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# **Geochemical Journal**

# Determination of REE abundances and Eu isotope ratio in GSJ and NIST feldspar reference standards (JF-1, JF-2, SRM 70a, 70b and SRM 99a) using ICP-QMS and MC-ICP-MS --Manuscript Draft--

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Short Title:	REE abundances and Eu isotope ratio in feldspar SRMs
First Author:	Seung-Gu Lee, Ph.D.
Order of Authors:	Seung-Gu Lee, Ph.D.
	Yoshihiro Asahara, Ph. D.
	Goeun Kim, Master of Science
Corresponding Author:	Seung-Gu Lee, Ph.D. Korea Institute of Geoscience and Mineral Resources KOREA, REPUBLIC OF
Abstract:	Rare earth element concentrations in feldspars provide valuable information for understanding geochemical implications during the evolution of igneous rocks due to magma differentiation. Europium exists in Eu2+ and Eu3+ states, which becomes a cause of Eu anomaly due to feldspar crystallization, and has two stable isotopes (151Eu and 153Eu). Recent reports for Eu isotope ratio in igneous rocks suggest that magma differentiation might bring out Eu isotope fractionation due to feldspar crystallization. Here, we first report Eu isotope ratio and REE concentration for five feldspar standard reference materials from NIST and GSJ. Most feldspar SRMs have large Eu positive anomalies except for NIST SRM70b. The potassium feldspar SRMs are enriched in the lighter Eu isotope (151Eu), whereas the sodium feldspar SRM is enriched in the heavier Eu isotope (153Eu). Our results indicate that crystallization of sodic and potassic feldspars may produce Eu isotope fractionation in the geological materials.
Manuscript Classifications:	20: Mineral and Rock Chemistry; 40: Isotope Geochemistry and Geochronology
Keywords:	Feldspars, REEs, Eu isotope fractionation

May 20, 2025 Executive Editor of Geochemical Journal Dr. Katsuhiko Suzuki Submarine Resources Researcher Center, JAMSTEC Japan

Dear Dr. Katsuhiko Suzuki

I wish to submit an original article for publication as an "Data in Geochemical Journal", entitled "Determination of REE abundances and Eu isotope ratio in GSJ and NIST feldspar reference standards (JF-1, JF-2, SRM 70a, 70b and SRM 99a) using ICP-QMS and MC-ICP-MS". The paper was coauthored by Seung-Gu Lee, Yoshihiro Asahara and Goeun Kim.

In this study, we measured REE concentrations and Eu isotope ratios for five feldspar Standard Reference Materials (SRMs) produced by GSJ and NIST via ICP-QMS and MC-ICP-MS, respectively and precisely. REE concentrations for NIST SRMs and Eu isotope ratio from five feldspar SRMs will be reported firstly in the world. Particularly, Eu isotope ratios of feldspars in this manuscript may become a clear evidence and interesting theme in clarifying mechanism of the Eu isotope fractionation in the igneous rocks during magma differentiation.

The corresponding author is as follows;

- 1) Name: Seung-Gu Lee
- 2) Address: Geology Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 34132, Korea
- 3) TEL : +82-42-868-3376
- 4) e-mail: sgl@kigam.re.kr

Particularly, we confirm that this manuscript is an original work that there is no published elsewhere or under consideration for publication elsewhere.

I would like to suggest three reviewers as follows;

- Edin A. Schauble, <u>schauble@ucla.edu</u> Department of Earth, Planetary, and Space Sciences, UCLA, Los Angeles, CA 90095-1567, USA
- 2) Frederic Moynier, <u>moynier@ipgp.fr</u> Insitut de Physique du Globe, Paris, France
- 3) Francois Tissot, <u>tissot@caltech.edu</u> California Institute of Technology, CA, USA
- Jiang-Hao Bai, <u>baijianghao@gig.ac.cn</u> State Key Laboratory of Isotope Geochemistry, CAS Center for Excellence in Deep Earth Science, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences,, Guangzhou 510640, China

Thank you for your consideration. I look forward to hearing from you.

Best regards, Seung-Gu LEE Korea Institute of Geoscience and Mineral Resources Gwahak-ro, Yuseong, Daejon 34132 Korea

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5	
6	<sup>1</sup> Geology and Space Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 34132,
7	Korea.
8	<sup>2</sup> Department of Earth and Environmental Sciences, Nagoya University, Nagoya 464-8601, Japan.
9	
10	*Corresponding author. e-mail: sgl@kigam.re.kr
11	

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17	<sup>1</sup> Geology and Space Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 34132,
18	Korea.
19	<sup>2</sup> Department of Earth and Environmental Sciences, Nagoya University, Nagoya 464-8601, Japan.
20	
21	*Corresponding author. e-mail: sgl@kigam.re.kr
22	
23	

## 24 ABSTRACT

Rare earth element concentrations in feldspars provide valuable information for 25 understanding geochemical implications during the evolution of igneous rocks due to magma 26 differentiation. Europium exists in  $Eu^{2+}$  and  $Eu^{3+}$  states, which becomes a cause of Eu 27 anomaly due to feldspar crystallization, and has two stable isotopes (<sup>151</sup>Eu and <sup>153</sup>Eu). Recent 28 reports for Eu isotope ratio in igneous rocks suggest that magma differentiation might bring 29 out Eu isotope fractionation due to feldspar crystallization. Here, we first report Eu isotope 30 ratio and REE concentration for five feldspar standard reference materials from NIST and 31 GSJ. Most feldspar SRMs have large Eu positive anomalies except for NIST SRM70b. The 32 potassium feldspar SRMs are enriched in the lighter Eu isotope (<sup>151</sup>Eu), whereas the sodium 33 feldspar SRM is enriched in the heavier Eu isotope (<sup>153</sup>Eu). Our results indicate that 34

35 crystallization of sodic and potassic feldspars may produce Eu isotope fractionation in the36 geological materials.

37

# 38 Keywords: Feldspars, , REEs, Eu isotope fractionation

## 40 **1. Introduction**

The REE geochemistry have provide abundant information for understanding the geochemical evolution of Earth and extraterrestrial materials as a result of their similar chemical behavior and continuously varying atomic masses of REEs. Particularly, Eu behavior in igneous rocks provides valuable information to understand magmatic differentiation in crust-mantle system (Burnham et al., 2015). For example, Eu anomalies in the chondrite-normalized REE patterns in igneous rocks were derived from feldspar fractional crystallization during magma evolution (Shearer and Papike, 1989).

48 Recently, Lee's groups (2019, 2021a, 2023, 2024) developed a method for determining highly precise and accurate Eu isotope ratios from geological materials using MC-ICP-MS, and 49 reported that Eu anomaly by feldspar crystallization and Eu isotope fractionation has a good 50 51 relationship. Schauble (2023) suggested that Eu isotope fractionation might be produced by feldspar crystallization whereas Hu et al. (2023) proposed that Eu isotope fractionation might 52 be produced by hydrothermal reaction. It means that REE concentrations and Eu isotope 53 54 ratios in feldspars are important factor in understanding the geochemical significance of Eu isotope fractionation. However, there is little precise data on the REEs concentration in 55 feldspar in the standard reference materials (SRMs). Analytical data on the Eu isotope ratio in 56 feldspars also have not been reported yet. Therefore, we determined REE concentration and 57 Eu isotope ratio of the feldspar SRMs produced by Geological Survey of Japan (GSJ) and 58 National Institute of standards and Technology (NIST). We also performed cross-checking 59 experiments using different kinds of ICP-MS at Korea Institute of Geoscience and Mineral 60 Resources (KIGAM) and at Nagoya University, Japan to improve the reliability of the REE 61 concentration data for JF-1, JF-2 and SRM 70b. 62

## 63 **2. Materials and analytical methods**

64 2.1. Materials

The SRMs used in this study are SRM 70a, SRM 70b, SRM 99a, JF-1 and JF-2. SRM 70a and SRM 70b of NIST and JF-1 and JF-2 of GSJ are potassium feldspars, and SRM 99a is sodium feldspar.

- 68
- 69 2.2. Sample digestion (Fig. S1)

Sample digestion procedures at KIGAM followed those described in Lee (2024). 70 Commercially available ultrapure HF, HNO<sub>3</sub> and HCl purchased from Merck company were 71 used to dissolve samples along with sub-boiled, high-purity perchloric acid (HClO<sub>4</sub>, Merck). 72 73 Approximately 100 ~ 200 mg of each SRM was decomposed by a 2:1 mixture of 2 mL of concentrated HF and 1 mL of concentrated HNO3 at ca. 160 °C for more than 72 hours in 30 74 mL Savillex vial. After the addition of 0.1~0.2 mL of concentrated HClO<sub>4</sub>, the decomposed 75 76 sample solution was heated to dryness at ca. 180 °C for more than 1 day. The dried cakes were redissolved in a 2:1 mixture of 1 mL of concentrated HCl and 0.5 mL of concentrated 77 HNO<sub>3</sub> at ca. 160 °C for 1 day. The re-dried samples were diluted in 10 mL of 6 M HCl as a 78 stock solution to determine REEs concentration and Eu isotope ratio. 79

In a cross-checking experiment for REE analysis, approximately 40 mg of three SRMs (JF-1, JF-2, SRM 70b) was decomposed by a 2:1 mixture of 2 mL of concentrated HF and 1 mL of concentrated HNO<sub>3</sub> at ca. 140 °C for more than 24 hours in 15 mL Savillex vial at KIGAM and Nagoya University. As for the sample digestion procedure at Nagoya University, commercially available ultrapure HF (TAMAPURE AA-100), HNO<sub>3</sub> (TAMAPURE AA-100) and HClO<sub>4</sub> (Kanto Chemical, Ultrapur<sup>TM</sup>) were used to dissolve the samples. After the addition of 0.1 mL of concentrated HClO<sub>4</sub>, the decomposed sample solution was heated to dryness at ca. 140 °C for more than 1 day. The dried cakes were redissolved in a 2:1 mixture of 1 mL of concentrated HCl and 0.5 mL of concentrated HNO<sub>3</sub> at ca. 160 °C for 1 day. The re-dried samples were diluted in 10 ml of 2% HNO<sub>3</sub> as a stock solution to determine REEs concentration for cross-checking experiment of REE abundance determination at Nagoya University and KIGAM.

92

93 2.3. Instrumentation and analytical procedures (Supplementary Table S1)

94 REE analysis was performed using inductively coupled plasma mass spectrometer (ICP-MS), 95 NexION350, Perkin Elmer at KIGAM and Agilent7700x at Nagoya University) (Supplementary Table S1). REE analysis using NexION350 ICP-MS at KIGAM was applied 96 the method by Lee et al. (2014, 2016) using one-point standard solution for each element 97 based on the concentration values for a chosen standard solution, which is similar to the 98 method by Schudel et al. (2015). REE analysis using Agilent7700 at Nagoya University was 99 performed using six standard solutions: the concentrations of individual elements in the six 100 REE standard solutions cover the concentration range estimated for dilute solutions of natural 101 terrestrial samples. Before the sample measurement, production rates of LREE oxides which 102 103 make interferences on HREE were determined by using several LREE solutions. The concentrations of the elements were measured using an internal standard (In), and two 104 different cell modes were used: helium (He) collision and No Gas modes. Normally, there 105 106 was no difference between the REE concentration data in He collision mode and No Gas 107 mode because the rates of isobaric interference due to oxide production were small and stable. Eu isotope ratios were measured using multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS; Neptune Plus, Thermo Fisher Scientific Ltd.) in static mode with nine Faraday cups at KIGAM. The isotopes <sup>147</sup>Sm(L4), <sup>149</sup>Sm(L3), <sup>150</sup>Sm(L2), <sup>151</sup>Eu(L1), <sup>152</sup>Sm(C), <sup>153</sup>Eu(H1), <sup>154</sup>Sm(H2), <sup>155</sup>Gd(H3), and <sup>157</sup>Gd(H4) were monitored simultaneously using nine Faraday cups for Sm normalization and Gd interference correction (Lee, 2024, and reference in).

The procedures for Eu separation from other REEs were described well by Lee (2024). The 114 REE fraction for Eu purification was separated by precleaned cation exchange 115 chromatography (BioRad AG50W-X8 resin) using 6 M HCl. Eu was separated from the 116 obtained REE fraction using 0.12 M 2-hydroxyisobutyric acid (HIBA, pH 4.5 ~ 4.6) and on a 117 quartz column (0.3 cm  $\times$  9.8 cm column) filled with 0.8 mL of cation-exchange resin 118 (BioRad AG50W-X8 resin, 200-400 mesh). Because incomplete Eu purification due to the 119 very low abundance of Eu becomes a cause of isobaric interference during Eu isotope ratio 120 measurement by MC-ICP-MS using Sm internal standardization (Lee, 2024), we always 121 checked for tailing of neighboring elements such as Sm and Gd to minimize isobaric 122 123 interference.

124

## 125 **3. Results and Discussion**

REE concentrations and Eu isotope ratios for the feldspar SRMs in this work were described in Tables S2 and S3, respectively. Figure 1 indicates chondrite-normalized REE patterns for 5 feldspar SRMs. REE data for JF-1, JF-2 and SRM 70b for a cross-checking experiment show that REE concentrations measured at KIGAM are consistent with those measured at Nagoya University (Table S2). 131 The REE data in this study are not consistent with some of the GSJ recommended values, but they show relatively smooth HREE patterns (Figure 1), strongly suggesting that our new data 132 are more reliable. Except for SRM 70b, 4 SRMs have extremely large Eu positive anomaly. 133 In addition, four SRMs are enriched in LREEs (La-Sm) and relatively flattened HREEs (Gd-134 Lu). However, SRM 70b has a LREE enriched and relatively flattened HREE pattern with 135 almost no Eu anomaly. Another geochemical feature of the REE patterns from the SRMs 136 seems to be Ce negative anomalies from JF-2 and SRM 70a. Ce anomalies in igneous rocks 137 were interpreted as a tracer of previously supracrustal material in source regions of igneous 138 rocks (Shimizu et al., 1992; Class and Le Roex, 2008), and may provide evidence for the 139 elevated redox state of magmas (Zhong et al., 2019). 140

Figure 2 shows Eu isotope ratios for five SRMs. Except for SRM 99a, four SRMs show <sup>151</sup>Eu enrichment compared to NIST3117a. However, SRM 99a clearly shows <sup>153</sup>Eu enrichment compared to NIST3117a. Except for SRM 99a, the others are potassium feldspars. Figure 2 seems to suggest that Eu isotope fractionation is a product of feldspar crystallization during magmatic differentiation. Therefore, Fig. 2 is different from the result that Eu isotope fractionation may not be produced by simple feldspar crystallization (Lee et al., 2023; Schauble, 2023).

Ismail et al. (1998) also found isotope effects in which the heavier isotope  ${}^{153}$ Eu is enriched in Eu<sup>2+</sup> in the Eu<sup>2+</sup>/Eu<sup>3+</sup> electron exchange system. It means that substitution of Eu<sup>2+</sup> for Ca<sup>2+</sup> in plagioclase during differentiation of the source magma brought about an isotope effect that enriched the heavier or lighter Eu isotope ( ${}^{153}$ Eu) in Eu<sup>2+</sup>. The study of Eu isotope fractionation is still in its early stages. However, rare earth elements in igneous rocks are distributed with the strongest regularity compared to other elements in the periodic table. 154 Therefore, our data for REE concentration and Eu isotope ratio for feldspar can be a strong155 indicator in the field of REE geochemistry and Eu isotope fractionation.

156

# 157 **4. Conclusion**

- 158 In this study, we measured REE concentration and Eu isotope ratios for 5 feldspar SRMs (JF-
- 159 1, JF-2, SRM 70a, SRM 70b and SRM 99a). In chondrite-normalized REE patterns, except
- 160 for SRM 70b, the others have extremely large Eu positive anomalies. In Eu isotope ratios,
- 161 SRM 99a shows heavier Eu isotope (<sup>153</sup>Eu) enrichment whereas the others show lighter Eu
- 162 isotope (<sup>151</sup>Eu) enrichment. Our results support that feldspar crystallization is one of the main
- 163 causes of Eu isotope fractionation during magma differentiation.

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#### **CRediT authorship contribution statement**

S-G. Lee performed ICP-MS and MC-ICP-MS experiments and wrote the manuscript. Y.
Asahara performed ICP-MS experiments and wrote the manuscript. G. Kim prepared SRM
70a and SRM 99a samples.

170

#### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personalrelationships that could have appeared to influence the work reported in this paper.

174

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181

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- 223

Figure captions
Fig. 1. Chondrite (McDonough and Sun, 1995)-normalized REE patterns for 5 feldspar SRMs.
NIST SRM 70b has almost no Eu anomaly.
Fig. 2. Eu isotope ratios of feldspar standard reference materials. Average value means the average of the five values calculated by each Sm isotope pair. The numbers of x-axis indicate

that there are no Gd isobar and Ba oxide interference during Eu isotope ratio measurementvia Neptune MC-ICP-MS.

233 
$$\delta^{153}Eu = \left[\frac{(153)^{151}Eu}{(153)^{151}Eu} - 1\right] \times 1,000$$

234



Figure 2



Figure S1





Model	Perkin Elemer NexION 350X	Agilent 7700x		
ICP-MS				
ICP RF power	1400 W	1550 W		
Gas flow rate Plasma	Ar gas 18 L/min	Ar gas 15 L/mi		
Auxiliary gas	1.2 L/min	0.9 L/min		
Nebulizer gas	0.96 L/min	1.01~1.11 L/mi		
Chamber type	Glass cyclonic spray chamber	Spray chamber (qu		
Nebulizer type	Quartz type A nebulizer (0.5 mL/min.)	MicroMist nebulizer (s		
Deflector voltage	-9.55 V	_		
Collision Reaction Cell	$CH_4$ , Universal Reaction Cell <sup>TM</sup>	No Gas / He colli		
Vaccum pressure	3.30e-7 Torr	1.1e-6 Torr (Analysis		
Analog stage voltage	-1820 V	2100 V		
Pulse stage voltage	-1250 V	1130 V		
Data acquisition				
Sweeps	20	100		
Reading	1 sec.	0.25 sec		
Replicates	3	3		

Table S1 Typical analytical condition of ICP-MS for determining REE concentrations in feldspar SRMs

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	JF-1							JF-2					
	This study								·	This study	his study		
Elemen	NexIO (KIG	N 350 AM)	Agilent 7700 (Nagoya U.)	Ave.	1SD	Watkin s & Le Rec. <sup>*2</sup> Roex		NexION 350 (KIGAM)		Agilent 7700 (Nagoya U.)	Ave.	1SD	
	no Colu. <sup>*1</sup>	Colu.*1	no Colu.			(1992)		no Colu.	Colu.	no Colu			
La	2.514	2.492	2.533	2.513	0.020	2.730	2.800	0.505	0.502	0.513	0.507	0.006	
Ce	4.023	4.175	3.980	4.060	0.102	4.060	4.190	0.504	0.484	0.480	0.489	0.013	
Pr	0.387	0.408	0.377	0.391	0.016	0.420	0.480	0.088	0.087	0.082	0.085	0.003	
Nd	1.461	1.573	1.430	1.488	0.075	1.510	1.460	0.315	0.318	0.320	0.318	0.002	
Sm	0 371	0 4 5 3	0 359	0 394	0.051	0.410	0.410	0 079	0.087	0.071	0 079	0.008	
Eu	0.916	0.760	0.635	0.770	0.001	0.740	0.410	0.367	0.345	0.549	0.420	0.112	
Gd	0.405	0.422	0.355	0.394	0.035	0.400	0.930	0.063	0.065	0.063	0.064	0.001	
Tb	0.068	0.069	0.062	0.066	0.004	0.069	0.076	0.009	0.009	0.009	0.009	0.000	
Dv	0.450	0.444	0.395	0.430	0.030	0.450	0.390	0.053	0.051	0.040	0.048	0.007	
Ho	0.093	0.090	0.084	0.089	0.005	-	0.110	0.010	0.009	0.009	0.009	0.000	
Er	0.284	0.260	0.246	0.263	0.019	0.290	0.310	0.029	0.028	0.025	0.027	0.002	
Tm	0.044	0.039	0.036	0.040	0.004	-	0.040	0.004	0.004	0.004	0.004	0.000	
Yb	0.289	0.262	0.250	0.267	0.020	0.310	0.350	0.034	0.022	0.025	0.027	0.006	
Lu	0.046	0.039	0.037	0.040	0.005	-	0.053	0.007	0.003	0.004	0.005	0.002	

Table S2 Rare earth element concentrations (ppm) of five feldspar SRMs in this study

\*1 colu: column chromatography
\*2 Rec.: recommend
\*3 SRMs of NIST do not have recommended values of REE.

		SRM 70b <sup>*3</sup>					SRM 70a <sup>*3</sup>				SRM	
		This stud						ly				
Watkin s & Le Roex	Rec.	NexIC (KIG	ON 350 GAM)	Agilent 7700 (Nagoya U.)	Ave.	1SD	NexION 350 (KIGAM)		Ave.	1SD	NexIC (KIC	ON 350 AM)
(1992)		no Colu.	Colu.	no Colu.			no Colu.	Colu.			no Colu.	Colu.
0.640	0.630	0.925	0.959	1.003	0.962	0.039	0.426	0.460	0.443	0.024	2.458	2.336
0.530	0.840	1.661	1.729	1.691	1.694	0.034	0.471	0.506	0.488	0.025	4.065	3.914
0.088	0.088	0.192	0.201	0.189	0.194	0.006	0.066	0.076	0.071	0.007	0.501	0.477
0.330	0.330	0.658	0.682	0.619	0.653	0.032	0.259	0.305	0.282	0.033	1.935	1.858
0.084	0.110	0.209	0.225	0.183	0.206	0.021	0.083	0.078	0.081	0.003	0.468	0.446
0.520	0.590	0.067	0.053	0.091	0.070	0.019	0.481	0.373	0.427	0.076	1.256	1.174
0.072	0.072	0.214	0.218	0.177	0.203	0.023	0.109	0.134	0.121	0.018	0.458	0.453
0.009	0.009	0.049	0.050	0.041	0.047	0.005	0.023	0.026	0.024	0.002	0.060	0.060
0.056	0.036	0.338	0.343	0.266	0.316	0.043	0.165	0.188	0.176	0.016	0.312	0.321
-	0.021	0.062	0.063	0.047	0.057	0.009	0.037	0.043	0.040	0.004	0.053	0.054
0.034	0.034	0.187	0.189	0.137	0.171	0.030	0.113	0.137	0.125	0.017	0.129	0.131
-	0.050	0.033	0.032	0.025	0.030	0.004	0.018	0.021	0.020	0.002	0.016	0.017
0.037	0.035	0.235	0.238	0.162	0.212	0.043	0.119	0.136	0.127	0.012	0.095	0.096
-	0.020	0.035	0.034	0.026	0.032	0.005	0.019	0.021	0.020	0.001	0.012	0.013

99a <sup>*3</sup>		
Ave.	1SD	
2.397	0.086	
3.990	0.107	
0.489	0.017	
1.896	0.054	
0.457	0.016	
1.215	0.058	
0.455	0.003	
0.060	0.000	
0.316	0.007	
0.053	0.000	
0.130	0.002	
0.016	0.000	
0.095	0.001	
0.012	0.001	

		Intensity (V	)	<sup>154</sup> Gd/ <sup>154</sup> Sm		
				intensity		
	<sup>153</sup> Eu	<sup>154</sup> Sm	<sup>155</sup> Gd	ratio <sup>a)</sup>	<sup>147/149</sup> Sm	<sup>147/152</sup> Sm
		~		(%)	~	~
	20.528	16.605	0.106	0.094	-0.210	-0.420
JF1-Aflaus II	18.631	16.488	0.102	0.091	-0.183	-0.423
	2.267	2.400	0.006	0.038	-0.118	-0.121
	2.724	2.427	0.010	0.062	-0.108	-0.104
IE1 1 Correct chamber	4.090	5.849	0.001	0.004	-0.163	-0.160
JF1-1_Spray chamber	4.565	5.455	0.006	0.016	-0.028	-0.049
	3.179	4.353	0.003	0.011	-0.145	-0.140
	4.172	4.903	0.008	0.023	-0.082	-0.084
		Av	erage		-0.130	-0.188
		1	SD		0.058	0.148
	3.367	4.869	0.002	0.005	-0.314	-0.307
IE2 1	3.095	4.515	0.001	0.003	-0.272	-0.281
J1 2-1	3.957	6.836	0.002	0.005	-0.349	-0.331
	2.564	4.476	0.009	0.031	-0.334	-0.334
		Av	erage		-0.317	-0.313
		1		0.034	0.025	
SBM70a	2.395	4.121	0.001	0.004	-0.132	-0.152
SIXIVI70a	0.948	0.554	0.003	0.070	-0.151	-0.162
		Av	erage		-0.142	-0.157
		1	SD		0.013	0.007
SRM70b	0.980	1.368	0.002	0.023	-0.210	-0.209
SIGNITOD	0.816	1.346	0.001	0.014	-0.183	-0.207
		Av	erage		-0.197	-0.208
		1	SD		0.019	0.001
	1.215	4.277	0.003	0.009	0.172	0.170
	2.771	1.559	0.009	0.082	0.170	0.098
SPM00a	1.786	6.553	0.005	0.010	0.146	0.152
51(1v1))u	2.423	2.080	0.009	0.066	0.106	0.074
	2.180	1.955	0.009	0.064	0.107	0.082
	1.271	1.138	0.003	0.042	0.104	0.077
		Av	erage		0.134	0.109
		1	SD		0.032	0.042

Table S3 Eu isotope ratio of feldspar standard reference materials used in this study

a)  ${}^{154}\text{Gd}/{}^{154}\text{Sm} = \text{Calculated intensity of } {}^{154}\text{Gd}/\text{measured intensity of } {}^{154}\text{Sm} \times 100 (\%)$ 

δ <sup>153/151</sup>	Eu (‰)		
<sup>147/154</sup> Sm	<sup>149/154</sup> Sm	<sup>150/154</sup> Sm	no normalizatio n
-0.195	-0.364	-0.331	-0.683
-0.208	-0.386	-0.378	-0.552
-0.117	-0.125	-0.092	-0.198
-0.083	-0.071	-0.071	-0.157
-0.161	-0.162	-0.170	-0.202
-0.052	-0.064	-0.058	0.194
-0.151	-0.152	-0.127	-0.301
-0.073	-0.056	-0.042	-0.109
-0.130	-0.173	-0.158	-0.251
0.058	0.131	0.128	0.270
-0.302	-0.298	-0.233	-0.148
-0.293	-0.304	-0.308	-0.198
-0.334	-0.328	-0.337	-0.266
-0.268	-0.248	-0.191	-0.545
-0.299	-0.294	-0.267	-0.289
0.028	0.034	0.067	0.177
-0.199	-0.223	-0.222	-0.233
-0.197	-0.217	-0.081	-0.127
-0.198	-0.220	-0.152	-0.180
0.002	0.004	0.100	0.075
-0.195	-0.194	-0.111	-0.109
-0.208	-0.228	-0.150	-0.177
-0.202	-0.211	-0.130	-0.143
0.010	0.024	0.028	0.048
0.172	0.174	0.187	0.019
0.056	0.009	0.306	0.157
0.159	0.169	0.266	0.135
0.098	0.094	0.134	0.073
0.067	0.039	0.081	0.187
0.084	0.067	0.090	0.053
0.106	0.092	0.177	0.104
0.048	0.068	0.093	0.065