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Simulation of extreme ground water flow in the fractal crack structure of Earth's crust – impact on catastrophic floods

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1. Recently, the contribution of groundwater in catastrophic floods is the question under discussion [1,2]. The principal problem in such an approach – to analyze the transportation ways for groundwater in dynamics, and especially – the reasons of exit it on land surface. The crackness, being a characteristic property for all rocks, should be associated with the process in respect of unified dynamic system as a river water basin is, taking into account fundamental phenomena of the 3D-crack network development/modification (up to faults) as a transport groundwater system [3].

2. In the system of fractal cracks (connected with the main channel for groundwater) the formation of extreme flow is possible, i.e. a devastating case occurs by instantaneous flash mechanism. The development of such a process is related to two factors.
First, within the main channel of propagation of the groundwater when a motion is turbulent. In accordance with the theory of Kolmogorov [4], we assume that such a turbulence is isotropic. The fact means that both velocity and pressure fields in the water flow have pulsations related to the non-linear energy transfer between the vortices. This approach allows us to determine both that a maximum possible size of the vortices defined by characteristic dimensions of the underground channel and another – a minimum size of their due to process of dissipation. Energy transfer in the eddies formed near a border, is a complex nonlinear process, which we described by using a modernized Prandtl semi-empirical model [5].
Second, the mechanism of groundwater propagation in the system of cracks extending from the main underground channel is described in the frames of the fractal geometry methods [6]. The approach allows to determine the degree of similarity in the crack system, i.e. the ratio of mean diameters and lengths of cracks/faults for each step of decomposition. The fact results in integrated quantitative characteristics of 3D-network in all, by fractal dimension. Formation of fractal cracks (in coupling of fault length and it number) ensures an optimal traveling network for propagation of water, but changes in external conditions can lead to the formation of hydroblow with extreme water flow formation on surface, i.e. a flash event arise.

3. The proposed approach allows to carry out the modeling in different spatial scales, to determine the features of hydrodynamic processes for generate extreme water flow, when it is going out on the land surface, and results in catastrophic water phenomenon development.

1. Trifonova T.A., Arakelian M.M., Arakelian S.M. European Geosciences Union General Assembly 2013, Vienna, Austria, 2013. http://www.egu2013.eu ;
2. Arakelian S.M., Trifonova T.A., Arakelian M.M. IGU Kyoto Regional Conference (KRC), Kyoto, Japan, 2013, www.igu-kyoto2013.org.
3.Trifonova T. A.. // Izv. RAS, series on geography, 2008, No.1, pp.28-36.
4. Kolmogorov A.N. //Bulletin of Soviet Academy of Science, 1941. V. 30, No.4. pp. 299-303.
5.Volynov M.A. // Fundamental research No.10. 2013, pp. 1676-1688.
6. Mandelbrot B.B. // Institute of computer research ISBN 5-93972-108-7 (2002).