SCIENTIFIC COMMUNICATION

THE RADIOMETRIC AGE OF THE REPOSAARI GRANITE AND ITS BEARING ON THE EXTENT OF THE LAITILA RAPAKIVI BATHOLITH IN WESTERN FINLAND

MATTI VAASJOKI, PEKKA PIHLAJA and MATTI SAKKO

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Matti Vaasjoki; Pekka Pihlaja and Matti Sakko: Geological Survey of Finland, SF-02150 Espoo, Finland.

Introduction

The Reposaari granite crops out in a small area in the northwestern corner of the Satakunta graben (Fig. 1). It is crosscut by Jotnian dolerites, but the relationship to the surrounding Svecofennian formations is obscure, as the contact is under the sea (Fig. 2). The rock is a reddish, coarse-grained potassium granite and resembles in texture the porphyritic granite at Kokemäki. The major constituents of the Reposaari granite are potassium feldspar, quartz and chlorite, with fluorite, zircon, apatite, amphibole and opaque minerals as accessories. Chemically the rock is similar to the biotite rapakivis of the Laitila batholith (Vorma 1976), which contain more SiO_2 and less CaO and Na_2O than the main type of the Laitila rock suite.

The area of Jotnian supergroup in Satakunta (cf. Hämäläinen 1987) forms a distinct minimum on the Bouguer anomaly map of the Geodetic Institute (1979). According to a gravimetric survey by Elo (1976) the maximum thickness of the sandstone-siltstone sequence filling the graben on a profile southwest of Pori is about 1.8 km. The lowest gravimetric Bouguer anomalies, about -55 mgal, occur at Reposaari on the northeastern fringe of the graben. These cannot be attributed to the sandstone alone, as its thickness should be 4—5 km. Moreover, in the fringe area of the graben there are inliers of Svecofennian rocks, dolerite dykes and outcrops of the Reposaari granite. It has been suggested that close to the surface of this area there is a large granite intrusion, possibly belonging to the rapakivi group.

To solve the problem of the age of the Reposaari granite, U-Pb analyses on zircon were carried out at the Unit for Isotope Geology of the Geological Survey of Finland. The results indicate that this rock belongs without any doubt to the rapakivi suite of western Finland.

Sample material and analytical methods

The sample for zircon dating was taken from Reposaari (map sheet 1142 07; X = 6834.69; Y = 522.34), from a site at Siikaranta on Riita-

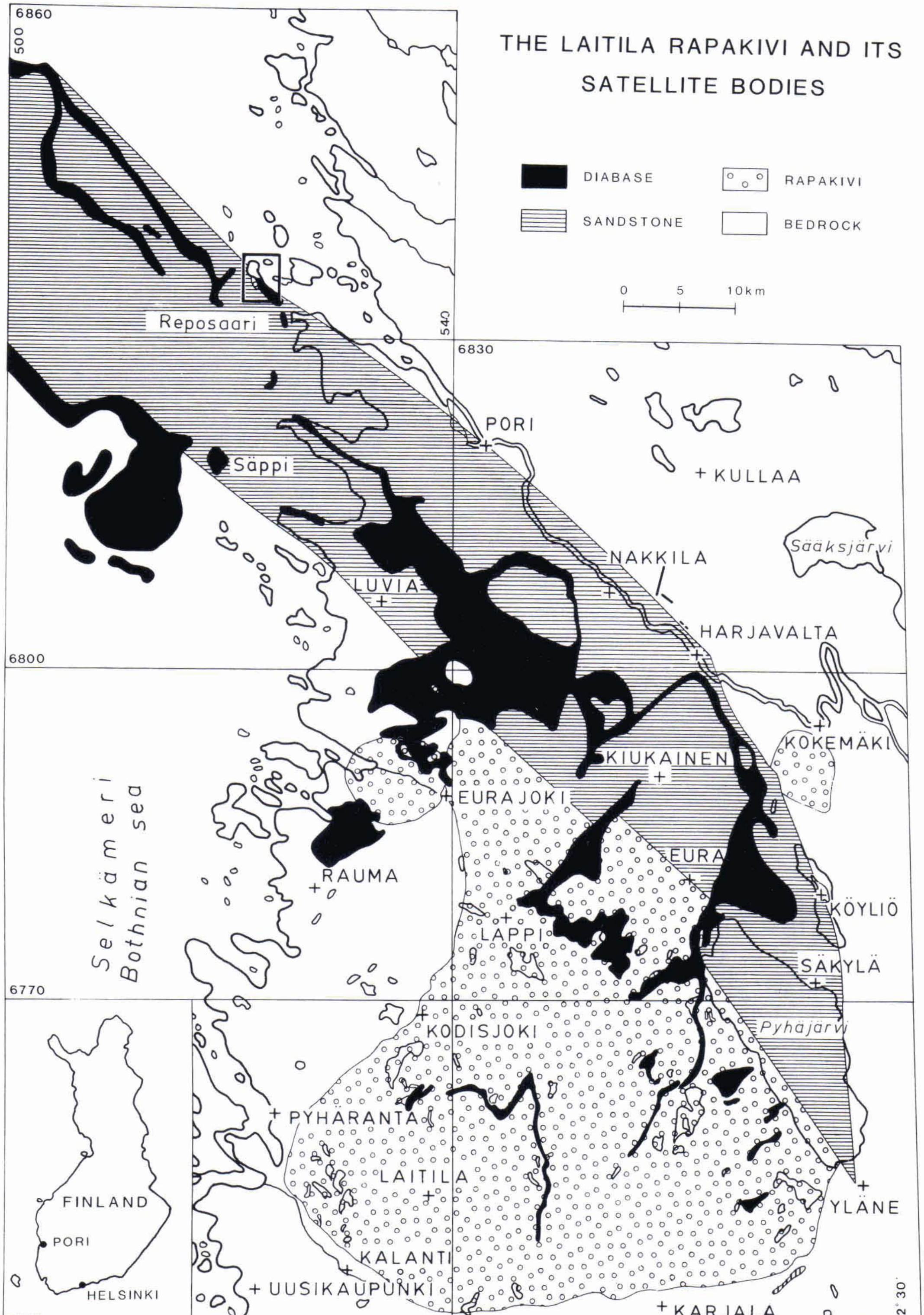

Fig. 1. The location of Reposaari in relation to the Satakunta graben and the Laitila rapakivi batholith.

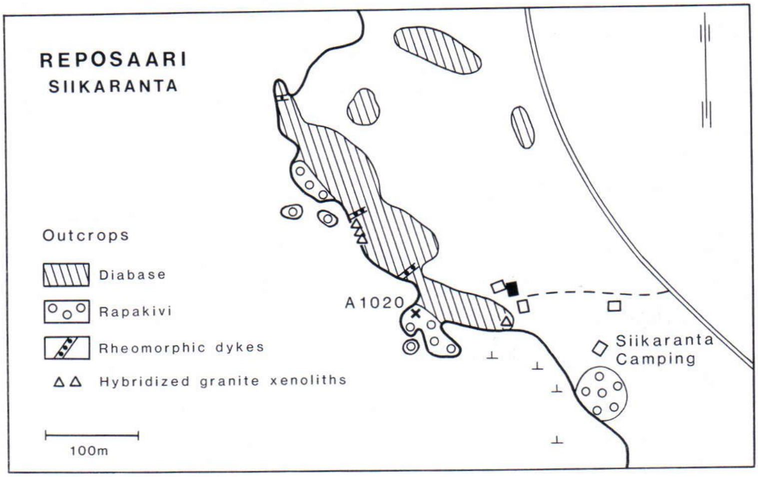

Fig. 2. A detailed map of the outcropping portion of the Reposaari granite. The site of A1020 is marked x.

kallio (quite appropriately, »quarrel rock» in English).

The rock contains a largish amount of almost euhedral, relatively coarse-grained (75 % > 100 µm) zircon, with tetragonal prisms terminating in simple pyramid faces. The length/breadth ratio varies from 2 to 5 with a median of 3. All the zircons are metamictized as there was no heavy ($d > 4.6$ g/cm^3) fraction, and the next lighter density fraction ($4.6 > d > 4.3$) was too small to be analysed. Two colour variants, pale brown and reddish, occur in a 2:1 ratio in all fractions.

Seven non-magnetic zircon fractions were analysed. Two density fractions, 4.3—4.2 and 4.2—4.0, were screened with 150 and 75 µm sieves, and the resulting aliquots were handpicked to separate the two colour variants. Some pale brown zircons of the heavier fraction were air abraded (Krogh 1982) in an attempt to produce more concordant data.

The zircons were combusted with the usual hydrothermal method and their uranium and lead were extracted by anion exchange chromatography in HCl solutions (Krogh 1973). The isotopic determinations were made on instruments constructed at the Geological Survey of Finland (cf. Vaasjoki 1981). The reported U/Pb ratios are accurate to within ±0.8 %. The regression analyses were done using the procedure of York (1969), and the uncertainties are guoted on a 2σ confidence level. The decay constants used were those recommended by the IUGS subcommission for geochronology (Steiger and Jäger 1977). The average galena lead isotopic composition from the greisen mineralization in the Eurajoki stock (Vaasjoki 1977) was used for the common lead correction.

Results

The results are summarized in Tables 1 and 2 and in Fig. 3. These show that the zircons conform to the usual pattern, i.e. their degree of discordancy increases as the uranium content increases and the abraded fraction is the least discordant. There is a clear difference between the red and the pale brown zircons from the same density and sieve fractions, as the red ones are always more discordant than the pale brown ones. Also, the common lead contents of the red zircons, manifested as lower $^{206}Pb/^{204}Pb$ ratios, is higher. Although the difference in colour could arise from weathering effects, the different common lead contents may suggest that the two zircon variants crystallized in slightly different en-

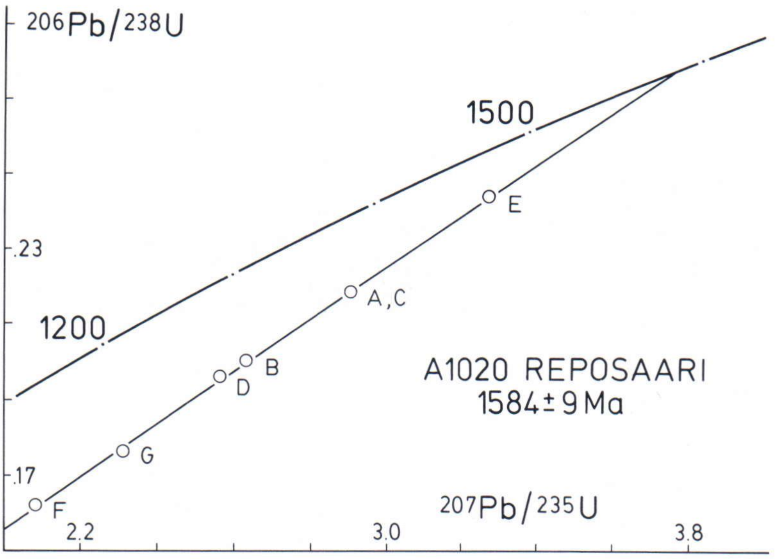

Fig. 3. The analytical results of the U-Pb determinations on zircons of the Reposaari granite on a concordia diagram.

Table 1. U-Pp analyses of zircons from the Reposaari granite.

Sample	Fraction density/size (μm)	Concentrations		$^{206}Pb/^{204}Pb$	Lead ratios, 206 = 100		
		^{238}U	Pb(tot)		^{204}Pb	^{207}Pb	^{208}Pb
A1020A	4.2—4.3/+150/b	737.4	174.1	3207	0.0312	10.08	13.91
A1020B	4.2—4.3/+150/r	795.1	174.7	1840	0.0544	10.28	14.99
A1020C	4.2—4.3/150—300/b	786.0	188.1	2720	0.0368	10.16	15.37
A1020D	4.2—4.3/150—300/r	864.2	192.2	1038	0.0964	10.81	17.76
A1020E	4.2—4.3/b/abraded	708.7	188.1	5110	0.0195	9.97	14.73
A1020F	4.0—4.2/+150/r	1075.8	191.4	1620	0.0617	10.19	15.24
A1020G	4.0—4.2/+150/b	1013.2	193.3	2807	0.0356	10.00	14.05

Concentrations in μg/g. Corrected for blank. b = pale brown; r = red.

Table 2. U/Pb ratios and apparent radiometric ages for zircons from the Reposaari granite.

Sample	Atomic ratios			Apparent ages (Ma)		
	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	T(6/8)	T(7/5)	T(7/6)
A1020A	0.2186	2.9078	0.0965	1274	1383	1557
A1020B	0.2005	2.6331	0.0953	1177	1309	1533
A1020C	0.2187	2.9102	0.0965	1274	1384	1558
A1020D	0.1963	2.5622	0.0947	1155	1289	1521
A1020E	0.2448	3.2730	0.0970	1411	1474	1566
A1020F	0.1620	2.0841	0.0933	967	1143	1494
A1020G	0.1764	2.3120	0.0950	1047	1215	1529

Atomic ratios corrected for common lead.
6/4: 16.07; 7/4: 15.42; 8/4: 35.79

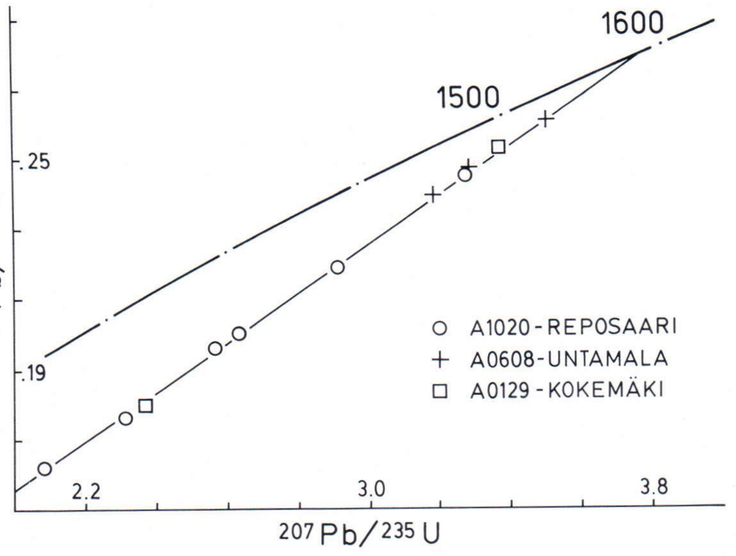

Fig. 4. A comparison of the U-Pb zircon data on the Reposaari granite with those of the main type of the Laitila rapakivi batholith (A608) and the Kokemäki granite (A129).

vironments. On the other hand, all seven analyses plot, within experimental error, on the same regression line (Fig. 3) in spite of the large variations in the degree of discordancy. Thus it can be assumed that there is no significant age difference between the colour variants, and all analyses can be used for the age calculations.

The upper intersect of the calculated regression line with the concordia curve gives an age estimate of 1584 ± 9 Ma, while the lower intersect yields 201 ± 29 Ma. The upper intersect age can be regarded as the maximum estimate for the beginning of the crystallization of the Reposaari granite magma. The lower intersect age is commonly found in Finnish zircons and cannot be connected with any known geological processes.

Discussion

The age of the Reposaari granite is, within experimental error, the same as that obtained for the main phases of the Laitila rapakivi batholith (1573 ± 9 Ma, Vaasjoki 1977). In Fig. 4 the results from the Reposaari granite are compared with those from sample A608-Untamala, which represents the main type of the Laitila rock suite. It is evident that all fractions from both samples plot on the same discordia line. Thus there is no doubt that the Reposaari granite belongs to the postorogenic group of the rapakivi granites and is coeval with the Laitila batholith.

Likewise coeval with the Laitila batholith is the postorogenic porphyritic Kokemäki granite (Fig. 1). Figure 4 demonstrates that the analyses from sample A129-Kokemäki (Vaasjoki 1977) plot on the same regression line as A1020 and A608. Thus at least two smallish rapakivi occurrences have been established northeast of the Satakunta graben while a major rapakivi batholith lies south-west of it.

As was pointed out in the introduction, the arkosic sandstone in the Satakunta graben cannot alone account for the negative gravity anomaly observed in the area. Geophysical modelling (Laurén 1970; Elo 1976 and 1982) suggests that the sandstone may be underlain by several kilometres of granitic material. The present results from the Reposaari granite clearly support the previous concept that this granitic material belongs to the rapakivi suite, and thus the real extent of the Laitila batholith may be twice its present outcropping area (Fig. 1). If this is the case, the formation of the Satakunta graben was a post-rapakivi event (cf. Vaasjoki 1977). Further discoveries of rapakivi granites northeast of the Satakunta graben would of course make this interpretation even more plausible than it is now.

Conclusion

U-Pb analyses on seven zircon fractions from the Reposaari granite form a linear array which yields an upper intersect age of 1584 ± 9 Ma on the concordia diagram. This coincides, within experimental error, with the ages of the Laitila rapakivi batholith and the Kokemäki granite. These radiometric ages are consistent with an interpretation of gravimetric data suggesting that the sandstone filling the Satakunta graben is underlain by postorogenic rocks of the rapakivi group.

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