

AI in Geophysics: The Past, Present, and (Forecasted) Future

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Abstract: For almost four decades, geophysical inversion has been dominated by the paradigm of regularized optimization, most notably "Occam's inversion." While these methods provided a stable path through the ill-posed nature of our inverse problems, they often resulted in "smooth" solutions that struggle to capture the complex, multi-scale realities of the subsurface. This talk explores the transition from these classical methods to the burgeoning era of Artificial Intelligence in geophysics. We begin by reviewing the historical reluctance toward Bayesian frameworks and the early "growing pains" of Machine Learning in the geosciences. We then pivot to the current state-of-the-art, identifying three primary frontiers currently reshaping the field: (1) Generative models that act as learned priors for complex geology; (2) Neural operators and surrogates that accelerate forward modeling by orders of magnitude; and (3) AI-driven decision-making under uncertainty. Finally, we discuss the path toward "Physically Consistent AI," the integration of deep learning with fundamental physical constraints, to provide scalable, high-resolution insights for the next generation of mineral exploration and carbon capture and storage projects.



William Davis is a Senior Computational Scientist at the AI exploration startup Terra AI. He holds a PhD in Earth and Planetary Sciences from the University of California, Berkeley, was previously the John W. Miles Fellow in Computational Geophysics at the Institute of Geophysics and Planetary Physics at Scripps Institution of Oceanography, and has been awarded the

Matthews award in geophysics. William's research explores geophysical simulation, inversion methods, & novel geoscientific data representations.

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