

3-dimensional Fracture Network Analysis by Persistent Homology

*Miyuki Miyazawa¹, Anna Suzuki², Atsushi Okamoto¹, Hiroyuki Shimizu³, Ippei Obayashi⁴, Yasuaki Hiraoka^{4,5}, Takatoshi Ito²

1. Graduate School of Environmental Studies, Tohoku University, 2. Institute of Fluid Science, Tohoku University, 3. Kajima Corporation, 4. The Advanced Institute for Materials Research, Tohoku University, 5. Kyoto University

Persistent homology (PH) based on topology is a method for capturing sizes and shapes of “holes”, that is information of connectivity. Because PH enables to quantify complex structures, automatic pattern recognition of fractures can be carried out.

Fluid flow in rocks is dominated by connectivity between fractures, so it can be expected that the relationship between fracture patterns and fluid flow can be obtained by the PH.

In this study, we quantified the images of the results from crack propagations simulation and natural mesh structures in serpentinites. The PH analysis helps to estimate the flow conditions in which the mesh structures in serpentinites were formed. And we can quantify 3D fracture structure by PH. It can be expected that PH is applied to design for geothermal reservoir by coupling PH analysis result of 3D fracture models with feature of fracture (e.g., surface area, volume, connectivity and permeability).

Keywords: Topology, Data science, Mesh structure, 3D printer

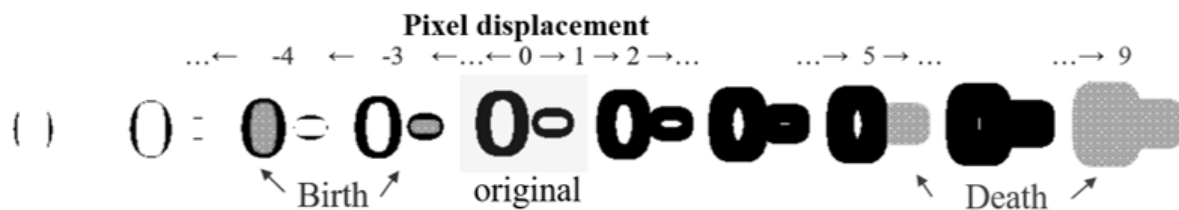


Fig.1 : Example of image analysis by persistent homology.

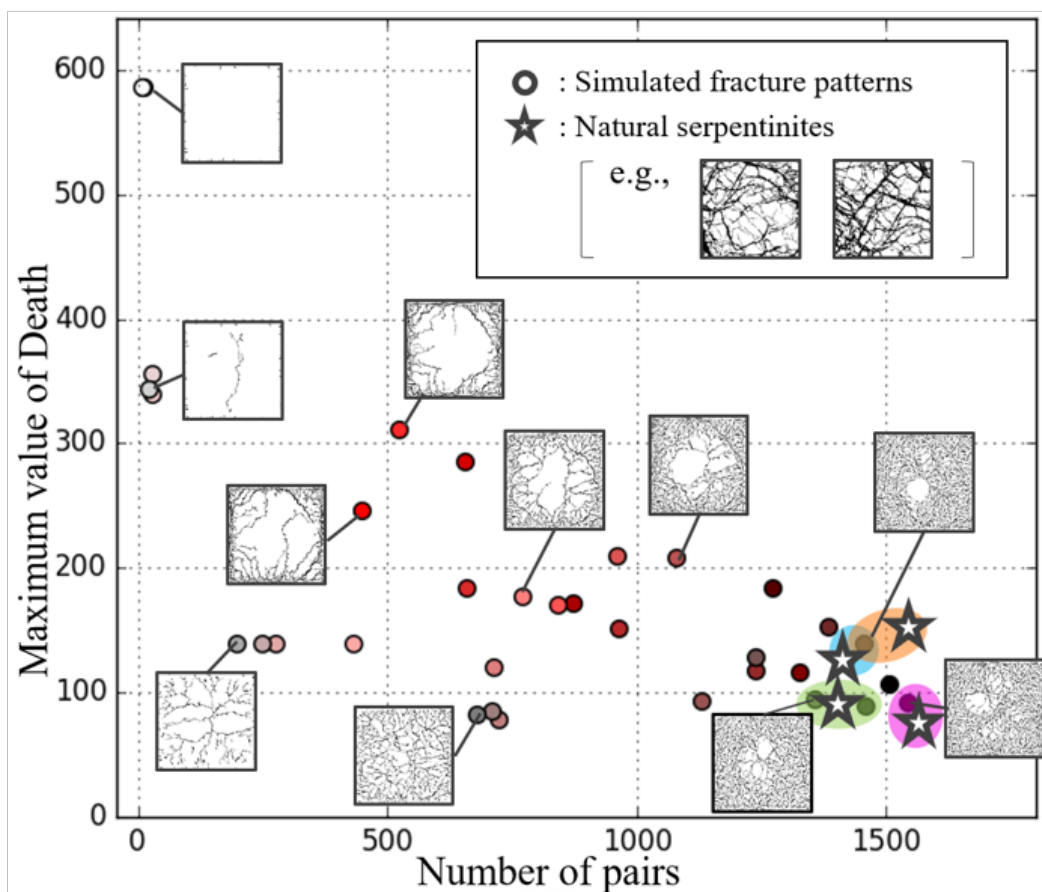


Fig.2 : PH analysis results.