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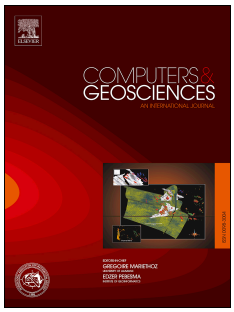

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Yang Wang, G.W. Ma, Feng Ren, Tuo Li

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A Constrained Delaunay Discretization Method for Adaptively Meshing Highly Discontinuous Geological Media

Yang Wang, G.W. Ma*, Feng Ren, Tuo Li

School of Civil, Environmental and Mining Engineering, the University of Western Australia, Perth, WA, 6009, Australia.

**Corresponding author E-mail Addresses:*

guowei.ma@uwa.edu.au *(G.W. Ma)*

Abstract:

A constrained Delaunay discretization method is developed to generate high-quality doubly adaptive meshes of highly discontinuous geological media. Complex features such as three-dimensional discrete fracture networks (DFNs), tunnels, shafts, slopes, boreholes, water curtains, and drainage systems are taken into account in the mesh generation. The constrained Delaunay triangulation method is used to create adaptive triangular elements on planar fractures. Persson's algorithm (Persson, 2005), based on an analogy between triangular elements and spring networks, is enriched to automatically discretize a planar fracture into mesh points with varying density and smooth-quality gradient. The triangulated planar fractures are treated as planar straight-line graphs (PSLGs) to construct piecewise-linear complex (PLC) for constrained Delaunay tetrahedralization. This guarantees the doubly adaptive characteristic of the resulted mesh: the mesh is adaptive not only along fractures but also in space. The quality of elements is compared with the results from an existing method. It is verified that the present method can generate smoother elements and a better distribution of element aspect ratios. Two numerical simulations are implemented to demonstrate that the present method can be applied to various simulations of complex geological media that contain a large number of discontinuities.