Geophysical Research Abstracts
Vol. 20, EGU2018-18239, 2018
EGU General Assembly 2018

Mechanisms of slow wave propagation in fragmented geomaterials in the presence of compression

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Fragmented geomaterials are characterised by the presence of fragments weakly connected to each other such that they posses a degree of independent translational and rotational movements. Fragmented geomaterials cover a range of scales, from fractured and fragmented rock mass near excavation walls to blocky rock mass to the fragmented tectonic plates and the Earth's crust. It is reported in the literature that waves propagating in such media may exhibit unusually low wave velocities. In this paper three possible mechanisms are considered. The first one is related to the translational movement of the fragments relative to each other resisted by soft interfaces. Then the macroscopic (effective) moduli are determined by low interface stiffnesses and depending upon the spacing between the interfaces can be very low, which produces low wave velocities. The second mechanism corresponds to the case when the resistance to the fragment movement towards each other is much higher than that in the opposite direction. This produces bilinearity, which is characterised by high modulus in compression and very low modulus in tension. Then tensile waves will be the waves propagating with low velocity. The third mechanism relies upon rotation of fragments. The wave propagation is modelled by replacing the fragmented geomaterial with the Cosserat continuum. As the fragments are never spherical their mutual rotation in the presence of compression creates the effect of negative stiffness, which leads to the emergence of negative Cosserat shear modulus. Then it can be demonstrated that the long shear-rotational and twist waves are slow. Understanding the mechanisms of slow wave propagation can assist in the reconstruction of the structure of geomaterial from the wave measurements.