

Determination of anorthite content of a plutonite from Grafenstein from indirect measurements.

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1 Description of the input data

The present analysis orients itself closely in the general procedure as described in the book by Reinhard [2].

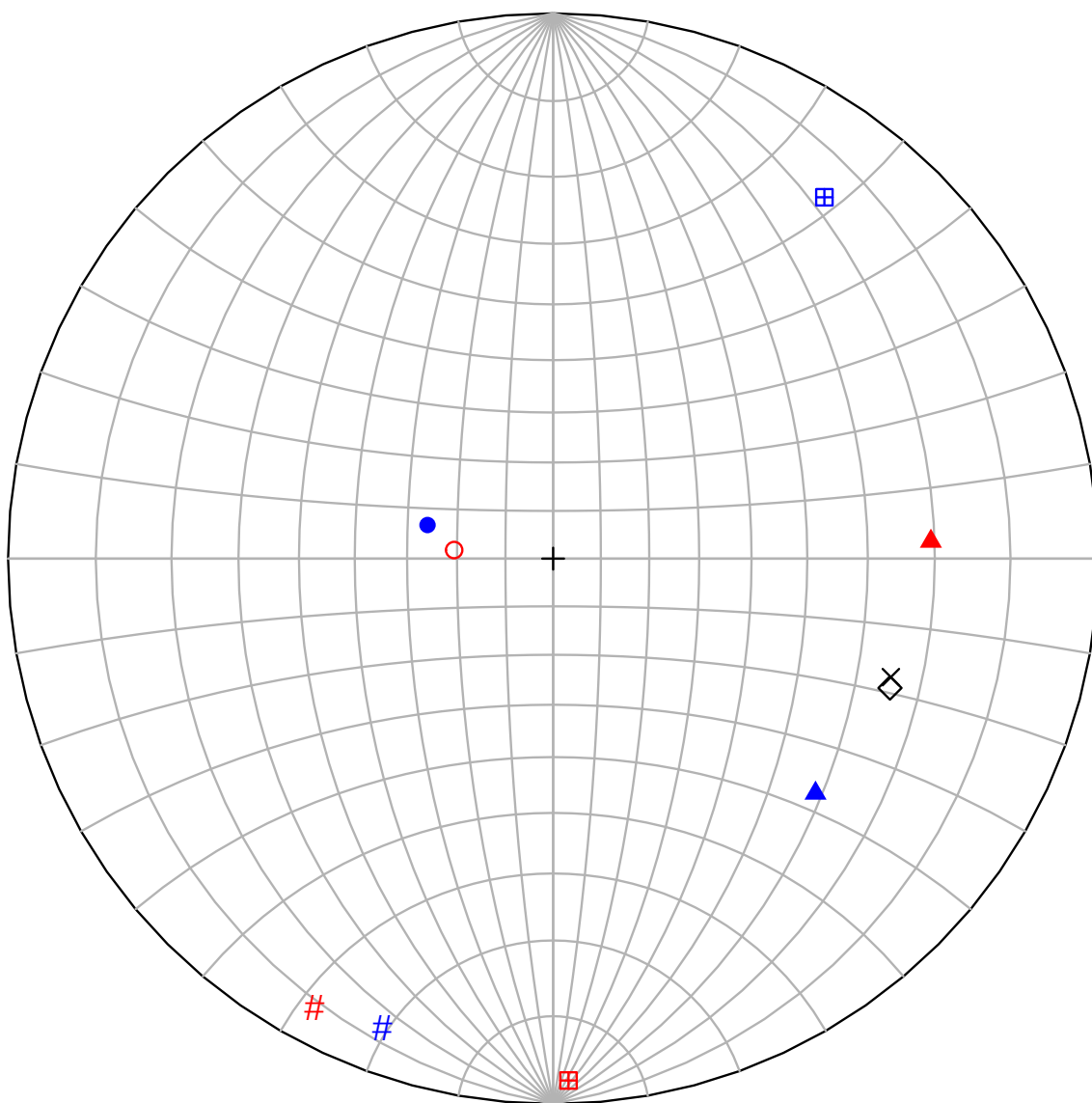
The input data are shown in Tab. 1 by individuum (group = 1 or 2), axis type (X, Y, or Z) and type of plane (cleavage plane (CP) or association plane (2)). At the moment, the program can handle only two groups, two axes per group, one association plane and one cleavage plane. The angles are to be input in degrees, where “n” refers to the angle of rotation around the axis “N” or “A1”, and “h” to the angle of rotation around axis “H” or “A2”. Positive values correspond to values read of the left Wright arc, while readings of the right Wright arc are to be reported with a negative sign.

For the present data, the angle between the two axes measured for individuum 1 is 90 degrees and for individuum 2, it is 90 degrees.

For the optical axes, the angle of rotation around the axis “K” or “A4” has to be entered instead of “n”.

group	type	n	h
1	Y	91.7	−2.5
1	Z	182.6	−20.5
2	Y	233.1	−10.7
2	Z	138.2	−24.3
1	AP	339.0	23.0
1	CP	242.0	4.0
2	CP	250.0	5.0

Table 1: The input data from the measurements on the universal stage (CP=cleavage plane), (AP=association plane). For the optical axes, the angle of rotation around axis K is reported instead of n.



$\circ$ x $\bullet$ $-x$ $+$ y $\boxplus$ $-y$ $\triangle$ z $\blacktriangle$ $-z$ $\times$ TA $\diamond$ AP $\#$ CP $\square$ OA

— 1 — 2

Figure 1: Plot of the measured elements.

Individuum	Type	Angle
1		
2		

Table 2: Angles $2V_x$ or $2V_z$ between optical axes of individuum 1 and 2.

orientations	X2	Y2	Z2	angles
1	1	1	1	176.9
2	1	-1	-1	173.3
3	-1	1	-1	139.5
4	-1	-1	1	41.2

Table 3: Rotation angles to bring the principal axis of the indicatrix to coincidence after an eventual change of direction of the axes of individuum 2. Should be nearly 180 deg, for the correct choice.

2 Calculated coordinates and relative orientation of the main optical axes

The two axes measured for each individuum are then orthogonalized symmetrically against each other and the missing axis is calculated. As only the direction of the axes is known, but not their orientation, the orientation of the axes for individuum 2 is redefined in such a way that the rotation angle to rotate the coordinate system 2 into that of one is as large as possible, ideally 180 degrees. The deviance of the actual angle which will rotate system 2 into system 1 is a good measure of the precision with which the axes have been measured. For the present data, the coordinates of the twin axis is $n = 160.7$ degrees and $h = 0.4$ degrees and the rotation angle is 176.9 degrees. The positions of all the elements determined up to now are shown in Fig. 1. To check further the relative alignment of the optical main axes of the twins, the twin axis is brought into the center of the projection in Fig. 3. The distribution of the poles should show a C2-symmetric pattern.

The angles between the axes Tab. 4 contain important quantitative information on the anorthite content of the plagioclas, cf. [3, p. 134, 136, 137], however, the twinning law must be known. Its determination is the scope of the next section.

$X' \wedge X''$	$Y' \wedge Y''$	$Z' \wedge Z''$
172.6	139.4	41.1

Table 4: Angles between the principal axes of the indicatrices

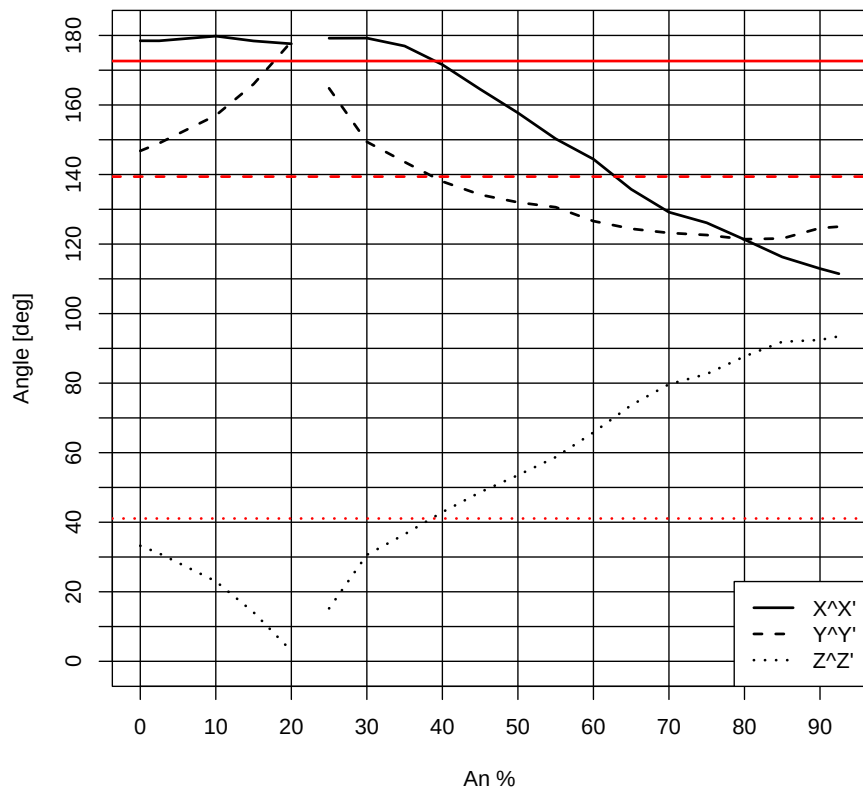


Figure 2: Angles between the principal axes according to the Albit law.

3 Determination of the orientation of the principal directions of the indicatrix relative to the crystal and determination of the twinning law

The absolute position of the principal axes of the indicatrix relative to the crystallographic axes can be inferred from special diagrams where the position of the crystallographic planes and directions are plotted relative to the fixed optical axes. As only the direction of the optical axis system is known but not their orientation, 4 different orientations have to be checked. The positions of the plane poles and directions correspond to the ones in [3, Tab. 223-25, 223-26]. These tables have been plotted using the original data from [1]. In the orientation, where the best match is achieved, the Miller indices of the twin axis, association plane and cleavage plane are read off, as well as the corresponding anorthite fraction. Only the values for the low temperature plagioclases are shown.

3.1 First orientation

The plot of the poles on the faces is shown in Fig. 4, that of the directions in Fig. 5.

3.2 Second orientation

The plot of the poles on the faces is shown in Fig. 6, that of the directions in Fig. 7.

3.3 Third orientation

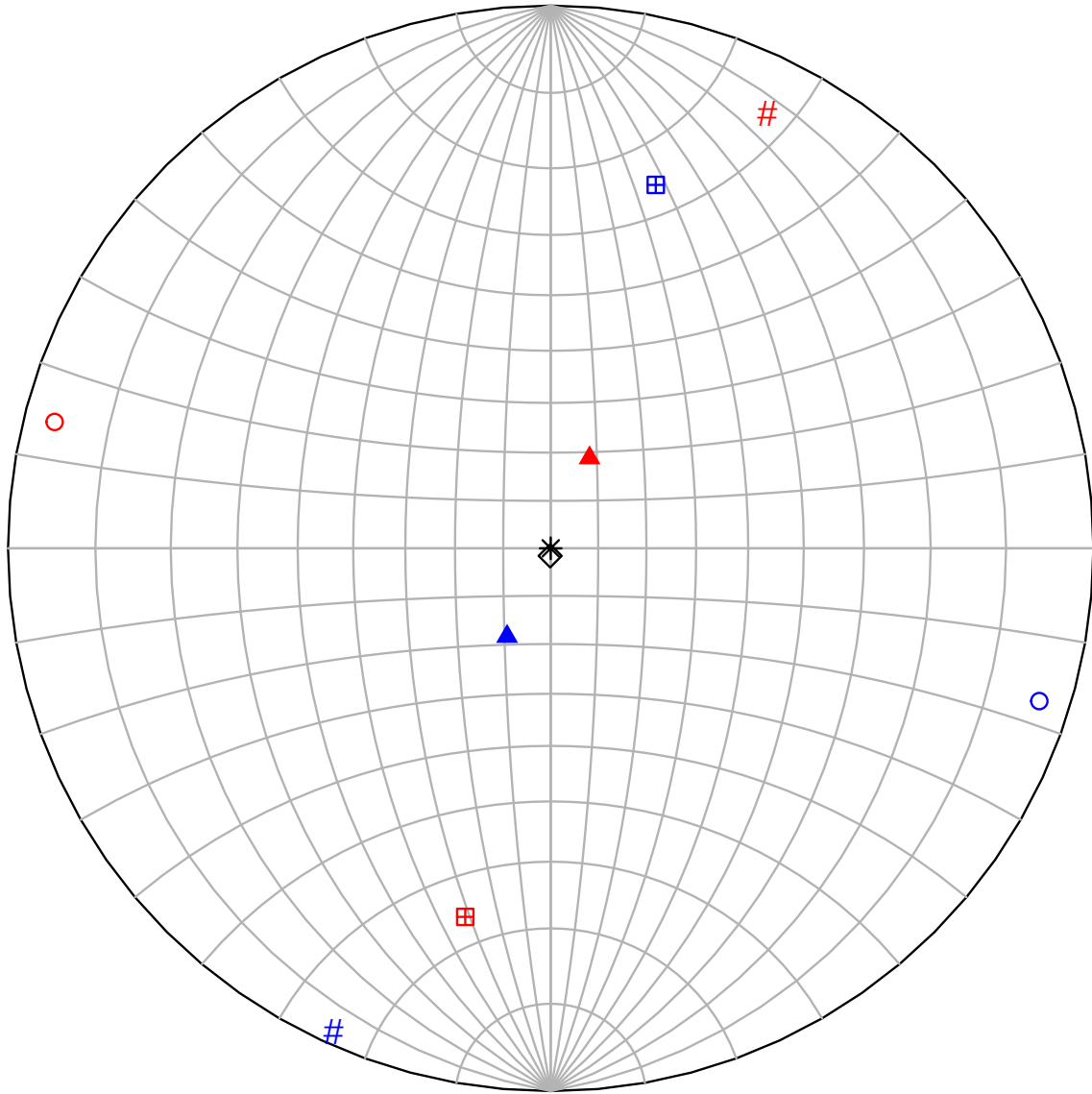
The plot of the poles on the faces is shown in Fig. 8, that of the directions in Fig. 9.

3.4 Fourth orientation

The plot of the poles on the faces is shown in Fig. 10, that of the directions in Fig. 11.

References

- [1] Conrad Burri, Robert L. Parker, and Eduard Wenk. *Die optische Orientierung der Plagioklase*. Birkhäuser Verlag, Basel and Stuttgart, 1967.
- [2] Max Reinhard. *Universal Drehtischmethoden: Einführung in die kristallographischen Grundbegriffe und die Plagioklasbestimmung*. Verlag von B. Wepf & Cie., Basel, 1931.
- [3] Walter Ehrenreich Tröger, Hans Ulrich Bambauer, Franz Taborszky, and H-D Trochim. *Optische Bestimmung der gesteinsbildenden Minerale-Teil I.: Bestimmungstabellen*. Schweizerbart'sche Verlagsbuchhandlung, 1982.



○ x ● -x + y ⊠ -y △ z ▲ -z × TA ◇ AP # CP □ OA

— 1 — 2

Figure 3: Plot of the elements projected along the twin axis.

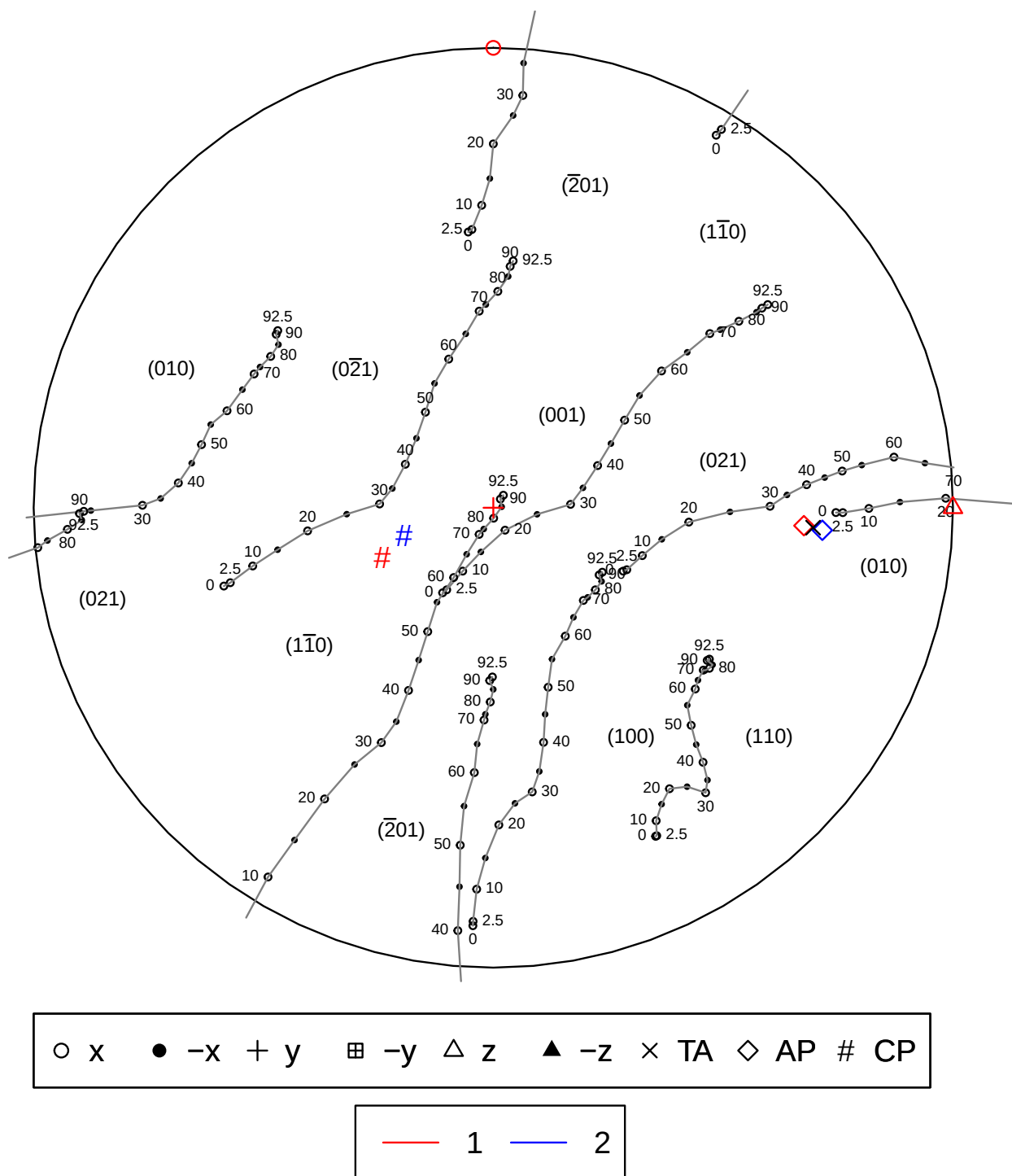


Figure 4: First orientation: Plot of the poles projected along the Y-axis.

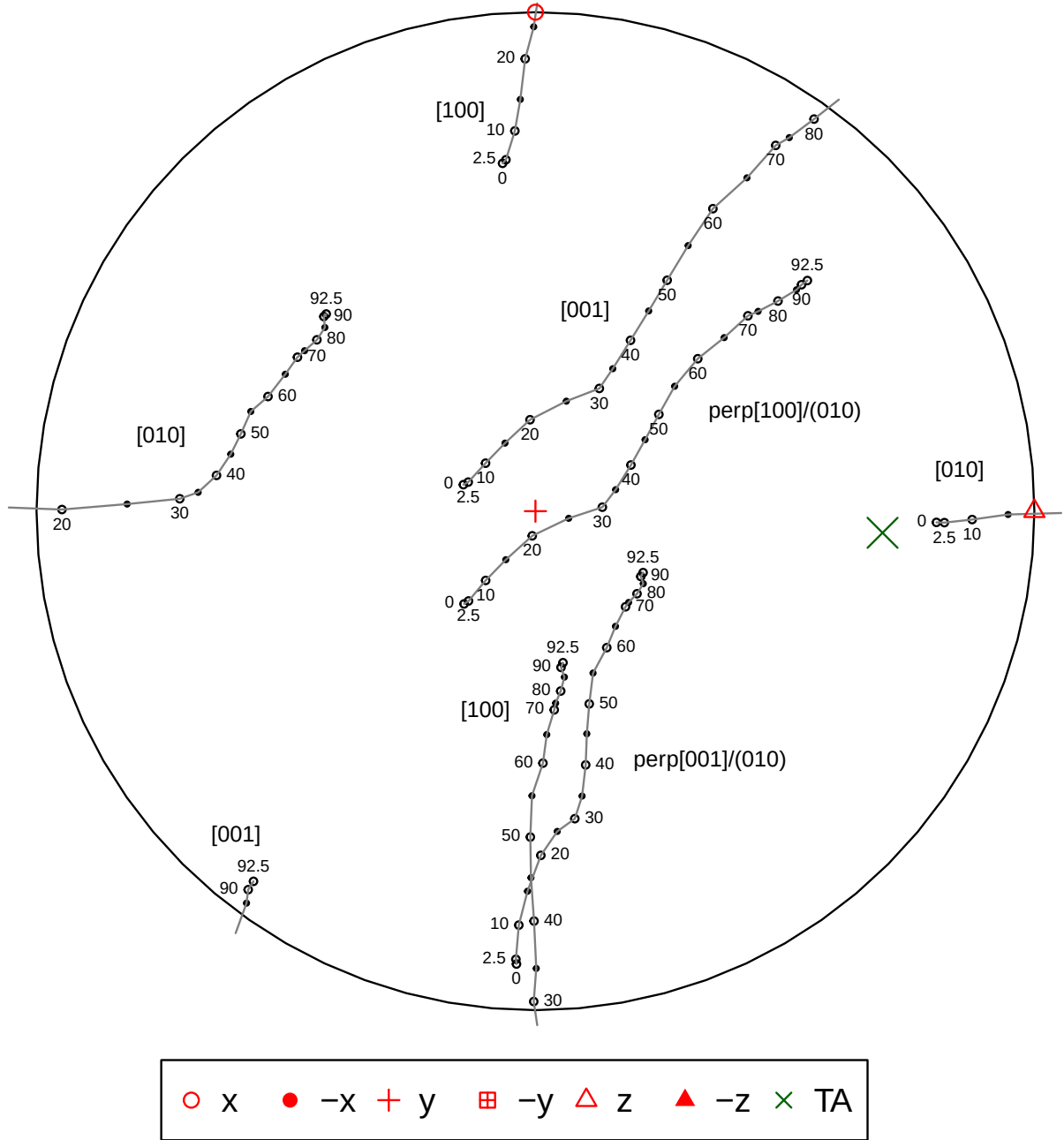


Figure 5: First orientation: Plot of the directions projected along the Y-axis.

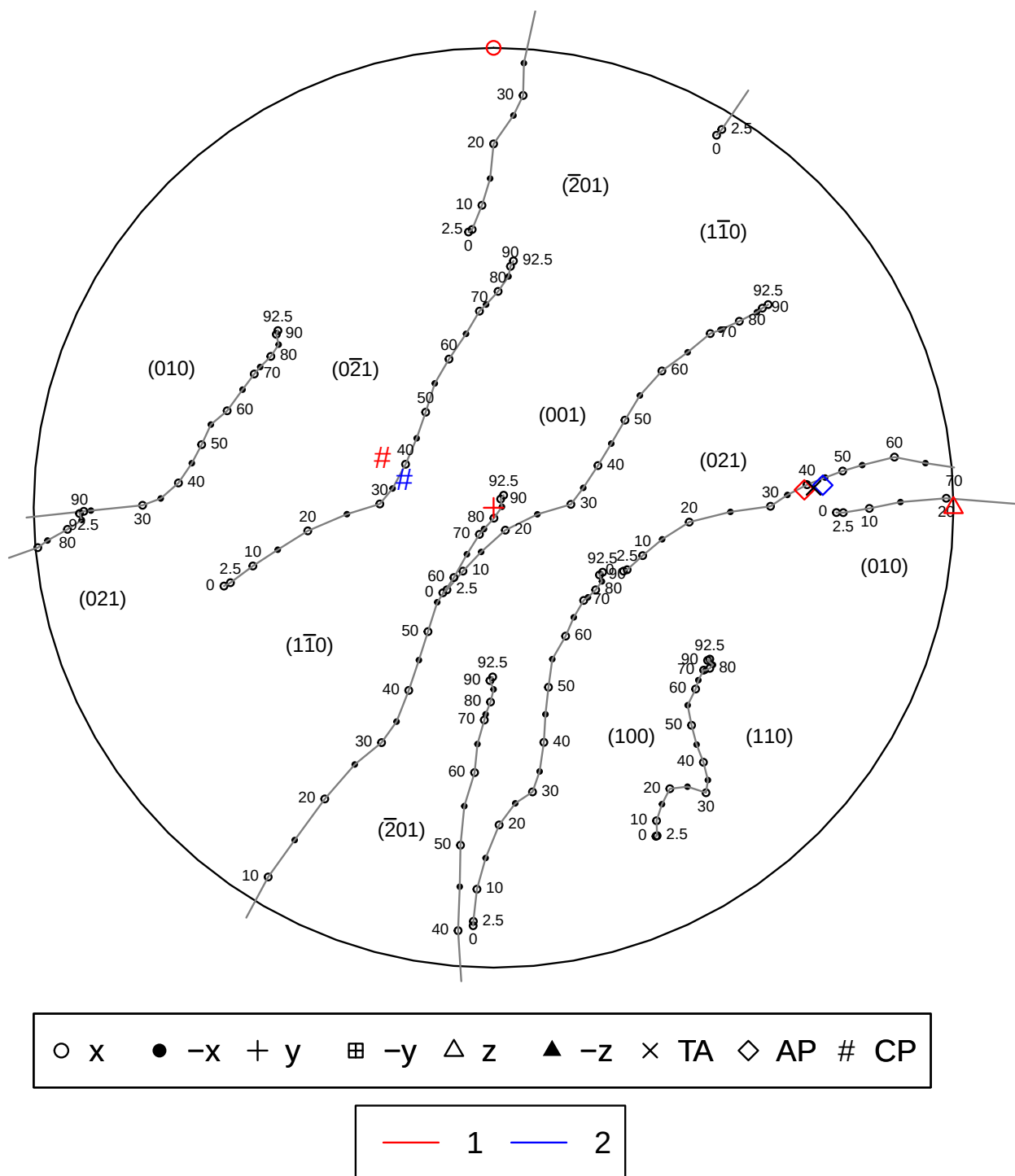


Figure 6: Second orientation: Plot of the poles projected along the Y-axis.

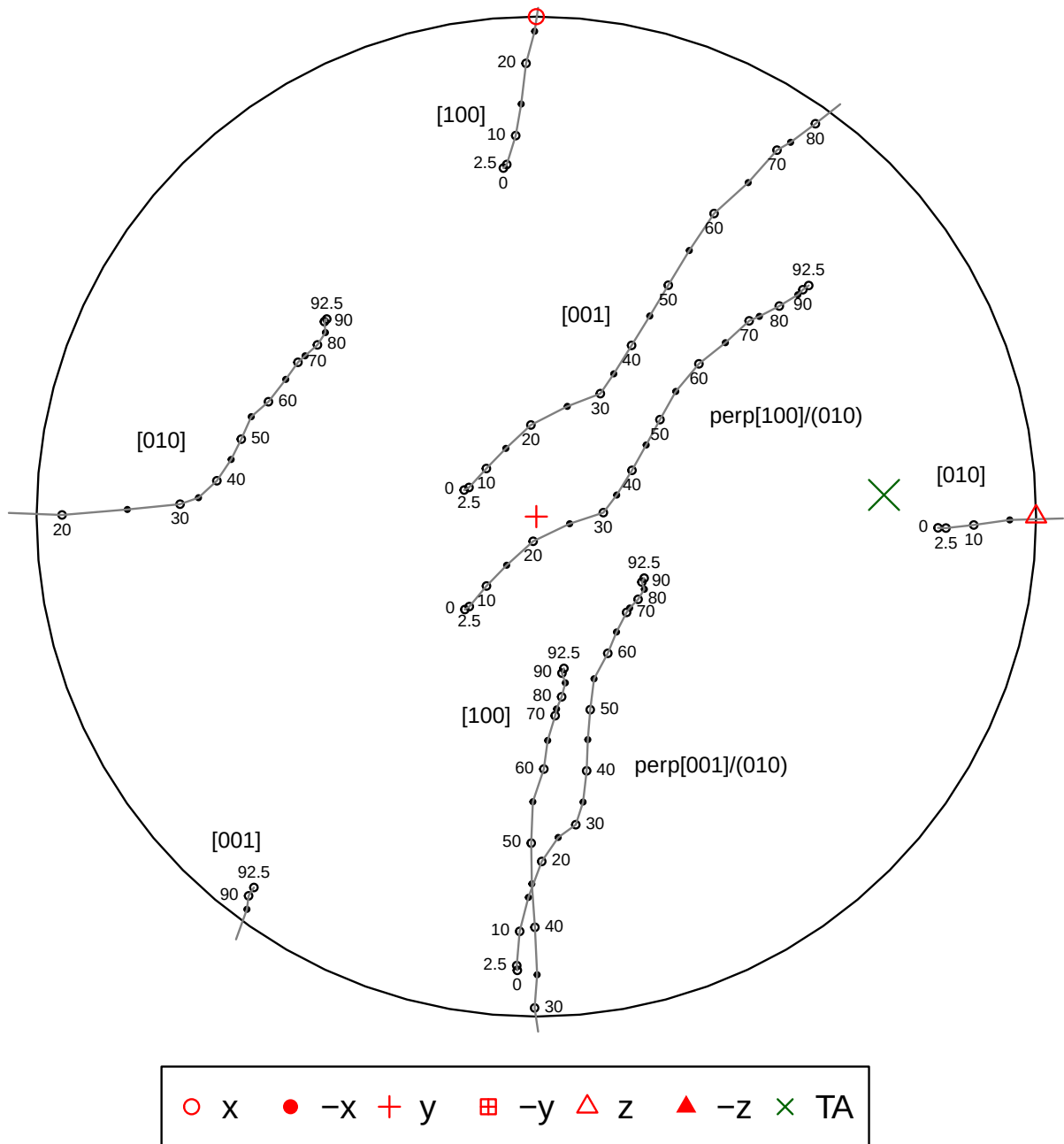


Figure 7: Second orientation: Plot of the directions projected along the Y-axis.

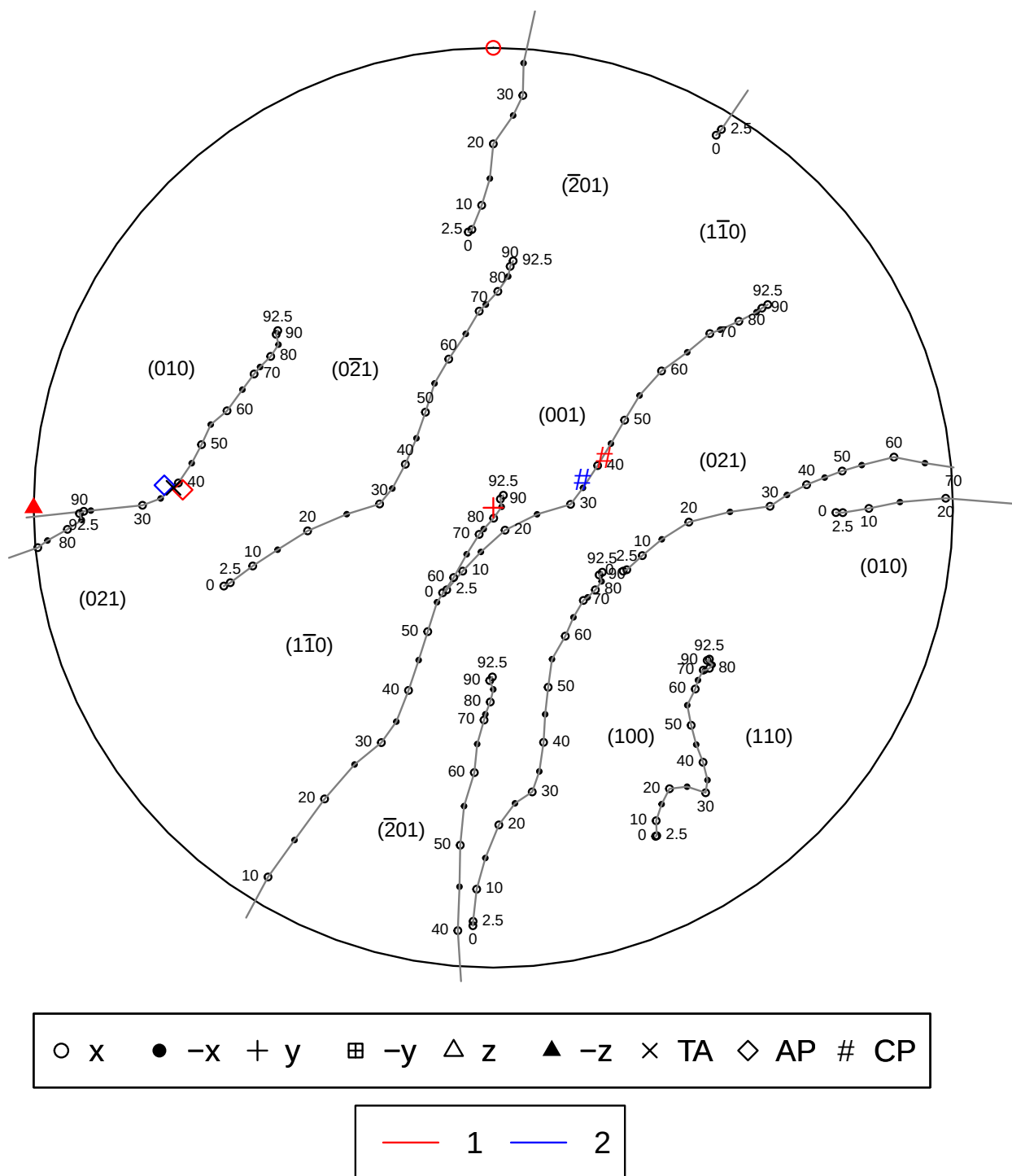


Figure 8: Third orientation: Plot of the poles projected along the Y-axis.

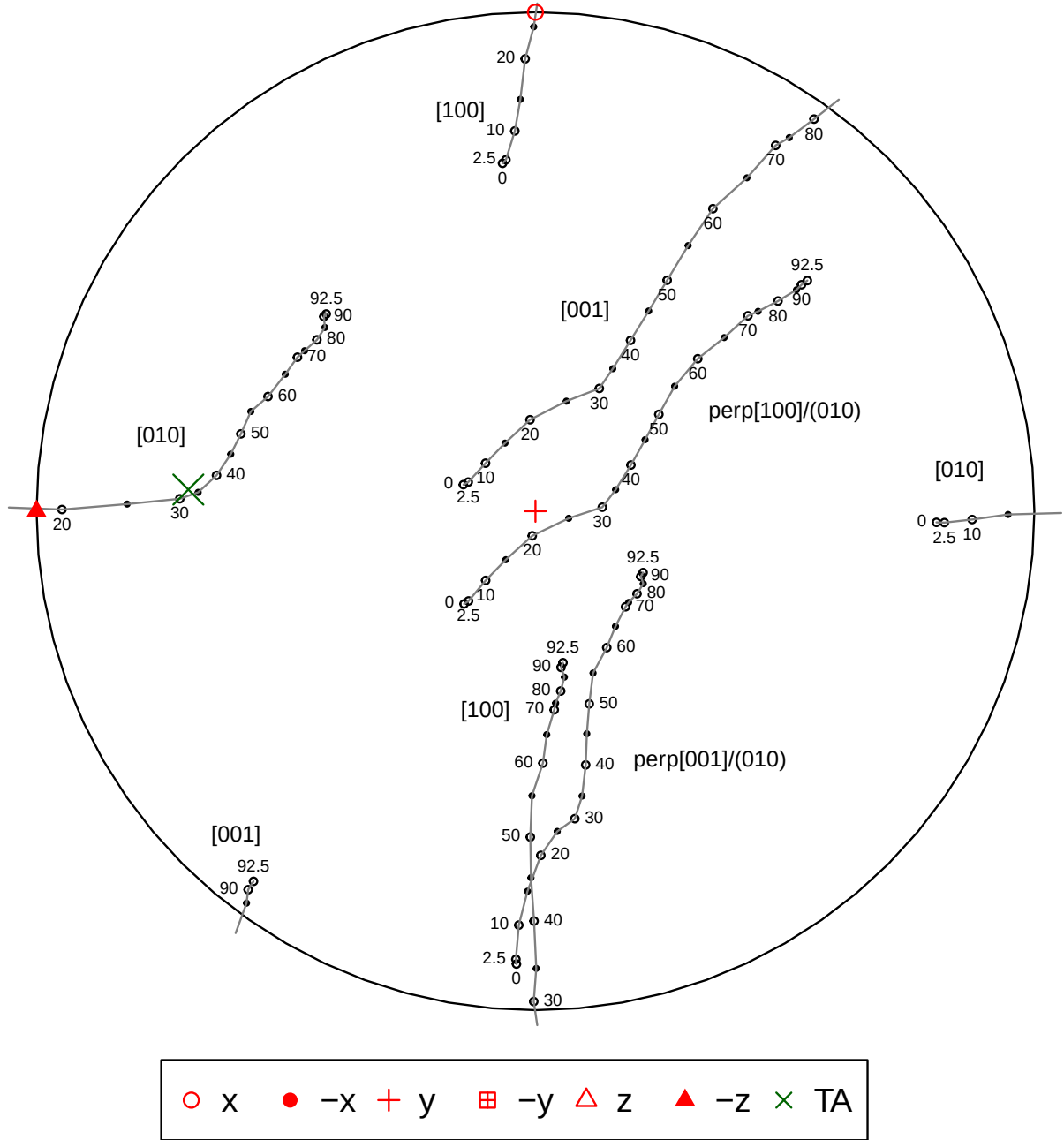


Figure 9: Third orientation: Plot of the directions projected along the Y-axis.

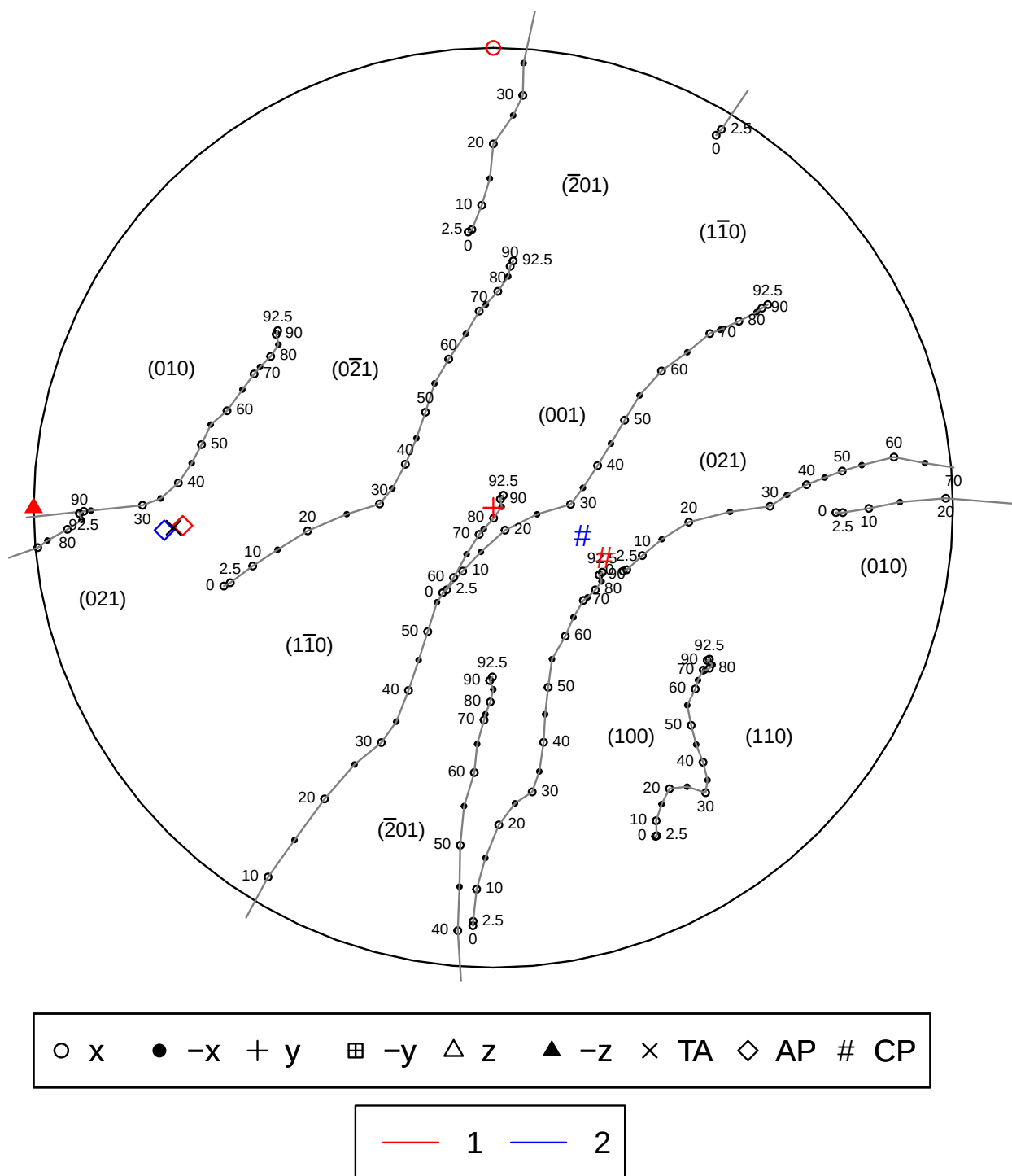


Figure 10: Fourth orientation: Plot of the poles projected along the Y-axis.

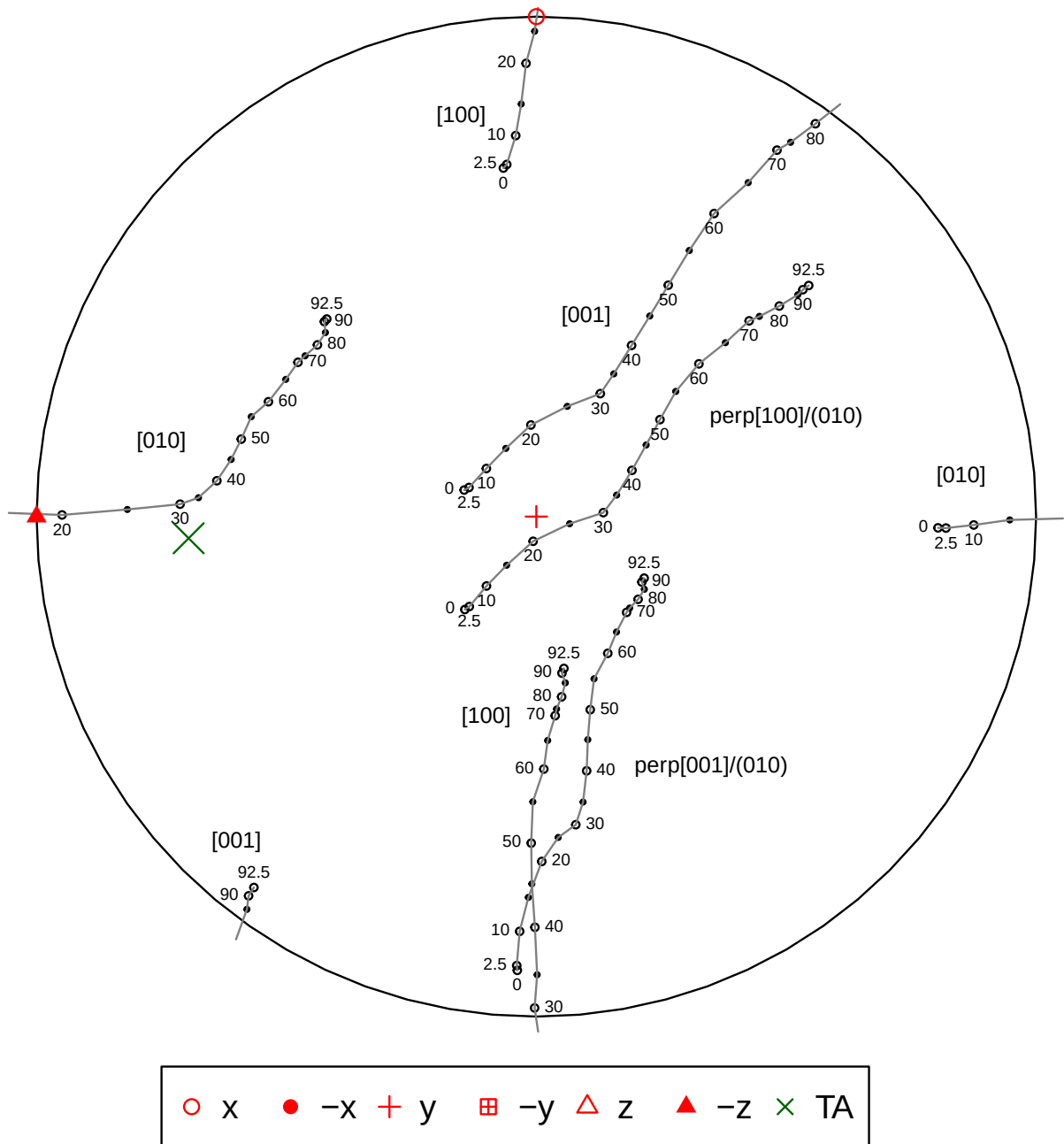


Figure 11: Fourth orientation: Plot of the directions projected along the Y-axis.