Title: **Dissolution of underground cavities: a multiple-scale view**

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Abstract:

The generation of underground cavities through dissolution processes is used favorably in many industrial applications (mining, gas storage, ...) but is also the source of hazardous phenomena due to cavity collapse. Dissolution is also fundamental in understanding karstic formations. Because of the intrinsic heterogeneous nature of geological formations, modeling dissolution processes must take into account the different multiple-scale features. Several questions are discussed in this paper to emphasize these multi-scale aspects.

First, the mathematical nature of dissolution models for porous formations is analyzed based on the upscaling of a simple, generic, dissolution problem. It is shown that several models may arise from the upscaling process depending on the relative importance of local and non-local effects. It is also pointed out that non traditional terms may play an important quantitative role, a problem which has been often underestimated in the literature.

Then, the question of determining *effective surface* conditions for describing in a smooth manner the dissolution of chemically and physically heterogeneous surfaces is discussed based on a domain decomposition technique. Such approaches are crucial if one wants to develop large-scale dissolution numerical simulations.

It is then shown how dissolution processes may be affected by dissolution instabilities (wormholing for instance) and how the size of the domain under investigation affects the stability conditions. Another interesting problem is the dissolution patterns induced by the coupling with hydrodynamic instabilities (natural convection for example) generated in the boundary layer near the dissolving surface.

Finally, some questions related to the numerical modeling of the dissolution of large-scale cavities are discussed: use of explicit interface tracking (such as ALE) versus diffuse interface models, the use of simplified momentum balance equations, etc...