Stylolites: when they became conduits for fluid pathway?

Giuseppe Repetto¹, Silvana Magni², Paul Sardini³, Marja Siitari Sattari⁴, Juuso Sammaljärvi, and Arnaud Mazurier

¹University of Genoa, Italy
²Tektonophysics, University of Mainz, Germany, silmagni@uni-mainz.de
³I2mp, umr 7285 cnrs, University of Poitiers France
⁴Hyrl, chemistry department, University of Helsinki, Finland

Dissolution process is a complex phenomenon controlled by several factors such as the nature of chemical dissolution, lithology, porosity, stress orientation, environmental conditions, networks of fractures. In the karst field, however, compressional tectonic structures, as like stylolites, are never been taken into consideration for fluid flow. Stylolites are formed by a pressure solution processes that dissolves the soluble particles and leads to an enrichment in insolvable, non-carbonate particles (NCP) along their surfaces. Potentially they play an important role in fluid circulation during carbonate deformation.

Although they seem macroscopically planar, stylolites have an extremely variable shape from the meso- to microscale, with variable porosity and permeability. Because of this, they have a strong effect on regional fluid flow and the formation of reservoirs since they can act as barriers or conduits for flow.

In this research we investigated the distribution of voids and pores present both within and near the stylolites. This task is challenging because the pore sizes are small and therefore difficult to investigate. To determine which role the NCP and these structures have on fluid circulation, a comparison is herein presented between two different methods used to map the submicroscopic arrangement of pores and voids in and around stylolites. Because the investigated stylolites are relatively narrow, around 30-50 µm, we decided to use a classical micro Computed Tomography (µCT) technique supported by the ¹⁴C-PMMA impregnation method on two marble samples. These two complementary methods characterize the spatial distribution of connected voids in and around stylolites. µCT analysis provide adequate information on the 3D distribution of voids even if nanometer scale pores and small fractures are difficult to observe using µCT.

¹⁴C-PMMA method is however able to reveal connected porosities from mineral areas that consist of nanometer scale pores. Methylmethacrylate intrudes into nanometer scale pores, and autoradiography is used to visualize the porosities thanks to ¹⁴C beta emissions. Combining these two techniques, CT tomography and PMMA autoradiography we can visualize the 3D pore structures of the studied samples.
The results show that the micro CT technique supported by the PMMA autoradiography technique provides a useful tool to characterize the voids and pore structures of geomaterials. The results allowed a more accurate description of the behavior of stylolites in fluid-rock interaction.

Key words: stylolites, permeability, microCT and $^{14}$C-PMMA impregnation