HEAT FLOW AND DIAMOND POTENTIAL OF THE BELOMORIAN KIMBERLITE PROVINCE

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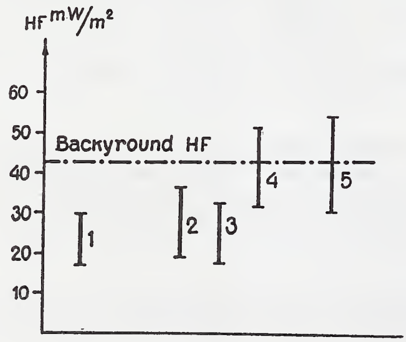
Results from geothermal investigations of the Belomorian kimberlite province (Tsibulya & Levashkevich, 1992) and summarized heat-flow (HF) data on kimberlite provinces of Laurasian ancient platforms (Tsibulya, 1992) have shown that the density of regional HF in kimberlite provinces is generally lower than the background values in the platforms (Fig.1). Besides, there is a relationship between HF values and diamond potential of the provinces: the lower the HF of a province, the higher the diamond potential. This dependence between HF and dimond potential is also observed within the provinces. Minimal HF values (17-20 mW/m^2) is the Siberian province are characteristic for the kimberlite zone of a diamond subfacies. When passing to kimberlite zones of diamond-pyrope and pyrope subfacies and to porphyritic ultrabasic and alkaline-ultrabasic rocks of the pyrope facies, the HF density is gradually increasing up to 35 mW/m^2 (Milashev and Posenberg, 1974; Tsibulya, 1992).



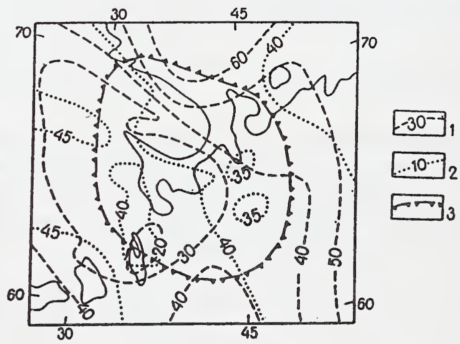
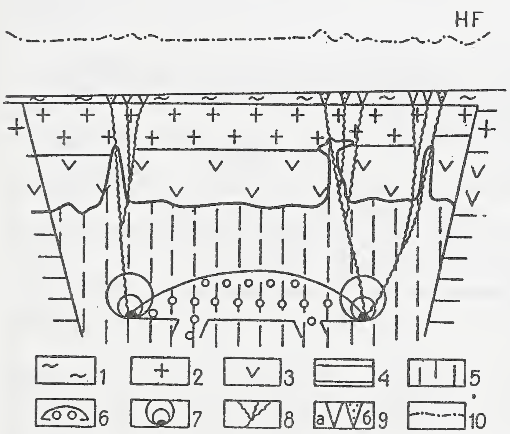


Fig.1. A heat-flow plot for provinces and areas of kimberlite magmatism in Laurasian platforms: 1 - Siberlian; 2 - Volynskaya; 3 - Belomorian; 4 - Priazovskaya; 5 - North-Ameriacan.

Fig.2. A scheme of HF and M-interface relief in the Belomorian kimberlite province. 1 - HF isolines, mW/m^2; 2 - isohypses of M-interface, km; 3 - contours of the Belomorian dome megastructure of the central type.

Discussion: Let us compare the HF density of the Belomorian kimberlite province with that of Siberian (Fig.1). Although, the area of the Belomorian negative-temperature anomaly is smaller and its extensive eastern part comprises regions with deeply eroded kimberlite pipes, the location of which is difficult to determine. Anomalously low HF values could be indicators of the presence of kimberlites. Contours of the regional low-HF field in this province almost coincide with the contours of the Belomorian central-type dome structure that is established from geologic-morphologic analysis (Soloviev, 1978). The M-interface in this structure is elevated (FIg.2). Yet, it is not the variable crustal thickness that is the main peculiarity of the Belomorian province, as well as of other diamond-bearing provinces worldwide. The most important thing is the enrichment of the crust and subjacent mantle with abyssal material, including diamond-bearing rocks. The upper layers of the lithosphere were saturated with abyssal material mainly in the Upper Archean and Lower Proterozoic due to asthenolith emplacement, dapirism and the presence of functioning fluid-thermal columns. All these processes occured within long-lived and pulsating asthenocones, whose area in the surface conforms with the boundaries of kimberlite provinces. Heat energy, which was released in the course of the evolution of these ancient asthenocones, has dissipated by the present time, and it does not affect the modern surficial temperature field of the kimberlite provinces. The modern temperature fields of these structures are stationary of quasistationary. HF in them is formed largely due to radiogenic heat generation. The content of radioactive elements in aleoasthenocone rocks is decreased, and, consequently, HF density is also decreased (Fig.3).



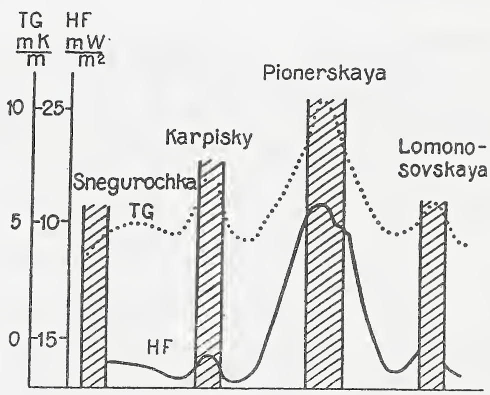


Fig.3. Heat flow and a scheme of deep structure of areas of kimberlite magmatism. 1 - cover, 2 - granite layer, 3 - basalt layer, 4 - upper mantle, 5 - deep intrusions, 6 - gas-geodynamic system, 7 - chambers of kimberlite magmatism and fronts of conductive heat distribution, 8 - system of bifurcating channels-fractures, 9 - explosive pipes (a - free, b - diamond-bearing), 10 - surficial HF variation.

Fig.4. Variation of temperature gradient and HF density in diatremes of the Zolotisky ore field of the Arkhangelst region.

Processes of platform kimberlite magmatism acted in conditions of brittle destruction of elastic medium. The formation of local magma chambers was related mostly to decompression of gas-geodynamic systems. Spatial distribution of the chambers and feed channels of kimberlite volcanism (Fig.3), their volumes and the short period of existence could not have a considerable influence on the temperature conditions in the crust as a whole. However, HF is slightly increased in the diatremes (Fig.4), which partly can be accounted for by an ascending movement of fluids along fractured channels, whose permeability in productive pipes is higher than in other pipes.

Conclusions: The analysis of HF field of kimberlite magmatism provinces suggests that diamonds were transported to the surface in two stages. In the first stage, they were uplifted to the upper layers of the lithosphere as a result of development of Upper Archean - Lower Proterozoic asthenocones. In the second stage, they were transported to the surface in the course of Paleozoic-Mesozoic kimberlite volcanism.

In general, HF data can be used to get an insight into the evolution and deep structure of the ancient continental crust, and also to perform regional and local prognostication of diamond presence in crustal segments.

References

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