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Modeling of compaction in volcanic cameras

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This study considers the processes of cooling and differentiation of partly melt matter in magmatic cameras in areas of Earth crust of continental rifts. The most distinctive and well-researched areas of that type are Iceland and East Greenland. During the spreading of continental rift warmed magma in the form of intrusions or sills is penetrating cold massive materials. In addition, there may be other manifestations of geodynamic settings of magmatism: intraplate magmatism, subduction zones, collision zones, hot spots.

Temperature inversion occurs. Processes of cooling and differentiation of partly melt matter start taking place in cameras. The matter is a heterogeneous mixture of magmatic fusion and viscous frame. Transitions between fluid and solid phases are possible. The state of this mixture may vary depending on the concentration of the fluid phase.

The entire volume of the magmatic camera may be divided into three zones. In the upper one the concentration of fluid exceeds approximately 30% - 40% and the state may be viewed as suspension. The process of sedimentation of solid heavy particles takes place here. As a result, at the bottom boundary of the suspended matter the properties of the mixture change and it transforms into porous viscous matter that occupies the middle zone of the camera. The process of compaction (compression of viscous frame and filtration of fluid) takes place here. The process of differentiation is most intensive in this part. That is the reason why this part is subject to modeling. In the lower zone, the relative motion of phases stops. The fluid is either absent or trapped in isolated pores. This zone cools intensively. In the second case the fluid solidifies.

Following the complete solidification of magmatic camera its structure is preserved for a long period of time. Observing it can help to understand the dynamic processes that took place during the partly melt condition of the camera long ago. In order to encrypt them a mathematical model of that process should be constructed.

Initially the entire camera is in the state of suspension. Due to thermal convection the temperature in suspended matter is evened vertically. Isothermal mode could then be applied. After the cooling of the lower layers of the camera and the process of sedimentation the lower boundary of suspension zone raises rapidly. The temperature at the boundaries of the compaction zone varies substantially, so the mode cannot be considered isothermal. After the boundaries move far enough the mode is stabilized and the temperature differences even. Thus, isothermal mode can be applied.

At this mode the hydrodynamic processes of compaction can be viewed in isothermal mode. Thermal processes (i.e. the general process of cooling) determine the velocity of boundaries moving and the velocity of phase transitions. Both values are intended to be known a priori.
The presence of moving internal boundaries in boundary value problem is the most significant distinction between this model and the McKenzie model. At the upper boundary the porous viscous matter transforms to suspension, while at the lower boundary the isolation of pores occurs.
One-dimensional approximation is considered. Boundary conditions at both boundaries of the compaction zone are stated. Finally, depending on the parameters both types of cumulates, adcumulates and orthocumulates, could be achieved using this model.