



Master Thesis Proposal 2023
Petroleum Engineering / Geoenergy Engineering

Detection of minerals by implementing image analysis on 2D SEM data

A comprehensive morphological,
geometrical, and statistical analyses
(DSW-1)

Supervisor: prof. Kris Ravi

Co-supervisor/Advisor: Ass. prof Michael Prohaska

Dipl.-Ing Arash Nasiri

Chair of Drilling and Completion



1. Abstract

The application of computed tomography gained attention by the oil & gas industry in the late 1980s ; it has been used generally for imaging and determination of fluid distribution and topology as well as quantifying petrophysical properties all of which are under digital core analysis studies. Since last decade the application of computed tomography has been expanded also to fishing expeditions and formation damage quantification. Here we are assessing a simple approach to identifying & quantify the minerals.

2. Problem Description

Inherently, extraction of mineralogical information (here particularly detection of minerals) could be expected as one of the interesting deliverables of μ CT. However, this capability has been limited owing to its high computational expenses, or the presence of minerals with similar attenuations. There is a surge of new techniques and algorithms (to analyze μ CT dataset better) to detect the minerals but they are often either sample-specific or demand more advanced and time-consuming Dual Energy CT (DECT). The chair of drilling and completion has already developed a simple approach to identifying rock samples minerals (Tectosilicates, Carbonates, and Clay); however, the model's accuracy should be improved by introducing new factors into consideration. The process of identifying those factors demands some good work with image analysis software; provided that the investigation is successful the result is entirely novel.

3. Project Objectives

The original objective of this thesis is to improve the accuracy of the aforementioned model by introducing more factors namely morphological and geometrical factors. Those factors demand statistical and image analysis techniques.

4. Project Work Packages and Schedule

- Developing expertise (elementary) with ImageJ & Original Lab [1 month]
- Developing expertise (medium) with PerGeos. [1 month]
- Developing a good understanding of morphological and geometrical factors (namely Euler characteristic and fractal dimension) on-going
- Investigate the database and calculate the Makowski functionals as well as fractal dimensionality for mineral phases. [4 months]

5. Project Milestones

- Kick-off meeting
- Introductory session to provide access to the image analysis software

- Regular working in the workstation until delivering the objectives

6. Project Partners

Chair of drilling and Completion

7. Project Coordination and Thesis Advisors

University Assistant Dipl.-Ing Arash Nasiri as advisor and coordinator

8. Necessary Input by Project Partners

The chair will provide access to the database

9. Necessary Infrastructure and Software

The chair will provide access to PerGeos Software.

10. Related Projects at the Chair

The project is defined under the development of 3D Digital Sample Workflow, here so-called DSW-1. This is the first step; hence the database includes SEM images with a resolution of [nm]-[μm]. The next step will be then to scale this finding up into 3D μCT voxel images in [μm]- [mm]

Examples of SEM images:

