

# The Lizard and Cornubian tin granites: 'Poldark' revisited

By Allen Nutman

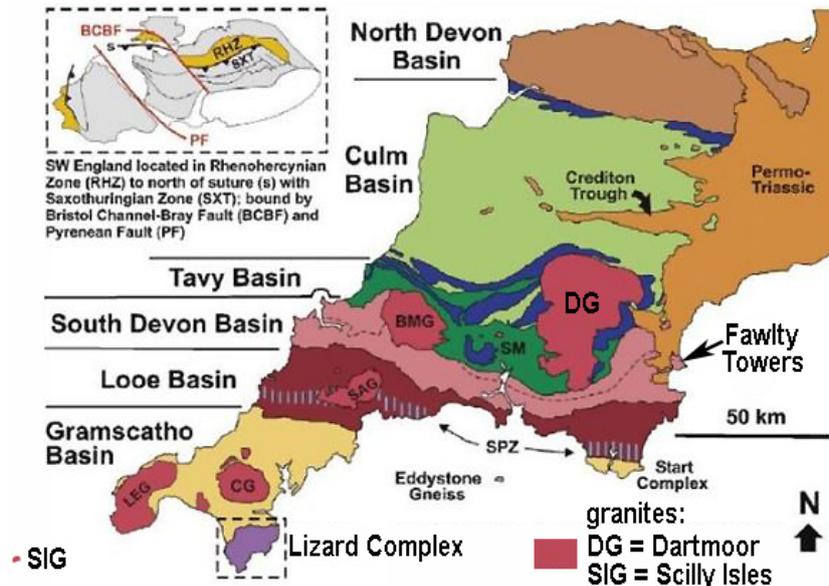


Figure 1. Geological sketch map of SW England, showing the 'S' type granites trending across structure, the Scilly Isles granite (SIG; all data previously acquired), Dartmoor granite (DG; data acquired with GeoQuEST funding) and the Lizard Complex (some new data still required)

The aim of this project was to reassess the geodynamics of SW England with the original concept to be tested being: That the Lizard Complex is a Devonian fore-arc with a peridotite diapir and boninites emplaced into Cambrian basement, whose corresponding arc shed detritus north, giving the source for the Cornubian (earliest Permian) tin granites

Covid severely disrupted this project: (i) A colleague in the U.K. (who is in his seventies) was to collect samples for this project. Because of the lockdown of older citizens, it was only late in the year that he was able to drive from his home in Oxford to Devon, to sample the Dartmoor granite. It was necessary to do this in a day-trip, thus he was not able to travel farther to Cornwall, to recollect gabbros from the Lizard Complex. (ii) Because of disruptions in ANU, the Dartmoor zircon separates were only completed just before Xmas. (iii) For the Lizard gabbros, I am in contact with my previous colleague David Green in Hobart, who has gabbros in his 1960s Lizard collection.

Despite these difficulties, the U-Pb zircon data from the Dartmoor granite and my previously acquired data from the Scilly Isles (the westernmost extremity of England) reveal an interesting story in their pre-magmatic inherited zircon ages. The first issue, first noticed in the previously acquired Scilly Isles data, is the rarity of very old (Precambrian) inherited zircons. This

immediately demonstrates that the sedimentary source(s) that melted to give the Cornubian granites were *not from a complex mature region of continental crust*, such as Avalonian northern Britain. This is summarised by mixture-modelling on the age spectra as presented in Table 1 below; where the very rare Precambrian zircons in the Scilly Isles granite have been excluded:

Table 1: Mixture modelling of Phanerozoic zircon ages

Scilly Isles, with % abundance	Dartmoor, with % abundance (GeoQuEST)	Lizard Complex Devonian ages
298 Ma; 58% magmatic	294 Ma; 29% magmatic	
325 Ma; 3% inherited	309 Ma; 35% inherited	Granites <sup>1</sup> 384, 391, 396 Ma
359 Ma; 12% inherited	320 Ma; 30% inherited	Gabbro <sup>2</sup> 387 Ma
381 Ma; 26% inherited	333 Ma; 6% inherited	Metamorphism <sup>1</sup> 379, 386, 387, 393 Ma

<sup>1</sup> Nutman et al. (2001); <sup>2</sup> Nutman data, currently unpublished

Despite that both show the lack of old recycled crust, from Table 1 there is clearly difference in inheritance from one end of the exposed Cornubian Batholith to the other. In the west, the Scilly Isles granites are intruded into the Devonian Gramscatho Beds (flysch), south of which is the allochthonous Lizard Complex with Devonian granites, gabbros and metamorphism leading to new zircon growth (Nutman et al., 2001). The dominance of Devonian inheritance in the Scilly Isles granite thus matches this local source. In the east, the Dartmoor granite is intruded into the Carboniferous flysch Culm Basin, and the inheritance is mostly Carboniferous, *not* Devonian (Table 1). This again suggests a singular, but different source. Study of detrital provenance in related Carboniferous basins in France (Martínez et al., 2016) has demonstrated a magmatic source from the Carboniferous Iberian-Armorican arc, which was active at the northwestern edge of Gondwana, prior to its final closure with Avalonia.

Thus the diverse provenance of the inherited zircons in the Cornubian granites can be matched with the sedimentary basins into which they were intruded. However this opens-up two conundrums:

- (i) The deep crustal structure of southwest England is portrayed as a thin-skinned orogen, in which the exposed Devonian-Carboniferous flysch basins overlay a 'hidden' Avalonian (northern) continental basement. If this is the case, then the melting generating the granites was focussed in the upper crust only – leading to questions about the heat source. Perhaps this thin-skinned model is incorrect, and the sedimentary basins continue to the deep crust
- (ii) The granites form a trend across the regional structure (Fig. 1), such that eastwards they intrude progressively younger folded flysch sedimentary basins. What is the nature of this

singular structure? Normally late orogenic granites follow the 'orogenic grain' rather than cut across it.

Despite these conundrums, the GeoQuEST-funded research, combined with my previously unpublished Scilly Isles data provide enough fodder for an international publication, which no doubt will spark debate about the tectonic evolution of southwest England.

#### Cited references

- Martínez, F.J., Dietsch, C., Aleinikoff, J., Cirés, J., Arboleya, M.L., Reche, J., Gómez-Gras, D., 2016. Provenance, age, and tectonic evolution of Variscan flysch, southeastern France and northeastern Spain, based on zircon geochronology. *Bull. Geol. Soc. Am.* 128, 842-859.
- Nutman, A.P., Green, D.H., Cook, C.A., Styles, M.T., Holdsworth, R.E., 2001. SHRIMP U/Pb zircon dating of the exhumation of the Lizard Peridotite and its emplacement over crustal rocks, Cornwall, England: Constraints for tectonic models. *J. Geol. Soc. Lond.* 158, 809-820.