GRANITE-GNEISS DOMES OF ALDAN SHIELD

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ABSTRACT

The analysis of available tectonic and cosmostructural schemes of Alden Shield shows the indefinity in granite-gneiss domes and ovals mapping. Granite-gneiss domes are most "light" objects within the Earth crust. These density is equal to 2.62 - 2.65 g/cm^3 while the density of surrounded supracrustal complexes is about 2.65 - 2.80 g/cm^3. So the data of gravimetric mapping were used for direct determination of such structures as granite-gneiss domes.

Three - layered Earth crust model was developed by extrapolation of geological-geophysical data. Upper layer (of 10 -15 km thick) has a slice-to-block like structure, and forms the area of granite-gneiss domes developing; Verhnetokkinsky, Verhekhaninsky, Chulmansky, Yakokutsky, Lomamsky, Ambardakhsky, Djeltelinsky, Gyonomsky and Uyansky (from West to East, respectively). Average size of domes are about 30-45 km.

Granite-gneiss domes are associated with the most known alkaline rocks massifs of Cretaceous age. These are gravitational minimums connected with granite-gneiss domes about 10 mGl. The depth interface of massifs are situated in space 4-8 km by dates of mathematic modelling. Jurassic alkaline rocks massifs usually have thickness 10-60 m. Average sizes of massifs are about 0,5-8,0 km. They have not any anomalies on the gravimetric maps. We'd like to stress that Jurassic and Cretaceous alkaline rocks are formed in different tectonic-magmatic situations. Cretaceous alkaline rocks are connected with final stage of forming granite-gneiss domes.

The Aldan (Aldan-Stanovic) Shield, the southeastern basement protrusion of the Siberian Platform, is known as a region of extended development of the early Precambrian deeply metamorphosed rock complexes and magmatic formations associated with them. In the north and east, the structural-substantial complexes of the Aldan Shield are covered by the blanket of upper Proterozoic and Phanerozoic deposits. In the south and west, the Aldan Shield borders with the regions of the Baikalian and Paleozoic folding. The most ancient formations of the Shield are discriminated in infractrustal complexes usually presented by gneisses and crystal schists of various composition.

The Aldan Shield Earth's crust building is viewed on the basis of the three layered model of the Earth's crust of the continental type and the concept of the tectonic layering of the lithosphere (Stogny el at., 1993). The upper layer has the capacity of 10 to 20 km at the density of its supracrustal and infracrustal complexes ranging from 2,60 to 2,80 g/sm^3 often being tectonically piled. The intermediate layer, the lowest border of which is determined as deep as 30 to 35 km, is characterized by the reduced lateral heterogenety and increased vertical layering of its components with the average density of 2,80 to 2,90 g/sm^3. The Moho surface which lies in the depth of 40 to 60 km borders the bottom of the lower layer with the average density of 3,10 g/sm^3. The modeling of the geological-geophysical cross-sections of the Earth's crust have been made by the gravitational and magnetic fields with extensive use of the geological and petrophysical data. To these basic material we refer the structural information based on the interpretation of the isostatic anomalies of gravity and on the material of deep geophysical methods (deep seismic sounding (DSS), magnetotelluric sounding (MTS and others). As a result of this, the difference between the earth's crust building of the Aldan domain and that of Stanovic one was found out. Within the Aldan domain the difference is between the Earth's crust building of the Olekma and Batomga granite-greenstone regions corresponding to the tectonic blocks, on the one hand, and the Aldan high-grade metamorphic region, consisting of the Central Aldan and Tympton-Uchur blocks with are separated by the Tyrkanda fault zone, on the other hand. (Fig. 1).

One of the characteristic elements of the Aldan Shield structure is gneissic and granit-gneissic domes. The analysis of the tectonic and cosmostructural schemes allows us to note that there is no unanimity in defining these structures. Even wider is the range of opinions about the conditions of their origin and evolution, the reconstruction of which is closely connected with the studies of the conditions of the continental Earth's crust formation. These structures are also of great practical interest as they are associated with ore occurrences of various mineral reserves, including uranium, rare earth metals and gold.

The reconstruction of the tectonic conditions of the granite-gneissic domes formation (Belevtsev, 1986) shows that the development lasted for a long period and took place on the background of numerous tectonic impulses and deformations. The early state was defined by radial stress caused by the "floating" out of gneissic cores. This radial stress was realized on the background of the horizontal flow of the material which determined the development of the layered shift flow, boudinage, metamorphic schistosity, stripes often coinciding with layers,

and injections of anatectic fusion. L.I.Salop (1982) noted that within the Aldan Shield there was an extended development of gneissic domes 10 to 40 km across the diameter and narrow and irregularly shaped carinate synclines or the packets of complicated isocline folds pressed between them. According to N.V. Gorlov's data (1989), the active intrusion of the supracrustal granite-gneissic rock masses into the bedding cover took place in the hard condition and was accompanied by the development of the structures of schistosity, conforming to the outlines of protrusions. The structural and other evidence of granitoid core's horizontal displacements found in granite-greenstone regions speaks for the block mechanism of the domes origin.

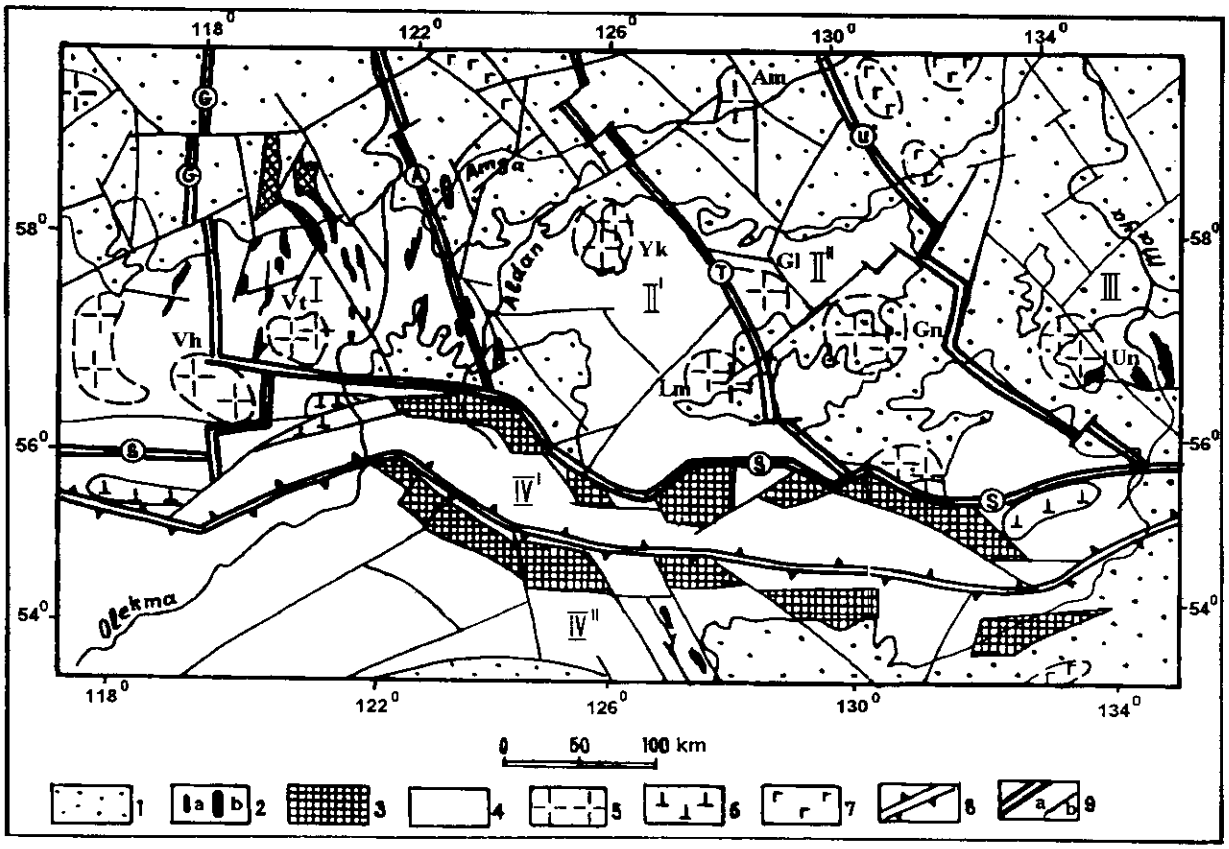

Fig. 1. The Earth's crust upper stage tectonic structure scheme on the level of 0 to 5 km.
1 - sedimentary deposits of the platform cover, 2 - greenstone belts: a - as known from geologic data, b - as isolated under sedimentary cover through the use of the geophysical data, 3 - bloks of the early Archean diorite and gabbro-diorite composition (Zverevsko-Kurultinsky complex), 4 - Archean metamorphic formations, 5 - granite-gneissic domes: **Vt** - Verkhnetokkinsky, **Vh** - Verkhnekhaninsky, **Yk** - Yakokutsky, **Lm** - Lomamsky, **Am** - Ambardakhsky, **Gl** - Geltulinsky, **Gn** - Gynymsky, **Un** - Uyansky, 6 - late Archean anortosite and gabbro-anortosite massifs, 7 - late Archean peridotite and gabbro massifs, 8 - Kalaro-Chogar interplate fault, 9 - tectonic dislocations: a - interblok faults: **G** - Guinsky, **A** - Amginsky, **T** - Turkandinsky, **U** - Uchursky, **S** - Stanovoy, b - inblock faults. *Regions*: I - Olekma granite-greenstone, II - Aldan granite-gneissic (II' - Central Aldan block, II" - Timpton-Uchur block), III - Batomga granite-greenstone, IV - Stanovik folded (IV' - North Stanovic zone, IV" - South-Stanovic zone).

When mapping the granite-gneissic domes we have widely used geophysical data. First of all, we have used the materials of the gravimetric survey on the scale of 1:200,000 - 1:50,000. We can give the following explanation to that. The structural-substantial complexes of the domes are the "lightest" in the Earth's crust sections of the Adlan Shield. Their average density is 2,62 to 2,65 g/sm^3, while the density of the supracrustal rock masses and infracrustal complexes framing them ranges between 2.69 and 2,80 g/sm^3 . On account of that we have separated the following granite-gneissic domes (fig. 2): Verkhnetokkinsky, Verkhnekhaninsky, Chulmansky, Yakokutsky, Lomamsky, Ambardakhsky, Geltulinsky, Gynymsky, Uyansky. Across the diameter size of these granite-gneissic domes varies within the range of 30 to 70 km. An inconsiderable stretch along one of the axes is frequently observed.

According to the data of the gravitational anomalies mathematical modelling, the lowest border the granite-gneissic domes is no deeper than 10 to 15 km, i.e. they are localized in the upper layer of the Earth's crust. As a rule, they have tectonic contacts of the fault type and of the type of overlap fault with framing structures. Also

radial systems of fractures with reference to the center of granite-gneissic domes are observed. Due to their structural features, the granite-gneissic domes may be correlated to the complexes of tectonic-metamorphic cores, tectonically laid out on the surface from the middle parts of the continental crust by overlap faults in early Precambrian.

The correspondence of the clusters of the alkaline Cretaceous magmatism to the granite-gneissic domes of the Aldan Shield is observed. These magatic clusters are: Yakokutsky, Geltulinsky, Ningamsky, Lomamsky, Omninsky and some others (fig. 2). According to the data of geophysical anomalies modelling, the Cretaceous massifs of syenite-granosyenite composition have vertical thickness up to 4 to 7 km. In our opinion, the formation of Mesozoic rock massifs took place during the final stage of initiation of the granite-gneissic domes connected with the collision of the Eurasian and the Amurian plates which was accompanied by the processes of tectonic layering and by the formation of the clusters of alkaline magmatism in the zones of the largest permeability to which the granite-gneissic domes belonged. In most cases spatially connected with the clusters of Mesozoic magmatism are areas of gold placer and gold ore.

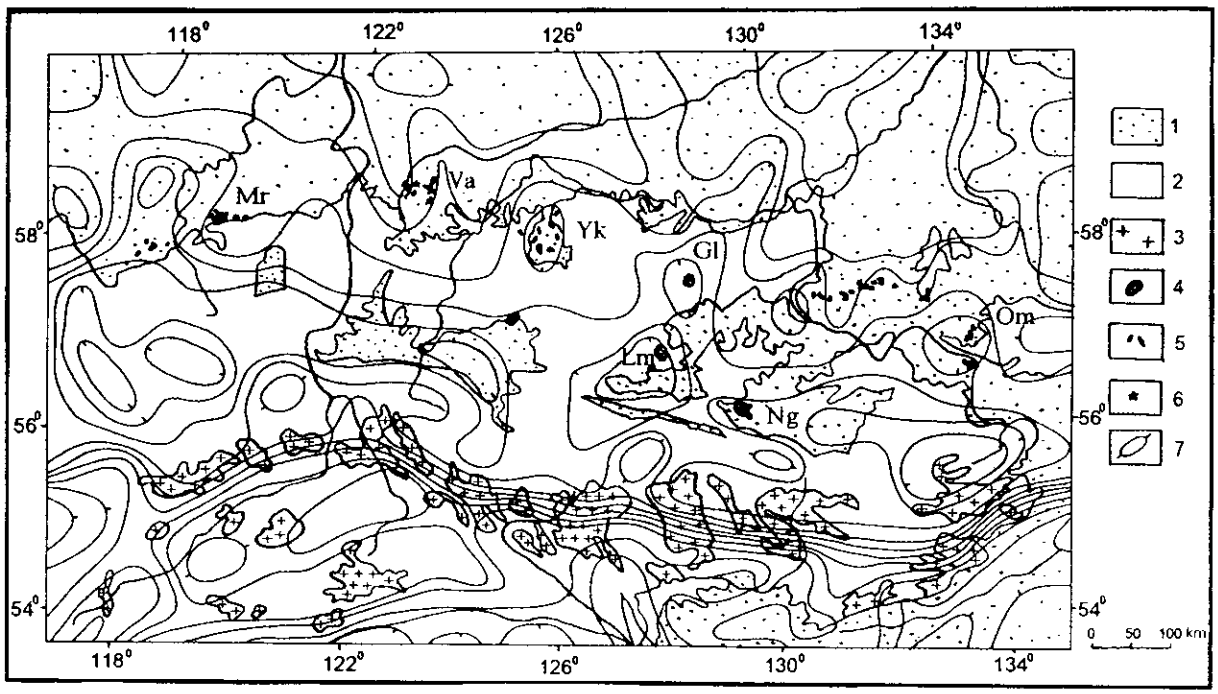

Fig. 2. The scheme of Mesozoic acid and alkaline magmatism of Aldan Shieldwith the elements of the regional part of gravimetric field.
1 - sedimentary cover rocks, 2 - metamorphic complexes of the Aldan Shield, 3 - massifs of granitoids (J_3 - K_1), 4 - Cretaceous alkaline massifs, 5 - Jurassic alkaline massifs, 6 - kimberlite pipes, 7 - isogals of the regional part of gravitational field. *Magmatic clusters*: **Mr** - Murnsky, **Va** - Verkhneamginsky, **Ya** - Yakokutsky, **Gl** - Geltulinsky, **Ng** - Ningamsky, **Lm** - Lomamsky, **Om** - Omninsky.

The Jurassic alkatline rocks widely developed within the Aldan domain and usually presented by sills and intrusive sheets with the thickness of 1 to 60 m, and length of 0,5 to 6-8 km, are not reflected in the materials of gravimetric survey on the scale of 1:50000 to 1:200,000. In V.G. Vetluzhskikh's (1983) opinion, the flat form of early stage intrusions (sills and bed bodies) of alkaline magmatism is controlled by subhorizontal fracture zones in basal rock masses of the sedimentary cover and in the basement which were formed during the throw and thrust movements of the basement blocks.

The Mesozoic granites of mainly Jurassic age, widely developed in the Stanovic domain, make up about 40% of its area. The Stanovic granitoid belt on the regional part of the gravity field (fig. 2) is correlated to the gravitational stair-type anomaly, which we are connecting with the deep Calaro-Chogar fault. Some massifs of granitoid composition are not reflected in the gravity field or they are defined by low-intensive anomalies of an amplitude of 2 to 4 mGl. That allows us to consider granitoid massifs as flaggyness bodies, formed in the zone of Kalaro-Chogar deep interplate fault during the collision of the Eurasian and Amurian plates.

The granite-gneissic domes of the Aldan Shield mapped by the gravimetric data have a number of peculiarities. Structurally they are characterized by fold structures and fracture structures, carrying the impression of

subhorizontal tectonic stress. The character of magnetism shows many-staged tectonic impulses in Archean, Proterozoic and Mesozoic cycles of tectionic activity. The given structures control ore manifestation and deposits of gold of the Aldan Shield.

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