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Semi-supervised Auto-segmentation Model for Enhanced Geomaterial Analysis

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Understanding porosity in geomaterials is the critical first step to advancing applications like carbon capture and storage, enhanced geothermal systems, and hydrogen storage, where accurate modeling can improve storage efficiency, permeability calculations, and safety. Sandstone, known for its complex and highly porous structure, provides an excellent basis for testing and improving predictive models. In this work, we propose a semi-supervised model for efficient porosity calculation, aimed at reducing the reliance on extensive labeled datasets. Our approach builds on Geo-SegNet, our previously developed contrastive learning-enhanced U-Net model, which uses contrastive learning in the feature extraction process to improve porosity feature detection. By integrating both labeled and unlabeled data through a semi-supervised strategy and employing auto-segmentation for automated porosity feature identification, the model enhances data efficiency and scalability. This advancement offers a cost-effective and robust solution for geomaterial characterization, providing critical insights to support carbon storage efforts and improve our understanding of geomaterial behavior.

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References

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