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Eastgate Geothermal Borehole Project: Predicting Fracture Geometry at Depth

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In 2004 an exploratory borehole at the Eastgate Geothermal Project encountered part of a vein system within the Weardale granite. At 995m depth brine was at a temperature of around 46°C. The geothermal source is likely related to the Slitt vein system that cuts through c.270m of carboniferous sedimentary strata overlying the Weardale granite pluton. The economic success of the Eastgate geothermal project is dependent on exploiting this vein system in an otherwise low permeability and low geothermal gradient setting.

The Slitt vein system has been extensively mined. Mining records show the attitude of the vein through the sedimentary strata, however, the trajectory and magnitude of the vein within the pluton itself is unknown. Using mine records, geological maps and published literature, models of the vein system up to the depth of the pluton were created. To extend this model into the pluton itself requires some knowledge regarding the geometry and evolution of the pluton and subsequently properties of vein systems and other fracture populations at depth.

The properties of fracture and vein populations within the granite will depend on forming processes including; cooling and contraction of the pluton, deformation of host rocks during pluton emplacement, and post emplacement deformation. Using published literature and gravity data a 3D model of the geometry of the pluton was constructed. Shape analysis of the pluton allows an estimation of the orientation of fractures within the pluton. Further modelling of the structural evolution of the pluton will enable kinematic or geomechanical strain associated with the structural evolution to be captured and subsequently used as a proxy for modelling both intensity and orientation of fracturing within the pluton.

The successful prediction of areas of high fracture intensity and thus increased permeability is critical to the development of potential geothermal resources in low geothermal gradient and low permeability settings. This is also important in EGS settings where stimulation will often re-activate existing fracture networks. The development at the Eastgate Geothermal Borehole project provides an opportunity to model fracture and vein populations within an intrusive body and validate those model predictions with production data from the site.