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On the dynamics of a fluid-filled crack by a time-domain boundary integral equation method

Hideo Aochi (1,2)

(1) Bureau de Recherches Géologiques et Minières, Orleans, France (h.aochi@brgm.fr), (2) Institute des Sciences de la Terre d'Orléans, University of Orléans, Orléans, France

Long period seismic events observed under many volcanoes are often interpreted in relation to any fluid-filled resonator. The kinematic mechanisms have been also studied seismologically in terms of seismic moment, and some of them indicate the geometry of a 'tensile' crack. In Volcanology, Chouet (1986) first solved the elasto-dynamic equations coupling with the fluid using a finite difference method, similarly to 'shear' crack problems treated in seismology, and this model is always a reference (Chouet and Motoza, 2013). But only a few studies have treated such dynamic problems (e.g. Yamamoto and Kawakatsu, 2009), while dynamic 'shear' cracks have been studied progressively in these two decades in seismology. This study presents a boundary integral equation method (BIEM) in the time domain to solve a 'tensile' crack resonance. The time-domain BIEM is often used for a 'shear' crack thanks to its accuracy, efficiency and flexibility, and usually adopted with an explicit approach (a time step Δt is short enough to an element size Δs so that any grid influences instantaneously itself, Δt <= Δs/(2*P-wave velocity)). However such explicit approach introduces severe high frequency oscillations on a 'tensile' crack whose frictional property is intrinsically different from a 'shear' crack. It is found that the implicit approach can retrieve the expected solution for a longer time step of $2\Delta t$ and no high-frequency oscillations is visible for a $4\Delta t$. Comparing to the other methods, the time-domain BIEM is easy to be combined with any boundary condition, so that the method would be widely applicable for the observed long period sources if the geometry of a tensile crack is inferred.