Europlanet TNA Report – 079-TNA3 (Smet)

PROJECT LEADER

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Date of TNA visit:	From 11 November 2012 to 4 December 2012				
No. of access days:	17				
No. of days stay:	25				
Host laboratory:	Vrije Universiteit Amsterdam, VUA, Isotope Geochemistry Facility (C8)				
Reimbursed	Yes/ No				

Geochemical investigation into the volcanic rocks from the westernmost part of the South Aegean arc: whole rock ¹⁷⁶Hf/¹⁷⁷Hf analyses

Scientific Report Summary.

(plain text, no figures, maximum 250 words, to be included in database)

Geochemical and petrological research into the volcanic rocks from the westernmost part of the South Aegean arc indicates that the identity of sources and processes involved in magma genesis are obscured by later-stage intensive magma mingling and - mixing. Only whole rock Pb isotopic data and the Hf isotopic compositions of zircons derived from these volcanic deposits indicate a more systematic variability amongst the magma sources for the 3 volcanic centres. Whole rock ¹⁷⁶Hf/¹⁷⁷Hf analyses of host rocks and enclaves would allow further investigation of this variability and be a valuable extra parameter to constrain the characteristics of different sources involved in the magma genesis of arc lavas in this part of the Aegean arc.

The magnitude of dissolution-related Hf blanks was investigated at Ghent University prior to the visit to the VUA Isotope Geochemistry Facility. Since blanks were less than 0.05 ng and thereby negligible compared to the typical sample size of 100-1000 ng, 38 zircon-bearing samples were digested at higher pressure in Parr bombs, and 45 zircon-free samples at atmospheric pressure with HF/HNO₃/HCI.

These samples were then brought to Amsterdam where the Hf isolation was successfully carried out for all 83 samples. However, due to malfunctioning of the MC-ICP-MS these Hf fractions could not yet be analysed.

Measurement of the ¹⁷⁶Hf/¹⁷⁷Hf is therefore postponed to the first half of 2013, and, based on the Hf concentration data from these fractions they are expected to shed light on the identity of potentially different sources and processes involved in the magma genesis of these volcanites.

Full Scientific Report on the outcome of your TNA visit

Approx. 1 page

Introduction & aims

Whole rock (WR) major and trace element data of the three volcanic centres Aegina, Methana and Poros, located in the westernmost part of the South Aegean active volcanic arc, indicate that geochemical trends are dominated by magma mixing, obscuring the influence of other processes (e.g., fractional crystallization, assimilation,...) involved in magma genesis. Whole rock Sr and Nd isotopic data also show scattered trends which overlap for all three volcanic centres. This points towards a complex combination of different sources responsible for magma genesis but also reveals significant crustal contamination. However, whole rock Pb isotopic data seem to be de-coupled from the Sr-Nd isotopic system and suggest distinct trends for the different volcanic centres and phases. Laser-ablation Hf isotopic analyses on magmatic zircons collected from 11 volcanites also seem to indicate a certain isotopic distinction between the three volcanic islands.

Higher-precision whole rock ¹⁷⁶Hf/¹⁷⁷Hf analyses of host rocks and enclaves from these 3 volcanic centres would allow further investigation of this variability and be a valuable extra parameter to constrain the characteristics of different sources involved in the magma genesis of arc lavas in this part of the Aegean arc. Since these geochemical analyses are not set up at Ghent University, the 079-TNA3 project provided for Hf isolation and subsequent ¹⁷⁶Hf/¹⁷⁷Hf isotopic measurements at VUA Isotope Geochemistry Facility, Amsterdam.

Results

Sr. Nd and Pb isotopic ratios for the volcanites sampled from Aegina. Methana and Poros, were used to select the samples that would be prepared for Hf isolation at the VU. Prior to this, a full set of blanks was collected and analysed from both the high pressure (HP: Parr bombs, 180°C, for zircon bearing samples) and low pressure (LP: HF/HNO₃/HCl, 110°C, for zircon-free samples) digestion procedure to estimate their potential contribution to the Hf concentrations. This showed however that only negligible amounts of Hf would be derived from acids and containers (less than 0.05 ng, whereas at least 100 ng Hf was expected to be present in the samples) - so that by July 2012 the HP digestion of 38 (samples + rock standards + full procedure blanks + duplicate sample) was initiated at Ghent University. The number of samples digested under high pressure conditions was hereby limited to the number of Parr bombs (4) present at Ghent Univeristy. 45 more (samples + rock standards + full procedure blanks + duplicate sample) were digested by standard low pressure acid dissolution at the end of October. Once all 83 samples were dissolved and dried down, they were redissolved in 2mL 6N HCl, and again dried down to facilitate redissolving them at the VU in 3N HCl prior to Hf isolation.

A selection of 50-60 samples was made prior to arriving at the VU because the time seemed limited for the isolation of 80+ samples. Nevertheless Hf isolation for all 83 samples was carried out between Monday the 12th and Thursday the 29th of November, The 83 Hf fractions were subsequently redissolved in 1mL, of which 50µL was used to determine the exact Hf concentration in each of the Hf fractions by quadrupole ICP-MS. These analyses were finalised by Tuesday the 4th of December, and showed that for all samples enough Hf was recovered (at least 100ng) to allow for isotopic measurement on the MC-ICP-MS.

Problems

Due to a technical defect in the MC-ICP-MS's interface, it was not possible to obtain the right vacuum conditions necessary for analyses. Since this problem could not be solved within the time scheduled for my work at the VUA, I returned to Ghent 4 days earlier than initially planned (on Tuesday the 4th of December instead of Saturday the 7th).

Future work

Since all 83 samples were successfully prepared for Hf isotopic measurement, they are now stored at the VUA where they will be analysed on the MC-ICP-MS at a later date (probably late winter/early spring 2013). I will therefore have to return to Amsterdam once more for about 5 working days (allowing for technical difficulties during set-up and tuning of the MC-ICP-MS instrument for ¹⁷⁶Hf/¹⁷⁷Hf analyses).

Expected results

Amongst the 83 Hf fractions are both LP and HP digestions for the 11 samples of which LA-MC-ICPMS zircon Hf isotopic data were already obtained. Comparison of the Hf concentrations between these two digestion types shows important systematic differences (see Table 1) – reflecting the non-dissolution of zircon during the LP procedure. Isotopic fingerprinting of these LP and HP Hf fractions, together with the zircons' Hf isotopic signature, will show whether one or more magma sources gave rise to these volcanites and their enclaves.

Comparison of the WR Hf isotopic data for the three volcanic centres will furthermore allow better understanding of the origin and development of sources involved in the different volcanic phases in the westernmost part of the South Aegean arc.

Planned publications

These WR Hf isotopic data represent the final analyses for my PhD research into the geochemistry and petrology of the westernmost part of the South Aegean active volcanic arc. They will therefore definitely be published in one of the (later) papers presenting, discussing and interpreting the large geochemical data set collected over the last years from Methana, Aegina and Poros.

Host approval

Prof. Gareth Davies communicated via e-mail his approval of this report:

'The report is excellent and I give approval to send it on to Beverley at the OU.'

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Bit-hbl-dac Palaiochora LP IA61 172,0 Bit-hbl-dac Megali Korifi HP IA59 248,6 333,5 Bit-hbl-dac Megali Korifi LP IA59 135,3 Bit-hbl-dac Megali Korifi LP IA59 135,3 Brodew bit-hbl-dac Kokinovrahos HP IA56 249,5 Bit-hbl-dac Kokinovrahos LP IA56 130,1 Bit-hbl-dac Kokinovrahos LP IA56 130,1 Bit-hbl-dac Kokinovrahos LP IA56 130,1 Kokk. HP IA338 304,7 Enclave bt-hbl-dac Kokk. HP IA338 Enclave bt-hbl-dac Kokk. HP IA338 (2) Enclave bt-hbl-dac Kokk. HP IA338 (2) Enclave bt-hbl-dac Kokk. HP IA338 (2) Bt-hbl-dac Koutalou IA327 244,7 Enclave bt-hbl-dac Kouti IA321 Kakoperato rhyodac LP IA97 8,2 Enclave bt-hbl-dac Koutalou IA321 273,1 Kakoperato rhyodac LP IA97 8,2 Enclave bt-hbl-dac Koutalou IA73 192,5 </td <td></td> <td></td> <td>0.44.0</td> <td>190,6</td> <td></td> <td></td> <td>300,5</td> <td>457.0</td>			0.44.0	190,6			300,5	457.0
Bt-hbl-dac Megali Korifi HP IA59 248,6 Bt-hbl-dac Megali Korifi LP IA59 135,3 Enclave bt-hbl-dac M. K. IA66 147,5 Bt-hbl-dac Kokinovrahos HP IA56 249,5 Bt-hbl-dac Kokinovrahos LP IA56 130,1 Bt-hbl-dac Kokinovrahos LP IA56 130,1 Bt-hbl-dac Kokinovrahos LP IA38 304,7 Kokk. HP IA338 (2) 155,7 Enclave bt-hbl-dac Kokk. IM315 200,8 Kokk. IA348 183,1 Bt-hbl-dac Tourli IA65 187,6 Kokk. IA348 183,1 Bt-hbl-dac Koutalou IA327 244,7 Enclave bt-hbl-dac IA321 273,1 Kakoperato rhyodac LP IA97 8,2 Bt-hbl-dac Koutalou IA327 244,7 Enclave Kakoperato IA98 209,7 Kakoperato rhyodac LP IA97 8,2 Cros andesiet IA80 221,0 Enclave Kakoperato IA98 209,7			341,0	(70.0				
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Enclave bt-hbl-dac M. K. IA66 147,5 Enclave bt-hbl-dac Kokinovrahos HP IA56 249,5 Bt-hbl-dac Kokinovrahos LP IA56 130,1 a3 IM319 190,1 Bt-hbl-dac Kokinovrahos LP IA36 184,0 a3 IM319 253,8 Bt-hbl-dac Kokinovrahos IA346 184,0 a3 IM319 200,6 Enclave bt-hbl-dac Kokinovrahos HP IA338 304,7 a6 IM315 200,8 Enclave bt-hbl-dac Kokk. LP IA338 120,8 a6 IM315 200,8 Enclave bt-hbl-dac Kokk. HP IA338 (2) 155,7 a6 IM316 217,4 Enclave bt-hbl-dac Tourli IA65 187,6 a8 IM303 253,3 Bt-hbl-dac Koutalou IA327 244,7 xenolith in qök2 IM386 36,9 Enclave bt-hbl-dac Kout IA321 273,1 βa8 Mavri Petra IM36 253,5 Kakoperato rhyodac LP IA97 8,2 a68 enclave IM36 183,0 Gas Mavri Petra IM29			248,0	405.0			247,9	400.7
Bt-hbl-dac Kokinovrahos HP IA56 249,5 a3 IM319 190,1 Bt-hbl-dac Kokinovrahos LP IA56 130,1 a3 - Enclave IM318 253,8 Bt-hbl-dac Kokinovrahos IA346 184,0 a3 - Enclave IM318 253,8 Bt-hbl-dac Kokinovrahos IA346 184,0 a6 IM295 200,6 Kokk. HP IA338 304,7 a6 IM294 195,4 Enclave bt-hbl-dac Kokk. LP IA338 120,8 a6 IM315 200,8 Kokk. HP IA338 (2) 155,7 a6 IM303 253,3 a6 Enclave IM303 253,3 Bt-hbl-dac Tourli IA65 187,6 a8 IM301 160,4 Enclave bt-hbl-dac Kout IA321 273,1 Kakoperato rhyodac IM36 253,5 Kakoperato rhyodac LP IA97 8,2 a8 a8 wari Petra IM36 253,5 Enclave Kakoperato IA98 209,7 8,2 a8 wari Petra IM329 164,			4 47 5	135,3				
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Enclave bt-hbl-dac Kokk. HP IA338 304,7 Enclave bt-hbl-dac Kokk. LP IA338 120,8 Enclave bt-hbl-dac Kokk. HP IA338 (2) 155,7 Kokk. HP IA338 (2) 155,7 Enclave bt-hbl-dac Kokk. HP IA338 (2) 155,7 Enclave bt-hbl-dac Kokk. IA348 183,1 Enclave bt-hbl-dac Kokk. IA348 183,1 Bt-bl-dac Tourli IA104 148,8 Enclave bt-hbl-dac Tourli IA104 148,8 Bt-hbl-dac Koutalou IA327 244,7 Enclave bt-hbl-dac Kout. IA321 273,1 Kakoperato rhyodac HP IA97 8,2 Enclave bas-and Oros IA73 192,5 Oros andesiet IA80 200,4 Hy-andesiet Oros IA75 213,3			494.0	130,1				
Kokk. HP IA338 304,7 δ6 - Enclave IM294 195,4 Enclave bt-hbl-dac Kokk. LP IA338 120,8 a6 IM315 200,8 Enclave bt-hbl-dac Kokk. HP IA338 (2) 155,7 a6 - Enclave IM316 217,4 Enclave bt-hbl-dac Kokk. IA348 183,1 a8 - IM303 253,3 Bt-hbl-dac Tourli IA65 187,6 a8 - Enclave IM301 160,4 Enclave bt-hbl-dac Tourli IA104 148,8 xenolith in qök2 IM366 36,9 Bt-hbl-dac Koutalou IA327 244,7 zenolith in mqkβa8 IM394 59,0 Enclave bt-hbl-dac Kout. IA321 273,1 βa8 Mavri Petra IM36 183,0 Kakoperato rhyodac LP IA97 8,2 ima8 - enclave IM30 263,5 Ga Mavri Petra IM29 306,1 a58 - enclave iM400 224,9 Oros bas-and (young) IA83 221,0 ima8 - enclave IM400 224,9 Oros andesiet IA80<		IA340	164,0		06	111/295		200,6
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Kokk. HP IA338 (2) 155,7 α6 - Enclave IM316 217,4 Enclave bt-hbl-dac IA348 183,1 α8 - IM303 253,3 Bt-hbl-dac Tourli IA65 187,6 α8 - IM303 253,3 Bt-hbl-dac Tourli IA104 148,8 α8 - IM301 160,4 Enclave bt-hbl-dac	Kokk.	LP IA338		120,8	α6	IM315		200,8
Kokk. IA348 183,1 α8 - IM303 253,3 Bt-hbl-dac Tourli IA65 187,6 α8 - IM301 160,4 Enclave bt-hbl-dac Tourli IA104 148,8 α8 - IM303 253,3 Bt-hbl-dac Koutalou IA327 244,7 xenolith in qõk2 IM386 36,9 Enclave bt-hbl-dac Kout. IA321 273,1 βα8 Mavri Petra IM36 253,5 Kakoperato rhyodac LP IA97 280,3 βα8 Mavri Petra IM36 183,0 Kakoperato rhyodac LP IA97 8,2 βα8 Mavri Petra IM29 306,1 Enclave Kakoperato IA98 209,7 αδ8 Avri Petra IM29 306,1 Mbl-And Nikolaki IA73 192,5 αδ8 Avri Petra IM400 224,9 Oros bas-and (young) IA83 221,0 'Andesite' IP46 207,8 'Dacite' HP IP49 251,2 'Dacite' 'Dacite' LP IP49 123,9	Kokk.	HP IA338 (2)	155,7		α6 - Enclave	IM316		217,4
Bt-hbl-dac Tourli IA65 187,6 α8 - Enclave IM301 160,4 Enclave bt-hbl-dac Tourli IA104 148,8 xenolith in qōk2 IM386 36,9 Bt-hbl-dac Koutalou IA327 244,7 xenolith in qōk2 IM386 36,9 Enclave bt-hbl-dac Kout. IA321 273,1 βα8 Mavri Petra IM36 253,5 Kakoperato rhyodac LP IA97 280,3 βα8 Mavri Petra IM29 306,1 Enclave Kakoperato IA98 209,7 aδ8 Mavri Petra IM29 306,1 Gors bas-and (young) IA83 221,0 aδ8 - enclave IM400 224,9 Oros andesiet IA80 200,4 'Andesite' IP46 207,8 'Dacite' HP IP49 251,2 'Dacite' IP49 123,9								
Enclave bt-hbl-dac TourliIA104148,8xenolith in q\deltak2IM38636,9Bt-hbl-dac KoutalouIA327244,7xenolith in $\pi q k \beta a 8$ IM39459,0Enclave bt-hbl-dac Kout.IA321273,1 $\beta a 8$ Mavri PetraIM36253,5Kakoperato rhyodacHP IA97280,3 $\beta a 8$ Mavri PetraIM36183,0Kakoperato rhyodacLP IA978,2 $\alpha \delta 8$ Mavri PetraIM29306,1Enclave KakoperatoIA98209,7 $\alpha \delta 8$ Mavri PetraIM29164,4Hbl-And NikolakiIA73192,5 $\alpha \delta 8$ - enclaveIM400224,9Oros bas-and (young)IA83221,0'Andesite'IP46207,8Enclave bas-and OrosIA72232,5'Andesite'IP46207,8Oros andesietIA80200,4'Dacite'HP IP49251,2Hy-andesiet OrosIA75213,3'Dacite'LP IP49123,9				183,1				
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Bt-hbl-dac Koutalou IA327 244,7 xenolith in πqkβα8 IM394 59,0 Enclave bt-hbl-dac Kout. IA321 273,1 βα8 Mavri Petra IM36 253,5 Kakoperato rhyodac HP IA97 280,3 βα8 Mavri Petra IM36 183,0 Kakoperato rhyodac LP IA97 8,2 αδ8 Mavri Petra IM29 306,1 Enclave Kakoperato IA98 209,7 αδ8 Mavri Petra IM29 164,4 Hbl-And Nikolaki IA73 192,5 αδ8 - enclave IM400 224,9 Oros bas-and (young) IA83 221,0 'Andesite' IP46 207,8 Oros andesiet IA80 200,4 'Dacite' HP IP49 251,2 'Dacite' LP IP49 123,9		14 10 4	140 0		vanalith in a <u>āk</u> 2	IM296	26.0	
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Kakoperato rhyodac HP IA97 280,3 βα8 Mavri Petra IM36 183,0 Kakoperato rhyodac LP IA97 8,2 αδ8 Mavri Petra IM29 306,1 Enclave Kakoperato IA98 209,7 αδ8 Mavri Petra IM29 164,4 Hbl-And Nikolaki IA73 192,5 αδ8 - enclave IM400 224,9 Oros bas-and (young) IA83 221,0 POROS			244,7	272.4				_
Kakoperato rhyodac LP IA97 8,2 αδ8 Mavri Petra IM29 306,1 Enclave Kakoperato IA98 209,7 αδ8 Mavri Petra IM29 164,4 Hbl-And Nikolaki IA73 192,5 αδ8 - enclave IM400 224,9 Oros bas-and (young) IA83 221,0 POROS			280.3	273,1			233,5	192.0
Enclave Kakoperato IA98 209,7 αδ8 Mavri Petra IM29 164,4 Hbl-And Nikolaki IA73 192,5 αδ8 - enclave IM400 224,9 Oros bas-and (young) IA83 221,0 POROS			200,5	8.2			206.1	105,0
Hbl-And Nikolaki IA73 192,5 αδ8 - enclave IM400 224,9 Oros bas-and (young) IA83 221,0 POROS							500,1	164.4
Oros bas-and (young) IA83 221,0 Enclave bas-and Oros IA72 232,5 Oros andesiet IA80 200,4 Hy-andesiet Oros IA75 213,3								
Enclave bas-and Oros IA72 232,5 'Andesite' IP46 207,8 Oros andesiet IA80 200,4 'Dacite' HP IP49 251,2 Hy-andesiet Oros IA75 213,3 'Dacite' LP IP49 123,9								££7,3
Oros andesiet IA80 200,4 'Dacite' HP IP49 251,2 Hy-andesiet Oros IA75 213,3 'Dacite' LP IP49 123,9					'Andesite'		207.8	
Hy-andesiet Oros IA75 213,3 'Dacite' LP IP49 123,9					-			
						-	201,2	123.0
Enclave hyp-and Oros IA77 (2) 196,6					LINAR VALIEL	11.00		223,1

Table 1. Qudrupole ICP-MS obtained data on the Hf amounts isolated and recovered at the VUA Isotope Geochemistry Facility from the 83 volcanic rock samples, standards, blanks and duplicates (indicated by '(2)'). LP = Low Pressure, HP = High Pressure. Grey coloured cells point out the significant difference between the Hf concentration retrieved from LP and HP dissolved aliquots from 11 samples. This is due to incomplete to nondissolution of zircon during LP digestion, and might reveal isotopic differences between groundmass and zircons of these samples.