Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

MIS021-P03 会場:コンベンションホール 時間:5 月 22 日 14:00-16:30

Hydroelectric coupling in a porous medium heated from below
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The mechanism of convection and electric phenomena around an isolated heat source in a fluid saturated porous media is of interest in geothermal processes and volcanology. Laboratory and numerical experiments (2D-3D) of transient convective flows and induced electric potentials in a porous layer with a local bottom heat source are reported. Axisymetric laminar plumes are experimentally generated by a small electric heater in a tank filled with water-saturated glass beads. The flow pattern is investigated for Rayleigh numbers up to 8000. Plumes ascent in two different regimes. For Ra<1600, the velocity of the plume head slowly decreases during the ascension in the porous medium (consistent with Elder, 1967). For Ra>1600, the velocity increases owing to the development of the thermal boundary layer, remains nearly constant during the rise, before decreasing at the top of the tank. Finally, the electric potentials induced by the development of the plume are analyzed. It is shown that the signal systematically decreases when the plume is detaching itself from the bottom, before increasing during the ascension of the water. This study is the first step to further experimental and numerical works on convective cells generation and induced electrokinetic potentials in a high permeability porous medium.

Elder J.W., Transient convection in a porous medium, J. Fluid Mech (1967), vol. 27, part 3, pp. 609-623

キーワード: Analog Experiment, Convection, Self-Potentials, Hydroelectric Coupling, Porous medium, Numerical modeling
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