

STREAM 3D project

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Overview

- 1 Introduction
- 2 Mathematical model
- 3 Numerical Plattform
- 4 Conclusion

Introduction



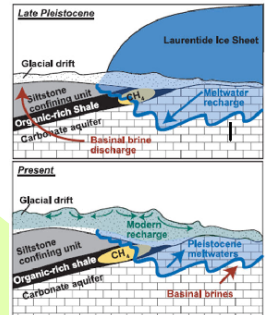
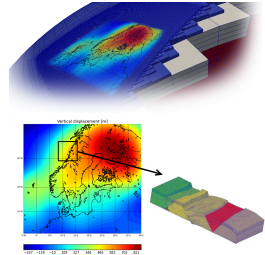
Background and Motivations

Key processes of sedimentary basin evolution:

- geomechanics and dynamic evolution of stress and deformations;
- transport of dissolved chemicals;
- geochemical reactive processes.

The effects of glaciations on the subsurface:

- the mechanical compaction due to the load of ice sheets;
- the deformation of the lithosphere by isostasy;
- the subglacial meltwater;



Mathematical model



$$\begin{aligned} -\nabla \cdot (2\mu\varepsilon(\mathbf{u}) + \nabla \cdot \mathbf{u}) + \alpha\nabla p &= \rho\mathbf{g}, \\ \partial_t \left(\frac{p}{M} + \alpha\nabla \cdot \mathbf{u} \right) + \nabla \cdot \mathbf{u}_d &= S_f, \\ \mathbf{K}^{-1}\mathbf{u}_d + \nabla p &= \rho_f\mathbf{g}, \end{aligned}$$

$$C_T \frac{\partial T}{\partial t} + (\phi \rho_l c_l \mathbf{v}_l + (1 - \phi) \rho_s c_s \mathbf{v}_s) \cdot \nabla T - K_T \nabla^2 T = Q.$$

$$C_T \frac{\partial C}{\partial t} + \mathbf{u}_D \cdot \nabla C - D \nabla^2 C = Q_c.$$

Poromechanics - Temperature Dynamics - Chemical transport

$$-\nabla \cdot (2\mu\varepsilon(\mathbf{u}) + \nabla \cdot \mathbf{u}) + \alpha \nabla p = \rho \mathbf{g},$$

$$\partial_t \left(\frac{p}{M} + \alpha \nabla \cdot \mathbf{u} \right) + \nabla \cdot \mathbf{u}_d = S_f,$$

$$\mathbf{K}^{-1} \mathbf{u}_d + \nabla p = \rho_f \mathbf{g},$$

$$C_T \frac{\partial T}{\partial t} + (\phi \rho_l c_l \mathbf{v}_l + (1 - \phi) \rho_s c_s \mathbf{v}_s) \cdot \nabla T - K_T \nabla^2 T = Q.$$

$$C_T \frac{\partial C}{\partial t} + \mathbf{u}_D \cdot \nabla C - D \nabla^2 T = Q_c.$$

$$\mu = 1.002 \cdot 10^{-3} (1 + \alpha_1(T) + \alpha_2(C_M)) \quad (1)$$

$$\rho_l = \rho_0(1 + \beta_1(T) + \beta_2(C_M)) . \quad (2)$$

Ice fraction

$$S_i = \begin{cases} 1 & T > T_L, \\ (1 - S_{lres}) \exp \left[- \left(\frac{T - T_L}{w} \right)^2 \right] + S_{lres} & T_L > T > T_{lres}, \\ S_{lres} & T < T_{lres}, \end{cases} \quad (3)$$

Numerical Plattform



GetFem

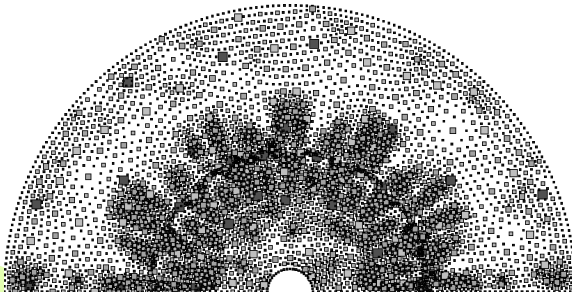
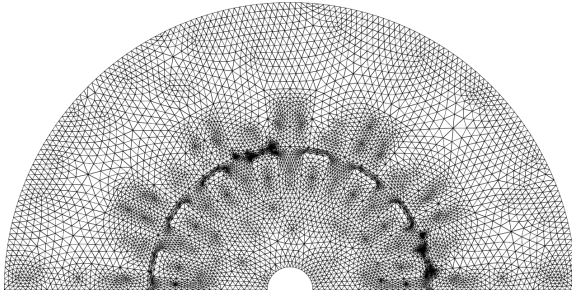
- c++ finite element platform
- Generic assembly language
- Level-set and finite element cut by one or several level-set (Xfem)

SAMG library

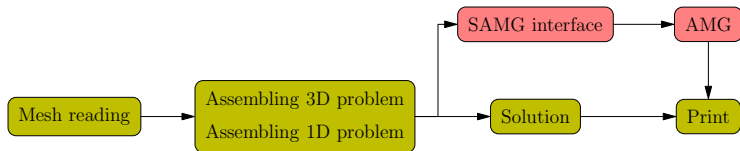
Algebraic Multigrid Methods
for Systems

- solution of large linear systems
- highly scalable
- easy to integrate

Geometric VS Algebraic



Integration



- Simple interface (CSR matrix)
- Same programming language

Conclusion

