Towards assimilating SAR data into an anisotropic model of an underground aquifer

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Abstract

In this study, we aim to shed light on the feasibility of assimilating synthetic aperture radar (SAR) data into a partial differential equation-based model of a poroelastic homogeneous aquifer with anisotropic hydraulic conductivity (AHC).

Although other authors [1] have considered the problem of assimilating SAR data into a poroelastic model that uses an inhomogeneous isotropic random field model for hydraulic conductivity, to the best of our knowledge, our study is the first to consider assimilating SAR data into a poroelastic model with AHC.

Our study is inspired by the work of [2] where an aquifer test is performed on the Anderson Junction aquifer in southwestern Utah. Due to the inherent preferential direction of the fractured sandstone at the Anderson Junction site, the ratio of hydraulic conductivity along the principal axes can be on the order of 24 to 1.

We build an anisotropically conductive poroelastic finite element model of the Anderson Junction site that can predict the coupled fluid flow and mechanical displacements. Our results show that the effective elastic response of the aquifer on the Earth's surface has an anisotropic nature driven by the underlying anisotropy in the fluid problem, even when the elasticity problem is assumed to be isotropic. We interpret these results in the context of using SAR data to improve the characterization of aquifer systems, like the Anderson Junction site, with strongly anisotropic behavior.

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