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A constrained Delaunay discretization method for adaptively meshing highly discontinuous geological media

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1 A Constrained Delaunay Discretization Method for Adaptively Meshing 2 Highly Discontinuous Geological Media

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8 **Abstract:**

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

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