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Metasomatic tourmaline at Cape Cornwall, Land's End

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Cape Cornwall, a west facing headland on the metamorphic aureole of the Land's End granite, lies 2km west of St. Just. The granite, exposed at Priest's Cove (Fig. 1) and at Porth Ledden beach (Fig. 2) to the north, dips WNW at 30° beneath dykeinfested metapelites and volcanics. The contact is characterised by tourmalinite and megacrystic feldspars and the whole area is intruded by later vein systems, some associated with mineralisation. Early work on the area includes Henwood (1843), and recently Charoy (1979, 1981 and 1982) concludes that a volatile-rich magma with boron and alkali separated during late fractionation to give the tourmaline-rich rocks of the granite margins. Jackson et al. (1982) classify vein types and van Marke de Lummen (1986) and Booth and Exley (1987) consider geochemical and petrological aspects.

The Priest's Cove microgranite, faulted against country rock along an ESE trending brecciated quartz iron oxide lode, is characterised by tourmaline veins feeding upwards to tourmaline/pegmatitic patches. Feeders follow fractures in the granite, but do not alter it, suggesting a close association, forming shortly after solidification of the still hot host microgranite.

At SW3523 3154 the rock has split to reveal a spectacular lm x lm patch, probably that mentioned by Jones (1987). The bottom 150mm contains quartz, tourmaline and white weathered feldspars, some clearly plagioclase laths, up to 5mm long. Pale mica is concentrated in zones and is associated with brown iron staining. A 30mm wide band of fine tourmaline follows and continues onto the sides of the patch to form a border. Within the

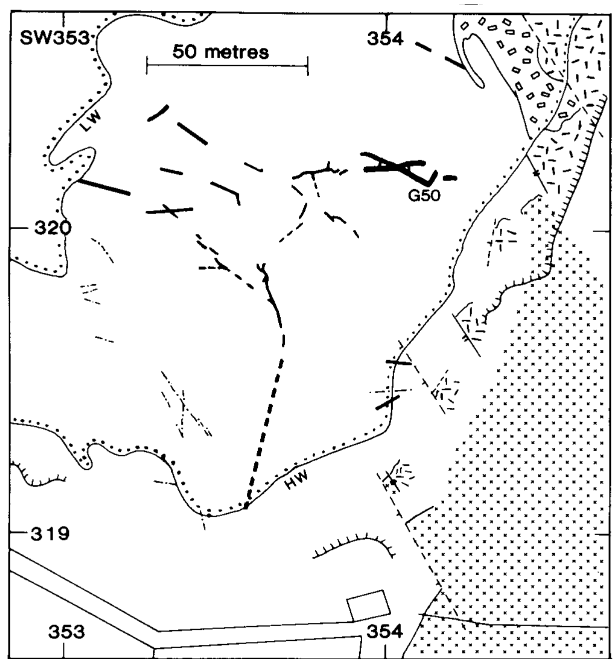

Figure 2. Simplified geology of Porth Ledden showing dykes and other granitic rocks (key as for Fig. 1).

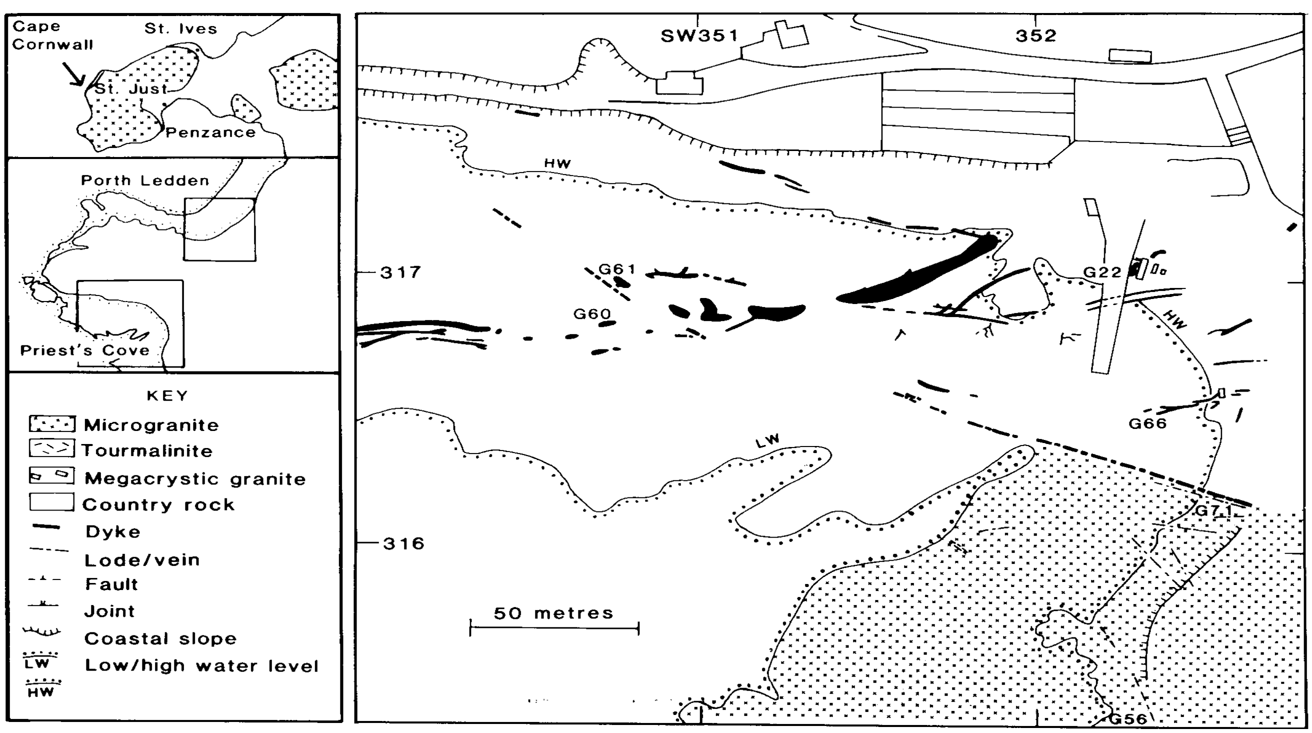

Figure 1. Simplified geology of Priest's Cove showing microgranite, dykes and sample locations.

band are pale micas in stacked sheets, large quartz and feldspars towards the top and pale yellow soft orthoclase pseudomorphs up to 10mm in size.

Three dyke trends intrude country rock and intersect to show that 20° of the 30° WNW regional tilting on 030° is post dykeemplacement. Thus the dykes are on the roof of the microgranite and closely related. Both dykes and microgranite contain scattered tourmalines. From a Priest's Cove dyke (G22) the SEM revealed apatite, a mineral thought to be struvenite (FeO-4.50%, TiO_2 - 83.34%, MnO - 0.0 1% and Nb_2O_5 - 11.77% (fit index only 2.5)) and an ilmenite cored tourmaline (FeO - 43.47%, TiO_2 - 53.66%, MnO - 2.46% and Nb_2O_5 – 1.21% (fit index 1.21)).

A Porth Ledden dyke (G50) in thin section showed yellow tourmalines, between and with apparent 'root zones' in plagioclase. Later alteration has left tourmaline as a 'shadow' within one K-feldspar, while a zone of degraded biotite may represent xenolithic material. Sericitisation of feldspar is common, coarse bands are defined by medium to coarse feldspar concentrations and fine green/blue acicular tourmaline is seen.

Millimetre wide barren quartz veins traverse the microgranite, as at the adit, SW3523 3155. Old tin lodes trend south east and the steeply dipping 130° trending vein at SW3507 3170 may continue at Pryor's Lode. It contains iron oxides and quartz and adjacent to the granite dyke (G61) showed a tourmalinised zone. Here black flow lines penetrate orange specks, probably altered feldspars, seen as aggregates of smaller minerals under reflected light. The SEM showed apatites, a thorium phosphate and cassiterite in vug like areas set in an orthoclase, quartz background.

A late vein, of tourmalinised appearance (G71) contained cassiterite in a quartz background. The SEM showed iron oxide with some bismuth, rose petal shaped siderite and zircon with traces of hafnium and calcium. Narrow quartz veins, trending at 85, 115 and 150°, often tourmalinised with alteration, are seen at Porth Ledden cross cutting all rock types and may be a second or third generation. From a late vertical 155°, 5mm wide vein in Priest's Cove (SW3524 3159) specks of sulphides penetrate the adjacent granite and include pyrite, chalcopyrite and arsenopyrite.

The 1m tourmalinite/pegmatite patch vein of Priest's Cove is reminiscent of a coffee stain on paper, the band of tourmaline being the tide mark, in reality a boron rich fluid invading and tourmalinising microgranite. While one tourmaline may show edge enrichment in sodium, calcium, magnesium and titanium, another tourmaline millimetres away may show decreasing trend (Fig. 3). This would be consistent with a crystal growing from the nearest available diffused cation rather than crystallisation from a magma. The fluid altered the plagioclase crystals seen in specimen 'G56', and removed all potassium except that in micas.

At SW3524 3165 a vein with acicular tourmaline growing normal to the wall, in places with a central zone of tourmaline, in metres passes east into an en echelon granite dyke. The tourmalines were sampled (G66) and similarities with the tourmalinite patch (G56) were found. There is no consistent centre-to-edge element change between adjacent crystals, however average compositions are almost identical, reflecting the original consolidating magma and suggesting tourmalinisation of a granite dyke (Fe_2O_3+TiO_2+MnO = 12.561% and 12.657%, MgO = 1.463% and 1.5588%, Na_2O = 3.408% and 3.406% for 'tourmalinite' patch and dyke respectively).

A whole rock analysis on a suite of granite and dykes produced a 0.982 Pearson correlation on Zr against Ti with depletion in granite dykes and tourmalinites and concentration towards contact zones of the granite. This is considered to represent early differentiation, prior to tourmalinisation and redistribution of more mobile elements such as potassium. This process is earlier than that associated with later fine needle-like blue/green magnesium-rich tourmalines and veins with cassiterite.

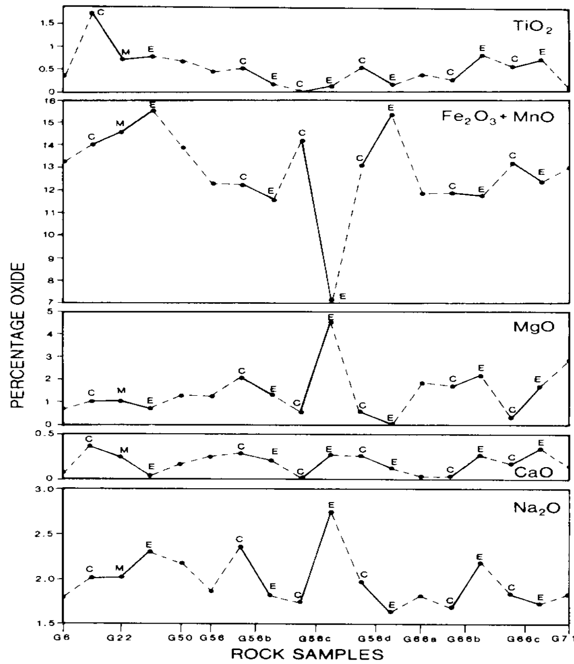

Figure 3. *A* plot *of* selected percentage oxide components of tourmalines as determined by microprobe analysis at Camborne School of Mines. Centre, middle and edge values are indicated by, `C', `M' and `E'. Dashed lines are intended only to aid correlation. Samples are referred to in the text and locations indicated on Fig. 1, except for `G50' on Fig. 2 and `G6' which is from a tourmalinite at SW3552 3214.

Dykes in the country rock were intruded contemporaneously with and above the granite, and have subsequently been tilted. Early differentiation was followed by tourmalinisation and redistribution of more mobile elements, thus giving potassium metasomatism. A later tourmalinisation event is responsible for blue/green acicular tourmaline and the introduction of cassiterite.

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