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Simultaneously ascending diapirs from different depths and different positions: a centrifuge study

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In this study, we investigate the diapiric ascent of buoyant material from two source layers, which are located at different depths. The diapirs rise from protrusions at different positions on top of both the source layers through a model made from different silicone putties. Theses models are aimed to explain the origin of concentrically zoned, inflated plutons, their ascent and emplacement. We want to test, if a rising diapir ascends straight upward or, if it might be deviated by a similar buoyant layer which is located within the overburden strata to follow the diapir stems developing from this layer.
A centrifuge is used to model the kinematics and dynamics of the buoyant material during ascent and emplacement of the diapirs. Four experiments are carried out: each consists of two buoyant PDMS layers and two layers of overburden of greater density above each PDMS layer. Throughout the experimental runs, the effects of different overburden viscosities and perturbation positions on the number of the diapirs, the diapir pathways and the deformation patterns of the overburden layers are investigated. In models 1-3 both the protrusions are offset; in model 4 both protrusions are located directly on top of each other. A fifth model has been made, without protrusion, in order to compare it with previous experiments, in particular to study the influence of the protrusion on the diapir pathways. Our models show that with higher overburden viscosity, the number of diapirs decreased. The modelling results also show that two diapirs rising from offset perturbations (models 1-3) do not take the same pathway through the overburden layer when rising upward. Rather, each diapir takes a different pathway, with the deeper diapir piercing through its overburden while rising, regardless if it was a PDMS layer or denser overburden layers. The reasons for this behaviour are, (1) that the upper buoyant layer thins out while diapirs are fed from it and (2) that the upper PDMS layer deforms already early during the experiments due to the rise of the lower diapirs even before those hit the upper buoyant layer. Both processes – thinning and deformation of the upper PDMS layer – prohibit that this layer can act as a favourable pathway for the lower diapirs, which instead simply pierce through it. However, when the two perturbations were situated directly above each other in the different PDMS layers (model 4), this resulted in the formation of one big diapir rather than several smaller ones, and the overburden layer was less deformed than with offset perturbations. A similar configuration is observed in the experiment without protrusion (model 5), two small individual diapirs began to grow upward and were situated directly above each other in the different PDMS layers.
Both observed ascent and emplacement behaviours have their natural counterparts. Diapiric structures as those derived from models 1-3 and 5, i.e. small individual not nested diapirs developing from source layers at different depths occur within the Great Kavir Basin (Iran), where numerous salt diapirs grew from several salt horizons and which show a similar spatial distribution as observed in our three first models (plus model 5 without any perturbation) . The natural analogue of our fourth model (two perturbations situated directly above each other) is close to what is observed in natural examples of composite batholiths such as the Bergsträßer Odenwald Crystalline Complex (Germany).