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Magnetic Properties of PT-Bearing Dunite of the Konder Massif (Russian Far East)

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SUMMARY

The observed gravitational field of the Konder pipe-like dunite-pyroxenite body coincides well with model field designed for a vertical cylinder with radius 2.7 km and density 3.3 g/cm3. It forced its way through crystalline basement and sedimentary cover of the Aldan Shield. Such process is a combination of rolling and hydroextrusion. Magnetic properties of dunite depend on distance from the pyroxenite rim and have a multiextreme character. The distance between extremes is 150-200 m. Magnetic susceptibility χ decreases from value ~ 0,01 unit SI. Variations of residual magnetization In are in an antiphase with spatial χ changes. Thermodemagnetization extremes at 310°C are characteristic of maghemite and localize in minimum zones of χ curves. Values, which are characteristic of magnetite are observed in maximum zones. Thus, various redox conditions are characteristic of maximum and minimum zones. Magnetic data explain some features of geochemical structure of the massif generated during emplacement because of localization of shift deformation in accommodation bands.

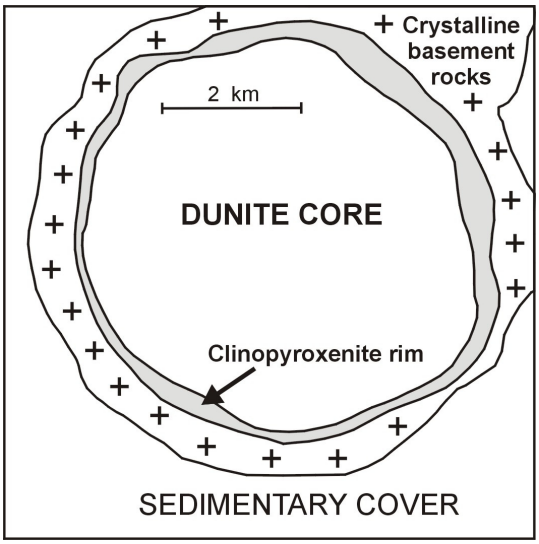

Fig. 1. Simplified geologic map of the Konder massif.

INTRODUCTION

Pt-bearing dunite of the Konder massif is similar to that of well-known massifs of the Platinum Belt of the Urals (Efimov & Tavrin 1978; Efimov 1998). But the Konder massif is situated in peculiar geological conditions and represents a pipe-like mantle body that intrudes the Archean crystalline basement of the Aldan Shield and its Sinian sedimentary cover up to 400 m thick (Rozhkov et al. 1962). The rounded dunite body of 5.5 km in diameter is bordered with a pyroxenite zone about 150-200 m in width (fig. 1). Layering of sedimentary formations is lifted upwards under a corner about 45° near to the massif. This dome-like structure was probably formed because of a diapiric intrusion of solid and hot dunite-pyroxenite body.

A sub-meridional profile about 10 km long has been made through the centre of the massif along which gravitational and magnetic measurements were executed with an interval of 50-200 m. There is an intensive positive gravity anomaly above the massif. The magnetic field has sharply variable character above dunite-pyroxenite contact. The observed gravitational field coincides well with the model field designed for the vertical cylinder which radius is accepted equal 2.7 km from geological and magnetic data. Calculation were executed for cylinders with the bottom basis on depths of 10 km and more. The best concurrence of measured and model fields has been received for density of 3.3 g/cm^3 (Efimov & Tavrin 1978). Thus, a solid cylindrical body forced its way through crystalline basement and sedimentary cover of the Aldan Shield under action of vertical elevating forces.

MAGNETIC DATA

With the purpose to study both geochemical zonality and features of formation of the Konder massif, we investigate magnetic properties of dunite for more than 150 samples, selected on three radial profiles located under corners approximately 120° to each other. An attempt to establish statistical connection between magnetic susceptibility χ, residual magnetization I_n, Fe/(Fe+Mg) ratio (Fe#) of dunite and distance of sampling points from contact with pyroxenite ring has been undertaken. Magnetic susceptibility χ values for all three profiles depend on distance and have multiextreme character (the contact dunite-pyroxenite is accepted as a zero point) (fig. 2).

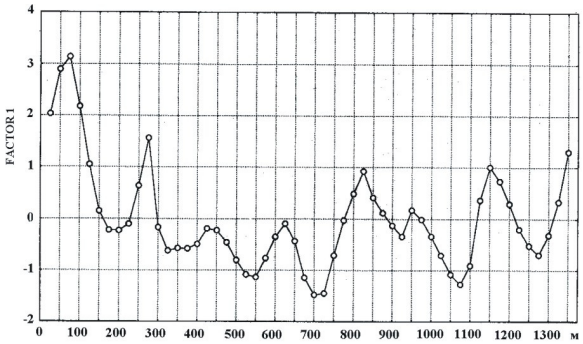

Fig. 2. Spatial variations of normalized magnetic susceptibility χ in cross section of the massif (distance from pyroxenite rim in meters).

The first from the pyroxenite ring maximum reaches the greatest value (~ 0,01 unit SI). Further, with increase of distance from periphery of the dunite massif, amplitudes of extremes naturally decrease. The distance between extremes is 150-200 m. Variations of residual magnetization of dunite I_n are in an antiphase with spatial changes of magnetic susceptibility χ, that is minimum of residual magnetization I_n corresponds to maximum of magnetic susceptibility χ. The Fe# values correlate with those of χ.

THERMODEMAGNETIZATION DATA

Thermodemagnetization of samples selected in maximum and minimum zones of profile curves was carried out with the purpose to establish the nature of spatial anomalies of dunite magnetic parameters. Two basic kinds of dependence of magnetic susceptibility χ on temperature are revealed. In the experiment temperature changed from 20 up to 700°C. There is a thermodemagnetization extreme approximately at 310°C in samples selected in minimum zones of magnetic susceptibility χ curves, which is characteristic of *maghemite* (fig. 3).

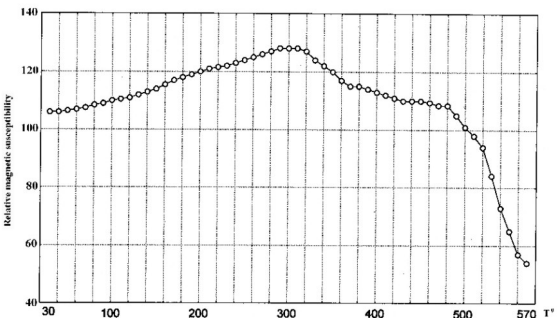

Fig. 3. Thermomagnetic curve for maghemitite + magnetite (type 1)

Thermodemagnetization curves, which are characteristic in the greater degree for *magnetite* (fig. 4) are observed in maximum zones.

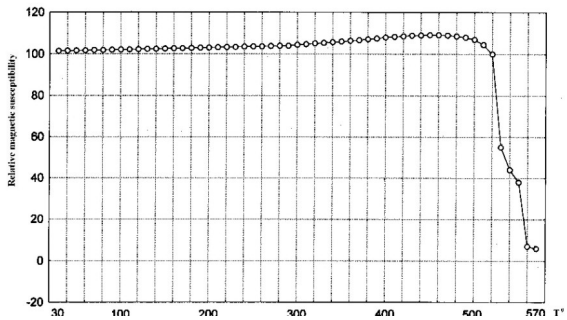

Fig. 4. Thermomagnetic curve for magnetite (type 2).

The samples selected near to contact dunite-pyroxenite occupy a special place. For them dependence of magnetic susceptibility χ on temperature characterizes thermodemagnetization of an isomorphic mix (ferroferrichromespinel). Thus, apparently, various redox conditions of formation of iron-containing minerals are characteristic of maximum and minimum zones.

NATURE OF MAGNETIC ANOMALIES

There is a natural interest to the probable nature of alternating ring magnetic anomalies of the Konder massif. It is possible to interpret process of its emplacement as a combination of rolling and hydroextrusion.

In this case a self-organizing system of local accommodation bands of deformation (macroanalogue of Luders-Chernov bands) arises (Panin & Grinyaev 2003). Such local shift bands arise on surface of a deformed body and are distributed in all its volume, representing damper zones, which interfere destruction of the body (fig. 5). Bands of the located deformation under constraint conditions may be seen on a surface as gofers.

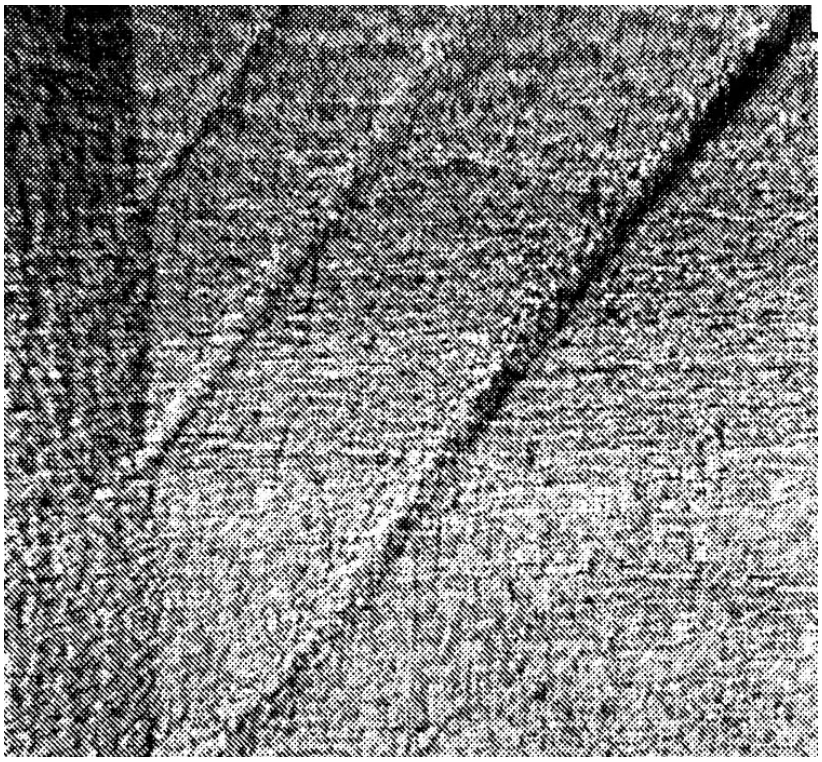

Fig. 5. Shift bands appearance in a steel specimen (Panin & Grinyaev 2003)

Relicts of goffering (a raised hypsometric level of terrestrial surface, which correlates with magnetic field) may be preserved only in separate parts of the massif surface. Most of goffers, probably, disappeared because of denudation process. From the point of view of synergetic phenomena during interaction of the matrix and deformable dunite body self-organizing

«secondary structures» should arise, being a screen which protects moving object. It is formulated in an universal principle of «structural-energetic conformableness» of materials at friction, that is with processes of self-organizing in a tribosystem. In given case, probably, such secondary structure may be rounded shape of the dunite body as well as ring shape of the pyroxenite rim about 150 m in width. They seem to be energetically the most favourable. Such a distance (about 150 m) should be commensurable with that between extremes of zones of localization of deformations. In a macrovariant these may be alternation of dilatancy zones (a combination of shift and increase in volume of a material) and elastic-deformable parts of the dunite body.

CONCLUSIONS

Most likely, we observe results of one-stage push-ahead of a solid dunite-pyroxenite body under constraint conditions which results in formation of dilatancy zones (dampers) which may be zones of drain of mineralized fluid (suction zone). Moreover, deformation processes are demonstrated by distribution of olivine grain size from periphery of the dunite core to its center. As a first approximation it varies from fine to medium and large in this direction.

Thus, magnetic data for Konder dunite explain some features of fine geochemical structure of the massif generated during emplacement because of localization of shift deformation in accommodation bands. The spatial sizes of the bands (150-200 m) are commensurable with width of the pyroxenite ring («secondary protective structure»).

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