DIRECTIONAL FEATURES WITHIN AN ASSEMBLAGE OF PRIMARY TEXTURES PRESERVED IN A KILOMETRE SECTION OF THE UPPER MANTLE PERIDOTITE, FROM THE LIZARD, CORNWALL

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Many relics of primary micro-textures of olivine are preserved in a kilometre section of the primary assemblage peridotite of the Lizard, Cornwall. The sequences of banded peridotite show concordant directions of crystallization of dunites, harzburgites, and pyroxenites. It is considered possible that directional features might be found within similar banded sequences elsewhere in the primary assemblage peridotite of the Lizard.

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INTRODUCTION

Overall details of the petrography, mineralogy, and deformation of the Lizard peridotite, and considerations of its petrogenesis have been published by Flett (1912), Green (1964) and Rothstein (1977, 1981, 1988).

A one kilometre length of coastal exposure of the primary assemblage Lizard peridotite has been identified by Rothstein (1988) as having a high proportion of relics of primary textures, formed within the spinel lherzolite facies of the upper mantle. This author showed that the rocks occurring elsewhere within the Lizard spinel-peridotite are more strongly deformed and have a lower proportion of primary relics. It was also shown (Rothstein, 1988) that the primary textures equilibrated at 1200° C ± 70° and 15 kb ± 7 kb, whilst more strongly deformed and recrystallized rocks from other parts of the Lizard peridotite equilibrated at lower temperatures and pressures.

The exposures consist predominantly of harzburgite with an apparent planar fabric (S1) associated with a weak mineralogical banding and, at places, peridotites with a pronounced mineralogical banding (S0). S1 and S0 are sub-parallel. The range of peridotites at these banded exposures includes dunite, harzburgite, lherzolitic harzburgites and pyroxenite. Early features of all these rocks, both weakly and strongly banded, have been modified, to different degrees, by subsequent penetrative deformation and recrystallization, leading to the development of Si.

USE OF SYMBOLS

The peridotites between H2 and I3 (see Fig.1.) are partially serpentinized and in many places lichen-covered. Thus, although macro-features are evident in the field, many of the small-scale features are not apparent, including for example, thin interbanded layers, particularly of serpentinized dunite and harzburgite, or the distinction between abrupt and transitional boundaries.

As well as field observations and a number of field photographs and sketches, data were obtained from a considerable number of samples taken from 48 points. Most of the samples had at least one face polished, and over 30 polished blocks were made. All the different faces were photographed and printed 1:1 or enlarged. Data were obtained from over 120 thin sections (many of a large size), with over 700 photo-micrographs. Comparative material was also available from other parts of the Lizard peridotite.

A considerable variety of textures and structures occurs in the peridotites between H2 and I3. The textures and structures may be classified into different groups and their repeated occurrence throughout the rock sequence shown. The many diverse features of the textures and structures of the peridotites are represented in this paper by a number of symbols showing the features observed in sections perpendicular to S0. Sections examined parallel to S0 in these particular rocks, very rarely show aligned features. The symbols are shown in Fig.2.

In the case of the symbols for olivine, the dominant mineral, or its serpentinized pseudomorph, this mineral often shows the following features: (i) Single crystals, which in some cases are completely enclosed by a single unit of pyroxene. (ii) An assemblage of linked crystals whose boundaries are outlined by pyroxene. (iii) Part of a matrix of relatively large more irregular areas of olivine, which may be a single crystal, or a group of crystals. (iv) There are examples where the olivine matrix contains somewhat elongated shapes which are seen to be parallel to each other, some examples of which are parallel to S0. (v) Often the olivine consists of polygonal mosaics which may have: (a) Sinuous internal boundaries. (b) Simple curved internal boundaries. (c) Relatively straight internal boundaries.

The scale of the textures ranges from a fraction of a millimetre to several centimetres, while the size of the individual olivine crystals ranges from a fraction of a millimetre to well over a millimetre. In one or two cases the olivine units may have been on the scale of centimetres.

THE SECTION H2 TO I3

Table 1 sets out systematically the details of the range and assemblage of rock types and primary textures present throughout the section, and also some of the deformational features. Abbreviations, if used, for minerals are: OL (olivine), OP (calcium-poor pyroxene), CLP (calcium-rich pyroxene), and SP (aluminous spinel). The texture element symbol number is given as [ ].

In the field an apparent planar fabric [3] is picked out by the weathering. In some thin sections this fabric is seen to be S1. In others however it is seen to be a particular element of the primary texture sub-parallel to S0, for example parts of the textures [5] and [9], that has been emphasized by the weathering.

If the textures are not recrystallized, OL is euhedral with respect to OP, and CLP is interstitial with respect to OP [35]. This latter texture while present in many of the samples, is only indicated in Table 1 in Hc and He where CLP is present to an exceptional extent, elsewhere it is a minor component. All samples show some deformation and recrystallization of the pyroxenes [36] and olivines [19]. The latter texture is marked in Table 1 in Zb, where it has been preserved in a serpentinized dunite.

Samples from the interbanded sequences were collected across the mineralogical layering, encompassing both the interbanded parts and the closely-related rock exposures on either side. This sampling covered at H3 2m, at H 8m, and at Z 4m.

At H3 (an interbanded sequence of dunites, harzburgites and pyroxene-rich rocks) the dunites range in thickness from H3c, as little as 20 mm, to H3e in places 80 mm and over.

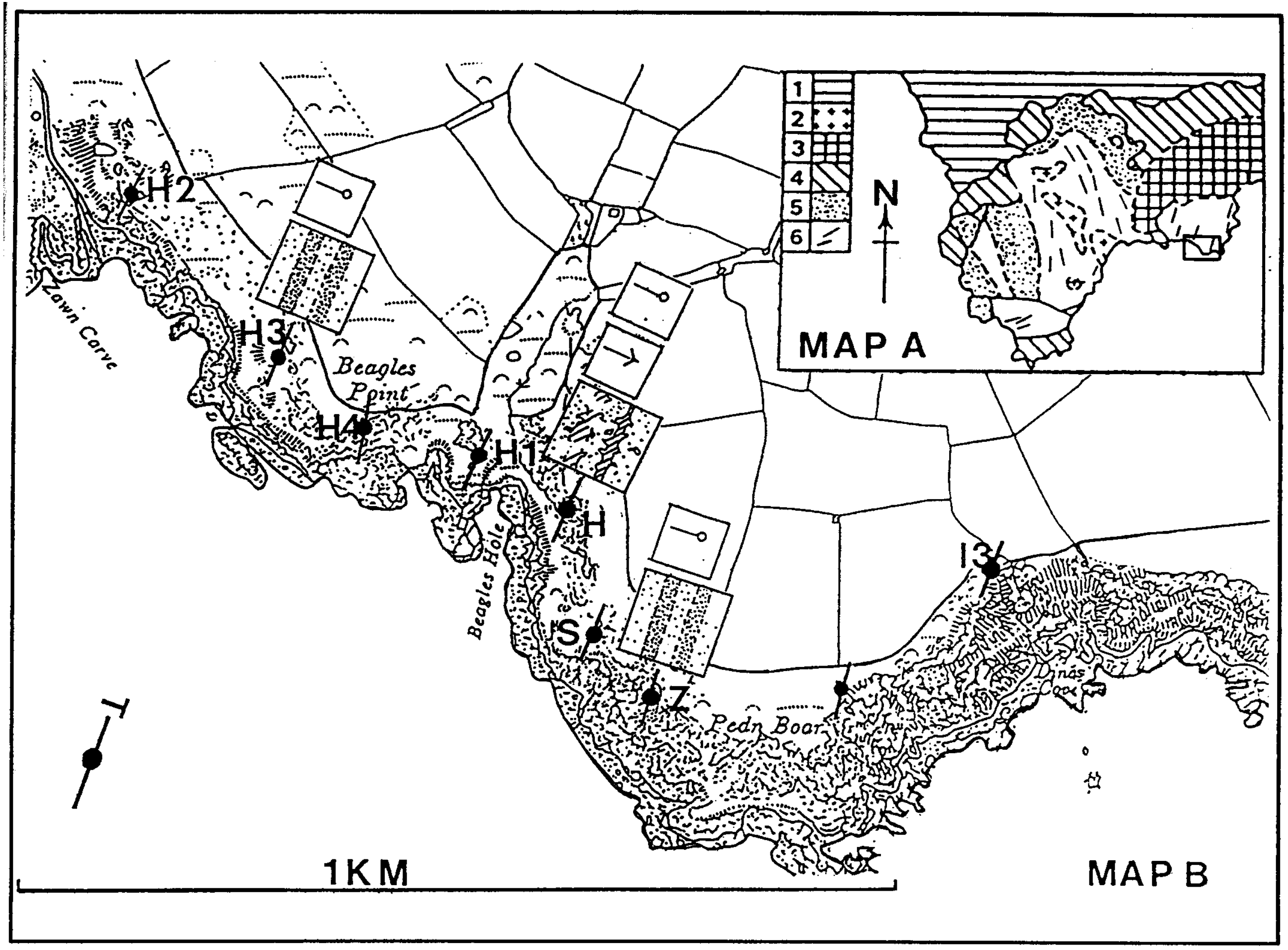

Figure. 1. Map of location of samples.

MAP A. The Lizard Complex and the location of Map B. Legend for Map A: 1. Gramscatho and Mylor beds. 2. Kennack Granite and Gneiss. 3. Gabbro. 4. Schist (principally hornblende schist). 5. Secondary assemblage peridotite. 6. Primary assemblage peridotite. Map A gives an indication of S1 in the primary assemblage peridotite. Its attitude is usually steeply inclined to vertical.

Map B. The location of samples in the section H2 to I3. Indicated (not to scale) are the dunite/harzburgite bands at H3 and Z, and the harzburgite/ pyroxenite bands at H. Also shown are the sites from which other samples referred to in this paper were collected at, H2, H4, H1, S, and I3. The orientation of the near-vertical S0 (and the sub-parallel S1) is shown. With respect to both S0 and S1 the different parts of the "T" are parallel to the dip and strike, and is the orientation in the field of the different samples collected. Looking along the strike of S0 towards the north the base of the T is to the left, while its head is towards the right, and each mineralogical layer has a left and right hand side. Equally given the orientation of "T", layers to the left are described as "preceding" while those to the right are described as "succeeding". The other symbols on the map are the directions of growth and crystallization (see Figure 2).

Pyroxene rich rocks H3g, some with CLP, occur as a development in the harzburgites of the banded sequence, but are not immediately adjacent to dunites H3c and H3e. Otherwise the sequence is relatively poor in CLP. Well-developed orientated olivine units [15,16] are present in the harzburgites of this sequence, particularly H3d.

At H (an interbanded sequence of harzburgites and pyroxenites) the pyroxenites, of which there are several, contain the assemblage OP+CLP+SP, and are from 2-3 mm to 10 mm in thickness, and occur within an exposure of harzburgite measuring some 6 m across the strike. Harzburgites occur with well-developed, and relatively undeformed primary micro-structures and textures, e.g. Hc and He. Compared to the sequences at H3 and Z, the sequence at H is relatively rich in CLP and some bands of lherzolitic harzburgite occur. Dunites are absent from the sequence.

At Z (an interbanded sequence of dunites and harzburgites) the dunite of layer Zc is notable for the disposition of the spinel [25] and the absence of pyroxene-rich rocks in immediate association with dunites. The thickness of the dunites ranges from 4 cm within Zc to 45 cm at Zf, while the dunite of Zb may be in places considerably thicker, but on sampling was found to be interbanded with thin harzburgites. Both Zb and Zf show dunite and harzburgite in fine scale interbanding. As a whole the sequence is relatively poor in CLP.

The harzburgites H2, H4, H1, S, and I3 (all examples in which strong mineralogical banding is absent) show the presence of the strong deformational texture [20] in H2, H1, and I3, and are harzburgites in which S1 is well developed. The harzburgite at S has a weak mineralogical banding, and relics of primary textures.

DIRECTIONAL FEATURES WITHIN THE TEXTURAL ASSEMBLAGE OF THE DIFFERENT PARTS OF THE PERIDOTITE SEQUENCE H2 TO I3

From details of the data it is possible to suggest that there are coherent sequences from H3 to Z, made up of four parts, albeit with parts repeated, omitted, or not exposed.

In the sequence H2 to Z there is a ubiquitous weak to moderate deformation and recrystallization [19,36] of the olivines and pyroxenes. It is possible to identify among the assemblage of pre-deformational textures and micro-structures those which can be interpreted as relic directional features of growth and crystallization, symbols [32] and [33]. These have been observed principally in the peridotites showing a strong mineralogical banding. The directional features are found to be from the left hand side to the right hand side of S0 (hereafter LHS and RHS).

The different parts are:

1. Dunites, occurring in interbanded sequences [1] with harzburgites.

There is an occurrence of a dunite (H3b) with a thin extended layer of spinel [24]. In this layer the spinel shows some forms which are parallel [27] to S0 and others which are at steep angles [28] to S0. This layer is succeeded, after a narrow intervening harzburgite (which has an extended development of olivine units at a steep angle to S0) by a dunite (H3e) with small aggregates of spinel which have some suggestion of a tangential disposition with respect to the left hand boundary of the dunite. This dunite has dissimilar left hand and right hand boundaries. The former boundary contains spinel traces parallel to S0 [23], whilst the latter has an olivine structure at steep angles to S0 [15]. One of the boundaries between the dunites and harzburgites (H3c) suggests corrosion [6] of the dunite by the harzburgite to the RHS. The rock sequence at H3 as a whole is asymmetrical from LHS to RHS.

Further on in the section (Zc) there is the undoubted occurrence of a dunite with interstitial spinel, in which the spinel train is arranged with a tangential disposition [25] with respect to the left hand boundary (Figure 3a). Although this feature suggests that of igneous sediments, the spinel itself has an anhedral form and there are no evident occurrences at Z of gravity concentrates of spinel.

Otherwise, as in the harzburgites, the spinel occurs as short traces parallel to S0 [23]. The dunites contain several examples (e.g. Zf) of thin lenses of harzburgite with preserved micro-textures (15]. Some of these micro-textures include small rounded olivines in OP [14], similar to some of the textures found at H. Some of these dunites contain examples of dispersed spinel [21].

2. Harzburgites, often constructed of olivine units at steep angles to S0 and which branch from LHS to RHS.

There is an extended occurrence of such units in one of the harzburgites within an interbanded dunite/harzburgite sequence. In the harzburgite (H3d), to the RHS of dunite (H3c), small-scale olivine micro-structures at steep angles to S0 develop into extended branching structures on the scale of at least 50 mm [15,16]. These branching structures appear to grow from the LHS towards the RHS (Figure 3b).

In some of the harzburgites there are micro-lenses with olivines lying parallel to S0 [18].

In many of the harzburgites, sub-parallel to the pyroxene interstices [7] and in places linking with them, there are short channel ways [11] containing pyroxene. These latter transect micro-textures parallel to S0, and in some cases may be seen to link with thin pyroxene-enriched lenses and layers parallel to S0 [8,9]. The following are some examples from (Hc) and (He1,2).

Development of pyroxene-enriched bands [9,10] in a harzburgite (Hc), which has a micro-structure orientated at steep angles to S0, shows associated micro-features which include:

i. Figure 3c shows micro-transection units (mtu) [11], principally of OP, which cut from LHS to RHS a micro-layer enriched in pyroxene with olivine and spinel, whose outlines are sub-parallel to S0 [18]. This feature could be interpreted as a consequence of the migration of a reactive liquid from LHS to RHS.

ii. Pyroxene interstice in the same harzburgite showing olivine branching towards RHS [15] (Figures 3e and 3f). Note that in Figure 3d the transition from olivine outlines sub-parallel to S0 to those at a steep angle is without a sharp break.

iii. An mtu in this harzburgite, on the LHS of the enriched layer, contains spinel branching towards RHS [30] and growing from the wall of the interstice (Figure 3g).

There is an enrichment in CLP in Harzburgite (Hel) to the LHS of a pyroxenite (He2) rich in CLP. The enrichment in CLP is from LHS to RHS. In the harzburgite the orientation of the interstices and mtus [7,11] are at steep angles to S0. There is a transition shown from textures parallel to S0, to olivine units at steep angles to S0, which show branching directions towards the RHS. There is a CLP enrichment at the right hand end of some of the mtus.

The structure of the harzburgite (He3) succeeding the pyroxenite layer (He2) is of interest. There is:

i. A coarse-grained olivine texture [17] with very little evident recrystallization.

ii. An example of olivine and spinel, enclosed in OP, showing branching towards the RHS [15,30]. The spinel has a slender curved structure indicative of rapid crystallization from a liquid, this being from LHS to RHS.

iii. An olivine micro-structure [15] orientated from LHS to RHS preserved in OP, to which OP there is a spinel cap [29] on the RHS.

A second sample of this harzburgite (He3), but with texture [5] on a relatively fine scale, to the RHS of the pyroxenite (He2), shows olivine at a steep angle [15] to S0 and development of interstices [7] between individual olivine units, branching towards the RHS. This harzburgite also shows links between pyroxene interstices at steep angles to S0 and at their right hand end those parallel to S0 [5]. This pyroxene encloses rounded olivines [14]. Again this suggests a feeder channel to a small lens of pyroxene and the migration from LHS to RHS of an interstitial reactive liquid through partially consolidated harzburgite. Such a liquid would have the ability to remove much of any primary euhedral form of the olivines.

None of the pyroxene enrichment in the harzburgites is immediately adjacent to dunite.

3. Pyroxenites [8] which in this kilometre section are thin and occur as part of a multiple banded sequence with harzburgites.

SYMBOL			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
LOC.		R																																				
I3		H			X																↑	X														↑	↑	↑
Z	g	H	X				X						X			X	X								X				X	X								
	f	D,H	X				X		X						X	X	X						X															
	e	H\D	X						X								X								X				X									
	d	D\H	X			X																																
	c	D,H	X			X	X					X	X			X	X		X					X			X			X				X				
	b	D,H	X													X	X		X		X		X															
	a	H					X					X	X				X						X		X				X								Z	
S	b	H\P			X						X		X			X	X												X									
	a	H			X		X						X			X	X		X						X				X									
H	g	H					X								X	X												X	X									
	f	H					X						X																X									
	e3	H		X			X		X				X			X	X	X	X	X									X	X	X	X	X	X				
	e2	P		X						X																		X									X	
	e1	H		X			X				X	X	X			X		X			Y							X	X				X		X	Y	X	Y
	d	H				X	X						X				X														X							
	c	H\P		X		X	X			X	X		X				X	X											X			X		X	X		X	
	b	H				X	X								X	X	X			X										X								
	a	H			X		X																		X													
H1		H			X						X					X				X		X																
H4		H			X		X		X					X			X																					
H3	g	H,Pr		X			X					X	X		X	X	X			X					X				X					X			Z	
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H2		H			X																↓	X														↓	↓	↓
T										—— S ——																												

Table 1. TEXTURAL ANALYSIS H2 TO I3.

LOC: Location. R Rock Type. X. Texture (or structure) present. D: Dunite. H. Harzburgite. Pr: Pyroxene-rich rocks. P: Pyroxenite. Y: Ubiquitous. Z: CLP often present as a minor component of harzburgites. For the sequence H2 to I3 and "S"(S0, S1) are as shown. H/D etc. represents harzburgite on the left band side and dunite on the right hand side of the sample.

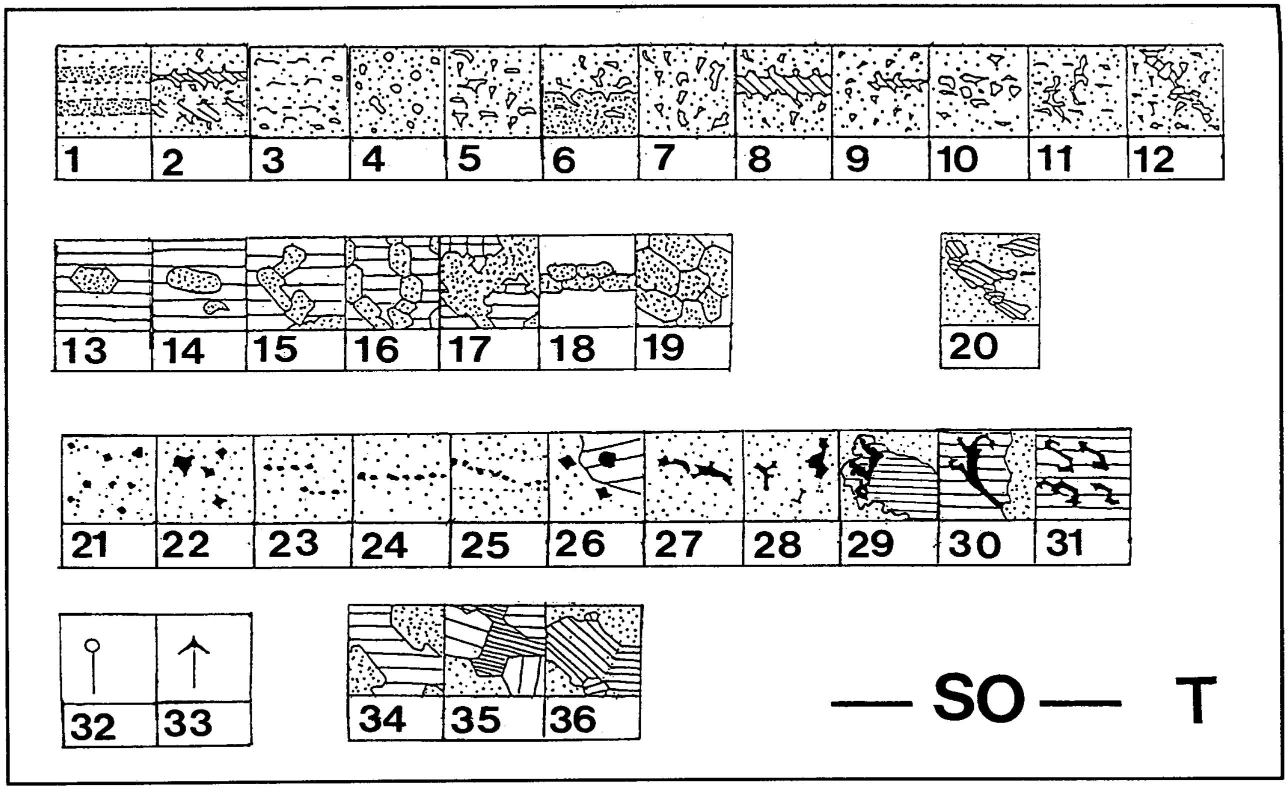

Figure 2. Key to symbols used for textural elements.

[1] Mineralogical banding (S0): dunite/harzburgite. [2] Mineralogical banding (S0): harzburgite/pyroxenite. [3] Planar structure in harzburgite. Includes both S0 and S1 which in this kilometre section are sub-parallel. [4] No evident planar structure. [5] In the harzburgites the pyroxenes are interstitial with respect to the olivine, in most cases of preserved primary textures and structures. These areas (and volumes) of pyroxene are referred to as "pyroxene interstices". This symbol [5] refers to a mixed orientation of pyroxene interstices, particularly marked by those at steep angles to S0 and those sub-parallel to S0. This contrast in orientation of pyroxene interstices is characteristic of the rocks of this section. Other pyroxene interstices of a more irregular character are present in most of the sections, and not represented by a symbol. [6] Sharp contact between dunite and harzburgite. [7] Pyroxene intertices principally at steep angles to S0. [8] Pyroxene layer(s) or band(s). This is as they appear in the field or within a polished block. However they could be the edges of thin flat lenses. [9] Pyroxene-rich lens. [10] Development of pyroxene-rich band. [11] Pyroxene interstice cutting across planar structures of S0. These are one or two mm in width and up to a cm or so in length. Referred to as micro-transecting unit or mtu. [12] Cross-cutting vein.

Habit of olivines: [13] Euhedral in OP. [14] Subhedral in OP. [15] Small units of olivine, often at steep angles to S0. [16] Extended units of olivine, often at steep angles to S0.[17] A macro-structure of olivine (of the type indicated by the symbol). A similar structure also occurs on a fine scale. [18] Several subhedral olivines lying sub-parallel to S0. [19] Olivine mosaic with polygonal boundaries, a ubiquitous occurrence. Note that the symbol is marked in the dunite Zb, where its occurrence, in a dunite, is particularly clear. Pyroxenes: [20] Very strong deformation and recrystallization, presence of clasts with tails, marking the development of S1 (sub-parallel to S0).Occurrence of spinels [21] Fine, dispersed. [22] Aggregates, which may be up to 10mm in diameter. [23] Tenuous bands. [24] Extended bands. [25] Tenuous bands with tangential contacts. Habit of spinels [26] Euhedral and subhedral, often in OP. [27] Anhedral shapes parallel to S0. [28] Anhedral shapes at steep angles to S0. [29] Anhedral fringes to OP, with spinel "fingers" pointing towards the right hand side of S0. [30] Curving slender structure of SP in OP, at a steep angle to S0, growing from the olivine surface, and branching towards to right band side of S0. [31] Graphic intergrowth of SP with OP. Directions of primary development and crystallization (see section on "directional features"): [32] Direction of development of micro-textures with respect to S0.[33] Direction of crystallization of micro-textures with respect to S0.

Ubiquitous textures: [34] OP interstitial to OL. [35] CLP interstitial to OP. [36] Weak to moderate deformation and recrystallization of pyroxenes and olivines.

They would seem to be the end member of a process of pyroxene enrichment, and occur principally at locality H. In a pyroxenite layer (He2) it can be observed that there are pyroxene "tails" into the preceding harzburgite (He1), indicating feeder channel ways [11]. Much smaller channels have been observed passing into the succeeding harzburgite (He3).

The mineral assemblage in the pyroxenites is the high pressure assemblage OP+CLP+SP, and the pyroxenites' textures show a sequence of crystallization from OP to CLP, the CLP being interstitial with respect to the OP.

Also found in a harzburgite (H4) was a centimetre-scale veinlet [12] with the assemblage OP+CLP+SP, cutting across, towards the right, already consolidated olivine micro-structures at a steep angle to S0. This feature is considered to be an example of the removal of trapped residual liquid.

4. Harzburgite with a less pronounced textural variety but still showing bands of differing proportions of interstitial pyroxene, for example at S. Many of these rocks (H2, H1, and I3) show the most pronounced development of S1. One of these (H1) contains a lens of dunitic material with olivine shapes parallel to S0 [18], the lens itself being associated with coarse grained OP+CLP+SP. Remarkably the OP of this lens contains examples of rounded olivines sub-parallel to S0.

Parts 1, 2, and 3, while showing the greatest textural variety, make up only a very minor part of the kilometre section. In these, in the interbanded rocks, dunite and harzburgite develop to roughly equal thicknesses, while the pyroxenites are a minor part of the harzburgites in which they occur. It is noticeable that dunites are not directly associated with pyroxenites. The major part of the kilometre is made up of the harzburgites of part 4. If parts 1-2-3 are regarded as developed as a differentiated sequence, with consistent directional features, then 4 might be regarded as the average rock, with the deformation overprinting and concealing diverse primary textures and structures.

THE INITIAL DEVELOPMENT OF STRUCTURES AND TEXTURES BETWEEN H2 AND I3, AND SUBSEQUENT DEFORMATION

The most marked development of olivine units orientated at steep angles to S0 is in the harzburgites of the mineralogically banded layers, both in dunite/harzburgite sequences and in harzburgite/pyroxenite associations, and would seem to be related to a process of crystallization and differentiation from IRS to RHS.

The details of the data show that in parts 1, 2, and 3 the overall sequence of crystallization is:

OL —> OL ± SP —> OP ± SP--> OP + CLP ± SP,

with a concordance on the macro- and micro- scale. Thus the sequence is from dunite to harzburgite, in which latter a pyroxene enrichment develops, and there are concordant directions of crystallization and formation of the primary micro-textures throughout the sequence. The different parts of this sequence and range of textures are those that could crystallize from an olivine-rich melt in the system OL+OP+CLP+SP. These precipitates, in the case of the section H3 to Z, developed in the direction of "T" (this is indicated on Figure 1 Map B). Part 4 could be part of this sequence.

The initial phase of the subsequent deformation is shown in most of the samples by the bending and fracturing of the pyroxene crystals and the development of polygonal mosaic units of olivine. This process proceeded further with the pyroxenes showing an increasingly intense sequence of deformation and recrystallization. Any deformation of the spinels is more difficult to detect, but there appears to be a disruption of their initial shapes. The extent to which these changes of deformation and recrystallization develops varies in each sample. Some are relatively undeformed, as for example at H. On the other hand, within the kilometre section, H2, H1, and I3 show a much more severe deformation in common with many other parts of the Lizard peridotite. The deformational textures have been shown (Rothstein, 1977, 1988) to develop with the disruption of an original structure and its replacement by planar and linear fabrics containing relics of this structure and its associated textures. This process occurred with declining temperatures and pressures (Rothstein 1988). The full details of the more intense phases of deformation and recrystallization of the Lizard peridotite are to be found in Green (1964) and Rothstein (1977, 1988). The serpentinisation was a later event.

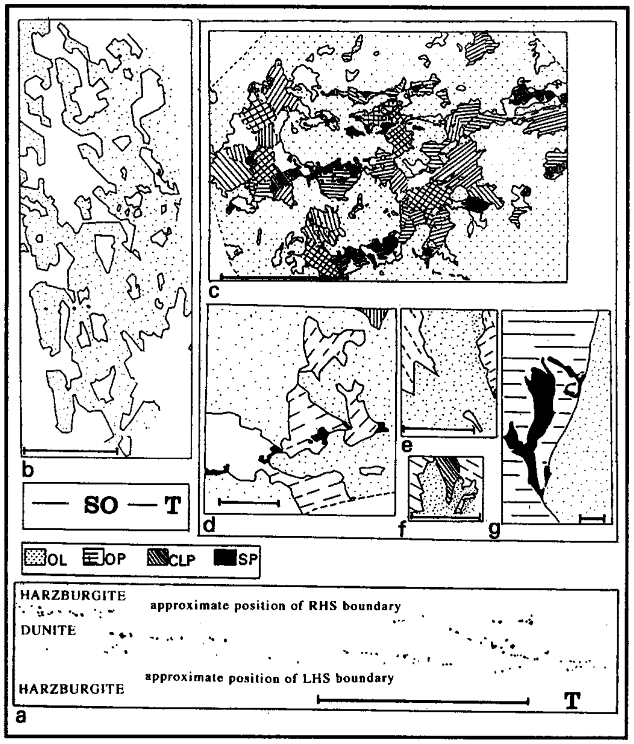

Figure 3. Directional features: (the orientation of S0 and T are as shown, and are the same for all the diagrams, the legend is for diagrams b to g). Figure 3a (Loc.Zc) Scale bar 100 mm. Dunite with spinel trace tangential to the left hand side of the dunite. Figure 3b (Loc.H3d) Scale bar 10 mm. Structure of olivine matrix in harzburgite. Growth at a steep angle to S0, from left band side to right hand side of S0. Figure 3c (Loc.Hc) Scale bar 10 mm. Pyroxene-rich harzburgite. Micro-layer with olivine and spinel parallel to S0 cut by pyroxene units, perpendicular to S0, from left hand side to right hand side. Figure 3d (Loc.Hc) Scale bar 1 mm. Transition from olivine matrix parallel to S0 to that at a steep angle to S0. Figures 3e and 3f (Loc.Hc) Scale bars 1 mm. Structure of olivine matrix of harzburgite. 3e shows olivine growing towards right hand side. 3f shows olivine budding towards right hand side. Figure 3g (Loc.Hc) Scale bar 0.1 mm. Spinel "tree" in one of the pyroxene "feeder" units perpendicular to S0. Growth of soinel towards right hand side.

DISCUSSION

Comparisons may be made with many other well-documented peridotite tectonites of upper mantle origin. These peridotites include a range of textures including protogranular and varieties associated with planar and linear fabrics.

The deformational sequences of the Lizard peridotite, in the superimposition of deformational textures upon earlier features, show some resemblances to, but also differences from, for example the complex deformational and textural sequences of the orogenic spinel lherzolites of the northern Pyrenees (Fabries *et al.,* 1991). Here the earliest stage are the coarse grained protogranular textures characterized by OP+CLP+SP clusters. Fabries *et al.* (1991) state that "evidence for the presence of garnet in the mantle source of the Pyrenean lherzolite is the preservation of coarse-grained protogranular textures with typical orthopyroxene-clinopyroxene-spinel clusters, which are commonly interpreted as being derived from garnet, either by reaction of this mineral in the solid state, or by crystallization from melt pockets produced on the sites of the garnets" and that "deformation textures of the peridotites show the imprint of two superimposed stages of plastic deformation and recrystallization". Clusters of OP+CLP+SP are absent from the Lizard peridotite sequence from H2 to Z. These Lizard primary rocks are characterized overall by the assemblage OP+CLP+SP, but these minerals, as has been shown above, are intimately associated with a range of textures, dominated by olivine often disposed at steep angles to S0, and which textures are associated in some cases with the development of pyroxene-rich lenses and layers parallel to S0. These primary peridotites and their associated textures, by penetrative deformation, pass into peridotite tectonites.

The Lizard peridotite tectonites show resemblances, for example, to the deformed rocks of the Vourinos complex, Northern Greece, wherein to quote Roberts (1992), "All the mantle sequence rocks exhibit a pervasive planar-linear fabric defined by flattened and elongate spinel and/or blocky pyroxene grains. The harzburgites and dunites record various degrees of deformation."

CONCLUSIONS

Comparing the data from the Lizard with the many published descriptions of orogenic lherzolites and ophiolite peridotite tectonites, which have parts that are of upper mantle origin, it may be seen that in the latter two groups of rocks textures occur falling within the categories set out by Nicolas *et al.* (1971) and by Mercier and Nicolas (1975). These textures are principally those of equilibration under metamorphic regimes characterised by processes of deformation associated with high temperatures and considerable pressures, and which have features associated with episode of partial melting.

The most primitive of the textures are the protogranular textures. However, in so far as the textural data are concerned, the Lizard peridotite, between H3 and Z, shows primary rocks with unusual features differing from the protogranular textures, principally in having micro-textures developed at steep angles to S0.

In searching for analogues of high temperature micro-textures orientated at steep angles to S0, comparisons were made by Rothstein (1981) between primary textures from the Lizard peridotite, crescumulates from layered intrusions, directed textures recorded from the linings of blast furnaces, and textures developed in zone refining. This discussion was further developed by Rothstein (1988) which included some response to the arguments of Davies (1984) and of Christiansen and Roberts (1986) that the Lizard primary textures were of a non-primary character. In extension of these comparisons and arguments, it is pertinent to draw attention to experimental work (Lesher and Walker 1988; Lesher 1989) where the development of directed textures and channel ways is recorded at steep angles to the cooling surface of melts. However Bussod and Christie (1991) have recorded the development of a network of channels approximating to an angle of 30 degrees to a maximum principal compressive stress, associated with deformation and dynamic recrystallization of spinel lherzolite, at hypersolidus conditions with overall P T values appropriate to the stability of the assemblage.

The upper mantle series of peridotites, H3-Z, developed as a sequence of thin and thick layers. The thin layers are well-banded, showing the greatest mineralogical variation, and encompassing dunite, harzburgite, and pyroxenite, and containing many relic primary textures. The thick layers, predominant in the sequence, show only weakly banded layers often of a more deformed harzburgite. The well-banded parts show consistent directions of layer formation, crystallization and growth of microstructures, and the migration of an interstitial liquid. Within this particular kilometre section these directions are concordant with "T" as indicated on Map B. It is possible that relics of primary directional features associated with, well-banded asymmetrical rock sequences might be found elsewhere at exposures of the primary assemblage peridotite, for example at Coverack, Lankidden Cove, Poltesco, or to the east and south-east of Kynance Cove. This information could contribute to an understanding of the extent and character of any liquid involved in the formation of the primary Lizard peridotite, and which high temperature high pressure analogue is the most appropriate.

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