of the sequence the ChRM shows normal or reversed polarity in sediments of different lithology. Experiments on magnetic mineralogy have identified magnetite (partially oxidized to maghemite) as the main carrier of the ChRM. There are other weighty arguments in favor of the primary magnetization of the ChRM component. Combination of magnetostratigraphy and biostratigraphy data is a powerful tool for identification the lowest Berriasian Jacobi and Grandis subzones. Calibration of magnetostratigraphy, calpionellids, ammonites and nannofossils zones to define a stage base in a wider Upper Tithonian to Lower Berriasian context was carried out.

Data on the anisotropy of magnetic susceptibility (AMS) of Tavric flysch complex show typical sedimentary structure of sediments after bedding correction. The minimum axis of the AMS ellipsoid is normal to bedding, while the direction of the maximum axis K1 is NE-SW for 7 sites and NW-SE - for 3 sites. In case the shape of the AMS tensor is related to tectonic deformation, the measurement of AMS in rocks of different ages allows to define an upper age limit of deformations.

Paleo- and recent stress regimes of the Crimea Mountains were determined based on micro- and macroscale tectonic analysis. The NW-SE orientation of the σ1 compressional axis prevails in the Crimea Mountains during the formation of the main compressional structures. The NW-SE trending of the σ1 compressional axis is perpendicular to the maximum axis K1 of the AMS ellipsoid obtained for majority of sites. The fact allows to make an assumption about the relation of the AMS and compression strain.

Collisional processes in the Crimean seismic zone

Murovska, Anna - murovskaya@gmail.com – Institute of Geophysics, National Academy of Sciences of Ukraine
Yegorova, Tamara - tameg22@yahoo.com – Institute of Geophysics, National Academy of Sciences of Ukraine
Gobarenko, Valentina - valja-gobar@gmail.com – Institute of Seismology and Geodynamics, Crimea Federal University
Sheremet (Korniyenko), Yevgeniya – korngane@gmail.com – University Côte d'Azur, UNS, CNRS, France

The Crimean seismic zone (CSZ) is located at the junction of the Scythian Plate of thick continental crust and Black Sea Microplate of very thin continental/or oceanic crust (Gobarenko et al, 2016). Southern limit of the CSZ coincides with the isohypses ~30 km in the map plan of Moho surface. Earthquakes with M £3 are located mainly at the southern edge of the continental crust of the Scythian Plate. We studied 32 focal mechanisms of strong earthquakes (M>4): all types of mechanisms have been obtained with the prevalence of inverse and nappe types. Based on 1) restored orientation of the stress tensor main axis for three groups of mechanisms in the Kerch-Taman, South-Crimean, and Sevastopol subzones of the CSZ and 2) reconstruction of the compression stress in the Crimea Mountain (CM) (kinematic method and Win Tensor program were applied to our numerous field data on slicken-sides), we conclude that the main trend of compression is orthogonal to the isometric zone of the crust thickening (> 48 km) in the Southern Crimea, and obviously reflects the crust congestion and thickening under compression.

The deepest (70–90 km) Kerch–Taman foci cluster of the CSZ is dipping north-eastward at about 30°. The compression stress in this branch has a NNE trend. The Kerch–Taman branch could be an evidence of thrusting of the very stretched crust of the East Black Sea Microplate (indentor) under the Scythian Plate with continental crust. The S-N-trending compact Alushta stripe of foci within the South-Crimean branch of CSZ coincides with Middle Jurassic magmatic body chain indicating the Alushta-Simferopol Fault Zone (ASFZ). These magmatic bodies underwent present-day deformations that are evidenced by tight foci distribution. ASFZ at present, experiences the left lateral transpression under NW compression. Velocity crust structure from the deep seismic study (Yegorova et al., 2018) indicates the horizontal stratification of the CM crust at the depths of 30-35 km, which makes possible to invoke mechanism of crustal wedging. The collisional process in the South-Crimean branch, caused by the East Black Sea crustal indentor, are complicated by presence of numerous magmatic bodies within the CM crust that results in significant thickening of the latter.

Keywords: Crimea, seismicity, earthquake focal mechanism, collision processes

Deformation styles at the contact between convergent thrust-belts, central Georgia

A. Lapadat[1], Z. Schleder[2], C. Asmar[2], M. Fallah[1], G. Tari[2] and N. Tevzadze[3]

[1]OMV Petrom, Exploration and Appraisal, Str. Coralilor 22, 013329 Bucharest, Romania

[2]OMV, Exploration and Production, Trabrennstrasse 6-8, 1220 Vienna, Austria

[3]Georgia Oil and Gas Limited, 4A Freedom Square, 0105 Tbilisi, Georgia

Continental collision zones are areas of intense and complex structural deformation which can hold important hydrocarbon accumulations in complex structural traps. The central part of Georgia is a particular case, where the active collision between Arabia and Eurasia generates the convergent movement and interaction between two thrust-belts: the south-propagating deformed Kura-Kartli foreland of the Greater Caucasus fold-and-thrust belt and the dominantly north-verging Atchara-Trialet fold-and-thrust belt. North and east of the city of Tbilisi, the NW-SE oriented Greater Caucasus deformation front completely overrides the E-W oriented Atchara-Trialet fold belt and enhances formation of structural hydrocarbon traps at multiple levels, such as the Norio and Satskhenisi oil fields within the frontal edge of the south-verging overriding thrusts and the Samgori-Patardzeuli fields within the sub-thrusted Atchara-Trialeti thrust-belt. In this study we investigate the along-strike variability of structural deformation at the contact between these two converging thrust-belts. We show that structural geometries can be highly variable, as a consequence of the manner in which strain is accommodated within the mechanically heterogeneous stratigraphic sequence. Reactivation of pre-existing extensional structures of the Atchara-Trialeti basin adds further complexity to the variability of deformation. Understanding better the characteristics of structural geometries can significantly enhance the exploration potential of the area, which was under-explored in the last three decades.

NEOTECTONICS AND GEOHAZARDS

Geodynamics and Seismicity of the Lithosphere of the Black Sea – Caspian Sea Region

Sh. Adamia - shota25adamia@gmail.com, - I. Javakhishvili Tbilisi State University

V. Alania - Victor.alania@tsu.ge, A. Chabukiani -alecocha@gmail.com, T. Mumladze -tea_mumladze@yahoo.com, A. Gventsadze - aleko@gventsadze@tsu.ge, N. Lursmanashvili -nona.lursmanashvili@tsu.ge and N. Sadradze - ninosadradze@gmail.com ; - I. Javakhishvili Tbilisi State University

The structure and geological evolution of thelithosphere of the Black Sea-Caspian Sea region are largely determined by its position between the still converging Eurasian, Indian and Africa-Arabian lithospheric plates, within a wide zone of continent-continent collision. Several events of subduction, and obduction of oceanic crust, lateral displacement of lithosphere fragments took place during the Phanerozoic. Final closing of the oceanic and back-arc basins, continent-continent collision, topographic inversion and formation of the present-day structure of the region was accomplished in the Late Cenozoic.

Studies related to the seismicity of the region and adjacent areas started long ago. Significant achievement in this field are connected with realization of several international projects: Caucasian Seismic Information Network (CauSIN), Earthquake Model of the Middle East (EMME), International Research Group (IRG) DARIUS etc. Some results of these projects have been published. The Earthquake Model of the lithosphere of the Middle East is a regional project of the GEM (Global Earthquake Model). The active tectonics of the region considered in EMME project is determined by the northward motion of the African, Arabian and the Indian plates towards the Eurasian plate. In the region, earthquake hypocenters usually are located in the upper crust (c. 5-35km). However, seismological data from the southern and middle Caspian Basin and easternmost Caucasus - pre-Caucasus reveal a deep-seated zone of stress and strain, a zone of the lower crust-upper mantle earthquake sources that dips beneath the eastern Caucasus. The most likely explanation for these subcrustal earthquakes appears interference of lithospheric folding in the region by simultaneous indentation of the Africa-Arabian and Indian plates. Submeridional trough of the Caspian Sea lithosphere may be a structure located at the borderland between the Arabian and Indian plates resulted from the interference of lithospheric folding. Therefore, S-N compression of the lithosphere of the Caucasus resulted in formation of sublatitudional fold-and-thrust mountain belts, while submeridional trough was due to simultaneous lateral push out of the lithosphere of the Caucasus and central Asia towards the Caspian Sea.

The Caucasus region is subject not only to S-N but also to E-W compression, since it is directly adjacent to the eastern Black Sea on the west and the Caspian Sea on the east, which both have suboceanic high-density crust that hampers lateral tectonic escape of the western and eastern Caucasus, respectively. Westward escape of the Rioni foreland did not occur either, because of the backstop provided by the stable crust of the eastern Black Sea Basin, so such compression led to formation of the seismoactive structure represented by the chain of Gali, Zugdidi, Khobi, Eki, and Abedati anticlines that fully delineates the Odishi piggyback basin.

Submeridional compression of the Caucasian lithosphere caused by Arabia-Eurasia convergence reaches its maximum within the central segment of the Caucasus, along a line running through the central part of the Transcaucasus. Westward of this line, compression is replaced by tension caused by the W-SW escape of central Anatolia, where the territory of the Black Sea is experiencing weak submeridional compression. Apparently, the same conditions also exist eastward of the line of maximal compression in the territory of the Kura foreland and Talysh in southeastern Caucasus.

Key words; Black Sea-Caspian Sea region, collision, seismicity, compression, subcrustal, tension, escape

Seismic hazard estimation based on active faults data for Georgia (Sakartvelo)

Author :Tsereteli, Nino -nino_tsereteli@tsu.ge- M. nodia Institute of Geophysics of Tbilisi State University 1

Co Author :Tibaldi, Alessandro- alessandro.tibaldi@unimib.it- University of Milan Bicocca, Italy 2

Co Author :Otar, Varazanashvili -otarivar@yahoo.com- M. nodia Institute of Geophysics of Tbilisi State University 1

Co Author :Laurentiu Danciu - laurentiu.danciu@sed.ethz.ch - Swiss Seismological Service (SED), ETH Zürich 3

Co Author : Fabio Luka Bonali - fabioluca.bonali@gmail.com-University of Milan Bicocca, Italy 2

Co Author : Elena Russo - e.russo11@campus.unimib.it - University of Milan Bicocca, Italy 2

The present work describesthe efforts towards evaluation of basic steps in PSH analysis for the Republic of Georgia. As usual, PSH wasestimated by seismic source characterization obtained by seismic data. This work is a first attempt to estimate PSH based on animproved database of active faults of Georgia compared to the database prepared in the framework of EMME project. Here we present two newly discovered active faults in the Rioni basin, whose geometry was reconstructed by means of geological-structural field data as well as seismic data. Fault slip rates were estimated for each fault from offset stratigraphic markers.Correlation equations between slip rates, fault length and magnitude were used for the active faults for which we know length from seismological and geological data. To each fault we assigned a Maximum magnitude (Mmax) by geological or historical data.

PSH were estimated also for seismic sources. The procedure for building Seismic sources SS is based on the allocation of a certain width along the active fault. In this case, the width of SS plays a decisive role in creating the SS models of the region. The width of SS depends on the information about the width of the fault, the slope of the fault plane, the thickness of the seismically active layer, and the geometric dimensions of the source of the maximum possible earthquake. The asymmetry of SS with respect to the axial line of the inclined fault is a characteristic feature of this construction. For each SS zone in the source model we determined the following parameters: the Mmax, the magnitude-frequency parameters of the seismicity, the parameters of depth distribution. Estimation of Mmaxwas made on the basis of the useof five methods within individual SS. Three of them are seismological methods and two are geological ones. Finally results of PSH obtained from different source data (active faults, SS) were compared and analyzed.

Keywords: active fault, slip rate, seismic hazard

Active tectonics of the eastern and south-eastern Caucasus (within Azerbaijan)

Kangarli Talat – tkangarli@gmail.com – Institute of Geology and Geophysics Azerbaijan NAS
Aliyev Fuad – fuad_al@yahoo.com – Institute of Geology and Geophysics Azerbaijan NAS
Rashidov Tofig – tofig.rashidov@gmail.com Institute of Geology and Geophysics Azerbaijan NAS

The stress state of the lithosphere in the Greater Caucasus, located in a zone of pseudosubduction interaction of the northern and southern Caucasus massifs (tectonic microplates), is the result of intercalation of the Arabian indenter into the buffer structures of Eurasia during the continental stage of Alpine tectogenesis (since the end of Miocene). This condition is well confirmed by geophysical data over the structures and seismogeodynamic activity of the regional Earth's crust that generally represents an underthrust zone of the southern Caspian microplate's Kakheti-Vandam-Gobustan margin under the Eurasia's southern zone (Scyth-Turan epi-Hercynian platform), accompanied by southward advancement of the allochthonous accretionary prism built by structural-material complexes of the Greater Caucasus margin. This factor determines peculiarities of both surface and deep structure of the orogens, reflected in geological mapping, seismic and electrical prospecting activities, as well as gravitational and magnetometric observations in Azerbaijan.

In this study we analyzed active tectonics of the region from the viewpoint of the mechanism of undergoing (pseudo-subduction) within convergence zone of the south and north microplates. We have also analyzed and interpreted the seismogeological data, as well as GPS monitoring results about contemporary geodynamic activity determining correlations with deep structure peculiarities. Analysis and correlation of historical and recent seismic events (until 2018) show that the earthquake focuses are mainly confined to the intersection nodes of differently striking rupture dislocations, or to the planes of deep tectonic failures and lateral displacements along the unstable contacts of material complexes with different competence. Earthquake focal mechanisms inform about predominantly near-vertical movements along normal fault planes and normal faults with strike-slip components, but in general earthquake focuses are confined to the intersection nodes of main- and anti-Caucasus rupture dislocations.

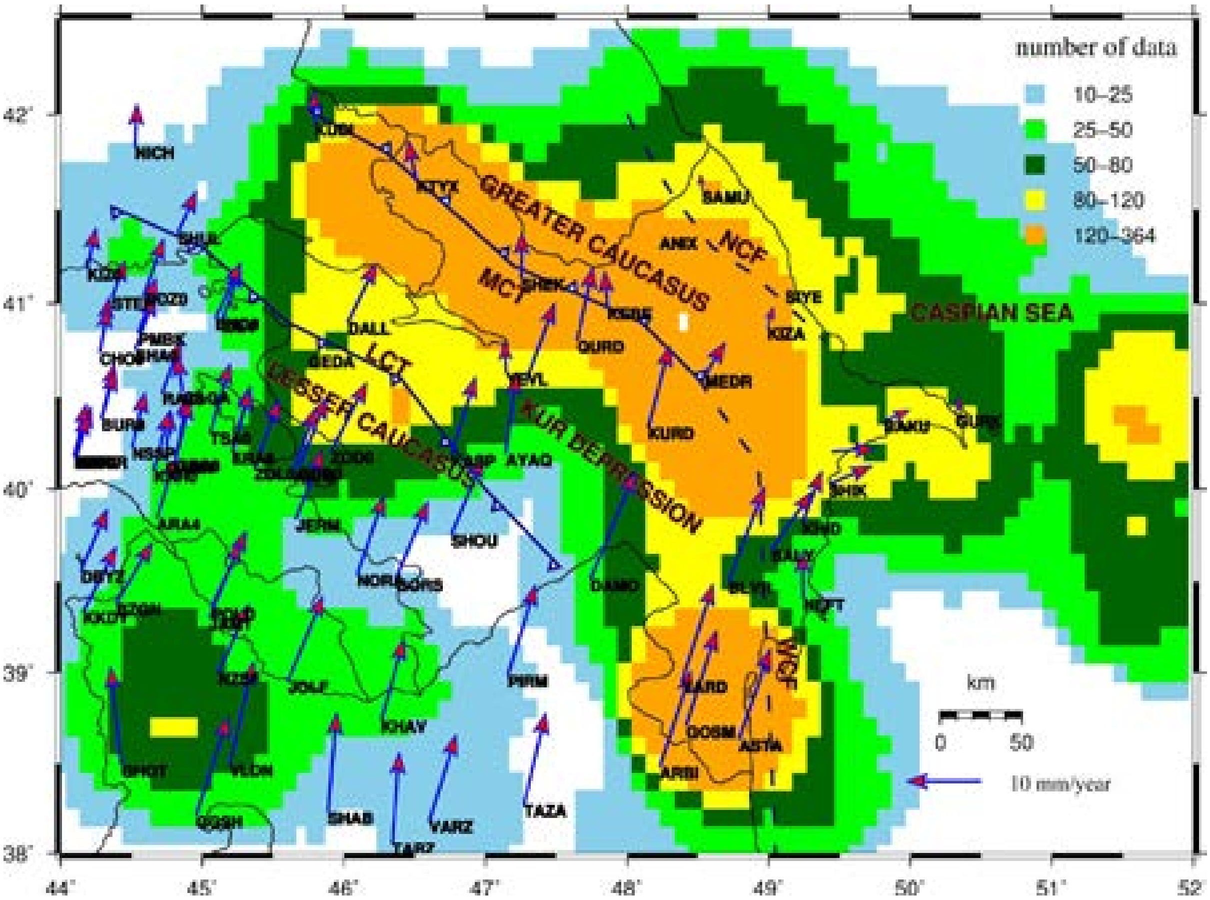
During the continental stage of Alpine tectogenesis (starting from the end of Miocene), intensive lateral compression process was caused by intrusion of the frontal wedge of the Arabian indenter into the buffer structures of the southern frame of Eurasia. This is evidenced by the GPS monitoring data on modern geodynamic activity, which demonstrates the Southern Caucasus block's intensive (up to 29 mm/year) intrusion in the northern edges as compared to the relative stability of the Northern Caucasus microplate (0-6 mm/year). This, in turn, is a reflection of the ongoing pseudosubduction regime (continental subduction) at the band of collision junction of these microplates. It is suggested that this process caused historically observed seismic activity in the study area, wherein the earthquakes occurred mainly in the southern slope's accretionary prism area and the adjacent strip of the Southern Caucasus microplate. In this article, we analyze and correlate the whole range of seismic events that occurred in the study area until 2018 and the focal mechanisms of the recently recorded earthquakes (2012-2018). It is established that earthquake foci are confined either to the intersection nodes of variously trending ruptures with the faults of different directions or to the planes of deep tectonic ruptures and lateral displacements along the unstable contacts between the material complexes with different competence. The focal mechanisms of seismic events reveal various, mostly near-vertical, planes of normal and strike-slip faults. However, the earthquake foci are generally confined to the intersection nodes between the Caucasus and anti-Caucasus-striking rupture dislocations.

Keywords: Earthquake, focal mechanism, geodynamics, accretionary prism.

Structural analysis of Earth`s crust GPS horizontal velocities and seismic hazard in Azerbaijan

Safarov, Rafig – rafiqsafarov@gmail.com – Institute of Geology and Geophysics, Azerbaijan National Academy of Sciences

Azerbaijan GPS network data is used to perform structural analysis of horizontal velocity field. On this purpose, distribution regularities of seismic events, regional faults and tectonic structures, distribution of north and east components of GPS velocity vectors in the territory of Azerbaijan were involved to comparison. Several "domain" areas which behave as rigid block were revealed: Greater Caucasus fold system; Lesser Caucasus fold system; Kur depression; Lower Kur depression-Gobustan-Absheron area; Talish fold system area and Gusar-Shabran back arc depression. "Domains" are the areas which have different GPS velocity characteristics from adjacent areas.



The high density of seismic events and the difference of GPS velocity vectors in orientation and in magnitude indicate rapid strain accumulation along the southern slope of Greater Caucasus. The seismic activity observed in Talish mountainous zone interpreted as the result of counteraction to the mass in motion along the Caspian fault zone and high east component rates on ARBI, ASTA, GOSM, YARD and BLVR GPS sites. Structural analysis of GPS rates allow to understand the properties of modern tectonic processes which take place in the Earth`s crust and to quantify the related seismic events.

Keywords: domen, hazard, GPS, seismicity

Level drop – hydrates decay – avalancheous slump – quake-triggered tsumani – chaotic deformation – sedimentary brecciation: Origin of MTDs in the Black sea basin

Kitchka, Alexander – kitchka@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Tyschenko, Andrii - aptyshchenko@gmail.com – Inst. of Geology, Shevchenko National University of Kyiv, and SE NaukaNaftogaz, Naftogaz Group

Quite intriguing deepwater seismic images and very unusual sedimentary breccias have the common denominator in the Black Sea basin, namely mass transport deposits (MTDs), formerly known as olistostromes s.str. Thematic interpretation of the regional 2D CDP seismic data (47 lines of almost 10000 km total length) acquired for NJSC Naftogaz of Ukraine in 2005 and re-processed applying true amplitude recovery technique by SE Naukanaftogaz in 2008 is a basic element of this study. Two large-scale areas of composite MTDs, the western and eastern slumping theatres have been outlined upon the interpretation results. The deepest MTC detachment level is related to Ip reference reflection horizon attributed to the base of the Middle Miocene mainly carbonate / calcareous shales parasequence set.

Full range of structural settings and related features of extensional, translation and compressive domains of the submarine mass transport deposits has been recognized by thematic interpreting of the regional 2D seismic data covering Ukrainian deepwater area in the Black Sea (see figure 1).

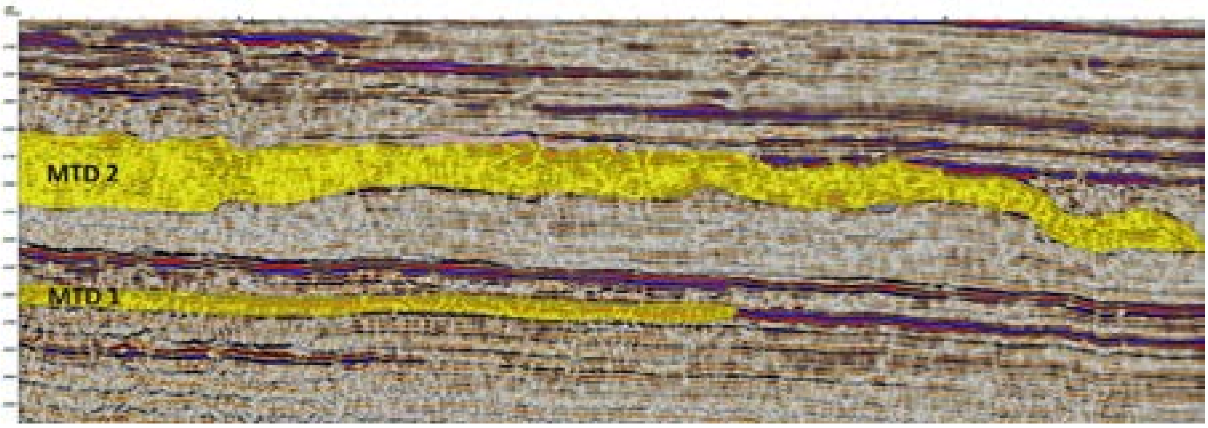


Figure 1 An example of two MTD flow tongues recognized in the Western slumping theatre (BS-05-24 Line).

The synchronous to deepwater MTDs the Sarmatian tempestites or even tsunamites known under local name heraclites (Lysenko V.I. & Lysenko V.I., 2001) as well as seismites are described and studied in the SW Crimea in the rock cliffs of the Heraclean Plateau south of Sevastopol.

This study links the rapid pulses of the Black sea level fall in the Middle to Late Miocene epochs accompanied by erosion of the shelf break areas and formation of submarine incision valleys, dissociation of gas hydrates, slope failures and large scale rock downslides triggering tsunamis (that imprinted the shore sequences outcropping around the basin) as precursors of the Messinian crisis s.l. manifestation in the Paratethys belt along with flexural count-reaction at crustal level afterwards.

Bituminization and presence of biodegraded light oil in some carbonate clasts of heraclites testify the establishment of early mature petroleum system (thick Maykop Fm black shales below is the best source rock candidate) at least by the beginning of the Middle Miocene.

Keywords: Black Sea, gas hydrate decay, submarine slumping, mass transport deposits, tsunami, heraclites.

Probable Tsunami in the South Caspian Sea by a Large Earthquake!

Nazari, Hamid -h.nazari@ries.ac.ir- Research Institute for Earth Sciences, Geological Survey of Iran, Tehran-Iran[1].
Hajian Barzi, Mahmoud- mah_hajian@yahoo.com- Exploration Division, National Iranian Oil Company, Tehran-Iran [2].

The risk of tsunami subsequent to earthquakes in coastal, usually populated areas has become, after the December 2004 Aceh and the march 2011 Fukushima events, an important topic in earth sciences. Passed events have demonstrated that natural hazards are commonly interrelated; hence, tsunami waves due to earthquakes and landslides. The south Caspian basin(SCB) is surrounded by the e-w central Alborz mountain range in South and N-S Talesh mountain in its South Western side. They bound SCB to the South and South West, as an active terrain belonging to the Alpine-Himalayan seismic belt. The Khazar fault, nearly 450 kilometers long, and Astara fault, 110 km long appear as the Northern border of the central Alborz and Eastern border of the Talesh chain where Mesozoic and Paleogene rock units overridden on the young deposits of the South Caspian plain. Base on morphotectonics and Paleoseismology studies, we suggest that a major part of the present shortening in Alborz is localized on the Northern face of the chain along the Khazar fault zone; it is however worth noting that this contact might be located further to the North under the sea. This border can be interpreted as frontal contact between Alborz and the South-Caspian basin.

A recent stratigraphic study on the Holocene – Pleistocene deposits in East central Alborz, suggests an incision rate of 1.25 mm/yr as calculated for the last 12 ka., if it is assumed that the incision is related to the vertical component along the Khazar fault, the horizontal N-S shortening along this fault would be 2.5 mm/yr (for a 34^{o}s-dipping fault). in South West of the SCB the Astara fault as major active fault system that propagated under the sea as well as the Khazar fault in its South shore. The recent studies confirmed well, that many earthquakes may have been caused by the activity of various branches of these fault systems in land or marine parts of the SCB. such as: in the West, along the Astara fault, in a single Paleo-Seismic trench 3-4 Paleo- Seismic events occurred in the past 3 ka., larger than 6.5 MW. When in south east of the Caspian, Archaeoseismological studies shows, 4-5 Paleo- earthquakes between 3500 to 5000 BP, (7 -6.2 Mw), with a mean recurrence time near to 375 years. although, regards to derived information from Baladeh eq. in 2004, maximum down dip rupture on the fault plane reach to ~ 50 km, with a subsurface slip ~5m. so, estimated maximum magnitude for next probable earthquake large earthquake with such as surface rupture along Khazar fault trace is 7.6± 3, with 1650 ±50 years' interval.

Concerning to the basin geometry, propagated faults to north or east and its land slope, besides more than 20 km thickness of Neogene and Quaternary deposits in the SCB in the scenario with the possibility of a seismic activity on the Khazar or the Astara faults or one of them propagated branches on the sea with a magnitude of 7, as the closest active faults to the most largest lake can trigger many large submarine earthquake ruptures or submarine landslides which is its potential for generating Seach wave or tsunamis in the steep Southern coast. So, this research aims at providing the incomplete geological information concerning the populated shores of the South Caspian Sea, in Iran to make a re-evaluate on the hazard assessment.

keywords: Earthquake, Tsunami, Khazar fault, Astara fault, Caspian, Iran.

Integration of petroleum industry and academic data sets in Georgia to mitigate geohazards in the broader Caucasus area

Tari, Gabor - gabor.tari@omv.com - OMV Upstream, Vienna, Austria

Tatishvili, Giorgi - g.tatishvili@saog.gov.ge - Agency for Mineral Resources, Ministry of Energy, Tbilisi, Georgia

Tsereteli, Nino - nino_tsereteli@tsu.ge - Institute of Geophysics, Javakhishvili State University, Tbilisi, Georgia

Ongoing NNE-SSW convergence between the Arabian and Eurasian plates is mostly taken up along the southern leading edge of the Great Caucasus folded belt in central and eastern Georgia. Present-day seismic activity, unevenly distributed along the deformation front, clusters along south-vergent thrust faults across onshore Georgia. The circa 80 km wide Racha zone exhibits especially strong earthquake activity, recorded by both historical and instrumental data, with dominantly compressional fault plane solutions. The primary reason for the Racha earthquake cluster is the large basement promontory of the Dziruli Massif. This basement high, partially outcropping in the foreland, is the continuation of the Shatsky Ridge of the Eastern Black Sea to onshore Georgia. The Dziruli Massif poses a kinematic obstacle for the southward propagation of the Great Caucasus frontal thrust system creating earthquakes in the upper crust.

West of the Dziruli Massif, some of the neotectonic shortening is taken up by a regional Upper Jurassic evaporite detachment level. This mostly anhydrite decollement surface is responsible for the prominent thin-skinned outlier of the leading edge anticlinal chain at Tsaishi. Seismic activity along this and other thrust segments in western Georgia is interpreted to be controlled by an underlying NW-SE striking structural fabric inherited from several large Cretaceous transform/transfer fault zones associated with the opening of the Eastern Black Sea. These prominent faults were mapped on offshore seismic reflection data sets and some of them have strike-slip fault solutions associated with them. This pattern is interpreted as the neotectonic reactivation of dormant Mesozoic transform faults to accommodate the overall convergence in the broader region in lieu of thrust faulting.

Therefore hydrocarbon industry seismic reflection data sets provide important additional clues to the understanding of the map-view characteristics of the present day earthquake activity in western Georgia. The integration of industry and academic data sets can be used to identify historically inactive fault zones which may pose seismic risk in the broader Caucasus region.

Keywords: seismic activity, neotectonics, transform fault, Caucasus, Eastern Black Sea, Dziruli Massif

Geodynamic analysis of gravity model

Sadigova Gunel Rafael

Institute of Geology and Geophysics, ANAS, Azerbaijan, Baku

gsadigova@yahoo.com

Complex study of deep structure and geodynamic situation in active zones of interaction between the Arabian and Eurasian plates is one of the most important tasks of modern geology and geophysics. These regions are involved in a global geotectonic activity, influencing the formation of the Earth's surface of the region. The crucial role in these processes is the presence of density inhomogeneity of the substance within the earth and, especially, in the lithosphere, in other words the inhomogeneous distribution of gravitational masses. One of the main methods of studying this inhomogeneity is the gravity modeling of the deep structure. Modern geodynamic problems are studied on the basis of space geodesy and seismic data.

Taking into account the geodynamic hazard for the infrastructure of the region (Baku-Novorossiysk oil pipeline, Takhtakorpu and Shollar water pipeline) and prospects of oil and gas exploration, the South Caucasian region of Azerbaijan has been selected as an object of research. On the other hand, the regularities of the deep structure with geodynamic conditions and kinematic parameters in the research area have not been identified so far and, accordingly, the study of this problem has a great scientific and experimental significance.

The average values of depth of density boundaries were defined on the basis of gravity field power spectrum of the investigated area by the use of the "Spector-Grant" method. It is established that the average depth of the density boundaries, which causes gravity anomaly in the Earth's crust of the investigated area, is 16.6 km and 1.8 km. The gravity model was constructed along the profile of Samur-Baku, passing along the western coast of the Caspian Sea using the initial section built on geological and geophysical data, as well as using the matching method, developed by E. G. Bulakh. It is shown that the surface of the upper and lower (granite and basalt) layers of the Earth's crust is 5-16 km and 28-32 km, and the surface of the Moho-47-57 km. Taking into account the seismicity and velocities of modern movements of the Earth's crust, obtained by the space geodesy GPS methods and high-precision leveling, the geodynamic conditions of the territory along the profile were analyzed. The strain accumulation zones near the Khudat, Charkhy, Siazan and Baku stations were determined based on the rates of modern vertical movements of the Earth's crust. The average strain values were determined by GPS measurements. According to the north component of GPS vectors, the highest values of deformation were obtained between Siazan and Khyzy stations (112.5 nanostrain/year), and on the east component - between Baku and Khyzy (30.2 nanostrain/year). The maximum total strain rate for both components of the velocities was 97.5 nanostrain/year between Siazan and Khyzy stations. It was established that the high strain rate corresponds to the zone between the Siazan and Khyzy stations where a sharp change of the relief occurs and to the territory of the Siyazan fault. The foci radius and magnitude of earthquakes (R_{max} = 21 km, M = 6.6) which influence the formation of geodynamic conditions along the Samur-Baku profile were determined. Calculations were made according to the formula of I. P. Dobrovolsky. It was found that the geodynamic state of the medium could be affected by an earthquake with magnitude M = 6,6, which would occur at a distance of 21 km from the profile. Elevated values of temperature were observed in the zones of stress concentration, revealed by the curves of modern vertical movement rates (Khudat, Siazan and Baku). The maximum temperature values were observed in the area of Siazan station. The temperature increase is likely to occur near the zone of the Siazan tectonic fault, which in turn is characterized by high seismic activity.

The obtained data can be used in estimation of geodynamic hazards for infrastructure of the region (Baku-Novorossiysk oil pipeline, Takhtakorpu and Shollar water pipeline).

Keywords: South-Eastern Caucasus, gravity model, geodynamics, earthquake, fault, GPS velocities, stress.

Poster presentation

Characteristics of focal mechanisms in South Caspian subduction zone

Zamanova ,Aynur Hummet, Asgerova Roksana Akper

Institute of Geology and Geophysics, ANAS, Azerbaijan, Baku AZ1143, H.Cavid. 119A

aynur-zamanova@rambler.ru

In this study we analyzed a relationship of strong earthquakes, including their focal mechanism solutions with the modern deep structure of the Earth's crust within South Caspian microplate on the basis of recent geophysical data.

The depth distribution of magnitude ml ≥ 3.0 earthquakes occurred during last 50 years (1970-2017 years) in Azerbaijan part of the Caspian basin was studied and a as a result, relatively high seismic activity within depths of 30-50 km was revealed. The analysis shows that about 60% of earthquakes occur at depths greater than 30 km. Based on depth distribution data, we can conclude these earthquakes belong to the consolidated oceanic type crust and the upper mantle.

Analysis of the seismicity of the South Caspian basin shows that its central part is characterized by a relatively weak seismic activity, while the northern edge is always and still characterized by higher seismic activity. Here, along with crustal earthquakes, very strong crust-mantle originated earthquakes had taken place. Strong (ml > 5.0) and deep focus (30-80 km and deeper) earthquakes in the northern flank of the South Caspian Basin are the result from the subduction of the consolidated crust of South Caspian Basin beneath the Epihercynian platform, established on the materials ultra-deep seismometry. Focal mechanisms of the most of deep (H > 30 km) earthquakes on the top level of the consolidated crust, mainly characterized by extension stresses which are likely associated with the bending with degree more than 22-25^0 and with subduction of the South Caspian plate to north, whereas in pre-platform zone with ruptures and by fragmentations of the platform edges and with displacement of its blocks.

A huge number of earthquakes occurred in Absheron sill and in pre-platform zone within the accretionary prism. Analysis of the focal mechanisms has shown that earthquakes at depths of 15-25 km within the accretionary prism are mainly associated with with complicated degradation-deformation of the Mesozoic-Paleogene sediments.

The analysis of the earthquake focal mechanisms confirms the existence of normal fault types for deep focus earthquakes along subduction zones in the northern flank of the South Caspian basin. Thrust and reverse fault types are observed in the Caucasus and Kopetdag, whereas the Transcaucasian and eastern Iran blocks are pseudosubducting under the Skif and Turan platforms.

Keyword: Focal mechanism, subduction zone, earthquake, South Caspian plate

Hydrocarbon potential of Kazakhstan and ways to search for new fields

Kuandykov, B.M., The Kazakh Association of Petroleum Geologists, Almaty, Kazakhstan

The Republic of Kazakhstan has a progressively developing oil and gas industry. Whereas yearly production was about 20 million tons of oil only 15-20 years ago, these days oil and gas production in Kazakhstan is over 90 million tons and 55 billion cubic meters, respectively. Oil and gas production in Kazakhstan is predicted to steadily increase considerably in the long term.

15 sedimentary basins are known in Kazakhstan. Relevant petroleum exploration techniques were used in each of these basins adapted to their special geological features. In the Precaspian basin, the pre-Kungurian pre-salt sequence of the sedimentary cover has been and still remains the main target. Investigation of the structure and petroleum potential of mostly non-structural traps, i.e. Carboniferous and Permian carbonate build-ups became the primary exploration play in this basin. In the salt dome province, accumulations in the post-salt Mesozoic sequence points to highly probable new discoveries in the Ural-Volga interfluve area and the Prorva group of fields, and also on the northern submerged area of the Aktobe-Astrakhan faulted zone.

New subsurface findings have also confirmed the potential of the Mesozoic sequence in Ustyurt and the Triassic sequence in the Mangystau petroleum province that were considered earlier as non-reservoirs or sequences of limited interest. Paleozoic-Triassic intermediate and Jurassic-Neogene plate stages whose structural plans inherit to a great extent the morphological specific features of the basement relief are identified in these areas. The intermediate structural stage is found everywhere in North Ustyurt, including East Aral.

Equally promising for the search of new oil and gas fields, naturally, is the offshore Caspian. It should be noted that a number of oil and gas fields with considerable reserves were discovered in the neighboring territory of Russia and some of them have already been brought into the development stage (Khvalynskoye, Rakushechnoye, West Rakushechnoye, Filanovskoyeand and Korchagin Fields). Drilling results in the South Torgai and Shu-Sarysu basins provided commercial inflows of oil and gas from Paleozoic rocks that were earlier assigned to the basement. Therefore, there is a clear need for the revision of existing structural and petroleum potential models. Industrial growth in East Kazakhstan and the economics of the country drive the need for a study and determination of the resources base in the Zaisan, Balkhash, Ili and Alakol Basins. The first interesting findings in the Zaisan Basin are now capturing the attention of all geologists in Kazakhstan. The North Kazakhstan basins, including the northern part of the Torgai Trough, the Petropavlovsk Monocline and Pavlodar Preirtyshiye also call for large-scale exploration studies. Apart from the Upper Jurassic-Valanginian deposits that are the most promising in terms of their petroleum potential, some upside potential is assigned to the totally unexplored Upper Paleozoic sequence.

The depth structure of the Syr-Darya Depression and the Pre-Aral area is also conceived differently lately. Reprocessing of available seismic data from the Aral Sea basin, whose territory to a large extent has already become dry land, points to the possibility of finding gas pools in the Paleogene sequence. In addition, there are favorable structural conditions for the Cretaceous and Jurassic formations and reef traps could be expected in the Middle Paleozoic sequence.

EXPLORATION, DEVELOPMENT AND PRODUCTION CASE STUDIES

Oil seeps as indicator of hydrocarbon potential in the Kura and Gabyrry interfluvial area, Western Azerbaijan

Javadova Arzu – javaa3@bp.com , BP AGTR
Afandiyeva Malahat – m.efendiyeva@mail.ru, OGI ANAS

Guliyev Ibrahim – i.guliyev@gmail.com, OGI ANAS

Guseynova Shalala - huseynova_shalala@yahoo.com, OGI ANAS

Vahabov Ulvi – u.vahabov@mail.ru, GIA ANAS

The western part of the Azerbaijan remains poorly explored and thus requires more research and understanding. There are about 30 oil seeps on the territory of the Kura and Gabyrry interfluvial area; most of the outcrops are confined to the rocks of Sarmatian age.

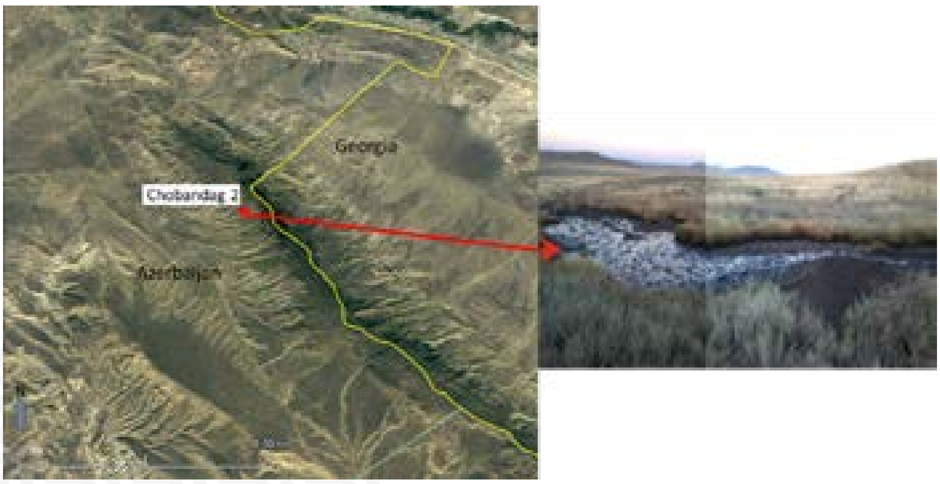
Current study covers oil seeps near Chobandag mountain. They coincide to the Chobandag thrust zone. Lithologically represent marls and shales of the Lower Sarmathian age.

Outcrop #1 represents seep of oil and bitumen with average values of pH 6.6 and Eh +31mV and very low carbonate content (average value is 1%). TOC content varies in the range of 0.29-0.4%. These suggest acidic reducing environment during Upper Maykop time.

Outcrop #2 characterized by a relatively higher bitumen content. The average value of pH is 8.9, Eh is +48 mV, carbonate content is 18.6%. The value of TOC in one of the samples has reached up to 6.82%. Integrated analysis of the analytical data suggests alkaline recovery nature of the depositional environment. Outcrop location is shown on the map below.

Further reaserch work includes detailed biostartrigraphic and biomarker analyses on selected samples, including fluid samples from the wells nearby.

In overall, field data and analytical studies indicate importance of further exploration work on the western part of Azerbaijan that will help unlock hydrocarbon potential of the area.



Outcrop# 2 - Location map and photo.

Key words: Western Azerbaijan, oil seeps, geochemistry, exploration potential

Geo-challenges of studying and exploring the structure and petroleum potential of the Odessa Gulf shelf

Kitchka, Alexander – kitchka@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Tyschenko, Andrii - aptyshchenko@gmail.com – Inst. of Geology, Shevchenko National University of Kyiv & SE NaukaNaftogaz, Naftogaz Group

Ishchenko, Ihor – ishchenko@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Shevchenko, Oleksandr – Shevchenko@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

The Krylov depression and Goubkin-Zmiyiny uplifted zone located in the Black Sea basin northwestern shelf known as the Odessa Gulf is one of the highly promising areas for oil and gas and least studied with modern seismics and exploration drilling at the same time. The area under investigation is characteristic of deeply dislocated the conjugation zone between the slope of the Precambrian East European Craton and Kimmerian Scythian plate superimposed by younger sediments of the Black Sea basin.

Recently, the Government of Ukraine has offered the Delfin E&P license permit for electronic bid round (under PSA model). Geographically, Delfin license covers 9 536.41 sq.km of total area excluding two existing permits for Odessa and Bezimenne gas fields under production and three license prospects as Kulisna, Riftova and Goubkina one. In terms of geology and the least political risk this acreage available for drilling covers six different prospective zones / exploration trends, namely from north to south:

- Transition onshore-offshore zone, with restricted accessibility due to shoreline environment and shoal waters;
- Marine continuation of the Dobrogean Foredeep to the Krylov depression till the Odessa transform fault, Lower Paleozoic and Devonian to Carboniferous reservoirs sealed by Mesozoic unconformity;
- Prospects related to the North-Golitsyno frontal thrust step and related smaller forefront thrusts;
- Kilija-Zmiyiny uplift small N-Q prospects plus exploration targets in the weathered crust & fractured reservoirs of the metamorphic Paleozoic basement;
- Goubkin Uplift southern slope (Histria trough northern flank) including Zonalna and Komsomolska North prospects;
- Potential HC traps related to the Neogene incised valleys (traversing the above zones).

Upon UkrSGPI estimation this aquatory is characterized by density of yet-to-find hydrocarbon reserves (of former C3+D1 resource categories) as much as 5-20 MTOE/sq.km. As to the geological and geophysical challenges to study and exploring the Odessa Gulf shelf it is necessary to mention the key tasks as follow

1. Re-processing available seismic data (applying new processing algorithms including depth pre-stack migration, etc.) existing only in time domain and adjust and spatially detail the velocity model for the set of vintage BS05 lines;

2. Harmonizing sequence stratigraphic model for the Ukraine - Romania transition offshore stratigraphic correlation;

3. Developing new depth model for this complicated horst-and-graben structural corner taking into account wrench tectonic movements;

4. Tracing buried paleo-valleys and paleo-canyons over all vintage 2D datasets;

5. Taking into account the low GR contrast and apparent resistivity of the Pliocene reservoirs discovered in Romanian waters resulting in uncertainty of gas-water contacts to re-analyze well-logging interpretation results for Ukrainian wells.

Keywords: Odessa Gulf, license, seismic data, tectonic structure, reservoir, hydrocarbons

Field-based Characterisation of Reservoir Units in the Kura-Kartli Foreland Basin, Central Georgia

Pace, Paolo [1] - paolo.pace@geplan.it; Ricciato, Angelo [1] - angelo.ricciato@geplan.it ; Borello, Stefano [1]- stefano.borello@geplan.it; Battara, Enrica [1]- enrica.battara@geplan.it; Ferretto, Paola [1] - paola.ferretto@geplan.it; Tevzadze, Prof. Revaz [2]; Tevzadze, Nikoloz [2] - niko@noc.ge; Janiashvili, Alexander [2] - alexander@noc.ge; Sanishvili, Artem [2] - artem@noc.ge; Alania, Victor [3] - victor.alania@tsu.ge; Enukidze, Onise [3] - onise.enukidze@tsu.ge;

[1] - G.E. Plan Consulting, Petroleum Geosciences, Italy

[2] - Georgia Oil & Gas Limited, Georgia

[3] - M. Nodia Institute of Geophysics, Tbilisi State University, Georgia

The Kura foreland fold-and-thrust belt defines the north-western edge of the Kura Basin that extends from central Georgia eastward to the Caspian Sea in the so-called Transcaucasian intermontane valley. It separates the Greater and Lesser Caucasus Mountain to the north and south, respectively. The compressional deformation, which is progressively increasing moving to the Greater and Lesser Caucasus, is associated to the convergence between the Arabian and Eurasian plates that is still active. Several hydrocarbon seeps and leaks in the region along with many shows reported in the drilled wells, some discoveries and few developed fields testify a working petroleum system in this foreland basin that has been overlooked in the past due to different reasons.

Currently, Georgia Oil & Gas Ltd. is carrying out an intense exploration program focussing in the Kura-Kartli basin by recovering, acquiring and integrating old and new geologic, seismic, gravity, magneto-telluric and geochemical data. The integrated interpretation of reprocessed seismic surveys in different license blocks reveals the occurrence of several leads and prospects. These prospective structures mainly belong to the north-directed contractional foreland deformation of the Adjara-Trialeti thrust belt (Lesser Caucasus). Therefore, the structures and reservoir units exposed along this mountain belt are considered to be analogue to the exploration targets identified in the subsurface. Unfortunately, a good knowledge about the reservoirs is missing in this region mostly because there is little information from the wells drilled during the previous exploration activity (vintage well logs, lack of BHI logs, lack of preserved cores). With the aim to reduce the exploration risk and uncertainties related to the reservoir units of interest (from Cretaceous to Miocene), a field-based reservoir characterisation study was carried out across the Adjara-Trialeti thrust belt. Several plugs were collected for the analysis of the matrix properties. The optical visual porosity was also estimated on thin-sections taken from collected hand-size samples. These matrix properties were then compared with the core data recovered from the vintage reports. Schmidt hammer measurements were taken for deriving values of the uniaxial compressive strength. Moreover, a portable gamma ray detector was used for logging well-exposed stratigraphic section for identification and correlation of sand bodies with the available well logs.

The fracture network was also analysed, in particular for the Middle Eocene volcaniclastics and Upper Cretaceous carbonates, with the aim to identify the main fracture trends and assess the fracture intensity in different structural positions and its vertical variability across the contrasting mechanical units.

Keywords: Kura Foreland Thrust Belt, Hydrocarbon Prospectivity, Reservoir Characterisation, Central Georgia

EXPLORATION, DEVELOPMENT AND PRODUCTION CASE STUDIES

Middle Eocene fracture analysis for Block XIB: Case Study from Patardzeuli Field, Georgia

A. Orlov, A. Carrillat, T. T. Yildiz, D. Tsaplin, J. Urazaliev., A. Goloborodko, S. Tirumanapalli, Schlumberger

Objective and Scope:

In the Kura fold and thrust belt, the Middle Eocene volcaniclastic rocks exhibit both low porosity and the absence of a matrix permeability. This is conflicting with the high production rates observed in the Patardzeuli field. High losses of drilling fluids are observed during drilling and FMI reveals clusters of fractures suggesting a naturally fractured reservoir type 1. This study aims at using an integrated approach spanning from seismic interpretation to FMI log data analysis to identify the fractures contributing to the hydrocarbon flow and to provide the basis of design of an optimum well.

Methods, Procedures, Process:

This integrated study uses borehole image log data (FMI) acquired in the Middle Eocene interval of the PAT-E1 exploration well. The main steps of the workflow were: 1) to carry out an interpretation of the FMI image for fractures identification, 2) to classify the fractures as open, closed or healed and define a hydrocarbon flow indicator by calibrating the fracture analysis to hydrocarbon flow zones (gas shows), and 3) to review this analysis in the context of the seismic structural interpretation and regional tectonic framework. The reprocessing and depth migration of the 3D seismic data allowed a detailed interpretation and improved image of subtle features supporting the field observations and outcrop data.

Results, Observations, Conclusions:

The results of the FMI interpretation for the Middle Eocene fractured volcaniclastic reservoir were used to identify hydrocarbon flow zones (in absence of PLT data). The analysis of open fractures orientation, dip, aperture together with field observations, petrophysical data, seismic interpretation, paleo- and current stress regimes enabled to determine the fracture type associated with potential hydrocarbon flowing zones and their occurrence in the Middle Eocene interval. The analysis reveals that not all open fractures identified on image log are effectively contributing to hydrocarbon flow. Accordingly, the selection of testing intervals on the basis of the highest density of fractures only is not a valid approach to determine prospective zones. It is observed that the best hydrocarbon zones are those where both open fractures and some matrix porosity is identified from the petrophysical interpretation. From a structural point of view, in the current strike slip regime, fracture direction and dip are the main control to hydrocarbon flow with best contribution coming from open fractures oriented near orthogonal to the fold hinge of the field anticlinal structure. The same observation is made from analogue field Ninotsminda located to the northeast of Patardzeuli where horizontal wells drilled at an angle to the fold hinge showed better production.

Novel/Additive Information:

The novel aspect of this project is the multi-scale approach rooted in seismic interpretation from newly reprocessed 3D PSDM seismic data, mapped regional structural trends, detailed fault imaging and interpretation, FMI log analysis combined together with Schlumberger's advanced logging suite from PAT-E1 to determine the orientation of flow contributing fractures for optimizing well testing and design.

Block XIB Lower Eocene, Paleocene, Upper Cretaceous formation characteristics and hydrocarbon potential

J. Urazaliev, T. T. Yildiz, A. Orlov, A. Carrillat, D. Tsaplin, A. Goloborodko, S. Tirumanapalli, Schlumberger - A. Suter, Retired Schlumberger Employee

Block XIB lies in the Kura basin of East Georgia, between the Greater Caucasus Mountains to the north and the Lesser Caucasus to the south. Historically, the block has been explored through the 1970s and 1980s and six oil fields have been producing from Middle and Upper Eocene reservoirs.

The Upper Cretaceous, Paleocene and Lower Eocene plays of Georgia are relatively poorly understood. Several wells were drilled on Teleti field targeting Upper Cretaceous. One well (TLT-55) tested gas from Upper Cretaceous-Paleocene interval at rates between 6000 – 7400 m3/d. The well report of TLT-11 indicates a gas blow-out while drilling of Upper Cretaceous sediments at the depth 2700 m MD. The gas flow rate recorded was up to 250 000 m3/day, which suggests potential for commercial gas accumulation in the Upper Cretaceous reservoirs. The Lower Eocene gas play has been tested by five wells in Samgori field, with total production of 29.96 MMSCM in 4 wells during 1990 - 2000. As part of the Lower Eocene play evaluation, the neighboring Patardzeuli structure was drilled in 2018 (PAT-E1). The results of drilling and testing of the PAT-E1 well allowed to significantly improve our understanding of Lower Eocene, Paleocene and the Upper Cretaceous formations. While drilling the 8.5 in and 5.875 in open hole sections, mudlogging, cutting sampling and its description, as well as high-resolution gas chromatography analysis was continuously performed. Advanced open hole logging including PEX, CMR, FMI, Sonic Scanner and LithoScanner were recorded in those sections to define test intervals. The analysis and integrated interpretation of all the available data allowed us to compile a lithology-petrophysical model of the Lower Eocene, Paleocene and Upper Cretaceous formation with a clear identification and justification of their boundaries. In accordance with the log data obtained, the thickness of the Lower Eocene deposits in the PAT-E1 well is 1171 m, the effective porosity of reservoir layers varying from 4 to 16%. FMI logs show the presence of open fractures throughout the Lower Eocene section with clusters of high fracture density.

The Paleocene sediments show a total thickness of 665 m and are distinguished by a monotonous stratum of marls with thin streaks of mudstones and limestones. The effective porosity of the Paleocene formation is very low (1-3%) and shows no permeability. These rocks could be considered as a good cap rocks for the Upper Cretaceous formation. Despite the absence of porous rocks in the Paleocene sediments, significant gas shows were recorded during drilling. These shows correspond to localized fractured zones which identified in FMI log data.

The Upper Cretaceous sediments are clearly distinguished by a drastic change in lithology where marls are replaced by limestone. The porosity evaluated in the Upper Cretaceous sediments is very low (1.0-1.5%). According to the FMI log data, fractures are identified throughout the entire Upper Cretaceous section. The fracture properties are different from the Lower Eocene sediments, as they show lower value of aperture (<0.015 mm) and a wider spread of fracture dips angles (6 to 90 degrees). The drilled thickness of Upper Cretaceous sediments in PAT-E1 well is 291 m. The Upper Cretaceous sediments and the lower part of the Paleocene were tested together in 5.875 in open hole section within 4558-5020 m MD interval. The gas flow rate for this interval ranged from 1400 to 3400 m3/day. The formation pressure gradient obtained in the open hole section is 1.45 SG, which corresponds to an over pressured Upper Cretace ous zone and confirms the good cap rock properties of Paleocene formation. Similar gas flow rates (6000 - 7400 m3/day) were obtained when testing the Upper Cretaceous sediments in the TLT-55 well. Legacy well test in Teleti field and the presence of over pressure zone in PAT-E1 well suggesting potential for commercial gas accumulation analogue Upper Cretaceous of Patardzeuli structure.

EXPLORATION, DEVELOPMENT AND PRODUCTION CASE STUDIES

Basin Architecture and Hydrocarbon Play Concepts in the Turkish Eastern Black Sea

Intawong, Anongporn (Yen) - Anongporn.Intawong@spectrumgeo.com - Spectrum Geo

Hodgson, Neil - Neil.Hodgson@spectrumgeo.com – Spectrum Geo; Rodriguez, Karyna - Karyna.Rodriguez@spectrumgeo.com - Spectrum Geo

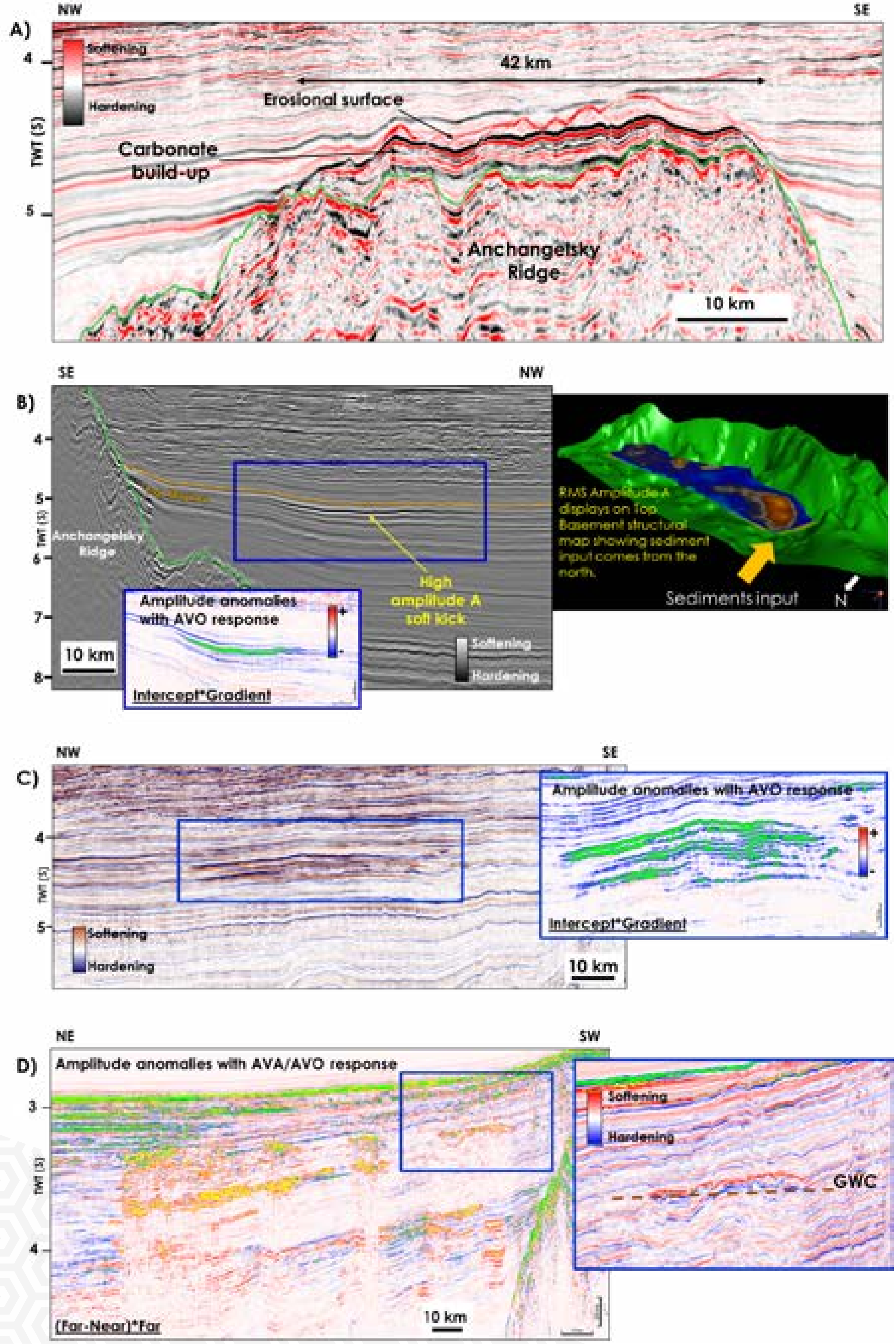
The Eastern Black Sea is an underexplored basin which has been much less studied than the Western Black Sea. New understanding of the Turkish Eastern Black Sea Basin has been achieved based on the interpretation of recently acquired 2D seismic data which indicates the presence of a foreland basin possibly associated with the evolution of the eastern Pontides orogenic belt. A NE-SW oriented frontal fold and thrust belt has been identified in the eastern part of the Turkish Eastern Black Sea believably continuing in to offshore Georgia. It could be interpreted as a splay of the main E-W Pontides fold and thrust belt onshore Turkey.

The Oligocene-Miocene Maykop marine shales formation is known as a major oil and gas source rock interval throughout the Black Sea in numerous publications. In the Arkhangelsky and Andrusov Ridges several amplitude anomalies have been identified on seismic sections, where the Maykop is modelled to be in an oil maturity window. A pre-foreland sedimentary sequence, probably in Early to Late Cretaceous age, is clearly recognised on the Arkhangelsky and Andrusov Ridges and in the inboard NE-SW oriented frontal fold and thrust belt. The pre-foreland sequence found within these ridges characteristically demonstrates potential syn-rift structures showing grabens and half-grabens with normal faulting and rift-flank uplifts. This pre-foreland sedimentary sequence could be considered as another potential source rock.

Several sea surface oil slicks have been identified in the Eastern Black Sea indicating that there is an active oil play within the area. In addition, numerous Direct Hydrocarbon Indicators (DHIs) have been observed on the new 2D seismic data, such as Bottom Simulating Reflectors (BSRs), pockmarks, gas and fluid escape pipes, and amplitude anomalies. Based on our observations, the gas and fluid escape pipes migrating upwards from a deep root along fault pathways were sealed by gas hydrates in the gas hydrate stability zone, and this could imply that the gas has a thermogenic origin. DSDP site 379 drilled above the Andrusov Ridge through BSRs reportedly has Ethane/methane ratio significantly increasing with depth, and this ratio is an evidence of early diagenetic production of ethane.

Several hydrocarbon play concepts are identified within the new 2D seismic data. These are Late Cretaceous to Palaeocene carbonate build-ups (A), Miocene basin floor fan within the Maykop and post-Maykop intervals with amplitude variation (AVO) support (B and C), as well as Late Miocene to Pliocene channel complexes with amplitude variation with angle/offset support (D).

Keywords: Eastern Black Sea, foreland, fold and thrust belt, play concepts, DHIs, AVA/AVO, hydrocarbon



A)
NW
SE
Softening
Hardening
42 km
Erosional surface
Carbonate build-up
TWT (S)
Anchangetsky Ridge
10 km
B)
SE
NW
Anchangelsky Ridge
High amplitude A soft kick
Amplitude anomalies with AVO response
Intercept*Gradient
10 km
Softening
Hardening
RMS Amplitude A displays on Top Basement structural map showing sediment input comes from the north.
Sediments input
N
C)
NW
SE
Amplitude anomalies with AVO response
Intercept*Gradient
Softening
Hardening
10 km
D)
NE
SW
Amplitude anomalies with AVA/AVO response
Softening
Hardening
GWC
(Far-Near)*Far
10 km

EXPLORATION, DEVELOPMENT AND PRODUCTION CASE STUDIES

Geological challenges and exploration lessons of the Subbotin oilfield discovery offshore Ukraine

Sergii Vakarchuk – svgoil@yahoo.com – U.B. Seismic Ukraine

Mykola Kharchenko – kharchenko@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Oleksandr Bezkhyzhko – zxcvbnm1900@i.ua – U.B. Seismic Ukraine

Oleksandr Shevchenko – shevchenko@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Pavlo Kuzmenko – kuzmenko@nng.com.ua – Inst. of Geology, Shevchenko National University of Kyiv & SE NaukaNaftogaz, Naftogaz Group

Georgii Bashkirov – bashkirov@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Igor Ishchenko – ischenko@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Alexander Kitchka – kitchka@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Discovery of the Subbotin oil field in 2005 south of Kerch Peninsula by key well Subbotin-403 has proved commercial productivity of the East Black Sea sub-basin thus finally rewarding the multi-task team from the upstream industry and academia. An extensive seismic program, including 3D data acquisition and interpretation with AVO analysis, stratigraphic studies, gravity, geochemical and remotely sensing data processing, was performed and revealed offshore the peninsula a dozen of faulted anticlinal traps striking WSW-ENE, from which the Subbotin fold (recognized by 2D mapping in 1976) was selected as a top priority exploration target. However, the way to success was not straightforward and complicated by further exploration results. Initially, the Subbotin structure was thought as rather simple faulted anticline. Despite of apparently well-correlated pre-drill seismic data package the discovery well has revealed an increased thickness of the Oligocene and Eocene formations due to stacking of the sequence by imbricate overthursts. Next three appraisal wells and have shown an extreme complexity of its tectonic architecture, spatial facies distribution and behavior as well as reservoir compartmentalization. Well test results, well-log correlation and core analysis have discarded previous idea about massive pool with single OWC, proving a vertical oil column over 600 m stacked by separated oil pools. Oligocene reservoir rocks, namely non-carbonate siltstones and fine- to medium-grained sandstones alternating with shales, as well as oil-saturated oblique and bed-parallel fractures make main challenge for understanding of the reservoir geometry. Strong Maykopian reservoirs compartmentalization due to imbricate reverse faults forming pop-up structure (Fig. 1) along with thin-bedded reservoir clastic rocks of turbidite origin and clinoform character are key geological lessons of the discovery.

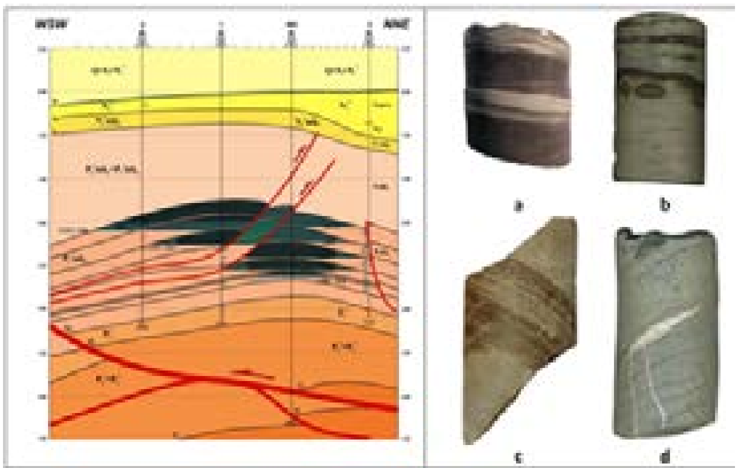


Figure 1. Seismo-geological cross-section of the Subbotin oil field and its core samples: Maykop turbidite fine-grained sandstones alternating with black shales (a), shales stained with oil upon fractures (b), massive medium-grained basal sandstones of Planorbellian stage (c), and Eocene calciturbidites with calcite veins upon tension gashes and bedding plane (d).

Keywords: Ukraine's offshore, Kerch Peninsula, East Black Sea sub-basin, Subbotin oil field, 3D seismic data, reservoirs

Petroleum systems analysis based on simulation results of a 2D numerical model, eastern Pannonian Basin

Harold, Zsófia - haroldzsofia@gmail.com - Department of Physical and Applied Geology, Eötvös Loránd University, Budapest, Hungary

Bartha, Attila - abartha@slb.com - Schlumberger, Software Integrated Solutions (SIS), Aachen, Germany

Csizmeg, János - jcsizmeg@vermilionenergy.com - Vermilion Energy, Budapest, Hungary

Sztanó, Orsolya - sztano@caesar.elte.hu - Department of Physical and Applied Geology, Eötvös Loránd University, Budapest, Hungary

Two-dimensional basin and petroleum system modelling was carried out in the eastern part of the Pannonian Basin to analyse the burial, thermal and maturity history, and the petroleum system elements and processes. Furthermore, the impact of uncertainties in the key input parameters on simulation results were also examined.

The area of interest included two Neogene depressions – the Derecske Trough and the Tiszapalkonya Depocenter – and the Ebes-Hajdúszoboszló Structural High between them. The tectono-sedimentary evolutionary model constrained by seismic and well data integrated the spatial and chronological variations of depositional, non-depositional and erosional events, as well as the progradation of the shelf-margin slope. The impact of its load on the mechanical compaction of sediments, pore pressure development, thermal history, maturation of effective source rocks, and hydrocarbon charge were also analysed.

Different maturation and petroleum generation reaction kinetics were tested, and their impact on thermal and maturation histories, and hydrocarbon charge were examined. The selection of proper vitrinite reflectance model had a key impact on the calibration of thermal history and timing of hydrocarbon generation. The use of different kinetic models resulted in slightly different hydrocarbon phases, compositions and volumes of predicted petroleum accumulations, as the transformation of organic matter took place at different temperatures.

Besides the thermogenic hydrocarbons, the generation of biogenic gases associated with the deposition of the sedimentary succession in the study area was also considered. Despite it was almost continuous during the depositional history, the preservation of gases was limited in time and space.

Due to the complex lithology and facies distribution predominant in Pannonian basin several migration methods were tested. The application of the Darcy Flow coupled with Invasion Percolation provided the best migration results, since it handled the lateral and vertical facies changes and the presence of stratigraphic traps in a realistic way.

By means of modifying the input data and optimizing the lithological and kinetic parameters, a model close to geological reality was created, in which the pore pressures and compaction trends were adjusted to the conditions prevailing in the basin, the thermal and maturity histories to measured thermal indicators, and the modelled petroleum accumulations to the known Ebes and Sáránd fields.

Keywords: Keywords: Basin and petroleum system modelling, PetroMod, Derecske Trough, Jászság Basin

Petroleum systems analysis based on simulation results of a 2D numerical model, eastern Pannonian Basin

Harold, Zsófia - haroldzsofia@gmail.com - Department of Physical and Applied Geology, Eötvös Loránd University, Budapest, Hungary

Bartha, Attila - abartha@slb.com - Schlumberger, Software Integrated Solutions (SIS), Aachen, Germany

Csizmeg, János - jcsizmeg@vermilionenergy.com - Vermilion Energy, Budapest, Hungary

Sztanó, Orsolya - sztano@caesar.elte.hu - Department of Physical and Applied Geology, Eötvös Loránd University, Budapest, Hungary

Two-dimensional basin and petroleum system modelling was carried out in the eastern part of the Pannonian Basin to analyse the burial, thermal and maturity history, and the petroleum system elements and processes. Furthermore, the impact of uncertainties in the key input parameters on simulation results were also examined.

The area of interest included two Neogene depressions – the Derecske Trough and the Tiszapalkonya Depocenter – and the Ebes-Hajdúszoboszló Structural High between them. The tectono-sedimentary evolutionary model constrained by seismic and well data integrated the spatial and chronological variations of depositional, non-depositional and erosional events, as well as the progradation of the shelf-margin slope. The impact of its load on the mechanical compaction of sediments, pore pressure development, thermal history, maturation of effective source rocks and hydrocarbon charge were also analysed.

Different maturation and petroleum generation reaction kinetics were tested, and their impact on thermal and maturation histories, and hydrocarbon charge were examined. The selection of proper vitrinite reflectance model had a key impact on the calibration of thermal history and timing of hydrocarbon generation. The use of different kinetic models resulted in slightly different hydrocarbon phases, compositions and volumes of predicted petroleum accumulations, as the transformation of organic matter took place at different temperatures.

Besides the thermogenic hydrocarbons, the generation of biogenic gases associated with the deposition of the sedimentary succession in the study area was also considered. Despite it was almost continuous during the depositional history, the preservation of gases was limited in time and space.

Due to the complex lithology and facies distribution predominant in Pannonian basin several migration methods were tested. The application of the Darcy Flow coupled with Invasion Percolation provided the best migration results, since it handled the lateral and vertical facies changes and the presence of stratigraphic traps in a realistic way.

By means of modifying the input data and optimizing the lithological and kinetic parameters, a model close to geological reality was created, in which the pore pressures and compaction trends were adjusted to the conditions prevailing in the basin, the thermal and maturity histories to measured thermal indicators, and the modelled petroleum accumulations to the known fields.

Keywords: Basin and petroleum system modelling, PetroMod, Pannonian Basin

Defining Independent Sandbodies Good Reservoirs in a Complex Environment With Many Challenges to Solve

Rachid.C. Sablit, Sabah Al Otaibi, Kuwait Oil Company

From the different environments of depositions of producing reservoirs found in the oil and gas industry the two most common are the fluvial and deltaic systems; although they are good reservoirs however still there are a lot of challenges to overcome specially those related to Tidal Influenced Delta systems. In these systems there are isolated sandbodies which are distal and detached from the main onshore bodies. These units are associated to the similar environments deposited in the area and are related to the same dynamic acting on them; in order to identify them, it requires an integration of different specialties as geology, seismic, petrophysics and reservoir engineering as to define them and establish their properties. These sandbodies show a behavior of being independent flow units; the high cyclicity of the sedimentation in the area evidenced by the presence of intervals of changing sea level, in a fifth order parasequence coincide with the maximum flooding surfaces (MFS) found and this corresponds to shaly intervals. The accumulation of each interval of these sandbodies is of a short period ranging from hundreds to thousands years of duration. The seismic attributes as acoustic impedance and reflection intensity were able to delineate the sandbodies hinting a specific type of lithology through which we can determine the volumetric properties of the bodies. For the Upper Member X of the formation the lithology is of unconsolidated sandstone, fine grain brown to light gray and white; intercalations of shale light gray, greenish to dark gray. The Lower Member Y is gray shale with abundant fauna with intercalations of local lignite and shaly sand. Another puzzle to solve is the one related to the direction of the oil migration and location of the source rock. These independent sandbodies have good reservoir properties. The migration of oil across the field appears to be taken place in the SW-NW direction; in this way the isolated bodies could have been filled from the first migration; which later and due to a possible stratigraphic or tectonic change occurred, it diverted the second migration on a different route and filled up the onshore sandbodies.

Numerous permeability barriers toward the east of the field allowed the oil to continue its route of migration to the west. Most likely the migration of oil from the source rock to the reservoir traps is controlled by the physico - chemical conditions of the sedimentary strata the oil is moving through. The result obtained is a model with high complexity but with highly prolific areas of oil accumulation and production. There could be more isolated bodies if we were to drill infill wells reducing the space from the current 231 mts to approximately 105 mts. It could be that any new body of clean sand or shaly sand by finding the right method of production could give good results even though they might have difference in rock properties mainly porosity and permeability.

Innovative and cost effective well testing solution for a tight oil and gas reservoirs

I. Kukva, R. Panferov, Y. Shumakov, T. T. Yildiz, D. Tsaplin, J. Urazaliev, S. Tirumanapalli, A. Goloborodko, Schlumberger.

Objective and Scope:

The well test operations are one of the most challenging operations performed at the well site today, especially it concerns well test operations performed in a tight oil and gas reservoirs with the limited capabilities of well to produce reservoir hydrocarbons to surface. Currently, there are no practically proven methods available to flow test those wells and determine a key reservoir information to minimize the risks in field development.

Methods, Procedures, Process:

For the last several decades, the oil industry has been trying to find the most effective ways to perform reservoir characterization and acquire the dynamic reservoir data in a tight reservoir formations.

This paper describes an inovative, practically proven and cost-effective well testing technique and equipment arangment allowing to flow test and to determine key reservoir dynamic data that credibly represents the reservoir properties and inflow performance of the well drilled in tight reservoir formations.

Results, Observations, Conclusions:

Until recently DST operations in tight reservoirs have been limited and deemed challenging due to complexities associated with the ability to create a sufficient pressure drawdown, unloading the liquid from the wellbore and clean-up of the well unlocking the true reservoir potentials.

With the adaptation of currently existing downhole DST tools and enhancements in the well test design with the appropriate equipment selection, a low flow rate test has been engineered for success by bringing together multi-disciplinary team and emphasizing the importance of proper job design.

The developed solution has included:

- Innovative well startup the process by utilising N2, enabling to start up the well in a cost-effective way, eliminating of using expensive coiled tubing which unavailable in the country and enabling to create a high-pressure drawdown.
- Custom built surface well test package, including the application of low gas metering skid for accurate flow rate measurements.
- Advanced software for closed chamber test design and well test interpretation.
- Real-time collaborative environment with full real-time data integration and superiors data visualisation capabilities.
- Monitoring of bottom hole flowing pressure using N2 cushion column in combination with the echometer allowed to optimize test duration and close the well for PBU at the right time.

Novel/Additive Information:

This paper presents a unique combination of technologies, process with the established track of an integrated cost-effectvie well testing solution for a tight oil and gas reservoirs. This concept allows new wells to be tested to determine key reservoir properties during DST, TCP or while workover operations if the wells are currently in production. This paper will also present several field examples from the operations performed around the globe.

Integration of Conventional Logs and Novel Preprocessing Methods for Identification of Fracture Parameters in the Carbonate Reservoirs (case study, carbonate Asmari Formation, SW Iran)

Ghasem Aghli (1.*), Reza Moussavi-Harami[1]

1. Department of Geology, Ferdowsi University of Mashhad, Mashhad, Iran

Fractures are considered as the most important feature in the fractured reservoirs, especially in the carbonate heterogeneous reservoirs. However, fractures diagnosis is not valuable, unless they could be applied to determine the porosity and permeability systems. The main purpose of this study is to find a quick and inexpensive method for identification of fractured zones and then fracture parameters such as fracture density (FVDC) and fracture aperture (FVAH) in these zones using petrophysical logs. Practically, raw conventional logs cannot be used as inputs for fracture parameters estimation, while some log preprocessing methods increase the relation between conventional logs and fracture parameters. The results show that, some parameters such as pore system, lithology and reservoir fluids effected on the petrophysical logs as the main factors. However, fracture parameters can be determined using conventional logs which corrected by statistical methods and logs energy. Hence, logs preprocessing is the most important step in such studies due to low initial relationship between conventional logs and fracture parameters. Results indicate that the zones with high fracture density and aperture are easily detectable by conventional logs. On the other hand, the behavior of these logs is a function of fracture parameters in the fractured intervals, especially in the zones with high fracture aperture. Also, results indicate that fractured and non-fractured zones are easily detectable using a combination of logs energy and lithology heterogeneity with high accuracy. RHOB, NPHI, GR, DT, PEF, PHIE, CAL and resistivity logs which have been applied in this study, are the best logs that may be used in the identification of fracture parameters. Based on their responds in the fractured zones and correction on responds, they can be used to fractures detection which show great correlation with image logs results. The results for 6 studied wells, show the excellent prediction ability in the fracture zones after logs preprocessing.

Keywords: Fracture parameters, Image logs, Petrophysical logs, Statistical and logs energy methods

Defining Independent Sandbodies Good Reservoirs in a Complex Environment With Many Challenges to Solve

Rachid.C. Sablit, Sabah Al Otaibi, Kuwait Oil Company

From the different environments of depositions of producing reservoirs found in the oil and gas industry the two most common are the fluvial and deltaic systems; although they are good reservoirs however still there are a lot of challenges to overcome specially those related to Tidal Influenced Delta systems. In these systems there are isolated sandbodies which are distal and detached from the main onshore bodies. These units are associated to the similar environments deposited in the area and are related to the same dynamic acting on them; in order to identify them, it requires an integration of different specialties as geology, seismic, petrophysics and reservoir engineering as to define them and establish their properties. These sandbodies show a behavior of being independent flow units; the high cyclicity of the sedimentation in the area evidenced by the presence of intervals of changing sea level, in a fifth order parasequence coincide with the maximum flooding surfaces (MFS) found and this corresponds to shaly intervals. The accumulation of each interval of these sandbodies is of a short period ranging from hundreds to thousands years of duration. The seismic attributes as acoustic impedance and reflection intensity were able to delineate the sandbodies hinting a specific type of lithology through which we can determine the volumetric properties of the bodies. For the Upper Member X of the formation the lithology is of unconsolidated sandstone, fine grain brown to light gray and white; intercalations of shale light gray, greenish to dark gray. The Lower Member Y is gray shale with abundant fauna with intercalations of local lignite and shaly sand. Another puzzle to solve is the one related to the direction of the oil migration and location of the source rock. These independent sandbodies have good reservoir properties. The migration of oil across the field appears to be taken place in the SW-NW direction; in this way the isolated bodies could have been filled from the first migration; which later and due to a possible stratigraphic or tectonic change occurred, it diverted the second migration on a different route and filled up the onshore sandbodies.

Numerous permeability barriers toward the east of the field allowed the oil to continue its route of migration to the west. Most likely the migration of oil from the source rock to the reservoir traps is controlled by the physico - chemical conditions of the sedimentary strata the oil is moving through. The result obtained is a model with high complexity but with highly prolific areas of oil accumulation and production. There could be more isolated bodies if we were to drill infill wells reducing the space from the current 231 mts to approximately 105 mts. It could be that any new body of clean sand or shaly sand by finding the right method of production could give good results even though they might have difference in rock properties mainly porosity and permeability.

Petroleum Systems in Georgia

Reinhard F., Sachsenhofer - Reinhard.sachsenhofer@unileoben.ac.at – Montanuniversitaet Leoben[1]

Magdalena Pupp[1], Achim Bechtel[1], Stepan Ćorić[2], Onise Enukidze[3], Reinhard Gratzer[1], Alexander Janiashvili[4] , Artem Sanishvili[4], Niko Tevzadze[4], M. Arif Yukler[4]

1) Department of Applied Geosciences and Geophysics, Montanuniversitaet Leoben, Austria;

2) Geological Survey Austria,

3) Institute of Geophysics, I. Javakhishvili Tbilisi State University, Tbilisi, Georgia

4) Georgia Oil & Gas Limited, 4A Freedom Square, Tbilisi 0105, Georgia

Georgia is located between the Greater and Lesser Caucasus. The country hosts two Cenozoic foreland basins which are separated by the Dzirula Massif: the Rioni Basin to the west, which continues into the Black Sea; and the Kartli-Kura Basin to the east which extends towards Azerbaijan and the Caspian Sea.

Source rocks in the Rioni Basin include the Middle Eocene Kuma Formation and the Oligocene part of the Maikop Group. Based on outcrop sections, the Kuma Formation and the Maikop Group may generate up to 2.4 tHC/m² and about 4 tHC/m², respectively. It is likely that hydrocarbons generated from both units charged the small Shromisubani oil field. Because both source units are immature onshore, hydrocarbon migration from offshore areas in the Eastern Black Sea is assumed. The presence of an additional Mesozoic source has been postulated based on geological setting and chemical signature of oil from the Okumi Field.

The Maikop Group in the upper Kura Basin is very thick (>3.5 km), but holds only a poor (to fair) source rock potential. Rocks with a fair potential occur in the Upper Eocene Navtlugi Formation, which directly overlies Middle Eocene volcaniclastic reservoir rocks. The best source rocks are found in Bartonian to lowermost Priabonian units in the Ildokani region north of Tbilisi. These rocks contain up to 5.3 wt.%TOC and a type II-III kerogen. Their petroleum potential is classified as “good”. Because the best petroleum source parameters are found in thin dark layers within brighter sediments, the net thickness of these rocks remains to be determined. Based on isotope and biomarker ratios, there is no convincing agreement between any of the above source rock horizons and the accumulated oils in the Near Tbilisi area. The relative best fit is found for the Maikop Group. This is surprising considering its low petroleum potential in the Tbilisi area. Even if admixtures from additional source rock units are considered, it is questionable whether the Maikop Group alone can be responsible for the proven reserves. In summary, it is likely that the accumulated oils are not the product of a single rich source rock unit, but that they represent mixtures of oil generated from different Middle Eocene (Bartonian) to Oligocene organic-rich units.

The Geological Evolution of West Georgia and the Petroleum Potential of the easternmost Black Sea

Vincent, Stephen J. – stephen.vincent@casp.cam.ac.uk – CASP, Cambridge, UK.

Barabadze, Teimuraz - t.barabadze@gtu.ge – Georgian Technical University, Georgia.

Morton, Andrew C. - heavyminerals@hotmail.co.uk – HM Research Associates, UK.

Hyden, Fiona - fionahyden@oilquest.co.uk – OilQuest Ltd., UK.

Kaye, Matthew N.D. - mattkaye@oceangrove.co.uk – Ocean Grove Geosciences, UK.

Carter, Andrew - a.carter@ucl.ac.uk – University College London, UK.

CASP has undertaken extensive fieldwork in West and Central Georgia. Two hundred outcrop localities were visited and over 400 outcrop and subsurface samples collected. The resultant outcrop observations and analytical results, when combined with published data, have enabled us to re-construct the tectonostratigraphic evolution of the region and delineate and characterise sediment pathways and source rock intervals. These provide insights into the likely hydrocarbon potential of the adjacent easternmost Black Sea.

Westernmost Georgia comprises three tectono-stratigraphic elements. From north to south these are: (1) The southern slope of the Greater Caucasus that comprises the Jurassic and Cretaceous relatively deep-water fill of the inverted Greater Caucasus Basin; (2) the Transcaucasus, a continental fragment that continues offshore as the Shatskiy Rise and whose basement is represented by the Dziruli Massif. This is overlain by (a) a syn-Greater Caucasus Basin carbonate-dominated succession isolated from siliciclastic input from the East European Craton because of the rift basin to its north and (b) a syn-compressional siliciclastic-dominated succession, largely derived from the inverting Greater Caucasus Basin / uplifting Greater Caucasus. The Transcaucasus cover sequence includes the Kuma Formation and Maykop Series source rock intervals. (3) The Adjara-Trialet Belt, a transtensional basin largely filled by Eocene volcanic rocks and volcaniclastic sediments, which, like the Greater Caucasus Basin, probably began to invert in the Late Eocene.

A source prone mudstone interval in the lower part of the Maykop Series has good to very good source potential, a Type II source quality and is at least 60 m thick. The Kuma Formation may form an important secondary source of hydrocarbons. Sands derived from the western Greater Caucasus and routed either through the Rioni Basin or directly offshore are typically lithic rich and contain abundant mudstone and volcanic rock fragments. Those derived from the Adjara-Trialet Belt almost wholly comprise volcanic rock fragments. Relatively quartz-rich sands derived from the Dziruli Massif are largely shed eastwards, away from the eastern Black Sea. As a consequence, reservoir quality is the critical risk in the Eastern Black Sea. Thermochronometric studies indicate low to moderate punctuated exhumation of the western Greater Caucasus during the Oligo-Miocene. Exhumation rates increased in the West Georgian sector of the range during the Plio-Pleistocene.

Keywords: source rocks, reservoir quality, tectonostratigraphic evolution

Rioni Basin, Georgia : Jurassic Potential Petroleum Systems.

Blanpied Christian - christian.blanpied@sorbonne-universite.fr

Barrier Eric, Brunet Marie-Françoise, Baudin François, Hamchiche Taoufik, Schnyder Johann.

Sorbonne Université, CNRS-INSU, Institut des Sciences de la Terre de Paris (ISTEP), France.

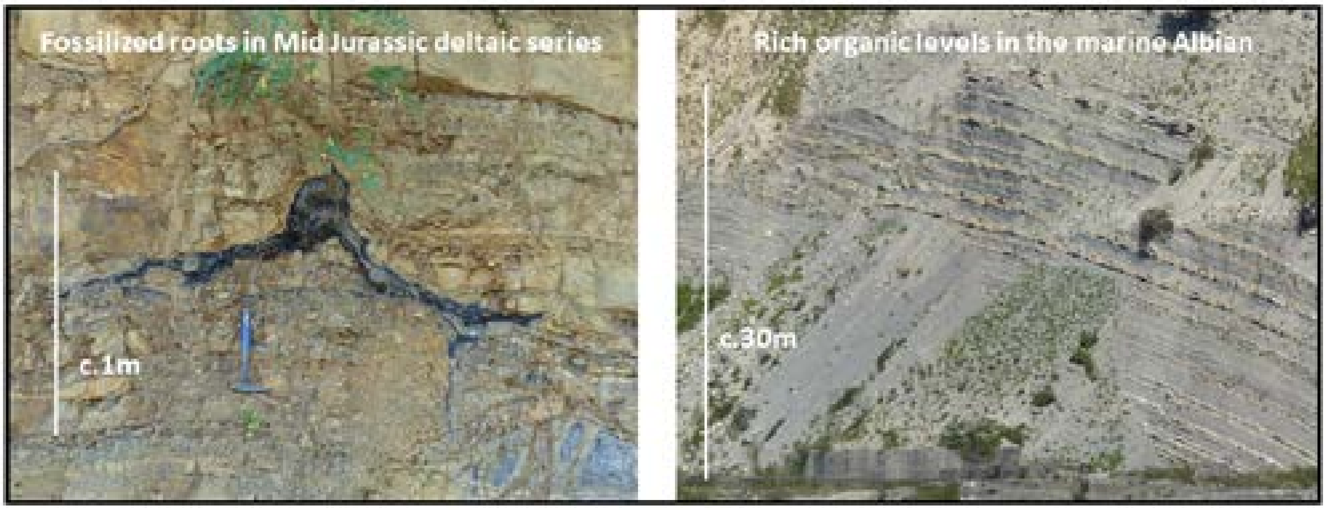
The intricate basins (Kura and Rioni) located between the Greater and the Lesser Caucasus are the site of several hydrocarbon fields. In eastern Georgia, the Samgori field in the western end of the vast Kura basin extends into Azerbaijan. It is the largest hydrocarbon discovery in Georgia, with a cumulative production of more than 250MbO. In western Georgia in the western and southern Rioni, only small size fields have been discovered (East Chaladidi, Supsa or Shromisubani, a few MbOE produced). The ingredients of the petroleum system belong to the Tertiary : source rocks from the Maikop formation, siliciclastics and volcanoclastics reservoirs, shaly intervals as cap rocks, and Neogene structures linked to the structuration of the Greater and Lesser Caucasus fold belts.

The Mesozoic series in the Kura basin constitute a speculative hydrocarbon target to be explored in the future although at greater depth below the Tertiary folds. In the Kartli sub-basin at the western end of the Kura basin, there is only scattered and often over-matured Mesozoic series to look for source, reservoir and cap rocks analogs.

In the Rioni basin, less mature Mesozoic series crop out, offering a possible evaluation of all the geologic elements and processes essential to an hydrocarbon accumulation. A preliminary investigation of the Mesozoic series revealed several organic rich horizons, reservoirs and cap rocks in the pre-Cretaceous series. This leads to propose a schematic pre-Cretaceous paleogeography constituting the base for defining possible petroleum systems. Preliminary organic geochemical analyses of organic-rich horizons lead to identify several layers having fair to moderate hydrocarbon potential for oil and gas. Based on this preliminary result, information derived from bibliography and published seismic lines, and 1D modeling with Petromod software lead to propose new potential plays in the Rioni basin.

This speculative study requires new biostratigraphic studies to confirm the ages of the various identified organic rich horizons, some of them being possibly new to refine the modelings. More detailed fieldwork should focus on reservoir quality and distribution. Eventually, analysis of reprocessed seismic data will permit to confirm new petroleum thematics.

Keywords : Georgia, Rioni basin, Jurassic, Petroleum System



New insights into Middle Eocene sedimentary basin and hydrocarbon reservoir architecture in the eastern Achara-Trialeti Fold and Thrust belt, Georgia

Onise Enukidze - onise.enukidze@tsu.ge - Tbilisi State University, Institute of Geophysics

Tamar Beridze - tamrikoberidze1969@gmail.com - Tbilisi State University, Institute of Geology

Graham Blackbourn – graham@blackbourn.co.uk – Blackbourn Geoconsulting

Victor Alania – victor.alania@tsu.ge - Tbilisi State University, Institute of Geophysics

Paolo Pace - paolo.pace@geplan.it - G.E.Plan Consultin

Marina Siradze - marina-siradze@mail.ru – Georgia Oil & Gas Ltd

Niko Tevzadze – niko@noc.ge - Georgia Oil & Gas Ltd

The Middle Eocene volcanogenic-sedimentary formation is the most productive play in Georgia. We present our preliminary results of sedimentological study, which is based on the recent field-work, logs and core data interpretations of the Middle Eocene reservoir in the Eastern Achara-Trialeti fold and thrust belt. The rocks involved in the deformation range from Paleozoic basement to Mesozoic-Neogene strata. During the Cretaceous and Paleogene, Achara-Trialeti extensional basin was filled with approximately 3500-4000m of sediments. The stratigraphic succession of the area is constrained by a borehole and the outcrop data from the study area. The stratigraphic relationships in the eastern Achara-Trialeti are complicated by phases of tectonism in the Cenozoic and represented by syn-rift megasequences (Paleocene-Middle Eocene), transitional megasequences (Upper Eocene) and post-rift megasequences (Oligocene).

Despite of more than 50 years study of hydrocarbon potential of the Middle Eocene strata there is no clear understanding of the quality and petrophysical parameters of Middle Eocene reservoir rocks as well as of facies architecture of the basin.

Two lower and upper parts have been distinguished in the Middle Eocene volcanogenic-sedimentary succession within the study area. Lower section is dominated by thinly interbedded fine sandstones and siltstones. Upper part of Middle Eocene succession contains laterally extensive, mostly homogeneous, occasionally bedded, turbidite sands with thick debrite sequences, possibly linked as single depositional flows. These are separated by thinner successions of bedded silts and finer-grained sands.

We suggest that Middle Eocene chaotic strata in the upper part of succession (tangle-bedded conglomerates or gravitational olistostromes according to previous interpretations) are strongly indicative of submarine mass-transport processes on the paleo-slope in extensional setting. Accordingly, it is supposed that these are mass transport deposits (MTD) comprising slump and linked debrite-turbidite units.

This will strongly contribute to reconstruction of the Middle Eocene sedimentary basin, better understanding and prediction of the reservoir quality in present structural position.

Key words: Middle Eocene; Eastern Achara-Trialeti fold and thrust belt; Turbidite; Mass transport deposits (MTD).

Fossil fauna assemblages and hydrocarbon source rock potential of the Oligocene (Ruslar Formation) in the Kamchia Basin, Bulgaria

Tulan E.[1.], Tari G.[2.], Sachsenhofer R.F.[1.], Witkowski J.[3.], Ćorić S.[4.], Bechtel A.[1.]

[1]Montanuniversität Leoben, Peter Tunner Strasse 5, 8700 Leoben, Austria
[2]OMV Exploration & Production GmbH, Trabrennstrasse 6-8, A-1020 Vienna, Austria
[3]Stratigraphy & Earth History Lab, Faculty of Geosciences, University of Szczecin, Mickiewicza 16a, 70-383 Szczecin, Poland
[4]Geological Survey of Austria, Neulinggasse 38, A-1030 Vienna, Austria

The Ruslar Formation, an equivalent of the Maykop Suite in the Paratethys region, forms a prominent Oligocene sequence in the Kamchia Basin. This basin is located north of the Balkans thrust front in eastern Bulgaria and it continues offshore into the Black Sea. The thickness of the Ruslar Formation varies considerably from 70 m in the Varna area to 500 m in the shelf sector of the Kamchia Basin drilled by several wells. In the deepwater part of the Western Black Sea Basin the formation thickness is up to 1500 m.

The exposed studied section with a thickness of 15 m is represented by fine laminated shale with sandstones intercalations. The fossil fauna is characterised by abundant diatom valves, frequent silicoflagellates and rarely calcareous nannoplankton and foraminifera. The diatoms are very diversified with approximate 30 genera, some of them so far unknown. The most common genera observed in the samples is Paralia with 29% abundance, Trochosira 16%, Stephanopyxis represents 15% followed by Actinocyclus 9%, and 3% Hemiaulus, Azpeitia, Pseudopodosira, Rouxia, Xanthiopyxis. Other siliceous microfossils are characterised by synurophyte scales Macrora stella and the silicoflagellates Mesocena apiculate, Naviculopsis biapiculata, Distephanus crux and Corbisema regina.

The hydrocarbon potential source rock of the Ruslar Formation measured on the samples collected in the same area is fair to good, with a TOC of 1.85 % wt. on average and type II-III kerogen which may generate oil and gas. However, based on the petroleum potential (S1+S2) the studied succession is categorised as a poor source rock. Given the fact that the Tmax (avg. 424° C) and HI are low (avg. 231 mg HC/g TOC), the studied section exposed at the coastline is immature. Biomarkers results indicate the contribution of diatoms to the lipids through the presence of C25HBI (avg. 0.87 µg/g TOC), as well as 24-norcholestane (avg. 2.68 µg/g TOC), another possible diatom biomarker indicator. Nonetheless, the presence of hop-17(21)-enes and C25HBI are clear indicators of an immature to low-maturity stage source rock.

The regional Solenovian event is indicating the absence of the connection between the Paratethys and the World Ocean Tethys which happened at the beginning of the nannoplankton zone NP23. From the results of this study, the Lower Oligocene Ruslar Formation reveal that it was deposited in a near-shore marine environment, mostly well oxygenated, with evidence for reduced bottom water oxygen conditions. In the studied segment of the Ruslar Formation we have found no indication of the brackish-water "Solenovian event" which often is correlated with oil-prone source rocks.

Keywords: Oligocene, Ruslar Formation, Maykop, Kamchia Basin, Bulgaria, Black Sea, Solenovian, source rock, nannoplankton

Hydrocarbon system modelling of Akchagyl Formation

“In South Caspian Region”

Mohajer Soltani, Hossein - hyuo1358@gmail.com – KEPCO

Fallah, Mohammad - Mohammad.Fallah@omv.com – OMV

Based on many published studies from the Eastern Parathetys (Northern margins of the Black Sea, Azerbaijan, Crimea and Kerch Peninsula), as well as Black sea and Mediterranean Sea a marine flooding event and reconnection (at least periodically) to global oceans of the Caspian basin took place during deposition of the Akchagyl sediments (Semenenko and Lulieva, 1978, 2006; Popov et al., 2004, 2006; Green et al., 2009; Gozhyk et al., 2015; Abdullayev et al., 2010, 2017) and a semi- marine regime is considered for the South Caspian Basin in this time (Popov et al., 2004, 2006)

In this research, the sedimentary environment and petrophysical evaluation of the Akchagyl formations were studied to determine of hydrocarbon system in the Caspian Sea region. In order to reach this goal, 95 sediment samples were taken from of Golestan, Mazandaran and Ardebil Provinces in Iran. Prepared thin microscopic sections were tested to determine microfacies & petrofacies, followed by calcium metric test to determine environmental ancients. Moreover, a total 14 samples were analysed by XRF and XRD for the geochemical study. This method encompass 7 samples of the sandstone and shale lithofacies of the Akchagyl formation for the provenance study and 7 samples of this formation to identify clay minerals of the fine grained sediments (mudstone-wackstone, shale facies).

Based on surface studies of area, stratigraphic columns and facies columns were Drown by Log plot 2003 software. Petrophysical evaluation was carried out Meghdad -1 well to Defined role of hydrocarbon systems in mentioned region. Finally, obtained results of petrophysical evaluation & surface sample were compared together. The results were as follows:

The results of facies studies indicated regression of Parathetys Sea toward Golestan of Region & retrogration of Ardabil & Mazandaran areas, which caused various facies in South of Caspian Sea. Generally, facies in the east, west and central of Caspian Sea were tidal, river and river-Lake respectly. In the following, the results of petrophysical evaluation of Meghdad-1well indicated nonpermiable layers & its role as a cap rock in hydrocarbon system. Finally, the results of present study defined the roles of Akchagyl formation as cap rock and reservoir rock.

Keywords: Akchagyl, Caspian Sea, Parathetys, Cap Rock

Hydrocarbon potential of Eocene and Oligocene rocks in Azerbaijan (Perikushkul Section).

Vusala Aghayeva - v.agayeva@geo.science.az - Institute of Geography, ANASBaku, Azerbaijan

Reinhard F. Sachsenhofer – reinhard.sachsenhofer@unileoben.ac.at - Montanuniversität Leoben, Austria

Shiyanova, Natalya – shnwpo@bp.com – BP-Azerbaijan, Xazar Center, Baku, Azerbaijan

Van Baak, Christiaan G.C. – Chris.vanBaak@casp.cam.ac.uk – CASP, Cambridge, UK

Vincent, Stephen J. – Stephen.Vincent@casp.cam.ac.uk – CASP, Cambridge, UK

A large number of studies has been performed on the hydrocarbon potential of Eocene and Oligocene rocks in Azerbaijan. However, because these studies yielded inconsistent results, there is a need for additional high resolution studies. Therefore, an approximately 200 m thick sucession has been logged in detail near Prikushkul, which offers a good opportunity to study the hydrocarbon potential of Middle and Upper Eocene sediments (Koun Formation) and the lower Oligocene part of the Maikop Formation. Here we report bulk geochemical data (total organic carbon [TOC] and sulphur contents, calcite equivalent percentages and Rock Eval parameters S_1, S_2, Hydrogen Index, and T_{max}) of 60 samples.

The studied Eocene succession (Koun Formation), about 50 m thick, contains calcareous Middle and Upper Eocene rocks. The Middle Eocene succession, 16 m thick, is characterized by a low amount of organic matter (average TOC: 0.90 wt%) with low HI values (av.: 46 mgHC/gTOC). TOC/S ratios are slightly higher (av.: 4.8) than in typical normal marine successions.

Upper Eocene rocks follow above a tectonized zone and are about 24 m thick. They comprise very low amounts of organic matter (av. TOC: 0.30) but HI is slightly higher (av.: 144 mgHC/gTOC) than in the underlying unit. TOC/S ratios are low (1.5) suggesting oxygen-depleted conditions than in the middle. Based on HI, type III kerogen prevails in Eocene units.

The stratigraphic position of the overlying organic matter lean interval (av. TOC: 0.09), about 40 m thick, remains unclear (Upper Eocene Koun Formation or Lower Oligocene Maykop Formation).

Maikop Formation is difficult to determine, but may be in the range of 100 m. Only two intervals (6 and 8 m thick, respectively) could be sampled. A single sample (lowermost sample from the upper interval) has a TOC of 11.2 % and a very high HI (420 mgHC/gTOC). The average TOC of the remaining samples is 0.6 % and the average HI is 232 mgHC/gTOC.

Average T_{max} (of samples with >0.2 %TOC) is 409°C showing that the organic matter is immature. With the exception of a single sample from the Maikop Formation

A single sample from the Maikop Formation contains a very good petroleum potential (S1+S2: 48 mgHC/g rock). In contrast, the petroleum potential of all other samples is very low (<1.3 mgHC/g rock). The average petroleum potential of different units ranges from 0.17 mgHC/g rock in the organic Because of major gaps and tectonic deformation, the thickness of the overlying rocks of the matter lean interval with uncertain age and 0.57 mgHC/g rock in the exposed part of the Maikop Formation (4.9 mgHC/g rock, if the sample with the exceptional high potential is considered). This shows that the studied interval is a very poor hydrocarbon source rock.

Upper Devonian and lover Permian reefs in the Cis-Caspian basin framing and their petroliferous

Zhuravleva, Liliya – email address zhurawlewa.lilia@yandex.ru – National University of Oil and Gas

Late Devonian reef formation in the frame of the Cis-Caspian depression began at the end of the Eifelian and they developed like single symmetrical reefs, which were formed within a relatively flat, slightly inclined shelf until the middle of the Frasnian.

The general sedimentation pattern changed drastically since the middle Frasnian when the terrigenous–carbonate sedimentation was replaced by the carbonate type. This was accompanied simultaneously by bending of the seafloor toward the Cis-Caspian deep-water noncompensated sedimentary basin, which were two bays of Cis-Caspian microocean: Kamyshin (Umetovo–Linevo) depression in the North-West and the Rubezhin depression in the North-East.

Reefs were formed in both areas of the basin, and their morphological type was determined by their location. The boundary between the shallow-water and deep-water settings was favorable for the formation of marginal reefs with asymmetric morphology, insignificant elevation of the ridge above the back-reef basin floor, and much more significant elevation relative to the deep-water part of the basin. Reefs of another type are represented by solitary intrabasin reefs located in the deep-water part of the bay. Their characteristics are very significant thickness and symmetry in the cross-section. Both types of reefs are associated with oil fields. The example of the fields in asymmetric systems are Zhirnovo, Severo-Dorozhkino, Linevo, Novokorobkovo, etc., the basin reefs are Kotov, Pamyat–Sasovo, Miroshnikovo and other oil fields.

Morphological types of reefs of early Permian are generally similar to late Devonian: asymmetric marginal reef systems bordered the Cis-Caspian depression from the North and West. In the deepwater area of the basin formed isolated reefs very significant thickness (reef Karachaganak). The same reef types can be traced in the lower Permian of Cis-Ural foredeep.

Oil and gas fields are also connected with low Permian reefs. The traps volume of asymmetric reefs is very small and is determined the excess of reef structures above the surface of the back-reef sediments, wich was insignificant. In addition, the regional slope of seafloor toward the inner part of the Cis-Caspian basin made this excess even less pronounced. A significant increase in the volume of traps in some cases occurs later in the imposition of post-sedimentation uplifting tectonic movement, which is fixed in the Zapadno-Teplovo reef of the same field. Sometimes back- reef deposits are dense rocks, and it creates an additional volume of the reservoir, determined by the thickness of impermeable rocks: such a structure has Gremyachino reef massive.

Thus, oil and oil fields are connected with the reefs of the upper Devonian and lower Permian framing of the Cis-Caspian depression. However, the conditions of their growth and geographical location determine different morphology and traps volume of reef reservoir.

Keywords: reef, morphology, oil traps volume

Evolution of the Mesozoic-Cenozoic Basins of the Caucasian region

Sh.Adamia - shota25adamia@gmail.com, I.Javakhishvili Tbilisi State university

V.Alania- Victor.alania@tsu.com, T.Beridze - tamara_beridze@yahoo.com, A.Chabukiani - alecocha@gmail.com , O.Enukidze -onise.enukidze@tsu.ge , N.Sadradze - ninosadradze@gmail.com , I.Javakhishvili Tbilisi State university

The region in the Mesozoic and Early Cenozoic belonged to the now-vanished Tethys Ocean and its northern (Eurasian) and southern (Gondwanian/Africa-Arabian) margins. Within this convergence zone there existed a system of island arcs, intraarc rifts, back-arc basins etc. characteristic of pre-collisional stage of evolution of the region. During syn-collisional (the Oligocene-Middle Miocene) and post-collisional (the Late Miocene-Quaternary) stages of the Late Alpine tectonic cycle as a result of continent-continent collision inversion of relief took place: at the place of back-arc basins were formed fold-thrust belts of the Great and Lesser Caucasus with the Transcaucasian intermontane lowland instead of Transcaucasian rigid blocks (microcontinents, island arcs). The normal marine basins were replaced by hemi-closed basins of euxinic type (Paratethys) and later on (the Late Miocene) – by intracontinental basins with subaerial and coastal conditions of sedimentation.

The region is divided into several tectonic units. Only some of these, are present in Georgia: the Great Caucasus and Achara–Trialeti fold–thrust mountain belts; the Rioni and Kura intermontane depressions–forelands; the northern Transcaucasian (Georgian and Azerbaijanian) rigid blocks; the southern Transcaucasian (Artvin–Bolnisi Block and Loqi–Garabagh belt). The Eastern Black Sea Basin unconformably overlies different structures of adjacent land and it's coastal line cuts the following main tectonic units: 1. the Southern Slope Zone of the Great Caucasus fold-thrust mountain belt; 2. the Rioni (Colkhis and Guria) Late Alpine intermontane trough formed over the rigid structure of the Georgian Block and now submerged under Neogene-Quaternary thick molasse sediments; 3. the Achara-Trialeti fold-thrust mountain belt; and 4. the Artvin-Bolnisi block. All the above mentioned structures are immediately extending into the Black Sea Basin. The submarine prolongation of the Southern Slope zone of the Great Caucasus is showing up along the northern, pre-Caucasian coastal stripe of the Sea. The Eastern Black Sea high - the Shattsky Ridge, is considered to be the submarine prolongation of the Georgian Block, while the submarine prolongation of the Artvin-Bolnisi Block and the Eastern Pontides is the Arkhangelsky-Andrusov (middle Black Sea) high. The Achara-Trialeti trough is immediately traced in the central part of the Eastern Black Sea Basin with sub-oceanic crust and formed during Adjara-Trialetian back arc rifting event (late Cretaceous-Paleogene), relatively short-term episode of evolution of lithosphere of the Black Sea region. But thick strata of sub-alkaline-alkaline basalts in the bottom of the salt-bearing variegated formation, which, according to its stratigraphic position, is attributed to the Upper Jurassic points to the possibility of similar rifting processes.

Previous studies conducted by different oil companies discovered several perspective structures for hydrocarbon reservoirs and oil shows in the sediments of various ages, from Early Jurassic to Pliocene, on the Black Sea shelf and adjacent areas of Georgia, also occurrence of oil films and gas bubbles on the seawater surface indicate high perspectivity of these structures.

Key words: Caucasus, Black Sea, collision, rifting, hydrocarbon reservoirs.

Variations in geothermal gradient and understanding crustal structure and evolution of Kura Basin, onshore Azerbaijan

N.R.Abdullayev[1], I.S.Guliyev[2], Sh.M.Huseynova[2], F.A.Kadirov[3], A.Sh.Mukhtarov[3]

1 – British Petroleum

2 – Oil and Gas Institute of Azerbaijan National Academy of Sciences

3 – Geology and Geophysics Institute of Azerbaijan National Academy of Sciences

Analysis of temperature outputs from 1D burial histories and calibration of heatflow data and geothermal gradient is a useful tool in understanding crustal structure of a basin where accurate measurements of such parameters are limited. We attempted to use existing temperature observations from well data to predict depth to basement and crustal thickness across the regional profile through Upper Kura, Middle Kura (Yevlakh-Agjabedi depression) and offshore South Caspian.

Clear boundaries exist between a number of specific regions including “cold” South Caspain proper with thick sediment cover where geothermal gradients vary from 15 to 18°C/km and Lower Kura basin where geothermal gradients average 20°C/km. Areas of Upper Kura Basin closer to the Lesser Caucasus have a range of geothermal gradients that vary between 26 to 40°C/km. Reasonable degree of correlation can be established between basement depth, crustal thicknesses and geothermal gradient.

Low heat flow density averaging 30-50 mW/m^2 predominate in Kura Basin despite few anomalies caused by mud volcanoes or regional faults. In contrast the Greater Caucasus is generally marked by high heat flow (70 to 145 mW/m^2), this is also true of Lesser Caucasus (around 100 mW/m^2).

The depth to basement in the central part of Kura Basin (Yevlakh Agjabedi depression) on seismic data reaches 14 km with crustal thickness of 20 to 25 km which implies an attenuated crust of extensional origin. Jurassic volcanic “basement” has been penetrated in 8 km deep Saatli-1 superdeep well on a Kurdamir high in the middle of Kura Basin. Geochemical analysis of these rocks suggests derivation from calc-alcaline magma of island arc type affinities. These rocks may be the closest analogues to the pre-sediment crust of SCB. As these rocks produce little of radiogenic heat being low on key radioactive elements, this results in low in geothermal gradient in most of onshore Azerbaijan.

Burial history of the restored wells implies island arc extension origin for basins adjacent to the South Caspian, early basin formation in Jurassic, with possible additional rifting in Eocene and flexural overprint in Tertiary.

Untapped world class natural gas potential of Central Georgia

Dr. M. Arif Yukler – yukler@aol.com – Georgia Oil & Gas Limited, Georgia.

Tevzadze, Nikoloz – niko@noc.ge – Georgia Oil & Gas Limited, Georgia;

Janiashvili, Alexander – alexander@noc.ge – Georgia Oil & Gas Limited, Georgia;

Sanishvili, Artem – artem@noc.ge – Georgia Oil & Gas Limited, Georgia;

Alania, Victor – victor.alania@tsu.ge – M. Nodia Institute of Geophysics, Tbilisi State University, Georgia;

Enukidze, Onise – onise.enukidze@tsu.ge – M. Nodia Institute of Geophysics, Tbilisi State University, Georgia.

Central Georgia is located at the western end of the prolific Kura Basin on the TransCaucasian Massif that extends from the Black Sea to the Caspian Sea. Sedimentation started in the Early Jurassic and has continued until Present. The compressional forces from the south since the Middle Jurassic times resulted in subduction directly south of the Lesser Caucasus starting in the Bajocian and were later activated in the Albian, Middle Eocene and Late Tertiary times. The continued compressional regime from the Middle Miocene to Late Pleistocene led to folding of the Mesozoic and Tertiary strata followed by thin-skin and later thick-skin thrusting. Most of the structures were formed in the Middle Pliocene to Pleistocene times.

The proven 3 primary source rocks are the Toarcian (mainly Type II kerogen with 0.5-2.8% TOC), Late Eocene (Type II and III kerogen with 1.3-10% TOC) and Maikop (Oligocene to Mid Miocene) shales (Type III and Type II kerogen with 0.5-11% TOC). The Upper Bajocian and the Uppermost Cretaceous are the secondary source rocks with some gas generation potentials. There are 6 potential reservoir rocks, namely, Aalenian sands, fractured Albian limestones, fractured Campanian to Maastrichtian limestones, fractured Middle Eocene volcanoclastics, Upper Eocene silty sandstones and Upper Maikop sandstones. The main producer is the fractured volcano-clastics of the Middle Eocene. The effective seals are the thick shales of Lower Eocene, Upper Eocene and Maikop formations.

Organic geochemical studies proved that Samgori, South Dome, Patarzeuli, Ninotsminda, Norio and Satskhenisi fields were sourced mainly from the Maikop and with some contributions from the Upper Eocene source rocks of the Norio kitchen to the north. Jointly these fields have produced more than 200 mmbbls.

The quantitative basin modeling study shows that peak oil generation have started at about 3.6 mabp and gas at 1.7 mabp at depths of 3,600 m to 4,700 m and 4,350 m to 6,100 m, respectively. To the south of the thrusts, oil and gas generation occurred at much shallower depths due to hot water circulation. The rapid generation of oil and gas in the shaly Cenozoic source rocks led to abnormal pressure formation and opening up additional pore space by fracturing and reduction of kerogen volume. Self-propagating microfractures resulted in high primary migration volumes to enter into the strike slip faults formed at the time of thrust activity from the Middle Pliocene to Late Pleistocene. The effective oil migration took place at past peak oil generation and, thus, oils in the fields are generally light, more than 34 degrees API, and with high gas content. Except for the Ninotsminda field, the gases in the oil fields are biodegraded. There is a continuous gas leak into the Ninotsminda structure from the north.

The computed most likely recoverable oil resources are 812 mmbbls and 365 mmbbls were already discovered during the Soviet Era. Most likely recoverable gas resources are 1.2 Tcm and this gas has not been explored yet.

BASIN MODELLING

Tectonic development of the Ararat Basin, Lesser Caucasus, Armenia

A.Avagyan[1]*, M. Sosson[2], L. Sahakyan[1], Y. Sheremet[2,3], S. Vardanyan[1,2], T. Atalyan[1]

[1]Institute of Geological Sciences. National Academy of Sciences of the Republic ofArmenia, 24[a]Baghramyan Av.,Yerevan 0019, Armenia e-mail avagn1064@gmail.com

[2] Université Côte d'Azur, Géoazur, CNRS, Valbonne, France.

[3] Institute of Geophysics, National Academy of Sciences of Ukraine, Kiev, Ukraine.

The Paleocene-Miocene Ararat basin is located in the foreland to the south of the NW-SE trending Lesser Caucasus orogenic belt in the Republic of Armenia.In the foreland to the north are the hydrocarbon-bearing Kura andRioni basins of Georgia. On the basis of recent studies in Armenia together with a critical review of previous work, we propose a new model for the structure and development of the Ararat basin. The basin's development is here interpreted within a compressional regional framework which has been dominated since the Late Cretaceous by the closure of Neotethys and the Arabia-Eurasia collision.

Previous studies have considered that the Ararat basin is an extensional graben, and that surface exposures of Palaeozoicrocks are related to horst structures controlled by normal faults. However new data suggest that surface structures in a study area in the northern flank of the basin arein fact oblique-slip reverse and thrust faults, activated in post-Oligocene-Miocene times (Fig.1). Regional compression resulted in the formation of asymmetric, fault-controlled folds including the Lanjanist and Urts anticlines to the NW of the Ararat basin and Parakar-bared and Sardarapat structures to the north and NW. The structural pattern is complicated by secondary normal faults which have resulted in gravitational slope processes and erosion. Pliocene and Quaternary (active) structures show evidence of structural inheritance.

In the subsurface, the Ararat basinis interpreted to contain obduction-related ophiolitic nappes which are exposed at the surface at various locations such as Sari Pap. Together with compressional anticlines and thrust faults, these Mesozoic nappes have potential as structural traps for hydrocarbons.

Keywords: Ararat basin, Lesser Caucasus, Armenia, structural trap, thrust fault, ophiolites.

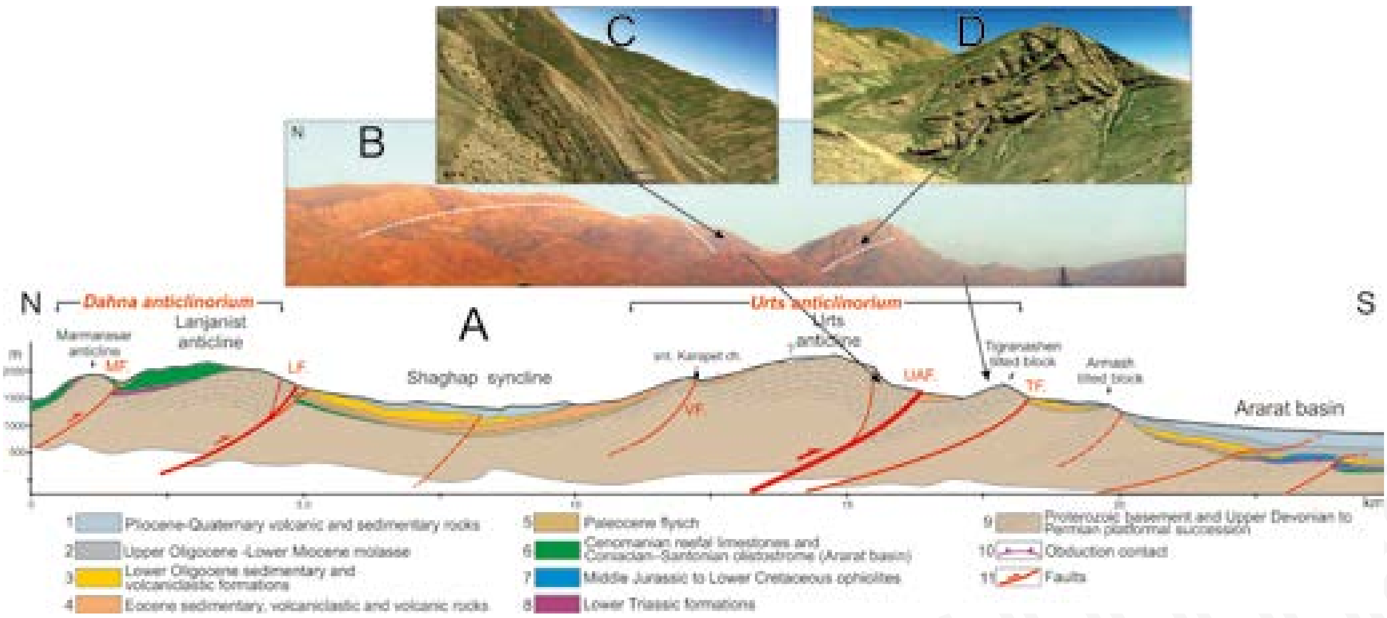


Fig. 1. A. North-south cross-section through the Lanjanist and Urts anticlines and the northern margin of the Ararat basin, Armenia. The anticlines are interpreted as fault-propagation folds located in the hangingwalls of major north-dipping thrust faults (LF, UF, VF, UAF, TF).

B. Field photograph of the Urts anticline and Tigranashen tilted block. C, D. 3D Digital Globe satellite images of the fore-limb of the Urts anticline and the Tigranashen tilted block.

3D basin and petroleum system modeling of the Pre-Dobrogea foredeep in the NW Black Sea region of Ukraine

Karpenko, Ivan - sharanskiy@gmail.com - Naftogaz Group, Kyiv, Ukraine

The Ukrainian and Moldavian segments of the Pre-Dobrogea foredeep are underexplored. This study presents a deep dive into petroleum system evolution of this foredeep basin based on a first ever 3D basin model with numerous computational simulations. This study stimulates and examines the thermogenic conventional and also the unconventional petroleum systems to identify yet-to-find hydrocarbon resources.

The modelled area covers about 15,000 km^2 of the onshore area of the basin along the coastline of the NW Black Sea, bordered by the Dobrogea fold belt and the Scythian Platform. The broader region is located in the area between Ukraine, Moldavia and Romania.

The Pre-Dobrogea area has a proven petroleum system with oil-prone source rocks, discovered commercial oil and gas accumulations, numerous gas shows. All the elements required for finding additional accumulations of oil and gas deposits are present. The challenge is to understand the preservation of hydrocarbon accumulations, partly because of the presence of paleo-volcanoes and also because of the large and deep-seated semi-regional fault systems crossing the area. There are two zones, Priprutskaya and Saratskaya, with preserved oil and gas accumulations with known commercial oilfields (i.e. Valensky oil field, 15-20 MMBBL; East Saratsky oil field, 171 MMBBL; and Zhovtoyarsky oil field, 42 MMBBL). Other preserved commercial accumulations are located within the Moldovian sector of Pre-Dobrogea foredeep (i.e. Viktorovsky and Eniki gas fields). Numerous commercial and sub-commercial production rates and also oil and gas shows were documented in the Jurassic, Permian-Triassic, Carboniferous, Devonian and Silurian units in the foredeep basin.

As to source rocks, Carboniferous and Devonian oil-prone coals with II type of kerogen are the major known sources of hydrocarbons within study area. The spatial distribution of coals within the area, however, is not well constrained everywhere, therefore an extrapolation was needed based on known depositional environments within study area. In the Late Visean-Late Serpukhovian units, we considered coastal marshlands of shallow sea. The bog-marine coal-bearing subformation has a coal with clarain composition of the reduced and transition genetic types. In the Late Serpukhovian-Late Bashkirian units swampy coastal lowlands were interpreted with a lagoon-delta shallow sea coast. Therefore the coals of the top coal-bearing subformation have mostly duroclarain composition. Coals with signs of salinity are recorded in coal sediments of both regions. The coals of high sodium content are also found in paralic formations of the Middle Miocene of Nizhneprutsky Bench adjacent to the SW part of Pre-Dobrogea depression. According to the level of geodynamic and geothermal activity during the formation of the Paleozoic sedimentary cover the Pre-Dobrogea depression is characterized and classified as hyperthermal basin.

Our first-ever subbasin-scale 3D basin model (15,000 km^2) was built using the Petrel software, whereas the petroleum systems were simulated using the PetroMod software. Inputs were generated from combination of numerous regional vintage structural maps, digitized 2D profiles, tens of deep exploration wells and vintage research studies describing lithofacies distribution, paleo-depositional environments, geochemistry, etc. The regional distribution of heat-flow and its paleo-trends was determined via 1D basin modelling. The modeled preserved accumulations were calibrated with the existing oil and gas fields.

Our basin modelling study highlights the regional petroleum system, including the known discoveries and gas shows and it also predicts yet-to-find petroleum accumulations. This study had rather regional objectives at this stage, but integration of additional exploration data will generate more prospect-scale results and could be used for future exploration efforts.

Keywords: basin analysis, petroleum system, 3D, basin modelling, yet-to-find, thermogenic, coal, oil-prone

3D modeling of the NW Black Sea basin as a new insight from seismic and well data

Tyshchenko, Andrii - aptyshchenko@gmail.com – Inst. of Geology, Shevchenko National University of Kyiv, SE NaukaNaftogaz, Naftogaz Group

Kuzmenko, Pavlo – kuzmenko@nng.com.ua – Inst. of Geology, Shevchenko National University of Kyiv, SE NaukaNaftogaz, Naftogaz Group

Kitchka, Alexander – kitchka@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

This paper presents interim results of the Naukanaftogaz research project aiming to cohesively clarify structural geology and sequence stratigraphy subdivision of the basin and its margins employing mainly open source data for neighboring areas. 3D modeling is a powerful tool to study petroleum systems and exploration value analysis basinwide and sort out with structural puzzles and settle due background for further palinspastic restorations as well.

The BS05 vintage set of 2D regional seismic data of the Ukrainian section of the Black Sea of 9 875 km total length exists only in the time domain. Exploration tasks require adjusting and refining velocity models for all BS05 lines without well control in the deepwater depocentral domain. So there is a practical demand to re-process seismic data applying new algorithms including depth pre-stack migration, etc. to solve interpretation problems to reveal deep structure of the Black Sea basin in detail. Its northwestern corner is one of the most structurally complicated in the basin. At this structural node the slope of the Precambrian East European Platform and marine continuation of the Cimmerian Dobrogea orogen are conjugated/superimposed with Cenozoic structure of the Black Sea basin (see fig. 1). One of the structural problems is to decipher kinematics along the Odessa crustal transtensile wrench (dextral transform zone) fault coupling with thrusts to the west of it and normal faulting to the east.

One of the regional profiles acquired by GWL (Nikishin et al., 2015) across the basin is taken as a benchmark line. We have built iterative time velocity model along that profile and determined velocities for all sedimentary units. Transformation of time sections into depth ones is the next step resulting in almost total identity of depth profiles is considered as key procedure. Also it is necessary to make joint interpretation of Ukrainian and Romanian seismic datasets and to develop concerted sequence stratigraphic model for the Ukrainian and Romanian offshore, and trace paleo-valleys and buried canyons to reveal new hydrocarbon prospects.

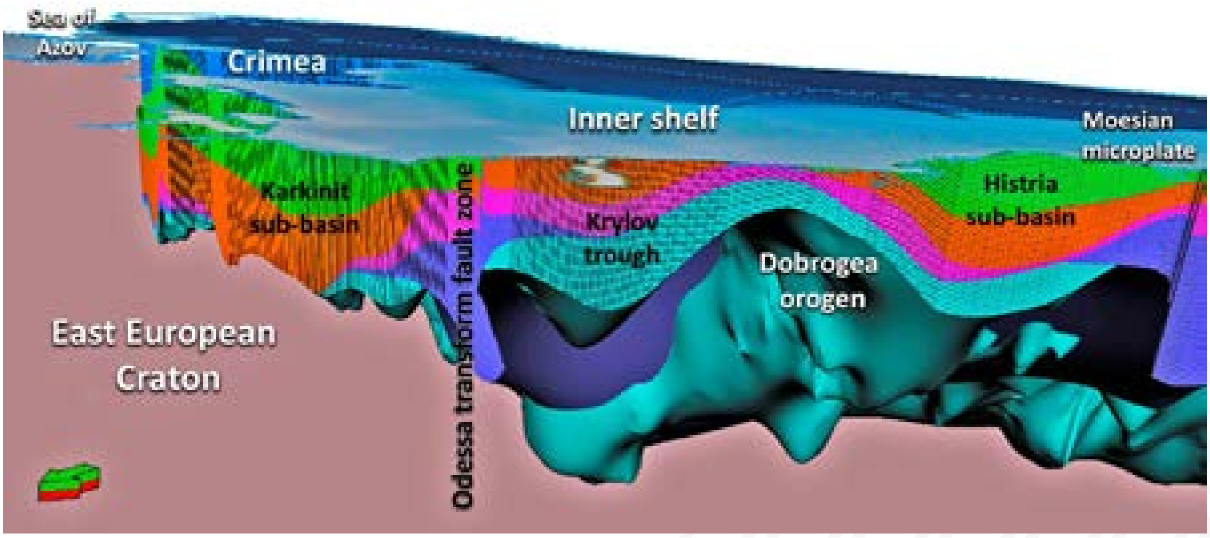


Figure 1 3D view through the Odessa inner shelf subsurface seismic velocity domain.

Keywords: Black Sea basin, 2D seismic datasets, velocity modelling, tectonic structure.

Evolution of Drainage Networks in Turkey Since Middle Miocene

Nuretdin Kaymakci[1] and Pieter van Heningen*[2]

1. Middle East Technical University (METU/ODTÜ), Department of Geological Engineering, 0680 Ankara, Turkey. kaymakci@metu.edu.tr

2. Provenance Exploration Consultancy BV, The Netherlands. pvheiningen@provenance-ec.com

Turkey is one of the main source areas for the Black Sea and eastern Mediterranean seas. It is characterized by three main morphotectonic domains; the Pontides in the north, Taurides in the south and the Anatolides in the centre. Anatolides are characterized by Mesozoic to early Cenozoic metamorphic rocks covering the large part of the Central Anatolian Plateau (CAP). Based on our topographical analysis, it seems that the drainage network in Turkey is directed to the north at Present. However, it was directed oppositely towards the south during which the western Anatolia and the Pontides were topographical highs while the southern and the eastern Anatolia was lowlands if not covered by sea. This is evidenced by the presence of Late Miocene marine deposits as far north as Konya-Karapınar-Niğde area placing the late Miocene coastline north of the Taurus mountains. In southern and eastern part of the CAP, the marine conditions prevailed until the end of Serravalian (~10Ma). Therefore, much of the Central Anatolian Plateau and Turkey was part of the Eastern Mediterranean hinterland. Nowadays, the CAP is characterized partly by several large scale isolated (internally drained) drainage basins like Tuzgölü and Konya drainage basins that have accumulated lacustrine marls and limestones overlain by actively accumulating salt deposits while other parts of CAP drain to the Black Sea Basin via severely deflected river valleys of Sakarya, Kizilirmak and Yesilirmak rivers. This shift took place around 6 My ago due to uplift of the Taurides in response to the slab-edge processes related to northwards subducting oceanic lithosphere of the African Plate along the South Aegean-Cyprian subduction system below Anatolia. These processes gave way to the tilt of the CAP to the north, reversing the flow directions of all drainages from SE to NW into the Marmara and Black Sea basins. All of these processes resulted in not only the drainage reversal but also shrinking of hinterland of eastern Mediterranean basins such as Adana-Cilicia and Antalya basins while the CAP has been severely incised.

Windgaps (drainage beheading) and associated drainage characteristics preserved in the present drainage divides, accompanied by high angle stream segments (of same Strahler Order) and downstream located watergaps (drainage capture) are provide evidence for the reorganization of drainage within the CAP. The major consequence of this reorganization is the change in the type and volume of the sediment load that has been transported to their ultimate location, the Black Sea and the eastern Mediterranean basins.

The petrography of the sediments strongly controls the quality of reservoir rocks. The known hydrocarbon exploration provinces like the Adana-Cilicia and Antalya basins have experienced the such change in sediment supply and provenance. In this contribution we present one of the many examples of how the reorganization of drainage has taken place as a consequence of the uplift of Taurides in Turkey.

Another potential connection between the Mediterranean and the Black Sea during the Messinian Salinity Crisis: the Sakarya Bosporus

Sipahioglu, Özgür Nazim - osipahi@tpao.gov.tr - Turkish Petroleum, Ankara, Turkey

Bati, Zühtü - bati@tpao.gov.tr - Turkish Petroleum, Ankara, Turkey

Tari, Gabor - gabor.tari@omv.com - OMV Upstream, Vienna, Austria

Fallah, Mohammad - mohammad.fallah@omv.com - OMV Petrom, Bucharest

There are two existing models for the physical connection between the Black Sea and the Mediterranean during the Messinian Salinity Crisis (MSC). One marine gateway has been proposed to be located some 50 km to the west of the Bosporus in the area of the Strandja Sill. Recent studies have found no evidence for the provisionally suggested "Karacaköy-Karadeniz" passage across the Strandja Sill during the MSC. Therefore, an alternative connection was proposed across the Balkans, some 100 km to the west of the Bosporus, following the Vardar Zone and reaching Carpathian foredeep basin during the MSC.

We propose yet another potential marine gateway, but to the east of the Bosporus. The Sakarya River reaches the Black Sea shorline some 100 km to the east from the Bosporus. Already Max Pfannenstiel coined the term of Sakarya Bosporus in the 1940s envisioning a marine connection in the Sakarya River valley during the Quaternary, connecting the Black Sea/ Lake through the Sakarya river valley across the Sapanca Lake to the eastern arm of the Izmit Gulf. From there the marine connection to the Mediterranean was from the Sea of Marmara to the Aegean Sea.

Indeed, previously acquired offshore data sets show the existence of a prominent Quaternary submarine Sakarya canyon including two canyon heads is found in front of the Sakarya Delta. The canyon extends to 1500–2000 m water depth and previous studies based on high-resolution academic seismic reflection data sets suggested either a very young age for the Sakarya Canyon or, alternatively, a continuous landward extension of an older canyon.

Our 2D industry seismic data sets show that the modern Sakarya submarine canyon is indeed underlain by a much older canyon filled by thick Pliocene sediments prograding into the paleo-canyon from its both sides. The exact age of these sediments cannot be determined due to a lack of well data penetrating this succession in the vicinity of the Sakarya Canyon. However, regional-scale correlation of deepwater seismic reflection horizons in the western Black Sea associated with the MSC shows that the paleo-canyon could have indeed initiated during the Messinian (Pontian in Paratethys terms) in age.

Keywords: Messinian Salinity Crisis, Bosporus, Sakarya, canyon drawdown, Pontian, sea-level fall

Fingerprints of the isolation of Eastern Paratethys in the Early Oligocene (Solenovian) in Thrace, Western Black Sea and South Caspian basins

Recep Hayrettin SANCAY[1*], Zühtü BATI[1]

[1]Turkish Petroleum Corporation (TPAO), Research and Development Center, Ankara, Turkey

The Thrace, Black Sea and South Caspian basins have unique locations for paleogeographical reconstructions. Even though very thick and extensive Eocene and Oligocene outcrops existed in Thrace Basin, only a few sections available in the western Black Sea onshore areas for biostratigraphical purposes. Biostratigraphical investigations of Eocene-Oligocene layers are also limited since most of the studies were focused on Mio-Pliocene reservoir rocks, so called productive series, in the South Caspian basin.

In this study 7 measured stratigraphic sections (5 from Western Black Sea, 1 from Thrace and 1 from South Caspian basins) were studied and palynomorph assemblages were identified quantitatively. Index dinoflagellate cyst events and the palynological biozonation established in the Mediterranean (Brinkhuis and Biffi 1993; Brinkhuis 1994; Wilpshaar et al. 1996; Torricelli and Biffi 2001) were applied successfully. Priabonian units reveal Achomosphaera alcicornu (Aal) biozone whereas Rupelian successions were represented by Areosphaeridium diktyoplokum (Adi), Reticulatosphaera actinocoronata (Rac), Corrudinium incompositum (Cin) and Hystrichokolpoma pusillum (Hpu) biozones in the studied sections (Figure 1).

Palynological analyses suggest that the youngest interval of the studied sections was from the Thrace basin where Lower Oligocene Mezardere Formation informally subdivided into Lower Mezardere Formation (LMF) and Upper Mezardere Formation (UMF) by Gürgey and Batı (2018). They distinguished two dinocyst assemblages in the Rupelian (?Pshekhian to Solenovian) The lower part of LMF has Glaphyrocysta cf. semitecta and interpreted as ?Pshekhian (?NP21/22) in age, whereas Solenovian (NP23-24) was assigned for the UMF based on the early Chattian last occurrence (LO) of Wetzeliella cf. gochtii.

In the Western Black Sea, four bio-chronostratigraphical intervals in Ceylan Formation in the Late Eocene-Early Oligocene, NP21, (corresponding to the Beloglinian-Pshekhian regional stages of Eastern Paratethys) were defined. The oldest unit (Aal zone) lies below the Glaphyrocysta semitecta zone, yielded Eocene dinoflagellates such as Areoligera tauloma-sentosa, Areosphaeridium michoudii, Rhombodinium perforatum, Homotryblium pallidum, Stoveracysta ornata, and interpreted as late Priabonian (Beloglinian) in age. In ascending order, Adi and Rac zones characterized by common occurrences of Glaphyrocysta semitecta, below the Wetzeliella gochtii zone, and interpreted as earliest Rupelian (Pshekhian) in age. Wetzeliella gochtii bearing intervals (Rac and Cin zones) are interpreted as early Rupelian whereas overlying sediments are belonging to early-(?middle) Rupelian (Pshekhian) of Cin zone.

Contemporaneous sediments of Beloglinian-Pshekhian (NP21) aged Koun and Maykop formations were also investigated palynologically in the South Caspian basin. Aal zone (in the latest Eocene) and Gse and Adi zones (in Early Oligocene) were distinguished based on four biostratigraphically important dinoflagellate events; the first occurrence (FO) of Achomosphaera alcicornu, the FO of Glaphyrocysta semitecta, the LO of Hemiplacophora semilunifera and the LO of Areosphaeridium diktyoplokum.

Paleogeographically, the Thrace, the Western Black Sea and South Caspian regions evaluated within the Eastern Paratethian Realm (Popov et al., 2004; Schulz et al., 2005; Sachsenhofer et al., 2009) during the Eocene-Oligocene transition. Besides the fresh water influx and brackish depositional settings due to lack of or limited seaway connections, the presence of manganese ore and source rock deposits were also reported as results of the isolation. The palynological fingerprints of the isolation of the Eastern Paratethys from the Tethys Ocean was traced in this study in that the presence of fresh water influx and decrease in the abundance and diversity of the marine palynomorphs were used as indicators. The studied Upper Eocene-Lower Oligocene successions in the Western Black Sea and South Caspian basins represent shallow to deep marine, nutrient-rich depositional conditions and dominated by marine palynomorphs without any indication of fresh water influx. Therefore, these sediments were interpreted as deposited before the isolation of the Paratethys when the Western Black Sea and South Caspian basins were still part of the Western Tethys during the Early Rupelian (Pshekhian), NP21-?22 (Figure 2). The Solenovian (NP 23-24) sediments recording the evidences of the isolation were not encountered in the Western Black Sea and South Caspian basins in this study but they are existed in the UMF in Thrace where the high fresh water influx (high abundances of Pediastrum) and pronounced shallowing accompanied by reduced diversity of marine palynomorphs were reported. Similar brackish depositional conditions were also reported in many other localities of the Eastern Paratethys (İslamoğlu, 2008; Schulz et al., 2004 and 2005; Bechtel et al., 2012; Batı, 2015; Gürgey and Batı, 2018 and references therein; Popov et al., 2019) in the late Rupelian (Solevonian). Even though the palynological records of the isolation in the South Caspian Basin in Solenovian is missing due to the unsuitable lithologies, Popov et al. (2008) studied the overlying Upper Oligocene-Middle Miocene successions, corresponding to middle and upper part of Maykop Formation, of the same section palynologically and reported common occurrences of fresh and brackish water algea and terrestrial palynomorphs representing the depositional conditions after the isolation

References

Popov SV, Rögl F, Rozanov AY, Steininger FF, Scherba IG, Kovac M. (2004). Lithological- paleogeographic maps of the Pratethys. Cour. Forsch. Senck. 250: 1-46.

Popov SV, Syaevskaya EK, Akhmet'ev MA, Zaporozhets NI, Golovina LA. (2008). Stratigraphy of the Maikop Group and Pteropoda beds in northern Azerbaijan. Stratigr. Geol. Correl. 103: 163-175.

Schulz HM, Bachtel A, Sachsenhofer RF. (2005). The birth of the Paratethys during Early Oligocene: From Tethys to a Black sea analogue. Global Planet Change 49: 163-176.

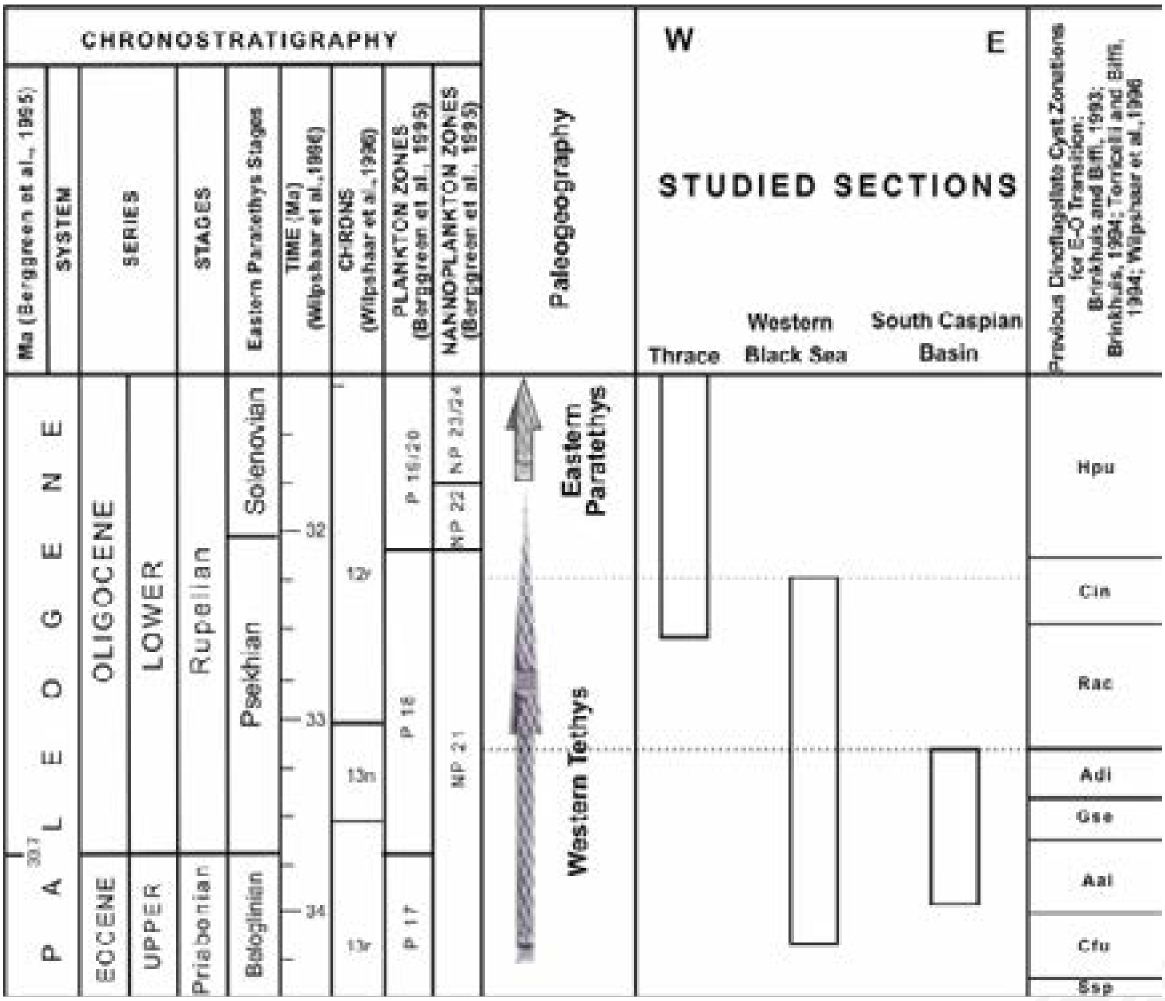


Figure 1. Bio-chronostratigraphic chart of the studied sections and their paleogeographical domains during Priabonian to Rupelian.

Oligocene –Lower Miocene climate and sea level changes in the South-Caspian basin: integration of lithofacies and diatom analyses

Aliyeva, Elmira – e_aliyeva@gia.ab.az - Geology and Geophysics Institute of Azerbaijan National Academy of Sciences

Huseynov, Dadash – d.huseynov@gia.science.az - Geology and Geophysics Institute of Azerbaijan National Academy of Sciences

Kerimova, Nailya - nayila_kerimova@mail.ru - Geology and Geophysics Institute of Azerbaijan National Academy of Sciences

Allakhverdiyeva, Kheyran - hallahverdiyeva63@gmail.com - Geology and Geophysics Institute of Azerbaijan National Academy of Sciences

The Maykopian sediments (Oligocene-Lower Miocene) are a second production unit in Azerbaijan after Pliocene Productive Series. A long production history from the Maykopian succession is recorded in a number of fields located within Kura-South Caspian basin. Understanding of the sedimentary processes governing accumulation of reservoir rocks became now one of the important questions.

The integration of lithostratigraphic, biostratigraphic (diatom analysis) data from the well documented continuous Maykopian successions cropping out in the Azerbaijan part of the South Caspian basin, and correlation them with the oxygen isotopic composition in the benthic foraminifera shells, as well as the Global Ocean and the Eastern Paratethys level fluctuation curves display a good link between depositional environmental changes, diatom algae associations' variability and climatic variations reflected in consequent sea level fluctuations. We can conclude that the studied sections are dominated by marine environment that is confirmed by the diatom complexes and sedimentological data. Based on the large amount of cryophile species we can state that temperature in the Early Maykopian time (Oligocene) within area of the study was low - 5ºC -15ºC. In some time intervals it could increase up to 20ºC.

There are 4 warming stages and 4 cooling stages in the Oligocene history of the Caspian basin (Figure 1). These climatic events fully coincide with the Eastern Paratethys level fluctuations (Popov et al., 2010). According to the results obtained the cold stages correspond to the Eastern Paratethys level decline. These time intervals are associated with the accumulation of thin sand beds, that, probably, reflects depositional environment changes from the outer shelf setting dominating in the section to the more proximal inner shelf exposed to storm processes resulted in the accumulation of coarse terrigenous material.

The mln year scale climatic cyclicity in the Maykopian time proved by diatom assemblages was reflected in the Eastern Paratethys level fluctuations of the third order.

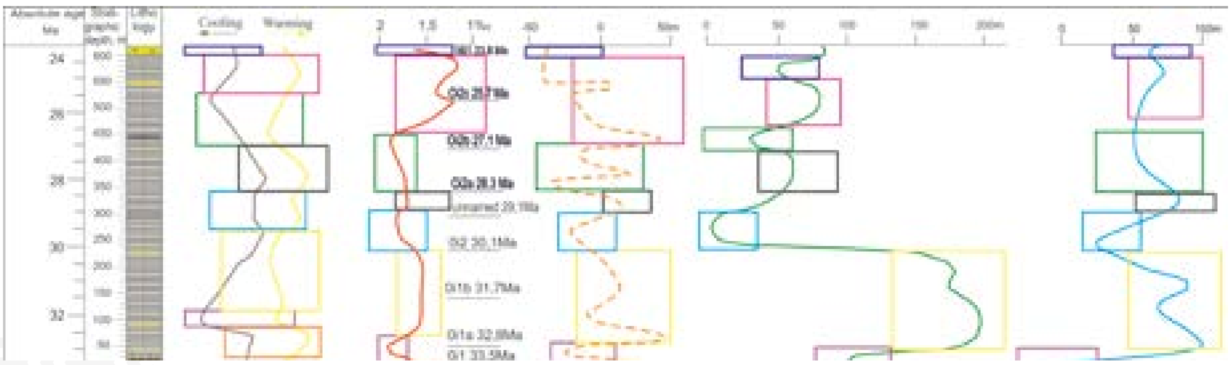


Figure 1. Curves displaying the changes in the: number of cryophile (brown line) and thermophile (yellow line) diatoms in the Lower Maykopian sediments, Pirakushkul section; oxygen isotope composition of benthic foraminiferas (red line); World Ocean level: by K. Miller et al. (2005) (orange dotted line); by B. Haq et al. (1987) (green line); (e) Eastern Paratethys level by S. Popov et al. (2010) (blue line).

Key words: Maykopian sediments, facies variability, Maykopian Sea level change, diatom algae, cooling - warming climatic stages.

Heavy metals in aquatic fresh water, coastal zones and their relation with sediment characteristics of south west of Caspian Sea

Razyeh, Lak - lak_ir@yahoo.com and director@gsi.ir –Research Institute for Earth Sciences, GSI 1

Ali, vosoogh - ali.vosoogh@gmail.com – Iran University of Science and technology 2

Heavy metals are potentially toxic for environment and microorganism. In this research, pollution intensity, risk release and bioavailability of heavy metals in aquatic fresh water and their relationship with sediments physical and chemical characteristics of south west of Caspian Sea have been studied. In order to study, surface sediment samples from rivers (40 stations from 15 rivers), wetland (2stations from 2wetlands) and coastal sediments (5stations) have been collected.

Physical (sediments size) and chemical (XRD and total concentration of heavy metals) were determined. Due to different geological formation, all of river sediments divided into two categories (east-central and west) by using fuzzy clustering and Fe, Al, Ca, Sr concentrations. At the next step, pollution intensities of sediments in different sizes calculated by cumulative ecological risk index (RI).The results showed that the maximum values of ecological risk index was for particle sizes 63-125 microns. In wetland sediments the greatest values was in particles under 38 microns. Ecological risk index for coastal sediments showed that the highest values of the samples belongs to stations near Anzali port.

To determine risk release of sediments, sequential extraction experiments were performed on selected samples. Metals existence in different bonds, exchangeable, carbonate, Fe and Mn oxides, organic and residual have been shown in percent. The results indicated that Cd had highest percentage of heavy metals in loosely bonds in river sediments less than 63 microns and for particles bigger than 63 microns, Pb and Co were the highest amounts. In the wetland sediments, the results were different with river sediments. In particles less than 63 microns, Cu, Cr, Cd, V and Co were the maximum participation with loosely bond. Ni and Pb in particles bigger than 63 microns were the highest. Finally, because of high participations of Pb, Ni, Cd and Co in loosely bond, the mobility and thus the risk release of these metals were higher than other.

For evaluating risk release of metals in different sizes, modified risk assessment code (mRAC) has been used. In wetland sediments, the highest amount of mRAC was for particles less than 38 microns. Particles between 63-125 microns have a maximum mRAC amounts in coastal sediments.

In the next step, bioavailability of size fractionated sediments were determined by single extraction with EDTA.

Keywords: Caspian Sea, Size fractionated sediments, Heavy metals, Pollution intensity, Risk release

Distribution and volume of sedimentary rocks in World's basins - unusual case of the South Caspian Basin

N.R.Abdullayev[1], Sh.M.Huseynova[2]

1 – British Petroleum

2 – Oil and Gas Institute of Azerbaijan National Academy of Sciences

This study gives a summary and brief overview of the sedimentary cover of the Earth and summarizes volumes and mass of sediments contained in the Earth sedimentary layer (stratisphere) pointing out a special nature of the South Caspian Basin as a unique sedimentary sink amongst other basins of the world. We have measured close to 900 sedimentary basins in the world from publically available sources and identified the relationships between the basin sedimentary thickness, areas and sediment volumes in these basins. Most of sedimentary basins are located on passive, active or rifted margins of the continents and interior of the continents such as cratonic sags, aulacogens or failed rifts. Most of the sediments are located in Eurasia (almost 45%), followed by sediments in North America (25%), Africa, South America and Australia. Most of sediments accumulated during Phanerozoic were in clastic rocks and were almost equally distributed in Paleozoic, Mesozoic and Cenozoic.

South Caspian deviates significantly from all other basins in a correlation of mean thickness to sediment volume It shows that with an average thickness of 13 km and a maximum of 26 km SCB dominates all other sedimentary basins and does not fit equations easily. The expected value of mean thickness for the sediment volume and the area is around 4 km if South Caspian was a passive margin basin. Most of this sediment pile accumulated in the last 4Ma in the Pliocene age Productive Series after a significant base-level fall. This base level fall was a result of isolation of the South Caspian from Black Sea, evaporation of the water volume and integration of sediment drainage into the South Caspian Basin as a result. More than 4-5km of sediments accumulated during a very short period of time. An anomalous subsidence of this kind is explained by sediment loading on unusually thin but dense crustal thickness below the basin . Furthermore, as there was a significant shortening resulting on subduction of the South Caspian Plate under the Absheron Ridge the SCB might have been geographically more extensive. We estimate that in order to make SCB consistent to the passive margin best fit trend the sediment thickness might be reduced by further 4 km and geographical area increased from 172,000 to around 400,000. This might indicate that potentially large areas of SCB were underthrust below the Absheron Ridge and the Caucasus – which allows to reconstruct paleogeography of the South Caspian and Greater Caucasus Basins.

A multi-proxy stratigraphic reference outcrop record for Miocene marine sediments of eastern Azerbaijan

Van Baak, Christiaan G.C. – Chris.vanBaak@casp.cam.ac.uk – CASP, Cambridge, UK

Vincent, Stephen J. – Stephen.Vincent@casp.cam.ac.uk – CASP, Cambridge, UK

Shiyanova, Natalya – shnwpo@bp.com – BP-Azerbaijan, Xazar Center, Baku, Azerbaijan

Richards, Keith – kr@paly.co.uk – KrA Stratigraphic, Deganwy, UK

Aghayeva, Vusala – vagayeva1@GMail.com – Geography Institute, Baku, Azerbaijan

Krijgsman, Wout – W.Krijgsman@uu.nl – Utrecht University, The Netherlands

Santos, Carlos – Carlos.Santos@uk.bp.com – BP, Sunbury, UK

Given the semi-isolated nature of the Eastern Paratethys Sea, key markers used in global biostratigraphic schemes are barely recognised. Instead, the biostratigraphic subdivisions of the Paratethyan sedimentary succession is based on faunal response to regional paleoenvironmental changes. In recent years, significant progress has been made in understanding the Middle Miocene to Recent Paratethys stratigraphy by creating integrated high-resolution, absolute age-dated multi-proxy stratigraphic records from outcrop records across the region. In these studies, the focus has predominantly been on marginal, shallow-water environments in which the Paratethys regional stages were originally defined. With this framework now in place, we aim to apply this knowledge to study deeper water, fine-grained sediment successions in which the macrofossil record is poorly developed.

The Gobustan region of eastern Azerbaijan has one of the most continuous outcrop records of Early Cenozoic deep-water sediments in the Eastern Paratethys region. We analysed the classic and widely studied Islamdag section, which exposes the Maykop Formation, and overlying Spirialis and Diatom formations of the Middle and Late Miocene. During fieldworks in 2016-2018, we logged 800 m of section at cm-scale, trenching in places through up to 1 m of weathered material to collect over 450 samples. A subset of around 90 samples have been analysed to develop a multidisciplinary biostratigraphic scheme. In the field, we referred back to stratigraphic subdivisions of the Gobustan area in Russian lithostratigraphic works dating from the 1920's and 1930's. These subdivisions and reference levels allow for straightforward correlation between outcrops, and their significance on a regional scale should be tested.

Here, we aim to establish a high-resolution, quantitative and multi-proxy, age-dated stratigraphic framework for these fine-grained marine sediments. The biostratigraphic dataset is predominantly based on palynology (dinoflagellate cysts, acritarchs, green algae, pollen and spores). Additional insights come from sedimentological observations and microfossils. Using our new constraints, we will propose a correlation both to global records, and to previously published biostratigraphic records in other regions in the Eastern Paratethys, including the Taman Peninsula (Southern Russia) on the shore of the Black Sea, to highlight the importance of these results in a Paratethys-wide context.

Keywords: Miocene, biostratigraphy, palynology, Azerbaijan

Environmental trends and taphonomic pitfalls in the palynology of the Productive Series and Akchagylian of Azerbaijan

Hoyle, Thomas M. - Tom.Hoyle@casp.cam.ac.uk – Department of earth Sciences, Utrecht University, Budapestlaan, Utrecht, the Netherlands, now at CASP, West Building, Madingley Rise, Madingley Road, Cambridge, CB3 0UD, UK

Leroy, Suzanne A. G. - leroy@mmsh.univ-aix.fr – Aix Marseille Univ, CNRS, Minist Culture, LAMPEA, UMR 7269, 5 rue du Château de l'Horloge, 13094, Aix-en-Provence, France

López-Merino, Lourdes - L.Lopez-Merino@kingston.ac.uk – Department of Geography, Geology and the Environment, Kingston University, Penrhyn Road, Kingston upon Thames, Surrey KT1 2EE, UK

Van Baak, Christiaan G. C. - Chris.vanBaak@casp.cam.ac.uk – CASP, West Building, Madingley Rise, Madingley Road, Cambridge, CB3 0UD, UK

Richards, Keith - kr@paly.co.uk – KrA Stratigraphic, 116 Albert Drive, Deganwy, United Kingdom

The Caspian Sea is the largest endorheic lake in the world and has developed in a more or less isolated state since the beginning of the Pliocene. As such, its base level and sedimentation regime are highly sensitive to climatic variability, and understanding the main driving mechanisms controlling the palaeoenvironmental evolution is far from straightforward. During the Pliocene and earliest Pleistocene two of the primary elements of the South Caspian hydrocarbon system were developed: the thick reservoir sands of the Productive Series, and the laterally extensive cap-rock of the Akchagylian regional stage. A reliable, well-dated climate and palaeoenvironmental proxy record was obtained for the Lokbatan outcrop of the South Caspian Basin in eastern Azerbaijan, which comprises the upper part of the Productive Series and the Akchagylian. High-resolution sampling was carried out across the transition interval.

Radiometric dating ($^{40}Ar/^{39}Ar$ on volcanic ashes) of the marine Akchagylian assigned the Lokbatan section to the Late Pliocene-Early Pleistocene. Terrestrial and marine palaeoenvironments were reconstructed using palynology (pollen and dinocysts) and supported by particle size analysis and geochemical analyses. Pollen data were used to interpret long-term vegetation successions at a catchment scale. The Akchagylian pollen record shows cyclic vegetation patterns, potentially related to obliquity-scale climate forcing. Akchagylian dinocyst records presented a marine succession linked to degree of fresh water input, base level variation and interbasinal connectivity. The behaviour of the dinocysts and geochemical records is more strongly influenced by connectivity between the Caspian Sea and adjacent basins than by climate.

New methodological approaches were explored to constrain known problems of reworking in dynamic depositional settings during the Pliocene (Productive Series). Distinction of comparatively old fossils in a relatively young geological setting is not the only aspect of identifying reworking, and it is more difficult to identify relatively contemporaneous reworking. As such, the reliability of the environmental signal was assessed using fluorescence microscopy, in order to constrain reworking not only from deep-time, but on the scale of orbitally-driven climate cycles. Serious issues relating to depositional environments and palynomorph taphonomy (i.e. transport, deposition / reworking) within the Productive Series were highlighted. This must be understood before the local/regional environment and stratigraphic framework can be determined reliably. Overall, this work provides a step forward in the understanding of climatic effects on the sedimentary architecture of South Caspian oil and gas reservoir succession.

Keywords: Productive Series, Akchagylian, climate, palynology, fluorescence microscopy, method development

Petrography and Geochemistry of clastic sediments as an evidence for Provenance of upper Pliocene and Pleistocene deposits, Central part of South Caspian Basin

Yousefi, Ramez - Ramez.Yousefi@alumni.ut.ac.ir - Department of Geology, University of Tehran

Amini, Abdol Hossein - Ahamini@khayam.ut.ac.ir. Department of Geology, University of Tehran

Taati, Farid - F.Taati@Kepco.ir - Khazar oil Company (KEPCO).

Mohajer.Soltani, Hossein - H.mohajer@Kepco.ir , Khazar oil Company (KEPCO).

.Fallah, Mohammad - Mohammad.Fallah@omv.com OMV Company.

Petrography and geochemistry (major elements) of clastic sediments from Aghchagil and Apsheron Formations (upper Pliocene-Pleistocene) in the central part of SCB (South Caspian Basin) have been investigated to understand their provenances. In the present study over 600 samples of cuttings from well X in Sardar-e-jangal field were studied from depth interval of 1307-2495 m below Caspian Sea level (-26m) by Binocular microscopy. 40 medium to coarse-grained sands were selected for modal composition analysis by Gazzi Dickenson method. Also, 16 selected samples from clay to medium size were selected for geochemical analyses from Depth interval of 1307 - 2495 m below Caspian Sea level. the Petrographical analysis suggests that the frequency of Quartz minerals in Apsheron and Aghchagil sands never reached higher than 75%, and the main constituents of Aghchagil and Apsheron sands were the labile minerals. So there were 4 type of sands (Lithic-Arkose, Feldspathic-Litharenite, and Litharenite) for both Formations. The geochemical analysis for Aghchagil and Apsheron Formations showed some similarities in Both Formations. Most major element contents were deviated from to upper continental Crust values (UCC) For instance Relative to UCC factor the both sands and clays samples showed relatively positive enrichment in presence of SiO_2, Al_2O_3, Fe_2O_3, CaO and a negative enrichment in amount of MnO and TiO_2. Also, the amount of SiO_2 in Sands was higher than Shales. In contrast, Shales were richer in the amount of MgO, K_2O, Fe_2O_3, and TiO_2. The Al_2O_3 abundance was used as a normalization factor to make comparison among different lithology. Elements such as SiO_2, Na_2O, K_2O, and MnO showed a positive correlation with Al_2O_3 whereas CaO, MgO exhibited a negative correlation with Al_2O_3. Rate of Na_2O and K_2O relative to Al_2O_3 shows that the dip of Na_2O was steeper than K_2O, and it could be because of the instability of plagioclase feldspars in comparison of K feldspars during chemical alteration. The mineralogical Maturity of sand based on Petrographical analysis suggested that the Apsheron and Aghchagil sands derived from the proximal source area. Modal composition (e.g., quartz, feldspar, lithic fragments) and geochemical indices of sands and shales indicated that they derived from the magmatic arc and a Felsic source rock. The Paleo-weathering condition based on Modal composition, chemical alteration index (CIA) and A-CN-K (Al_2O_3-CaO+Na_2O-K_2O) relationships determined that probably chemical weathering in the source area and the recycling processes have moderately affected both formations in a semi-arid climatological condition. In conclusion, based on the result of this study and previous studies that had been investigated on paleocurrnet and geological setting of suspicious area it has been suggested that the main source for either both Formations likely located in a magmatic arc basin (Eocene rifted basin in Azeri Talysh peninsula).

Keywords: South Caspian Basin, Apsheron, Aghchagil, Kura River, Talysh, Provenance, Sardar-e-Jangal.

Stratigraphic age of paleo-volcanoes in the deepwater Black Sea

Tari, Gabor - gabor.tari@omv.com - OMV Upstream, Vienna, Austria

Sipahioglu, Özgür Nazim - osipahi@tpao.gov.tr - Turkish Petroleum, Ankara, Turkey

Bati, Zühtü - bati@tpao.gov.tr - Turkish Petroleum, Ankara, Turkey

Tatishvili, Giorgi - g.tatishvili@saog.gov.ge - Agency for Mineral Resources, Ministry of Energy, Tbilisi, Georgia

Abundant Turonian and to Campanian volcanics, widespread within the Pontides, have been interpreted by many as the expression of back-arc volcanism, coeval with the opening of both the Western and the Eastern Black Sea basin segments. In particular, in the Western and Central Pontides, there are two Upper Cretaceous volcanic units distinguished traditionally. The lower volcanic unit is named Dereköy Formation and it is Turonian to Coniacian in age. It is thought to be deposited within extensional grabens, contemporaneously with rifting in the Western Black Sea basin. The upper volcanic unit is called Cambu Formation. According to biostratigraphic data, it was deposited throughout the Campanian, as the product of arc magmatism during the post-rift evolution of the basin. There has been very little information published regarding the offshore extent of these Cretaceous volcanic sequences, until recently.

Exceptionally high-quality, long-offset reflection seismic data revealed the existence of numerous (more than 20) very large (up to 3-4 km high) paleo-volcanoes distributed along the deepwater part of the entire Turkish Black Sea margin. These "pointy", cone-shaped volcanic edifices, showing no signs of erosion, were undoubtedly formed in a submarine environment and appear to be positioned within the post-rift sequence of the basin fill. Some suggested a Campanian age for all the large paleo-volcanoes. However, using the same high-quality regional seismic data set, we interpret two distinct phases of volcanism imaged along the Turkish margin. We speculate that these volcanic episodes, defined only by seismic data and no well-control, do correspond to the two Upper Cretaceous volcanic units known from the Pontides. The older paleo-volcanoes of presumably Turonian age (Dereköy Formation), sitting within or on top of the syn-rift succession, have an uneroded, spiky and triangular shape suggesting their formation already in a deepwater environment. The younger volcanics, tentatively correlated with the Campanian Cambu Formation, appear to be located within the early post-rift basin fill, partially onlapping the older volcanic features. The general position of these younger volcanics appears to be located inboard from the older one in the offshore. The uniform character of all these seismically mapped paleo-volcanoes along the entire Turkish Black Sea margin is at odds with the Eocene age assignment proposed by some for these features located in the Eastern Black Sea segment.

Whereas the Upper Cretaceous paleo-volcanoes in the Black Sea region are largely confined to the southern margin of the basin in Bulgaria, Turkey and Georgia, both offshore and onshore, Turonian effusive volcanics were documented on the southern edge of the Odessa shelf. A thick Turonian volcanic sequence, penetrated in the Ilichevsk-2 well between 1172 and 1714 m, is overlain by Santonian pelagic limestones. The present-day location of these Turonian basalts is approximately 400 km to the north from the outcrops of the age-equivalent Dereköy Formation outcropping in the Central Pontides. Therefore the very large present-day separation of the same volcanic units implies a largely post-Turonian opening of the Western Black Sea Basin

Keywords: paleo-volcano, Black Sea, submarine, arc volcanism, Cretaceous, basin opening

Poster presentation

The Samgori-Patardzeuli Field Middle Eocene Petrophysical Properties And Reservoir Mineralogy Composition Based On Open Hole Logging Formation Evaluation And Cuttings Xrd – Xrf Analysis

J. Urazaliev, T. T. Yildiz, A. Orlov, D. Tsaplin, A. Goloborodko, S. Tirumanapalli, Schlumberger - A. Suter, Retired Schlumberger Employee

The Samgori-Patardzeuli field in Block XIB has been the main producing field in Georgia since 1970s when discoveries were made in Samgori, Samgori South Dome, Teleti, and Krtsanisi fields. The oil reservoirs are Middle Eocene volcaniclastic rocks deposited in the Kura Basin. The Middle Eocene deposits consist primarily of volcanogenic-sedimentary rocks including tuffaceous siltstones, phyllites and argillites. In the reservoir zones, fractures enhance permeability and caverns are observed predominantly along the fracture's zones. Analysis of the core matrix shows relatively low effective porosity (average 3.9%) and is practically impermeable. Core permeability s varies from 0.001 mD to 0.1 mD, and one validated sample shows up to 2 mD. Samples with higher permeability are characterized by developed secondary porosity. This is supporting that oil production comes mainly from highly distributed fractures associated with matrix porosity.

During drilling of Middle Eocene formation in PAT-E1 well (12.25in hole section), advanced wireline logging was performed. The logging suite included PEX (HRLA, NEUT, DEN, Spectral GR, HD Caliper, GPIT), CMR, FMI, Sonic Scanner and LithoScanner. An ELAN multimineral model was built using dry weight elements of LithoScanner data and open hole logs: Bulk Density, Neutron Porosity, Compressional Slowness, Spectral Gamma Ray data. The Density and Neutron Porosity measurements were used for porosity computation. The NMR porosity was used as a guide in qualitative level as it is independent of lithology. The Spectral Gamma Ray data (potassium and thorium concentrations) along with elements' dry weights were used for clay volume computation. As per the ELAN evaluation, the average effective log porosity is 4.4%, which is close to the value of effective porosity obtained from core study.

In the upper part of the Middle Eocene formation GR shows high reading while Neutron-Density logs is showing crossover, which is indicating presence of clean reservoir with an average effective porosity of 8 to 10%, an average water saturation of ~50%, a clay volume of 0-10% and a permeability of 22-140 mD. For validation of permeability values obtained from ELAN and CMR logs, the Sonic Scanner Stoneley mobility analysis was conducted, which shows that Stoneley mobility is comparable with ELAN derived KINT permeability (Mobility < KINT) and CMR computed KTIM permeability (Mobility > KTIM).

High Gamma Ray values (140-150 GAPI) observed in front of some reservoirs are associated with the presence of potassium and sodium feldspars (might be zircon as trace mineral) determined from LithoScanner data. To support the ELAN formation evaluation results, especially in the best porous zone, XRD, XRF and SEM analysis was performed for whole Middle Eocene section's cutting at 5m sampling interval. The XRD results suggest that the reservoir layers with high GR readings show high content of feldspar (52%), which are relatively higher compared with to most of the Middle Eocene intervals.

The correlation of high GR peak indicates good lateral distribution in the wells drilled on Patardzeuli field. The high GR peaks are considered as a good indicator of presence of porous layers. In terms of oil production enhancement, this information serves as an important discriminator for well workover candidates' selection and for further operation planning.

Stratigraphy and depositional settings of the Cretaceous sediments in the South of Ukraine

Ishchenko, Ihor – ishchenko@nng.com.ua – SE NaukaNaftogaz, Naftogaz Group

Upon the set of geodata originated from 646 deep wells and boreholes it was made the subdivision of Cretaceous sediments till a sub-stage level within the Conjugation zone between EEP and Scythian plate as well as bed-to-bed correlation in the area studied.

The geological structure of the Cretaceous sediments for all tectoni-structural elements of the EEP and Scythian platform in the area studied is detailed and their structure and litho-facies features are described. The genetic groups of sediments corresponded to different bathymetric zones from littoral with active hydrodynamics to rather deepwater ones of a marine basin are recognized. Four facies zones (one for early Cretaceous and three ones for late Cretaceous times) continuously changed each other in the basin. The obtained results have made the basis for new structural & facies zonation of the area.

Four structural and facies regions, namely Scythian (for Early Cretaceous), Northern, Central, and Southern (Late Cretaceous) ones comprising 16 different structural & facies zones have been recognized. Restoration of geological evolution of the paleo-basin during Cretaceous period within the area studied is made. The peculiarities of the different types of Cretaceous rocks combination in the sedimentary sequence and their position in the section point out onto cyclicity character of their sedimentation. It is proved that the whole sequence of the Cretaceous rocks is composed by five large transgressive-regressive cycles (stages): Oxfordian-Berriasian, Valanginian-Middle Aptian, Late Aptian-Early Cenomanian, Middle Cenomanian-Middle Santonian, and Late Santonian-Maastrichtian.

For the first time it was recognized five regional stratigraphic subdivisions of Cretaceous sedimentary sequence in the Ukrainian sector of the Conjugation zone between EEP and Scythian plate, namely: Yaylian (Oxfordian-Early Berriasian), Belogorian (Valanginian – Middle Aptian), Tarkhankutian (Late Aptian – Early Cenomanian), Odessian (Middle Cenomanian – Early Santonian), and Karkinitian (Late Santonian – Maastrichtian) ones, as well as 14 horizons: Goncharovkian (composing Yaylian regio-stage); Soldatovkian, Ozerianskinan, Kholmogorian, Novoselovkian (Belogorian regio-stage); Chernomorskian, Severokrymian, Dzhankoyian (Tarkhankutian regio-stage); Serebryanskian, Borisovkian and Semenovkian (Karkinitian regio-stage); Maksimovskian, Shtormovian and Shtylevian (Odessian regio-stage).

Issuing from the obtained results it was recognized local stratigraphic units (suits): 19 suites are established in the Early Cretaceous sequence (12 from them are new ones) and two formations, and 38 suites in the Late Cretaceous sequence (37 are new ones) and two formations as well.

It was built an original regional correlation chart of the Cretaceous sedimentary succession for the area studied. In the Cretaceous sequence it was recognized and characterized five petroleum-bearing and petroleum-prone rock complexes (formations) based on conducted geological restorations and litho-facies studies which are corresponded to the above regional stages: Yaylian, Belogorian, Tarkhankutian, Karkinitian and Odessian.

Keywords: Cretaceous, stratigraphy, Black Sea, lithological features, petroleum potential.

Heraclites as products of carbonate synthesis of Prokaryotes fed by deep hydrocarbon-bearing fluids in Miocene time, SW Crimea

Lysenko, Vitaliy – niagara_sev@mail.ru –Moscow State University, Sevastopol Branch

The heraclites (named upon the cliff rocks in the Heraclean plateau south of Sevastopol) are pebbly carbonate breccias (Fig. 1) composed by clastic material of carbonate paleo-buildups formed by methanotrophic and methanogenic prokaryotes around paleo-degassing undersea centers in the southwestern Paratethys during Mid-Late Miocene epoch, especially in the Sarmatian time. The formation of carbonates in heraclites by bacterial synthesis is evidenced by the data of their studies as follows: very characteristic slaty exterior form of the clasts; their micritic and sparitic structure; unusual textural features; presence of bacterial fossil matter as well as terrigenous and micro-meteoritic matter without traces of chemical weathering; presence of hydrocarbon products of Archaea chemosynthesis and oxidized deep asphaltenes; detrital inclusions and shellfish fragments; pseudo-stratigraphic position in the sequence containing heraclites.

Figure 1. A heraclite bed in the shore cliff.

The insoluble acid residual of the heraclites was studied by scanning electronic microscope by GO 'Borok' at IPE Russian Ac. Sci., analytics done by V.A. Tselmovich, 2014. Their geochemical analysis was made using inductively coupled plasma mass spectrometer. A composition of the residual samples is a polymineral one. It represented by carbonaceous matter, authigenous quartz, exogenous clastics and accessory micro- and nano-crystals related to deep fluids. The carbonaceous matter is responsible for the color of heraclites due to the presence of light oil, high molecular resins and asphaltenes and indigenous dispersed organic matter. The acid residual contains micro-crystals and nano-particles represented by silicates, phosphates, sulphates, chlorides, sulphides, oxides, native metals, intermetallics, and possibly carbides. A lot of native nickel, iron and copper, sometimes zinc, bismuth, silver, tin, manganese, aluminum, tungsten and platinum particles are found in the insoluble acid residual of heraclites. Native nickel, iron and copper have a form of elongated lamellae or aggregated flakes of craggy form. Nanoparticles of Ni, Fe and Cu separately overfill with spots the clasts of carbonaceous matrix. The findings of intermetallics in the probes of heraclites excite a particular interest, namely copper and zinc (native brass); titanium and iron, iron and chromium, zinc and aluminum, zinc and iron, nickel and copper. ICP-MS analyses of heraclites samples have evidenced that ones are characterized by anomalous geochemical association of chalco-, sidero-, litho-phillic and rare earth elements. Besides, there are noticed an increased concentration of lanthanides in heraclites: Ce, La, Nd, Pr, Gd, and Dy. The study of mineral composition of the trace elements in heraclites and results of the ICP-MS made by carbon dioxide, nitrogen, methane, ethane, propane, as well as hydrothermal solution with heavier hydrocarbons. The heavier hydrocarbons or likely metal-organic compounds have played the role of carriers for the metals and intermetallics. Deep of paleo-fluids were involved into complex biochemical process by prokaryotes that resulted in formation of organic matter and carbonates of the Miocene biostromes and buildups.

Keywords: heraclites, Black Sea basin, Crimea, carbonate biostromes, trace elements, native metals.

EXPLORATION IN THE SOUTHERN CASPIAN REGION

An overview of hydrocarbon prospectivity in the Iranian South Caspian Basin

Fallah, Mohammad - mohammad.fallah@omv.com - OMV Petrom, Bucharest

Tari, Gabor - gabor.tari@omv.com - OMV Upstream, Vienna, Austria

The South Caspian Basin (SCB) is a promising oil- and gas-bearing province and there are numerous large oil and gas fields in this area. However, the Iranian sector of the SCB had a prolonged history of technical and non-technical challenges until the first discovery by the Sardar-e Jangal-01 (SJ-1) deep-water well in 2012.

The relative scarcity of exploration is largely due to several main reasons. a) The water is significantly deeper in this part of the basin than middle and northern Caspian. The deepest water at approximately 1,025 m, for example, is situated in the south-western part of SCB, in the Iranian segment. b) Super giant fields in onshore basins of Iran, like in the Zagros, make it difficult to justify deep-water expensive exploration in the Iranian South Caspian realm. c) Besides the mobilization limitations for a deepwater drilling unit in the Caspian, being a closed lake, there are several other technical challenges (e.g. high-pressure reservoirs, shallow drilling hazards, etc). d) Maritime boundaries are not yet fully agreed to and clarified in the SCB. e) Exploration in the Iranian sector of the SCB facing extra political complications for the last few years.

Systematic petroleum exploration activities have been started only in the past 50 years in the Iranian segment of the SCB. In contrast, the other countries in the same region explore and produce in their sides from this reasonable well-known basin for more than 150 years. After three unsuccessful wells, the SJ-1 well proved workable petroleum system in the Iranian SCB. However, there is still very little information published about this important discovery.

This study shows an overview of the petroleum systems in the SCB including all the potential exploration plays. The Oligocene-Miocene Maykop shale is the major source rock in the SCB and the Chelekan Formation (a time equivalent of the Productive series) with its brownish sandstones, is the main reservoir unit in Iranian sector of SCB (Fig. 1). Reservoir quality seems to be the most challenging element in this part of the basin, which can be de-risked to some extent if the source of the sedimentary fairway can be identified. In general, reservoir units with a southern provenance are expected to have less quality.

The SJ-1 is a very important discovery, which significantly lowered the play risk in this part of the SCB. If the above mentioned technical and non-technical challenges can be mitigated, there could be numerous follow-up exploration targets in the play fairway proven by the SR-1 discovery in Iran.

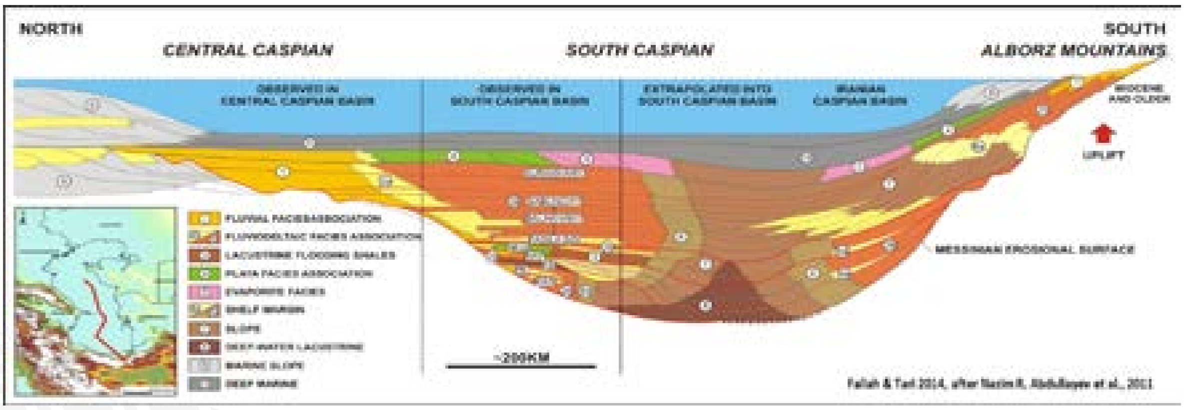


Figure 1. A conceptual depositional model of the Chelekan Formation in the Iranian sector of the SCB.

Keywords: South Caspian Basin, Sardar-e Jangal well, discovery, Chelekan Formation, play fairway

Petrophysical evaluation of Natural Gas Hydrate in Caspian deepsea as an existence geohazard

Mohammad Saeed Hosseinzad – gozargah@yahoo.com – KEPCO

Fallah, Mohammad - Mohammad.Fallah@omv.com – OMV

Gas hydrates are solid crystalline compounds in which gas molecules (referred to as guests) are lodged within the lattices of ice crystals (called hosts). Gas-hydrate deposits occur in two distinctly different geologic settings where the necessary favorable thermodynamic conditions exist for their formation and stability: in the permafrost and in deep ocean sediments. Because of different formation processes, these two types of accumulations have distinctly different attributes. One of the zone favorable for hydrate formation is the sea bottom. The pressure in the sea by a depth of 500 m the water pressure will reach more than about 50 atm. At that depth the sea bottom temperature usually does not exceed 4-6° C. As a result of biological degradation of organic matter, the sediments at near sea bottom are saturated by carbon dioxide, hydrocarbon, and sulfur gases. So all four components are present for hydrate formation, and in this way layers of hydrates do form in the sediments near sea bottom.

The presence of in situ gas hydrate in marine sediments is rarely given adequate attention before drilling of the well. Hazards arise from the fact that hydrates are only quasi-stable; if the temperature is increased at a fixed pressure or the pressure decreased at a fixed temperature, or both, then it is easy to pass out of the stability field of hydrates. Without prior indication of hydrate, either by analog data at nearby offset wells or the presence of other data, the existence of hydrate is usually not considered. Failure to account for the presence of hydrate in drilling operations has resulted in well trouble, ranging from minor gas flows to borehole instability. Adressing these scenarios is therefore of primary importance to the offshore industry. These scenarios must include robust geohazard analysis techniques that integrate geophysical and petrophysical modeling, seismic interpretation, and pore pressure evaluation. The dissociation of gas hydrates can be slow, or explosive. Which happens depends on the chemical content and concentration of the hydrates and, what is more significant, how fast the pressure-temperature conditions change. But the hydrate can also dissociate explosively when the pressure is released very fast or the temperature increases rapidly. In the absence of direct seismic indicators, such as a BSR, the presence of hydrate in marine sediment cannot be confirmed reliably before drilling and measurement. A variety knowledge of the petrophysical properties of hydrate in sediment can contributes to this issue. Identification of hydrate can only be certain in cases where there is visual confirmation by remotely operated vehicles (ROV).

This research will work on the petrophysical properties of natural gas hydrate and their impact on selected well logging (formation evaluation) measurements. In this Research, Based on analysis of log data as well as borehole observations, I will concentrate in Detection, Evaluation of properties, estimation of parameters and finally suggestions about extracting of gas from gas hydrate in shallow layers of deepwater seas by petrophysical issues. Analysis of these indicate that hydrate occurrence was accompanied either by unexplained gas flows, hydrate precipitation on seafloor equipment, borehole instability, or any combination of the three. The detailed petrophysical interpretation which delivers lithology evaluation through any available data of captured gamma ray spectroscopy; total, free and bound fluid porosity from formation density, neutron porosity and nuclear magnetic resonance in conjunction with resistivity anisotropy and acoustic properties will be used. A comparison of various hydrate saturation evaluation techniques will be provided, and the applications of borehole images (if available) are also shall be discussed. This research demonstrates how these formation evaluation techniques provide an effective method of evaluating natural gas hydrate resources as geohazard.

Keywords: Natural gas hydrate, geohazard, deepwater exploration, petrophysical evaluation

The geochemistry of mud volcano in South of Caspian Basin

Mohajer Soltani, Hossein - hyuo1358@gmail.com – KEPCO

Taati, Farid – ftaati345@gmail.com – KEPCO

Fallah Kheyrkhah, Mohammad - Mohammad.Fallah@omv.com – OMV

Mud volcanoes are frequently reported from southern parts of the Caspian Sea where the highest frequency occurring towards Azerbaijan and Turkmenistan. The eastern coastline of the Caspian Sea also contains several mud volcanoes in the vicinity of the Golestan Province.

Variable concentrations of natural gas and other hydrocarbons constitute variable proportions of ejected material. These natural gaseous hydrocarbons are suggested to be produced from degradation of organic matter and may comprise CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}, CO_2, N_2, etc. (CH_4) constitutes the highest concentration in most mud volcanoes around the world.

This paper presents new geochemical data of hydrocarbon-rich gases released from some mud volcanoes of south Caspian basin in Golestan Province (coastline north area of IRAN).Based on existing database, the studies area is characterized by various sizes of mud volcanoes as follow: The Garniarigh mud volcano (east of the Gumishan); The Naft-e-Lijeh mud volcano (northeast of the Gumishan); The Sofikam mud volcano (eastern side of the Sofikam main road).The collected samples from mud volcanoes may contain water, mud, breccias and gas. Each type of sample would typically require a unique set of analytical procedures depending on the purposes of the study. In this regard gas sample analysis include gas isotope analysis $\delta^{18}O$, $\delta^{13}C$, δD, $\delta^{3}H$ (MS) & hydrocarbon and major fixed gas analysis (GC-MS). Based on a comprehensive study of compositional and isotopic data on gas samples collected from the Gorgan Plain mud volcanoes, the following conclusions could be made:

The gas sample collected from the Sofikam, mud volcano has a biogenic origin and is very likely generated at very shallow depths. Therefore, this mud volcano may not be an effective indicator of underground petroleum accumulations;

The Garniarigh mud volcano is the oldest one among the studied mud volcanoes based on its unique morphological aspects. Based on the geochemical data presented in this study, gases coming out of the Garniarigh mud volcano contain mixtures of biogenic and thermogenic gases. Accordingly, the presence of this mud volcano can be an indicator for subsurface hydrocarbon accumulations (e.g., most likely gas accumulations); Gases ejected from the Naft-e-Lijeh mud volcano are also classified as mixed thermogenic/biogenic in origin. This mud volcano very likely represent an underground oil accumulation residing at a depth greater than 1000 meters.

The comparison between our studied mud volcanoes and a worldwide dataset of geochemical readings has provided useful findings. Our results indicate that mud volcanoes studied from the Gorgan Plain (specially the Garniarigh and Naft-e-Lijeh) have a high degree of similarity to those reported from Azerbaijan, Turkmenistan and Georgia. Considering the proximity of Turkmenistan basin to our studied area on one hand and its great potential for having huge reserves of gas on the other, the data presented in this study can have important implications for future explorations. This further highlights the significance of data collected for the Gorgan Plain mud volcanoes throughout this study.

Keywords: Mud Volcano, Caspian Sea, Golestan Province, Geochemistry.

The South Caspian Basin subsidence and its bearing on depositional environment of Upper Barremian-Lower Aptian successions (Tirgan Formation), Western Koppet-Dagh (NE Iran)

Mahmoud Hajian-Barzi[1], Behrooz Ariafar[2], Mohsen Yazdi-Moghadam[3]

1- (Email: mah_hajian@yahoo.com) Correspondent author

2- (Email:geoariaf@yahoo.com)

3- (Email:Mohsen.moghadam@gmail.com)

N.I.O.C. Exploration Directorate, 1st Dead End, Seoul St., NE Sheikh Bahaei Sq. P.O. Box 19395-6669, Tehran-IRAN

The carbonates of the Upper Barremian – Lower Aptian (Tirgan Formation) is one of the most important petroleum reservoir in the west of Kopet- Dagh basin in northeast of Iran. The objectives of this study are to facies analysis, depositional environments, sequence stratigraphy and paleogeography of the sedimentary successions in order to recognize the sea-level change and subsidence affected by extension of the South Caspian Basin (SCB) on the sedimentary system in the study area. This study is based on datas adopted from six outcrop sections have been measured in terms of stratigarphy and sedimentology ahd one exploration well (well A). We have also compared our results with two outcrop sections (Keldzhe and Tekedzhic) in the south of Krasnovodsk in Turkmenistan.

The Tirgan Formation shows the first transgressive phase in the Lower Cretaceous in Koppet- Dagh basin and was in general deposited in a ramp setting in the Late Barremian and shelf setting in the Early Aptian. There are significant changes in thicknesses and lateral variations of facies between the north (Maraveh Tapeh Graben (MTG)) and south parts of the study area during the Late Barremian- Early Aptian. These observations are supposed to have originated from local differences in subsidence affected also by local tectonics (extension of the Caspian Sea and W-E faults activities).

Based on lateral facies changes, the region can be divided into two major sedimentary zones. These zones are located at southern and northern parts of the Takal Kuh Fault (TKF). The south and east part of the TKF (sedimentary zone) is characterized by shallow marine (tidal-flat, lagoon and barrier) with low subsidence. Whereas during the same time, the northwestern part of the TKF (MTG) is marked by high subsidence and sedimentations in slope and basin environments (deeper conditions).

The MTG located in the north of TKF and south of Ashkabat Fault Zone (AF) in Turkmenistan. This fault (AF) forms the northeastern boundary of the South Caspian Microplate (SCM) (V.G. Kazmin, 2009).

The MTG and western Turkmenistan are characterized by northwest – southeast axial trends with high sedimentation rates and deeper conditions from middle Jurassic to Neogene. The eastern limitation of the spreading zone in the SCB has not been detected clearly yet, but in the Lower Barremian – Early Aptian it might be terminates to the east of MTG.

Keywords: Tirgan, Kopet Dagh, Late Barremian-Early Aptian, Marave Tapeh, Facies, South caspian

Exploration case studies from play definition to drilling

" Research on Cretaceous volcanic activities in the Southern Caspian Sea (Alborz structural zone)"

Kheirkhah,Monireh- kheirkhah.monireh@gmail.com; Associate professor in Research Institute for Earth Sciences, Geological Survey of Iran, Azadi Square, Meraj Avenue, Tehran, Iran; Samane Nemati and S.J.Omrani.

The active volcanic of the Western Alborz mountain, is a part of Alp-Himalaya orogenic belt system (e.g. SW Asia, Tibet). This area was influenced by Neothyan subduction from late Mezozoic to early Cenozoic time.

Although the Cretaceous magmatic activities in Iran were limited, but some lower Cretaceous volcanic rocks are occurred in northern part of Iran, south of Caspian Sea. The main aim of this research is to present petrology and geodynamic of the lower Cretaceous volcanic rocks in SW Caspian Sea, in Alborz structure zone.

Lower Cretaceous volcanic rocks are related to geodynamic evolution of Iranian plateau. The bed rock consists of a Pleozoic-Mezozoic sedimentary sequences. The Cretaceous volcanic lavas are sited on the Paleozoic sedimentary rocks in South western Caspian Sea. These lavas are exposed in form of lava flow, pillow lava and pyroclastic in submarine environments.

The composition of these volcanic rocks is generally basalt, trachy-basalt, basaltic andesite and the pyroclastic rocks (hydroclastic facies), lithic tuff, vitric tuff and crystal tuff. Spilitization is common in basaltic pillow lavas. These volcanic rocks mainly contain of olivine, plagioclase and pyroxene, opaque and secondary minerals.

The Rare earth and trace element variations exhibit an overall negative slope of LREE and MREE patterns flattening towards HREE. The geochemical studies on these rocks show an OIB like source and the negative Nb-Ta and Ti anomalies is characteristic for metasomatized subduction lithospheric mantle melt sources.

Tectonic discrimination diagrams indicate continental within plate basalts. These basalts are located in the alkaline domain which might be produced with 10-15% melting of spinel lherzolite in origin magma.

Regarding to mineral chemistry and geobarometry, this is reveal that the pillow lava basalts are originated from the alkaline magma source at 1150-1400 ˚C temperature and 1.2-2.5 Gpa pressures in a volcanic compression phase of Late Cimmerian.

Keywords: Turkish-Iranian Plateau; Alborz structural zone; pillow lavas; Cretaceous; Caspian Sea.

Poster presentation

Fluid flow simulation and flow assurance investigation in production and transportation pipelines with Olga software in one of the Caspian oilfields

Barati-Harooni, Ali - alibarati.2012@yahoo.com– Petroleum Engineering Department, Khazar Exploration and Production Company, Tehran, Iran

Hosseinzadegan, Ahmad - a.asheghi@gmail.com – Petroleum Engineering Department, Khazar Exploration and Production Company, Tehran, Iran

Shirzadi, Ahmad, - shirzadia@yahoo.com – Petroleum Engineering Department, Khazar Exploration and Production Company, Tehran, Iran

The flow assurance in the oil industry is a parameter that influences the flow of oil and gas from reservoir to surface and in various equipment. The flow assurance can be divided into several categories of problems, including the deposition of solids and fluid dynamics. These problems are associated with a decrease in fluid flow that leads to reduced production. In many cases temperature problems are caused by emulsions, hydrates and deposition of asphaltenes and waxes. Flow assurance risks in oil systems are highly influenced by the type of fluid reservoir (gas, oil and water). The flow assurance in the offshore wells is vital subject in petroleum engineering. In deep waters, seawater temperature is usually much lower than air temperature. With the water temperature decreasing, the probability of hydrate and wax formation increases and pipeline flows face a variety of problems. In oilfields in the Caspian Sea, considering the composition of the fluid and the studies carried out, there is a potential for wax sedimentation and blockage of the fluid flow path. Thus, simulating flow in pipelines and simulating effective parameters in Wax sedimentation in pipelines is a very important issue in onshore wells, especially deep seas.

In this study, the main goal is to simulate fluid flow in the pipelines and also investigate the important parameters in the fluid flow. This simulation is done using the OLGA software. In this study, Wax sediment is simulated in pipelines. Also, the amount of wax dissolved in the fluid and the rate of sedimentation of these compounds in pipelines in different temperature and physical conditions are investigated.

Keywords: Offshore fields, deep water, flow assurance, wax deposition, OLGA software, flow assurance, flow simulation.

Identification of electrical and petrophysical rock types based on core and well logs: utilizing the results to delineate prolific zones in a deep water sandy package, South Caspian Sea basin

Najmeh Jafarzadeh[1], Ali Kadkhodaie[2], Farid Taati[3]

Najmeh Jafarzadeh - Najme.jafarzadeh@yahoo.com- School of Geology, University College of Science, University of Tehran1

Ali Kadkhodaie - Earth Sciences Department, Faculty of Natural Sciences, University of Tabriz, Tabriz, Iran 2

Farid Taati- ftaati345@gmail.com - Head of Geolody Caspian Petroleum Company, Tehran, Iran3

The characterization of reservoir rocks in terms of their depositional and diagenetic properties plays a significant role in reservoir studies. The main properties are usually defined by descriptive macroscopic and microscopic studies on core intervals (lithofacies) and thin sections (petrofacies/microfacies) respectively. Considering that the core data is not found in all the wells, the main focus is on well log data which exists in all the wells continuously.

In the current study, with focus on sandy reservoir deposits of a field in the southern area of the Caspian Sea, reservoir rocks were characterized based on the integration of the results from core description, thin section studies and petrophysical well logs analysis. In this respect, the well logs responses were analyzed through the electrofacies concept on the basis of the Multi Regression Graph Base Clustering (MRGC).

This process has eventually led to the identification of four facies. The best facies, determined with the help of correlating between the three methods of acquiring facies, is a facies with high production potential. Facies Code One has been assessed as the best facies on the basis of reservoir quality which has a good compatibility with the best rock facies of PFI. Eventually, the best facies in terms of reservoir quality has been identified as the Facies Code One which has the most extensiveness in the Fasila reservoir zone. Finally the best production zone can be assessed on the basis of Fasila B reservoir quality zone.

Keywords: Petrofacies, Electrofacies, Multi Regression Graph Base Clustering (MRGC), South Caspian

Jobtitle	Company
Dr.	Aix-Marseille University
Researcher	ANAS Institute of Geography named after academician Hasan Aliyev
Principal Geologist	ArcGeoLink Ltd
Mr.	Arili+
Director	Blackbourn Geoconsulting
Non Executive Chairman	Block Energy Plc
Chief Executive Officer	Block Energy Plc
Technical Director	Block Energy Plc
Financial Manager	Block Energy Plc
Exploration Advisor	BP
Petroleum Systems Analyst	BP
Geologist	CASP
Geologist	CASP
Geologist	CASP
Chief Geologist	CASP
President / Ceo	Caspian Well Services Ltd
Executive Chairman	CEEC SG Executive Committee
Sales Geoscientist	CGG
Technical Manager	CGG Robertson
Director Of Research	CNRS Université Côte d'Azur
Prof. Dr.	Department of Geosciences - Univ. Fribourg
Master Student	Department of Geosciences Univ. Fribourg (Switzerland)
Phd Student	Eötvös Loránd University
Geologist	ExxonMobil
Business Development Advisor For Europe/ Caspian/Mena	ExxonMobil
Geoscientist	ExxonMobil International Limited
New Opportunities Manager	ExxonMobil International Ltd
Geologist	ExxonMobil International Ltd
Petrophysicist	Ferdowsi university of mashhad
Geologist	Freelance geologist
Geologist	Freelance geologist
Member Of The Management Board	Geogals
Leading Research Scientist	Geology and Geophysics Institute of Azerbaijan National Academy of Sciences
Dr.	Geophysics
Consultant	Georgia Oil & Gas
Chief Advisor For Exploration	Georgian Oil and Gas Ltd

Structural Geologist, Phd	GEPlan Consulting
Senior Geophysicist/ Sales Executive	Getech
Senior Geophysicist	Getech
Geophysicist	Getech
Director	GOG Branch Office Ltd.
Country Representative	GOG Branch Office Ltd.
Director	GOG Ltd.
Director	GOG Ltd.
Geologist	GOG Ltd.
Geologist	GOG Ltd.
Structural Geologist	I. Javakhishvili Tbilisi State University
Researcher	I. Javakhishvili Tbilisi State University
Associate Director	IHS Markit
Phd Student	Imperial College London
Tectonic Development Of The Ararat Basin, Lesser Caucasus, Armenia	Institute of Geological Sciences of Armenia
Head Of Department	Institute of Geology and Geophysics ANAS
Researcher	Institute of Geology and Geophysics ANAS
Geoscientist	Institute of Geology and Geophysics of Azerbaijan National Academy of Sciences
Geoscientist	Institute of Geology and Geophysics of Azerbaijan National Academy of Sciences
Senior Researcher	Institute of Geology and Geophysics, Azerbaijan National Academy of Sciences
Researcher	Institute of Geophysics of National Academy of Sciences of Ukraine
Editor	Journal of Petroleum Geology
General Director	JSC Georgian Oil and Gas Corporation
Commercial Director	JSC Georgian Oil and Gas Corporation
Adviser For Security Affairs	JSC Georgian Oil and Gas Corporation
Head Of Oil And Gas Contracts Management Department	JSC Georgian Oil and Gas Corporation
Chief Geologist	JSC Georgian Oil and Gas Corporation
Head Of Control Department	JSC Georgian Oil and Gas Corporation
Exploration Geologist	KEPCO
R&D Engineer	Khazar Exploration and Production Company
Exploration Geologist	Khazar oil company
Director	Kura Basin Operating Company LLC
Program Designer	Kuwait oil company
Researcher	La Sorbonne Université Paris
President	Meridian Petroleum LLP

Geologist	Montanuniversitaet Leoben
Prof.	Montanuniversitaet Leoben
Honorary Professor	Montanuniversitaet Leoben
Sr. Upstream Analyst	Naftogaz Group
Head Of Research And Technology	National Iranian Oil Company - Exploration Division
Director	Ninotsminda Oil Company Limited
Petrophysisct	NIOC
Sheif Geologist	North Uralian petroleum Co
Ceo	NVP Georgia (VIIB Block)
Director	NVP Georgia (VIIB Block)
Acquisitions & Divestments Director	OMV
Director Exploration & Appraisal	OMV Petrom SA - UPSTREAM, RO 1590082
Senior Department Manager Black Sea	OMV Petrom SA - UPSTREAM, RO 1590082
Senior Department Manager Geology	OMV Petrom SA -UPSTREAM, RO1590082
Senior Department Manager Geology	OMV Petrom SA - UPSTREAM, RO1590082
Associate Professor	Reasearch Institute for Earth Sciences, Geological Suervey of Iran
Repsol Exploration Europe And Russia Manager	Repsol Exploration SA
Structural Geologist	Repsol S.A.
Vice-Director, Deputy In Research	Research Institute for Earth Sciences, Geological Survey of Iran
Director (Dean)	Research Institute for Earth Sciences, GSI
Senior Exploration Geologist	Schlumberger
Subsurface Manager	Schlumberger
Reservoir Geophysicist	Schlumberger
Asset Manager	Schlumberger
Downhole Testing Product Champion	Schlumberger
Chief Geologist	Schlumberger Rustaveli
Deputy Head Of The Department	SE Naukanaftogaz, NAFTOGAZ Group
Principal Researcher	SE Naukanaftogaz, NAFTOGAZ Group
Head Of Seismic Processing Department	SE NaukaNaftogaz, Naftogaz Group
Explorer	Shell
Researcher	Sorbonne Universite
Researcher	Tbilisi State University

Senior Geoscientist	TGS
Vp Mediterranean & Middle East	TGS
Geoscientist	TOTAL SA
Counselor	TPAO Genel Müdürlüğü
Manager	TPAO Genel Md.
Project Manager / Senior Geoscientist / Palynologist / Tp R&D Center	TPAO Genel Md.
Deputy Manager	UkrCreditFinance LLC
Post Doc	Université Côte d'Azur
Phd Student	Université de Nice Sophia Antipolis, Géoazur
Professor	University of Aberdeen
Postdoctoral Researcher	University of Geneva
Ceo	Vertex Fiduciaries Ltd.
Enterpreneur	Vertex Fiduciaries Ltd.
Geologist	WOODSIDE ENERGY
Exploration Manager Europe	Woodside Energy
Grm Director	Zhaikmunai LLP/Nostrum Oil & Gas
District Manager	TPAO Genel Müdürlüğü

AAPG®
Europe Region

GEORGIA OIL AND GAS LIMITED

OMV Petrom

ExxonMobil

GEORGIAN OIL & GAS CORPORATION

Schlumberger

BLOCK ENERGY PLC