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Modelling of fractured geological systems: from scattered data to 3D Finite Element simulations

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To simulate processes occurring in fractured geological systems it is essential to capture the coupling of different active mechanisms within their realistic three dimensional geological environment. The complexity of fractured networks hampered a detailed representation of the real geometry often resulting in oversimplified models of the natural systems. The present paper describes a new approach to generating 3D meshes for realistic fault geometries embedded in layered geological systems. The method improves the integration of generic dipping structures into a 3D porous medium. This enables to simulate the coupling and interactions between discrete fractures and the rock matrix. The approach is automated by a C++ based source code and requires a minimum amount of information to be provided a priori. Input data are files of scattered data points describing the geometry of the geological model (layers' interfaces plus faults). Based on this information, 3D unstructured tetrahedral meshes are generated where faults of generic dipping are represented as 2D discrete surfaces within a 3D geological boundary volume. Formats of the output files are easily exported to existing software to simulate (T)hermal-(H)ydraulic-(M)echanical-(C)hemical processes by means of finite element or finite volume numerical techniques. Numerical simulations of coupled T-H processes for a relatively simple geometry (two layers cut by two crossing dipping faults) and for a real case geological setting (based on a simplified structural model of the GroßSchönebeck geothermal reservoir in northern Germany) are presented to show the reliability and robustness of the method.