Age of the Conachair Granite, by M. Brook - St. Kilda: an illustrated account of the geology

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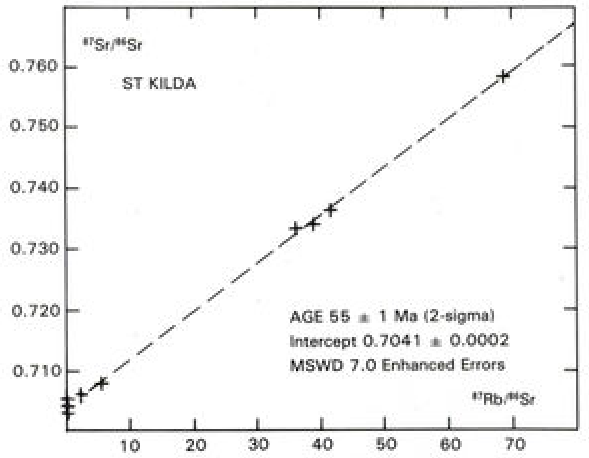

Figure 40 Diagram showing Rb and Sr ratios of St Kilda intrusions

Chapter 22 The age of the Conachair Granite

Keywords: Rb–Sr isotopes, initial $^{87}Sr/^{86}Sr$ ratios, granite, gabbro

The islands of St Kilda are made up of a series of intrusive igneous rocks whose relative ages can be determined by examining their mutual contacts, but the boundary between the whole complex and the surrounding country rock has so far proved inaccessible beneath more than 50 m of water. So in this case one cannot assign an older age limit to the complex by identifying the country rock, and, similarly, a younger limit cannot be assigned from field mapping methods because (apart from glacial deposits) neither lavas, sediments nor any other country rock remains of the cover that must have overlain the complex. The intrusions have been considered Tertiary solely on the basis of their similarity with those in Mull, Skye and other Tertiary centres.

One way to determine rock age uses the radioactive decay of part of the trace element rubidium (Rb). Rubidium consists of two isotopes with different masses, ^{85}Rb and ^{87}Rb; the latter breaks down to ^{87}Sr by losing an electron. The rate of this breakdown or decay is constant, so if the amount of Rb in the rock and the amount of Sr that has formed as a result of the decay are known, the time taken to form the Sr can be calculated. This radiogenic ^{87}Sr joins the isotopes of Sr (88, 87, 86 and 84) initially present in the rocks, the extra amount being most conveniently measured as an increase in the $^{87}Sr/^{86}Sr$ ratio. The parts of the rock that contain high Rb will, through time, gain more ^{87}Sr than those parts with low Rb and this is best illustrated by measuring and plotting the $^{87}Rb/^{86}Sr$ and $^{87}Sr/^{86}Sr$ isotope ratios on a graph known as an isochron diagram.

Ideally, the slope of the isochron is proportional to the age of the rock. Each sample of the rock should lie on the isochron but in practice this rarely happens. First because there are small experimental errors in measuring the isotopic ratios and secondly because the isotopic systems may be disturbed and small amounts of radiogenic strontium may be lost from certain samples by weathering and other processes of alteration. Isotopic measurements were made on 33 samples from St Kilda. The results are tabulated in (Table 41). When all the data are plotted on an isochron diagram, the scatter about the best fit line is considerable as indicated by the high value of 31 for the MSWD (mean square weighted deviates, an estimate of the goodness of fit of the points to a single line). When MSWD has a value of 2.5 or less, all the scattering about the line can be attributed to analytical error, but if the number is greater than 2.5, then there is a geological reason for the scattering and the errors on the age of the rock must be increased to account for this. Two samples from St Kilda fall statistically a long way from the line which passes through all the other points: an aplite vein, which is probably younger than the other intrusive bodies; and a marginal sample of the Conachair Granite which may be contaminated. When these samples are removed from the plot, the MSWD becomes 7 (Figure 40) and when the errors on the age are enhanced to allow for the small excess scatter, the age of the St Kilda intrusive complex becomes 55 ± 1 Ma, in good agreement with the conclusions drawn from the Palaeomagnetism results in the previous section.

On this basis one can calculate the apparent initial $^{87}Sr/^{86}Sr$ ratios for each point and evaluate the differences in these for each phase of intrusion and thus suggest possible geochemical relationships between the different phases. The Conachair Granite shows the widest range in possible initial strontium ratios which may reflect varying source contamination of the magma or later disturbance of the Rb-Sr systematics ((Table 41)). The calculated possible initial strontium ratios for the Mullach Sgar Diorite, the Mullach Sgar Microgranite and the Glen Bay Granite show remarkable internal consistency. The means of the initial ratios for each phase are significantly different and suggest varying contamination of the source magma for each distinct intrusion. However, the total range in initial $^{87}Sr/^{86}Sr$ ratios is very small and may indicate derivation from a common magma reservoir. The sample of aplite, No. 327A, appears to be younger than the main intrusive phases. For an age of 55 Ma, its calculated apparent initial ratio is unacceptably low. With the more realistic value for the initial $^{87}Sr/^{86}Sr$ ratio of 0.7039, the age calculated for this phase becomes 50 Ma.

In the context of Tertiary igneous rocks of the North Atlantic region, the initial $^{87}Sr/^{86}Sr$ ratios are amongst the lowest yet recorded.

(Table 41) Rb-Sr data for intrusive rocks on St Kilda

	Sample	Rb(ppm	Sr(ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	$^{87}Sr/^{86}Sr_o$	Calculated assuming an age of 55 +1 Ma Mean $^{87}Sr/^{86}Sr$ ±2 s.e.
	234	102	7.9	38.534	0.73390	0.70379	
	322	100	8	38.690	0.73395	0.70372	
Conachair Granite	326A	78	79	2.8665	0.70310	0.70302	
	206A	123	5.2	68.3850	0.75816	0.70473	0.70410 ± 65
	90	96	7.9	35.7900	0.73323	0.70527	
	232	103	7.3	41.2150	0.73626	0.70406	
	298A	31	291	0.3091	0.70443	0.70419	
Mullach Sgar Complex	298B	29	290	0.2889	0.70429	0.70406	
	299A	24	267	0.2607	0.70431	0.70411	

	300B	35	249	0.4096	0.70451	0.70419	0.70414 ± 5
Dun Passage	301A	31	263	0.3463	0.70446	0.70419	
Diorite	302A	24	311	0.2276	0.70427	0.70409	
	302B	24	310	0.2208	0.70429	0.70412	
	303	56	131	1.2349	0.70526	0.70430	
	305	61	123	1.4345	0.70535	0.70423	
Mullach Sgar Complex	306	53	136	1.1309	0.70516	0.70428	
	307	56	123	1.3054	0.70526	0.70424	
	308	58	130	1.2825	0.70525	0.70425	0.70426 ± 3
Na h-Eagan Microgranite	309	47	129	1.0565	0.70512	0.70429	
	310	54	137	1.1516	0.70515	0.70425	
	181B	71	95	2.1730	0.70608	0.70438	
	113	72	40	5.3950	0.70800	0.70378	
	237	55	98	1.6409	0.70512	0.70384	
	238	60	104	1.6728	0.70501	0.70370	
Glen Bay Granite	239	58	108	1.5723	0.70504	0.70381	
	240	57	105	1.5895	0.70500	0.70376	0.70379 ± 5
	241	59	100	1.6926	0.70511	0.70379	
	242	57	108	1.5215	0.70498	0.70379	
	244	56	109	1.5030	0.70506	0.70389	
Boreray Gabbro	369B	6.7	104	0.1867	0.70525	0.70510	
Aplite	327A	97	2.4	113.45	0.78488	0.69624	
Glen Bay Gabbro	H7387	15	263	0.1622	0.70423	0.70410	
Western Gabbro	H7640	7	160	0.1270	0.70311	0.70302	

References

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