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EMPLACEMENT STYLES WITHIN THE LAND'S END GRANITE, WEST CORNWALL.

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The Land's End Granite is the youngest of the major plutons of the Cornubian batholith and comprises a number of discrete bodies of both coarse-grained granite (CGG) and fine-grained granite (FGG). Detailed re-mapping of selected parts of the composite Land's End pluton indicates that individual granite intrusions take a variety of forms, including dykes and sub-horizontal sheets. U-Pb (monazite) and ^{40}Ar-^{39}Ar (muscovite) age data have been interpreted elsewhere to indicate that the CGG and FGG of the northern "Zennor lobe" were emplaced c. 2-3 m.y. before the CGG and FGG of the southern "St Buryan lobe". Separating the two lobes is a large body of aphyric granite, the "St Just wedge", which is as yet undated. Relationships at Porth Nanven, where an irregular contact is discordant to a magmatic-state fabric in CGG of the St Buryan lobe, and at Porth Ledden, where sheets of aphyric granite intrude CGG, suggest that the St Just wedge is younger than the two main lobes. The composite nature of the pluton is exemplified by variations in grainsize and texture and in the size, abundance and alignment of alkali-feldspar phenocrysts. The subtle nature of petrographic variation in such felsic rocks makes identification of contacts between CGGs difficult, but those between CGG and FGG are more easily recognizable. At Bosigran, there is a laterally persistent north-west dipping sheet of CGG which exhibits a sharp, planar contact with underlying MGG. Immediately to the north, at Carn Veslan, the same MGG has a gradational contact with non-porphyritic FGG. At Sennen and Land's End, contacts between slightly different CGGs are denoted by the presence of distinct mafic zones, planar at Sennen and much more irregular at Land's End. The contrasting nature of these contacts suggests different time-intervals between intrusive events. At Porth Nanven, granite dykes with sharp, planar margins intrude the aphyric granite of the St Just wedge. Throughout the pluton, bodies of FGG demonstrate a variety of temporal relationships with adjoining CGG, including contemporaneous, sub-rounded masses and later sub-horizontal sheets. These and other examples within the Land's End Granite demonstrate that, rather than having originated as a large, diapirically emplaced magma body, as suggested in earlier models, the pluton is composed of a series of discrete intrusions.

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INTRODUCTION

The Land's End Granite, which consists predominantly of porphyritic coarse-grained granite (CGG) with minor fine-grained granite (FGG) and medium-grained granite (MGG), intrudes Upper Devonian metasedimentary and metavolcanic rocks (Goode and Taylor, 1988). Early research in the region was focused upon the petrography and structure of individual plutons. Although mineralogical and textural variations were described, the mechanisms responsible for producing them were not discussed in detail (De la Beche, 1839; Reid and Flett, 1907; Reid *et al*, 1910; Ghosh, 1927). Later models of the Cornubian Batholith proposed that the major plutons consist of a coarse-grained carapace and a fine-grained, less megacrystic core, offshoots from which broke through the marginal facies to produce late-stage FGG sheets and aplites (Booth and Exley, 1987; Floyd *et al*, 1993). Booth (1966) advanced a similar model for the Land's End Granite, suggesting that it was emplaced diapirically as a single body of magma, and that textural variability was a consequence of either *in situ* differentiation, or metasomatic alteration combined with remobilisaton of the less megacrystic core. Although this model was later shown by Stone and Exley (1968) to be inapplicable to other plutons of the batholith, the Land's End Granite has been considered by a number of workers to have been emplaced diapirically (Rattey and Sanderson, 1984: Goode and Taylor, 1988; Floyd *et al*, 1993). Halls (1987, 1994) also referred to the composite nature of the Cornish plutons, proposing a concentric shell structure with internal contacts delineated by stockscheider pegmatites.

Recent work on the Land's End Granite (Salmon, 1994; Salmon and Powell, 1998) has confirmed and further developed earlier studies (Reid and Flett, 1907; Mount, 1985; van Marcke de Lummen, 1986; Goode *et al*, 1987; Goode and Taylor, 1988;), indicating that it is a composite body made up of a series of discrete granite intrusions. U-Pb and ^{40}Ar-^{39}Ar geochronology (Chen *et al*, 1993; Clark *et al*, 1993, 1994) led to suggestions that the pluton comprises two main segments, the northern Zennor lobe and the southern St Buryan lobe, with mean ages of 277±2 Ma and 274.5±2 Ma respectively. Underlying the new age data is the clear inference that the two lobes have themselves built up of a succession of intrusive units, with CGGs and FGGs being shown to be sensibly coeval in each lobe. Salmon (1994) and Salmon and Powell (1998) recognised the coeval nature of certain of the CGGs and FGGs which occur in both lobes. Separating the two postulated lobes is a body of aphyric CGG, the St Just wedge (Chen, 1994), which is as yet undated (Figure 1). Recent selective detailed mapping has revealed a picture of emplacement and pluton construction that is even more complex than this tripartite division may suggest. Because of their distinct textures, contacts between bodies of FGG and adjacent CGG are readily identifiable and have been described elsewhere (Salmon, 1994; Salmon & Powell, 1998). However, contacts between CGG bodies are easily overlooked and relationships between the various CGGs have previously been reported as being gradational (Dangerfield and Hawkes, 1981). The current re-mapping programme has identified a number of previously unreported internal granite contacts within the Land's End pluton. The purpose of this paper is to describe the nature of these contacts, establish

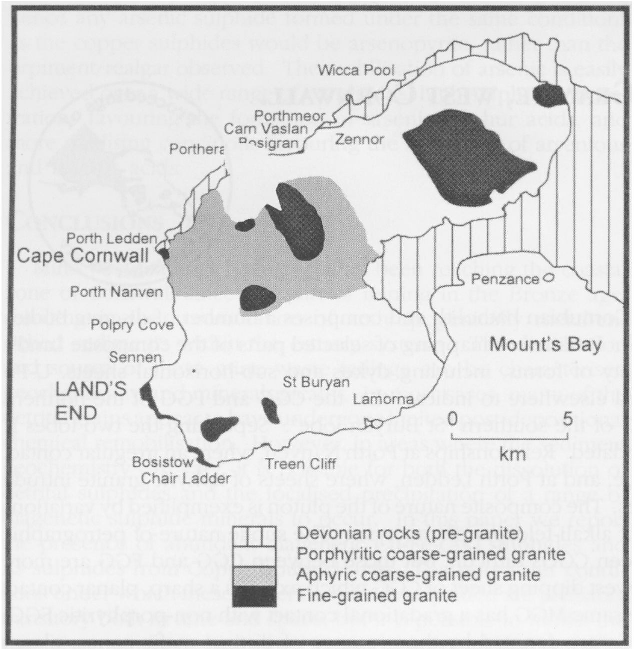

Figure 1. *Geological sketch map of the West Penwith peninsula, Cornwall (modified after Goode and Taylor, 1988).*

a more complete emplacement chronology and demonstrate the increasing complexity of the Land's End Granite.

TEXTURAL VARIATION

It has long been recognized that there is a wide degree of textural variety among the CGGs of the Land's End Granite (and of the Cornubian Batholith as a whole). In general, the CGG conforms with the 'Type B' granite of Floyd *et al.* (1993), and consists predominantly of quartz, alkali-feldspar (orthoclase), plagioclase (albite-oligoclase) biotite and cordierite, with muscovite, tourmaline, monazite, zircon, apatite, topaz, fluorite and andalusite being variably present as accessory minerals. The principal textural variations are in groundmass grain-size, the abundance and size of phenocryst phases and the presence and orientation of magmatic-state fabrics. Quartz phenocrysts occur as single crystals or, more commonly, anhedral aggregates up to 1.5 cm in diameter and vary in abundance. One of the most striking features of the Cornish granites is the present of tabular alkali-feldspar phenocrysts that vary in size (1.5 cm to 15 cm), abundance (10% - 20%) and may define a magmatic-state foliation. These feldspars have in the past been interpreted as metasomatic in origin and Booth (1968) attributed the differences in phenocryst populations to variable concentrations of potassium-rich metasomatizing fluids. However, Stimac *et al* (1995) concluded that the corrosion of, and occasional oligoclase overgrowths upon, the megacrysts indicates a magmatic origin. This is supported by evidence of oscillatory zoning in megacrysts, as shown by cathodoluminescence imaging (Northcote, 1996). Salmon (1994), described elongate meta-sedimentary xenoliths orientated parallel to the foliation of alkali-feldspars and identified these as further evidence of magmatic flow. Vernon (1986), in a more general review, also concludes that alkali-feldspar phenocrysts in granites are mainly magmatic in origin. The foliation defined by the alkali-feldspars must therefore be interpreted as primarily magmatic in origin, an interpretation confirmed by reference to the criteria of Paterson *et al*. (1989). Regional (within pluton) differences in the size and abundance of phenocrysts, and the magmatic-state fabrics they define are likely to indicate the presence of separate magma batches.

INTERNAL GRANITE CONTACTS

The nature of primary contacts between igneous rocks reflects the rheology of the magmas at the time of juxtaposition, and may be partially dependent upon the time elapsed between emplacement events. The extent of physical and chemical interaction between magmas can therefore be, at least partially, determined by the nature of internal contacts. In the Land's End Granite these range from sharp to protrusive (see below) to gradational and either planar or with varying degrees of sinuosity. Examples of the various types of contact relationships are given below and are summarized in Table 1.

Planar, sharp or protrusive contacts

Contacts which are most readily identifiable are those where the earlier of the adjacent granites was solid or substantially crystallized when the second was emplaced. Such contacts are planar and either sharp or protrusive. A protrusive contact is defined as one where crystals, and especially phenocrysts, from one rock protrude across the contact into the adjoining one (Porter, 1997). A good example of a planar contact is present at Bosigran (Figure 1) where a sharp contact between CGG (above) and MGG (below) dips 30° north-west. The overlying CGG appears to be an inclined sheet (Figure 2a). Clear evidence of age relationships has not been observed, but inclusions of MGG occur within the overlying CGG (Figure 2b) suggesting that the latter is the younger. Sub-horizontal sheets are known from elsewhere within the Land's End Granite, with good examples at Bosistow and Pellitras (Figure 1), both on the south coast (Goode and Taylor, 1988; Salmon and Powell, 1998). The sheet at Bosistow is composed of FGG with steeper offshoots having a dyke-like form. The sheet at Pellitras, which is intruded into both FGG and CGG, is fine-grained at its margins and becomes gradually coarser inwards (Salmon, 1994). In these three examples the juxtaposed granites have distinctive textures, but where they have similar textures the contact may only become apparent when highlighted by associated phenomena. A good example is at Sennen (Figure 1), where a planar contact between two very similar CGGs is marked by a distinct mafic zone, with a higher concentration of biotite. (Figure 2c).

In other instances the intruding granite forms sub-vertical dykes. A number are present along the coast around Cape Cornwall (Figure 1). In Priest's Cove a narrow fine-grained granite dyke, similar to those described by Mount (1985), invades a body of FGG, whilst further south, at Porth Nanven, more substantial dykes intrude the aphyric CGG of the St Just wedge (Salmon and Shail, 1999). One of the dykes at Porth Nanven is c. 150 cm wide with planar, protrusive contacts. The dyke is medium-grained with randomly oriented tabular alkali-feldspar phenocrysts, up to c. 2.5 cm in length. A marginal zone up to 10 cm wide is finer-grained and slightly more mafic than the central portion and within it most phenocrysts lie sub-parallel to the contacts. Other examples of granite dykes are present at Treen Cliff (Figure 1) and Porth Chapel (both on the south-west coast) and at Porthmeor Cove and Wicca Pool (north-east of Bosigran).

Gradational contacts

A good example of a gradational planar contact occurs at Porth Nanven (Figure 1), where aphyric CGG of the St Just wedge is in contact with a body of porphyritic CGG. The contact is broadly planar (though locally undulose) sub-vertical and discordant to a well-developed magmatic-state foliation defined by alkali-feldspar phenocrysts in the porphyritic CGG (Figure 2d). The discordance suggests that the granite of the St Just wedge postdates the porphyritic CGG, which had achieved a sufficiently advanced stage of crystallization to maintain its textural integrity and preserve the magmatic foliation. At Porth Ledden (Figure 1), immediately north of Cape Cornwall, a sheet of aphyric CGG, very similar to that of the St Just wedge, intrudes porphyritic CGG (Figure 2e). The contacts are much sharper than that at Porth Nanven, and appear to

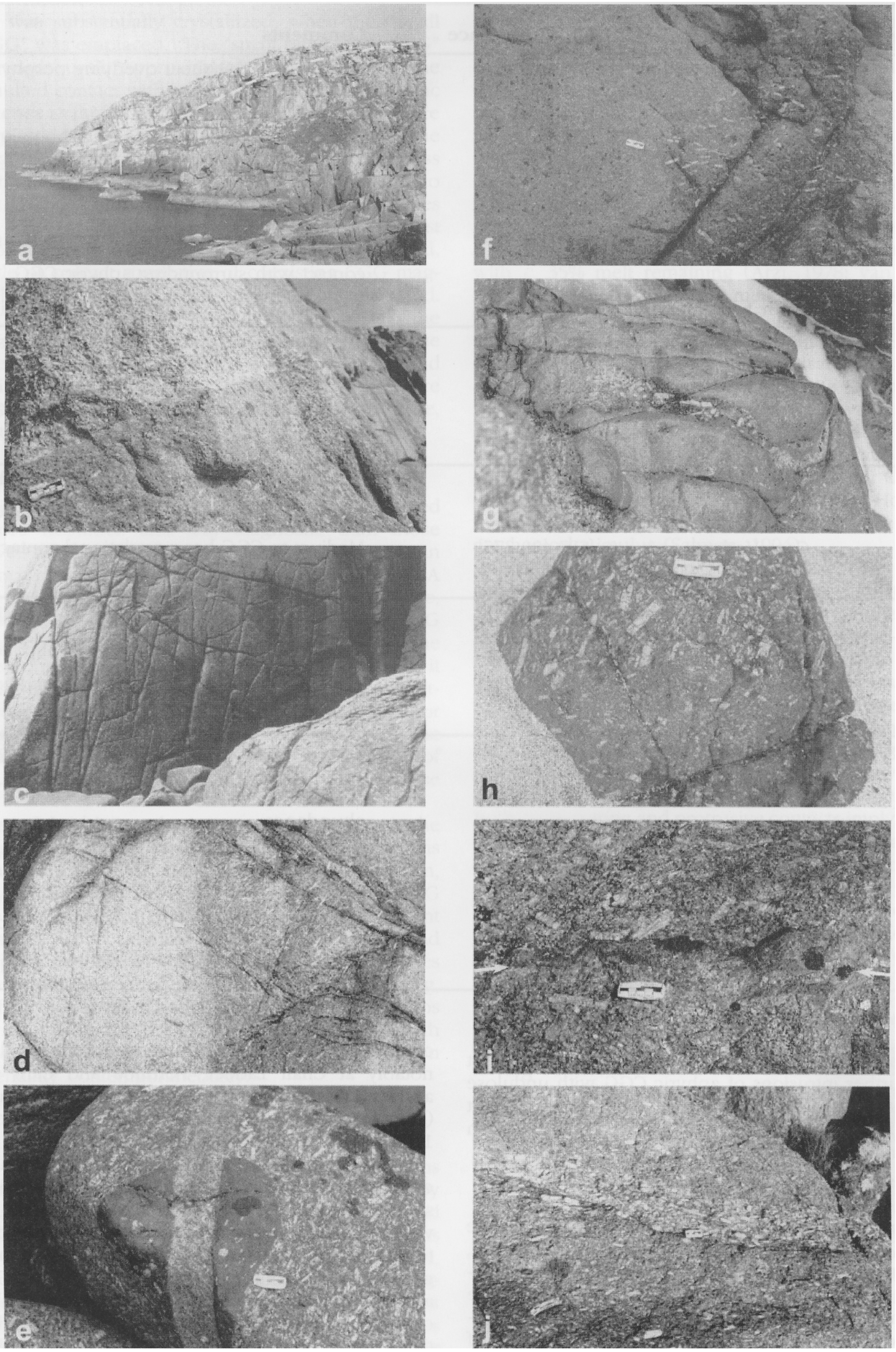

Figure 2. *Styles of contact relationship in the Land's End pluton:* ***a)*** *Bosigran cliff with the dashed line marking the contact between MGG (below) and CGG (above). The arrow marks the location of 2b (below). Maximum height of cliff is c. 120 m.* ***b)*** *Part of the contact between the sheet of CGG and underlying MGG at Bosigran (arrowed in 2a). Note thin sliver of (apparently) MGG c. 10 cm above the contact.* ***c)*** *Planar contact between two very similar CGGs at Sennen emphasized by a fine-grained mafic zone.* ***d)*** *Contact between aphyric CGG of the St Just wedge (left) and porphyritic CGG just south of Porth Nanven. The contact is gradational, sub-vertical and discordant to the magmatic state fabric defined by feldspar phenocrysts in the porphyritic CGG.* ***e)*** *Sheet of aphyric CGG, similar to that of the St Just wedge, intruding porphyritic CGG and a fine-grained enclave at Porth Ledden.* ***f)*** *Sheet of aphyric MGG intruded into porphyritic CGG at Chair Ladder. The sheet is markedly discordant to magmatic state phenocryst foliation in the CGG.* ***g)*** *Sinuous contacts between coexisting granite magmas at Portheras Cove. Sparsely porphyritic CGG has invaded porphyritic CGG.* ***h)*** *Porphyritic CGG (top) intruded by 'small phenocryst CGG' at Portheras Cove. The contact is discordant to the magmatic state foliation in the porphyritic CGG, with phenocrysts of this protruding into the 'small phenocryst CGG'. Undulose contact between two similar porphyritic CGGs at Land's End. The contact is marked by a mafic zone and is indicated by the two arrows.* ***j)*** *Linear, densely porphyritic zone within porphyritic CGG at Lamorna Cove.*

Contact Type	Locality	Grid Reference	Comments
Planar, sharp	Bosigran	[SW 415 369]	Porphyritic CGG sheet overlying porphyritic MGG, contact dipping 30° NW.
	Bosistow	[SW 357 2321	Sheet of FGG with dyke like offshoots.
	Sennen	[SW 347 261]	Contact between two similar porphyritic CGGs - contact marked by mafic zone.
	Porth Nanven	[SW 356 309]	Sub-vertical dykes of porphyritic MGG in sharp contact with surrounding aphyric CGG.
	Porth Ledden	[SW 355 321]	Aphyric CGG sheets intruding porphyritic CGG.
Protrusive	Portheras	[SW 387 358]	Contact between porphyritic CGG and 'small phenocryst CGG'.
	Chair Ladder	[SW 365 216]	Aphyric MGG intruded into porphyritic FGG, in places discordant to foliation in FGG.
Gradational	Porth Nanven	[SW 355 306]	Aphyric CGG with gradational contact discordant to phenocryst alignment of porphyritic CGG.
	Carn Veslan	[SW 420 375]	Medium to CGG has a gradational contact with a non-porphyritic FGG.
Sinuous	Portheras	[SW 387 358]	Contacts between porphyritic CGG, 'small phenocryst CGG' and aphyric to sparsely porphyritic CGG.
	Land's End	[SW 346 256]	Contact between two similar CGGs marked by irregular mafic zone.
Nebulous or Cryptic	Polpry Cove	[SW 356 298]	Zone of less porphyritic CGG separating bodies of CGG with different phenocryst alignment and/or abundance.
	Wicca Pool	[SW 464 401]	Zone of more densely porphyritic CGG with gradational contact of ca 10-20 cm.
	Lamorna	[SW 453 244]	Densely porphyritic zone (>30% phenocryst abun dance) within porphyritic CGG.

Table 1. *Distribution of the various types of internal granite contact.*

confirm the emplacement chronology. Further intrusions of aphyric CGG with undulose or irregular contacts are exposed in Polpry Cove (Figure 1). At Carn Veslan, (Figure 1), the MGG which is present at Bosigran passes gradationally into non-porphyritic FGG.

Undulose or irregular contacts

When a granite magma is emplaced into another granite magma, both of which are above their CMF (< ~ 65% crystallized, see below), distinctive contact relationships are formed. Contacts are usually sharp, locally protrusive, and vary from undulose to irregular. Enclaves of the earlier magma are generally sub-rounded. At Treen Cliff, Porthcurno (Figure 1), a large body of FGG, which has been variously described as 'sheet-like' or `dome like' (Salmon, 1994), intrudes, and is in places discordant to magmatic-state foliation within CGG (Salmon and Powell, 1998). Large rounded enclaves of the FGG within overlying CGG may indicate the diapiric emplacement of one magma into another. Sub-horizontal sheets of fine or fine- to medium-grained granite, generally *c.* 50 cm thick, invade CGG just north of Land's End (Figure 1). Contacts here are undulose and vary from sharp to protrusive. Immediately south of Chair Ladder (Figure 1), a sheet of aphyric MGG is intruded into porphyritic FGG. Contacts are undulose and fairly sharp, often protrusive, and in places the sheet is markedly discordant to magmatic-state foliation in the FGG (Figure 2f). There are several examples of co-existing CGG and FGG magmas in the Land's End Granite, notably at Chair Ladder, Porthloe and Carn Gloose, where aphyric CGG of the St Just wedge intrudes the Carn Gloose FGG (Salmon, 1994; Salmon and Powell, 1998; Salmon and Shail, 1999).

Contacts between coexisting CGG magmas also occur, with excellent examples present at Portheras Cove (Figure 1). At the southern end of the cove, porphyritic CGG is in stoped contact with the country rocks. Feldspar phenocrysts in this CGG are up to 12 cm in length. Within c. 10 m of the contact, two other granites are in contact with this porphyritic CGG. One is an aphyric (locally sparsely-porphyritic) CGG, which has undulose or sinuous contacts with the porphyritic CGG (Figure 2g.). The third granite is a "small-phenocryst CGG", so called because its feldspar phenocrysts are uniformly smaller than those in the porphyritic CGG. Contacts between the porphyritic CGG and the "small-phenocryst CGG" are protrusive, with feldspar phenocrysts of the former protruding across the contact into the "small phenocryst CGG" (Figure 2h). The contacts are also strongly discordant to the magmatic-state foliation in the porphyritic CGG. The contact relationships suggest that all three granites were present as coexisting magmas and detailed examination allows determination of the order of emplacement. The sinuous contact relationships indicate that, following the porphyritic CGG, the second magma emplaced was that of the aphyric CGG. This was followed by the magma of the "small-phenocryst CGG". Protrusive contact relationships indicate that the porphyritic CGG was not solid, but was substantially crystallized, when the "small phenocryst CGG" was emplaced. The "small phenocryst CGG" extends northwards until, approximately half-way along the cove, it is in faulted contact with a body of sparsely porphyritic CGG. This extends as far as the northern end of the cove where a body of porphyritic CGG (similar to that in contact with the country rocks at the southern end) appears. Problems of access preclude examination of the contact between the latter two granites, although the occurrence of elongate, sinuous enclaves of porphyritic CGG within the sparsely porphyritic CGG just south of the contact zone suggests that they may also be coeval.

Another style of contact suggestive of coexisting CGG magmas is observable at the foot of the cliffs just north of Land's End. Here, two porphyritic CGGs are distinguished on the basis of the size, abundance and foliation of feldspar phenocrysts. The contact between them is sub-horizontal, diffuse over 2-3 cm and marked by a distinct fine- to medium-grained mafic zone (Figure 2i). Phenocrysts of the upper CGG impinge into the mafic zone, suggesting that it was the earlier.

Nebulous or cryptic contacts

Elsewhere in the pluton lithological features are observed which are more nebulous and less diagnostic than those described above. Many of them consist of a distinct variation in either abundance or alignment of the feldspar phenocrysts. A good example is exposed on the east side of Lamorna Cove, where a planar or tabular zone of densely porphyritic CGG (Figure 2j) occurs within moderately porphyritic CGG. The margins of this zone are distinct, and the phenocrysts within it are parallel to them. It is not clear whether this represents a sheet-like contact between two similar CGGs, a dyke-like intrusion, or a zone of magmatic-state shear within a single magma. The relatively dense packing of the phenocrysts suggests a degree of filter pressing, which could occur as a result of any of these processes.

Similar zones of densely porphyritic granite are present in the main body of granite at Wicca Pool (Figure 1), but the margins here are gradational over 10-20 cm. Elsewhere in the pluton, planar, slightly less porphyritic zones within bodies of CGG separate areas which have differences in phenocryst alignment and/or abundance. Good examples occur at Polpry Cove and Nanjulian (Polpry Cove). Again, it is unclear what such zones represent. They may be the product of magmatic-state shearing, or examples of "cryptic" contacts such as described by D'Lemos (1996), which result from the coalescing of felsic magmas with similar physical and chemical properties which have been emplaced essentially contemporaneously.

DISCUSSION

It is now widely recognized that many granite plutons traditionally regarded as diapirs may have been emplaced by other mechanisms. Many new interpretations rely on dyke and sheeting mechanisms for transport and emplacement (Clemens and Mawer, 1992; Petford *et al*, 1993; McCaffrey and Petford, 1997; Petford, 1996; Weinberg, 1996; Baker, 1998). The space problem has been partially resolved by invoking displacement and/or dilation across faults, shear zones and tensile fractures (Tikoff and Teyssier, 1992; Tobisch and Cruden, 1995; Gleizes *et al*, 1998). Dyking is now widely accepted as a mechanism of magma transport and emplacement, although sheeted complexes are difficult to recognize because of the similar physical and chemical properties of felsic magmas. These similarities may lead felsic magmas to coalesce, creating an homogeneous appearance (Hutton, 1992; D'Lemos, 1996). Geophysical properties, such as the anisotropy of magnetic susceptibility (AMS), have been used to overcome the problem of recognizing sheeted complexes (Bouillin *et al*, 1993; Leblanc *et al*, 1996; Gleizes *et al*, 1998, Benn *et al*, 1998). When considering these questions a distinction has to be made between transport and emplacement. The shape of individual granite bodies which make up a pluton or batholith in part depends on the rheology of the earlier granite and/or country rock into which they are emplaced. If the earlier granite is solid or substantially crystallized it will fracture to form dykes or sheets. Alternatively, the newly arrived batch of magma may be emplaced into an earlier magma, so that, despite its transport through the crust being along planar fractures, the new magma will be emplaced in a diapiric form.

Within the Land's End Granite, a variety of different types of contact relationship occur between adjacent granite bodies. The nature of these, contacts provides evidence of the relative physical states of the magmas when they were juxtaposed. As a magma crystallizes it will reach a critical melt fraction (CMF), with c. 35% melt remaining (Arzi, 1978; van der Molen and Paterson, 1979). Where the melt fraction is less than 35% (i.e. **below** the CMF) then the magma approximates a granular, rather than suspension-controlled system (Pitcher, 1993). The degree of crystallization, together with chemical composition and water content, controls the rheology of the magma and directly influences the mode of interaction of adjoining magmas (Sparks and Marshall, 1986). If magmas are of a similar composition (as is the case throughout the Land's End Granite) and at a similar early stage of crystallization, well above their CMF, they should be able to mix, i.e. hybridize (Shaw, 1972). However, magmas may survive as separate entities in the absence of a physical or mechanical stimulus (Salmon, 1994).

Contacts may be concordant or discordant with respect to host structures (such as magmatic-state foliations), sharp or diffuse, planar or irregular, and intrusive or faulted (Clarke, 1992). Planar contacts which cut earlier magmatic-state fabrics or minerals suggest complete solidification prior to emplacement of the second magma. Planar, but somewhat less sharp contacts indicate that the earlier magma was not completely solid, but was probably crystallized below its CMF. Such contacts may crosscut minerals in the earlier phase, but are more likely to be "protrusive" in nature, where the mineral framework of the earlier/magma has been pulled or forced apart, rather than fractured. Both cross-cutting and protrusive contacts imply a relatively long time interval between intrusions, although this can be affected by other factors, notably the relative size of the two magma bodies. Diffuse or gradational contacts suggest a degree of physical and/ or chemical interaction, requiring the presence of a relatively higher proportion of residual liquid in the earlier magma (i.e. a lesser degree of crystallization). This in turn may imply a shorter elapsed time interval between intrusions. Where such a contact is discordant to a magmatic-state foliation, it indicates that the earlier magma was crystallized to such a degree that it was able to maintain its textural integrity (lock in the foliation) whilst still having sufficient residual fluid to interact with the incoming magma. Undulose, sinuous or irregular contacts indicate the presence of two (or more) coexisting magmas, each of which is **above** its CMF, inferring an even shorter elapsed time. Such contacts are usually sharp, but may be diffuse to varying degrees, indicating a degree of physical and/or chemical interaction. In all of these examples, with the exception of knife-sharp contacts, we are dealing with emplacement of, and physical interaction between, crystal `mushes'. The nature of the contacts are a very useful field indication of the degree of 'mushiness'.

In many instances the geometric form of the individual intrusions which make up the Land's End Granite can be discerned, i.e. they are dyke- or sheet-like (e.g. Bosigran, Porth Nanven, Bosistow, Pellitras). These relationships indicate that the later granite magmas were intruded into earlier granites which were solid or at an advanced stage of crystallization. There are, however, several instances where individual intrusions do not have (or appear not to have) a distinct geometric form. A good example is the FGG at Treen Cliff. Such irregularly shaped bodies of granite represent a situation where a 'fluid' magma is intruded into another 'fluid' magma. In such a situation, the later magma, constrained only by the effective viscosity of the enclosing magma, may take on a diapiric form. Such a process may account for the "diapiric" shape of certain granite bodies which in the past lent support to that mechanism of emplacement.

Most early models interpret the plutons which make up the

Cornubian batholith as being emplaced diapirically with localized stoping at the final emplacement level, despite recognizing evidence, albeit limited, for the plutons being composite (Ghosh, 1934; Hill and Manning, 1987; Stone, 1987). Structural evidence in the form of 'christmas tree' D3 folding around the pluton has been proposed as adding further weight to the inference that the Land's End Granite is a forcefully emplaced diapiric body (Rattey and Sanderson, 1984). However, recent work has suggested that emplacement of the Land's End Granite was accommodated by fault displacements during regional extension (Alexander and Shail, 1995; Shail and Alexander, 1997).

CONCLUSION

The number of newly recognized internal contacts indicates that a succession of granite magmas was emplaced over the formative lifetime of the Land's End Granite pluton. U-Pb and ^{40}Ar-^{39}Ar dates confirm a protracted multiphase history of pluton emplacement and cooling. This evidence is at odds with earlier models of diapiric emplacement of one or more large magma bodies. The varying nature of the contacts themselves may suggest different elapsed time intervals between the separate intrusive events or may indicate the degree of physical or chemical interaction which subsequently took place. Although the form of the separate intrusions may be used to infer mechanisms for final emplacement, they do not provide evidence of the mechanisms by which the magma travelled through the crust.

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