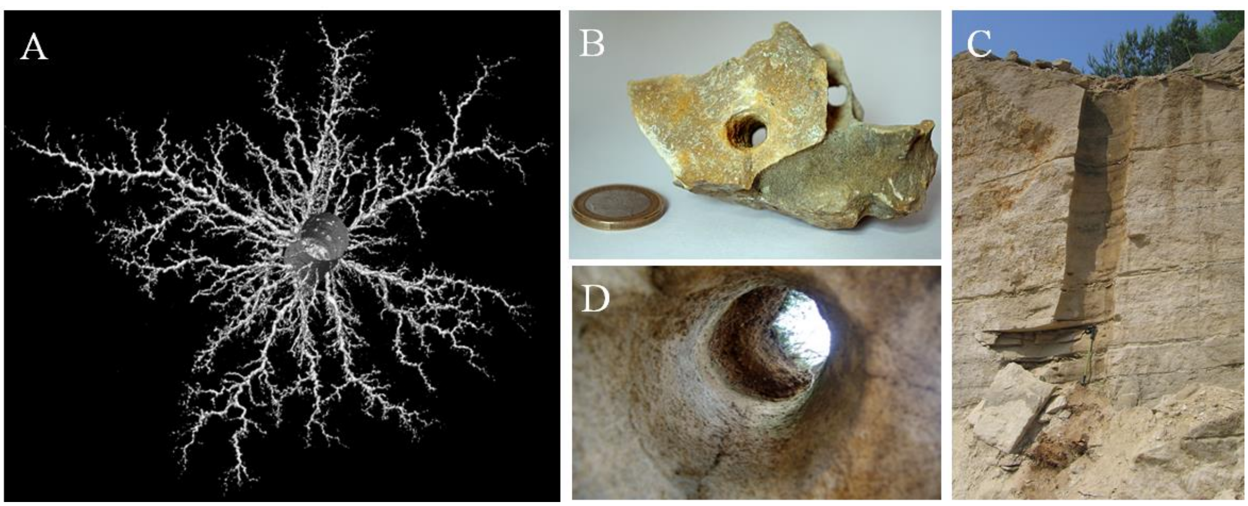
Instabilities play an ubiquitous role in shaping our environment: wind shear at the air-water interface generates a Kelvin-Helmholtz instability leading to ocean waves, convective instabilities create the wind itself, dripping taps and inkjet printing are both manifestations of the Rayleigh-Plateau instability. However, the patterns created by most instabilities -- ocean waves, droplets, convection cells or viscous fingers -- are transient and disappear when energy transfer stops. Geological formations are a notable exception, since the patterns created are often frozen and can persist for hundreds of millions of years after the processes leading to them have stopped. A particularly important class of geomorphological forces are the processes of weathering and erosion. Whereas mechanical erosion is shaping the river valleys and mountain ridges on the Earth's surface, chemical erosion, which is a topic of this project, is active in many subsurface processes such as cave formation. The rates of natural chemical erosion are usually very low, with significant changes taking place only after thousands of years. However, in engineering applications, where the concentrations of reactant are orders of magnitude higher than in nature, a system can be eroded within minutes. A relevant example here is the acidization of petroleum reservoirs where acid enlarges the natural pores of the reservoir and stimulates the flow of oil.

Petroleum engineers were first to notice that the dissolution around the acidized wellbore is often nonuniform and, consequently, the flow becomes spontaneously localized in pronounced channels, which they have called ``wormholes'. They have learned to use wormholes to their advantage - wormholes transport fluids in an effective manner while not requiring large amounts of reactant for their creation. Therefore, wormholes provide an efficient way of increasing the permeability of the rock body.

In the present project, we study the shapes of wormholes. In particular, we intend to understand how these shapes are connected with the micro-architecture of pores naturally existing in the rock. Would the rock with a large number of small pores dissolve in a different way from the rock with small number of large pores? Will vugs and cavities in the rock impact the dissolution patterns? Why natural wormholes in karst formations are smooth, whereas the ones produced in laboratory have fractal shapes? These are the questions that we will attempt to answer in the present project.



A: Tomography image of a dissolution pattern produced by acidization of a limestone block
B, C, D: Natural wormholes (solution pipes) in the limestone quarry in Smerdyna (Poland), showing regular, cylindrical forms across a vast range of scales – from small pipes 0.5cm in diameter (B) up to massive pipes of several meters in length and 0.5 meter in diameter (C, D)