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Feasibility study of characterizing crustal cracks by EMR in the VLF band using interferometry

LIU, Lanbo[1*] ; HUANG, Qinghua[2]

[1]Department of Civil and Environmental Engineering, University of Connecticut, [2]Department of Geophysics Peking University

In this paper we present the three-dimensional (3D) numerical simulation results aimed to shed a light on the feasibility of mapping the density and orientation of crustal cracks by looking into the features of electromagnetic radiation (EMR) from cracks using interferometry from a surface observation array. We use 3D finite difference time domain (FDTD) technique to conduct the numerical modeling. The cracks are statistically generated with specified density, size, orientations, and electromagnetic (EM) properties. The measuring points are placed on the earth surface and can be distributed in any arbitrary fashion to investigate the optimistic configuration of the field observation arrays. The objective of this numerical test is two-fold:

1) Investigate the EMR efficiency on the surface by looking into different physical mechanisms (such as charge separation processes between (OKeefe and Thiel, 1995) or along (Gershenzon et al., 1986) the crack walls associated with micro-cracking; 2) crack-induced movement and reorientation of dislocations (Misra and Gosh, 1980; Slifkin, 1993); 3) the surface vibrational-wave model of Frid et al. (2003) and Rabinovitch et al. (2007)).

2) Investigate the influence of strong radiation from VLF transmitters on using EMR for tectonic and earthquake studies.

As the existing preliminary observations (e.g., Krumbholz, 2010; Krumbholz et al. 2012) have shown, the hope of using EMR to determine the horizontal principal stress orientation at one location by looking into the EM amplitude from a single station alone is diminished. This motivates us to look into the interferometry approach to eliminate the strong influence of active VLF transmissions.

Keywords: seismoelecgtric, crustal cracks, interferometry, VLF, electromagnetic radiation, numerical simulation