LAWS OF STRUCTURAL CONTROL OF LOCALIZATION OF KIMBERLITE PIPES IN THE DALDYN FIELD FROM CDPM SURVEY DATA

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Structural criteria for local forecast of buried kimberlites can be developed on the basis of detailed deciphering of structures of the known kimberlite fields, recognition of structural control factors, and determination of concrete structural positions of kimberlite bodies.

Under geological conditions of the eastern part of the Siberian platform, a CDPM survey is the most effective tool to solve the above tasks because other geological-geophysical methods used in search of kimberlites yield information of quite limited structural value.

Review of the efforts to solve structural tasks using CDPM data in light of the Daldyn kimberlite field (Pavlikov, 1976; Chaplygin & Kalinin, 1978; Milyaev & Kalinin, 1979; Poltoratsky et al., 1982; Podmogov et al., 1983, 1987; Merzlyakova et al., 1985) demonstrates that the value of the obtainable geological information depends much on a purposeful choice of the structural mapping surface.

Careful analysis and re-interpretation of CDP sections obtained from seismic surveys carried out in the Daldyn field has revealed that most informative, for studying the structure of the field, is the surface of the roof of a crystalline basement because structural reconstructions made on the basis of any of the seismic reflecting horizons in a sedimentary cover fail to fully reflect hidden basement faults which largely control the structure of the kimberlite field. Special attention was given to identification and tracing of hidden, ancient, small-amplitude synvolcanic faults in the basement and the late Precambrian sequence at the base of the sedimentary cover. As a result, the author has constructed a map of basement dislocations which is alternative to the previous maps compiled on the basis of the seismic horizon VR-2 (upper part of late Precambrian carbonate sediments) and reflects objective laws of structural control of localization of kimberlites.

It has been found that the Archean crystalline basement (at 2.25-2.5 km depth) of faulted-block structure has zones and relic zones of late Precambrian faults of ENE (60-65°), sublatitudinal (70-75°) and NW (310-320°) strike. The ENE and sublatitudinal ancient faults (fractures) are right-lateral strike slips, with horizontal offset of 100 to 600 m. The largest pipes of the field Udachnaya and Zarnitsa - are located in fault zone of strike slips with horizontal offset of 500 to 600 m on total.

A set of kimberlite-controlling and kimberlite-localizing faults of Order II-III consists of discretely reactivated dislocations of the NE-striking master fault zone, as well as synvolcanic, superposed dislocations orientated at 58-60 azimuth, coincident with the strike of the z-principal strain axis. Amplitudes of vertical offsets of synvolcanic faults along base sequences of the sedimentary cover do not exceed 50 m. Together with the discretely reactivated NW faults of similar order, they form an irregular but clearly defined rhombic network.

The bulk (77%) of kimberlite bodies of the field is found to be restricted to a disturbed rhombic block measuring 15 km by 16 km. The block is delineated by an outer fault frame and badly disturbed by internal upper crust faults to form the rhombic network. The spatial position of the block is entirely controlled by a fragment of a 15 km wide, somewhat arcuate, ancient major fault zone of NE strike. In the southern and south-western parts of the territory, there are two closely associated and one separate linear-chain group of kimberlite bodies restricted to blocks measuring 2.1-2.25 km by 2.2 km and 1.5 km by 2.5 km. These are structural components of larger 5x6 km blocks.

Linear and local-junction structural elements have been identified which control the localization of the kimberlites. The linear-group localization is controlled by 0.5-1.5 km wide subzones bounded by Order II fractures. The length of the subzones varies from 5-7 km to 17-35 km. Within the major kimberlite-enclosing fault block, there are 8 subparallel subzones divided by 300-750 m wide longitudinal blocks. In the southern part of the field, 3 kimberlite-controlling and 7 discrete potentially kimberlite-controlling subzones have been identified.

Discrete, often en echelon series of swarms of magma-feeding dilation (break away) and tension fractures of Order III are grouped into 50-350 m wide and 4-17 km long belts with orientation at 58-60. The discrete character of the kimberlite-localizing fracture (joint) belts arises from their blocking by crosscutting dislocations and from their convergence with the peripheral fractures of the kimberlite-controlling subzones. At the intersections of individual magma-feeding fracture belts with the crosscutting subzones of NW strike, there are up to 2 km long local tension fractures that control a chain of two to five kimberlite bodies. Some tension fractures of Order IV localize kimberlite veins or dikes.

A topological series of linear structural elements has been identified which control a linear-group localization of kimberlites: zone - subzone - belt of break-away or tension fractures - individual break-away or tension fracture, which respectively exert control on kimberlite fields, groups and chains, chains and individual bodies, individual associated pipes, veins or dikes.

The local-junction localization of kimberlite bodies is controlled by intersection of the kimberlite-controlling fractures (faults) with the crosscutting dislocations of similar order (rank). Local control is exerted by a rhombic, fracture-junction structural unit. Its size determines the crosscutting parameters of the intersecting, similar-order elements of the structural-fault network. The size of the field-controlling, zoned block-frame is 15 km by 15-17 km. Subzonal junctions correspond to blocks measuring from 700 m by 750 m to 2.25 km by 2.25 km. Typical size is 1.5 km by 1.5 km. Their structural units accomodate groups of 2 to 4 kimberlite bodies or chains of 2 to 5 bodies. Individual bodies are, as a rule, controlled by units of fracture junctions measuring 50 m by 50 m to 350 m by 400 m.

The identified topological series of the fault-structural units which control a local areal distribution of the kimberlites is: zoned frame - subzonal junction - fracture junction, with corresponding control being that of a field, group or chain of adjacent bodies, individual pipe.

From the direction of the longer axes of the kimberlites (data of the Amakinsk Geological Survey), the following conclusion has been made: 35 % have orientations at 30-57° , coincident with (theoretically feasible) left-lateral; 35 % at 62-90°, coincident with right-lateral dilation joints; 16 % at 292-333°, coincident with joints of the NW striking faults; 9 % have orientations at 180 or 270°. Only 5 % of kimberlite bodies have orientations coincident with that of the kimberlite-controlling faults (58-60°). This indicates that the longer axes of kimberlite pipes cannot serve as a basis for tracing kimberlite-controlling dislocations.

Paragenetic unity of the fractures and the depressional tectonic structures controlled by them mainly stipulates the location of kimberlite bodies within them or on their periphery. It allows to consider the latters as the direct structural objects of local diatrem control. It permits to introduce the idea of kimberlite depressional structural trap or nishe, among which pick out volcano-tectonic grabens, structures of block depression and draben-synclines.

The predominant role of the junctions (intersections) of the faults of different order (rank) in controlling the position of kimberlites and the established laws of their structural tectonic control allows to consider them as key structural criteria for forecast of the localization of the buried kimberlite bodies.