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Levant Fault Zone in Northeast Syria

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The Levant fault zone in northwest Syria is characterized by left slip displacements that surpass the vertical displacements by a factor of 10 or more. The rate of Holocene slip is about 5 mm/yr. Movements along faults of the zone occurred from the beginning of the Pliocene and displaced the structural-formational zones over distances of as much as 20-25 km. In the region of articulation of the submeridional Levant zone with the northeast-trending East Anatolian left-slip zone, clockwise rotation of the eastern limb by 35-40° is also inferred based on paleomagnetic investigation of the Lower Miocene deposits.

INTRODUCTION

As early as the 1930s-1940s a large zone of faults that received the name Dead Sea zone, and later Jordanian or Levant zone, was isolated and described on the eastern Mediterranean coast. Subsequent studies showed that this zone is detached from the Red Sea rift in the Gulf of Agaba and extends northward to the Syrian-Turkish border. Here the Levant zone comes in contact with the East Anatolian fault zone, which, beginning close to the Gulf of Iskenderun of the Mediterranean Sea, continues northeastward by Lake Hazar, intersects the eastern part of the North Anatolian zone of active faults and then bifurcates (Fig. 1). The main branch bends eastward in the form of an arc of North Armenian faults, with chich the catastrophic earthquakes of 30 October 1983 near the cities of Kars and Sarykamysh and of 7 December 1988 in Spitak are associated. The other branch is traced northeastward to the upper reaches of Kura River where it is replaced *en echelon* by the Kazbek-Tskhinval' fault described by Ye. Ye. Milanovskiy [4]. Significant signs of modern activity have not been found along it.

Confinement of such an expressive structure as the Dead Sea graben to the Levant zone was the reason that most attention was initially focused on vertical displacements along faults of the zone and the graben itself was viewed as a rift. Ye. Begmann [2] noted subsidence by 30 cm of' the eastern limb of one of the dislocations of the west bank of the Dead Sea in the ruins of the monastery at Hirbet-Kumrane associated with the earthquake of 31 B.C. and F, Diksi [3] estimated the total amplitude of recent faults at 2-3 km.

At the same time, two characteristic features of the structural pattern of the zone suggests a different direction of movement. In the first place, a left echelon structure is seen: The principal faults are positioned en echelon, each more northerly fault beginning to the west of the preceding one. The large graben-like depressions of the Dead Sea (Fig. 2), Lake Tiberias and El-Gab (Fig. 3) are situated in the sections of articulation of the faults. In the second place, in the Lebanese segment the zone deviates from a meridional direction to north-northeast and signs of overthrusting appear along its faults. Here compressed folds and faults of the Palmyrides with a significant overthrust component of the displacements are detached from the Levant zone to the northeast [1]. These characteristics suggest left-slip displacements along the faults of the zone. The latter was confirmed by direct observations of left-lateral displacements of geological bodies, their boundaries and structural formational zones in the southern part of the Levant zone [9-11]. Left-slip displacements of Late Quaternary relief forms have also been found there [10, 13]. Left-slip displacements were also found in the East Anatolian zone, κ 20-cm slip was recorded in the region of Lake Hazar during the Bengel earthquake of 1971 with a magnitude of 6.7 [12] and about 1 m northwest of Sarykamysh during the earthquake of 30 October 1983 with a magnitude of 6.9 [8]. The latter was accompanied by reverse faulting of the northeastern limb to 60 cm.

Throughout these years the morphology and kinematics of the Syrian segment of the Levant zone remained uninvestigated. However, it is of interest not only in refining the geology and earthquake hazard of western Syria, but also in understanding the history of development of the zone as a whole. For this reason, in 1983 and 1986 V. G. Trifonov together with Syrian geologists undertook systematic study of the Syrian segment of the zone and adjacent structures according to programs for joint studies of the

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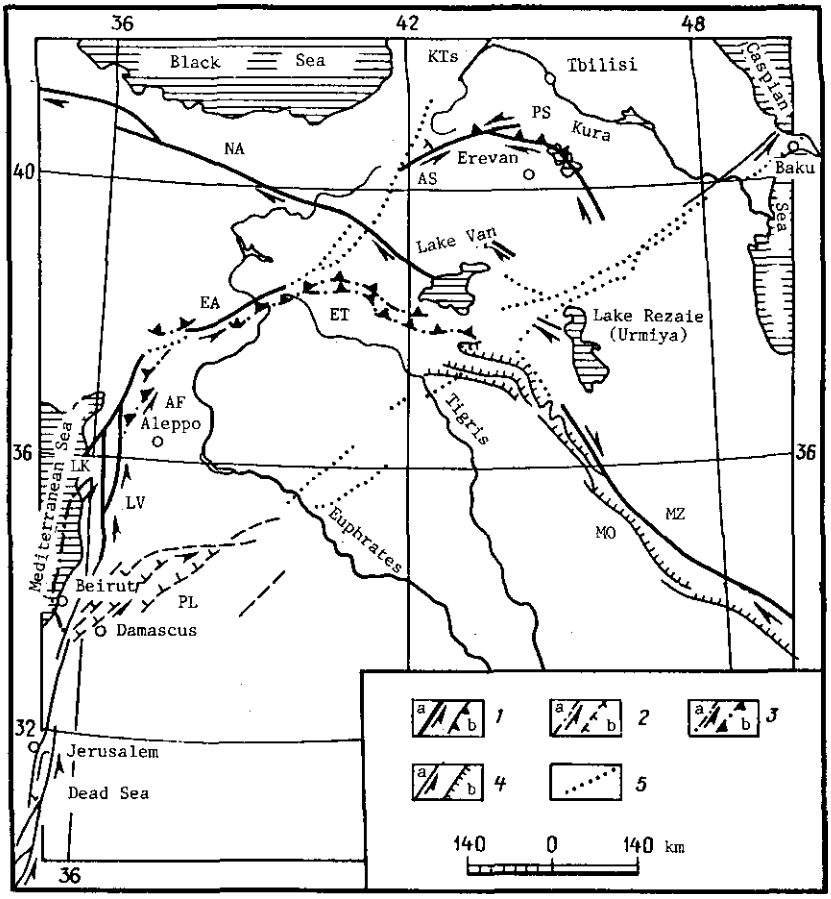

Fig. 1. Large recent faults of the Caucasus-Arabian segment of the Alpine-Asiatic orogenic belt. *1-4)* Faults (a - strike-slip faults, b - overthrusts and reverse faults): *1)* Pliocene-Quaternary, *2)* Late Miocene, *Z)* Early-Middle Miocene, *4)* Neogene and Neogene-Quaternary; *5)* continuation of faults interpreted on satellite photographs. Fault zones: EA - East Anatolian, Et - East Taurus, MO - Main Zagros Overthrust, MZ - main modern Zagros fault, LV - Levant, PL - Palmyrides, NA - North Anatolian; faults: AF - Afrin, AS - Amasiya-Sarykamysh (Zheltorechensko-Sarykamysh), KTS - Kazbek-Tskhinval', LK - Latakia, PS - Pambak-Sevan and Khanarasar.

USSR Academy of Sciences and geological organizations of Syria. The results of these studies are discussed below.

LATE QUATERNARY DISPLACEMENTS

To determine the directions and magnitudes of Late Quaternary movements, detailed study of a 26-km segment of the Levant zone was conducted in the region of Masyaf between Sahlie (Asafa) in the north and El-Beida in the south (Fig. 4). The two main branches of the fault and several smaller dislocations are readily visible here. Numerous left slips and bends of valleys and ravines have been found along both branches. The valleys and their elements of different age are displaced over varying distances. In the northern part of the western branch valley, displacements of 400-450, 60-70, and 30-40 m have been found. In the southern part of the same branch in the region of El-Beida, the young strike-slip fault does not exceed 25 m. In the northern part of the eastern branch, slip displacements of 130 and 13-20 m have been found (in one case 75-80 m). To the south they increase to 150-175 and 34-40 m respectively. Analysis of the relief shows that the last numbers in each series characterize Holocene displacements; the others are Late Pleistocene-Holocene. The magnitude of the slip displacements along the western branch diminish from north to south, and along the eastern branch they increase, but in sum they remain unchanged, at least for the Holocene. The total rate of slip along both branches can be tentatively estimated at 0.5-0.6 cm/yr. The

Fig. 2. Levant zone in the region of the Dead Sea. Photograph from the Salyut-4 space station, KATE-140 camera.

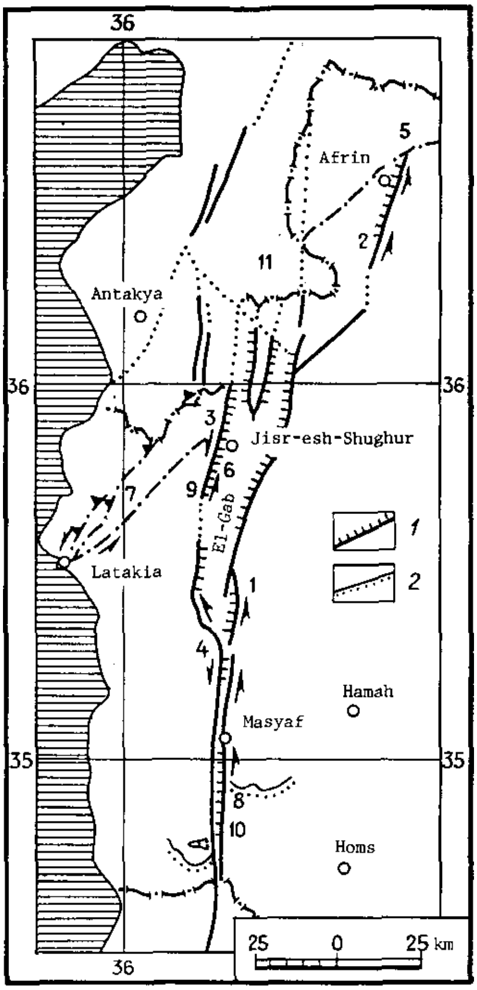

Fig. 3. Syrian segment of the Levant fault zone. *1)* Faults with an upthrow component of displacement; *2)* northern boundary of the field of Late Miocene plateau basalts. See Fig. 1 for other notation. Numbers on the map: 1 - ruins of Afamiya (Apamea), 2 - Dar-Taaz, 3 - Zhanudie, 4 - Jur el Ain el Kruum, 5 - Midanki, 6 - Nahr-el-Azi, 7 - Salyb-Yastin, 8 - Saraiya natural boundary, 9 - Sarmanie, 10 - Haddi, 11 - Lake Al-Umk.

left displacement by 0.6 m of the Late Ancient or Early Byzantine aqueduct near El Hafr along the eastern branch of the fault zone is consistent with this. Everywhere the vertical displacements surpass the horizontal ones of the same age several-fold.

Determinations of the magnitude of young left-slip displacements along the southwestern and western flanks of the El-Gab depression are close to the cited figures, but the ratios of vertical and horizontal components of displacement here are greater than in the more southerly 26-km segment of the zone described above. Thus, in the southwestern flank of the depression in the region of Jur el Ain el Kruum, the southwestern limb is uplifted by 10-11 m with left bending of the valley by 28-30 m. On the west flank of the depression between Sarmanie and Jisr-esh-Shughur, left displacements of the valleys by 150-200, 24-32, and 6 m are noted. Small streams are bent leftward by 6-7 m with a rise in forms of the eastern limb of the same age by 1.5m along the fault of the eastern flank of the El-Gab depression to the south of the

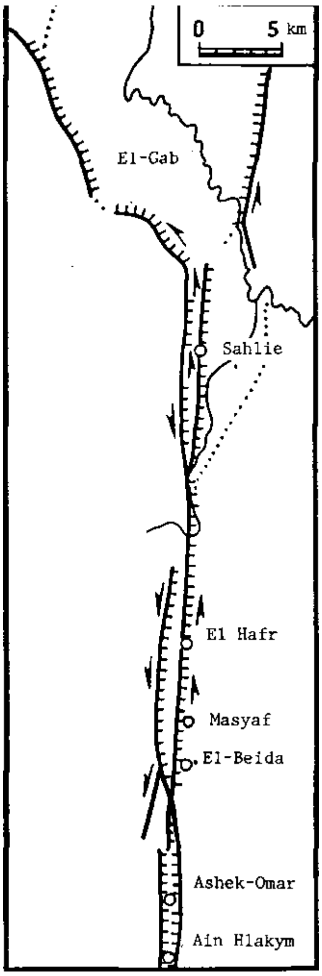

Fig. 4. Active faults of the Masyaf segment of the Levant zone. See Figs. 1 and 3 for notation.

ruins of ancient Apamea.

TOTAL RECENT DISPLACEMENT

The structure of the Syrian segment of the Levant fault zone becomes complicated in a northerly direction. The single fault in northern Lebanon close to the Syrian-Lebanese frontier divides into two branches (see Fig. 3) that separate from each other by a distance of as much as 1.5 km. Low-amplitude feathering fractures appear farther to the north in the western limb. Still farther to the north the compact zone breaks down into two main faults that enclose the El-Gab depression on the west and east with a width up to 18 km. Further complication occurs in the northern part of the depression. A central horst is isolated in its axial part. Low-amplitude feather jointing appears in the western limb. A fracture detaches from the fault of the eastern limb to the north-northeast, along which a cupola 350 m high and 3-4 km diameter immediately west of Dar-Taaz, slightly elongated in the northeasterly direction and composed of Helvetian-Tortonian carbonates, is broken off and displaced leftward by about 800 m. A vertical component of displacement is almost absent. Farther north near Afrin it appears in the form of a steep scarp with an uplifted eastern limb, but investigation of fracturing indicates predominance of slip displacements as before.

Reaccentuation of the importance of the two main branches of the Levant zone enclosing the El-Gab depression occurs in an northerly direction. The western fault is better expressed in the south. As already mentioned, Late Quaternary slips of greater amplitude occurred along it. The amplitude of the recent vertical movements is also greater. The difference in hypsometric surface levels allow us to estimate them: 1300-1400 m on the western flank of the depression, about 600 m on the eastern flank and 200 m on the bottom of the depression. According to geophysical data, the basement of the recent deposits of the depression lies at depths of a few hundred meters. We can therefore assume that the recent rise of the western flank above the bottom amounts to 1500 m and that of the eastern flank 800 m, whereas the rise in the western flank above the eastern reaches 800 m in places. To the north the difference in elevation of the limbs diminishes. The western branch close to the present Turkish-Syrian border (Lake Al-Umk) attenuates, whereas the eastern branch becomes predominant and continues northward, coming in contact with a nevj branch trending north-northeastward from Antakya (see Fig. 3).

In order to estimate the total recent displacement in the Syrian segment of the Levant zone we will consider the geologic structure of the limbs. In the north, close to the Turkish-Syrian border, the structural zones trend northeastward. West of the El-Gab depression the Bassit block, the Burh-Islara zone and the Nahr-el-Kebir trough are distinguished from north to south, pinching out to the northeast. Rocks of the ophiolite complex predominate in the Bassit block, participating in the structure of the series of tectonic sheets discordantly overlain by Maastrichtian and Paleogene deposits. The Burh-Islan zone is mostly composed of a Paleogene carbonate bed up to 1000 m thick contorted into large simple folds and discordantly overlain by a thin Helvetian bed that Is usually gently dipping. The Paleogene deposits in Nahr-el-Kebir trough are comparatively thin, but the Neogene deposits reach significant thickness (to 2500 m). Tortonian and Helvetian strata are widely distributed, the latter occurring on the underlying beds with an erosional unconformity.

The Latakia fault zone — part of the Latakia-Kilis system of faults distinguished by V. P. Ponikarov and his colleagues— extends along the boundary between the Burh-Islam and Bassit zones with the Nahr-el-Kebir trough. The zone consists of en echelon series of faults trending north-northeast and forming a large lineament of northeasterly trend that coincides over a significant distance with the El-Kebir River valley and in the west is expressed in the relief by a scarp with an uplifted northwestern limb. One of the faults of the zone is exposed near Salyb-Yastin. The ophiolites are overthrust along it onto the Helvetian marls and, judging from the orientation of the slip grooves, a left-slip component of the displacements was present.

The Paleogene carbonates in a railroad cut and coastal bluff on the southern outskirts of Latakia are disrupted by overthrusts that dip northwest 30-35°, the orientation of the slip grooves on their slip grooves on their surfaces also indicating a significant left-slip component of the displacements. The Paleogene bed together with the overthrusts is tilted and overlain with a 100° unconformity by Helvetian deposits. They form a small syncline which is discordantly overlain on the sea coast by Early Quaternary sandstones. On the fault strike the sandstones contain large blocks of Helvetian and Paleogene rocks indicating disruption of the geomorphologically expressed fault scarp. Finally, fragments of ancient ceramics have been found here on a continuation of the upthrown limb of the described group of faults in the profile of marine terrace I (elevation 3.5-4 m), indicating continued uplifting in historical time at a rate of no less than 2 mm/yr. Thus, the principal phase of overthrusting pertains to the pre-Helvetian, when folding occurred in the Burh-Islam zone and additional deformations in the Bassit block. Weaker displacements occurred later up to the modern epoch.

The northwestern zone of ophiolites, Jurassic and Cretaceous deposits and the southeastern zone of Maastrichtian-Paleogene rocks are distinguished east of the El-Gab depression in the region of Kurd-Dag. The Maastrichtian deposits in the northwestern zone discordantly overlie the underlying formations, for which complex deformations of the ophiolites and an overall imbricate structure are characteristic, but in turn are gently contorted and disrupted by fractures. The Maastrichtian-Paleogene rocks in the southeastern zone are overlain with erosion by Lower Miocene deposits. Simple folds and small fractures are characteristic. The zone is bounded on the southeast by the Afrin lineament, which is expressed in this location by an eroded scarp with an upthrown northwestern limb.

Despite certain structural differences we can compare the northwestern zone of Kurd-Dag with the Bassit block and the southeastern block with the Burh-Islam zone. The Afrin lineament represents a continuation of the Latakia fault zone. If this is so, then all these zones, in which intense folding and fracturing was completed in pre-Helvetian time, were then displaced leftward by 20-25 km along the Levant zone.

To the south of El-Beida, covers of Neogene basalts lie on the Jurassic and Cretaceous beds of the limbs of the Levant zone discordantly with a gentle slope. The main areas, especially the northern boundary, are displaced on the western and eastern limbs relative to each other leftward by about 10 km. This might be explainable not by horizontal movements, but by the' characteristics of the volcanic structures, basalt flows and their subsequent erosion (such erosion actually did occur, especially on the western limb), were it not for two facts. In the first place, on the eastern limb in the region of Haddi and farther to the south (see Fig. 3), basalt dikes of mostly northwesterly strike are common, but on the western limb they are not found, probably having been displaced southward. In the second place, on Landsat photos of the northern part of the basalt field and next to them in the Jurassic and Cretaceous rocks, a ring structure is interpreted about 20 km in diameter. Its two parts, separated by faults of the zone, are displaced leftward along them by roughly 10 km. The detected left-slip displacements surpass the vertical displacements by a factor of 10 or more.

AGE OF THE SYRIAN SEGMENT OF THE LEVANT ZONE

The fact that the structure displaced by the faults of the Levant zone were completed by the Helvetian age, limits the age of displacements to the Late Miocene, Pliocene, and Quaternary period.

The Neogene plateau basalts form flat mountain peaks enclosing the zone. The surface of the plateau basalts diminishes gently to the west and east. South of Ain Hlakym the thickness of the basalts increases and they form the flank of the Recent Horns depression. No increase in thickness of the basalts toward the fault valley or within it is noted. Given the high mobility of the basalt flows, which extended to tens of kilometers, this suggests the absence of a geotnorphologically expressed fault valley during eruption of the plateau basalts.

In the central and southern parts of the pleateau basalt field their thickness probably reaches several hundred meters. On the northern flank it is less, although even here more than 10 separate covers are isolated. An idea concerning them is offered by the plateau basalt profile in the Sarai natural boundary on the eastern limb of the Levant zone (Fig. 5). All the covers have a severely altered, weathered surface, sometimes eroded. The degree of alterations of the basalts diminishes markedly upward along the profile. It is obvious that their formation occupied a significant time interval. This is also indicated by three determinations of the radiometric age of the basalts by the potassium-argon method: 5.8-7.5 and 10 My [7].

Three rock complexes have been described among the deposits of the rift valley proper. The first is represented by profiles near the

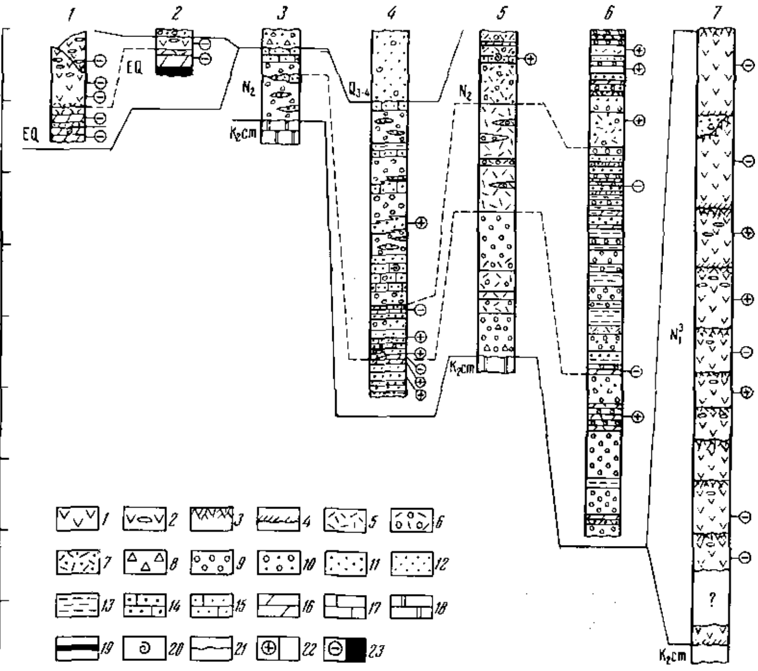

Fig. 5. Profiles of Recent deposits of the Syrian segment of the Levant fault zone: *1)* Jisr-esh-Shughur, *2)* Nahr-el-Azi, 3, *4)* Afamiya (Apamea), *S)* Ashek-Omar, *6)* Ain Hlakym, ?) Saraiya. *1)* Basalt; *2)* vestibular basalt; *3)* weathered and fractured upper part of basalt flow; *4)* quenched basalt in base of flow; *5)* tuff; *6)* tuff-breccia; ?) tuff-sandstone; *8)* breccia; *9)* conglomerate; *10)* gritstone; *11)* sandstone; *12)* siltstone; *13)* clay; *14)* calcareous sandstone; *IS)* calcareous siltstone; *16)* marl; *17)* marly limestone: *18)* limestone; *19)* lignite; *20)* faunal remains; *21)* surface of unconformity; *22–23)* magnetization: *22)* direct, *23)* inverse (left in Fig. 5, right in Figs. 6 and 7).

villages of Ain-Hlakym and Ashek-Omar with a thickness to 100 m (see Fig. 5). They contain many conglomerates consisting mostly of fragments of Cretaceous carbonate and siliceous rocks with pebbles of the above-cited basalts being represented in limited amounts. The conglomerates alternate with basal tuffs and subordinate interlayers of gritstone, sandstone, argillaceous-aleuritic rocks, and rare marls. All these rocks are fairly compacted, and close to the faults of the Levant zone they were subject to dynamometamorphism. The profiles near the ruins of ancient Apamea, which are more weakly consolidated and are devoid of a tuff fraction, however, are similar to them in terms of characteristics of the terrigenous and carbonate fractions. Apparently the centers of eruptions were located farther to the south. It is possible that their relicts are the small basalt bodies extending along the faults of the Levant zone and differing from the plateau basalts. The nature of the described profiles suggests alluvial-proluvial, rarely lacustrine origin of the deposits, which formed under conditions of broken relief that formed as a result of movements along faults of the zone. Faunal remains classified as Pliocene by Syrian paleontologists have been found at the top of the Ashek-Omar profile. The middle, relatively thin (15-20 m) complex crops out in the northern part of the El-Gab depression near Jisr-esh-Shughur and Nahr-el-Azi (see Fig. 5). It is represented in the lower part by marls and lignites with interlayers of tuffs, and in the upper part by basalts of local volcanos. It is obvious that relief was generally relatively level at this time in the northern part of the fault valley. Lakes were present with individual volcanic structures. The freshwater fauna from the marls of the Jisr-esh-Shughur profile were determined to be Pleistocene by Syrian paleontologists.

The third complex is composed of alluvia and deluvia of the Recent bottom and slopes of the El-Gab depression up to a few tens of meters thick. Some of the best preserved basalt volcanoes of the northern part of the depression and its mountain framework possibly pertain to it. The relief of the fault valley at this time was close to the modern relief.

The last complex is obviously dated Holocene, Late and possibly Middle Pleistocene. Determinations of remanent magnetization of rocks carried out and analyzed by V. M. Trubikhin at the Institute of Geology of the USSR Academy of Sciences were involved in substantiating the age of the remaining complexes. The samples of the collection were sawed into standard cubes with a 2 cm edge and measured on a JR-4 magnetometer (Czechoslovakia). All the samples were subjected to standard thermal cleaning by sequential heating to 100 and 200° in a nonmagnetic space. Most of the samples afforded good results, permitting reliable isolation of the sign of polarity and compilation of a paleomagnetic stratigraphic column. It is true that the number of samples is inadequate for final conclusions. The proposed variants of comparison with the world magnetochronological scale should therefore be viewed as tentative.

Different lava covers of profile 7 (Saraiya) gave different magnetization values (Fig. 6). Considering the change in signs of magnetization and the above-cited determinations of the radiological age of the basalts, it is logical to compare their sequence with magnetic anomalies from 3ar-3br to 4ar, which encompass a time interval from 5.8 to 8.9 My. It is possible, although less likely, that the upper lava cover, much less altered than the underlying one, is comparable to magnetic anomaly 2ar-3r, i.e., close in age to 4 My.

The terrigenous and tuffogenic deposits of profiles 4-6 (see Figs. 5 and 6) correlate with each other in terms of both material composition and magnetization of individual horizons. Direct magnetization predominates with two inversely magnetized horizons. These profiles are compared fairly reliably with magnetic anomaly 2a (the Gauss paleomagnetic epoch), having an age of 2.5–3.4 My with which individual faunal determinations also agree. The volcanogenic-sedimentary profiles 1-2 are characterized by reverse magnetization and, considering their location in the El-Gab depression and the Pleistocene age of the faunal determinations, can be compared with magnetic anomaly 1r-2r, i.e., with the Matuyama epoch (0.7-2.5 My), most likely with its Pleistocene part, younger than 1.8 My.

Thus, the fault valley in the Levant zone within Syria appeared by infilling with sediments no earlier than 3.5 Ma. Six and possibly 4 million years ago, no signs of the faults are noted either in the orientation of the chains of basalt volcanos or in the relief characteristics that determine the lava flows. For this reason, emplacement of the Syrian continuation of the Levant zone and the possible onset of Strike-slip displacements along it should be assigned to the very end of the Miocene-beginning of the Pliocene (5.5-6 Ma), whereas the onset of displacement of the plateau basalts should probably be assigned to a somewhat later epoch, but one that began no later than 3.5 Ma. The average of Pliocene-Quaternary slip along the Levant zone is therefore defined at 3.5-4 mm/yr.

POSSIBLE ROTATION OF STRUCTURES OF THE EASTERN LIMB OF THE LEVANT ZONE

The Levant and East Anatolian fault zones have different trends: The former is meridional, the latter northeast. They join in the region of Antakya at an angle of about 30°. Owing to this bending, the limbs of the Levant zone in its northern part were under different geodynamic conditions and could have experienced additional deformations. In order to check this supposition, samples were taken from two profiles of the Lower Miocene deposits located in different limbs of the fault zone (on the southeastern margins of the Bassit and Kurd-Dag zones) to determine the orientation of the remanent magnetization elements. The first profile is located near Zhanudie northwest of Jisr-esh-Shughur and the second near Midanki on the right bank of the Afrin River (Fig. 7). Both profiles begin with massive Middle Eocene limestones, in places containing a large amount of nummulites. Higher in the first profile a significant hiatus occurs and Aquitanian strata lie on the limestones with a concealed unconformity. Like the younger Lower Miocene deposits, they are represented by marls with beds of marly limestones and rare marly siltstones. In the second profile the range of the stratigraphic hiatus is smaller. Upper Eocene and Oligocene strata occur on the limestones with erosional unconformity, basal conglomerates and sandstones. Interlayers of siltstone, sandstone, and rate conglomerate are present together with the predominant marls and marly limestones. They are also present at the bottom of the Aquitanian, where tuffogenic sandstones appear with conglomerate, lenses and blocks of coral limestone, probably redeposited Oligocene formations. The overlying part of the Lower Miocene is similar to the first profile.

Paleomagnetic measurements of the Lower Miocene deposits were carried out according to the same method as for the Late Miocene plateau basalts and Pliocene-Quaternary deposits of the fault valley considered above. During thermal cleaning for a number of samples it was not possible to reliably distinguish the direction of the ancient geomagnetic field. The same samples from the Lower Miocene, which could be evaluated as suitable for paleomagnetic interpretations, proved adequate to speak generally of the sign of polarity, but inadequate for reliable statistical processing. Nevertheless, some preliminary judgments can be made.

In the first place, an upper normally magnetized part and a lower inversely magnetized part with two normally magnetized episodes are distinguished in both Lower Miocene profiles. This permits more reliable correlation of the profiles. At the same time, the thickness of the Lower Aquitanian horizons in the profile of the western limb is much greater, possibly in conjunction with more intense sedimentation (and subsidence?).

In the second place, a difference in the profiles in the orientation of magnetization Is

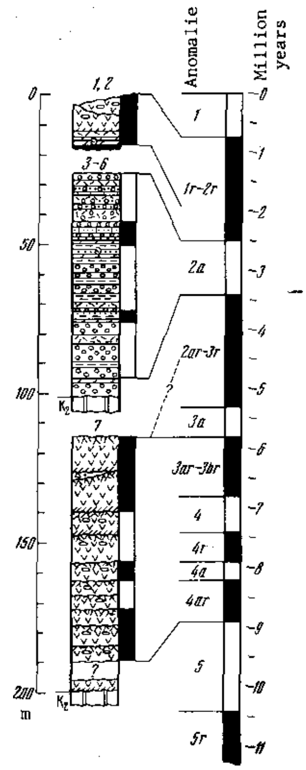

Fig. 6. Paleomagnetic characteristics of profiles of recent deposits of the Levant fault zone. See Fig. 5 for notation.

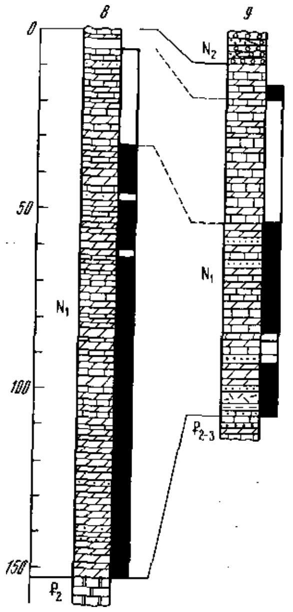

Fig. 7. Profiles of Lower Miocene deposits of the western limb of the Levant fault zone near Zhanudie *(8)* and the eastern limb near Midanki (9). See Fig. 5 for notation.

^ ε

seen. Figure 8 shows the distribution on a sphere of the normally magnetized samples from both profiles. The profile of the western limb shows a direction of the vector coinciding with the direction of the ancient geomagnetic field for the given region (declination 0-5°, dip about 50"), whereas in the profile of the eastern limb a deviation from the ancient direction of the geomagnetic field by 35-40° is recorded (declination 40°, dip 55°). This can be evaluated as an indication of a possible later clockwise rotation of the eastern limb of the zone by 35-40°.

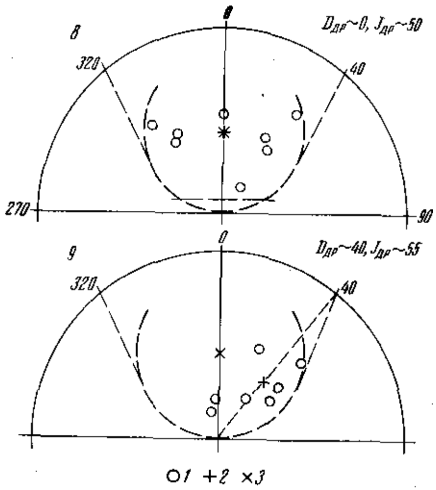

Fig. 8. Directions of vector of remanent magnetization of normally magnetized rocks of profiles of Lower Miocene deposits 8 and 9 (see Fig. 7). *1)* Single determinations; *2)* "center of gravity" of individual measurements; *Z)* direction of vector of Early Miocene geomagnetic field for the considered region.

CONCLUSION

The Levant fault zone within Syria is a left-lateral strike-slip fault with a vertical (upthrown) component that lags behind slip by a factor of 10 or more. The total recent slip reaches 20-25 km. It is interesting in this connection that a total left-slip displacement of 107 km was estimated in the Israeli segment of the zone by A. Quennel [11], allowing for the appearance of two phases of movement: Miocene (according to the modern division - Early-Middle Miocene) by 64 km and Pliocene-Quaternary, which in the modern understanding includes the Late Miocene, by 43 km. R. Freund [9], who estimated the total displacement within Israel at 60-80 km, assumed a longer time of movement, but was close to A. Quennel in determining the magnitude of the Late Miocene-Quaternary displacements. Thus, the difference in total amplitudes of slip in the Israeli and Syrian segments of the zone is connected with the much shorter duration of the displacements within Syria. Here there was a rate opportunity to determine the age of rocks that formed both in the structures of the formed zone and before its appearance. This placed a constraint on the time of emplacement and development of the Syrian segment of the zone to the last 5.5-6 million years. As a result, the average rates of slip in the Syrian (3.5-4 mm/yr) and Israeli (about 4 mm/yr) segments proved to be comparable. The rates of the Holocene displacements also differ little in these segments: 5-6 mm/yr in Syria [1] and 7.5 mm/yr in Israel [13].

These facts, however, raise the following question: To where did the Israeli segment of the Levant zone continue before the end of the Miocene, the left-slip displacement along which surpassed 60 km? This question requires special consideration that goes beyond the scope of the article. For this reason, we will merely note possible ways to solve it. As mentioned above, the structures of northwestern Syria that trend northeastward and are cut by the Pliocene-Quaternary continuation of the Levant zone developed as a result of intense Late Cretaceous deformations and were significantly reworked in the Middle Miocene, more precisely pre-Helvetian. The previously formed structures were complicated in the Middle Miocene, and new folds developed along with the left-lateral overthrust strike-slip faults of the Latakia-Afrin zone that extend along them. In the east they were continued by marginal folds and overthrust of the eastern Taurus directly grading into the zones of the main Zagros overthrust. We can assume that in this period the Levant zone to the north of the latitude of Beirut passed along the bottom of the Mediterranean Sea along the continental slope and came in contact near Latakia with the indicated zone of faults and folds, forming a single structural framework for the Arabian plate with it.

In part simultaneously with this fold-fault zone, but mostly later, at the end of the Miocene, the folded-disruptive system of the Palmyrides intensely developed, having branched off from the Levant zone within Lebanon and southwestern Syria. Not only overthrusts, but also left-slip displacements occurred along the fault of the Palmyra trend [1]. Continuing to the northeast, these faults came in direct contact with the Main Zagros Overthrust and in the Late Miocene separated the northwestern part of the Arabian plate (Aleppo block). In the Pliocene-Quaternary, with weakening of the movements in the Palmyrides, the modern continuation of the Levant zone in northwest Syria developed. Such migrations of plate boundaries are in no way a unique phenomenon [6].

The Pliocene-Quaternary age of the northern part of the Levant zone offers a basis to presume the same young age for the Eastern Anatolian fault zone that continues it to the northeast. Simultaneous left-slip displacements along both zones with differences in trend led to clockwise rotation of the eastern limb of the northern part of the Levant zone. Continuing to the northeast, the East Anatolian fault zone intersects the North Anatolian right slip zone. Judging from expression of the zones on satellite photographs, none of them in the region of intersection significantly displaces another. But each of the zones is curved in the direction of slip along the other zone. This could indicate comparable rates of horizontal movements along both zones and confirms their relative geological youth, owing to which the amplitudes of displacements in the region of intersection have still not reached a significant value.

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