

USING STRUCTURAL FEATURES TO TARGET KAOLIN DEPOSITS IN SOUTH-WEST ENGLAND

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Kaolin formation within the granite pluton at St Austell, Cornwall has occurred from the dissolution of feldspar crystals in the presence of alteration fluids. This alteration is shown to increase upon proximity to pre-existing structural features, such as veins and fractures, as they have provided a flow-path through the impermeable host rock. At major structural features, such as faults, the density of fractures allow for a well-connected flow-path, significantly increasing fluid volume, speed of flow and length of exposure - all of which contribute toward intense kaolinisation and improved grade of the final product. Due to this strong spatial relationship, it is suggested that computer-based methods using discrete fracture networks may be employed to target drilling and concluded that smart exploration of primary kaolin deposits is feasible.

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INTRODUCTION

Kaolin is the commercial term used to describe a white, industrial clay composed largely of the mineral kaolinite ($\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$). Just over 1 million tonnes of kaolin are produced annually from the St Austell granite pluton in South-West England (Bide *et al.*, 2015) and are utilised in applications ranging from paper and ceramics to ink and pharmaceuticals. Production levels have steadily decreased in recent years (Figure 1), attributed to competition within the Western European paper markets and substitution (Cornwall Council, 2013).

This increased competition within the global market has reduced profitability, with many companies responding with corporate restructuring and cost-saving production strategies. Focus has shifted to Brazil, where enormous kaolin deposits and low production costs are more cost-effective in spite of additional shipping costs (Cornwall Council, 2013). Whereas the Brazilian deposits are secondary (transported away from their original location by water), the kaolin located within the St Austell granite is primary, formed from the in-situ alteration of feldspar crystals by convecting fluids (Brown, 1953; Fuge and Power, 1969). Matrix permeability within these igneous deposits is restricted by the interlocking, crystalline nature of the grains, with global permeability controlled by the presence of fractures and cracks which help channel the fluids through the rock mass. The kaolinisation at St Austell is of a particularly advanced nature, with over 50% of the pluton showing some degree of alteration. The western extent hosts the bulk of high-grade deposits and also shows the highest intensity of fracturing (Alderton and Rankin, 1983). These fractures, along with other structural features, such as veins and faults, have allowed alteration fluids to collect and circulate, with their interconnectivity determining the flow rate, exposure length, and pervasion of fluids within the pluton (Exley, 1964).

Kaolin production, 2003-2013

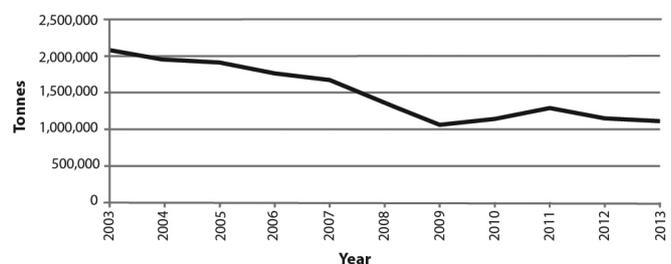


Figure 1. Kaolin production in tonnes over a ten year period (British Geology Survey, 2009; Bide *et al.*, 2015).

This paper aims to investigate the relationship between fracturing and kaolinisation. It is proposed to use discrete fracture networks (DFNs) to target drill-campaigns, shifting the focus of cost-saving efforts to the exploration (rather than production) phase. As this method is particularly suitable for primary deposits, where alteration has remained in-situ, it could help ensure that Cornwall remains at a strong position in the global market.

KAOLINISATION

Formation

The alteration of albite (Na) and orthoclase (K) feldspars into kaolinite by alteration fluids is identified as one of the last mineralisation episodes within the St Austell pluton (Pyrillos *et al.*, 1998). Often montmorillonite (a smectite clay group member) is considered to be an intermediate assemblage, with field samples of montmorillonite at St Austell often appearing to