# 科学的興味を誘起するキッチン地球科学的材料（1）
# Complex rheology fluids as a curiosity-arousing agent in "Kitchen Earth Science"

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Kitchen earth science aims to excite scientific curiosity through the five physical senses in our daily life-style experiments. Not in the virtual worlds but using our hands stimulates our brain. To do this the essential point is simple set-up to start experiments with ease. The selection of kitchen materials can provide a way with low "activation energy". At the same time, to excite curiosity selection of the experimental material is quite important so as the experiments contain a flavor of enigma. Variety of food additives to modify food texture are one of the ideal materials for kitchen experiments. In this presentation we report complex rheology of kelzan and its curious behaviors which would be useful in designing kitchen earth science experiments.
Kelzan is a comercial product of xanthan gum as a foodaditive, which is used as a thickner to control rheology. This is famous for having strong shear-thinning rheology. Because of this as well as clear transparency kelzan has been used extensively as a demonstration material for a complex fluid( eg. Placios-Morales and Zenit,2013, Velez-Cordero and Zenit 2011). Here we show several examples of curious behavior of kelzan, which can be used as seeds in applications of kitchen earth science.

**Particle cluster formation during sedimentation**

Sedimentation process is universally observed in various situations of earth science such as the core formation and in evolving magma chamber and in the ocean. During sedimentation specific structural patterns are observed to be formed by fluid dynamical interactions, which control overall efficiency of differentiation.
In sedimentation of glass beads particles through kelzan solutions particle clusters are easily formed. This can be demonstrated in comparison with the case of Newtonian fluid,glycerol solution. In Newtonian fluid initial fluctuation of particle concentration grows to form a large cluster. Since a larger cluster has a larger sinking velocity a larger cluster captures and entrains particles and smaller clusters and grows faster. In shear-thinning fluid intermediate-sized clusters are formed at relatively early stage so that size distribution of the cluster is different. At the wake of fast-moving cluster local viscosity becomes lower than the surrounding area because of shear-thinning nature so that the particles can be entrained into this region effectively. This controls the aggregation process.

**Bubble trains and bubble interaction**

When air bubbles are introduced by air-diffuser placed at the bottom of the fluid container with regulated air supply, bubble curtan is formed during the ascent. In kelzan solution width of the curtain is thinner and the location is stable without fluctuation. Then the curtain separates into several bubble trains. In the bubble train a pair of bubble is frequently formed. This is also due to local decrease of viscosity at higher fluid velocity.
Throughout these experiments kelzan solution provides a good example in understanding importance of structure formation. These simple experiments can be extended and implemented in the various contexts of earth science. We will show these examples as image gallery in the presentation.

 

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