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Supplemental Material for
Empirical Constraints on Progressive Shock Metamorphism of Magnetite from the Siljan Impact Structure, Sweden

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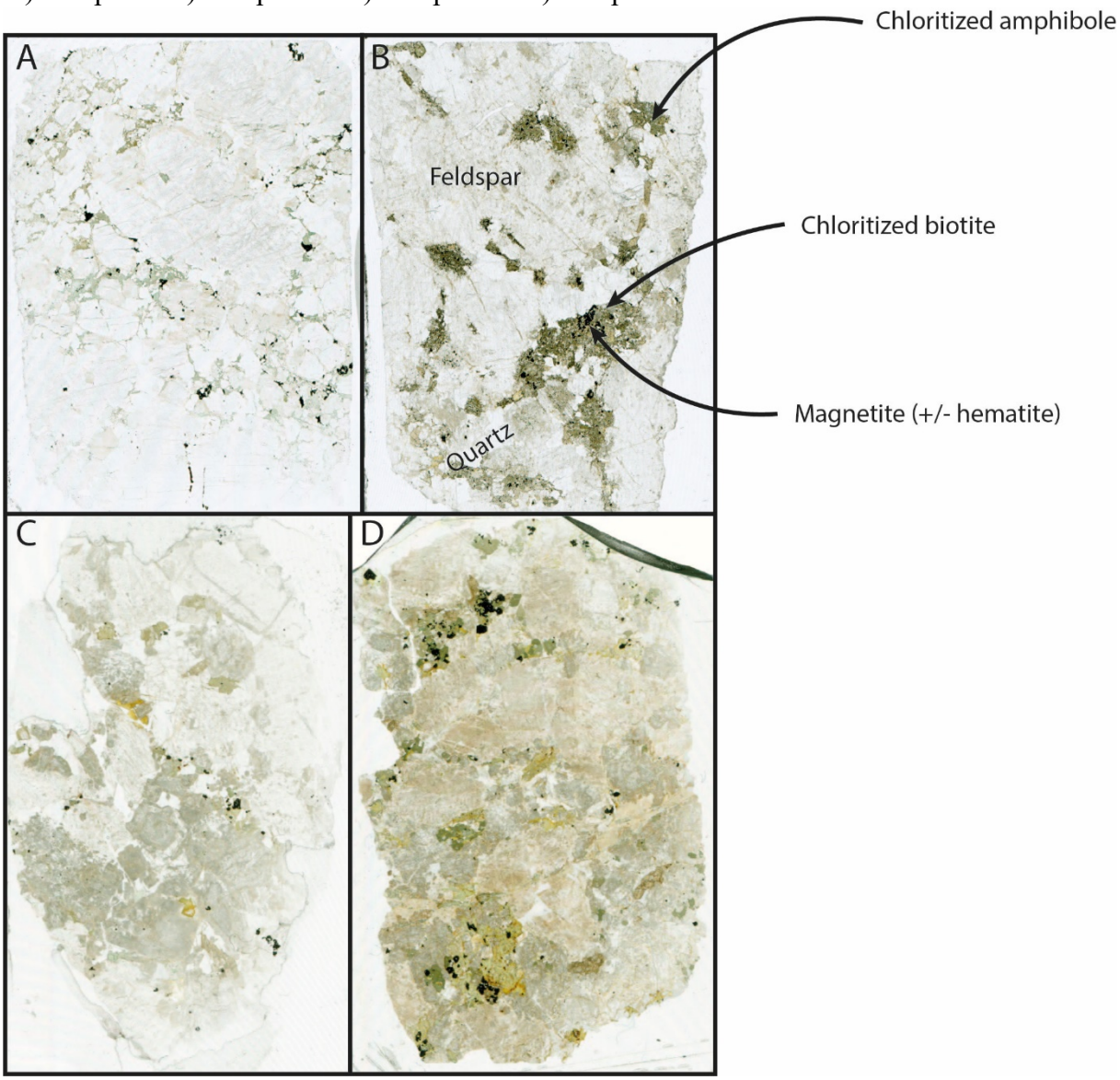
Item S1. Scanned thin sections showing textures and petrography of the investigated Siljan granitoid samples. Mineralogy highlighted in B is the same in all investigated samples. Note that the more altered (more brownish) feldspar is plagioclase, and less altered is K-feldspar. A) Sample 5. B) Sample 21. C) Sample 58. D) Sample 69.



Item S2. Sample preparation and SEM analysis conditions.

Sample preparation
Polished thin sections were polished with colloidal silica for EBSD analysis.

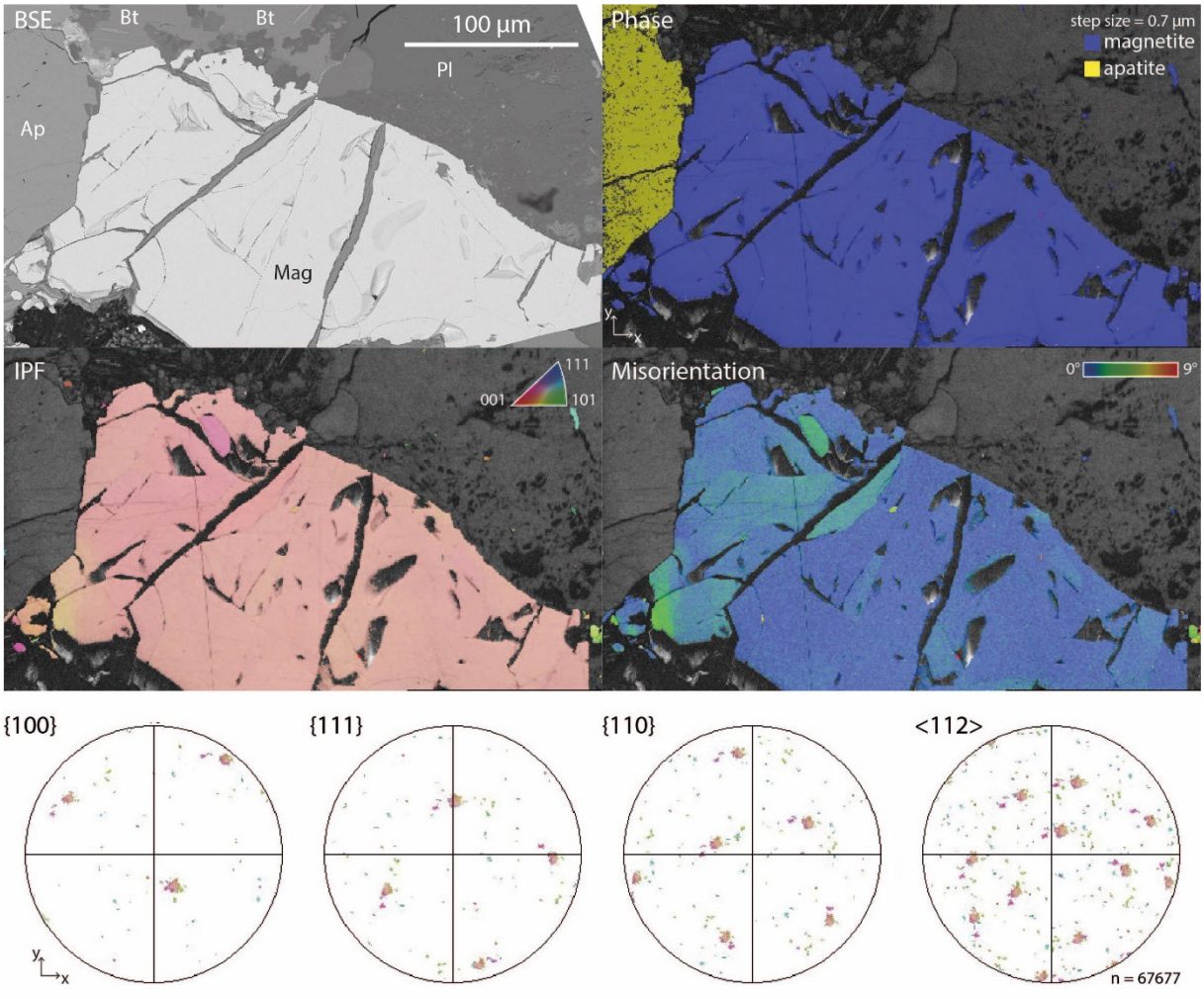
Microscopy
Initial investigation of the thin sections was performed with a polarizing microscope and samples were then further studied with the aim of acquiring mineral phase information, crystal orientation, and microstructural information with a Tescan Mira3 High Resolution Schottky FE-SEM equipped with an Oxford Instruments energy dispersive spectrometer (EDS), an electron backscatter diffraction (EBSD) detector, and a cathodoluminescence (CL) system, located at the Department of Geology, Lund University, Sweden. Before the analysis, thin sections were mounted on a 70° pre- tilted specimen holder. No carbon coating was applied for EBSD work (carbon coating was applied for BSE imagery), with one exception: sample 69, grain 6, which was coated with a thin (<5 nm) carbon coat prior to EBSD analysis. Orientation data was collected with a step size of 0.1 to 1 μm depending on the region of interest, with match units defined based on Della Guista et al. (1987; magnetite), Estifanos et al. (1997; hematite), and the Inorganic Crystal Structure Database (zircon). Each EBSD map used match units for magnetite, hematite, and zircon. BSE images were obtained after thin sections were carbon coated and mounted flat. Further details are provided in DR Table 7.

Post-analysis and construction of pole figures was performed with Channel5 software packages Mambo and Tango from Oxford Instruments. Noise-reduction of the data included removal of wild-spikes and replacement of zero solution pixels by extrapolation from six neighboring pixels. Pole figures were plotted as equal area, lower hemisphere projections, using an inverse pole figure coloring scheme to reveal misorientation between areas.

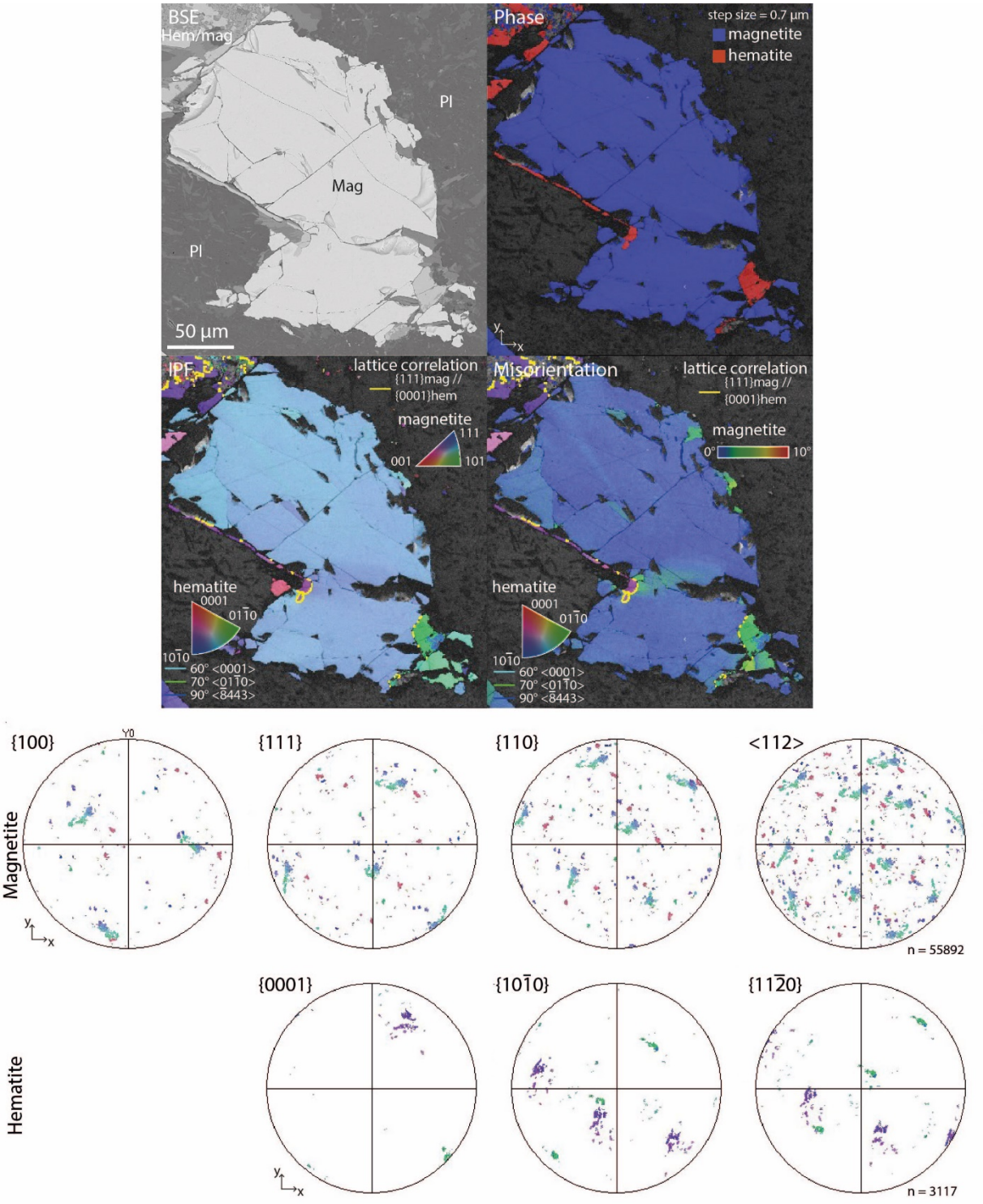
In the following DR items, several types of EBSD maps are shown. Band contrast (BC) images show differences in crystallography/crystallinity between areas of the same grain, with e.g., fractures, grain boundaries, and mineral twins, darker in the gray-scale color. BC images are shown together with other EBSD maps. Texture component maps show misorientation relative to a reference point. Inverse pole figure (IPF) maps show orientation relative to color coded for specific Miller indices. Pole figures are equal area, lower hemisphere stereonet projections.

References:
Della Guista, A., Princivalle, F., and Carbonin, S., 1987, Crystal structure and cation distribution in some natural magnetites: Mineralogy and Petrology, vol. 37, p. 315–321, https://doi.org/10.1007/BF01161823.
Estifanos, B., Ståhl, K., Andréasson, P.G., Bylund, G., Johansson, L., 1997, Norsk Geologisk Tidsskrift, vol. 77, p. 119–122.

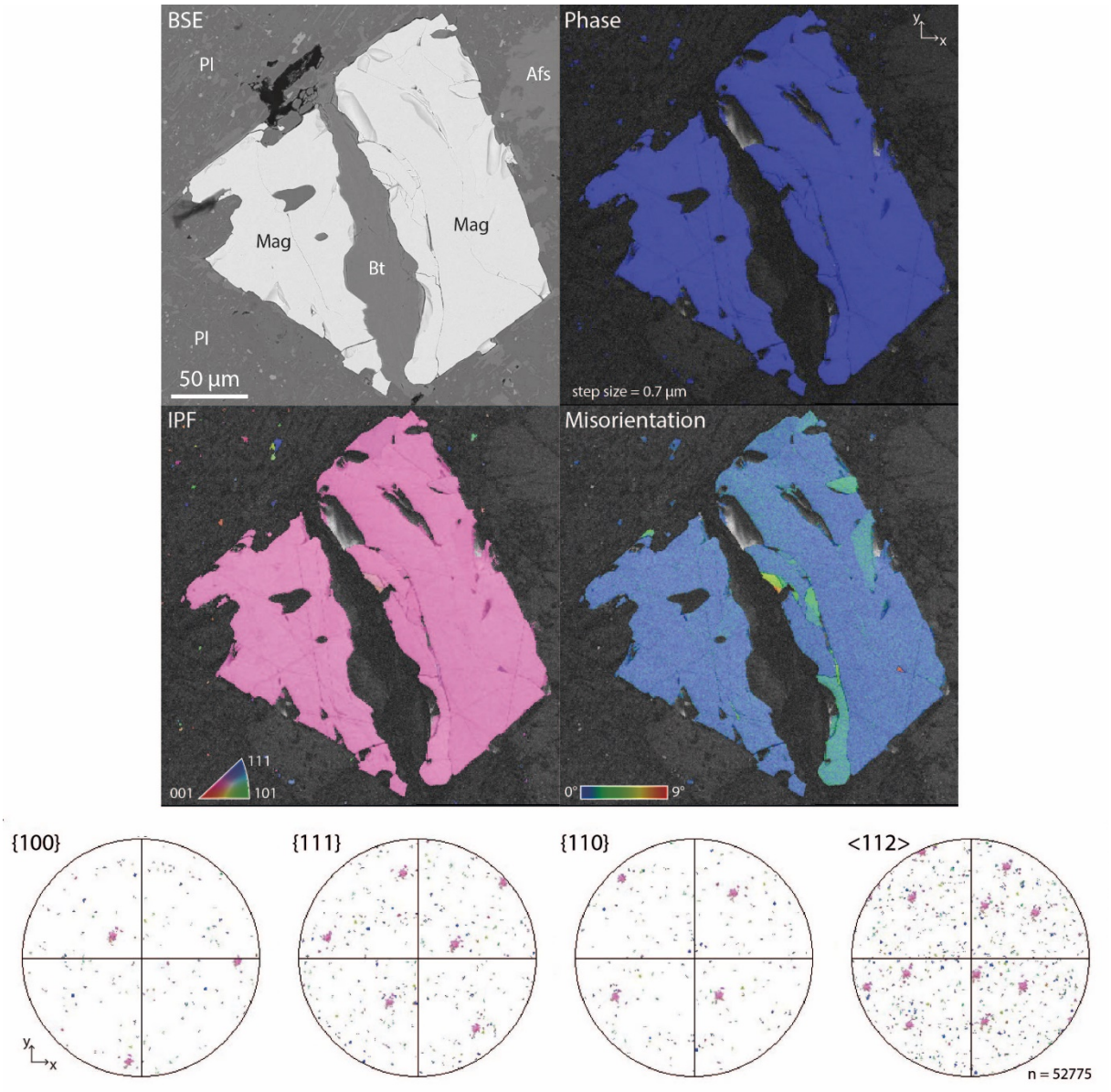
Item S3A. EBSD data for sample 5, grain 1. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Pl = plagioclase, Bt = biotite, Mag = magnetite, Ap = apatite.



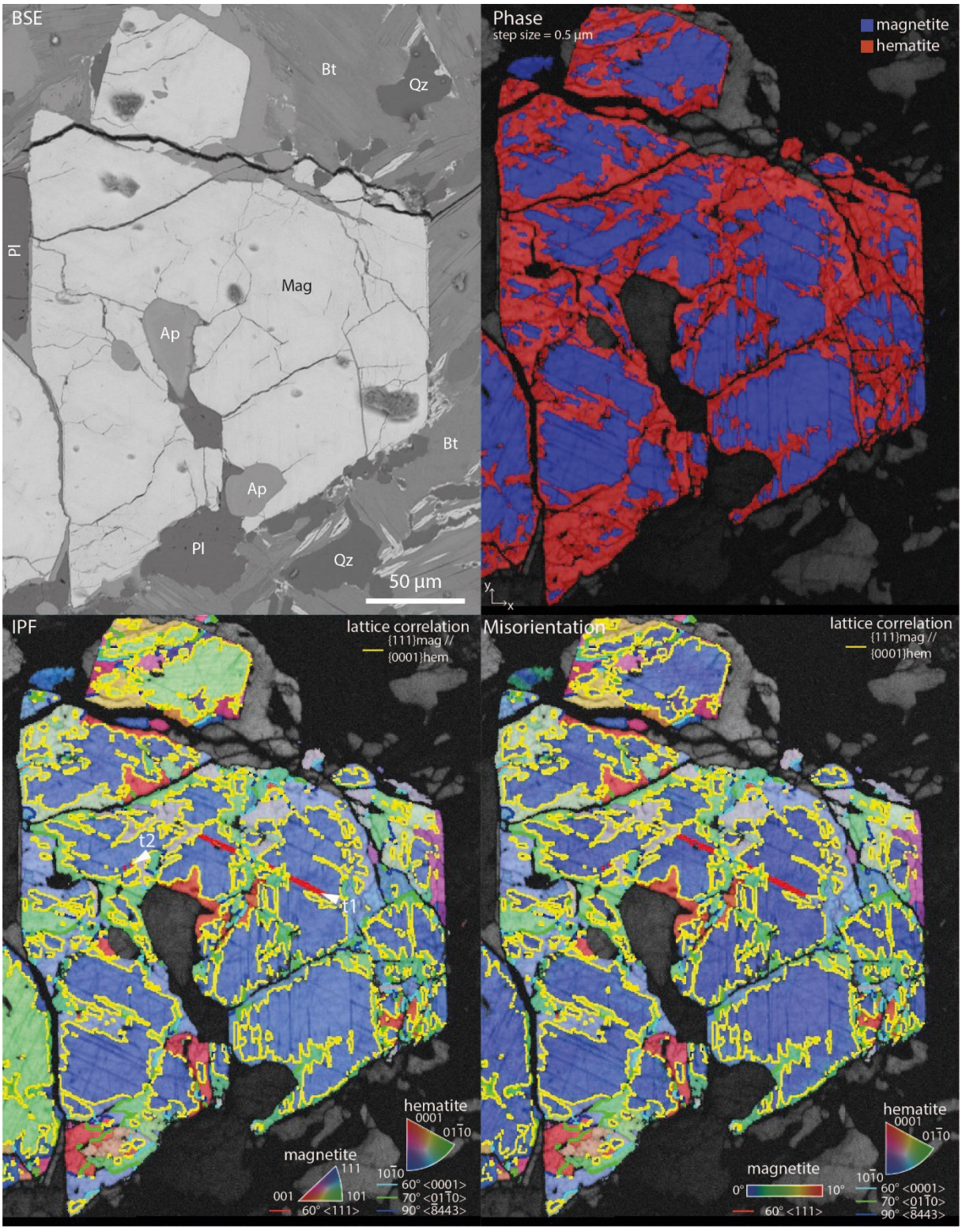
Item S3B. EBSD data for sample 5, grain 2. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Pl = plagioclase, Mag = magnetite, Hem = hematite.



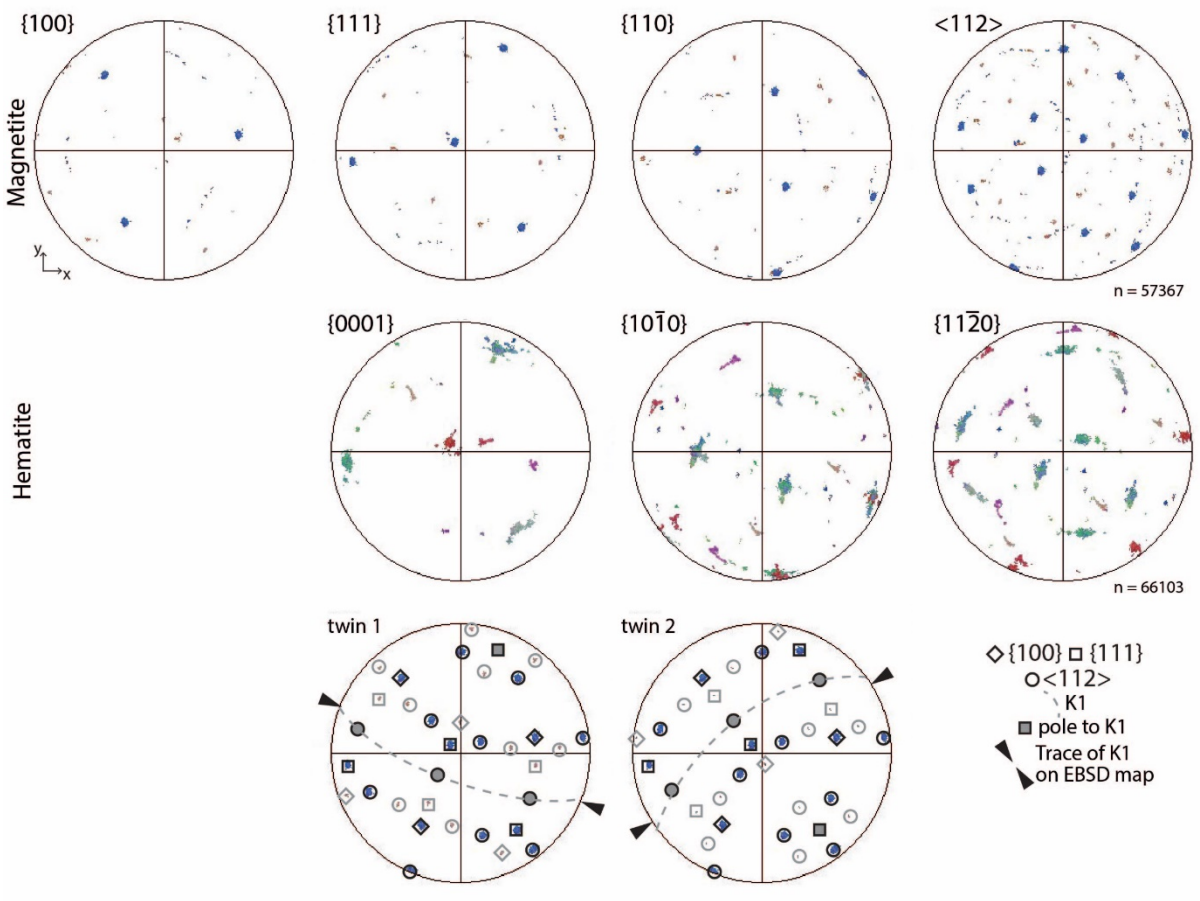
Item S3C. EBSD data for sample 5, grain 3. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation(s) + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Pl = plagioclase, Afs = K-feldspar, Bt = biotite, Mag = magnetite.



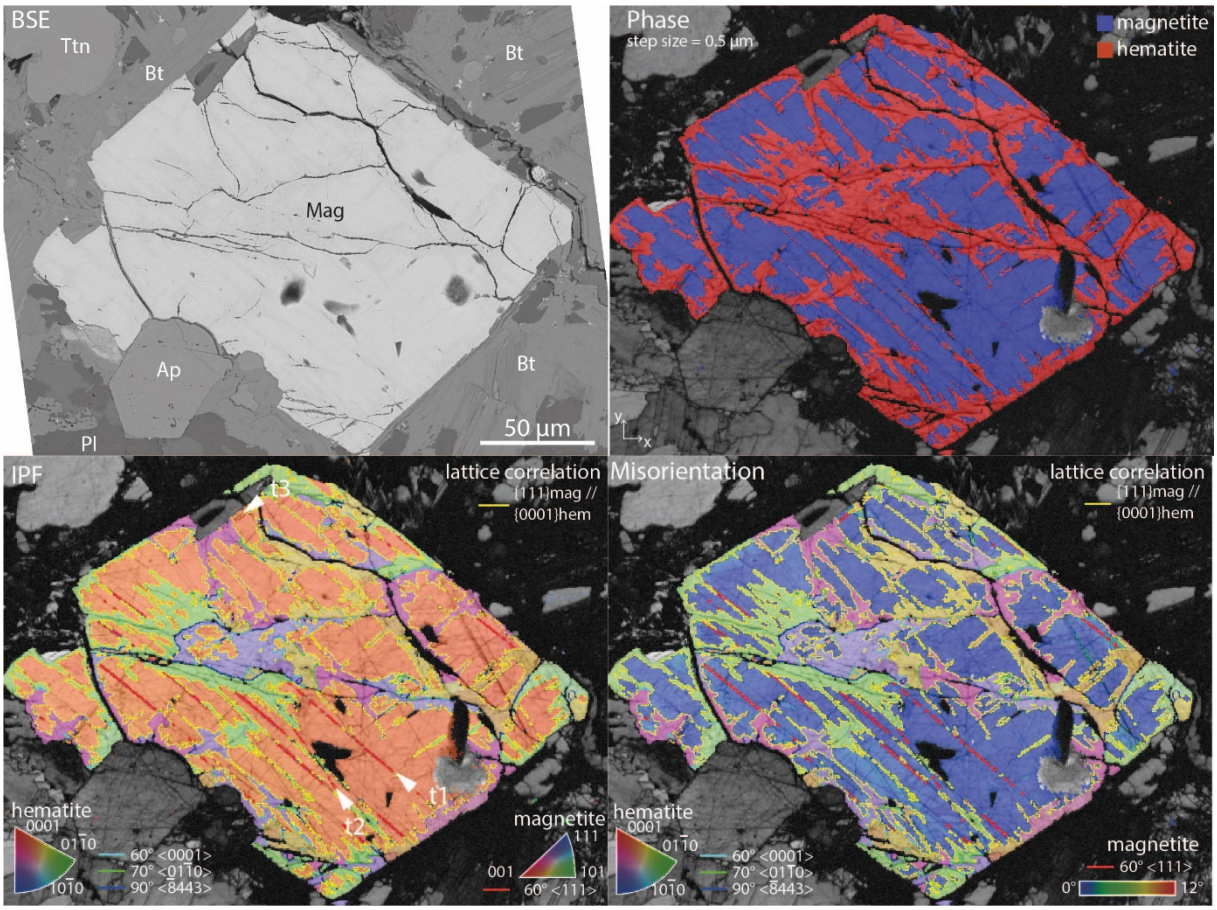
Item S4A. EBSD data for sample 21, grain 1. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation(s) + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Pl = plagioclase, Bt = biotite, Qz = quartz, Mag = magnetite, Ap = apatite.



Item S4A (cont.).



Item S4B. EBSD data for sample 21, grain 2. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Bt = biotite, Mag = magnetite, Ttn = titanite, Ap = apatite.



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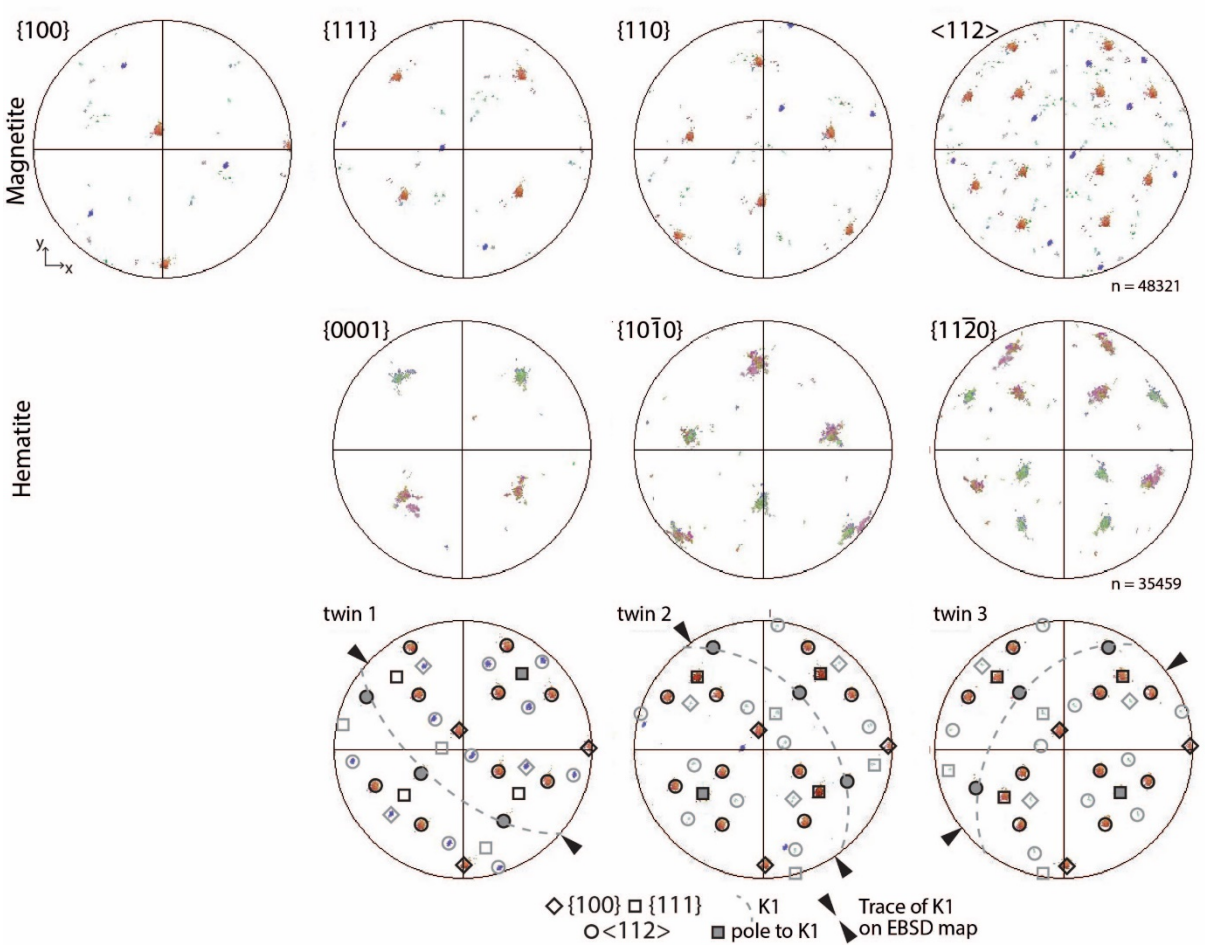
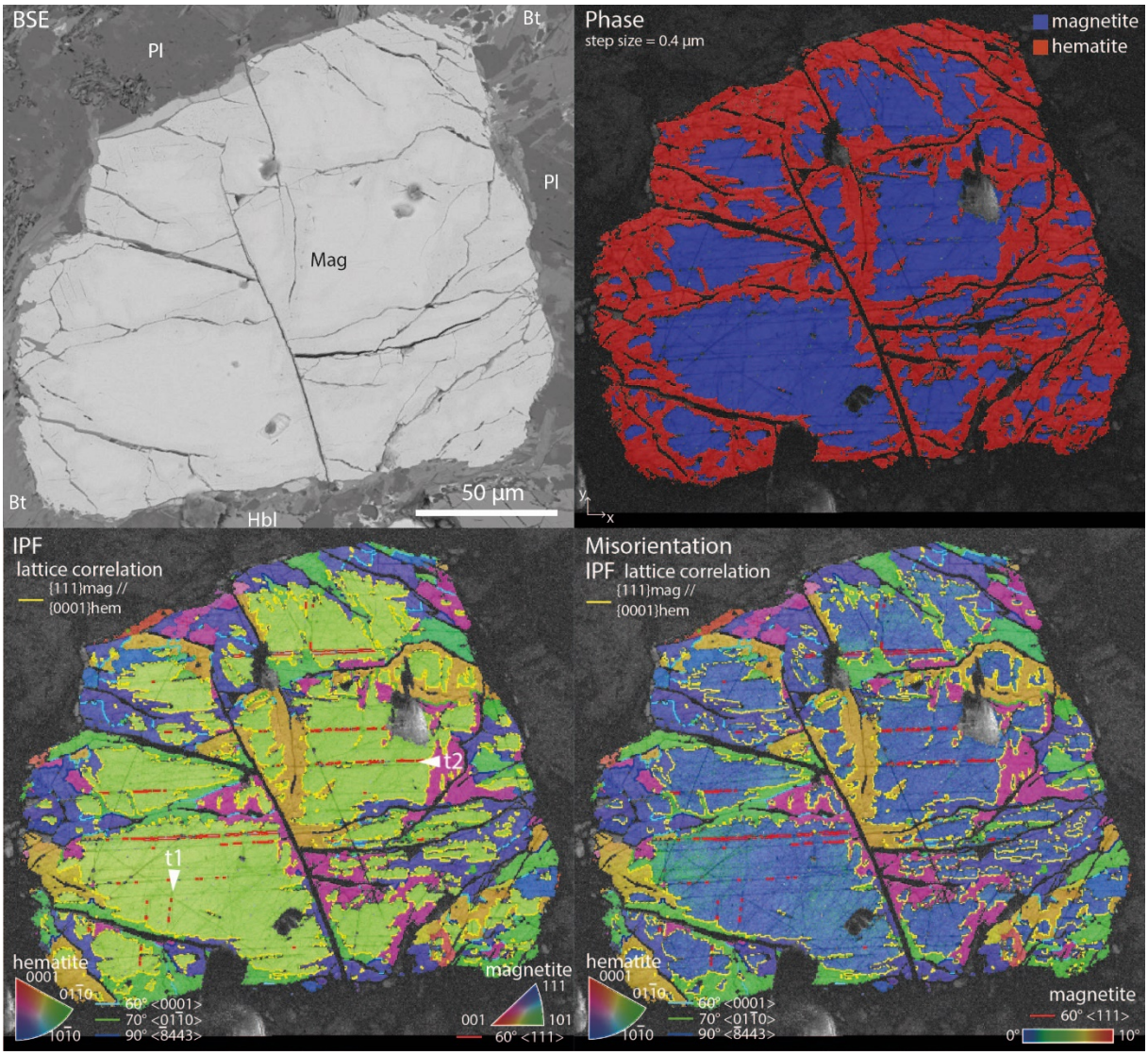
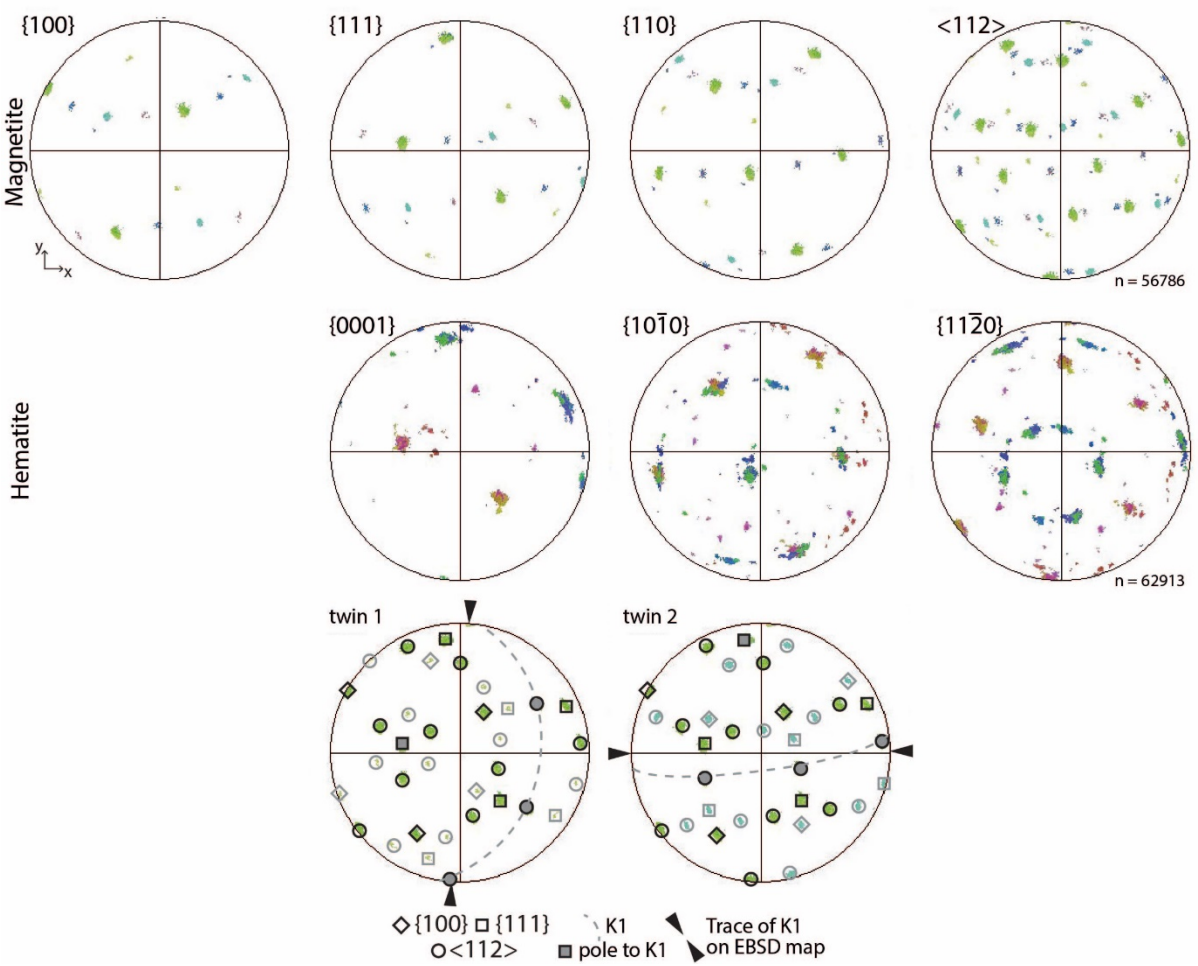


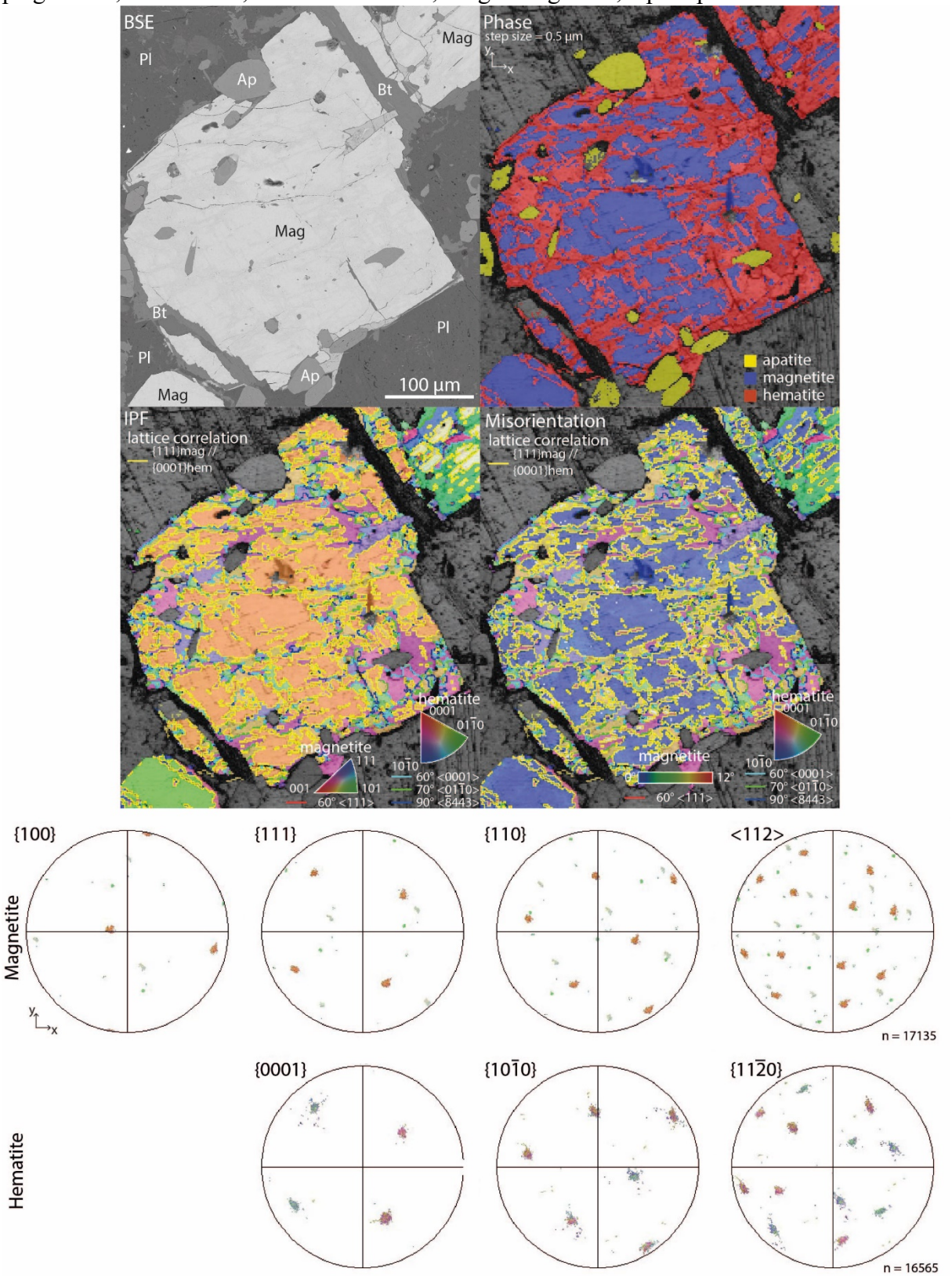
Item S4C. EBSD data for sample 21, grain 3. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Pl = plagioclase, Bt = biotite, Hbl = hornblende, Mag = magnetite.



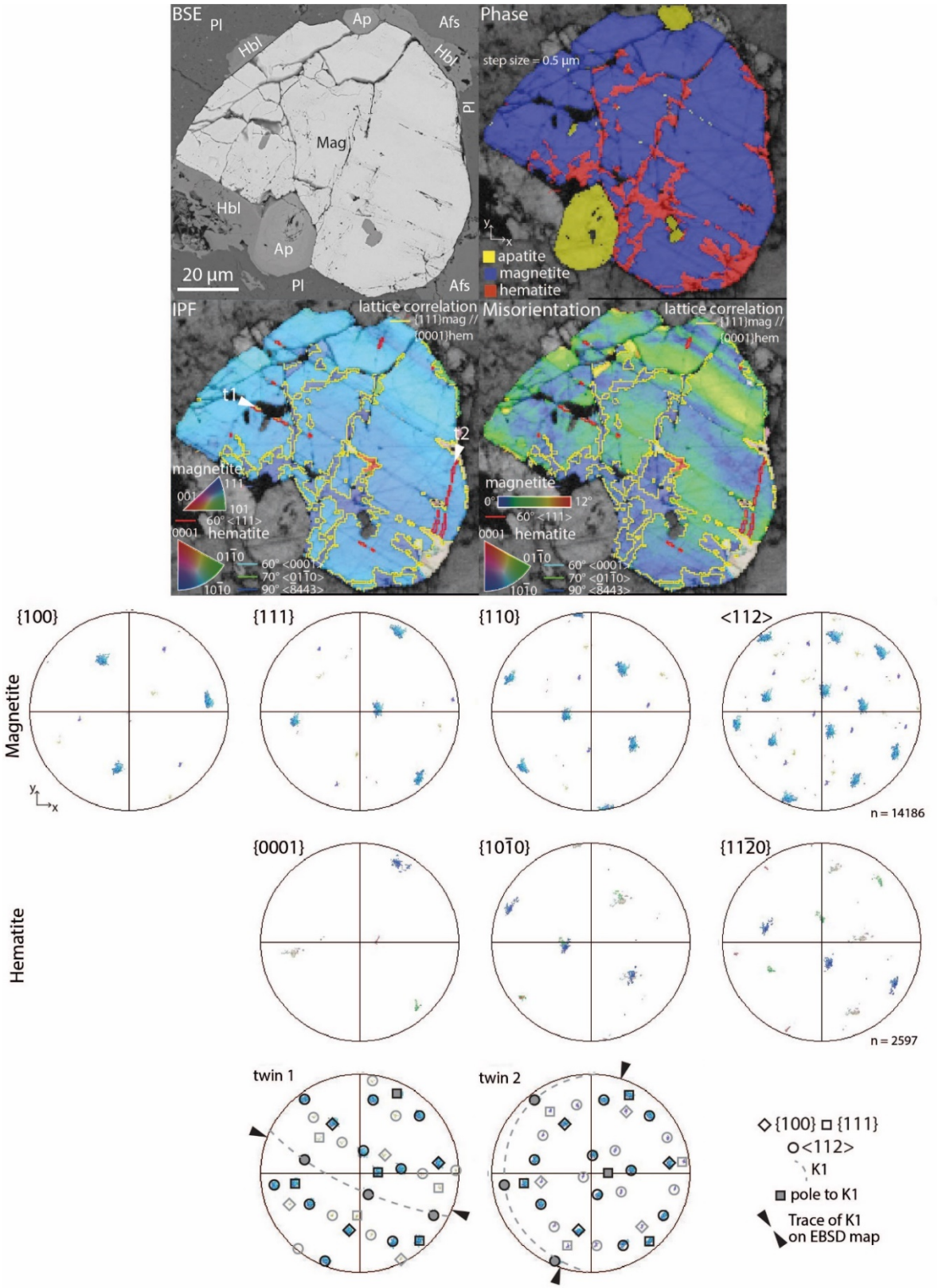
Item S4C (cont.).



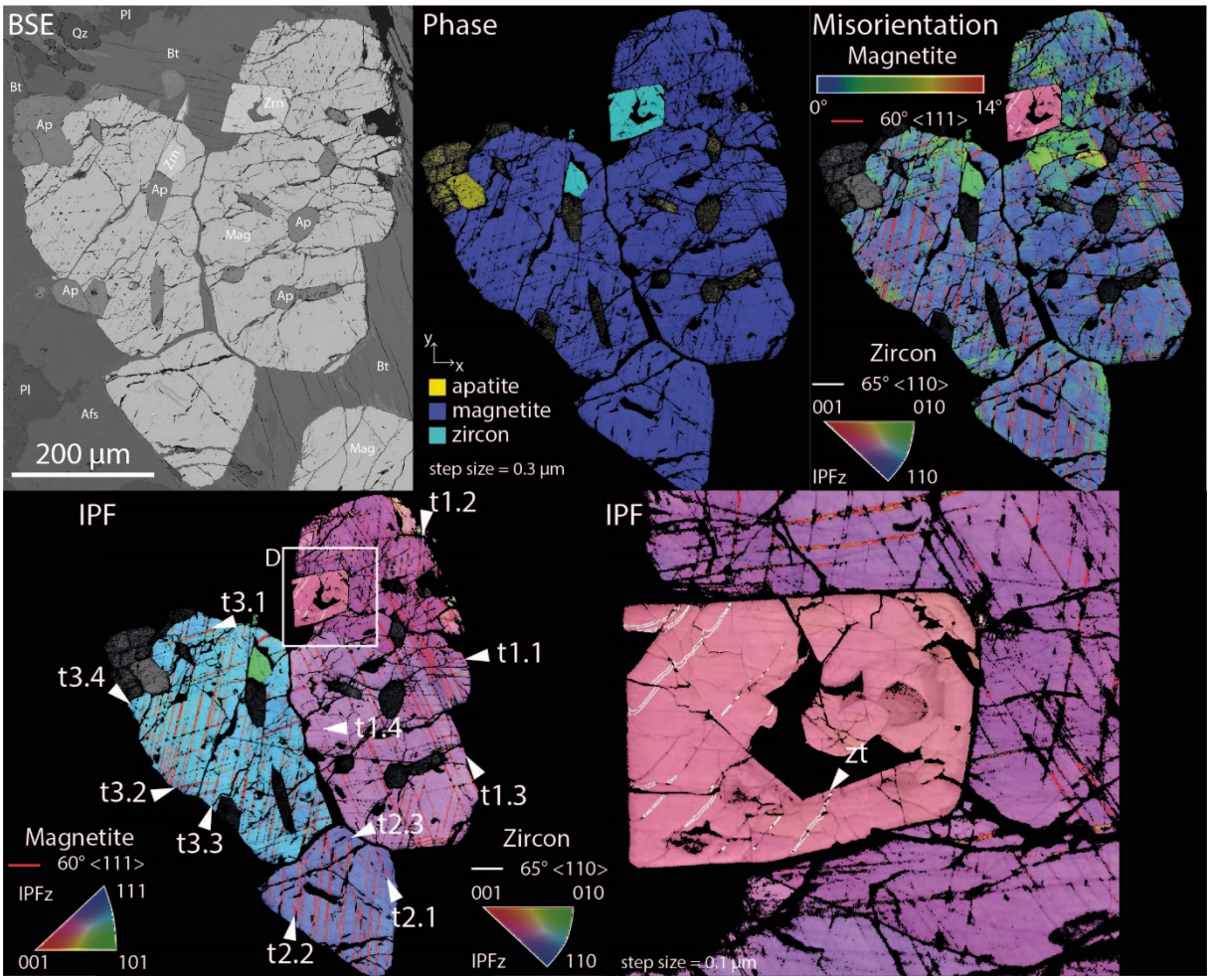
Item S5A. EBSD data for sample 58, grain 1. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Afs = K-feldspar, Pl = plagioclase, Bt = biotite, Hbl = hornblende, Mag = magnetite, Ap = apatite.



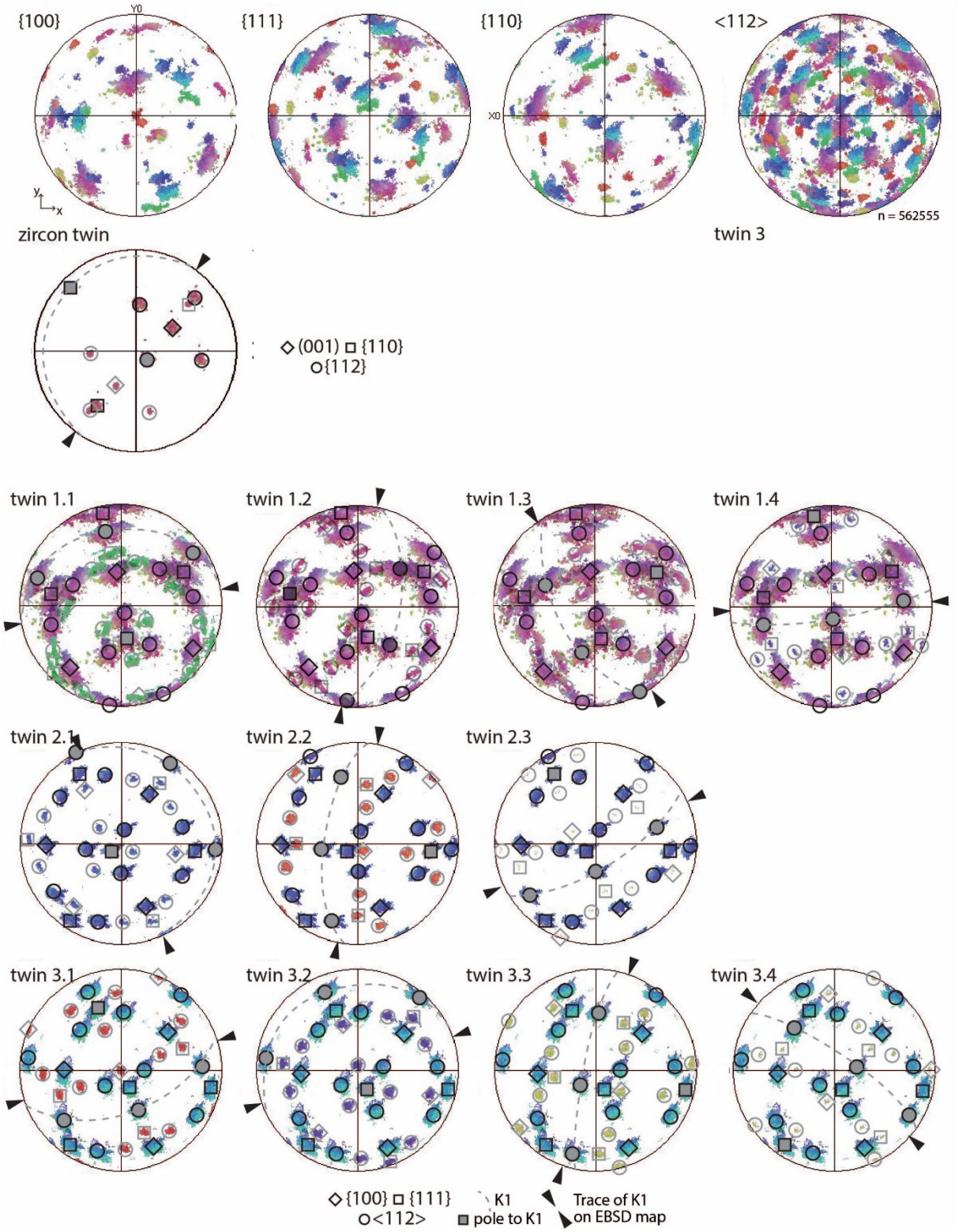
Item S5B. EBSD data for sample 58, grain 2. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Pl = plagioclase, Bt = biotite, Mag = magnetite, Ap = apatite.



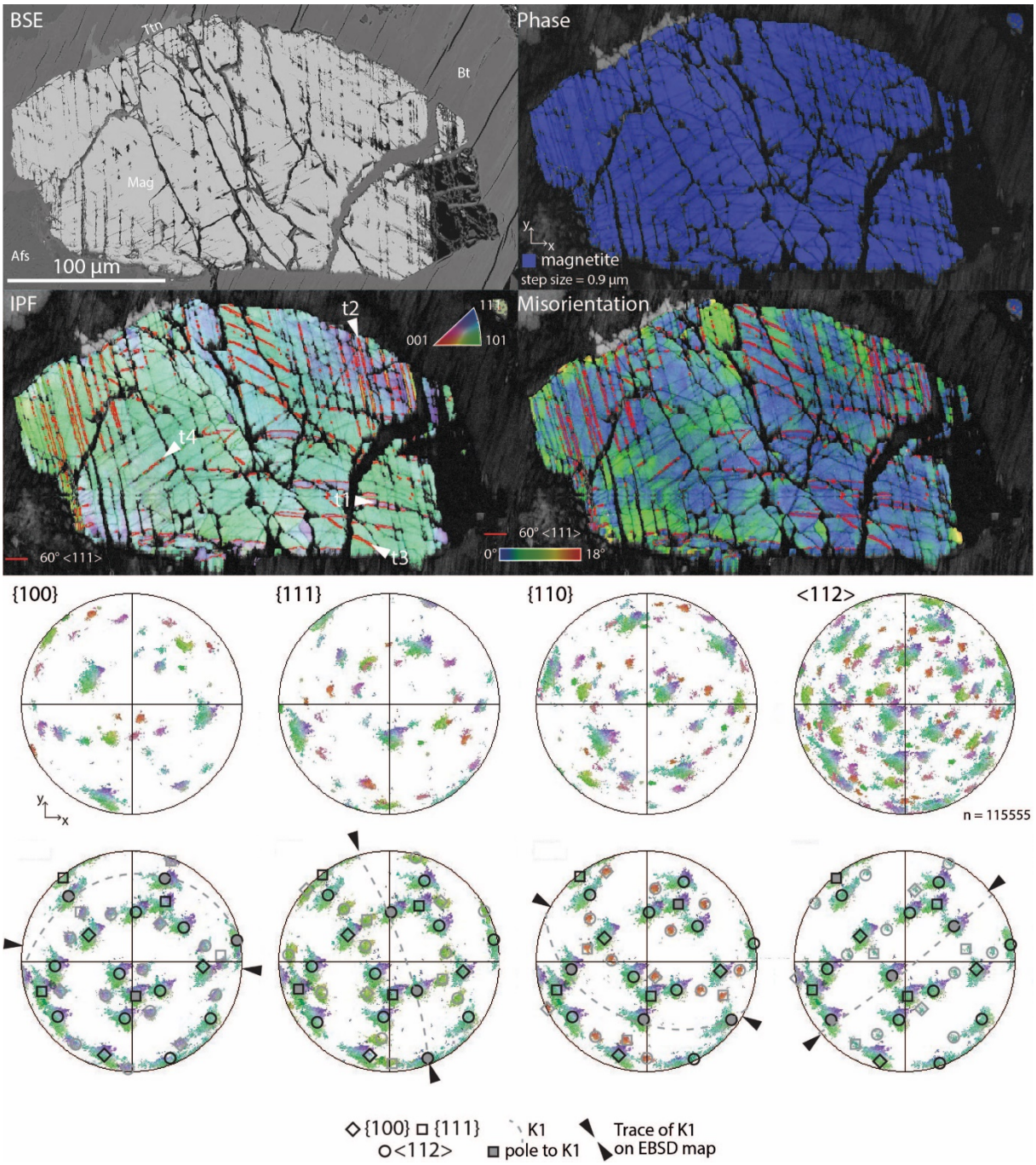
Item S6A. EBSD data for sample 69, grain 1. Note that this is a collection of subgrains. From top left: BSE image with phases marked, phase information map + BC, misorientation map + BC, IPF maps denoting the grain orientation(s) with close-up of zircon grain with twins + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Twin labels (t1.1, t2.1, t3.1, etc.) distinguishes twins in each subgrain (1-3). Afs = K-feldspar, Pl = plagioclase, Qz = quartz, Bt = biotite, Mag = magnetite, Zrn = zircon, Ap = apatite.



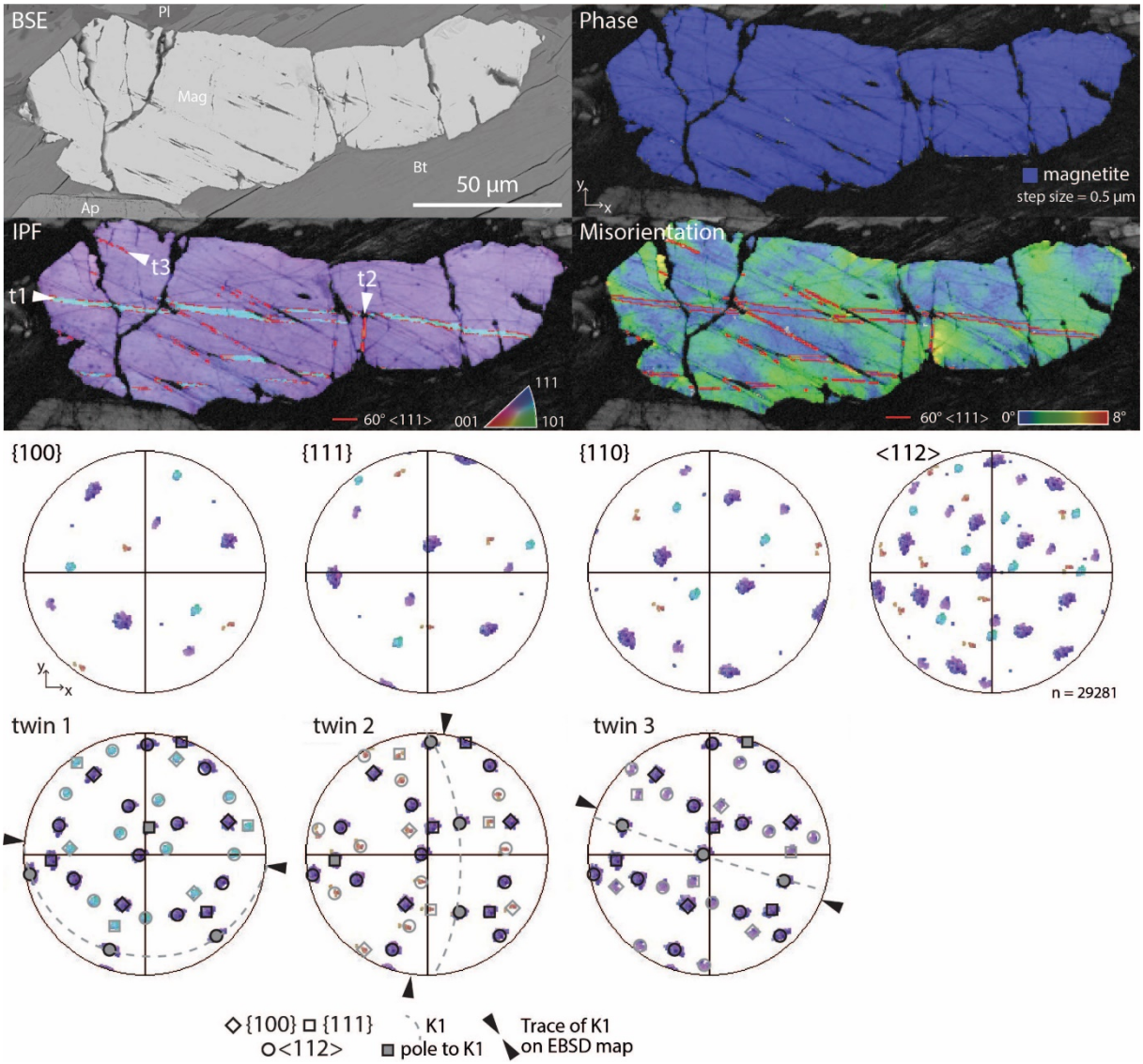
Item S6A. (cont.)



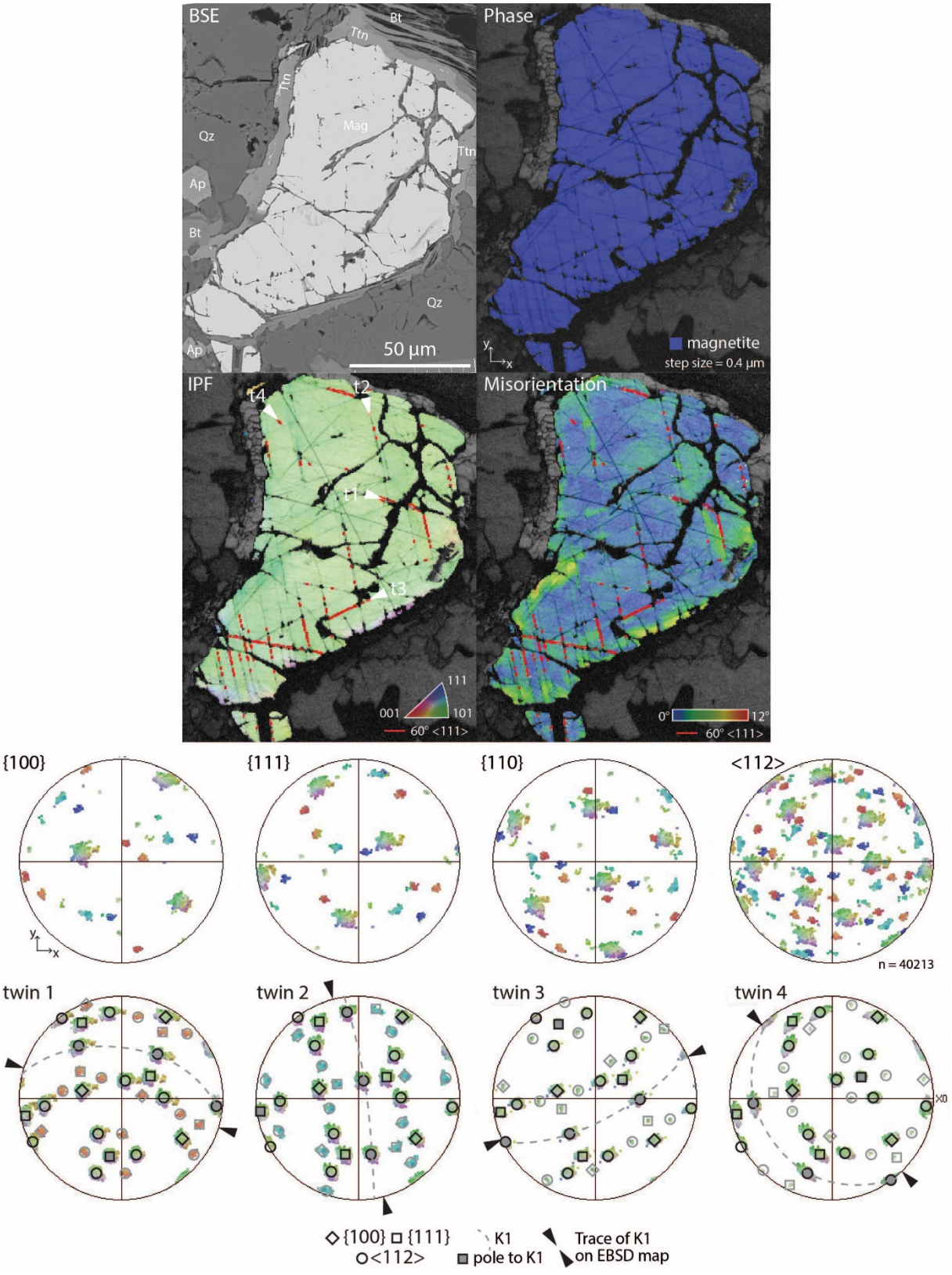
Item S6B. EBSD data for sample 69, grain 2. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation(s) + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Afs = K-feldspar, Bt = biotite, Mag = magnetite, Ttn = titanite.



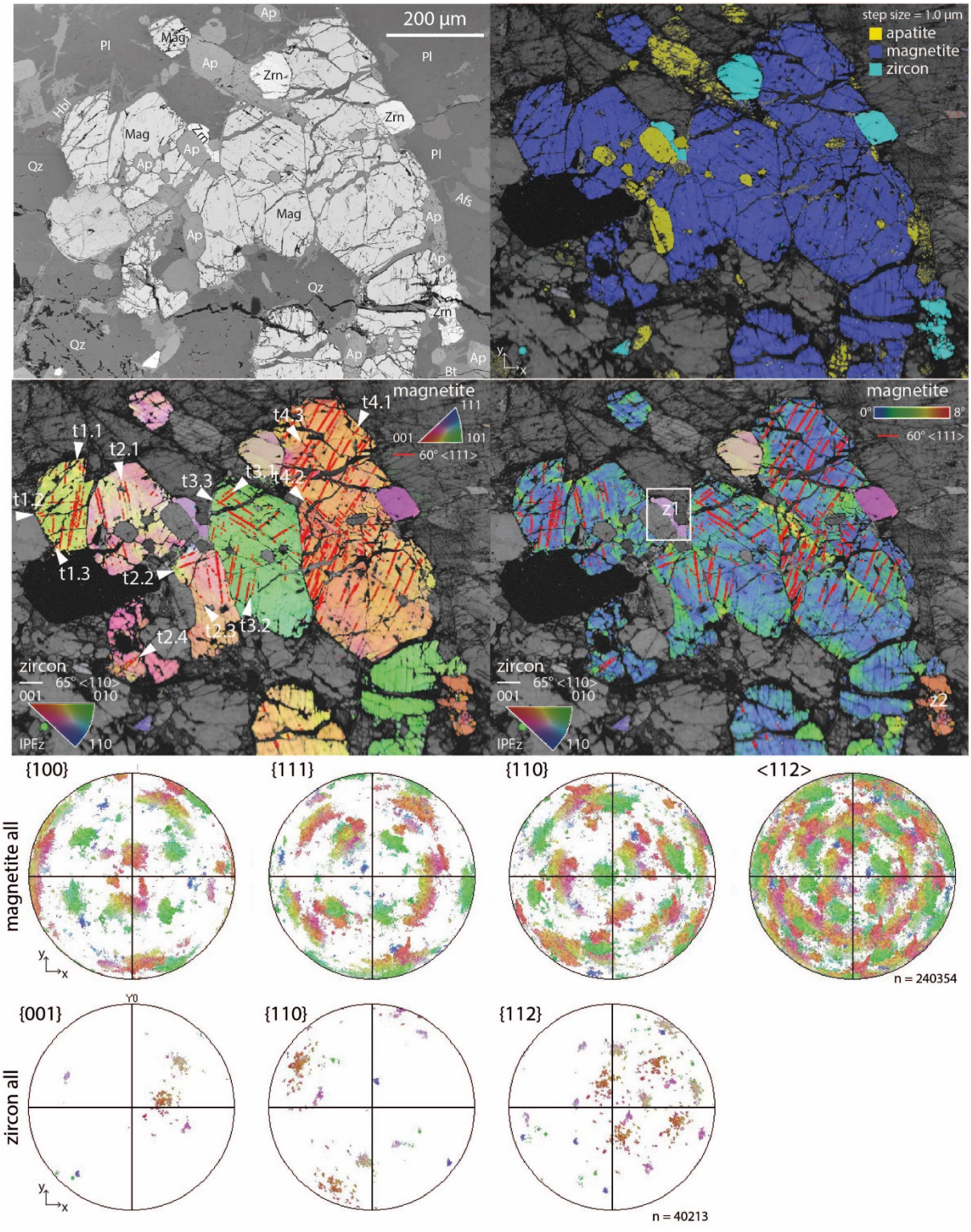
Item S6C. EBSD data for sample 69, grain 3. From top left: BSE image with phases marked, phase information map + BC, IPF map denoting the grain orientation(s) + BC, misorientation map + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Pl = plagioclase, Bt = biotite, Mag = magnetite, Ap = apatite.



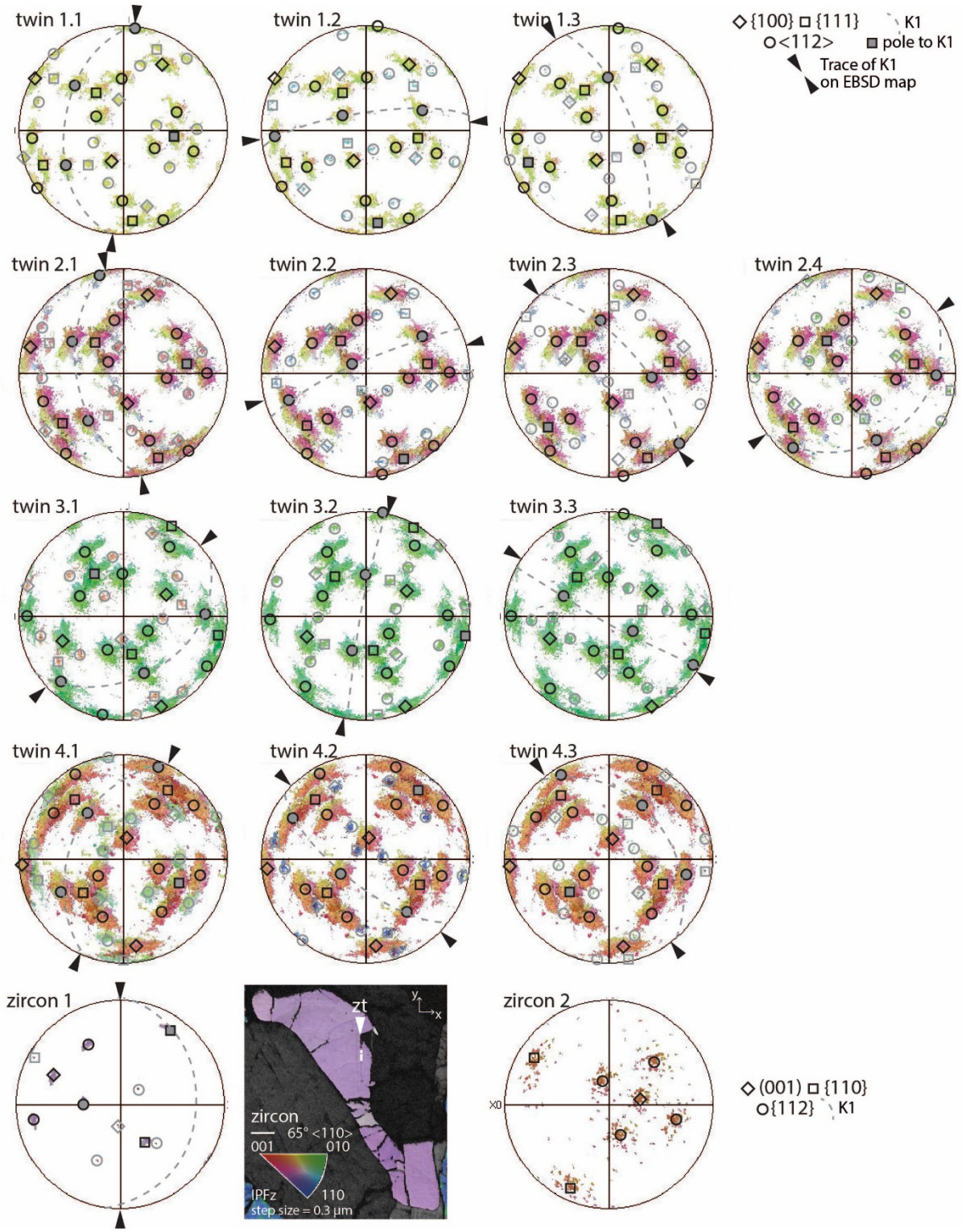
Item S6D. EBSD data for sample 69, grain 4. From top left: BSE image with phases marked, phase information map + BC, misorientation map + BC, IPF map denoting the grain orientation(s) + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Qz = quartz, Bt = biotite, Mag = magnetite, Ap = apatite, Ttn = titanite.



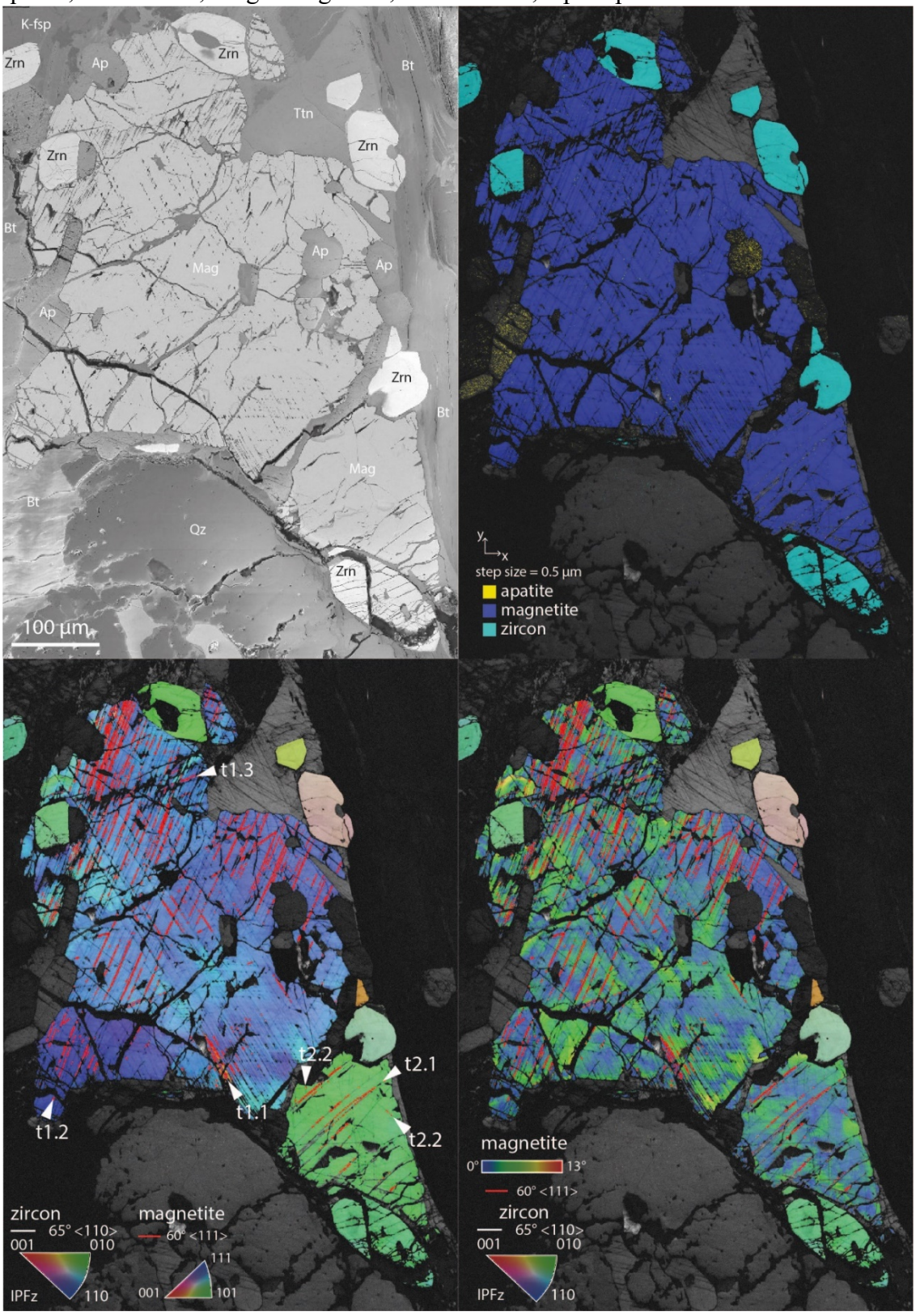
Item S6E. EBSD data for sample 69, grain 5. Note that this is a cluster of subgrains and that each twin (t1.1, t2.3 etc) is labeled individually to separate twins in each subgrain and tie them to their respective pole figure. From top left: BSE image with phases marked, phase information map + BC, misorientation map + BC, IPF map denoting the grain orientation(s) + BC, and pole figures. Stereo net projections are equal area, lower hemisphere. BC = Band contrast; IPF = Inverse pole figure. Afs = K-feldspar, Pl = plagioclase, Qz = quartz, Bt = biotite, Hbl = hornblende, Mag = magnetite, Zrn = zircon, Ap = apatite.



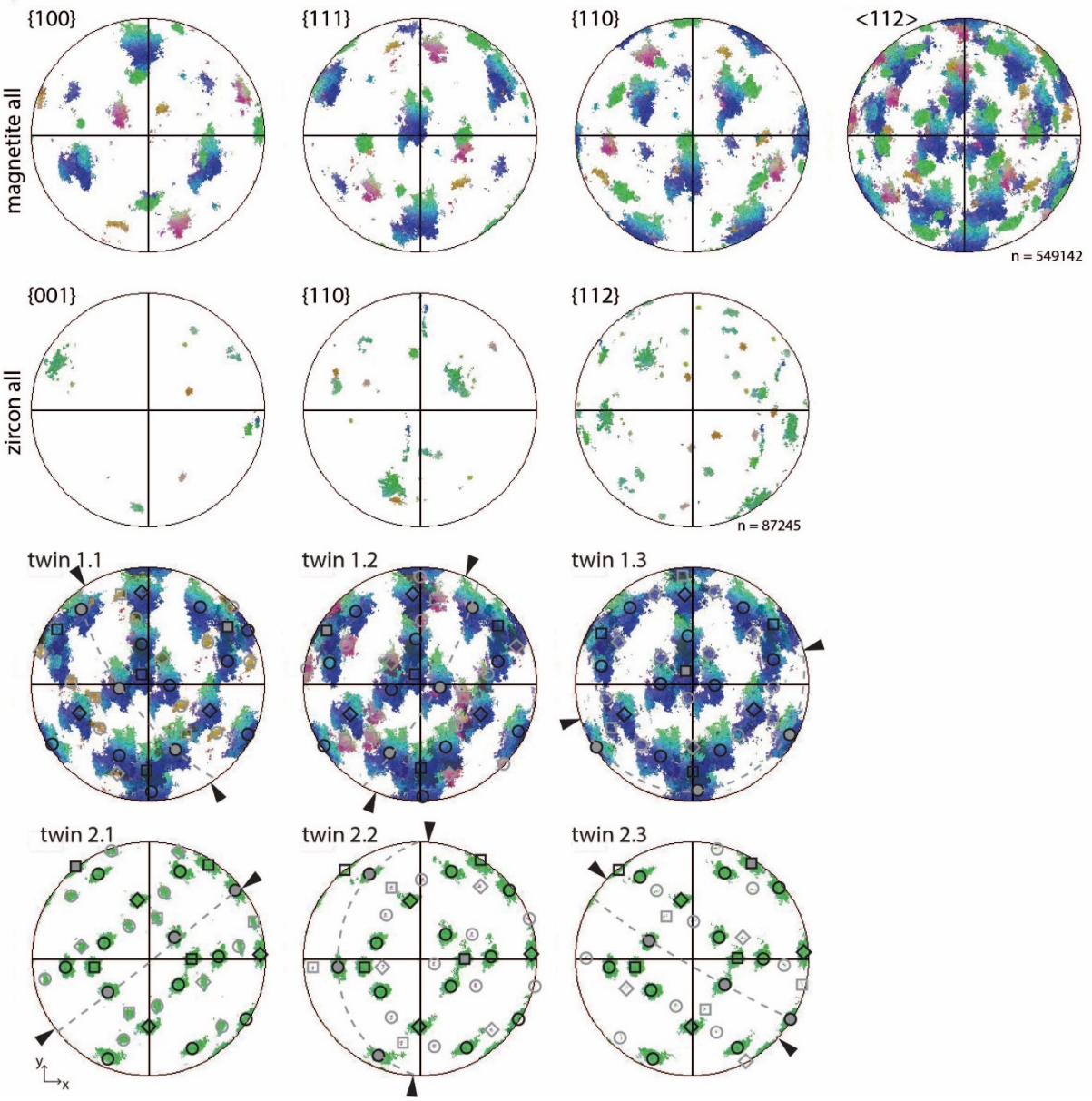
Item S6E (cont.).



Item S6F. EBSD data for sample 69, grain 6. Note that this is a cluster of two subgrains and that each twin (t1.1, t2.3 etc) is labeled individually to separate twins in each subgrain and tie them to their respective pole figure. From top left: BSE image with phases marked, phase information map + BC, misorientation map + BC, IPF map denoting the grain orientation(s) +BC. BC = Band contrast; IPF = Inverse pole figure. Afs = K-feldspar, Pl = plagioclase, Qz = quartz, Bt = biotite, Mag = magnetite, Zrn = zircon, Ap = apatite.



Item S6F (cont.).



Item S7. EBSD SET UP INFORMATION

Sample	5			21			58		69							
Grain/area	1	2	3	1	2	3	1	2	1	2	3	4	5	6	Grain 1 Z1	Grain 5 Z1
Shown in figures	DR* 3A	3, DR 3B	DR 3C	DR 4A	DR 4B	3, DR 4C	DR 5A	3; DR 5B	2, DR 6A	3, DR 6B	DR 6C	DR 6D	DR 6E	DR 6F	2, DR 6A	DR 6E
Acquisition speed (Hz)	40.8	81	81	20.1	3.2	85.4	5.6	5.5	41.9	39.5	4.5	38	17.2	41.7	40.9	41.7
Auto background correction	on	on	on	on	on	on	on	on	on	on	on	on	on	on	on	on
Binning	–	–	–	4 x 4	2 x 2	–	2 x 2	2 x 2	–	–	2 x 2	–	–	–	–	–
Resolution (pixles)	1244 x 1024	1244 x 1024	1244 x 1024	–	–	1244 x 1024	–	–	1244 x 1024	1244 x 1024	–	1244 x 1024	1244 x 1024	1244 x 1024	1244 x 1024	1244 x 1024
EBSD camera gain	2	2	2	1	1	2	1	1	2	1	1	2	2	2	2	2
Hough resolution	60	60	60	80	80	60	80	80	60	60	80	60	60	60	60	60
Band detection	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Xcells	500	357	371	452	494	499	238	177	1964	661	388	271	914	1211	1239	259
Ycells	289	427	398	578	369	458	266	173	2405	367	147	341	987	1740	1155	300
Step size (μm)	0.7	0.7	0.7	0.5	0.5	0.4	0.5	0.5	0.3	0.9	0.5	0.4	1.0	0.5	0.1	0.3
Number of pixels in map (magnetite, hematite, zircon)	67677, N.A.†, N.A.	55892, 3117, N.A.	52775, N.A., N.A.	57367, 66103, N.A.	48321, 35459, N.A.	56786, 62913, N.A.	17135, 16565, N.A.	14186, 2597, N.A.	562555	115555, N.A., N.A.	29281, N.A., N.A.	40213, N.A., N.A.	240354, N.A., 40213	549142, N.A., 87245	1431045	77700
Acquisition time	00:58:29	00:28:21	00:28:21	03:32:34	15:46:15	00:43:11	03:09:24	01:30:11	18:41:05	01:42:15	03:31:56	00:40:34	14:34:25	14:03:05	09:43:47	00:31:05
Noise reduction methods Wildspike	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n neighbor zero solution extrapolation	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SEM Model: Tescan Mira3 FE-SEM																
EBSD system (Oxford)	Symmetry	Symmetry	Symmetry	NN§	NN	Symmetry	NN	NN	Symmetry	Symmetry	NN	Symmetry	Symmetry	Symmetry	Symmetry	Symmetry
Match units: Magnetite from Della Guista et al. (1987), hematite from Estifanos et al. (1997), and zircon from the Inorganic Crystal Structure Database.																
Grains were in thin sections, mounted flat, and grounded with carbon tape and silver paint. The samples were mounted on a pre-tilted (70°) sample holder. The samples were not carbon coated, except for grain 6, sample 69 (<5 nm).																
Accelerating voltage (kV)	20	20	20	20	20	20	20	20	20	30	20	20	20	20	20	20
Working distance (mm)	15	14.4	15.9	20.6	15.7	15	20.1	20.8	15.1	17	17.6	17	15.3	14.8	16.8	12.4

*DR = Data Repository

†N.A. = Not applicable

§NN = NordlysNano