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3D model of fault and fissures structure of the Kovdor Baddeleyite-Apatite-Magnetite Deposit (NE of the Fennoscandian Shield)

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The Kovdor baddeleyite-apatite-magnetite deposit (KBAMD) is represented by a large vertical ore body and is located in the southwestern part of the Kovdor ultramafic-alkaline central-type intrusion. The intrusion represents a concentrically zoned complex of rocks with an oval shape in plan, and straight zoning, which complies with the injection and displacement of each of further magma phases from the center towards the periphery. The operation of the deposit in open pits started in 1962, and nowadays, it has produced over 500,000,000 tons of ore. This is one of the largest open pits in the Kola region, which is ca. 2 km long, 1.8 km wide, and over 400 m deep.
Regular structural studies has been carried out since late 1970. A unique massif of spatial data has been accumulated so far to include over 25,000 measurements of fissures and faults from the surface, ca. 20,000 measurements of fissures in the oriented drill core (over 18 km) etc.
Using this data base the 3D model of fault and fissures structure was designed. The analysis of one has resulted in the identification of a series of laws and features, which are necessary to be taken into account when designing a deep open pit and mining is carried out. These are mainly aspects concerning the origin, kinematics, mechanics and ratio of spatial extension of various fault systems, variation of their parameters at deep horizons, features of a modern stress field in the country rocks, etc.
The 3D model has allowed to divide the whole fracture / fissure systems of the massif rocks into 2 large groups: prototectonic system of joints, including cracks of 'liquid magmatic (carbonatite stage) contraction genesis', and newly formed faults due to the superimposed tectonic stages. With regard to the deposit scale, these are characterized as intraformational and transformational, respectively. Each group shows a set (an assemblage) of fault systems with unique features and signs, as well as regular interconnections.
The prototectonic assemblage of fissures includes the following main systems: 2-3 subsystems Rd of radial with angle of dip within 65-90º (median at 78º), two subsystems S of a circular subvertical (tangential, crossing Rd) with angle of dip within 60-90º (74º), and two diagonal-conic ones: a centriclinal C dipping towards the center of the intrusion at angles of 25-55º (43º), and a periclinal P dipping from the center of the intrusion at angles of 5-35º (18º). The system of subhorizontal joints L (angle of dip within 0-12º) at deep horizons is insignificantly manifested. All the prototectonic systems are regularly interrelated, and vary asymuthal features according to the law of axial symmetry (when moving around the vertical axis of symmetry passed through the geometric center of the carbonatite intrusion).
The superimposed tectonics of post-ore stages forms a few large faults and systems of rupture discontinuities. A few (up to 3) variously oriented displacements are documented in the field on kinematic features (slide furrows, oriented cleavages). They were used for reconstruction of stresses and tectonic evolution. The superimposed tectonic faulting has heterogeneous (local) distribution in the rocks of the deposit, and slight predictability of main parameters.
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