SCIENTIFIC COMMUNICATION

RADIOMETRIC AGES ON ZIRCONS FROM A COGENETIC GABBRO AND PLAGIOCLASE PORPHYRITE SUITE IN HYVINKÄÄ, SOUTHERN FINLAND

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Introduction

The Hyvinkää gabbro pluton (Fig. 1) lies 50 km north of Helsinki in a belt of mafic plutonic and volcanogenic rocks. The pluton is composed of several different gabbro types which grade into diorite (Härme 1954, 1978, 1980; Tenhola 1971 and Puranen 1968, 1971). Early-kinematic and synkinematic intrusions gabbros, diorites, quartz diorites and granodiorites are both spatially and petrologically so closely related to volcanites that their intrusions have been interpreted as subvolcanic magma chambers (Härme 1954, 1978) of stratovolcanoes (Härme 1980).

The volcanics are of basaltic and andesitic composition, andesites being the most common. The rock association contains flows, agglomerates, tuffs and tuffites. Uralite porphyrite and plagioclase porphyrites are represented both by extrusive rocks and by marginal variants of the gabbro.

In some parts of the gabbro pluton the texture is still unmetamorphosed, hypidiomorphic. These gabbro types are often pyroxene bearing, and their plagioclase is rich in anorthite. A minor olivine content is found in the gabbro, but hornblende gabbros are the most abundant. The mineral composition is mostly primary. However, in places, products of metamorphism can be found: the amphibole is uralitic and the composition of plagioclase has chanced. Some gabbros grade into peridotite and anorthosite (Härme 1954, p. 20), into diorite and further into quartz diorite and granodiorite. In places, the gabbros contain small pegmatoidic portions.

Some minor calcareous bands have been found in diopside gneiss in the zone of volcanogenic rocks in the Hyvinkää area (Härme 1978). According to Wampler & Kulp (1962), who analysed the lead isotope composition of the crystalline limestone in Kytäjä, south of the Hyvinkää gabbro, the common lead model age corresponds to 1950 (+80, —130) Ma.

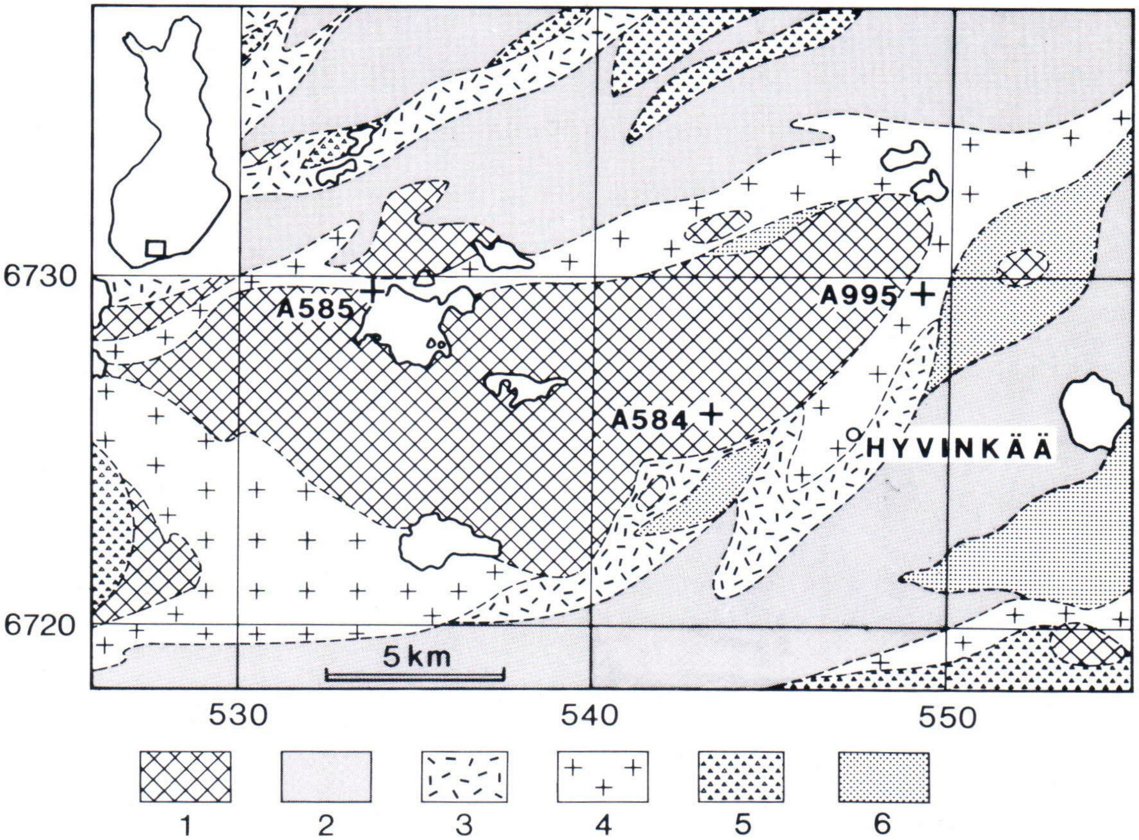

Fig. 1. Geological map of the Hyvinkää area (simplified from Härme 1953, Kaitaro 1956 and Härme 1980) showing the sites of the samples studied by isotopegeological methods. 1 = gabbro, 2 = granite, 3 = granodiorite, 4 = mafic volcanics, 5 = mica gneiss and 6 = acid volcanics.

A plagioclase porphyrite sample (A995) was selected for dating to test whether the Hyvinkää gabbro and the surrounding volcanogenic rocks are cogenetic and synkinematic (Svecofennian) or whether earlykinematic volcanogenic rocks also exist, as suggested by Härme (1980, p. 33).

The isotope analyses were carried out at the laboratories of the Isotope geology branch of the Geological Survey of Finland. The methods used are described in Vaasjoki (1977) and Huhma (1986).

Chemical composition

The gabbro pegmatoids very probably have an anomalously enriched chemical composition, as demonstrated by features such as the high zircon content. The chemical compositions of the Hyvinkää gabbro and the plagioclase porphyrite (A995, see Fig. 1),were compared with the aid of two previously analysed, standard samples from the Hyvinkää gabbro. The concentrations of the main elements, determined with the classical methods, and those of some trace elements, determined with XRF: are listed in Table 2. The compositions are close to each other, although the aluminium content of the plagioclase porphyrite is higher owing to plagioclase enrichment. The aluminium content in the gabbros reported here are higher than the mean values for differ-

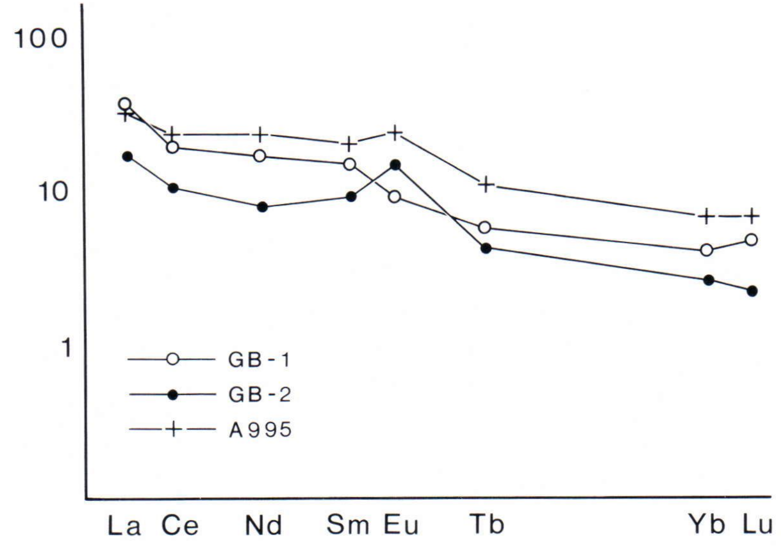

Fig. 2. Chondrite-normalized REE patterns of the Hyvinkää gabbro and plagioclase porphyrite.

Table 1. Locations of samples studied by isotope-geological methods.

No	Location	Map sheet	Grid coordinates*
A584	Usmi, Hyvinkää	2044 02	x = 6726060 y = 543370
A585	Hirvijärvi, Riihimäki	2042 11	x = 6729480 y = 533770
A995	Shooting range, Hyvinkää	2044 02	x = 6729240 y = 549530

*The grid coordinates refer to the Finnish national net.

Table 2. Chemical analyses of the plagioclase porphyrite, A995, and the reference gabbro samples from the Hyvinkää area. Analysts: Risto Saikkonen (GB1, classical method: Zr and Ba with XRF) and Väinö Hoffrén (XRF analyses).

Sample	SiO_2	Al_2O_3	Fe_2O_3t	MgO	CaO	Na_2O	K_2O	MnO	TiO_2	P_2O_5	Rb	Sr	Zr	Ba
A995	47.90	18.33	11.55	4.81	10.53	2.53	.57	.17	1.42	.27	.0	.044	.007	.03
GB-1	51.49	17.61	8.28	7.23	10.69	2.59	.65	.14	.76	.14	.002	.061	.004	.04
GB-2	51.02	16.90	8.25	7.92	11.80	2.30	.05	.14	.54	.09	.0	.045	.005	.03

A995 plagioclase porphyrite
GB-1 Hyvinkää gabbro reference sample (RS1) of the chemical laboratories of the Geological Survey of Finland
GB-2 Hyvinkää gabbro reference sample (VRTGBII) of the chemical laboratories of the Geological Survey of Finland.

ent gabbro types from the Hyvinkää pluton reported by Mäkinen (1987). The neutron activation analyses on the RE elements are given in Table 3. The distribution patterns plotted in Fig. 2 suggest a close relationship between the hornblende gabbro and the plagioclase porphyrite.

Table 3. REE analyses (in ppm) of the plagioclase porphyrite studied with reference to gabbro samples from the Hyvinkää area.

Sample	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu
A995	11.1	22	15.8	4.4	1.98	.54	1.47	.23
GB-1	11.9	17.5	10.9	3.2	.75	.32	.92	.17
GB-2	6.3	10.2	5.1	2	1.14	.24	.61	.08

Sampling for mass analytical work

The sampling sites for age determinations are marked on the simplified geological map of the Hyvinkää area in Fig. 1 (for coordinates see Table 1).

The gabbro pegmatoid (A585) was sampled from a road cut near the shore of the lake Hirvijärvi, close to the northern contact of the Hyvinkää gabbro pluton. The rock is very rich in plagioclase and is pegmatoidic in grain size. In the ca. 7 m long and 1.5 m thick body in the road cut the plagioclase is unevenly accumulated to irregular cumulate patches. The surrounding rock is a normal coarse-grained hornblende gabbro.

The normal hornblende gabbro of Hyvinkää from the type locality of Usmi (A584) did not yield enough zircon for U-Pb dating, but Sm-Nd isotopic data on this sample are given by Patchett and Kouvo (1986, Table 3).

Andesitic, partly amygdaloidal, lava flows, are common in the Hyvinkää area, the best examples being visible in the railway cuttings just north of the station. Some agglomeratic flows are also met.

East of Hyvinkää, a well-preserved medium, in places up to coarse grained plagioclase porphyrite (A995), crops out NNE of the town at the shooting range (ampumarata). This plagioclase porphyrite has abundant zircon. The zircon crystals are short, rich in crystal faces and have plenty of impurities, most of them on the surface.

Mass analytical results

U-Pb isotope data on six zircon fractions from the gabbro pegmatoid (A585) are given by Patchett and Kouvo (1986, Table 1) and on the four analysed zircon fractions from the plagioclase porphyrite (A995) in Table 4 in the present study.

The isotope ratios plotted on the concordia diagram in Fig. 3 yield an upper intercept age of 1880 ± 5 and a lower intercept age of 125 ± 160 Ma for the gabbro pegmatoid (A585) and an upper intercept age of 1880 ± 3 and a lower intercept age of 177 ± 141 Ma for the plagioclase porphyrite (A995). The lower intercept age of the ten fractions together is 120 ± 103 Ma.

The $^{206}Pb/^{204}Pb$ ratio in the HF preleached fractions is high, showing that the common lead has been removed. The high $^{208}Pb/^{206}Pb$ ratio indicates that the gabbro has a notably higher Th/U ratio than the plagioclase porphyrite (see Table 4 and Table 1 in Patchett and Kouvo 1986).

Table 4. U-Pb isotopic data on A995-Hyvinkää; plagioclase porphyrite.

Sample no.	Fraction d = g/cm³ HF = HF-leached	Concentration µg/g		$^{206}Pb/^{204}Pb$ measured	Isotopic composition of lead ^{206}Pb = 100			Atom ratios and radiometric ages, Ma		
		^{238}U	^{206}Pb radiog.		204	207	208	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
A995A	d>4.6	183.4	52.02	1433	.06771	12.400	8.752	.3279	5.192	.11485
								± 17	± 31	± 25
								1828	1851	1877
B	d>4.6; HF	164.3	48.24	5197	.01711	11.725	6.950	.3393	5.377	.11493
								± 17	± 29	± 10
								1883	1881	1879
C	4.2<D<4.6	313.3	84.15	3555	.02676	11.836	7.260	.3105	4.912	.11474
								± 16	± 26	± 6
								1743	1804	1875
D	4.2<d<4.6; HF	296.5	84.83	14489	.005152	11.584	6.431	.3307	5.249	.11514
								± 17	± 28	± 7
								1841	1860	1882

Decay constants: Jaffey et al. (1971).

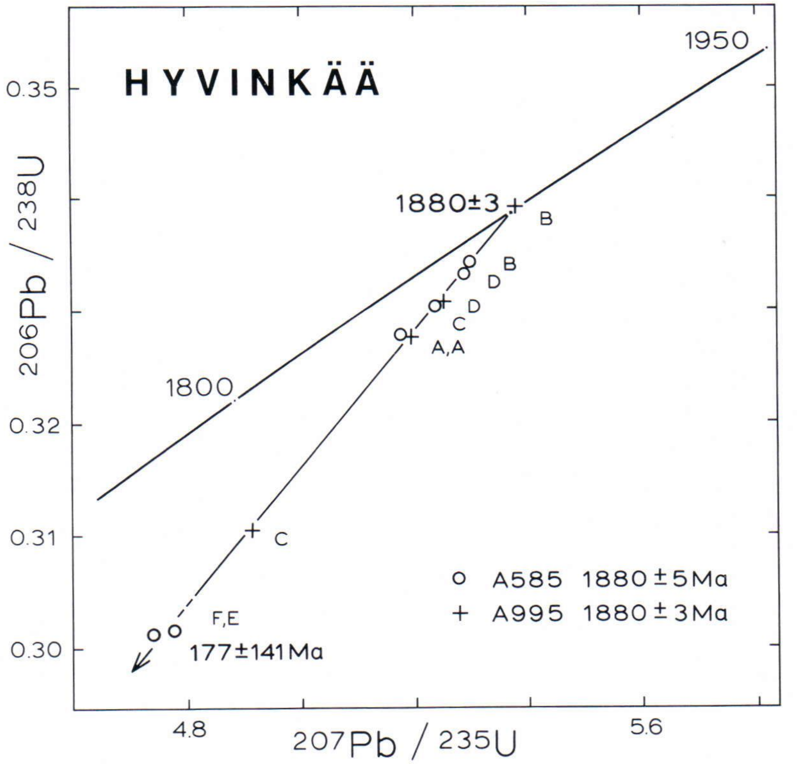

Fig. 3. Concordia plot of zircon fractions from the gabbro pegmatoid A585, Hirvijärvi (data from Patchett & Kouvo 1986) and plagioclase porphyrite A995, Hyvinkää shooting range. Errors are quoted at 2 sigma level.

Conclusions

The data points of the zircon fractions from the Hyvinkää gabbro and the plagioclase porphyrite show a linear distribution suggesting cogenetic suites (see Fig. 3). There are no signs of older material among the zircons of the plagioclase porphyrite.

The ages are the same within the limits of error and are consistent with a cogenetic origin for the Hyvinkää gabbro and the plagioclase porphyrite, as are the similarities in composition and spatial occurrence. Few though they may be, the trace element and REE compositions and the distribution patterns support the concept of cogenetic, synkinematic Svecokarelian origin.

The age of the gabbro and plagioclase porphyrite, 1880 Ma, is a typical syntectonic intrusion age of Svecokarelian rocks in southern Finland. The ϵ_{Nd} for the Hyvinkää hornblende gabbro (A584) is + 2.6, indicating a crustal and mixed mantle derived magma source with a slight crustal addition (Patchett & Kouvo 1986).

The lower intercept ages are somewhat too low for Svecokarelian rocks in southern Finland. They do not show any signs of a later metamorphic event; neither do they show a recent lead loss.

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