RECONSRATION OF THE JURASSIC TECTONIC STRUCTURE OF THE KARABAKH SUBZONE BASED ON PALEOMAGNETIC STUDIES (AZERBAIJAN)

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Abstract
The article presents the results of paleomagnetic studies of the Jurassic of the Karabagh uplift subzone of the Lesser Caucasus in order to determine the horizontal displacements and rotations of the part of the earth's crust within the local structure. On the basis of paleomagnetic data, the Karabagh uplift zone movement's kinematic parameters and horizontal displacements to the north, were determined. It has been established that during the Jurassic period, the region under study, located at a latitude of 20-220 NL, shifted northward by approximately 20-220, or 2200-2400 = 300 km. At the same time, the average speed of forward movement is 1.3-1.5 cm per year for the entire territory. Also, based on paleomagnetic data, the block structure of the Lesser Caucasus region has been proven.

Keywords: paleomagnetism, paleo-tectonics, Jurassic formations, Karabakh tectonic subzone.

Introduction

The transverse contraction of the Alpine-Himalayan folded belt and the closure of the Mesozoic Tethys Ocean led to the formation of the tectonic structure of the Lok-Karabakh zone. The debate about the model of tectonic development of the Lesser Caucasus has not subsided to this day. In this regard, there is still no generally accepted model of the tectonic development of the Lesser Caucasus. The need to trace the history of the development of the Lok-Karabakh tectonic zone is due to the identification of patterns of placement of ore deposits (pyrite, alunite, iron ore, cobalt and other ores) in its bowels. This reflects the relevance of a detailed and comprehensive tectonic study of the territory of the Lesser Caucasus.

As is known, when rocks (volcanogenic and sedimentary) are formed in magnetic minerals, vectors of paleomagnetic directions corresponding to the geological time of their formation are fixed. Therefore, any horizontal movements of the rock masses, accompanied by their rotation, will necessarily cause corresponding rotations of the vectors of paleomagnetic directions. The paleolatitudes determined by paleomagnetic inclinations will not be consistent with the latitudes of the massifs of the studied tectonic structures. This fact indicates that the array under study has been moved. Information about the horizontal movements of the Earth's crust is obtained from two paleomagnetic parameters: the inclination of the natural remnant magnetization (NRM) and the paleolatitude φm. Determining the parameters of all types of tectonic blocks' movement in the Karabakh subzone will allow us to present a picture of tectonic development.

Based on paleomagnetic data from the Jurassic period, a paleotectonic reconstruction of the Karabakh uplift zone was performed. A quantitative assessment of the rotation of the blocks relative to the Earth's magnetic north pole was also made [4, 8].

2. Geological setting

The Karabakh uplift is the internal structure of the Gokce-Karabakh zone according to E.Sh. Shikhalibeyli [9]. In his opinion, the Karabakh uplift zone separates two negative structures (composed mainly of Cretaceous deposits) located in the northeast and southwest of the zone. In the south-east, the Karabakh uplift stretches from the vicinity of the village of Agoglan to the lower reaches of the Levchai River. In the west, the Karabakh uplift has a north-westerly extension. The structures of the Samkhito-Agdam zone are of Jurassic sediments (for example, the Dashkesan depression). The Karabakh uplift is oriented at an angle varying from 30° to 40°. The stratigraphic division of the Jurassic deposits of the Karabakh uplift has not been studied sufficiently. Since the fauna found in the structure of the Karabakh Uplift characterizes only the Upper Jurassic, the stratigraphic division of the Jurassic sediments needs more detail. Attributed to the Bathonian stage, the sediments are a fairly wide development. They form the entire axial band of the structure and are represented by various facies varieties of volcanogenic and sedimentary formations. The ***Bathonian*** age of this stratum is now recognized by almost all researchers of the Small Caucasus.

The entire stratum of the Karabakh Uplift's Bathonian (along the Shusha-Lachin valley) is clearly divided into two bundles: the lower bundle is mainly represented by volcanogenic formations (lower sublayer), and the upper bundle is sedimentary, represented by terrigenous (upper sublayer) formations [9]. In the Kolotag River basin, among tuff-sedimentary formations of the Bathonian's upper sublayer [2] the *"Rhynchonella" retrosinuata Var., Synsyclonema demissium* (Phill) and others were discovered and identified by T.A.Hasanov. The lower bundle (Bt_1) reaches a thickness of a little over 350 m. The section in the lower part of the lower bundle (about 180 m) is represented by lava flows (thickness from 2-3 m to 12-15 m), interspersed with tuffs (15-20 m) and thin interlayers (3-4

m) of mudstones and sandstones. Further (about 120 m), there is only an alternation of tuffs, tufoconglomerates, and lavas. The section ends with pillow lavas (150 m). The bulk contains small crystals of pyrite and magnetite, as well as brown deposits of iron hydroxides.

Occupying the rock's volume from 45 to 70% tuffs are represented by medium- and coarse-grained materials. The composition of tuffs varies from basalts to andesite-dacites. The angular shape of the tuff grains is characterized. The cementation material is highly chloritized.

Sedimentary rock layers are characterized by fine-grained and good layering. The small fragments of quartz, chlorite, epidote, pyroxene, hornblende, and calcite are represented. Small grains of pyrite and magnetite are found.

A wide variety of sizes, from 2-3 to 30-35 cm, tuff conglomerates are characterized by well-rounded clastic material. The fragments fit very tightly to each other and probably occupy at least 75-80% of the rock volume. Andesite-basalts and andesites are mainly represented. The cementing material is terrigenous with an admixture of tufa.

Pillow lavas are clusters of globular and cushion-shaped individuals, reaching 2-3 m in diameter. Their structure is aphyric, less often, porphyritic. The phenocrysts consist of plagioclase and pyroxene, and small sulfide individuals are present. The glassy bulk is highly chloritized.

The deposits of the upper pack (Bt_2) are exposed on the northeastern wing of the Karabakh uplift and, overlapping all volcanic formations, occupy the stratigraphically highest position among the deposits of the Bathonian.

The section was taken by the staff of the laboratory "Paleo-magnetism" on the road Shusha-Lachin. The thickness of the studied section reaches 370 m ***(Fig.1).***

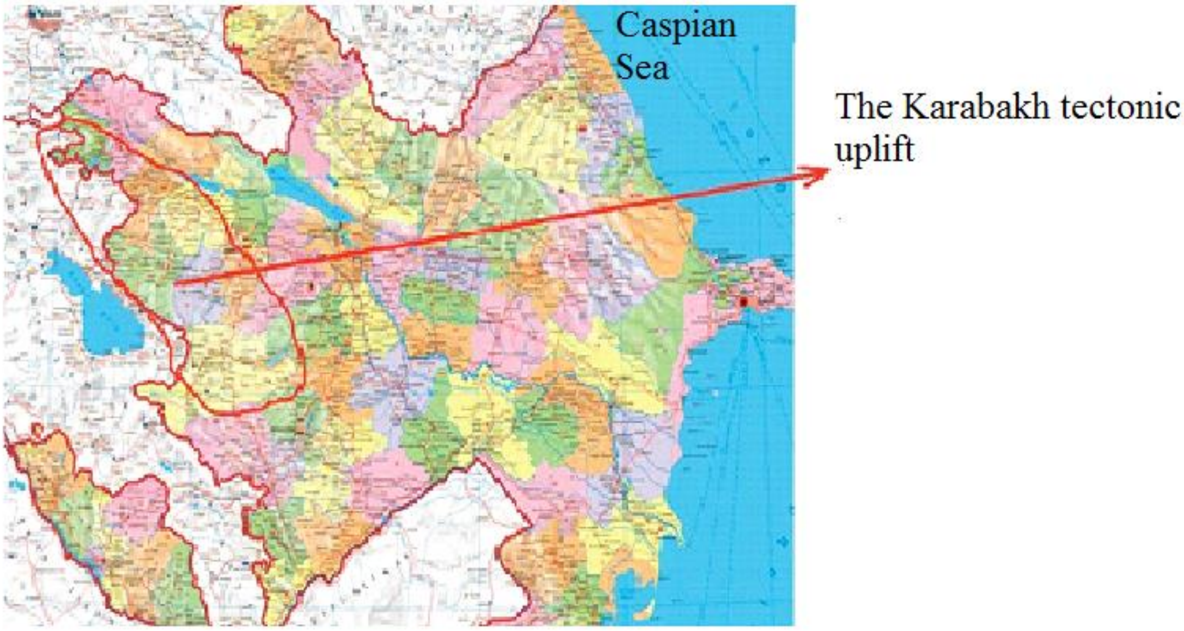

Figure 1. Contour of the area under study

The entire pack is represented by an alternation of thin (from 15-20 cm to 1.2-2.5 m) interlayers of thin-layered tuff sandstones, tuffogravelites, mudstones, sandstones, levrotuffites, and other volcanogenic. They consist of small fragments of various rocks and minerals, among which feldspar and quartz prevail.

The rocks contain small amounts of point ore minerals such as pyrite, less often magnetite, and hematite. Only in a few sections have the volcanogenic been detected. Their power ranges from 8 to 20 m.

In the contour of the Karabakh uplift, the Callowian and Oxfordian stages have development limited. They are marked only north of the middle course of the Terter River (Chapar village), as well as in the south-eastern dip of the Karabakh uplift (Doma village). Identified by similarity with other structures of facies, the Callowian and Oxfordian stages are very conditional here.

In folded regions, rock masses simultaneously participate in local and regional movements, so it is necessary to separately determine the parameters of all types of movement in order to decipher the history of the region's tectonic development and perform palinspastic reconstructions [6, 7].

The Jurassic formations have been studied in 8 sections of the main structural elements of the Karabakh uplift of the Lesser Caucasus. These sections include Gazakh-Elchilar, Khanbulag, Dashkesan, Gushchu-Kharkhan, Sherkhan, Asrikhchay, and Arkhashan. Volcanic, volcanic-sedimentary, and sedimentary formations are involved in their geological structure [9, 10, 1].

The Jurassic formations were studied along 7 sections. Volcanic formations are involved in their geological structure [9, 10, 1].

3 Methods

Measurements of the magnitude and direction of natural residual magnetization and magnetic susceptibility of rock samples were conducted at the Geomagnetism Department of the Institute of Geology and Geophysics of the National Academy of Sciences of Azerbaijan.

3.1 Sampling

For paleomagnetic studies, oriented rock samples (volcanic, volcanic-sedimentary, and sedimentary formations) were taken from the sections mentioned above. The hand specimen samples taken were cut into oriented cubes measuring 24×24×24 mm. In addition, the magnetic susceptibility was measured in the field using a Czechoslovakian kappameter KT-5 (sensitivity of 12.6×10-5 SI).

3.2 Methods of paleomagnetic research

Sample selection, sample measurements, and data processing were carried out using the standard methodology in paleomagnetism [11]. Measurements of natural remnant magnetization (NRM) were performed using a JR-6 spin magnetometer (AGİCO, Czech Republic). The volume magnetic susceptibility (k) was measured

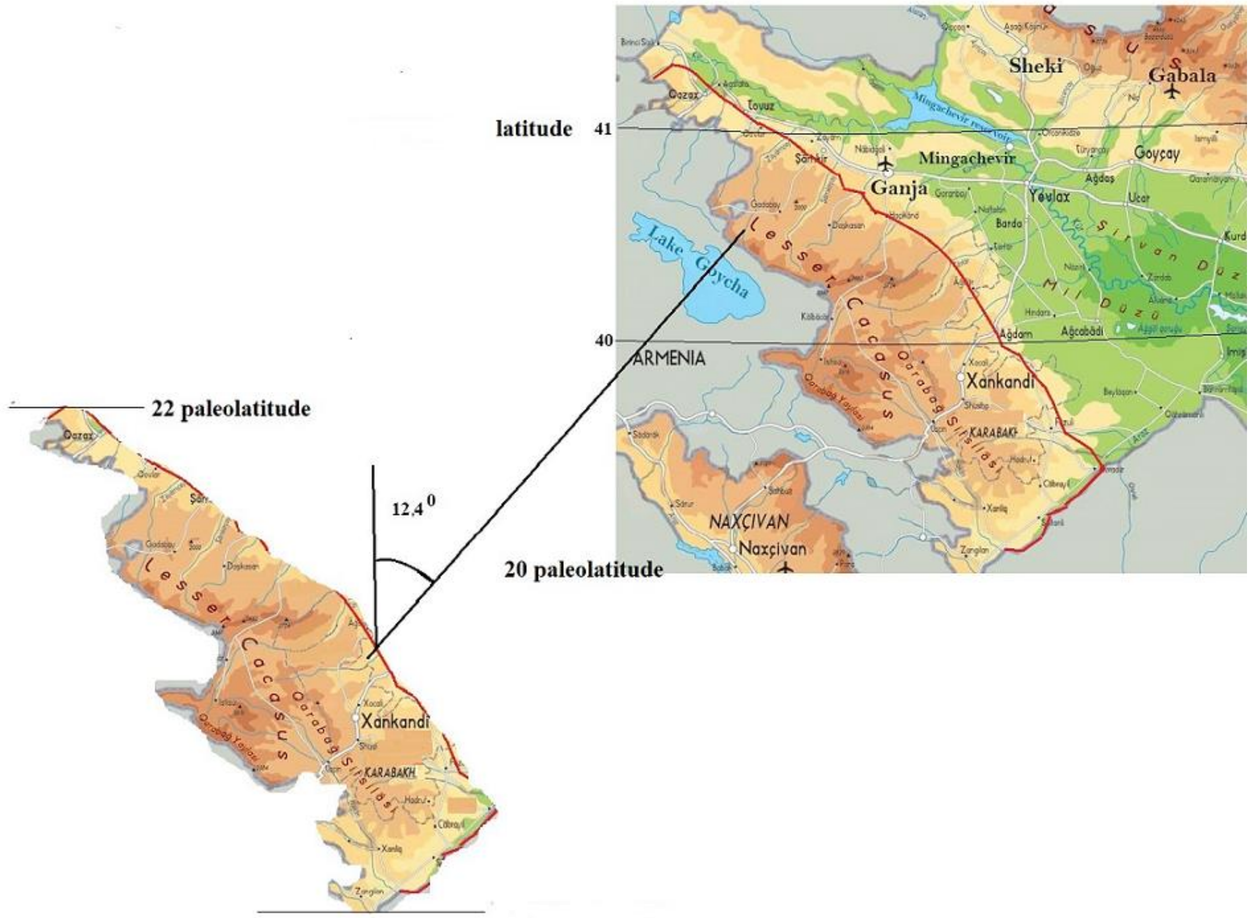

Fig.2 Position of the Karabakh Anticline during the Jurassic Period

using a Czech device called KT-5. The magnetic-mineralogical studies consisted of thermomagnetic analysis. The data for thermomagnetic analysis were obtained by demagnetizing the samples using a thermomagnetic magnetometer designed by K.S. Burakov. Data on demagnetization in an alternating magnetic field were used. The results of demagnetization were used to construct demagnetization curves and analyze the curves. Samples that exhibited significant magnetic susceptibility anisotropy were discarded. Time-based cleaning, temperature-based cleaning, and variable magnetic field cleaning were used to isolate the ancient component of the NRM. The choice of cleaning, as well as its parameters, such as temperature, amplitude of the alternating magnetic field, were determined by the degaussing curves of the EON. The type of cleaning was also determined by the course of changing the projection of the NRM vector on stereograms and by the Zijderveld diagrams. For those sections where it was possible, a direct method for determining the direction of the ancient component was used – the method of crossing the remagnetization circles. The Tellier method and the stability parameter comparison method were used to determine the nature of the NRM. The paleo-intensity of the geomagnetic field was determined using the Tellier method and the coercive spectrum method.

4. Discussion of the results.

In paleomagnetic studies, the primary question is the primacy of natural remnant magnetization. The NRM of rocks mainly consists of two main components: In_0-primary remnant magnetization, which is synchronous with the formation time of the rock itself, and In_h-secondary remnant magnetization, which occurs after the formation of primary remnant magnetization.

The main paleomagnetic parameter valuable for paleotectonic reconstruction is In_0- primary remnant magnetization. To date, several field and laboratory methods have been developed and are being used to determine In_0 [10].

Horizontal movements of the Earth's crust are calculated by using paleomag-netic parameters such as the inclination J_0 and paleolatitude φ_m. Analysis of these parameters allows us to quantify the translational movements. The calculations showed that the inclination of the eastern part of the Lesser Caucasus in the Jurassic period was 38^0 on average, and the inclination of the remagnetization circles was 36^0, with paleolatitude of φ_m=19.9÷22^0, respectively. Within the α_{95} = 6.8^0, these values are well-consistent. Using this technique, the parameters of horizontal movements were determined. It has been established that during the Jurassic period, the region under study, located at a latitude of 20-22^0 NL, shifted northward by approximately 20-22^0, or 2200-2400 = 300 km. At the same time, the average speed of forward movement is 1.3-1.5 cm per year for the entire territory.

5. Conclusion

Thus, the conducted paleomagnetic studies have shown that the paleomagnetic directions are ancient, synchronous with the time of rock formation, and can be used to analyze patterns related to the ancient magnetic field.

The results obtained allowed to clarify the history of geological development of the Lesser Caucasus's Karabakh uplift in the Jurassic period. As follows from the above, the leading role in this development belongs to the horizontal movement of lithospheric plates and microplates. The rotation of the studied region is 12.4^0 clockwise.

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