THE GEOLOGY OF THE LIZARD COMPLEX; 100 YEARS OF PROGRESS

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Styles, M. T., Cook, C. A., Holdsworth, R. E. 2000. The geology of the Lizard complex; 100 years of progress *Geoscience in south-west England,* **10,** 092-098

The Lizard Complex in south Cornwall is a classic area of British geology and has been an area of great interest for well over 100 years. The latter part of the nineteenth century was a particularly active period with several papers by prominent geologists of the time such as Bonney and Teall, which described most of the main features of the complex. This phase of activity culminated in the Geological Survey mapping and subsequent memoir by Flett and Hill early this century. It was a classic of descriptive and interpretative geology that is generally highly regarded by modern workers.

The next 50 years saw only a few papers on specific topics and a revised version of the memoir by Flett. In 1964 Green published three papers on most of the petrological aspects of the Lizard and in particular recognised that the peridotite was a piece of the Earth's mantle, thereby opening the modern phase of study. This work soon became a classic and the Lizard was regarded as a type example of high-temperature peridotite intrusions. With the 'invention' of plate tectonics, global tectonics and ophiolites became 'all the rage'. Ultramafic complexes throughout the world, including the Lizard, were therefore of considerable interest. A number of studies followed and papers were published on many aspects including petrology, geochemistry, detailed structure, isotopic dating and regional tectonics.

These newer ideas will be outlined and comparisons made with the theories of 100 years ago. How well these old ideas have stood the test of time will be reviewed and their relevance to modern theories discussed.

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STUDIES BEFORE 1850

The Lizard Complex in Cornwall is a classic area of British and Variscan geology and has been an area of great scientific interest for many years. Over 400 papers have dealt with aspects of Lizard geology and the number of publications has fluctuated as time progressed (Figure 1). Over 200 years ago it was realised that the Lizard was different from the rest of Cornwall and contained serpentine and 'soap rock' (Borlase 1758). The mineral mennacanite (now known as ilmenite) was described from streams draining northwards from the Lizard through the village of Mannacan and was the first reported natural occurrence of the element titanium (Gregor 1791). Early in the nineteenth century several eminent scientists published papers on the Lizard. The first volume of the Transactions of the Royal Geological Society of Cornwall in 1818 had a description of the geology of the Lizard by Majendie and a paper by Sir Humphrey Davy (later to be famous for his invention of miners safety lamps). Sedgewick (1822) and the founder of the Geological Survey, Sir Henry de la Beche (1839) published accounts, the latter identifying many of the rock groups we use today.

The latter part of the nineteenth century saw a huge increase in the interest in the Lizard with over 50 papers a year published. Many discoveries were made and controversies arose during this period. The state of knowledge after the mapping of the Lizard by the Geological Survey culminated in the publication of the map (Sheet 359) and Memoir (Flett and Hill 1912). The advances in knowledge during this and subsequent periods will be described and discussed.

THE PERIOD AROUND 1900

The development of knowledge

There is an excellent description of the developments during this period in the Memoir of 1912 and here only a few main points will be given. This was a period of tremendous growth in the knowledge of Lizard geology. Particularly prominent amongst the geologists making important contributions was Prof T G Bonney who was the first to use 'modern' methods, particularly the petrographic microscope. He described the schists as belonging to various groups: micaceous, hornblendic and granulitic, which were intruded by serpentine, gabbro and epidiorite dykes. The serpentine was correctly identified as lherzolite, in an advanced state of decomposition, and the higher grade of metamorphism of Lizard rocks compared to the rest of Cornwall was emphasised. During the early part of his studies (1877) he considered the schists to be of 'about lower Devonian age' in agreement with the Geological Survey viewpoint, but he soon became convinced that they were Archean and that the serpentine was probably of similar age, but possibly much younger.

This was a period when many papers were published on descriptions of localities and field relations. Notable amongst these was the work of a local geologist from Falmouth, Mr Howard Fox. He described many places, including the complex area around the cliffs at Predannack on the west coast (Fox and Teall 1889), and recorded the discovery of gneissic rocks on the reefs lying off the southern tip of the Lizard (later known as the Man of War Gneiss) (Fox 1888). His maps are valuable because some features have disappeared due to coastal erosion, and others must be much more overgrown than a hundred years ago, as they can no longer be seen. Teall (1886) published a paper on 'the metamorphosis of the Lizard gabbros' describing the spectacular flaser gabbros from Carrick Luz. This was one of the first papers emphasising deformation, metamorphism and tectonism as important components of the geological history of the Lizard.

There was much discussion and controversy, about the granulitic group, now known as the Kennack Gneiss group. Bonney(1883) regarded them as metamorphosed sediments that pre-dated serpentine intrusion, and claimed they had relics of bedding and even current-bedding. In contrast others, particularly Teall (1887) and Fox and Somervaill (1888) regarded them as igneous intrusions that post-dated intrusion of the serpentine, but had undergone various stages of fluxioning (deformation). They drew attention to a range of field relations that demonstrated this and to the presence of included xenoliths of serpentine within the gneiss at several places.

In 1891, Bonney and McMahon agreed that some of the granulitic group might be igneous in origin but still regarded it as being older than the serpentine.

The age of the Lizard rocks had always been problematical as they were widely recognised as essentially different to the slaty rocks and conglomerates of the Meneage to the north. The Meneage rocks were known to contain pebbles and boulders of Lizard-like rocks such as serpentine, gabbro and hornblende schist and in the Roseland area sandstone bodies contained Ordovician fossils. Some assumed that the Lizard rocks must therefore be pre-Ordovician, but other fossil finds such as radiolaria amongst pillow basalts on Mullion Island, (Hinde 1893) and later within the Meneage showed the presence of Silurian or possibly Devonian strata, which implied the Meneage rocks must be of that age. The age and nature of the Meneage rocks was not clear. Bonney was of the opinion that the metamorphic rocks of the Lizard must be Archean, alluding to similarities with rocks from the Lewisian of north west Scotland and the Channel Islands. An interesting paper by Somervaill (1894) raised the perceptive point that the appearance and nature of the rocks was solely a function of the processes to which they had been subjected and not indication of age. He went on to suggest that the Lizard rocks were post-Ordovician and pre-Devonian, a remarkably good proposal in light of recent work. This was based on two assumptions: a) the Lizard rocks were intrusive into the Meneage rocks (later shown to be wrong) and b) that the Meneage rocks were Ordovician (also later proved wrong). Obviously rather lucky.

OVERALL INTERPRETATION AROUND 1900

This period of study is considered to close with the Geological Survey remapping of the area (Map Sheet 359) by Flett covering the metamorphic rocks and Hill dealing with the Meneage zone and sediments to the north. This work describes all the rocks of the area, their petrology (there are over 1000 thin sections in the Survey collection from this period) and their field relationships. This is firstly, a classic of careful observation and thorough description, which is everywhere separated from interpretation and speculation. This makes it a valuable source of information and hence it is still used and admired by many current workers. It does however go on to discuss their own findings from the survey in the context of theories and controversies current at the time and, in many instances, a preferred option is suggested. The synthesis from the Lizard Memoir is given here as representative of the consensus at the time.

The metamorphic rocks of the Lizard were regarded as a combination of igneous and sedimentary rocks. The oldest of the sedimentary rocks were thought to be the Old Lizard Head series of mica schists, green schists (hornblende-chlorite schists) and granulites (quartz schists). Associated with the mica schists, and possibly interlayered with them, were the Landewednack hornblende schists that were interpreted as a sequence of basic sheets, lavas and tuffs possibly analogous to the 'plateau basalts' of Skye. These two groups were thought to be intruded by the Man of War Gneiss, and the whole sequence deformed and metamorphosed together. This was followed by a period of plutonic intrusions, principally the serpentine, followed by gabbro. There were also phases of minor intrusions that included small bodies of highly deformed gabbros that pre-dated serpentine intrusion, the Traboe hornblende schists, and basaltic dykes that were locally abundant and post dated the gabbro intrusion, followed finally by mixed basic and granitic intrusions. The whole sequence was regarded as the result of a differentiating magma system evolving from ultrabasic to acid compositions possibly in a subvolcanic plutonic complex.

The sedimentary rocks of the Meneage to the north of the metamorphic rocks were problematical and the two authors could not agree on the interpretation. The slaty rocks (killas) immediately north of the Lizard were known to contain large masses (hundreds of yards in extent) of hornblende schist, pillow lava and quartzite, and were also locally brecciated. It was called the Meneage crush breccia and assigned to the Veryan series and thought to be Ordovician in age. Overlying the Meneage breccias, with a coarse conglomerate at its base, were the Mylor series, which in some places were thought to be Devonian on the basis of rare plant fossils. The exact extent of supposed Devonian and Ordovician rocks was not well defined and the nature of the contact between these and the igneous complex was uncertain, Hill thought it was intrusive, while Flett suggested it was tectonic. The verdict was left open.

THE PERIOD 1910-1960

Following the flurry of activity around the turn of the century, a quiet period followed as much of the petrology had now been done and attention moved to the stratigraphy of the Meneage rocks and relations to other areas of Cornwall. A worker of particular note during this period, particularly the 1920's and 30's, was Miss E M Lind Hendriks. She discovered plant fossils showing some strata to be no older than middle Devonian and the stratigraphy erected by Hill for the first Lizard Memoir had to be revised for the second memoir

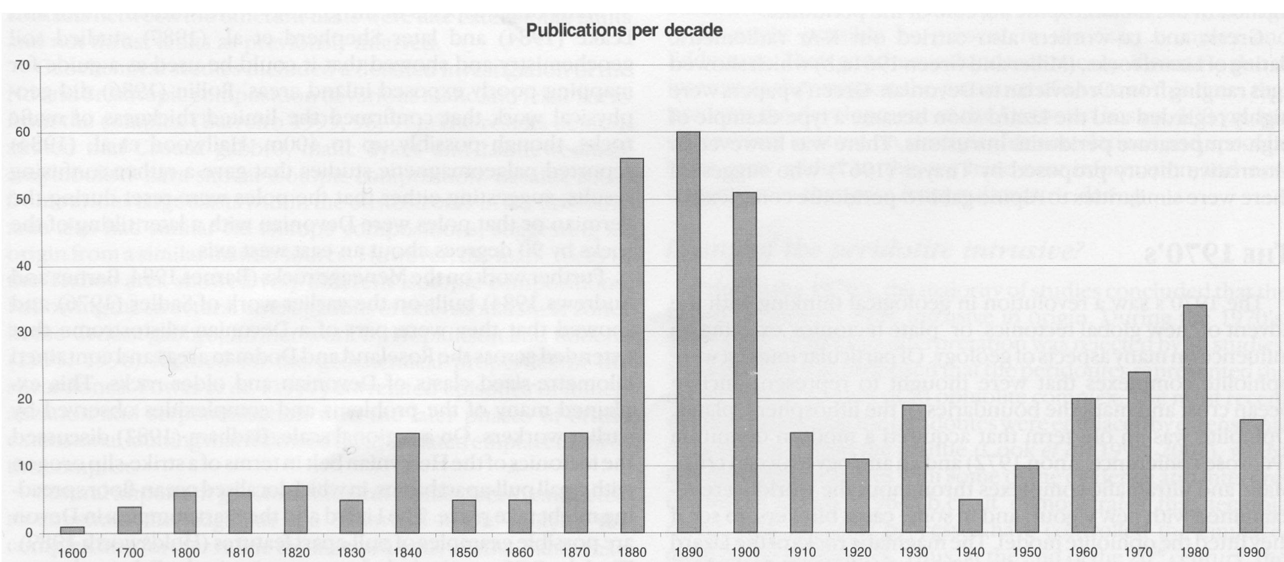

Figure 1. *The number of publications on the geology of the Lizard shown by decade back to 1800 and by century prior to that.*

(Flett 1946). She also drew attention to the similarities between Lizard basic and ultrabasic rocks and clasts in the breccias in the Roseland area and proposed the idea of a large regional scale Start-Lizard thrust that separated these exotic rocks from the rest of Cornwall (Hendriks, 1939). Stubblefield (1939) also described and identified Devonian fossils within the Meneage rocks.

The Lizard map and memoir were revised by Flett after his retirement as Director of the Geological Survey, with the map appearing in 1934. The memoir, though completed by 1939, was not published until 1946 due to the intervention of the Second World War. The main changes were concerned with the Meneage rocks, incorporating the works mentioned above but that covering the metamorphic complex had changed little. The conclusion regarding the Meneage built on that previously proposed by Flett: that they were a tectonic 'crush breccia' of Devonian age containing Ordovician clasts formed during northwards thrusting of the Lizard complex during Variscan earth movements. The metamorphic rocks were thought to be much older, probably Archean.

A remarkable short paper by Sanders (1955), based on an undergraduate mapping thesis, gave the first pointer to a new way of interpreting the geology of the Lizard. Based on mapping around the south-eastern part of the Lizard, he suggested that the serpentine was a thin tectonic sheet not a steep-sided intrusion. He also suggested that the Kennack Gneiss was the result of metamorphism and migmatisation of the Lizard Head mica schists and amphibolites, caused by overthusting of a hot peridotite.

THE 1960'S

The 1960's saw a major resurgence in interest in the Lizard complex due to the work of D H Green (1964a, b, c), who carried out a major restudy of the peridotite and surrounding rocks. He recognised several varieties of peridotite, very similar in extent to those defined by Flett. On the basis of petrographic observations and geochemical studies he suggested that they were all derived from a single parent formed by progressive recrystallisation associated with intrusion, rather than a sequence of separate intrusions. From the compositions and phase relations of minerals he showed that the peridotite had originated in the mantle at high pressure and temperature, 15kb 1200C, and suggested that recrystallisation occurred during diapiric intrusion into continental crust, consisting of sediments and hornblende schists. The Traboe hornblende schists, thought to be early intrusions by Flett, were re-interpreted as the metamorphosed equivalent of the Landewednack hornblende schists, formed in the metamorphic aureole of the peridotite.

Green and co-workers also carried out K-Ar radiometric dating of Lizard rocks, (Miller and Green 1961a, b) which showed ages ranging from Ordovician to Devonian. Green's papers were highly regarded and the Lizard soon became a type example of high-temperature peridotite intrusions. There was however an alternative theory proposed by Thayer (1967) who suggested there were similarities to Alpine gabbro-peridotite complexes.

THE 1970'S

The 1970's saw a revolution in geological thinking with the advent of 'new global tectonics' or 'plate tectonics' exerting an influence on many aspects of geology. Of particular interest were ophiolite complexes that were thought to represent ancient ocean crust and mark the boundaries of the lithospheric plates. Ophiolite was an old term that acquired a modern definition (Penrose conference, Anon 1972) and an analogy to ocean crust. Mafic and ultramafic complexes throughout the world were re-examined with new vigour, and in some cases blinkers, to see if they fitted the ophiolite model. The magmatic rocks of the Lizard were no exception and a number of papers were published asking the question was the Lizard an ophiolite?.

After the initial speculations by Thayer (1967), Bromley (1973) suggested similarities to ophiolites on the basis of the field relations on the east coast where gabbros and a dyke complex are found. More detailed studies particularly using geochemistry were carried out by Floyd *et al*. (1976) and a group based at Southampton University (Kirby 1979). These geochemical studies showed that many of the mafic rocks had similarities to MORB (mid-ocean ridge basalt), a diagnostic feature of ophiolite complexes. Kirby also showed that the Traboe hornblende schists were not chemically identical to the Landewednack hornblede schists. Rather that they had slightly overlapping compositional fields and hence were unlikely to be the same rocks at different metamorphic grades. The overall structure of the peridotite was investigated by boreholes drilled by BGS (then IGS); (IGS boreholes 1978, Styles and Kirby (1979) which showed that the peridotite was essentially sheet-like and around 300m thick, not a steep-sided diapir.

The Southampton group also published papers on the regional tectonics and started work on the sedimentary rocks to the north of the Lizard. Meanwhile at the opposite end of the size spectrum, Rothstein (1977) published the first of a series of papers on detailed microfabrics of the peridotites, suggesting they preserved early cumulate textures.

THE 1980'S

The 1980's saw publication of many of the studies aimed at investigating the ophiolitic nature of the complex and detailed studies of many aspects of the geology. A special meeting of the Geological Society of London in 1982 was devoted to Lizard geology and the papers published by the Society in 1984.

Detailed geochemical studies of the gabbros, amphibolites and dykes confirmed the wide occurrence of MORB-like rocks. There were similarities to small bodies of basalt in south Cornwall, but differences with the main greenstone sequence (Floyd 1984). Leake and Styles (1984) described a series of boreholes in the Traboe area which showed that the Traboe hornblende schists contained a wide variety of rocks ranging from ultramafic cumulates such as dunites and clinopyroxenites through gabbros and norites to anorthosites. They suggested the Traboe rocks were an intensely deformed and metamorphosed cumulate complex that had formed in the lower part of the 'oceanic crust'. Two geochemical studies were made of the Kennack Gneisses by students from Memorial University in Newfoundland, but they reached opposing conclusions about their origin. Malpas and Langdon (1985) suggested they were migmatised mica schists similar to the theory of Sanders (1955) while Sandeman (1988) proposed that they were composite, co-mingled igneous intrusions, similar to Flett and Hill (1912).

Many other aspects of the geology were studied: Smith and Leake (1984) and later Shepherd *et al*. (1987) studied soil geochemistry and showed that it could be used as a guide for mapping poorly exposed inland areas. Rollin (1986) did geophysical work that confirmed the limited thickness of mafic rocks, though possibly up to 400m. Hailwood *et al*. (1984) reported palaeomagnetic studies that gave a rather confusing results, suggesting either that the poles were reset during the Permian or that poles were Devonian with a later tilting of the rocks by 90 degrees about an east west axis.

Further work on the Meneage rocks (Barnes 1984, Barnes and Andrews 1984) built on the earlier work of Sadler (1976) and showed that they were part of a Devonian olistostrome that extended across the Roseland and Dodman areas and contained kilometre-sized clasts of Devonian and older rocks. This explained many of the problems and complexities observed by earlier workers. On a regional scale, Badham (1982) discussed the tectonics of the Hercynian belt in terms of a strike-slip orogen with small pull-apart basins, in which localised ocean-floor spreading might take place. The Lizard and the Start complex in Devon are possible examples of pull-apart features (Holdsworth 1989). Work by BGS, particularly from mapping in the Falmouth area, developed models for south Cornwall as an accretionary thrust stack developed during closure of the Gramscatho basin.

The tectonic emplacement of the Lizard complex is part of this basin closure (Leveridge *et al*., 1984; Holder and Leveridge, 1986: Leveridge *et al*, 1990).

Geochronologicalworkwas carried out attempting to `see past' the possible resetting that could have affected the K-Ar dates reported in the 1960s. Styles and Rundle (1984) dated a granite vein from the Kennack Gneiss by whole rock Rb-Sr and Davis (1984) dated a gabbro from Coverack by whole rock Sm-Nd. Both studies obtained almost identical ages of 370ma suggesting that the Lizard complex was formed during middle Devonian times.

THE 1990'S

The 1990's saw many detailed studies of particular aspects of the complex, and there were fewer papers on the general geology of the complex. Structural studies encompassed most units of the complex and some discussed it within the context of the regional tectonic evolution of SW England. There were several geochemical studies and geochronological work provided significant age constraints. Floyd *et al* (1993) presented detailed descriptions of key geological sites and a comprehensive review of the current and past interpretations of the complex.

Gibbons and Thompson (1991) and later Roberts *et al* (1993) described extensional faults and shear zones within the Crousa gabbro, and amphibolites in the Porthoustock area, and suggested that these were related to extension of the lower oceanic crust at a spreading ridge. Cook *et al.* (1998; in press) reexamined the fabrics, microstructural and geochemical evolution of the peridotites and suggested that the peridotites could have been emplaced along an extensional detachment within the mantle. Studies of the temperatures and pressures of various mineral assemblages in the peridotites allied to other petrological features indicated that the rate of uplift is not consistent with the rise of a mantle diapir. The rate of uplift was more appropriate to a continental margin rifting environment than a mid ocean ridge. This implied a tectonic setting in a small pull-apart basin rather than a large Rheic ocean.

Jones (1994; 1997) showed that the basal unit of the complex recorded a protracted deformation history related to later ductile thrust emplacement. A series of structural investigations were made by a group of researchers at the Camborne School of Mines with the results reported in several papers including Shail and Wilkinson, (199 and Alexander and Shail, (1996). These papers addressed the late- to post-Variscan period of late-orogenic extensional faulting in south Cornwall, and demonstrated that this extension involved extensive reactivation of pre-existing thrusts. Power *et al.* (1996) re-interpreted the internal structure of the Lizard complex and showed that many of the tectonic contacts between the different units were late extensional faults and not thrust faults as previously inferred.

Geochemical studies included a detailed investigation of the Nd and Sr isotopic composition of various mafic and felsic rocks from the complex (Barreiro 1995, 96, 97). The results demonstrated that Crousa gabbro, mafic dykes and Landewednack amphibolites have similar isotopic composition. Basaltic rocks from various large clasts within the olistostrome in the Roseland area also had similar Nd isotope compositions, suggesting an origin from a similar mantle source. However, the mafic rocks in the Traboe area showed very different isotopic compositions. Following the structural investigations of extensional shear zones in the Crousa gabbro, further work by Hopkinson and Roberts (1995; 1996) focused on the geochemical properties of the shear zones. Power *et al.* (1997) correlated episodes of mineralization and serpentinisation with the later phases of brittle extensional faulting that followed thrust-related emplacement of the complex.

Several important geochronological studies were conducted to constrain the magmatic age of several of the units of the complex and further refine the metamorphic events. Sandeman *et al.* (1995) demonstrated that thrust emplacement and metamorphism of basal Landewednack amphibolites took place at *c.* 365-370 Ma, suggesting that the complex was emplaced shortly after its initial formation. One of the most important discoveries of the 1990's, was the 499 Ma (Cambrian) magmatic age for the Man of War Gneiss obtained by U-Pb zircon dating (Sandeman *et al.* 1997). This was of great significance as the Man of War Gneiss is now demonstrably much older than the Devonian age of the other ophiolitic rocks of the complex and represents a fragment of pre-Hercynian basement. A U-Pb zircon age for a plagiogranite from the Traboe cumulate complex demonstrated that metamorphism and extensional development of the complex took place at 397 Ma (Clark *et al.* 1998a). Clark *et al.* (1998b) presented further Ar-Ar dates for the metamorphism Old Lizard Head Series and Landewednack amphibolites, which confirmed that later, thrust-related, emplacement of the complex was a Late Devonian event. SHRIMP dating of zircons from the granitic Lizard Head Sill, by Nutman *et al.* (in press), demonstrated that the Old Lizard Head Series is also Cambrian in age, and is related to the Man of War Gneiss. SHRIMP dating of zircon from a mica schist interleaved with the Landewednack amphibolites suggested that the source was also from a terrain of Cambro-Ordovician age, possibly similar to the Old Lizard Head series.

PROBLEMS NOW COMPARED TO 100YRS AGO

There are still many problems relating to the understanding of the geology of the Lizard, and several of these are the same as those highlighted from 100 yrs ago. A selection will be outlined in the following section.

Age of the complex - how much is Ordovician?

The recent spate of geochronological studies have demonstrated that several of the units of the Lizard Complex are of Cambrian age, and thus, older than they have been considered for the last 30 years. These units definitely include the Man of War Gneiss, and the Old Lizard Head Series, whilst the age of the Landewednack amphibolites is still uncertain. Therefore the question of concern now is how much of the complex is Cambro-Ordovician and how much is Devonian. At present, the magmatic ages of the Kennack Gneiss and Crousa Gabbro are reliably known to be Devonian and it is likely that Traboe Cumulate Complex is also of this age. However, we cannot be certain about the age of the Lizard Peridotite. Although it is known that emplacement of the peridotite and concomitant deformation/metamorphism of the cumulates is a Devonian tectonothermal event, we cannot be absolutely certain that these rocks are not related to the older Cambro-Ordovician units. These age differences are significant as they show that there is Cambro-Ordovician basement within the Hercynian belt of south-west England. This basement is only definitely known from the Lizard but simliar age rocks might possibly be present in the Start complex and Eddystone. Their geochemical and tectonic significance is also of interest as they suggest the presence of an arc at this time, that predates the development of the Devonian basins. 100 yrs ago controversy centred on stratigraphic correlations and speculations, now added to this we have new information and new uncertainties that arise from radiometric dating.

Is any of the peridotite intrusive?

Prior to the 1970's, the majority of studies concluded that the Lizard peridotites were intrusive in origin. During the 1970's, 1980's and 1990's this interpretation was rejected by all studies, and instead it was proposed that the peridotites represented the upper mantle section of an ophiolite complex. The most recent studies suggest that the peridotites were emplaced by extensional detachment within the mantle (Cook *et al.* 1998; 2000), whilst this explanation agrees with some of the evidence and interpretations of Green (1964a, b, c), it demonstrates that tectonic rather than intrusive processes have controlled the emplacement of the peridotites. Thus, at the end of the 20th century, the studies of the peridotites conclude that none of it is intrusive, which strongly contrasts with the ideas at the beginning of the 20th century.

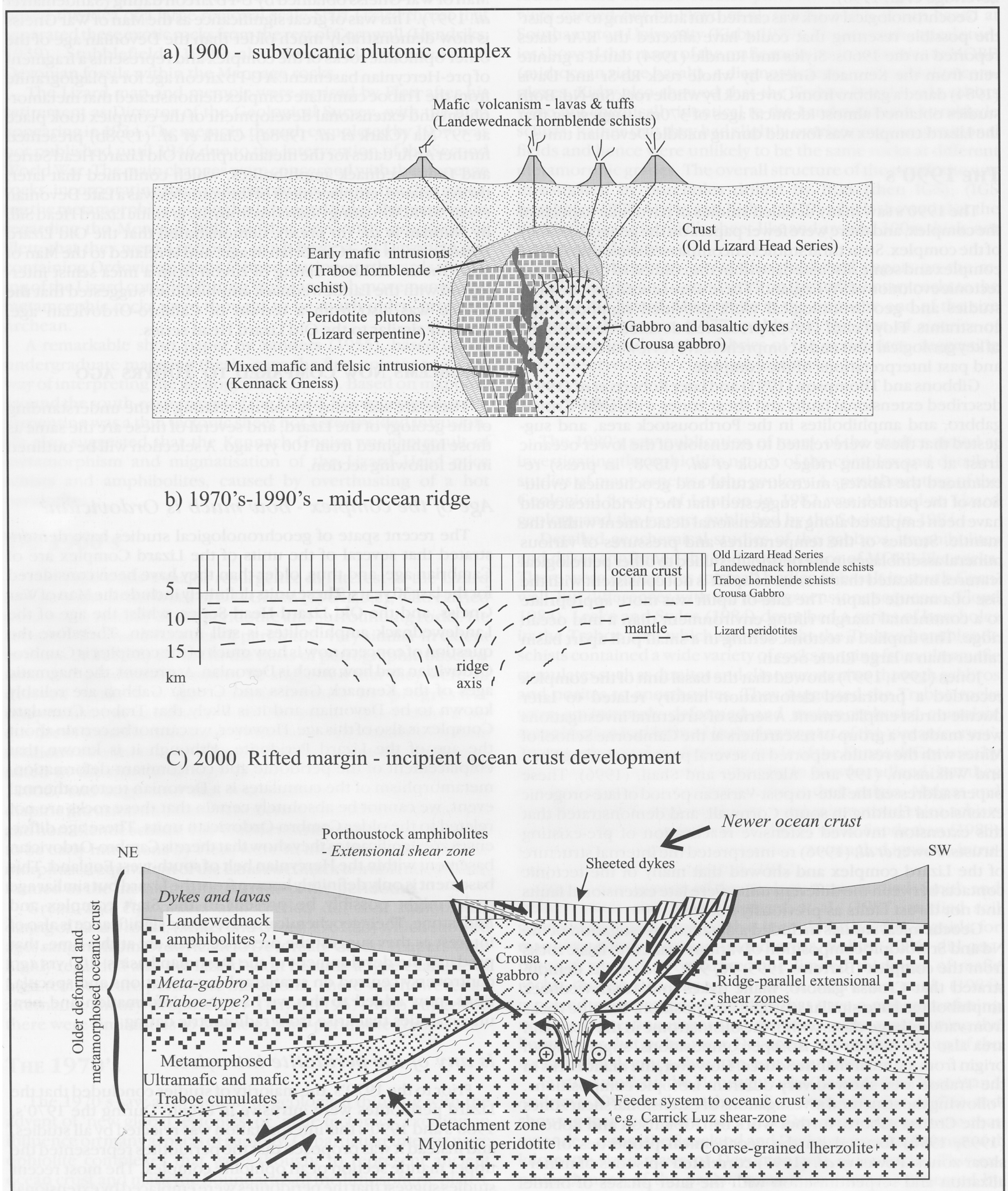

Figure 2. *Theories for the origin of the Lizard Complex.*

The nature and relationships of the Traboe amphibolites

The nature and relationships of the Traboe amphibolites (cumulate complex) compared to the Landewednack amphibolites have been a source of controversy throughout the last 100 years and still remain a hotly debated matter. Studies of bulk chemistry particularly rare earth elements (Cook 1999, BGS unpublished data) have demonstrated both similarities and difference between the Traboe and Landewednack amphibolites. However, recent isotopic studies have shown that the two groups have very different isotopic compositions (BGS unpublished data) and hence are unlikely to be equivalent but at different metamorphic grades.

Structure of the west coast near Mullion

The structural relationships between amphibolites and peridotites on the west coast of the Lizard, particularly in the Predannack region, have also been contentious. 100 years ago, the exposures on the cliffs in this area were reported to show that there were complex intrusive relationships between peridotite and gabbroic rocks. In the 1960's, Green (1964 a, b, c) suggested that the rocks preserved evidence for melting and mobilisation of amphibolites in the dynamothermal aureole of a hot peridotite intrusion. More recently, these rocks have been regarded as being a highly folded and truncated part of the Traboe Cumulate Complex sequence (Floyd *et al*. 1993). Jones (1997) suggested that the structures in this area were related to folding and ductile thrusting during large-scale sheath folding.

THE TEST OF TIME

Most of the theories about the geology of the Lizard that were current 100yrs ago were based on the study of field relationships, and apart from optical petrography, laboratory study had played only a tiny part. How have these theories stood the test of time?

The main lithologies had been identified and the relative ages and relationships had been established by the time of the first Lizard memoir nearly 100 yrs ago. Most of these proposals are still accepted today though the amount of detail known about the characteristics of the rocks tells us very much more about them and their origins.

The amphibolite sequences were recognised as having different components, one essentially derived from basalts and the other from gabbros. These differences were ascribed to differences in metamorphic grade rather than origin by Green (1964), whilst more recent studies have refined but generally reconfirmed the earlier view. They have different origins that lead to their different field appearance and relationships.

The Kennack Gneiss has had the most controversial theories about its origin. Early suggestions were that they were ancient, (Archean), and predated the peridotite and mafic intrusions. This had been rejected by the time of the first memoir in which they were considered to be the youngest intrusive phase, formed as composite intrusions. This origin is supported by the most recent publications though several forays towards a migmatitic origin have been also seen. The age is now firmly in the Devonian and they are regarded as one of the youngest units.

The mica schists were regarded as one of the oldest components by the early workers but studies in the 1960's and 70' suggested they were metamorphosed Devonian sea-floor sediments, and thus part of the ophiolite assemblage. The most recent dating studies show however that they are part of a Cambro-Ordovician basement and older than most of the magmatic rocks. Thus the early suggestion proved almost correct, though not for the same reasons.

The peridotite was originally thought to be intrusive, possibly part of a subvolcanic complex. This has been completely discarded and it is now regarded as an ophiolite complex, a piece of upper mantle and associated 'oceanic' crust that has been tectonically emplaced.

The main changes are largely those brought about by the application of modern laboratory methods and general awareness and understanding of tectonic processes. This has extended the type and scope of information available and led to the development of theories about geological evolution of the complex. The changes in the theories of the origin of the Lizard are shown schematicaly in Figure 2.

The role played by advances in technology and geological theories in general towards our understanding of a particular area were appreciated 100 years ago. We would like to close with a quote from Bonney (1883), that makes this point most eloquently. Here he refers to the work of de la Beche, but the sentiment might more generally be applied by geologist of the day to earlier workers. 'Each day's work has increased my admiration of the genius of the first chief of the British Geological Survey, and I will venture to say that if he could have had the advantages which we now posses, he would have left little for our generation to do in Cornwall'.

ACKNOWLEDGEMENTS

We would like to thank Dr B E Leveridge and Dr M T Holder for many discussions about the geology of south Cornwall and useful comments on this manuscript. This paper is published by permission of the Director of the British Geological Survey (NERC).

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