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GEOLOGY

Peculiarities of Tectonic Evolution of the Flyschoid Olistostrome Complex of the Western Shore of the Aleutian Basin

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The flyschoid olistostrome complex is developed in the form of a narrow belt along the western shore of the Aleutian Basin. It occupies the lowest structural position in the system of sheets of the eastern Olyutor Range. This complex is overlapped by allochthonous slices of siliceous, volcanogenic-siliceous, and volcanogenic rocks (Fig. 1) [1, 2, 8]. The question of the conditions of the development of this complex is very important, because its solution would allow one to either validate or disprove the hypothesis of subduction of the Aleutian Basin crust under the Olyutor margin after the Cretaceous. Structural investigations of the flyschoid olistostrome complex of the Vitgenshtein Cape for the purposes of reconstructing the tectonic stress field which determines the evolution of this complex were carried out to solve this problem.

The flyschoid olistostrome complex described in the region of the Vitgenshtein Cape can be divided into two subcomplexes: flyschoid and olistostrome. It has been suggested that olistostrome sequences are thrust over flyschoid formations. The dipping of the thrust plane probably has a southwestern orientation on the western coast of the cape and a northwestern orientation on its eastern coast. The flyschoid subcomplex outcrops on the eastern coast of the Vitgenshtein Cape. Isoclinal folding of the southern and southwestern vergences are established in flysch deposits. Cleavage of the axial surface of folds is developed. The southern limbs of folds are often detached. The fault plane has a low-angle dipping towards the north and northwest. The tectonodynamic analysis was carried out for the flyschoid subcomplex.

(1) The reconstruction of the local tectonic stress fields was conducted with Nikolaev's method [6, 7]. The section along the eastern coast of the Vitgenshtein Cape as a whole is accepted to be homogeneous in structure. Mass measurements of structural elements of joints were conducted in 35 points, mostly on the limbs of folds. From 20 to 60 measurements were made at each point, according to the expressiveness of the cleavage. Then, the diagram-matrix was prepared for each observation point [7]. Isolines of the density of joints with different orientations were plotted on this diagram. The position of local maximums of jointing for each observation point was established. Then the position was plotted on the master matrix for the overall area (Fig. 2a). Three main maximums of jointing are distinguished on the diagram. One of them (*I*) was eliminated from further study, because it is related to the sandstone blocks which are heterogeneous in structure as compared with flyschoid section. The determination of orientation and identification of the main stress axes were made on the basis of two major maximums of jointing (*II*, *III*) (Fig. 2b). Asymmetrical scattering of the joint orientations clearly pronounced on the master diagram-matrix, which allows one to determine unambiguously the position of the compression axis is directed toward the extension axis [7, p. 67]. This is necessary and sufficient condition for postulating of their conjugation; hence, σ_1—167 (SE)/37, σ_3—320 (NW)/45.

(2) The orientation of the main stresses on the basis of the population of shear displacement directions was determined with Gushchenko's kinematic method [3, 4]. Measurements of the joint orientations, slide marks, and slickensides were made within the flyschoid section. The kinematic diagram was then prepared [4] (Fig. 2c). The definite type of the stress condition of the area can be suggested on the basis of the kinematic diagram of the tectonic jointing poles. The tendency of intersection in a limited sector of the diagram is noted for the population of kinematic planes of conjugate systems of shear dislocations. This zone is interpreted as the zone of possible position of the stress axis. The general view of the diagram is typical for compression structures [3]. Kinematic analysis shows that the modern structure of investigated area formed under the condition of active compression $[\sigma_3] \gg [\sigma_2] > [\sigma_1]$, $(\sigma_3 < 0)$.

Orientation of the compression axis obtained with the Nikolaev's method falls into the area of possible orientation of the compression axis derived from Gushchenko's method.

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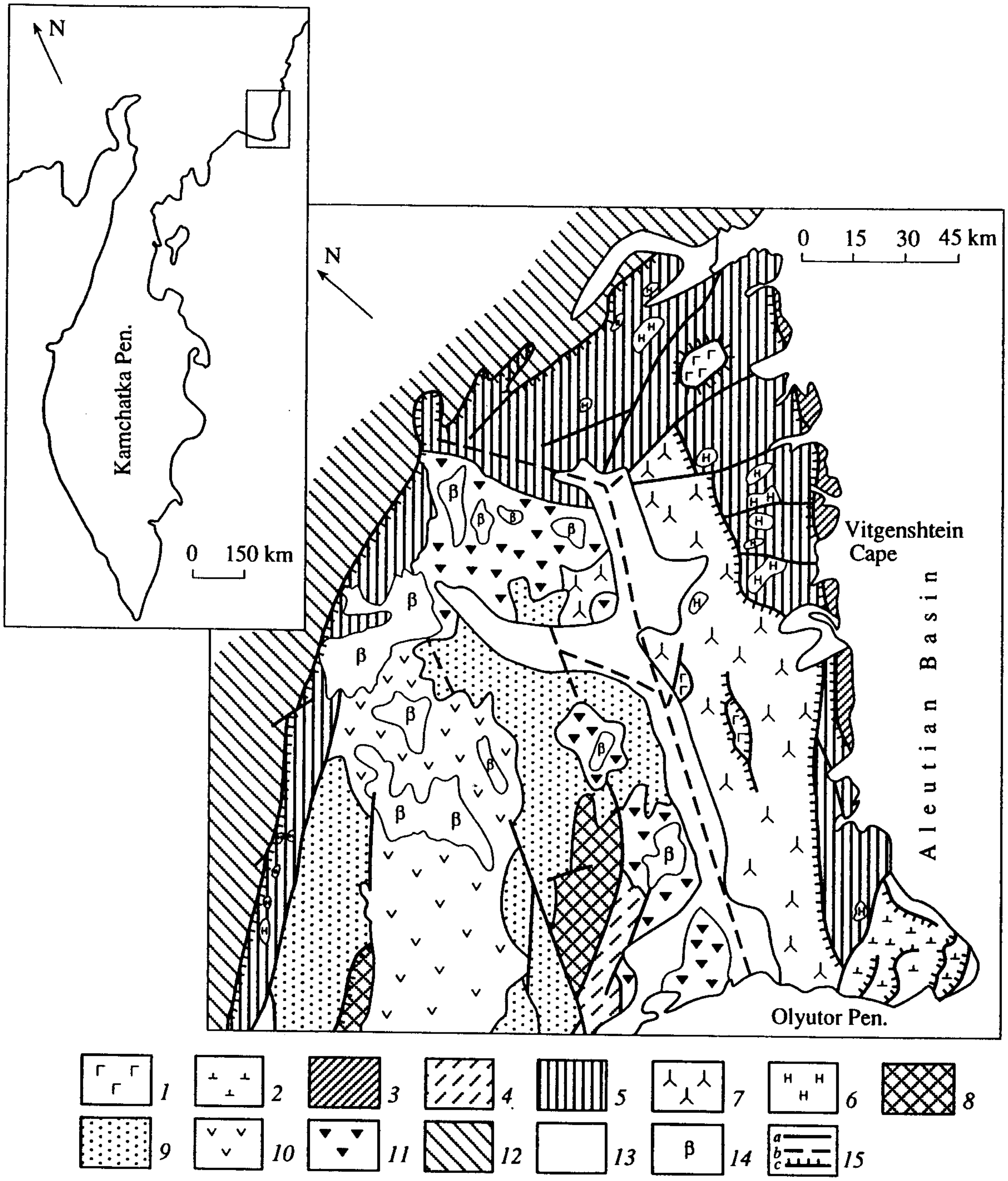

Fig. 1. Schematic geological structure of the fragment of the Olyutor terrane modified after [8]. Groups of oceanic complexes: (*1*) Cretaceous tholeiitic basalts of marginal seafloor type, (*2*) Cretaceous basalts of oceanic rise type, (*3*) oceanic olistostromes, and (*4*) group of complexes of deep trenches and adjacent accretion prisms, Paleogene flysch. Groups of island-arc complexes: (*5*) Late Cretaceous siliceous-volcanogenic, (*6*) Late Senonian–Early Paleocene volcanogenic-clastic, (*7*) relics of deep magmatic chambers of island-arc (dunite–pyroxenite–gabbro), (*8*) Paleogene volcanogenic-sedimentary, (*9*) Paleogene–Early Miocene terrigenous-volcanomictic, (*10*) Pliocene–Quaternary Apuk–Vyven complex, (*11*) riftogenic complexes, (*12*) Ukelayat flysch complex, (*13*) Quaternary loose deposits, (*14*) Quaternary volcanogenic deposits, and (*15*) faults: a) proven, b) assumed, and c) thrusts.

(3) Measurements of microjointing orientation were made with the use of oriented samples sampled from the flyschoid section. Microjoints are filled by carbonate. Their thickness ranges from 0.5 to 5 mm. Then normal to microjoint planes were plotted on the Wulff net. The projections of normals form a clearly pronounced maximum in the center of the diagram. Subhorizontal microjoints are characterized by the normal distribution of orientations throughout the section. Microjoints are perpendicular to the axial surfaces of folds and are developed both on the limbs and hinges of folds.

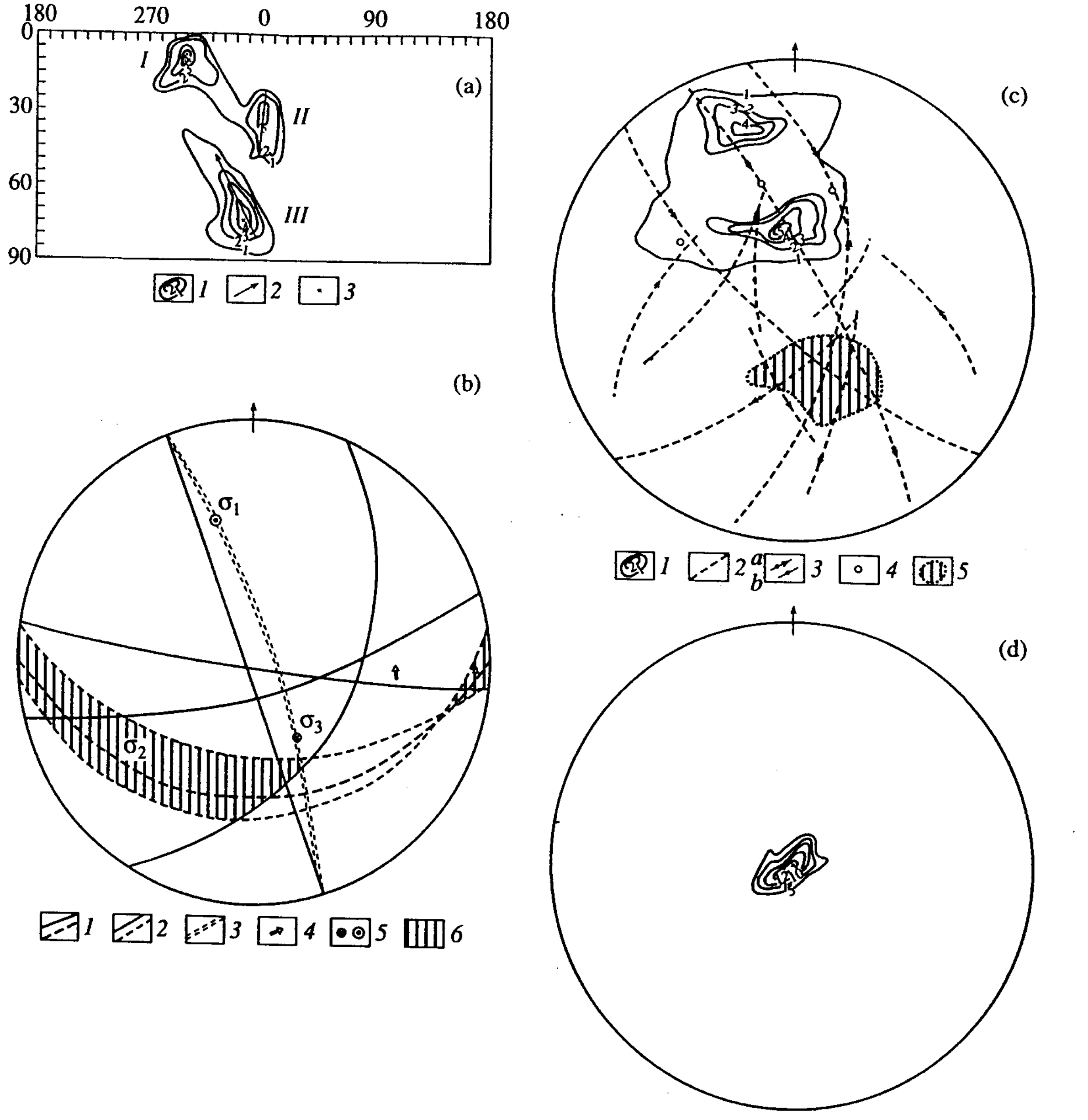

Fig. 2. Reconstructions of tectonic stress fields. (a) Diagram-matrix of jointing [6], along the horizontal and vertical axes (in degrees); (*1*) isolines of jointing, (2) direction of scattering, (*3*) maximums of jointing, (b) reconstruction of main stress axes, Wulff net, projection on the upper hemisphere (the same for the Figs. 2c, 2d): (*1*) planes of main maximums, (2) planes of limiting points of scattering direction, (*3*) kinematic plane, (*4*) direction of scattering, (*5*) exits of the main stress axes on the upper hemisphere, (*6*) exit zone of the intermediate axis, (c) kinematic diagram [4]. (*1*) Distribution of joint pole density, exit on the upper hemisphere of: (2) kinematic planes of rare shear dislocations, (*3*) poles of shear dislocations and orientations of slickensides with (*a*) definite and (*b*) indefinite direction of relative displacements of limbs, (*4*) main extension axes, (*5*) zone of possible position of the compression axis; (d) diagram of microjointing (isolines show distribution of microjoint pole density).

Conducted geostructural investigations allow one to draw the following conclusions.

(1) The current structure of the Vitgenshtein Cape was formed under compression and the vector of the force was probably directed from the southeast to the northwest. At least two stages of deformations were established for this region on the basis of paleomagnetic investigations [5]. At the first stage, the normal latitudinal folds were formed. At the second stage, these folds were inverted to the north. The reconstructed field of tectonic stress is part of the last (second) stage of deformation.

(2) The poles of microjoints form one maximum in the center of the diagram. This allows one to classify them as shear joints formed after folding and directed parallel to the compression stress upon the older isoclinal-folded section. On the correlation of this result with paleomagnetic data [5], origination of these microjoints

can be assigned to the end of the first stage of deformations. The dipping of microjoints changed from inclined to subhorizontal at the second stage during inversion of the structure.

(3) The upper boundary of sedimentation of the flyschoid olistostrome layer determined by complexes of radiolarians and nannoplankton [8] belongs to the Maastrichtian. Thus, all observed deformations took place after the Maastrichtian period.

(4) The last stage of deformations may be connected with either the spreading in the Aleutian Basin [9] occurring after the Cretaceous or the displacement of the structures of the Olyutor Range to the east caused by the back-arc spreading.

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