Consequences of adiabatic decompression melting on magmatic channeling instabilities

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In the partially molten region of the earth, the solid mantle upwells and melts due to adiabatic change in pressure. The melts that are produced, however, can react with the upwelling solid to form dissolution “channels” which may have widths of 0.1-100 m or larger. A lot of work has been done to understand this process for the problem of a static solid being fluxed by a reactive melt. However, it is still unclear how the solid upwelling affects the channel formation process. A 1-D column model is used to explain the process for the upwelling reactive system. Based on the original nonlinear equations governing flow in reactive, deformable media, we now include the effect of solid upwelling velocity in a simplified linear model. Linear analysis shows that there exists a critical value of both the upwelling velocity and the reactive region height, beyond which no channels can be observed in the reactive region. A phase diagram of the existing channels is generated from the linear analysis and we combined the model with the observational information about the earth to verify the existence of channels in the partially molten region. Both the linear analysis and the numerical model supports the result that channels could exist in the earth yet is affected by different value of solid upwellings and region height.