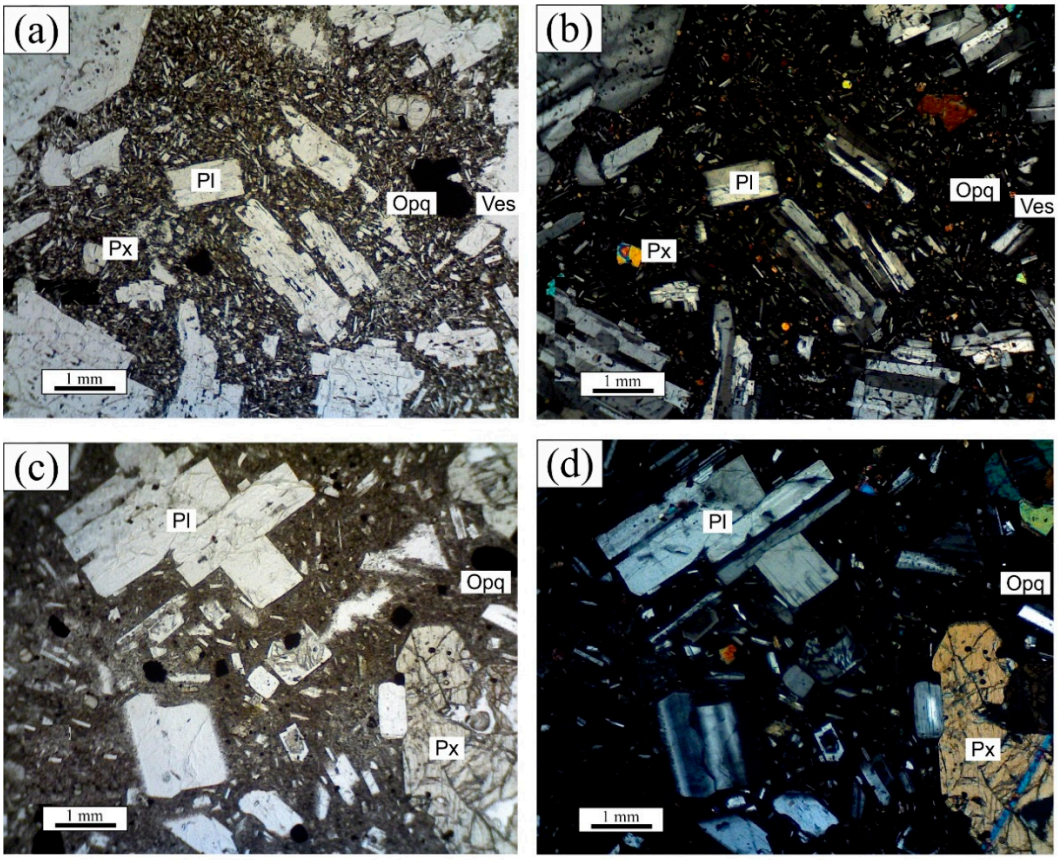
Supplementary Materials

Detail Petrographic Description

Figure S1 shows the results of a thin section analysis of all samples from Ijen Crater. All samples had a porphyritic texture composed of plagioclase, pyroxene, and opaque minerals as phenocryst (>0.5 mm), microphenocryst (0.125-0.5 mm), and groundmass microlite (<0.125 mm). In addition, there was significant amount of glass as groundmass. Vesicular cavities were also found in all samples. The percentage of mineralogy in all samples can be seen in Table A. Some samples had significant differences, both texture and microlites abundances. The phenocrysts size of IJ 1; IJ 3: and IJ 5 were smaller than IJ 2 and IJ 4. Meanwhile, sieve texture was present significantly in IJ 1 and IJ 5 samples (Figure S2). In IJ 2 and IJ 4 samples, there were glomerocrystal textures between plagioclase and pyroxene minerals (Figure S2). IJ 1, IJ 3, IJ 5, ANY 1, ANY 2, ANY 3, and ANY 4 had a higher microlite abundances compared to than IJ 2 and IJ 4. The percentage of mineralogy in all samples can be seen in Table S1.



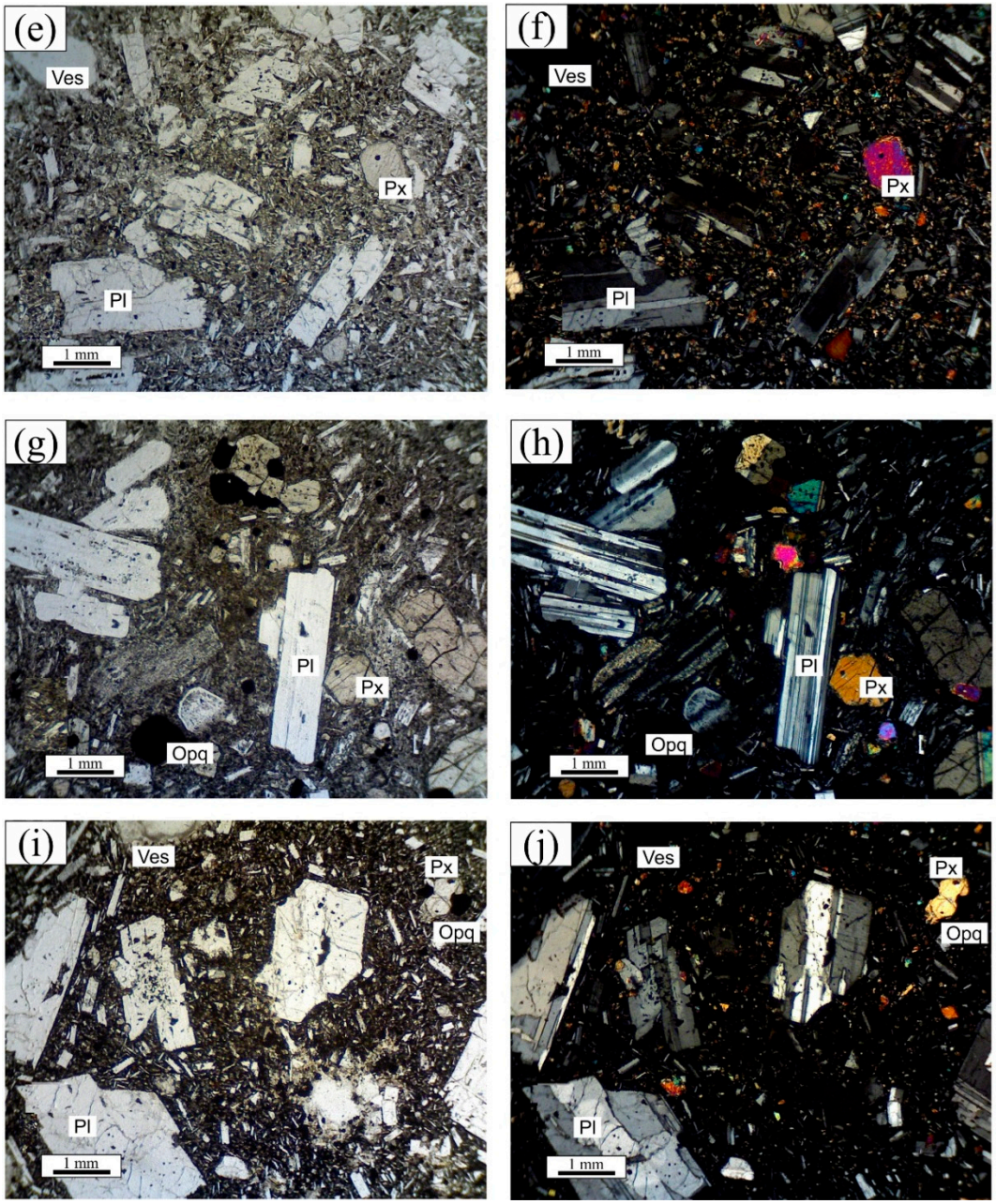


Figure S1. Thin section analysis of: (a) IJ 1 (parallel nicol), (b) IJ 1 (cross nicol), (c) IJ 2 (parallel nicol), (d) IJ 2 (cross nicol), (e) IJ 3 (parallel nicol), (f) IJ 3 (cross nicol), (g) IJ 4 (parallel nicol), (h) IJ 4 (cross nicol), (i) IJ 5 (parallel nicol), (j) IJ 5 (cross nicol). Pl: Plagioclase, Px: Pyroxene, Opq: Opaque mineral, and Ves: Vesicular (porosity).

Table S1. Percentages of mineralogy from petrography analysis.

Sample	Plagioclase (Vol.%)		Pyroxene (Vol.%)		Olivin (Vol.%)		Opaque Mineral (Vol.%)		Glass (Vol.%)	Vesicular/ Porosity (Vol.%)	Total (Vol.%)
	Phenocryst	Groundmass	Phenocryst	Groundmass	Phenocryst	Groundmass	Phenocryst	Groundmass			
IJ 1	19	26	3	17	-	-	4	3	23	5	100
IJ 2	20	20	9	9	-	-	4	4	31	3	100
IJ 3	19	25	4	20	-	-	2	5	15	10	100
IJ 4	21	19	8	10	-	-	4	4	32	2	100
IJ 5	18	23	6	17	-	-	1	5	15	15	100
ANY 1	25	24	8	16	-	-	2	6	15	4	100
ANY 2	18	25	5	19	-	-	3	3	15	12	100
ANY 3	18	23	4	18	-	-	4	3	18	12	100
ANY 4	17	24	5	18	-	-	2	4	15	15	100

Figure S3 shows the results of a thin section analysis of all samples from Mount Anyar. The mineralogy of the sample was similar to the samples from Ijen Crater, plus a few olivine minerals found in the ANY 1. Several samples from Mount Anyar also had significant differences in both texture and mineralogy percentage. Trachytic and intergranular were found in ANY 1. Moreover, the sieve texture was dominantly seen in ANY 3 and ANY 4 (Figure S3). Opaque minerals were found as primary minerals with a smaller size than the sample from Ijen Crater. The phenocryst of opaque mineral was ~0.5 mm, whereas the microphenocryst was between 0.125-0.5 mm, and groundmass microlite was smaller than 0.125 mm. They present as inclusion in plagioclase and pyroxene as well as a single mineral among the groundmass.

In general, the samples included in the basaltic andesite and basalt trachyandesite lithology had more plagioclase and less pyroxene than the samples with basalt lithology. In some samples, the composition of plagioclase, including basalt, basaltic andesite, and basalt trachyandesite, belongs to andesine-labradorite ($An_{35–60}$). This result corresponds to those previously reported [1,2] that igneous rock included in basalt andesitic had a plagioclase with andesine-labradorite composition.

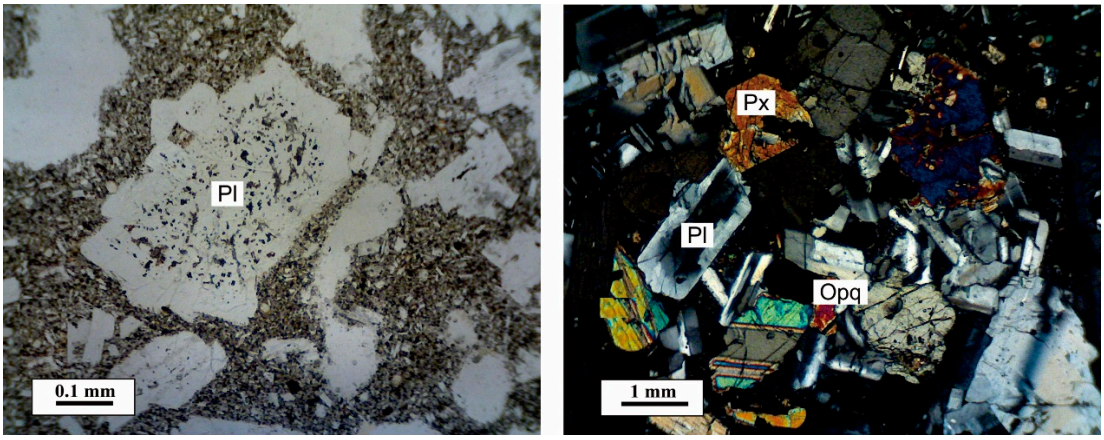
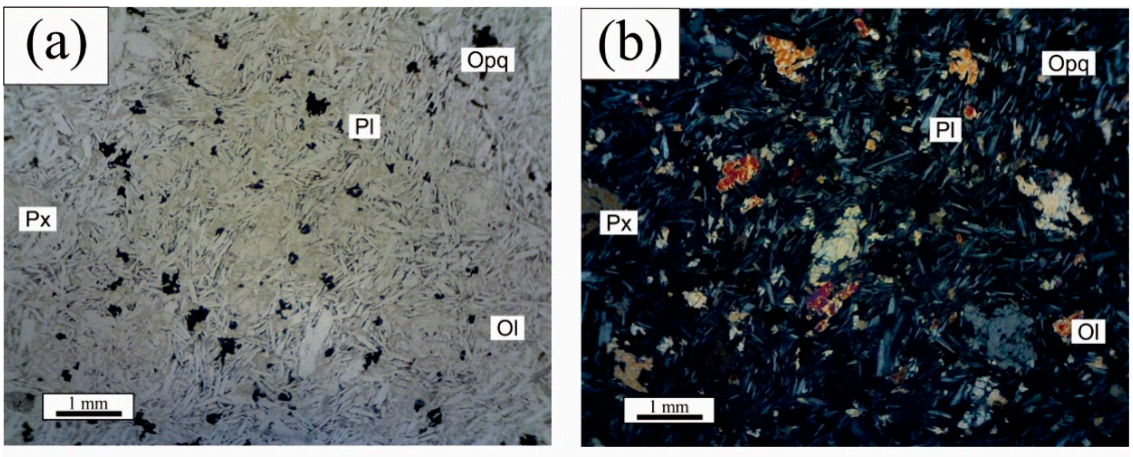


Figure S2. (a) Petrography analysis (parallel nicol mode) of IJ 1. The figure shows sieve texture in plagioclase mineral (Pl), (b) Petrography analysis (cross nicol mode) of IJ 4. The figure shows glomerocrystal texture between plagioclase (Pl); pyroxene (Px); and opaque mineral (Opq).



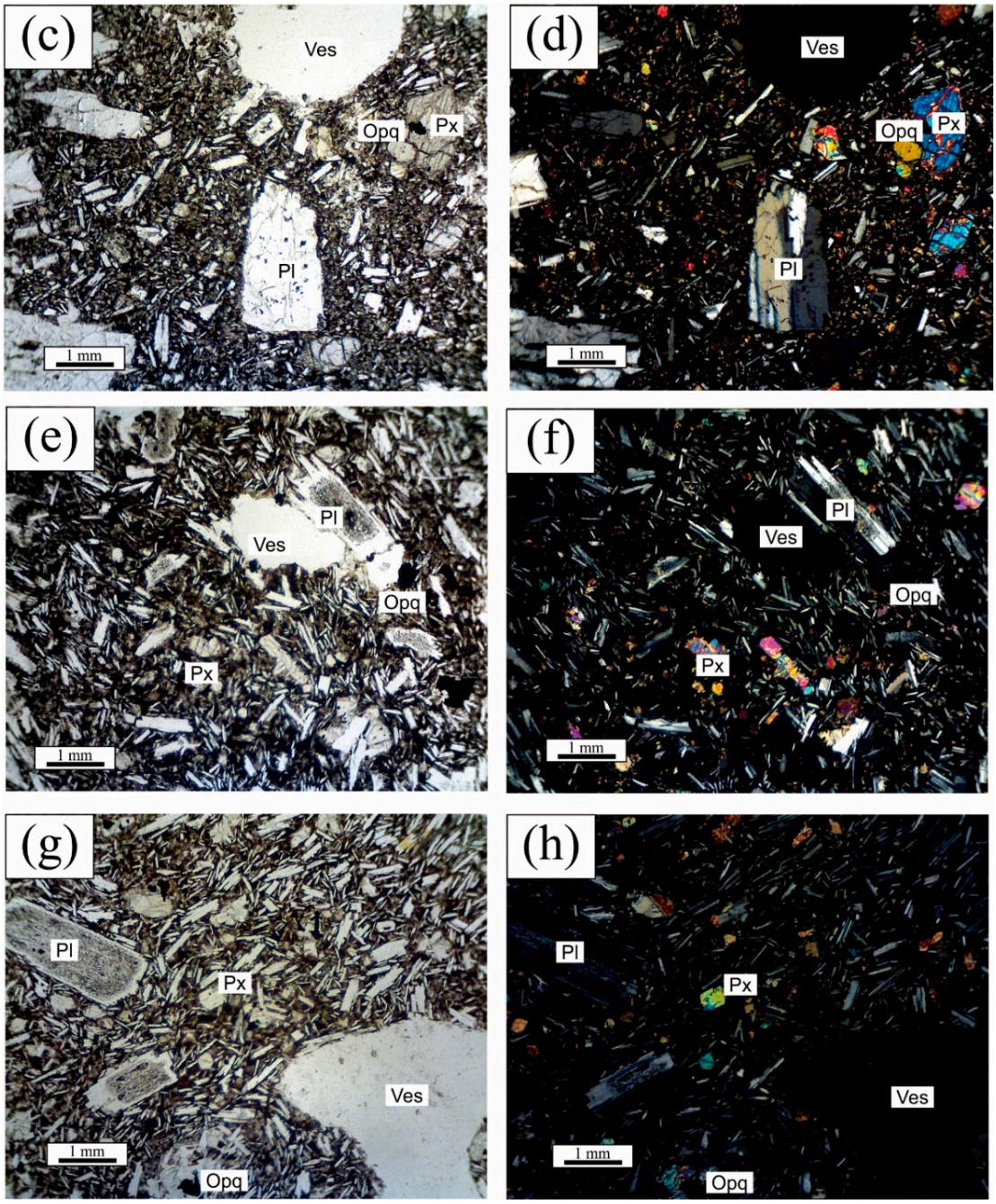


Figure S3. Thin section analysis of: (a) ANY 1 (parallel nicol), (b) ANY 1 (cross nicol), (c) ANY 2 (parallel nicol), (d) ANY 2 (cross nicol), (e) ANY 3 (parallel nicol), (f) ANY 3 (cross nicol), (g) ANY 4 (parallel nicol), and (h) ANY 4 (cross nicol). Texture sieve on plagioclase minerals were found in ANY 3 and ANY 4 samples. Pl: Plagioclase, Px: Pyroxene, Ol: Olivine, Opq: Opaque mineral, and Ves: Vesicular (porosity).

SEM-EDS Analysis

The SEM-EDS analysis was conducted on some representative samples in each group (IJ 3; IJ 4; IJ 5; and ANY 3) which aims to know the characteristics of microlites and magnetic minerals. Characteristics of microlites lead to understand about crystallization process [3].

The BSE images reveals that plagioclase; pyroxene; and titanomagnetite microlites, vary in their size, morphology, and abundance between samples (Figure S4). The microlite sizes of IJ 3; IJ 5; ANY 3 were larger than IJ 4 and ANY 1. The plagioclase and pyroxene microlites predominantly were prismatic shape. They were more elongated than titanomagnetite microlite. But, some of microlites

were blocky shape, correlated with smaller microlite sizes. In contrast with the prismatic crystal shape, which was correlated with larger microlite sizes. Meanwhile, the microlite sizes were correlated with the microlite abundances.

The magnetic minerals in our samples were Fe-rich titanomagnetite and Ti-rich titanomagnetite. They were subhedral-anhedral and associate with pyroxene, both microphenocryst and microlite. In some samples, we found glomerocrystal textures between pyroxene and titanomagnetite. Samples IJ 3; IJ 5; ANY 3 have predominantly Ti-rich titanomagnetite, ranging in Ti content is between 9.14 and 14.73 mass% (Figure S4). Few of Fe-rich titanomagnetite also are found in these samples. Meanwhile, samples IJ 4 have Fe-rich titanomagnetite, with Ti content is 6.21 and 7.80 mass% Table S2 shows mass% of Ti, Fe, and O in the samples.

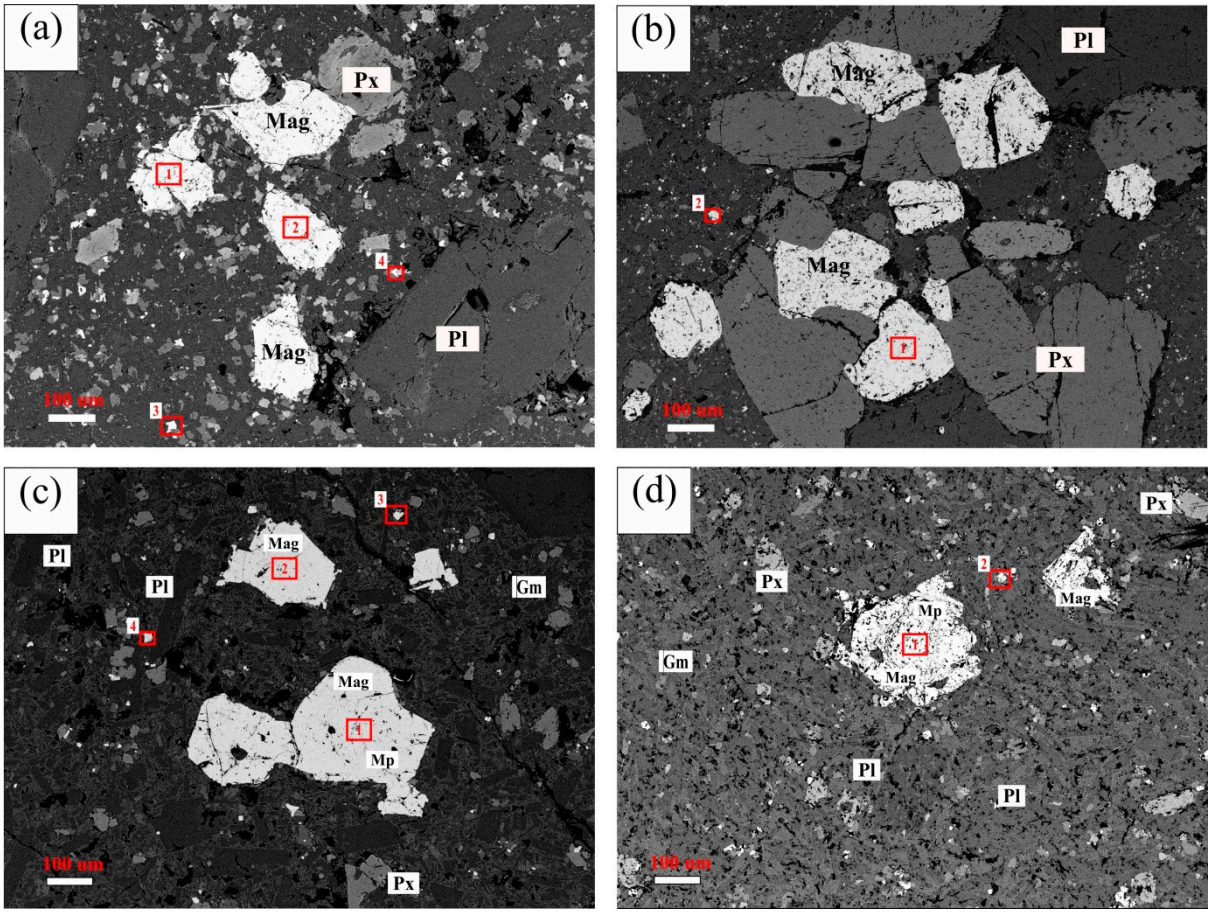


Figure S4. Scanning electron microscopy (SEM) images of (a) IJ 3; (b) IJ 4, (c) IJ 5; and (d) ANY 3 obtained with the back scattered electrons (BSE) image mode. The red rectangulars are the EDS area. Mineral abbreviations: Pl = plagioclase; Px = pyroxene, Mag = titanomagnetite, Gm = groundmass microlite, Mp = microphenocryst.

Table S2. The percentages of Fe, Ti, and O (Mass%) in magnetic minerals of some samples.

Samples	Area	Elements (Mass%)		
		Fe	O	Ti
IJ 3	1	57.67	27.14	12.10
	2	59.91	26.43	12.57
	3	52.42	28.59	13.70
	4	52.10	28.59	14.73
IJ 4	1	57.93	27.74	6.210
	2	62.69	26.08	7.800
IJ 5	1	58.81	27.11	9.640
	2	58.13	27.08	9.140
	3	61.23	26.51	6.050
	4	53.17	28.43	10.54
ANY 3	1	54.41	28.02	10.61
	2	53.68	28.27	10.65

References

1. Wyaatt, M.B.; Hamilton, V.E.; McSween, H.Y., Jr.; Christensen, P.R.; Taylor, L.A. Analysis of Terrestrial and Martian Volcanic compositions using Thermal Emission Spectroscopy: Determination of Mineralogy, Chemistry, and Classification Strategies. *J. Geophys. Res.* **2001**, *106*, 14711–14732.
2. Chadwick, J.P.; Troll, V.R.; Waight, T.E.; van der Zwan, F.M.; Schwarzkopf, L.M. Petrology and geochemistry of igneous inclusions in recent Merapi deposits: A window into the sub-volcanic plumbing system. *Contrib. Mineral. Petrol.* **2013**, *165*, 259–282, doi:10.1007/s00410-012-0808-7.
3. Preece, K.; Barclay, J.; Gertisser, R.; Herd, R.A. Textural and micro-petological variations in the eruptive products of the 2006 dome-forming eruption of Merapi volcano, Indonesia: Implications for sub-surface processes. *J. Volcanol. Geotherm. Res.* **2013**, *261*, 98-120.