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Mathematical and analytical analysis of electromagnetic scattering from flat and rough single rock fracture

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Abstract:

Recently, Egypt suffers from the lake of energy resources as it was using mainly thermal power plants for electricity generation. Those power plants were using oil fuel but since few years the population and the development in Egypt consume more energy with time. For that reason, nowadays the Egyptian government urges researchers to search for other alternatives of energy for future development. One of these resources is geothermal energy which expected to have high potentiality in several locations in Egypt like Gulf of Suez (Ain Musa) ,and Western desert (Bahriah and Khargah oasis).

Full polarimetry borehole radar system that can be used for measuring inside small diameter boreholes represents one of the direct tools for subsurface rock fracture characterization. This property of borehole radar enables it to be applied in different applications where one of the most important ones is geothermal energy extraction and deep buried of highly hazard nuclear waste disposals.

Although full polarimetric borehole radar analyses have uniqueness results for fractures characterization still we do not know exactly the scattering behavior of electromagnetic waves due to fracture roughness. For this, I create single fracture (same upper and lower surfaces) which has well known parameters, like its surface frequency content and determined surface roughness, then i simulate it using finite difference time domain method. We integrate measured and simulated results with mathematical solution of electromagnetic reflectivity for this single fracture as a model when it has flat and rough surfaces using Cascade (ABCD) matrix. This analysis represents the basis for understanding electromagnetic scattering well from rough fractures.