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To cite this article: E A Abubakarova et al 2018 IOP Conf. Ser.: Earth Environ. Sci. 194 082001

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Demonstration of disjunctive dislocations of Tersko-Kaspiyskiy trough in potential fields using Koskad 3D software

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Abstract. The work presents a historical survey of investigation of deep faults and presents fault tectonics in gravity and magnetic fields of Tersko-Kaspiyskiy trough. The paper compares potential geophysical fields and disjunctive dislocations of the region under study.

1. Introduction
The faults play appreciable role in the structure of fold systems, platform regions, oil and gas content and seismic activity. The first information about faults appeared in scientific records in late XIX–early XX century and have sophisticated and long history. This term assumes various folds, dislocation (shears, drop faults, etc.). The issues connected with the character of deep fault bearing, their impact on tectonic peculiarities of sub-structure and sedimentary mantle and on formation of oil and gas accumulations within Fore-Caucasus were discussed by many researchers, such as: V.V. Belousov, G.D. Azhgirey, M.F. Mirchink, M.V. Muratov, B.G. Sokratov, N.Yu. Uspenskaya, A.I. Letavin, B.K. Lotiev, M.N. Smirnova, Yu.A. Sterlenko, R.S. Kerimova I.A., Mollaeva Z.Kh., et al.

At the first research stage, roughly E-W trending deep faults were distinguished within Fore-Caucasus: Pshekish-Tyryauzskiy, Sredinniy, Chernogorskiy and other faults. Two more deep faults located in subparallel to Pshekish-Tyryauzskiy one are southern deep fault and Khasautskiy fault.

In 1963, in the composed scheme of Caucasian deep faults, Milanovskiy E.E. and Khain V.E. distinguished faults with two directions: longitudinal Caucasus and lateral Anticaucasus direction.

Within Tersk-Kaspiysk trough in 1966 by the analysis of geological and geophysical data, three systems of deep faults were identified: northwestern pre-Cambrian faults; Hercynic Anticaucasus faults and Alpine E-W trending faults.

In 70-80s of the previous century, Tersk-Kaspiysk trough was studied by scientific and industrial organizations in terms of contemporary dynamics of Earth crust. The study within Tersk-Kaspiysk trough resulted in separation of diversely oriented lineament and ring structures. V.D. Skaryatin has compared lineaments and ring structures with known deep faults and structure-tectonic elements within Tersk-Kaspiysk trough. In general, the fault-block structure of Tersk-Kaspiysk trough is
notable for denser network of lineaments and, correspondingly, multitude of small blocks. Terskiy and Sunzhenskiy deep faults correspond to one large E-W trending lineament and several smaller lineaments.

North-East trending Argunsk fault corresponds to a number of lineaments stretching in the same direction. Edge E-W trending fault and N-W trending Benoisko-Eldarovskiy fault regionally coincide with Chervlensko-Burunniy and Eldarovskiy lineaments. Gudermessko-Mozdokskiy fault partially corresponds to Chapaevsko-Bragunsko-Pravoberezniy lineament. Besides, there are more several N-W trending lineaments. An E-W trending lineament located to the west from Datykhskaya structure coincides with Chernoorsk fault. The largest and distinct ring structures are identified in regions of Malgobekskaya, Benoyskaya, Datykhskaya and Burunnaya areas [1–7].

In the late 80s, a number of researchers (M.N. Smirnova, I.M. Krisyuk, V.D. Talalaev et al) within Tersk-Kaspiysk trough have identified systems of diversely oriented E-W trending, N-W trending and N-E trending deep faults of the sub-structure.

2. Materials and Methods
The study of fault-block tectonics is based on the results of interpretation of initial geophysical data and methods included into Koskad 3D software for spectral and correlation data analysis. This work used methods of automatic tracing of axes of anomalies, field expansion, etc. Disjunctive dislocations of the region under study are the main factor of the complex nature of geophysical fields. Block structure of the studied territory forms the crossing of diversely oriented faults that determine the history of geological development, oil and gas content of separate structural and tectonic zones and local traps associated with them. The faults distinguished by geological and geophysical data serve as boundaries for platforms, edge troughs and intermountain troughs. On the lofted limbs of such flexural folds, in a number of cases, swells and chains of local structures are located.

The disjunctive dislocations of Tersk-Kaspiysk trough are evident in the gravity field. Obviously, in Fig. 1a, the field anomalies are expressed as negative gravity values and characterize regional regularities of geological structure.

The gravity field of the studied territory belongs to central and western part of Tersk-Kaspiysk regional low. The analysis of gravimetric maps within the described territory allows identifying a number of G-force field peculiarities. The gravity field of the region is mainly characterized by E-W trending of isoanomaly curves. For the whole described territory, typical zones are large anomalous E-W trending and N-W trending zones. The exclusion is the southern part of the region, where anomalous near N-S trending and N-E trending deep faults are present.

In the north of described territory, one can distinguish zone of smooth decrease of the gravity field. The northern zone of the gravity field gradually extends from west to east. Together with general decrease of the field to the south, there are problems presented by typical flexures or dilation of isoanomals. Tectonically, this gravitation slope corresponds to the northern edge of platform of Tersk-Kaspiysk edge trough.

The magnet field is weakly differentiated and characterized by positive anomalies. On the magnetic field map (Fig. 1b), there is large E-W trending Groznensky regional maximum. This regional maximum is conditioned by intrusive rock complex connected with large deep fault. The region of negative magnetic field in the north corresponds to deep bedding of pre-Cambrian sub-structure. On the meridian of Vladikavkaz city, Groznenskiy maximum joins the lateral magnetic maximum, which is evidently has the same origin. For the south of the studied territory, a large amount of small anomalies of both signs is typical. They are conditioned, obviously, by magmatism in fault zones [2–5].
Figure 1. Maps of anomalous gravity (a) and magnetic (b) fields

Evidently, the gravity and magnetic field maps contain a number of features, such as large gradients of gravity and magnetic fields, bands of intense positive magnetic and gravity anomalies, chains of gravitational force maxima and chains of rounded positive magnetic anomalies, steep change in the trends of magnetic and gravity fields, sharp sign swings of magnetic and gravity fields, sharp swings of the general behavior of magnetic and gravity fields, the fields are intricately differentiated, weakly distorted, almost anomaly-less or the linear shape of weakly distinguished anomalies changes to isometric one.

3. Results

To identify linear nonuniformities of gravity and magnetic field, initial data were transformed using computer-assisted spectral correlation analysis of geophysical data. The software algorithms allow identifying axial linear zones of extreme magnitude, detecting weak anomalies and other.

Lineament zones identified in Fig. 2 primarily correspond to known deep faults. The nature of lineament zones without fault analogs, evidently, conditioned by deep processes as well that probably were not presented by previous geological and geophysical studies because of their small magnitude.

Figure 2. Tracing axes of anomalies along local component of gravity (a) and magnetic (b) fields

Distribution of disjunctive dislocations is the most distinct in gravity field within Terskaya and Sunzhenskaya anticlinal zones.

The analysis of the distribution of increased density of lineaments demonstrates that they are concentrated in the intersections of two and more tectonic zones of different trends, i.e. in the areas of maximum contemporary deformations conditioned by the realization of interaction stresses or juxtaposition of oppositely oriented fields [6].
The faults of different age are different in geophysical fields. The oldest faults forming inheritance in relation to the sub-structure are clearly distinguished in the magnetic field (Fig. 3) and sometimes in the gravitation one as well (Fig. 4) as intense linear anomalies or high-gradient zones. Young overlapping faults transversal in relation to the sub-structure are seen only in the gravity field as evident gravitation steps or change in anomaly trends. The majority of oil and gas accumulation zones is connected with the location of separate faults and sub-structure shatter zone [7].

4. Conclusions
Positively, faults lead to earth crust fissuring and create favorable conditions for vertical migration and concentration of hydrocarbons. Besides, these are the most recent vertical dislocations of sub-structure blocks that frequently condition the formation of swells and local structures of the sedimentary mantle. The identification of faults has both scientific and practical significance [8].

The geological interpretation and analysis of morphological peculiarities of gravitation and magnetic fields of Tersk-Kaspiysk trough by computer-assisted technologies allowed identifying the regions of rock decompression, tectonic zones corresponding to fault structure of the studied territory, mapping space regulations of fault tectonics that control the distribution of hydrocarbon deposits in Tersk-Kaspiysk trough.

From the results, the following regularities can be identified:
- after processing of potential fields, tectonic zones corresponding to fault structures of the studied territory were identified;
- trend regions and intersections of faults are characterized by high contemporary geodynamical activity.
- faults are associated with high-gradient zones of regional and local lows of gravitational force.
References

[1] Kerimov I A, Mollaev Z Kh 1989 Gravity field and seismic activity of Chechen-Ingushetiya. Issues of seismic activity of Eastern Fore-Caucasus 40 90-97

[2] Kerimov I A, Gaisumov M Ya, Abubakarova E A 2009 Geophysical fields and fault tectonics of Tersk-Kaspiysk trough. Geodynamics. Deep structures. Earth heat field. Interpretation of geophysical fields. Memorial Lectures 6-10 226-230

[3] Kerimov I A, Krisyuk I M, Gaisumov M Ya 1992 Geophysical fields, fault systems and seismic activity of Chechen-Ingushetiya. Deposited in All-Union Institute of Scientific and Technical Information. No. 1066-V 92 as of 30.03.92

[4] Azhgirey G D 1974 General geology. (Moscow: Prosveshchenyi)

[5] Kerimov I A, Gaisumov M Ya, Daukaev A A 2010 Evolution of vision of fault tectonics of Tersk-Kaspiysk trough. Proceedings of the Academy of Sciences of Chechen Republic 1(12) 63-74

[6] Smirnova M N, Brazhnik V M, Kerimov I A 1988 Fault systems of Tersk-Kaspiysk trough and their role in endodynamics of the territory. Geophysical methods for studying the earth crust fault systems and principles of their application in prognosticating ore fields. (Dnepropetrovsk)

[7] Smirnova M N, Stanulis V A, Yakovleva T V 1967 Recommendations for further prospecting and exploration and recent data on deep structure of Tersk-Kaspiysk trough. (Grozny: Worker of Grozny)

[8] Kerimov I A, Abubakarova E A, Akhmatkhanov R S, Badaev S V, Chimaeva Kh R 2013 Fault tectonics of Tersk-Kaspiysk trough and its occurrence in anomalous geophysical fields. Problems of regional ecology 6 21-25