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THE STRUCTURAL POSITION OF THRUSTS IN THE RECENT OROGEN OF THE CENTRAL TIEN SHAN

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Close mapping of the areas of recent thrusts of the Central Tien Shan demonstrates that they are elements of intricately built shear zones. A system of conjugate diagonal faults of NW and NE strikes, which are secondary with respect to the marginal ones, develops within sublatitudinal blocks bordered by sinistral reverse faults and strike-slip faults. Mass motion along the system of conjugate faults gives rise to local compression zones at the top of wedge-shaped blocks. In the actual geologic structure, these zones are compensated by major reverse faults and thrusts. When the thrusts come to the surface, the frontal part of the allochthon is destroyed, which is marked by Neogene-Early Pleistocene tectonic gravitational mixtites. The described structure of the shear zones formed in a transpression setting.

Thrusts, faults, tectonic gravitational mixtites, transpression, Tien Shan

INTRODUCTION

The major structures of the Tien Shan mountains are zones of stable uplifts and stable warping zones between them. The boundaries of these zones (ranges and basins) inherit, as a rule, marginal faults of Paleozoic origin, dividing the upper crust into large blocks of latitudinal and WSW strikes [1–3]. These blocks were considered to be zones of Caledonian or Hercynian consolidation, each with its own section type and structural paragenesis [1, 4]. Now it is known that the marginal faults are Late Paleozoic sinistral strike-slip faults with horizontal shifts of about 20–60 km [5–8].

According to most scientists, the majority of the recent faults of the Tien Shan are reverse faults and thrusts. Submeridional tangential compression is considered to be the main factor determining recent tectonics in the region [3, 9, 10]. From the viewpoint of plate tectonics, these data are regarded chiefly as a result of subductions and collisions occurring in the zone of collision between the Indo-Australian and Eurasian lithospheric plates [11–13].

Comprehensive geophysical study of the Earth's crust and the upper mantle of the Tien Shan, structures of intermontane areas, and Cenozoic magmatism allowed many scientists to assume the taphrogenic nature of the modern Tien Shan structure [14–18].

These arguments for the collisional or taphrogenic model of the Tien Shan origin were obtained during general studies. Trofimov [19, 20] is probably the only expert who performed detailed structural studies which allowed an unambiguous reconstruction of the emergence of faults in the Central Tien Shan, a region including ranges from the Khan-Tengri mountain group in the east to the Fergana Range in the west.

This problem is most crucial for the areas of occurrence of recent thrusts. In geodynamic analysis, the latter are described either as common [3, 9, 21], or small-amplitude break thrusts [10], or as large-scale overthrusts [12], or even as structures of gravitational sliding of an original taphrogenic structure [15]. We investigated in detail three areas of this type at different distances from the boundary between the Tien Shan and the Kazakhstan Shield: in the center of the Kyrgyz Range, on the southern slope of Kungei Ala-Too, and in the valley of the Karakudzhur River, separating the Terskei Ala-Too and Karadzhorgo Ranges (Fig. 1).

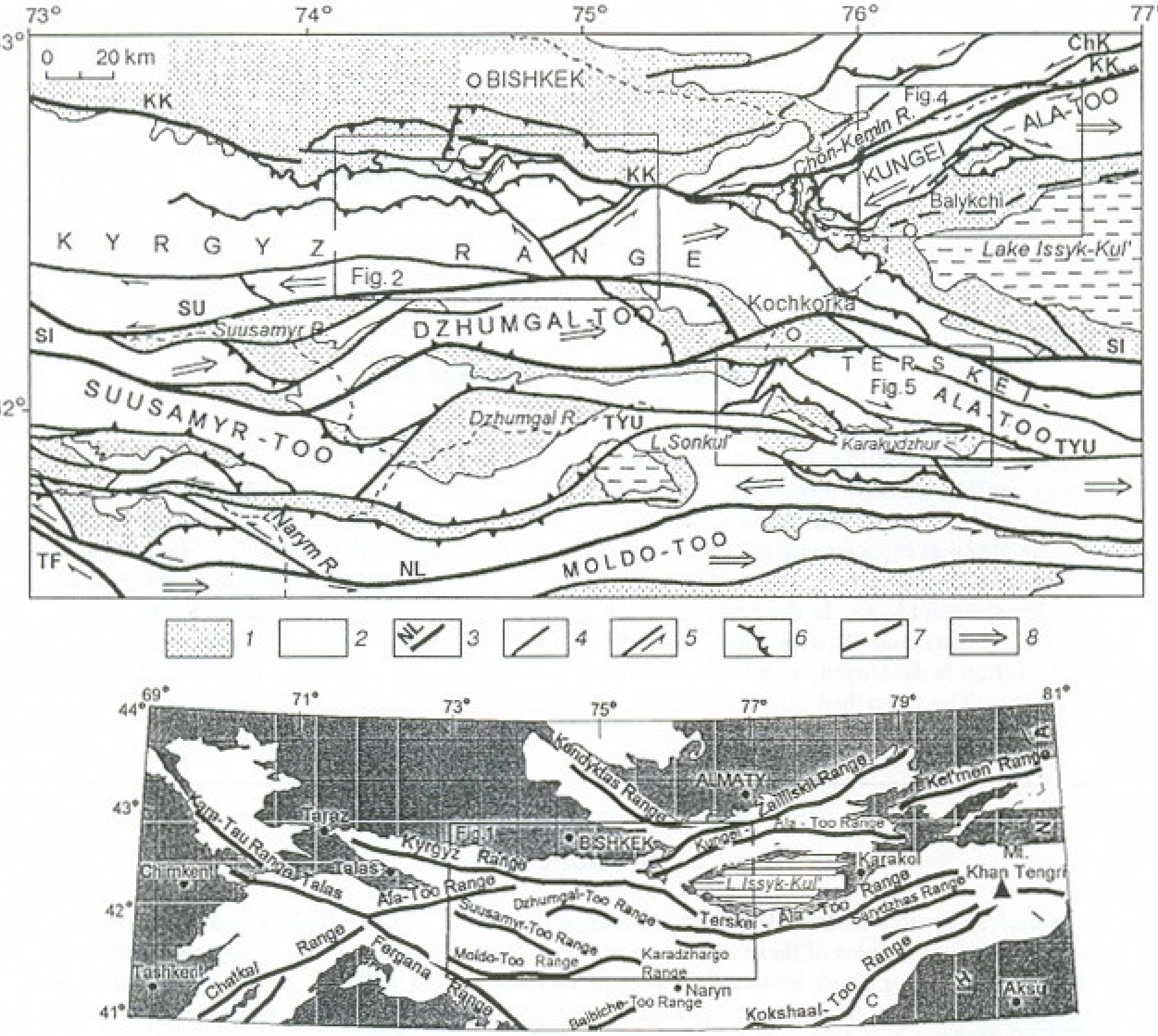

Fig. 1. Recent tectonic map of the western part of the Central Tien Shan compiled according to [22]. ***1*** **— intermontane and intramontane basins filled with Cenozoic deposits;** ***2*** **— recent tectonic uplifts made up of Riphean-Paleozoic complexes;** ***3–7*** **— faults:** ***3*** **— marginal,** ***4*** **— intrazonal,** ***5*** **— strike-slip,** ***6*** **— thrusts,** ***7*** **— overlain by a cover of Quaternary deposits;** ***8*** **— sheet movement direction. Marginal faults: ChK — Chon-Kemin (northern), KK — Kyrgyz-Kungei, SU — Suek, SI — Suusamyr–Issyk-Kul', TYU — Tyulek, NL — "Nikolaev line", TF — Talas-Fergana. Inset map: main ranges of the Central Tien Shan, Meso-Cenozoic deposits of intermontane basins (gray filling), and outline of the investigated region.**

REFERENCE AREAS

Central part of the Kyrgyz Range. The Kyrgyz Range is one of the major Tien Shan uplifts. It is strongly dissected near the divide, and the preorogenic peneplain (POP) was completely eliminated by recent erosion [21]. The maximum elevations of the hilltop surface reach 4000–4900 m. In the south, the Kyrgyz Range is bordered by the steep Suek fault, and the Suusamyr intermontane basin is adjacent to the range along this fault. The roof of the Paleozoic basement of the basin occurs at absolute elevations of 750–1200 m. The overlying Cenozoic sedimentary prism is 1000–1500 m thick. The amplitude of vertical displacement of POP along the Suek fault is 2.5–3 km [10]. The vertical movements are probably accompanied by a synchronous sinistral strike slip of mountains, because the eastern end of the Suek fault is conjugate with a series of thrusts of northwestern strike, where the Paleozoic complexes of Dzhumgal-Too are thrust over the Cenozoic

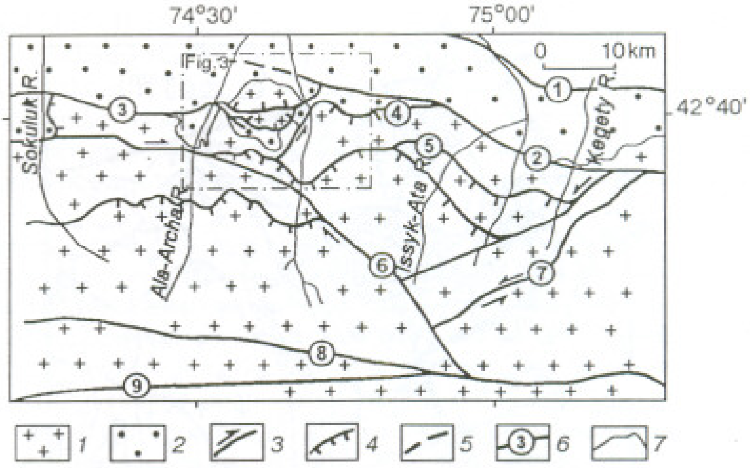

Fig. 2. Recent tectonic map of the central part of the Kyrgyz Range. *1* **— combined Riphean-Paleozoic structures;** *2* **— Cenozoic deposits;** *3* **— strike-slip faults;** *4* **— thrusts and reverse faults;** *5* **— faults covered with Quaternary deposits;** *6* **— fault number as mentioned in the paper;** *7* **— stratigraphic contacts.**

sediments of the Kochkor basin (Fig. 1). The considered fault is inherited from the Late Paleozoic structure of the region, where it was ranked as a boundary fault between zones [22].

The uplift under consideration is bordered in the north by the boundary Kyrgyz-Kungei fault, which appeared in the Late Paleozoic and became active at the recent stage. In the Paleozoic structure of the region, it separates the Caledonian-Hercynian complexes of the Kyrgyz Range from the coeval structures of the basement of the Chu basin and the Kendyktas Range. To the east from the end of the Chu basin, this fault runs among the rocks of the pre-Cenozoic basement and separates the Riphean-Paleozoic continental complexes of the Issyk-Kul' massif, forming the eastern part of the Kyrgyz Range and Kungei Ala-Too, from the Early Paleozoic island-arc complexes of the Chon-Kemin valley (Kemin zone). At present, this fault appears as a sinistral reverse-slip fault with an amplitude of 2–3 km, which is determined from a displacement of left tributaries of the Chon-Kemin River [23]. Kyrgyzstan geologists refer to the eastern Kyrgyz-Kungei fault as the Southern Chilik-Kemin fault. Kazakhstan geologists refer to it as the Northern Kungei fault.

The amplitude of the vertical POP displacement along the Kyrgyz-Kungei fault reaches its maximum of 3–4 km in the middle of the Chu basin and gradually decreases east- and westward. There, at the longitude of Bishkek, the maximum subsidence of the roof of the Paleozoic basement is recorded. It reaches 4.5 km below sea level. The Cenozoic prism filling the basin gently pinches out northward [9, 18, 22]. The boundary between the Chu basin and the Kyrgyz Range is not continuous along the strike. At the recent stage, the boundary fault was divided into minor faults, which are sequentially conjugated to each other with a sinistral displacement (Fig. 2). In the Shamsa segment (Fig. 2, fault 2), the continuous Paleogene-Neogene cover of the basin is adjacent to the Paleozoic complexes of the range at the longitude of the Kegety River. As close as the right bank of the Ala-Archa River, the fault vanishes among the modern alluvial-proluvial deposits, and the Kyzylbeles segment is considered to be a boundary between the uplift and the basin (Fig. 2, fault 3).

A distinct bundle of splitting sinistral overthrusts (Tatyr virgation), forming a package of slices of southern vergence, occurs at the junction of the segments (Fig. 3). Each slice is composed of Ordovician granodiorites overlain by Paleogene red-colored deposits (Fig. 3, section). Such slices occur where shearing strains attenuate [24]. The Early Pleistocene activity of the boundary fault and formation of the Tatyr overthrusts is confirmed by the fact that they break the Sharpyldak Formation (N_2^3-Q_1^1) but are overlain by Middle Pleistocene deposits.

Being sinistral reverse faults, the Kyrgyz-Kungei and Suek faults outline the uplift of the Kyrgyz Range, an intricately built zone of recent strains. The strains manifest themselves, in the Riphean-Paleozoic rocks, where higher-order strike-slip faults are oblique to the range. To the west from the arbitrary meridional boundary approximately corresponding to the Ala-Archa and Alamedin divide (Fig. 3), the range is dissected by dextral faults of northwestern strike (Fig. 2, faults 6 and 8), whereas sinistral faults are common to the east from the boundary (Fig. 2, faults 4 and 7). The geometry of these faults was established from slickensides and asymmetric folds adjacent to the faults.

The mentioned disjunctions separate Riphean, Early Paleozoic, and Middle Paleozoic assemblages. For

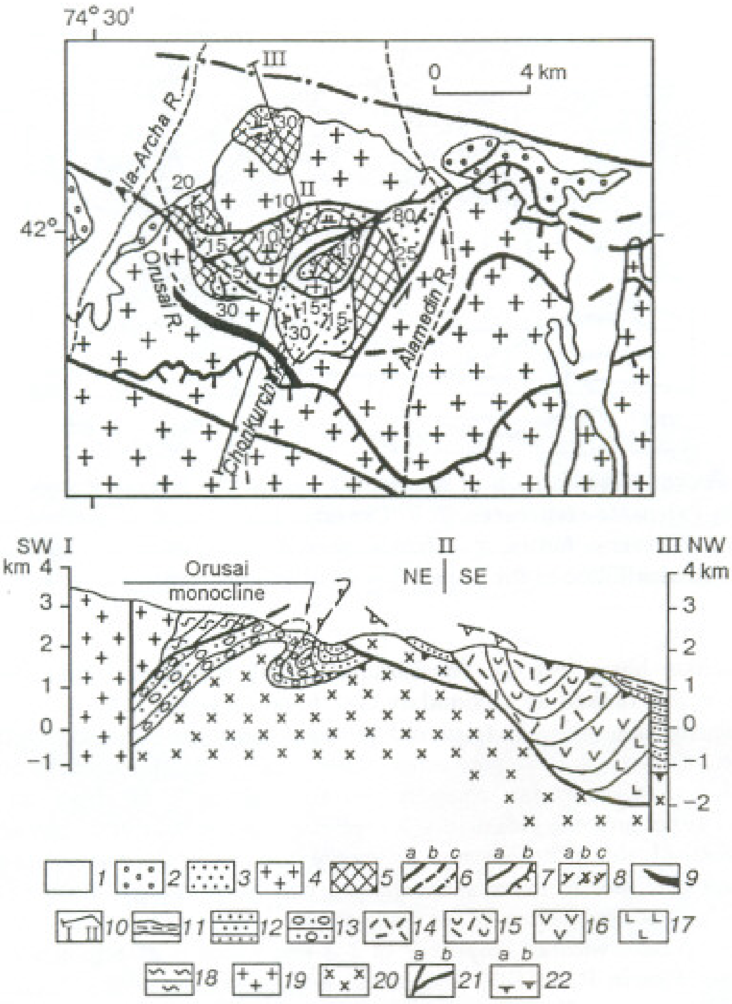

Fig. 3. Geological sketch of the Ala-Archa – Alamedin interfluve. For the geological map: *1* – Quaternary, *2* – Upper Pliocene-Lower Quaternary, *3* – Paleogene-Neogene deposits; *4* – combined Riphean-Paleozoic structures; *5* – preorogenic peneplain with Paleogene-Neogene erosion outliers (out of scale); *6* – steeply dipping faults: *a* – established, *b* – inferred, *c* – established by geophysical methods beneath the Quaternary cover; *7* – fault geometry: *a* – strike-slip faults, *b* – thrusts; *8* – bedding: *a* – normal, *b* – tilted, *c* – occurrence of the preorogenic peneplain; *9* – axis of the Orusai anticline; *10* – section line I-II-III. For the section: *11* – Quaternary deposits; *12* – Paleogene-Neogene deposits; *13* – Upper Devonian-Lower Carboniferous red-colored assemblage; *14, 15* – Middle Devonian volcanogenic deposits: *14* – rhyodacites, *15* – tuffs; *16, 17* – Lower Devonian volcanogenic deposits: *16* – andesites, *17* – basalts; *18* – Upper Riphean apodacitic shales; *19* – Lower Silurian leucocratic granites; *20* – Upper Ordovician granodiorites; *21* – faults: *a* – steeply dipping, *b* – thrusts; *22* – preorogenic peneplain: *a* – intact, *b* – eroded.

this reason, they were considered to be elements of the Caledonian-Hercynian structure of the region [25]. We did not rule out the Late Paleozoic age of the emergence of the complex, but comprehensive examination of all faults revealed signs of their recent activity in the form of POP and watercourse dislocations, clusterization of epicenters of weak earthquakes, or seismic dislocations [26, 27]. In particular, the location of the Karakol fault (Fig. 2, fault 8) determines the asymmetric structure of the Kyrgyz Range. The fault is separated from the Suek marginal fault (Fig. 2, fault 9) at the headwaters of the East Karakol River and can be traced in the western direction along the divide of the range. The narrow tectonic block bordered by the mentioned faults possess a well-preserved POP, gently sloping to the south, and forms the southern slope of the range [10].

On the northern slope of the Issyk-Ata Range, the Alamedin (6) and Kegety (7) faults form a conjugate system of strike-slip faults bordering the Kashkasui thrust (5) in the southeast and southwest (Fig. 2). The frontal part of the Kashkasui thrust is made up of Riphean rhyodacite tuffs thrust over Ordovician granites and Upper Devonian red-colored rocks. The bottom of the thrust contains an up to 50 m thick zone of mylonites and cataclasites. Seemingly, this is a type fragment of a Late Paleozoic structural complex, except for the fact that the Kashkasui thrust cuts the Alamedin fault (4), and both of them certainly belong to the recent paragenesis.

Combined seismological, geological, and geodesic studies in the zone of dynamic influence of the Alamedin fault demonstrated that it was seismically active throughout the Late Holocene. The hypocenters of earthquakes related to the fault occur at depths of 18–20 km and are characterized by sinistral movements at the foci. Electrooptical distant measurements performed from August 1988 to March 1991 showed that the average rate of the sinistral movement over the fault is 2 mm/year [26]. The sinistral movements along the Alamedin fault at its northeastern end are compensated by the thrust of the Paleozoic complexes of the Kyrgyz Range over the Pliocene-Early Pleistocene and Middle Pleistocene deposits of the piedmonts (Fig. 3).

Outliers of the Kyrgyz red-colored complex (₽-N_1) have been preserved to the west from the above-described strike-slip fault, in the Chonkurchak–Ala-Archa interfluve. Together with the underlying Middle Paleozoic deposits, they are involved in intense folding along the front of the Kashkasui thrust (5). The Orusai anticlinal fold tilted to the northeast was mapped in the Upper Devonian-Lower Carboniferous terrigenous deposits. To the northwest, the anticline flattens out and is periclinally closed on the right bank of the Ala-Archa River. The southeastern end of the fold is cut by the Kashkasui thrust. The gentle southwestern flank of the Orusai anticline is profoundly eroded, but the tilted northeastern flank retains not only POP but the stratigraphically overlying red-colored rocks of Paleogene age. The red-colored rocks dip to the northeast 150–200 m east of the contact and flatten out, forming the Chonkurchak syncline. In the north, this structure is cut by the thrust slips of the Tatyr virgation (Fig. 3, section).

We observed the upturned superposition of the Kyrgyz red-colored complex (₽-N_1) on the left bank of the Chonkurchak Brook. There, the Upper Devonian-Lower Carboniferous sandstones and conglomerates underlie the basal Kokturpak horizon of the Kyrgyz red-colored complex made up of characteristic breccia-like marls and red-brown clays with an angular unconformity of 20–30°. This contact is of paramount importance for revision of the existing view on the recent tectonics of the area. So far it has been described as the Chonkurchak boundary thrust, along which the Paleozoic complexes of the near-divide area of the ridge moved onto the Cenozoic red-colored rocks of the high piedmonts [10, 28]. This opinion is shared by the scientists investigating this region and persists in all papers on the recent tectonics of the Central Tien Shan.

Southern slope of Kungei Ala-Too. The Kungei recent tectonic uplift is separated in the north from the Chilik-Kemin graben, striking along the Chon-Kemin River, by the Kyrgyz-Kungei fault. The Issyk-Kul' intermontane basin occurs to the south from the Kungei uplift (Figs. 1 and 4). The most downwarped middle part of the basin is referred to as the Central Issyk-Kul' graben-syncline. Within this structure, the roof of the Paleozoic basement occurs at a depth of 3000–3500 m below sea level, whereas the maximum thicknesses of the Cenozoic deposits reach 4000 m. This is explained by overcompensated sedimentation in the closed basin [10, 20]. In the north, it borders the cis-Kungei trough, which strikes along the southern piedmont of the Kungei Range. The trough is separated from the Central Issyk-Kul' graben-syncline by the Tasma fault (13), which matches the steepest slope of the Issyk-Kul' basin. The boundary with the Kungei uplift is drawn along the cis-Kungei fault series (11, 12) [10, 20]. The cis-Kungei trough is a monocline. The Paleozoic basement, observed at elevation of 1000–1500 m in the northern part of the fault series, submerges in the south to 1000–2000 m below sea level. The thickness of the Cenozoic cover increases in this direction from 1000 to 2500 m. A discrete piedmont zone consisting of three isolated areas runs along the northern margin of this trough [10, 20]. We performed a close examination of the westernmost Tor-Aigyr area (Figs. 4 and 5), which is of peculiar interest because just there a recent tectonic thrust was described for the first time in the Central Tien Shan [29].

According to our studies, the paragenesis of the recent structures of Tor-Aigyr is bounded by sublatitudinal marginal faults: the Kyrgyz-Kungei fault (10) in the north, with a 2–3 km long sinistral displacement of river valleys along it, and the Tasma fault (13), in the south. In the investigated area, the Tasma fault is chiefly covered with modern deposits. According to E. A. Strel'tsov (oral communication), who performed a hydrogeological survey there, this fault can be reliably detected by electric prospecting methods and is traceable 4–6 km to the north from Lake Issyk-Kul'. Its southern flank subsides for 200–300 m (Fig. 4).

A conjugate system of second-order strike-slip faults occurs within the tectonic sheet bounded by the mentioned boundary faults. In the area under study (Figs. 4 and 5), they are the dextral Kul'-Tor strike-slip

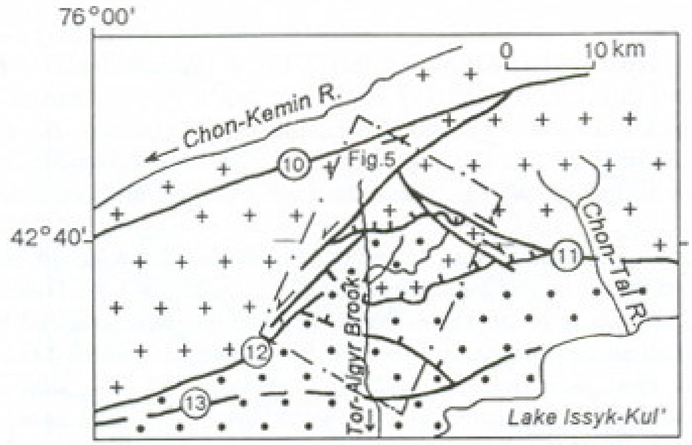

Fig. 4. Recent tectonic map of the western part of the Kungei Ala-Too Range. Designations follow Fig. 2.

fault (11), striking to the northwest, and the sinistral Toguzbulak one (12), striking to the northeast and consisting of three parts arranged in en-echelon pattern. The strike-slip nature of the Toguzbulak fault is proven by a displacement of the deposits of the Sharpyldak Formation (N_2^3-Q_1^1). The Kul'-Tor fault occurs in Paleozoic granitoids, and its dextral displacement was revealed by investigation of slickensides. At a distance from the intersection, the strike of these faults changes to sublatitudinal, and the displacement surfaces gradually flatten out and subside to the north. On these grounds, our colleagues [10, 20] regarded the faults as a system of the cis-Kungei boundary thrusts, separating the Paleozoic compexes of the range and the Cenozoic deposits of the Issyk-Kul' basin.

Thrusts and reverse faults with southern vergence occur in the southern sheet, bounded by the Kul'-Tor (11) and Toguzbulak (12) conjugate strike-slip faults (Fig. 5). The northernmost one is the most prominent. It is the fault that was described by Pomazkov [29] as the recent Kungei tectonic thrust. The Paleozoic rocks exposed at the piedmont of Kungei Ala-Too consist of Silurian red medium-grained and porphyry granites. The preorogenic peneplain emerging on them and the overlying deposits of the Kyrgyz red-colored complex gently (5–20°) dip to the north and northwest.

In the upper reaches of the Tor-Aigyr and Chirpykty Brooks, the Ordovician granitoids and related metamorphic rocks making up the near-divide area and the northern slope of Kungei Ala-Too thrust over the red-colored sandstones and siltstones of the Shamsa Formation. The thrust zone is very intricate. The intact red-colored rocks are immediately thrust over by Silurian intensely broken-down red granites of an autochthonous complex, containing slices of dislocated sediments of the Shamsa Formation. They are about 50 m thick. Up the section, there are tectonic rocks of an allochthonous complex: blocks of weakly modified light-gray granites and granodiorites, granite-gneisses, migmatites, and amphibolites, 5–50 m long and up to 20 m thick. They are immersed into matter disintegrated to a varying extent (from coarse-clastic breccias to attrition clay). The tectonic melange forms a 300–350 m thick zone gently (10–15°) dipping to the north. Ordovician unaltered granitoids occur stratigraphically higher. The tectonic melange zone on the surface is 0.6–1 km wide. Dislocated tectonic breccias are "peeled" off weakly cemented tectonic structures exposed on the day surface. The breccias form a rockslide train down the slope at 1.5–2 km from the frontal area of the thrust. The red-colored rocks of the Kyrgyz complex are eroded to the east from the Kol'-Tor Brook. There, tectonic melange and related rockslide train immediately overlie Silurian red granites. According to Utirov [30], Middle Pleistocene moraines cut into the tectonic structures and the rockslide matter (considered by him to be seismogravitational structures), thereby dating the Kungei thrust to the Early Pleistocene.

Seven kilometers to the south, the drainage system dissects the Kyzyl-Kol'-Tor mountains, made up of Silurian granites, which are overlain by the red-colored rocks of the Kyrgyz complex, thrust over the deposits of the Sharpyldak Formation (N_2^3-Q_1^1). The fault fissure dips to the north at 55–65°, but as close as the right bank of the Tor-Aigyr Brook this thrust is overlain by a Late Pleistocene proluvial cone, indicative of the Middle Pleistocene age of the Kyzyl-Kol'-Tor reverse fault. Five kilometers farther downstream, the Tor-Aigyr Brook dissects the Ak-Teke mountains, made up of poorly cemented lacustrine deposits of the Chu Formation (N_2). They are horizontally bedded but form an asymmetric anticlinal fold near the southern margin of the

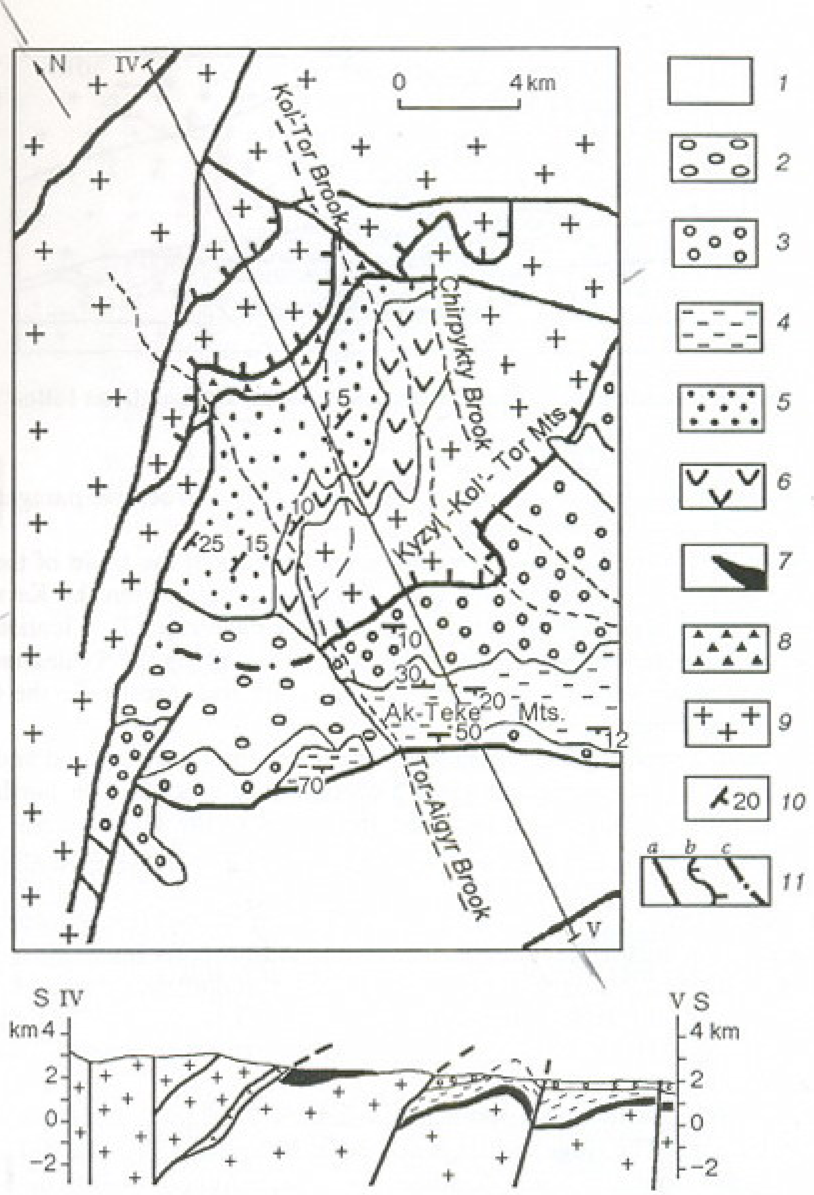

Fig. 5. Geological sketch of the Tor-Aigyr Brook. Deposits: *1* — recent, *2* — Upper Pleistocene, *3* — Upper Pliocene-Lower Quaternary, *4* — Upper Neogene; *5–7* — Kyrgyz red-colored assemblage: *5* — red-colored sandstones and conglomerates of the Shamsa Formation (₽$_3$-N$_1$), *6* — basalts and clays of the Kokturpak Formation (₽$_{1-2}$), *7* — combined Kyrgyz assemblage (for the section); *8* — tectonic melange; *9* — combined Riphean-Paleozoic structures; *10* — dips and strikes; *11* — faults: *a* — steeply dipping, *b* — thrusts, *c* — covered with Quaternary deposits.

range. The loams, evenly bedded sandstones, and conglomerates of the Issyk-Kul' Formation are thrust over the Late Pleistocene-Holocene deposits forming an alluvial bench of the northern flank of the Issyk-Kul' basin along a recent fault bordering the range in the south. This exposure was shown to me by K. E. Abdrakhmatov, who reasoned that the recent age of the fault is proven by a displacement of terraces of various ages on the banks of the Tor-Aigyr Brook.

Thus, the sheet under consideration has been active during the whole Quaternary. Tectonic stresses are compensated by emergence of reverse faults and thrusts, sequentially shifted to the south. The faults demarcating the field of Cenozoic deposits on the southern slope of Kungei Ala-Too are subsidiary or minor structures in the paragenesis under study and cannot be regarded as the cis-Kungei boundary fault, as in [10, 20]. Obviously, this notion should change the fundamentals of recent tectonic zoning, because the Tor-Aigur

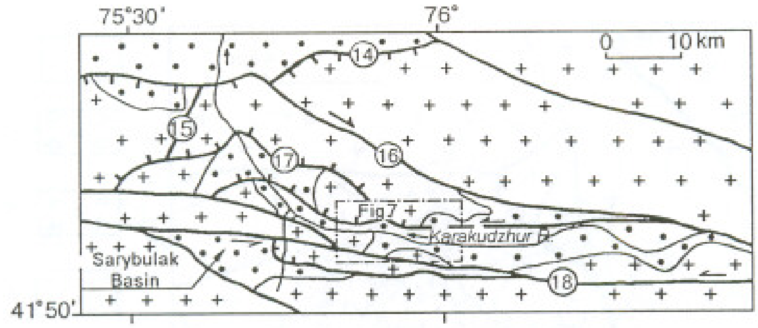

Fig. 6. Recent tectonic map of the Karakudzhur basin. Designations follow Fig. 2.

triangular sheet, Kungei uplift, and cis-Kungei monocline form a larger structural paragenesis, separated from the Issyk-Kul' basin by the Tasma boundary fault.

Karakudzhur valley. The Karakudzhur intermontane area occurs in the basin of the Karakudzhur River (Fig. 6). In the south, it is bounded by the Tyulek fault (18), separating it from the Karadzhorgo Ridge. The sinistral movements found in the fault were inherited from the Late Paleozoic [7]. A lenticular block (3×30 km) formed by Riphean shales from the northern flank of the fault strikes along the Tyulek fault. During its recent movement to the west, this block was extruded from the fault zone and thrust over the Cenozoic deposits of the Sarybulak basin and underlying Ordovician granites.

The Karakudzhur basin is made up of Paleogene-Neogene red- and gray-colored and variegated deposits, conformably overlying the peneplain and gently (5–20°) dipping to the north. The northern boundary of the basin is the Karakudzhur thrust (17), running along the right bank of the Karakudzhur River. In the middle 1970s, T. A. Dodonova mapped the thrust and noted a thick zone of tectonic crushing and transported breccias along the thrust strike.

The right tributaries of the Karakudzhur River are well exposed, and this allowed a close investigation of the internal structure of the mixtite assemblage. The mentioned breccias resulted from degradation of the frontal part of a tectonic sheet migrating to the south along the Karakudzhur thrust. A geologic sheet made up of tectonogravitational mixtites (olistostrome) is traceable for 10 km by 0.7–2.5 km wide outcrops (Fig. 7). The olistostrome rests on the POP or Paleogene-Neogene deposits and is laterally substituted by the same red-colored and variegated rocks.

The mixtites are, as a rule, partly turf-covered at the surface. They form a cascade of ridges, descending to the south from the thrust zone. The ridge surface is formed by alternating hills and sinks, which is determined by wide occurrence of sagging funnels 2–5 m in diameter. The composition of clastics in the mixtites is perfectly correlated with the rock varieties forming the allochthone. It varies from Riphean phyllites and metabasalts in the west to Late Ordovician hornfelses and granites in the east. The maximum thickness of the olistostrome (800 m) is observed in the Dzhartash stow. There, the section is stratified owing to a change in rock composition in the mixtites. The lowermost horizons of the olistostrome are made up of irregularly bulked boulders, rock debris, and gruss, virtually without a finer filler. This rock mass, up to 70 m in thickness, covers the peneplain surface or the Paleogene-Neogene detrital loams and gravelstones which appear in the lower part of the section east of the Bel'che Brook and are no more than 20–30 m thick. The peneplain surface and overlying loams dip to the north at 10–20°. Above the basal uncemented breccias, the mixtite structure is more regular owing to the presence of outliers of tectonic slices made up of Riphean and Early Paleozoic rocks. Their thicknesses range from 10 to 50 m, sometimes to 100 m. Shear fractures are abundant at the bases of the rootless slices. The slices are underlain by zones of loose cataclastics, up to 2 m in thickness, consisting of attrition clays and including crushed rock debris. Down the section, there are uncemented breccias formed by degradation of the frontal part of the thrusting sheet. They are 2 to 20 m thick. The fragments in the breccias are angular, mainly of detrital size, but there are also boulders, whose surfaces demonstrate tectonic striation and friction planes. The breccias are filled with psammitic cataclasite. Along the strike, the tectonic slices give way to kakirites and then to breccias. At the eastern and western ends of the Karakudzhur basin, the breccias are substituted in facies by the deposits of the Kyrgyz red-colored complex, which suggests their Paleogene-Neogene age.

The tectonic movements along the Karakudzhur thrust were interrupted in the Late Pliocene, as evidenced by a trail of fine-grained terrigenous sediments of the Sharpyldak Formation (N_2^3-Q_1^1) in the basin of the Ukok

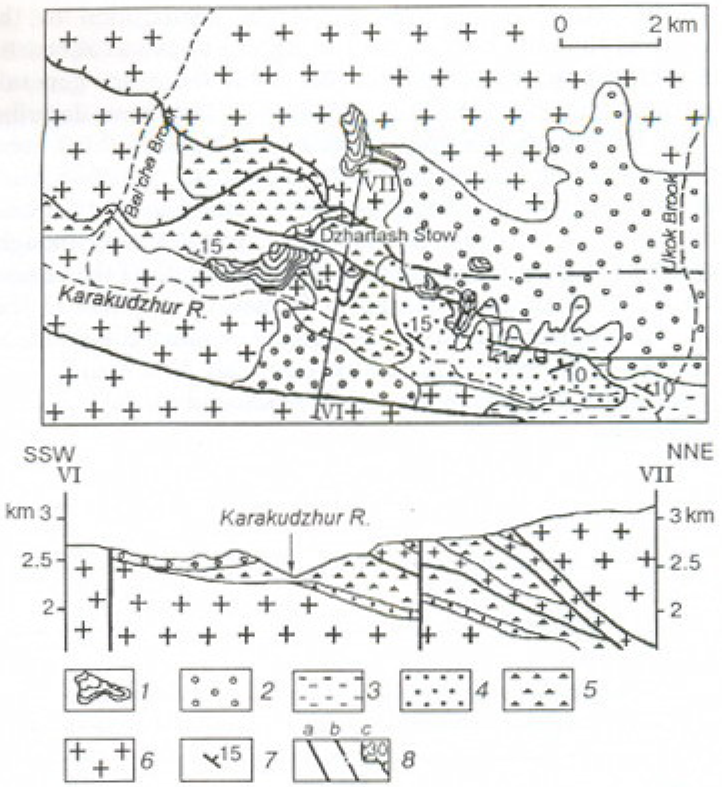

Fig. 7. Geological sketch of the western part of the Karakudzhur basin. ***1*** **— recent and Late Quaternary rockslides;** ***2*** **— Upper Pliocene-Lower Quaternary deposits;** ***3*** **— Upper Neogene deposits;** ***4*** **— Paleogene-Lower Neogene deposits,** ***5*** **— olistostrome,** ***6*** **— combined Riphean-Paleozoic structures;** ***7*** **— dips and strikes;** ***8*** **— faults:** ***a*** **— steeply dipping,** ***b*** **— covered with Quaternary deposits,** ***c*** **— thrusts.**

Brook. The movement along the thrust resumed as early as the Middle Pleistocene. In the western part of the basin, the allochthonous slice significantly advanced to the south, and the Paleogene-Neogene autochthonous deposits are observed only on the deeply incised flanks of the Karakudzhur valley (Fig. 6). A series of recent and Late Quaternary faults of latitudinal strike occur in the Dzhartash stow and to the east from it (Fig. 7). They are responsible for the resumption of the movement of the loose mass of the olistostrome and emergence of a series of rockslides.

In spite of the fact that the recent deformations complicated the structure of the considered area, it is obvious that the Karakudzhur thrust is confined to the slice bounded by oblique faults (15, 16), which, in turn, are of a lower rank than the sublatitudinal faults (14, 18).

DISCUSSION AND CONCLUSIONS

It is commonly believed that basins similar to the Karakudzhur basin develop against the background of general uplifting and differ significantly from intermontane troughs in the habit of filling deposits and development conditions [10]. Our studies demonstrate that there are no fundamental differences between the recent tectonic structure of the Karakudzhur area and the marginal areas of intermontane basins. All of them have regular patterns of faults varying in rank and geometry. A system of conjugated diagonal strike-slip faults of NW and NE strikes occurs within sublatitudinal sheets bounded by sinistral strike-slip faults. The diagonal faults have a lower rank than the marginal ones. Movements along the system of the conjugate strike-slip faults generate local compression zones [24] which are compensated in the geologic structure by formation of reverse faults and thrusts. Further movements with the thrust base coming on the day surface result in degradation of the frontal part of the allochthon and formation of tectonogravitational mixtites.

This scheme can be applied to recent thrusts throughout the Central Tien Shan. To the west from the region under study, at the bottom of the Talas thrust, bounding the Talas basin in the south, there is a mixtite assemblage consisting of breccias and olistoliths similar in composition to the Riphean rocks of the allochthonous sheet. The olistoliths and breccias tens of meters in thickness alternate with Neogene sandstones and siltstones. In the east, the boundary thrust and the Talas basin are generally bounded by a sinistral strike-slip fault of the northeastern strike [31]. By analogy with the above-described areas, it is conceivable that the eastern part of the Talas basin is a fragment of a sublatitudinal shear zone.

Emergence of deformation shifts, accompanied by transverse reduction and longitudinal extension of shear zones, was named transpression [32]. Probably, shear parageneses are more widespread in the recent tectonic structure of the region under consideration than it was formerly thought. This was confirmed by Makarov [3], who demonstrated that the recent orogene structure south of the region considered in the present study, within the Baibiche-Too and Kokshaal Ranges is formed by a system of sheets conjugate en-echelon, which is indicative of their development under the conditions of sinistral displacement.

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