Geologists have recently discerned naturally occurring discrete localized planar zones of deformation, associated with compaction of initially high-porosity rock. Such compaction bands may influence fluid transport, and stress/strain distribution in sedimentary formations. In order to gain insight into the formation mechanisms of compaction bands under a variety of boundary conditions, we developed a discrete model, in which the material is represented as a hexagonal lattice of springs that can transfer only normal forces (Central Force Spring model). The model easily allows for a discrete statistical distribution of material properties at a physically relevant scale. The occurrence of grain crushing and porosity reduction is represented by a change in the equilibrium length and elastic properties of each element that exceeds a certain stress threshold. Parametric analysis is conducted to explore and predict the conditions under which compaction bands form and develop. Some of our results duplicate the different types of compaction propagation observed in laboratory tri-axial compression experiments.

The first part of our work evaluates the role of heterogeneity in material's properties and elastic mismatches at its boundaries due to contact with other materials. Both of these parameters modulate the compaction nucleation sites, and influence the emerging compaction patterns. The second part of our work focuses on the spatial and temporal evolution of a single compaction band nucleated by a small flaw, and discuss how our results compare with the concept of "anticrack" propagation.
Although some of these features have been observed experimentally, our model provides the first quantitative picture of this important physical process.