

# **Integrating Unet into a Multi-scale Waveform Inversion for Salt Body Building**

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## **Abstract**

Full-waveform inversion (FWI) is an optimization technique that reconstructs the subsurface velocity by minimizing the misfit between an observed and modeled data. Due to the high non-linearity in the seismic data, FWI is most likely to fail when starting with a poor initial model especially if the data lack the low frequencies and large offsets. For salt provinces, these issues are heightened as the salt bodies are often large with irregular geometry and distinct physical properties. Conventionally, the salt bodies are included in the FWI starting model by recursively interpreting the salt boundaries from seismic images, and apply a flooding (unflooding) process to detect the top (base) of the salt. We develop an approach to invert for the salt body starting from a constant initial model, limited offsets ( 6km) and a minimum frequency of 3 Hz. We leverage deep learning, three Unet networks, to apply a multi-stage flooding and unflooding in the velocity domain. The networks are applied as a post-processing step after an FWI inversion (FWI-Unet). Specifically, starting from a constant velocity, we sequentially apply three FWI-Unet, where the networks in the first two are trained to flood the salt and the network in the last FWI-Unet is trained to unflood it. Since the flooding and unflooding are inherently a 1D process, we use a 1D version of the Unet architecture for the three networks and generate abundant 1D velocity models for training. To avoid adding any cost, we utilize the multi-scale nature of FWI, where low frequency ranges are used in the inversion first and the higher ones are gradually included. Therefor, each FWI-Unet will handle a different range of frequencies starting from the lowest range to the full frequency bandwidth. We verify the method in a synthetic data using the BP 2004 salt model benchmark. We show that the proposed method can correctly recover the salt model even when starting from a constant velocity model. We also show that the method contains a self-correction mechanism and that FWI and Unet somewhat compliment each other. Applications on real data are in progress and will be shared during the meeting.