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REFINED THREE-DIMENSIONAL MODELLING OF THERMALLY-DRIVEN FLOW IN THE BORMIO SYSTEM (Central Italian Alps)

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Thermal springs are widespread in the European Alps, where more than 80 geothermal sites are known and exploited. The quantitative assessment of those thermal flow systems is a challenging issue and requires accurate conceptual model and a thorough understanding of thermo-hydraulic properties of the aquifers. Accordingly in the last years, several qualitative studies were carried out to understand the heat and fluid transport processes driving deep fluids from the reservoir to the springs.

Our work focused on thermal circulation and fluid outflows of the area around Bormio (Central Italian Alps), where nine geothermal springs discharge from dolomite bodies located close to a regional alpine thrust, called the Zebrù Line. At this site, water is heated in deep circulation systems and vigorously upwells at temperature of about 40°C.

The aim of this paper is to explore the mechanisms of heat and fluid transport in the Bormio area by carrying out refined steady and transient three-dimensional finite element simulations of thermally-driven flow and to quantitatively assess the source area of the thermal waters. The full regional model (ca. 700 km2) is discretized with a highly refined triangular finite element planar grid obtained with Midas GTS NX software. The structural 3D features of the regional Zebrù thrust are built by interpolating series of geological cross sections using Fracman. A script was developed to convert and implement the thrust grid into FEFLOW mesh that comprises ca. 4 million elements. The numerical results support the observed discharge rates and temperature field within the simulated domain. Flow and temperature patterns suggest that thermal groundwater flows through a deep system crossing both sedimentary and metamorphic lithotypes, and a fracture network associated to the thrust system. Besides providing a numerical framework to simulate complex fractured systems, this example gives insights into the influence of deep alpine structures on groundwater circulation that underlies the development of many hydrothermal systems.