Denis N. Voroshchuk, Vladislav A. Miryaha*, Igor B. Petrov, and Alexander V. Sannikov

Discontinuous Galerkin method for wave propagation in elastic media with inhomogeneous inclusions

Abstract:Adiscontinuous Galerkin method on unstructured grids is adapted and implemented for simulation ofwave response of subvertical fractured systems in carbonate rocks for numerical solution of direct problems of seismic exploration. The present paper compares seismic responses for several mechanical-mathematical models of a fractured reservoir. The models of collectors di_er in the presence and location of media interfaces relative to the collector and also in away of its speci_cation, namely, an explicit selection of fractures with the parameters of the medium in the domain of collector coinciding with the host medium, or di_ering from it. We indicate the ability to take into account inter-fracture interactions with the use of the model of a fractured layer presented in the paper and study wave processes formed as the result of interaction of seismic pulses with fractured reservoirs.

Keywords: DGM, exploration seismology, glide contact condition, _uid-_lled crack, converted waves.
MSC 2010: 65M60, 86A15
DOI: 10.1515/rnam-2016-0004
Received September 7, 2015; accepted November 24, 2015

The starting point for the theoretical study of anisotropic fractured media in seismic exploration and geophysics can be attributed to 50–60th years of the last century [2, 5, 7, 27, 30]. The interest of seismologists to numerical modelling of wave response with the use of systems of continuum mechanics equations became apparent in recent decades. On the one hand, this interest relates to a substantial proportion of fractured reservoirs in mineral deposits and, on the other hand, to the development of computer technologies and numerical methods to the level allowing one to consider speci_c features of rocks in mathematical models. Undoubtedly, one of important tasks of seismic exploration is to detect fractured areas whose response was studied by numerical methods [13, 18, 26, 29, 31, 33], in laboratory tests of [1, 8], and in a number of practical works [3, 11, 12, 28]. Those papers justify the model of fractured reservoirs in carbonate rocks used in this paper (we are talking about systems of subvertical cracks having the length of about 100 meters). An analysis of behaviour of response from such fractured reservoirs and a comparison with theoretical calculations were performed in [20]. However, solving this problem, a series of di_culties appear, one of which is the lack of a universal method for description of such media, namely, the relationship of physical parameters of the medium with experimental results obtained by geologists. In its turn, this leads to insu_cient information about the wave structure of responses, in particular, about exchange waves [4].