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Generalized Regional Thermal Model of the Earth's Crust in the Territory of Armenia

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ABSTRACT

In the framework of the polimorph-advection hypotheses of the development of active regions (Gordienko, 1982), the generalized regional thermal model of the earth's crust and the top mantle of territory of Armenia is constructed. In the model are allocated asthenosphere (60-170km) and a layer of partial fusion (17-23km). The roof of the last is positioned on an isotherm 600 ºC, and a base is poistioned at a level of speed of 6.8 km/s. The constructed model is comparable with gravitational, magnitotelluric and seismic fields.

The opportunity of introduction on the top horizons of the earth's crust (up to 3-5km) hot magmatic pH is shown.

Later, the thermal model of the earth's crust has been constructed along a structure of deep seismic sounding Armash-Bavra. On a section of the structure there are sites with significant differences of thermal flux so, at a distance of 40 km the thermal stream increases from 40 mVt/m^2 up to 110 mVt/m^2. It once again confirms an opportunity of the presence at small depths of hot objects which can become deposits of geothermal energy. Concrete objects can be established as a result of a combination geothermal, magnitometric and gravimetric data.

1. THERMAL FIELD OF TERRITORY OF ARMENIA

On the available data on heat flow (HF) the 1:1000000 scale map of territory Armenia is constructed. In view of group values, the average error in HF shown on the map are approximately 5mVt/m^2, isolines are shown, accordingly, through 15 mVt/m^2 (Vardanyan, Gordienko, 1984) (fig. 1).

The structure of the thermal field of Armenia is closely connected to tectonic-magmatic evolution of the recent geological past. Isolines of HF cross Small Caucasian alpine geosynclines and a volcanic belt, matured at a stage of young activization of the region. Outside of the active zone, HF is sharply lowered: it makes less than 45 mVt/m^2, values less than 40 mVt/m^2 are fixed also. It concerns to the hollow framing of the central block of the earth's crust, lifted by recent movements.

Let us note, that the changes that are taking into account surface distortions of a heat flow are not included in values of HF.

Within the limits of the central block of values, the HF increases quickly, reaching a maximum in a northwesterly strip of, a little bit to the south of l. Sevan. At a distance of 40 km, the transition from isoline 45 mVt/m^2 to isoline 105 mVt/m^2 is seen.

The analysis of the map convinces that the influence of the deep factor obviously prevails about what influences the form, the sizes and the boundaries of the anomalies.

Figure 1: A map of heat flow of territory of Armenia.

2. INTERPRETATION OF ANOMALIES OF HEAT FLOW

For the territory of Armenia, the average value of background HF - in 50 mVt/m^2 is established (Vardanyan, 1984), the heat flow in suburban hollows in the north and the south completely follows the background. Here values a little bit below settlement background are distributed, that, probably, is connected with structural or other suburban effects. And in the central strip of the HF anomaly, values reaching 50-60 mVt/m^2 are allocated. More intensive perturbations of the thermal stream are obviously connected with shallow objects. and, basically, dated for hydrothermal systems of the territory.

Interpretation of the observed HF anomalies has been executed in the framework of the polimorph-advection hypotheses (Gordienko, 1982): deep sources of heat have been submitted by a series of consistently emerging astenolites - superheated and in part fused substance of a mantle. According to accepted hypotheses, these deep sources have provided Alpine geosynclinal rugosity (25-30 mln. year) and mioplotsen magmatic activization of territory (6 mln. year). Anomalous HF values were calculated with assistance the formula

$$q_{z=0} = \frac{\Delta T \lambda}{4\sqrt{\pi a t}} \left[e^{-\frac{h_1^2}{4at}} - e^{-\frac{h_2^2}{4at}} \right] \left[\Phi \frac{x_1}{2\sqrt{at}} - \Phi \frac{x_2}{2\sqrt{at}} \right] \times \quad (1)$$
$$\times \left[\Phi \frac{y_1}{2\sqrt{at}} - \Phi \frac{y_2}{2\sqrt{at}} \right]$$

where - ΔT is the anomalous temperature; λ - heat conductivity of environment equal 2.5Vt/(m.s); a-temperature conductivity of environments - 6×10-7 m^2 /s; t - time; h_1 and h_2- depth of a roof and a sole of a source of heat (SH); and x_1, x_2, y_1, y_2 - distances from a point of calculation up to edges of a source in corresponding coordinates.

As calculation was carried out only on one profile, results should be carried to the central part of the Small Caucasian geosynclines. The width of the geosynclinal zones is about 160 km (Aslanyan, 1970, Gabrielyan and etc., 1981), sizes of SH transversely prodeleting there are less than-100 km. By the described SH, it is possible to explain the HF on the geosynclinal periphery. The residual in the central part of the anomaly nongeosynclinal origins explain magmatic activization of region whose source has width 30 km, and displacement of his center under the attitude of center of SH geosynclinal activization on 25 km to the southwest. The used sources of heat have allowed with sufficient accuracy to explain observable distribution of the heat flow.

Anomalous deep temperatures have been designed under the formula (Gordienko, etc., 1982)

$$T = \frac{\Delta T}{8}\left[\Phi\frac{x_1}{2\sqrt{at}} - \Phi\frac{x_2}{2\sqrt{at}}\right]\left[\Phi\frac{y_1}{2\sqrt{at}} - \Phi\frac{y_2}{2\sqrt{at}}\right]\times \quad (2)$$

$$\times\left[\Phi\frac{h_1+z}{2\sqrt{at}} - \Phi\frac{h_2+z}{2\sqrt{at}} + \Phi\frac{h_2-z}{2\sqrt{at}} - \Phi\frac{h_1-z}{2\sqrt{at}}\right]$$

For reception of deep temperatures to anomalous temperatures are added also the background, received on values heat-generation (HG) in breeds of a surface (Gordienko, etc., 1982)

$$HG = 1.4\exp 1.25(6 - V_P) \quad (3)$$

Comparison of deep temperature with soliduses of breeds of a surface and a mantle has shown, that in two intervals of depths - about 20 km and 60-130 km probably partial fusion substances.

The interval of 60-130 km is considered as asthenosphere, that is comparable also with results of magnitotelluric sounding (Chernyavsky, etc., 1980) on which approximately on the same depths zones of raised electroconductivity are fixed.

As a result of the lead calculations the generalized regional thermal model of the earth's crust and the top mantle of territory of Armenia (fig. 2) has been constructed. Materials available until now on a heat flow model do not yet allow to lead more detailed interpretation of the thermal field of the territory of Armenia, however, occurrence of a structure of deep seismic sounding (DSS) in Armash-Bavra has given calculations of deep temperatures and a heat flow already on the basis of speeds of distribution of seismic waves in the earth's crust and top of the mantle.

The DSS profile Armash-Aspindza was done with the purpose of studying circumscribed zones of catastrophic earthquake of Spitak, 1988. By a structure the complex of geophysical research (Schukin, 1990) is executed. From the geothermal point of view the conclusion is important, that almost all the lithosphere is involved in convective movement, that is under the section of Mokhorovichich the substance is in a plastic condition. This conclusion is comparable with opinions, that the regional minimum of anomaly Bug is caused by a condition of substance in bottom of a surface and in an under crust layer, that there is the raised temperatures.

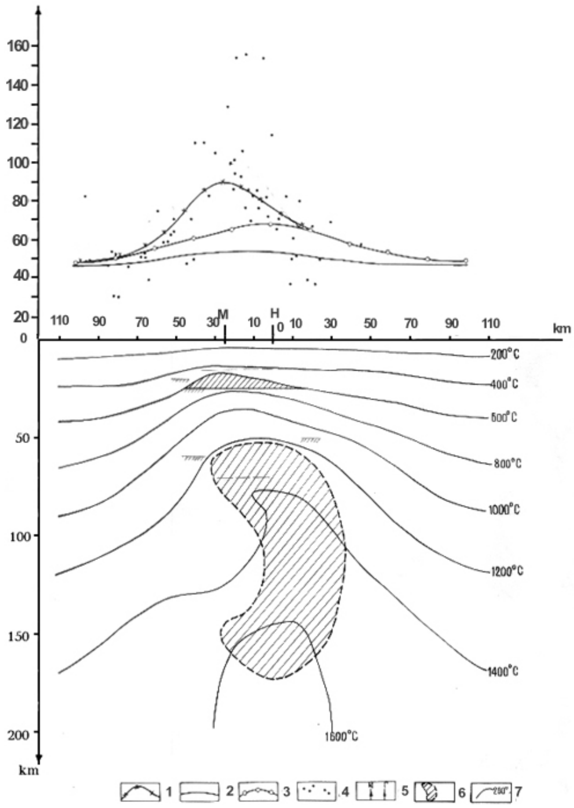

Figure 2. The generalized regional thermal model of an earth's crust and the top mantle of territory of Armenia. 1-curve settlement of HF, taking into consideration effects of geosynclinal rugosity of magmatism and a radiogenic background. 2-background HF, 3-curve settlement HF, taking into consideration effects of geosynclinal rugosity and a radiogenic background, 4-observed HF, 5-centers magmatic and geosynclinal rugosity, 6-zones of partial fusion in a surface and in a mantle, 7-isolines of temperatures.

Profile Armash-Bavraa is crossed with structure Markara-Poyli in area of the Yerevan zone of deep breaks (Aslanyan, 1970), however comparison of speeds of distribution seismic waves is impossible, as profile Markara-Poyli is constructed by a method of the exchange waves caused by earthquakes and reservoir speeds are not determined. Along the researched profile Armash-Bavra, background fluxes which change from 42 up to 54 mWt/m^2 (Vardanyan, 2002) were calculated (fig. 3). Comparison between background and recorded heat flow shows an anomaly of HF at a rate of 35-40 mVt/m^2, spatially dated to the Sevan orotectonic belt. In comparison with the Markara-Poyli profile, the intensity of the HF anomaly is a little bit lower, but, certainly, is of a deep origin. In effect the Markara-Poyli and Armash-Bavra profiles are at a small distance and significant distinctions are not expected.

On the DSS structure Armash - Bavra, on a field of speeds of distribution of seismic waves, are allocated mid-water objects of different character, and, a picture of the most motley at depths from 9 up to 22 km where there are sharp differences of speeds, contouring low-velocity objects.

The accounts of heat flow and deep temperatures are under interpretation, they will be submitted further. The unequivocal interpretation of the received picture is not achievable yet.

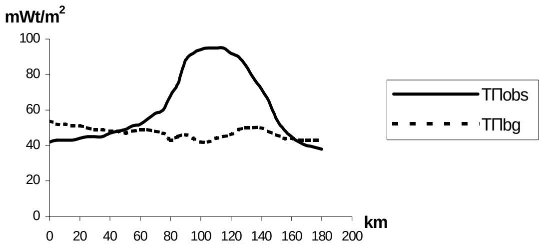

Figure 3. Background and observed HF along profile Armash-Bavra. 1-HF_{bg} 2. HF_{obs}

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