FLUID MECHANISM OF ORE DEPOSIT ORIGIN IN THE UPPER CRUST

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A possible mechanism [1] of ore deposit origin in the continental platform regions is considered. It is related with oscillatory movements (including self excited vibrations) in faults, jointing zones and waveguides of the upper crust. This work aims towards the systematic study of the fluid dynamic and ore origin in rupture structures of the upper crust in terms of some concept [2,3]. This concept covers an investigation on the micro- and macro scale levels. It concerns a rupture of brittle rocks and attendant phenomena in the fluid systems.

Macro scale phenomena include the dilatation and filtration processes in faults and jointing zones. A pore pressure gradient at dilatation processes is commensurable with the gravity force. It is limited with strength of rock only. There are not other phenomena in the upper crust with such great pore pressure gradient on big sizes. On the micro scale level we consider processes of physical kinetics.

The main driving force of all over Earth mantle processes is a mantle thermal convection. It produces a global stress and movement in lithosphere plates. This stress is redistributed in the upper crust and transforms into local and zonal stresses. The last drives fluids – the most mobile and aggressive agent of transportation and transformation of mineral substances.

As a whole the crust has a layered structure. Weakened jointing layers alternates with a monolith medium. Acoustic waves are propagating in weakened layers as in waveguides. That is why one names them waveguides. The upper crust is cool and brittle in comparison with low crust. It is saturated with water fluids, which can move in all over directions. A jointing structure and processes in the upper crust are the complicated multiscale system. The space and time scales changes by many orders of magnitude.

There are four levels of mineral deposit origin in the upper crust: subsurface, hypabyssal, and ultraabyssal [4]. The most of ore deposits and their variety are on the hypabyssal layer. The abyssal level is more exhausted than above levels. One can propose that this stratification is in existence for long time. Therefore, there is a mechanism to support it. It is a fluid movement.

An overwhelming majority of mineral resources is small dissoluble. In their initial form they were distributed all over crust or mantle. On account of this reason it is necessary the recurring fluid movements with bulk of cycles. This fluid migration spreads out on large distance and time scale to create this stratification of mineral composition and ore deposits.

There are two groups of above processes to carry out the indicated processes. The first group includes repeated fluid movements and transportation of dissolved minerals on great distances. Processes of the second group include chemical and physical chemical transformations to a specific form adapted to carrying over by fluid flows. There are advective thermo conductivity, diffusion, osmose, thermo elasticity, hydratation and another processes. High energetic kinetic processes in the tip of cracks have an essential significance. We investigate this phenomenon between other second group phenomena only. These phenomena take place on small distance only. Ore deposits originate from combined interaction of both process groups. We investigate them with help of mathematical models.

In the first place the specific jointing horizontal layers (1000 km in length) known as waveguides are considered. Usually waveguides have a propensity for high conductivity layers and are related with listric faults and another rupture structures. The proposed geomechanical model of waveguide predicts self-excited wave movements [5]. This model describes a two layer system. The horizontal tectonic stress forces this system to make relative movement. The upper layer displaces over waveguide as on lubricant layer. The specific waveguide properties and interaction of both layers produce self-excited wave movements. This periodic waveguide oscillations force vertical fluid movements. Some concept is considered. It suggests this is dominating mechanism of a fluid movement in the upper crust.

On the macro level a dilatancy at the shear stress and thermal convection are dominating mechanisms. Dilatancy is attended with a following elastic consolidation or viscous compaction. At the same time in the frame of concept we considered micro mechanisms of mineral substance transformation. Huge forces in the crack tip arise on the atomic level. They result in atom ionization and other attendant phenomena. By this reason the crack tips are source of the metallic and silicate clusters and catalyst of geochemical processes. This concept contains a new understanding of an evolution of ore and hydrocarbon deposits in the upper crust. It gives a possibility to propose one of a

probable mechanism their origin.

At the time of dilatation phase the downward fluid streams carry in waveguides the dissolved minerals. During compaction phase the upwelling fluids convey these substances to upper layers. This is a mechanism of transportation and concentration of minerals and ore origin. It plays an important part in a geological evolution of the upper crust.

Analogous oscillations arise in the upper crust faults on the various space scales. They force an intensive water circulation on smaller space scales. Mathematical models of these processes are proposed. They are based on nonlinear properties of jointing medium of faults. At the phase of dilatation the permeability increases and fluids are pumped up into faults from an environment. During the consolidation phase the permeability fall and fluids run away from rupture zone along a fault. In case of asymmetric fault properties they migrate in direction of greater permeability. It provides for fluid circulation in the weak seismicity zones.

As for micro scale we investigate kinetic processes in the crack tip during crack bursting. The huge forces arise in this small domain. They ionize atoms induce the emission of X-radiation and so on. On account of that the tips of cracks are sources of the metallic and silicon clusters and catalyst of geochemistry processes [6]. At high temperature and pressure the clusters and neogenic substances are expelled from tips of cracks into a free crack volume. Then they take part in a fluid circulation and subsequent mineral concentration. We consider a kinetic model in terms of the Ito-Stratonovich's stochastic equations. There is a stochastic equivalence them with Fokker-Plank-Kolmogorov's and Boltzmann's equations. We received solution of these equations and proposed its physical interpretation.

Above concept gives a possibility look at the mechanism of ore origin (as well as hydrocarbon origin) in a new fashion. The upper crust is a field where separation and concentration processes take place under the influence of inner inherent factors.

References

1. *Karakin A.V.* Fluid dynamic models of ore deposit origin in the platform regions // Geoinformatics. 2002. № 2, PP. 45-56.
2. *Kuznetsov O.L., Karakin A.V.* Concept of jointing structure and fluid regime in the upper crust // Geoinformatics. 2002. № 3. PP. 11-15.
3. *Karakin A.V., Kur'janov Yu.A., Pavlenkova N.I.* Faults, jointing zones and waveguides in upper layers of the Earth shell. Moscow: VNIIgeosystem. 2003. 228 P.
4. *Starostin V.I., Ignatov P.A.* Geology of mineral resource. Moscow University. 1997. 302 P.
5. *Karakin A. V.A.* Mathematical Model of the Crustal Waveguide. Online journal. Russian Journal of Earth Science. 2001. V. 3. N 4.
   http://ries.wdcb.ru or http://www.agu.org/WPS/rjes/
6. *Kuznetsov O.L., Karakin A.V., Levchenko T.V.* Fluid movement mechanism and ore mineral concentration at moderate seismicity. International Geophysical Conference and Exhibition. Russia, Moscow, September 1-4, 2003. Abstract.

Electronic Scientific Information Journal "Herald of the Department of Earth Sciences RAS" № 1(22)'2004
Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2004
URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2004/informbul-1_2004/hydroterm-19e.pdf
Published on July, 1, 2004