Quantifying Magmatic Strain in Plutons Using Anisotropy of Magnetic Susceptibility in the Coast Plutonic Complex, Bella Coola, British Columbia

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Abstract
The Coast Plutonic Complex (CPC), British Columbia, Canada is a magmatic arc consisting of Jurassic and Cretaceous plutons. This study focuses on magmatic fabrics found in Mesozoic plutonic suites of the central CPC in the Bella Coola area, British Columbia. Magmatic fabrics (foliations and lineations) form during deformation of partially crystallizing magma and may record strain patterns that can be used to interpret the timing and nature of regional deformation during arc construction. Field mapping and anisotropy of magnetic susceptibility (AMS) are used to quantify the orientation, intensity and shape of the magmatic fabrics recorded in Jurassic through Cretaceous plutons. AMS is used to define magnetic fabrics within rocks. AMS data can be used to infer mineral fabrics even if fabrics are weak. AMS is a useful tool in the CPC because magmatic fabrics in plutons are often weak. Measured magnetic foliations correlate well with foliation measurements from the field and have a steep NW-SE orientation. Magnetic lineations, interpreted to reflect mineral lineations are shallow to moderately SE plunging. Shapes of fabric ellipsoids are generally oblate, indicating flattening strains in the arc, but some locally occurring prolate fabric ellipsoids suggest possible constriction associated with regional shear zones.

Regional Overview
Terrane mapping showing the setting of the Canadian Cordillera in British Columbia, and the general setting of the CPC. The CPC is bounded to the east by volcanic and sedimentary rocks of the Mesozoic to Paleozoic Stikine terrane and in the west by the Coast Range orogen. The boundary of the CPC is marked by the Pootlass Shear Zone that is the result of subduction along the western margin of North America. This study focuses primarily on Jurassic and Early Cretaceous plutons of the CPC, which include the Desire, Four Mile, Big Snow, Fougner, Howe Lake, and Desire plutonic suites.

Targeted sample collection was conducted in Jurassic through Cretaceous plutons of the central CPC during summer 2011 fieldwork. Samples were collected in the field so that laboratory analyses could be placed back into their Susceptibility Bridge.

AMS Foliation
Magmatic and Magnetic Fabric Data and Results

Methodology
The anisotropy of susceptibility can be represented by a second order tensor: the susceptibility ellipsoid. The susceptibility ellipsoid is defined by three perpendicular, principle axes: K1 (maximum), K2 (intermediate) and K3 (minimum). The susceptibility ellipsoid represents the shape and intensity of magmatic fabrics (foliations and lineations). K3 is the pole to magnetic foliation and K1 is parallel to magnetic lineation. If K1+K2=K3 then the ellipsoid is a sphere, and the rock is magnetically isotropic. If K1=K2 and K3=K1+K2 then the ellipsoid is oblate (pancake-shaped) and if K1,K2,K3 then the ellipsoid is prolate (cigar-shaped).

Magnetic fabric ellipsoids can reflect the alignment of elongate or platy paramagnetic grains in the whole rock (above: e.g., hornblende). In plutonic rocks these magnetic fabrics are often interpreted to represent magmatic foliations and lineations. Magnetic foliations and lineations are often formed during the latest stages of crystalization of a magma and can record regional strain. A simplistic view is that elongate or platy grains are rotated passively during deformation of the crystalizing magma. Thus, AMS ellipsoids are used to infer fabric patterns in weakly deformed plutonic rocks.

Summary
• Magmatic foliations measured in the field show a regional NW-SE trend that does not consistently correlate with AMS fabrics. • AMS results from the Howe Lake and Desire Suites could be interpreted as containing flattening fabrics based on P' vs. T plots. • The smaller number of samples from other suites makes regional interpretations difficult. • The presence of magnetite and hornblende in the rock samples make interpretations of AMS tenuous. Magnetite has an extremely high K, and even small amounts will influence bulk K and fabric orientations. In plutonic rocks magnetite could be secondary, and therefore would not record magnetic strain. Additionally, hornblende and multi-domain magnetite create inverse magnetic fabrics that can further complicate AMS interpretations. These complications are being resolved using additional magnetic techniques.

References