Tectonic Evolution of the Mardin Uplift, SE Turkey

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Introduction

License blocks were acquired By TransAtlantic Petroleum Turkey on the Mardin High in SE Turkey over 460,000 acres (1862 sq km). Within this area, gravity measurements were taken by recording the vertical components of the gravitational attraction of the underlying formations. It is believed structures in this area are compressional and extensional fault related structures some of which have surface expression. If the anticlines are fault related and higher density sediments have been thrusted upwards, then higher gravity readings will be recorded over these areas. After gravity measurements were collected over the Mardin High, several areas of interest were identified by Bouguer highs. Identifying these high gravity anomalies and correlating them with fault related surface anticlines will decrease the amount of seismic required in search of them. Interpretation of the residual gravity anomalies will allow for 2D cross-sections to be produced for the region. In order to correlate high gravity anomalies with fault related anticlines a residual gravity map was produced which displayed density contrasts with older lithologies. The correlation of nearby well data helped to identify the formations when producing the 2D cross-section. Imaging these subsurface structures with the production of 2D cross-sections and being able to reconstruct the evolutionary history of the region, along with identifying areas of exploration interest without the use of extensive seismic was the objective of this study.

Methods

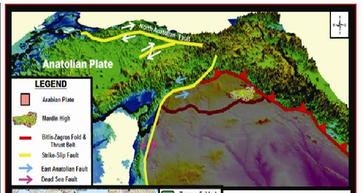
Residual gravity Maps helped to identify areas of high density rocks. Production of a residual map was required removing the upper most gravity highs from the regional field in order for the residual anomalies to be isolated. This process was completed using ArcGIS software by creating a 1st and 2nd order polynomial. After calculations of the two different interpolations, the 2nd order polynomial was subtracted from the first resulting in a residual anomaly. Average values from this operation were near the uppermost high gravity readings in the regional Bouguer gravity map. Logs from wells located on the Mardin High were used to analyze different lithologies and formation tops were transferred into the SMT Kingdom's cross-section module. Density logs were used to identify the lithology of the different formations. These data show that the deeper, older Jurassic and Triassic aged rocks were higher density, typical of carbonates and anhydrites. Above the L. Cretaceous (Paleocene sands and shale) and below the Jurassic/Triassic (Paleozoic sand, shale and possibly salt), lithology is correlated by different density values. The deeper high density Jurassic/Triassic rocks are thrust upward by reverse faults, creating a density contrast with the surrounding younger Paleocene rocks. Gravity data identifies these thrust fault related with higher gravity readings. These high gravity anomalies can then aid in the making of 2D cross-sections over the region.

Results

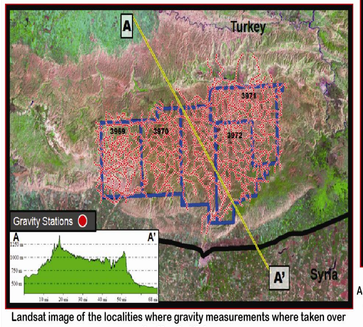
Using density data, well logs, surface geological maps, satellite data and gravity readings allowed for a 2-D cross section to be generated. Older existing seismic data did not allow for reflectors to be continuously traced making for difficult interpretation. Comparing the 2-D cross section with vintage seismic helped confirm that high gravity anomalies are associated with southward verging thrust faults. The regional geology explains the different lateral variations that occur along the cross-sections. Most of the rock units become thicker towards the southeast of the Mardin High and are explained because this area was in a shelf environment during the closure of the Neo-Tethys Sea. North of Gercus well, Jurassic age sediments thin within the Cudi Group. The explanation of this thinning is partially due to an early Cretaceous regional uplift. During uplift in the Cretaceous, sedimentation ceased and erosion removed Jurassic age sediments along the northwestern part of the Mardin High. The lower Paleocene Germav shale thins to the southeast due to localized highs during the Maastrichtian stage of the Upper Cretaceous. A regression near the end of the Cretaceous resulted in restricted deposition related to presence of topographic highs that were fault related. Erosion of younger sediments exposed uplifted Upper Paleocene, Lower Paleocene and Cretaceous aged rocks near the Gercus well, which also explains the exceptionally high gravity anomaly present. Younger thrust faults near the Bakuk wells lead to an increased rate in erosion over the fault related anticlines, thus depositing the sediments in the Selmo formation.

Conclusions

The prospective areas of interest are identified by the high gravity anomalies produced in the residual gravity map over the Mardin High. Close inspection of these prospective areas can be analyzed without acquisition of new seismic, as seen in the created 2D cross-sections. Locations of gravity highs indicate a fault related anticline that provides potential structural traps for the Cretaceous, Jurassic and Triassic age carbonates. The overlying shale's of the Germav formation provides an impermeable regional seal for the potential hydrocarbons. Paleozoic and Jurassic-Triassic age source rocks are within the oil and gas window in some areas of the Midyat high and are mature to the north and the south of the Midyat-Mardin High. Potential exploration locations within the gravity highs should be considered when drilling new wells for oil and gas within the Mardin High. Existing seismic, well control and gravity data provides adequate information to create 2D cross-sections and structure maps, to better understand the evolutionary history of the Mardin High. The integration of different datasets has lead to a better understanding of the region and prospective areas for hydrocarbon exploration. These integrated data sets can be used to identify trends and analogues in furthering an exploration program outside of the immediate study area. It will also allow the company to better plan and/or minimize future seismic acquisition saving millions of dollars in unnecessary speculative seismic programs.



Geographic tectonic features in relationship to Turkey. In addition the defined political boundaries in relation to the Zagros Folded Zone and the Gravity taken over the Mardin High.



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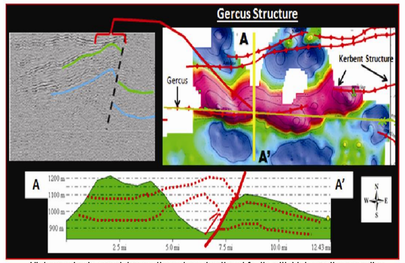
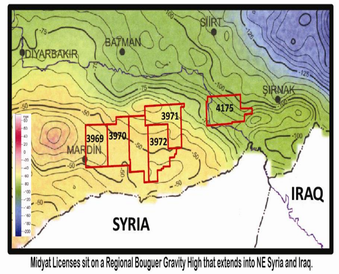


Vintage seismic correlates southward verging thrust faults with high gravity anomalies.



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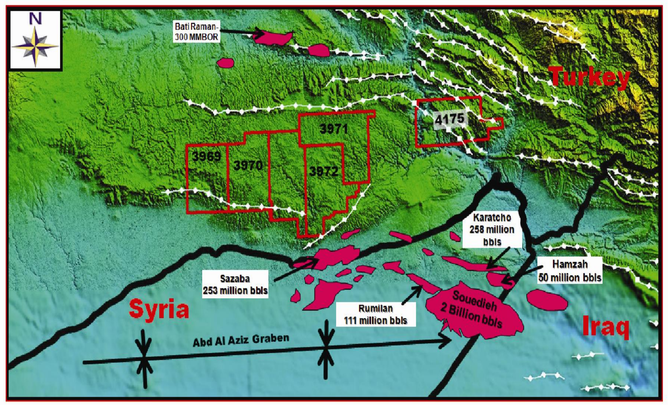

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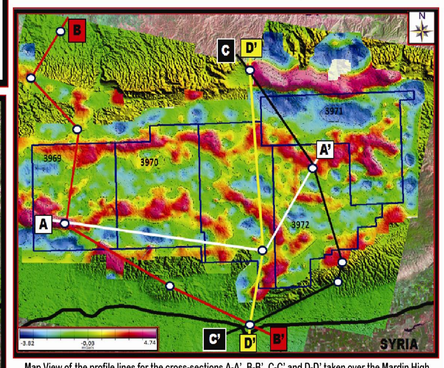
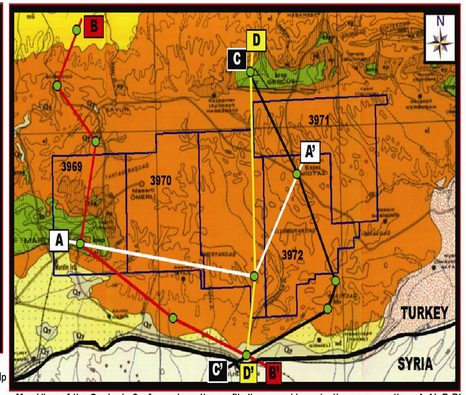


Map View of the profile lines for the cross-sections A-A', B-B', C-C' and D-D' taken over the Mardin High. ASTER DEM (5 Meter Resolution) in addition to log data from wells over the Mardin High were also used to help correlate fault related anticlines. High gravity values from the produced residual also indicate where thrust faults are present.



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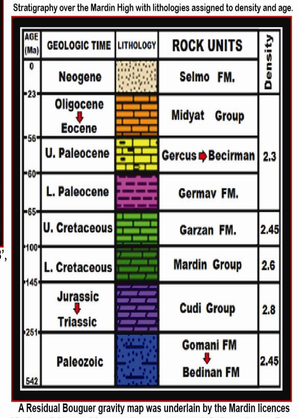

Stratigraphy over the Mardin High with lithologies assigned to density and age.

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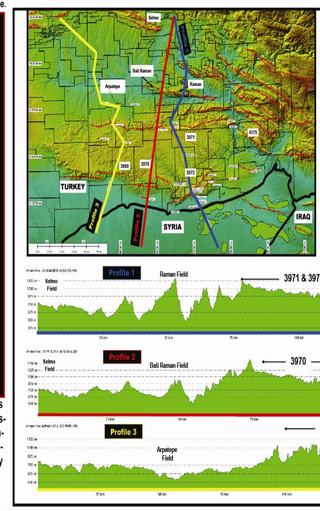

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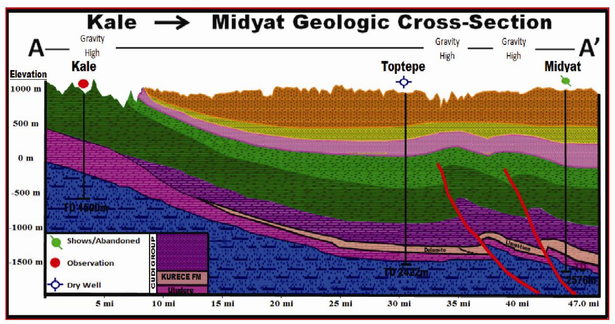

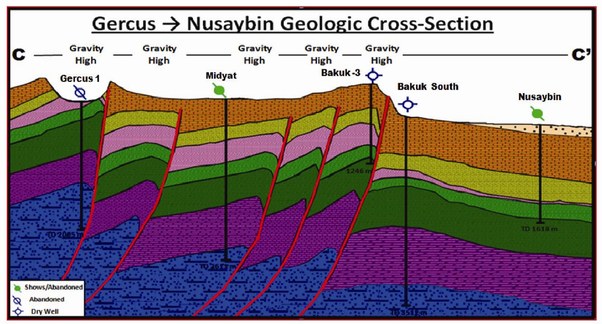

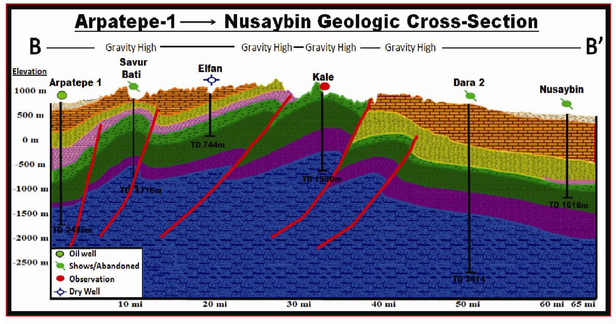

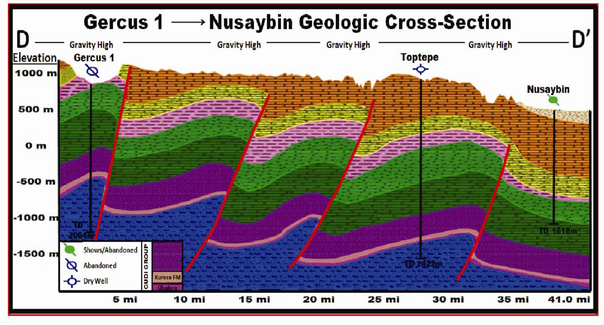

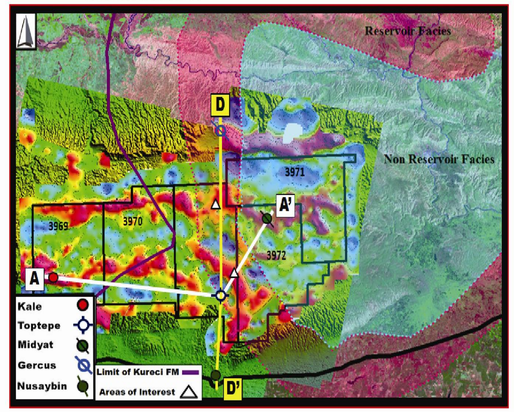

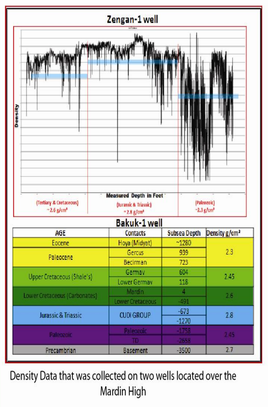

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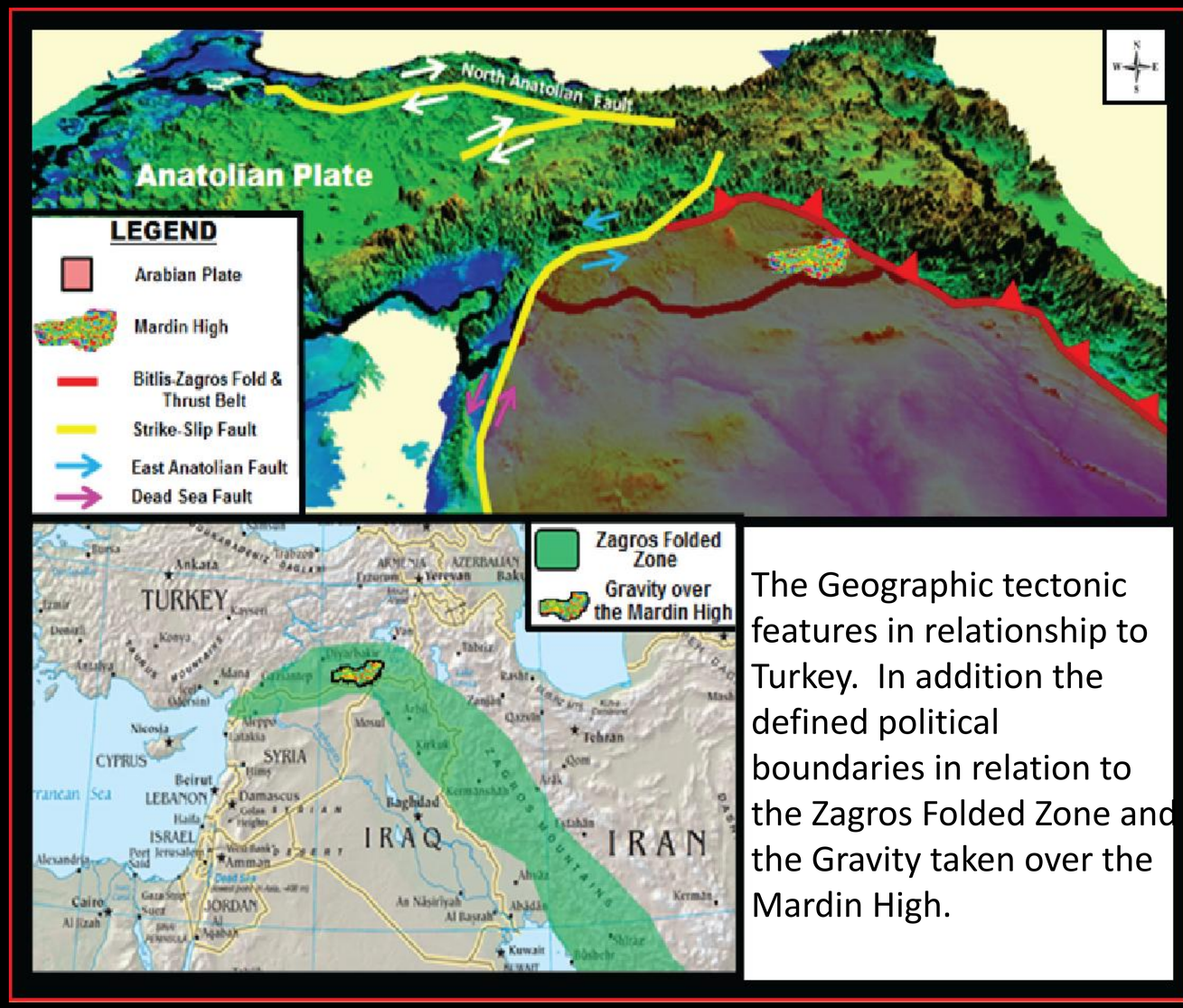

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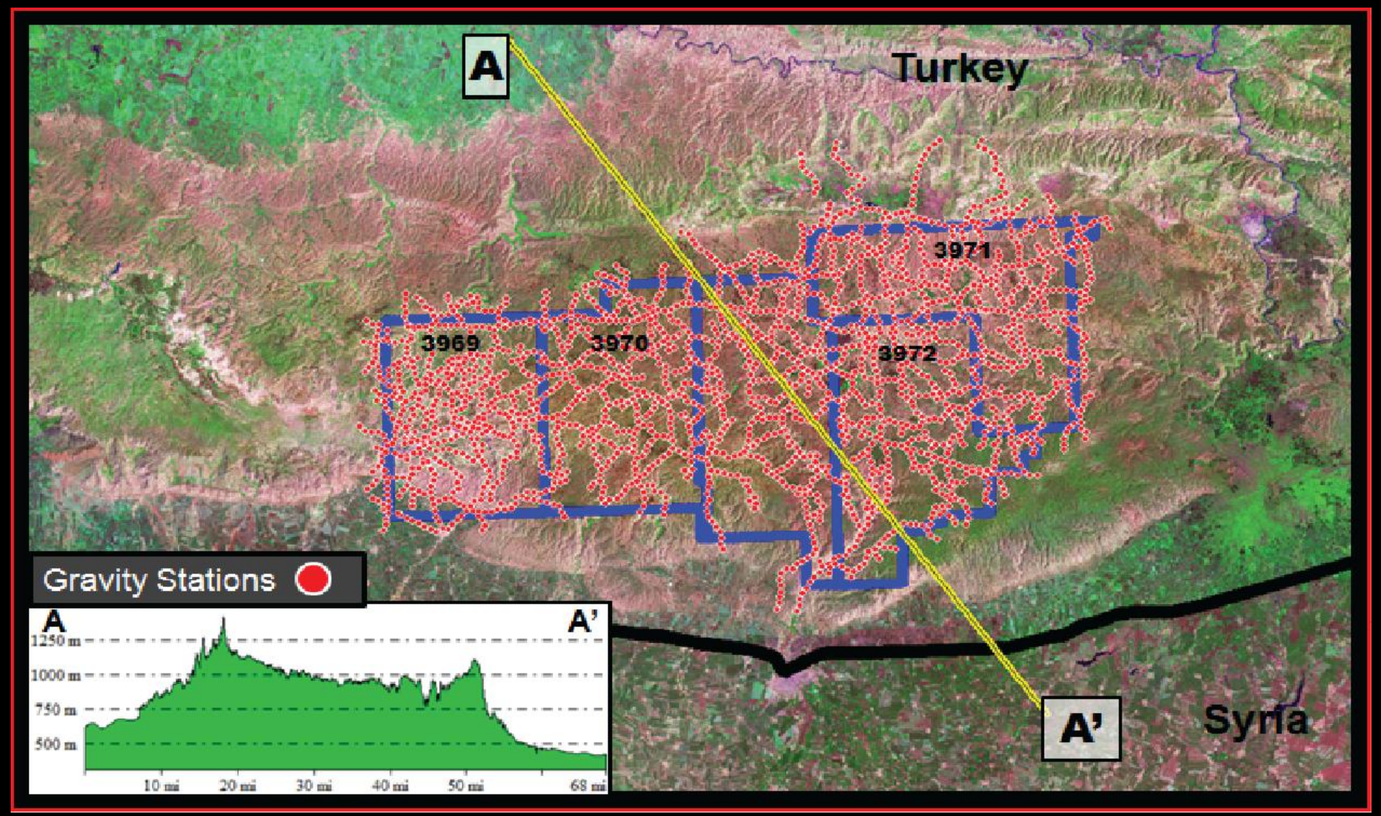

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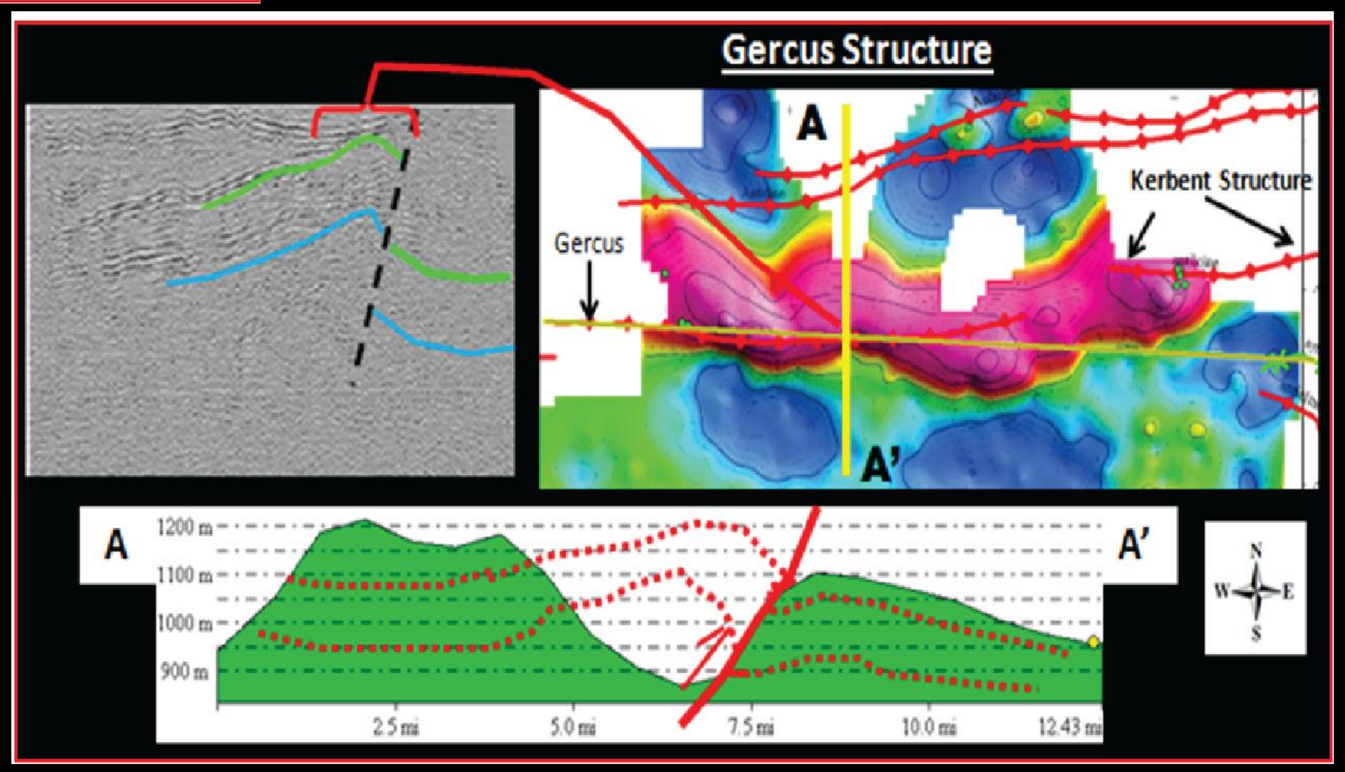

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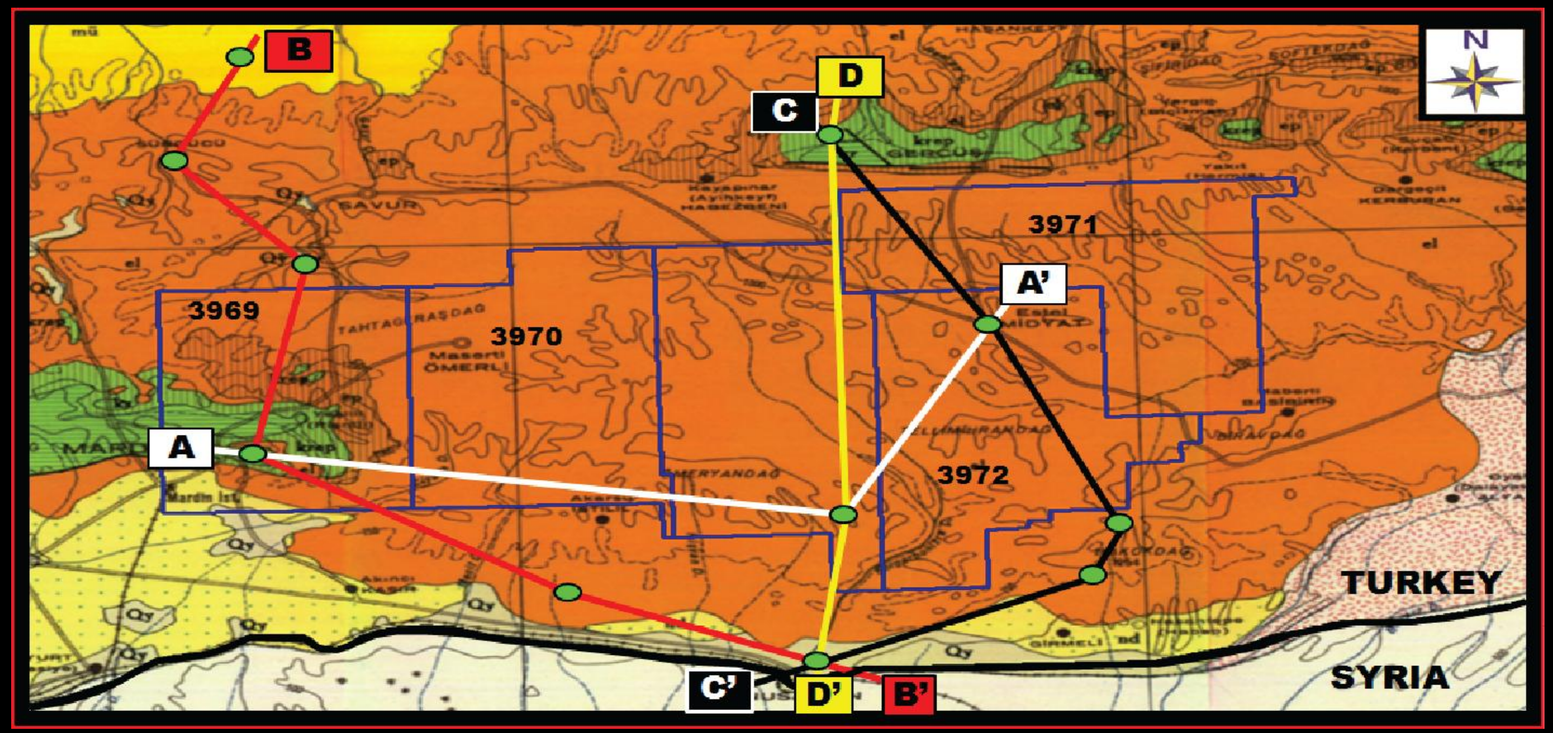

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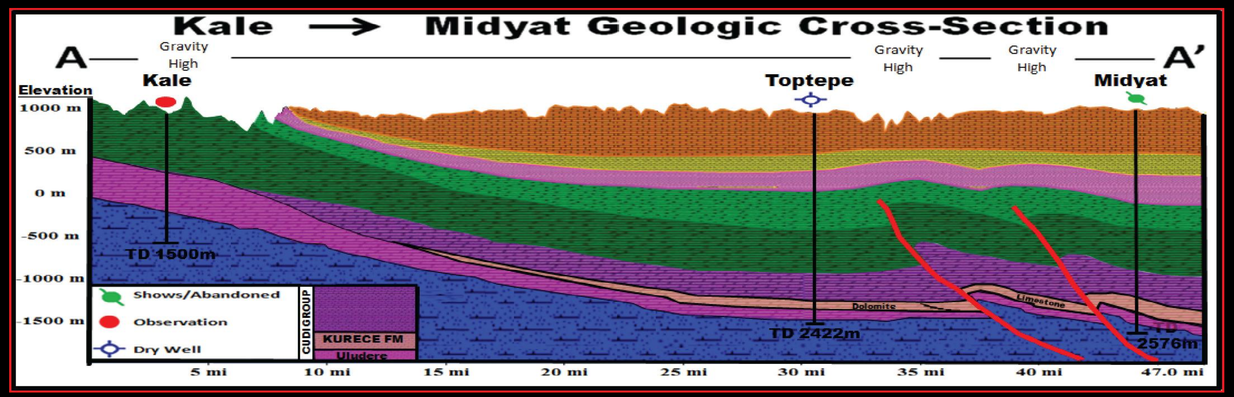

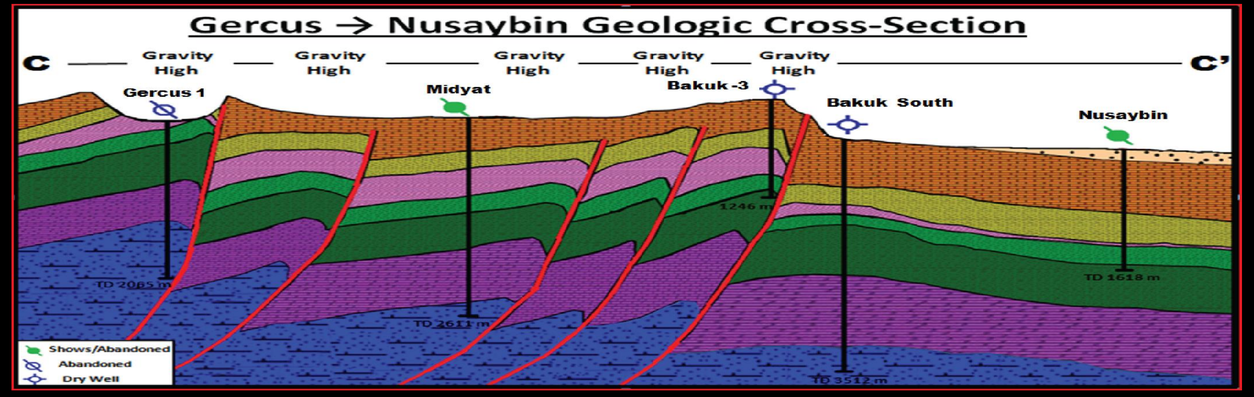

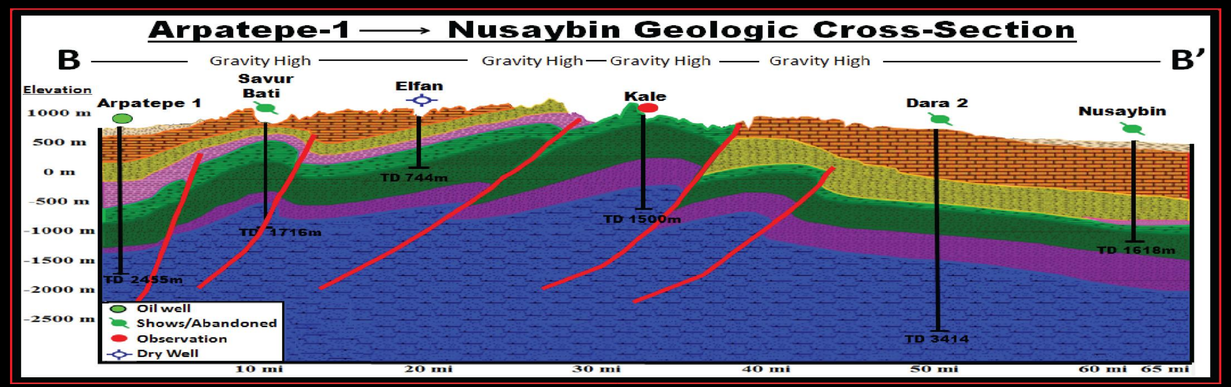

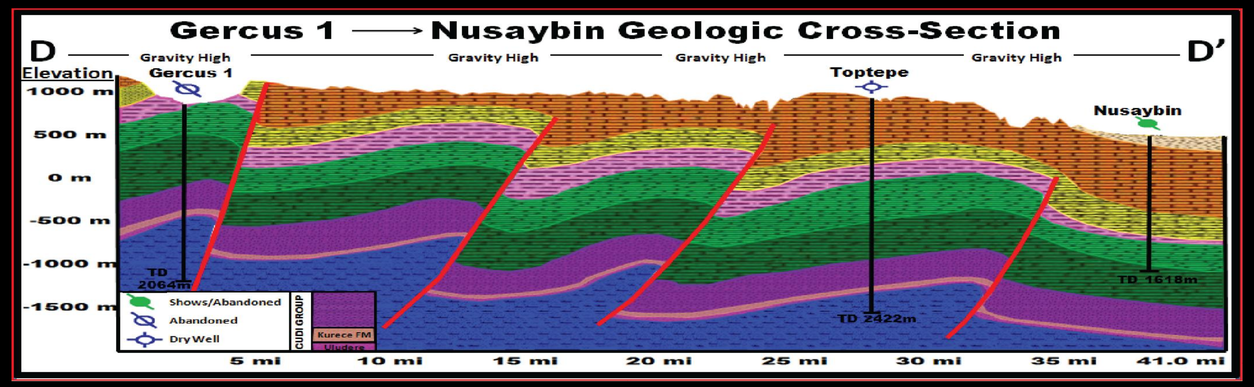

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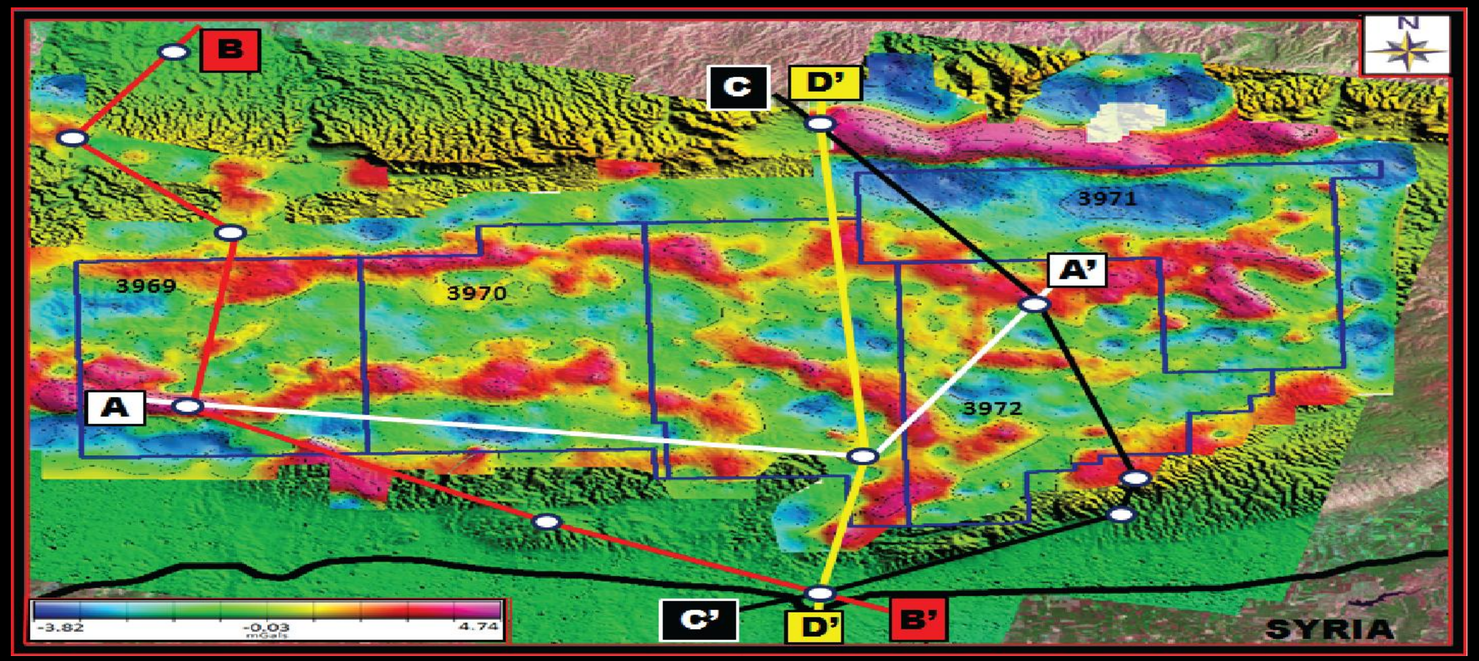

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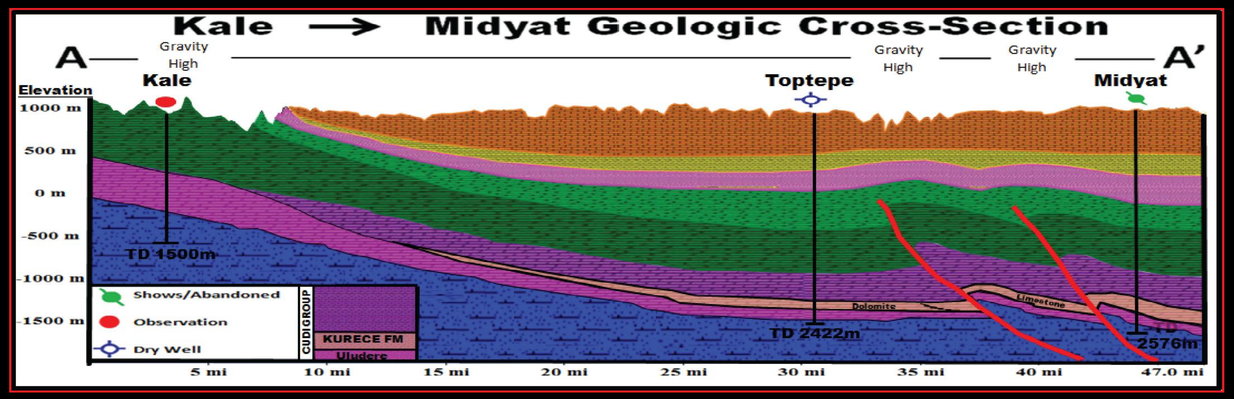

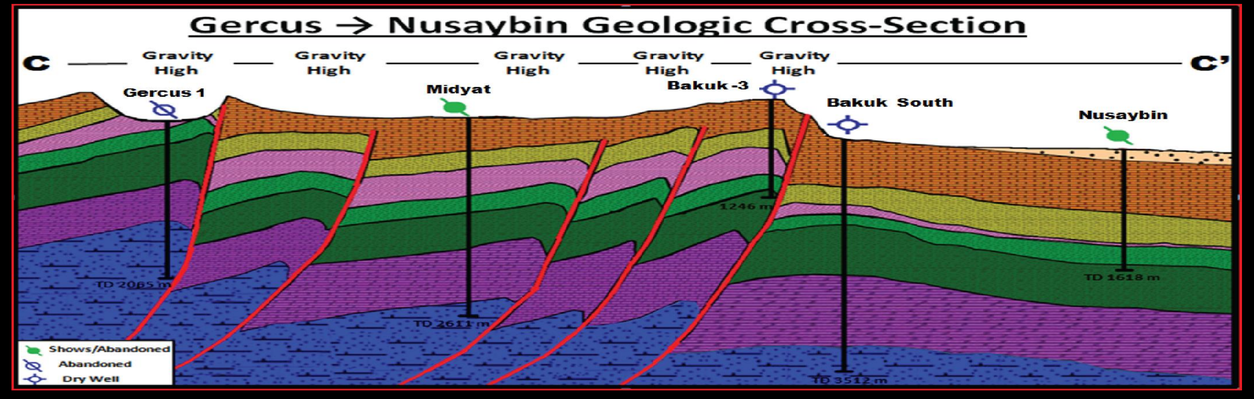

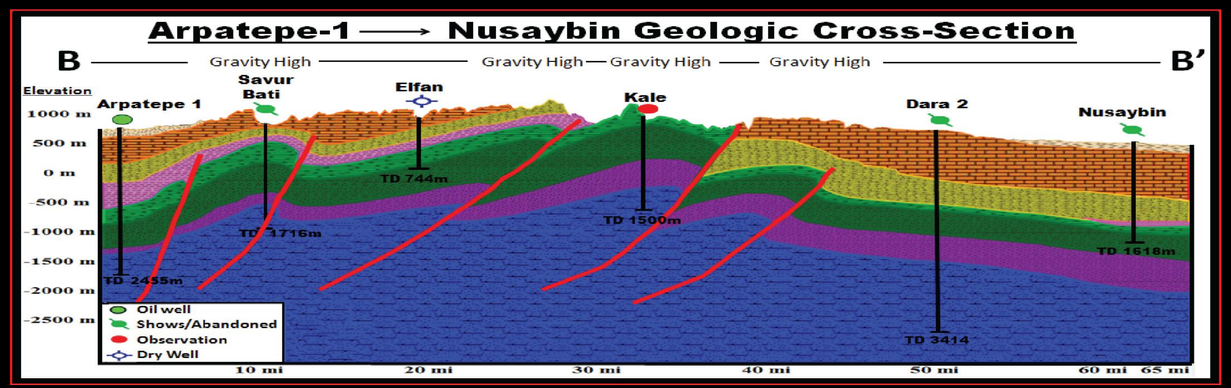

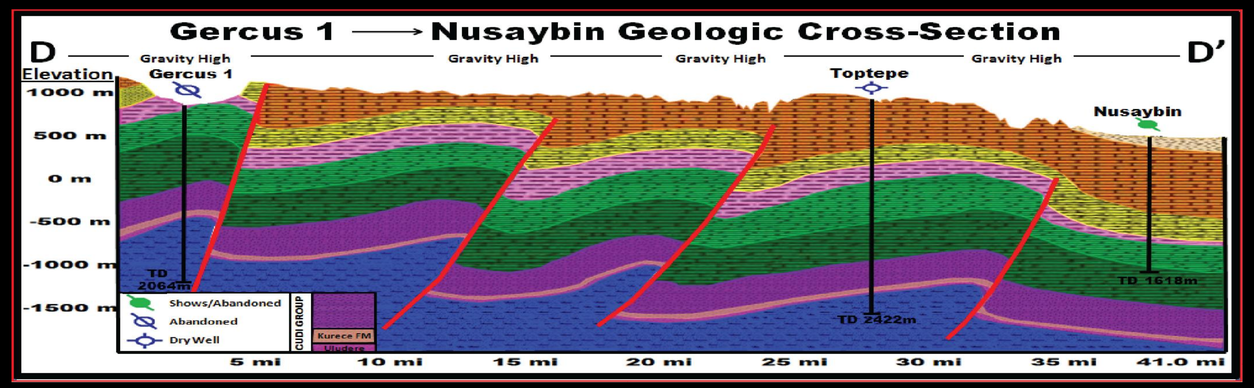

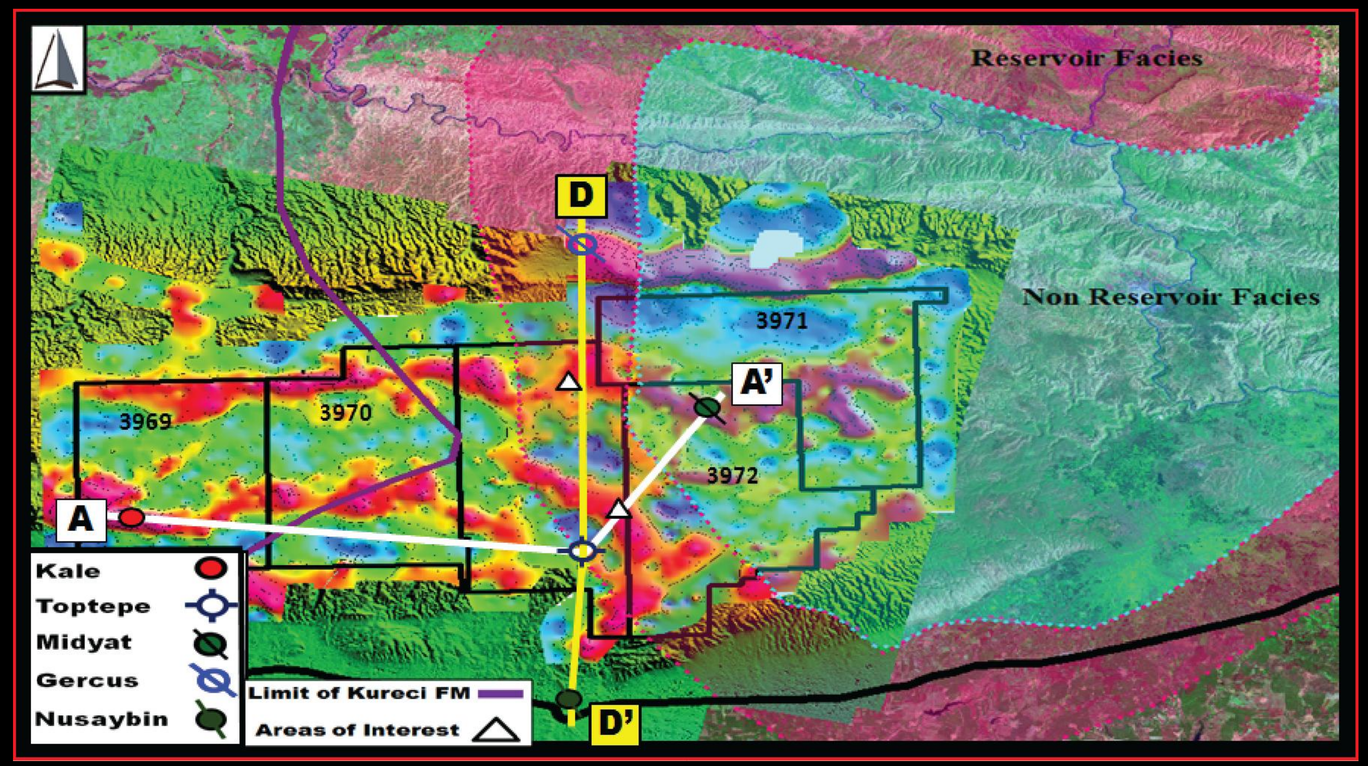

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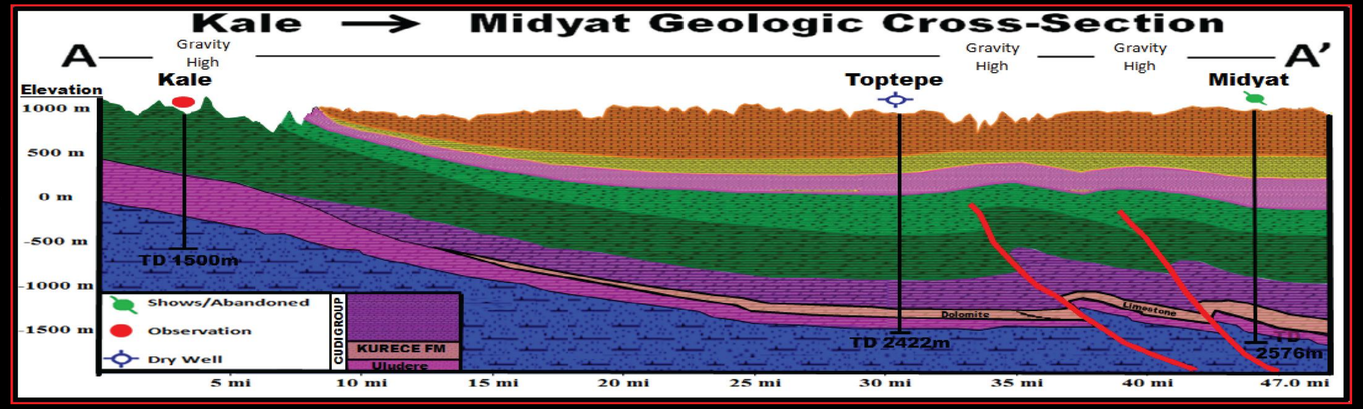

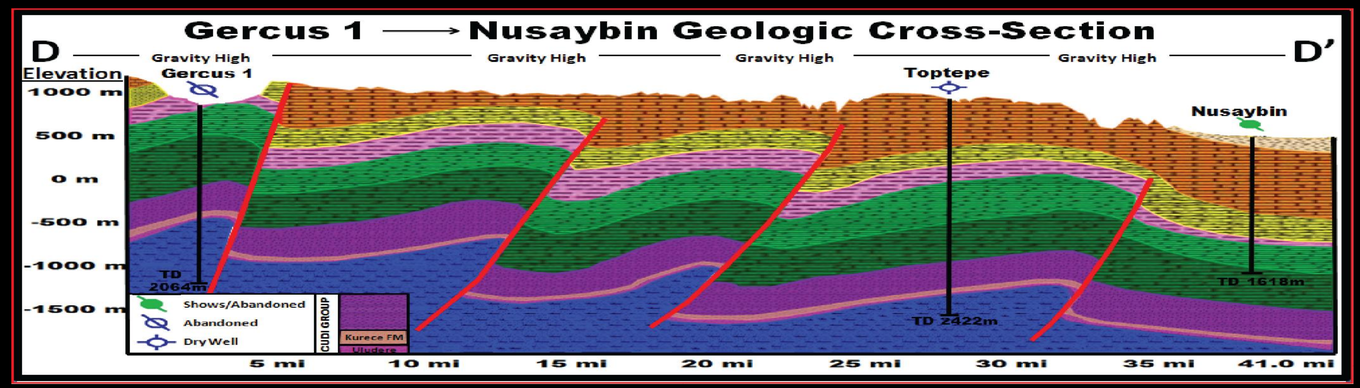

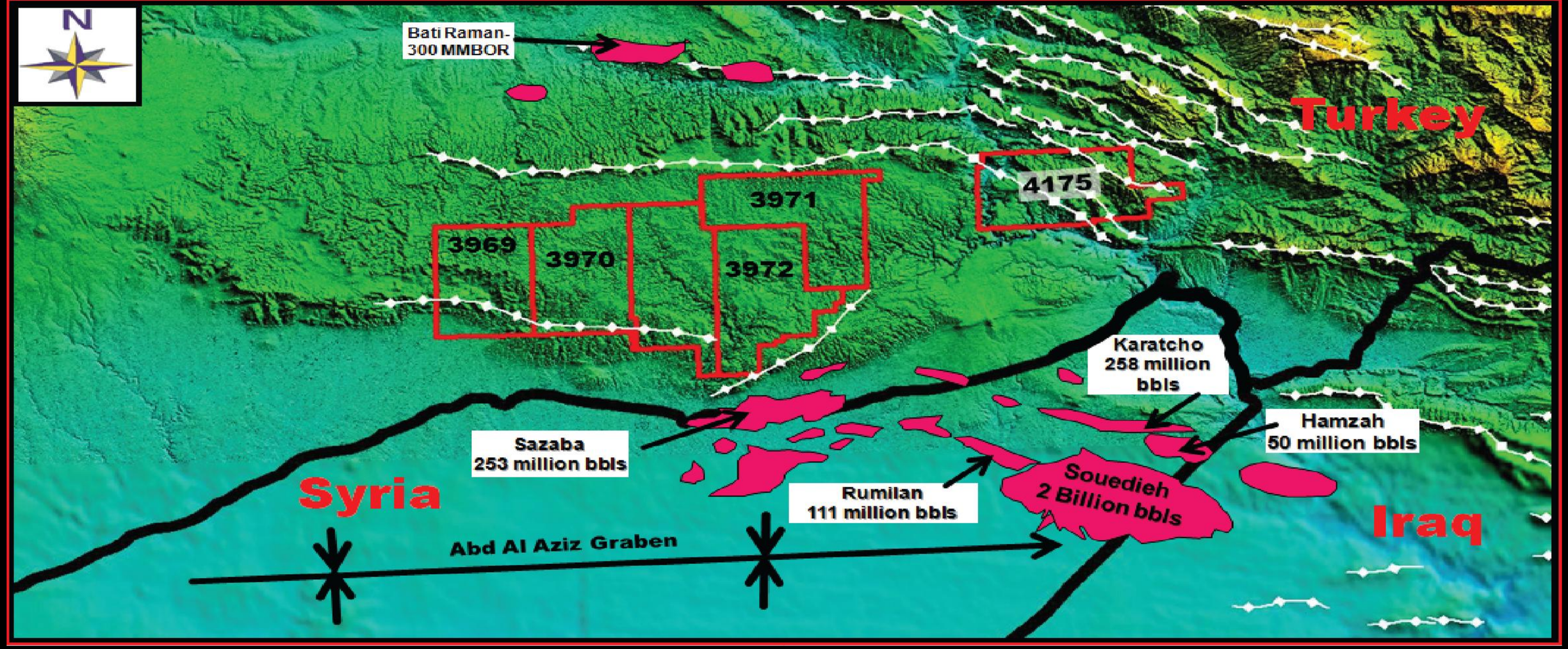

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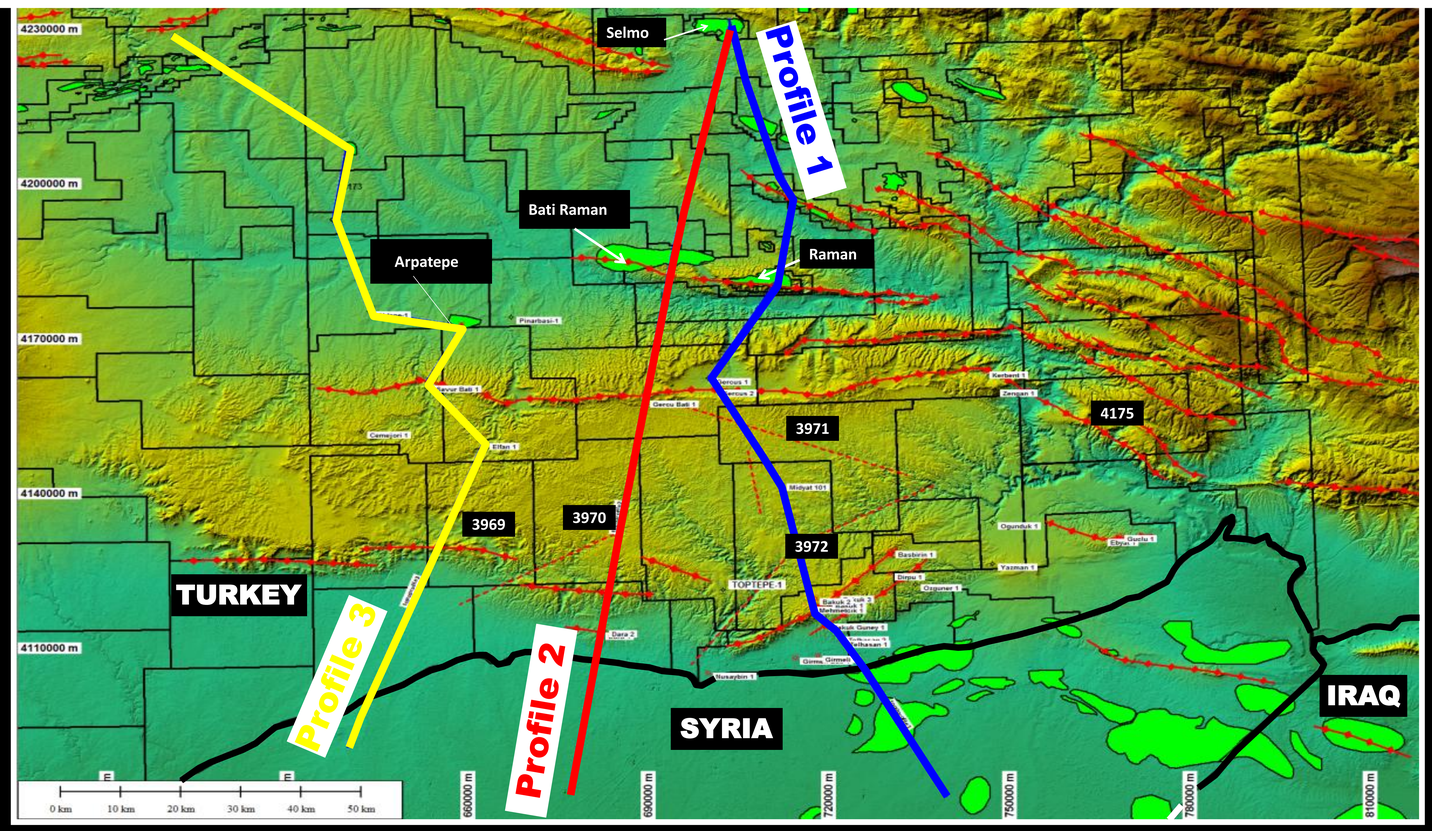

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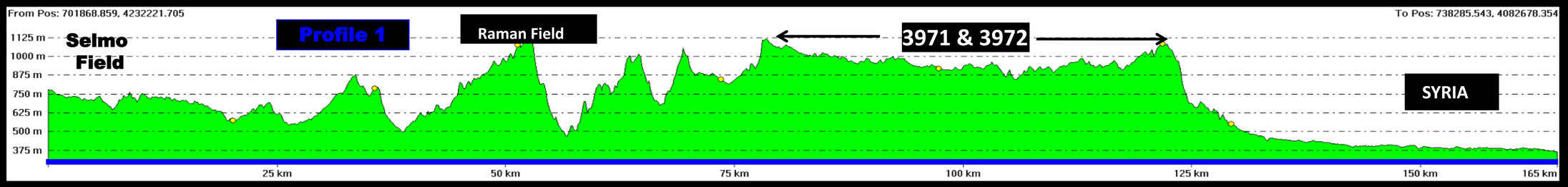
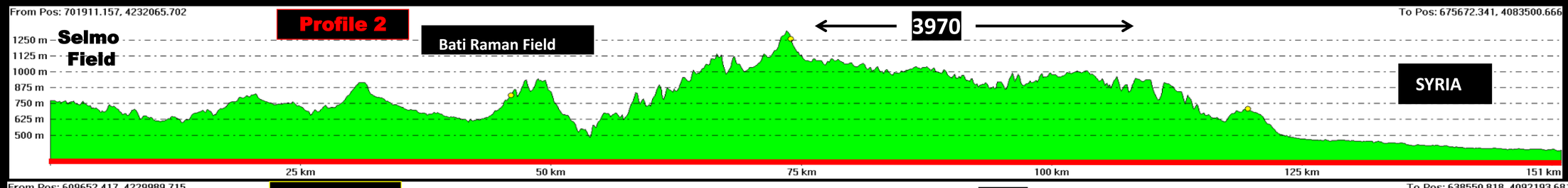
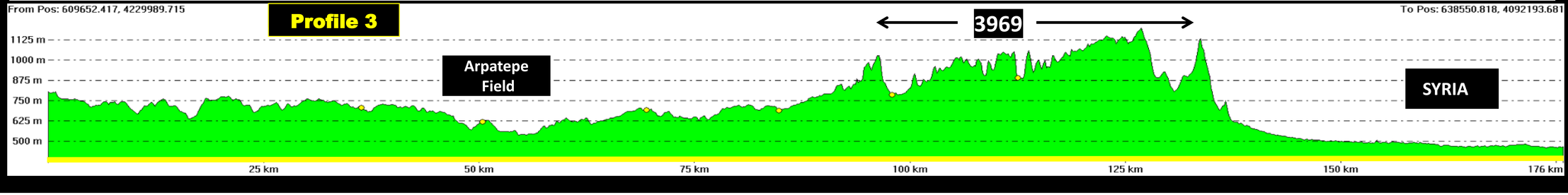
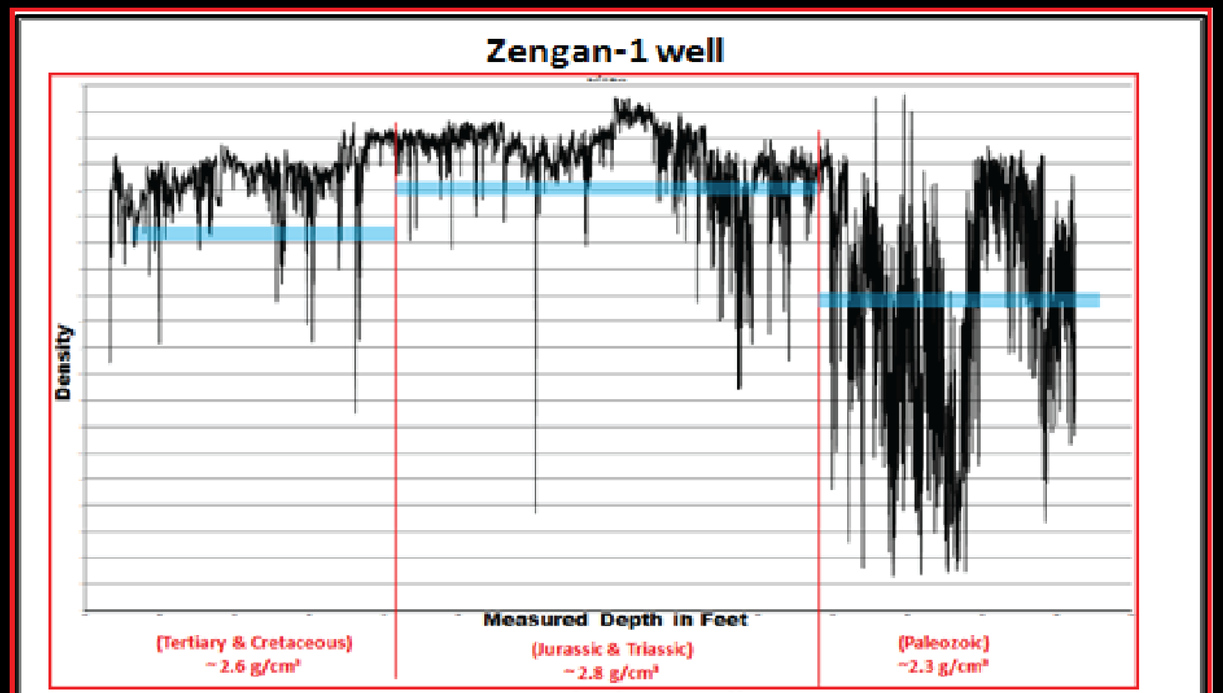




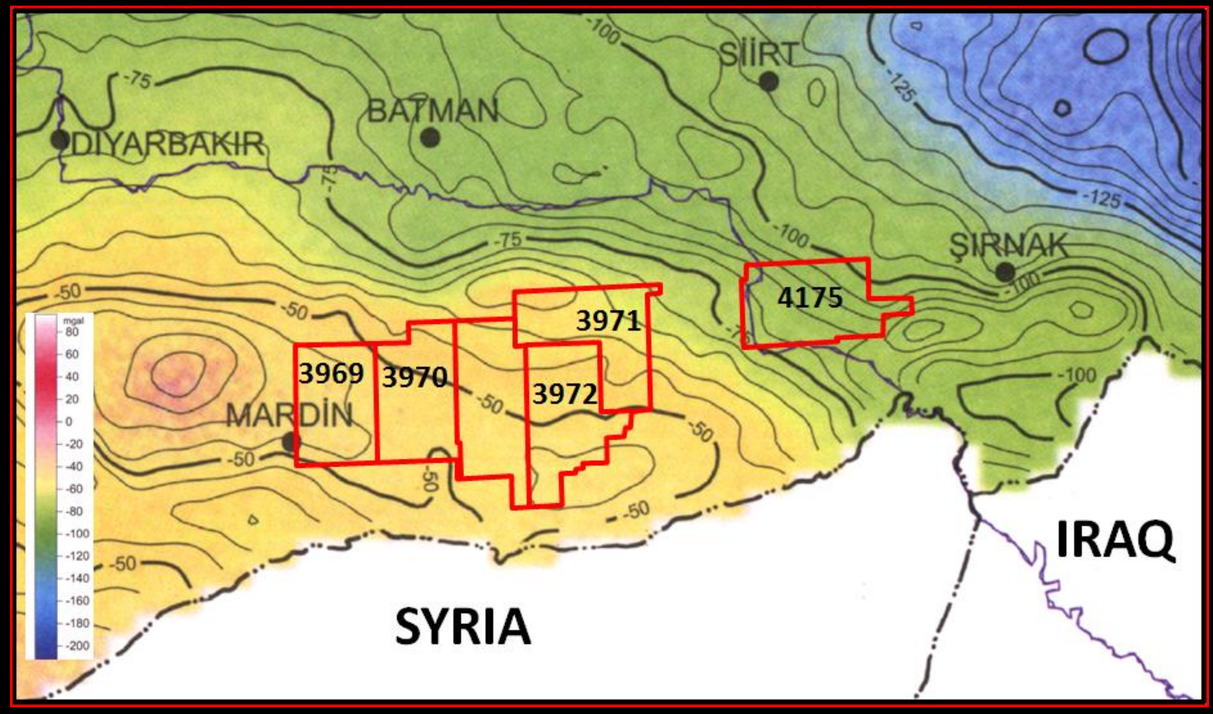


Density Data that was collected on two wells located over the Mardin High. Used to assign different densities to the correct formations when producing the Residual Bouguer



Bakuk-1 well

AGE	Contacts	Subsea Depth	Density g/cm³
Eocene	Hoya (Midyat)	~1280	2.3
Paleocene	Gercus	939	
	Becirman	723	
Upper Cretaceous (Shale's)	Germav	604	2.45
	Lower Germav	118	
Lower Cretaceous (Carbonates)	Mardin	4	2.6
	Lower Cretaceous	-491	
Jurassic & Triassic	CUDI GROUP	-673	2.8
		-1270	
Paleozoic	Paleozoic	-1758	2.45
	TD	-2658	
Precambrian	Basement	-3500	2.7



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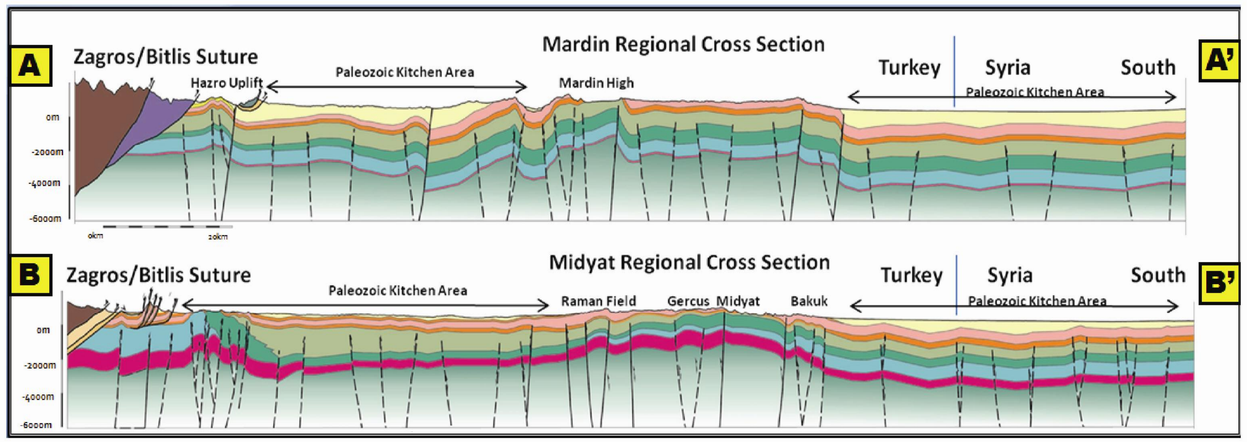
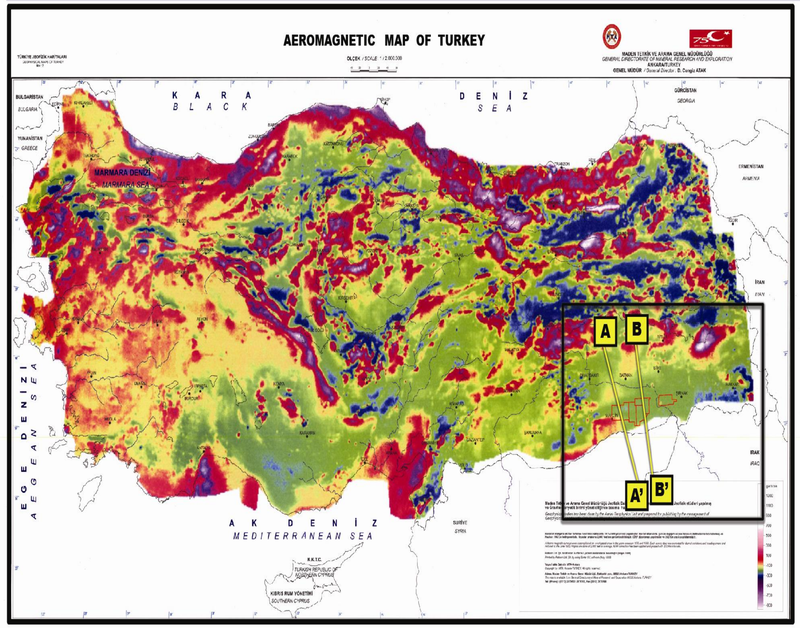
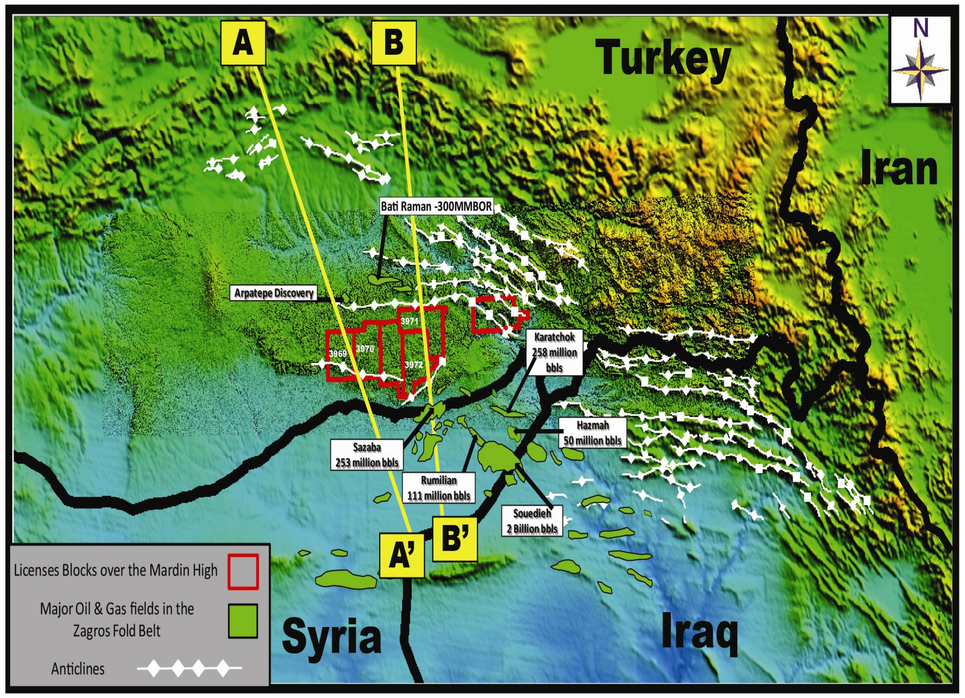


Strat column for the Midyat and Mardin Regional Cross-Sections A-A' & B-B'

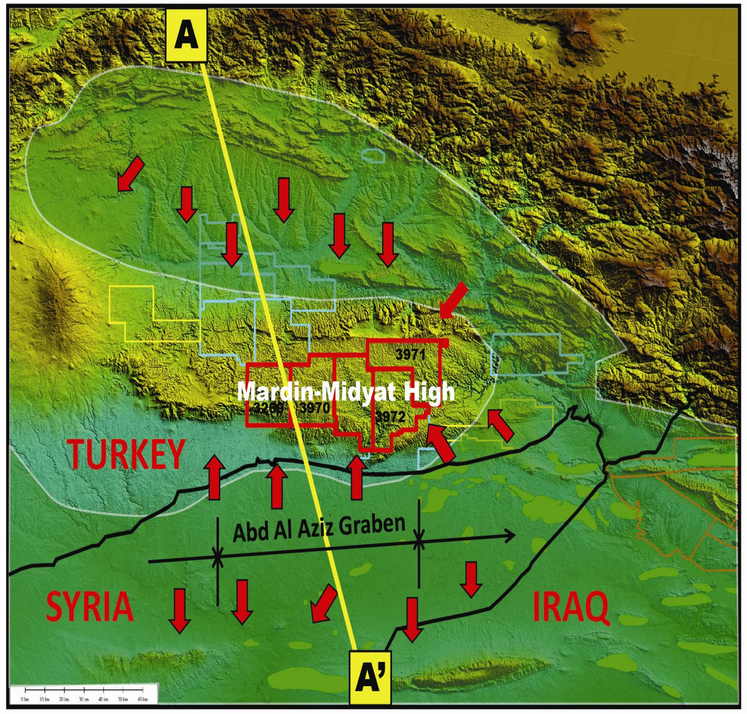
- Quaternary Basalts
- Miocene to Pliocene: Selmo Fm + Silvan Fm
- Oligocene: Germik Fm
- Upper Eocene to Oligocene: Midyat Gp, Pila Spi Fm
- Lower Eocene to Upper Eocene: Gercus Fm
- Upper Cretaceous to Paleocene undifferentiated
- Lower Cretaceous to Middle Cretaceous: Mardi Gp
- Middle Triassic to Lower Cretaceous: Cudi Gp
- Permian to Lower Triassic undifferentiated



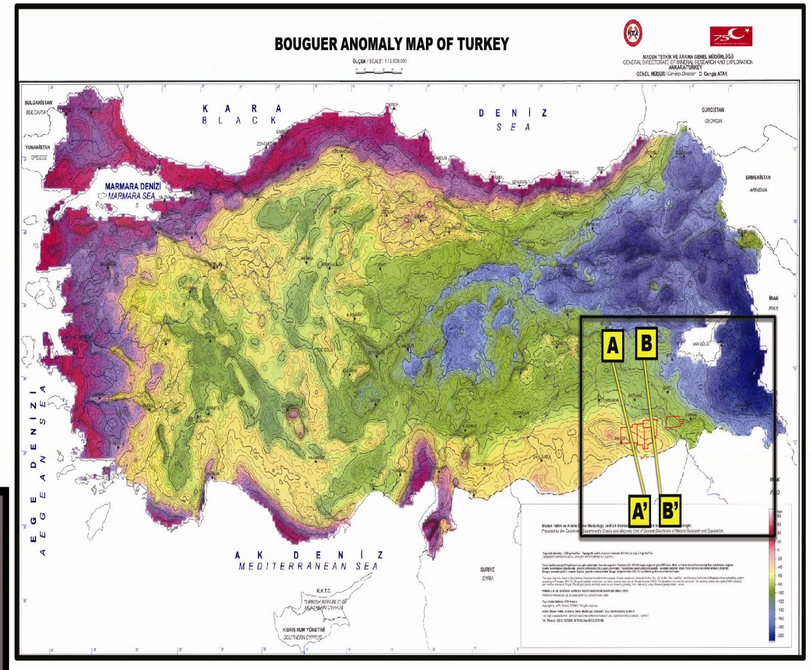
Midyat Licenses sit on a regional Bouguer Gravity high that extends into SE Syria and Iraq



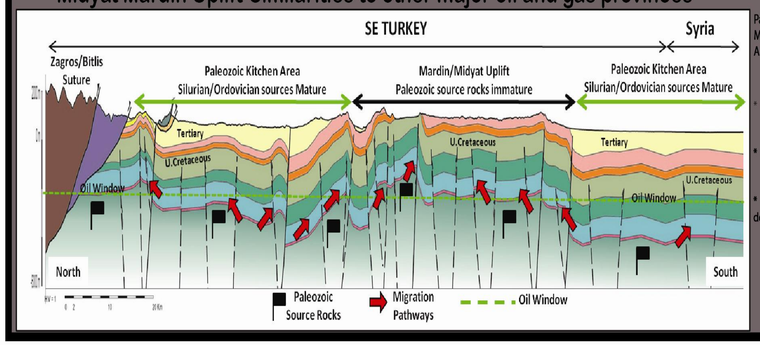
Location of Licenses 3969, 3970, 3971, 3972 in SE Turkey are on trend with the major oil



Paleozoic Triassic "kitchen" areas north and south of the Mardin Midyat High generate hydrocarbons that migrate updip to the uplift.

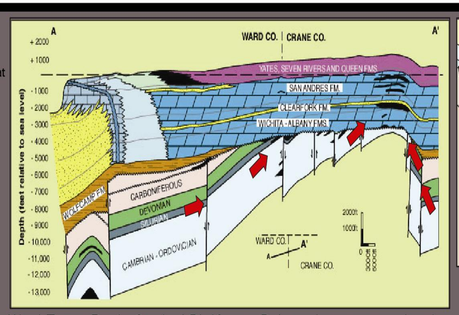


Midyat Mardin Uplift-Similarities to other major oil and gas provinces

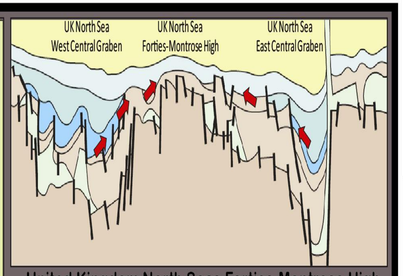


Paleozoic Play Concepts & Migration Pathways in the Midyat Area.

* Ordovician clastic reservoir (Bedinan)
* Rich Silurian source rock (Dadas)
* Petroleum Kitchen in fore-deep basin.



West Texas Basin Central Platform. Paleozoic sources migrate into younger Permian Carbonates outside of the kitchen.



United Kingdom North Seas Forties-Montrose High. Upper Jurassic source rocks migrate from kitchen into younger Paleocene /Eocene sandstones.

NPA SATELLITE MAPPING

FUGRO

TRANSATLANTIC Petroleum Ltd.

Strat column for the Midyat and Mardin Regional Cross-Sections A-A’ & B-B’

- Quaternary Basalts
- Miocene to Pliocene: Selmo Fm + Silvan Fm
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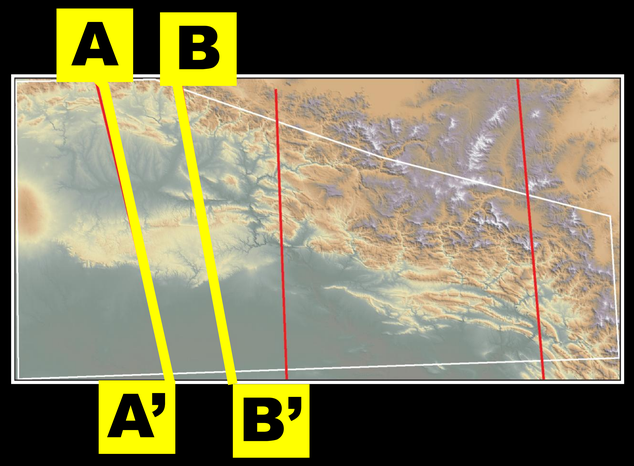
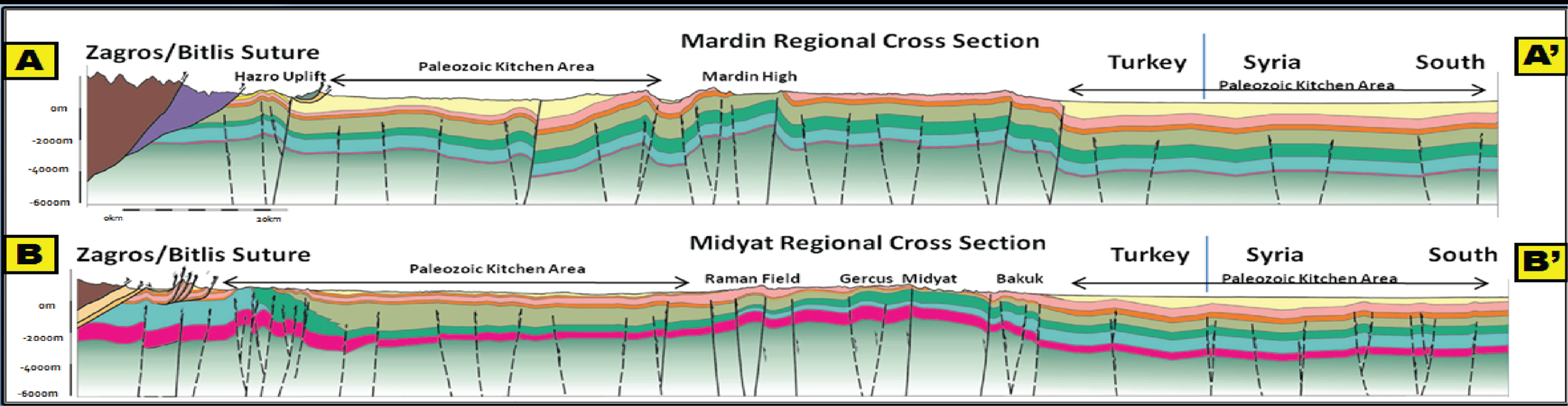


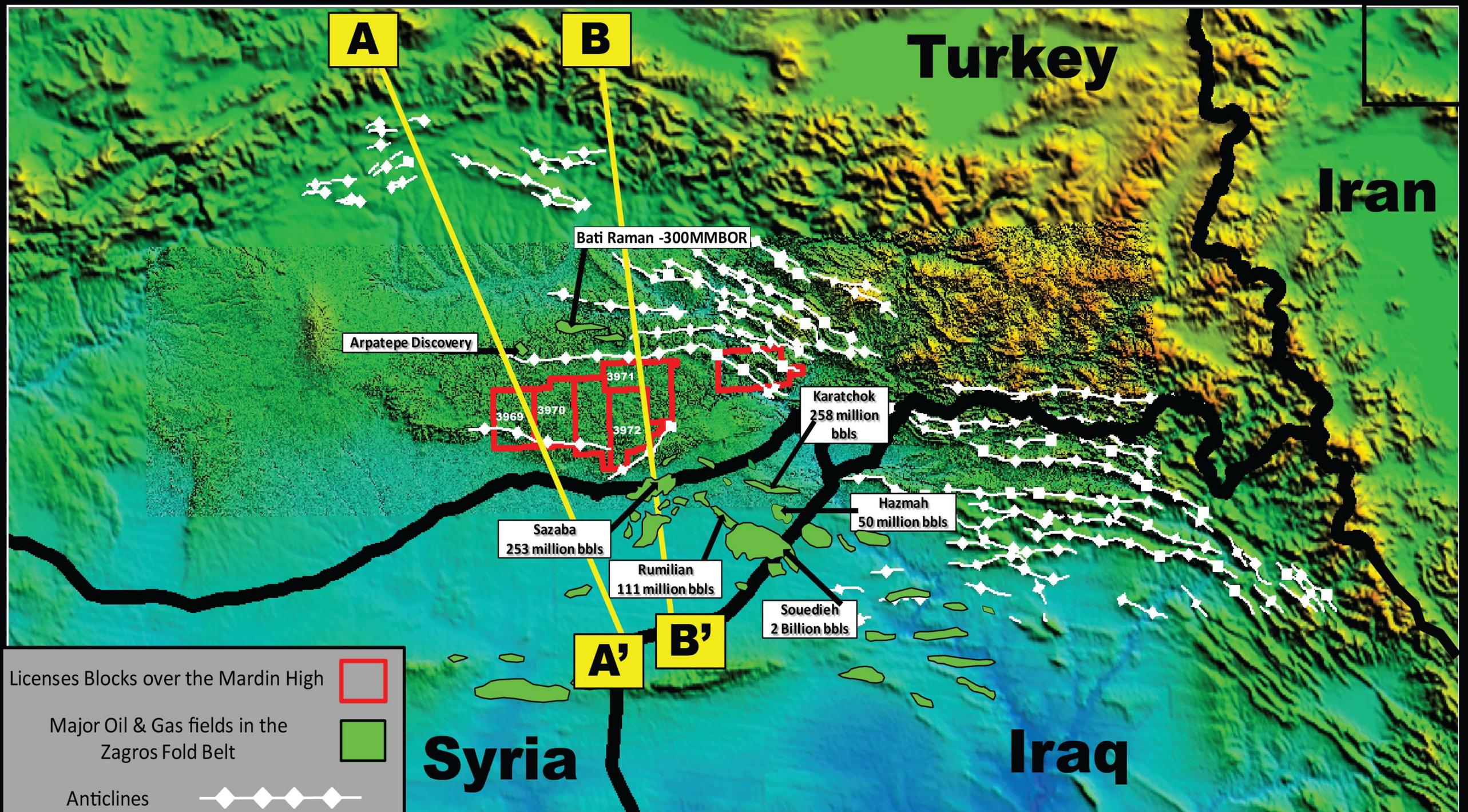
TRANSATLANTIC Petroleum Ltd.

NPA SATELLITE MAPPING

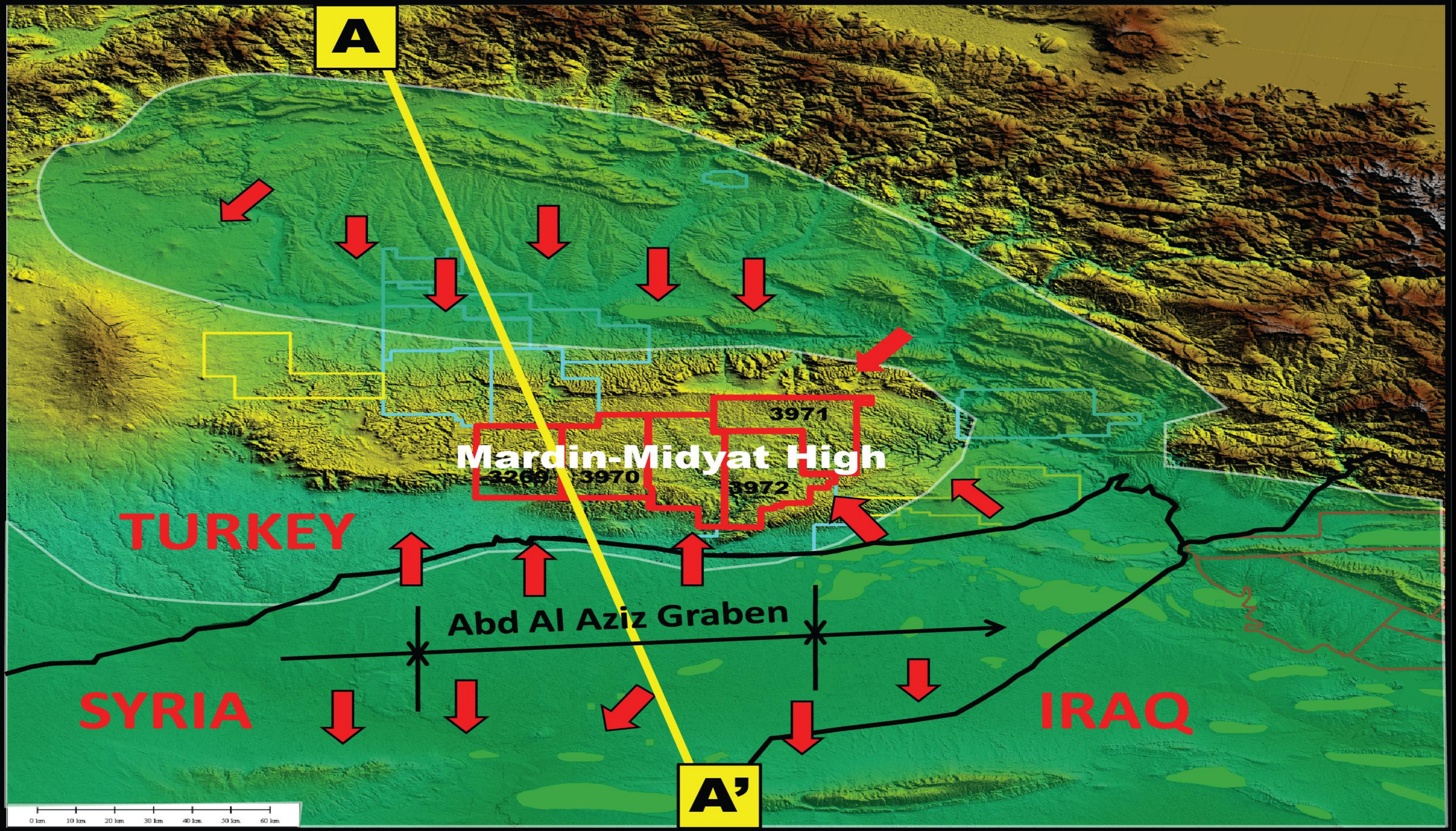
FUGRO



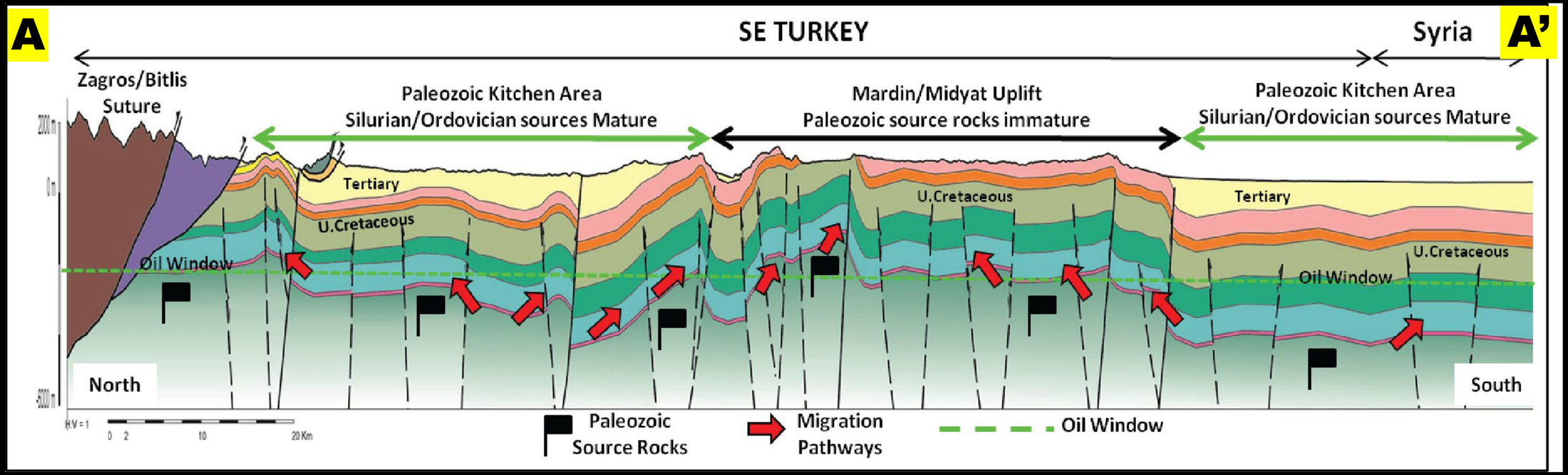
Location of Licenses 3969, 3970, 3971, 3972 in SE Turkey are on trend with the major oil and gas fields in the Zagros fold belt.



Paleozoic Triassic “kitchen” areas north and south of the Mardin Midyat High generate hydrocarbons that migrate up dip to the uplift.



Midyat Mardin Uplift-Similarities to other major oil and gas provinces

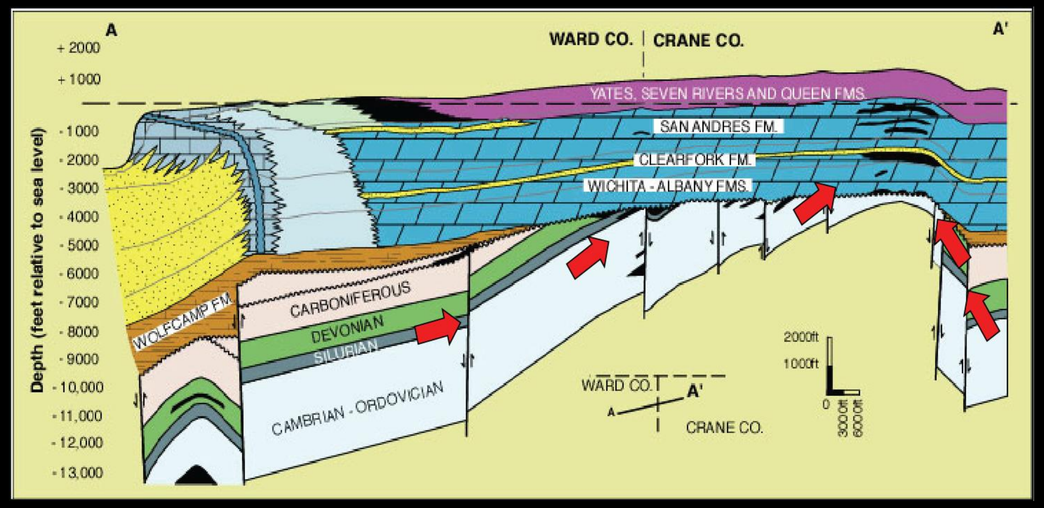


Ordovician clastic reservoir (Bedinan)

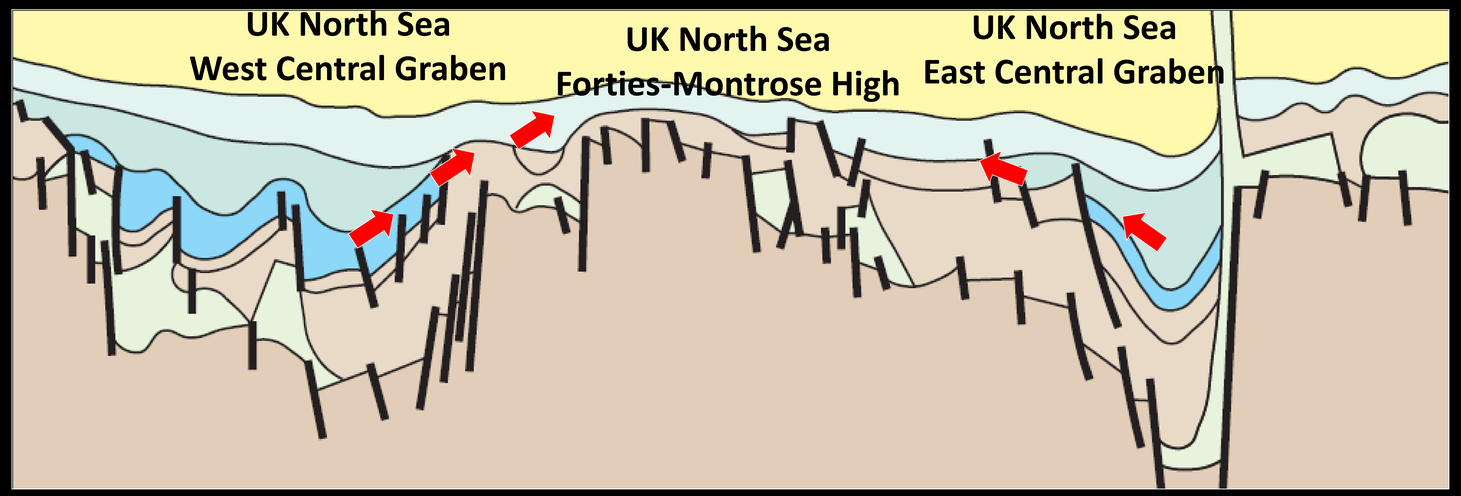
Rich Silurian source rock (Dadas)

Petroleum Kitchen in foredeep basin.

West Texas Basin Central Platform.
Paleozoic sources migrate into younger Permian Carbonates outside of the kitchen.



United Kingdom North Seas Forties-Montrose High.
Upper Jurassic source rocks migrate from kitchen into younger Paleocene /Eocene sandstones.



BOUGUER ANOMALY MAP OF TURKEY

ÖLÇEK / *SCALE* : 1 / 2.000.000

40 20 0 20 40 60

K A R A D E N İ Z
B L A C K S E A

E G E D E N İ Z
A E G E A N S E A

A K D E N İ Z
M E D I T E R R A N E A N S E A

BULGARİSTAN
BULGARIA

YUNANİSTAN
GREECE

GÜRCİSTAN
GEORGIA

ERMENİSTAN
ARMENIA

SURİYE
SYRIA

İRA
IRA

IR
IR

MARMARA DENİZİ
MARMARA SEA

EDİRNE, KIRKLARELİ, TEKİRDAĞ, İSTANBUL, ÇANAKKALE, BALIKESİR, BURSA, BİLECİK, YALOVA, KOCAELİ, SAKARYA, BOLU, ZONGULDAK, BARTIN, KARABÜK, KASTAMONU, ÇANKIRI, SİNOP, ÇORUM, AMASYA, TOKAT, SAMSUN, ORDU, GİRESUN, TRABZON, RİZE, ARTVİN, ARDAHAN, KARS, GÜMÜŞHANE, BAYBURT, ERZURUM, AĞRI, ERZİNCAN, SİVAS, YOZGAT, ANKARA, KIRIKKALE, ESKİŞEHİR, KÜTAHYA, UŞAK, AFYON, MANİSA, İZMİR, AYDIN, DENİZLİ, ISPARTA, BURDUR, MUĞLA, ANTALYA, KIRŞEHİR, TUZ GÖLÜ, NEVŞEHİR, AKSARAY, NİĞDE, KONYA, KARAMAN, KAYSERİ, TUNCELİ, ELAZIĞ, MALATYA, ADIYAMAN, K.MARAŞ, GAZİANTEP, ŞANLIURFA, OSMANİYE, ADANA, İÇEL, HATAY, MUŞ, VAN GÖLÜ, VAN, BİTLİS, SİİRT, BATMAN, DİYARBAKIR, MARDİN, ŞIRNAK, HAKKARİ

A, B, A', B'

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TURKISH REPUBLIC OF NORTHERN CYPRUS

KIBRIS RUM YÖNETİMİ
SOUTHERN CYPRUS

Maden Tetkik ve Arama Genel Müdürlüğü Jeofizik Dairesi Gravite-Manyetik biriminde hazırlanmıştır.
Prepared by the Geophysics Department's Gravity and Magnetic Unit of General Directorate of Mineral Research and Exploration.

Yoğunluk (density) : 2.67 gr/cm3'tür. Topografik tashih J zonuna kadardır (6.6 km) ve yoğ. 2.4 gr/cm3'tür.
Topographic correction is up to J zone (6.6 km) and density is 2.4 gr/cm3.

Temel harita Lambert Projeksiyonuna göre çizilmiştir. Gravite değerleri Potsdam (981 274.00 mgal) değerine göre MTA Gen. Müd. ve Harita Genel Komutanlığı Baz şebekesine bağlıdır.
Enlem düzeltmeleri Uluslararası Gravite formülüne (1967) göre yapılmıştır. Yükseklikler deniz yüzeyine göredir. Anomali değerleri mgal (1000 cm/sn2) ve kontur aralığı 5 mgal dir.
Bouger anomali eğrileri, arazide ölçülen gravite noktalarındaki Bouger değerlerinden 5X5 Km aralıklarla gridlenerek hazırlanmıştır.

The base map was drawn in the Lambert Projection transformation system. Gravity values are connected to the Gen. Dir. of Min. Res. and Expl. and General Command of Mapping's base networking system according to Potsdam (981 274.00 mgal) Latitude corections has been done by international Gravity formula (1967). The elevations are from the sea level. The anomaly values are mgals (0.001 cm/sec2) and contour interval is 5 mgal. The Bouger gravity anomaly contours are drawn by gridding 5 km interval by using observed gravity station values.

Petkom Ltd. Şti. tarafından Surfer 6.0 yazılımı kullanılarak basılmıştır (Mayıs 1999)
Printed by Petkom Ltd. Şti. by using Surfer 6.0 software (May 1999)

Adres: Maden Tetkik ve Arama Genel Müdürlüğü, Eskişehir yolu, 06520 Ankara-TURKEY
The map is available from General Directorate of Mineral Research and Exploration 06520 Ankara, TURKEY
Tel: (Phone) : (0312) 2873430, 2878700, Fax (0312) 2879188

0 0 0 0 0 00 20 40 60 00

AEROMAGNETIC MAP OF TURKEY

ÖLÇEK / *SCALE*: 1 / 2.000.000

40 20 0 20 40 60

K A R A D E N İ Z
B L A C K S E A

BULGARİSTAN
BULGARIA
YUNANİSTAN
GREECE
GÜRCİSTAN
GEORGIA
ERMENİSTAN
ARMENIA
İRAN
IRAN
IRA
IRA
SURİYE
SYRIA

EDİRNE
KIRKLARELİ
SİNOP
BARTIN
ZONGULDAK
KASTAMONU
SAMSUN
ARTVİN
ARDAHAN
TEKİRDAG
İSTANBUL
KARABÜK
ORDU
GİRESUN
TRABZON
RİZE
KARS
MARMARA DENİZİ
MARMARA SEA
YALOVA
KOCAELİ
SAKARYA
BOLU
ÇANKIRI
ÇORUM
AMASYA
GÜMÜŞHANE
BAYBURT
IĞDIR
ÇANAKKALE
BURSA
BİLECİK
TOKAT
ERZURUM
AĞRI
BALIKESİR
ESKİŞEHİR
ANKARA
KIRIKKALE
YOZGAT
SİVAS
ERZİNCAN
KÜTAHYA
KIRŞEHİR
TUNCELİ
BİNGÖL
MUŞ
MANİSA
UŞAK
AFYON
İZMİR
TUZ GÖLÜ
NEVŞEHİR
KAYSERİ
BİTLİS
VAN GÖLÜ
VAN
AKSARAY
MALATYA
AYDIN
DENİZLİ
ISPARTA
BURDUR
KONYA
NİĞDE
ADIYAMAN
DİYARBAKIR
BATMAN
SİİRT
HAKKARİ
ŞIRNAK
MUĞLA
KMARAŞ
MARDİN
KARAMAN
ŞANLIURFA
GAZİANTEP
OSMANİYE
ANTALYA
İÇEL
ADANA
UKİLİS
HATAY

E G E D E N İ Z
A E G E A N S E A

A K D E N İ Z
M E D I T E R R A N E A N S E A

K.K.T.C.
TURKISH REPUBLIC OF NORTHERN CYPRUS
KIBRIS RUM YÖNETİMİ
SOUTHERN CYPRUS

A
B
A'
B'

gamma
1300
1100
900
700
500
300
100
-100
-300
-500
-700
-900

Maden Tetkik ve Arama Genel Müdürlüğü Jeofizik Dairesi Havadan Jeofizik Birimince Jeofizik etüdleri yapılmış ve Gravite-Manyetik birimi yöneticiliğince basıma hazırlanmıştır

Geophysics studies has been done by the Aerial Geophysics Unit of Geophysics Department and published by the management of Gravity and Magnetic Unit of Geophysics Department's Gravity and Magnetic Unit of Geophysics Department of Mineral Research and Exploration

Havadan manyetik etütler birbirine bindirmeli sahalarda, 1975-1989 yılları arasında yapılmıştır. Elde edilen veriler günlük değişim ve yön hatası düzeltmelerine tabi tutulmuş ve Haziran 1982'ye indirgenmiştir. Uçuşlar ortalama 2,000 feet'ten gerçekleştirilmiştir. IGRF düzeltmesi yapılmıştır ve 2X2 Km aralıkla gridlenmiştir.

Airborne magnetic surveys were accomplished on overlapped areas in the years between 1975 and 1989. Each survey data was corrected for diurnal variations and heading errors and reduced to the June 1982. Flights are done at 2,000 feet on avarage. IGRF correction has been applied and gridded with 2X2 Km intervals.

Petkom Ltd. Şti. tarafından Surfer 6.0 yazılımı kullanılarak basılmıştır (May 1999)

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