

EGU2020-13829

<https://doi.org/10.5194/egusphere-egu2020-13829>

EGU General Assembly 2020

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## Modelling channelized fluid flow: failure physics and geological setting

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Fluid flow instability in deforming porous rock, commonly known as porosity waves, has been used to explain formation of seismic chimneys, one of the most important expressions for the localized fluid flow in the subsurface. Experiments show that volumetric deformation of rocks is strongly coupled with shear deformation, leading to shear-induced decompaction at low confining pressure and shear-enhanced compaction at higher confining pressure. Previous studies introduce a weakening factor of  $R$  for bulk viscosity in the viscous deforming regime. While it has successfully reproduced the channelized fluid flow in numerical models, it cannot investigate the effect of shear deformation. More controversially, negative effective pressure ( $P_t - P_f$ ) is required for the channel formation. Here, we develop a viscoplastic rheology that takes into account effects of shear stress and plastic failure on the volumetric deformation, consistent with experimental data. A dilation pressure is naturally introduced through viscoplastic strain-rate when plastic failure occurs under high fluid pressure and shear stress condition. Our model results show that this new rheology can produce channelized fluid flow without negative effective pressure in the model.

In order to apply our models into real geological setting, we test the effects of reservoir properties, geological layering, transport properties of the layers and faults. Our results show that fluid channel initiates at local topography highs in the reservoir and a high-permeability fault can also trigger the initiation of fluid channels. Fluid channels can have different length and time scales in different layers, depending on bulk viscosity and permeability of the layers.