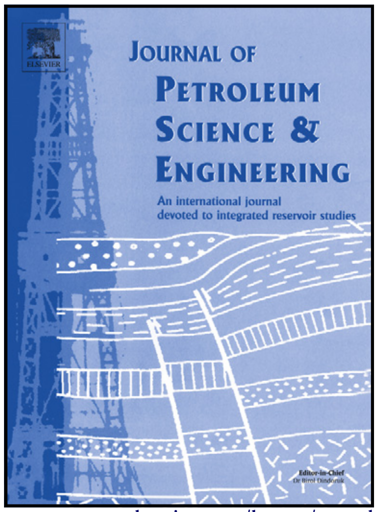

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Maximization of wave motion within a hydrocarbon reservoir for wave-based enhanced oil recovery

C. Jeong[a,1,*], L. F. Kallivokas[b,2], S. Kucukcoban[c,3], W. Deng[d,4], A. Fathi[b,5]

[a] *Department of Civil Engineering*
The Catholic University of America, Washington, DC 20064, USA

[b] *Department of Civil, Architectural and Environmental Engineering*
The University of Texas at Austin, Austin, Texas 78712, USA

[c] *Stress Engineering Services, Houston, TX, 77041, USA*

[d] *Department of Civil, Architectural and Environmental Engineering*
Missouri University of Science and Technology, Rolla, MO 65409, USA

Abstract

We discuss a systematic methodology for investigating the feasibility of mobilizing oil droplets trapped within the pore space of a target reservoir region by optimally directing wave energy to the region of interest. The motivation stems from field and laboratory observations, which have provided sufficient evidence suggesting that wave-based reservoir stimulation could lead to economically viable oil recovery.

Using controlled active surface wave sources, we first describe the mathematical framework necessary for identifying optimal wave source signals that can maximize a desired motion metric (kinetic energy, particle acceleration, etc) at the target region of interest. We use the apparatus of partial-differential-equation (PDE)-constrained optimization to formulate the associated inverse-source problem, and deploy state-of-the-art numerical wave simulation tools to resolve numerically the associated discrete inverse problem.

Numerical experiments with a synthetic subsurface model featuring a shallow reservoir show that the optimizer converges to wave source signals capable of maximizing the motion within the reservoir. The spectra of the wave sources are dominated by the amplification frequencies of the formation. We also show that wave energy could be focused within the target reservoir area, while simultaneously minimizing the disturbance to neighboring formations –a concept that can also be exploited in fracking operations.

*Corresponding author
Email address: jeong@cua.edu (C. Jeong)
[1] Assistant Professor
[2] Professor
[3] Senior Analyst
[4] Assistant Professor
[5] PhD Candidate