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月地殻形成モデルにおける変形しうる多孔質媒体中の対流現象
Modes of convective flow through deformable porous media,implication for lunar crust formation

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Modes of convective flow through deformable porous media,implication for lunar crust formation   Existence of pure anorthite crust on the Moon as revealed by KAGUYA mission(0htake et al, Science 2010) indicates not only intensive floatation of plagioclase in the lunar magma ocean but further completion of compaction from the state of crystal mush. The time scale of this compaction process should control chemical composition of the anorthositic crust. The initial state of floating anorthosite aggregates is expected to be a kind of random close packing of crystals, which means melt phase should be included at about 30% vol. in the case of homogeneous grain size. During this stage fluid migration through crystal aggregate occurs extensively. Although this process has been conventionally modeled as fluid flow through porous media and convection in permeable flow and the time scale of fluid migration is estimated based on porous flow model, an important difference exists between rigid frame model and the lunar protocrust. In the lunar case porous frame which is constructed of plagioclase crystals should be deformable and it is slowly compacting so that the interstitial melt is finally squeezed out. Motivated by this difference we focus on the significance of deformability of porous frame in the convective flow through porous media. In this presentation we report on laboratory experiments which compare style of convective fluid flow in porous media between deformable frame and rigid one. As the rigid case glass beads are used for the porous frame whose grain size is 0.4mm to 3mm. To check density difference between solid and liquid(aqueous solutions) styrene beads(0.5-2 mm in diameter) are also used. As the deformable case soft gel such as agar and hydrogel is used. To see the difference in flow style we have conducted thermal convection experiments by using localized heat source at the base of experimental tank. Since the porous media is not transparent enough to allow optical inspection of fluid flow such as PIV we measured temperature at several points around the heater in vertical and horizontal directions. We observed localization of high temperature above the heater,which reflects convective flow induced by localized heat source. In the case of deformable frame not only the fluid but solid grains also exhibit slow migration in consistent with the convective flow. This induces rearrangement of particles, which should enhance effective compaction and efficient squeeze-out of melt phase.
Keywords: Convective flow in a fluid in a porous medium