TECTONIC IMPLICATIONS OF FELSIC DIKES WITHIN THE COAST PLUTONIC COMPLEX NEAR PRINCE RUPERT, BRITISH COLUMBIA, CANADA

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INTRODUCTION

The Coast Plutonic Complex near Prince Rupert, British Columbia has a complex history including several stages of deformation and several episodes of intrusive activity. The region consists largely of accreted terranes (Fig. 1). The area of study is divided into three tectonic belts: The western belt (insular superterrane), the Central Gneiss Complex and the eastern belt. The east boundary of the insular superterrane is defined by the Coast Steep Zone lineament (also referred to as the Work Channel lineament). The Central Gneiss Complex is a migmatitic complex bounded by the Coast Steep Zone on the west. The ponder pluton is intruded between the Central Gneiss Complex and the eastern belt, and obscures the original contact between these two belts (Fig. 2).

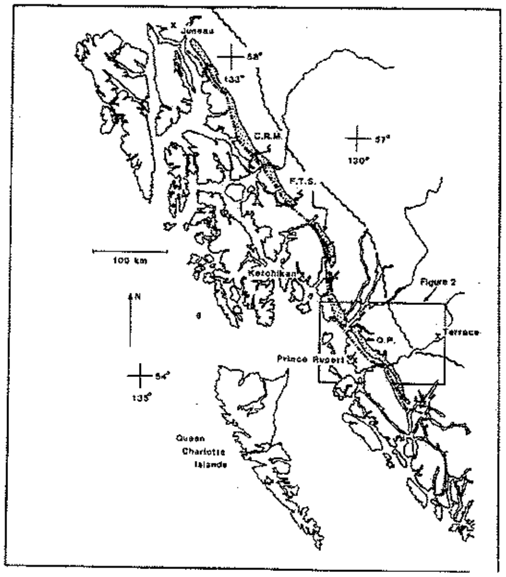

Fig 1. Map of the west coast of British Columbia showing the terrane boundaries, the Coast Plutonic Complex and the location of figure 2.

Compressional tectonics characterized this region prior to about 67 Ma followed by a period of regional extension (Crawford et al., 1998). During the change in tectonic regimes the area was intruded by several plutons and regional scale uplift of the Central Gneiss Complex took place (Crawford et al., 1987). A large number of felsic dikes intruded and crosscut these plutons and older terranes. The felsic dikes were in turn crosscut by a smaller number of mafic dikes.

The purpose of this study was to document the felsic dikes in the field and relate them to regional tectonic evolution. Compositionally, the felsic dikes show characteristics of S-type granitoid intrusions. Some dikes contain muscovite and a small population garnet. The majority are aplitic in texture while a smaller

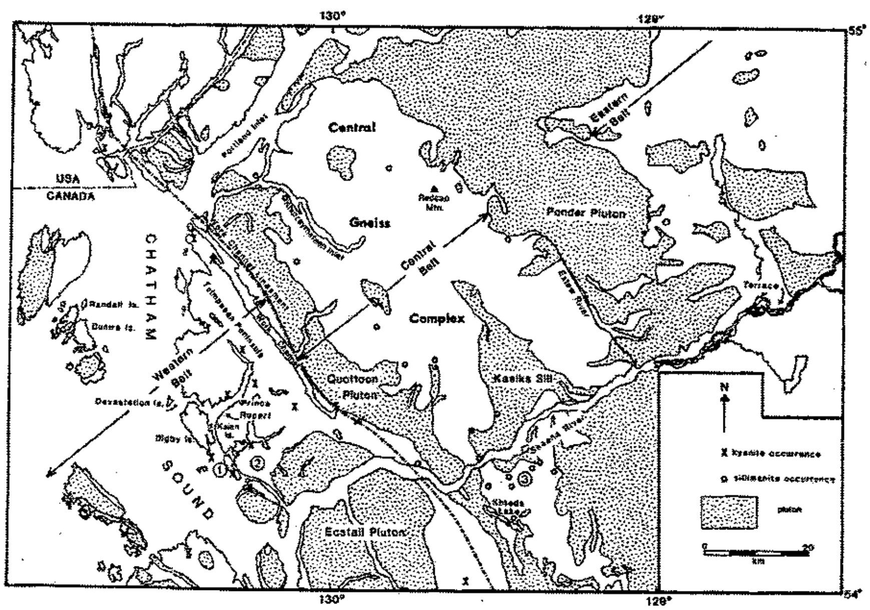

Fig. 2. Map of the Prince Rupert-Terrace area showing the three tectonic belts and the distribution of plutons. Highway 16 is located parallel to the north bank of the Skeena

number are pegmatitic. Most dikes crosscut the country rock foliation although some contacts are parallel or subparallel to foliation. Many dikes demonstrate evidence of movement along their contacts following intrusion (Fig. 3). Some number of the total population of the dikes may have been emplaced during the late stages of earlier metamorphic events. Dikes that are possibly associated with earlier events are typically non-planar in geometry and commonly include pinching and swelling along their trends (Fig. 4).

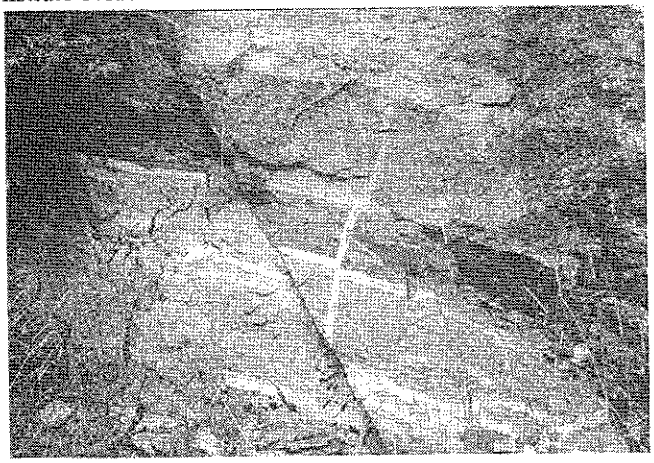

Fig. 3. Photo showing two sets of tabular, thin (thickness less than 10 cm) dikes offset by a fault. Notice the small displacement along the contact of the most vertical dike after intrusion

Highway 16 is the only road across the study area and provides the only well developed bedrock exposures. The highway provided a rough cross section traverse across the region displaying the dikes on both sides of the Coast Steep Zone and into the Central Gneiss Complex. The dikes occur throughout the area of study. They are exposed in numerous outcrops along Highway 16. Sets of dikes commonly crosscut each other, but no systematic pattern of cross-cutting relationships could be established. Individual dike thicknesses varied from less than a centimeter to up to tens of meters. Despite their wide-spread occurrence, the spatial distribution of dikes is not uniform. Some outcrops had numerous intrusions while others had none.

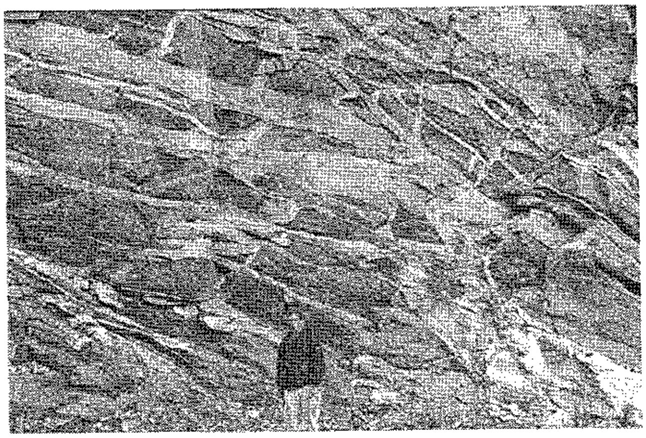

Fig. 4. Photo showing two sets of dikes with variable thicknesses (from less than ten centimeters up to one meter). Thicker dikes show some pinching and swelling. The outcrop shows an unusual high density of dikes.

METHODS

Strike, dip and thicknesses of a population of about 347 dikes were collected from outcrops along 50 km of Highway 16 between Tyee and Extew (between the east side of the Ecstall pluton and west of the Ponder pluton). A representative number of dikes were selected and documented at each station. Dikes included in the data set were selected on the basis of the following criteria: 1) the dike was traceable across most of the outcrop 2) the dike was tabular 3) the outcrop showed the dike contact in three dimensions. Most outcrops showed two or three sets of dikes with distinct orientations. Data were collected on at least one dike per set. At least one foliation orientation was determined at every station. Strike and dip of dikes and foliation plane orientations were collected in azimuth notation using a brunton compass. The thickness was determined and data were recorded in a field notebook and later posted on a GIS basemap. Crosscutting relationships were determined where possible. Field sketches and obvious textural characteristics were also included.

Data from the outcrops along Highway 16 were located using a hand held Garmin GPS receiver. A GPS location was collected at each outcrop, and several locations were determined for lengthy outcrops. Each GPS point represents a station, and several dikes were measured at each station. The GPS data were incorporated into a GIS map.

Two outcrops representative of the dike density in the region were chosen for more detailed structural analysis. At these outcrops, strike, dip and thickness of all dikes were collected. One outcrop was located within the Quottoon pluton and the other within the Central Gneiss Complex. An attempt was made to calculate the amount of dilation present in these outcrops and extrapolate it to the region. Digital images with a defined scale were taken at each outcrop. A calculation was done using Adobe Photoshop and the digital image to calculate the percent dilation in area caused by dike intrusion for each of the outcrops. A second calculation that involved decomposing the vectors that represent oriented thicknesses into components in three directions was also completed.

Twenty rock samples were collected for thin section analysis to characterize the petrology of the dikes. Sixteen thin sections were stained to identify potassium feldspar and point counts were done to establish the modal mineralogy. This information was used to attempt to identify possible dike suites based on their petrological characteristics.

Orientations of dikes representative of the region were plotted as poles and illustrated as contoured density distributions on stereonets using Spheristat 2.1 to reveal any developed trends (Fig. 5). Dike orientations were also used to estimate relative amounts of dilation produced as a result of their intrusion. The orientation of all dikes was plotted first, and then subsets were broken out into different categories and plotted on separate diagrams. The categories include dikes emplaced in different host rocks (Fig. 5); dikes split out into different thicknesses (below 10 cm, above one meter, and between 10 cm and a meter) (Fig. 6a, 6b, 6c); dikes parallel to or cross cutting foliation planes; pegmatitic and aplitic dikes; and dike distributions east and west of the Coast Steep Zone.

RESULTS

The strike and dip data plotted as density distribution diagrams show a fairly well developed bimodal pattern. The relationships of the plotted maximae for these two sets suggest a possible conjugate set of extensional shear fractures that are steeply dipping and striking at about 340° (Fig. 5). The strike direction is generally parallel to the Coast Steep Zone lineament. The interpreted direction of prior compression differs from the determined direction of extension. The direction of extension is determined to be at 250 °, while the direction of prior compression is interpreted to be at about 230°. The southwest dipping set of dikes is larger in number than the northeast dipping set. A majority of shallow dipping dikes are inclined to the southwest. These shallower dipping dikes also tend to be thicker than the steeply dipping sets (Fig. 6a, 6b, 6c). Thicker dikes are limited to the Central Gneiss Complex, while thinner dikes are widespread over the entire area of study. The highest density of dikes occurs within the Quottoon pluton and the Amphibolite unit that are located to the east of, and parallel to, the Coast Steep Zone.

DISCUSSION

The plotted data show a bimodal set of dikes striking parallel to the Coast Steep Zone. Extension perpendicular to this lineament may be responsible for this bimodal pattern. These dikes may represent intrusion of felsic magma into a conjugate set of extensional shear fractures. The orientation of this set of fractures suggests dip-slip motion could have taken place during regional extension.

The felsic dikes intruded the regional country rock in several stages, but neither the number of stages nor their relative timing based upon crosscutting relationships could be established. Nevertheless, the timing of intrusion of the felsic dikes as a suite can be constrained to a period of time beginning with the intrusion of the major plutons and ending with the intrusion of mafic dikes. The youngest of the plutons crosscut by felsic dikes is the Kasiks pluton, which intruded the country rock at 53 Ma. (Andronicos et al., 2000). This age provides a lower limit on the age of felsic dikes. The upper limit is provided by the age of mafic dikes that clearly crosscut all units in the region. Preliminary 40Ar/39Ar dates of Biotite and Hornblende from a mafic dike in the Quottoon pluton suggests that these felsic dikes are older than 46 Ma (Rodriguez, this volume). However, the validity of this single date is open to some question.

The presence of muscovite and garnet suggests that the source magma for the felsic dikes was generated as a result of partial melting deep within the Central Gneiss Complex. However, some of the dikes measured in the field and included in the data sets may be leucosomes or large, late stage veins associated with regional metamorphism.

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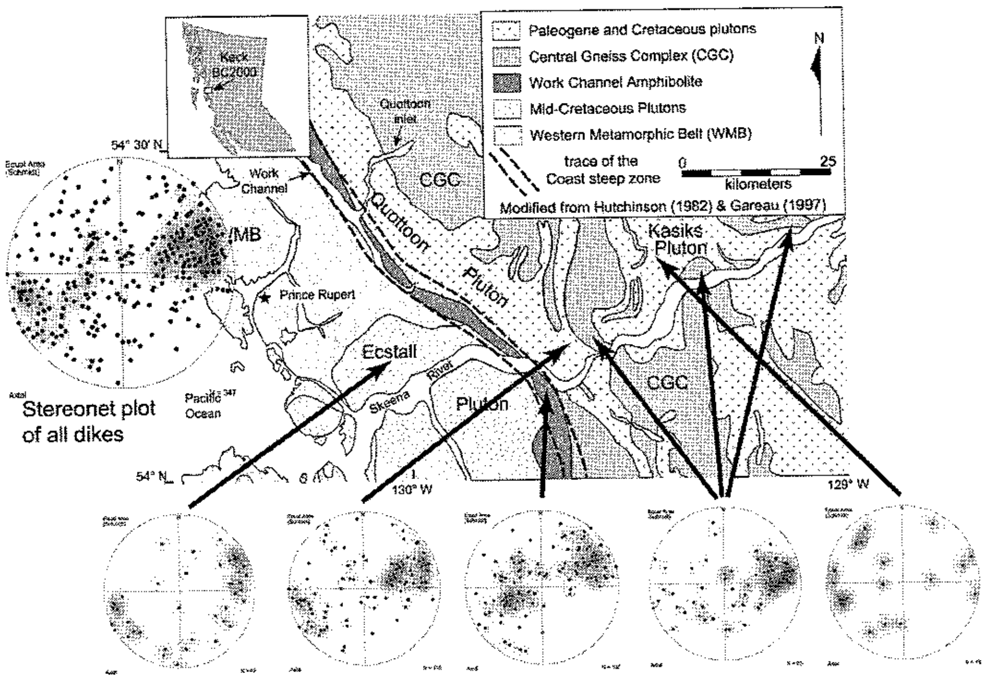

Fig 5. Map of the study area showing geological units (modified from Hutchinson and Gareau) and stereonet plots of dikes intruding each geological unit. Notice that the bimodal pattern is pervasive with respect to lithology.

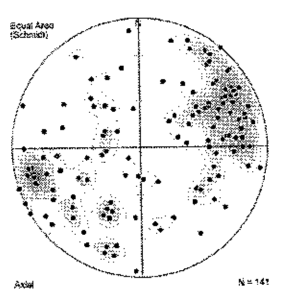

Fig 6a. Stereonet plot of dikes with thickness smaller than ten centimeters.

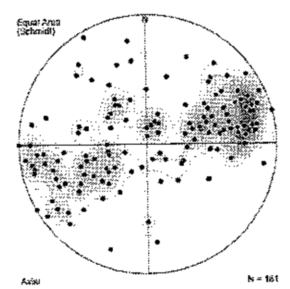

Fig 6b. Stereonet plot of dikes with thickness between ten centimeters and one meter.

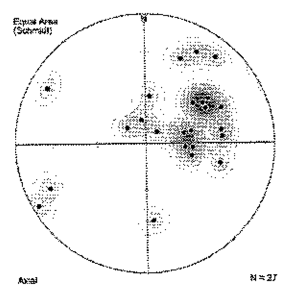

Fig 6c. Stereonet plot of dikes with thickness greater than one meter.