Three programs are designed to model the two-phase media:

- crack_KT: model program for two phase media based on Kuster-Toksöz's method. This program can be used to model fluid-saturated sphere (option=0) or spheroid (option=1) shape cavities.
- crack_KTB: model program for two phase media based on Berrymann's generalization of Kuster-Toksöz model. This program can be used to model fluid-saturated sphere (option=1), needle (option=2), disk (option=3), or penny-shape (option=4) cavities.
- crack_Hudson: cracked media model based on Hudson's theory for penny-shape cracks, assuming ONE SET of cracks with normal aligned with 3rd axis. This program can be used to model fluid-saturated (option=1, using anisotropic fluid substitution through Brown and Korringa's relation), weak inclusion filled (option=2) or dry (option=3) penny-shape cracks.

KUSTER-TOKSÖZ MODEL FOR TWO-PHASE MEDIA

1. crack_KT

function [Vp_eff,Vs_eff]=crack_KT(Dens1,Vp1,Vs1,PHI,alpha,Dens2,Vp2,Vs2,option)

Input (parameters for matrix and inclusions):
dens1,Vp1,Vs1: density and velocity of uncrack media
dens2,Vp2,Vs2: density and velocity of inclusion media
PHI: concentration of inclusion;
alpha: aspect ration of inclusion.
option: inclusion shape, 0: sphere
1: spheroid.

The first four input parameters are required, and the last four have default values, which considered the inclusion to be saline, and the aspect ration-alpha, 0.01;

Output (velocities of effective media):
Vp_eff: P-velocity of cracked media;
Vs_eff: S-velocity of cracked media.

This program is based on Kuster-Toksöz's model. The effective elastic moduli is derived based on scattering theory, however multiple scattering is neglected. Two kinds of inclusion shape are considered: sphere and spheroid. IMPORTANT results: effective elastic moduli depend on both the concentration and the shape of inclusion. This program only simulates the solid matrix case.

2. crack_KTB

function [Vp_eff,Vs_eff]=crack_KTB(Dens1,Vp1,Vs1,PHI,alpha,Dens2,Vp2,Vs2,option)

Input (parameters for matrix and inclusions):
dens1,Vp1,Vs1: density and velocity of uncrack media
dens2,Vp2,Vs2: density and velocity of inclusion media

PHI: concentration of inclusion;
alpha: aspect ration of inclusion.
option (inclusion shape): 1 = spheres;
2 = needles;
3 = disks;
and 4 = penny cracks;

The first four input parameters are required, and the last four have default values, which considered the inclusion to be saline, and the aspect ration-alpha, 0.01;

Output (velocities of effective media):
Vp_eff: P-velocity cracked media;
Vs_eff: S-velocity cracked media.

This model is based on Kuster-Toksöz model and Berrymann's generalization of this model. The effective elastic moduli is derived based on scattering theory, multiple scattering is neglected.

CAUTION:

1. Because the cavities are isolated with respect to flow, this approach simulates very high frequency saturated rock behavior appropriate to ultrasonic laboratory conditions. At low frequencies, when there is time for wave-induced pore pressure increments to flow and equilibrate, it is better to find the effective moduli for dry cavities and then saturated them with the Gassmann low-frequency relations.
2. Each set of inclusions must be distributed randomly, and thus its effect is isotropic.
3. IMPORTANT COMMENT: c/alpha should not be too large, otherwise the assumption will be violated (multiple scatter can not be neglected).

HUDSON'S MODEL FOR CRACKED MEDIA

function [Vp_eff,Vs_eff]=crack_Hudson(Dens,Vp,Vs,PHI,alpha,Dens2,Vp2,Vs2,option)

This is fracture model program based on Hudson's cracked media, assuming ONE SET of cracks with normal aligned with 3rd axis. The effective moduli of cracked media are calculated from background moduli and two-order corrections. The cracked media will display transverse isotropic symmetry with respect to the 3rd axis.

Input:
Dens: density of uncracked media
Vp, Vs: P- and S-velocity of uncracked media
PHI: crack porosity
alpha: aspect ratio
Dens2: density of inclusion media
Vp2, Vs2: P- and S-velocity of inclusion media
option = 1 effective moduli from fluid substitution for fluid filled cracks;
= 2 effective moduli for weak inclusion (no fluid substitution);
= 3 dry cracks.

Output:
Vp_eff: P-velocities (Vp0: along crack normal, Vp90: along crack plane) of cracked media
Vs_eff: S-velocities (Vsv0: along crack normal, Vsv90: along crack plane) of cracked media

Assumption and limitations

1. Idealized crack shape (penny-shaped) with small aspect ratios and crack density are assumed: crack radius and distance between cracks are much smaller than a wavelength.
2. The Hudson's model is appropriate for high-frequency laboratory conditions. For low-frequency field situations Brown and Korringa's relation is used for fluid substitution.

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