STREAM 3D project

D. Cerroni, L. Formaggia, A. Scotti and P. Zunino

October 2, 2017

Politecnico di Milano

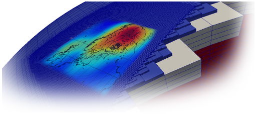
Overview

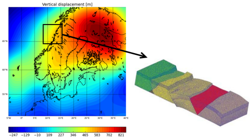
Introduction

Background and Motivations

Key processes of sedimentary basin evolution:

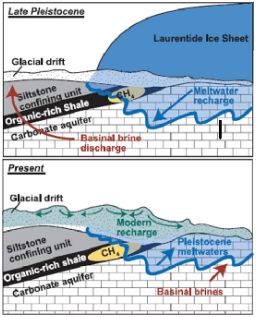
- geomechanics and dynamic evolution of stress and deformations;
- transport of dissolved chemicals;
- geochemical reactive processes.





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

Poromechanics

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

Temperature Dynamics

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

Chemical transport

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

Coupled model

Poromechanics - Temperature Dynamics - Chemical transport

$$
\begin{aligned}
-\nabla \cdot (2\mu\varepsilon(\mathbf{u}) + \nabla \cdot \mathbf{u}) + \alpha \nabla p &= \rho \mathbf{g}\,, \\
\partial_t \left(\frac{p}{M} + \alpha \nabla \cdot \mathbf{u} \right) + \nabla \cdot \mathbf{u_d} &= S_f\,, \\
\mathbf{K}^{-1}\mathbf{u_d} + \nabla p &= \rho_f \mathbf{g}\,, \\
C_T \frac{\partial T}{\partial t} + (\phi \rho_l c_l \mathbf{v_l} + (1-\phi)\rho_s c_s \mathbf{v_s}) \cdot \nabla T - K_T \nabla^2 T &= Q\,. \\
C_T \frac{\partial C}{\partial t} + \mathbf{u_D} \cdot \nabla C - D \nabla^2 T &= Q_c\,.
\end{aligned}
$$

Numerical Plattofrm

Conclusion