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GRAVITY MODELLING OF THE REGIONAL PROFILE ACROSS SOUTH CASPIAN BASIN AND TECTONIC IMPLICATIONS

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Summary

The South-Caspian Basin (SCB) underlies the southern part of the Caspian Sea, between the ranges of the eastern Greater Caucasus, Talysh, Alborz, and Kopet Dagh. A 2-D regional gravity model along a profile from the Alborz Mountains to the Absheron Ridge has been constructed, constrained by deep (20 s TWT) seismic reflection data. The deep structure model has been evaluated in terms of earthquake focal mechanisms and GPS velocity data to elucidate active tectonic processes and the geodynamic evolution of the SCB.

We believe that the rapid increase in the thickness of Mesozoic sediments along the profile from ~8 km in the middle part of the profile up to ~15 km in the area of the Absheron Ridge can be explained by inherent basin geometry created by thermal subsidence followed by sediment loading as well as additional effect of tectonic related shortening of sedimentary succession. Near the boundary of oceanic and continental crust in the northern SCB, flexure of oceanic crust is inferred from the observed seismic data and gravity modelling, most probably connected to ongoing subduction of lithosphere of the South Caspian underneath the Scythian Plate of the Mid-Caspian. Subduction beneath the Absheron Ridge is accompanied by the delamination of sediments from the oceanic crust (“basaltic” layer) and creation of accretionary wedge in the overlying sedimentary succession. The focal mechanisms of the larger earthquakes (M>6) occurring along the northern boundary of the SCB show steep normal-type faulting above the bend of the downgoing slab while, along the southern boundary, thrust faults are inferred. Some thrust-type earthquakes near the northern boundary occur in the lower crust or uppermost mantle and may be associated with compression in the lower part of the brittle lithosphere due to plate flexure. Displacements measured along the coastline of the Caspian Sea by GPS are consistent with the direction of potential oblique subduction of oceanic crust of the SCB beneath the Mid-Caspian. It is speculated that subducting oceanic crust beneath the Absheron-Pribakhan Ridge will eventually be consumed and fold-thrust belt tectonics similar to Eastern Caucasus will commence.

Keywords: South Caspian Basin, Bouguer gravity, geodynamic modelling, subduction, earthquake focal mechanisms, GPS velocity.
**Introduction**

The South-Caspian Basin (SCB) underlies the southern part of the Caspian Sea, between the ranges of the eastern Greater Caucasus (GC), Talysh (TL), Alborz (AG), and Kopet Dagh (KD) (fig. 1), all of which are situated within the Alpine–Himalayan collision zone (Jackson et al., 2002, Reilinger et al., 2006). Its northern boundary is formed by a line of submerged trends that forms a so-called Absheron-Pribalkhan Ridge or, simply Absheron Ridge (AP in fig. 1). The SCB is a large intramountain basin, unique characteristic of which are anomalously thick sediment cover (up to 25km), extensive mud volcanism and relatively thin lithosphere underlying it. (Yakubov et al., 1971; Artyushkov, 1993; Khain V.E. and Bogdanov N.A., 2003; Khain, 2005; Artyushkov, 2007). According to deep seismic sounding studies (Neprochnov, 1968; Mangino and Priestley, 1998; Baranova et al., 1991) and seismic reflection profiling (Glumov et al., 2004; Knapp et al., 2004), the thickness of sediments in the SCB reaches 20-30 km. The results of the refraction studies and teleseismic analysis receiver shows that the SCB contains a 15-20 km thick low-velocity layer (Vp < 4.8 km/s) and 10-18 km thick high-velocity ‘basaltic-type’ velocities with Vp varying between 6.4-7.4 km/s (Aksenovich et al., 1962, Baranova et al., 1991, Jackson et al., 2002, Green et al., 2009), which suggests that the SCB may be underlain by oceanic crust (Artyushkov, 1993; Jackson et al., 2002; Khain, 2005; Artyushkov, 2007; Green et al., 2009).

Ultradeep seismic sounding in Central Caspian Basin reveals another type of crustal structure, which is of more “continental” type, with a thin sedimentary succession (2-3 km), medium thickness ‘granitic-type’ layer (10 km) and a thick ‘basaltic-type’ layer (15-20 km) Velocities in the SCB crust are close to such ‘basaltic-type’ layer (Jackson et al., 2002; Khain, 2005, Green et al., 2009).

The main tectonic framework of the SCB are illustrated in figure 1. Ultradeep seismic reflection profiles acquired over the last decade were used by Green et al., 2009 and Mammadov, 2008 to provide new insights into basin structure and evolution, specifically by seismic imaging of the down going slab and accretionary wedge. On the whole, however, there is a lot of uncertainty about the internal crustal structure and crustal composition of the SCB which is discussed in Artyushkov, 1993; 2007; Knapp et al., 2004; Glumov et al., 2004; Mammadov, 2006; Mammadov, 2008. Majority of the current authors assume the subduction of lithosphere of the South Caspian underneath the mid-Caspian continental Scythian Plate (Khalilov et al., 1987; Granath et al., 2000; Allen et al., 2002; Knapp et al., 2004; Egan et al., 2009; Green et al., 2009).
Fig. 1. The major structural elements of SCB (International Tectonic map of Caspian Sea and its edging, editors Khain V.E. and Bogdanov N.A., 2003; The basement of platform areas (1-4) : 1) - Early Precambrian; 2 - Baikalian; 3 - Hercynian; 4 - Early Cimmerian; the Alpine folding-cover systems (5,6) : 5) - Great Caucasus and Kopet Dagh; 6 - Lesser Caucasus, Talesh, Alborz; 7 - foredeeps and troughs; 8 - troughs with oceanic crust ; 9-faults corresponding to the boundaries of large structures; 10 - other relevant faults. The major structures (letters in circles): TZ – Tuarkyr zone, KB – Middle-Caspian-Karabogaz anteclise, KD – Kusar-Divichi trough, AK – Absheron – Kobustan trough, AP - Absheron-Pribalkhan zone, WK – West Kopet Dagh zone, LC - fold system of Lesser Caucasus, AR - Lower-Aras flexure, TL – Talesh zone, AG - Alborz-Gogran foredeep, WT - West-Turkmen trough, GD – Gogran Dagh-Okarem zone, GC- Greater Caucasus folds system, SM- South Mangyshlak-Ustyurt system of troughs; AA- Location of profile forming the basis of this research investigation.
The purpose of this study has been to propose a crustal model and describe some characteristic of the crustal structure of the SCB along a regional profile from the Alborz to the Absheron Ridge, integrating available seismic data with Bouguer gravity anomaly along the profile. The analysis of deep structure along the selected profile has been combined with an analysis of earthquake focal mechanisms and GPS velocity data to evaluate the active tectonics and geodynamic evolution of the basin.

**Bouguer Gravity anomalies in the SCB**

A map of the Bouguer gravitational field anomaly of the SCB is shown in figure 2 and has been used in previously by Dehghani and Makris, 1983; Gravity map of the USSR, 1990; Kadirov, 2000 (fig. 2).

![Map of Bouguer gravitational anomalies of the SCB.](image)

**Fig. 2.** Map of Bouguer gravitational anomalies of the SCB. S- Safidrud uplift, G- Godin uplift. (mGal)
There are several areas of anomaly observed in this map. In the northwestern part of the map, there is a large gravity minimum with an amplitude reaching -125 mGal. The central part of the basin is represented by general gravity low increasing to gravity highs towards the maximum of 30mGal the south the southwest and to the southeast (areas Safidrud and Godin uplifts). The area of increased gradients from the Alborz Mountains to the south up to the deep-water part of the basin is typical for the southern part of the SCB (Dehghani and Makris, 1983). The area of the Central Alborz is also characterized by a large negative anomaly (-120 mGal) equal in magnitude to the one under Absheron Ridge.

**Geological-geophysical Cross-section along Alborz-Absheron Ridge**

A model profile has been generated, which extends for almost 650 km from southwest Central Alborz range towards the northeast in the mid-Caspian (fig. 1). The initial model has been created Mammadov P.Z. (2006, 2008) and, later, utilized in models of Brunet et al, 2003. on the basis of the recent ultra deep 20 sec TWT cross-sections integrated with published data on deep seismic sounding and earthquake analysis (Aksenovich et. al., 1962; Baranova et al., 1991; Allen et. al., 2002; Jackson et. al., 2002; Brunet et. al., 2003; Knapp et. al., 2004; Babayev and Gadjiyev, 2006). This initial gravity model of geological-geophysical cross-section A-A’ is shown on the fig. 3.

![Fig. 3. The geologic-geophysical cross-section along a regional profile from the Alborz to the Absheron Sil which served as an initial model (from P.Mammadov, 2006; 2008)](image)
This model has some significant uncertainties pertaining to the way authors constructed this cross section, what kind of seismic velocities were used for each layer and what kind of constraint exists on depth to basement and depth to Moho from reflection seismic and deep seismic sounding. The objective of this work is to constrain and modify this geological model further.

Figure 3 highlights the following parts of the model: 1) the seismic boundary between the Neogene and Paleogene; 2) the boundary between the Paleogene and Mesozoic; 3) the upper boundary of the consolidated crust in the middle of the basin (“basaltic” layer with “basalt-type” velocities), which differentiates sedimentary and consolidated rock complexes; and 4) the Mohorovicic discontinuity (created on the basis of gravimetric data). In addition there are internal crustal boundaries between upper crust “granitic” and lower crust “basaltic” layers.

For instance, depth to sediment pile in the initial model along the profile is 20-25 km on average and reaches almost 30 km below Absheron Ridge. Similar depths were used along the nearly identical profile from Alborz to Absheron Ridge by Granath, 2000 and showed on average over 20 km and at the maximum over 30km, of basement depth below Absheron Ridge.

Green et. al., 2009, however, have used a slightly different depth to basement for their lithospheric model from the similarly located profile at about 15km on with the deepest values around 25-26km. The difference between these two depths is most likely down to the velocity model used to convert time section. In order to understand which of the depth might be more reasonable we have attempted forward gravity modelling along the profile A-A’ (fig. 1)

Gravity model

Gravity modelling was developed on the basis of minimization of multi-parametric functionals with the use of the matching method. The following criterion was used to fit the observed gravity curves $g(x_i), F = \sum_{i=1}^{n} \left[ g(x_i) - \Phi(x_i) \right]^2 = \min$, where $\Phi(x_i)$ is the estimated gravity at point $i$, $x_i$ are the coordinates of observation points, and $n$ is the number of points used at the approximation (Tikhonov and Arsenin, 1977, Bulakh et. al., 1984; Bulakh and Markova, 1994; Bulakh, 2000).

The gravity model along the selected profile was constructed applying a forward modelling process including the fit of the initial model to the observed gravity profile, re-calculation of the anomaly, and comparison of
the modelled and observed anomalies. This procedure was repeated with adjustment of the model parameters until the calculated and observed anomalies were considered a sufficient match (based on data uncertainties and model resolution).

The density values used in our initial model for the crust and upper mantle were selected from published density data (Gadjiyev, 1965; Shengelaya, 1984; Yegorova et. al., 1995). Following density values were provided in table 1: Cenozoic sediments – 2.4 g/cm³ (initially split into Neogene and Paleogene section but then combined) Mesozoic sediments - 2.6 g/cm³; Granitic layer (Upper Crust) - 2.75 g/cm³; Basaltic layer (lower crust) - 2.90 g/cm³; Basaltic Layer (Caspian Sea crust) - 2.95 g/cm³; and mantle, 3.3 g/cm³.

### Table 1

<table>
<thead>
<tr>
<th>Location A – Alborz Trough (188km)</th>
<th>Location B – South Caspian Basin (460km)</th>
<th>Location C – North Absheron (524km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Initial, Depth, km</td>
<td>Best Fit Depth, km</td>
</tr>
<tr>
<td>Cenozoic</td>
<td>2.4</td>
<td>0</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>2.6-2.64</td>
<td>11</td>
</tr>
<tr>
<td>Upper Crust</td>
<td>2.75</td>
<td></td>
</tr>
<tr>
<td>Lower Crust</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Crust of “Oceanic Type”</td>
<td>2.95</td>
<td>24</td>
</tr>
<tr>
<td>Mantle</td>
<td>3.3</td>
<td>33</td>
</tr>
<tr>
<td>Mismatch in Mgal</td>
<td>-83 Mgal Negative</td>
<td>4Mgal -50 Mgal</td>
</tr>
</tbody>
</table>

However, calculated values of the gravitational field from the initial geological model did not provide a close match to the observed gravitational field (table 1) and showed significant discrepancies. In order to evaluate discrepancies we highlighted 3 key locations along the profile (table 1) also shown in figures 4. The largest mismatch appeared to be in the around
Location A in Alborz Trough, 188 km from the beginning of the profile (2mgal observed positive values, with about 80 mgal mismatch from a model) and location C north of the Absheron Ridge (mismatch of up to 120 mgal between observed low negative and large negatives in the initial model). In the center of the SCB (Location B) there were generally always more negative values (30-50mGal mismatch) on anomaly predicted from the model compared to observation (table 1).

Fig. 4. Initial gravitational model and topography along selected Alborz-Absheron Ridge profile showing a) observed and calculated gravity response and b) corresponding density model. The values of density are in g/cm³.

For compensation of the observed gravitational field, we have varied depth to key density boundaries (upper boundary of basaltic layer of oceanic and continental crust and Moho surface) until best fit between the observed and modelled values of the gravitational field was attained. These are also reflected in table 1, with values of mismatch now no more than 10mGal. The final gravitational model, observed and calculated Bouguer gravity anomaly along the selected profile is demonstrated in fig. 5.

Key discrepancy across the profile, which interested us, was overestimation of the large negative Bouguer anomaly at the north of the profile (between Locations B and C) with the initial crustal model, which had impact on changing our assumptions.
Fig. 5. Best fit gravitational model and topography along selected Alborz-Absheron Ridge profile showing a) observed and calculated gravity response and b) corresponding density model. The values of density are in g/cm$^3$.

The new model best fit (fig. 5) introduces a dense “basaltic” type crust boundary (densities of 2.95 g/cc) only 6km thick in places close to Absheron Ridge (Location B), and draws it as downdropping below the Absheron Ridge, therefore suppressing the crust-mantle boundary. Isostatic compensation in this model therefore will occur in the mantle. Unlike previous models of Granath, 2000 thickness of this thin dense crust is not kept constant but is variable and increases to 10-12 km to the south around of Location B in the middle of SCB. Best fit also substitutes very thick sediment pile from the Mesozoic wedge by upper crustal “granitic layer”, which also supported by seismic observations. Our best fit Basement surface is taken to be a deepest interpreted seismic reflector in Green et al., (2009), which is generally shallower than in the initial model by about 5 km (table 1) across all of the profile and ranges between 16 and 20km. Our best fit model also puts maximum depth to sediments layer underneath Absheron Ridge to about 22-25km as opposed to 30km from some places in the initial model.

Modelled “bending” of the oceanic crust, in both initial and best fit models, can explain large gravity north of Location B. Values of gravity without less dense downdropping slab and thickened continental crust north of Absheron Ridge will not achieve a fit and therefore may be less reasonable.
The thickness of the Mesozoic layers in the middle part of the profile is ~8 km, which increases northward, reaching the peak value (~20 km) in the Absheron-Pribalkhan Ridge rather stays than constant as in Granath, 2000. Subduction underneath the Absheron-Pribalkhan Ridge is accompanied by the sliding of the sediments from the basaltic layer, forming accretionary wedge, which can be observed on ultradeep seismic profiles (Knapp, et al., 2004) and some of the increased thickness is clearly the result of shortening.

Green et al., (2009) also state, that while, some of the anomalous thickening is a result of shortening, especially close to the Absheron Ridge, a geographically larger part of the thick is believed by to be original feature. This feature according to authors is caused by Mesozoic rifting followed by thermal subsidence and sediment loading in the post-rift phase following the formation of the basin in Late Jurassic. Forward lithospheric modelling performed by Green et al., 2009 and Abdullayev (unpublished work) also supports existence of thin (6km) oceanic crust with high values of stretching beta-factor south of Absheron Ridge, increasing in thickness to the south. This crustal variation has been modelled in figure 5B to achieve the best fit.

There are of course other possible combination of densities and depths to achieve the best fit, however the proposed crustal model for is supported by modelling and observation from Green et al, 2009 and better describes a geological scenario than initial model.

**Earthquake data**

The South Caspian region is one of the most tectonically active regions in the world, having suffered from severe earthquakes throughout recorded history. Earthquake studies (Ambraseys & Melville, 1982; Berberian, 1983; Jackson, 1992; Berberian & Yeats, 1999; Jackson et al., 2002; Mangino & Priestley, 1998; Priestley et al., 1994, Ulomov, 2003) suggest that the SCB is a relatively rigid, aseismic block within the active Alpine–Himalayan orogenic belt (fig. 6).

To constrain better the character of thin slab the lithosphere of the South Caspian potentially undergoing subduction, we investigate also earthquake data with magnitudes in the range, 3-7 (Knapp et.al., 2004. Data were compiled from the earthquake catalogues of the Geophysical Center of RAS, including information from international seismological centers, such as NEIC, IRIS, CTBTO, ANSS, and Republican Center of Seismological Services of Azerbaijan National Academy of Sciences, for the period of 1963-2008. The earthquake distribution with in the SCB and adjacent regions is shown in the
Figure 6a. For analysis of seismicity, we used those earthquakes for which the focal mechanisms were solved and their results exist in the Harvard catalogue (http://www.globalcmt.org/CMTsearch.html) for the period 1976-2008 and located within a 2º wide area along the profile (fig. 6b). Figure 7 demonstrates the depth distribution of earthquakes and their focal mechanisms along the gravitational model profile.

**Fig. 6.** Earthquake distribution within the SCB and adjacent territories: a) from the catalogue for the 1963-2008 with M≥3, b) from the Harvard catalogue of strong earthquakes mechanisms for the period of 1976-2008, located on the 2º stripe parallel to the studied profile

Figure 7 shows that earthquake hypocenters are mainly scattered in the zone where the possible downgoing slab dips and bends underneath the continental crust. Such depth distribution of hypocenters of strong earthquakes allows us to relate the nature of these earthquakes and the frequency of their generation to the processes of emerging subduction of lithosphere of the South Caspian underneath the mid-Caspian. The focal mechanisms of the larger earthquakes (M=6.1; 6.2; 6.3) demonstrate that this zone is characterized by steep, normal-type faulting. In contrast, focal mechanisms of strong earthquakes occurring along the southern boundary of the SCB around Alborz depression demonstrate the existence of thrust faulting (fig. 7). The few thrust-type earthquake focal mechanisms near the northern boundary of the SCB
occur in the lower crust or uppermost mantle and may be associated with compression in the lower part of the brittle lithosphere due to plate bending.

Gravity modelling shown above, and seismic observations from ultradeep seismic are consistent with the hypothesis that subduction of oceanic lithosphere underneath the continental lithosphere of the northern Caspian Sea is the dominant geological process controlling seismic activity and tectonic deformation within the crust of SCB.

GPS data

The monitoring of active tectonic deformation in the South Caspian region using the Global Positioning System (GPS) measurements during the past decade provides direct observational constraints on regional geodynamic processes as well as precise constraints on fault activity (i.e., 3-D geometry, slip rates, locking depths). Results of GPS monitoring on the sites of Azerbaijan and Iran along the south and west sides of Caspian Sea were highlighted in the following researches (Nilforoushan et.al. 2003; Reilinger et al. 2006; Masson et. al., 2006; Kadirov et.al. 2008). Figure 7 shows GPS-derived velocities for sites in Azerbaijan and Iran along the south and west sides of Caspian Sea (from Nilforoushan et.al. 2003; Reilinger et al. 2006; Masson et. al., 2006; Kadirov et.al. 2008). Velocities are shown in a Eura-
sia-fixed reference frame determined by minimizing motions for GPS stations that have been observed well and are broadly distributed across the Eurasian plate. Horizontal velocity uncertainties are mostly less than 0.6 mm/yr (1 sigma) for sites in Azerbaijan and ~1 mm/yr for sites in Iran.

Fig. 8. GPS-derived velocity field, and 95% confidence ellipses for Azerbaijan (Kadirov et al., 2008) and surrounding areas (along south and west sides of Caspian Sea) shown with respect to Eurasia. Site velocities outside the territory of Azerbaijan are from Reilinger et al. (2006), Masson et al. (2006); Nilforoushan et al. (2003)

On a broad scale, the distribution of GPS velocity vectors indicate that the Lesser Caucasus block is currently characterized by anti-clockwise rotation (Reilinger et al., 2006). A striking feature of the velocity field around the S and W boundaries of the SCB is the change in the azimuth of the velocity vectors from south to north along the western part of Caspian Sea (GOSM, YARD, BILE, SHIK), and the sharp decrease in site velocities immediately adjacent to the Caspian Sea south of the Absheron Peninsula (fig. 8). GPS velocity values for site GURK, located at the edge of the Absheron-Pribalkhan zone are near-
zero with respect to Eurasia. The velocity fields clearly defines active convergence between the Lesser Caucasus/Kura Depression and the Greater Caucasus with strain concentrated along the Main Caucasus Thrust Fault (MCT). Interpretations of the GPS velocity field by Kadirov et. al, 2008 place region of Baku at the edge of SCB at the junction of four active fault systems, the MCT, the North Caspian fault and West Caspian Fault (likely right-lateral, strike slip bounding SCB), and the Central Caspian Seismic Zone.

The direction of site movements located along the coastline of the Caspian Sea in the Caucasus block parallels with SE-NW direction of potential subduction of oceanic crust of the SCB beneath the Mid-Caspian and shows the movement at the edges of the plate.

Discussion and comparison with other models

Although it remains a subject of debate, the occurrence of subduction in the northern SCB has been confirmed by a number of investigators (Khalilov et. al., 1987; Granath et. al., 2000; Allen et. al., 2002; Knapp et. al., 2004; Mammadov, 2006; Mammadov, 2008; Egan et. al., 2009; Green et.al., 2009). Granath et. al.(2000) used gravity modelling along a cross-section profile extending from south-west to north-east beginning from Iran (Albourz) using satellite-derived free - air gravity data for the SCB. The resultant model suggested that the Caspian crust is sinking beneath the Eurasian continental crust (Scythian Plate), geometrically resembling subduction. Granath et. al. (2000) kept thickness of subducting Caspian crust constant at 15km.

Based on seismicity and free-air gravity data, Allen et. al. (2002) suggested that the basement of the SCB is in the initial stages of subduction under the middle Caspian region to the north. Knapp et. al. (2004) interpreted the gentle northward deepening of the crust in the eastern part of Absheron peninsula on the Caspian Sea profile as evidence for northward subduction of the South Caspian lithosphere beneath the Central Caspian lithosphere across the Absheron Ridge. They suggest that most of the earthquake hypocenters occur within the interpreted South Caspian subducting crust, with a few events in the mantle lithosphere.

Egan et. al. (2009) present convincing evidence that the crust beneath the SCB is being subducted beneath the Central Caspian region based on seismic reflection profiling of the crust and uppermost mantle across the Absheron Ridge. Finally, Green et al. (2009) used a structural cross-section derived from a series of 2D ultradeep lines that extend from the SCB to the central Caspian area with a southeast-northwest orientation also showed subduction and addressed variation crustal structure around SCB through
forward modelling and flexural backstripping.

The best fit model presented in this paper is broadly similar to previous models. However, building on results of lithospheric crustal modelling by Green et al. (2009), the model also shows that the “basaltic-type” oceanic crust varies in thickness between 5-6km near Absheron Ridge to 10-12km in the centre of SCB, which indicates significant crustal stretching, implying a presence of Mesozoic age rift below SCB. This thin crust is shown as being subducted underneath Absheron Ridge. Also, depth to basement values from the best fit model use the interpreted deepest seismic reflector from Green et al. (2009) where it is less than 20km on average, compared with other models where it generally exceeds 20km.

The best fit model demonstrated a better calibration with some published seismic data. For example, ultradeep profile (fig. 8) published in Ismailzade et al. (2004), runs slightly less than 200km in broadly parallel direction to our modelled crosssection and shows 1) thickening of Tertiary and Mesozoic sediments before Absheron Ridge, 2) downgoing nature of the seismic reflector interpreted as Top “Basaltic” layer with depth similar to our best fit model and 3) additional thickening of Mesozoic sediments through tectonic shortening as a result of accretionary prism formation.

Best fit model therefore shows the following characteristics 1) agreement with some of published seismic data and sediment thickness model of Green et al. (2009) which accounts for somewhat reduced sediment thicknesses compared to the initial model 2) variation in thickness of the oceanic crust between “true” oceanic (6-7km) and thickened “transitional” values of 10-12 km 3) subducting slab at depth above 50km, conforming to earthquake data 4) deeper Base Crust depths for the continental crust north of Absheron Ridge and Alborz and 5) thicker upper “granitic” crust north of Absheron Ridge compared to the initial models and other sources.

Unlike some of the previous models our best fit model utilizes earthquake data focal mechanism and shows that concentration of earthquakes at depth 30-40km underneath Absheron Ridge corresponds to a depth of subducting slab from density and gravity model.

The Alborz part of the profile, where crustal thrust faulting is determined from earthquake data has not been studied in detail and requires more gravity modelling to provide geological scenarios for the large negative anomaly underneath the range.
Conclusions

Optimized 2-D gravitational model created by us along a N-S regional profile helped to understand the crustal structure variation under the SCB and helps to establish upper boundary of the “basaltic layer” slightly higher than in previous gravity models and confirms similar depth to base crust (close to Moho discontinuity) across central part of the basin. Thickness of this “basaltic layer” varies from 10-12 km in the central part of the basin to about 6 km in the northern portion of SCB, south of Absheron Ridge, which is similar to values for true oceanic crust. This indicates significant crustal stretching in this region and supports proposal of Green et al. (2009) for presence of Late Jurassic oceanic rift under SCB.

In the northern part of the profile, our results are consistent with subduction of this oceanic lithosphere underneath the mid-Caspian continental crust. The sedimentary layers of already thick rift sequence experience additional compression, resulting in tectonic thickening of Mesozoic and Cenozoic layer reaching locally ~20 km at Absheron Ridge. Subduction along the Absheron-Pribalkhan Ridge results in the occurrence of strong earthquakes, mainly with normal-fault type focal mechanisms related to the bending of the lithosphere as it begins to sink into the mantle below the north Caspian region. We speculate that the subduction has occurred recently and subducting slab have not reached great mantle depths to create melt volcanism.

Interpretation of GPS data and velocities shows counterclockwise rotational movement of the Caucasus block with respect to Eurasia confirming the continuing northward push with large slip rates along faults bounding the block in the west. It can be suggested that the geodynamics of this part of Greater Caucasus collision zone has influenced the orientation and magnitude of SCB subduction zone by pushing this block obliquely along West Caspian Fault towards area of Baku. This would cause rotation of the SCB plate in direction of Absheron Ridge.

In the Alborz thrust zone (in the southern part of the profile), compression of the oceanic crust is observed, which is accompanied by strong earthquakes with thrust type focal mechanisms that we relate to ongoing compression associated with Arabia-Eurasia continental collision. Possibility of crustal shortening in this region should be assessed in future gravity modelling studies.

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