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A framework to map pore volume change and mineral dissolution/precipitation of wellbore cement exposed to high concentration CO2 using micro-CT images

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In this study, an image processing framework was proposed for mapping Ca(OH)2 dissolution, CaCO3 precipitation, and pore volume change of wellbore cement samples exposed to high concentration CO2 under laboratory-simulated geologic CO2 storage conditions. The main workflow covered in this framework is to, 1) remove noises, artifacts, beam hardening effects, etc. from micro-CT images of cement samples before and after reaction with CO2; 2) register cement CT images before and after reaction; 3) generate grayscale intensity difference images showing CO2-induced cement alteration, and convert grayscale intensity difference into X-ray attenuation coefficient change; 4) calculate pore volume change and local content changes of Ca(OH)2 and CaCO3 at each voxel, given X-ray attenuation coefficient change; 5) generate pore volume change and Ca(OH)2/CaCO3 content changes in 3D view. The effectiveness of the framework was validated through a step-by-step demonstration of results when deploying the framework to process the micro-CT images of six cement samples acquired before and after reaction with CO2. The 3D CaCO3 precipitation and Ca(OH)2 dissolution map was obtained, and the internal and external CaCO3 shells were visualized. Overall, the 3D precipitation and dissolution map gives more intuitive and interpretable results of CO2-induced alteration of cement than the direct visual comparison from original CT images.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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