

V.L. Leonov

**Institute of Volcanology,
Far East Division of the Academy of Sciences of Russia**

**Regional Structural Positions
of Geothermal Areas and Hydrothermal Systems on Kamchatka**

There are two volcanic belts on Kamchatka peninsula - Eastern and Sredinny (Fig. 1). They are extended along the peninsula in northeast direction (NE 30°) and are about 700 km long and up to 100 - 130 km wide each. These belts are composed by mainly Pliocene-Pleistocene age volcanos, merging by the foundation. Almost all active volcanos (except one) are concentrated within the boundaries of the East volcanic belt, next to its south-eastern boundary. The overwhelming part of modern hydrothermal systems and thermal manifestations in Kamchatka is located within the boundaries of volcanic belts and also next to their south-eastern boundary. The high-temperature hydrothermal systems of Kamchatka are arranged by groups, which V.V.Averyev offered to call

geothermal areas (V.V.Averyev et.al., 1971). He had singled out three such areas on East Kamchatka: Pauzhetsky, Mutnovsky and Uzon - Semyachiksky.

Studies of arrangement peculiarities of hydrothermal systems and thermal manifestations within the boundaries of volcanic belts show (Leonov, 1989), that their localization is determined by the intersecting (in relation to volcanic belts) more ancient (presumably Myocene) faults of the northeast strike (CB 40 - 50°). These faults, arranged wing-like along the volcanic belts, divide the latter into separate zones (segments) and have a number of peculiarities, allowing to consider them original traps, responsible for magmatic and hydrothermal activity. The performed analysis on distribution of various age rocks, fractures, volcano-tectonic structures along these faults (Leonov, 1991) shows, that regular change of their age and sizes within the boundaries of volcanic belts occurs in from SW to NE, and also occurs regular change of natural heat resources of known hydrothermal systems. All in all the revealed peculiarities allow to assume, that in the interior part of the earth of Kamchatka there is horizontal transportation of substance, directed east-north-east, thus faults of the northeast strike act like the most convenient magma- and fluid conduits. In these conditions the most favourable places, where the hydrothermal systems are grouped, are the northeast endings (within the boundaries of volcanic belts) of the northeast strike faults. The confined to them groups of the largest high-temperature hydrothermal systems of Kamchatka were allocated by V.V.Averyev as geothermal regions. The analogous position in the Sredinny volcanic belt is occupied by the areas where Kireunskiye-Dvukhyurtochnye, Ukinskie and Rusakovskie-Palanskiye thermal springs are situated.

The important role in localization of thermal manifestations and hydrothermal systems on Kamchatka is played also by the young (mainly medium-late-Pleistocene-Holocene) ruptures of north-north-east strike (NNE 20 - 30 °). Widest of all they are advanced along the axial lines of volcanic belts, where they are present either as tension joints, supervising manifestations of late Pleistocene-Holocene volcanism, or as fault systems, forming the young grabens. In many cases namely these faults (and formed by them grabens) are responsible for distribution of thermal manifestations and hydrothermal systems on the surface (examples are: Pauzhetsky graben, North-Mutnovskaya zone, Paratunsky graben, Nalachevsky graben etc.). The majority of structures, generated by faults of northeastern strike, have sharply asymmetric structure - their west-north-west wing is more lifted and is clearer outlined. Such peculiarities of their structure are also related, apparently, to the horizontal transfer of substance within the interior part of the earth of Kamchatka directed east-north-east. Presence of such displacements turns the faults of NNE strike into zones of tension, which fit for manifestations of volcanism and shows of thermal activity along them.

Thus, as a whole, the distribution of thermal manifestations and hydrothermal systems on Kamchatka is determined in general - by volcanic belts of Pliocene-Pleistocene age; within the boundaries of belts - by zones of rather ancient intersecting faults of northeast strike (geothermal regions are confined to their northeast endings; within the boundaries of zones of northeast strike and between them - by young, medium-late- Pleistocene-Holocene faults of NNE strike. Distribution of thermal manifestations experiences also influence of the prospective flow of substance in the interior part of Kamchatka directed ENE, which usually results in displacements of thermal manifestations within the boundaries of hydrothermal systems to ENE related to zones of their probable thermal feed (Fig.2).

Fig. 1. Location map of the volcanic belts, active fault zones and modern hydrothermal systems on Kamchatka

I - volcanic belts (I - Eastern, II - Sredinny); 2 - modern hydrothermal systems (a- lower-temperature, b - high-temperature), 3 - ancient (presumably Myocene) northeast fault zones, reactivated in recent time (magma-and fluid conduits); 4 - medium- latepleistocene-holocene north- northeast strike fissure systems (a) and faults (b), bergstrichs shows prefer direction of the dip of fault planes.

Arrows and numbers shows: on Eastern Kamchatka - geothermal regions allocated by V.V.Averyev (1 - Pauzhetsky. 2 - Mutnovsky, 3 - Uzon-Semyachiksky), on North and Middle Kamchatka - the areas where next thermal springs are situated. 4 - Kireunskiye - Dvukhyurtochnye, 5 - Ukinskie, 6 - Rusakovskie - Palanskiye

Fig. 2. Structural schemes of Mutnovsky geothermal region (a) and area of Kireunskiye - Dvukhyurtochnye thermal springs (b)

1 - limits of pleistocenic volcanic and volcano- tectonic structures, 2 - calderas and craters of volcanoes; 3 - northeast faults (bergstrichs shows direction of the dip of fault planes); 4 - thermal springs.