Appendix 6

6.1 XRD analyses

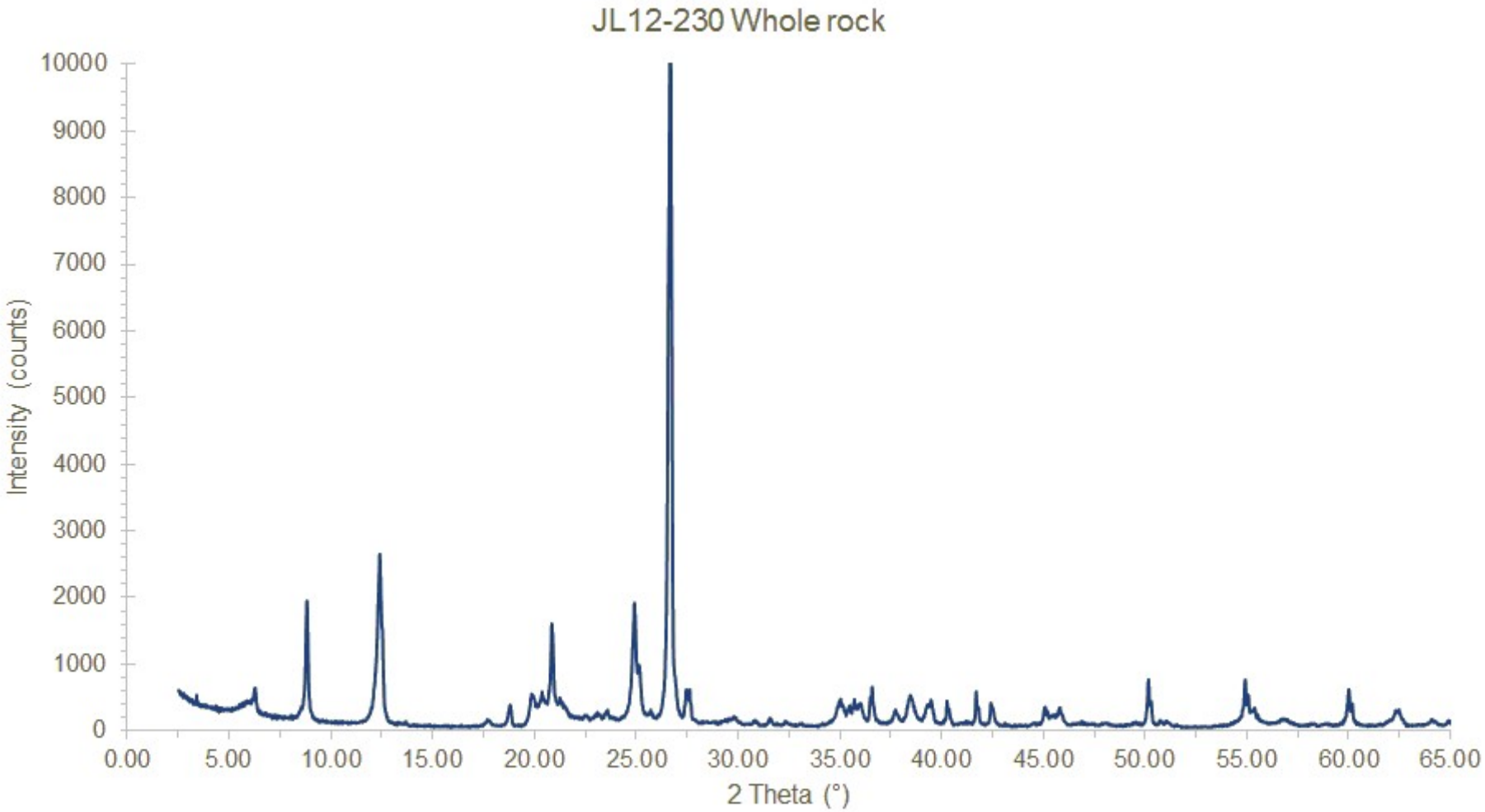
The reader is referred to Moore and Reynolds (1997) for the theory of X ray diffraction as applied to clay minerals. The XRD sample preparation are adopted from this source.

The XRD samples are run on a Philips PW1820 operated at 40 kV and 40 mA using Cu K-alpha radiation.

6.1.1 Sample preparation

6.1.1.1 Whole rock

Whole rock samples were crushed with a jaw crusher to <2cm size. 37 samples were hand crushed by pestle and mortar until a talc-like consistency (i.e. approximately 5-35μm). This whole rock powder was side-stacked into a 1mm deep aluminium sample holder ensuring a random orientation of crystals, but a flat surface (i.e. low topography). The unorientated samples were scanned from 2.5-65° at 0.02° 2θ with a counting time of 3 seconds per step. These samples are labelled JLxx.xxx WR, which corresponds to their original sample number. These whole rock XRD patterns revealed that quartz, feldspar and sulphides are the major phases, with the correct identification of clay phases present difficult due to peak dilution from these phases, thus clay seperates were produced for better identification of clay minerals.


JL12-230 Whole rock
Intensity (counts)
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8000
7000
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
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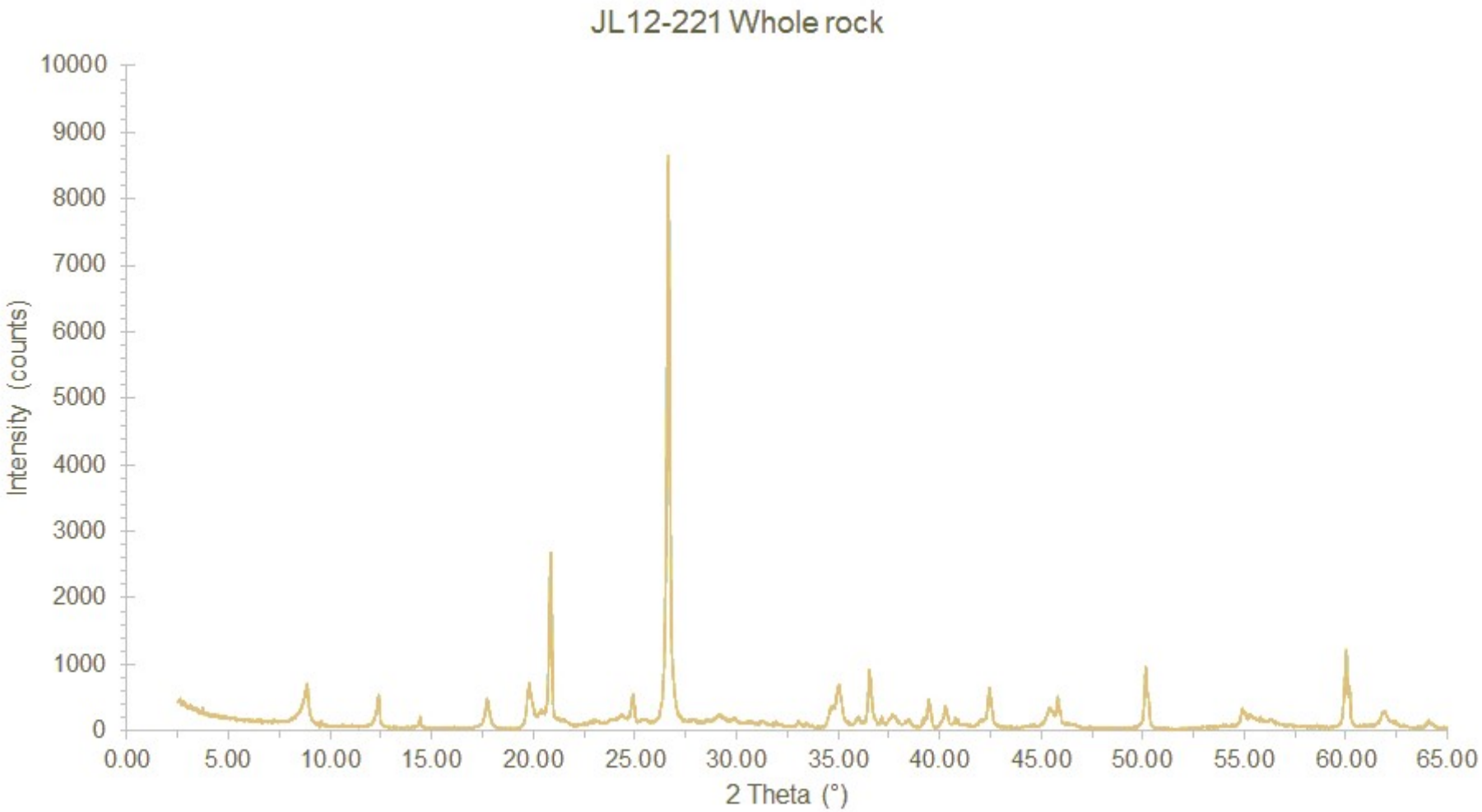
50.00
55.00
60.00
65.00
2 Theta (°)


JL12-221 Whole rock
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5000
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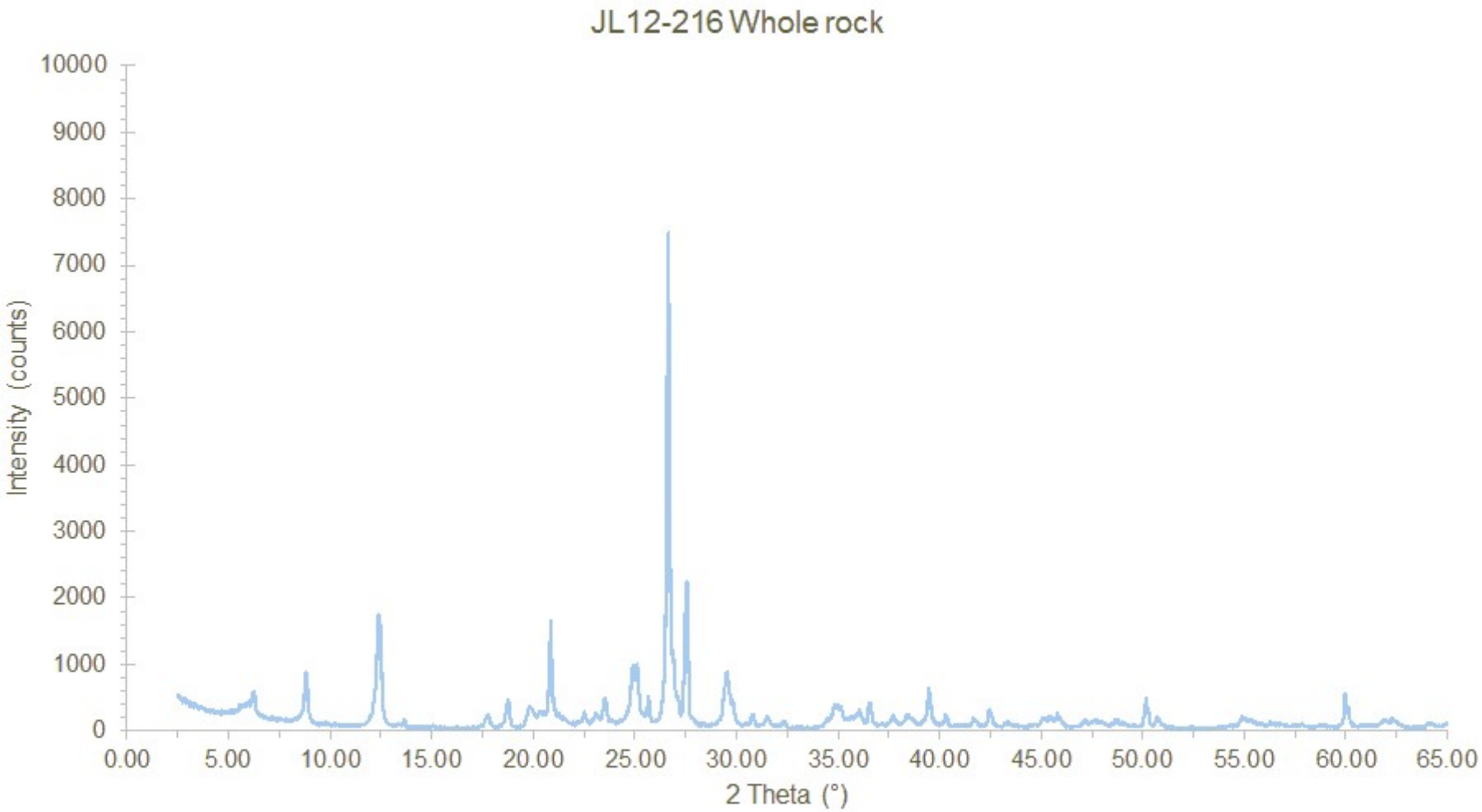
2 Theta (°)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10.00
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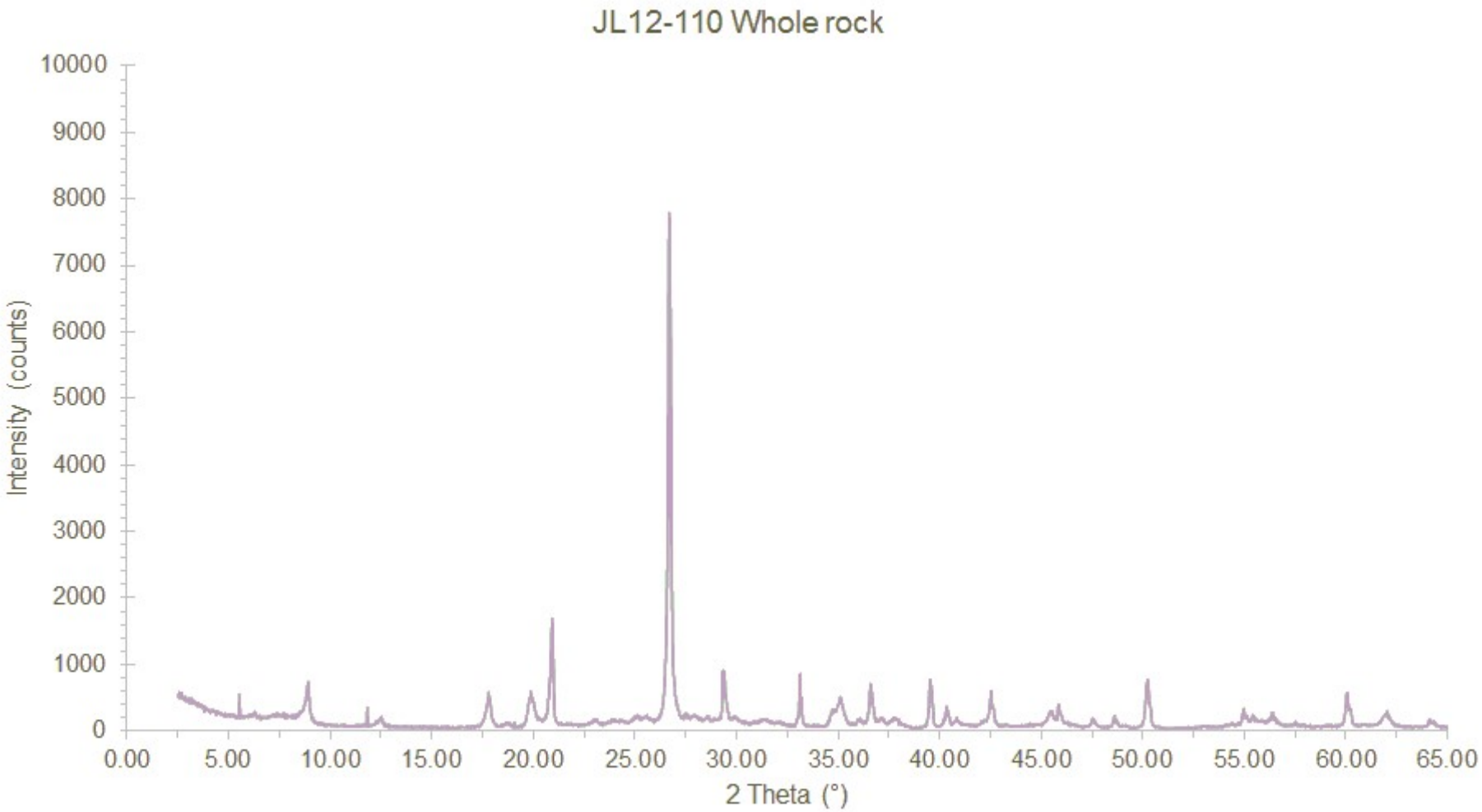
65.00
2 Theta (°)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3000
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10.00
15.00
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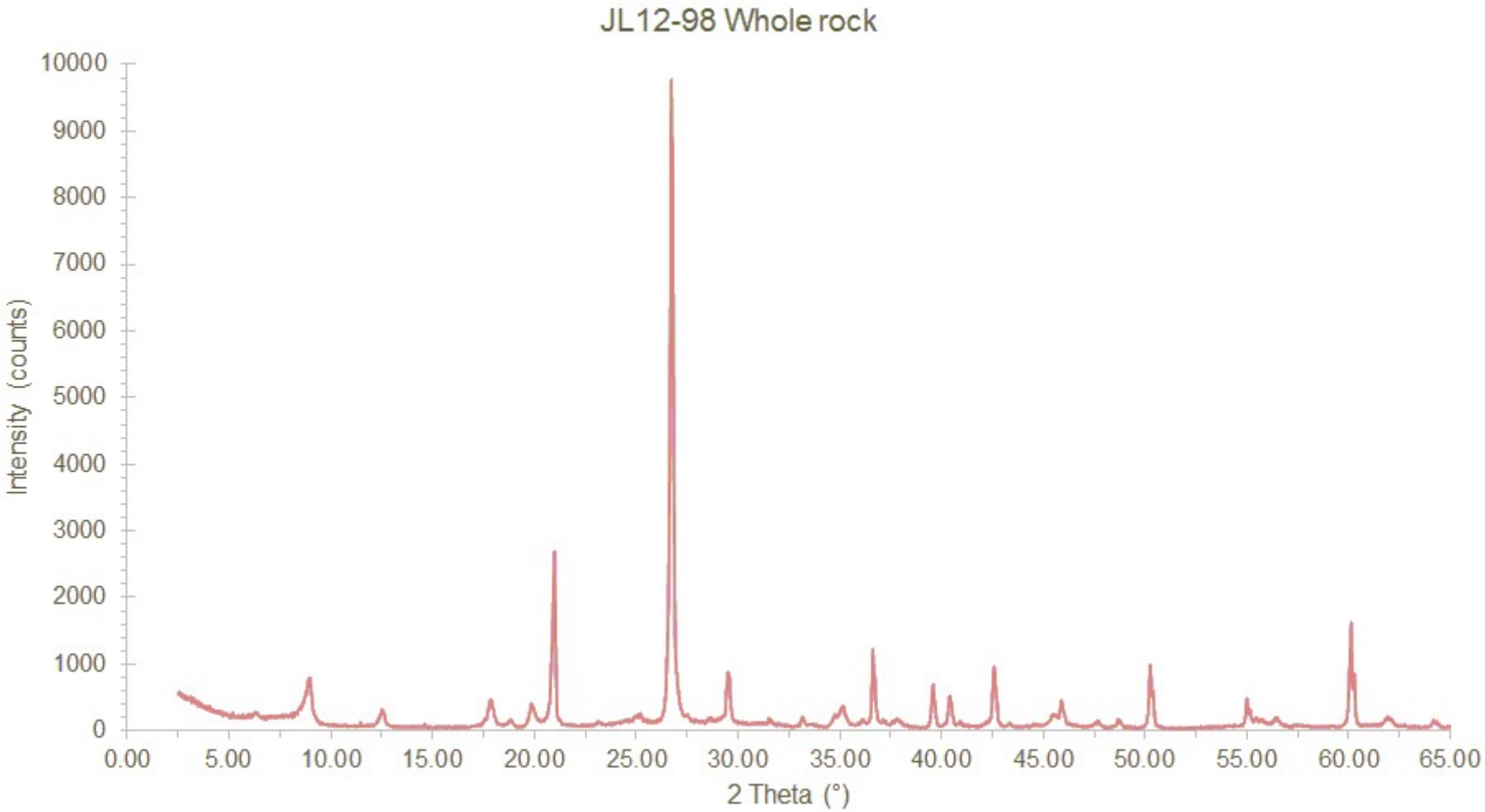
55.00
60.00
65.00
2 Theta (°)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10.00
15.00
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40.00
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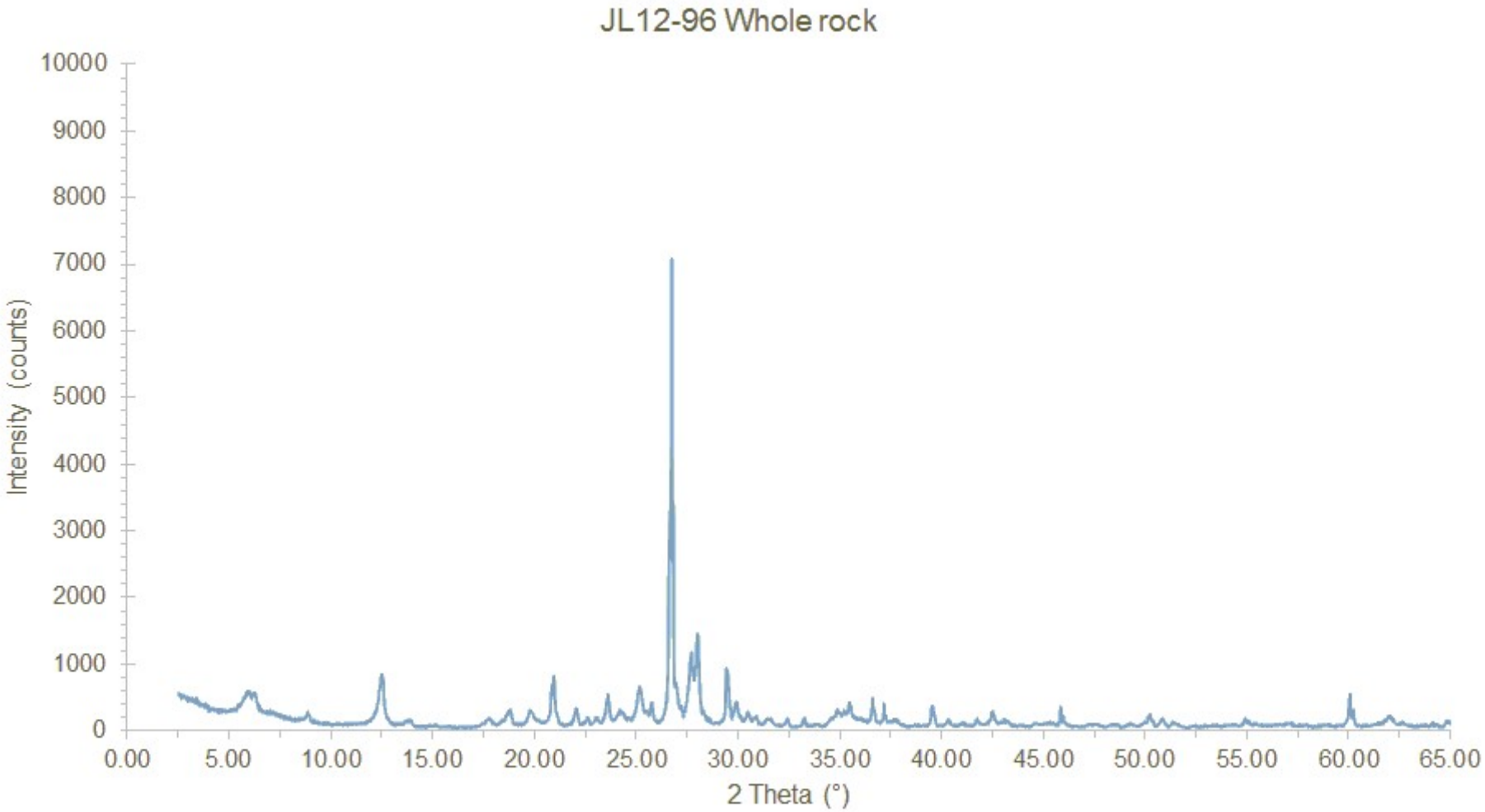
50.00
55.00
60.00
65.00
2 Theta (°)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4000
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10.00
15.00
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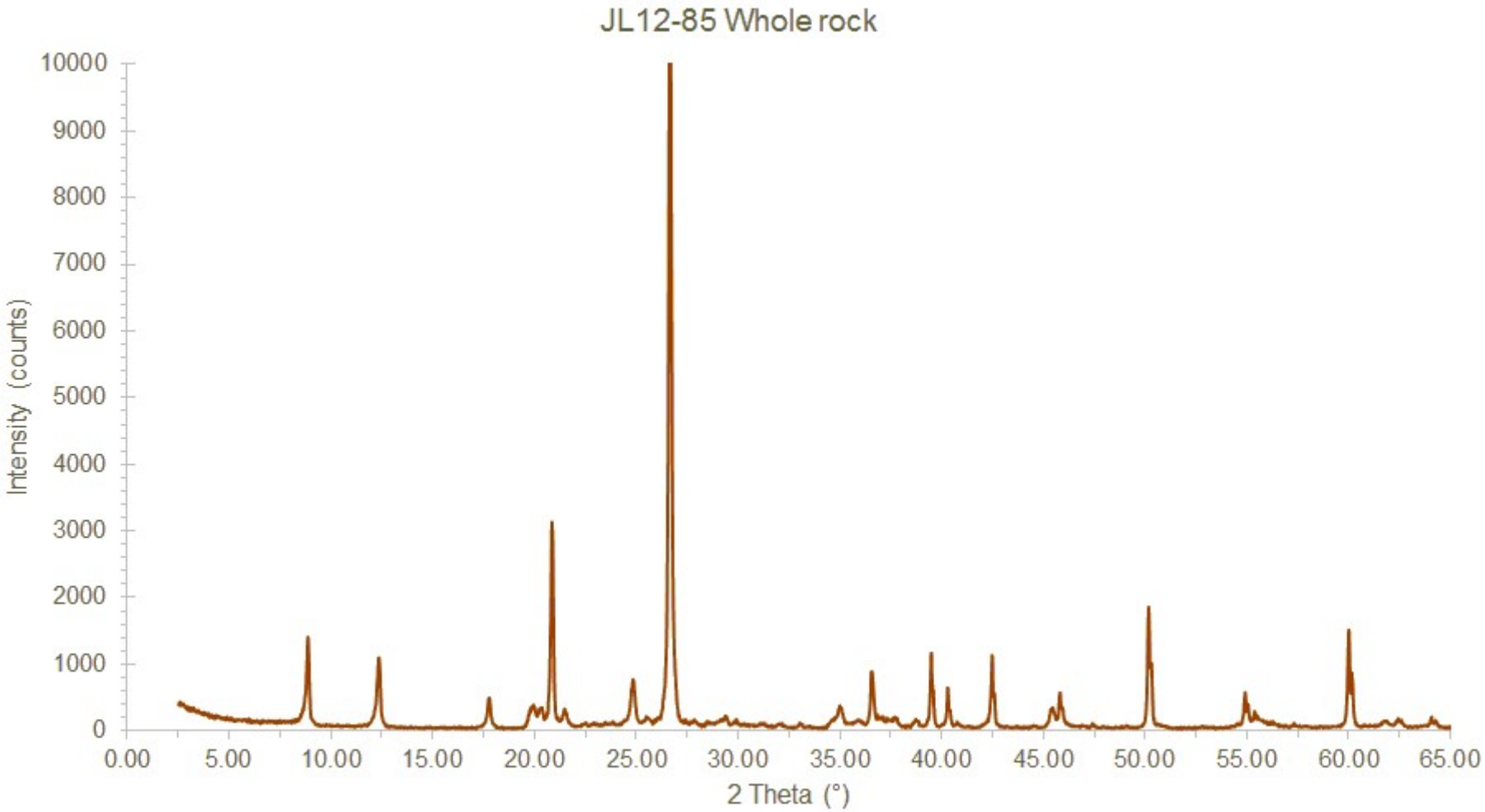
50.00
55.00
60.00
65.00
2 Theta (°)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10.00
15.00
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35.00
40.00
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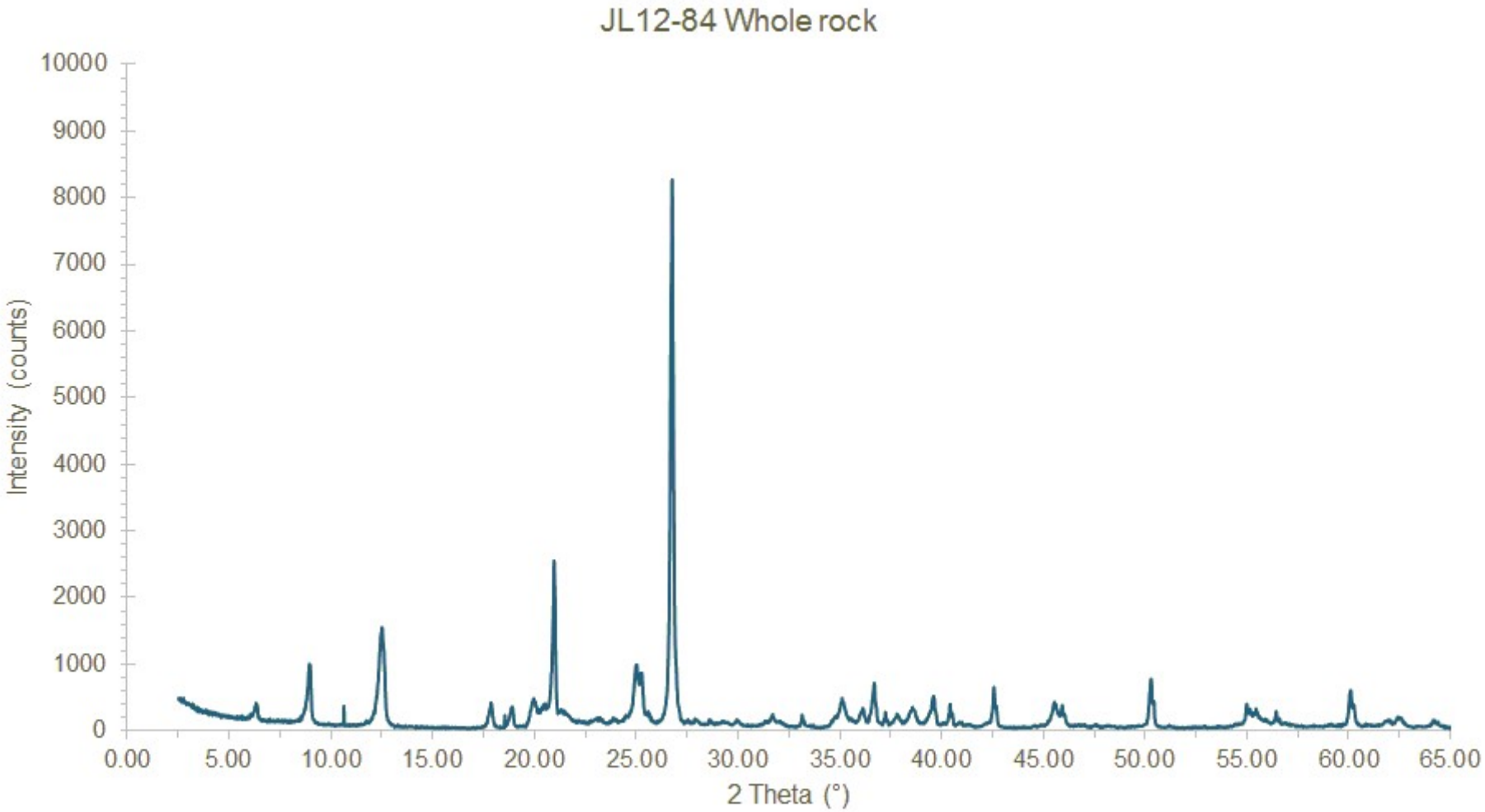
50.00
55.00
60.00
65.00
2 Theta (°)


JL12-84 Whole rock
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4000
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2000
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10.00
15.00
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55.00
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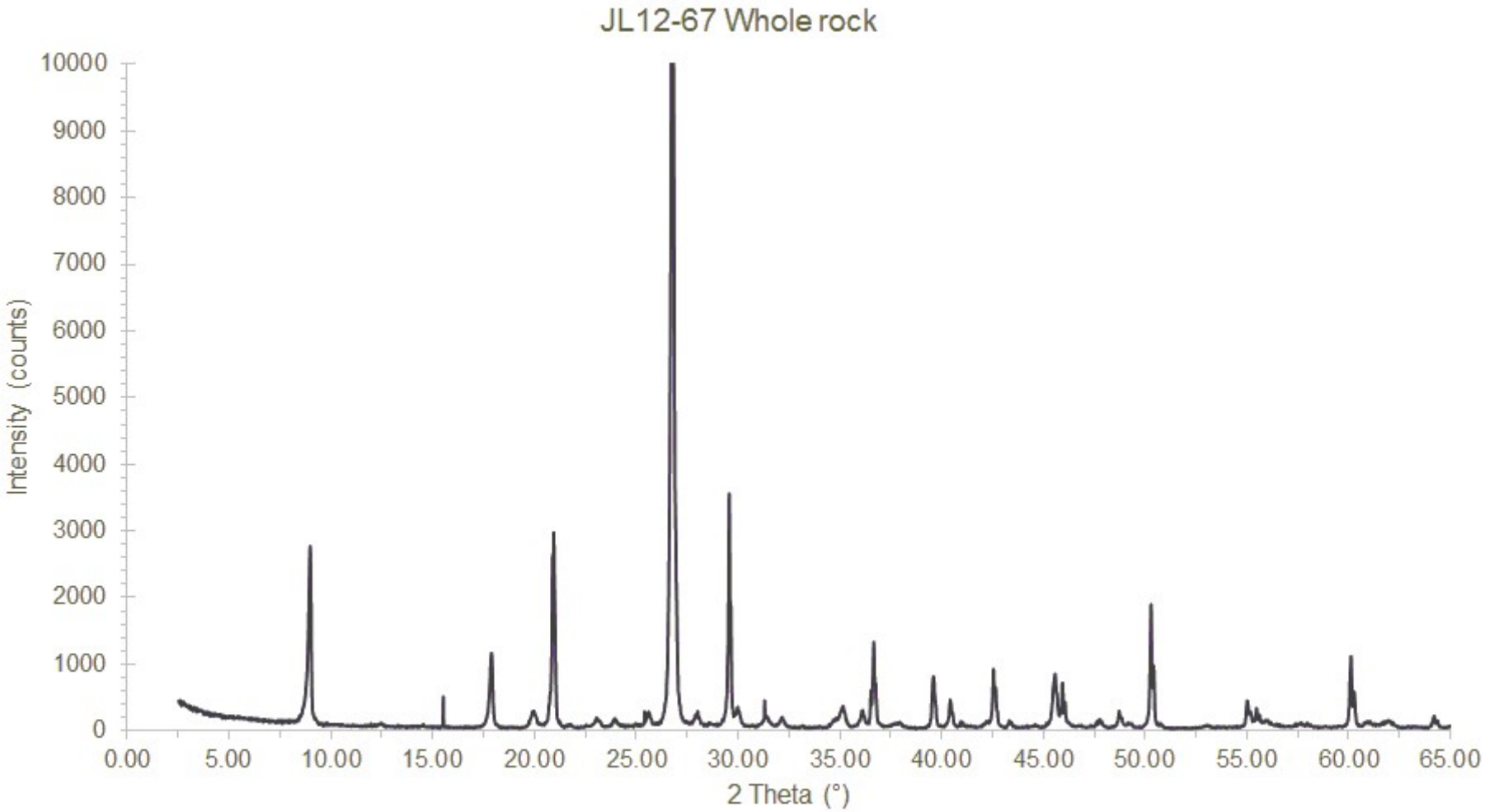
65.00
2 Theta (°)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6000
5000
4000
3000
2000
1000
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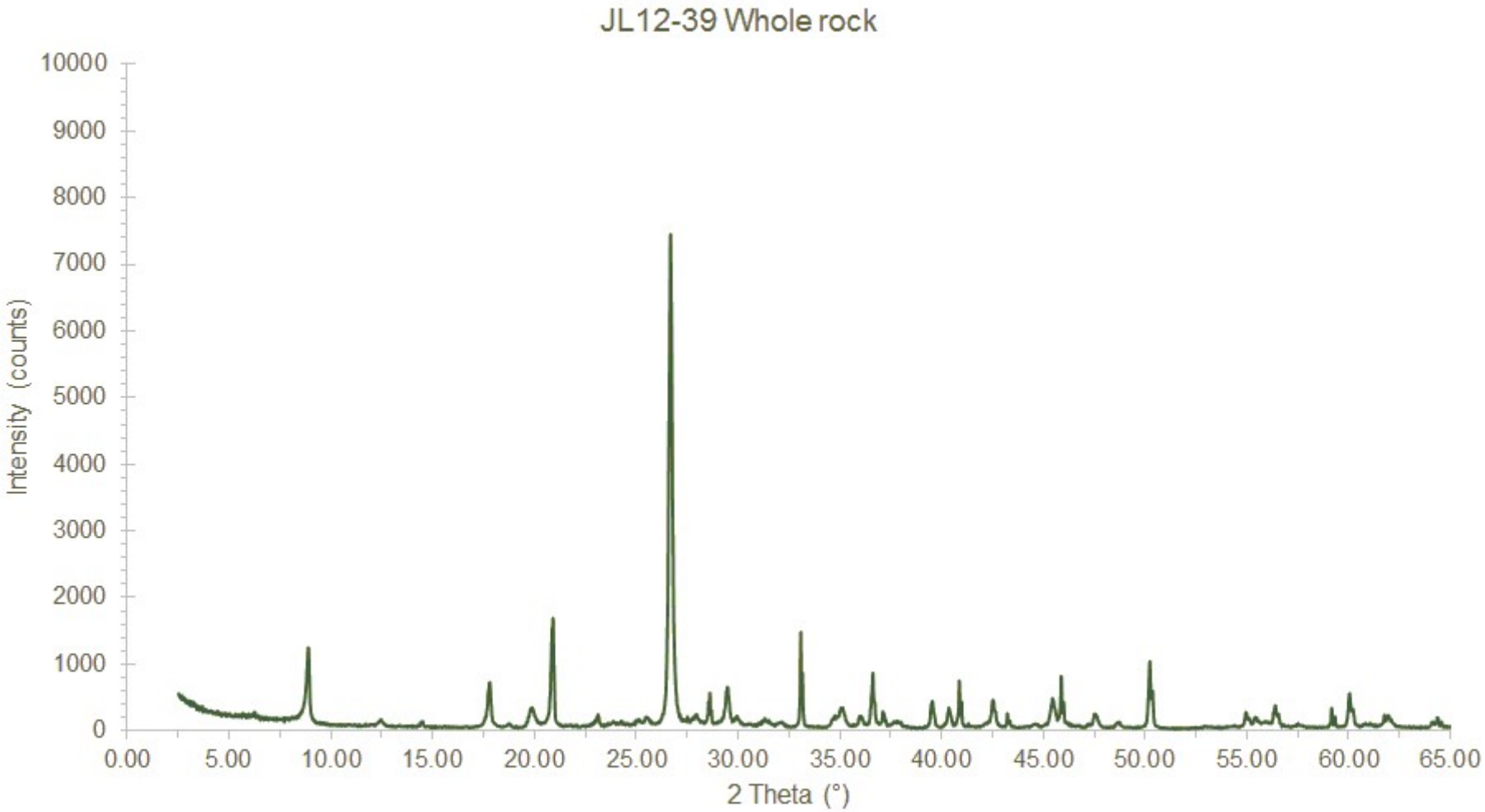
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL12-39 Whole rock
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7000
6000
5000
4000
3000
2000
1000
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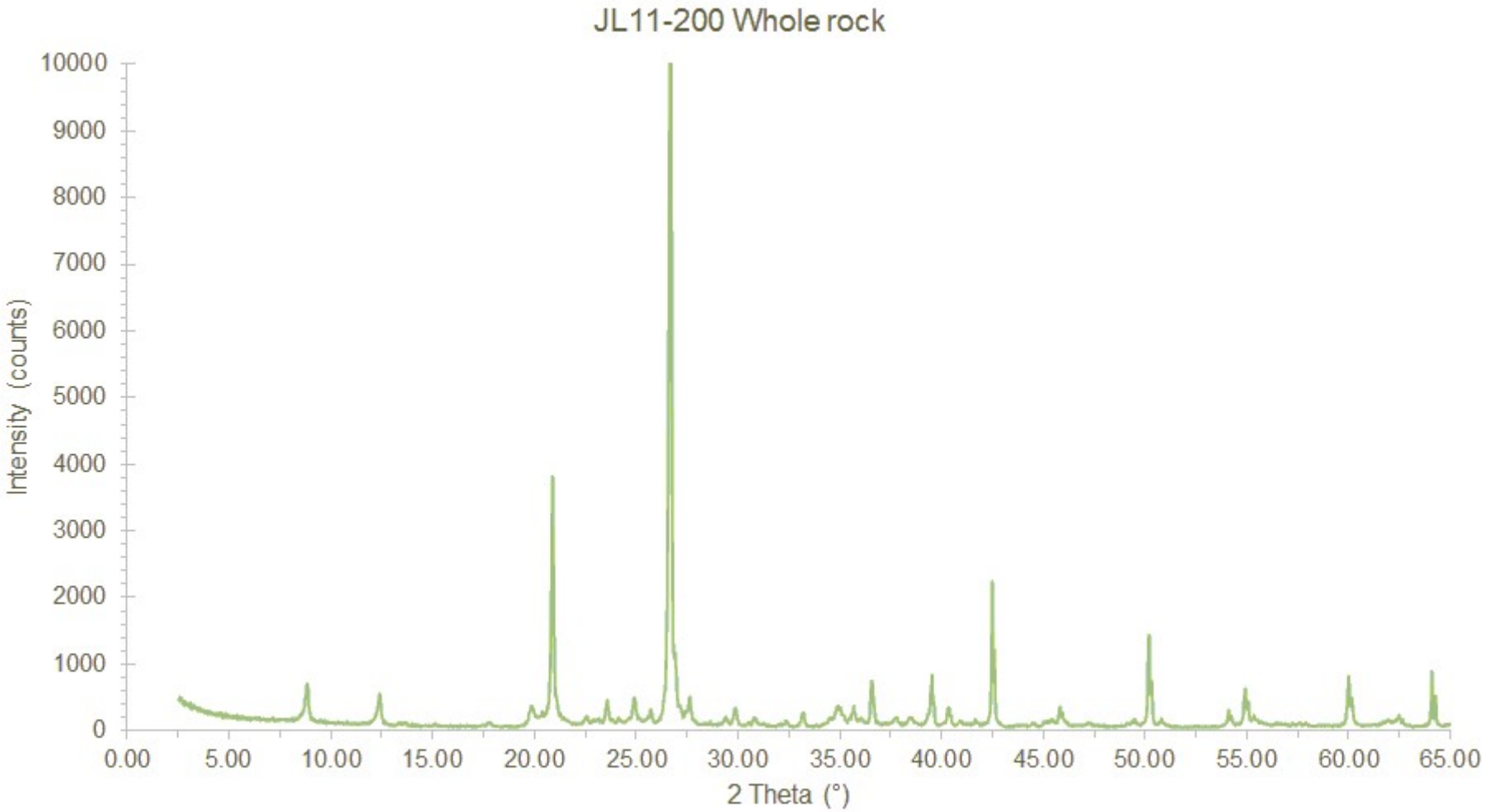
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-200 Whole rock
Intensity (counts)
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8000
7000
6000
5000
4000
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2000
1000
0
0.00
5.00
10.00
15.00
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30.00
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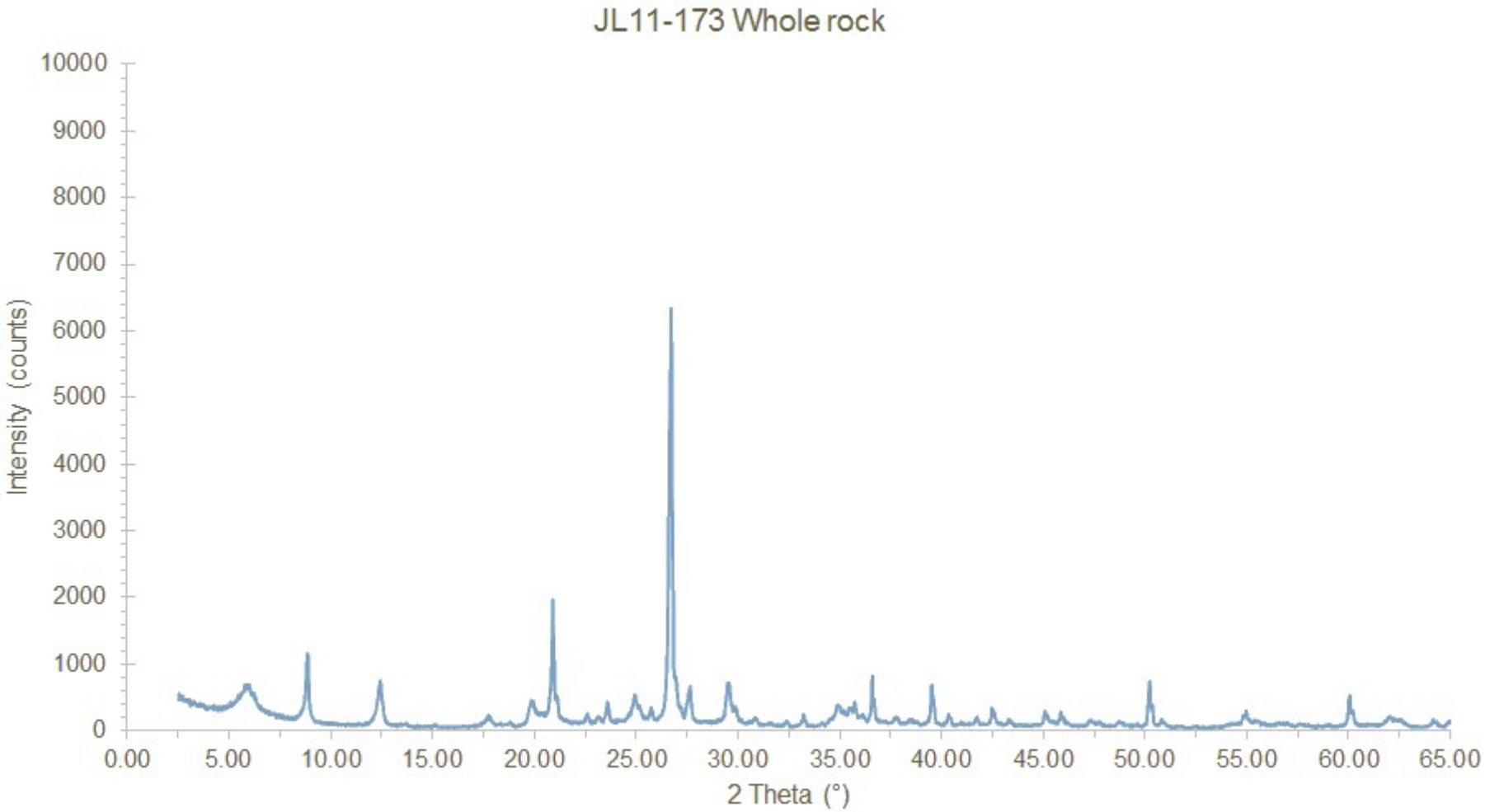
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)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7000
6000
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2000
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0.00
5.00
10.00
15.00
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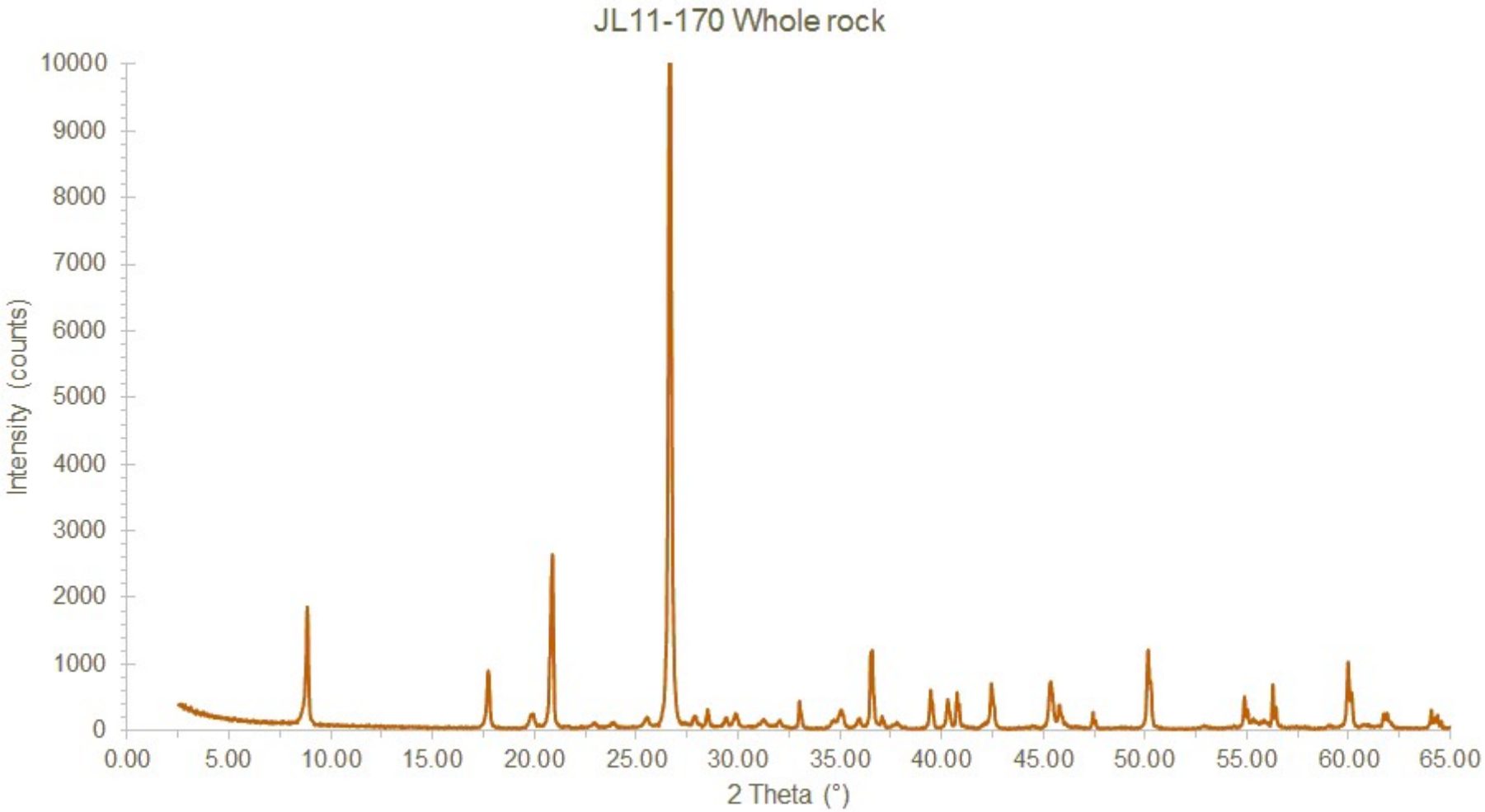
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)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4000
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2000
1000
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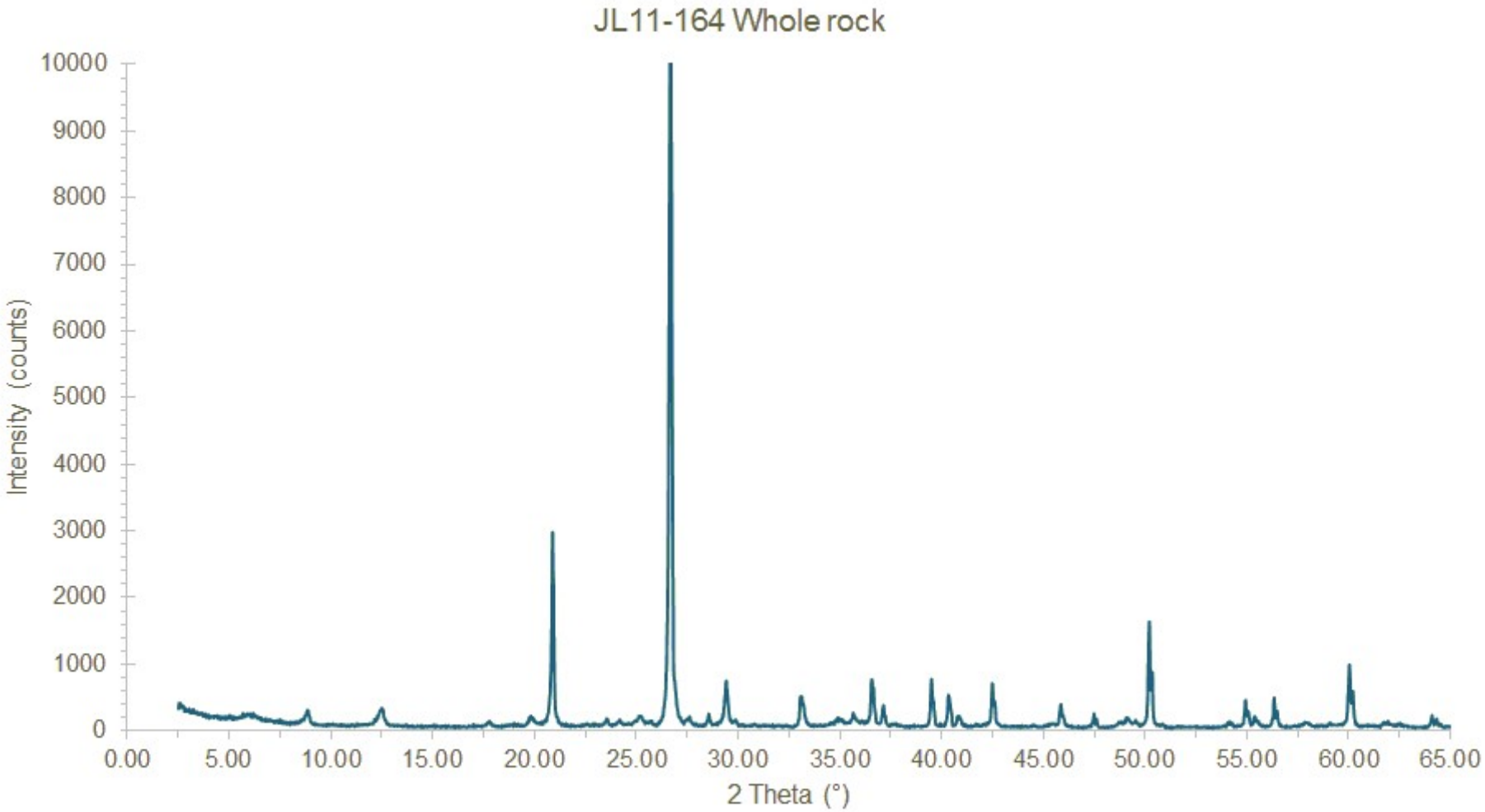
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-164 Whole rock
Intensity (counts)
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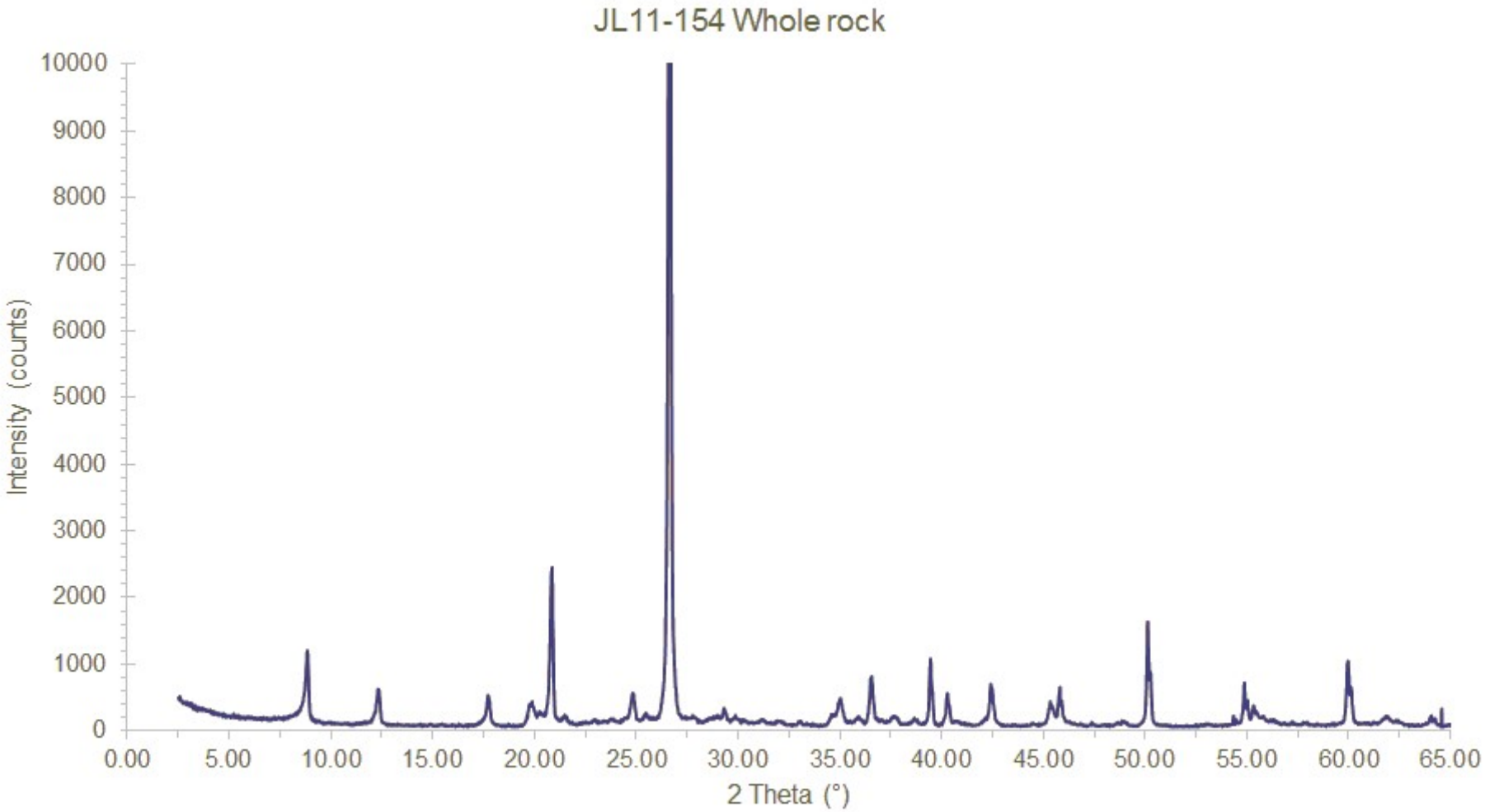
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)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Intensity (counts)
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6000
5000
4000
3000
2000
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0.00
5.00
10.00
15.00
20.00
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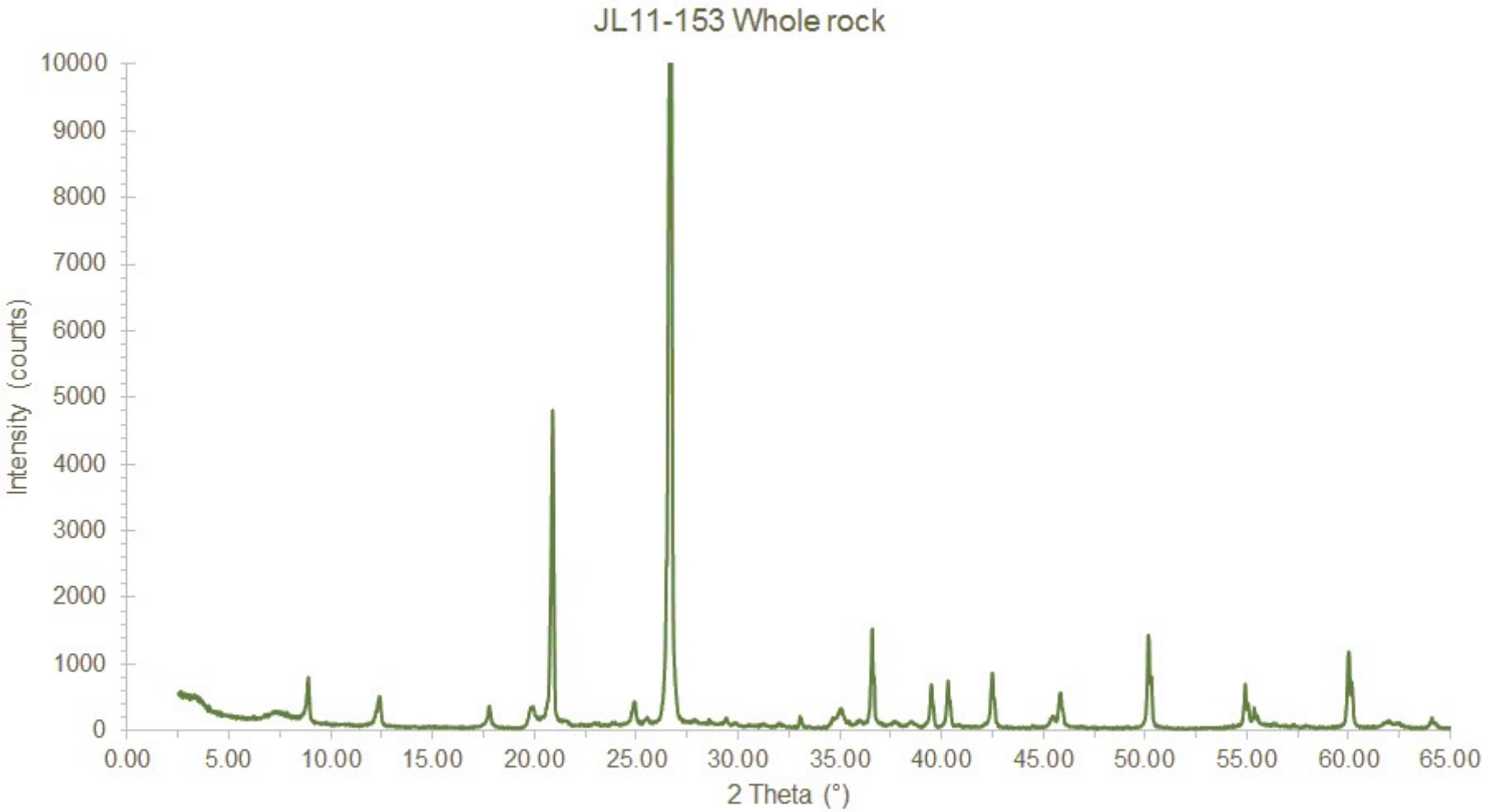
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)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Intensity (counts)
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5.00
10.00
15.00
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30.00
35.00
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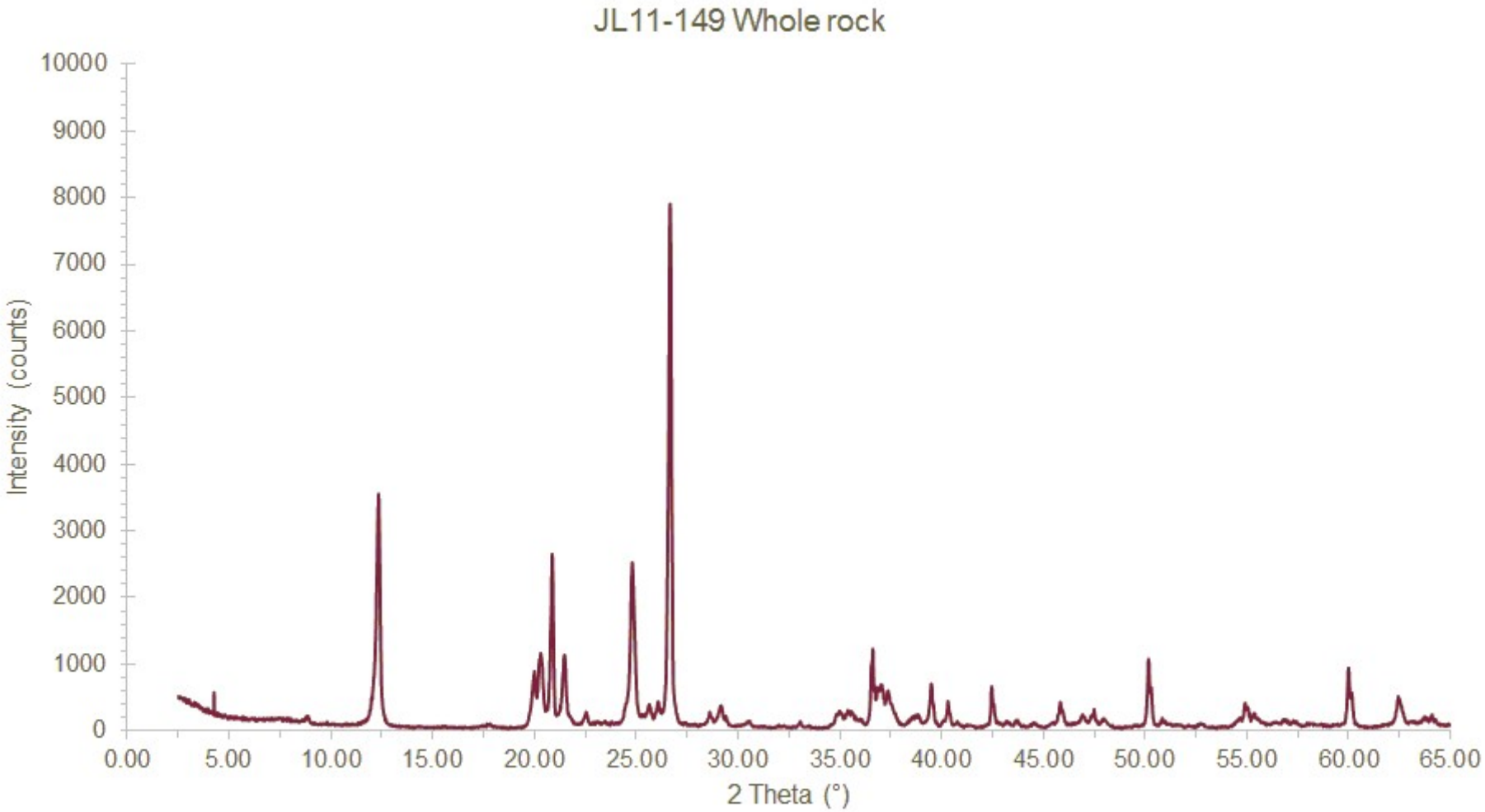
50.00
55.00
60.00
65.00
2 Theta (°)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10.00
15.00
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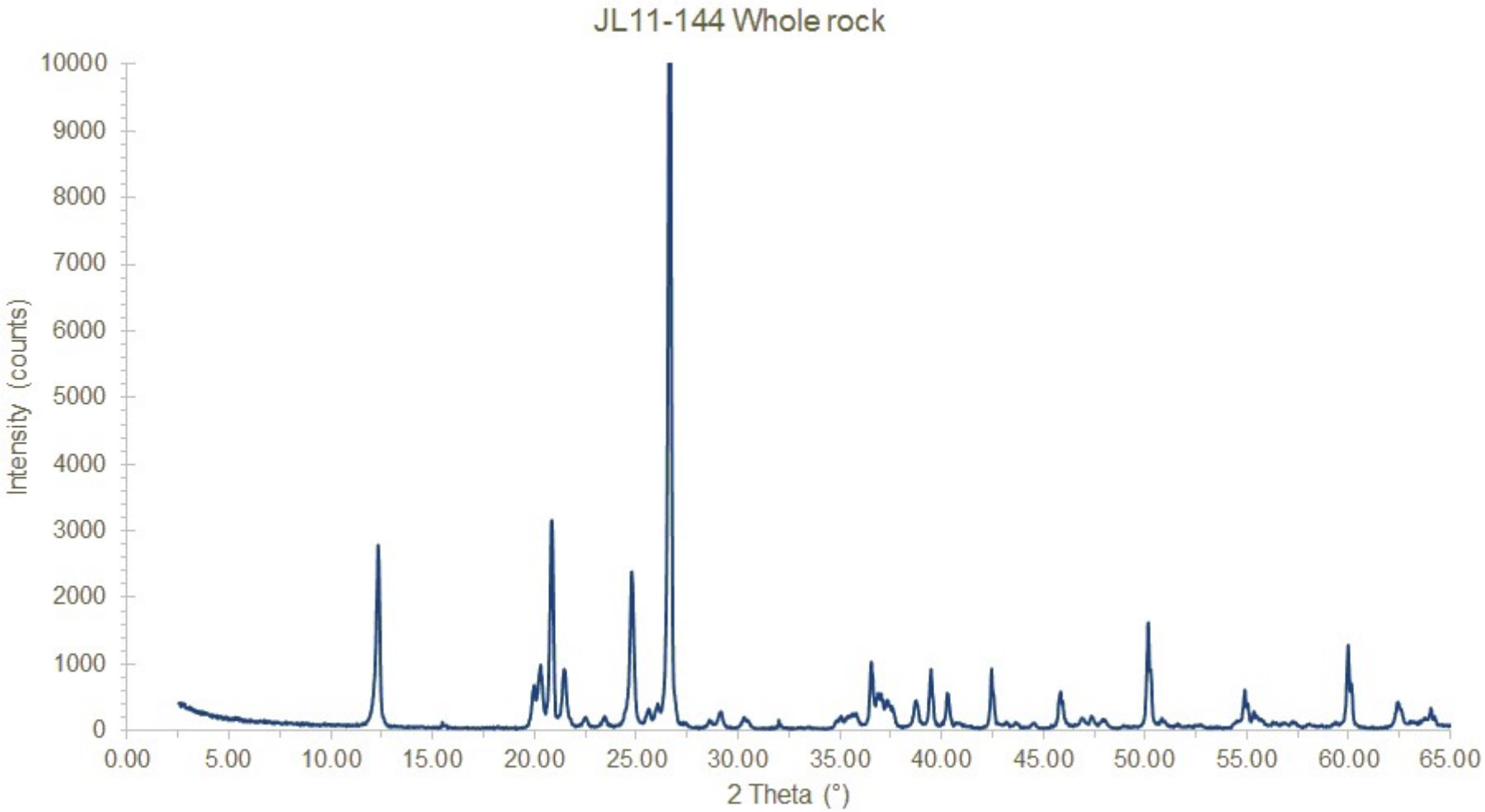
55.00
60.00
65.00
2 Theta (°)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10.00
15.00
20.00
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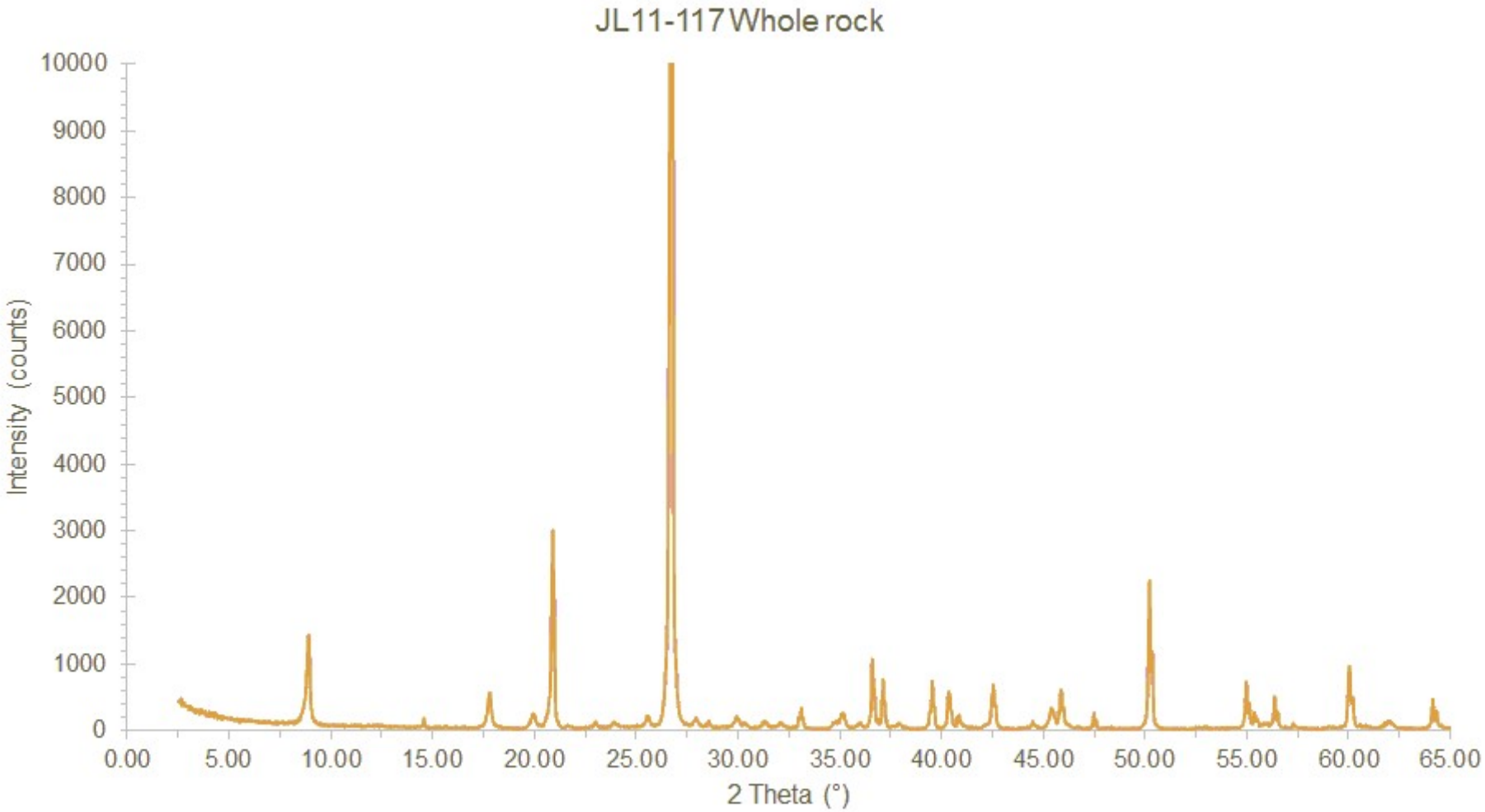
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)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10.00
15.00
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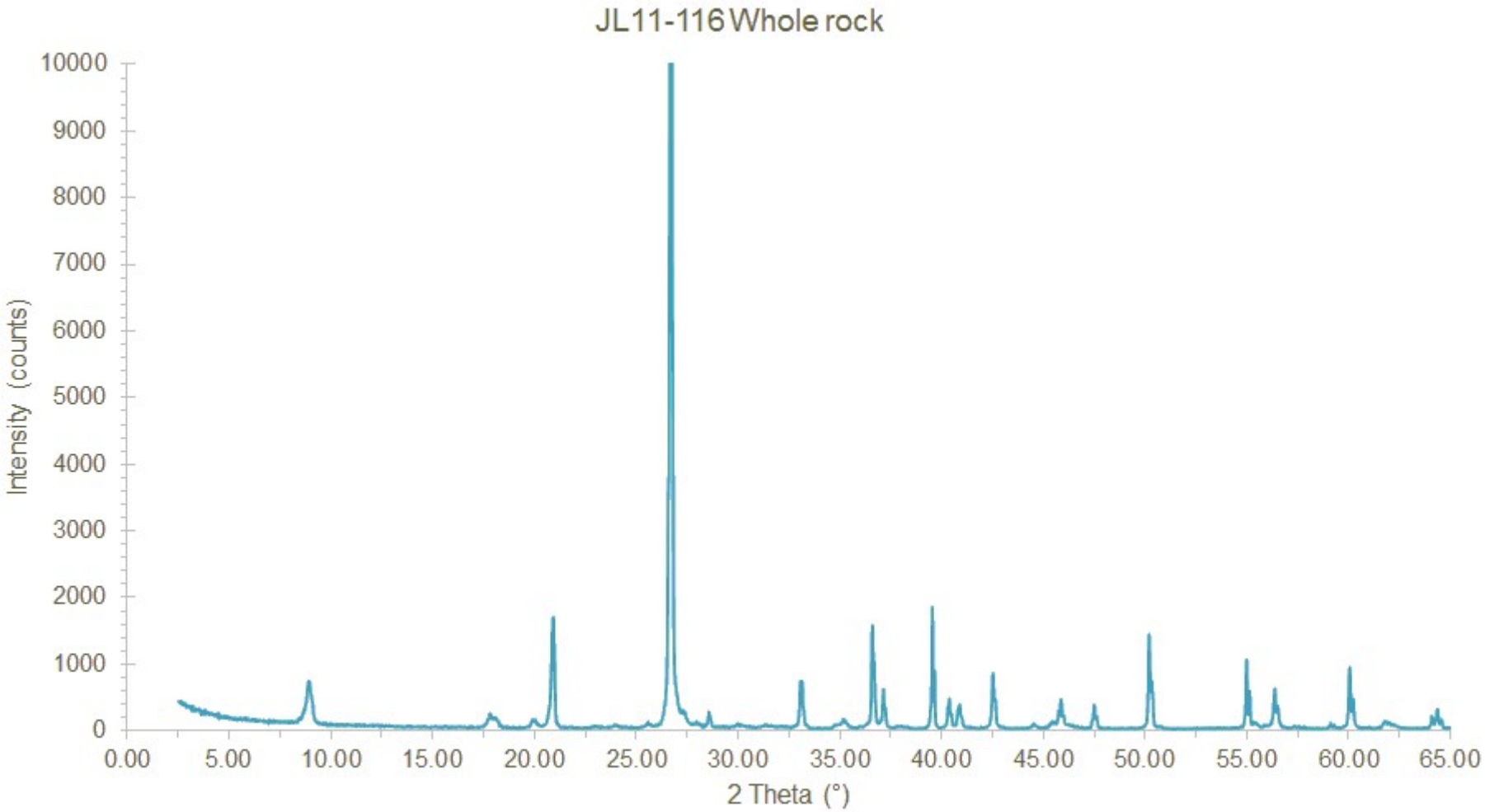
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)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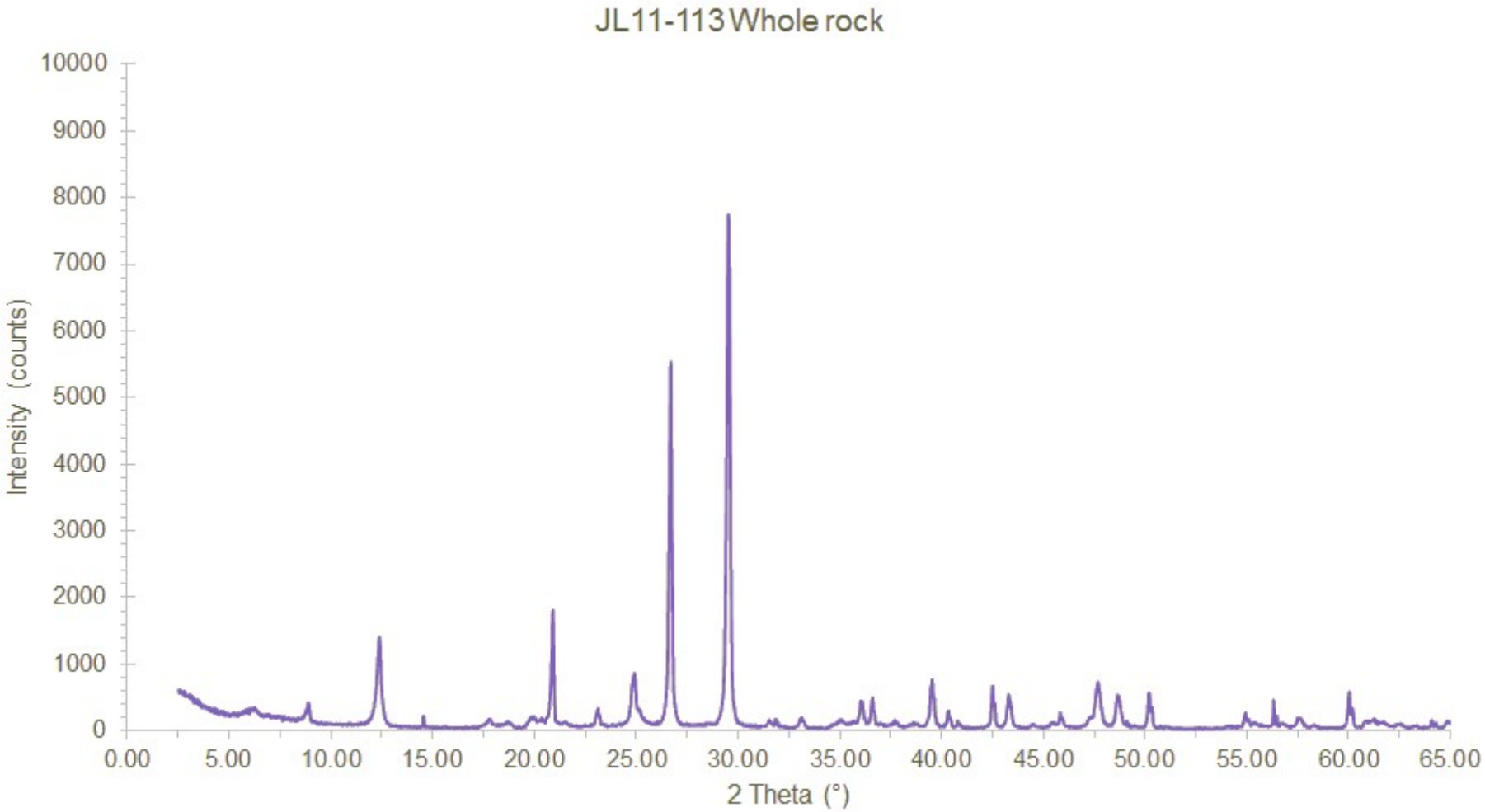
55.00
60.00
65.00
2 Theta (°)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65.00
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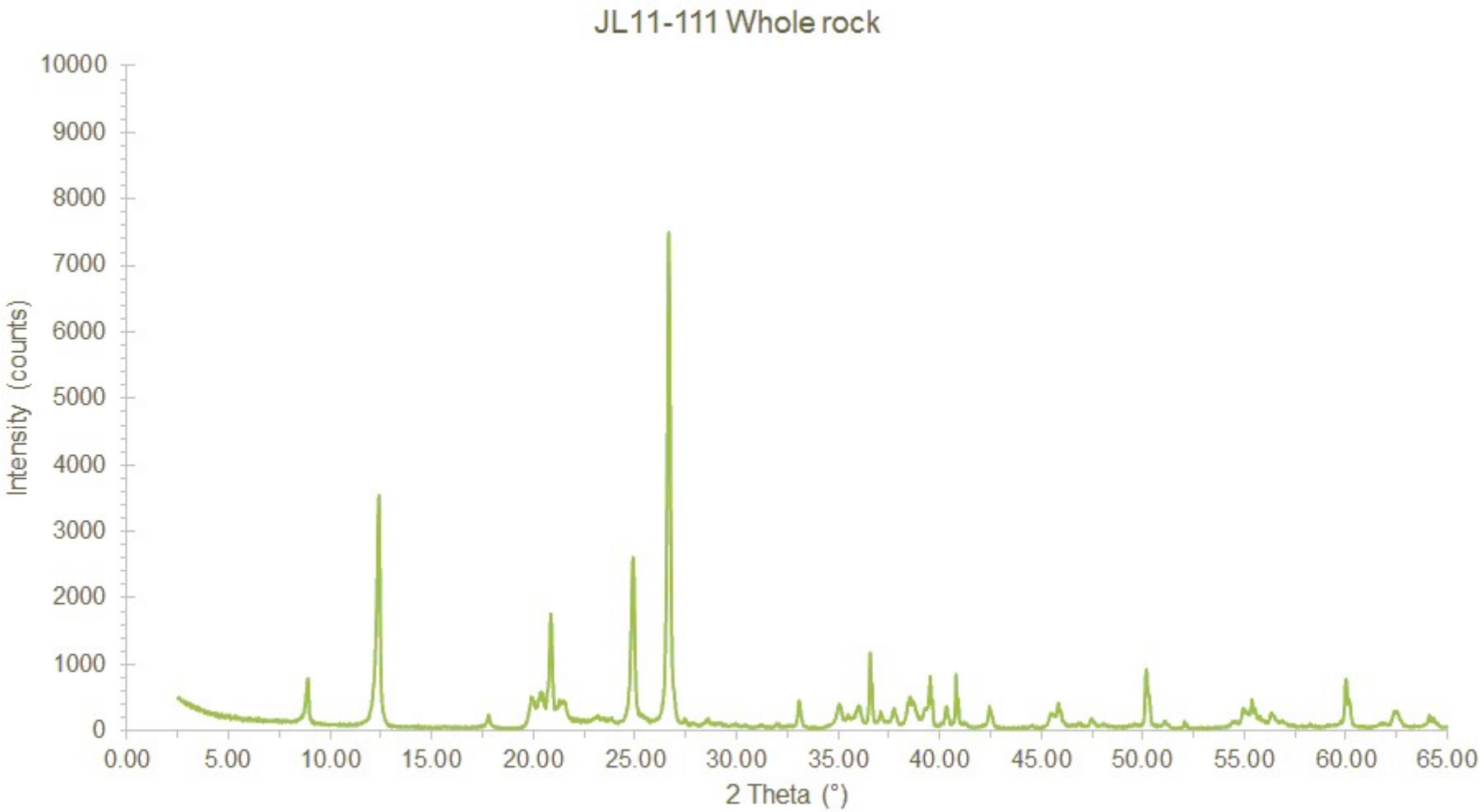
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55.00
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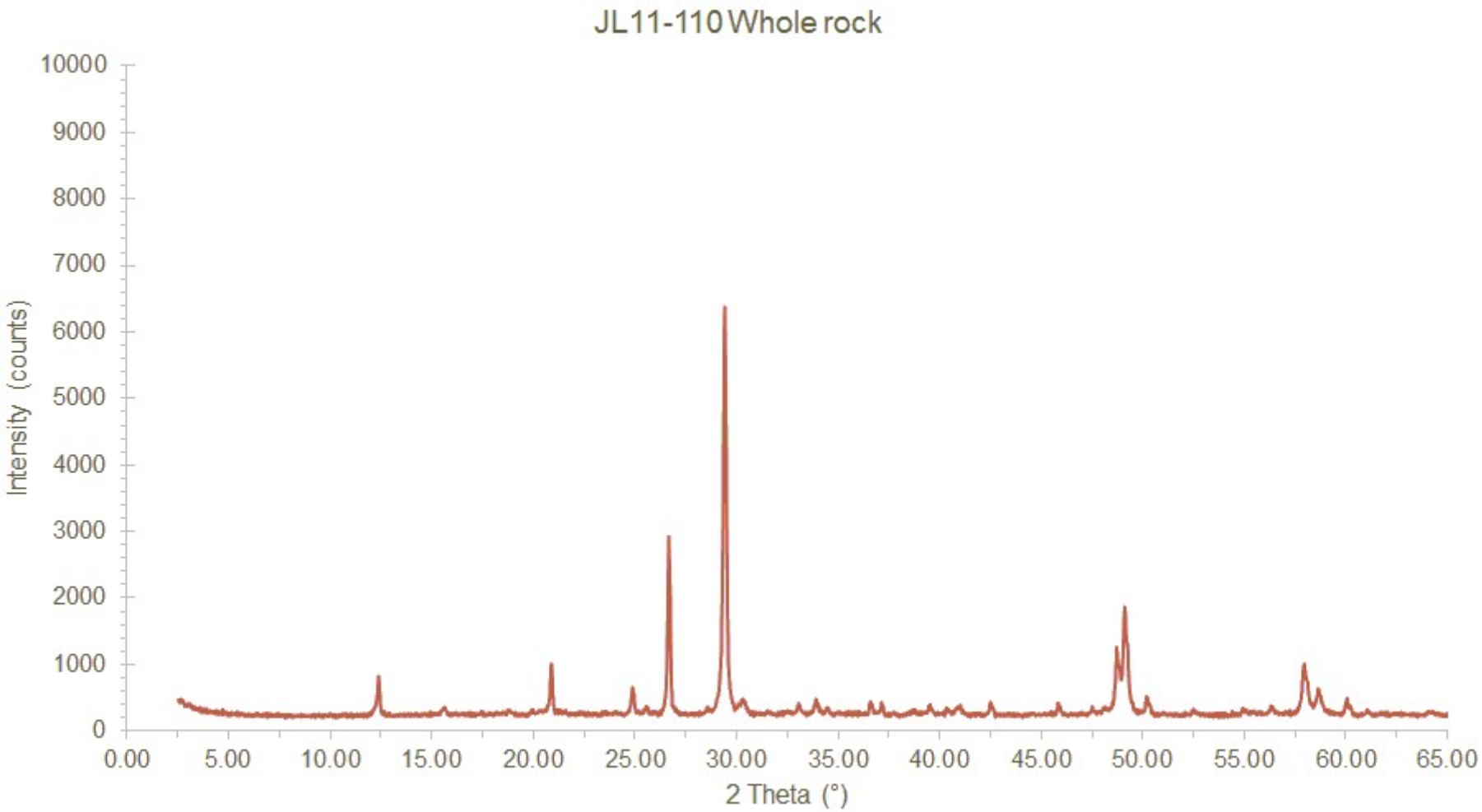
65.00
2 Theta (°)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Intensity (counts)
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0.00
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10.00
15.00
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35.00
40.00
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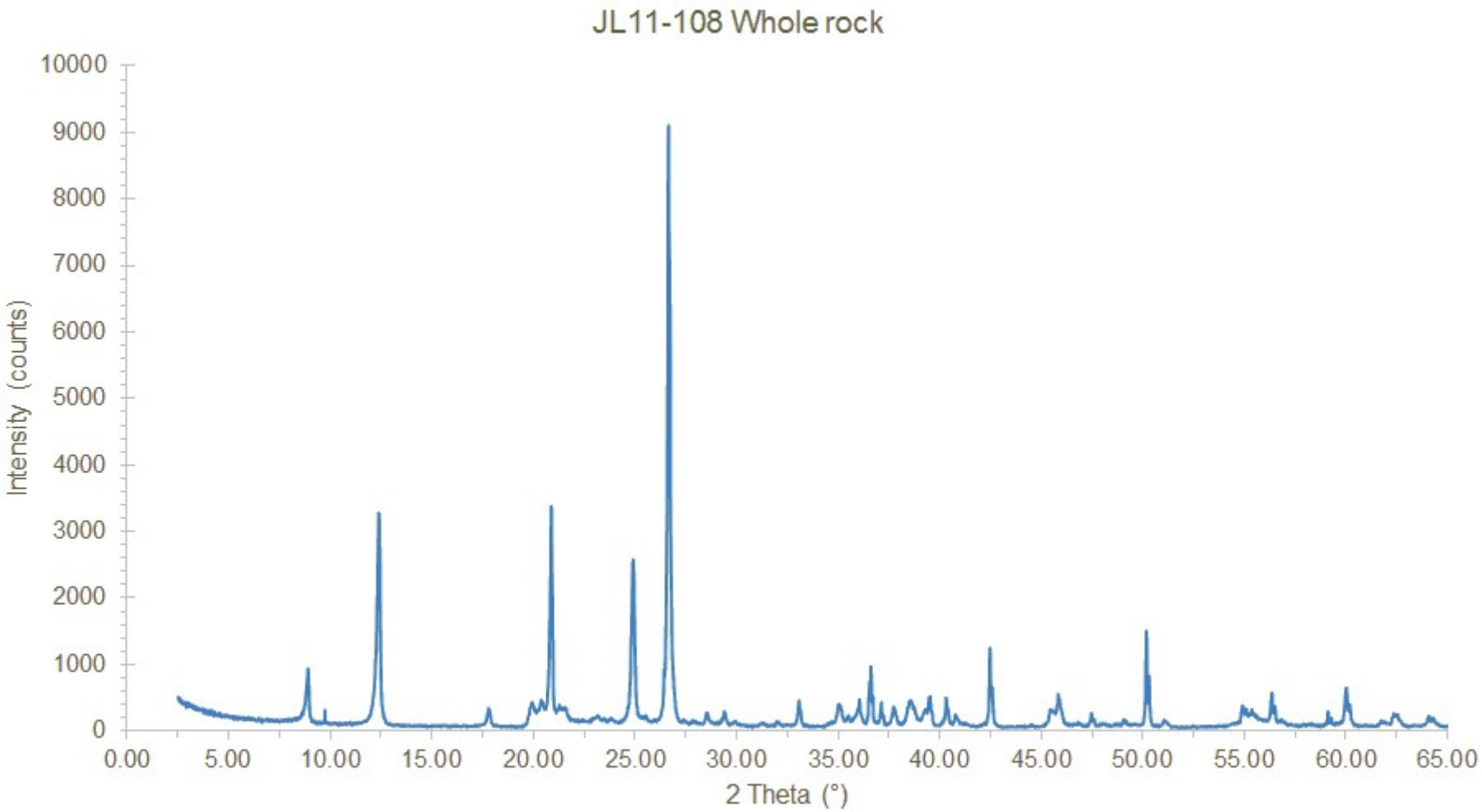
50.00
55.00
60.00
65.00
2 Theta (°)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10.00
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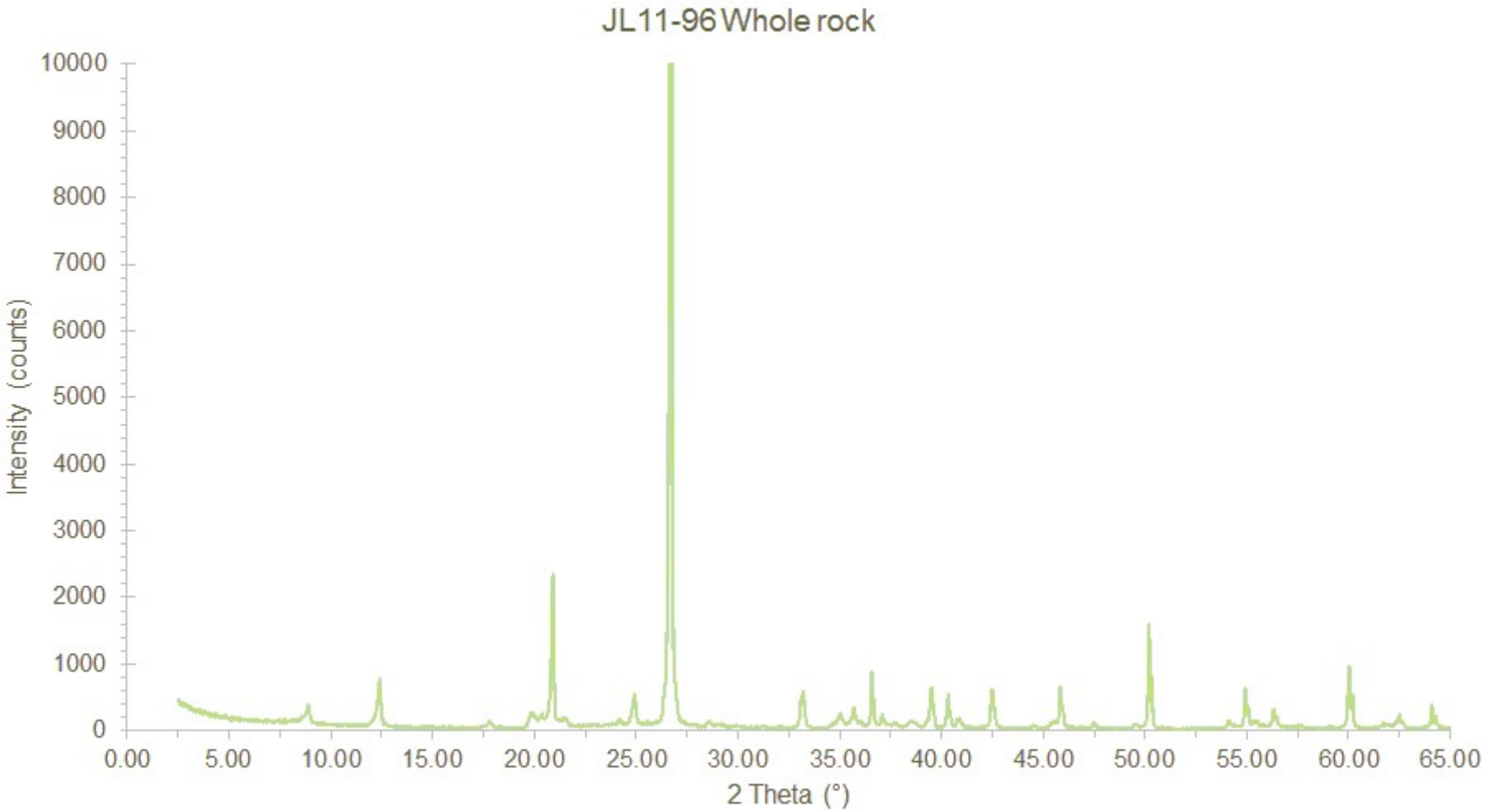
55.00
60.00
65.00
2 Theta (°)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10.00
15.00
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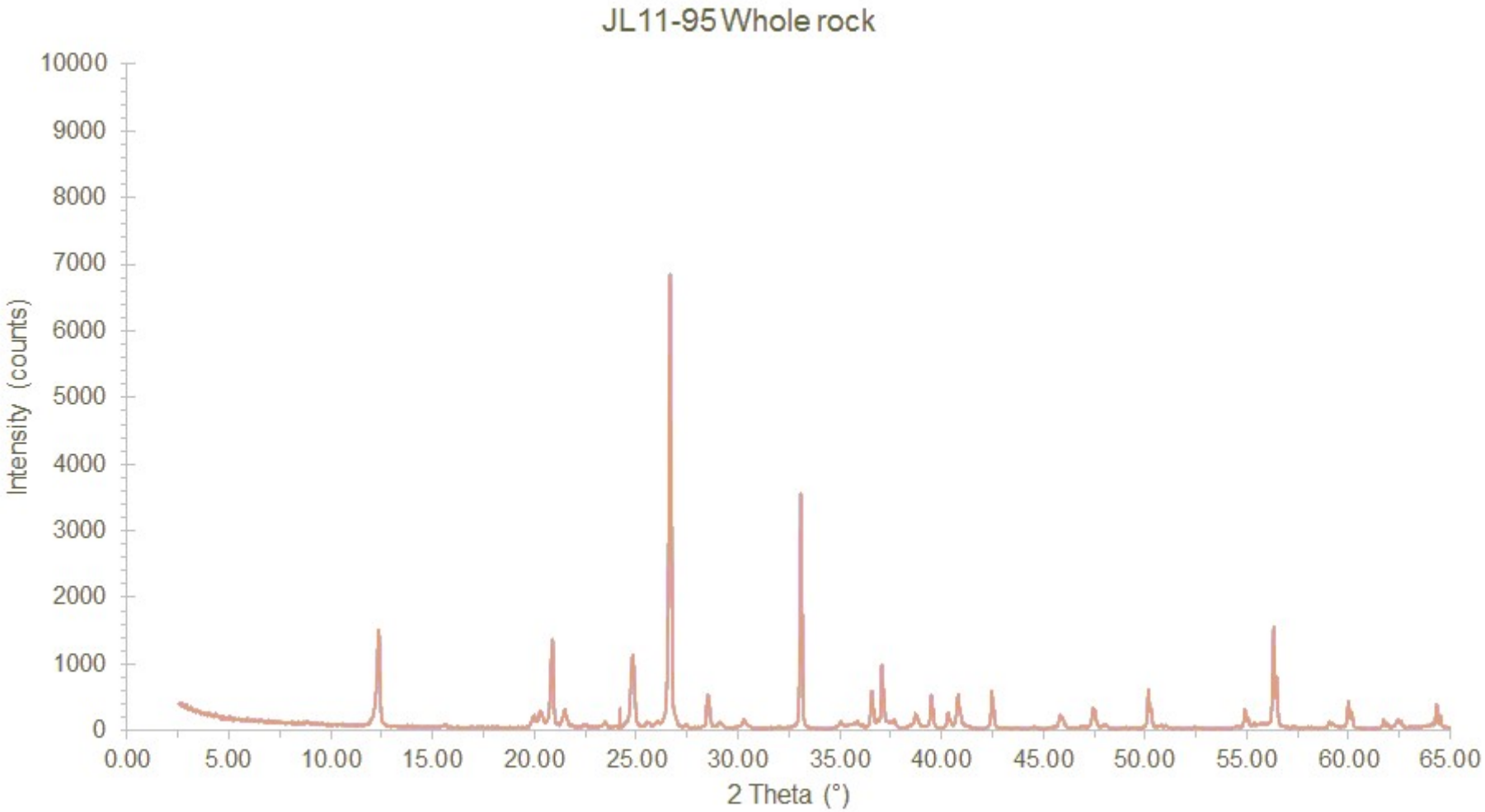
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)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Intensity (counts)
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10.00
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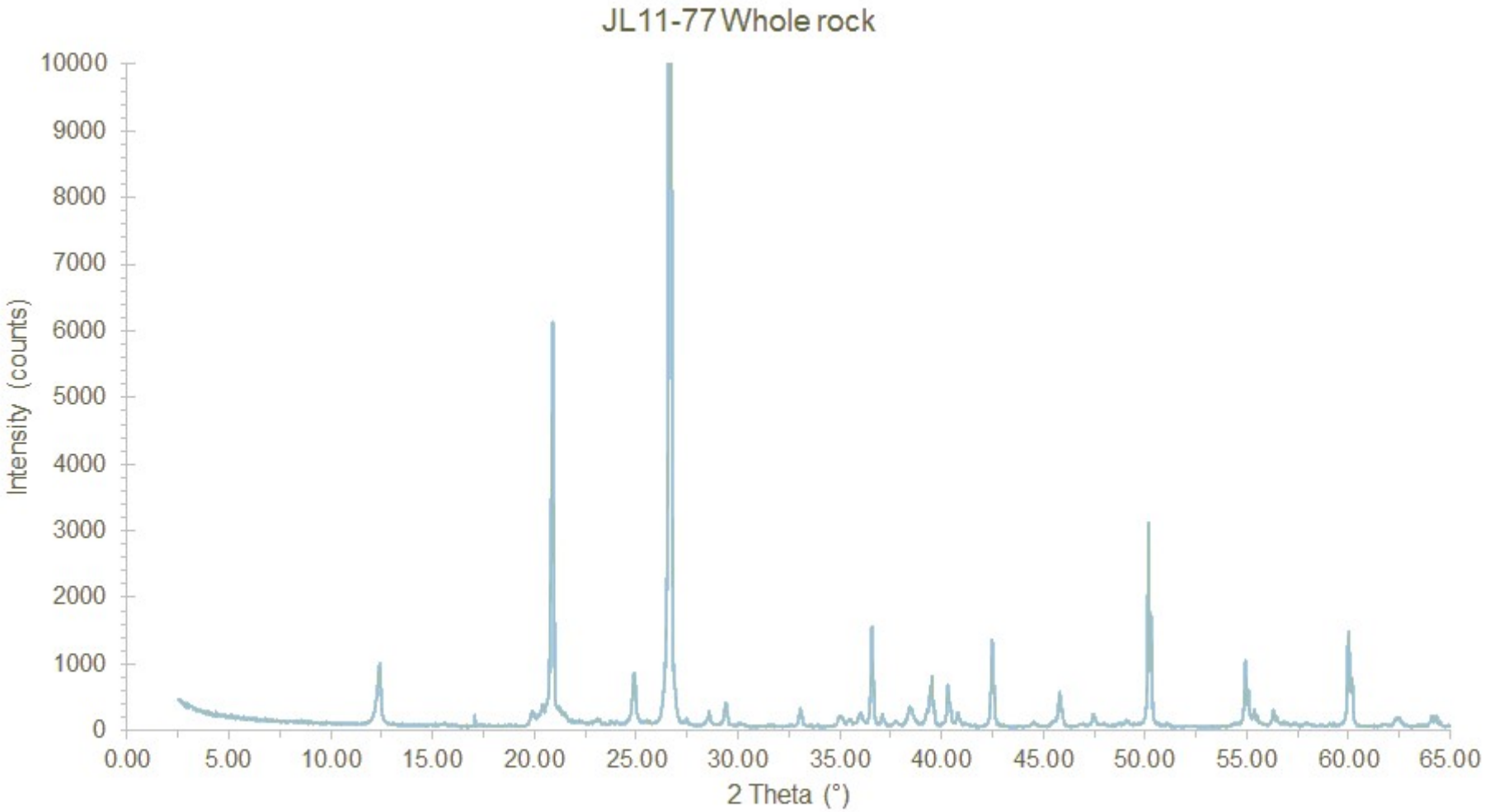
55.00
60.00
65.00
2 Theta (°)


JL11-77 Whole rock
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7000
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5.00
10.00
15.00
20.00
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30.00
35.00
40.00
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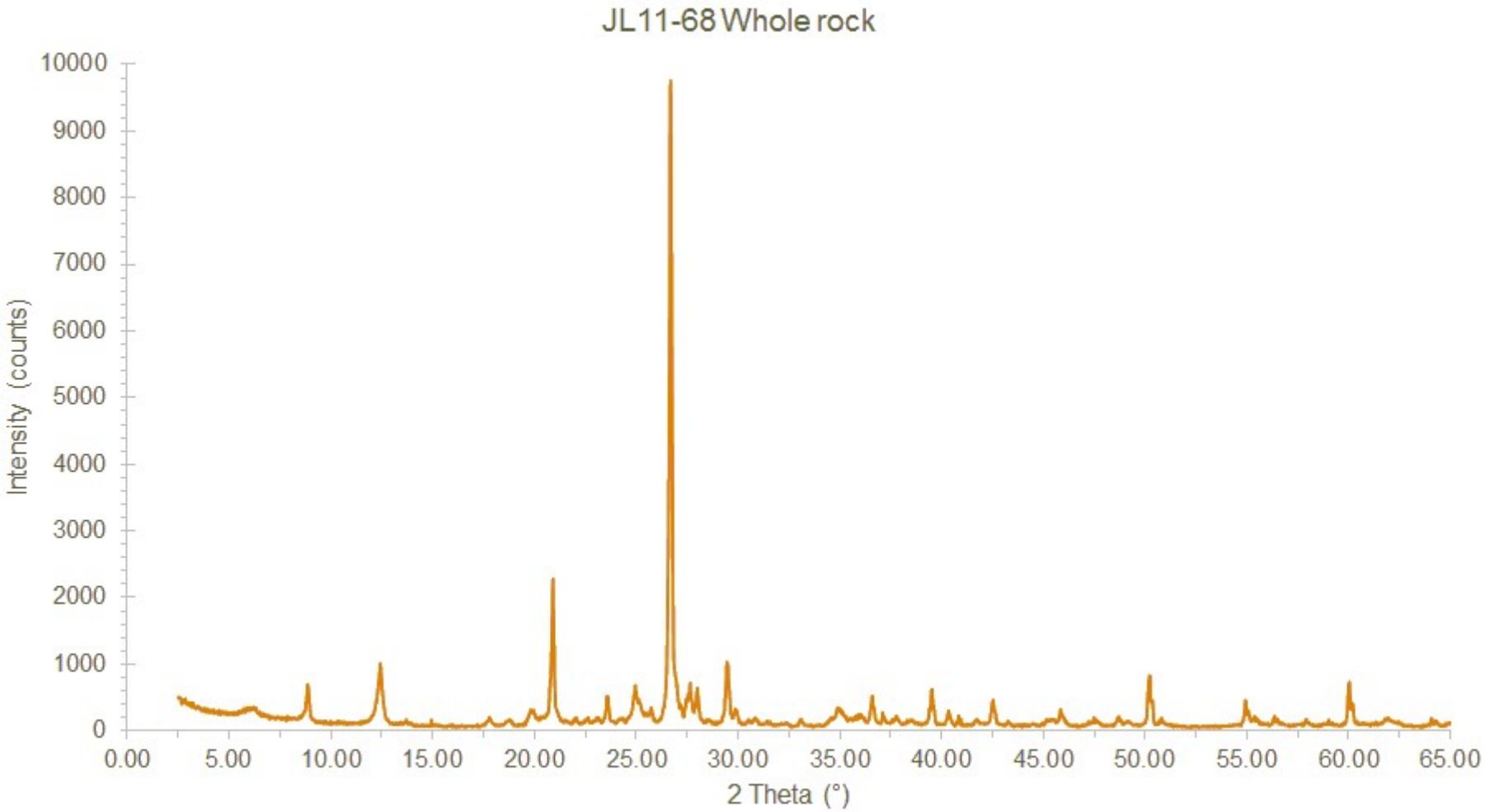
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-68 Whole rock
Intensity (counts)
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7000
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4000
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10.00
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20.00
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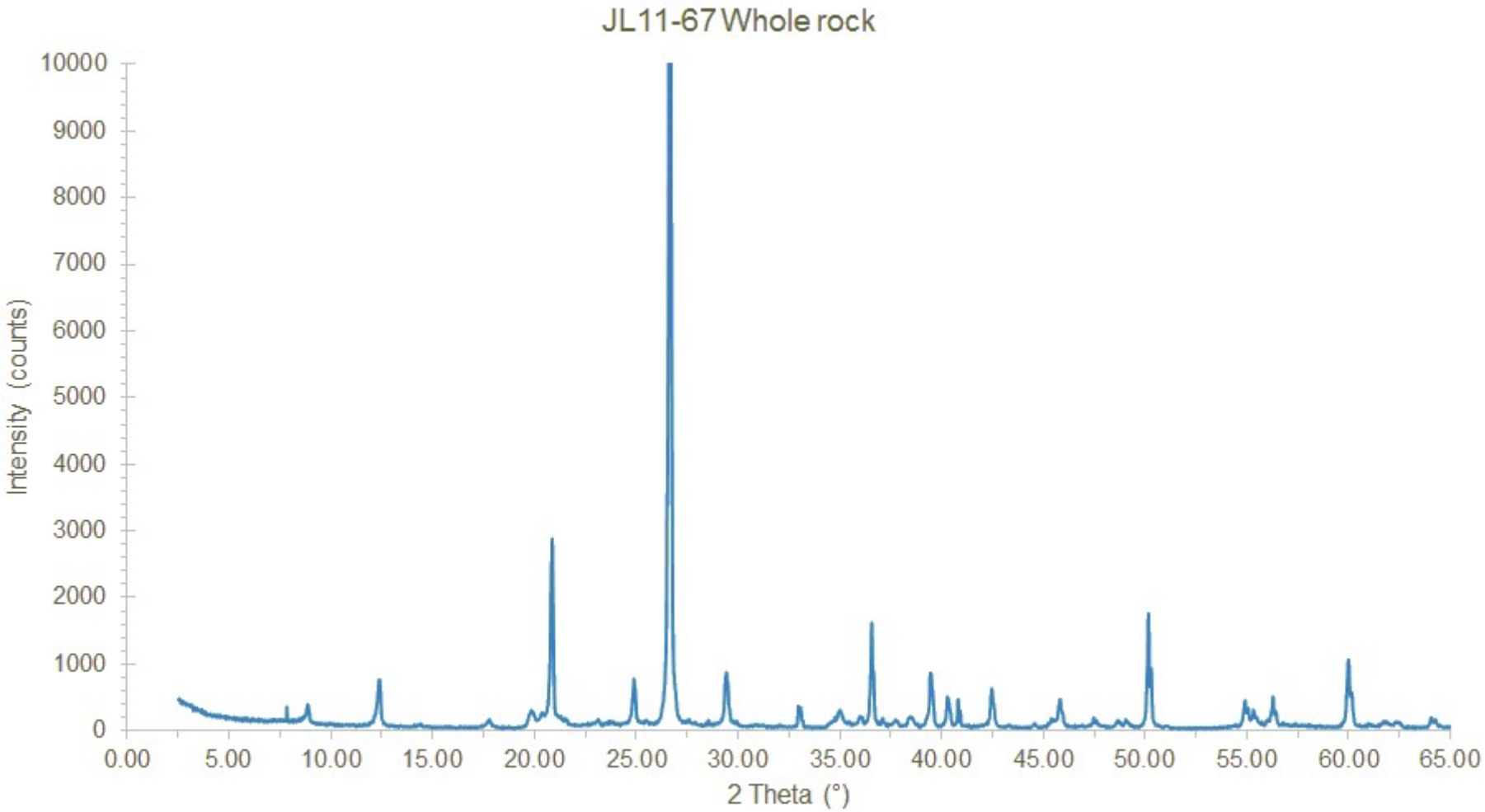
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-67 Whole rock
Intensity (counts)
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8000
7000
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
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35.00
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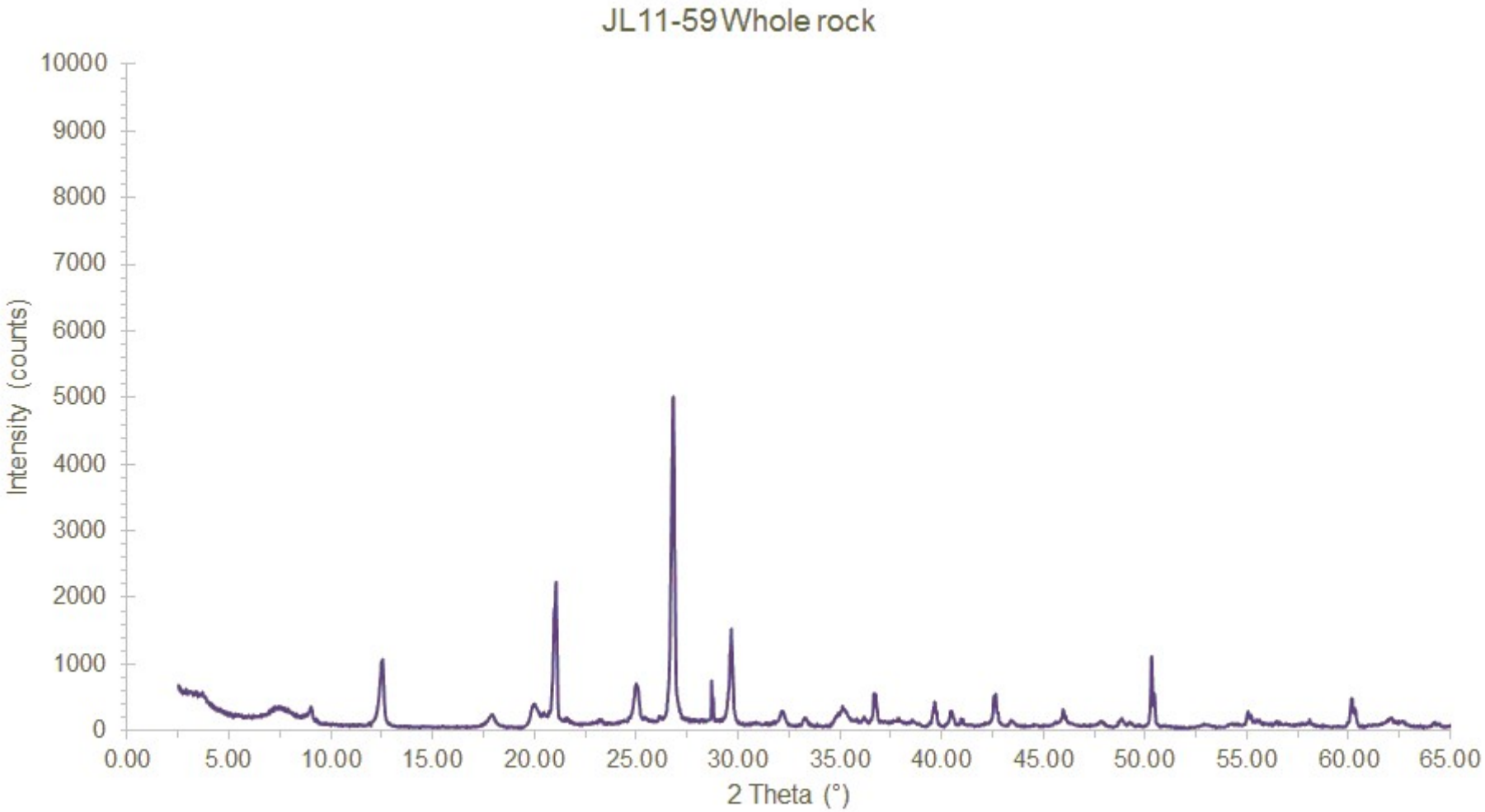
55.00
60.00
65.00
2 Theta (°)


JL11-59 Whole rock
Intensity (counts)
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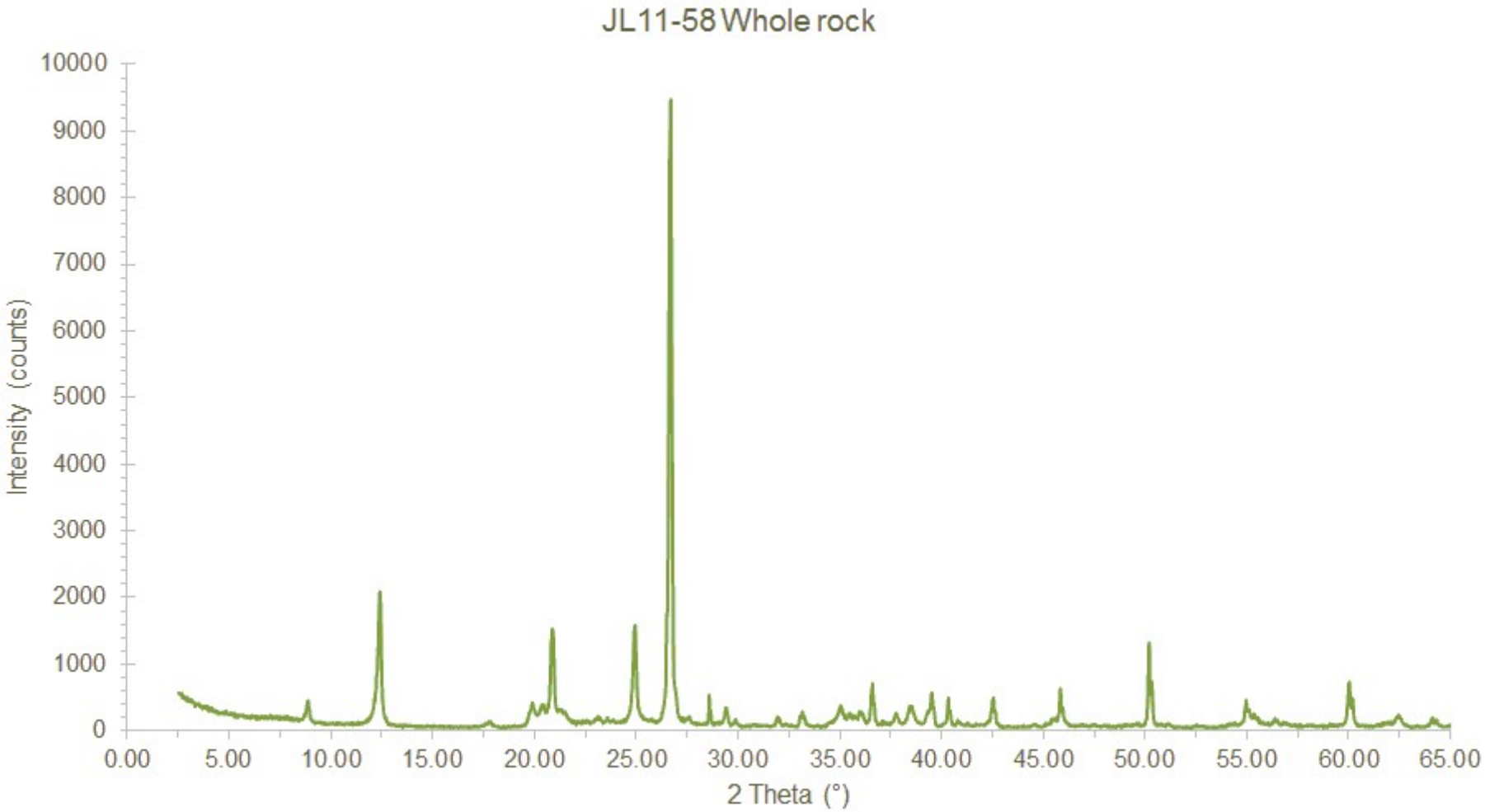
8000
7000
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-58 Whole rock
Intensity (counts)
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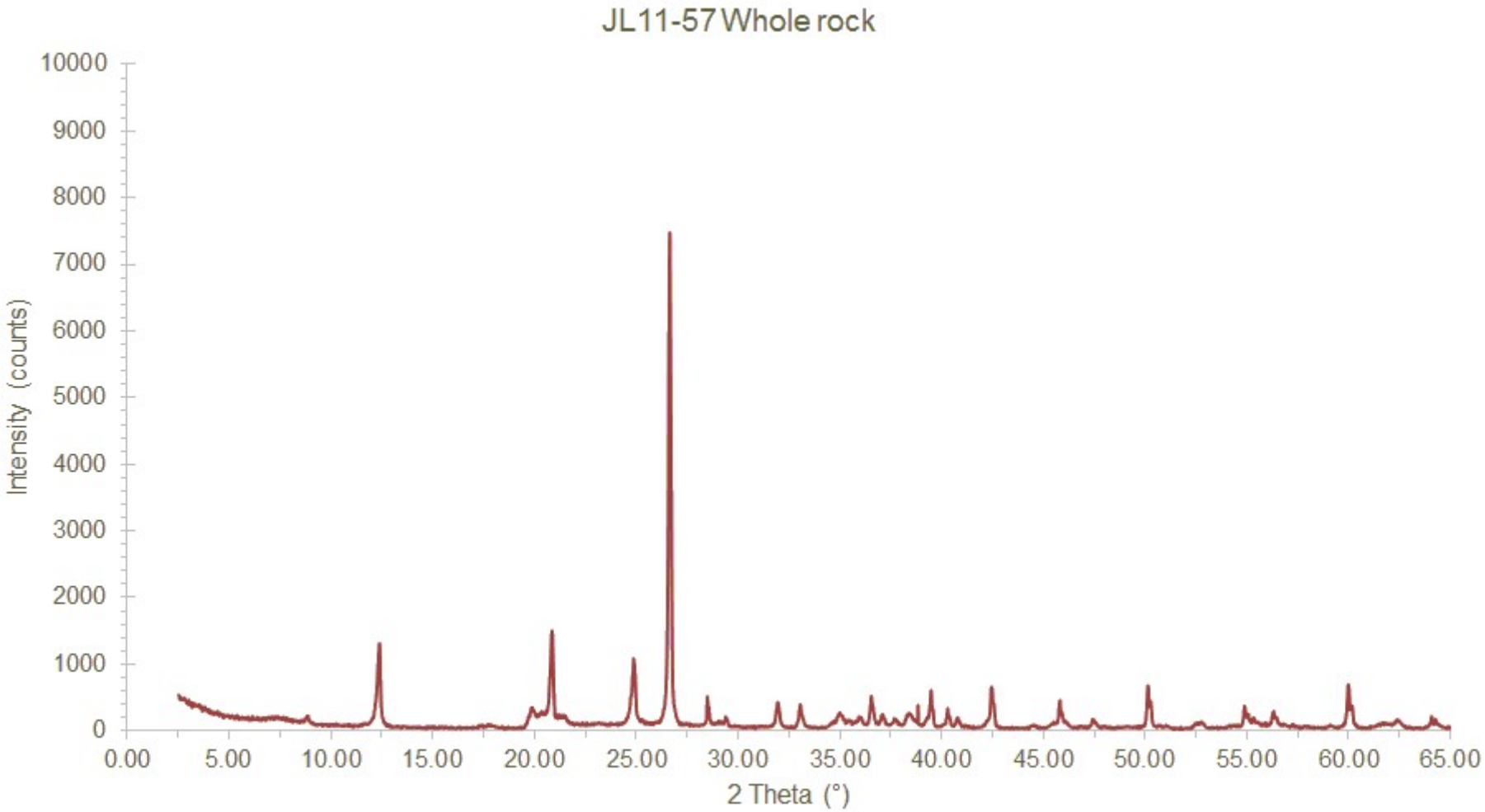
7000
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-57 Whole rock
Intensity (counts)
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5.00
10.00
15.00
20.00
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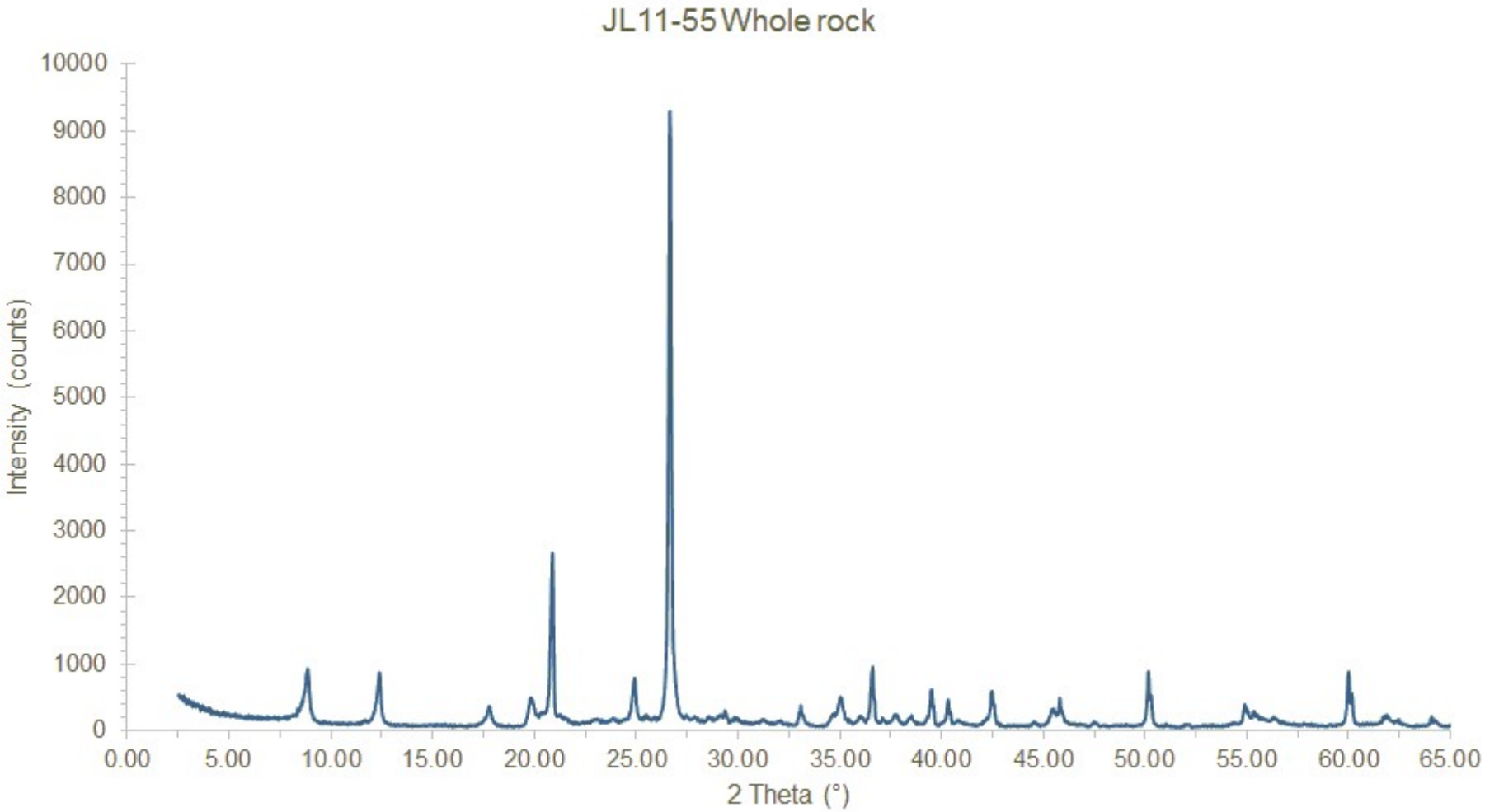
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-55 Whole rock
Intensity (counts)
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3000
2000
1000
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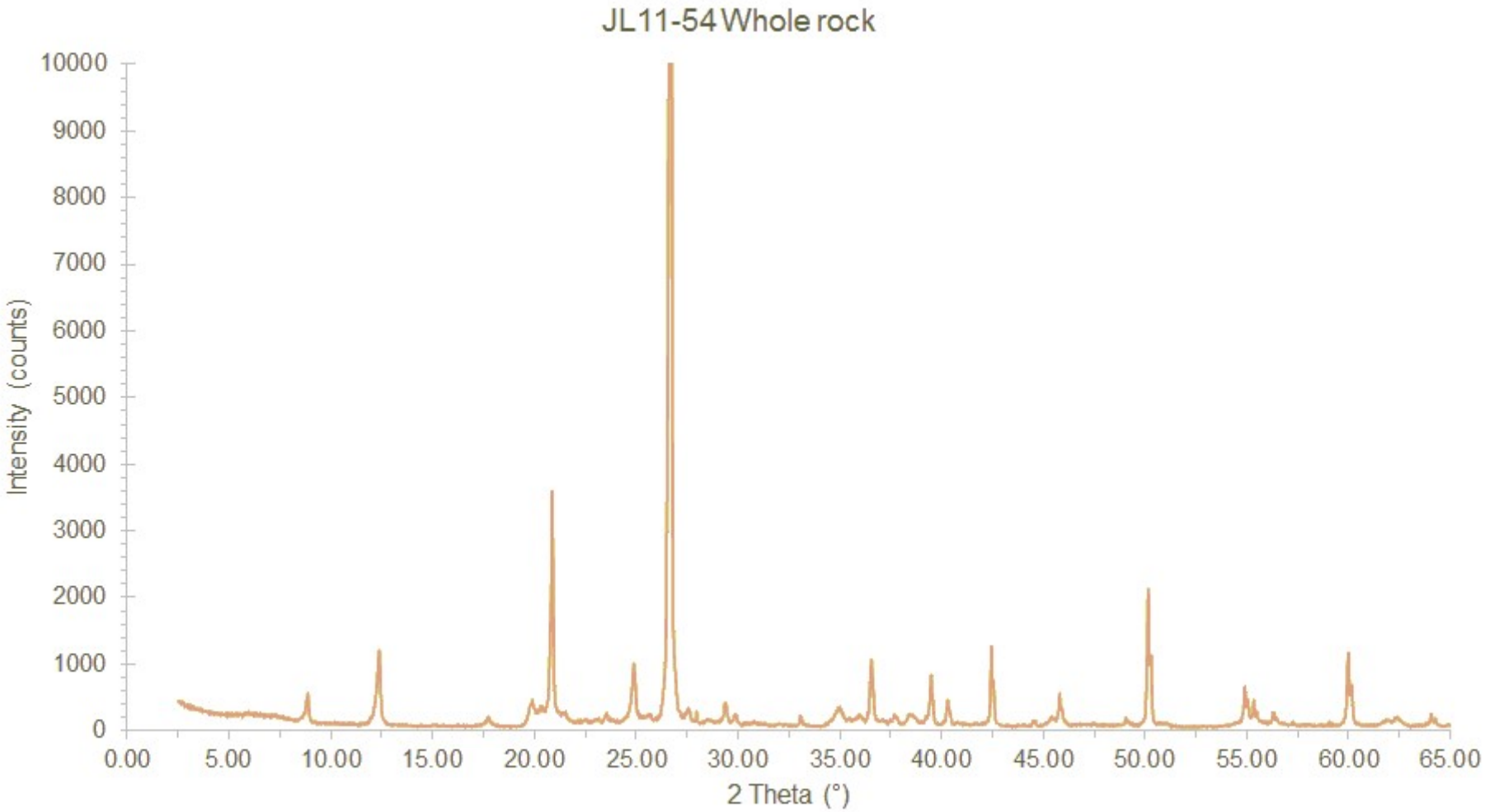
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-54 Whole rock
Intensity (counts)
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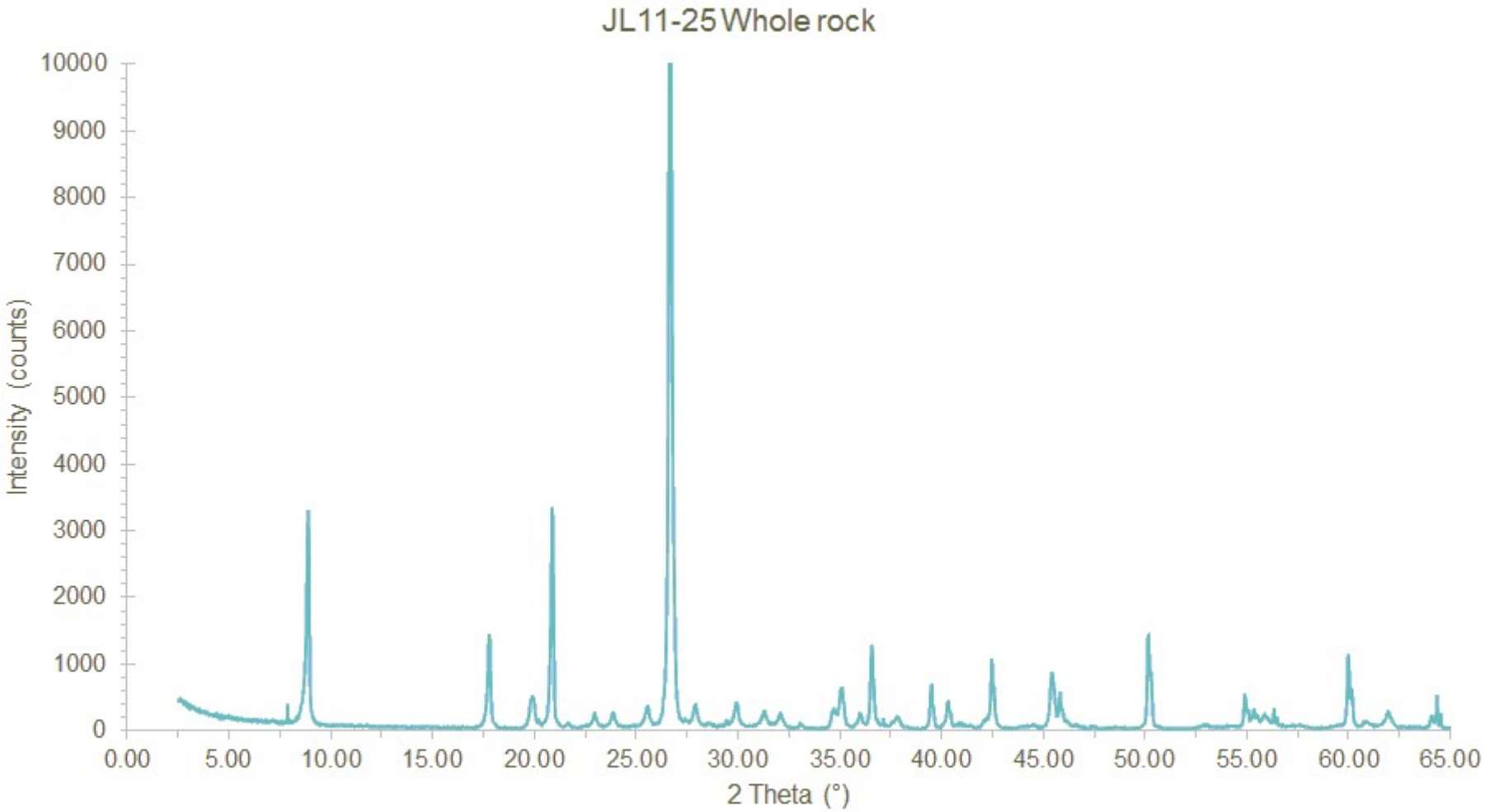
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-25 Whole rock
Intensity (counts)
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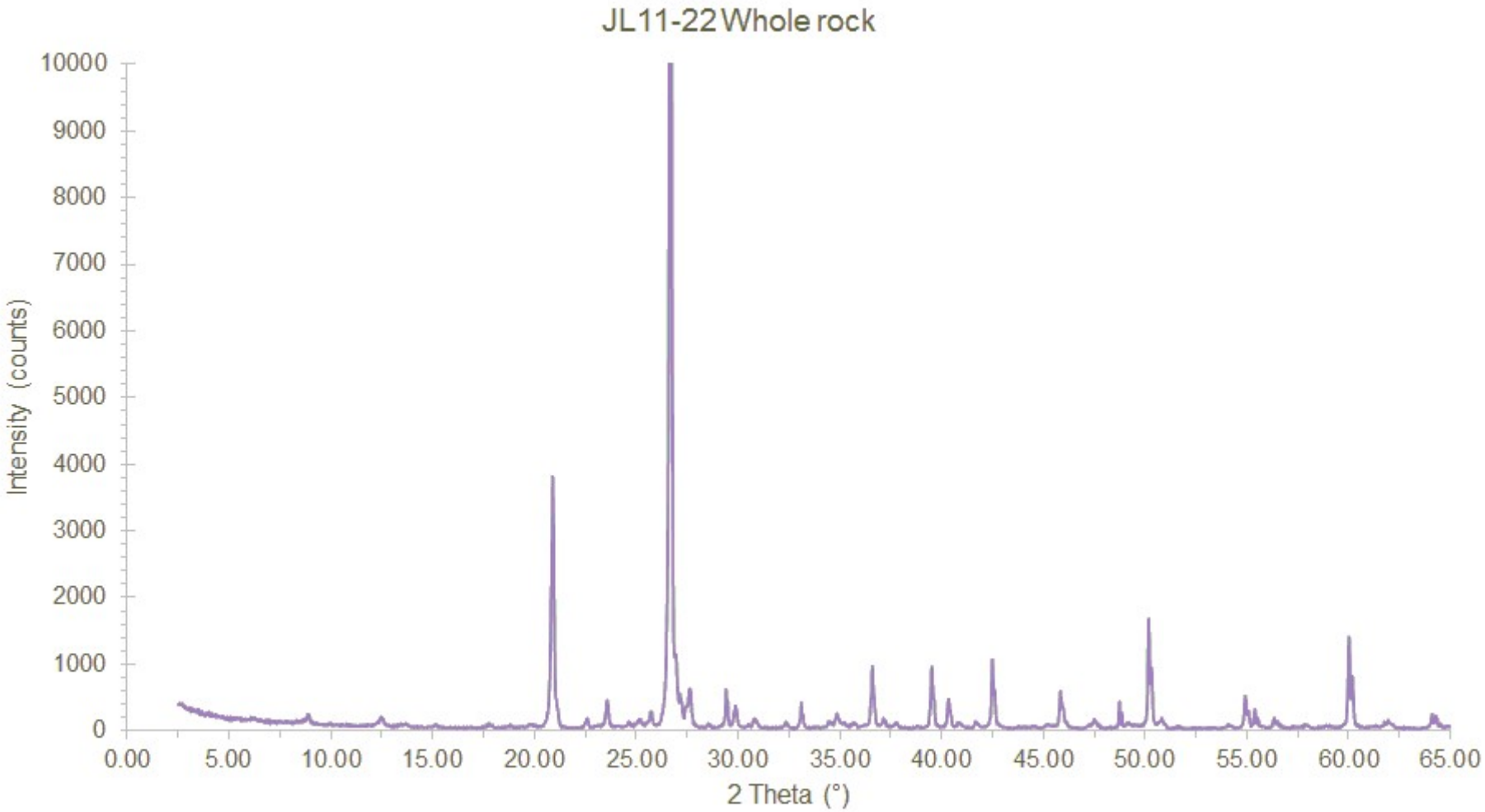
8000
7000
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-22 Whole rock
Intensity (counts)
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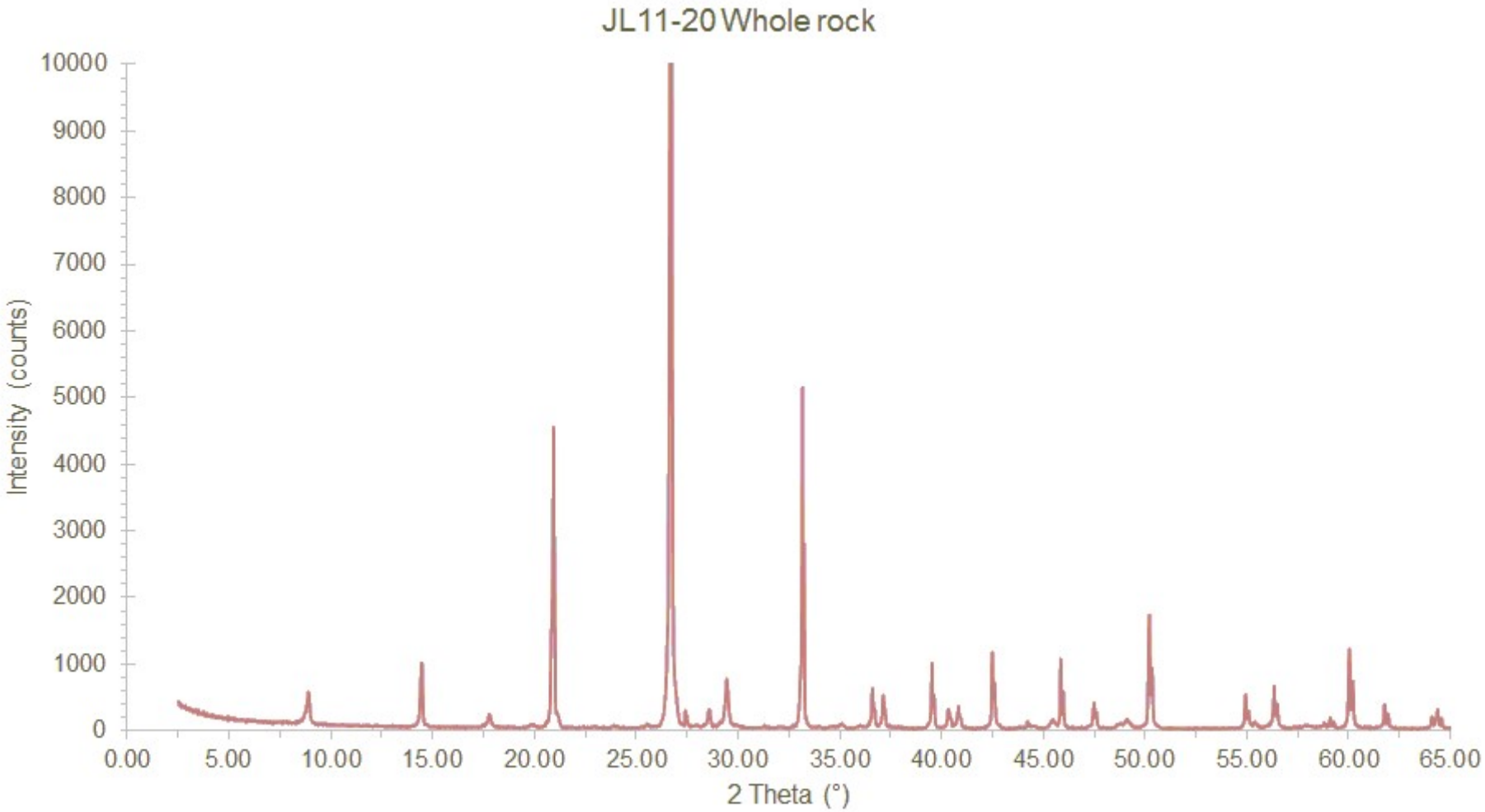
8000
7000
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)


JL11-20 Whole rock
Intensity (counts)
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9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
2 Theta (°)

6.1.1.2 Clay separates

Orientated clay separates are scanned at two seconds per step with a step size of 0.015° from 2.5-27°. Each sample run equates to an hour and twenty minutes. The syntaxes are attributed to pre-treatments as defined in Table 6.1.

Table 6.1: Significance of syntax and clay separate treatment.

Syntax	Significance
A	<2μm clay separate, air dried
F	<1μm clay separate, air fried
G	Hydrated with ethylene glycol
H	Heated to 350°C for 1 hour
I	Heated to 550°C for 1 hour

A blank scan of the porcelain tile is measured (**Error! Reference source not found.**) and thus these peaks can be attributed to the feldspar and quartz within the porcelain tile, especially in thin clay separates.

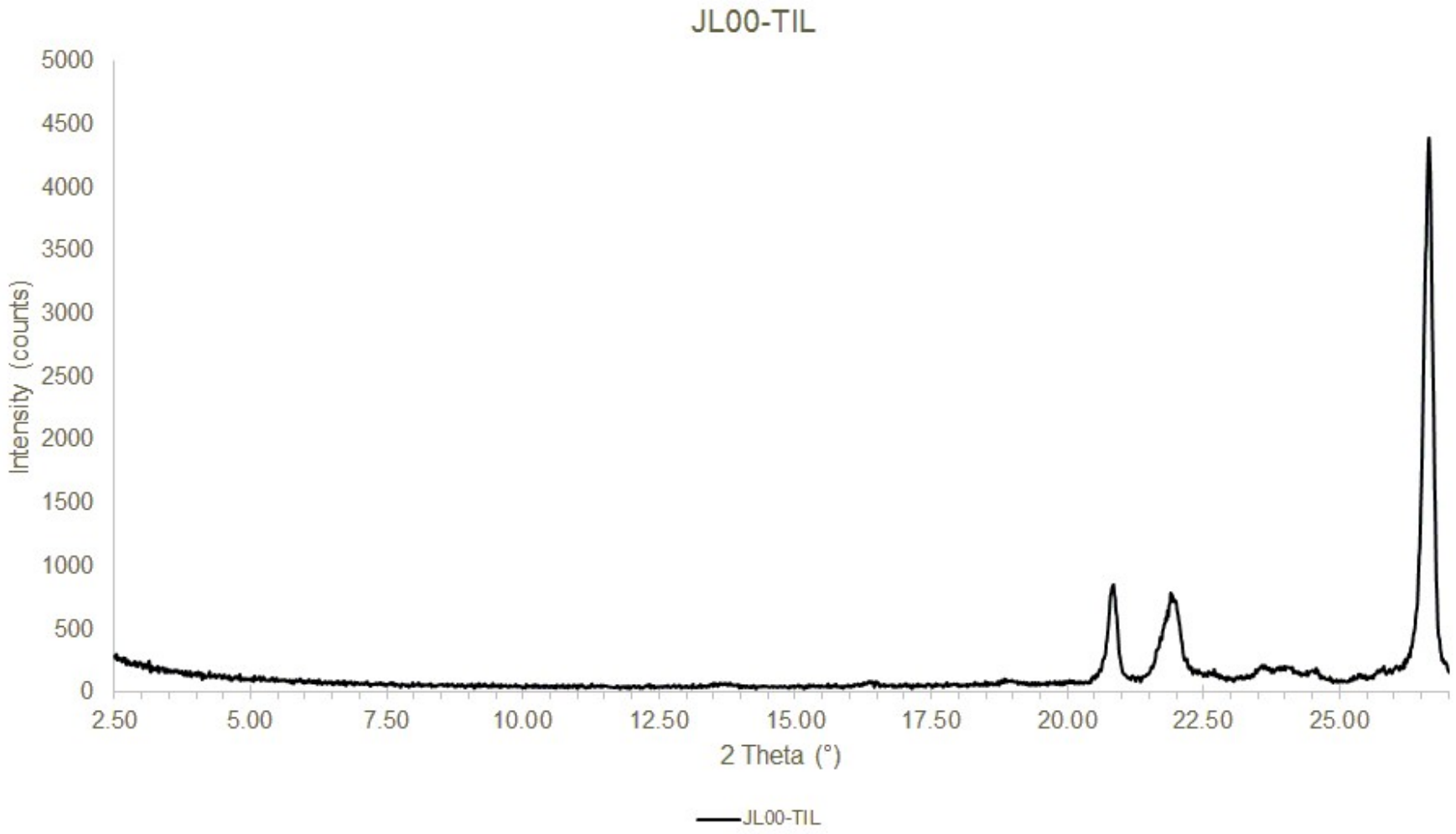
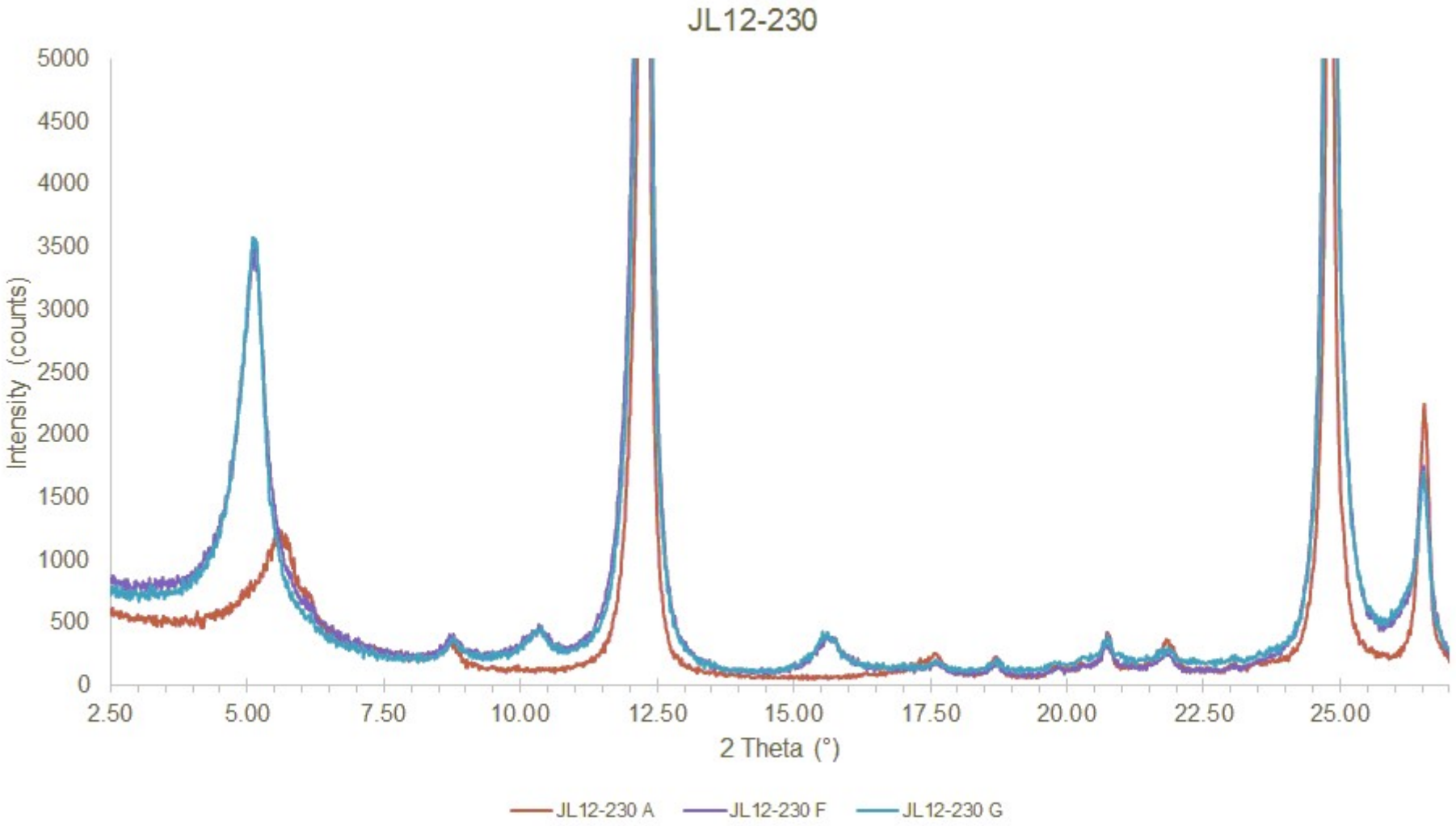


Figure 6.1:: XRD pattern of the porcelain tile on which clay mineral separates are mounted.


JL12-230
Intensity (counts)
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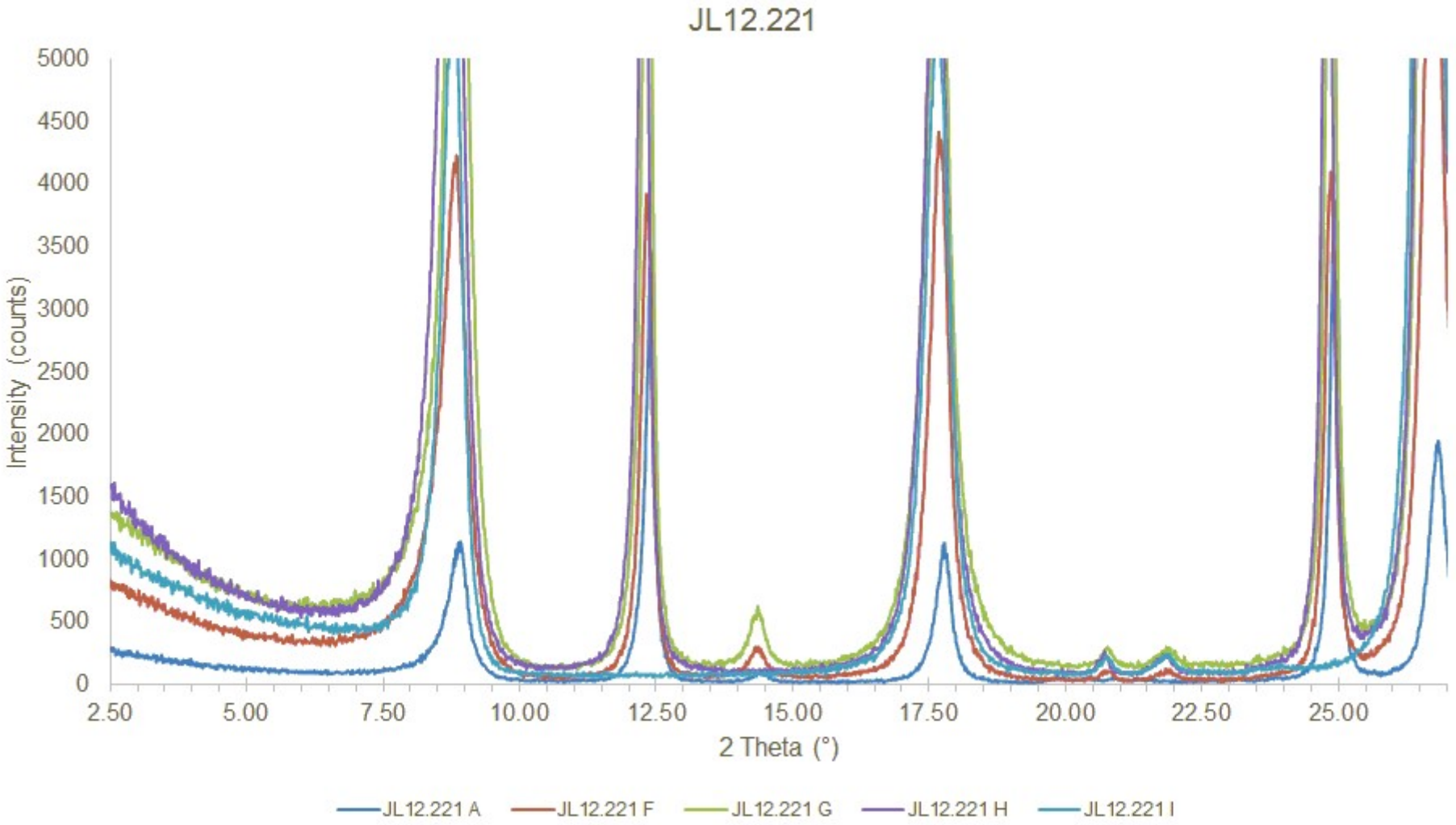
3500
3000
2500
2000
1500
1000
500
0
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-230 A
JL12-230 F
JL12-230 G


JL12.221
Intensity (counts)
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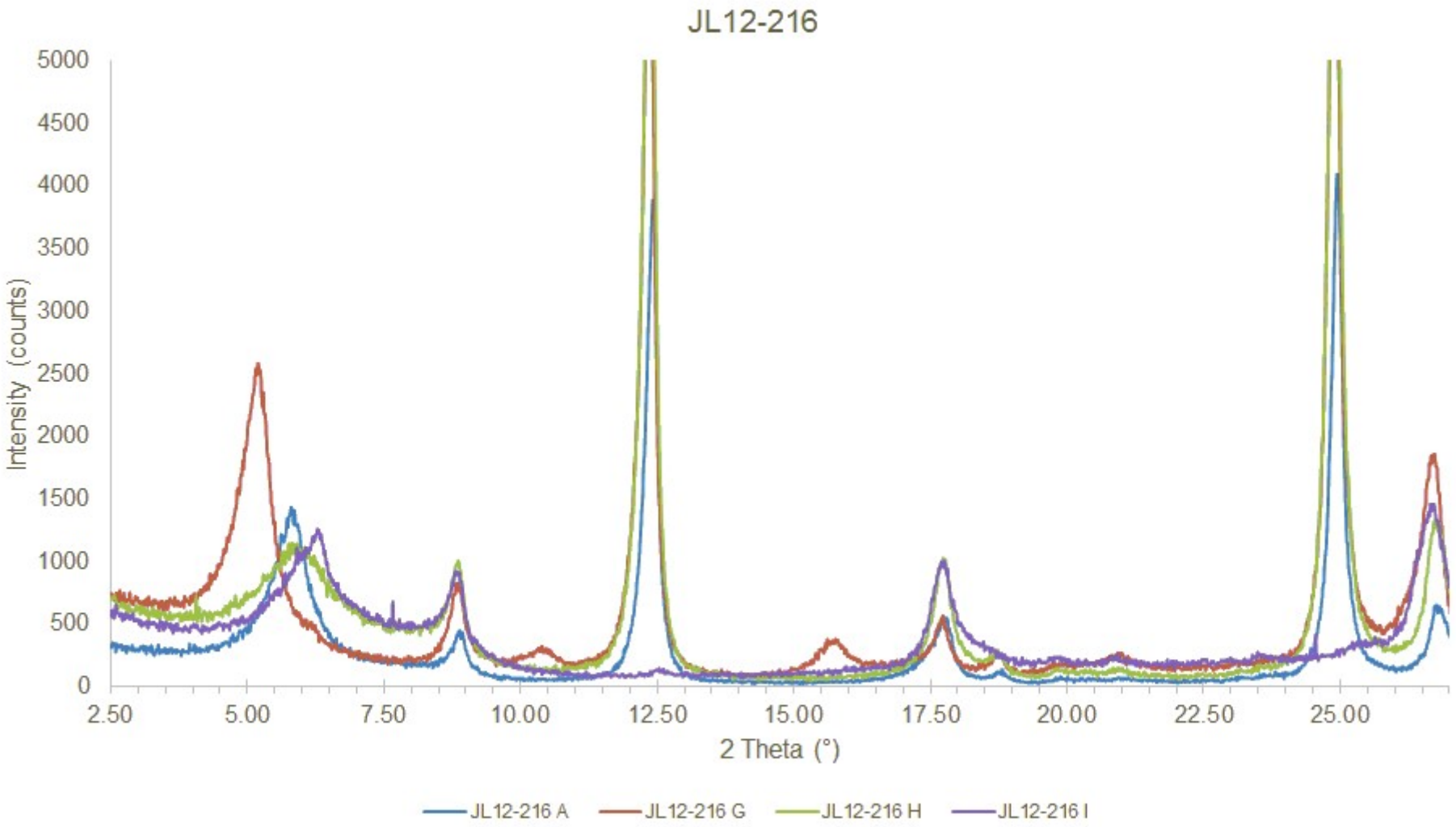
3500
3000
2500
2000
1500
1000
500
0
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12.221 A
JL12.221 F
JL12.221 G
JL12.221 H
JL12.221 I


JL12-216
Intensity (counts)
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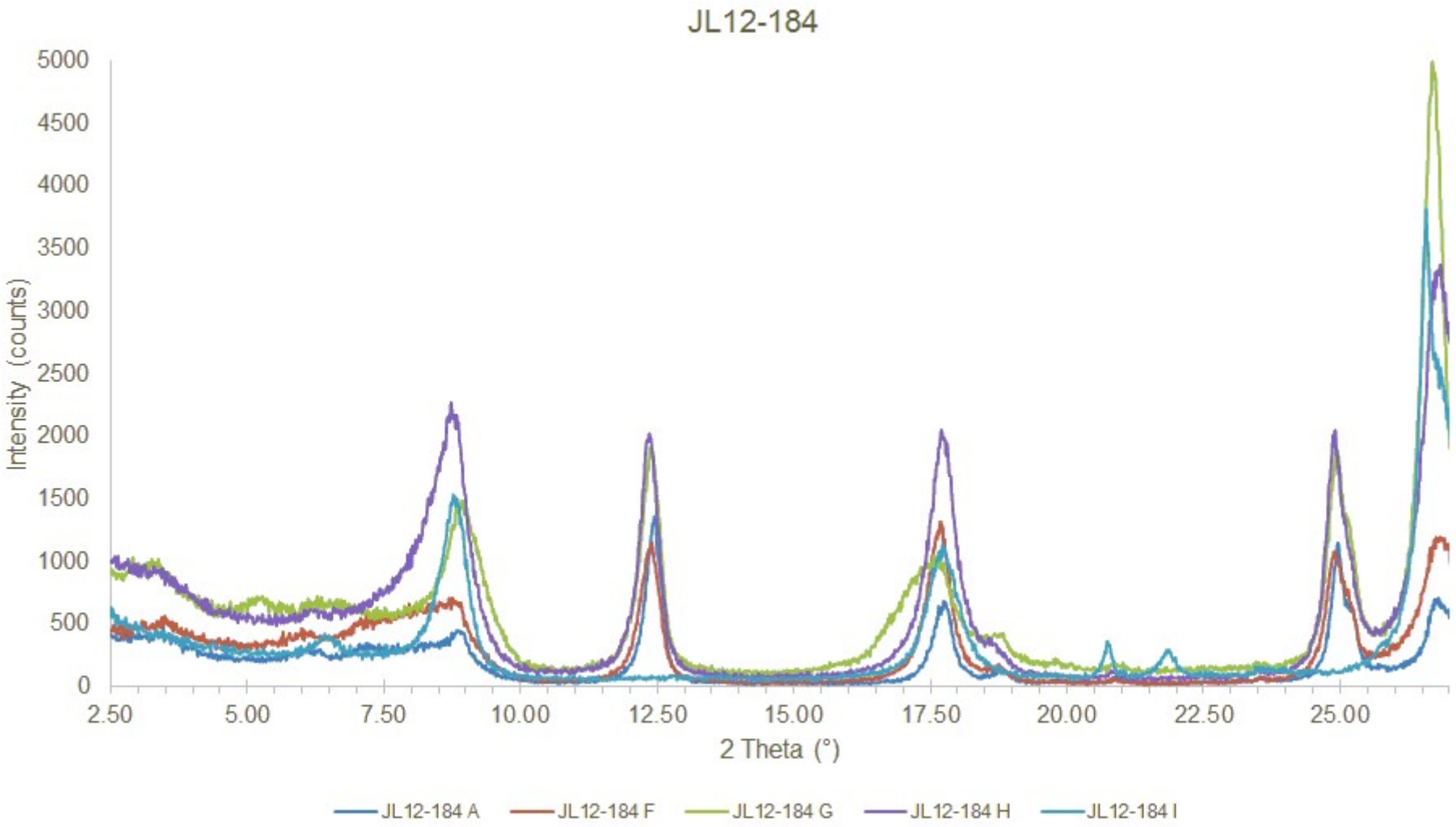
3000
2500
2000
1500
1000
500
0
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-216 A
JL12-216 G
JL12-216 H
JL12-216 I


JL12-184
Intensity (counts)
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3500
3000
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1500
1000
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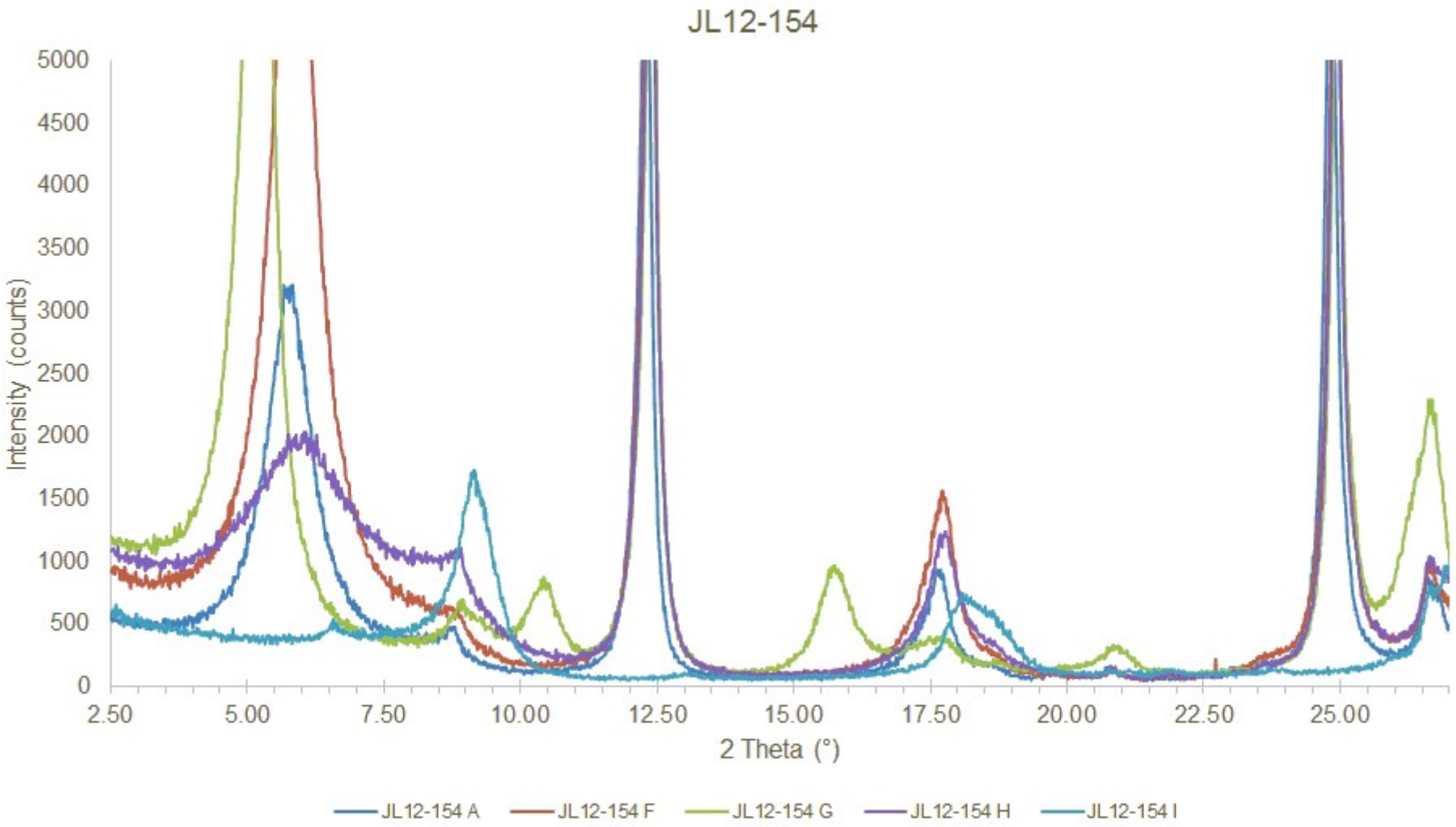
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-184 A
JL12-184 F
JL12-184 G
JL12-184 H
JL12-184 I


JL12-154
Intensity (counts)
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1000
500
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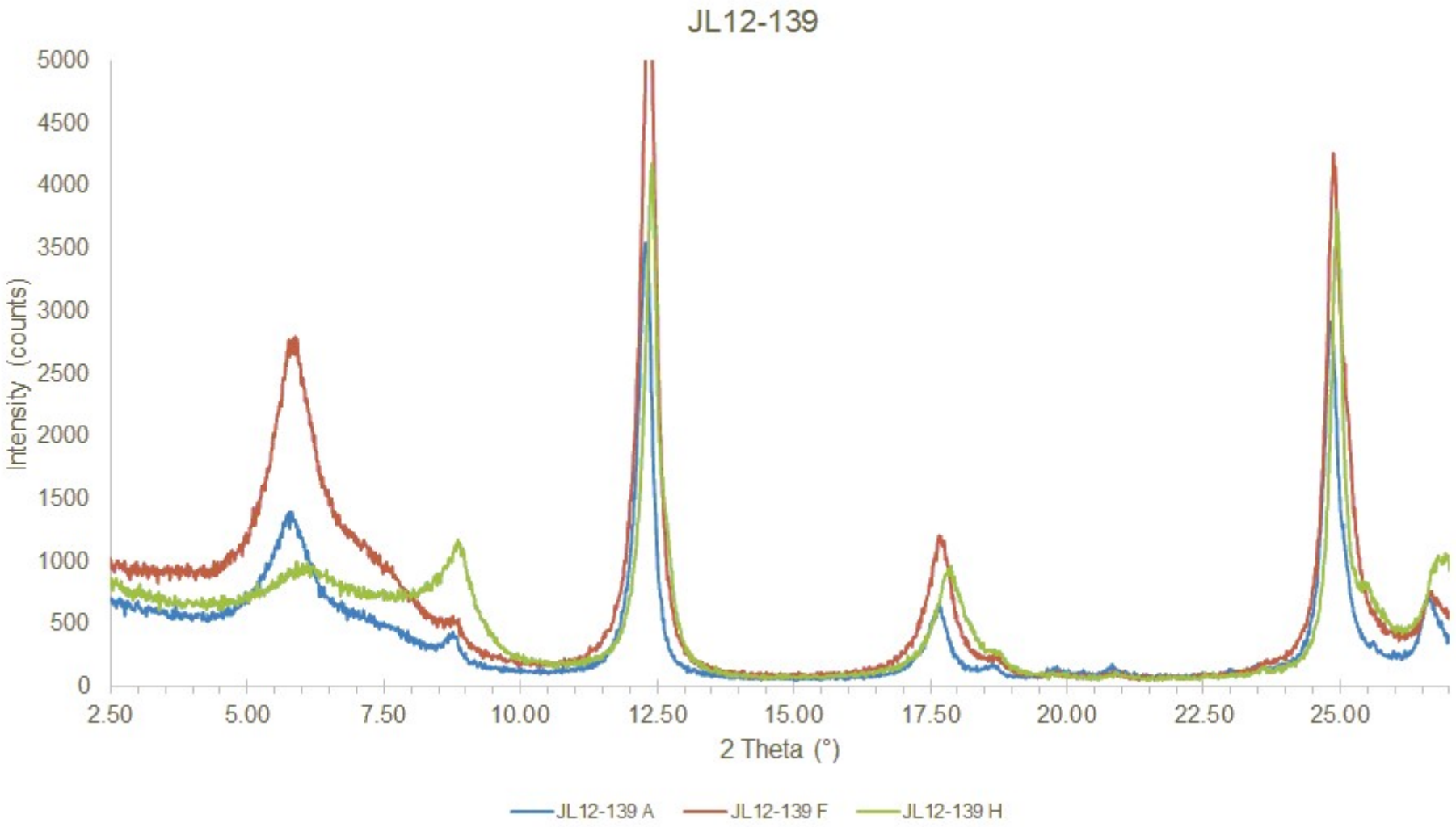
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-154 A
JL12-154 F
JL12-154 G
JL12-154 H
JL12-154 I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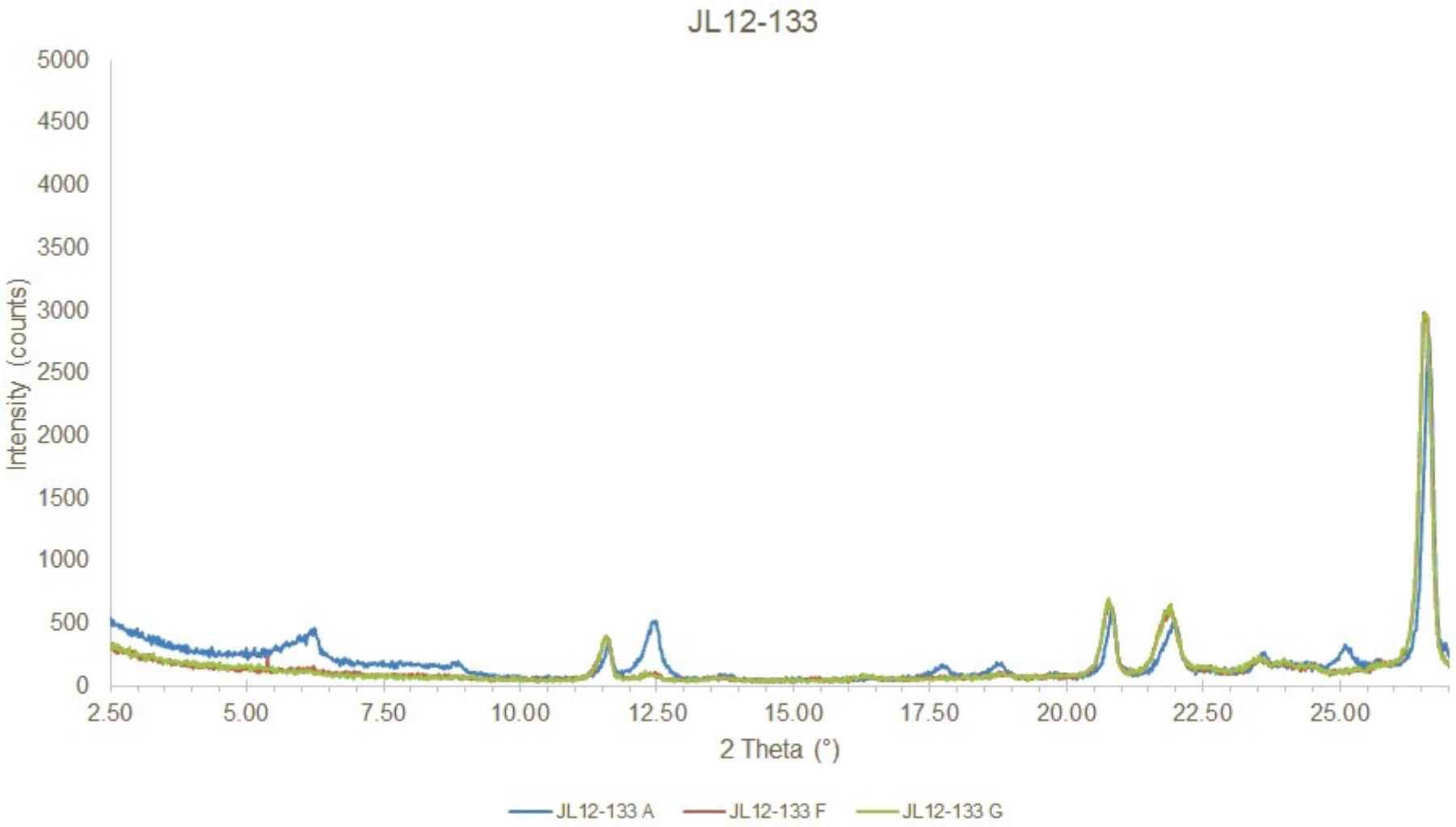
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-139 A
JL12-139 F
JL12-139 H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Intensity (counts)
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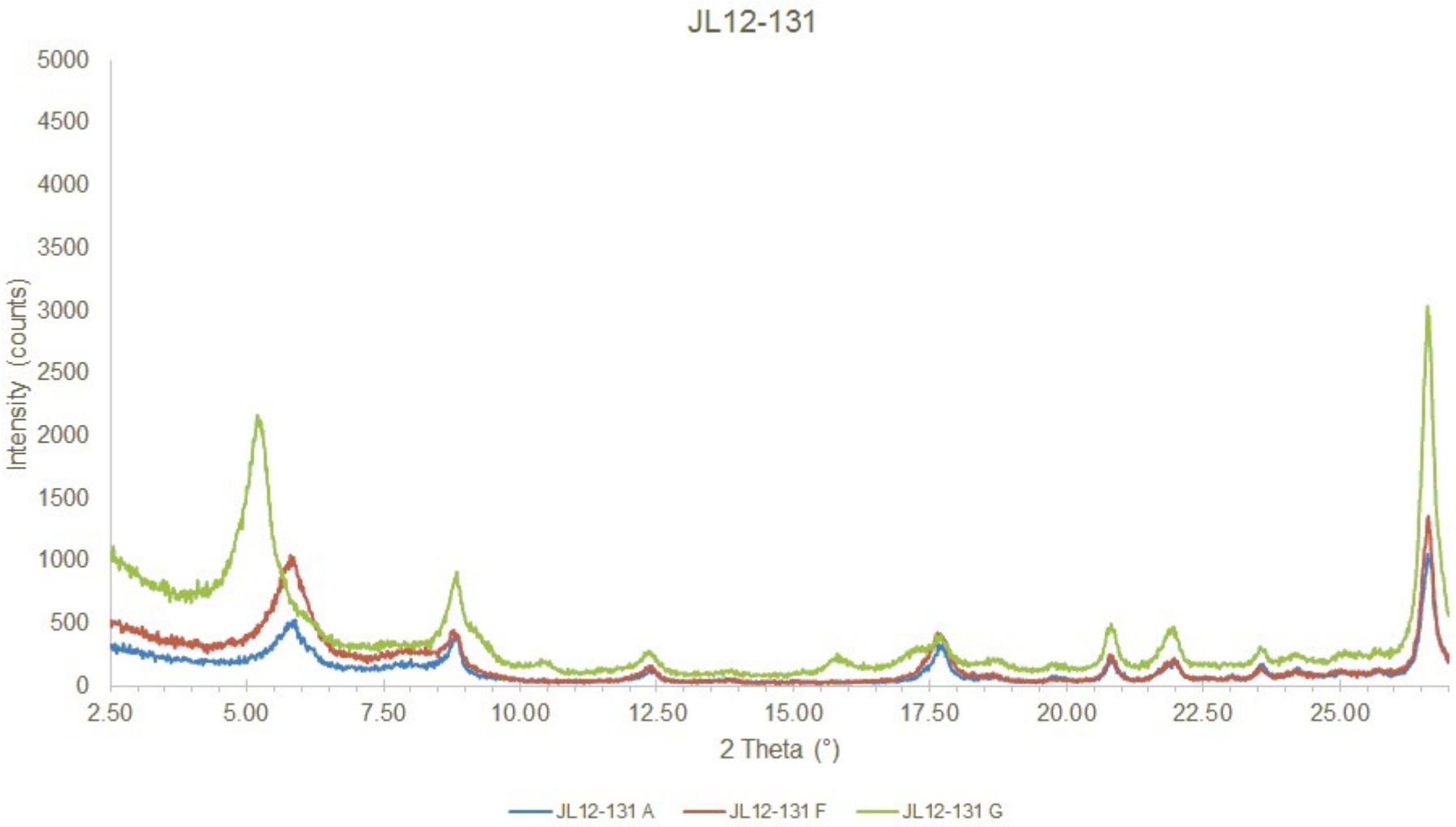
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-133 A
JL12-133 F
JL12-133 G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Intensity (counts)
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7.50
10.00
12.50
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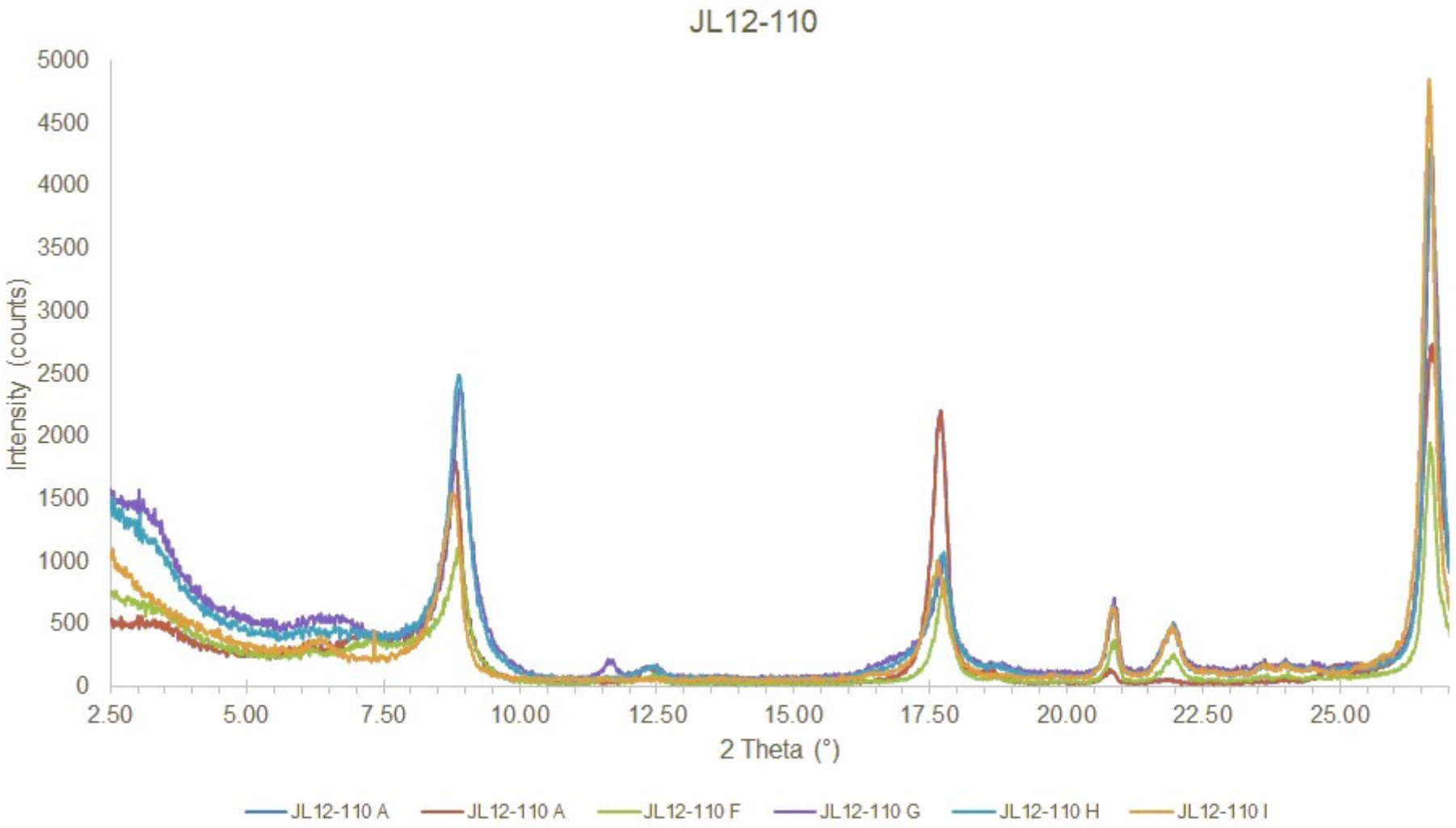
20.00
22.50
25.00
2 Theta (°)
JL12-131 A
JL12-131 F
JL12-131 G


JL12-110
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1000
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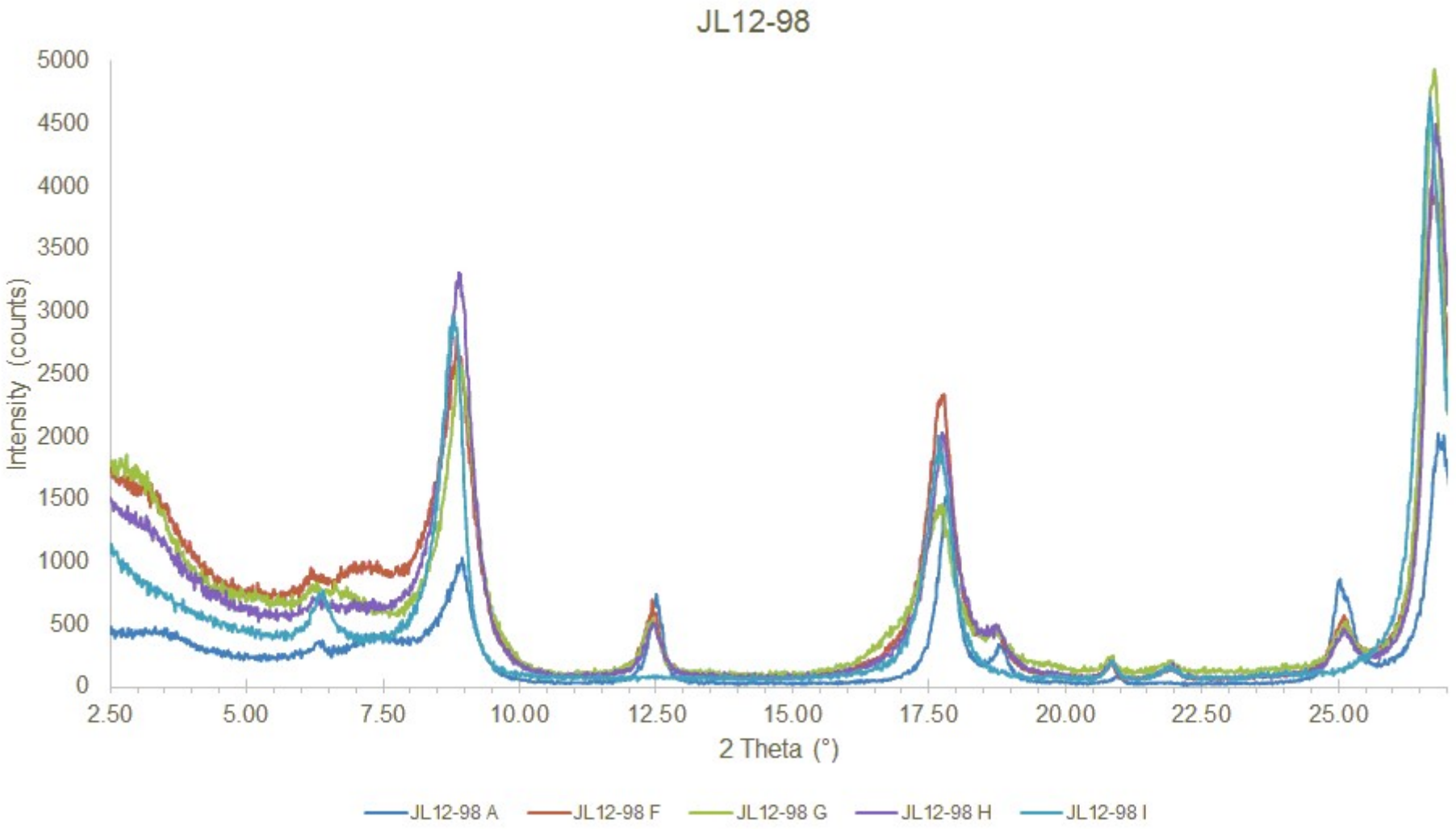
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-110 A
JL12-110 A
JL12-110 F
JL12-110 G
JL12-110 H
JL12-110 I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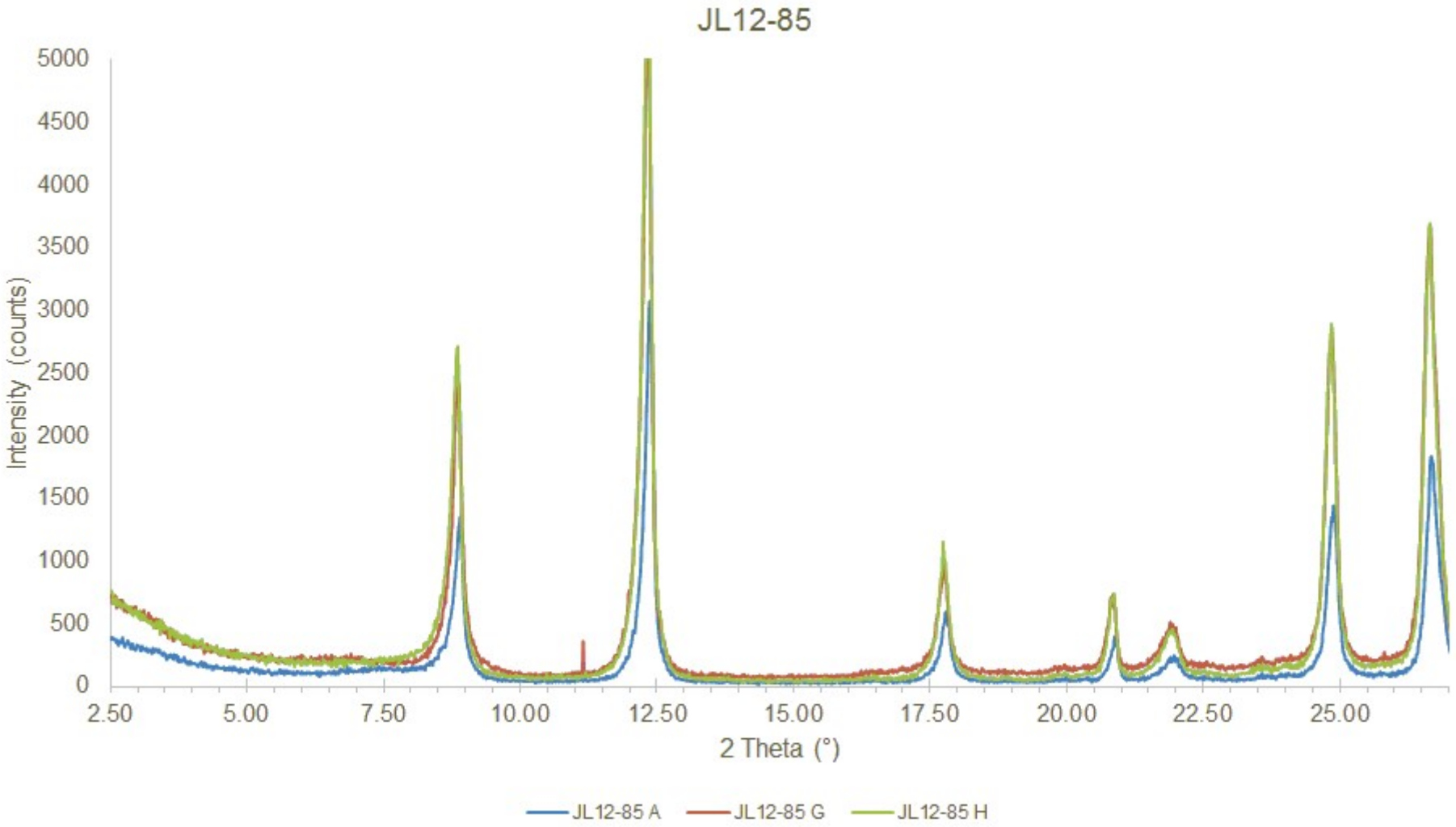
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-98 A
JL12-98 F
JL12-98 G
JL12-98 H
JL12-98 I


JL12-85
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10.00
12.50
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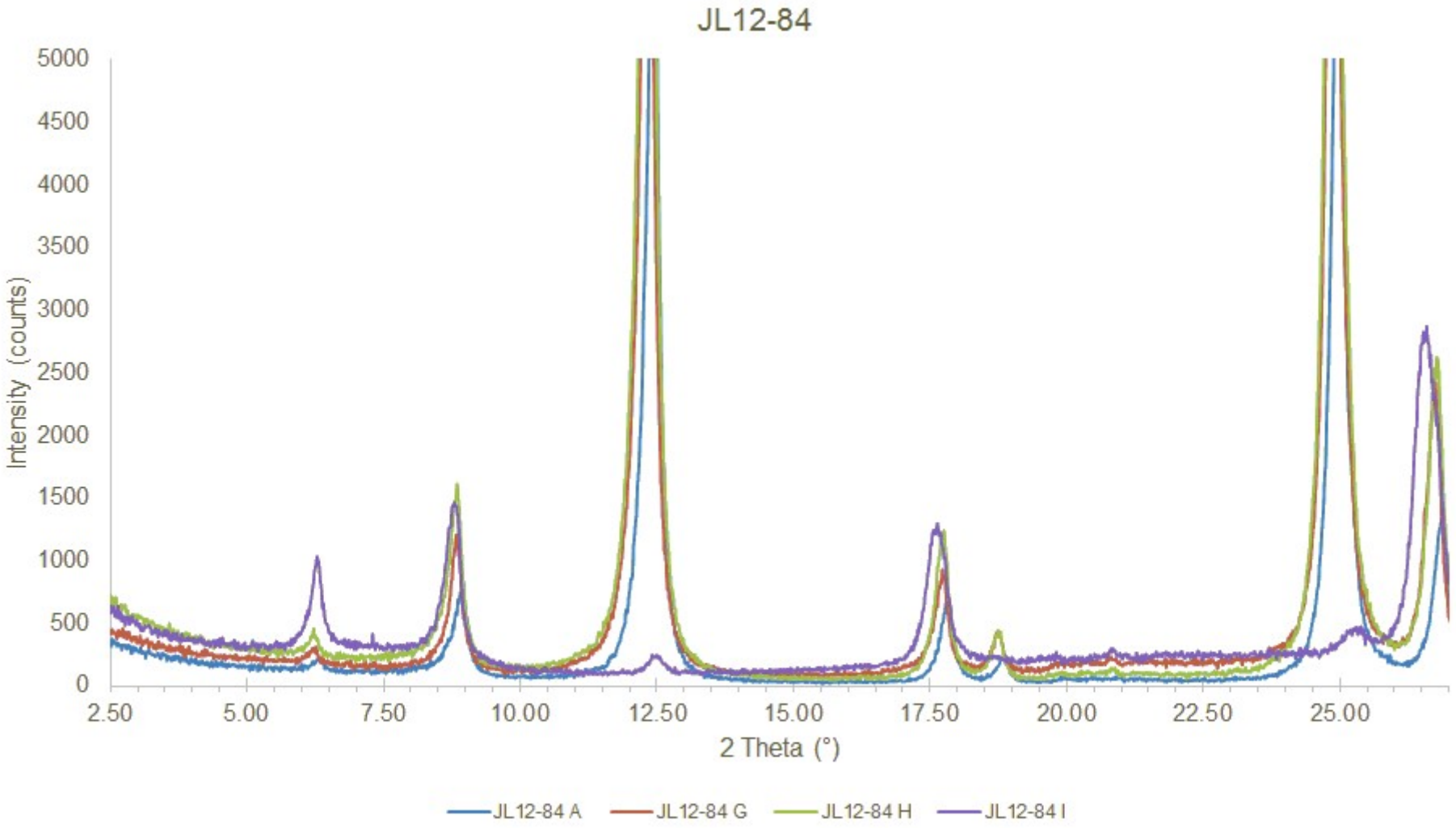
20.00
22.50
25.00
2 Theta (°)
JL12-85 A
JL12-85 G
JL12-85 H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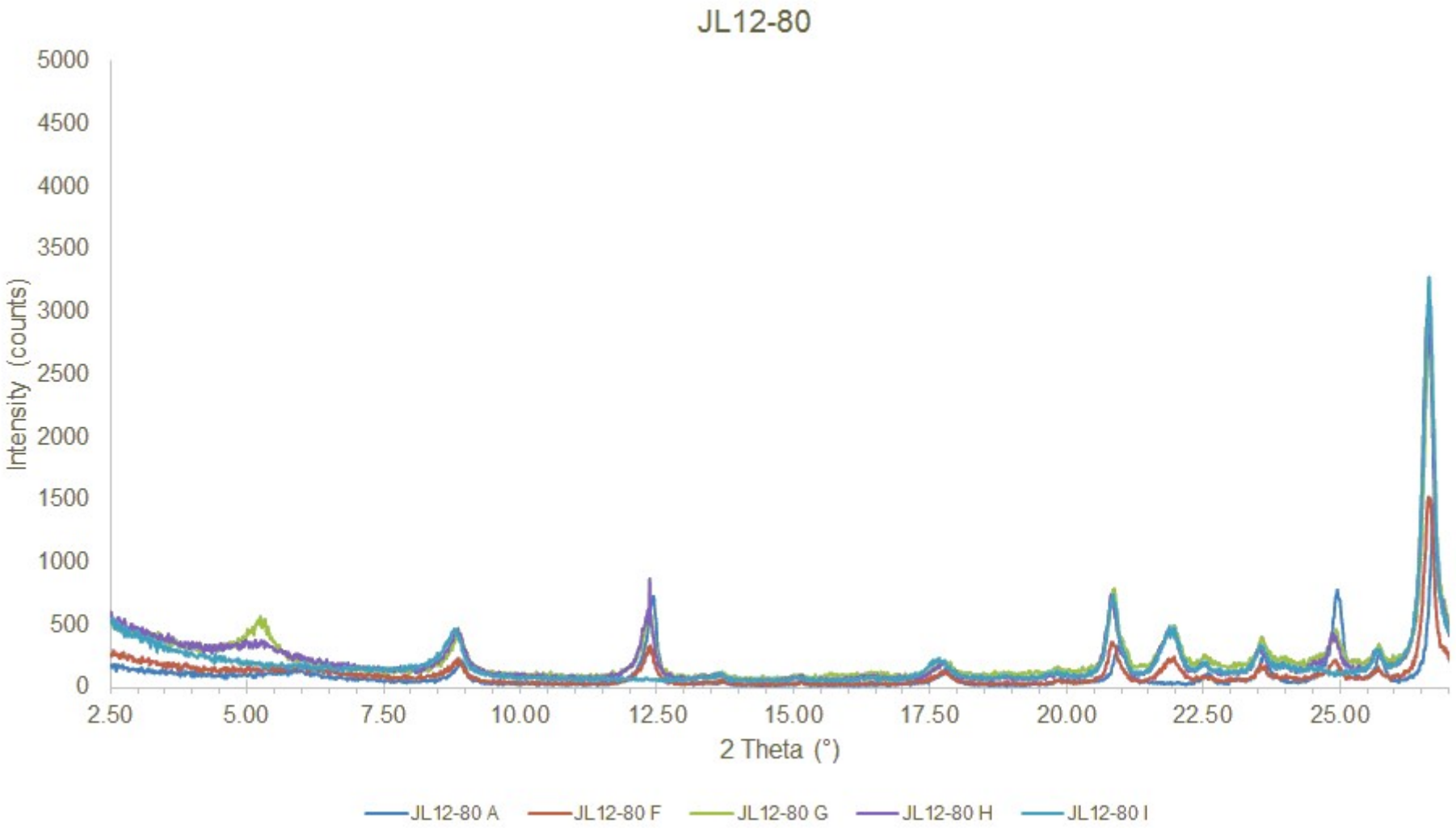
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-84 A
JL12-84 G
JL12-84 H
JL12-84 I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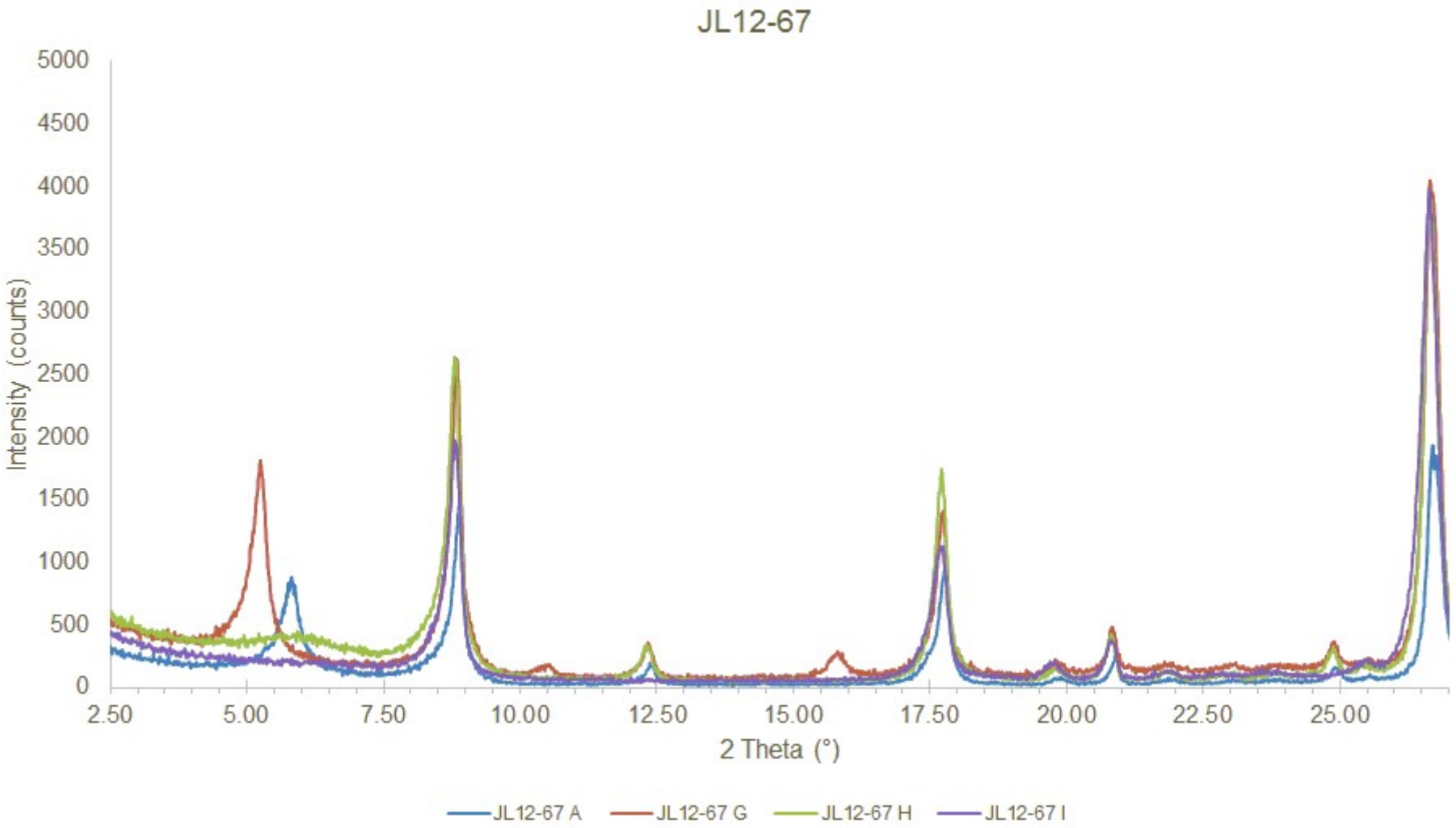
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-80 A
JL12-80 F
JL12-80 G
JL12-80 H
JL12-80 I


JL12-67
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12.50
15.00
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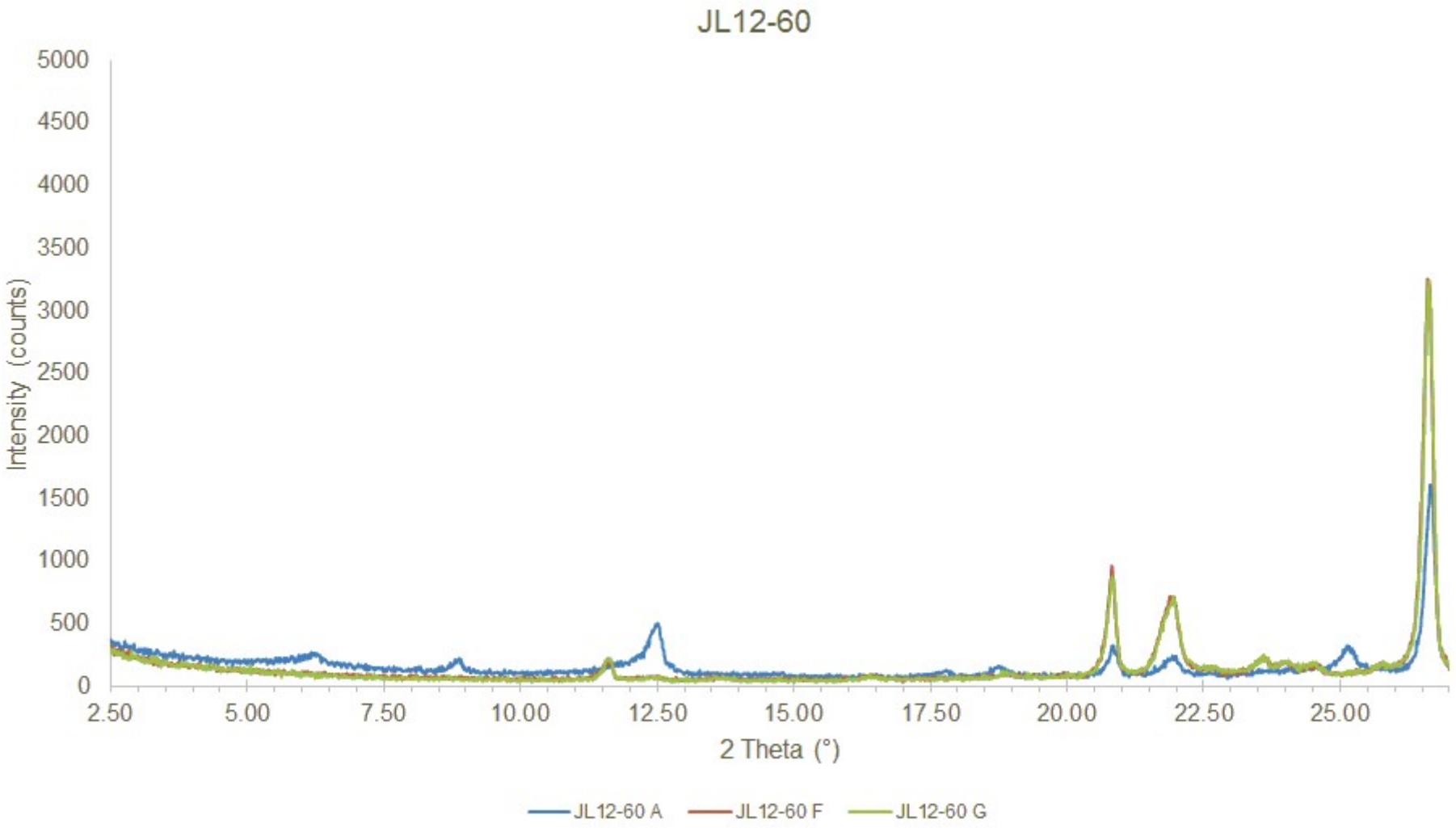
25.00
2 Theta (°)
JL12-67 A
JL12-67 G
JL12-67 H
JL12-67 I


JL12-60
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1500
1000
500
0
Intensity (counts)
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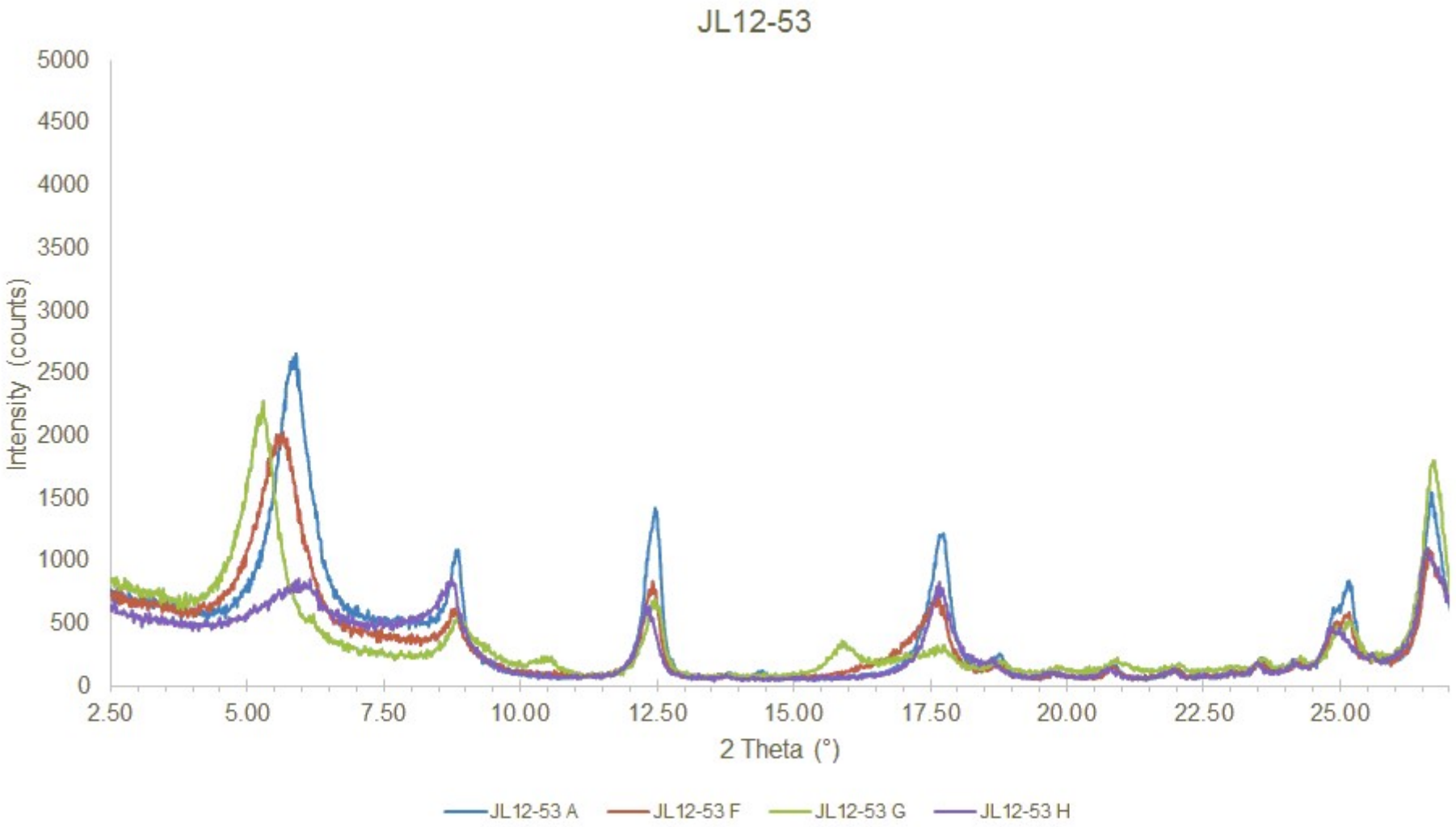
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-60 A
JL12-60 F
JL12-60 G


JL12-53
Intensity (counts)
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1000
500
0
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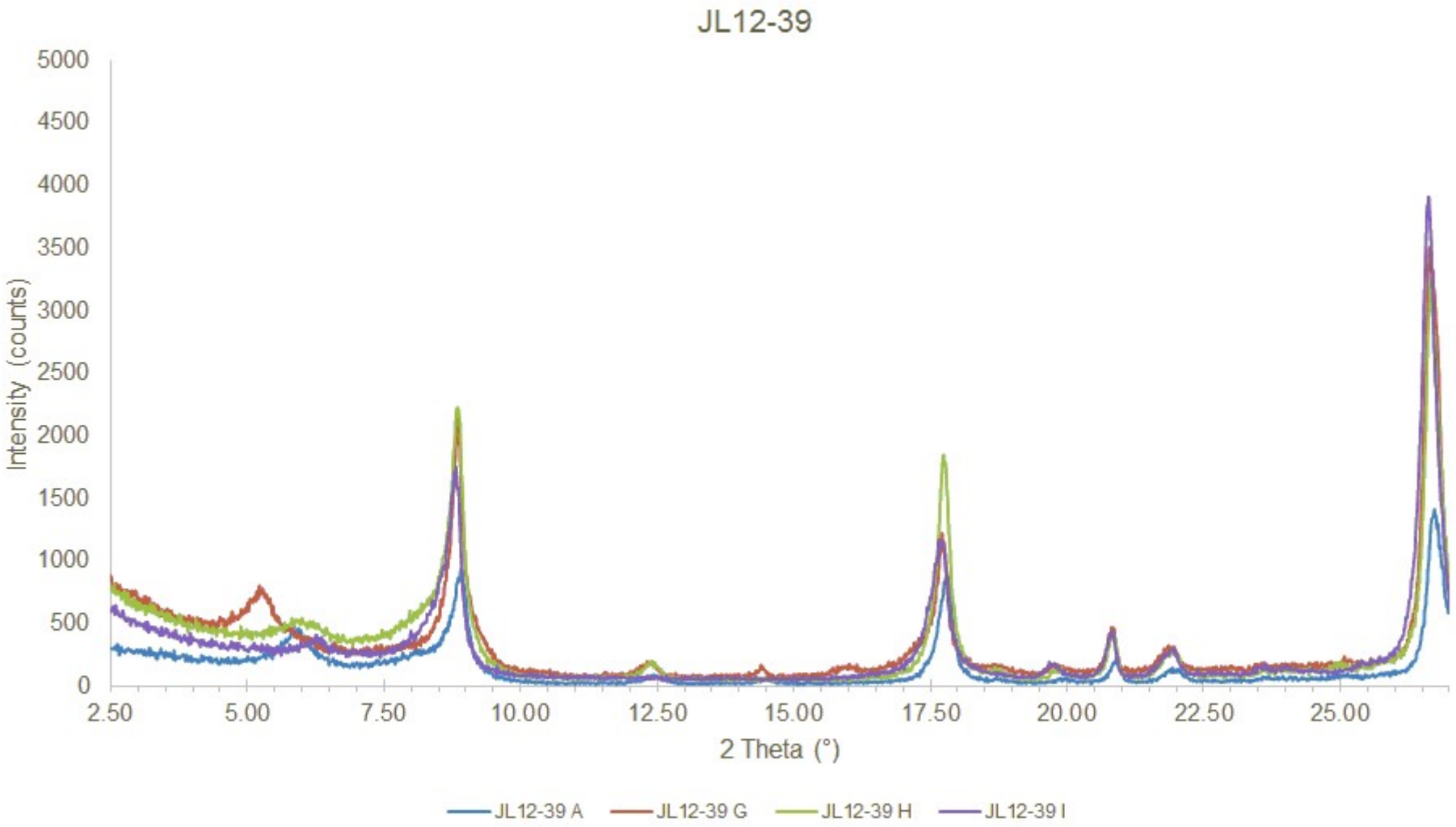
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-53 A
JL12-53 F
JL12-53 G
JL12-53 H


JL12-39
Intensity (counts)
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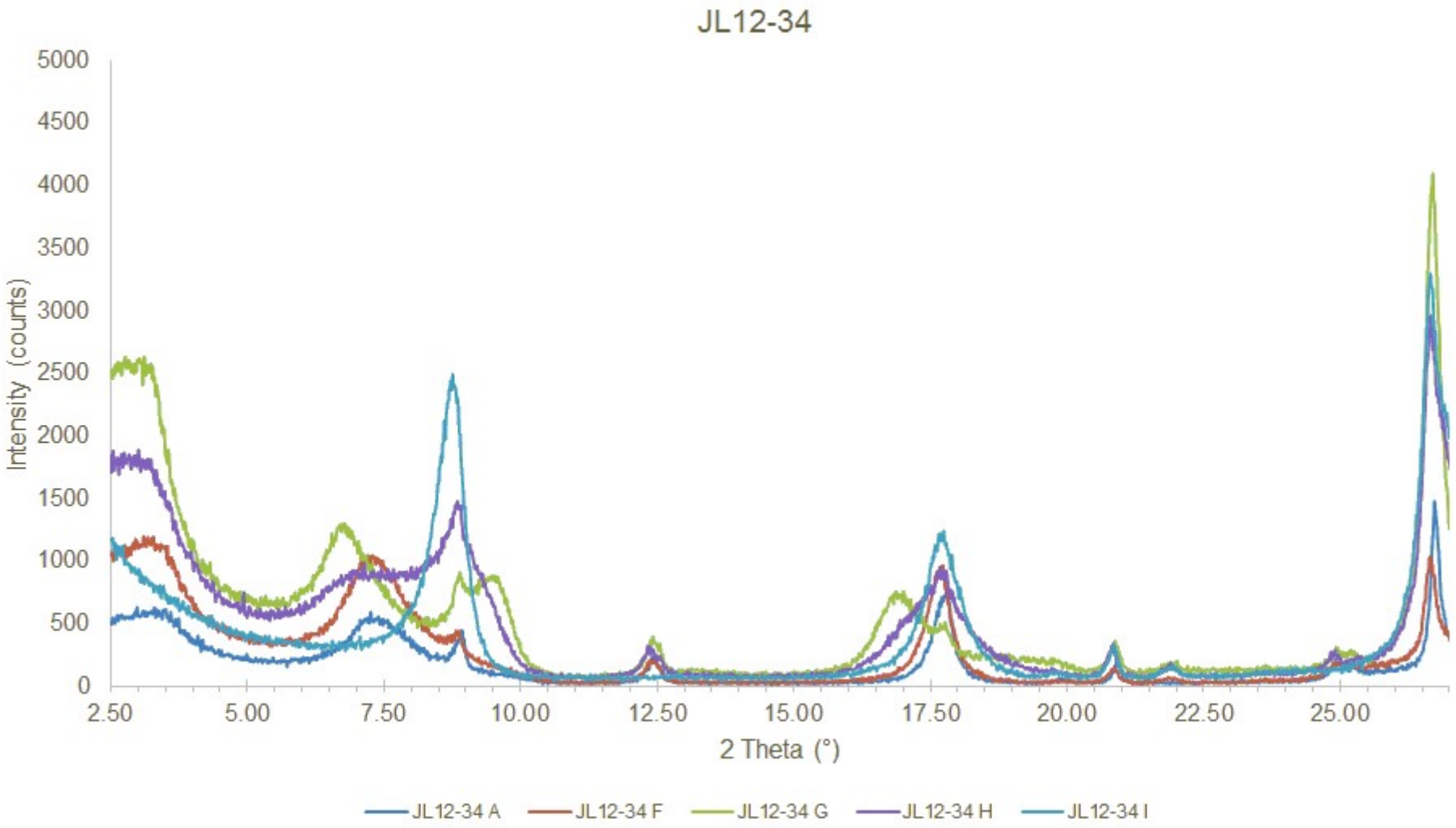
500
0
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-39 A
JL12-39 G
JL12-39 H
JL12-39 I


JL12-34
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1000
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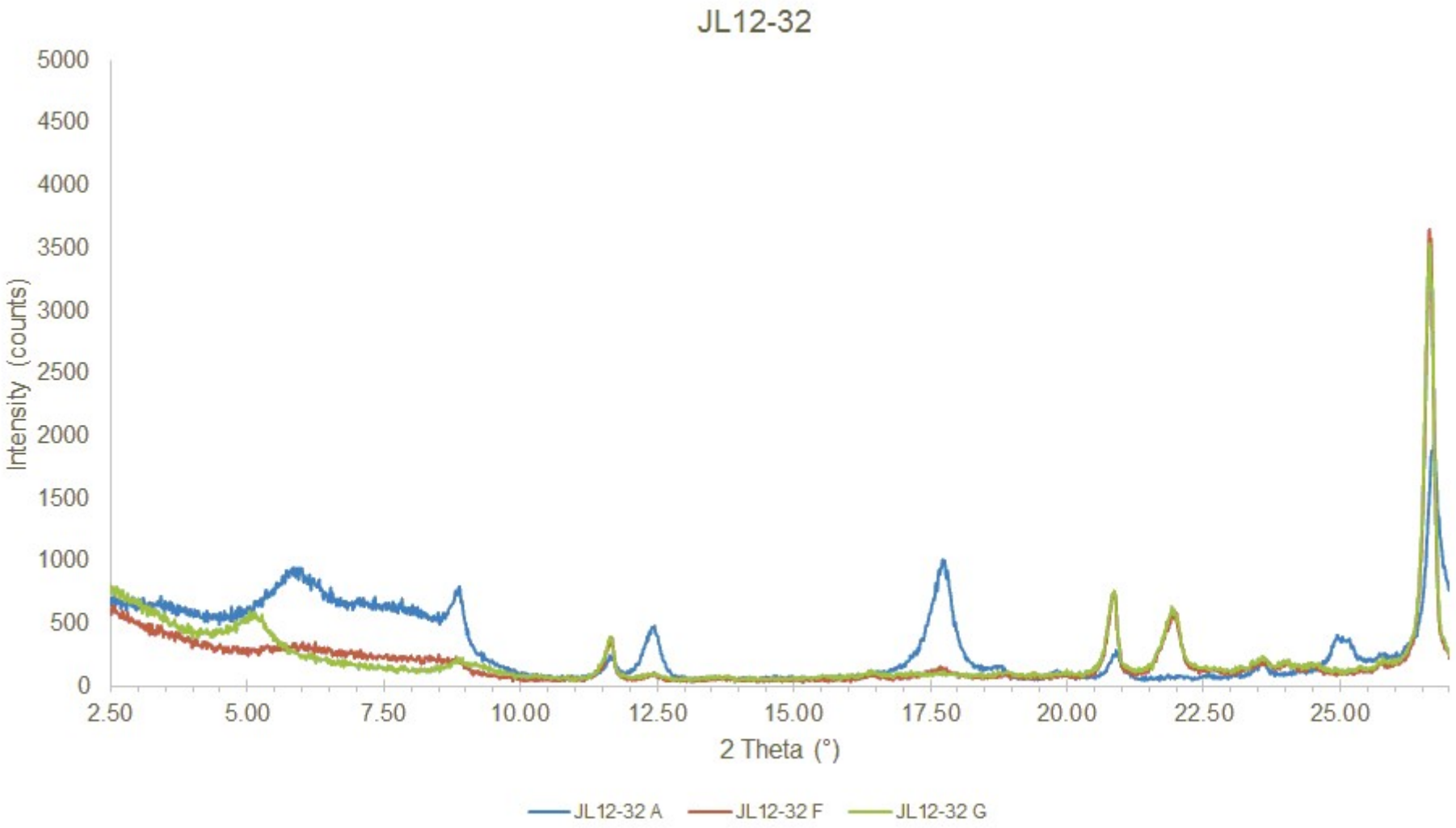
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-34 A
JL12-34 F
JL12-34 G
JL12-34 H
JL12-34 I


JL12-32
Intensity (counts)
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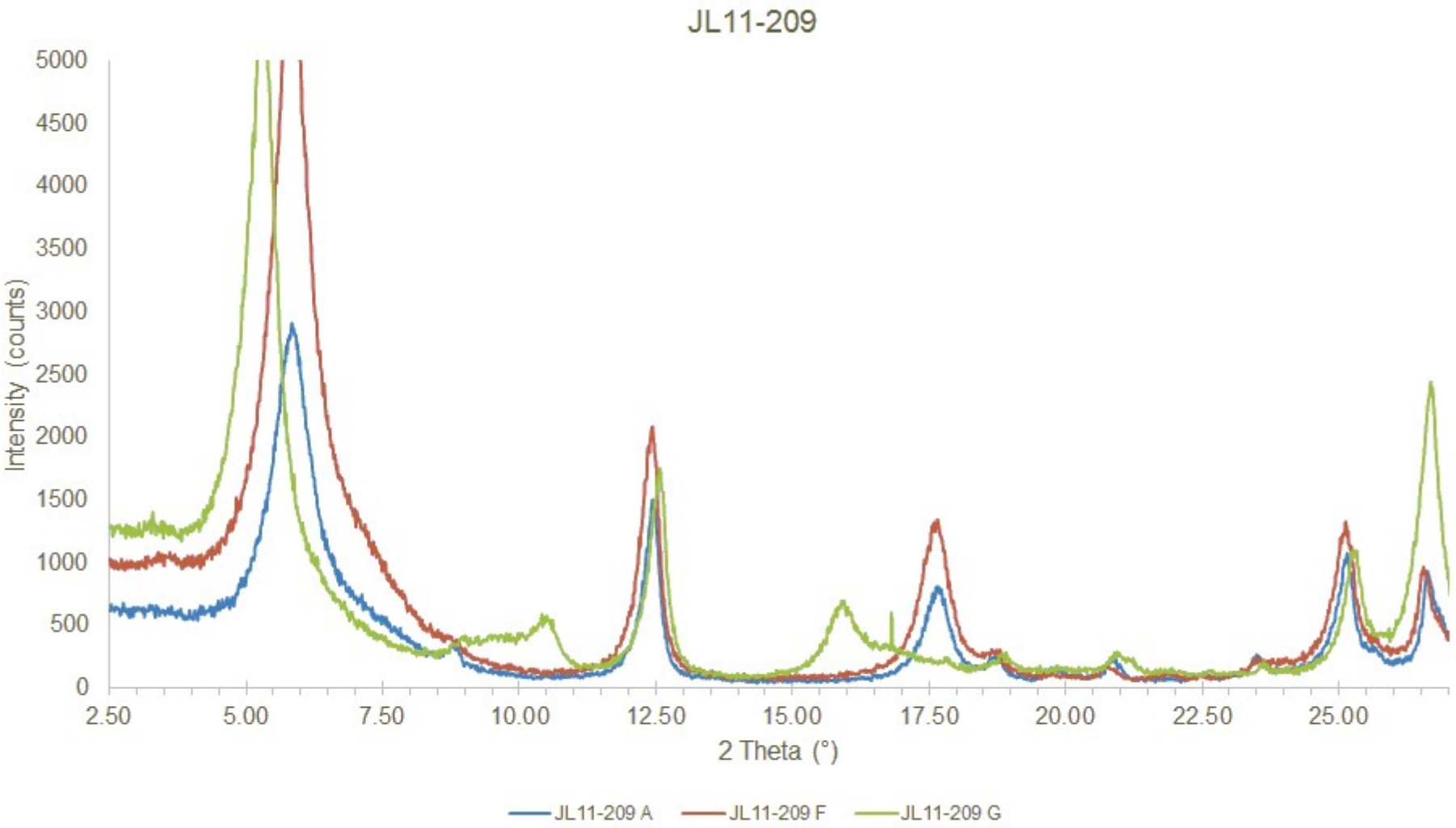
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-32 A
JL12-32 F
JL12-32 G


JL11-209
Intensity (counts)
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7.50
10.00
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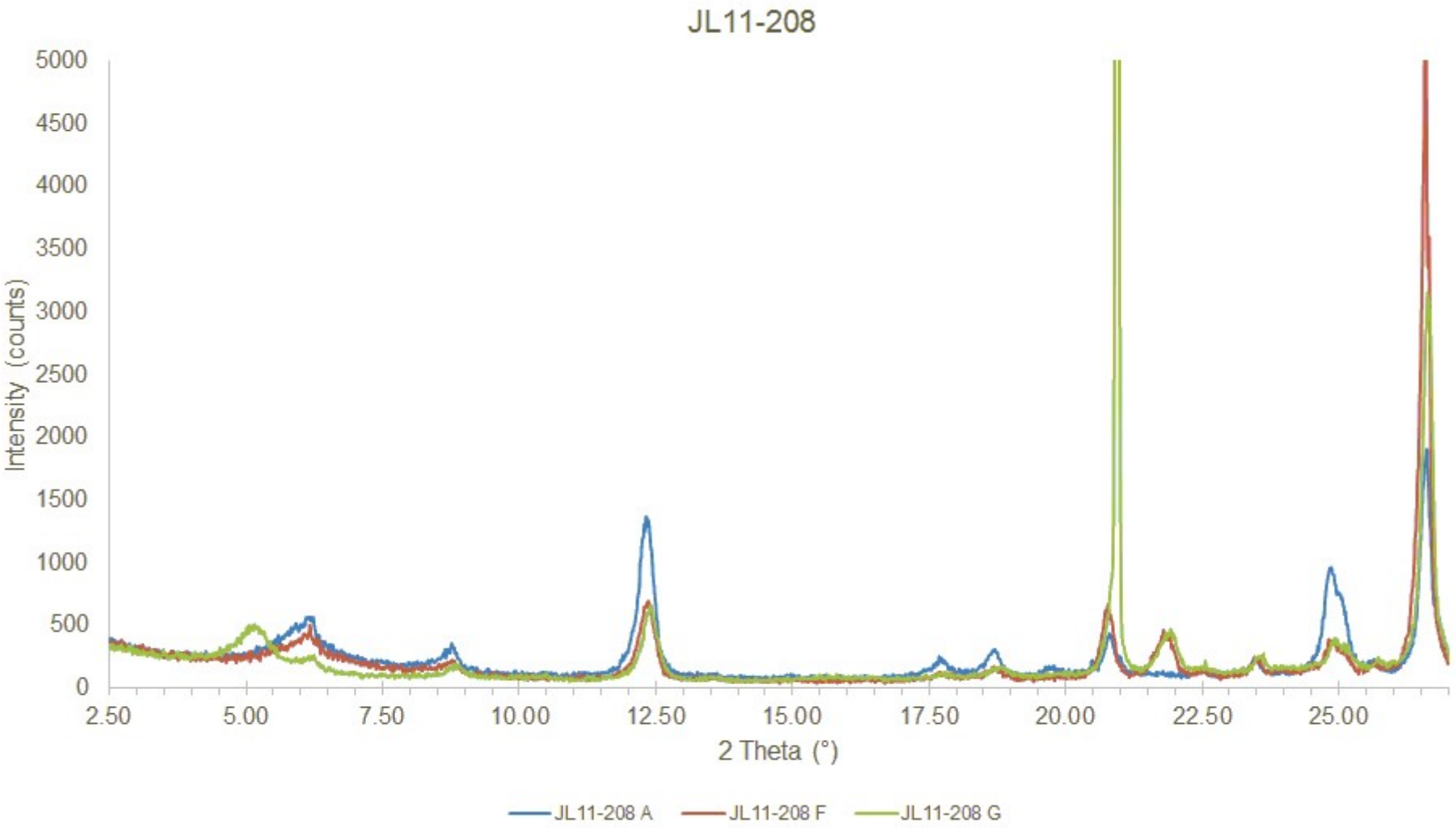
20.00
22.50
25.00
2 Theta (°)
JL11-209 A
JL11-209 F
JL11-209 G


JL11-208
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7.50
10.00
12.50
15.00
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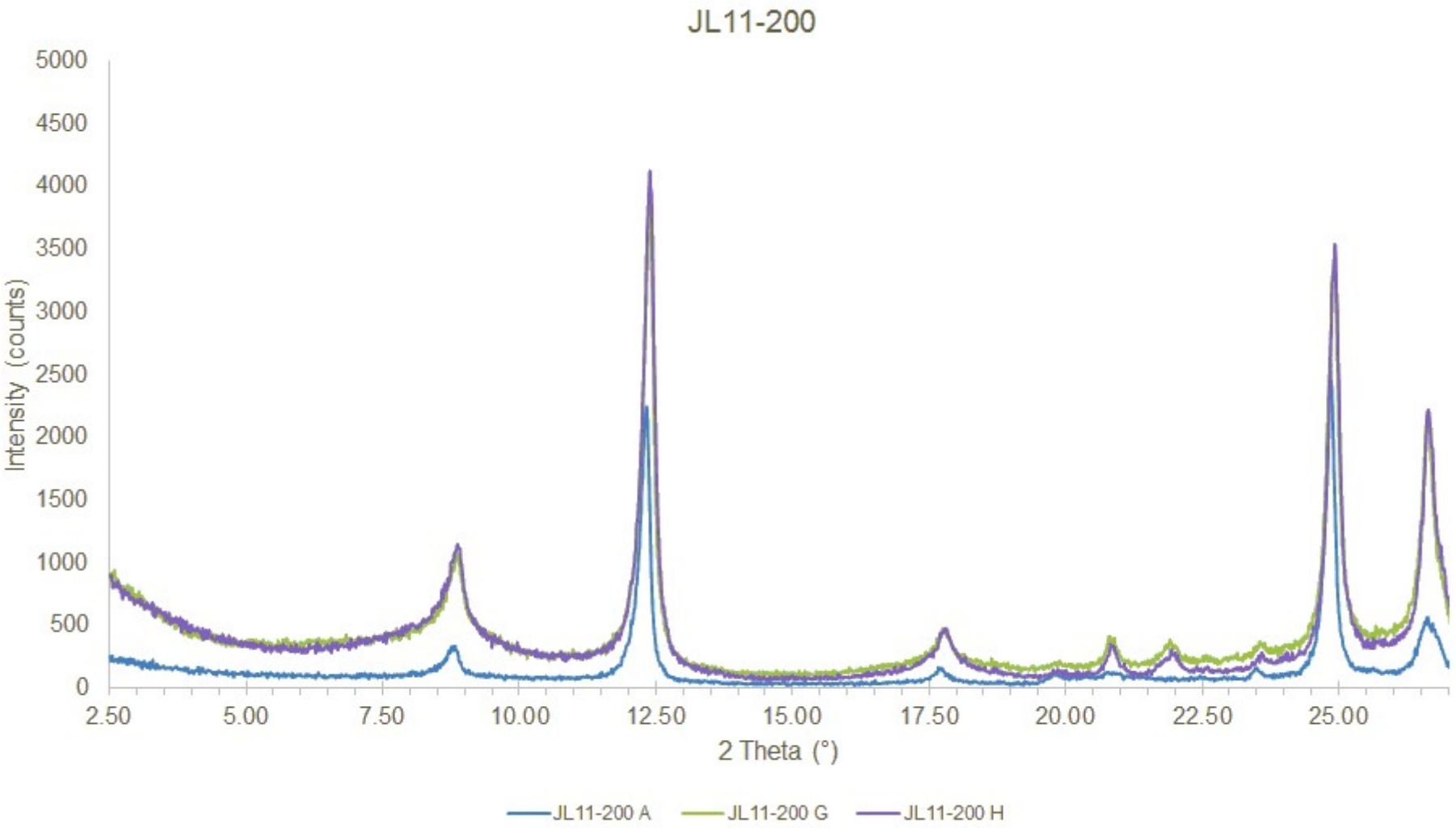
20.00
22.50
25.00
2 Theta (°)
JL11-208 A
JL11-208 F
JL11-208 G


JL11-200
Intensity (counts)
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3000
2500
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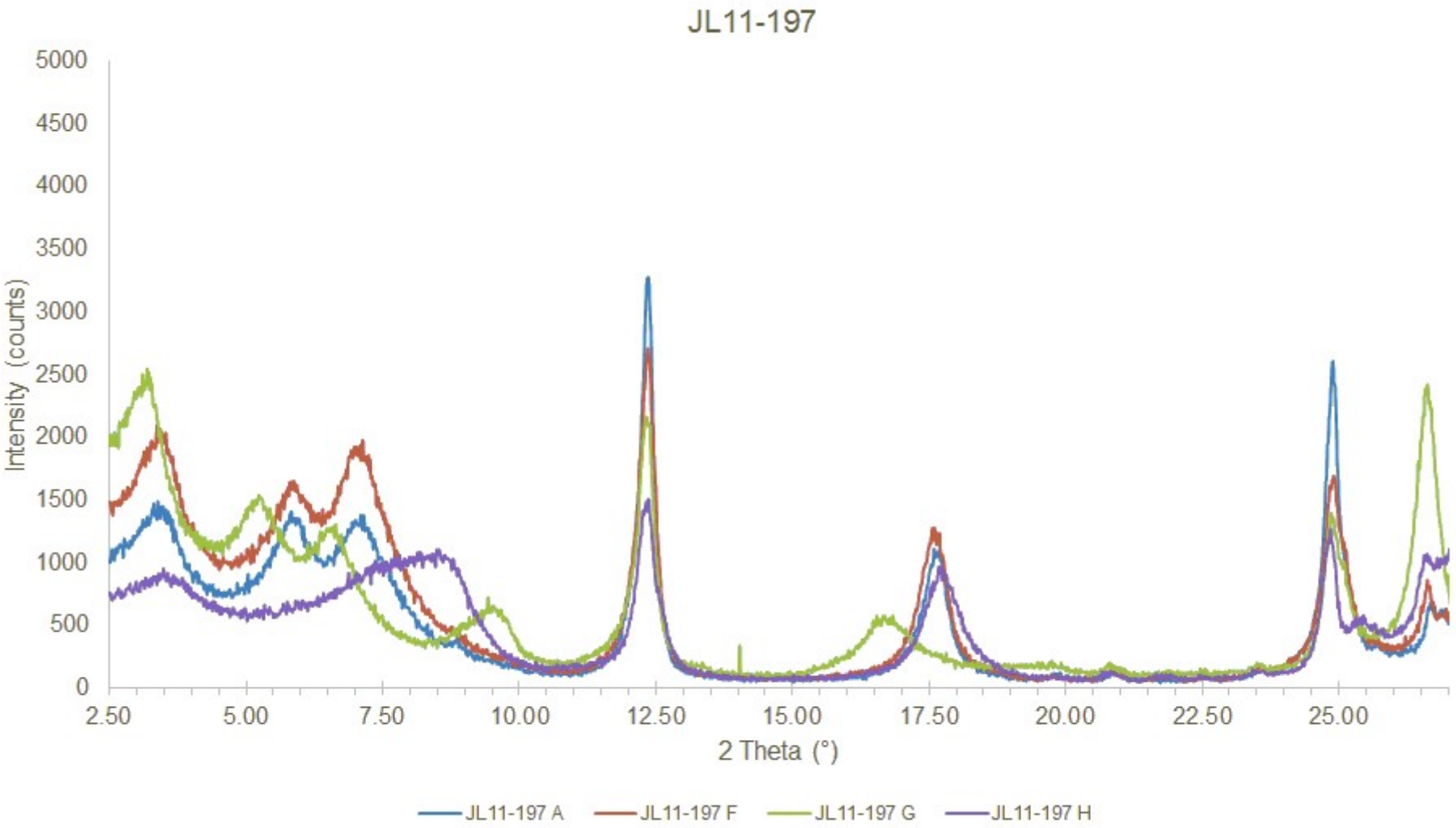
1000
500
0
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL11-200 A
JL11-200 G
JL11-200 H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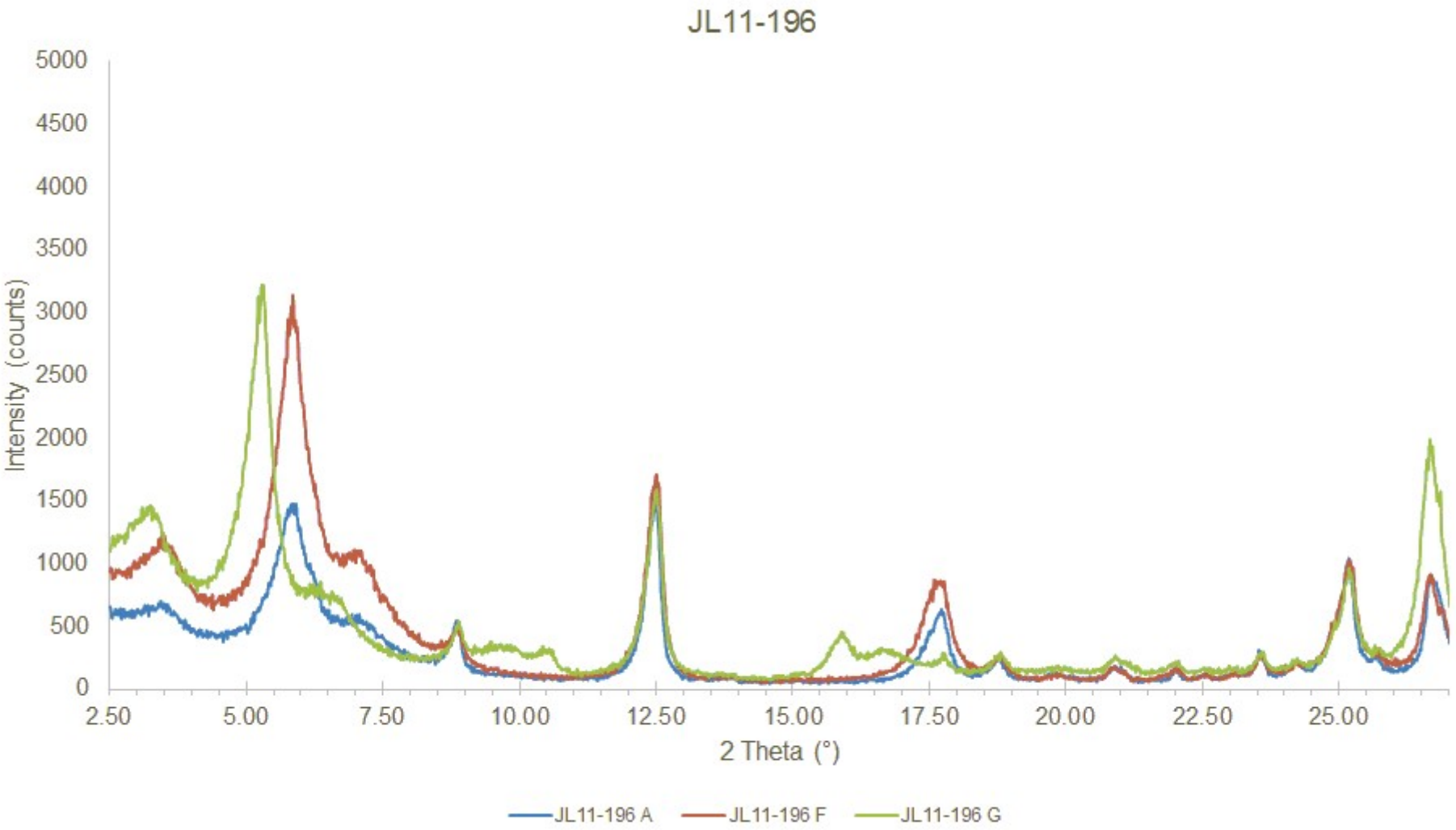
2 Theta (°)
JL11-197 A
JL11-197 F
JL11-197 G
JL11-197 H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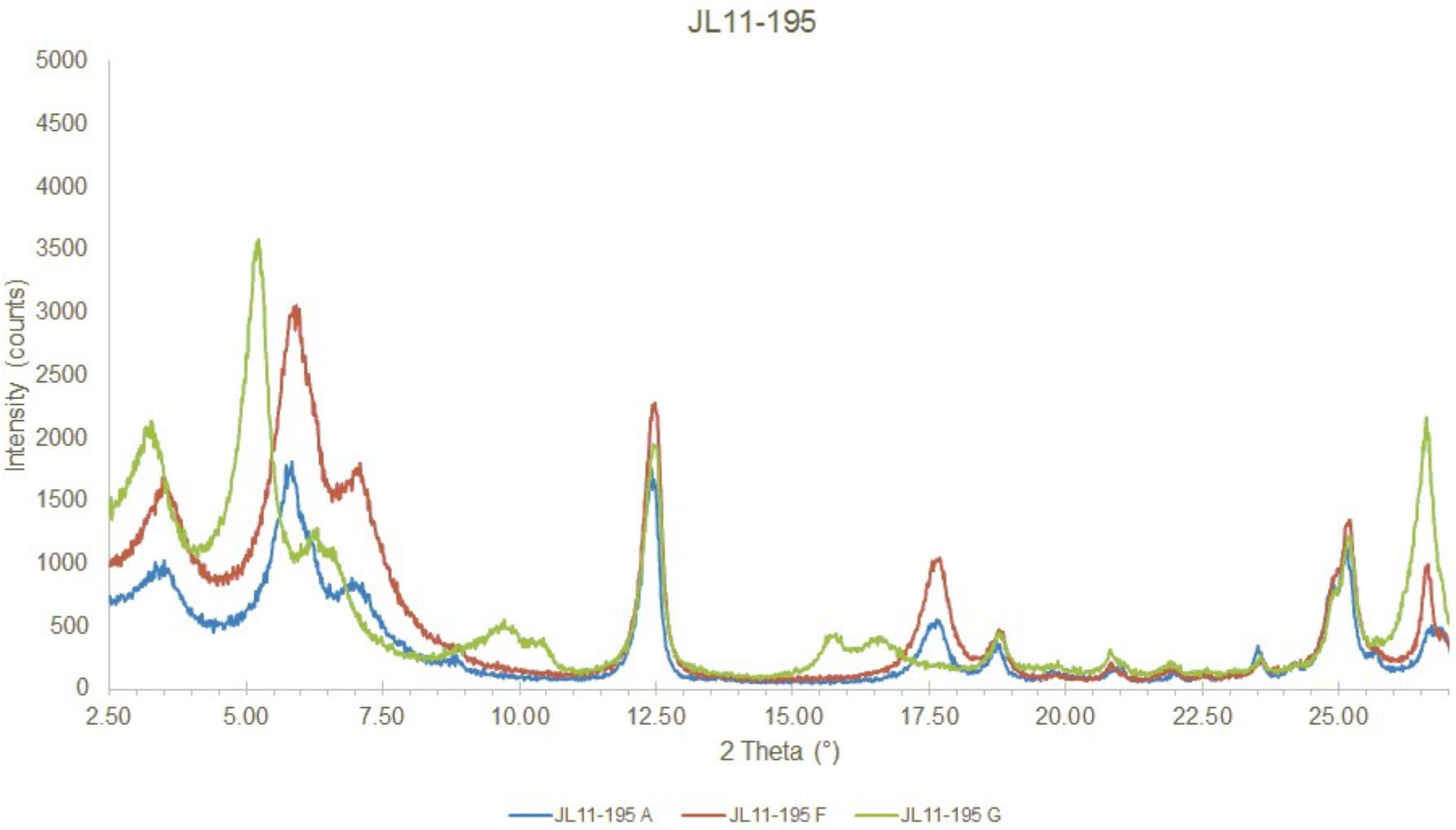
2 Theta (°)
JL11-196 A
JL11-196 F
JL11-196 G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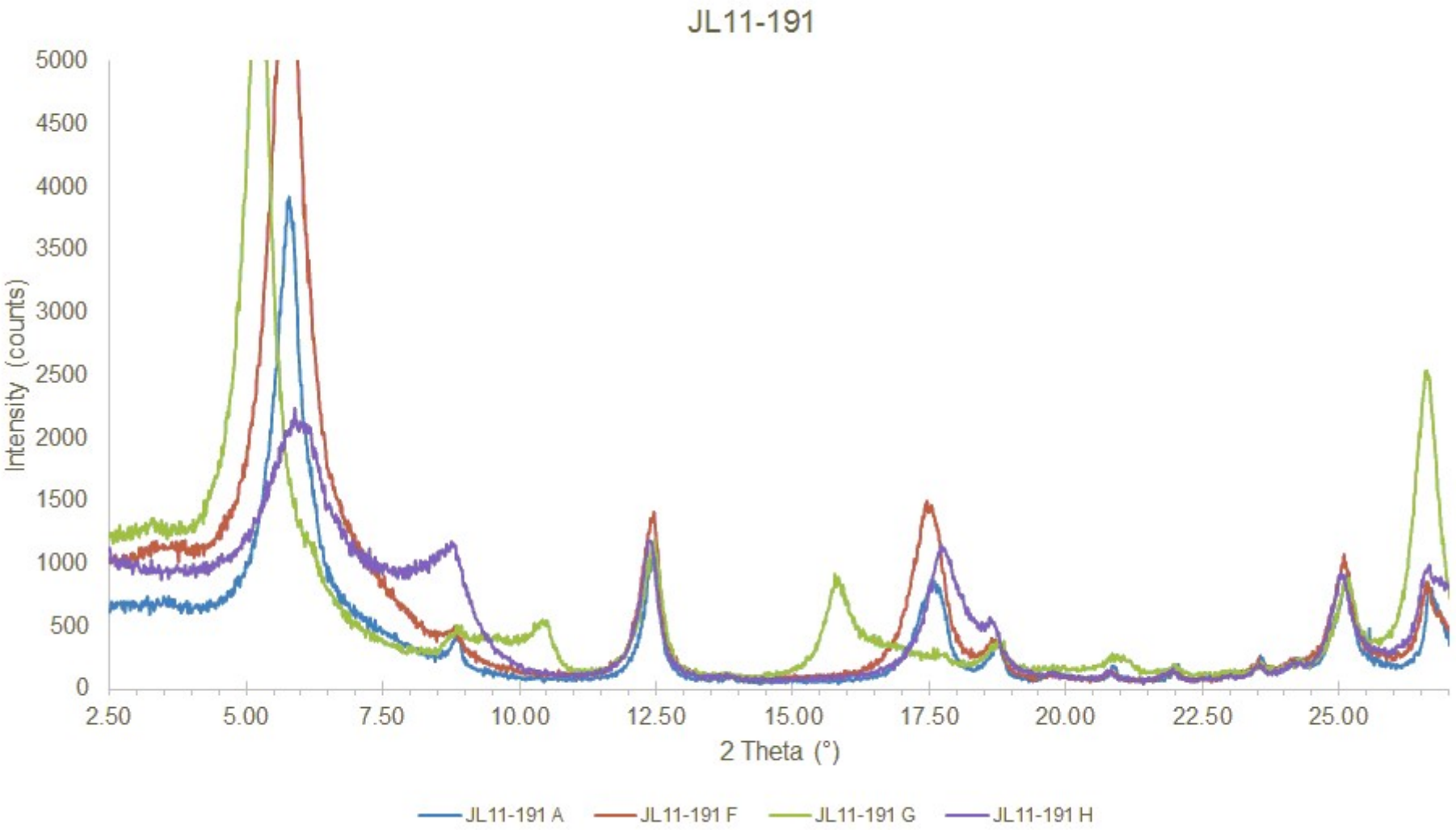
25.00
2 Theta (°)
JL11-195 A
JL11-195 F
JL11-195 G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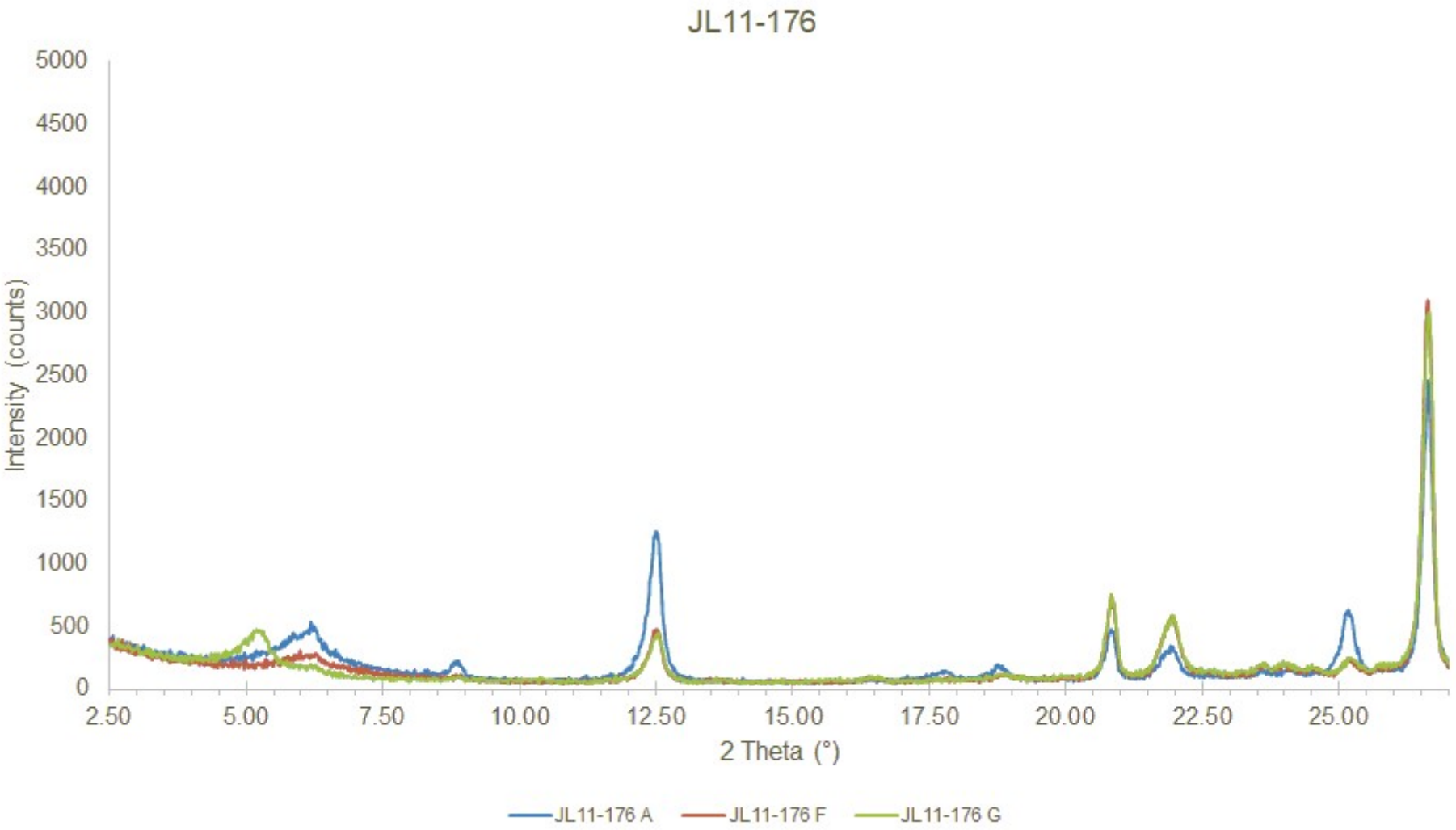
25.00
2 Theta (°)
JL11-191 A
JL11-191 F
JL11-191 G
JL11-191 H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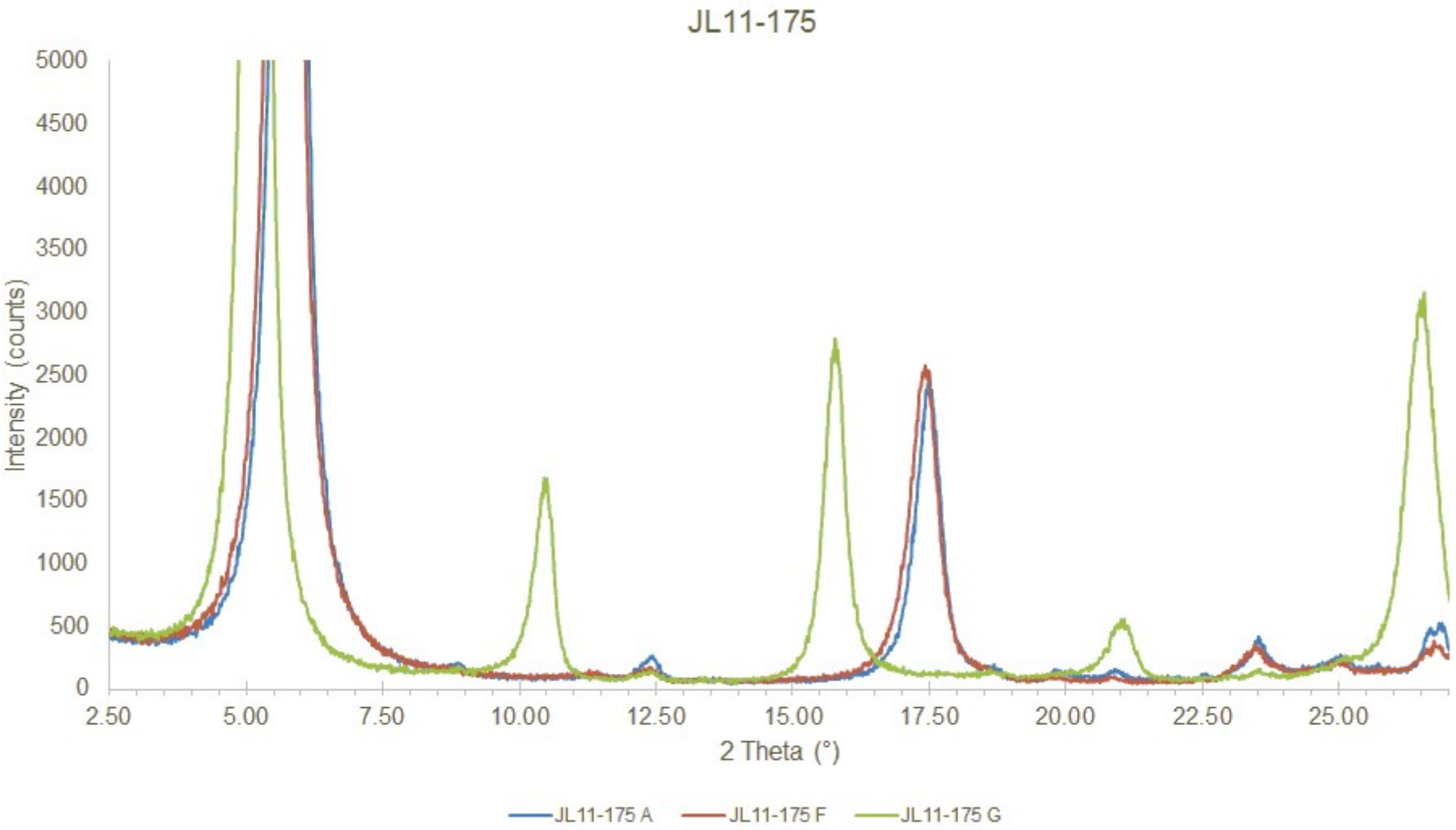
25.00
2 Theta (°)
JL11-176 A
JL11-176 F
JL11-176 G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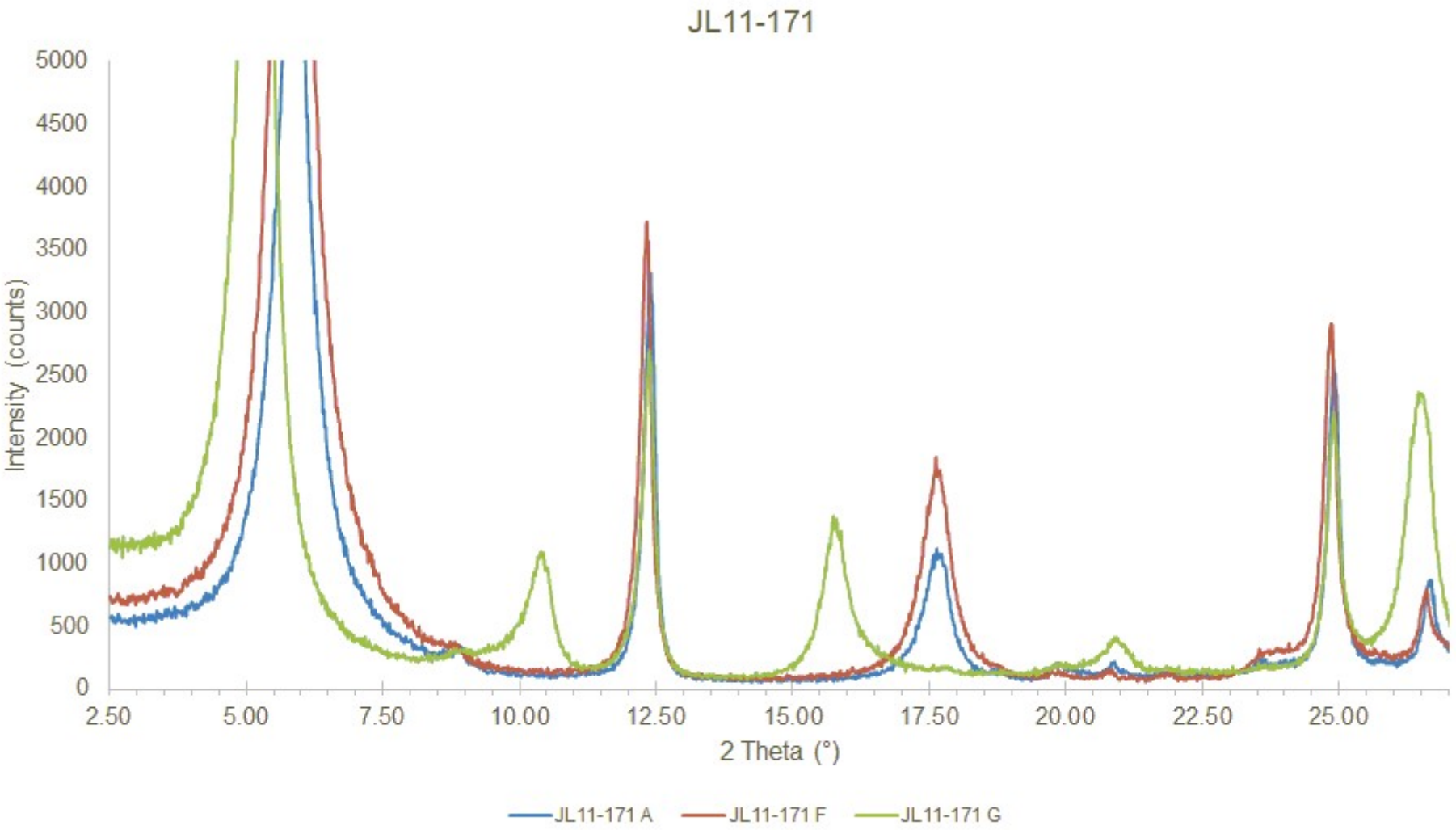
25.00
2 Theta (°)
JL11-175 A
JL11-175 F
JL11-175 G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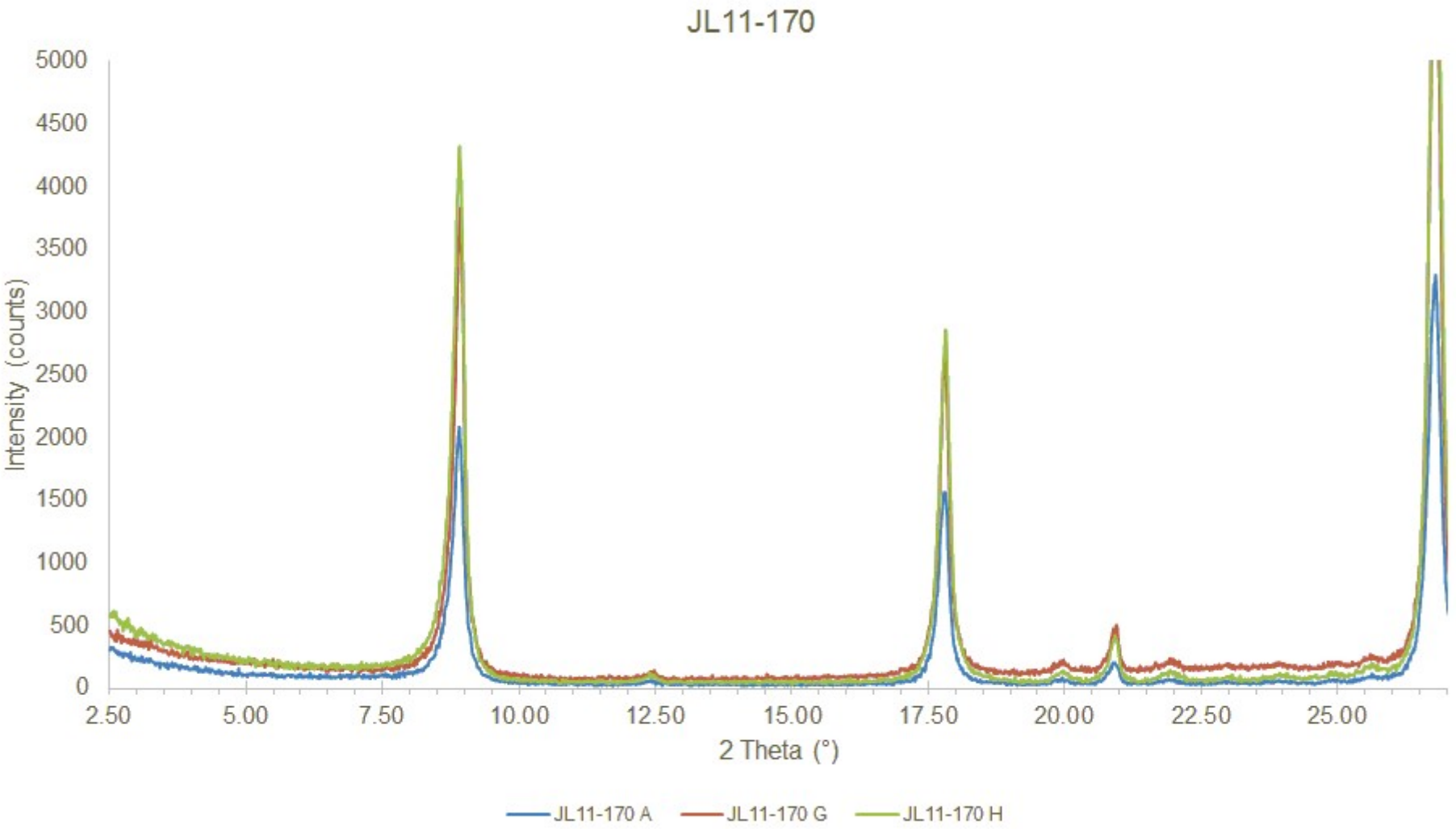
22.50
25.00
2 Theta (°)
JL11-171 A
JL11-171 F
JL11-171 G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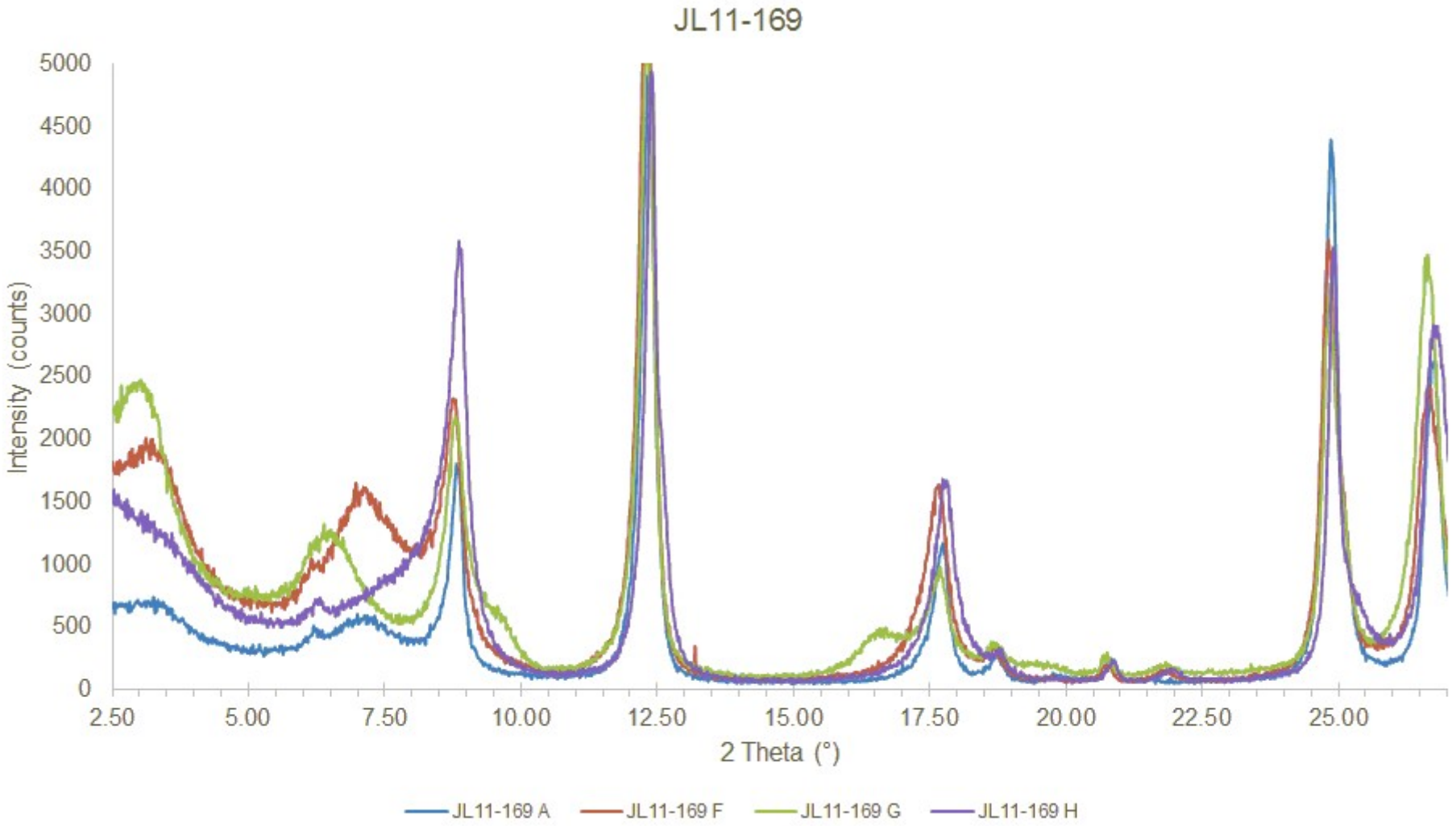
22.50
25.00
2 Theta (°)
JL11-170 A
JL11-170 G
JL11-170 H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12.50
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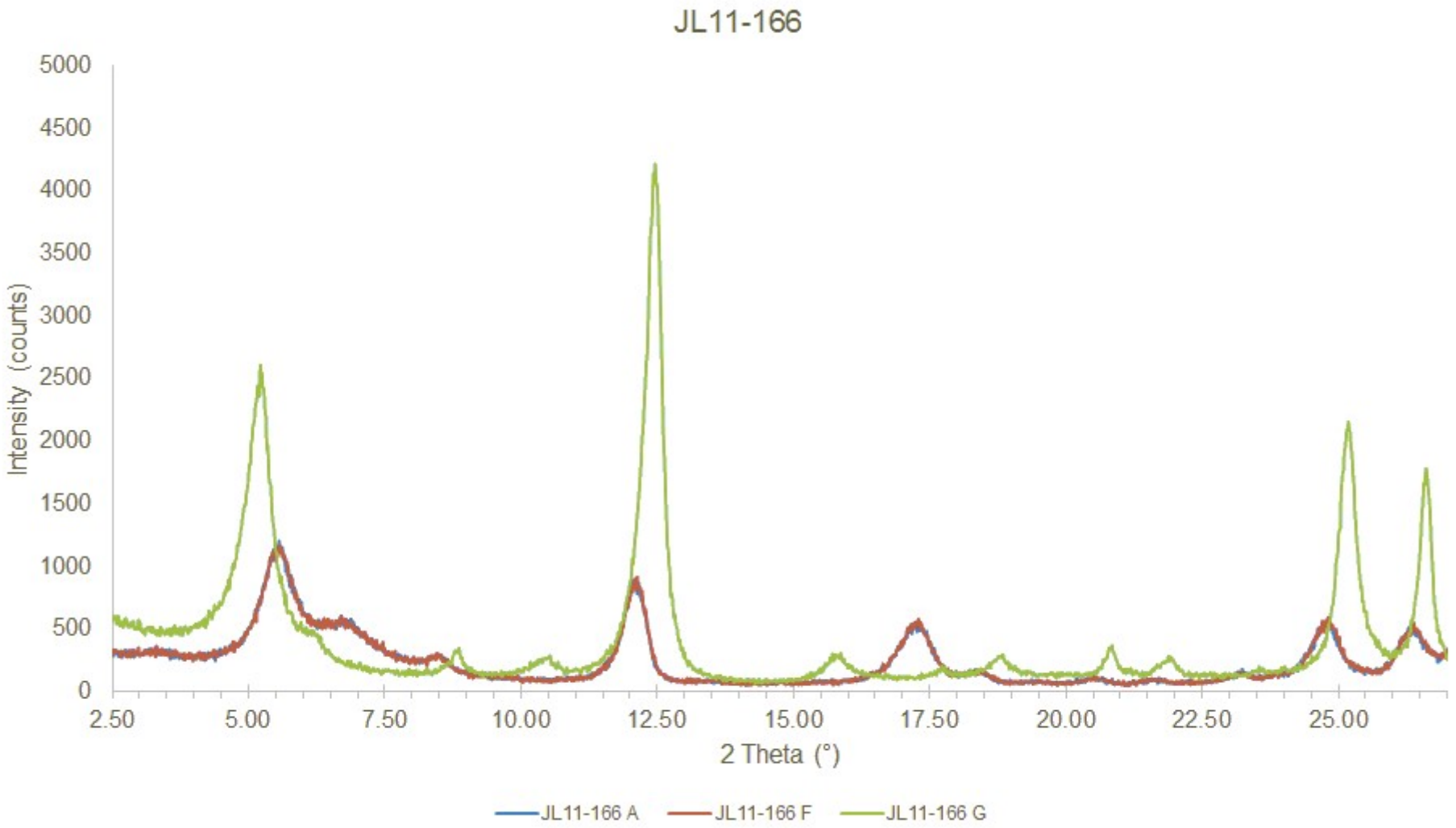
22.50
25.00
2 Theta (°)
JL11-169 A
JL11-169 F
JL11-169 G
JL11-169 H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22.50
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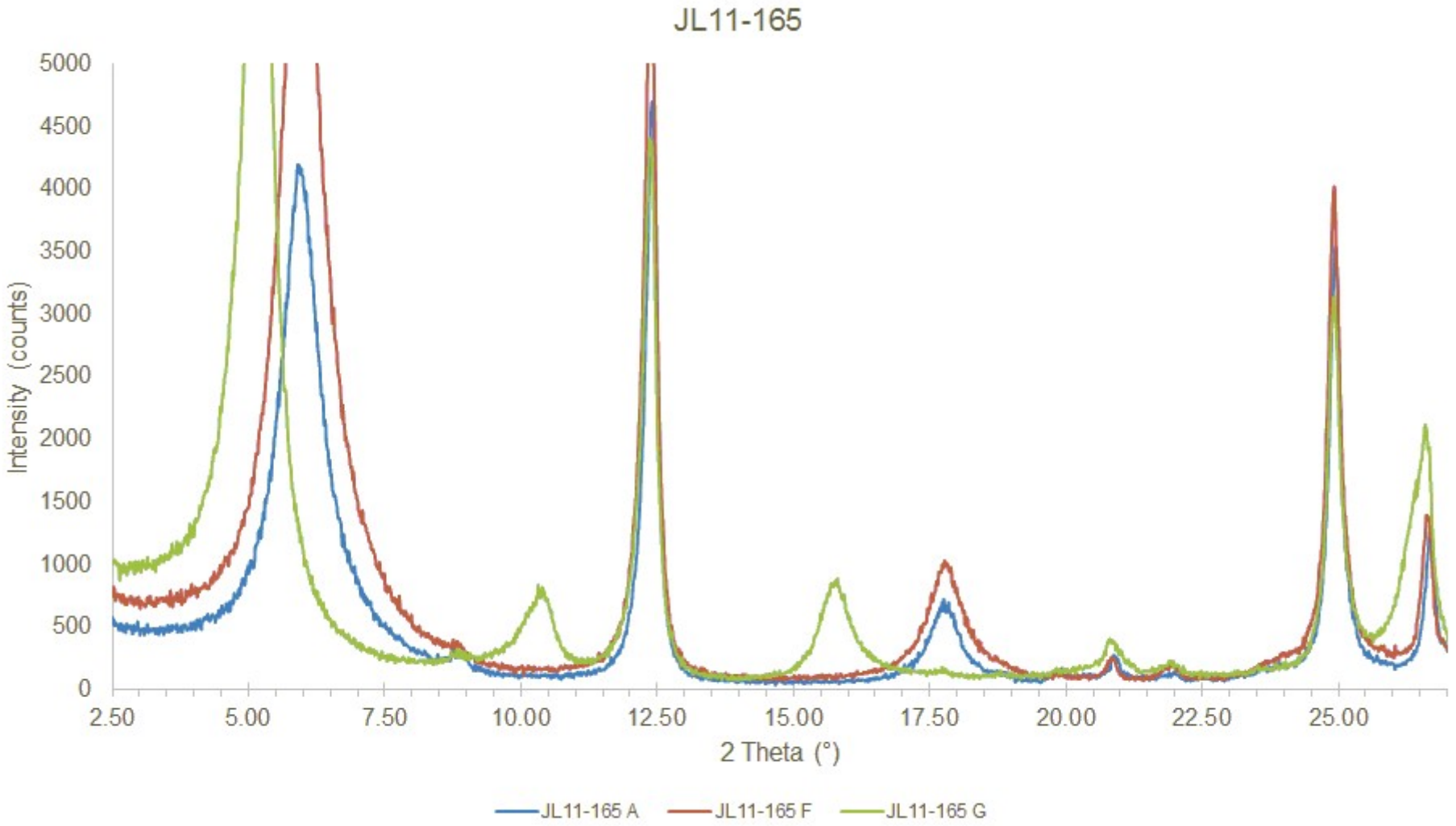
2 Theta (°)
JL11-166 A
JL11-166 F
JL11-166 G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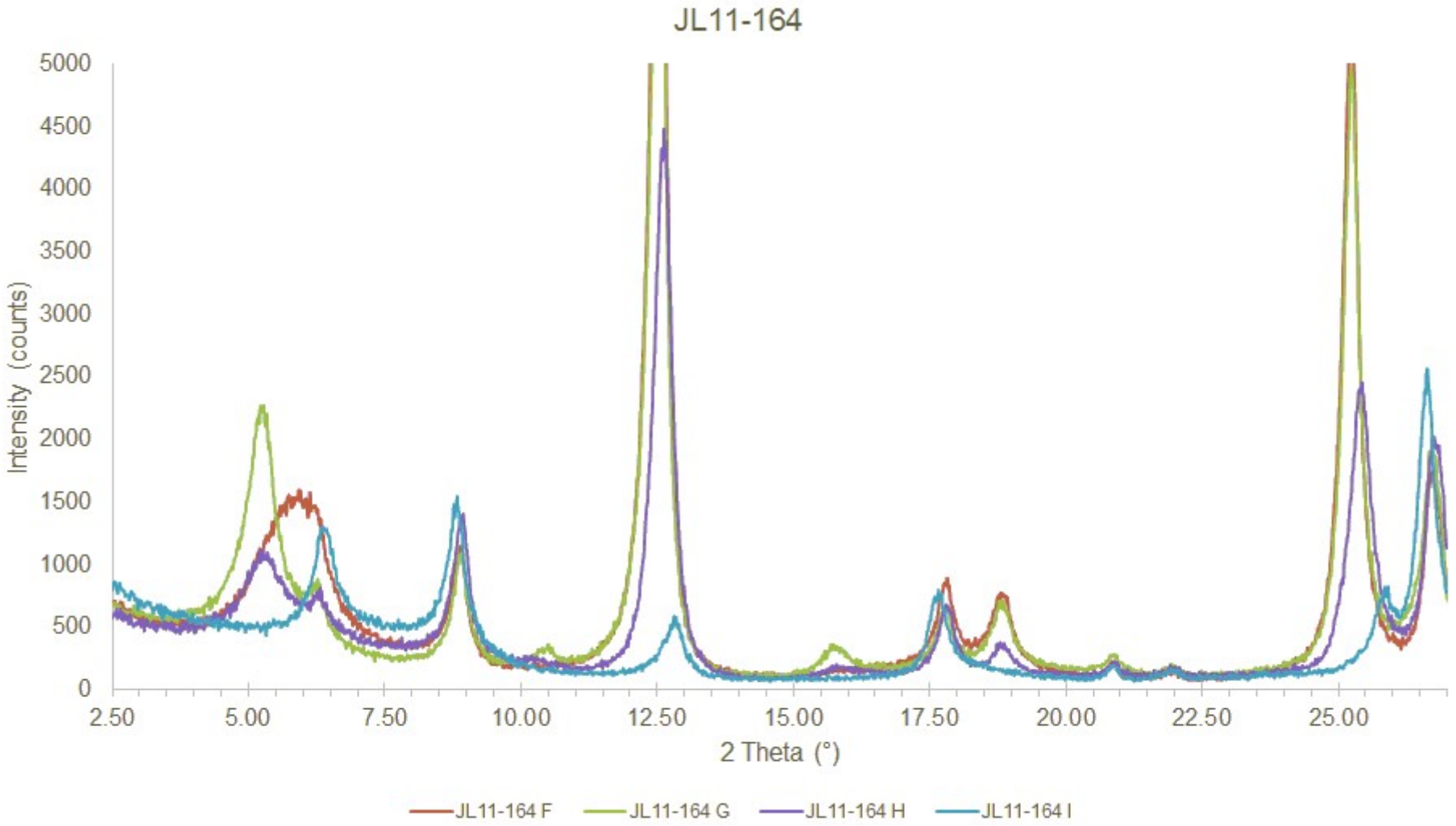
2 Theta (°)
JL11-165 A
JL11-165 F
JL11-165 G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12.50
15.00
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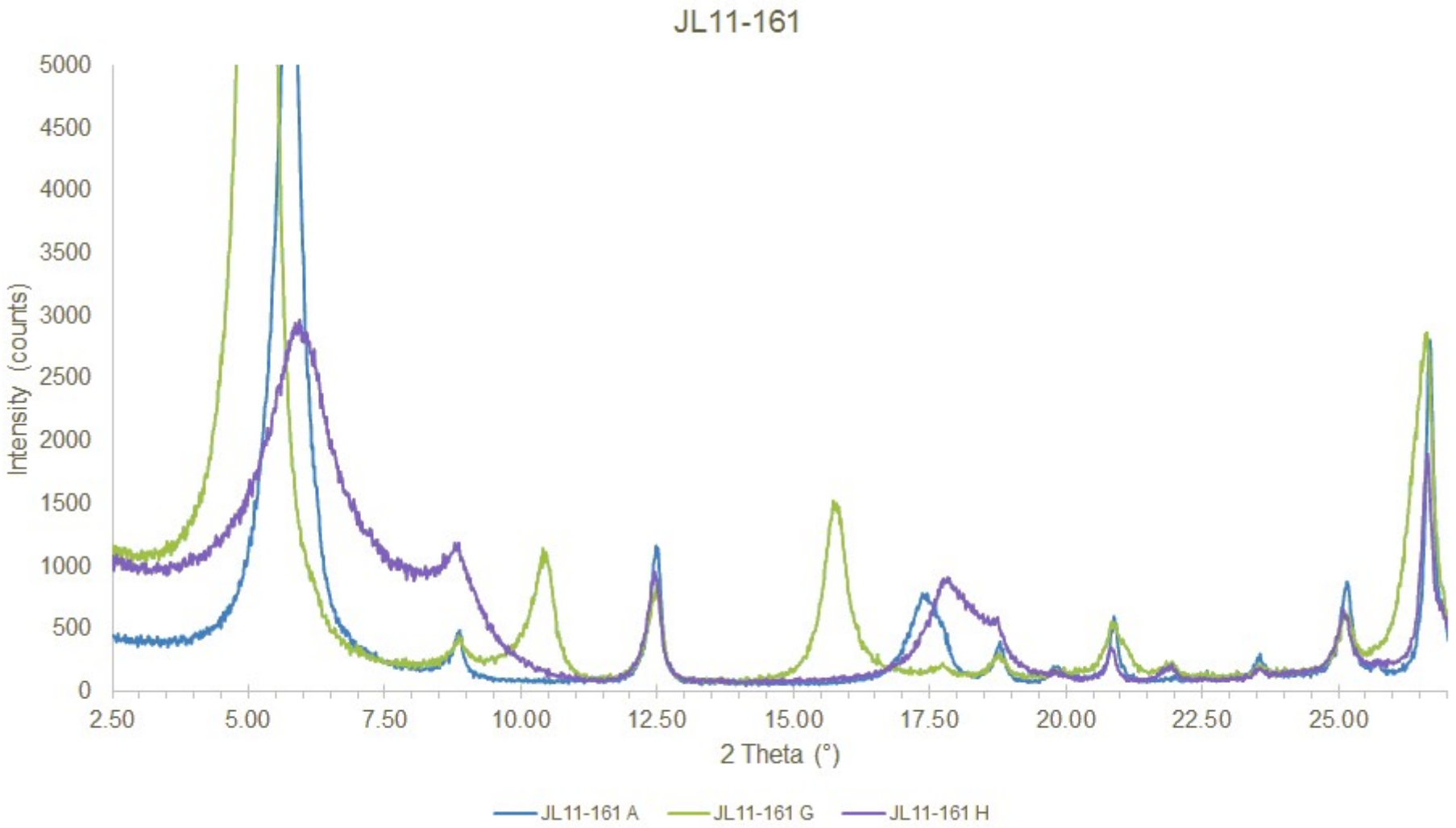
2 Theta (°)
JL11-164 F
JL11-164 G
JL11-164 H
JL11-164 I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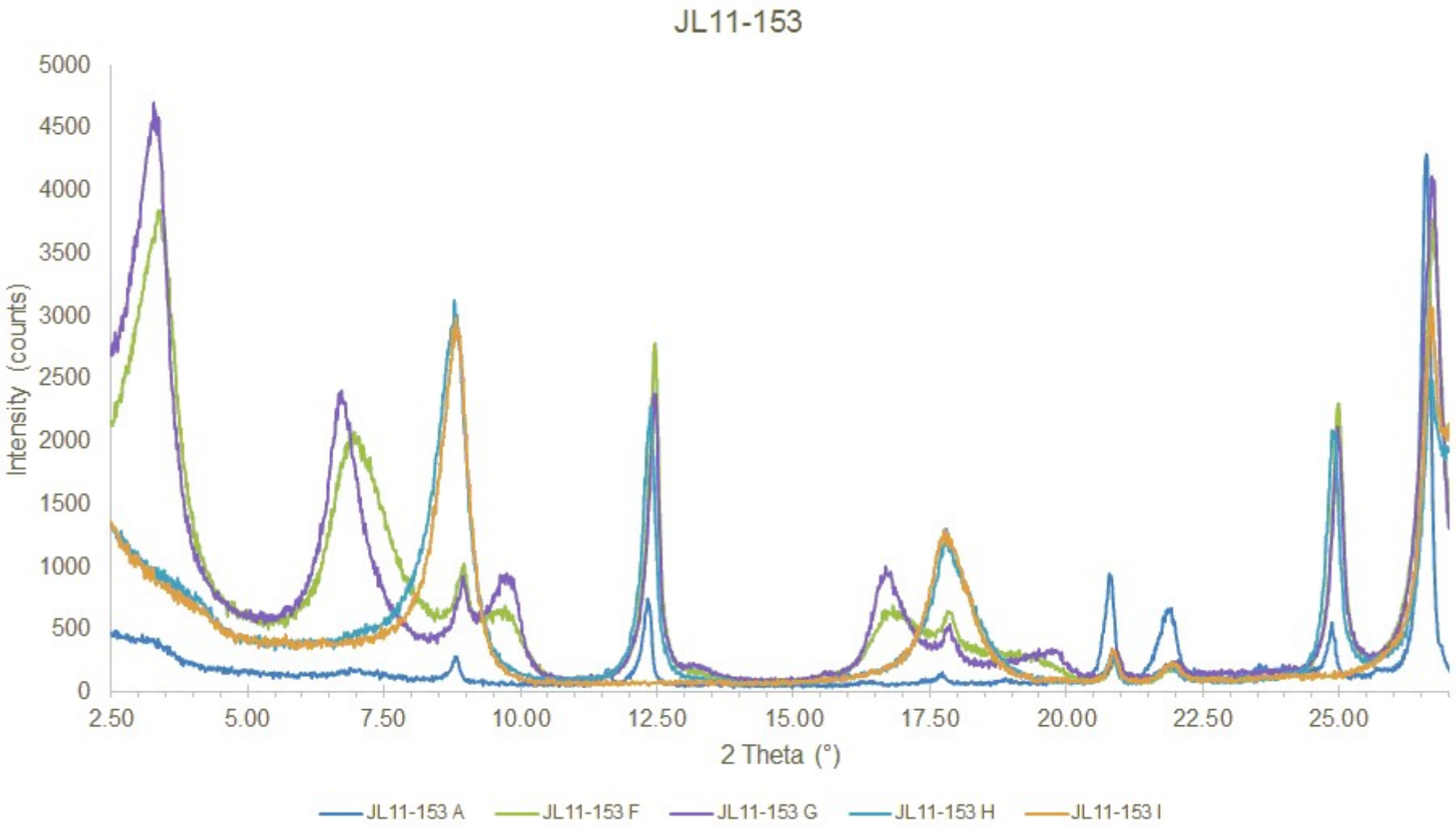
2 Theta (°)
JL11-161 A
JL11-161 G
JL11-161 H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7.50
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15.00
17.50
20.00
22.50
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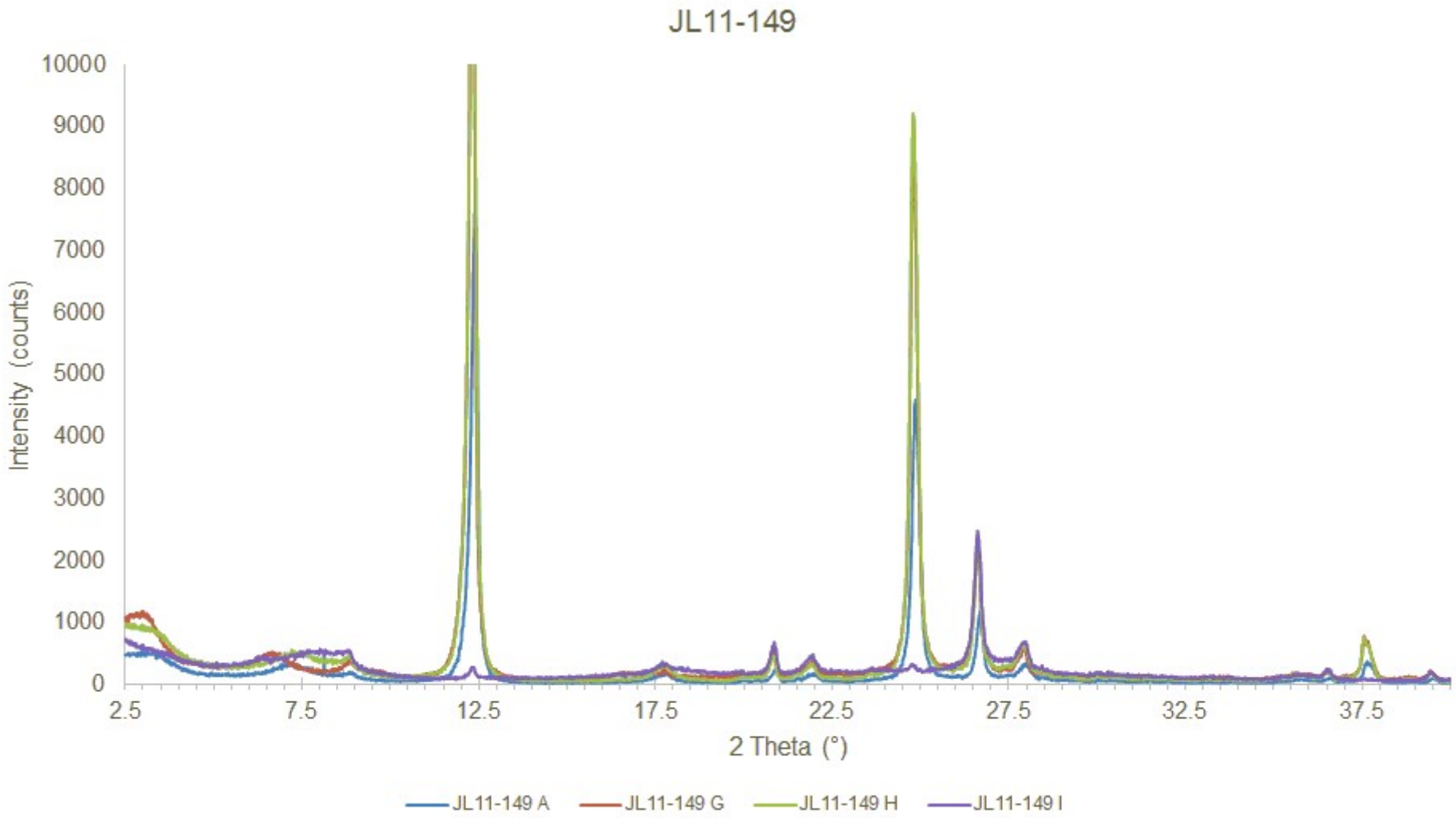
2 Theta (°)
JL11-153 A
JL11-153 F
JL11-153 G
JL11-153 H
JL11-153 I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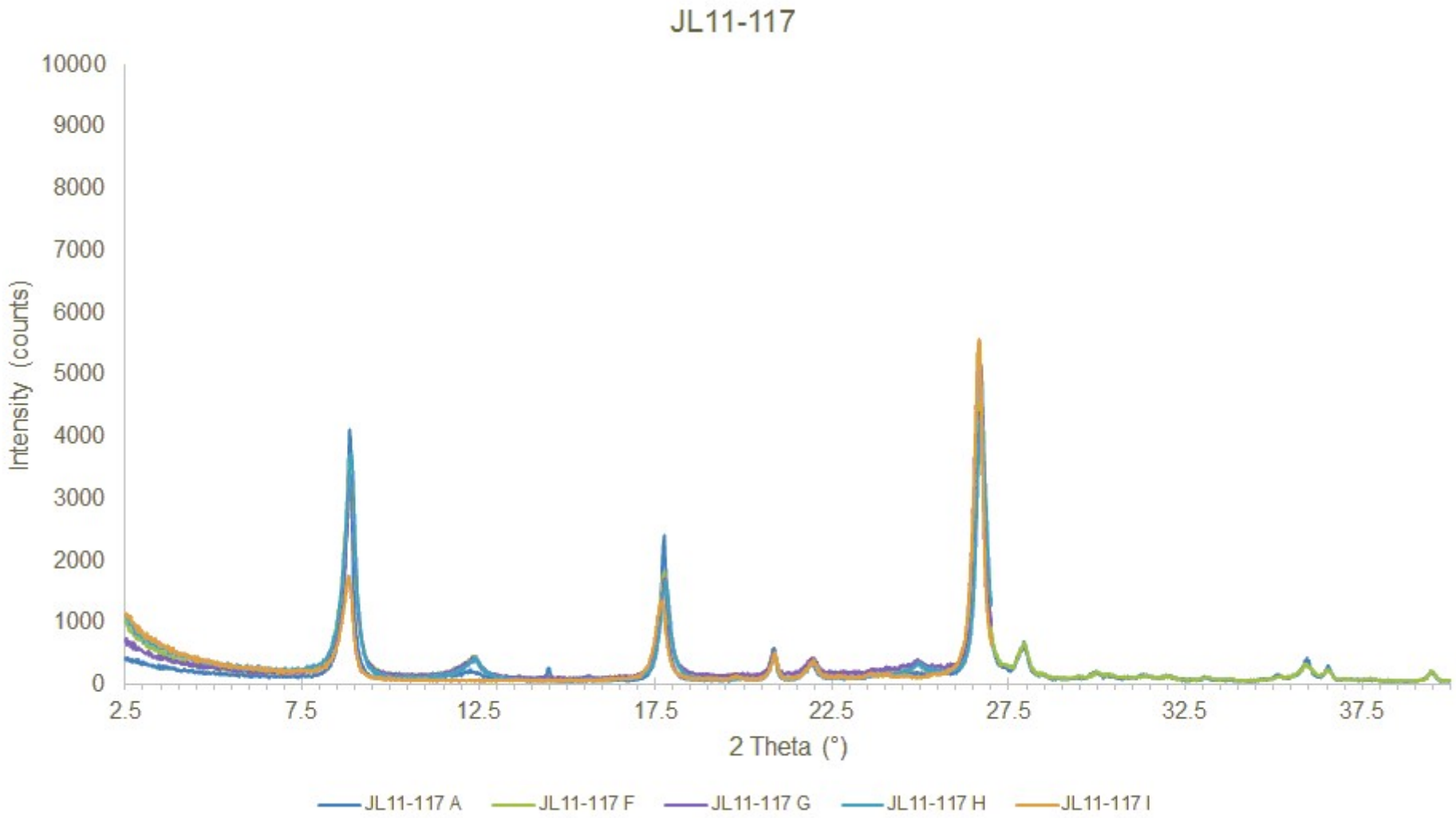
12.5
17.5
22.5
27.5
32.5
37.5
2 Theta (°)
JL11-149 A
JL11-149 G
JL11-149 H
JL11-149 I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12.5
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27.5
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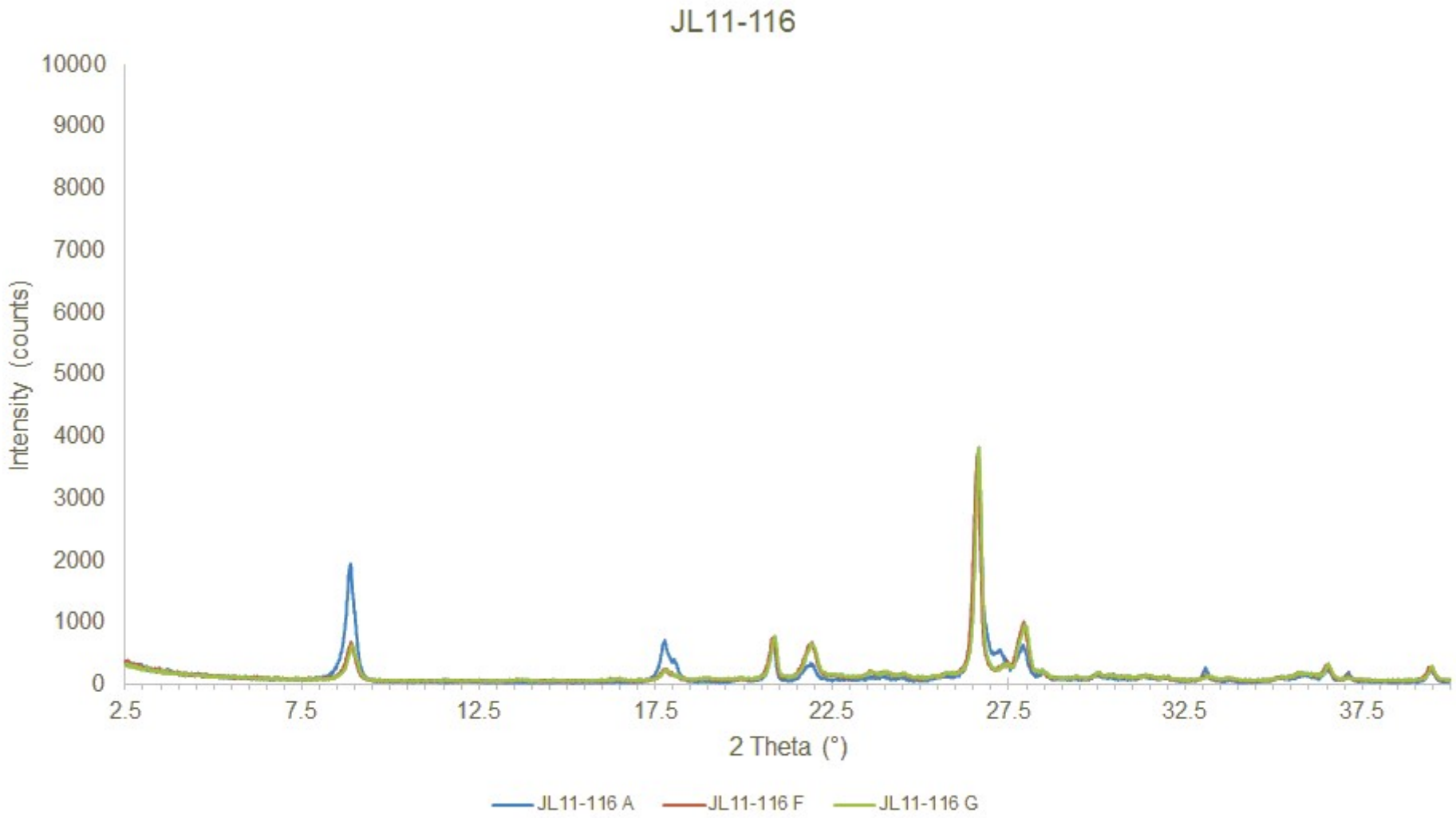
2 Theta (°)
JL11-117 A
JL11-117 F
JL11-117 G
JL11-117 H
JL11-117 I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Intensity (counts)
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7.5
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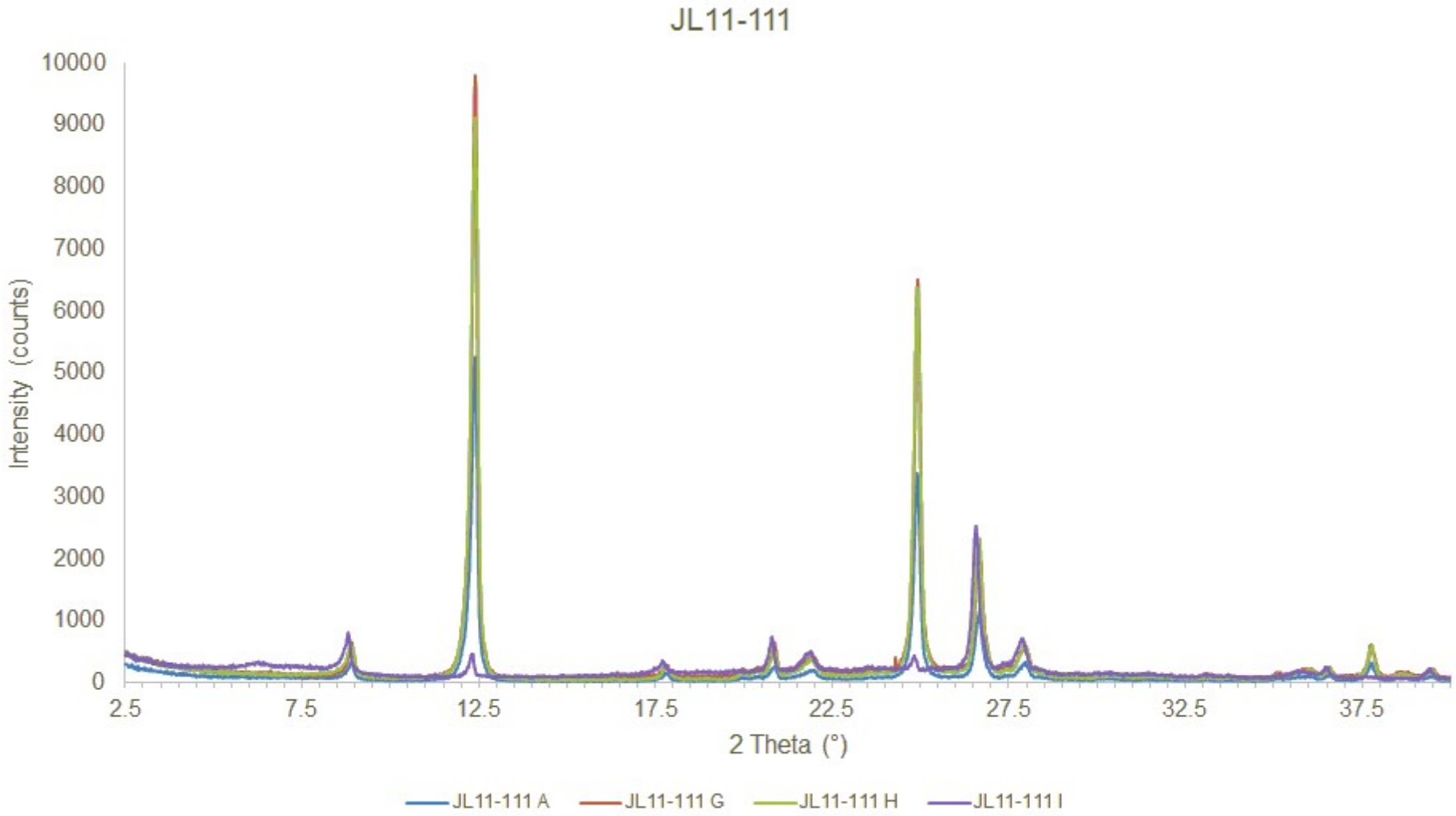
2 Theta (°)
JL11-116 A
JL11-116 F
JL11-116 G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12.5
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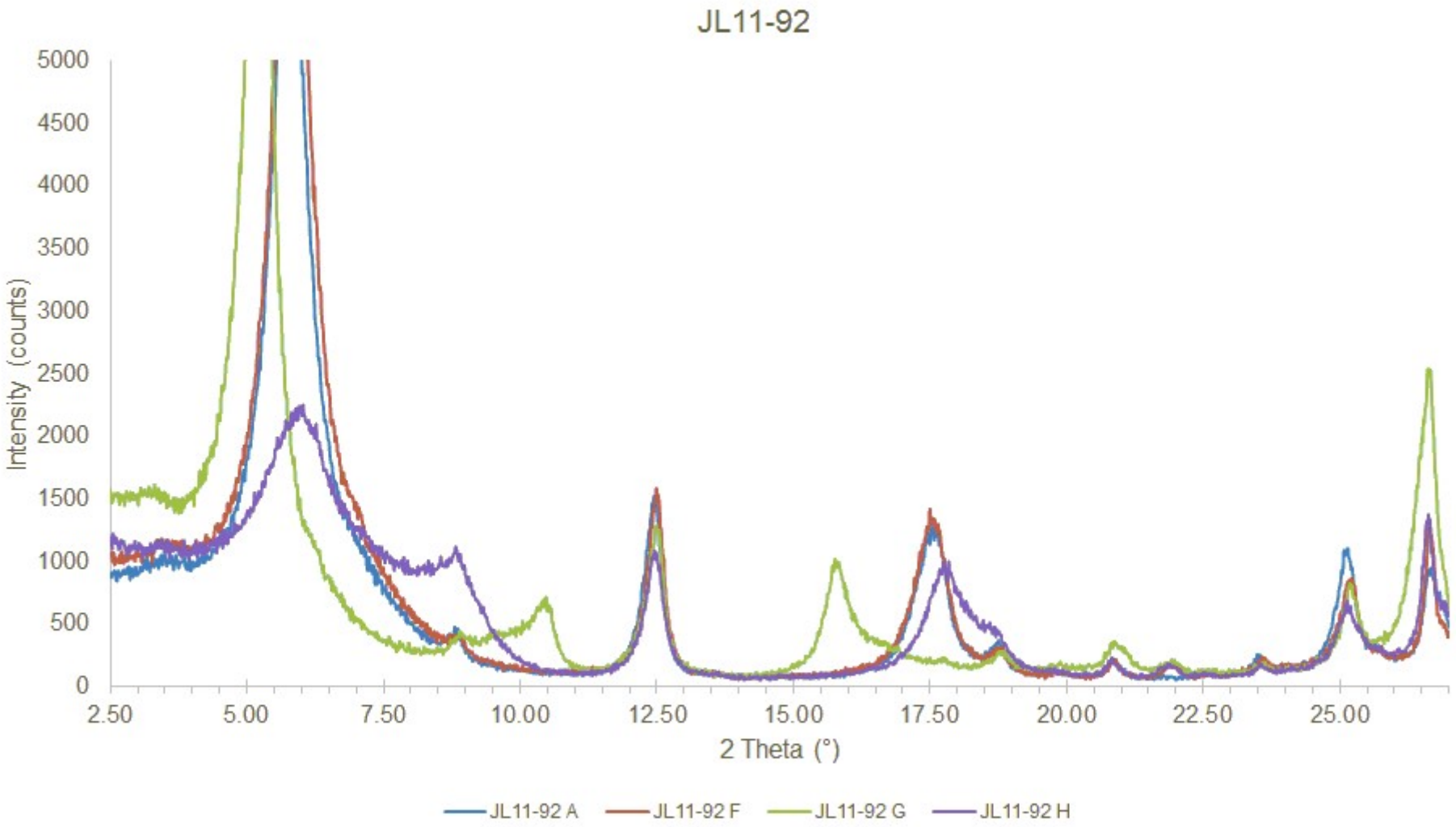
37.5
2 Theta (°)
JL11-111 A
JL11-111 G
JL11-111 H
JL11-111 I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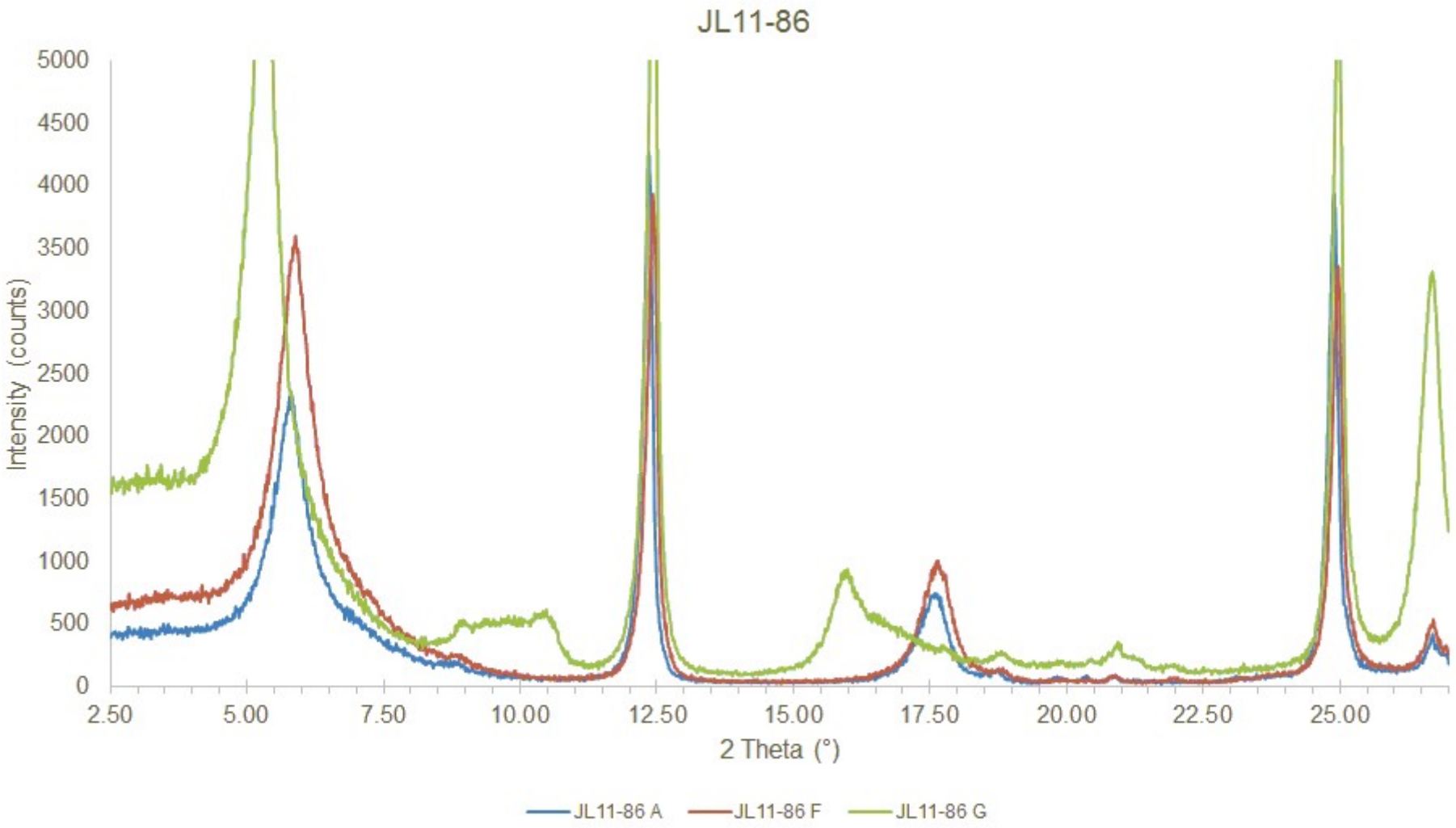
2 Theta (°)
JL11-92 A
JL11-92 F
JL11-92 G
JL11-92 H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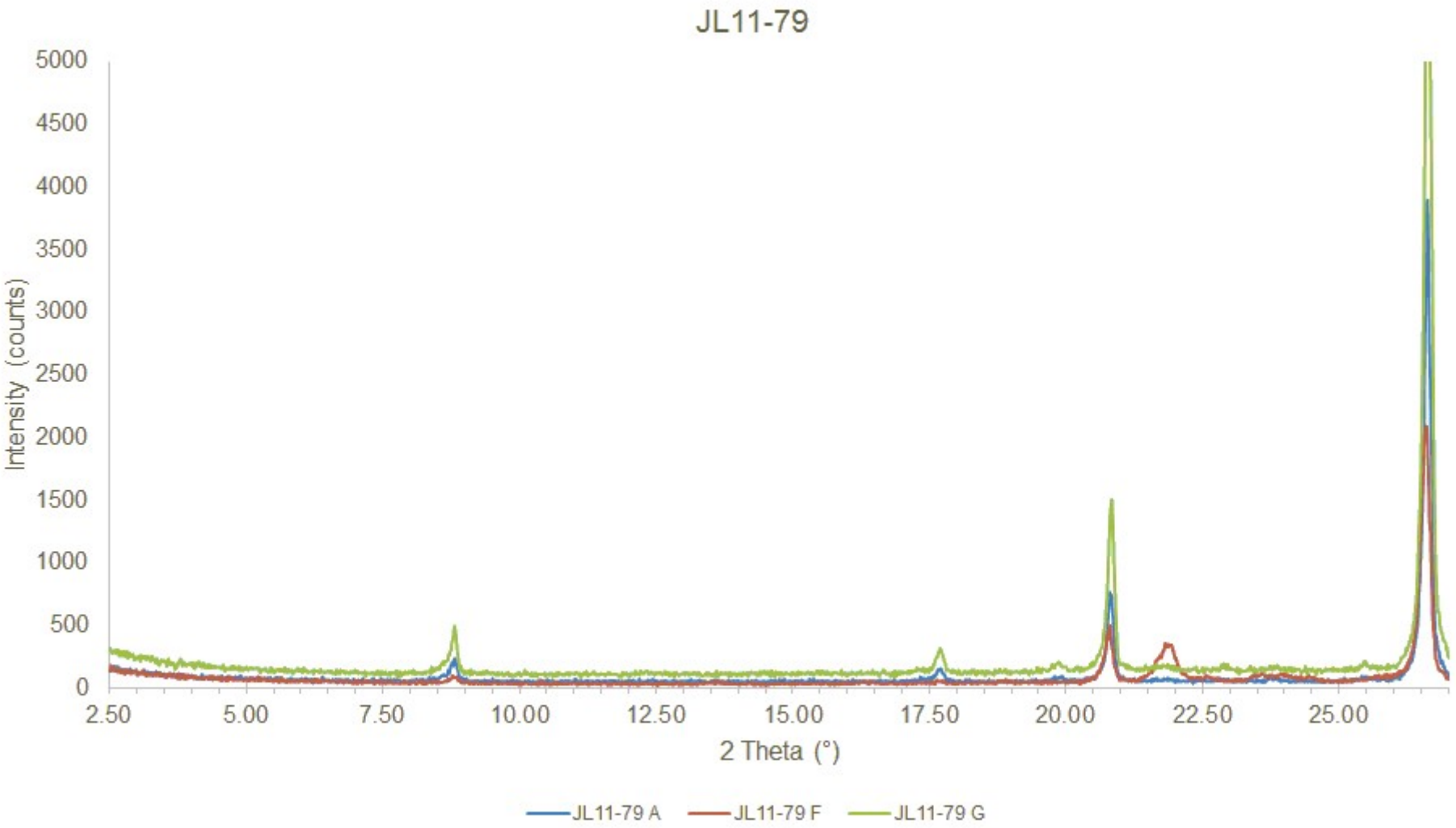
2 Theta (°)
JL11-86 A
JL11-86 F
JL11-86 G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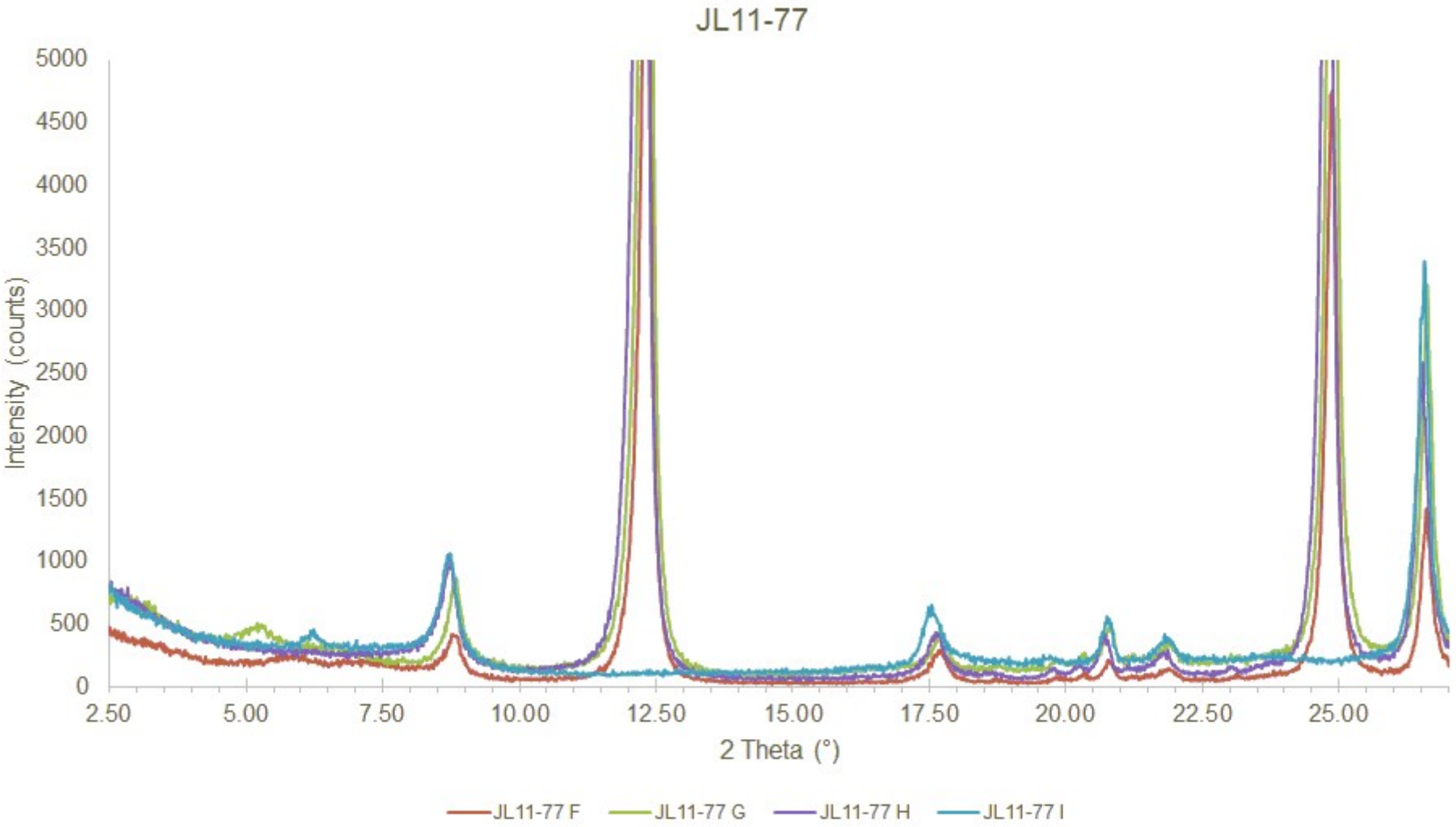
2 Theta (°)
JL11-79 A
JL11-79 F
JL11-79 G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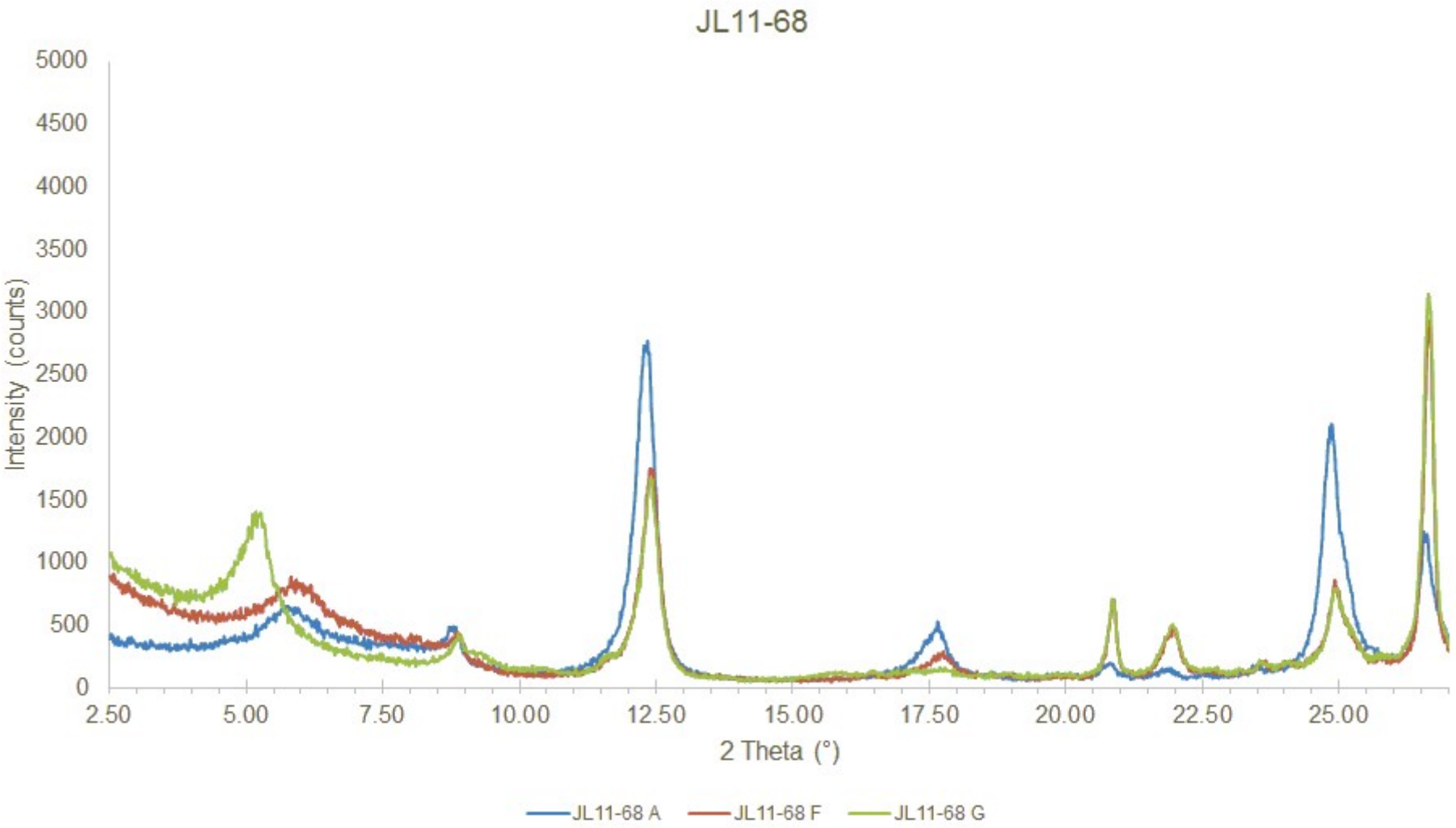
2 Theta (°)
JL11-77 F
JL11-77 G
JL11-77 H
JL11-77 I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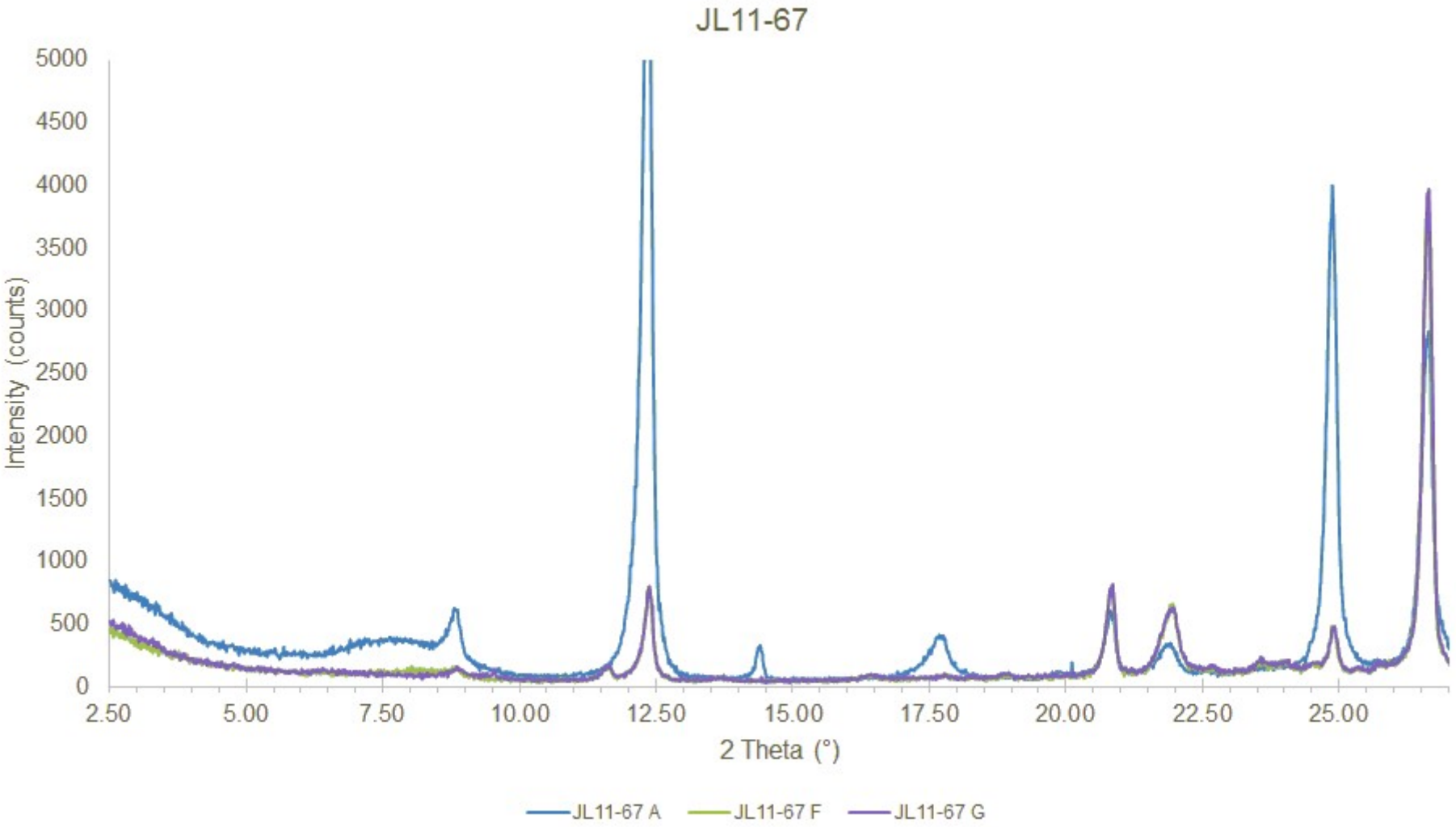
2 Theta (°)
JL11-68 A
JL11-68 F
JL11-68 G


JL11-67
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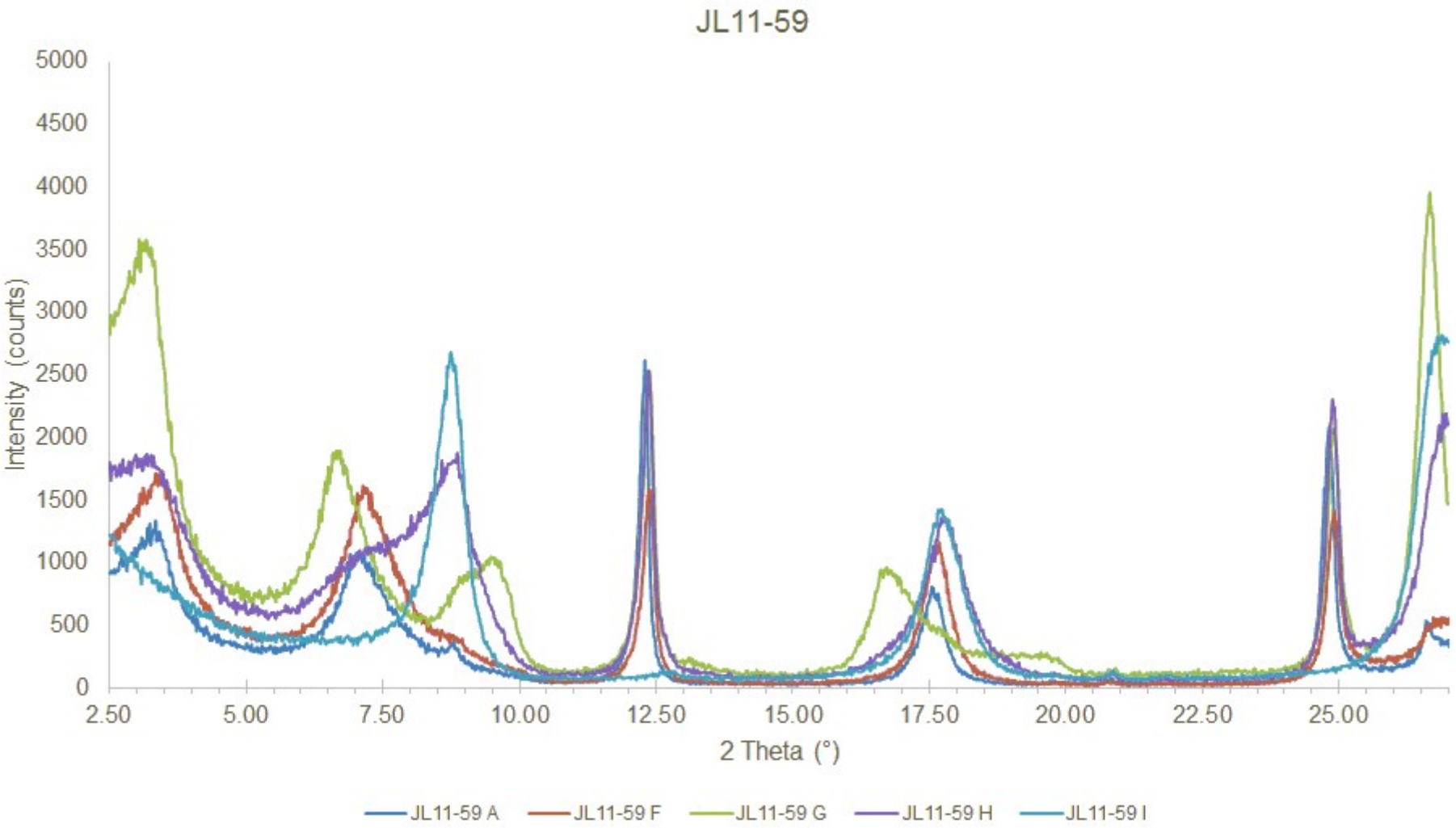
2 Theta (°)
JL11-67 A
JL11-67 F
JL11-67 G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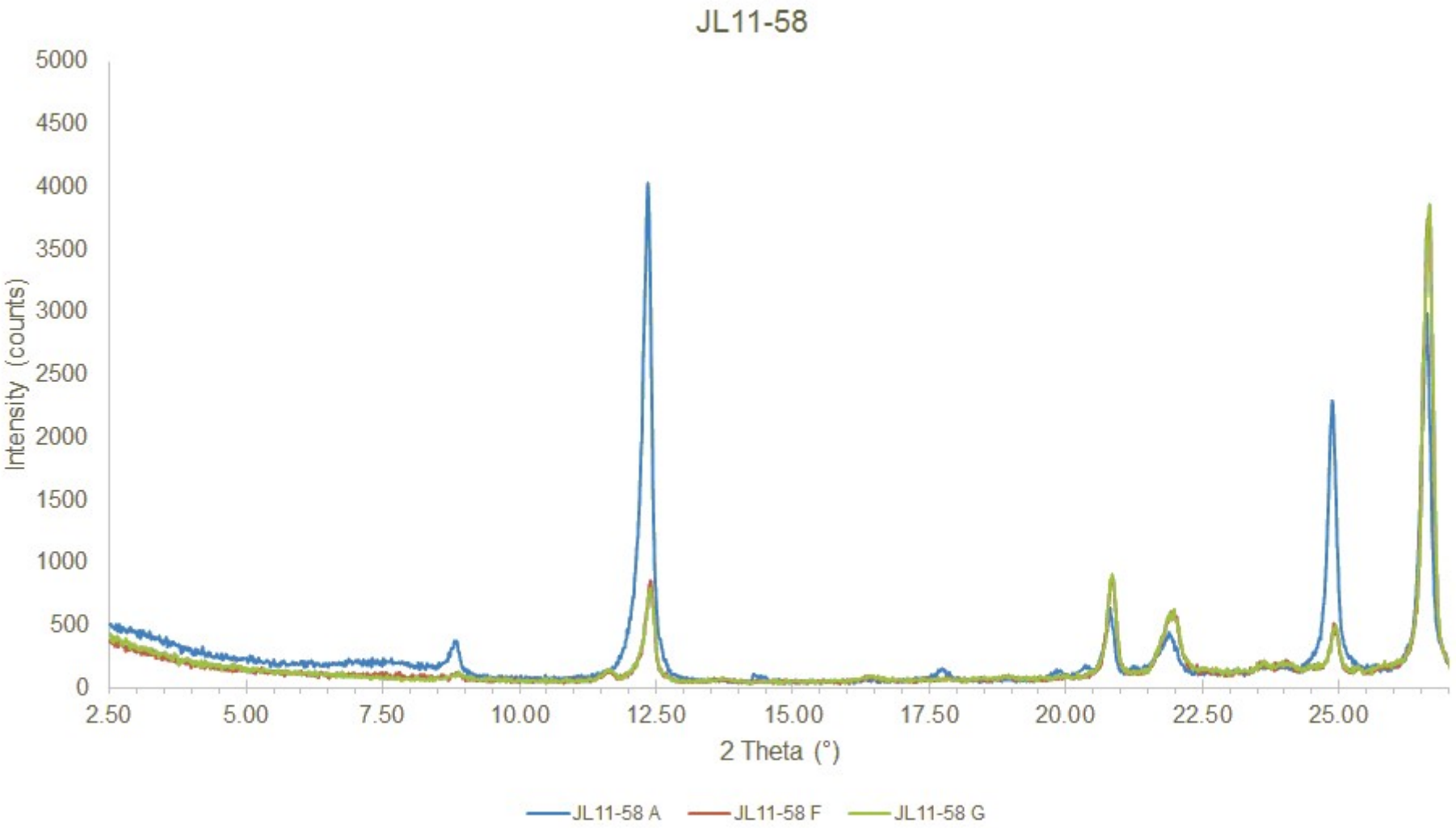
2 Theta (°)
JL11-59 A
JL11-59 F
JL11-59 G
JL11-59 H
JL11-59 I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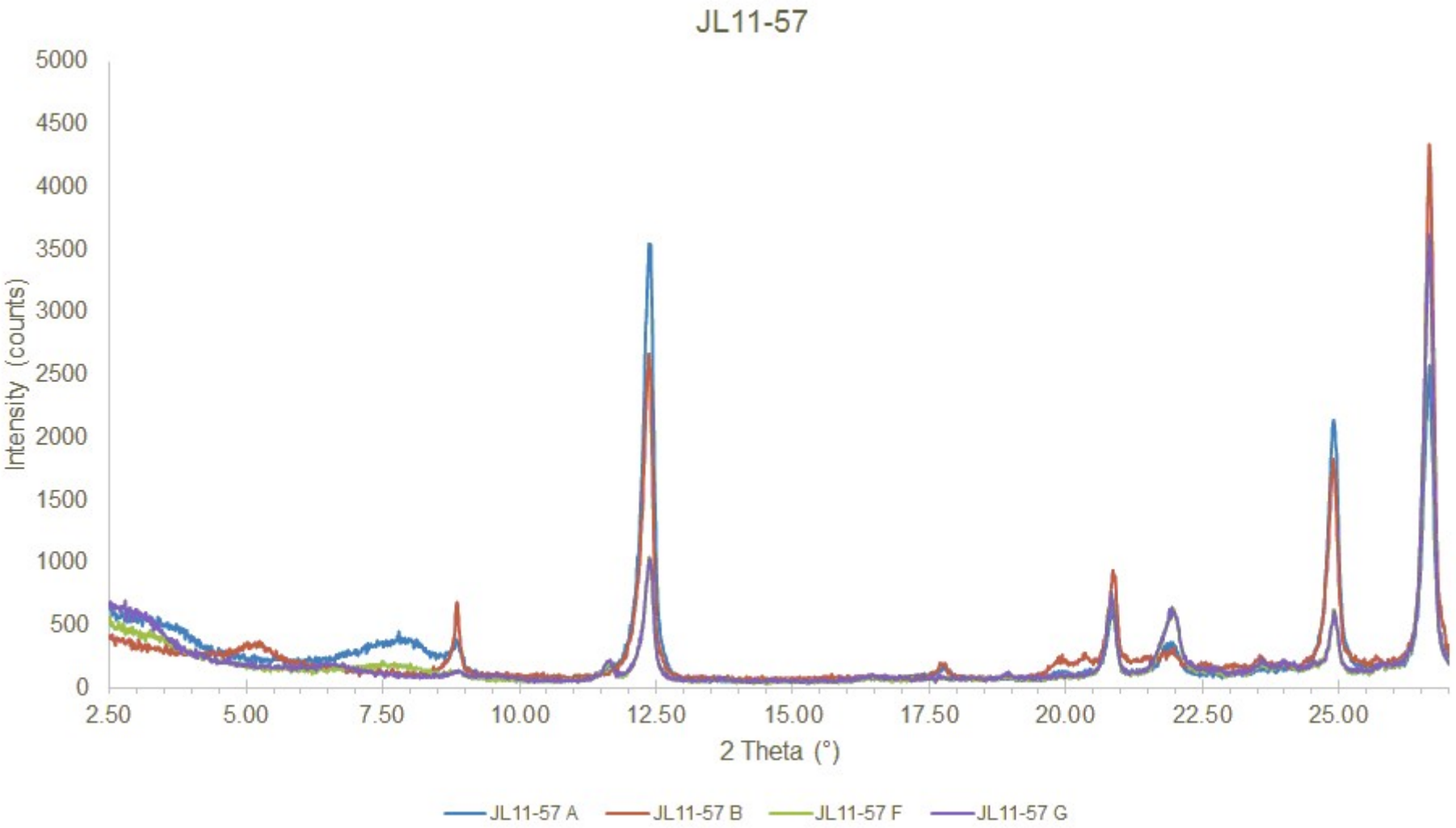
2 Theta (°)
JL11-58 A
JL11-58 F
JL11-58 G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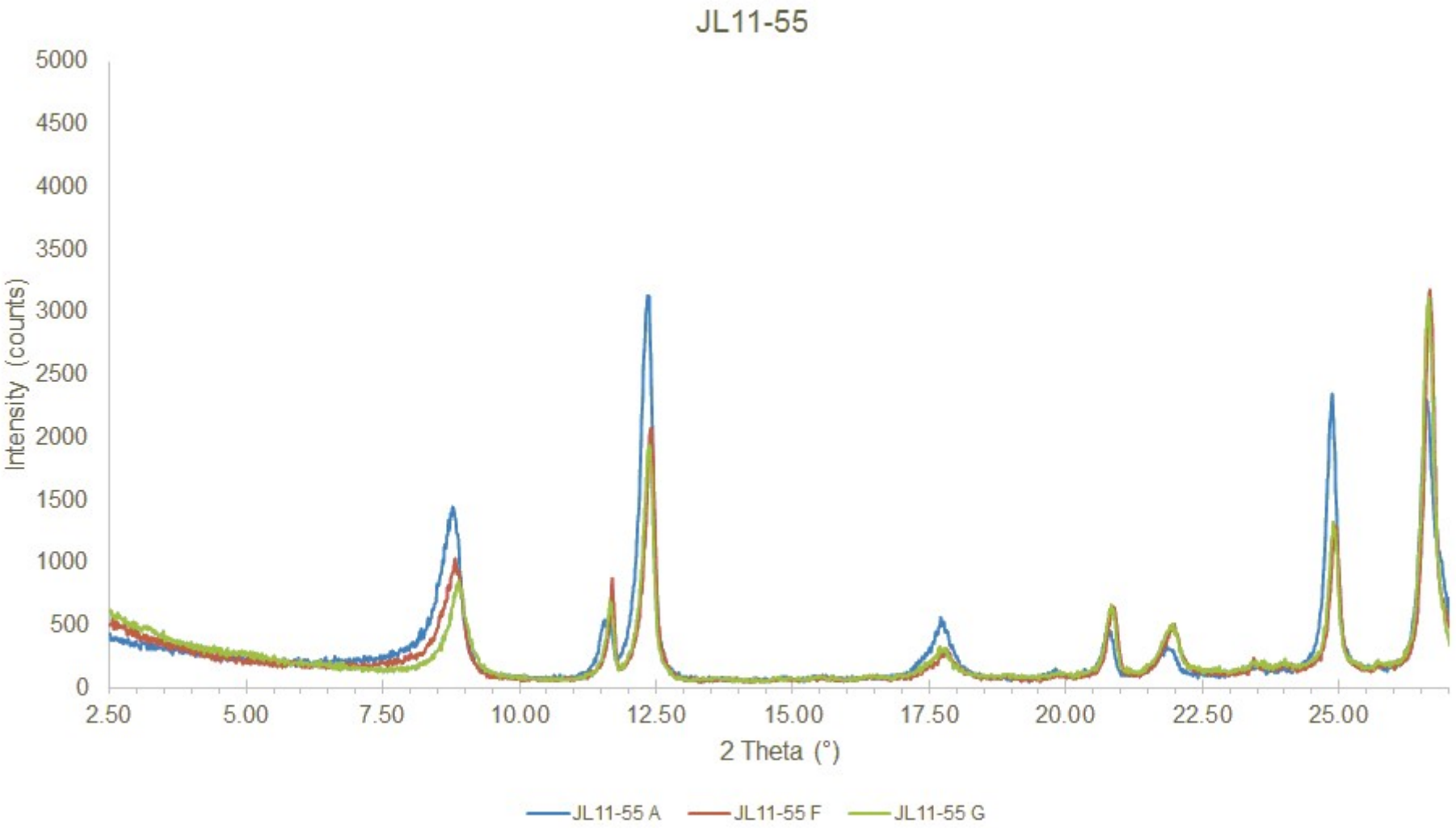
2 Theta (°)
JL11-57 A
JL11-57 B
JL11-57 F
JL11-57 G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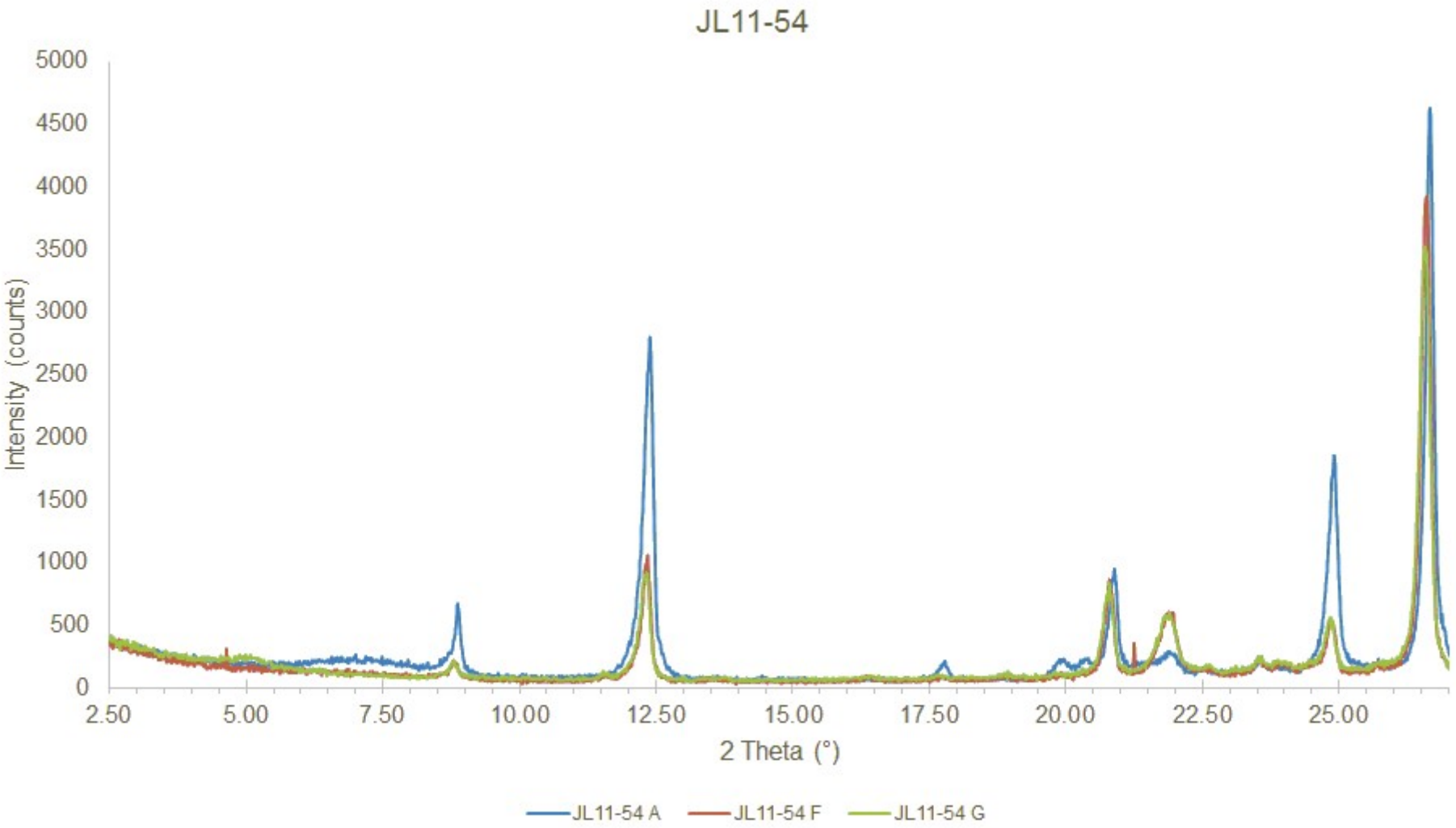
2 Theta (°)
JL11-55 A
JL11-55 F
JL11-55 G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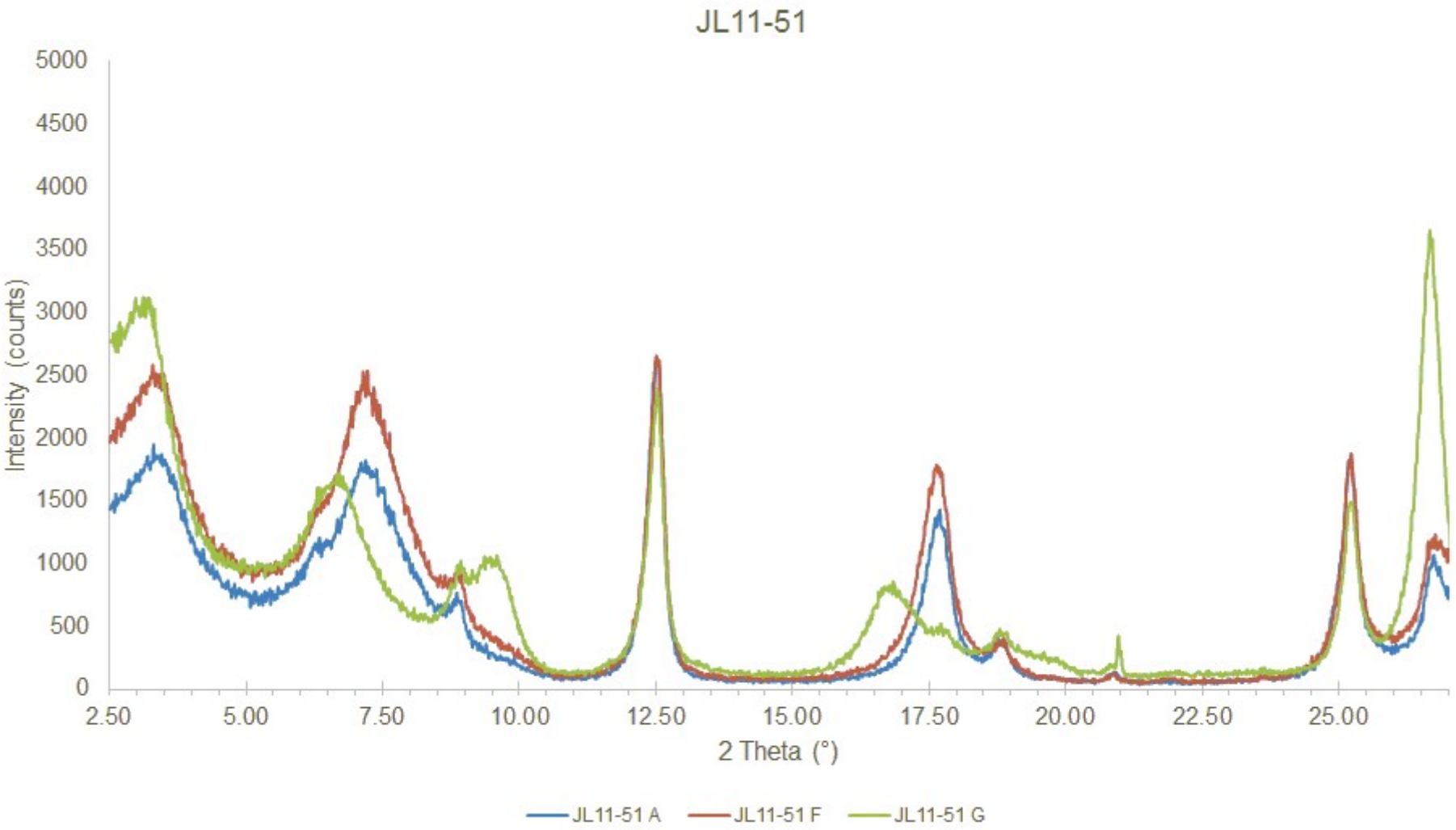
2 Theta (°)
JL11-54 A
JL11-54 F
JL11-54 G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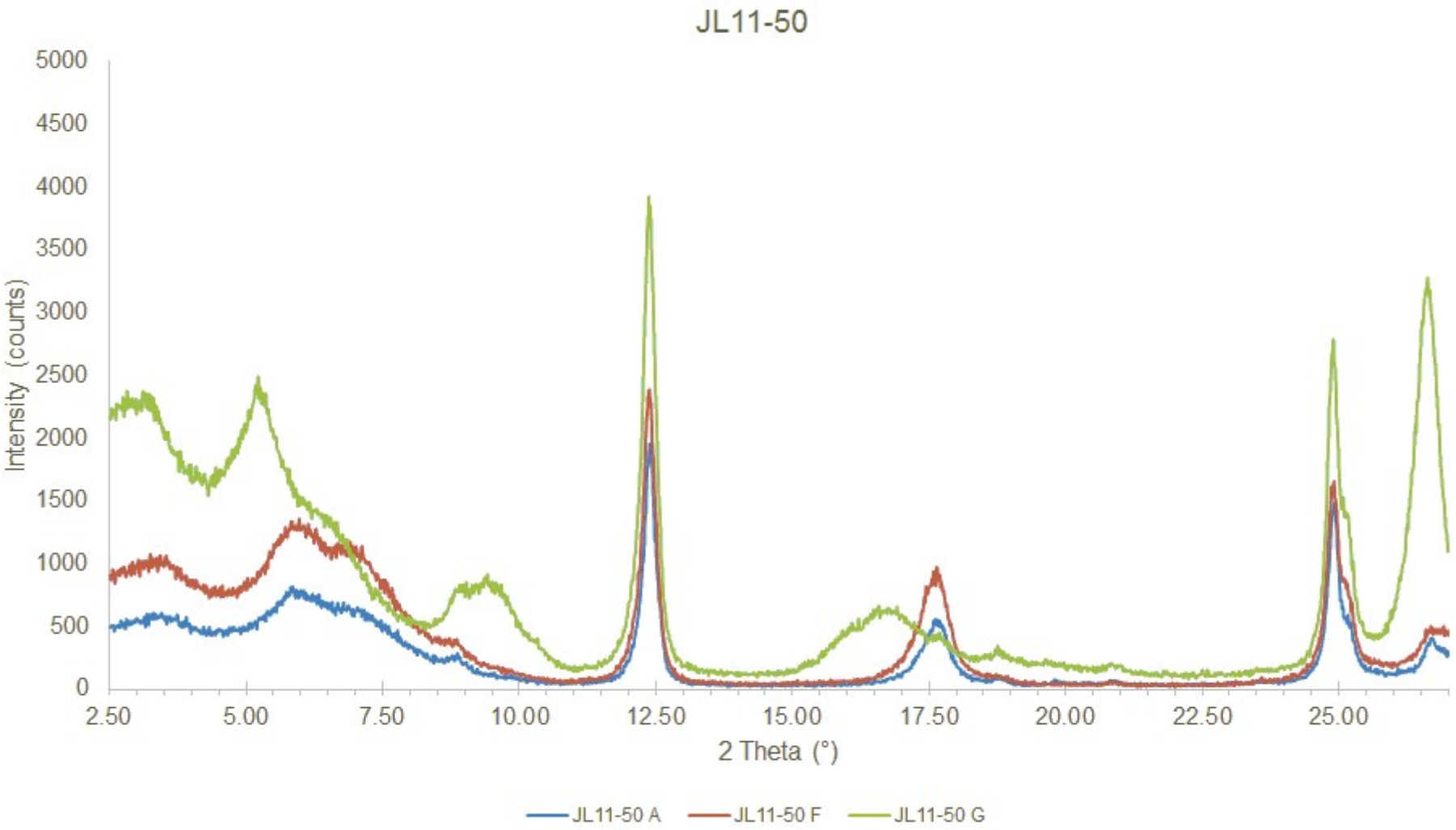
2 Theta (°)
JL11-51 A
JL11-51 F
JL11-51 G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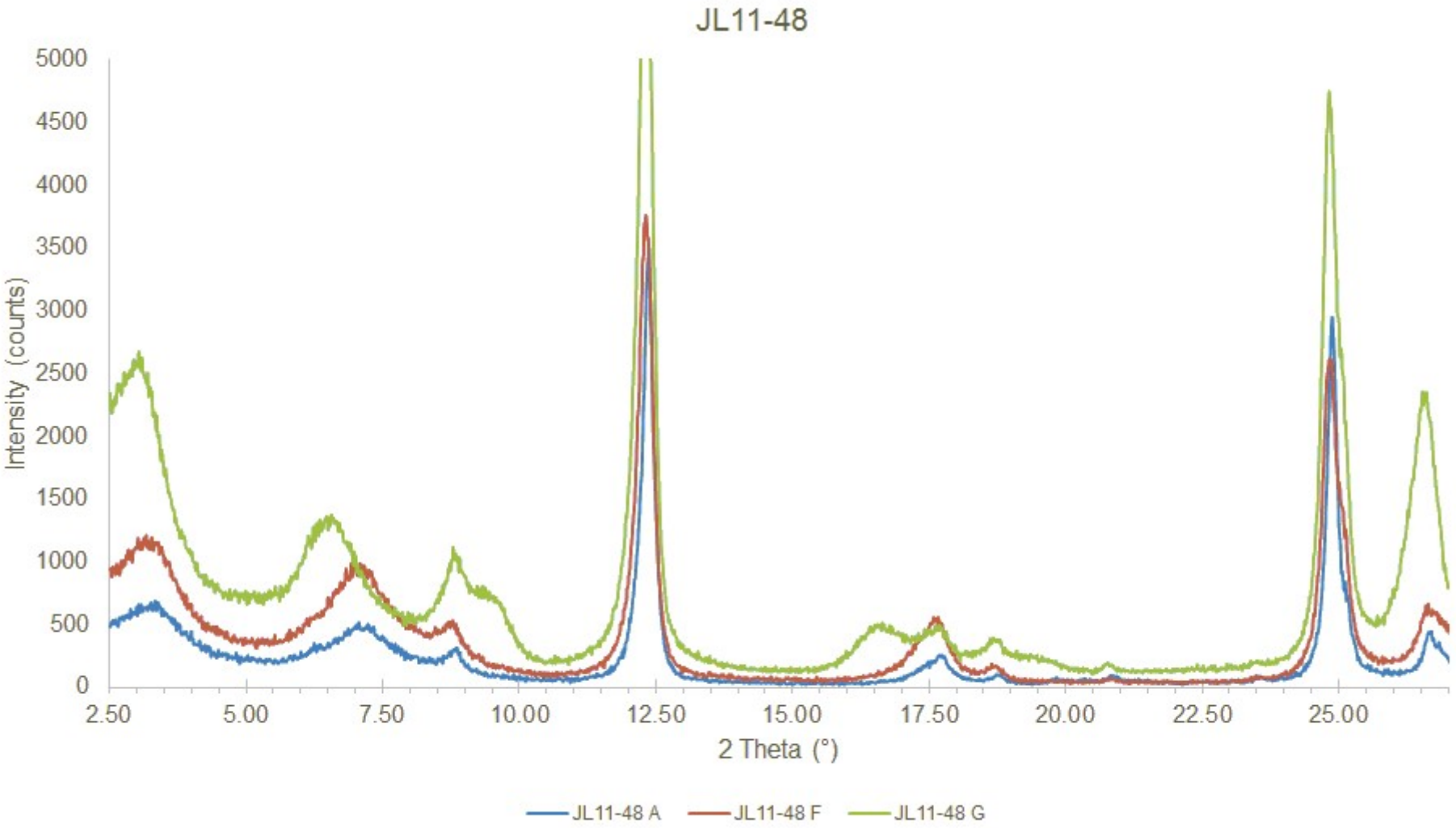
2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL11-50 A
JL11-50 F
JL11-50 G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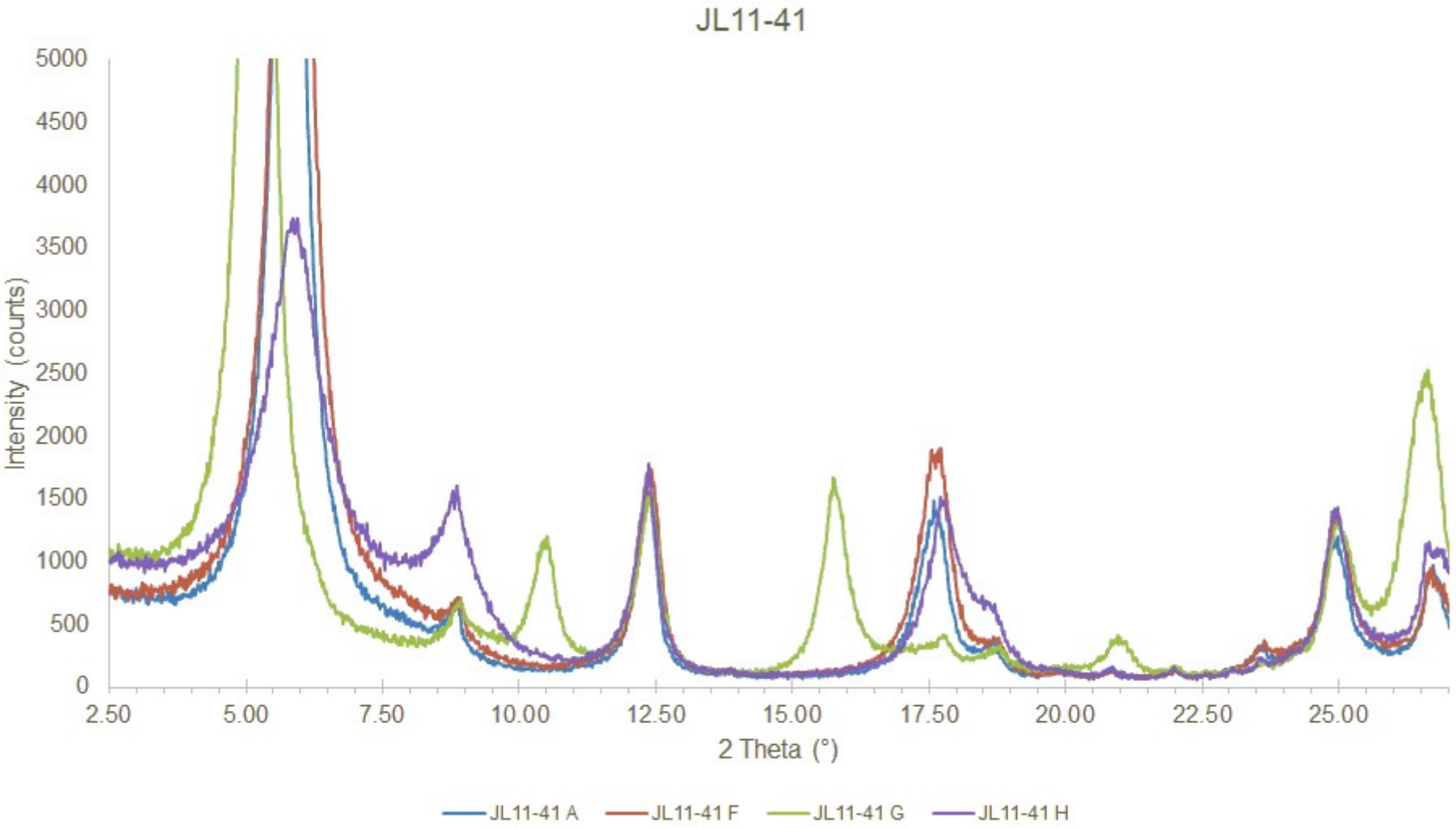
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL11-48 A
JL11-48 F
JL11-48 G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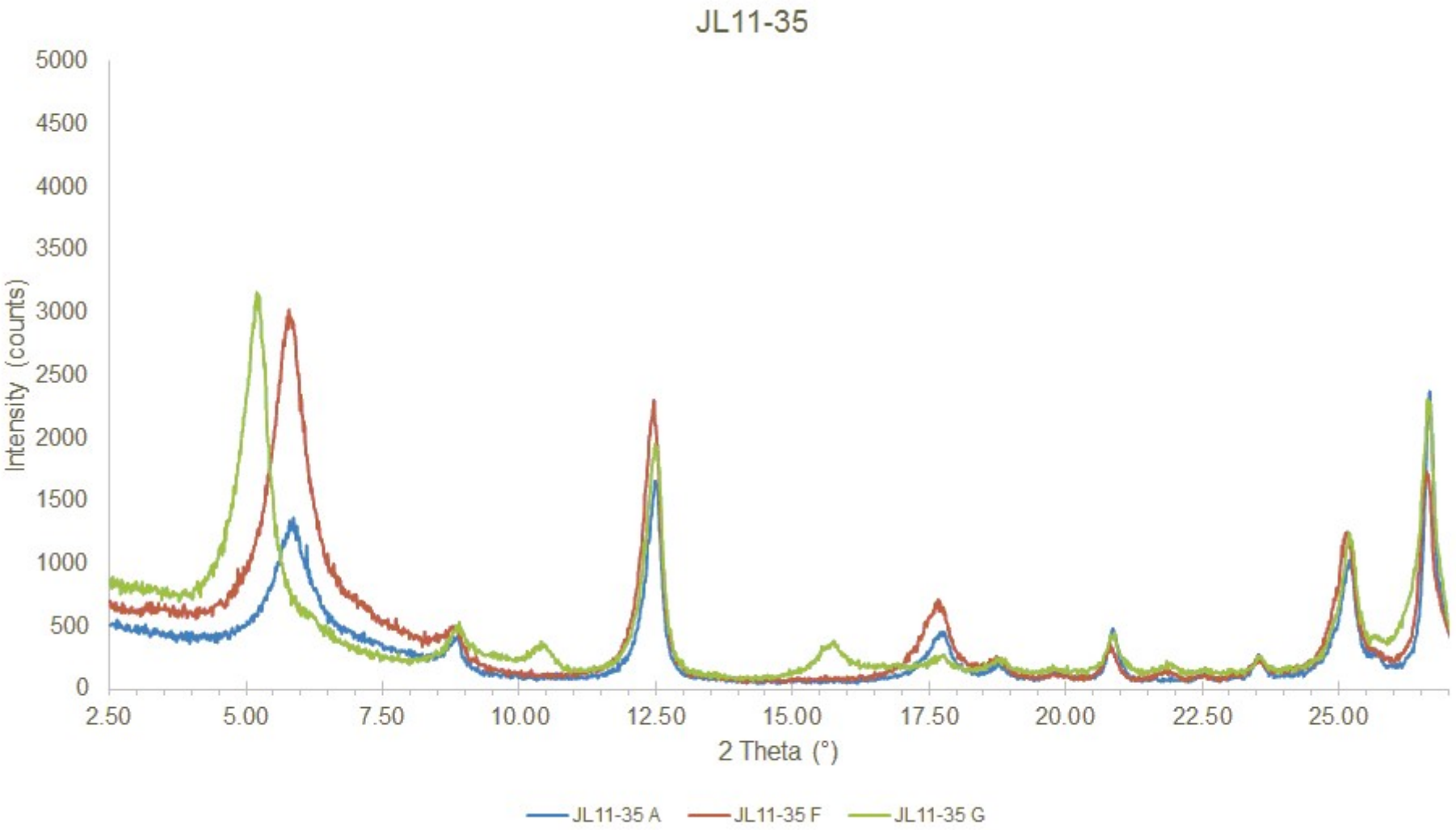
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL11-41 A
JL11-41 F
JL11-41 G
JL11-41 H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7.50
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12.50
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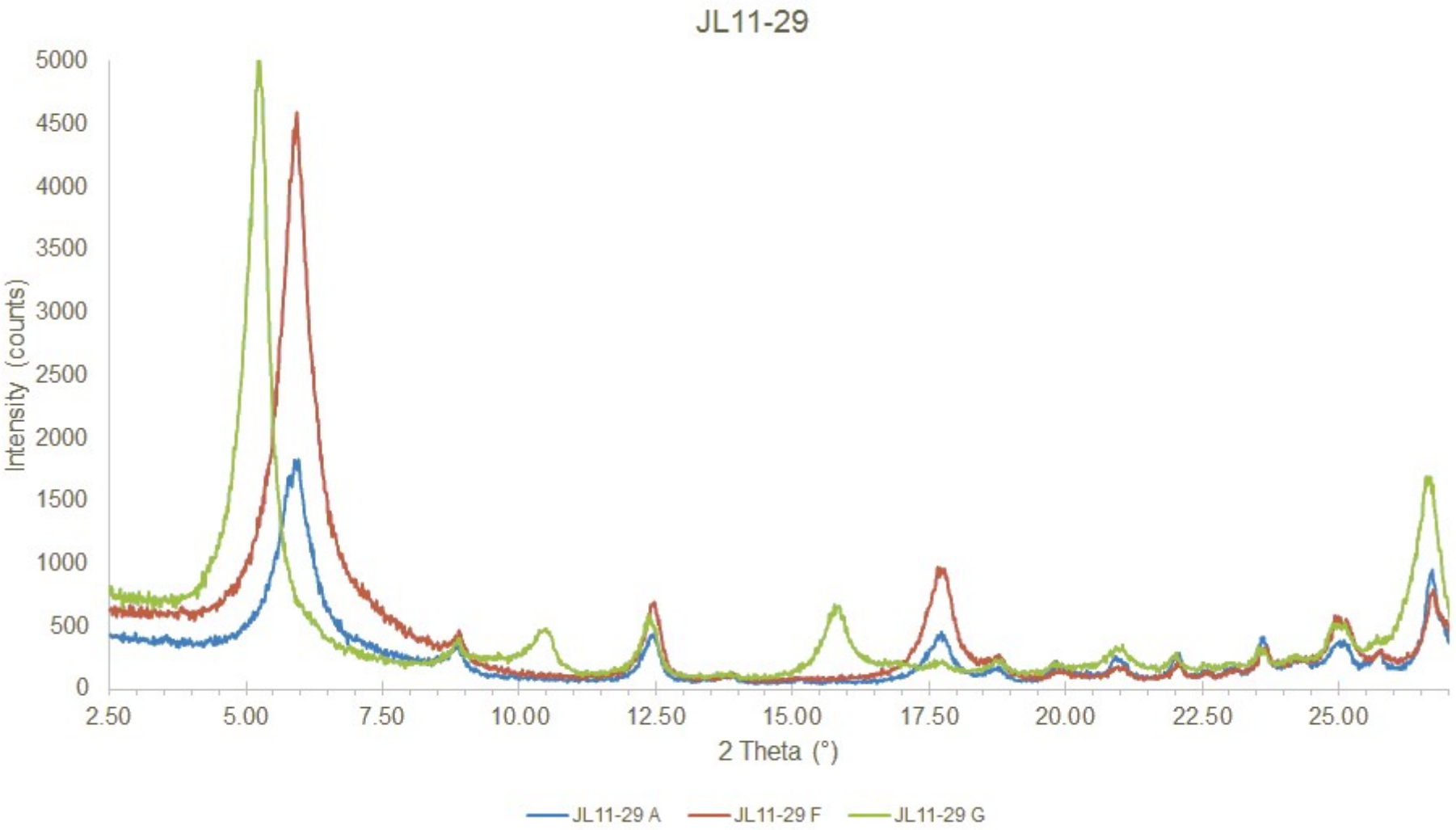
17.50
20.00
22.50
25.00
2 Theta (°)
JL11-35 A
JL11-35 F
JL11-35 G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10.00
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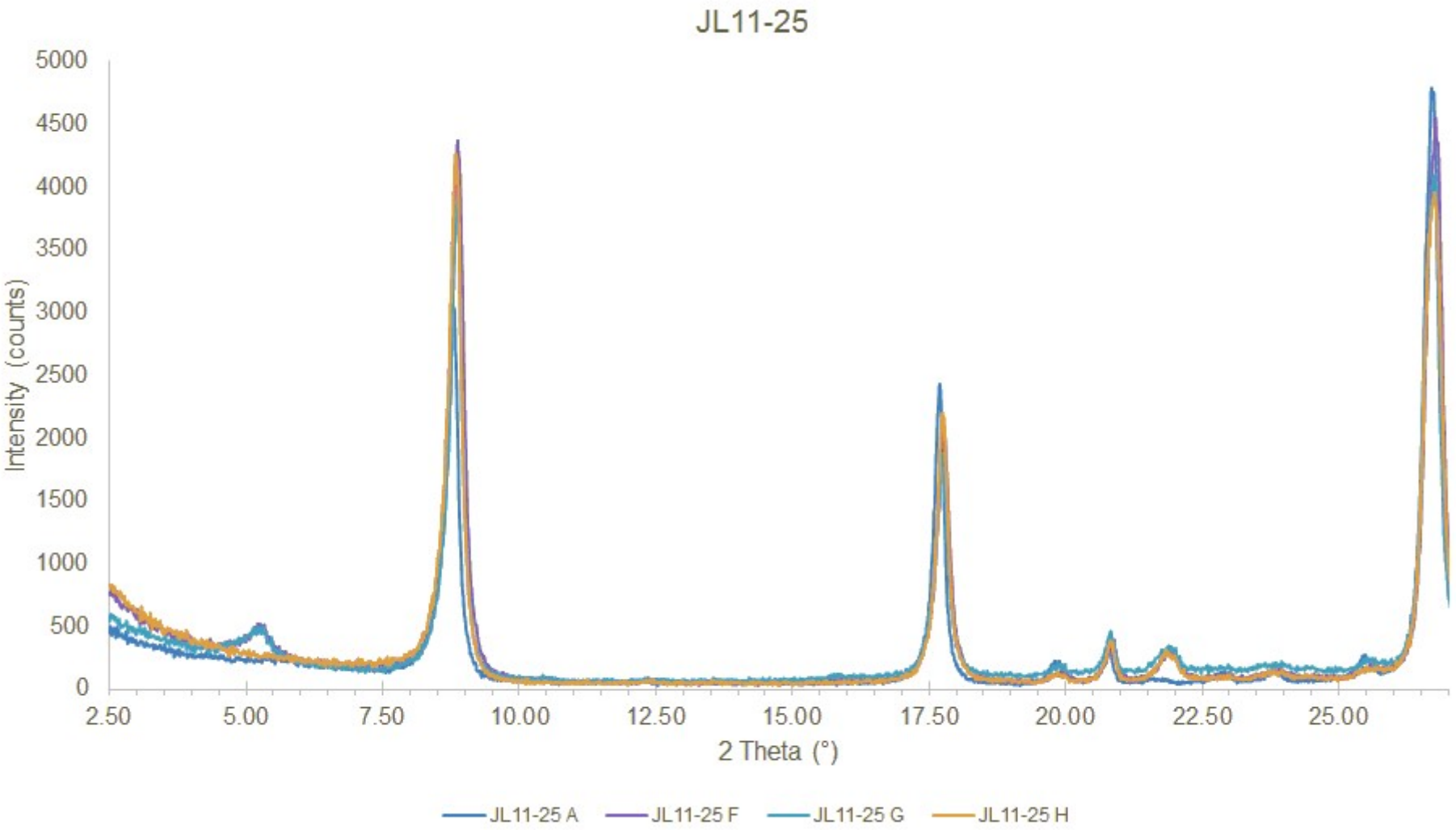
20.00
22.50
25.00
2 Theta (°)
JL11-29 A
JL11-29 F
JL11-29 G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12.50
15.00
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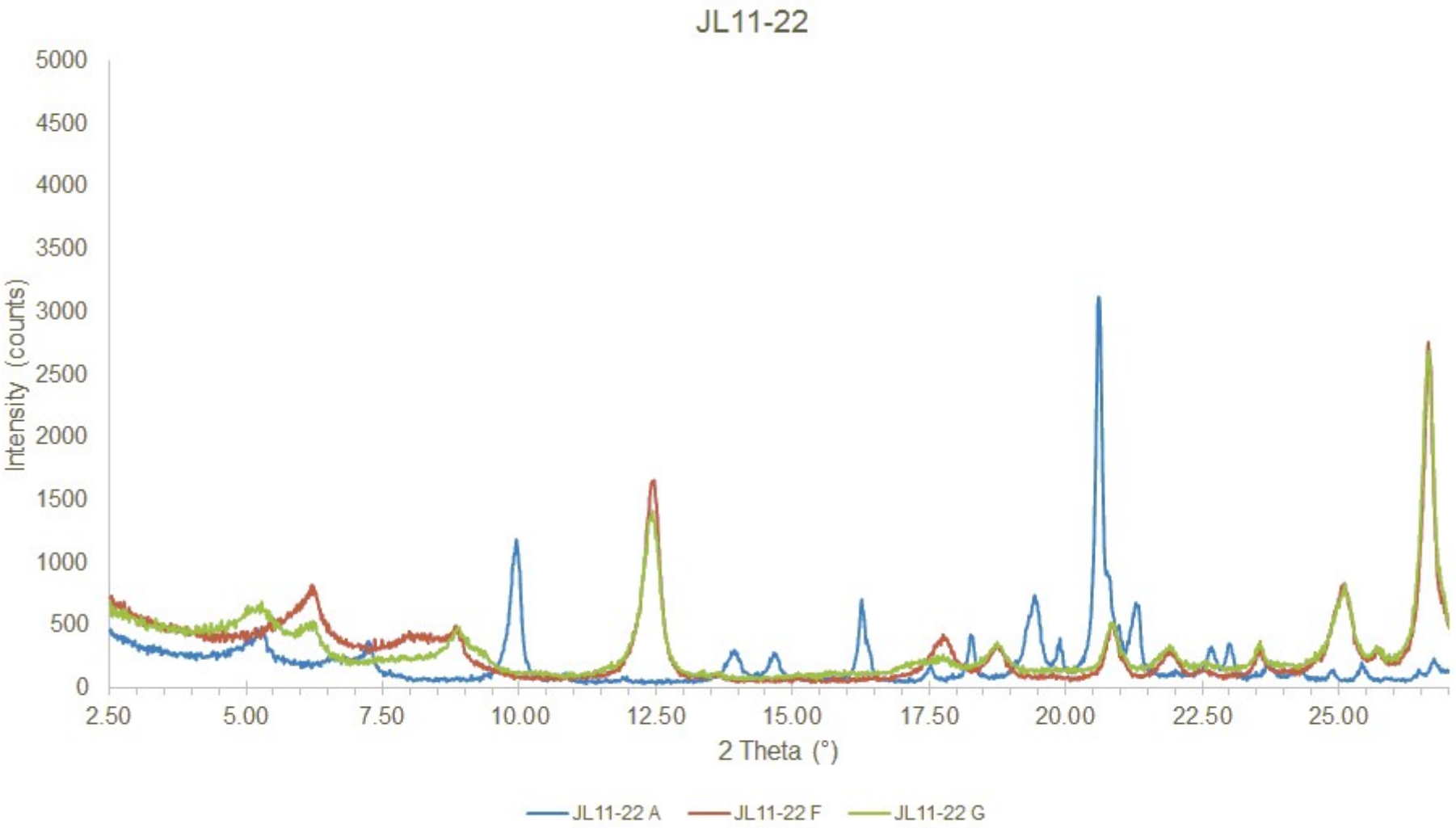
22.50
25.00
2 Theta (°)
JL11-25 A
JL11-25 F
JL11-25 G
JL11-25 H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7.50
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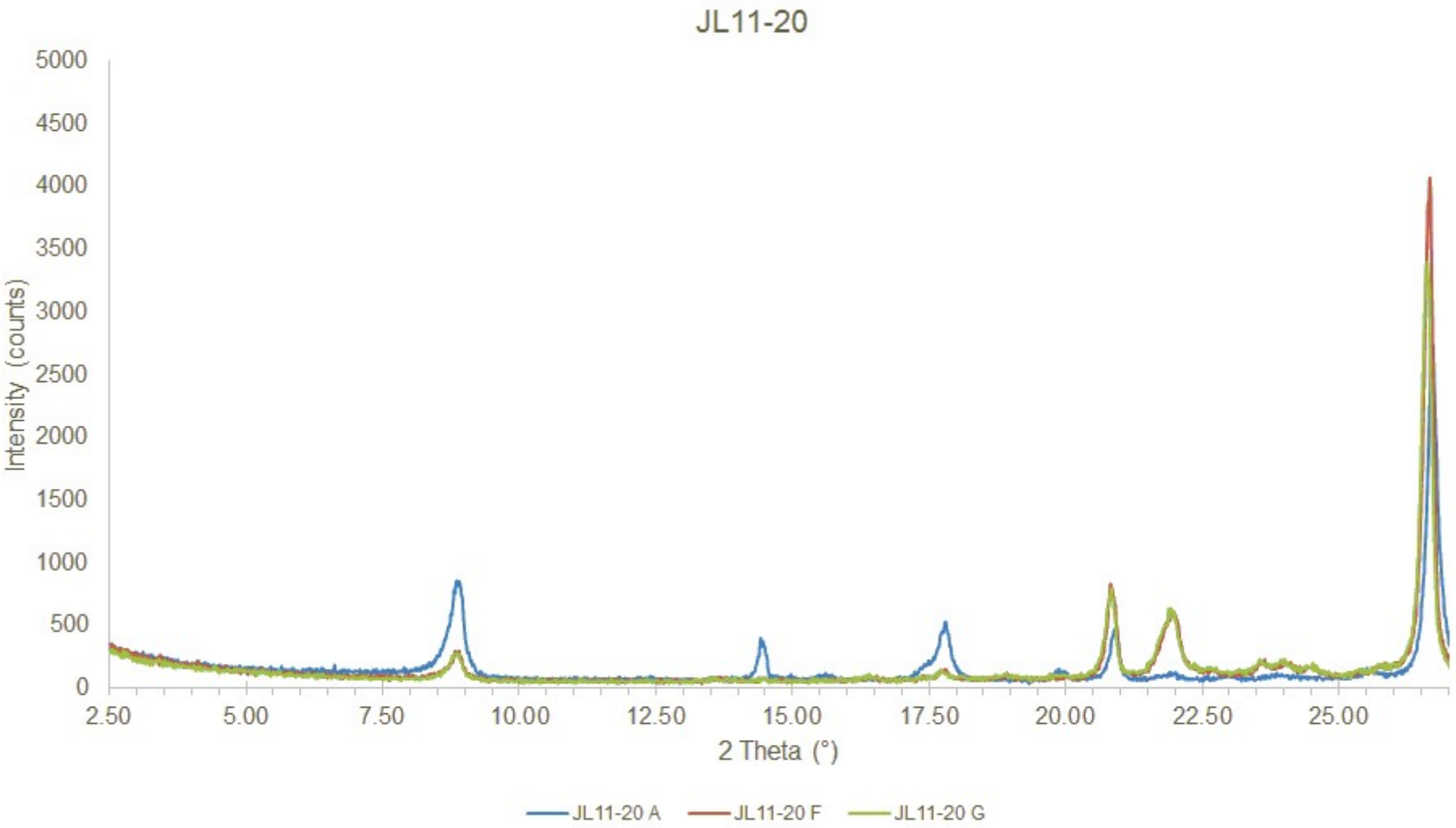
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL11-22 A
JL11-22 F
JL11-22 G


JL11-20
Intensity (counts)
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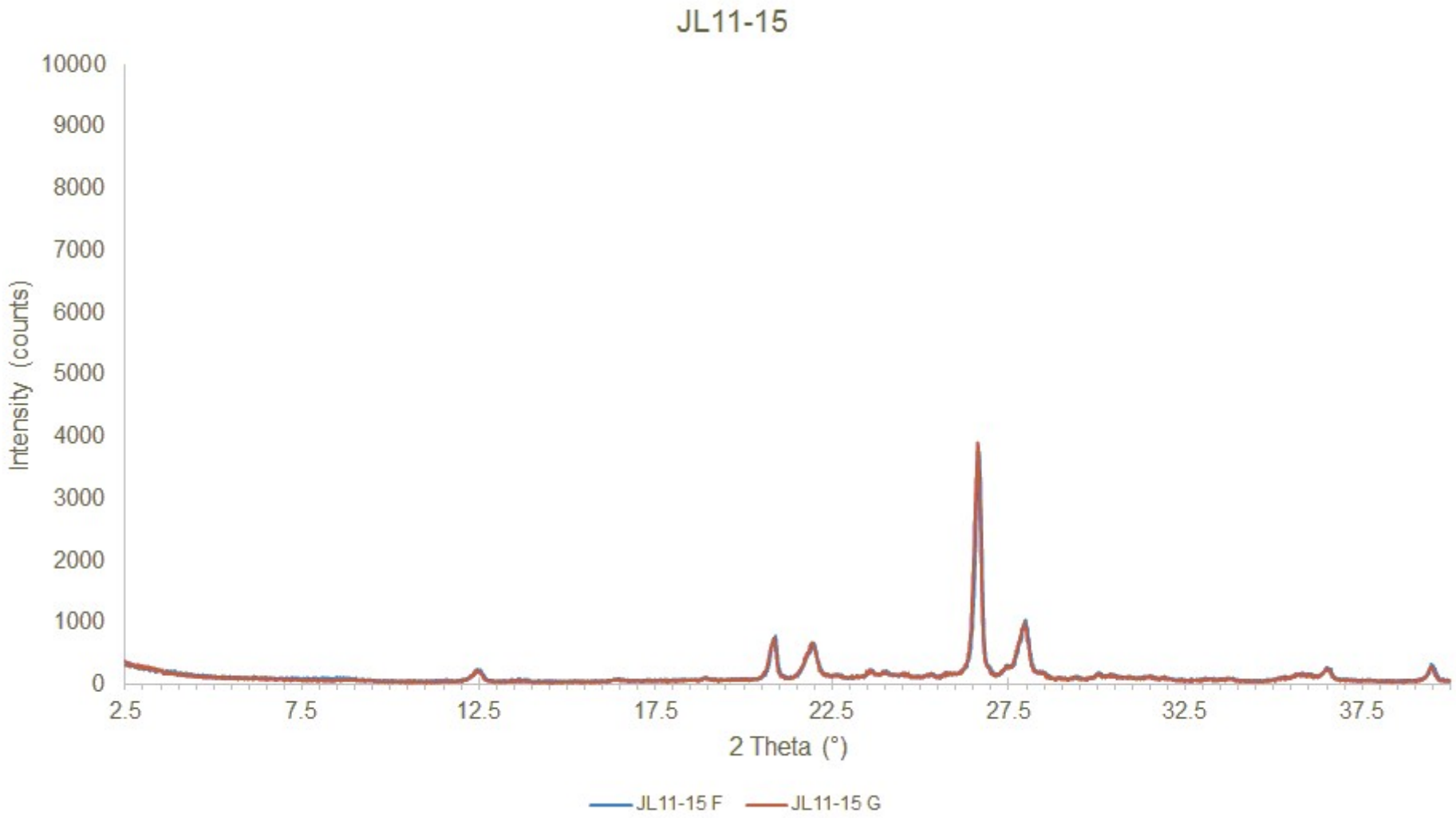
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL11-20 A
JL11-20 F
JL11-20 G


JL11-15
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8000
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6000
5000
4000
3000
2000
1000
0
Intensity (counts)
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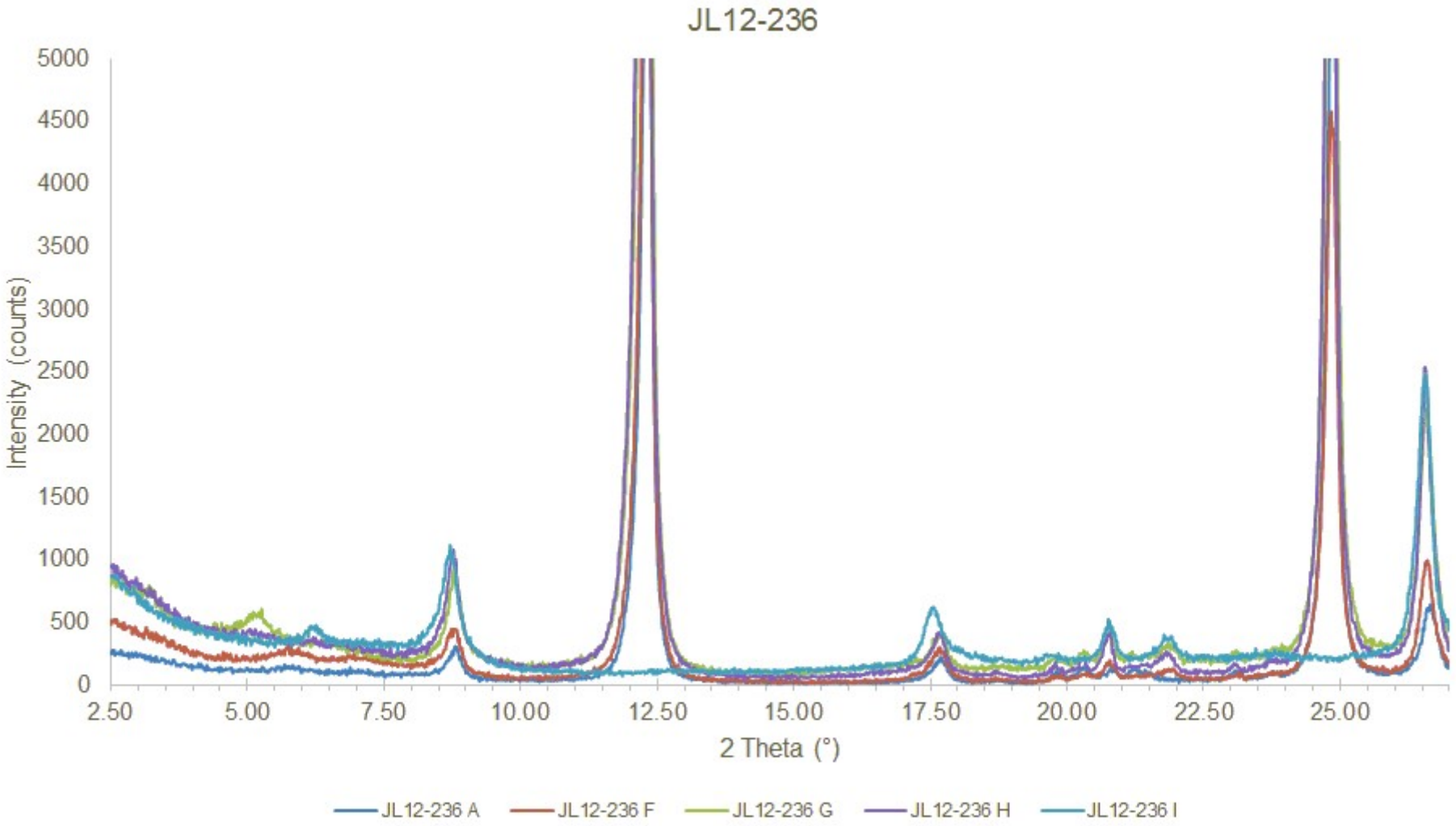
7.5
12.5
17.5
22.5
27.5
32.5
37.5
2 Theta (°)
JL11-15 F
JL11-15 G


JL12-236
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7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
2 Theta (°)
JL12-236 A
JL12-236 F
JL12-236 G
JL12-236 H
JL12-236 I

6.2 References

Moore, D. M., & Reynolds, R. C. (1997). *X-ray Diffraction and the Identification and Analysis of Clay Minerals*. Oxford University Press. 378