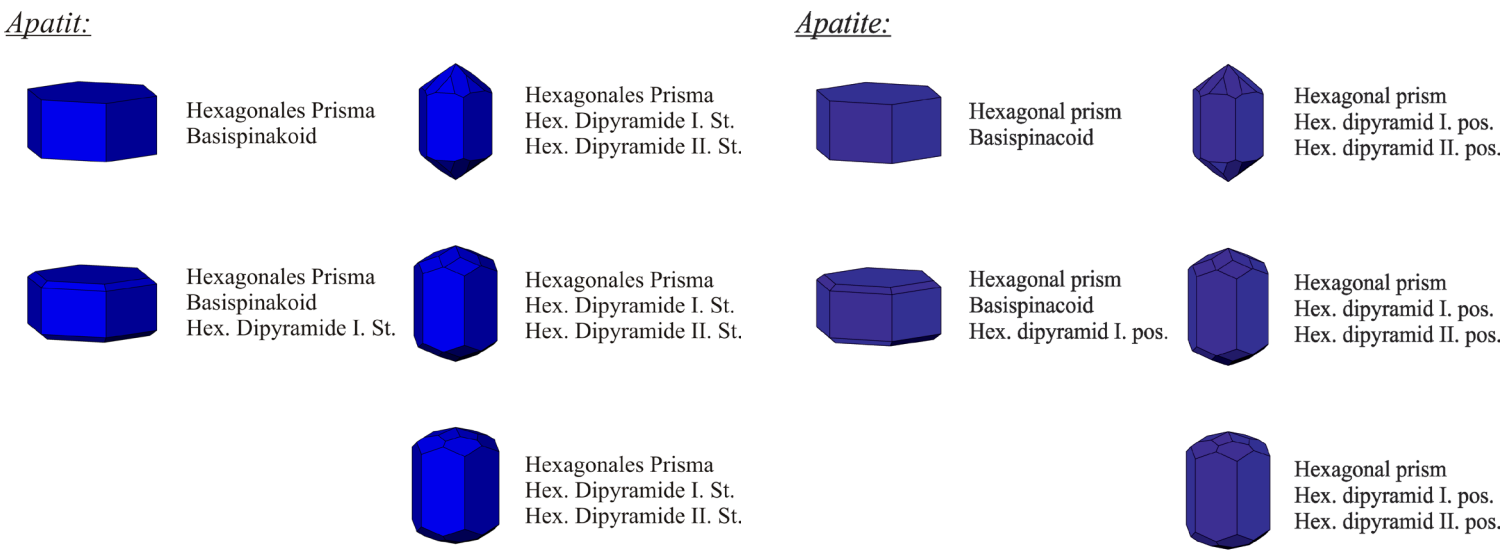
HALLESCHES JAHRBUCH
FÜR
GEOWISSENSCHAFTEN

BEIHEFT 39



HERBERT PÖLLMANN & CHIMEDNOROV OTGONBAYAR

SYMMETRIE UND DIE 32 PUNKTGRUPPEN IN DEUTSCHER UND ENGLISCHER SPRACHE

SYMMETRY AND 32 POINTGROUPS IN GERMAN AND ENGLISH LANGUAGE

HALLE (SAALE) 2017

HALLESCHES JAHRBUCH FÜR GEOWISSENSCHAFTEN

BEIHEFT 39

Halle (Saale) 2017
Institut für Geowissenschaften und Geographie
der Martin - Luther Universität Halle-Wittenberg

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Vorwort

Im vorliegenden zusammenfassenden Buch wird versucht, die Grundlagen der Kristallographie und insbesondere der Symmetrielehre in deutscher und englischer Sprache darzustellen. Die Zusammenfassung der Symmetrielehre basierend auf den 32 Punktgruppen wird erweitert durch Anwendungsbeispiele der makroskopischen Form von wichtigen Mineralen sowie Hinweisen zu den Raumgruppen.

Die Zusammenarbeit zwischen deutschen und brasilianischen Wissenschaftlern über lange Jahre basiert hierbei nicht nur auf der Kooperation in wissenschaftlichen Projekten sondern wurde darüber hinaus auch durch einen regen Wissenschaftler- und Studentenaustausch weiter intensiviert. Die Unterstützung des Deutschen Akademischen Austauschdienstes (DAAD) auf deutscher Seite, bzw. Capes/Cnpq auf brasilianischer Seite soll an dieser Stelle besonders hervorgehoben werden.

Die Idee, Sprachbarrieren durch gemeinsame Grundlagenpublikationen abzubauen, ergab sich aus den Schwierigkeiten von Austauschstudenten, Vorlesungen und Übungen in einer fremden Sprache und zudem einer fremden Fachsprache zu verstehen. Oft werden fehlende Kenntnisse der deutschen oder portugiesischen Sprache dann über Englisch ausgeglichen.

Das Buch ist vor allem dahingehend ausgerichtet, zu helfen, erste Sprachbarrieren zu überwinden und entsprechendes Grundlagenwissen anschaulich darzustellen. Durch die Komplexität des Gesamtgebietes kann hier natürlich nur ein kleiner Ausschnitt aufgezeigt werden, der trotzdem Basisdaten in beiden Sprachen darstellt und als Einführung verwendet werden kann.

Hier soll bewusst der Versuch unternommen werden, die für den Austausch zwischen Brasilien und Deutschland notwendigen Sprachen in den Vordergrund zu stellen. Es ist geplant, diese Zusammenstellung in den kommenden Jahren auszuweiten, zu vervollständigen sowie auch eine entsprechende Zusammenstellung in englischer Sprache zur Verfügung zu stellen.

Besonderer Dank gebührt Frau Prof. Dr. Dorothee Mertmann für die geduldige und hilfreiche Umsetzung des Manuskriptes in die vorliegende Endform.

Herbert Pöllmann

Halle, Oktober 2017

Preface

The present book tries to give some introductory basic knowledge of crystallography, especially for the training of symmetry in German and English language. The concentration of training is mostly due to the 32 point groups and adjacent knowledge on application examples of macroscopic forms of important minerals including some hints on space groups.

The collaboration between German and other international groups of scientist makes it necessary to have some tools available to discuss relevant crystallographic details in different languages. This is also based on exchange of students and scientists in different fields. The first booklet in this field was published in German and Portuguese language.

The idea to overcome basic barriers due to language knowledge should be overcome by using different translations in different languages.

Therefore especially an English translation of this basic book is highly necessary.

The book focuses mainly on helping to overcome barriers in different languages and show the basic knowledge in crystallography clearly.

The complexity of this documentation makes it necessary to show only a small part, but containing despite all details in 2 languages. It can be used as an introductory work.

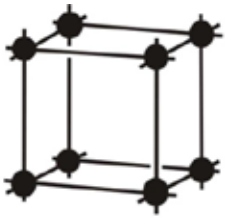
The trial, to consciously include different languages for this topic should help to minimize language barriers and to focus on the scientific work. This bilingual book will be offered also in other languages now or in the future. Also some extensions to other important topics are planned for the future.

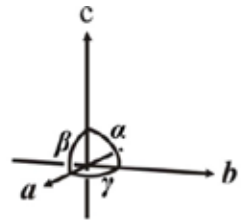
Special thanks are due to Prof. Dr. Dorothee Mertmann for her patience and helpful transformation of the manuscript into the present form of the book.

Herbert Pöllmann

Halle, Oktober 2017

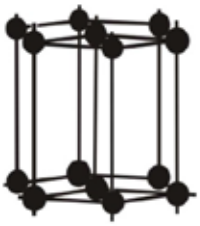
Die 7 Kristallsysteme

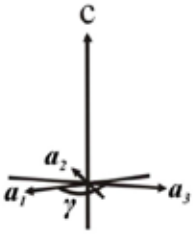




Kubisch:

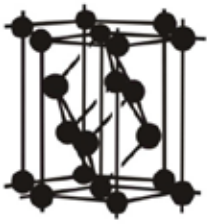
$a_0 = b_0 = c_0$
$\alpha = \beta = \gamma = 90°$

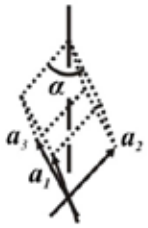




Hexagonal:

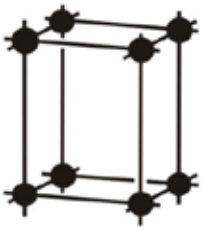
$a_1 = a_2 = a_3 \neq c_0$
$\alpha = \beta = 90°; \gamma = 120°$

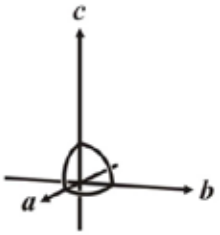




Rhomboedrisch:

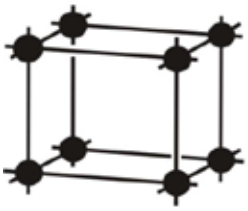
$a_1 = a_2 = a_3$
$\alpha_1 = \alpha_2 = \alpha_3 \neq 90°$

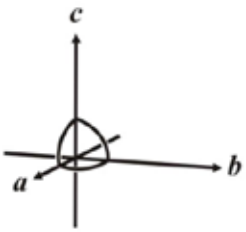




Tetragonal:

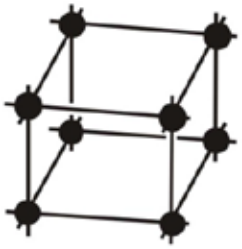
$a_0 = b_0 \neq c_0$
$\alpha = \beta = \gamma = 90°$

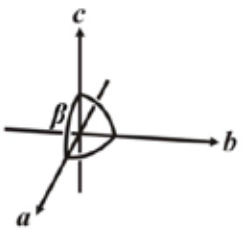




Orthorhombisch:

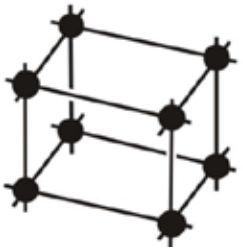
$a_0 \neq b_0 \neq c_0$
$\alpha = \beta = \gamma = 90°$

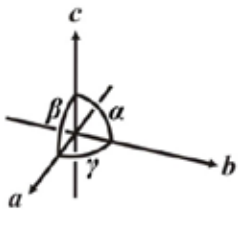




Monoklin:

$a_0 \neq b_0 \neq c_0$
$\alpha = \gamma = 90°; \beta \neq 90°$

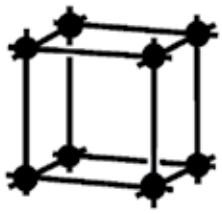
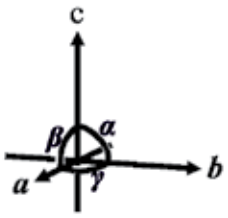




Triklin:

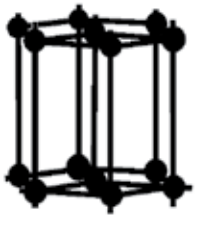
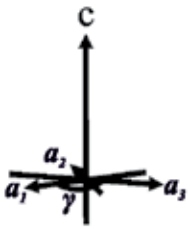
$a_0 \neq b_0 \neq c_0$
$\alpha \neq \beta \neq \gamma \neq 90°$

The 7 crystal systems

Cubic:

$a_0 = b_0 = c_0$
$\alpha = \beta = \gamma = 90°$

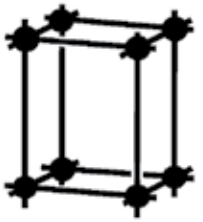
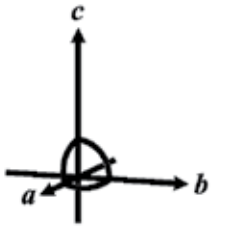



Hexagonal:

$a_1 = a_2 = a_3 \neq c_0$
$\alpha = \beta = 90°; \gamma = 120°$

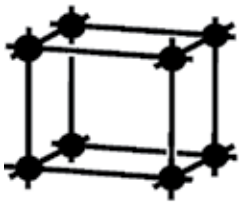
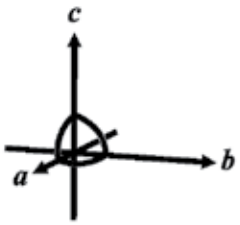

Rhombohedral:

$a_1 = a_2 = a_3$
$\alpha_1 = \alpha_2 = \alpha_3 \neq 90°$

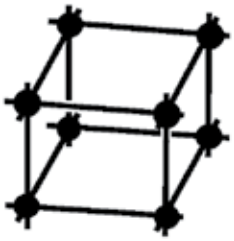
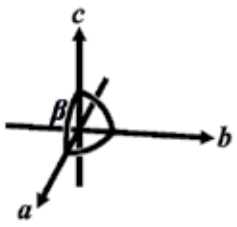
Tetragonal:

$a_0 = b_0 \neq c_0$
$\alpha = \beta = \gamma = 90°$

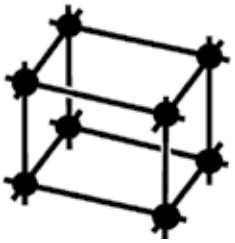
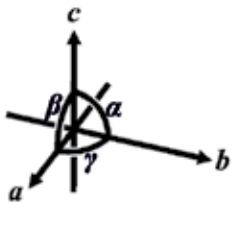
Orthorhombic:

$a_0 \neq b_0 \neq c_0$
$\alpha = \beta = \gamma = 90°$

Monoclinic:

$a_0 \neq b_0 \neq c_0$
$\alpha = \gamma = 90°; \beta \neq 90°$

Triclinic:

$a_0 \neq b_0 \neq c_0$
$\alpha \neq \beta \neq \gamma \neq 90°$

Häufigkeit von Mineralen

5091 Minerale sind derzeit bekannt (www.mindat.org, August 2017). Nach einer alten Aufstellung sind:

Kubisch	5 Crystal classes	346	9,9%
Hexagonal	7 Crystal classes	326	9,3%
Trigonal-Rhomboedrisch	5 Crystal classes	295	8,4%
Tetragonal	7 Crystal classes	278	7,9%
Orthorhombisch	3 Crystal classes	774	22%
Monoklin	3 Crystal classes	1129	32,2%
Triklin	2 Crystal classes	332	9,5%
Amorph		30	0,8%

aus „Minerale: Bestimmen nach äußeren Kennzeichen / HOCHLEITNER; PHILIPSBORN;WEINER“

Wirkung der verschiedenen Drehachsen

Name	**Symbol**	**Wirkung**
Inversion	* / i	Inversion am Zentrum
Zweizählige Drehachse	⬮ / 2	Drehungen um 180°
Spiegelebene / inverse zweizählige D.	m = $\bar{2}$	Spiegelung an einer Ebene
Dreizählige Drehachse	▲ / 3	Drehungen um 120°
Inverse dreizählige D.	⧋ / $\bar{3}$	Drehungen um 120° und Inversion
Vierzählige Drehachse	◆ / 4	Drehungen um 90°
Inverse vierzählige D.	◈ / $\bar{4}$	Drehungen um 90° und Inversion
Sechszählige Drehachse	⬢ / 6	Drehungen um 60°
Inverse sechszählige D.	⬘ / $\bar{6}$	Drehungen um 60° und Inversion

Occurrence frequency of minerals

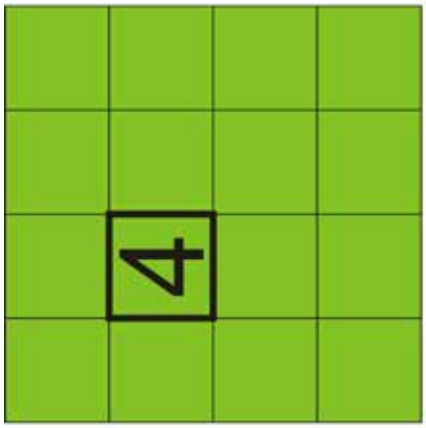
5091 minerals are known to date (www.mindat.org, august 2017).
Following crystal systems are based on older data sets:

Cubic	5 Crystal classes	346	9,9%
Hexagonal	7 Crystal classes	326	9,3%
trigonal - rhombohedral	5 Crystal classes	295	8,4%
tetragonal	7 Crystal classes	278	7,9%
orthorhombic	3 Crystal classes	774	22%
monoclinic	3 Crystal classes	1129	32,2%
triclinic	2 Crystal classes	332	9,5%
amorphous		30	0,8%

from „Minerale: Bestimmen nach äußeren Kennzeichen / HOCHLEITNER; PHILIPSBORN; WEINER“

Influence of different axes

Name	**Symbol**	**Influence**
Inversion	* / i	Inversion at the center
Two-fold rotation axis	⬮ / 2	Rotation of 180°
Mirror plane / inverse two-fold rotation axis	m = $\bar{2}$	A reflection at a plane
Three-fold rotation axis	▲ / 3	Rotation of 120°
Inverse three-fold rotation axis	△ / $\bar{3}$	Rotation of 120° and Inversion
Four-fold rotation axis	◆ / 4	Rotation of 90°
Inverse four-fold rotation axis	◈ / $\bar{4}$	Rotation of 90° and Inversion
Six-fold rotation axis	⬢ / 6	Rotation of 60°
Inverse six-fold rotation axis	⬙ / $\bar{6}$	Rotation of 60° and Inversion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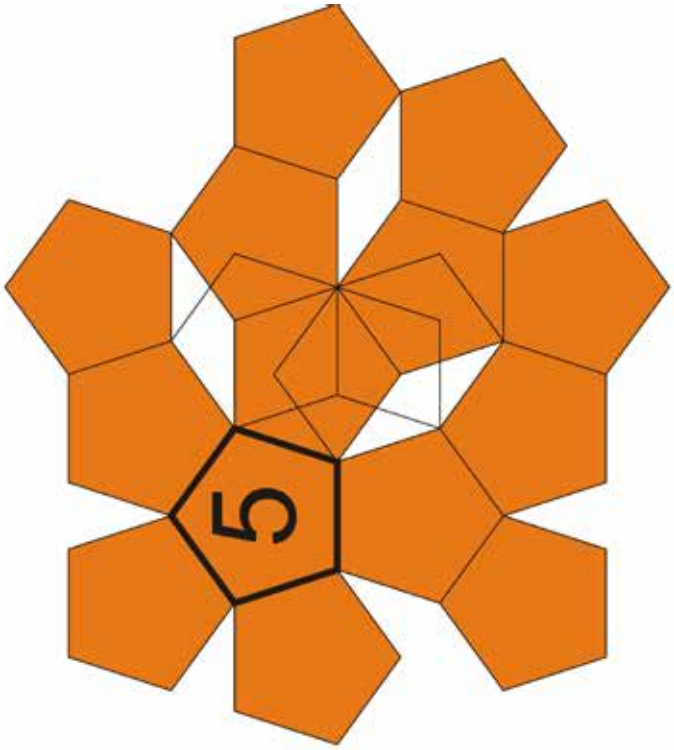
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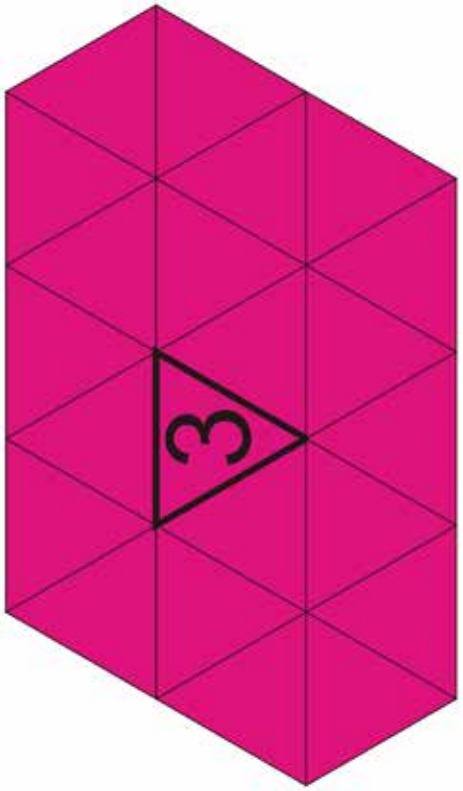
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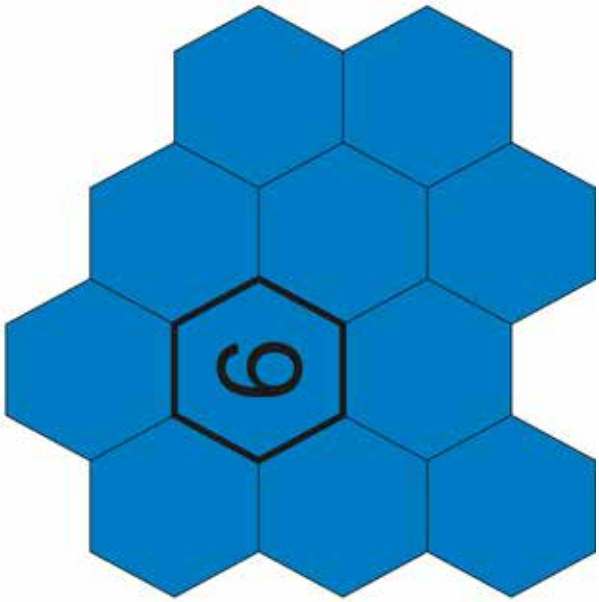
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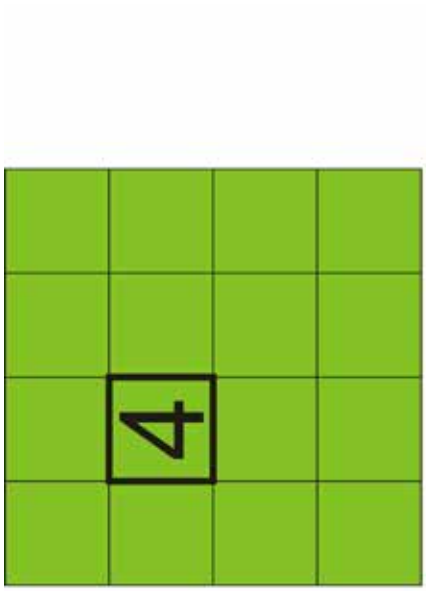
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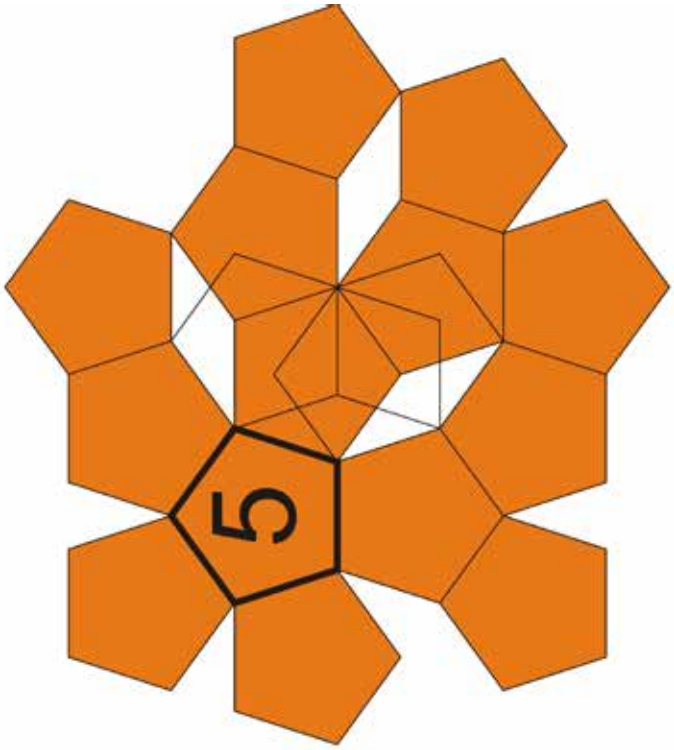
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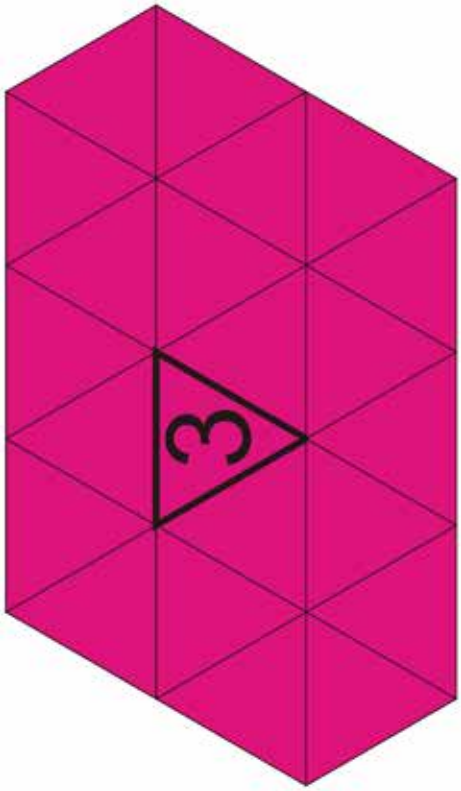
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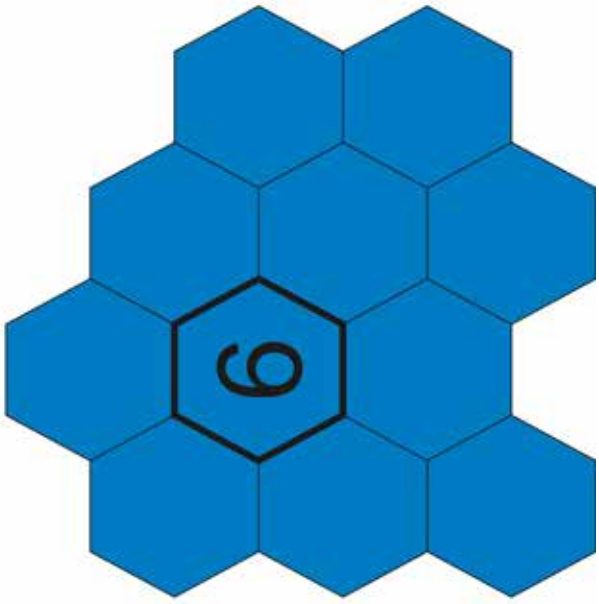
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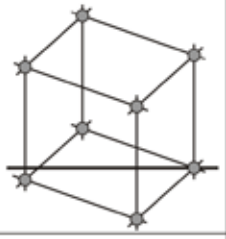
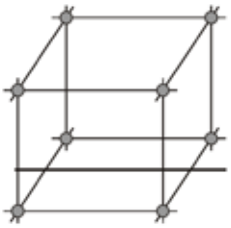
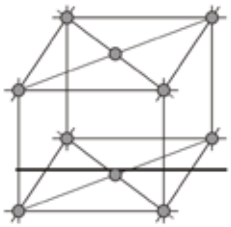
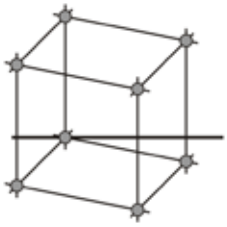
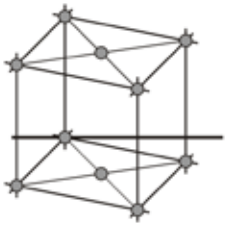
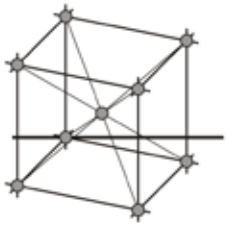
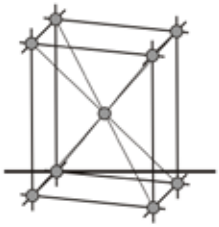
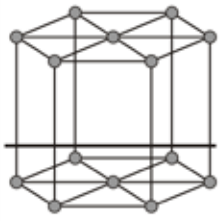
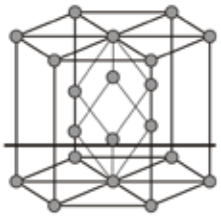
triklin				
monoklin			identisch mit C-Gitter	identisch mit C-Gitter
ortho-rhombisch				
tetragonal		identisch mit P-Gitter		identisch mit I-Gitter
trigonal				
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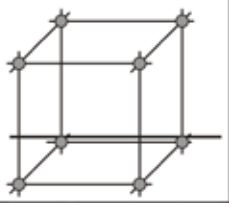
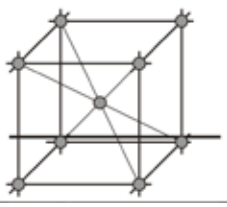
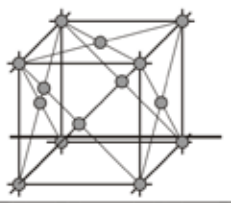
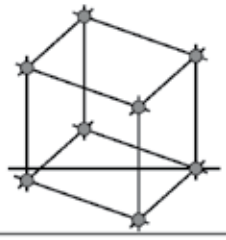
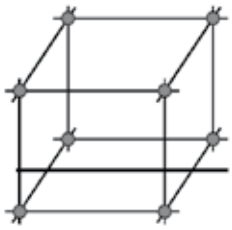
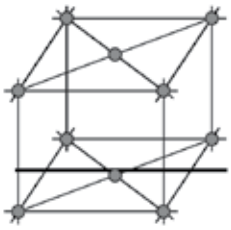
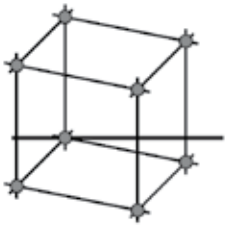
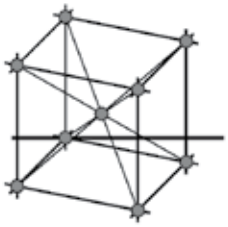
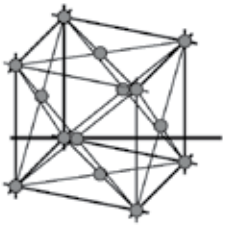
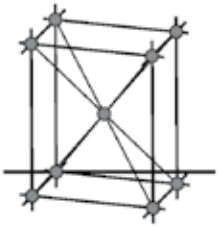
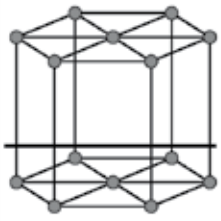
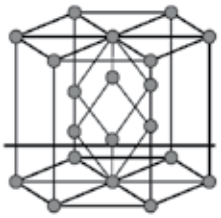
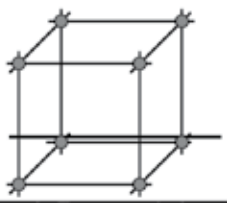
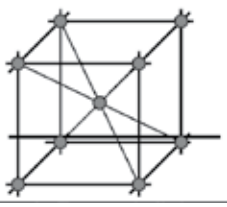
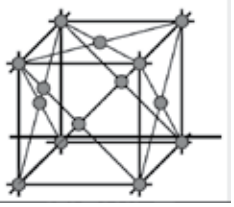
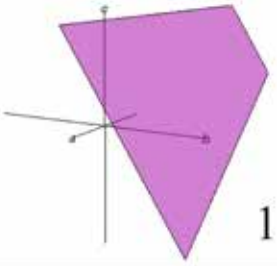
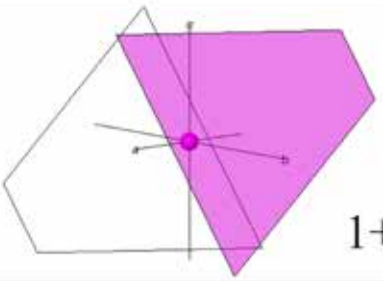
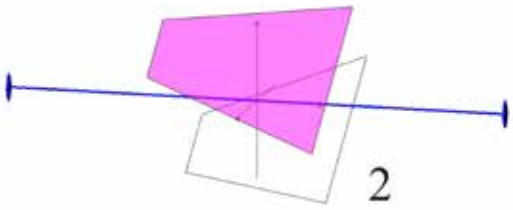
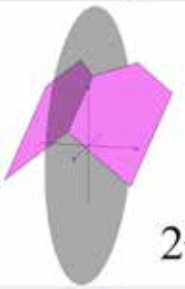
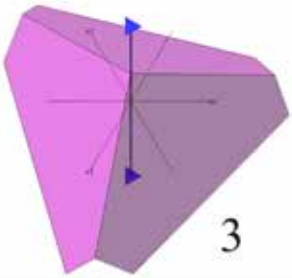
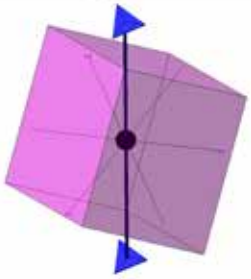
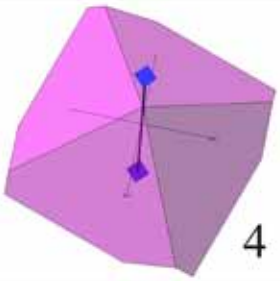
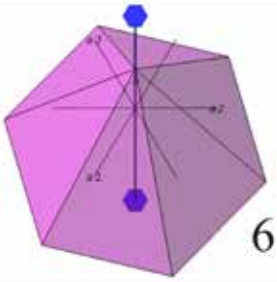
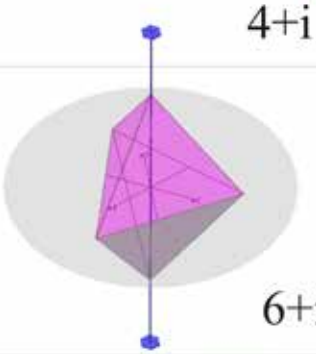
kubisch		unmöglich		

	P	C	I	F
triclinic				
monoclinic			identical with C-lattice	identical with C-lattice
ortho-rhombic				
tetragonal		identical with P-lattice		identical with I-lattice
trigonal				
hexagonal				
cubic		impossible		

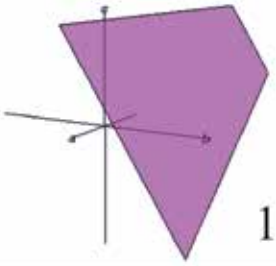
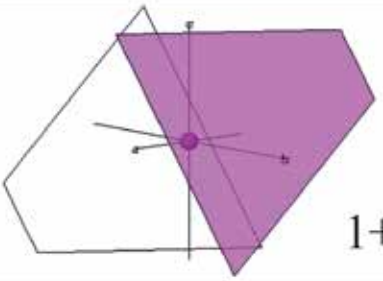
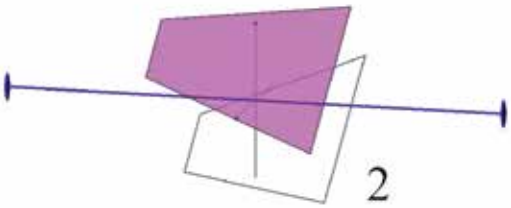
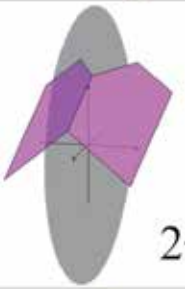
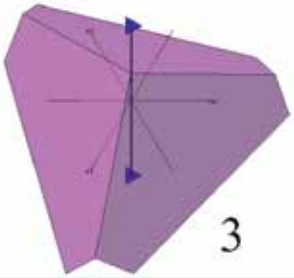
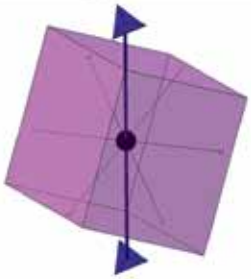
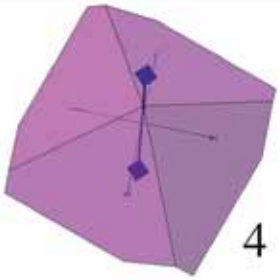
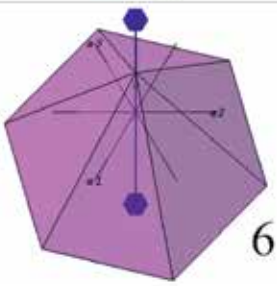
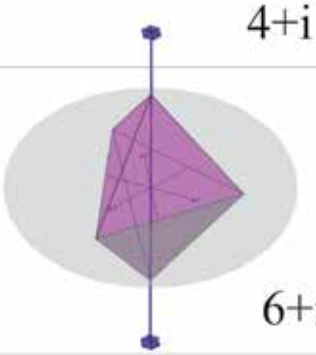
Die Symmetrieelemente

(normale Drehachsen, Drehachsen kombiniert mit Inversion)

normal		kombiniert mit Inversionszentrum
 1	1	 1+i
 2	2	 2+i = m
 3	3	 3+i
 4	4	 4+i
 6	6	 6+i

Symmetry elements

(normal rotation axes, rotation axes combined with inversion)

normal		combined with inversion center
 1	1	 1+i
 2	2	 2+i = m
 3	3	 3+i
 4	4	 4+i
 6	6	 6+i

Symmetrie	***Symbole nach***	***Symbol***				
		*	⬮	▲	◆	⬣
(polare Drehachse)	*Schönflies*	C_1	C_2	C_3	C_4	C_6
	Hermann-Mauguin	*1*	*2*	*3*	*4*	*6*
Kombination von Drehachsen und horizontalen Symmetrieebenen	*Schönflies*		C_{2h}	C_{3h}	C_{4h}	C_{6h}
	Hermann-Mauguin		*2/m*	*3/m* ($\bar{6}$)	*4/m*	*6/m*
Kombination von Drehachsen und vertikalen Symmetrieebenen	*Schönflies*	C_s	C_{2v}	C_{3v}	C_{4v}	C_{6v}
	Hermann-Mauguin	*m*	*mm2*	*3m*	*4mm*	*6mm*
Kombination von Drehachsen, horizontalen und vertikalen Symmetrieebenen	*Schönflies*		D_{2h}	D_{3h}	D_{4h}	D_{6h}
	Hermann-Mauguin		*mmm*	$\bar{6}$*2m*	*4/mmm*	*6/mmm*
Kombination mit zweizähligen Drehachsen	*Schönflies*		D_2	D_3	D_4	D_6
	Hermann-Mauguin		*222*	*32*	*422*	*622*
Symmetriezentrum und Inversionsachsen	*Schönflies*	C_i		C_{3i} D_{3d}	S_4 D_{2d}	
	Hermann-Mauguin	$\bar{1}$	$\bar{2}$ *(m)*	$\bar{3}$ $\bar{3}$*m*	$\bar{4}$ $\bar{4}$*2m*	6 *(3/m)* $\bar{6}$*2m*

Elements of symmetry

Symmetry	Symbols according to	Symbol				
		*	●	▲	◆	⬢
(polar rotation axis)	Schoenflies	C_1	C_2	C_3	C_4	C_6
	Hermann-Mauguin	*1*	*2*	*3*	*4*	6
Combination of rotary axes and horizontal symmetry planes	Schoenflies		C_{2h}	C_{3h}	C_{4h}	C_{6h}
	Hermann-Mauguin		*2/m*	*3/m* ($\bar{6}$)	*4/m*	6/m
Combination of rotary axes and vertical symmetry planes	Schoenflies	C_s	C_{2v}	C_{3v}	C_{4v}	C_{6v}
	Hermann-Mauguin	*m*	*mm2*	*3m*	*4mm*	6mm
Combination of rotary axes, horizontal and vertical symmetry planes	Schoenflies		D_{2h}	D_{3h}	D_{4h}	D_{6h}
	Hermann-Mauguin		*mmm*	$\bar{6}$*2m*	*4/mmm*	6/mmm
Combination with two-fold rotary axes	Schoenflies		D_2	D_3	D_4	D_6
	Hermann-Mauguin		222	32	422	622
Symmetry center and inversion axes	Schoenflies	C_i		C_{3i} D_{3d}	S_4 D_{2d}	
	Hermann-Mauguin	$\bar{1}$	$\bar{2}$ *(m)*	$\bar{3}$ $\bar{3}$*m*	$\bar{4}$ $\bar{4}$*2m*	$\bar{6}$ (3/m) $\bar{6}$2m

Die 32 Punktgruppen

Kristallsystem	**Triklin**	**Monoklin**	**Orthorhombisch**	**Trigonal**	**Hexagonal**	**Tetragonal**	**Kubisch**
Holoedrie	$\bar{1}$	$\frac{2}{m}$	$\frac{2}{m}\frac{2}{m}\frac{2}{m}$	$\bar{3}\frac{2}{m}$	$\frac{6}{m}\frac{2}{m}\frac{2}{m}$	$\frac{4}{m}\frac{2}{m}\frac{2}{m}$	$\frac{4}{m}\bar{3}\frac{2}{m}$
Blickrichtung	- keine-	[010]	[100] [010] [001]	[001] [100]	[001] [100] [1$\bar{1}$0]	[001] [100] [1$\bar{1}$0]	[001] [111] [1$\bar{1}$0]
Punktgruppen	1	2	2 2 2	3	6	4	2 3
	$\bar{1}$	m	m m 2	3 2	6 2 2	4 2 2	4 3 2
		$\frac{2}{m}$	$\frac{2}{m}\frac{2}{m}\frac{2}{m}$	3 m	6 m m	4 m m	$\frac{2}{m}\bar{3}$
				$\bar{3}$	$\bar{6}$	$\bar{4}$	$\bar{4}$ 3 m
				$\bar{3}\frac{2}{m}$	$\bar{6}$ 2 m	$\bar{4}$ 2 m	$\frac{4}{m}\bar{3}\frac{2}{m}$
					$\bar{6}$ m 2	$\bar{4}$ m 2	
					$\frac{6}{m}$	$\frac{4}{m}$	
					$\frac{6}{m}\frac{2}{m}\frac{2}{m}$	$\frac{4}{m}\frac{2}{m}\frac{2}{m}$	

32 Crystallographic point groups

Crystal systems	Triclinic	Monoclinic	Orthorhombic	Trigonal	Hexagonal	Tetragonal	Cubic
Holoedry	$\bar{1}$	$\frac{2}{m}$	$\frac{2}{m}\frac{2}{m}\frac{2}{m}$	$\bar{3}\frac{2}{m}$	$\frac{6}{m}\frac{2}{m}\frac{2}{m}$	$\frac{4}{m}\frac{2}{m}\frac{2}{m}$	$\frac{4}{m}\bar{3}\frac{2}{m}$
Viewing direction	- keine-	[010]	[100] [010] [001]	[001] [100]	[001] [100] [1$\bar{1}$0]	[001] [100] [1$\bar{1}$0]	[001] [111] [1$\bar{1}$0]
Point groups	1	2	2 2 2	3	6	4	2 3
	$\bar{1}$	m	m m 2	3 2	6 2 2	4 2 2	4 3 2
		$\frac{2}{m}$	$\frac{2}{m}\frac{2}{m}\frac{2}{m}$	3 m	6 m m	4 m m	$\frac{2}{m}\bar{3}$
				$\bar{3}$	$\bar{6}$	$\bar{4}$	$\bar{4}$ 3 m
				$\bar{3}\frac{2}{m}$	$\bar{6}$ 2 m	$\bar{4}$ 2 m	$\frac{4}{m}\bar{3}\frac{2}{m}$
					$\bar{6}$ m 2	$\bar{4}$ m 2	
					$\frac{6}{m}$	$\frac{4}{m}$	
					$\frac{6}{m}\frac{2}{m}\frac{2}{m}$	$\frac{4}{m}\frac{2}{m}\frac{2}{m}$	

Die 32 Kristallklassen

Anzahl der Klassen	Bezeichnung nach Herman-Mauguin		Bezeichnung der Kristallklasse
	komplett	abgekürzt	
Triklines System			
2 Klassen	1	1	Triklin Pedial
	-1	-1	Triklin Pinakoidal
Monoklines System			
3 Klassen	2/***m***	2/***m***	Monoklin Prismatisch
	m	***m***	Monoklin Domatisch
	2	2	Monoklin Sphenoid
Orthorhombisches System			
3 Klassen	2/***m***2 /***m***/***m***	***mmm***	Orthorhombisch Dipyramidal
	mm2	***mm***2	Orthorhombisch Pyramidal
	222	222	Orthorhombisch Disphenoid
Tetragonales System			
7 Klassen	4/***m***2/***m***2/***m***	4/***mmm***	Ditetragonal Dipyramidal
	4***mm***	4***mm***	Ditetragonal Pyramidal
	422	422	Tetragonal Trapezoedrisch
	4/***m***	4/***m***	Tetragonal Dipyramidal
	4	4	Tetragonal Pyramidal
	4-2 ***m***	4-2 ***m***	Tetragonal Skalenoedrisch
	-4	-4	Tetragonal Disphenoidisch
Hexagonales System:			
7 Klassen	6/***m***2/***m***2/***m***	6/***mmm***	Dihexagonal Dipyramidal
	6***mm***	6***mm***	Dihexagonal Pyramidal
	622	622	Hexagonal Trapezoedrisch
	6/***m***	6/***m***	Hexagonal Dipyramidal
	6	6	Hexagonal Pyramidal
	-6***m***2	-6***m***2	Ditrigonal Dipyramidal
	-6	-6	Trigonal Dipyramidal
Trigonales System:			
5 Klassen	-3 2***m***	-3***m***	Ditrigonal Skalenoedrisch
	3***m***	3***m***	Ditrigonal Pyramidal
	32	32	Trigonal Trapezoedrisch
	3	3	Trigonal Pyramidal
	-3	-3	Trigonal Rhomboedrisch
Kubisches System			
5 Klassen	4/***m***-3 2/***m***	***m***3***m***	Hexakisoktaedrisch
	432	432	Pentagonikositetraedrisch
	2/***m*** -3	***m***3	Disdodekaedrisch
	-4 3***m***	-4 3***m***	Hexakistetraedrisch
	23	23	Tetraedrisch Pentagondodekaedrisch

The 32 crystal classes

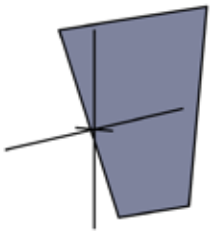
Amount of Classes	Symbol according Hermann-Mauguin		Crystal class
	complete	Abrev.	
Triclinic System			
2 Classes	1	1	Triclinic Pedial
	-1	-1	Triclinic Pinakoidal
Monoclinic System			
3 Classes	2/***m***	2/***m***	Monoclinic Prismatic
	m	***m***	Monoclinic Domatic
	2	2	Monoclinic Sphenoid
Orthorhombic System			
3 Classes	2/***m***2 /***m***/***m***	***mmm***	Orthorhombic Dipyramidal
	mm2	***mm***2	Orthorhombic Pyramidal
	222	222	Orthorhombic Disphenoid
Tetragonal System			
7 Classes	4/***m***2/***m***2/***m***	4/***mmm***	Ditetragonal Dipyramidal
	4***mm***	4***mm***	Ditetragonal Pyramidal
	422	422	Tetragonal Trapezoedric
	4/***m***	4/***m***	Tetragonal Dipyramidal
	4	4	Tetragonal Pyramidal
	4-2 ***m***	4-2 ***m***	Tetragonal Scalenoedric
	-4	-4	Tetragonal Disphenoidic
Hexagonal System:			
7 Classes	6/***m***2/***m***2/***m***	6/***mmm***	Dihexagonal Dipyramidal
	6***mm***	6***mm***	Dihexagonal Pyramidal
	622	622	Hexagonal Trapezoedric
	6/***m***	6/***m***	Hexagonal Dipyramidal
	6	6	Hexagonal Pyramidal
	-6***m***2	-6***m***2	Ditrigonal Dipyramidal
	-6	-6	Trigonal Dipyramidal
Trigonal System:			
5 Classes	-3 2***m***	-3***m***	Ditrigonal Scalenoedric
	3***m***	3***m***	Ditrigonal Pyramidal
	32	32	Trigonal Trapezoedric
	3	3	Trigonal Pyramidal
	-3	-3	Trigonal Rhomboedric
Cubic System			
5 Classes	4/***m***-3 2/***m***	***m***3***m***	Hexakisoktaedric
	432	432	Pentagonikositetraedric
	2/***m*** -3	***m***3	Disdodekaedric
	-4 3***m***	-4 3***m***	Hexakistetraedric
	23	23	Tetraedric Pentagondodekaedric

Triklines Kristallsystem

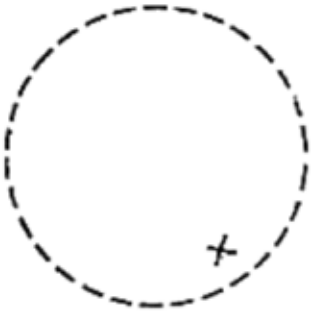
Trikline Hemiedrie
Triklin-pediale Klasse

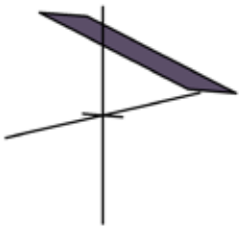
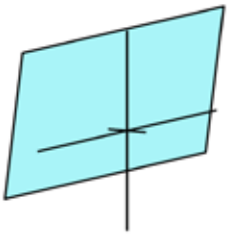
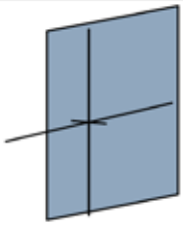
Symbol: 1 oder C_1

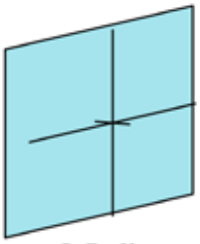
Allgemeine Form:
{hkl}



Pedien IV.St.



{0kl}	{h0l}	{hk0}
 Pedien I.St.	 Pedien II.St.	 Pedien III.St.

{100}	{010}	{001}
 I. Pedion	 II. Pedion	 III. Pedion

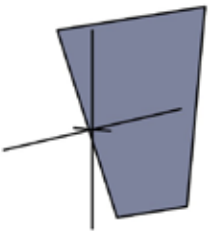
Mineral-Bsp.:
Sinnerite $Cu_6As_4S_9$
Hartite $C_{20}H_{34}$
Nekoite $Ca_3[Si_6O_{15}]*7H_2O$

Triclinic crystal system

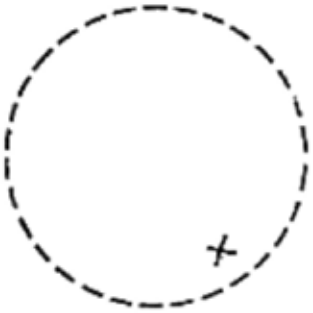
Triclinic hemiedry
Triclinic pedial class

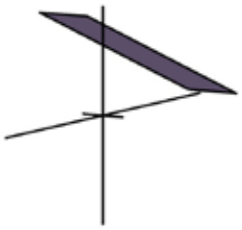
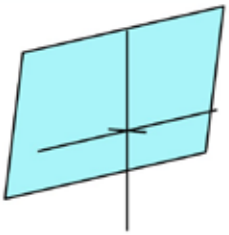
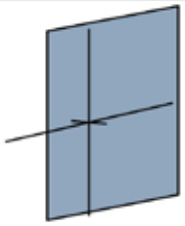
Symbol: 1 or C_1

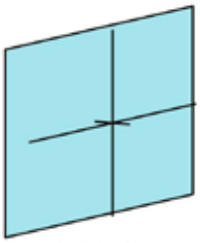
General form:
{hkl}



Pedien IV.pos.



{0kl}	{h0l}	{hk0}
 Pedien I.pos.	 Pedien II.pos.	 Pedien III.pos.

{100}	{010}	{001}
 I. Pedion	 II. Pedion	 III. Pedion

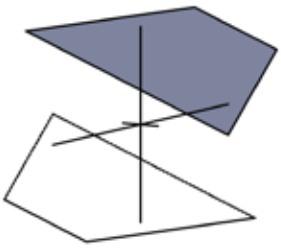
mineral examples:
Sinnerite $Cu_6As_4S_9$
Hartite $C_{20}H_{34}$
Nekoite $Ca_3[Si_6O_{15}]*7H_2O$

Triklines Kristallsystem

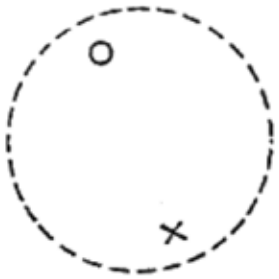
Trikline Holoedrie — Symbol: $\bar{1}$ oder C_i

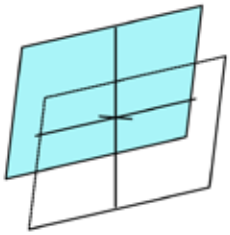
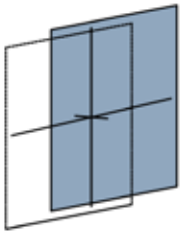
Triklin-pinakoidale Klasse

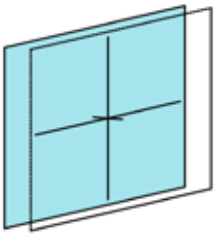
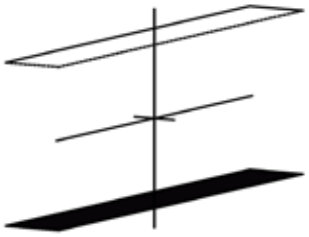
Allgemeine Form:
{hkl}



Pinakoide IV.St.



{0kl}	{h0l}	{hk0}
 Pinakoide I.St.	 Pinakoide II.St.	 Pinakoide III.St.

{100}	{010}	{001}
 I. Pinakoid	 II. Pinakoid	 III. Pinakoid

Mineral-Bsp.:

Albit $Na[AlSi_3O_8]$

Kyanit/Disthen $Al_2[O/SiO_4]$

Wollastonit $Ca[SiO_3]$

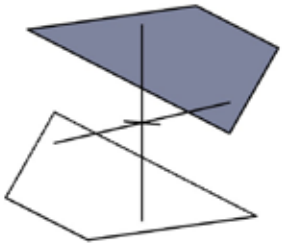
Axinit $Ca_2(Fe,Mn)Al_2[BO_3OH/Si_4O_{12})$

Triclinic crystal system

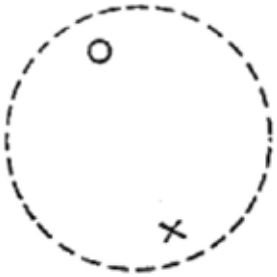
Triclinic holoedry Symbol: $\bar{1}$ or C_i

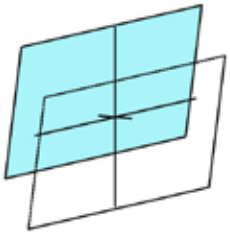
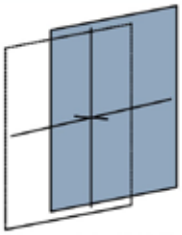
Triclinic pinacoidal class

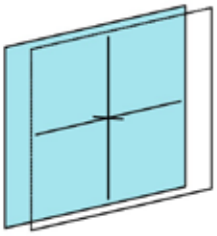
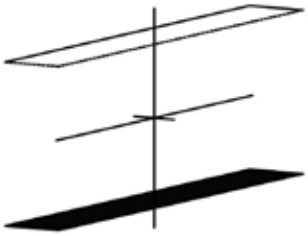
General form:
{hkl}



Pinacoid IV.pos.



{0kl}	{h0l}	{hk0}
 Pinacoid I.St.	 Pinacoid II.St.	 Pinacoide III.St.

{100}	{010}	{001}
 I. Pinacoid	 II. Pinacoid	 III. Pinacoid

mineral examples:

Albite $Na[AlSi_3O_8]$

Kyanite/Disthene $Al_2[O/SiO_4]$

Wollastonite $Ca[SiO_3]$

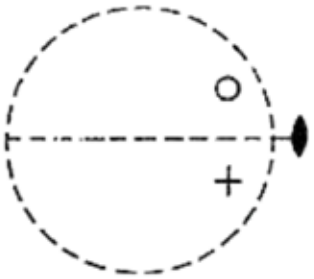
Axinite $Ca_2(Fe,Mn)Al_2[BO_3OH/Si_4O_{12})$

Monoklines Kristallsystem

Monokline Hemimorphie Symbol: 2 oder C_2
Monoklin-sphenoidische Klasse

Allgemeine Form:
{hkl}

Sphenoide IV.St.



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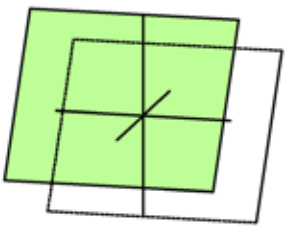
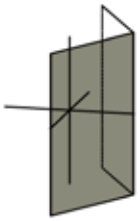
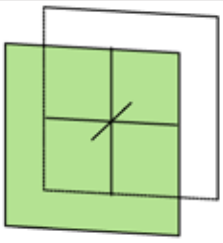
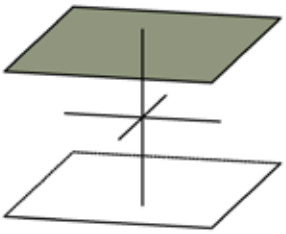
		
Sphenoide I.St.	Pinakoide II.St.	Sphenoide III.St.

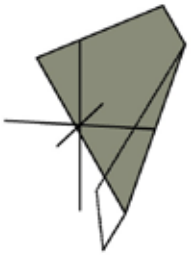
{100}	{010}	{001}
		
I. Pinakoid	II. Pedion	III. Pinakoid

Mineral-Bsp.:
(Rohr-/Kandis-)Zucker $C_{12}H_{22}O_{11}$
Weinsäure $C_4H_6O_6$
Latiumite $(Ca,K)_8(Al,Mg,Fe)[(Si,Al)_{10}O_{25}/(SO_4)]$

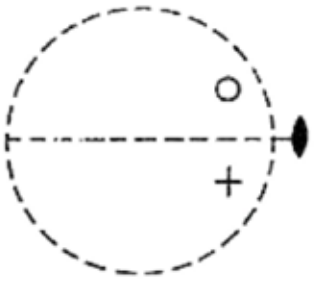
Monoclinic crystal system

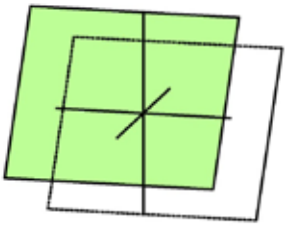
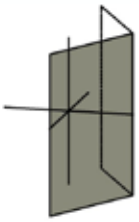
Monoclinic hemimorphy Symbol: 2 or C_2
Monoclinic sphenoidal class

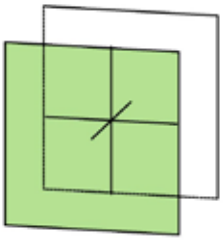
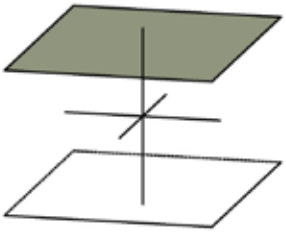
General form:
{hkl}



Sphenoid IV.pos.



{0kl}	{h0l}	{hk0}
 Sphenoid I.pos.	 Pinacoid II.pos.	 Sphenoid III.pos.

{100}	{010}	{001}
 I. Pinacoid	 II. Pedion	 III. Pinacoid

mineral examples:

(cane/candy)sugar $C_{12}H_{22}O_{11}$

Tartaric acid $C_4H_6O_6$

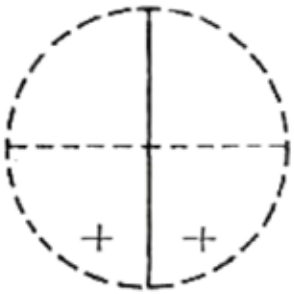
Latiumite $(Ca,K)_8(Al,Mg,Fe)[(Si,Al)_{10}O_{25}/(SO_4)]$

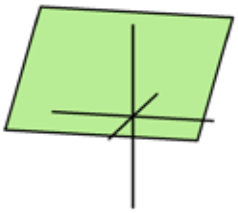
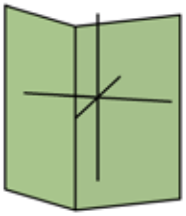
Monoklines Kristallsystem

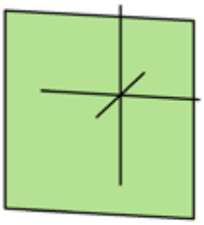
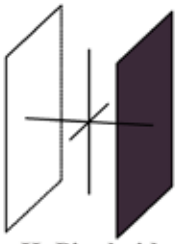
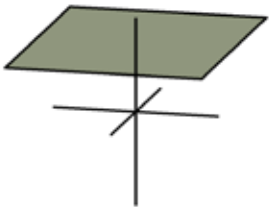
Monokline Hemiedrie II.Art Symbol: m oder C_s
Monoklin-domatische Klasse

Allgemeine Form:
{hkl}

Domen IV.St.



{0kl}	{h0l}	{hk0}
		
Domen I.St.	**Pedien II.St.**	**Domen III.St.**

{100}	{010}	{001}
		
I. Pedion	**II. Pinakoid**	**III. Pedion**

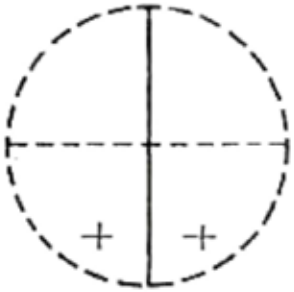
Mineral-Bsp.:
Posnjakite $Cu_4[(OH)_6/SO_4]*H_2O$
Hilgardit $Ca_2[Cl/B_5O_8(OH)_2]$
Skolezit $Ca[Al_2Si_3O_{10}]*3H_2O$

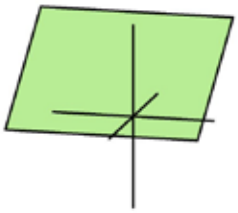
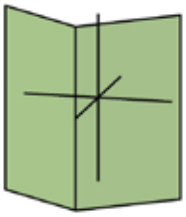
Monoclinic crystal system

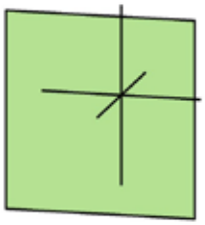
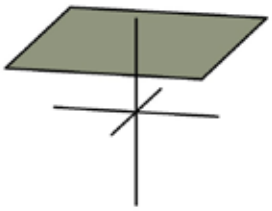
Monoclinic hemiedry II. type Symbol: m or C_s
Monoclinic domatic class

General form:
{hkl}

Domen IV.pos.



{0kl}	{h0l}	{hk0}
 Domen I.pos.	 Pedien II.pos.	 Domen III.pos.

{100}	{010}	{001}
 I. Pedion	 II. Pinacoid	 III. Pedion

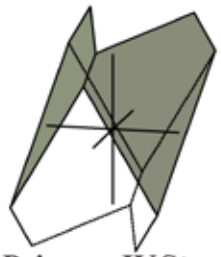
mineral examples:

Posnjakite $Cu_4[(OH)_6/SO_4]*H_2O$
Hilgardite $Ca_2[Cl/B_5O_8(OH)_2]$
Scolecite $Ca[Al_2Si_3O_{10}]*3H_2O$

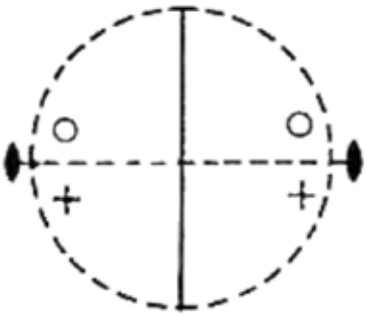
Monoklines Kristallsystem

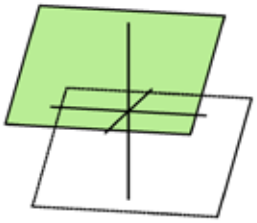
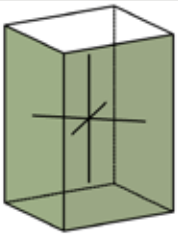
Monokline Holoedrie Symbol: 2/m oder C_{2h}
Monoklin-prismatische Klasse

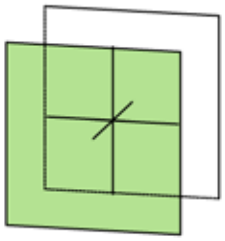
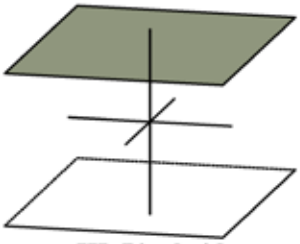
Allgemeine Form:
{hkl}



Prismen IV.St.



{0kl}	{h0l}	{hk0}
		
Prismen I.St.	Pinakoide II.St.	Prismen III.St.

{100}	{010}	{001}
		
I. Pinakoid	II. Pinakoid	III. Pinakoid

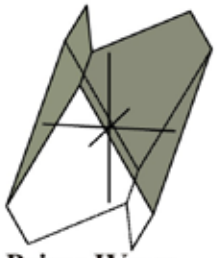
Mineral-Bsp.:

- häufigste Kristallklasse
- siehe Zusatzseite

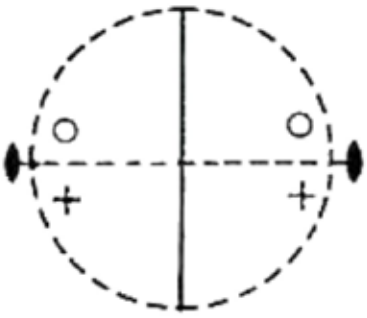
Monoclinic crystal system

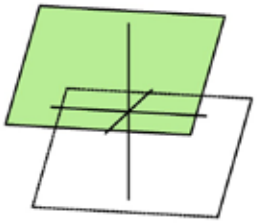
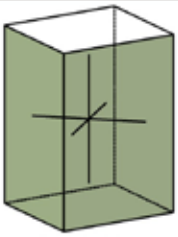
Monoclinic Holoedry Symbol: 2/m or C_{2h}
Monoclinic prismatic class

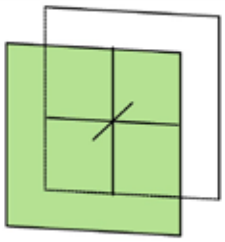
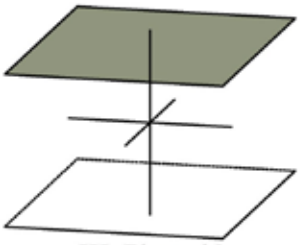
General form:
{hkl}



Prism IV.pos.



{0kl}	{h0l}	{hk0}
 Prism I.pos.	 Pinacoid II.pos.	 Prism III.pos.

{100}	{010}	{001}
 I. Pinacoid	 II. Pinacoid	 III. Pinacoid

mineral examples:

- most common crystal class
- see additional page

Mineral-Bsp. für 2/m: (häufigste Kristallklasse)

Gips $Ca[SO_4]*2H_2O$
Diopsid $Ca(Mg,Fe)[Si_2O_6]$
Orthoklas $K[AlSi_3O_8]$
Soda $Na_2[CO_3]*10H_2O$
Arsenopyrit FeAsS
Azurit $Cu_3[(CO_3)_2/(OH)_2]$
Biotit $K(Mg,Fe^{2+},Mn^{2+})_3[(OH,F)_2/(Al,Fe^{3+},Ti^{3+})Si_3O_{10}]$
Borax $Na_2[B_4O_5/(OH)_4]\cdot 8H_2O$
Chalkosin Cu_2S
Epidot $Ca_2(Fe,Al)_3[(Si_2O_7)/(SiO_4)_3/(OH)_2]$
Hornblende $Ca_2(Mg, Fe, Al)_5\ [(Al, Si)_8O_{22}/(OH)_2]$
Kryolith Na_3AlF_6
Malachit $Cu_2[(CO_3)/(OH)_2]$
Muskovit $KAl_2[Si_3AlO_{10}/(OH,F)_2]$
Phlogopit $KMg_3[Si_3AlO_{10}/(F,OH)_2]$
Realgar AsS
Sanidin $(K,Na)[Al_3SiO_8]$
Staurolith $(Fe^{2+},Mg,Zn)_2Al_9[(Si,Al)_4O_{22}/(OH)_2]$
Titanit $CaTi[O/SiO_4]$

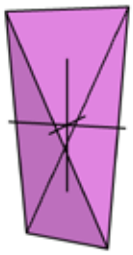
mineral examples for 2/m: (most common crystal class)

Gypsum $Ca[SO_4]*2H_2O$
Diopside $Ca(Mg,Fe)[Si_2O_6]$
Orthoclase $K[AlSi_3O_8]$
Soda $Na_2[CO_3]*10H_2O$
Arsenopyrite FeAsS
Azurite $Cu_3[(CO_3)_2/(OH)_2]$
Biotite $K(Mg,Fe^{2+},Mn^{2+})_3[(OH,F)_2/(Al,Fe^{3+},Ti^{3+})Si_3O_{10}]$
Borax $Na_2[B_4O_5/(OH)_4]\cdot 8H_2O$
Chalcocite Cu_2S
Epidote $Ca_2(Fe,Al)_3[(Si_2O_7)/(SiO_4)_3/(OH)_2]$
Hornblende $Ca_2(Mg, Fe, Al)_5\ [(Al, Si)_8O_{22}/(OH)_2]$
Cryolite Na_3AlF_6
Malachite $Cu_2[(CO_3)/(OH)_2]$
Muscovite $KAl_2[Si_3AlO_{10}/(OH,F)_2]$
Phlogopite $KMg_3[Si_3AlO_{10}/(F,OH)_2]$
Realgar AsS
Sanidine $(K,Na)[Al_3SiO_8]$
Staurolite $(Fe^{2+},Mg,Zn)_2Al_9[(Si,Al)_4O_{22}/(OH)_2]$
Titanite $CaTi[O/SiO_4]$

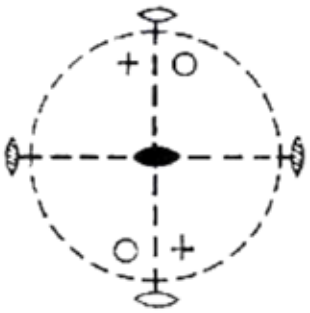
Orthorhombisches Kristallsystem

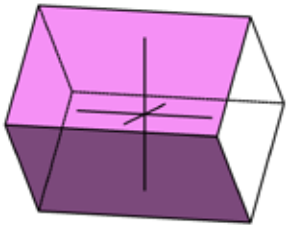
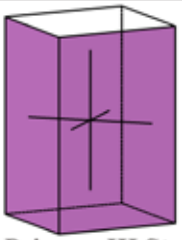
Rhombische Hemiedrie Symbol: 222 oder D_2
Rhombisch-disphenoidische Klasse

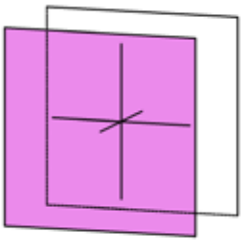
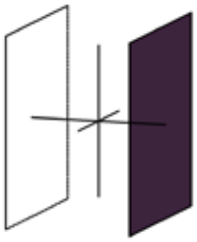
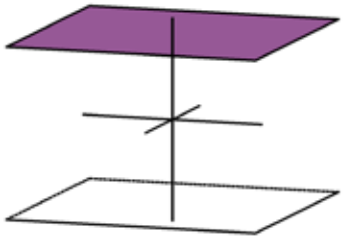
Allgemeine Form:
{hkl}



Rhombische Disphenoide



{0kl}	{h0l}	{hk0}
		
Prismen I.St.	**Prismen II.St.**	**Prismen III.St.**

{100}	{010}	{001}
		
I. Pinakoid	**II. Pinakoid**	**III. Pinakoid**

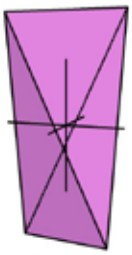
Mineral-Bsp.:
Epsomit (Bittersalz) $MgSO_4*7H_2O$
Zinkvitriol/Goslarit $ZnSO_4*7H_2O$
Austinit $CaZn[(AsO_4)/(OH)]$
Arsenoclasite $Mn_5[(AsO_4)_2/(OH)_4]$

Orthorhombic crystal system

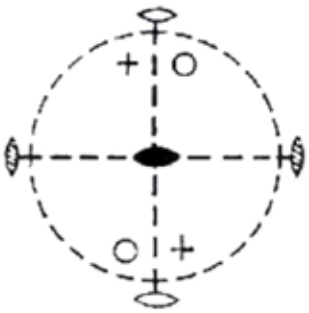
Rhombic hemiedry Symbol: 222 or D_2

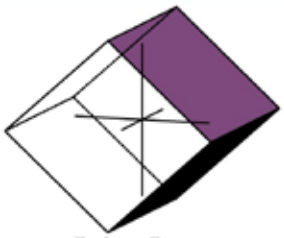
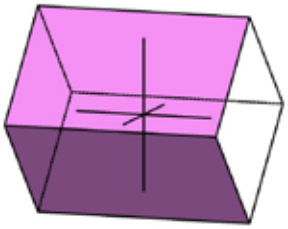
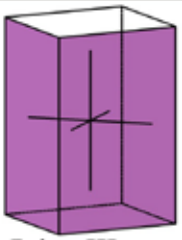
Rhombic-disphenoidal class

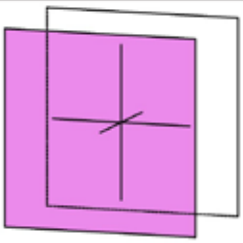
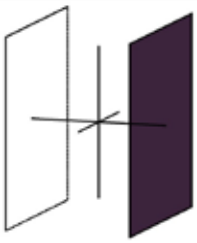
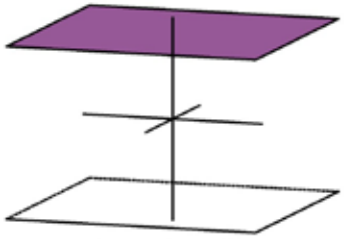
General form:
{hkl}



Rhombic disphenoids



{0kl}	{h0l}	{hk0}
 Prism I.pos.	 Prism II.pos.	 Prism III.pos.

{100}	{010}	{001}
 I. Pinacoid	 II. Pinacoid	 III. Pinacoid

mineral examples:

Epsomite (Epsom salt) $MgSO_4*7H_2O$

Zinc vitriol/ Goslarite $ZnSO_4*7H_2O$

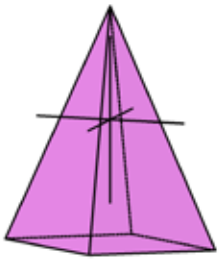
Austinite $CaZn[(AsO_4)/(OH)]$

Arsenoclasite $Mn_5[(AsO_4)_2/(OH)_4]$

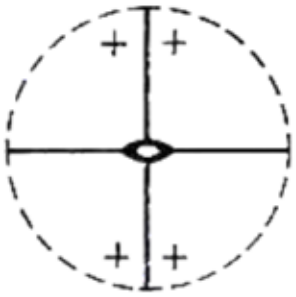
Orthorhombisches Kristallsystem

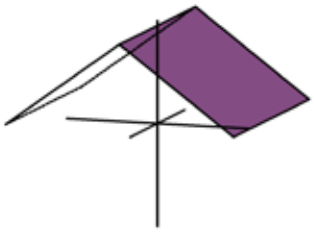
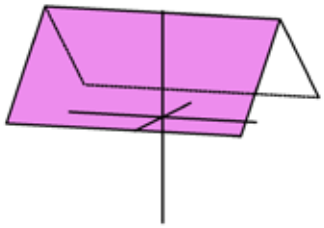
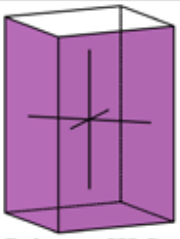
Rhombische Hemimorphie Symbol: mm2 oder C_{2v}
Rhombisch-pyramidale Klasse (mm)

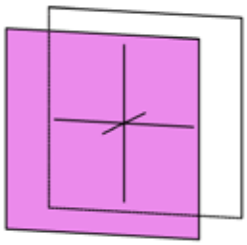
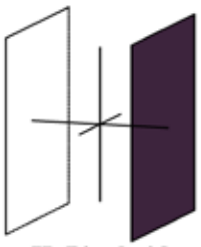
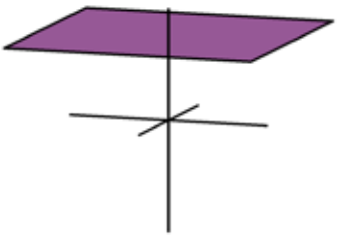
Allgemeine Form:
{hkl}



Rhombische Pyramiden



{0kl}	{h0l}	{hk0}
		
Domen I.St.	Domen II.St.	Prismen III.St.

{100}	{010}	{001}
		
I. Pinakoid	II. Pinakoid	III. Pedien

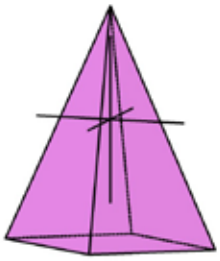
Mineral-Bsp.:
Hemimorphit/Kieselzinkerz $Zn_4[(OH)_2/Si_2O_7]*H_2O$
Struvit $MgNH_4[PO_4]*6H_2O$
Prehnit $Ca_2Al_2[Si_3O_{10}/(OH)_2]$

Orthorhombic crystal system

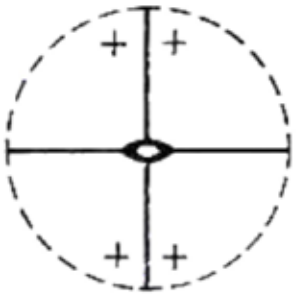
Rhombic Hemimorphy
Rhombic-pyramidal class

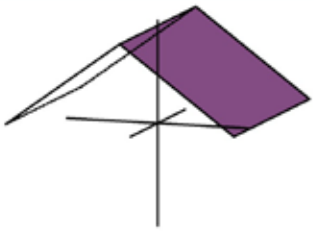
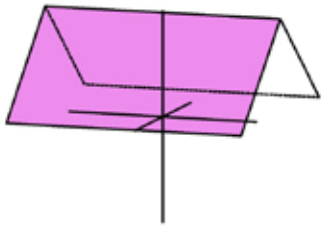
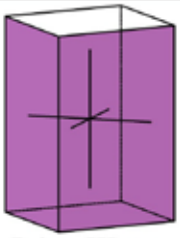
Symbol: mm2 or C_{2v}
(mm)

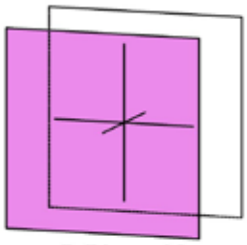
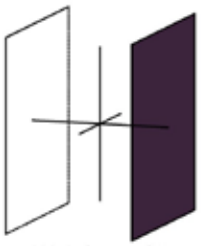
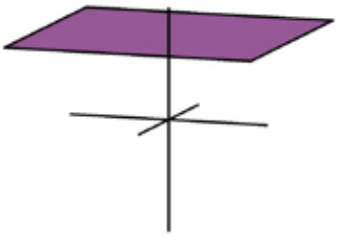
General form:
{hkl}



Rhombic pyramids



{0kl}	{h0l}	{hk0}
 Domen I.pos.	 Domen II.pos.	 Prism III.pos.

{100}	{010}	{001}
 I. Pinacoid	 II. Pinacoid	 III. Pedien

mineral examples:

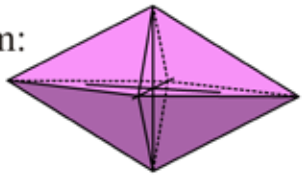
Hemimorphite/Kieselgalmey $Zn_4[(OH)_2/Si_2O_7]*H_2O$
Struvite $MgNH_4[PO_4]*6H_2O$
Prehnite $Ca_2Al_2[Si_3O_{10}/(OH)_2]$

Orthorhombisches Kristallsystem

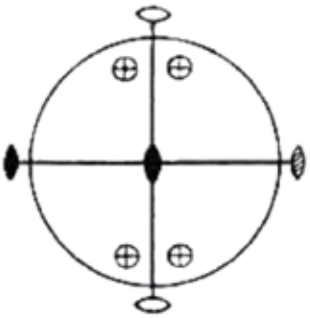
Rhombische Holoedrie
Rhombisch-dipyramidale Klasse

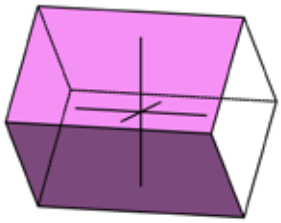
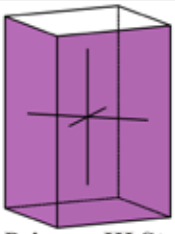
Symbol: 2/m 2/m 2/m
(mmm) oder D_{2h}

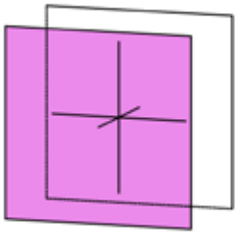
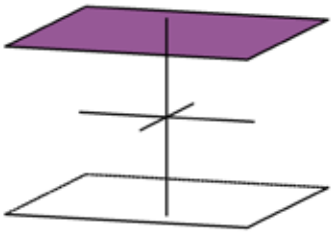
Allgemeine Form:
{hkl}



Rhombische Dipyramiden



{0kl}	{h0l}	{hk0}
		
Prismen I.St.	**Prismen II.St.**	**Prismen III.St.**

{100}	{010}	{001}
		
I. Pinakoid	**II. Pinakoid**	**III. Pinakoid**

Mineral-Bsp.:

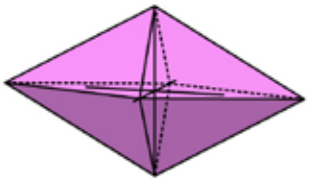
Schwefel S
Aragonit $Ca[CO_3]$
Anhydrit $Ca[SO_4]$
Baryt $Ba[SO_4]$
Topas $Al_2[F_2/SiO_4]$
Olivin $(Mg,Fe)_2[SiO_4]$

Orthorhombic crystal system

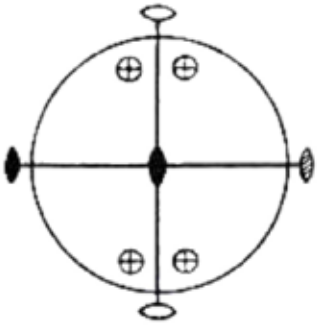
Rhombic Holoedry
Rhombic-bipyramidal class

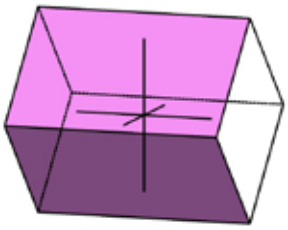
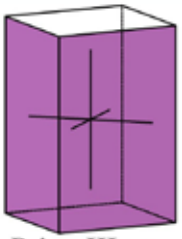
Symbol: 2/m 2/m 2/m
(mmm) or D_{2h}

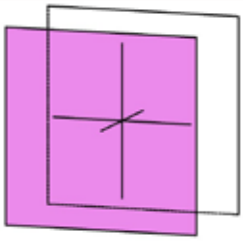
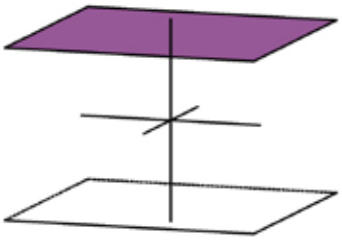
General form:
{hkl}



Rhombic bipyramid



{0kl}	{h0l}	{hk0}
 Prism I.pos.	 Prism II.pos.	 Prism III.pos.

{100}	{010}	{001}
 I. Pinacoid	 II. Pinacoid	 III. Pinacoid

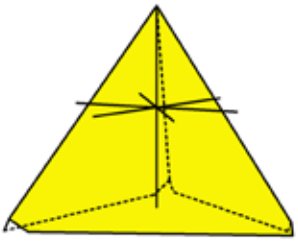
mineral examples:

Sulphur S
Aragonite $Ca[CO_3]$
Anhydrite $Ca[SO_4]$
Baryte $Ba[SO_4]$
Topaz $Al_2[F_2/SiO_4]$
Olivine $(Mg,Fe)_2[SiO_4]$

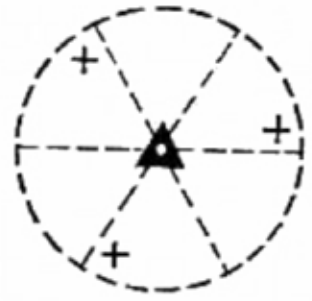
Trigonales Kristallsystem

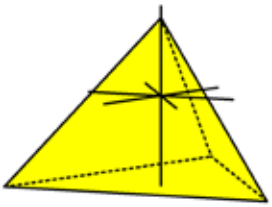
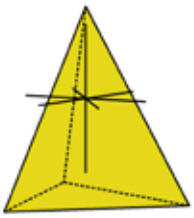
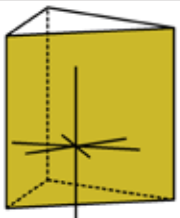
Hemimorphie d. trig. Tetartoedrie Symbol: 3 oder C_3
Trigonal-pyramidale Klasse

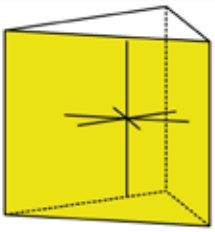
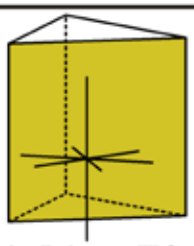
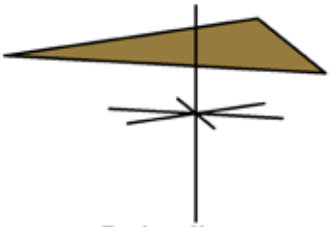
Allgemeine Form:
{hkl} / {hkil}



Trigonale Pyramiden III. St.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Trig. Pyramiden I.St.	**Trig. Pyramiden II.St.**	**Trig. Prismen III.St.**

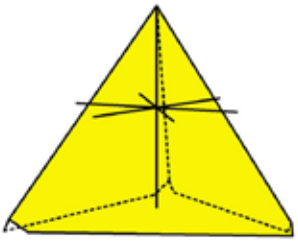
{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Trig. Prismen I.St.	**Trig. Prismen II.St.**	**Basispedien**

Mineral-Bsp.:
Susannite $Pb_4[(SO_4)/(CO_3)_2/(OH)_2]$
Carlinit TlS_2
Bleigermanat(Tieftemp.Modifikation) $Pb_5Ge_3O_{11}$

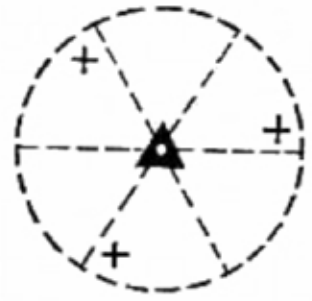
Trigonal crystal system

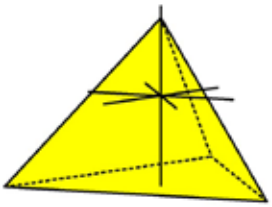
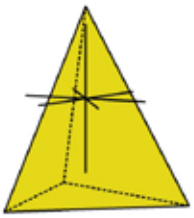
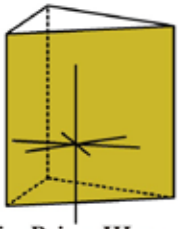
Hemimorphy of trig. Tetartoedry Symbol: 3 or C_3
Trigonal pyramidal class

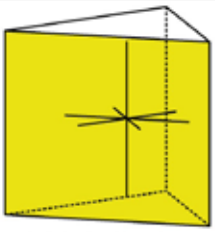
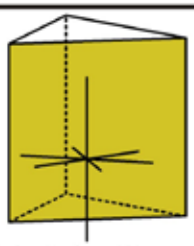
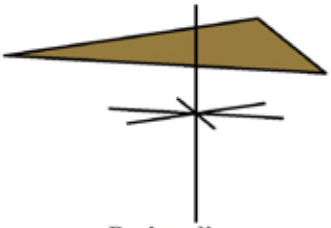
General form:
{hkl} / {hkil}



Trigonal pyramid III. pos.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
 Trig. Pyramid I.pos.	 Trig. Pyramid II.pos.	 Trig. Prism III.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
 Trig. Prism I.pos.	 Trig. Prism II.pos.	 Basispedia

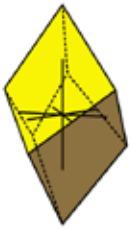
mineral examples:
Susannite $Pb_4[(SO_4)/(CO_3)_2/(OH)_2]$
Carlinite TlS_2
Lead germanate (low-temperature modification) $Pb_5Ge_3O_{11}$

Trigonales Kristallsystem

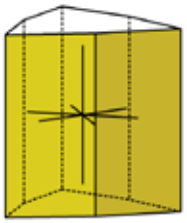
Hexagonal-trapezoedrische
Tetartoedrie
Trigonal-trapezoedrische Klasse

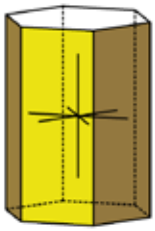
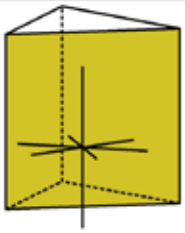
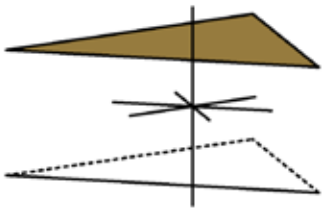
Symbol: 32 oder D_3

Allgemeine Form:
{hkl} / {hkil}



Trig. Trapezoeder

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Rhomboeder I.St.	Trig. Diyramiden II.St.	Ditrig. Prismen II.St.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex. Prisma I.St.	Trig. Prismen II.St.	Basispinakoid

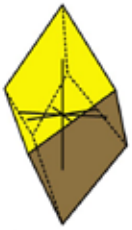
Mineral-Bsp.:
Zinnober/Cinnabarit HgS
Tiefquarz SiO_2
Selen Se
Tellur Te

Trigonal crystal system

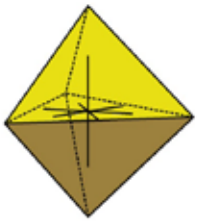
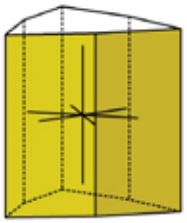
Hexagonal trapezohedral tetartoedry
Trigonal trapezohedral Class

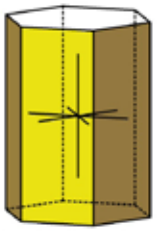
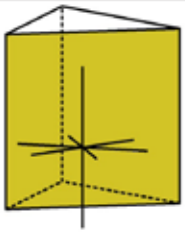
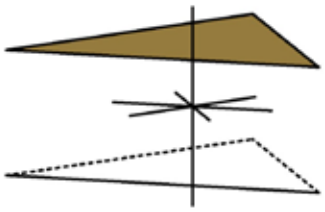
Symbol: 32 or D_3

General form:
{hkl} / {hkil}



Trig. Trapezohedron

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Rhombohedron I.pos.	Trig. Bipyramid II.pos.	Ditrig. Prism II.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex. Prism I.pos.	Trig. Prism II.pos.	Basispinacoid

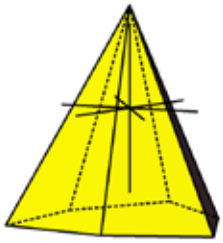
mineral examples:

Cinnabar HgS
Quartz SiO_2
Selenium Se
Tellurium Te

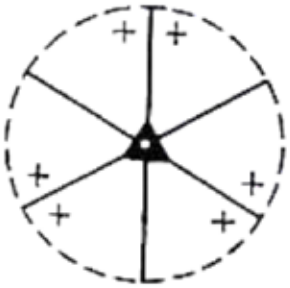
Trigonales Kristallsystem

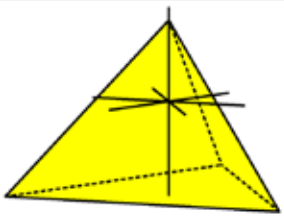
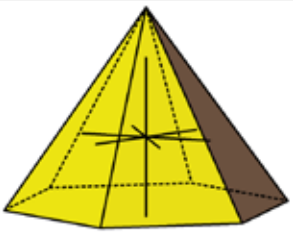
Hemimorphie d. rhomboedrischen
Hemiedrie — Symbol: 3m oder C_{3v}
Ditrigonal-pyramidale Klasse

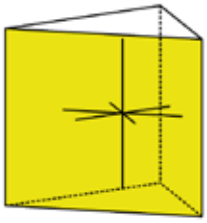
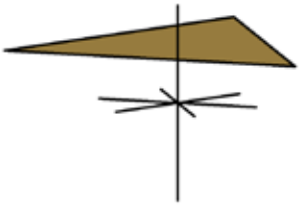
Allgemeine Form:
{hkl} / {hkil}



Ditrig. Pyramiden I.St.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Trig. Pyramiden I.St.	Hex. Pyramiden II.St.	Ditrig. Prismen II.St.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Trig. Prismen I.St.	Hex. Prisma II.St.	Basispedien

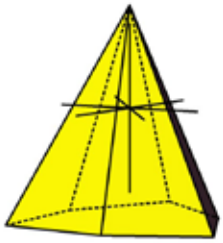
Mineral-Bsp.:
Turmalin $(X)(Y_3)(Z_6)[Si_6O_{18}/(BO_3)_3/(V_3)(W)]$
Proustit Ag_3AsS_3
Lithiumniobat $LiNbO_3$

Trigonal pyramidal class

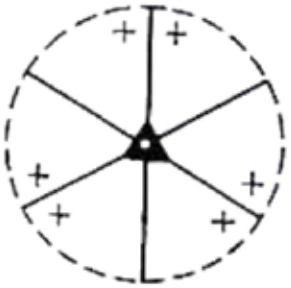
Hemimorphy of rhomboedric hemiedry
Ditrigonal-pyramidal class

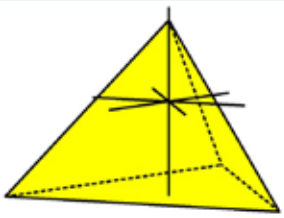
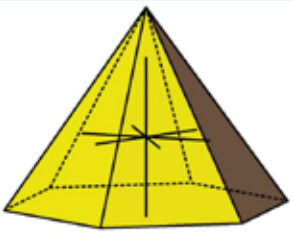
Symbol: 3m or C_{3v}

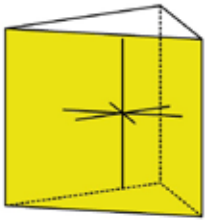
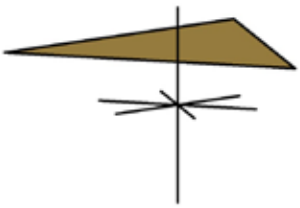
General form:
{hkl} / {hkil}



Ditrig. Pyramid I.pos.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Trig. Pyramid I.pos.	Hex. Pyramid II.pos.	Ditrig. Prism II.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Trig. Prism I.pos.	Hex. Prisma II.pos.	Basispedia

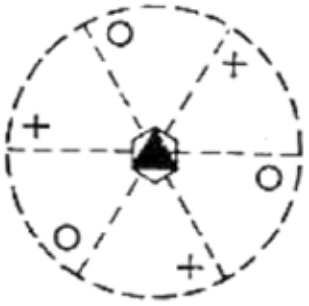
mineral examples:

Tourmaline $(X)(Y_3)(Z_6)[Si_6O_{18}/(BO_3)_3/(V_3)(W)]$
Proustite Ag_3AsS_3
Lithium niobate $LiNbO_3$

Trigonales Kristallsystem

Hexagonal-rhomboedrische
Tetartoedrie
Rhomboedrische Klasse

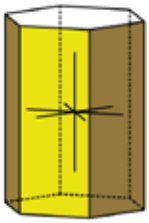
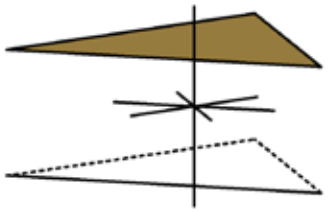
Symbol: $\bar{3}$ oder C_{3i}



Allgemeine Form:
{hkl} / {hkil}

Rhomboeder III.St.

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Rhomboeder I.St.	**Rhomboeder II.St.**	**Hex. Prismen II.St.**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex. Prisma I.St.	**Hex. Prisma II.St.**	**Basispinakoid**

Mineral-Bsp.:
Dolomit $CaMg[(CO_3)_2]$
Dioptas $Cu[Si_6O_{18}]$
Phenakit Be_2SiO_4

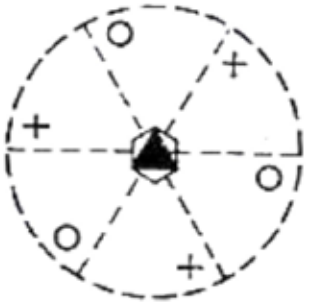
Trigonal crystal system

Hexagonal-rhomboedral
tetartoedry
Rhombohedral class

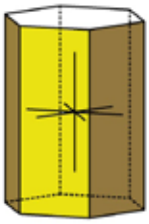
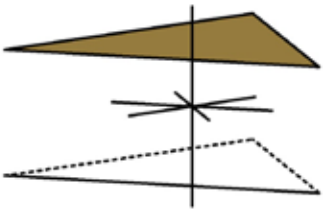
Symbol: $\bar{3}$ or C_{3i}

General form:
{hkl} / {hkil}

Rhombohedron III.pos.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Rhombohedron I.pos.	Rhombohedron II.pos.	Hex. Prism II.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex. Prism I.pos.	Hex. Prism II.pos.	Basispinacoid

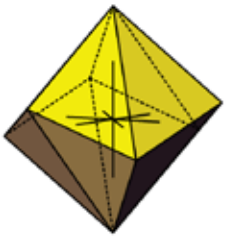
mineral examples:

Dolomite $CaMg[(CO_3)_2]$
Dioptase $Cu[Si_6O_{18}]$
Phenakite Be_2SiO_4

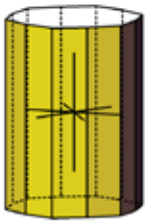
Trigonales Kristallsystem

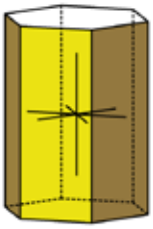
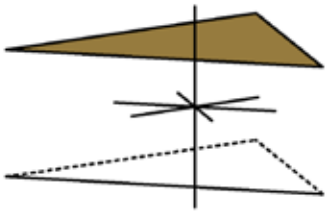
Hexagonal-rhomboedrische
Hemiedrie — Symbol: $\bar{3}$ 2/m oder D_{3d} ($\bar{3}$m)
Ditrigonal-skalenoedrische Klasse

Allgemeine Form:
{hkl} / {hkil}



Ditrig. Skalenoeder

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Rhomboeder I.St.	Hex. Dipyramiden II.St.	Dihex. Prismen

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex. Prisma I.St.	Hex. Prisma II.St.	Basispinakoid

Mineral-Bsp.:

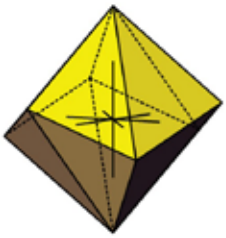
Calcit $CaCO_3$ — Siderit $FeCO_3$
Korund Al_2O_3 — Rhodochrosit $MnCO_3$
Hämatit Fe_2O_3

Trigonal crystal system

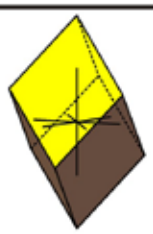
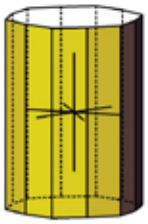
Hexagonal-rhombohedral
hemiedry
Ditrigonal-scalenohedral class

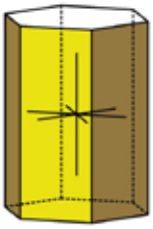
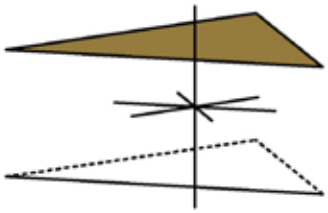
Symbol: $\bar{3}$ 2/m or D_{3d}
($\bar{3}$m)

General form:
{hkl} / {hkil}



Ditrig. Scalenohedron

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Rhombohedron I.pos.	Hex. Dipyramid II.pos.	Dihex. Prism

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex. Prism I.pos.	Hex. Prisma II.pos.	Basispinacoid

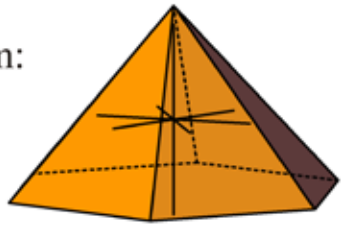
mineral examples:

Calcite $CaCO_3$ Siderite $FeCO_3$
Corundum Al_2O_3 Rhodochrosite $MnCO_3$
Hematite Fe_2O_3

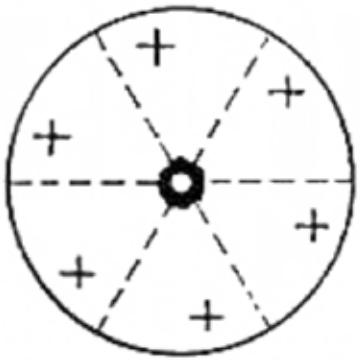
Hexagonales Kristallsystem

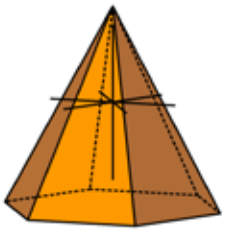
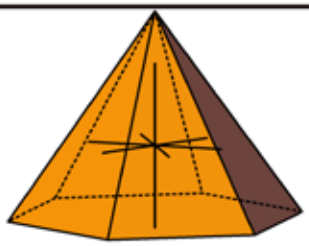
Hexagonale Tetartoedrie Symbol: 6 oder C_6
Hexagonal-pyramidale Klasse

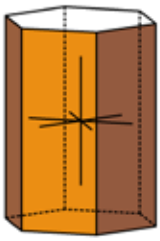
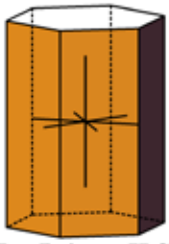
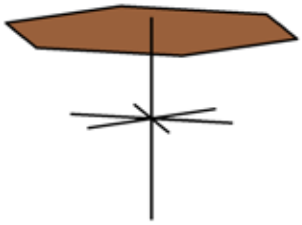
Allgemeine Form:
{hkl} / {hkil}



Hexagonale Pyramiden III. St.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Hex.Pyramiden I.St.	**Hex. Pyramiden II.St.**	**Hex.Prismen III.St.**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prisma I.St.	**Hex.Prisma II.St.**	**Basispedien**

Mineral-Bsp.:

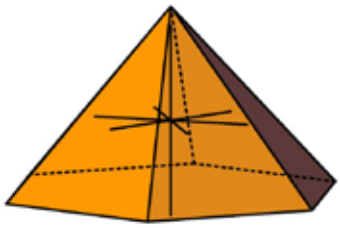
Lithiumiodat α-$LiIO_3$
Nephelin $(Na,K)[AlSiO_4]$
Thaumasit $Ca_3[SO_4/CO_3/Si(OH)_6]*12H_2O$

Hexagonal crystal system

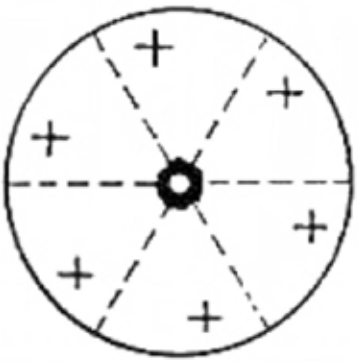
Hexagonal tetartoedry
Hexagonal-pyramidal class

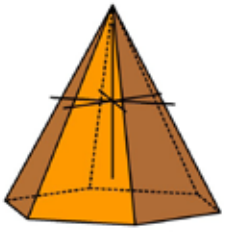
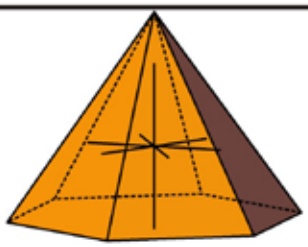
Symbol: 6 or C_6

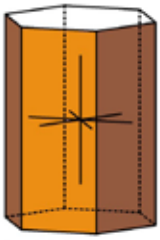
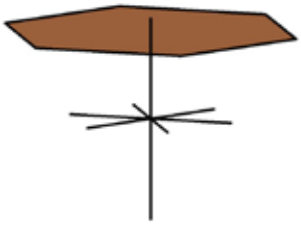
General form:
{hkl} / {hkil}



Hexagonale Pyramiden III. St.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
 Hex.Pyramid I.pos.	 Hex. Pyramid II.pos.	 Hex.Prism III.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
 Hex.Prism I.pos.	 Hex.Prism II.pos.	 Basispedia

mineral examples:

Lithium iodate α-$LiIO_3$
Nepheline $(Na,K)[AlSiO_4]$
Thaumasite $Ca_3[SO_4/CO_3/Si(OH)_6]*12H_2O$

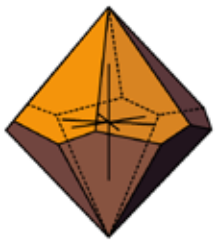
Hexagonales Kristallsystem

Hexagonal-trapezoedrische
Hemiedrie
Hexagonal-trapezoedrische Klasse

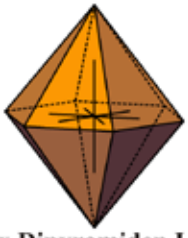
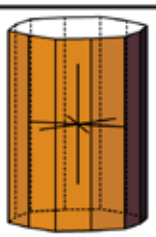
Symbol: 622 oder D_6

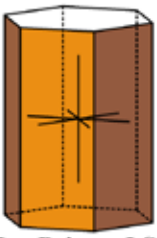
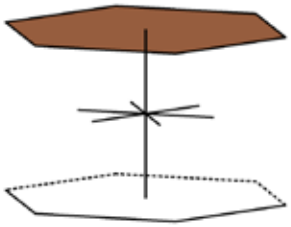
(6 2)

Allgemeine Form:
{hkl} / {hkil}



Hexagonaler Trapezoeder

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Hex.Dipyramiden I.St.	**Hex. Dipyramiden II.St.**	**Dihex. Prismen**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prisma I.St.	**Hex. Prisma II.St.**	**Basispinakoid**

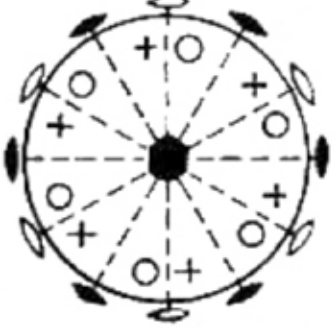
Mineral-Bsp.:
Hochquarz SiO_2
Virgilit $LiAlSi_2O_6$
Rhabdophan $(Ce,La)PO_4*H_2O$

Hexagonal crystal system

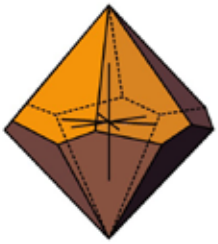
Hexagonal- trapezohedral hemiedry
Hexagonal-trapezohedral Class

Symbol: 622 or D_6

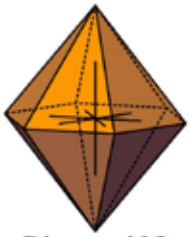
(6 2)

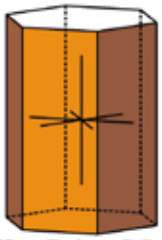
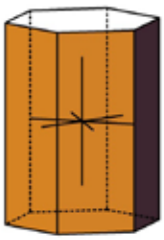
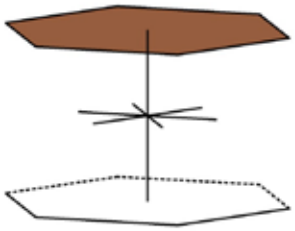


General form:
{hkl} / {hkil}



Hexagonal Trapezohedron

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Hex.Dipyramid I.pos.	**Hex. Dipyramid II.pos.**	**Dihex. Prism**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prism I.St.	**Hex. Prism II.pos.**	**Basispinacoid**

mineral examples:

Quartz-beta SiO_2

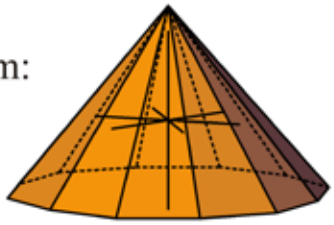
Virgilite $LiAlSi_2O_6$

Rhabdophane $(Ce,La)PO_4*H_2O$

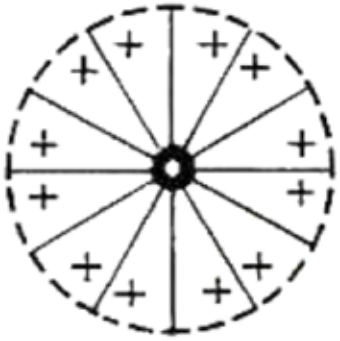
Hexagonales Kristallsystem

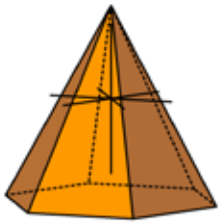
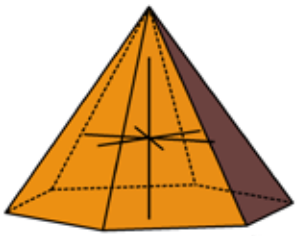
Hexagonale Hemimorphie Symbol: 6mm oder C_{6v}
Dihexagonal-pyramidale Klasse

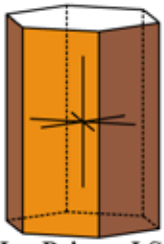
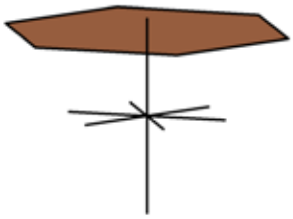
Allgemeine Form:
{hkl} / {hkil}



Dihexagonale Pyramide



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Hex.Pyramiden I.St.	**Hex. Pyramiden II.St.**	**Dihex.Prismen**

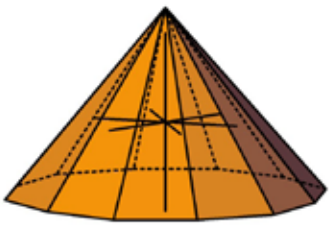
{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prisma I.St.	**Hex.Prisma II.St.**	**Basispedien**

Mineral-Bsp.:
Wurzit ZnS
Zinkit ZnO
Greenockit CdS

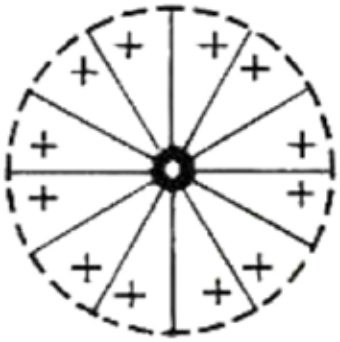
Hexagonal crystal system

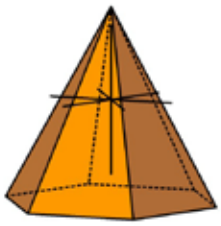
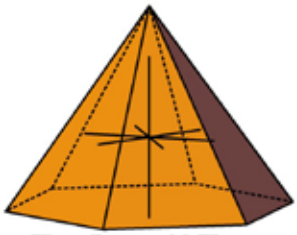
Hexagonal Hemimorphy Symbol: 6mm or C_{6v}
Dihexagonal-pyramidal class

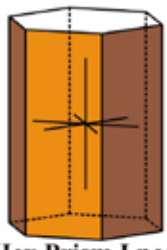
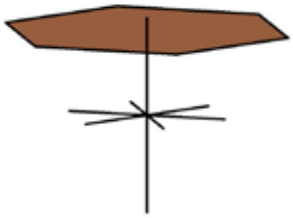
General form:
{hkl} / {hkil}



Dihexagonal Pyramid



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
 Hex.Pyramid I.pos.	 Hex. Pyramid II.pos.	 Dihex.Prism

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
 Hex.Prism I.pos.	 Hex.Prism II.pos.	 Basispedia

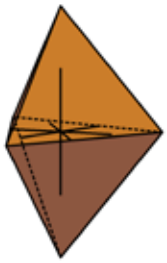
mineral examples:
Wurzite ZnS
Zincite ZnO
Greenockite CdS

Hexagonales Kristallsystem

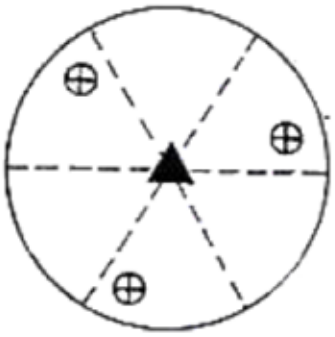
Trigonale Tetartoedrie — Symbol: $\bar{6}$ oder C_{3h}

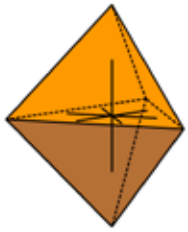
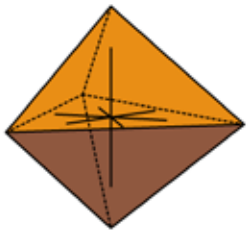
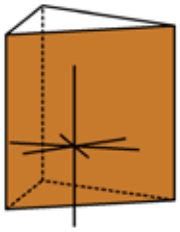
Trigonal-dipyramidale Klasse

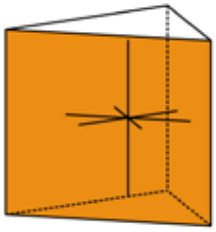
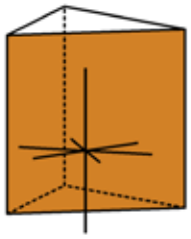
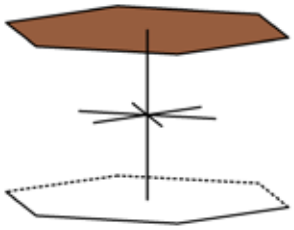
Allgemeine Form:
{hkl} / {hkil}



Trig. Dipyramiden III.St.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Trig. Dipyramiden I.St.	**Trig. Dipyramiden II.St.**	**Trig.Prismen III.St.**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Trig.Prismen I.St.	**Trig.Prismen II.St.**	**Basispinakoid**

Mineral-Bsp.:

Bleigermanat(Hochtemp.Modifikation) $Pb_5[Ge_3O_{11}]$

Penfieldit $Pb_2[Cl_3/OH]$

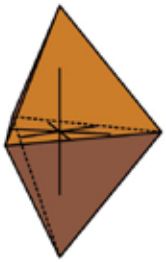
Ganomalit $Pb_9Ca_5Mn[(Si_2O_7)_3/(SiO_4)_3]$

Hexagonal crystal system

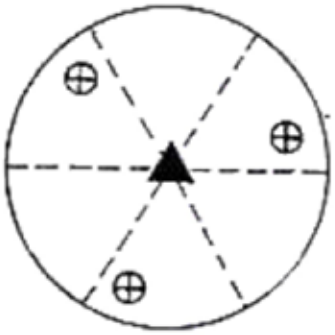
Trigonal tetartoedry
Trigonal-dipyramidal classe

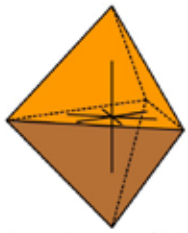
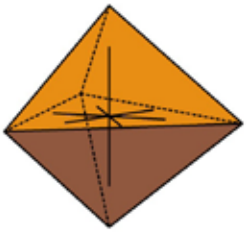
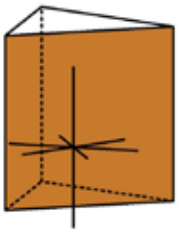
Symbol: $\bar{6}$ or C_{3h}

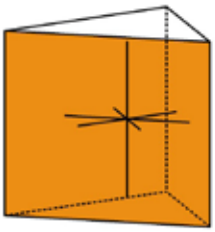
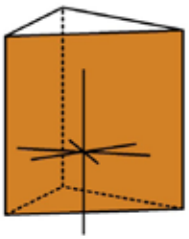
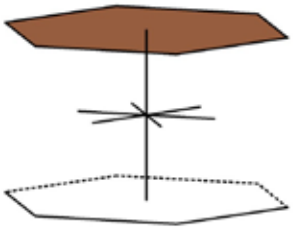
General form:
{hkl} / {hkil}



Trig. Dipyramid III.pos.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Trig. Dipyramid I.pos.	Trig. Dipyramid II.pos.	Trig.Prism III.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Trig.Prism I.pos.	Trig.Prism II.pos.	Basispinacoid

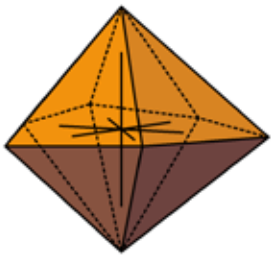
mineral examples:

Lead germanate (Hightemp. Modification) $Pb_5[Ge_3O_{11}]$
Penfieldite $Pb_2[Cl_3/OH]$
Ganomalite $Pb_9Ca_5Mn[(Si_2O_7)_3/(SiO_4)_3]$

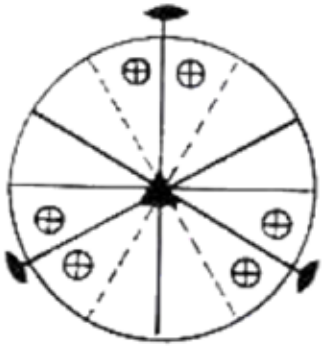
Hexagonales Kristallsystem

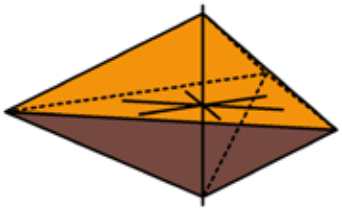
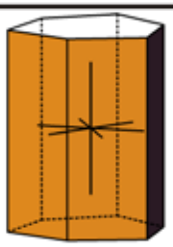
Trigonale Hemiedrie Symbol: $\bar{6}2m$ oder D_{3h}
Ditrigonal-dipyramidale Klasse

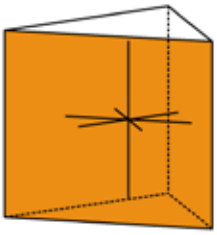
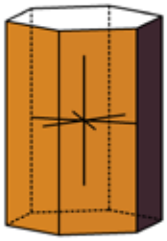
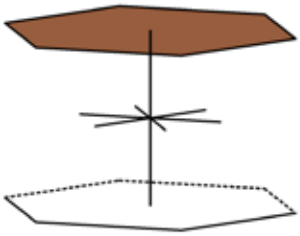
Allgemeine Form:
{hkl} / {hkil}



Ditrig. Dipyramiden



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Trig. Dipyramiden I.St.	**Hex. Dipyramiden II.St.**	**Ditrig.Prismen III.St.**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Trig.Prismen I.St.	**Hex.Prismen II.St.**	**Basispinakoid**

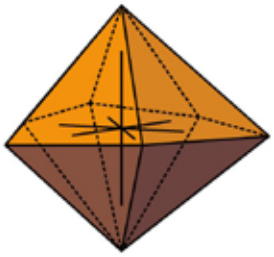
Mineral-Bsp.:
Benitoit $BaTi[Si_3O_9]$
Belkovit $Ba_3(Nb,Ti)_6(Si_2O_7)_2O_{12}$

Hexagonal crystal system

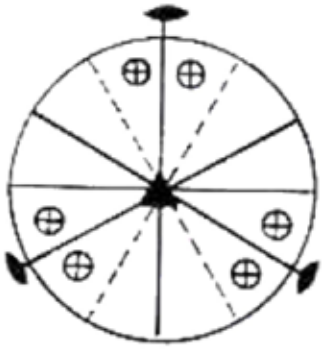
Trigonal Hemiedry Symbol: $\bar{6}2m$ or D_{3h}

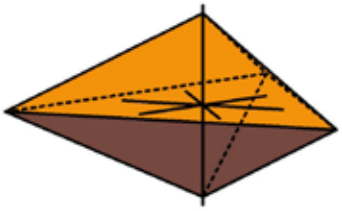
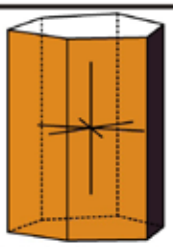
Ditrigonal-dipyramidal class

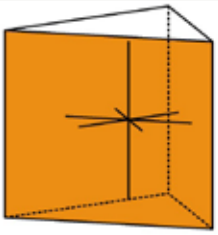
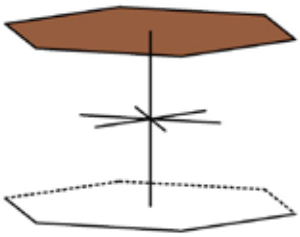
General form:
{hkl} / {hkil}



Ditrig. Dipyramid



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2}$hl}	{hk0} / {hki0}
		
Trig. Dipyramid I.pos.	Hex. Dipyramid II.pos.	Ditrig.Prism III.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Trig.Prism I.pos.	Hex.Prism II.pos.	Basispinacoid

mineral examples:

Benitoite $BaTi[Si_3O_9]$

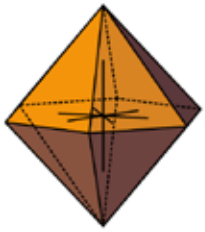
Belkovite $Ba_3(Nb,Ti)_6(Si_2O_7)_2O_{12}$

Hexagonales Kristallsystem

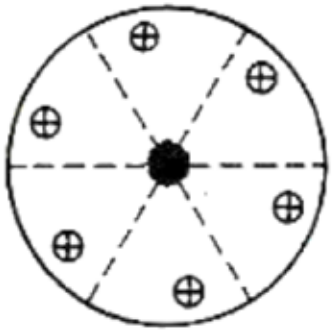
Hexagonal-pyramidale
Hemiedrie
Hexagonal-dipyramidale Klasse

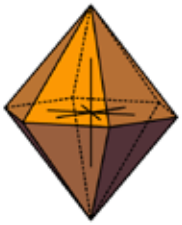
Symbol: 6/m oder C_{6v}

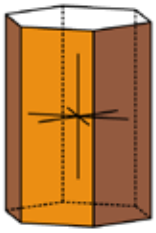
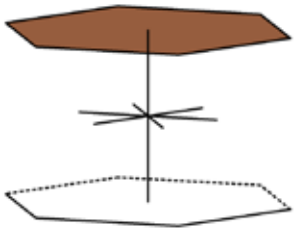
Allgemeine Form:
{hkl} / {hkil}



Hexagonale Dipyramide III.St.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh2$\bar{h}$l}	{hk0} / {hki0}
		
Hex.Dipyramiden I.St.	**Hex. Dipyramiden II.St.**	**Hex.Prismen III.St.**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prisma I.St.	**Hex.Prisma II.St.**	**Basispinakoid**

Mineral-Bsp.:

Apatit $(Ca,Ba,Pb,Sr,etc.)_5[(PO_4,CO_3)_3/(F,Cl,OH)]$

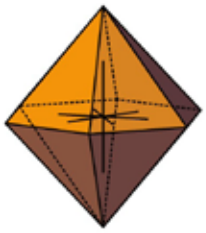
Pyromorphit $Pb_5[(PO_4)_3/Cl]$

Vanadinit $Pb_5[(VO_4)_3/Cl]$

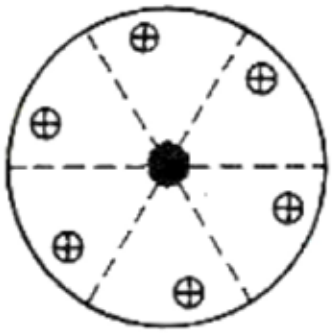
Hexagonal crystal system

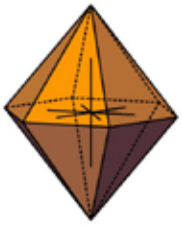
Hexagonal-pyramidal Hemiedry
Hexagonal-dipyramidal class Symbol: 6/m or C_{6v}

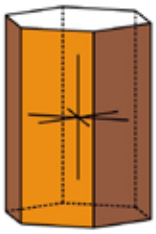
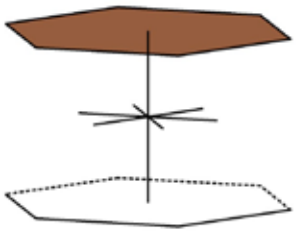
General form:
{hkl} / {hkil}



Hexagonal Dipyramid III.pos.



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Hex.Dipyramid I.pos.	Hex. Dipyramid II.pos.	Hex.Prism III.pos.

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prism I.pos.	Hex.Prism II.pos.	Basispinacoid

mineral examples:

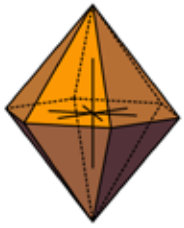
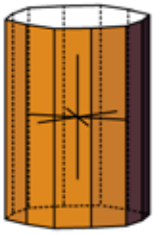
Apatite $(Ca,Ba,Pb,Sr,etc.)_5[(PO_4,CO_3)_3/(F,Cl,OH)]$
Pyromorphite $Pb_5[(PO_4)_3/Cl]$
Vanadinite $Pb_5[(VO_4)_3/Cl]$

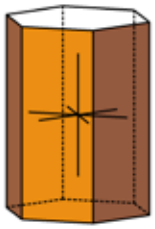
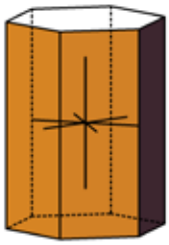
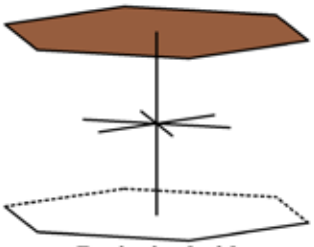
Hexagonales Kristallsystem

Hexagonale Holoedrie Symbol: 6/mmm oder D_{6h}
Dihexagonal-dipyramidale Klasse (6/m 2/m 2/m)

Allgemeine Form:
{hkl} / {hkil}

Dihexagonale Dipyramiden

{h0l} / {h0$\bar{h}$l}	{hhl} / {hh2$\bar{h}$l}	{hk0} / {hki0}
		
Hex.Dipyramiden I.St.	**Hex.Dipyramiden II.St.**	**Dihex.Prismen**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prisma I.St.	**Hex.Prisma II.St.**	**Basispinakoid**

Mineral-Bsp.:

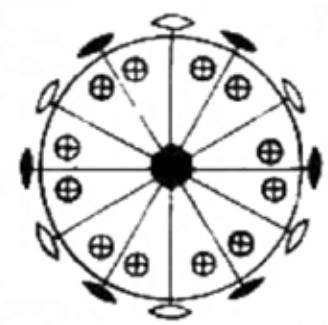
Beryll $Be_3Al_2[Si_6O_{18}]$ Covellin CuS
Graphit C Eis H_2O
Hochtridymit SiO_2

Hexagonal crystal system

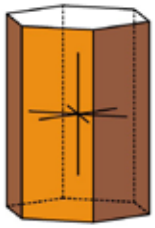
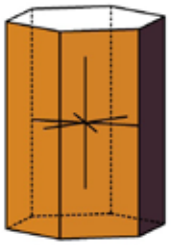
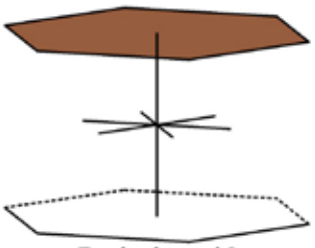
Hexagonal holoedry Symbol: 6/mmm or D_{6h}
Dihexagonal-dipyramidal class (6/m 2/m 2/m)

General form:
{hkl} / {hkil}

Dihexagonal Dipyramid



{h0l} / {h0$\bar{h}$l}	{hhl} / {hh$\bar{2h}$l}	{hk0} / {hki0}
		
Hex.Dipyramid I.pos.	**Hex.Dipyramid II.pos.**	**Dihex.Prism**

{100} / {10$\bar{1}$0}	{110} / {11$\bar{2}$0}	{001} / {0001}
		
Hex.Prism I.pos.	**Hex.Prism II.pos.**	**Basispinacoid**

mineral examples:

Beryl $Be_3Al_2[Si_6O_{18}]$
Graphite C
High tridymite SiO_2
Covellite CuS
Ice H_2O

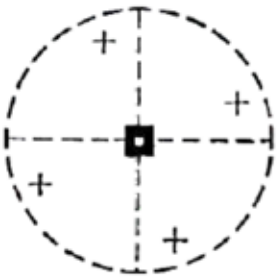
Tetragonales Kristallsystem

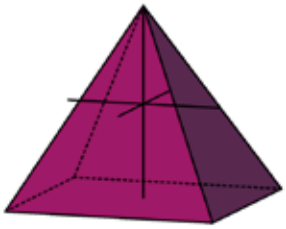
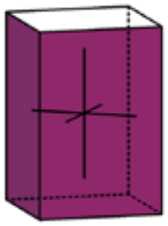
Hemimorphie d. tetragonal-pyramidalen Hemiedrie
Tetragonal-pyramidale Klasse

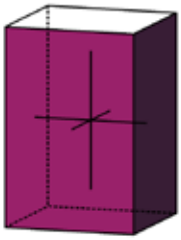
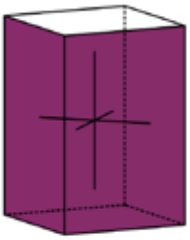
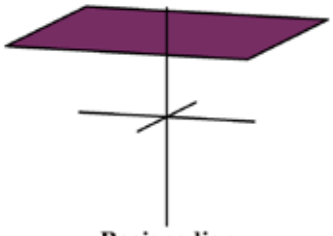
Symbol: 4 oder C_4

Allgemeine Form:
{hkl}

Tetrag. Pyramiden III.St.



{h0l}	{hhl}	{hk0}
 Tetrag.Pyramiden II.St.	 Tetrag.Pyramiden I.St.	 Tetrag. Prismen III.St.

{100}	{110}	{001}
 Tetrag.Prisma II.St.	 Tetrag.Prisma I.St.	 Basispedien

Mineral-Bsp.:
Piypite $K_2Cu_2[O/(SO_4)_2]$
Pinnoite $Mg[B_2O_4]*3H_2O$
Percleveite-(Ce) $(Ce,La,Nd)_2[Si_2O_7]$

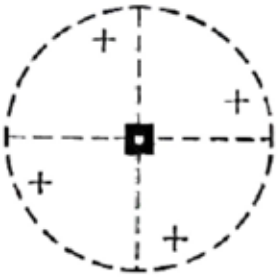
Tetragonal crystal system

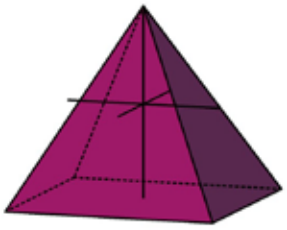
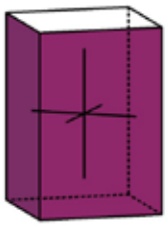
Hemimorphy of tetragonal - pyramidal hemiedry
Tetragonal-pyramidal class

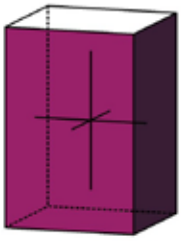
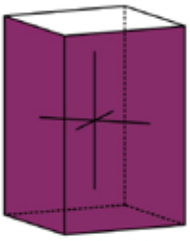
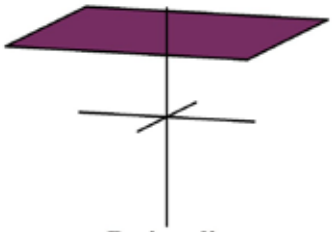
Symbol: 4 or C_4

General form:
{hkl}

Tetrag. Pyramid III.pos.



{h0l}	{hhl}	{hk0}
		
Tetrag.Pyramid II.pos.	Tetrag.Pyramid I.pos.	Tetrag. Prism III.pos.

{100}	{110}	{001}
		
Tetrag.Prism II.pos.	Tetrag.Prism I.pos.	Basispedia

mineral examples:

Piypite $K_2Cu_2[O/(SO_4)_2]$
Pinnoite $Mg[B_2O_4]*3H_2O$
Percleveite-(Ce) $(Ce,La,Nd)_2[Si_2O_7]$

Tetragonales Kristallsystem

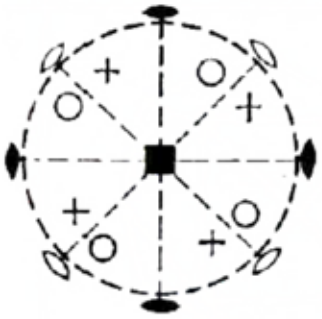
Tetragonal-trapezoedrische Hemiedrie

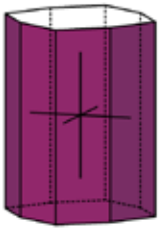
Symbol: 422 oder D_4

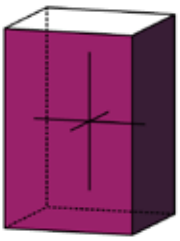
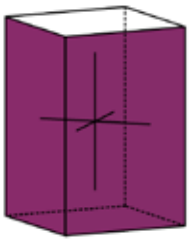
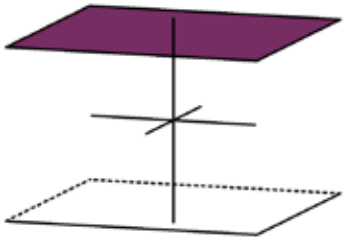
Tetragonal-trapezoedrische Klasse

Allgemeine Form: {hkl}

Tetrag. Trapezoeder



{h0l}	{hhl}	{hk0}
		
Tetrag.Dipyramiden II.St.	Tetrag.Dipyramiden I.St.	Ditetrag. Prismen

{100}	{110}	{001}
		
Tetrag.Prisma II.St.	Tetrag.Prisma I.St.	Basispinakoid

Mineral-Bsp.:

Retgersit $Ni[SO_4]*6H_2O$

Maucherit $Ni_{11}As_8$

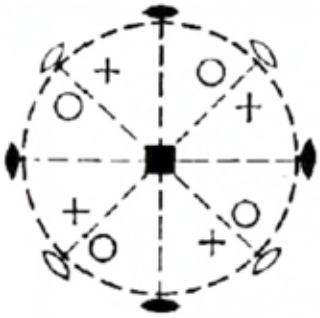
Cristobalit SiO_2

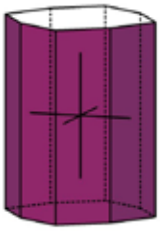
Tetragonal crystal system

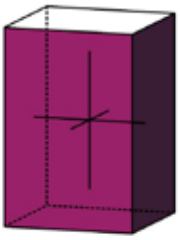
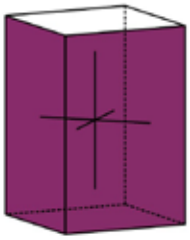
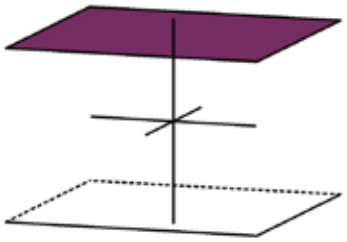
Tetragonal-trapezohedral hemiedry
Tetragonal-trapezohedral class Symbol: 422 or D_4

General form:
{hkl}

Tetrag. Trapezohedron



{h0l}	{hhl}	{hk0}
		
Tetrag.Dipyramid II.pos.	Tetrag.Dipyramid I.pos.	Ditetrag. Prism

{100}	{110}	{001}
		
Tetrag.Prism II.pos.	Tetrag.Prism I.pos.	Basispinacoid

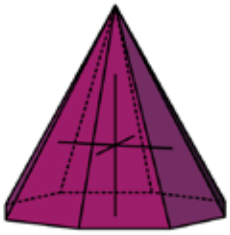
mineral examples:
Retgersite $Ni[SO_4]*6H_2O$
Maucherite $Ni_{11}As_8$
Cristobalite SiO_2

Tetragonales Kristallsystem

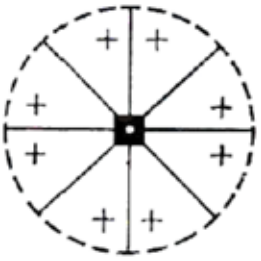
Hemimorphie d. tetragonalen
Holoedrie
Ditetragonal-pyramidale Klasse

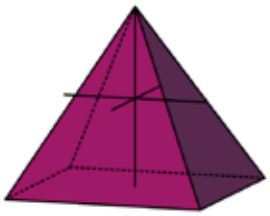
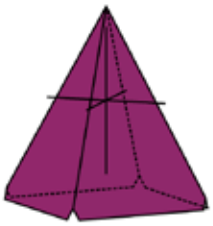
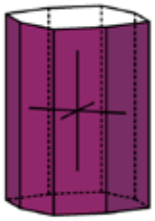
Symbol: 4mm oder C_{4v}

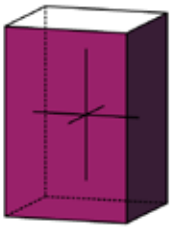
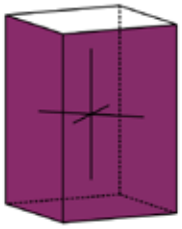
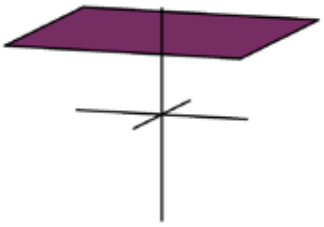
Allgemeine Form:
{hkl}



Ditetrag. Pyramiden



{h0l}	{hhl}	{hk0}
		
Tetrag.Pyramiden II.St.	**Tetrag.Pyramiden I.St.**	**Ditetrag. Prismen**

{100}	{110}	{001}
		
Tetrag.Prisma II.St.	**Tetrag.Prisma I.St.**	**Basispedien**

Mineral-Bsp.:
Diaboleit $Pb_2Cu[Cl_2/(OH)_4]$
Macedonite $PbTiO_3$
Nielsenite $PdCu_3$

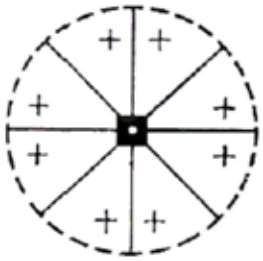
Tetragonal crystal system

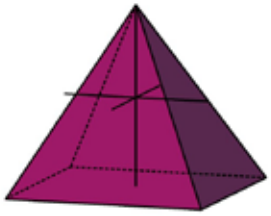
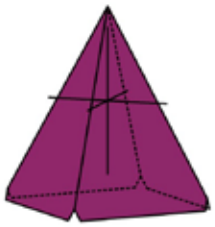
Hemimorphy of tetragonal holoedry
Ditetragonal-pyramidal class

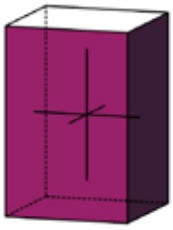
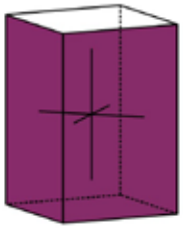
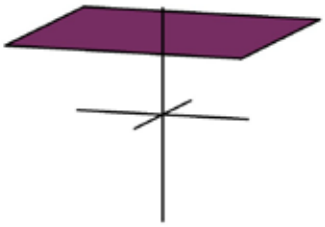
Symbol: 4mm or C_{4v}

General form:
{hkl}

Ditetrag. Pyramid



{h0l}	{hhl}	{hk0}
 Tetrag.Pyramid II.pos.	 Tetrag.Pyramid I.pos.	 Ditetrag. Prism

{100}	{110}	{001}
 Tetrag.Prism II.pos.	 Tetrag.Prism I.pos.	 Basispedia

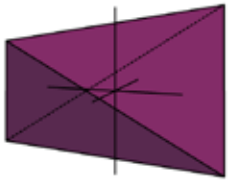
mineral examples:
Diaboleite $Pb_2Cu[Cl_2/(OH)_4]$
Macedonite $PbTiO_3$
Nielsenite $PdCu_3$

Tetragonales Kristallsystem

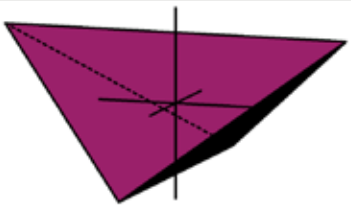
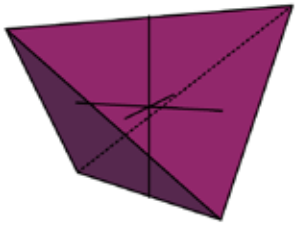
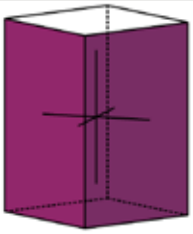
Tetragonal-sphenoidische
Tetartoedrie
Tetragonal-disphenoidische Klasse

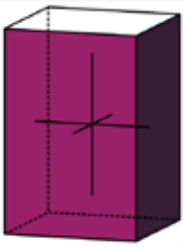
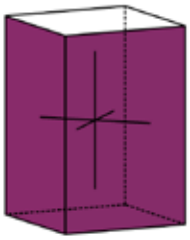
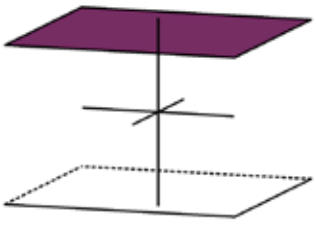
Symbol: $\bar{4}$ oder S_4

Allgemeine Form:
{hkl}



Tetrag.Disphenoide III.St.

{h0l}	{hhl}	{hk0}
		
Tetrag.Disphenoide II.St.	Tetrag.Disphenoide I.St.	Tetrag.Prismen III.St.

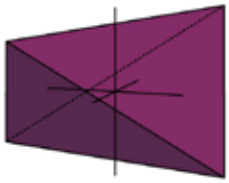
{100}	{110}	{001}
		
Tetrag.Prisma II.St.	Tetrag.Prisma I.St.	Basispinakoid

Mineral-Bsp.:
Cahnit $Ca_2[AsO_4/B(OH)_4]$
Tugtupit $Na_8[(AlBeSi_4O_{12})_2/Cl_2]$
Schreibersit $(Fe,Ni)_3P$

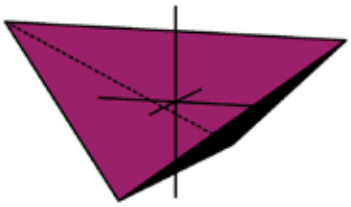
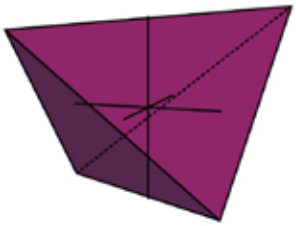
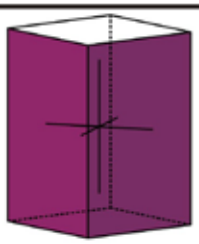
Tetragonal crystal system

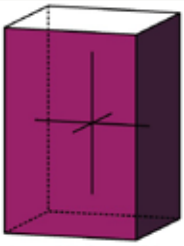
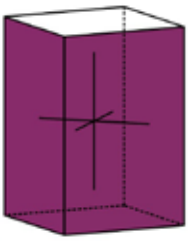
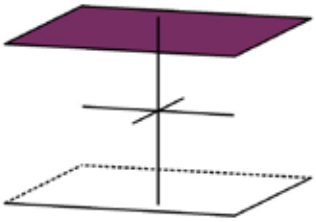
Tetragonal-sphenoidal tetartoedry
Tetragonal-disphenoidal class Symbol: $\bar{4}$ or S_4

General form:
{hkl}



Tetrag.Disphenoid III.pos.

{h0l}	{hhl}	{hk0}
		
Tetrag.Disphenoid II.pos.	Tetrag.Disphenoid I.pos.	Tetrag.Prism III.pos.

{100}	{110}	{001}
		
Tetrag.Prism II.pos.	Tetrag.Prism I.pos.	Basispinacoid

mineral examples:
Cahnite $Ca_2[AsO_4/B(OH)_4]$
Tugtupite $Na_8[(AlBeSi_4O_{12})_2/Cl_2]$
Schreibersite $(Fe,Ni)_3P$

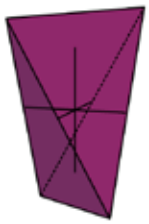
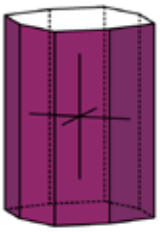
Tetragonales Kristallsystem

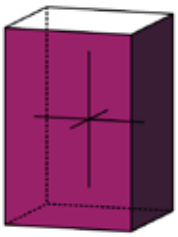
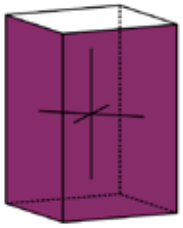
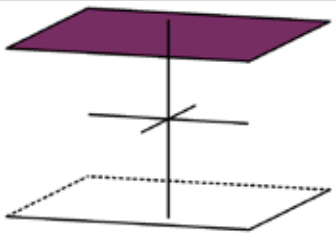
Tetragonal-sphenoidische
Hemiedrie
Tetragonal-skalenoedrische Klasse

Symbol: $\bar{4}2m$ oder D_{2d}

Allgemeine Form:
{hkl}

Tetrag. Skalenoeder

{h0l}	{hhl}	{hk0}
		
Tetrag.Dipyramiden II.St.	**Tetrag.Disphenoide I.St.**	**Ditetrag. Prismen**

{100}	{110}	{001}
		
Tetrag.Prisma II.St.	**Tetrag.Prisma I.St.**	**Basispinakoid**

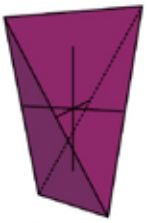
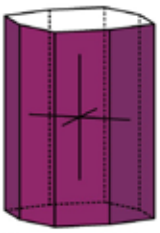
Mineral-Bsp.:
Chalkopyrit $CuFeS_2$
Mooihoekite $Cu_9Fe_9S_{16}$
Stannit Cu_2FeSnS_4

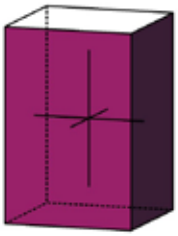
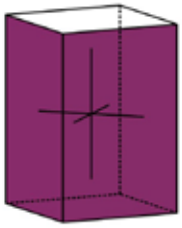
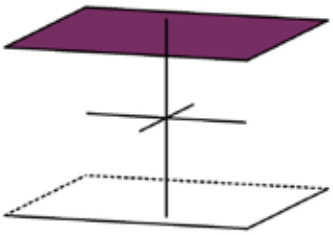
Tetragonal crystal system

Tetragonal-sphenoidal hemiedry
Tetragonal-scalenohedral class Symbol: $\bar{4}2m$ or D_{2d}

General form:
{hkl}

Tetrag. Scalenohedron

{h0l}	{hhl}	{hk0}
		
Tetrag.Dipyramid II.pos.	**Tetrag.Disphenoid I.pos.**	**Ditetrag. Prism**

{100}	{110}	{001}
		
Tetrag.Prism II.pos.	**Tetrag.Prism I.pos.**	**Basispinacoid**

mineral examples:
Chalkopyrite $CuFeS_2$
Mooihoekite $Cu_9Fe_9S_{16}$
Stannite Cu_2FeSnS_4

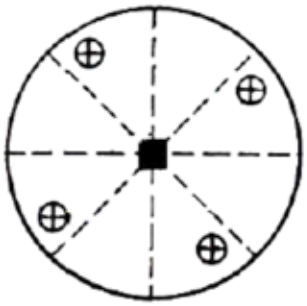
Tetragonales Kristallsystem

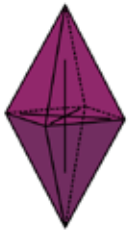
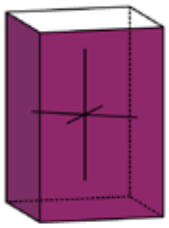
Tetragonal-dipyramidale
Hemiedrie
Tetragonal-dipyramidale Klasse

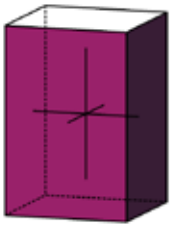
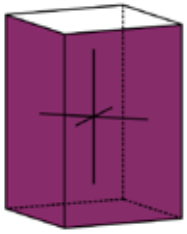
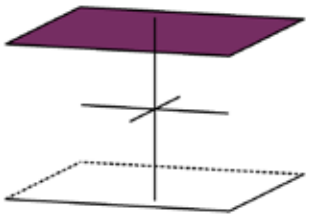
Symbol: 4/m oder C_{4h}

Allgemeine Form:
{hkl}

Tetrag.Dipyramiden III.St.



{h0l}	{hhl}	{hk0}
		
Tetrag.Dipyramiden II.St.	Tetrag.Dipyramiden I.St.	Tetrag.Prismen III.St.

{100}	{110}	{001}
		
Tetrag.Prisma II.St.	Tetrag.Prisma I.St.	Basispinakoid

Mineral-Bsp.:
Scheelit $Ca[WO_4]$
Vesuvian $Ca_{19}(Mg,Fe,Ti)_4Al_9[(OH,F)_{10}/(SiO_4)_{10}/(Si_2O_7)_4]$
Fergusonit $YNbO_4$

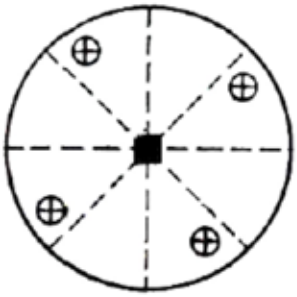
Tetragonal crystal system

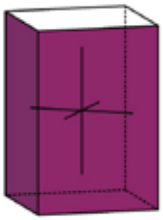
Tetragonal-dipyramidal hemiedry
Tetragonal-dipyramidal class

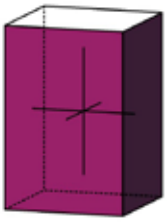
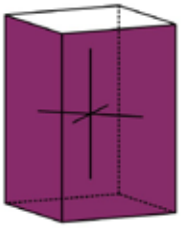
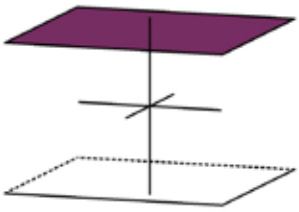
Symbol: 4/m or C_{4h}

General form:
{hkl}

Tetrag.Dipyramid III.pos.



{h0l}	{hhl}	{hk0}
		
Tetrag.Dipyramid II.pos.	Tetrag.Dipyramid I.pos.	Tetrag.Prism III.pos.

{100}	{110}	{001}
		
Tetrag.Prism II.pos.	Tetrag.Prism I.pos.	Basispinacoid

mineral examples:

Scheelite $Ca[WO_4]$

Vesuvianite $Ca_{19}(Mg,Fe,Ti)_4Al_9[(OH,F)_{10}/(SiO_4)_{10}/(Si_2O_7)_4]$

Fergusonite $YNbO_4$

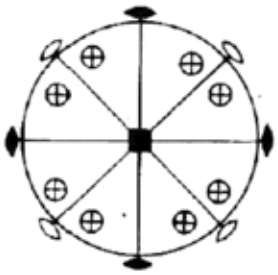
Tetragonales Kristallsystem

Tetragonale Holoedrie
Dietragonal-dipyramidale Klasse

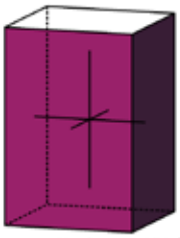
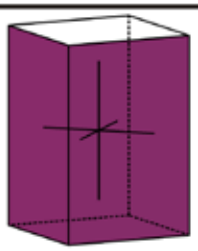
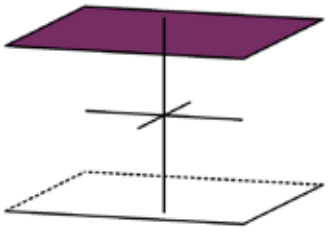
Symbol: 4/m 2/m 2/m
(4/m m m) oder D_{4h}

Allgemeine Form:
{hkl}

Ditetrag. Dipyramiden



{h0l}	{hhl}	{hk0}
		
Tetrag.Dipyramiden II.St.	**Tetrag.Dipyramiden I.St.**	**Ditetrag.Prismen**

{100}	{110}	{001}
		
Tetrag.Prisma II.St.	**Tetrag.Prisma I.St.**	**Basispinakoid**

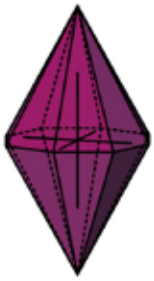
Mineral-Bsp.:
Rutil TiO_2
Anatas TiO_2
Zirkon $Zr[SiO_4]$

Tetragonal crystal system

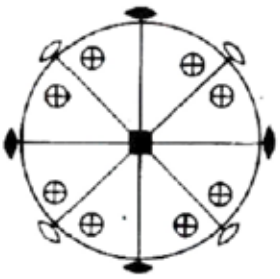
Tetragonal holoedry
Dietragonal-dipyramidal
class

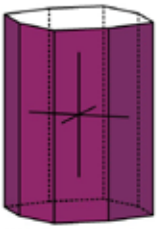
Symbol: 4/m 2/m 2/m
(4/m m m) or D_{4h}

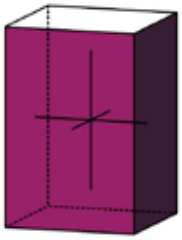
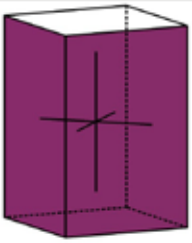
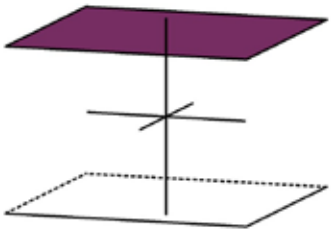
General form:
{hkl}



Ditetrag. Dipyramid



{h0l}	{hhl}	{hk0}
 Tetrag.Dipyramid II.pos.	 Tetrag.Dipyramid I.pos.	 Ditetrag.Prism

{100}	{110}	{001}
 Tetrag.Prism II.pos.	 Tetrag.Prism I.pos.	 Basispinacoid

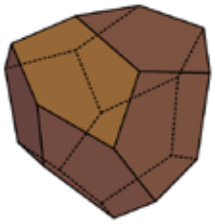
mineral examples:
Rutile TiO_2
Anatase TiO_2
Zircon $Zr[SiO_4]$

Kubisches Kristallsystem

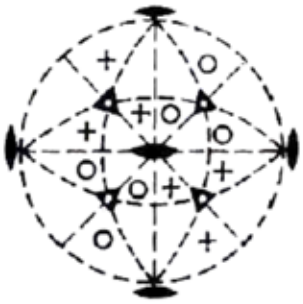
Kubische Tetartoedrie
Tetraedisch-pentagon-
doekaedrische Klasse

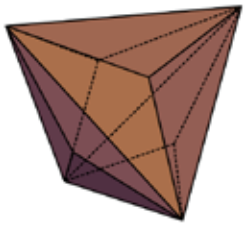
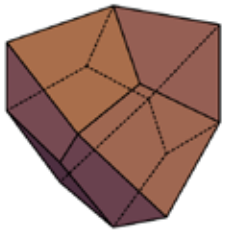
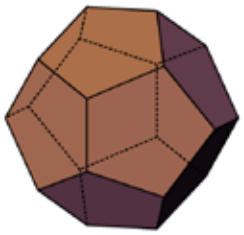
Symbol: 23 oder T

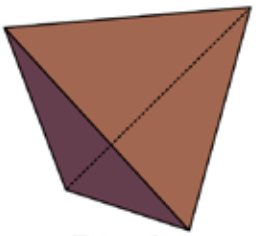
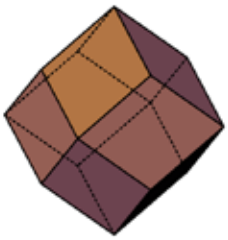
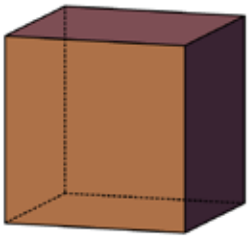
Allgemeine Form:
{hkl}



Tetraedr.Pentagondodekaeder



{hll}	{hhl}	{hk0}
		
Pyramidentetraeder	Deltoiddodekaeder	Pentagondodekaeder

{111}	{110}	{100}
		
Tetraeder	Rhombendodekaeder	Würfel/ Hexaeder

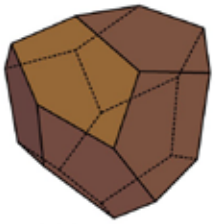
Mineral-Bsp.:
Langbeinit $K_2Mg_2[(SO_4)_3]$
Ullmannit NiSbS
Gersdorffit NiAsS

Cubic crystal system

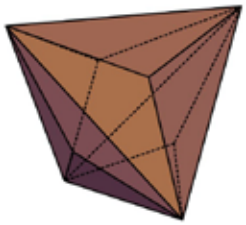
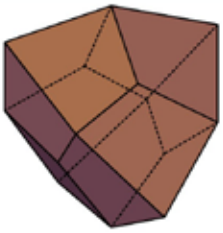
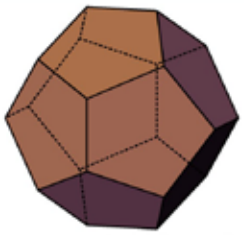
Cubic Tetartoedry
Tetrahedral-pentagon-dodecaedric class

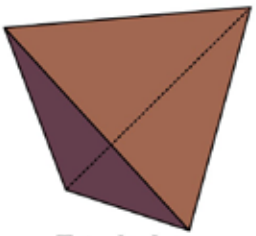
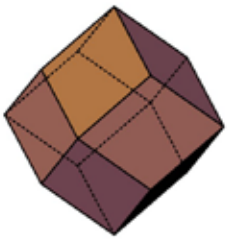
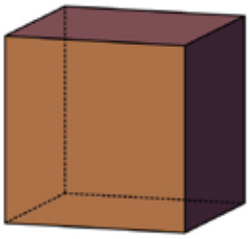
Symbol: 23 or T

General form:
{hkl}



Tetrahedral Pentagondodecaeder

{hll}	{hhl}	{hk0}
		
Pyramidal tetrahedron	Deltoidal dodecahedron	Pentagonal dodecaeder

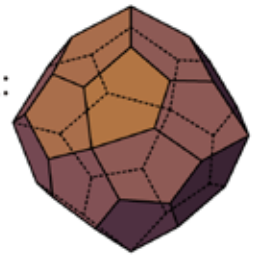
{111}	{110}	{100}
		
Tetrahedron	Rhombic dodecahedron	Cube/Hexahedron

mineral examples:
Langbeinite $K_2Mg_2[(SO_4)_3]$
Ullmannite NiSbS
Gersdorffite NiAsS

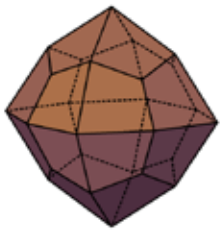
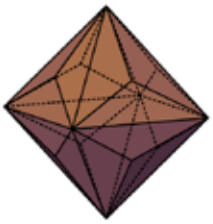
Kubisches Kristallsystem

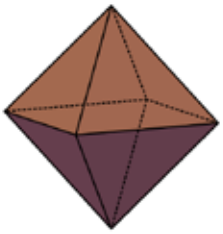
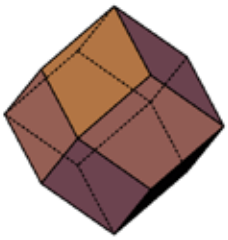
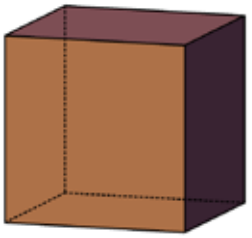
Gyroedrische Hemiedrie Symbol: 432 oder O
Pentagonikositetraedrische Klasse

Allgemeine Form:
{hkl}



Pentagonikositetraeder

{hll}	{hhl}	{hk0}
		
Deltoidikositetraeder	Pyramidenoktaeder	Pyramidenwürfel

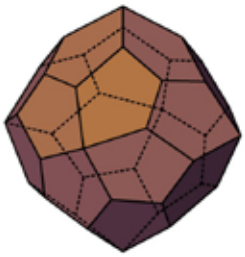
{111}	{110}	{100}
		
Oktaeder	Rhombendodekaeder	Würfel/ Hexaeder

Mineral-Bsp.:
Maghemit Gamma-Fe_2O_3
Choloalit $CuPb[(TeO_3)_2]$
Petzit Ag_3AuTe_2

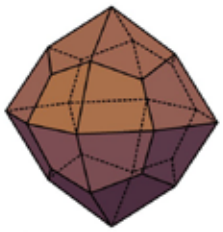
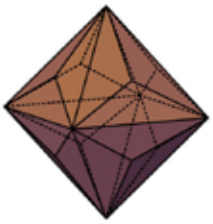
Cubic crystal system

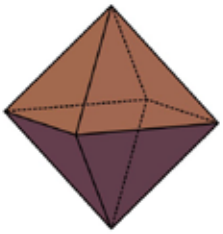
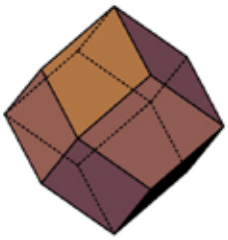
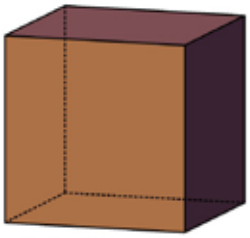
Gyroedric hemiedry Symbol: 432 or O
Pentagonal icositetrahedral class

General form:
{hkl}



Pentagonal icositetrahedron

{hll}	{hhl}	{hk0}
		
Deltoidal icositetrahedron	Pyramidal octahedron	Pyramidal cube

{111}	{110}	{100}
		
Octahedron	Rhombic dodecahedron	Cube/ Hexahedron

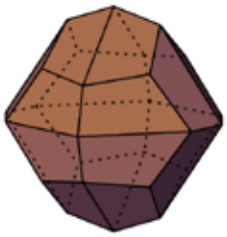
mineral examples:
Maghemite Gamma-Fe_2O_3
Choloalite $CuPb[(TeO_3)_2]$
Petzite Ag_3AuTe_2

Kubisches Kristallsystem

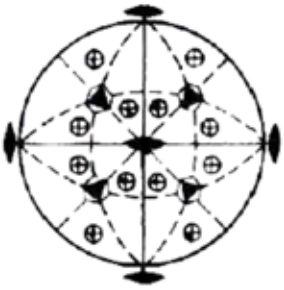
Parallelflächige Hemiedrie
Disdodekaedrische Klasse

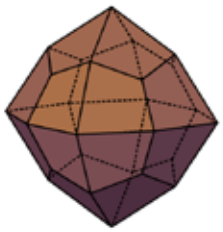
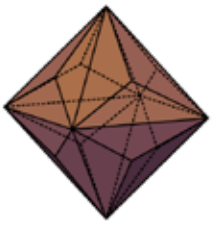
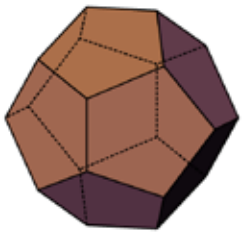
Symbol: 2/m $\bar{3}$ oder T_h
(m3)

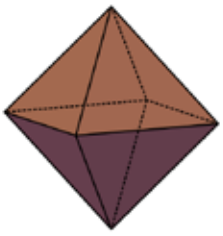
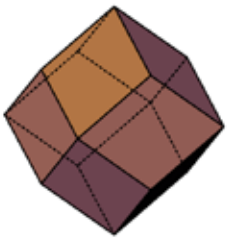
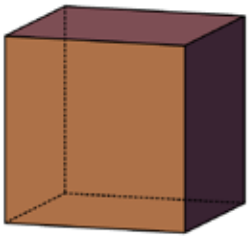
Allgemeine Form:
{hkl}



Disdodekaeder



{hll}	{hhl}	{hk0}
		
Deltoidikositetraeder	Pyramidenoktaeder	Pentagondodekaeder

{111}	{110}	{100}
		
Oktaeder	Rhombendodekaeder	Würfel/Hexaeder

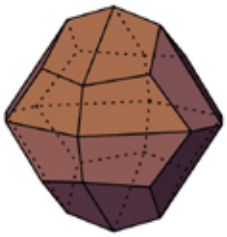
Mineral-Bsp.:
Pyrit FeS_2
Cobaltin CoAsS
Alaune, z.B. $KAl[SO_4]_2*12H_2O$
Bixbyit $(Mn,Fe)_2O_3$

Cubic crystal system

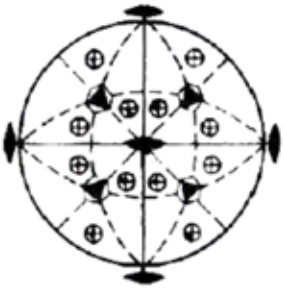
Parallel Hemiedry
Disdodecaedric class

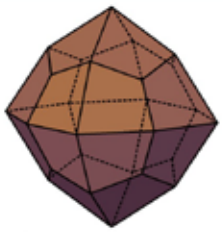
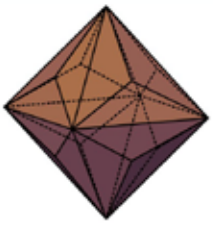
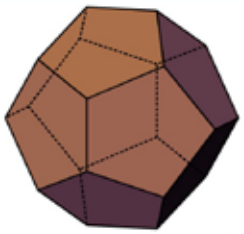
Symbol: 2/m $\bar{3}$ or T_h
(m3)

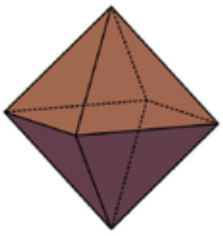
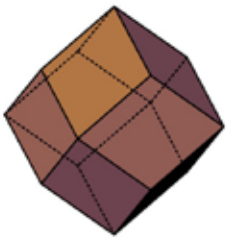
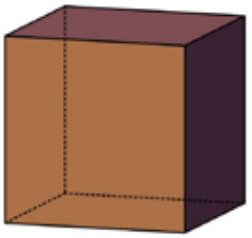
General form:
{hkl}



Disdodecahedron



{hll}	{hhl}	{hk0}
		
Deltoidal icositetrahedron	Pyramidal octahedron	Pentagonal dodecahedron

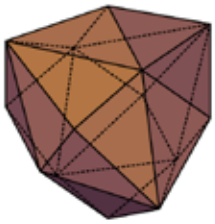
{111}	{110}	{100}
		
Octahedron	Rhombic dodecahedron	Cube/Hexahedron

mineral examples:
Pyrite FeS_2
Cobaltite CoAsS
Alum, z.B. $KAl[SO_4]_2*12H_2O$
Bixbyite $(Mn,Fe)_2O_3$

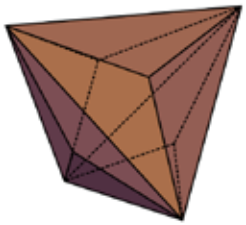
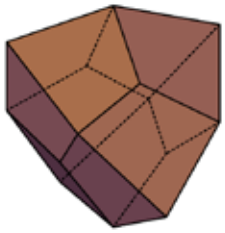
Kubisches Kristallsystem

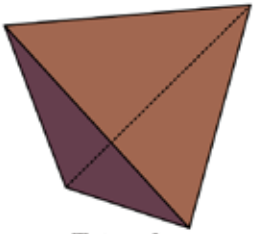
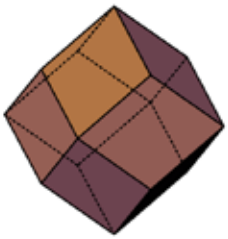
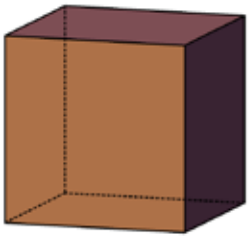
Geneigtflächige Hemiedrie Symbol: $\bar{4}3m$ oder T_d
Hexakistetraedrische Klasse

Allgemeine Form:
{hkl}



Hexakistetraeder

{hll}	{hhl}	{hk0}
		
Pyramidentetraeder	**Deltoiddodekaeder**	**Pyramidenwürfel**

{111}	{110}	{100}
		
Tetraeder	**Rhombendodekaeder**	**Würfel/ Hexaeder**

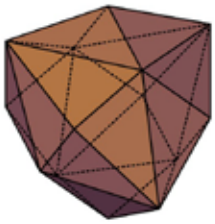
Mineral-Bsp.:
Sphalerit/Zinkblende ZnS
Tetraedrit $(Cu,Fe)_{12}[Sb_4S_{13}]$
Sodalith $Na_8[(Cl)_2(AlSiO_4)_6]$
Mayenit $Ca_{12}Al_{14}O_{33}$

Cubic crystal system

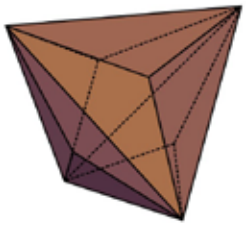
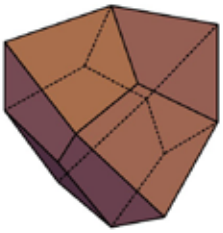
Inclined Hemiedry
Hexacistetrahedral class

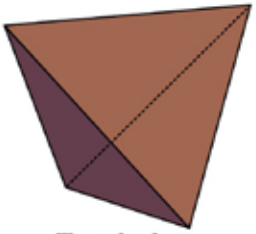
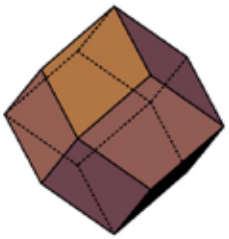
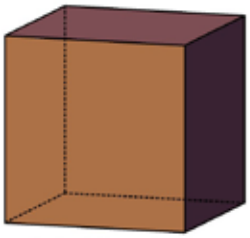
Symbol: $\bar{4}3m$ or T_d

General form:
{hkl}



Hexacistetrahedron

{hll}	{hhl}	{hk0}
		
Pyramidal tetrahedron	Deltoidal dodecahedron	Pyramidal cube

{111}	{110}	{100}
		
Tetrahedron	Rhombic dodecahedron	Cube/Hexahedron

mineral examples:

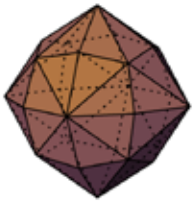
Sphalerite/Zinc blende ZnS
Tetrahedrite $(Cu,Fe)_{12}[Sb_4S_{13}]$
Sodalite $Na_8[(Cl)_2(AlSiO_4)_6]$
Mayenite $Ca_{12}Al_{14}O_{33}$

Kubisches Kristallsystem

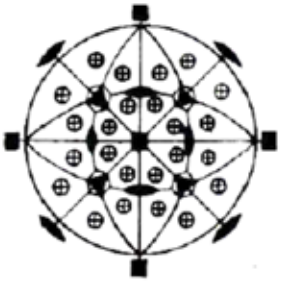
Kubische Holoedrie
Hexakisoktaedrische Klasse

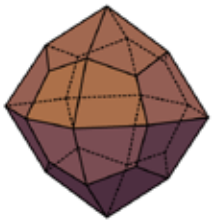
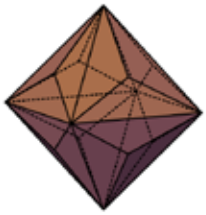
Symbol: 4/m $\bar{3}$ 2/m oder O_h
(m3m)

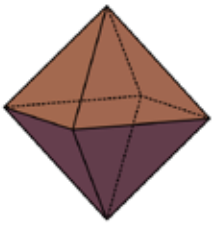
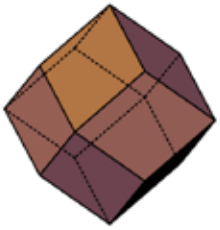
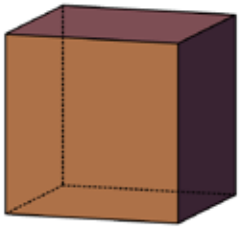
Allgemeine Form:
{hkl}



Hexakisoktaeder



{hll}	{hhl}	{hk0}
		
Deltoidikositetraeder	**Pyramidenoktaeder**	**Pyramidenwürfel**

{111}	{110}	{100}
		
Oktaeder	**Rhombendodekaeder**	**Würfel/Hexaeder**

Mineral-Bsp.:
Elemente: Au, Ag, Cu, Pt, Pb, Fe, W, Si, C(Diamant)
Halit/Steinsalz NaCl

Galenit/Bleiglanz PbS
Fluorit/Flußspat CaF_2
Spinelle, z.B. $MgAl_2O_4$
Granate $Me^{II}_3Me^{III}_2[SiO_4]_3$

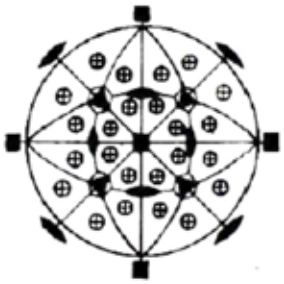
Cubic crystal system

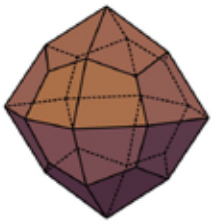
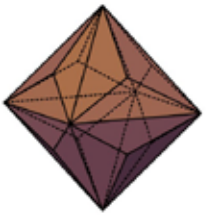
Cubic holoedry
Disdyakis dodecahedral class

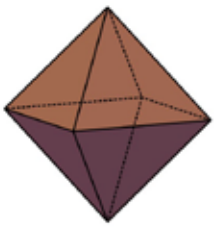
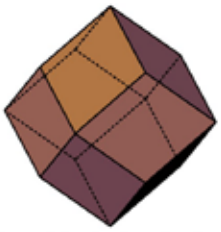
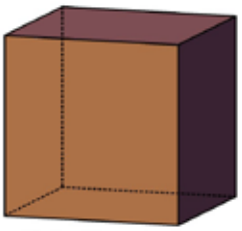
Symbol: 4/m $\bar{3}$ 2/m or O_h
(m3m)

General form:
{hkl}

Disdyakis dodecahedron



{hll}	{hhl}	{hk0}
		
Deltoidal icositetrahedron	Pyramidal octahedron	Pyramidal cubic

{111}	{110}	{100}
		
Octahedron	Rhombic dodecahedron	Cube/Hexahedron

mineral examples:
Elements: Au, Ag, Cu, Pt,
Pb, Fe, W, Si, C(Diamond)
Halite/ Rock salt NaCl

Galena /Lead glance PbS
Fluorite/Flusse CaF_2
Spinel, z.B. $MgAl_2O_4$
Garnet $Me^{II}_3Me^{III}_2[SiO_4]_3$

Beipiele für korrelate Kristallformen

Formenausbildung

Positiv - Negativ

Rechts - Links

Oben - Unten

Vorn - Hinten

Examples for correlate crystall forms

Crystal forms

Positive - Negative

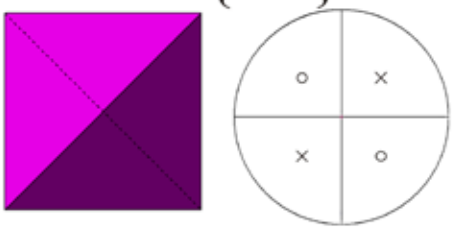
Right - Left

Up - Down

Front - Above

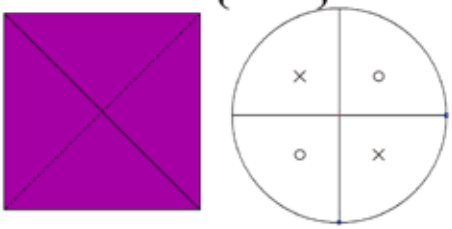
Kubisches Kristallsystem

Tetraeder $\{\overline{111}\}$



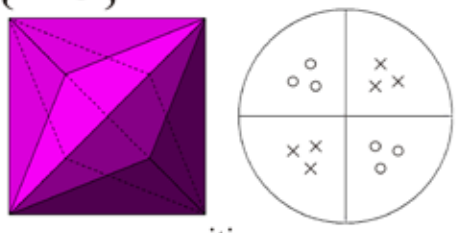
negativ

Tetraeder $\{111\}$



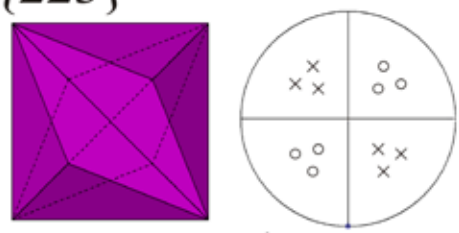
positiv

Pyramidentetraeder $\{223\}$



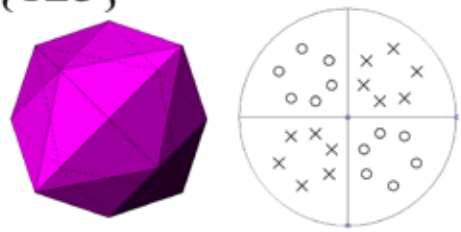
positiv

Pyramidentetraeder $\{\overline{223}\}$



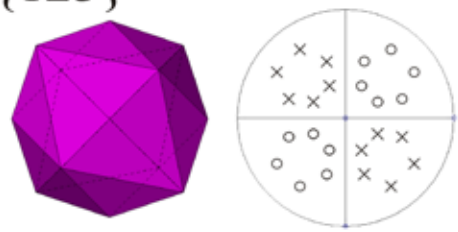
negativ

Hexakistetraeder $\{123\}$



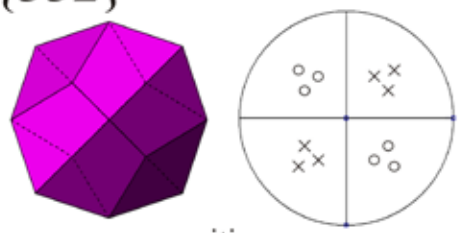
positiv

Hexakistetraeder $\{\overline{1}23\}$



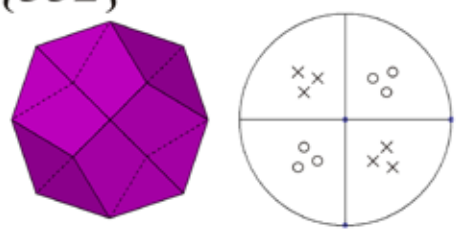
negativ

Deltoiddodekaeder $\{332\}$



positiv

Deltoiddodekaeder $\{\overline{332}\}$

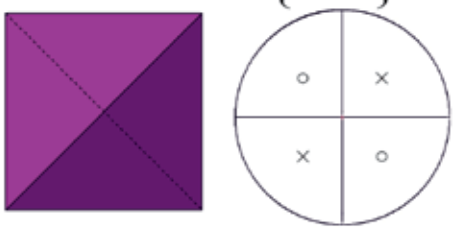


negativ

Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

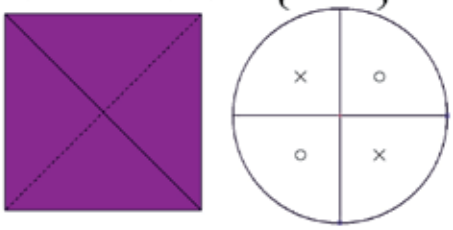
Cubic crystal system

Tetrahedron $\{\overline{111}\}$



negative

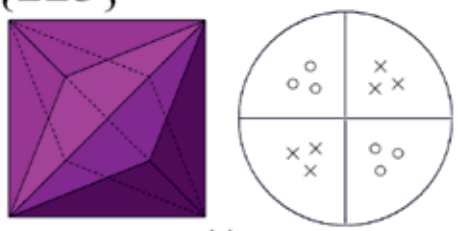
Tetrahedron $\{111\}$



positive

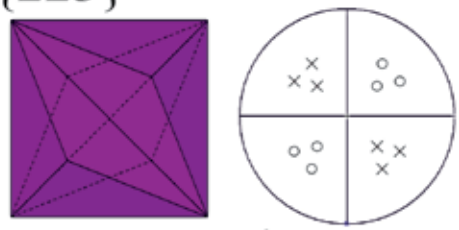
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Pyramidal tetrahedron $\{223\}$



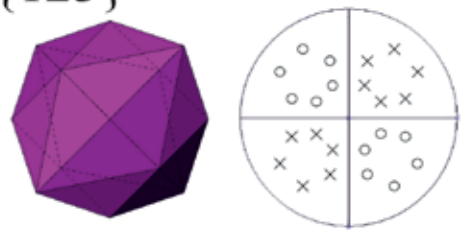
positive

Pyramidal tetrahedron $\{\overline{223}\}$



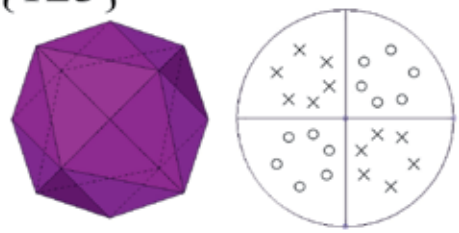
negative

Hexacistetrahedron $\{123\}$



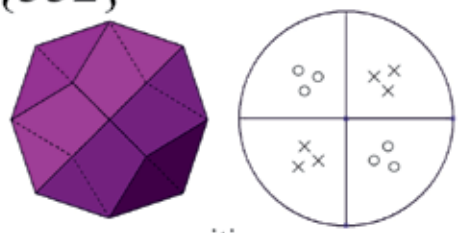
positive

Hexacistetrahedron $\{\overline{1}23\}$



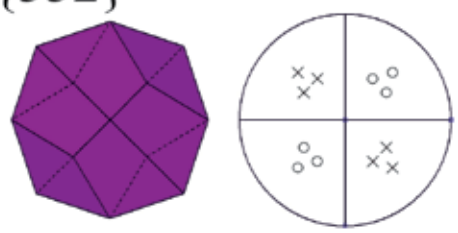
negative

Deltoid dodecahedron $\{332\}$



positive

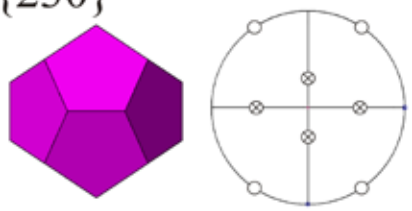
Deltoid dodecahedron $\{\overline{332}\}$



negative

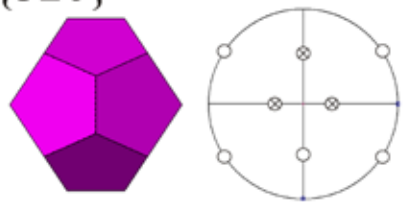
Kubisches Kristallsystem

Pentagondodekaeder {230}



rechts
(positiv)

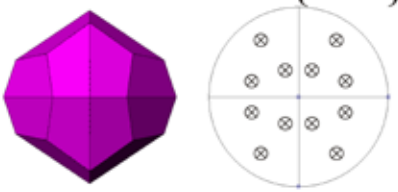
Pentagondodekaeder {320}



links
(negativ)

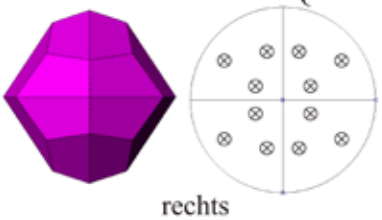
Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

Disdodekaeder {213}



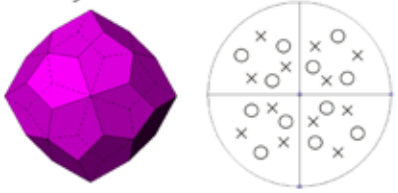
links
(positiv)

Disdodekaeder {123}

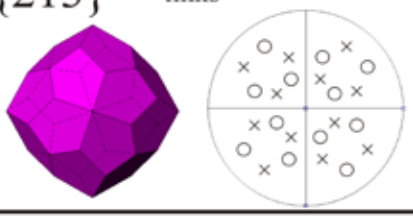


rechts
(negativ)

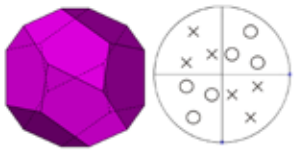
Pentagonikositetraeder {123} rechts



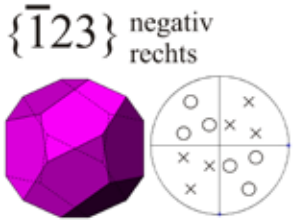
Pentagonikositetraeder {213} links



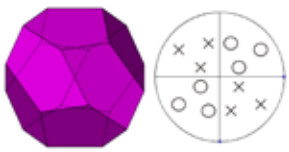
Tetraedrischer Pentagondodekaeder



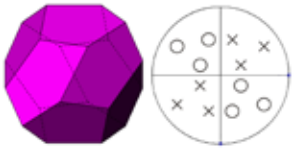
{123} positiv rechts



{$\bar{1}$23} negativ rechts



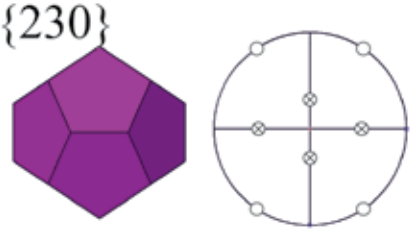
{213} positiv links



{$\bar{2}$13} negativ links

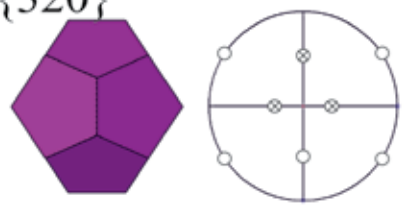
Cubic crystal system

Pentagonal dodecahedron {230}



right (positive)

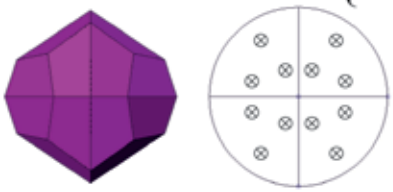
Pentagonal dodecahedron {320}



left (negative)

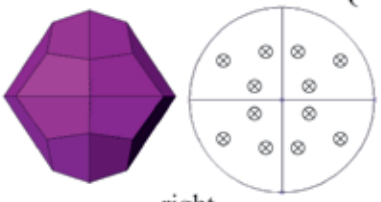
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Disdodecahedron {213}



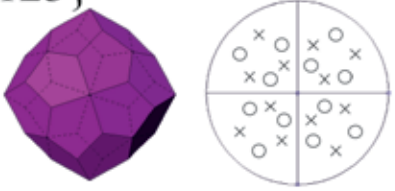
left (positive)

Disdodecahedron {123}

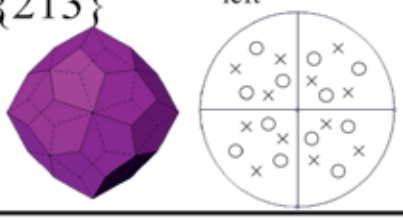


right (negative)

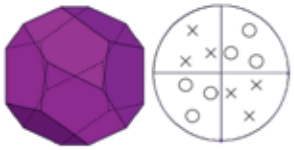
Pentagonal icositetrahedron {123} right



Pentagonal icositetrahedron {213} left

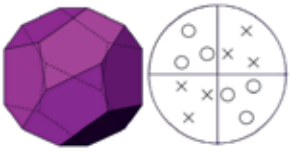


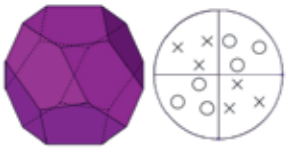
Tetrahedral pentagonal dodecahedron



{123} positive right

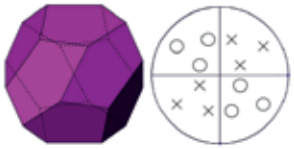
{$\bar{1}$23} negative right





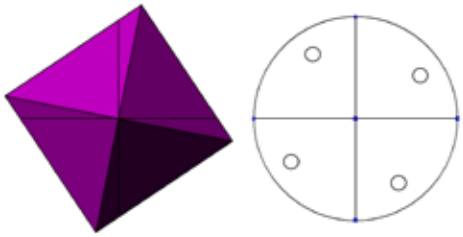
{213} positive left

{$\bar{2}$13} negative left



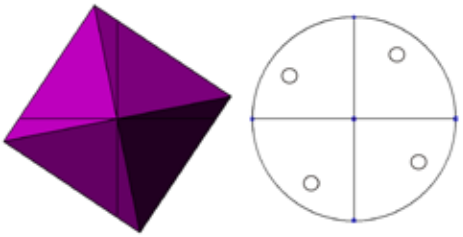
Tetragonales Kristallsystem

Pyramide {321}



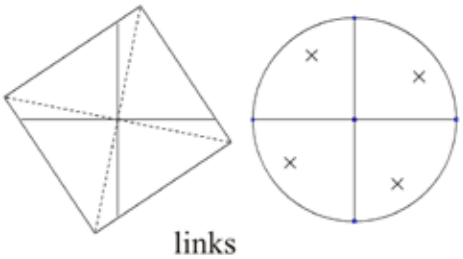
links
oben

Pyramide {231}



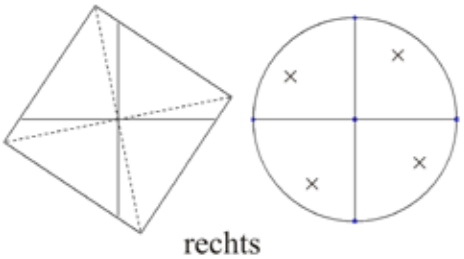
rechts
oben

Pyramide {32$\bar{1}$}



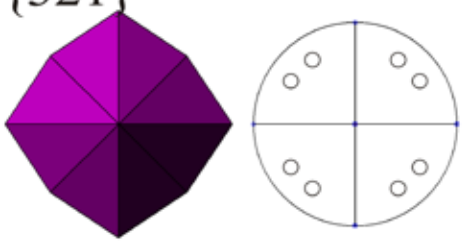
links
unten

Pyramide {23$\bar{1}$}



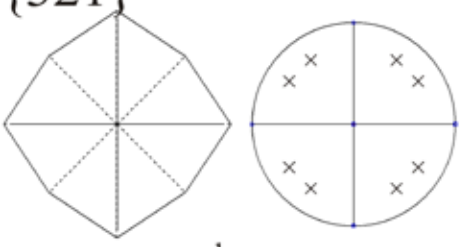
rechts
unten

Ditetrag. Pyramide {321}



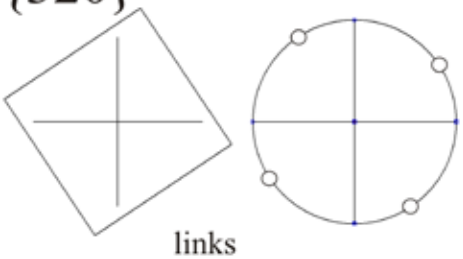
unten

Ditetrag. Pyramide {32$\bar{1}$}



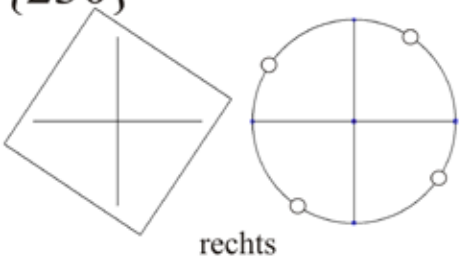
oben

Prisma III.Stellung {320}



links

Prisma III.Stellung {230}

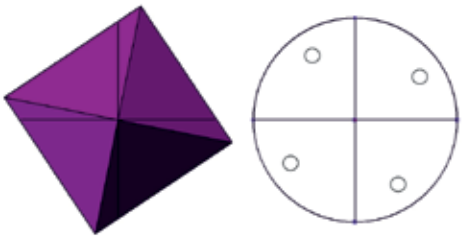


rechts

Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

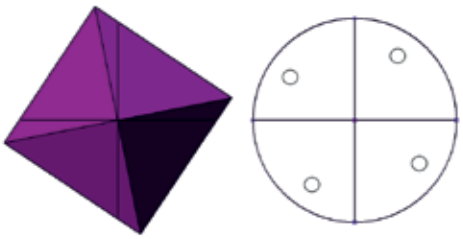
Tetragonal crystal system

Pyramid {321}



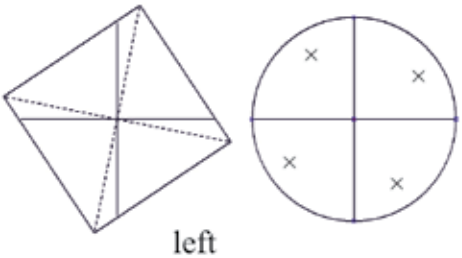
left
up

Pyramid {231}



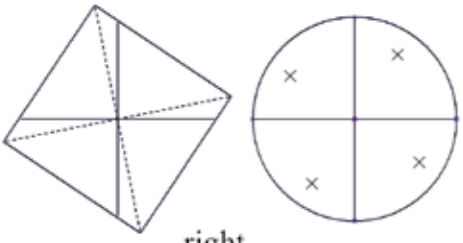
right
up

Pyramid {32$\bar{1}$}



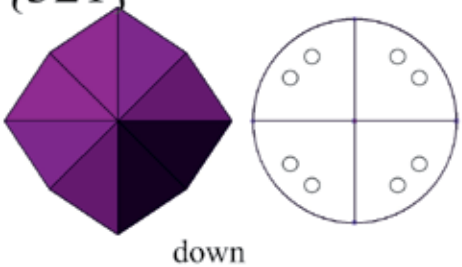
left
down

Pyramid {23$\bar{1}$}



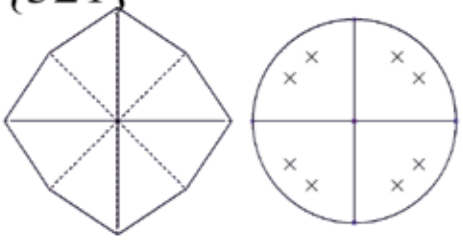
right
down

Ditetrag. Pyramid {321}



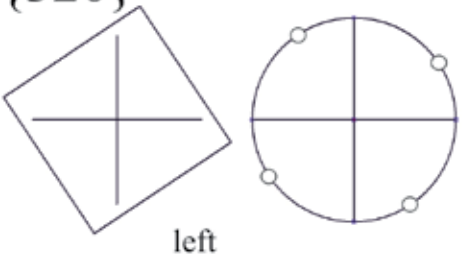
down

Ditetrag. Pyramid {32$\bar{1}$}



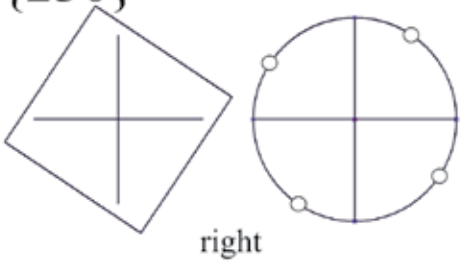
up

Prism III.Position {320}



left

Prism III.Position {230}



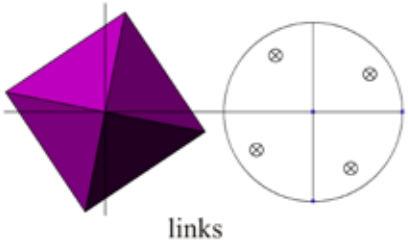
right

These stereographic projections do not contain any symmetry elements; they are merely reference lines

Tetragonales Kristallsystem

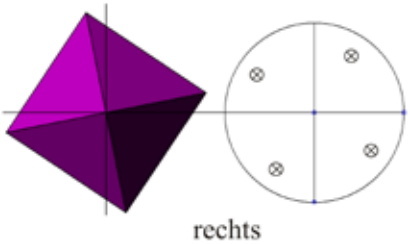
Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

Dipyramide {321}



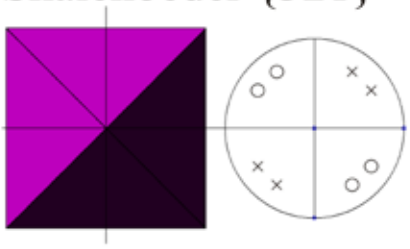
links

Dipyramide {231}



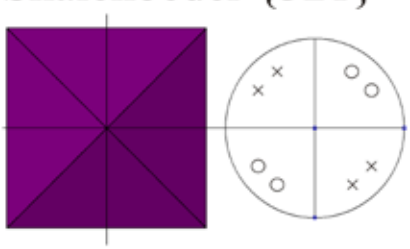
rechts

Skalenoeder {321}



positiv

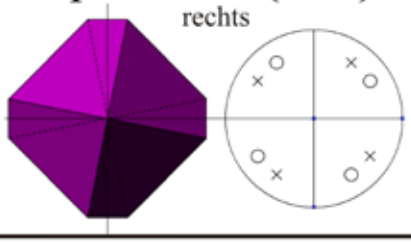
Skalenoeder {$\bar{3}$21}



negativ

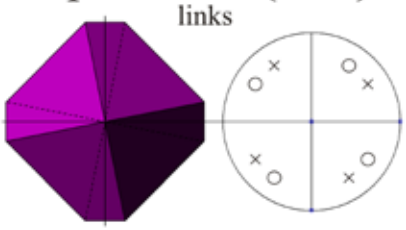
Trapezoeder {321}

rechts



Trapezoeder {231}

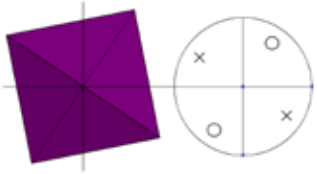
links



Tetragonales Disphenoid

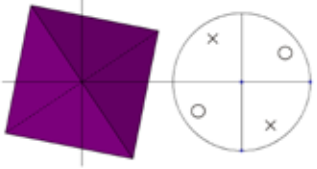
links
positiv
{321}

links
negativ
{$\bar{3}$21}

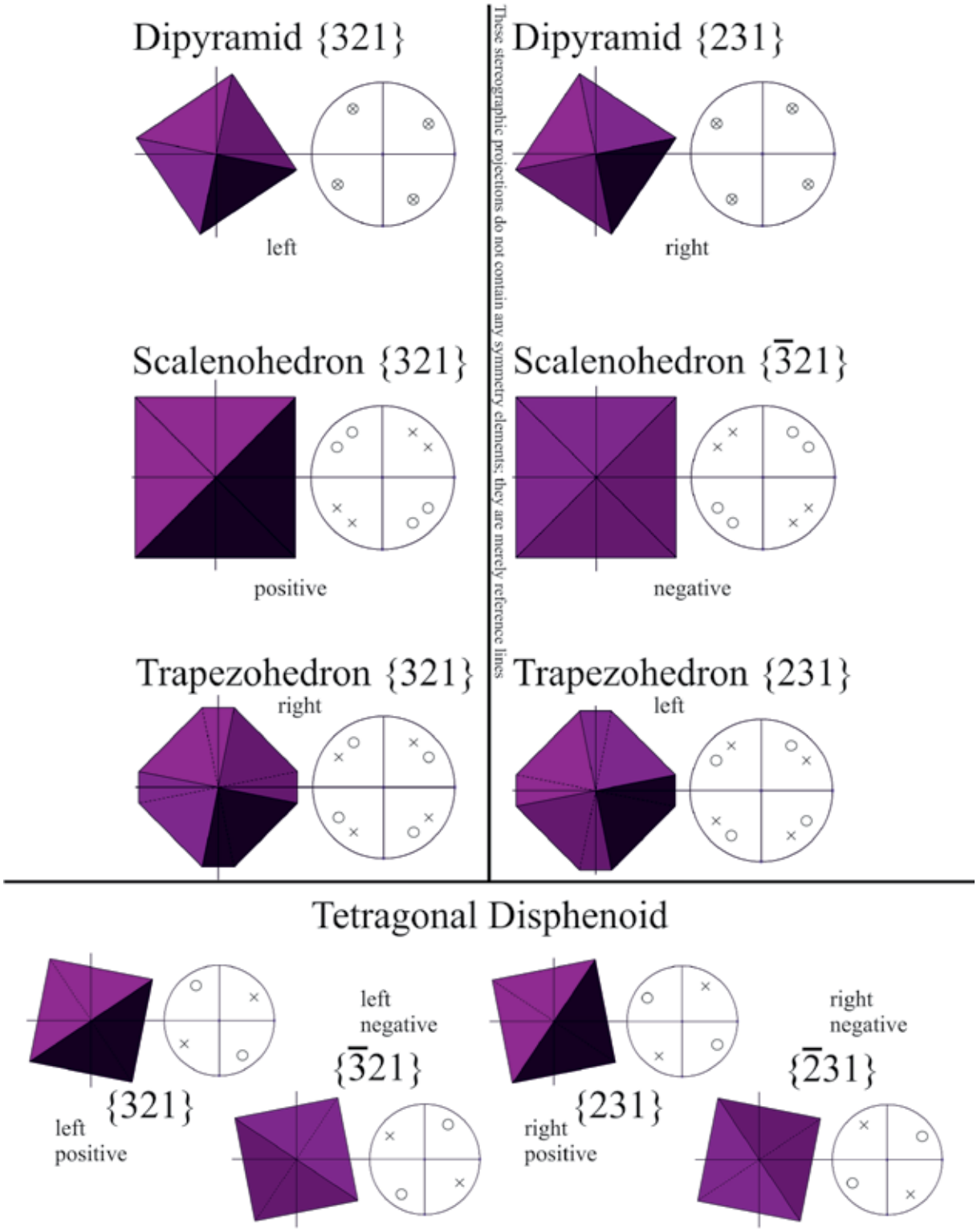


rechts
positiv
{231}

rechts
negativ
{$\bar{2}$31}

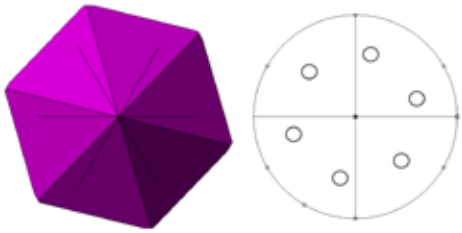


Tetragonal crystal system



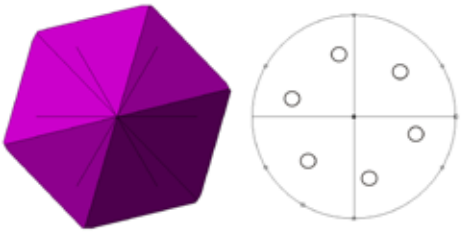
Hexagonales Kristallsystem

Pyramide {132}



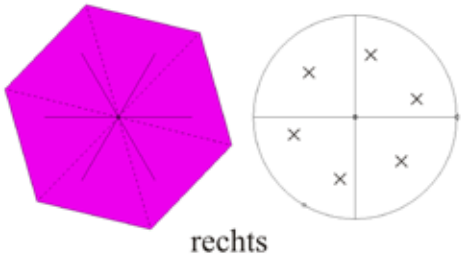
rechts
oben

Pyramide {312}



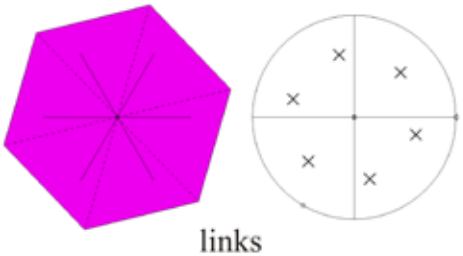
links
oben

Pyramide {13$\bar{2}$}



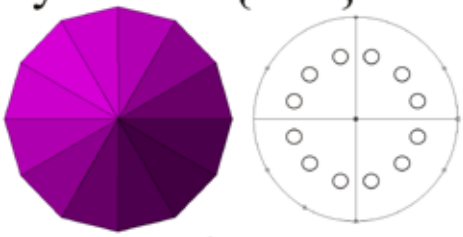
rechts
unten

Pyramide {31$\bar{2}$}



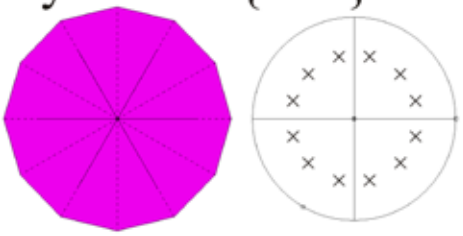
links
unten

Dihexagonale Pyramide {312}



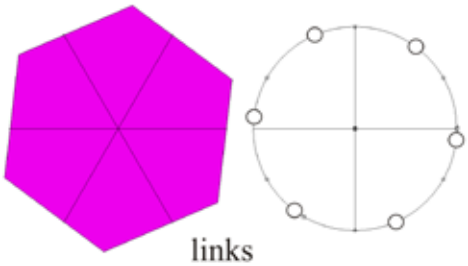
oben

Dihexagonale Pyramide {31$\bar{2}$}



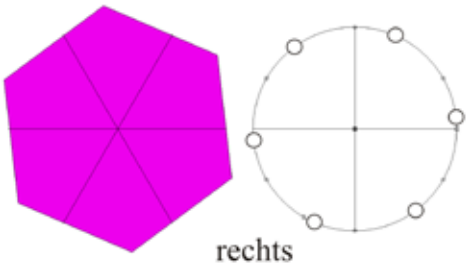
unten

Prisma {320}



links

Prisma {230}

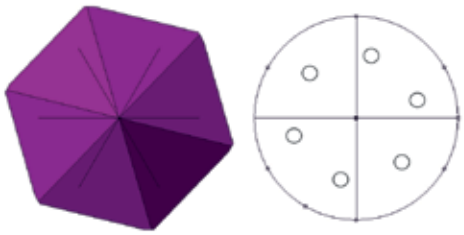


rechts

Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

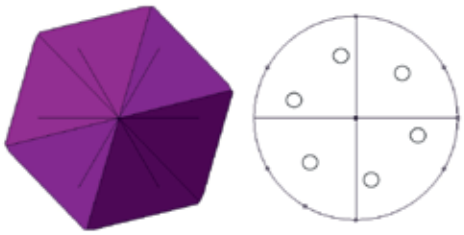
Hexagonal crystal system

Pyramid {132}



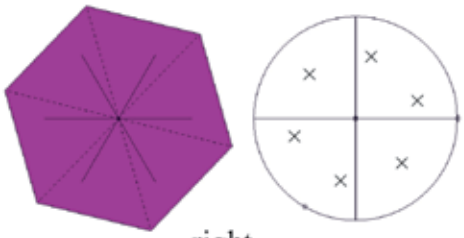
right
up

Pyramid {312}



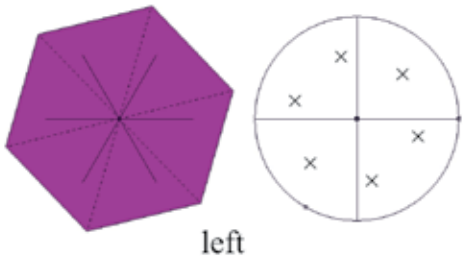
left
up

Pyramid {13$\bar{2}$}



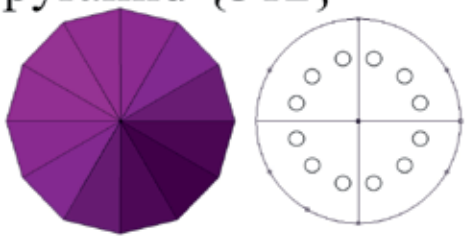
right
down

Pyramid {31$\bar{2}$}



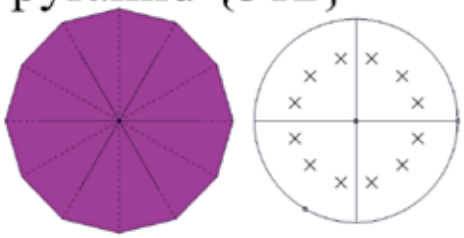
left
down

Dihexagonal pyramid {312}



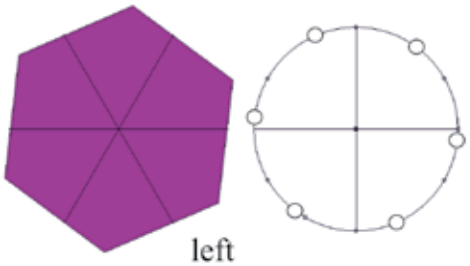
up

Dihexagonal pyramid {31$\bar{2}$}



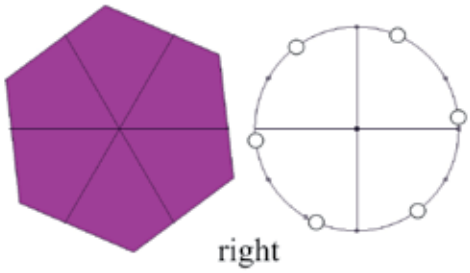
down

Prism {320}



left

Prism {230}



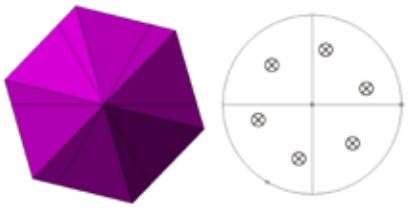
right

These stereographic projections do not contain any symmetry elements; they are merely reference lines

Hexagonales Kristallsystem

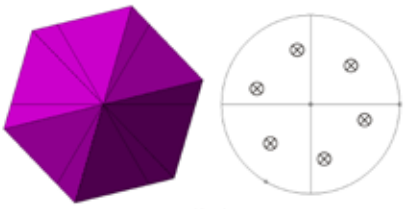
Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

Dipyramide {132}



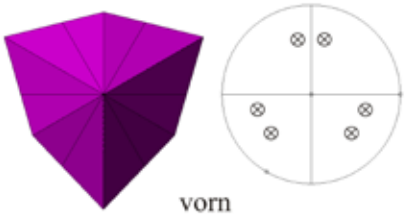
rechts

Dipyramide {312}



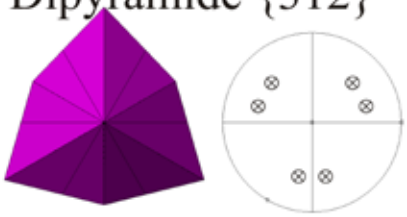
links

Ditrigonale Dipyramide {132}



vorn

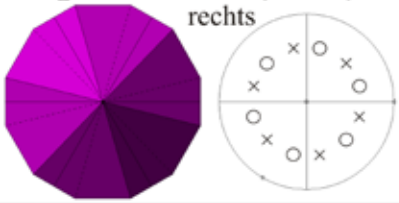
Ditrigonale Dipyramide {312}



hinten

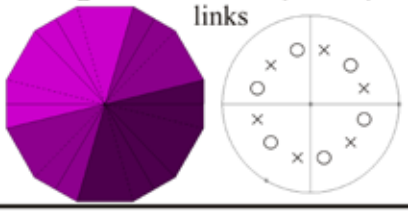
Trapezoeder {132}

rechts



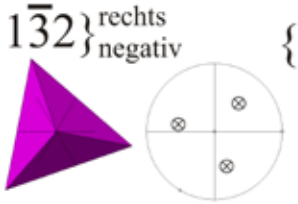
Trapezoeder {312}

links



Trigonale Dipyramide

{132} rechts positiv



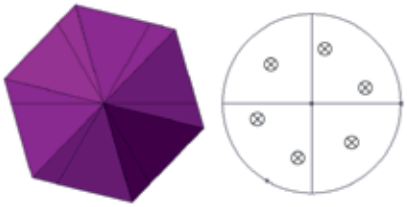
$1\bar{3}2\}$ rechts negativ

{312} links positiv

$\{\bar{3}12\}$ links negativ

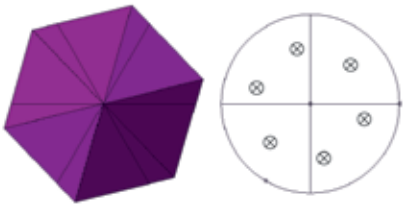
Hexagonal crystal system

Dipyramid {132}



right

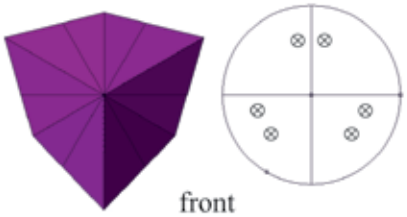
Dipyramid {312}



left

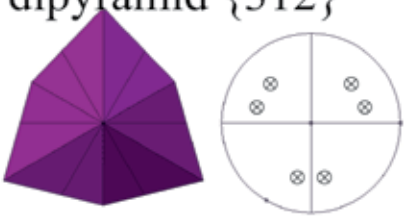
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Ditrigonal dipyramid {132}



front

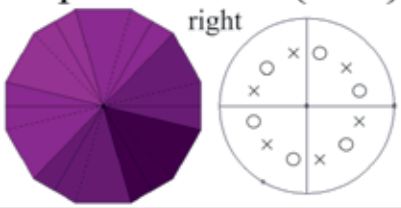
Ditrigonal dipyramid {312}



back

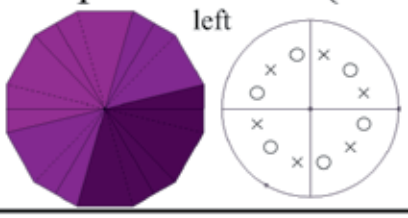
Trapezohedron {132}

right

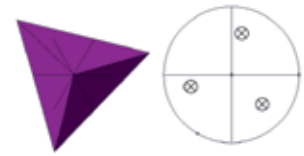


Trapezohedron {312}

left

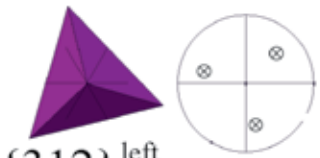


Trigonal Dipyramid



{132} right positive

$1\bar{3}2\}$ right negative

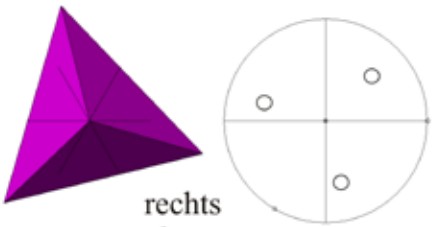


{312} left positive

$\{\bar{3}12\}$ left negative

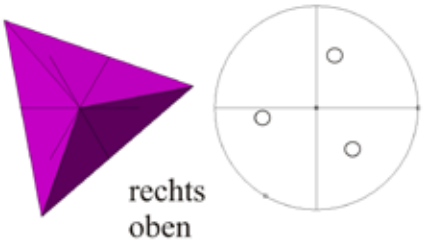
Trigonales Kristallsystem

Pyramide {312}



rechts
oben
vorn

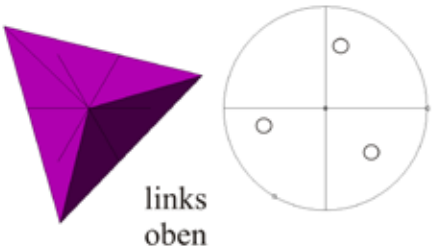
Pyramide {$\bar{3}$12}



rechts
oben
hinten

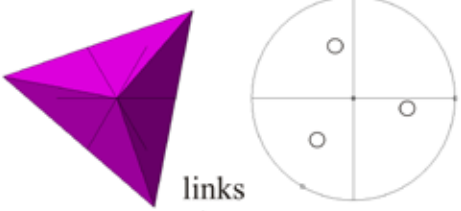
analog
dazu
“unten”

Pyramide {132}



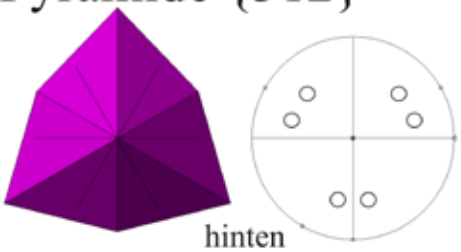
links
oben
vorn

Pyramide {$\bar{1}$32}



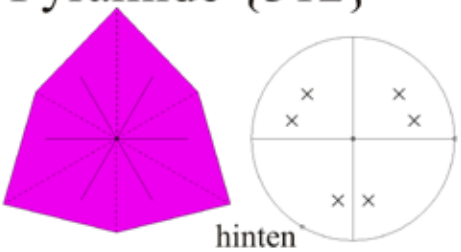
links
oben
hinten

Ditrigonale Pyramide {312}



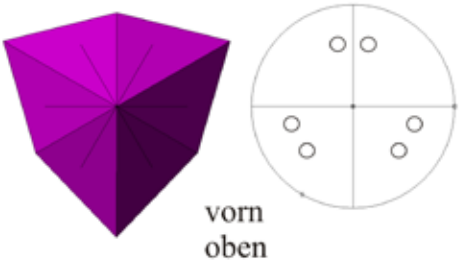
hinten
oben

Ditrigonale Pyramide {31$\bar{2}$}



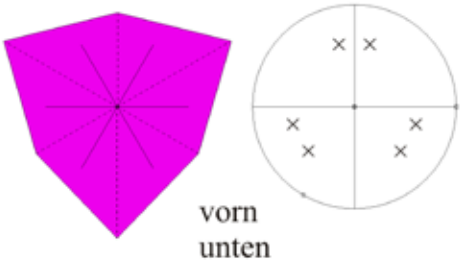
hinten
unten

Ditrigonale Pyramide {132}



vorn
oben

Ditrigonale Pyramide {13$\bar{2}$}

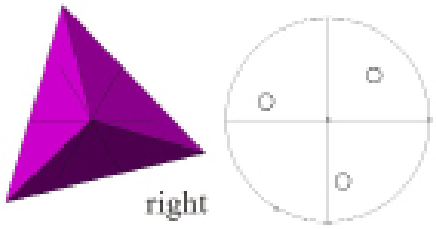


vorn
unten

Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

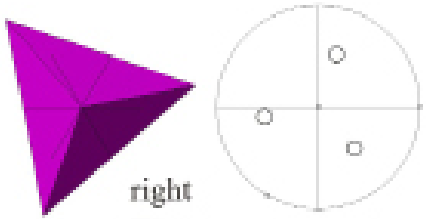
Trigonal crystal system

Pyramid {312}



right
up
front

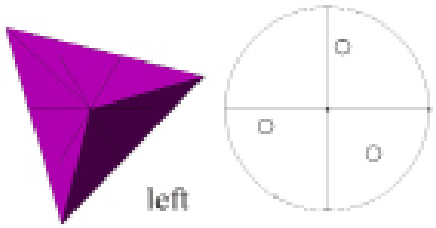
Pyramid {$\bar{3}$12}



right
up
back

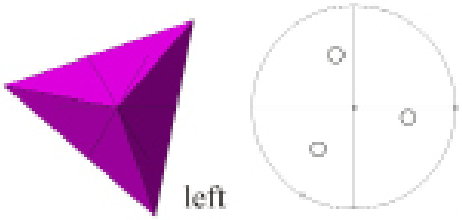
analog to "down"

Pyramid {132}



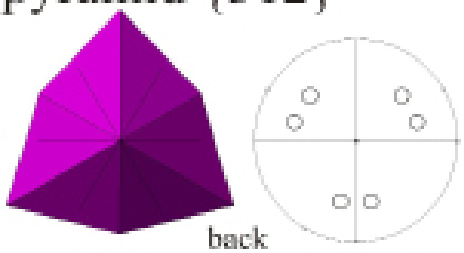
left
up
front

Pyramid {$\bar{1}$32}



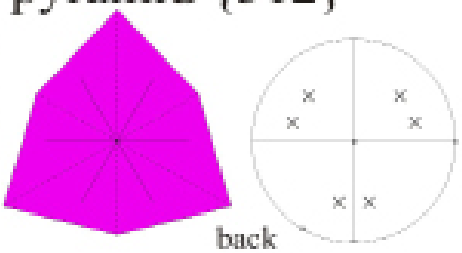
left
up
back

Ditrigonal pyramid {312}



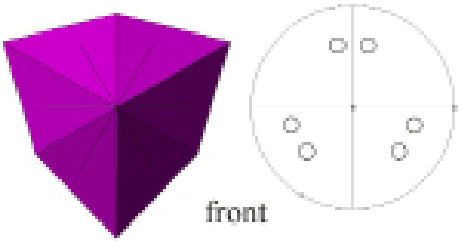
back
up

Ditrigonal pyramid {31$\bar{2}$}



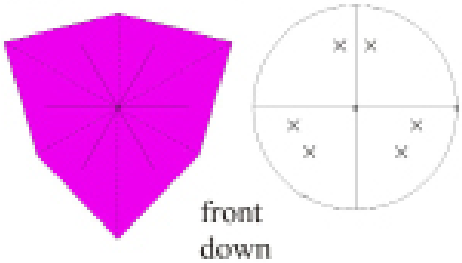
back
down

Ditrigonal pyramid {132}



front
up

Ditrigonal pyramid {13$\bar{2}$}



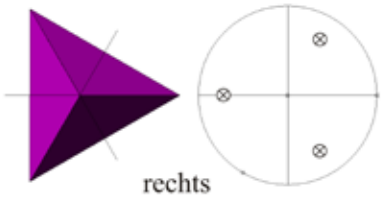
front
down

These stereographic projections do not contain any symmetry elements; they are merely reference lines

Trigonales Kristallsystem

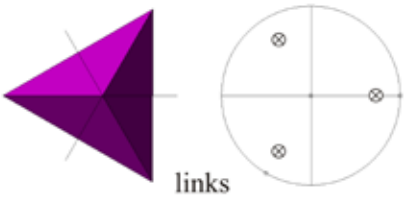
Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

Dipyramide {332}



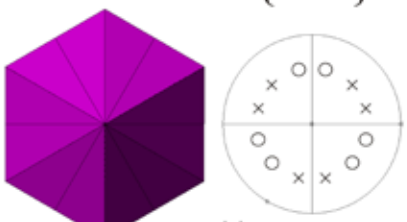
rechts
(positiv)

Dipyramide $\{\overline{3}\overline{3}2\}$



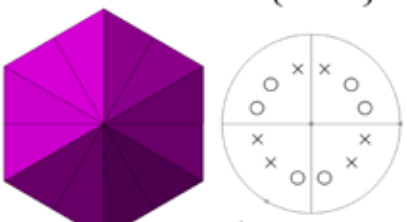
links
(negativ)

Ditrigonaler Skalenoeder {132}



positiv
(rechts)

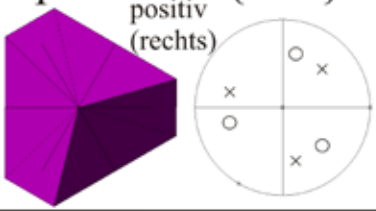
Ditrigonaler Skalenoeder {312}



negativ
(links)

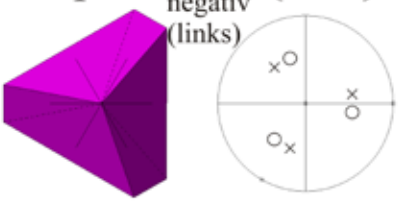
Trapezoeder {132}

positiv
(rechts)



Trapezoeder $\{\overline{1}32\}$

negativ
(links)



Trigonaler Rhomboeder

{132} rechts positiv

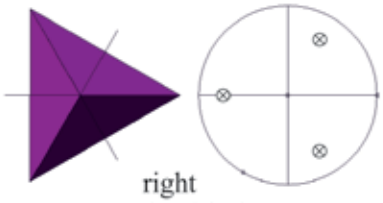
$\{\overline{1}32\}$ rechts negativ

{312} links positiv

$\{\overline{3}12\}$ links negativ

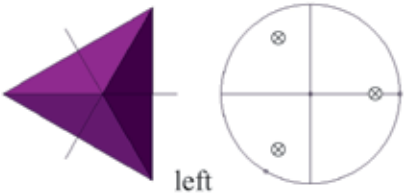
Trigonal crystal system

Dipyramid {332}



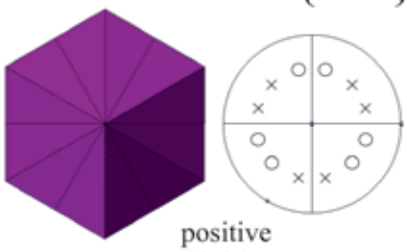
right
(positive)

Dipyramid {$\overline{3}\overline{3}2$}



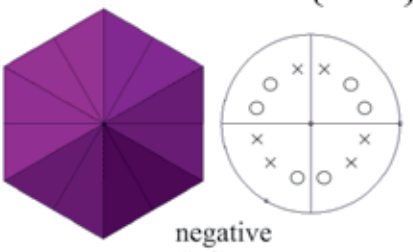
left
(negative)

Ditrigonal scalenohedron {132}



positive
(right)

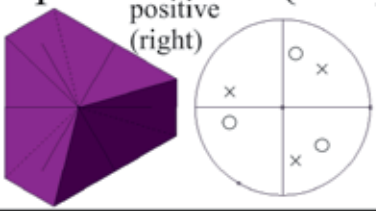
Ditrigonal scalenohedron {312}



negative
(left)

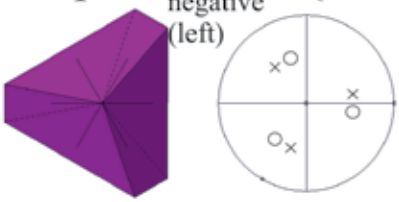
Trapezohedron {132}

positive
(right)



Trapezohedron {$\overline{1}$32}

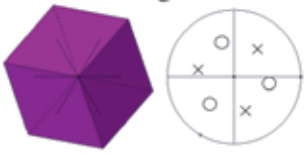
negative
(left)



These stereographic projections do not contain any symmetry elements; they are merely reference lines

Trigonal rhombohedron

{132} right positive



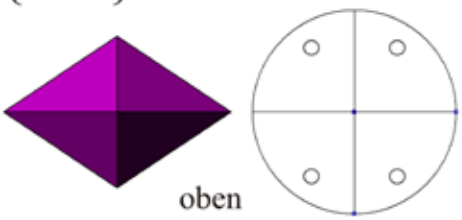
{$\overline{1}$32} right negative

{312} left positive

{$\overline{3}$12} left negative

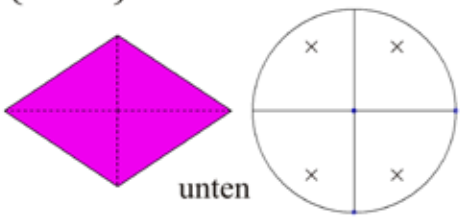
Orthorhombisches Kristallsystem

Rhombische Pyramide {321}



oben

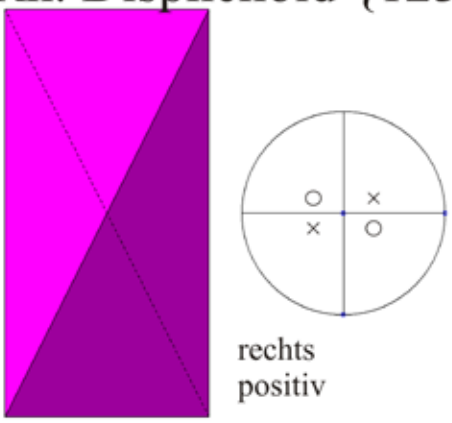
Rhombische Pyramide {321}



unten

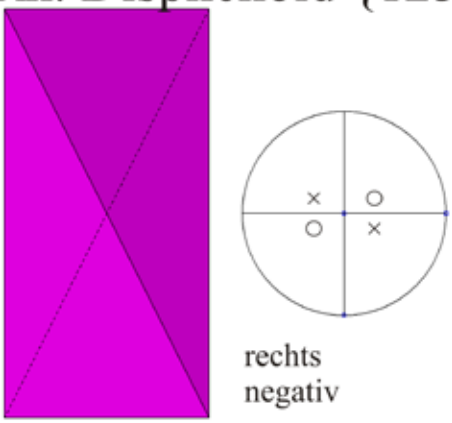
Diese stereographischen Projektionen beinhalten keinerlei Symmetrieelemente, es handelt sich hier lediglich um Bezugslinien

Rh. Disphenoid {123}



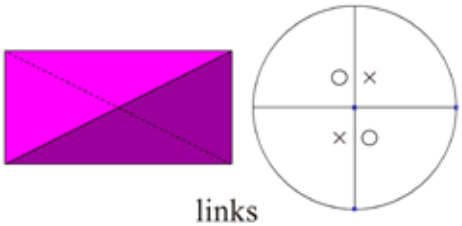
rechts
positiv

Rh. Disphenoid {$\bar{1}$23}



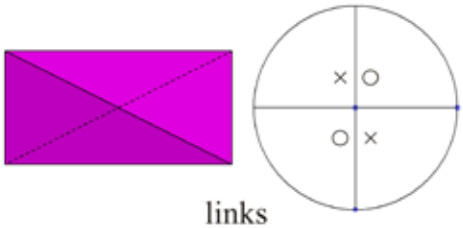
rechts
negativ

Rh. Disphenoid {213}



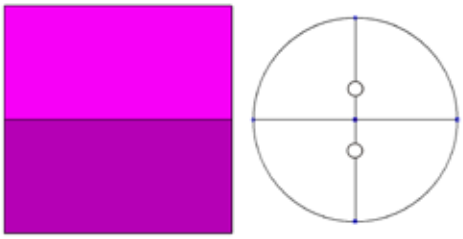
links
negativ

Rh. Disphenoid {$\bar{2}$13}



links
negativ

Doma II.Stellung {203}



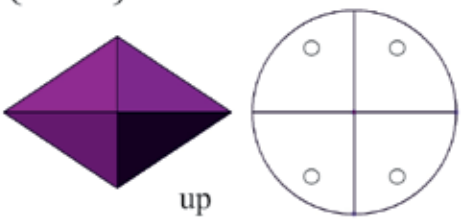
oben
(positiv)

Doma II.Stellung {$\bar{2}$03}

unten
(negativ)

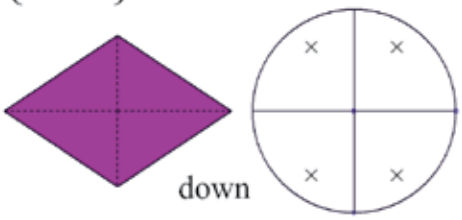
Orthorhombic crystal system

Rhombic pyramid {321}



up

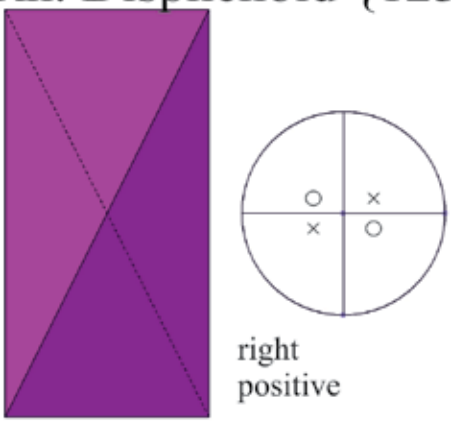
Rhombic Pyramid {321}



down

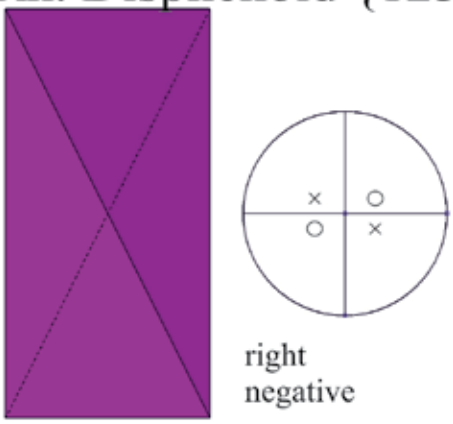
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Rh. Disphenoid {123}



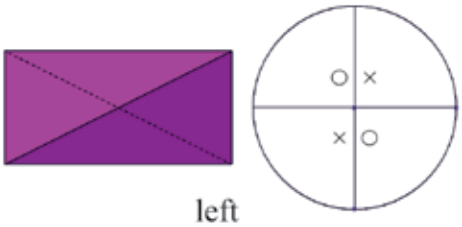
right
positive

Rh. Disphenoid {$\bar{1}$23}



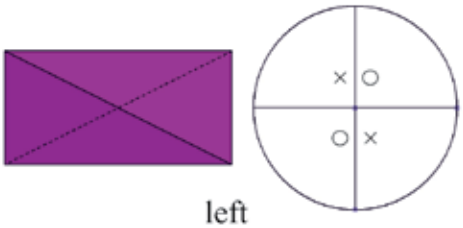
right
negative

Rh. Disphenoid {213}



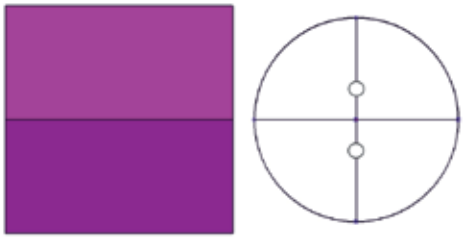
left
negative

Rh. Disphenoid {$\bar{2}$13}



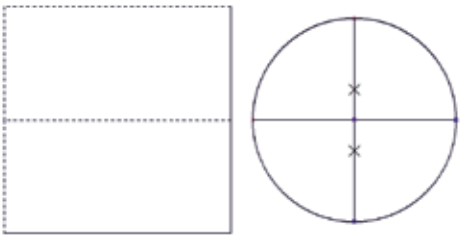
left
negative

Doma II.position {203}



up
(positive)

Doma II.position {$\bar{2}$03}



down
(negative)

System	Klasse	Symmetrieelement	polare Richtungen im Kristall	nichtpolare Richtungen im Kristall
triklin	1	-	* alle	keine
monoklin	2	$1\vec{\bullet}$	* b	alle $\perp$ b
	m	$1m\ (m \equiv \bar{2})$	a, c und alle Zonen die in (010) liegen	b
orthorhombisch	mm2	$1\vec{\bullet} + 1m + 1m$	* c	alle $\perp$ c
tetragonal	4	$1\vec{\blacklozenge}$	* c	alle $\perp$ c
	4mm	$1\vec{\blacklozenge} + 2m + 2m$	* c	alle $\perp$ c
trigonal	3	$\vec{\#}$	* c und alle Zonen $\perp$ c	keine
	32	$1\# + 3\vec{\bullet}$	a_1, a_2, a_3 und alle Zonen $\perp$ c	alle $\perp a_1, a_2, a_3$
	3m	$1\vec{\#} + 3m$	* c	a_1, a_2, a_3
hexagonal	6	$1\vec{\hexagon}$	* c	alle $\perp$ c
	$\bar{6}$	$1\hexagon \equiv \# + m$	* a_1, a_2, a_3 und alle Zonen $\perp$ c	c
	6mm	$1\vec{\hexagon} + 3m + 3m$	* c	alle $\perp$ c
	$\bar{6}2m$	$1\hexagon + 3\vec{\bullet} + 3m$	alle $\bullet$	a_1, a_2, a_3 und alle Zonen $\perp$ auf $\bullet$ die dazwischenliegen
kubisch	23	$3\bullet + 4\vec{\#}$	a_1, a_2, a_3	alle $\perp a_1, a_2, a_3$
	$\bar{4}3m$	$3\blacklozenge + 4\vec{\#} + 6m$	a_1, a_2, a_3	alle $\perp a_1, a_2, a_3$

Weitere azentrische Klassen mit polaren Richtungen: 222, 4, 422, 42m, 622, 432

*= Klassen mit einzigartigen polaren Achsen, zu denen keine äquivalenten Achsen existieren: ferroelektrische Stoffe

System	Class	Symmetry element	Polar directions in crystal	Not polar direction in crystal
triclinic	1	-	* all	None
monoclinic	2	$1\vec{\bullet}$	* b	all ⊥ b
	m	1m ($m \equiv \bar{2}$)	a, c and all Zones lying in (010)	b
orthorhombic	mm2	$1\vec{\bullet} + 1m + 1m$	* c	all ⊥ c
tetragonal	4	$1\vec{\blacklozenge}$	* c	all ⊥ c
	4mm	$1\vec{\blacklozenge} + 2m + 2m$	* c	all ⊥ c
trigonal	3	$\vec{\#}$	* c and all Zones ⊥ c	keine
	32	$1\# + 3\vec{\bullet}$	a_1, a_2, a_3 and all Zones ⊥ c	all ⊥ a_1, a_2, a_3
	3m	$1\vec{\#} + 3m$	* c	a_1, a_2, a_3
hexagonal	6	$1\vec{\hexagon}$	* c	all ⊥ c
	$\bar{6}$	$1\hexagon \equiv \# + m$	* a_1, a_2, a_3 and all Zones ⊥ c	c
	6mm	$1\vec{\hexagon} + 3m + 3m$	* c	all ⊥ c
	$\bar{6}2m$	$1\hexagon + 3\vec{\bullet} + 3m$	all $\bullet$	a_1, a_2, a_3 and all Zones ⊥ on $\bullet$ in between
cubic	23	$3\bullet + 4\vec{\#}$	a_1, a_2, a_3	all ⊥ a_1, a_2, a_3
	$\bar{4}3m$	$3\blacklozenge + 4\vec{\#} + 6m$	a_1, a_2, a_3	all ⊥ a_1, a_2, a_3

Other acentric classes with polar directions: 222, 4, 422, 42m, 622, 432

*= Classes with unique polar Axes, with no equivalent axes : ferroelectric materials

Die Kombination von Formen

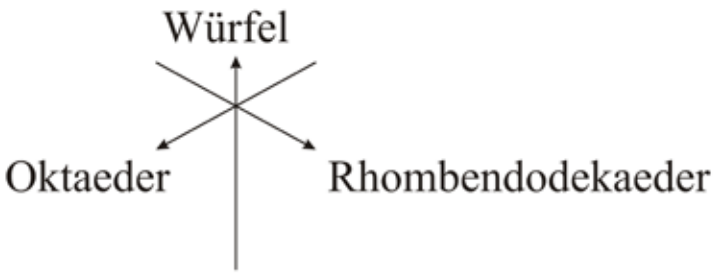
Zwei Formen: Würfel ↔ Oktaeder

Rhombendodekaeder → Würfel, Oktaeder

Tetraeder → Würfel, Rhombendodekaeder

positiver Tetraeder ↔ negativer Tetraeder

Drei Formen:



Kombinationen von Flachen und Steilen Rhomboedern

The combination of forms

Two forms:

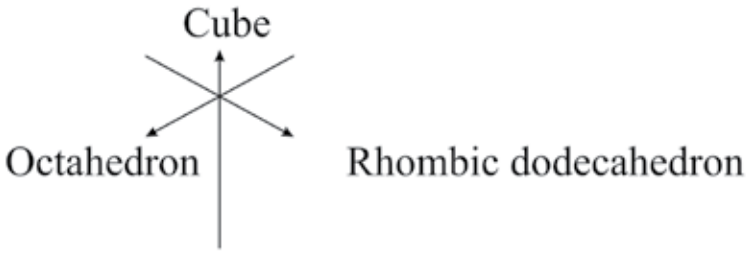
Cube ↔ Octahedron

Rhombic dodecahedron → Cube, Octahedron

Tetrahedron → Cube, Rhombic dodecahedron

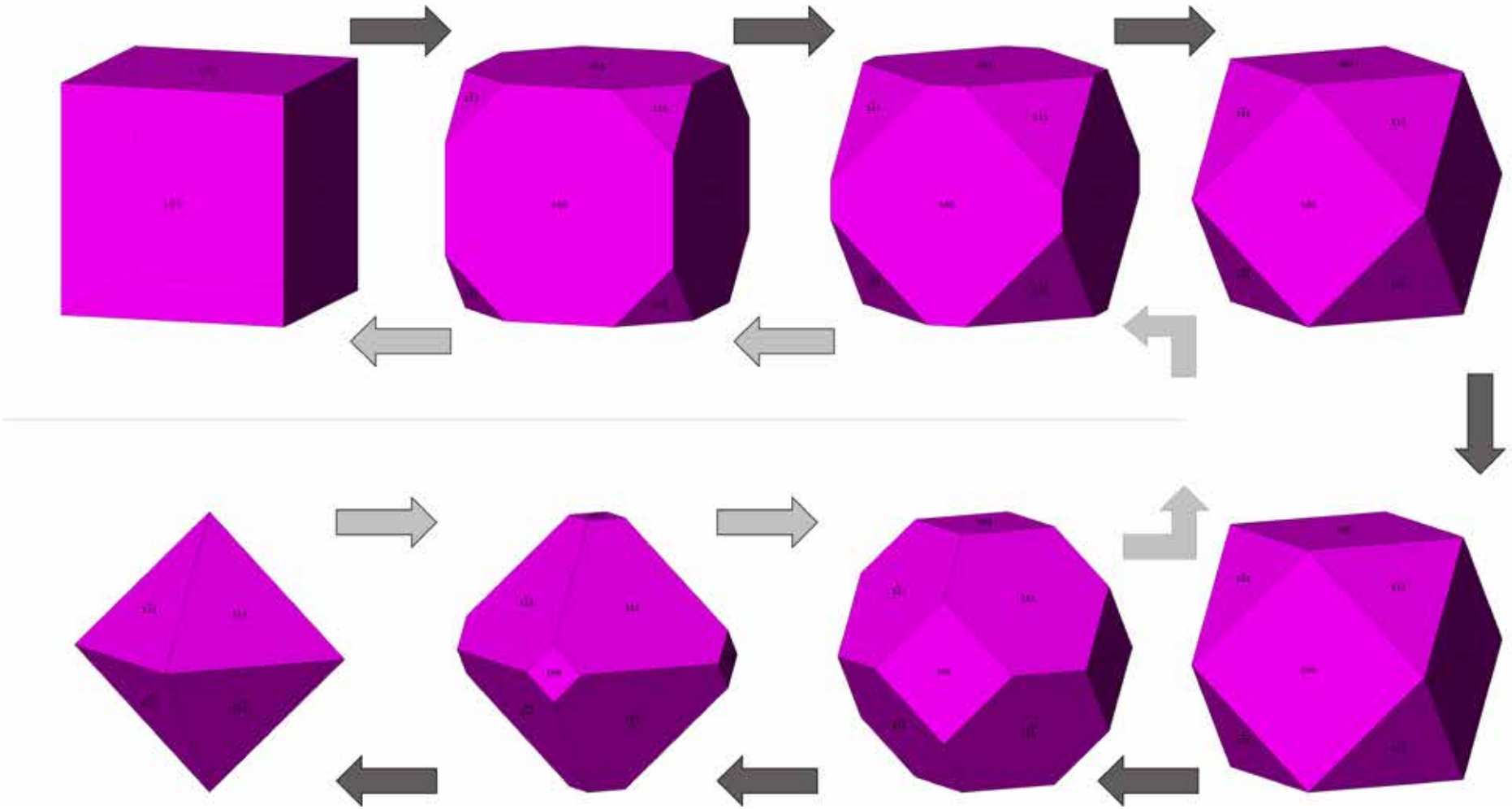
positive tetrahedron ↔ negative tetrahedron

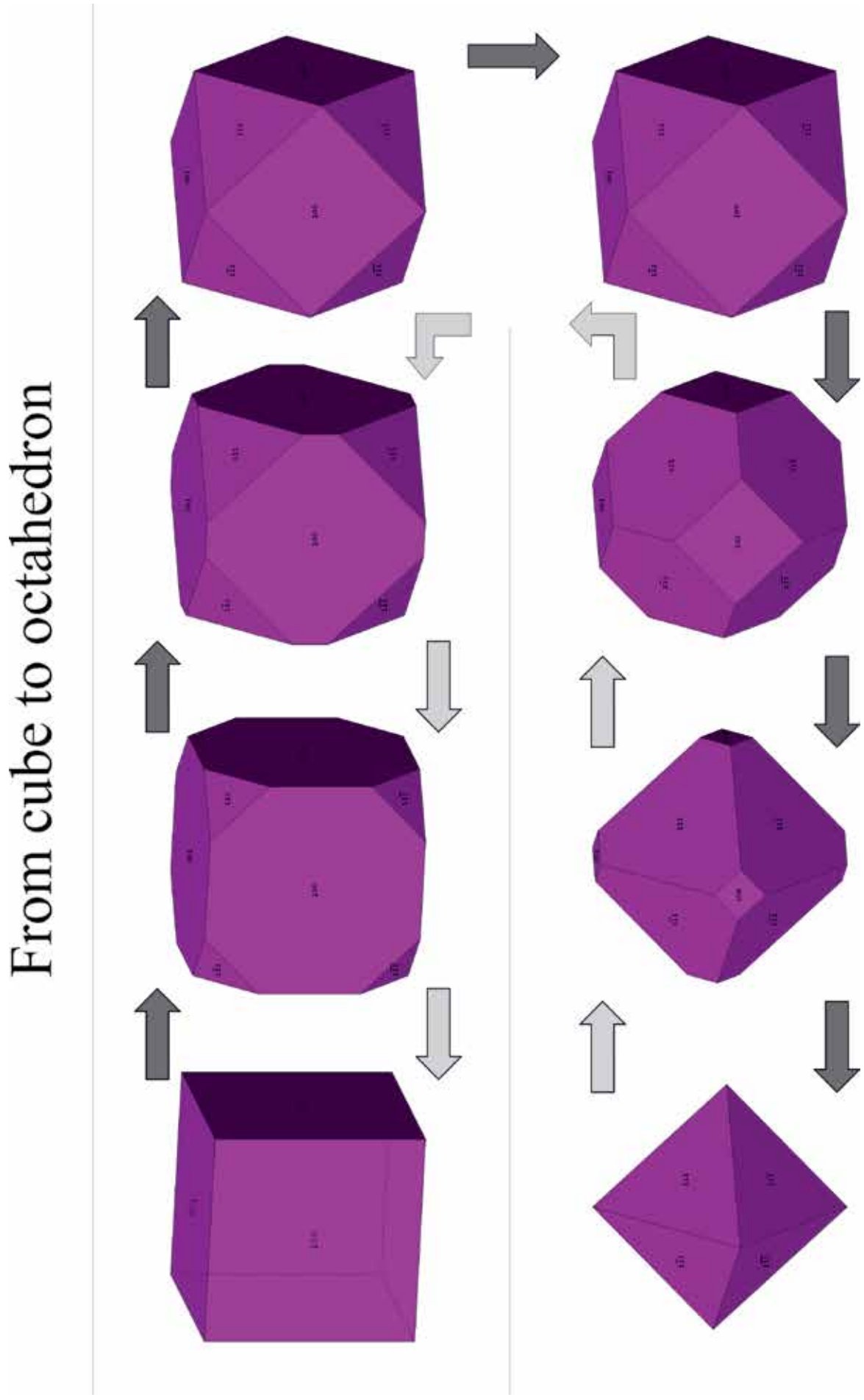
Three forms:



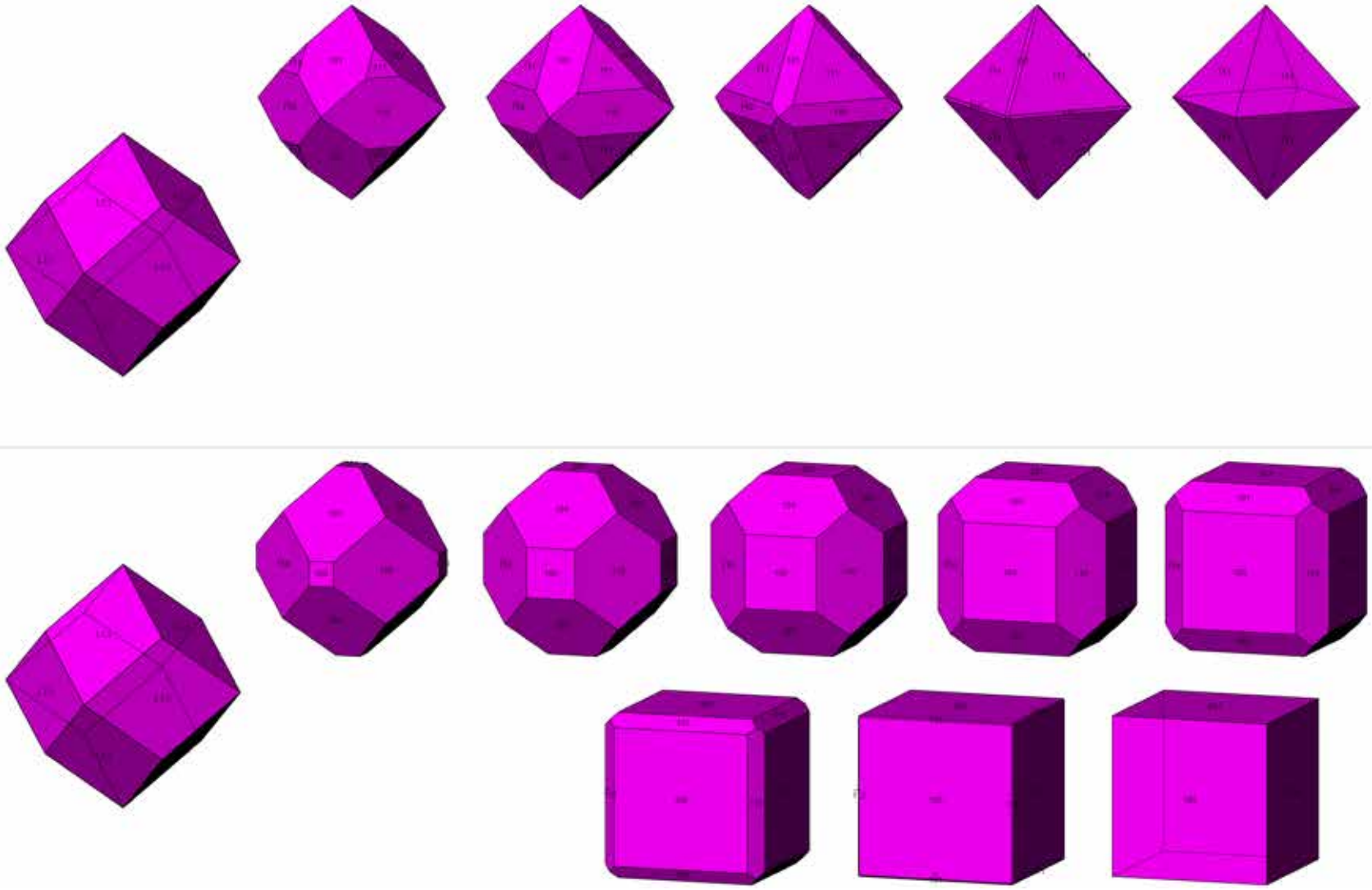
Combinations of flat and steep rhomboids

Vom Würfel zum Oktaeder



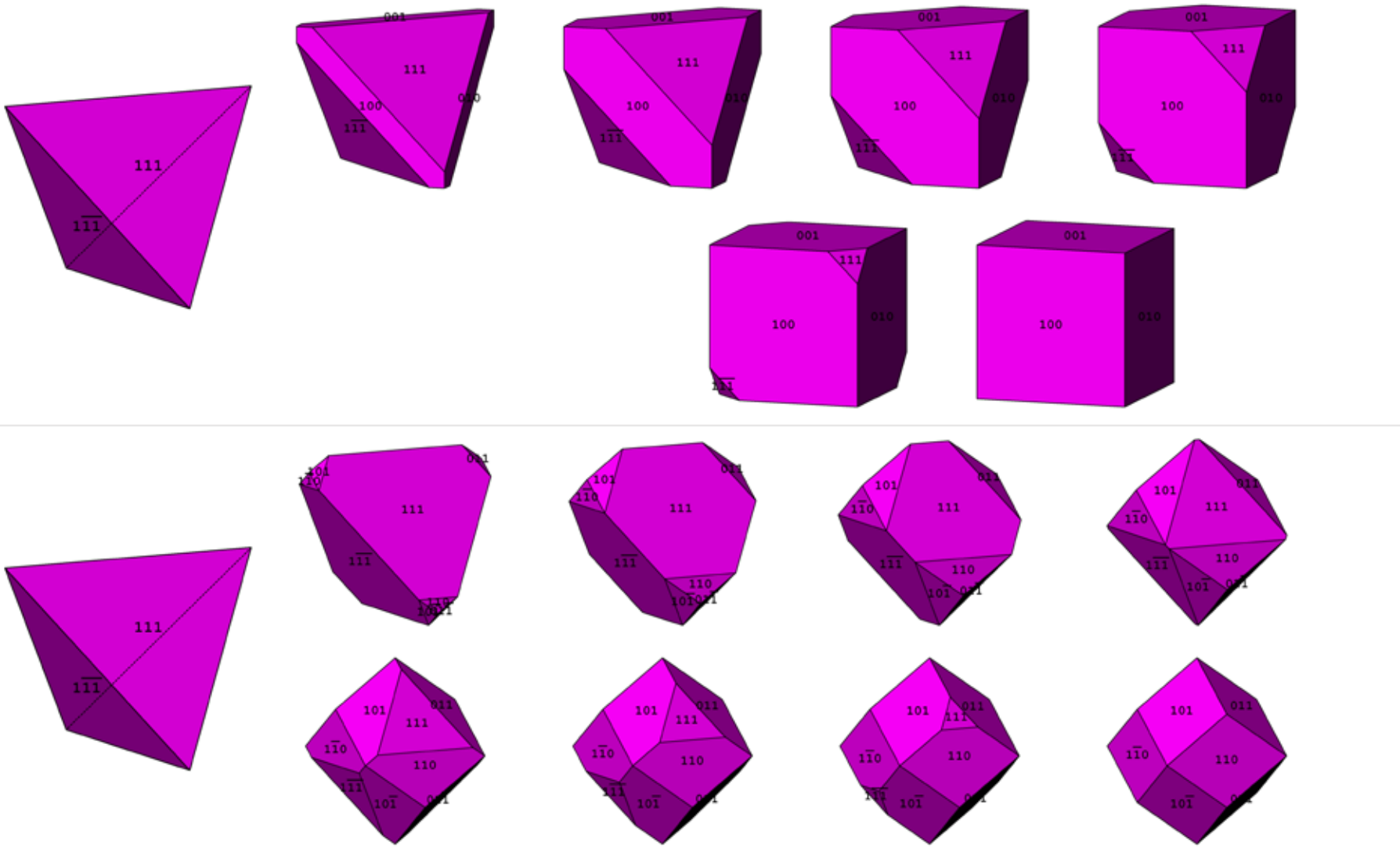

From cube to octahedron

Kombination des Rhombendodekaeder mit Oktaeder und Würfel

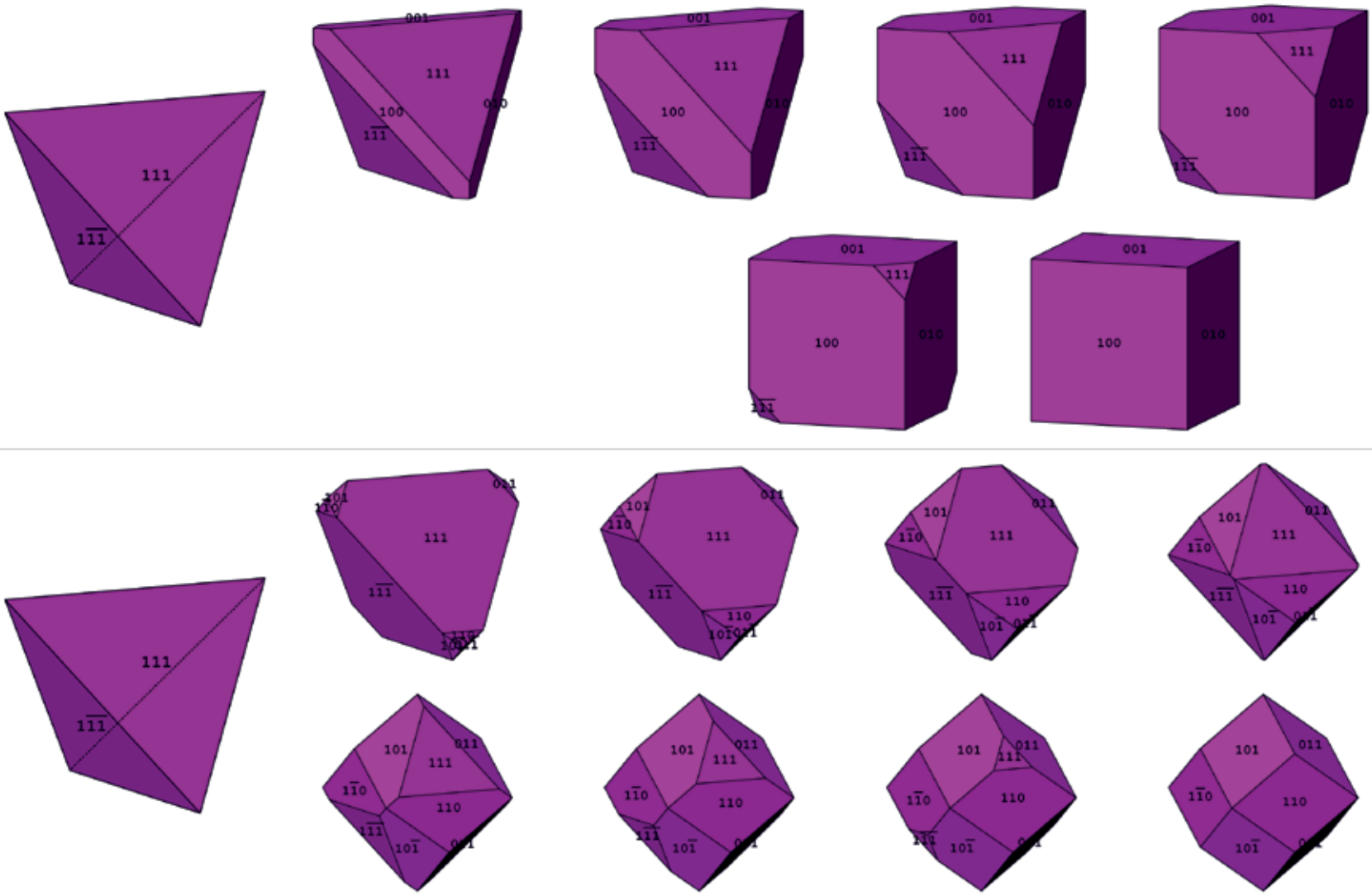


Combination of rhombic dodecahedron with octahedron and cube

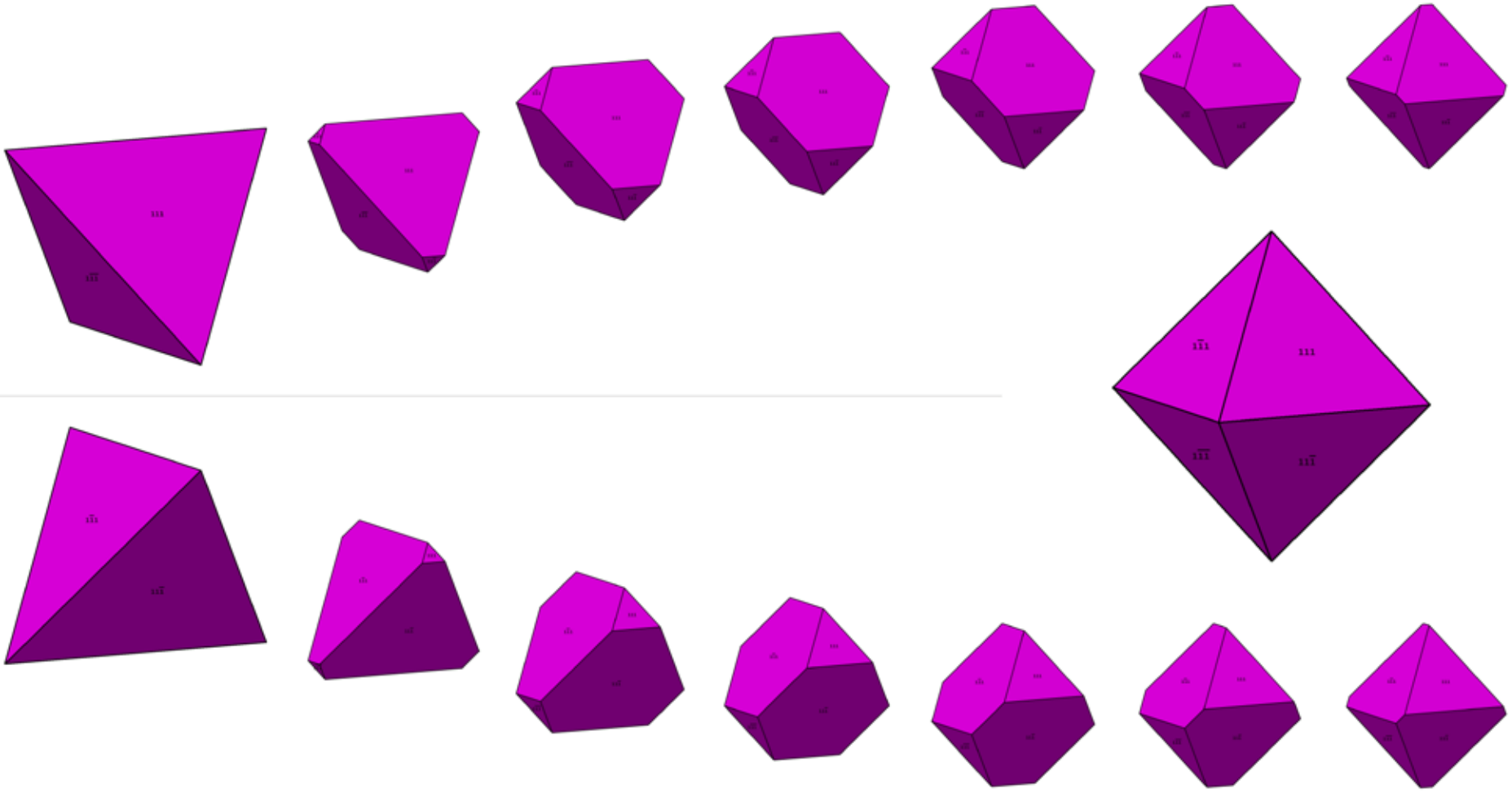
Kombination des Tetraeder mit Würfel und Rhombendodekaeder



Combination of tetrahedron with cube and rhombic dodecahedron

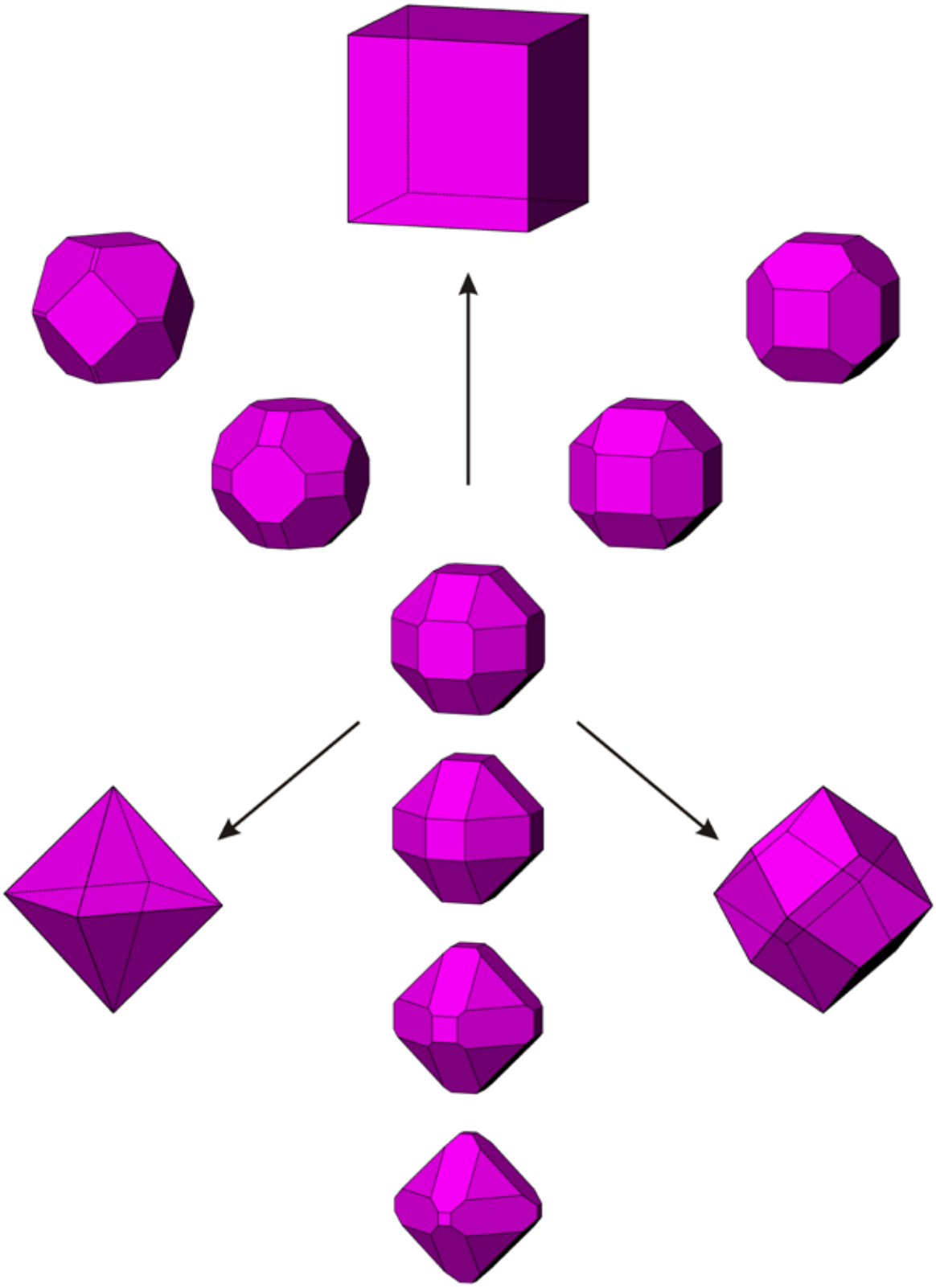


Kombination von positivem und negativem Tetraeder

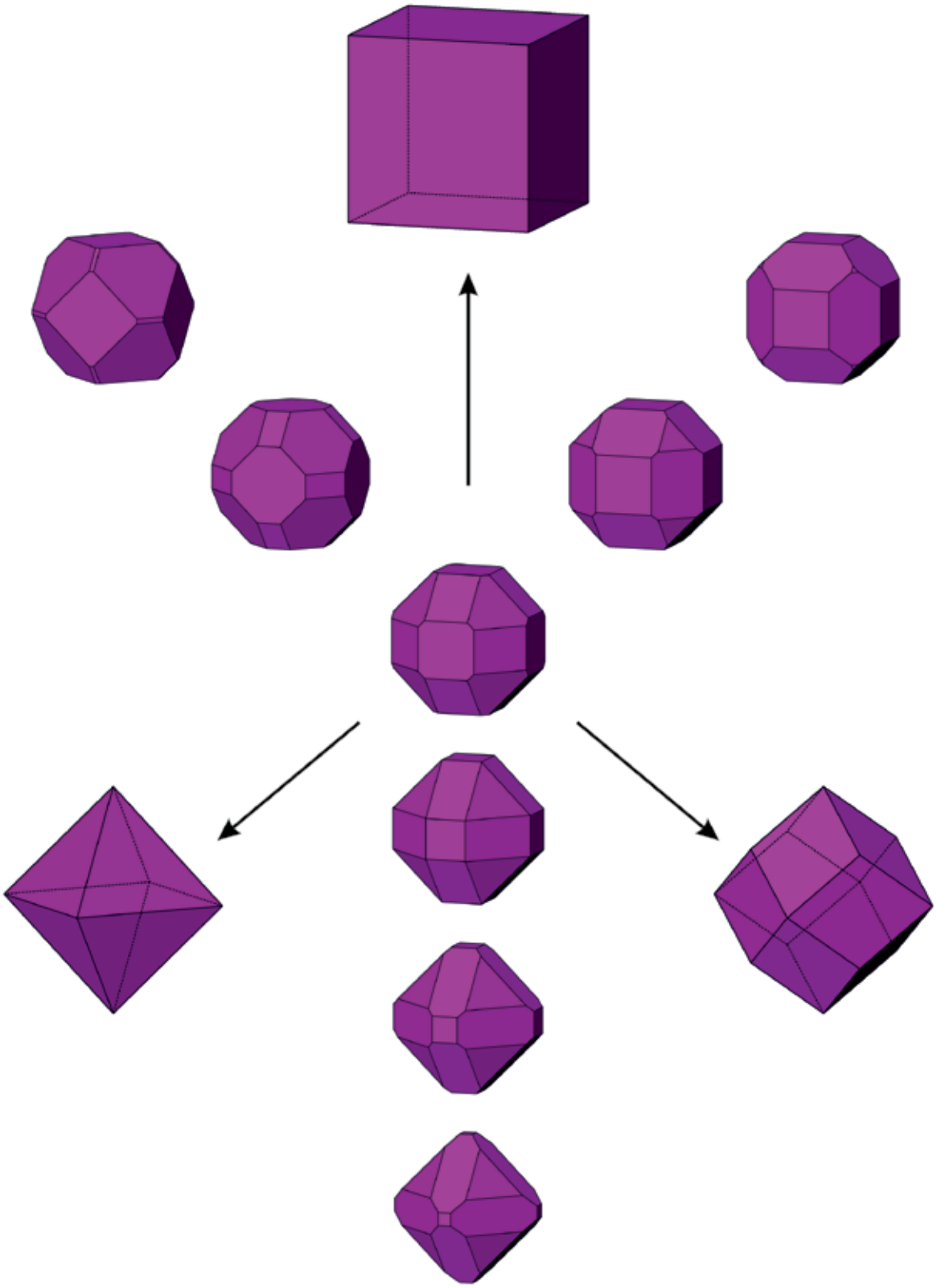


Combination of positive and negative tetrahedron

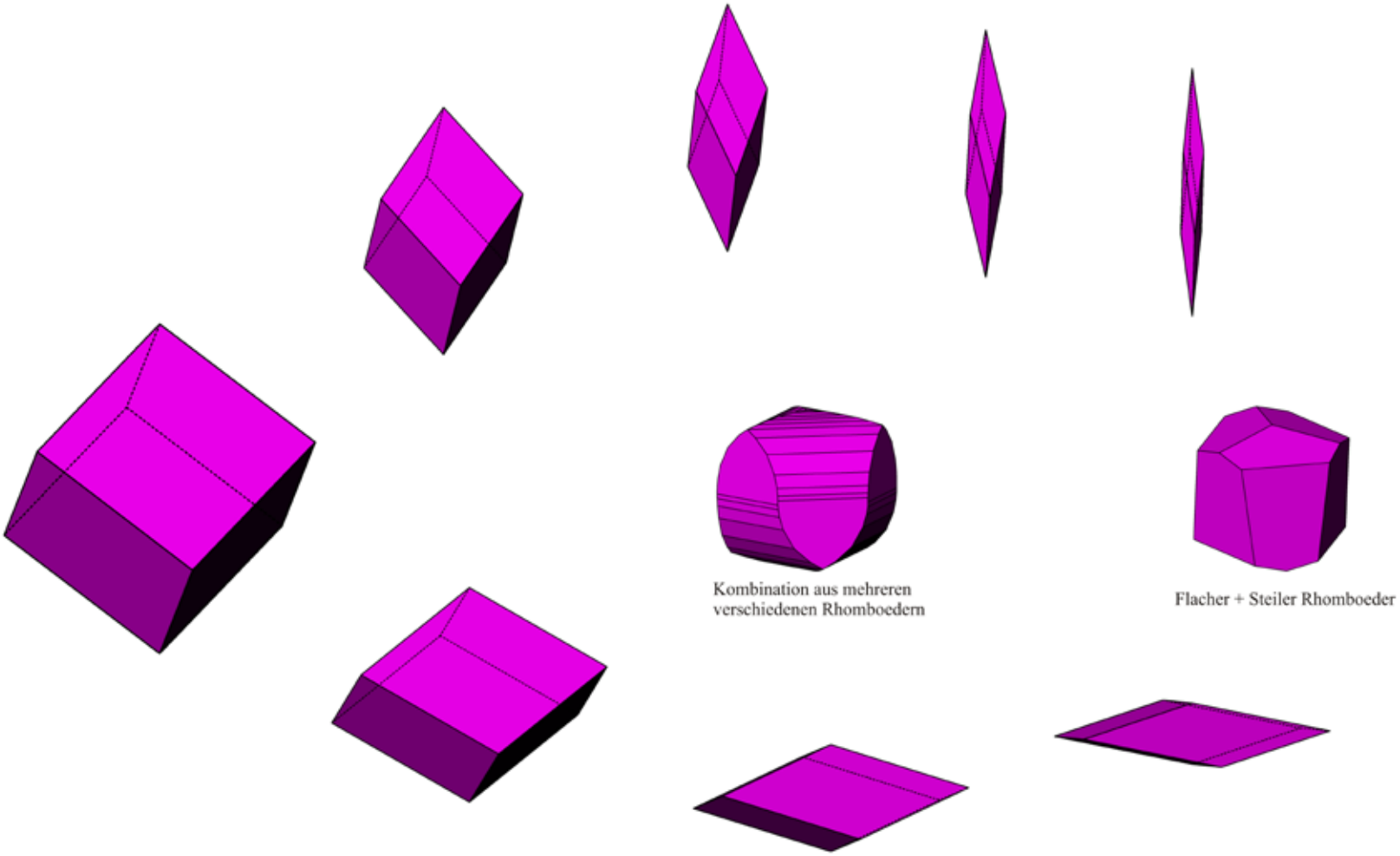
Kombinationen aus Würfel, Oktaeder
und Rhombendodekaeder



Combinationen of cube, octahedron
and rhombic dodecahedron



Verschieden steile und flache Rhomboeder

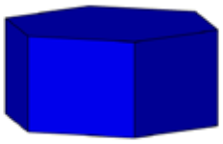


Different steep and flat rhombohedron
flat + steep rhombohedron
Combination of several
various rhomboids

Einige ausgewählte Formen und Kombinationen nach Mineralbeispielen

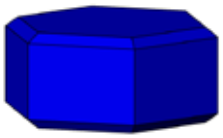
Some selected crystal forms and combinations using some mineral examples

Apatit:

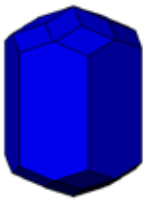


Hexagonales Prisma
Basispinakoid

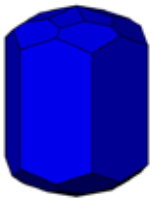
Hexagonales Prisma
Hex. Dipyramide I. St.
Hex. Dipyramide II. St.



Hexagonales Prisma
Basispinakoid
Hex. Dipyramide I. St.



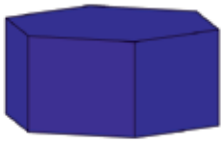
Hexagonales Prisma
Hex. Dipyramide I. St.
Hex. Dipyramide II. St.



Hexagonales Prisma
Hex. Dipyramide I. St.
Hex. Dipyramide II. St.

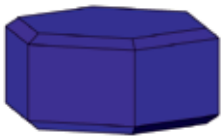
Chemische Zusammensetzung	: $Ca_5[(PO_4)_3(F,Cl,OH]$
Kristallsystem	: Hexagonal, 6/m
Elementarzelle	: a_o=9.38 Å, c_o=6.89 Å
Raumgruppe	: P 63/m
Ausbildung	: Derb, eingewachsen, körnig, kryptokristallin, krustenartig, xx säulig, dicktafelig, nadelig

Apatite:



Hexagonal prism
Basispinacoid

Hexagonal prism
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.



Hexagonal prism
Basispinacoid
Hex. dipyramid I. pos.

Hexagonal prism
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.

Hexagonal prism
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.

Chemical composition	: $Ca_5[(PO_4)_3(F,Cl,OH]$
Crystal system	: Hexagonal, 6/m
Elementary cell	: a_o=9.38 Å, c_o=6.89 Å
Space group	: P 63/m
Forms	: Massive, intergrown, granular, cryptocristalline, crusts, xx columnar, tabular, needles

Arsenopyrit:

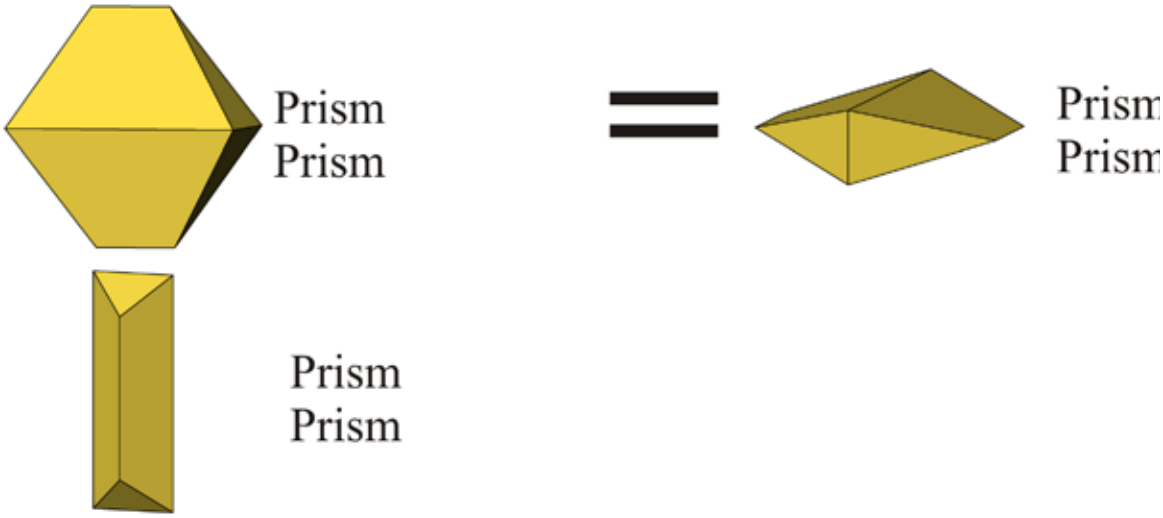
Prisma
Prisma

Prisma
Prisma

Prisma
Prisma

Chemische Zusammensetzung	: FeAsS
Kristallsystem	: Monoklin, pseudorhombisch
Elementarzelle	: ao= 5.74 Å, bo= 5.68 Å, co= 5.79 Å, ß = 112.17 o
Raumgruppe	: P 21/c
Ausbildung	: idiomorphe Kristalle, körnig

Arsenopyrite:



Chemical composition	: FeAsS
Crystal system	: Monoclinic, pseudorhombic
Elementary cell	: ao= 5.74 Å, bo= 5.68 Å, co= 5.79 Å, ß = 112.17 o
Space group	: P 21/c
Forms	: idiomorphic crystals, granular

Augit:

Pinakoid
Prisma
Pinakoid
Pinakoid
Prisma

=

Pinakoid
Prisma
Pinakoid
Pinakoid
Prisma

Chemische Zusammensetzung	: (Ca, Mg, Fe, Al, Ti) $[(Si, Al)_2O_6]$
Kristallsystem	: Monoklin
Elementarzelle	: a_o= 9.69 Å, b_o= 8,84 Å, c_o= 5.28 Å, ß = 106.3°
Raumgruppe	: C 2/c
Ausbildung	: Kurzprismatische bis tafelige xx, achteckige Querschnitt, oft zonar aufgebaut

Augite:

Pinacoid
Prism
Pinacoid
Pinacoid
Prism

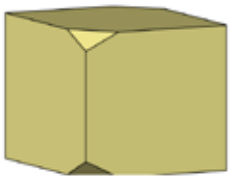
=

Pinacoid
Prism
Pinacoid
Pinacoid
Prism

Chemical composition	: (Ca, Mg, Fe, Al, Ti) $[(Si, Al)_2O_6]$
Crystal system	: monoclinic
Elementary cell	: a_o= 9.69 Å, b_o= 8,84 Å, c_o= 5.28 Å, ß = 106.3°
Space group	: C 2/c
Forms	: short prismatice to tabular xx, 8-cornered cross section, often zonal

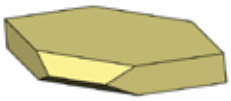
Baryt:

Basispinakoid
Prisma

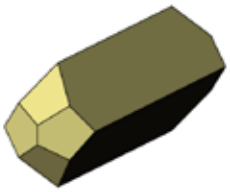


Basispinakoid
Prisma
Prisma

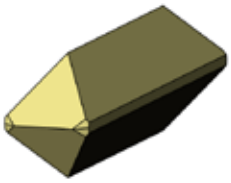
=



Basispinakoid
Prisma
Prisma



Prisma
Prisma
Prisma

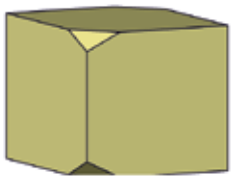


Prisma
Prisma
Pinakoid
Dipyramide

Chemische Zusammensetzung	: $BaSO_4$
Kristallsystem	: Rhombisch, 2/m 2/m 2/m
Elementarzelle	: a_o= 8.88Å, b_o= 5.45Å, c_o= 7.15Å
Raumgruppe	: P b n m
Ausbildung	: Dicht, feinkristallin, grobspätig, blättrig, xx meist tafelig oder meißelförmig

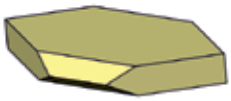
Baryte:

Basispinacoid
Prism

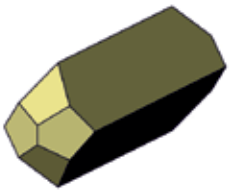


Basispinacoid
Prism
Prism

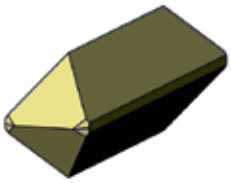
=



Basispinacoid
Prism
Prism



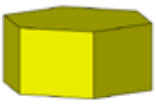
Prism
Prism
Prism



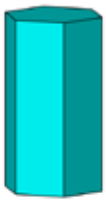
Prism
Prism
Pinacoid
Dipyramid

Chemical composition	: $BaSO_4$
Crystal system	: Rhombic, 2/m 2/m 2/m
Elementary cell	: a_o= 8.88Å, b_o= 5.45Å, c_o= 7.15Å
Space group	: P b n m
Forms	: compact, fine cristalline, spary, laminated, xx mostly tabular or chisel form

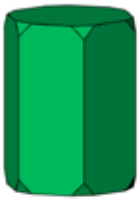
Beryll:



Hexagonales Prisma
Basispinakoid



Hexagonales Prisma
Basispinakoid



Hexagonales Prisma
Basispinakoid
Hex. Dipyramide II. St.

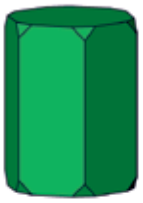
Hexagonales Prisma
Basispinakoid
Hex. Dipyramide I. St.
Hex. Dipyramide II. St.

Chemische Zusammensetzung	: Be_3Al_2 [Si_6O_{18}]
Kristallsystem	: hexagonal
Elementarzelle	: a_o= 9.22Å, c_o= 9.19Å
Raumgruppe	: P 6/m m c
Ausbildung	: säulig, stengelig, dominierend Prisma (1 0 – 1 0) und Pinakoid (0 0 0 1)

Beryl:

Hexagonal prism
Basispinacoid

Hexagonal prism
Basispinacoid



Hexagonal prism
Basispinacoid
Hex. dipyramid II. pos.

Hexagonal prisma
Basispinacoid
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.

Chemical composition	: Be_3Al_2 [Si_6O_{18}]
Crystal system	: hexagonal
Elementary cell	: a_o= 9.22Å, c_o= 9.19Å
Space group	: P 6/m m c
Forms	: columnar, columnar, dominating Prism (1 0 – 1 0) and Pinakoid (0 0 0 1)

Biotit:

Basispinakoid
Prisma
Pinakoid

=

Basispinakoid
Prisma
Pinakoid

Basispinakoid
Prisma
Pinakoid
Prisma

Chemische Zusammensetzung	: K $(Mg, Fe)_3[(OH)_2 / AlSi_3O_{10}]$
Kristallsystem	: Monoklin, trioktaedrisches Dreischichtsilikat
Elementarzelle	: a_o= 5.35 Å, b_o= 9.26 Å, c_o= 10.23 Å, ß = 100.3°
Raumgruppe	: C 2/m
Ausbildung	: Tafelig, plattig, schuppig

Biotite:

Basispinacoid
Prism
Pinacoid

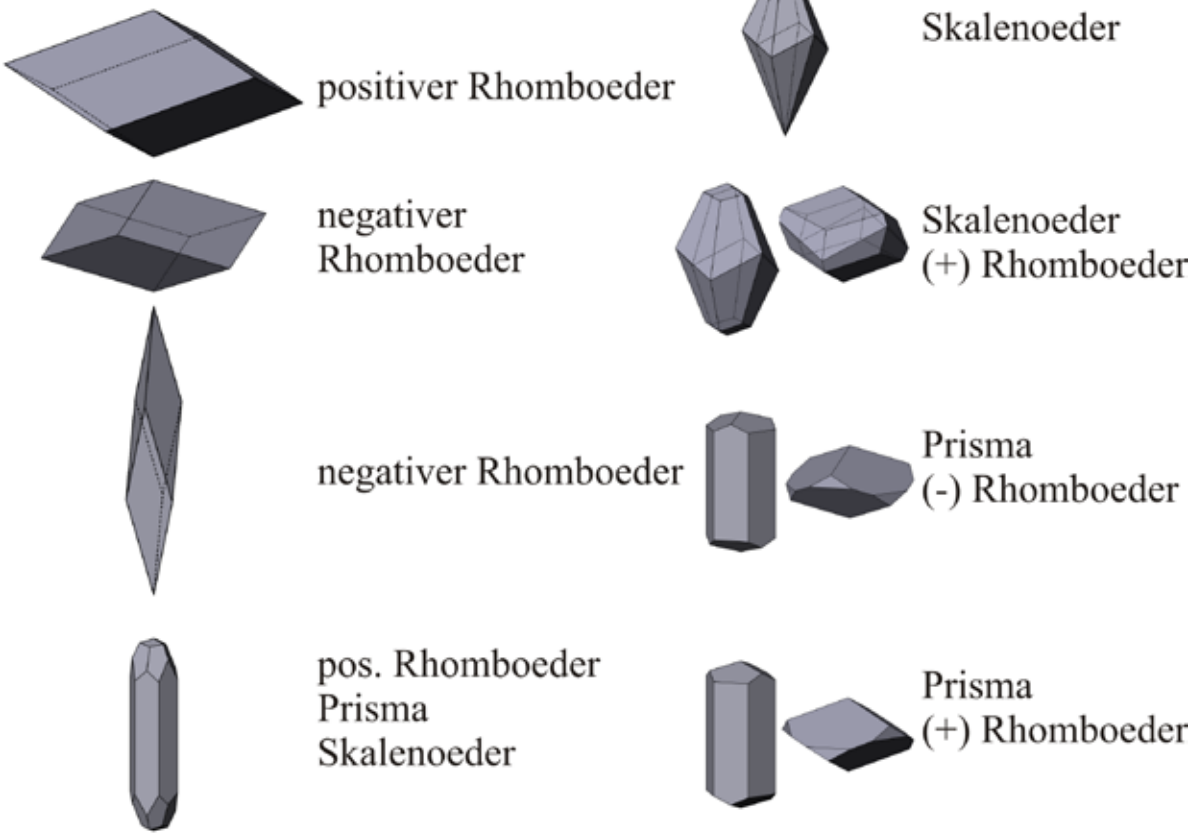
=

Basispinacoid
Prism
Pinacoid

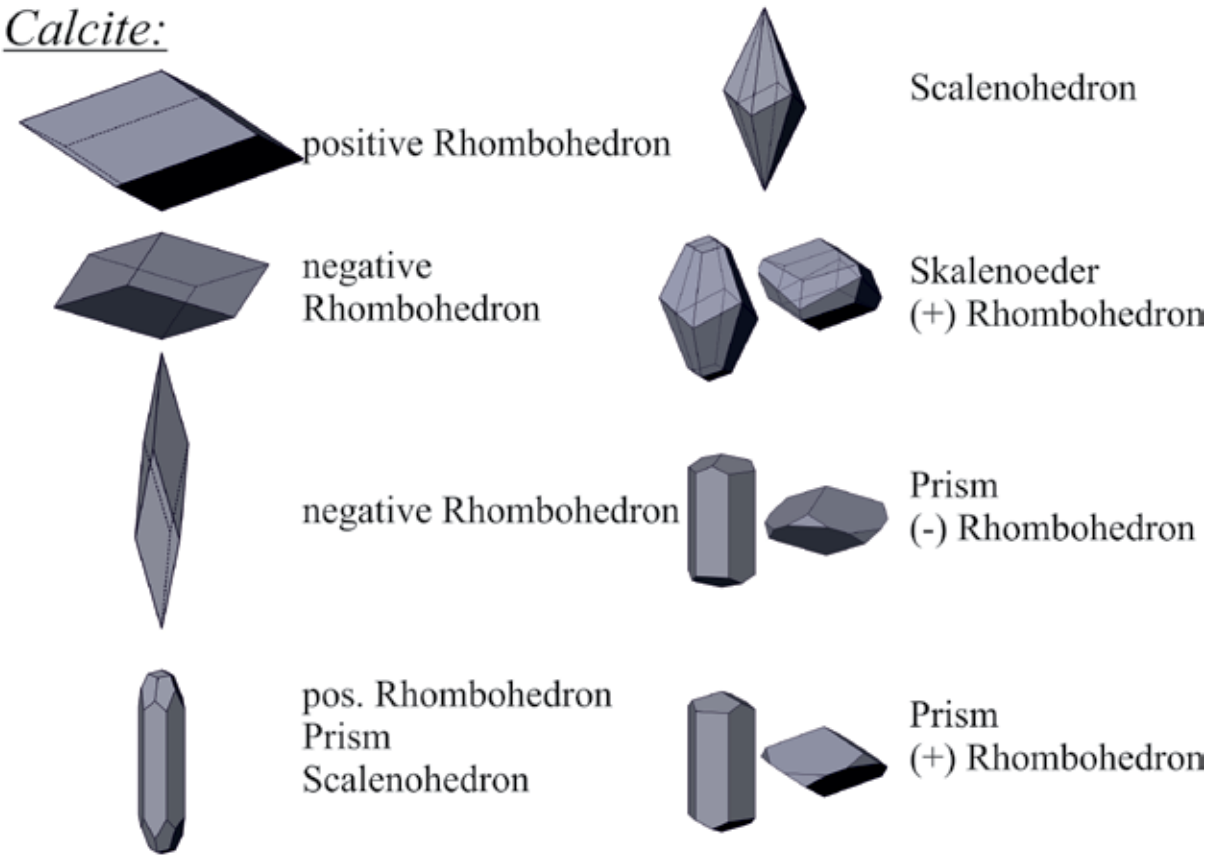
Basispinacoid
Prism
Pinacoid
Prism

Chemical composition	: K (Mg, Fe)$_3$[(OH)$_2$ / AlSi$_3$O$_{10}$]
Crystal system	: monoclinic, trioktaedric 3-layered silicate
Elementary cell	: a_o= 5.35 Å, b_o= 9.26 Å, c_o= 10.23 Å, ß = 100.3°
Space group	: C 2/m
Forms	: tabular, bladed, flaky

Calcit:

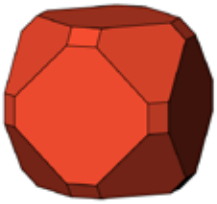


Chemische Zusammensetzung	: $CaCO_3$
Kristallsystem	: Trigonal, -3m
Elementarzelle	: a_o= 4.99, c_o= 17.06
Raumgruppe	: R-3c
Ausbildung	: Gesteinsbildend, dicht, oolithisch, derb grobspätig, sehr verschieden (formenreiches Mineral!),z.B. Rhomboeder und Skalenoeder, säulige xx u.a



Chemical composition	: $CaCO_3$
Crystal system	: trigonal, -3m
Elementary cell	: a_o= 4.99, c_o= 17.06
Space group	: R-3c
Forms	: Rock forming mineral, compact, oolithic, massive spaty, xx very different xx (different shapes of this Mineral!), example Rhombohedra and Scalenohedra, columnar xx a.o.

Cuprit:



Hexaeder
Oktaeder
Rhombendodekaeder

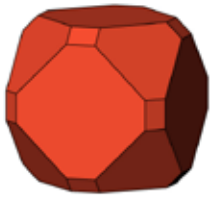
=

Hexaeder
Oktaeder
Rhombendodekaeder

Hexaeder
Oktaeder
Pentagonikositetraeder

Chemische Zusammensetzung	: Cu_2O
Kristallsystem	: Kubisch
Elementarzelle	: a_0=4.27 Å
Raumgruppe	: Pn3m
Ausbildung	: Derb, eingesprengt, Würfel, Oktaeder, nadelige

Cuprite:



Hexahedron
Octahedron
Rhombic dodecahedron

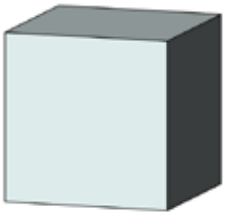
=

Hexahedron
Octahedron
Rhombic dodecahedron

Hexahedron
Octahedron
Pentagonal icositetrahedron

Chemical composition	: Cu_2O
Crystal system	: cubic
Elementary cell	: a_o=4.27 Å
Space group	: Pn3m
Forms	: passive, disseminated, cubes, octahedra, needle x

Diamant:



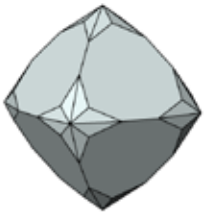
Hexaeder

Oktaeder

Rhombendodekaeder

Tetrakishexaeder

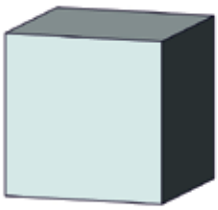
Hexakisoktaeder



Oktaeder
Hexakisoktaeder

Chemische Zusammensetzung	:	C
Kristallsystem	:	Kubisch
Elementarzelle	:	a_o= 3.559 Å
Raumgruppe	:	F d3m
Ausbildung	:	Oktaeder, Rhombendodekaeder, Würfel, meist abgerundet

Diamond:

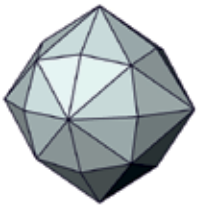


Hexahedron

Octahedron

Rhombic dodecahedron

Tetrakishexaeder

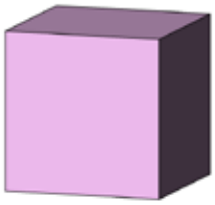


Hexakis octahedron

Octahedron
Hexakis octahedron

Chemical composition	:	C
Crystal system	:	cubic
Elementary cell	:	a_o= 3.559 Å
Space group	:	F d3m
Forms	:	octahedra, rhombic dodecaedron, cubes, xx mostly rounded

Fluorit:

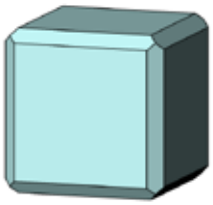


Hexaeder

Oktaeder

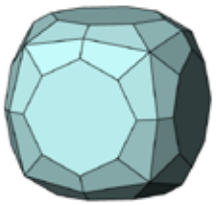
Hexaeder
Oktaeder

Oktaeder
Rhombendodekaeder



Hexaeder
Rhombendodekaeder

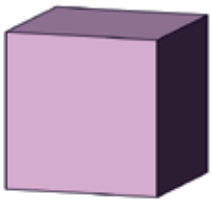
Tetrakisohexaeder



Hexaeder
Hexakisoktaeder

Chemische Zusammensetzung	: CaF_2
Kristallsystem	: Kubisch
Elementarzelle	: a_0= 5.46 Å
Raumgruppe	: F m3m
Ausbildung	: Derb, grobspätig, Würfel, Oktaeder, Rhombendodekaeder, oft grobkristallin

Fluorite:

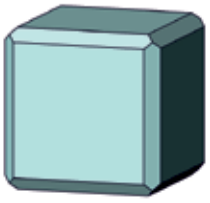


Hexahedron

Octahedron

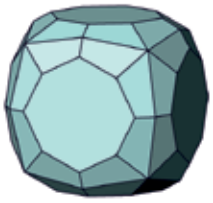
Hexahedron
Octahedron

Octahedron
Rhombic dodecahedron



Hexahedron
Rhombic dodecahedron

Tetrakis hexahedron



Hexahedron
Hexakis octahedron

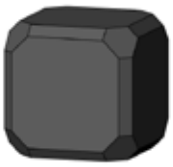
Chemical composition	: CaF_2
Crystal system	: cubic
Elementary cell	: a_o= 5.46 Å
Space group	: F m3m
Forms	: massive, grobspätig, cubes, octahedra, Rrhombic dodecahedron, often cristalline,

Galenit:

Oktaeder

Würfel

div.
Kub-Oktaeder



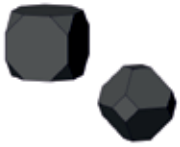
Würfel
Oktaeder
Rhombendodekaeder

Chemische Zusammensetzung	: PbS
Kristallsystem	: Kubisch, NaCl-Gitter
Elementarzelle	: a_o= 5.94 Å
Raumgruppe	: F m 3 m
Ausbildung	: Derb, eingesprengt, Würfel, Oktaeder, Rhombendodekaeder, oft Kombinationen

Galenite:

Octahedron

Cube

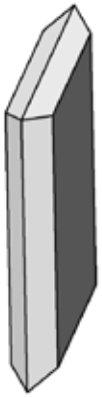


various
Cube-Octahedron

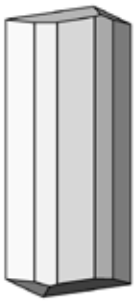
Cube
Octahedron
Rhombic dodecahedron

Chemical composition	: PbS
Crystal system	: cubic, NaCl-lattice
Elementary cell	: a_o= 5.94 Å
Space group	: F m 3 m
Forms	: massive, dissemnited, cubes, octahedra, rhombic dodecaedron, often combinations

Gips:



Prisma
Prisma
Pinakoid

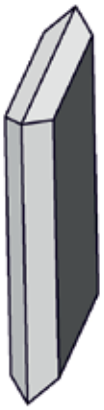


Prisma
Prisma
Prisma
Prisma
Pinakoid

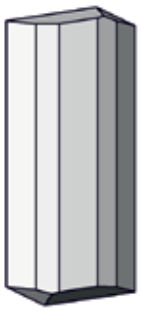
Prisma
Basispinakoid
Pinakoid

Chemische Zusammensetzung	: $CaSO_4 * 2H_2O$
Kristallsystem	: Monoklin, 2/m
Elementarzelle	: a_o= 5.68Å, b_o= 15.18Å, c_o= 6.89Å, ß =113.83
Raumgruppe	: A 2/a
Ausbildung	: Dicht, feinkörnig, faserig, xx nadelig, primatisch, tafelig, oft Schwalbenschwanzzwillinge

Gypsum:



Prism
Prism
Pinacoid



Prism
Prism
Prism
Prism
Pinacoid

Prism
Basispinacoid
Pinacoid

Chemical composition	: $CaSO_4 * 2H_2O$
Crystal system	: monoclinic, 2/m
Elementary cell	: a_o= 5.68Å, b_o= 15.18Å, c_o= 6.89Å, ß =113.83
Space group	: A 2/a
Forms	: compact, finely granular, fibrous, xx needles, primatic,tabular, often dove tail twins

Granat:

Rhombendodekaeder

Deltoidikositetraeder

Rhombendodekaeder
Deltoidikositetraeder

Rhombendodekaeder
Deltoidikositetraeder
Tetrakishexaeder
Hexakisoktaeder
Trisoktaeder

Chemische Zusammensetzung : $X_3Y_2[SiO_4]_3$
X: Mg, Fe^{2+}, Mn^{2+}, Ca (8er Koordinat.)
Y: Al, Fe^{3+}, Cr^{3+}, V^{3+} (6er Koordinat)
Für (SiO_4) auch (AlO_4) oder (OH)

Kristallsystem : Kubisch

Ausbildung : Rhombendodekaeder (110), Deltoidikositetraeder (211)

„Pyralspite“

Pyrop: $Mg_3Al_2[SiO_4]_3$

Almandin: $Fe_3Al_2[SiO_4]_3$

Spressartin: $Mn_3Al_2[SiO_4]_3$

“Ugrandite”

Uwarowit: $Ca_3Cr_2[SiO_4]_3$

Grossular: $Ca_3Al_2[SiO_4]_3$

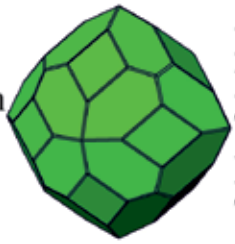
Andradit: $Ca_3Fe_2[SiO_4]_3$

Garnet:

Rhombic dodecahedron

Deltoidal icositetrahedron

Rhombic dodecahedron
Deltoidal
icositetrahedron



Rhombic dodecahedron
Deltoidal icositetrahedron
Tetrakis hexahedron
Hexakis octahedron
Trisoctahedron

Chemical composition : $X_3Y_2[SiO_4]_3$
X: Mg, Fe^{2+}, Mn^{2+}, Ca (8 coord.)
Y: Al, Fe^{3+}, Cr^{3+}, V^{3+} (6 coord.)
(SiO_4) replaced by (AlO_4) or (OH)
Crystal system : cubic
Forms : Rhombic dodecaedron (110), Deltoidikositetrahedron (211)

„Pyralspite“

Pyrop: $Mg_3Al_2[SiO_4]_3$

Almandin: $Fe_3Al_2[SiO_4]_3$

Spessartine: $Mn_3Al_2[SiO_4]_3$

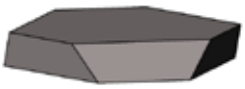
“Ugrandite”

Uwarowite: $Ca_3Cr_2[SiO_4]_3$

Grossular: $Ca_3Al_2[SiO_4]_3$

Andradite: $Ca_3Fe_2[SiO_4]_3$

Hämatit:



Rhomboeder
Basisspinakoid

=

Rhomboeder
Basisspinakoid

Dipyramide
Basisspinakoid

Rhomboeder
Dipyramide

Rhomboeder
Dipyramide
Rhomboeder

Chemische Zusammensetzung	: Fe_2O_3
Kristallsystem	: Trigonal
Elementarzelle	: a_o= 5.03Å, c_o=13.74Å
Raumgruppe	: R -3c
Ausbildung	: Erdig, schuppig, radialstrahlig, knollig, nierig, xx tafelig, plattig

Hematite:

Rhombohedron
Basispinacoid

Rhombohedron
Basispinacoid

Dipyramid
Basispinacoid

Rhombohedron
Dipyramid

Rhombohedron
Dipyramid
Rhombohedron

Chemical composition	: Fe_2O_3
Crystal system	: trigonal
Elementary cell	: a_o= 5.03Å, c_o=13.74Å
Space group	: R -3c
Forms	: earthy, flaky, radial, nodular, nierig, xx tabular, platy

Korund:

Prisma
Basispinakoid

Prisma
Basispinakoid
Dipyramide

Prisma
Basispinakoid
Dipyramide
Dipyramide
Rhomboeder

Chemische Zusammensetzung	: Al_2O_3
Kristallsystem	: Trigonal
Elementarzelle	: a_o=4.75 Å, c_o= 12.98 Å
Raumgruppe	: R-3c
Ausbildung	: Eingesprengt, säulige bis tonnenförmig, meist mit Flächenstreifung

Corundum:

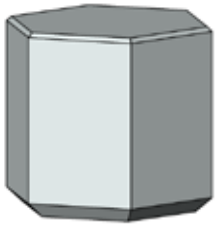
Prism
Basispinacoid

Prism
Basispinacoid
Dipyramid

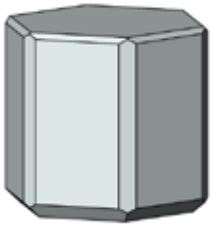
Prism
Basispinacoid
Dipyramid
Dipyramid
Rhombohedron

Chemical composition	: Al_2O_3
Crystal system	: Trigonal
Elementary cell	: a_o=4.75 Å, c_o= 12.98 Å
Space group	: R-3c
Forms	: disseminated, columnar to barrel like forms xx, mostly with streaking

Nephelin:



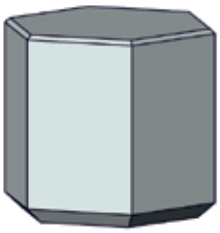
Prisma
Basispedion
Basispedion
Pyramide
Pyramide



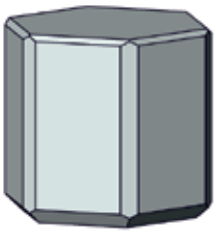
Prisma
Basispedion
Basispedion
Pyramide
Pyramide
Prisma

Chemische Zusammensetzung	: $KNa_3[Al\ SiO_4]_4$
Kristallsystem	: Hexagonal
Elementarzelle	: a_o= 9.99 Å, c_o= 8.37 Å
Raumgruppe	: P 6_3
Ausbildung	: Derb, selten säulig

Nepheline:



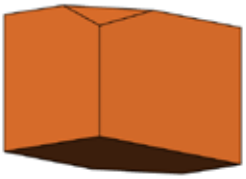
Prism
Basispedia
Basispedia
Pyramid
Pyramid



Prism
Basispedia
Basispedia
Pyramid
Pyramid
Prism

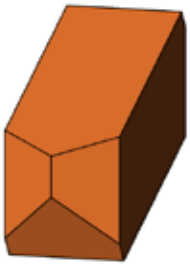
Chemical composition	: $KNa_3[Al\ SiO_4]_4$
Crystal system	: hexagonal
Elementary cell	: a_o= 9.99 Å, c_o= 8.37 Å
Space group	: P 6_3
Forms	: massive, rare column crystals xx

Orthoklas:



Prisma
Pinakoid
Pinakoid

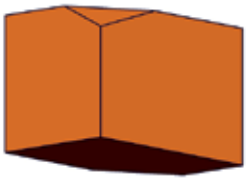
Prisma
Basispinakoid
Pinakoid
Pinakoid



Prisma
Pinakoid
Basispinakoid
Pinakoid

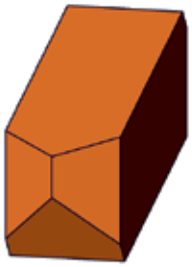
Chemische Zusammensetzung	: $K[Al\,Si_3O_8]$ „Kalifeldspat“
Kristallsystem	: Monoklin
Elementarzelle	: a_o= 8.62 Å, b_o= 12.99 Å, c_o= 7.19 Å, ß =116.02 °
Raumgruppe	: C 2/m
Ausbildung	: Gesteinsbildend, tafelig, prismatisch, häufig Zwillinge (Karlsbader, Manebacher, Bavenoer Gesetz)

Orthoclase:



Prism
Pinacoid
Pinacoid

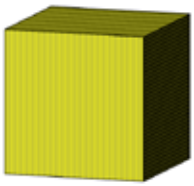
Prism
Basispinacoid
Pinacoid
Pinacoid



Prism
Pinacoid
Basispinacoid
Pinacoid

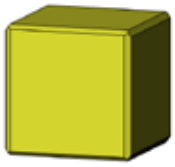
Chemical composition	: $K[Al\ Si_3O_8]$ „Kalifeldspat“
Crystal system	: monoclinic
Elementary cell	: a_o= 8.62 Å, b_o= 12.99 Å, c_o= 7.19 Å, ß =116.02 °
Space group	: C 2/m
Forms	: rockforming mineral, xx tabular, prismatic, common twins (Karlsbader, Manebacher, Bavenoer twin law)

Pyrit:



Würfel (Hexaeder) mit Flächenstreifung

Pentagondodekaeder



Pentagondodekaeder
Würfel (Hexaeder)

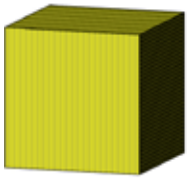
Pentagondodekaeder
Würfel (Hexaeder)

Pentagondodekaeder
Oktaeder
= “Pseudo-Ikosaeder”

Pentagondodekaeder
Oktaeder

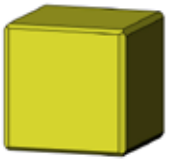
Chemische Zusammensetzung	: FeS_2
Kristallsystem	: Kubisch: Struktur: ähnlich NaCl, S_2-Hanteln liegen parallel (1 1 1)
Elementarzelle	: a_o= 5.42 Å
Raumgruppe	: P a 3
Ausbildung	: Derb, eingesprengt, Würfel (oft mit Flächenstreifung), Oktaeder, Pentagondodekaeder

Pyrite:



Cube (hexahedron) with surface stripping

Pentagonal dodecahedron



Pentagonal dodecahedron
Cube (hexahedron)

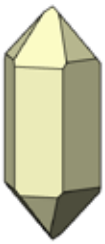
Pentagonal dodecahedron
Cube (hexahedron)

Pentagonal dodecahedron
Octahedron
= "Pseudo-icosahedron"

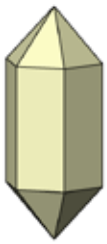
Pentagonal dodecahedron
Octahedron

Chemical composition	: FeS_2
Crystal system	: cubic Structure; similar to NaCl, S_2-barbells parallel (1 1 1)
Elementary cell	: a_o= 5.42 Å
Space group	: P a 3
Forms	: massive, disseminated, cubes, (often with plane striations), octahedron, pentagonal dodecahedron

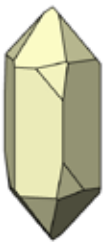
Quarz:



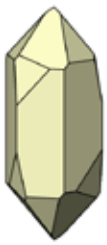
Hexagonales Prisma
pos. Rhomboeder
neg. Rhomboeder



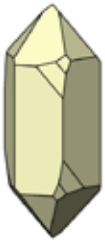
Hexagonales Prisma
Hex. Dipyramide
Hochquarz!
(andere Symetrie)



Hexagonales Prisma
pos. Rhomboeder
neg. Rhomboeder
rechter Trapezoeder

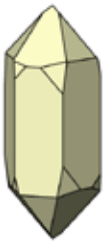


Hexagonales Prisma
pos. Rhomboeder
neg. Rhomboeder
linker Trapezoeder



Hexagonales Prisma
pos. Rhomboeder
neg. Rhomboeder
rechter Trapezoeder
rechte Dipyramide

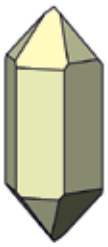
Hexagonales Prisma
pos. Rhomboeder
neg. Rhomboeder
linker Trapezoeder
linke Dipyramide



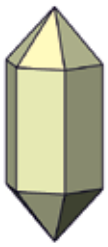
Hexagonales Prisma
pos. Rhomboeder
neg. Rhomboeder
“linker”
“rechter” Trapezoeder

Chemische Zusammensetzung	: SiO_2
Kristallsystem	: Trigonal
Elementarzelle	: a_o= 4.91 Å, c_o= 5.40 Å
Raumgruppe	: $P\,3_1\,2\,1$, $P\,3_2\,2\,1$
Ausbildung	: derb, schöne Kristalle, z.T. wasserklar

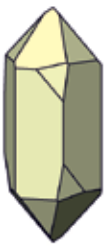
Quartz:



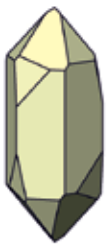
Hexagonal prism
pos. rhombohedron
neg. rhombohedron



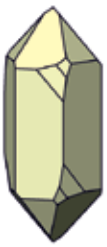
Hexagonal prism
Hex. dipyramid
high quartz!
(other symmetry)



Hexagonal prism
pos. rhombohedron
neg. rhombohedron
right trapezohedron



Hexagonal prism
pos. rhombohedron
neg. rhombohedron
left trapezohedron



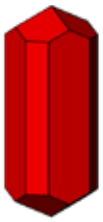
Hexagonal prism
pos. rhombohedron
neg. rhombohedron
right trapezohedron
right dipyramid

Hexagonal prism
pos. rhombohedron
neg. rhombohedron
left trapezohedron
left dipyramid

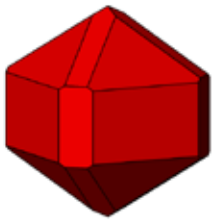
Hexagonal prism
pos. rhombohedron
neg. rhombohedron
"left"
"right" Trapezohedron

Chemical composition	: SiO_2
Crystal system	: trigonal
Elementary cell	: a_o= 4.91 Å, c_o= 5.40 Å
Space group	: P 3_1 2 1 , P 3_2 2 1
Forms	: massive, nice crystals, partially clear transparent

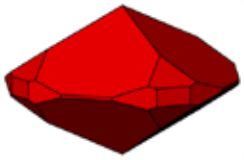
Rutil:



Prisma
Prisma
Dipyramide



Prisma
Prisma
Dipyramide
Dipyramide

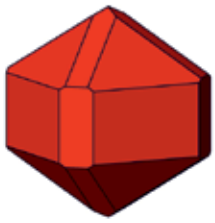


Prisma
Prisma
Dipyramide
Dipyramide
ditetragonales Prisma

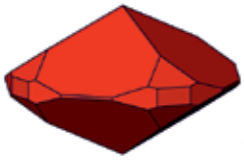
Chemische Zusammensetzung	: TiO_2
Kristallsystem	: Tetragonal
Elementarzelle	: a_o=4.594Å, c_o=2.958Å
Raumgruppe	: P 4/ m n m
Ausbildung	: Derb, nadelige, stengelig, häufig Verzwilligung (Winkel 120°)

Rutile:

Prism
Prism
Dipyramid



Prism
Prism
Dipyramid
Dipyramid

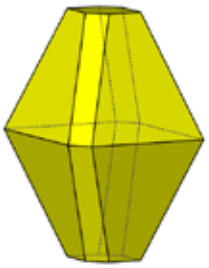


Prism
Prism
Dipyramid
Dipyramid
Ditetragonal prism

Chemical composition	: TiO_2
Crystal system	: tetragonal
Elementary cell	: a_o=4.594Å, c_o=2.958Å
Space group	: P 4/ m n m
Forms	: massive, nadelige, columnar, common twins (angle 120°), gratlike aggregates

Schwefel:

Dipyramide



Dipyramide
Basispinakoid
Prisma

Dipyramide
Dipyramide
Basispinakoid
Prisma

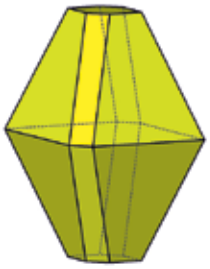
=

Kopfbild
Dipyramide
Dipyramide
Basispinakoid
Prisma

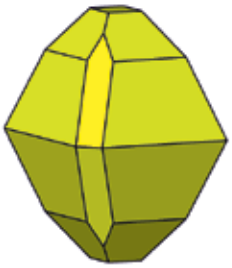
Chemische Zusammensetzung	:	S
Kristallsystem	:	orthorhombisch
Elementarzelle	:	a_o= 10.45 Å, bo= 12.85 Å, c_o= 24.46 Å
Raumgruppe	:	F ddd
Besonderheiten	:	bis 95° orthorhombisch, ab 95° monoklin, Schmelzpunkt 119,2 °C Ringförmige S_8-Moleküle, zwischen den Molekülen nur Van-der-Waalsche Bindung
Ausbildung	:	Derbe, dichte, erdige Aggregate, pyramidale und sphenoidische xx

Sulfur:

Dipyramid



Dipyramid
Basispinacoid
Prism



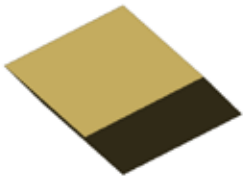
Dipyramid
Dipyramid
Basispinacoid
Prism

=

Headshot
Dipyramid
Dipyramid
Basispinacoid
Prism

Chemical composition	:	S
Crystal system	:	orthorhombic
Elementary cell	:	a_o= 10.45 Å, bo= 12.85 Å, c_o= 24.46 Å
Space group	:	F ddd
Specials	:	up to 95° orthorhombic, ab 95° monoclinic, Melting point 119,2 °C Ringlike S_8-Molecules, between molecules only Van-der-Waalsche Bonding
Forms	:	massive, compact, earthy aggregates, pyramidal and sphenoidic xx

Siderit:



Rhomboeder

Rhomboeder
Skalenoeder

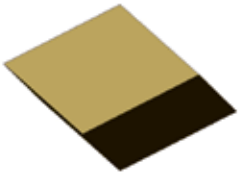
Rhomboeder
Skalenoeder
Skalenoeder
Rhomboeder

Rhomboeder
Basispinakoid

Rhomboeder
Basispinakoid
Rhomboeder
Skalenoeder

Chemische Zusammensetzung	:	$FeCO_3$
Kristallsystem	:	Trigonal, -3m
Elementarzelle	:	a_o= 4.72, c_o= 15.46
Raumgruppe	:	R -3c
Ausbildung	:	Feinkörnig bis grobspätig, rhomboedrische xx

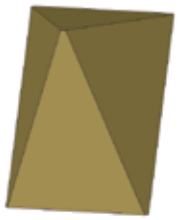
Siderite:



Rhombohedron

Rhombohedron
Scalenohedron

Rhombohedron
Scalenohedron
Scalenohedron
Rhombohedron



Rhombohedron
Basispinacoid

Rhombohedron
Basispinacoid
Rhombohedron
Scalenohedron

Chemical composition	: $FeCO_3$
Crystal system	: trigonal, -3m
Elementary cell	: a_o= 4.72, c_o= 15.46
Space group	: R -3c
Forms	: Fine granular, spaty, rhomboedric xx

Staurolith:

Prisma
Basispinakoid
Pinakoid
Prisma

Prisma
Basispinakoid
Pinakoid
Prisma

=

Prisma
Basispinakoid
Pinakoid
Prisma

Chemische Zusammensetzung	: $(Fe,Mg)_2Al_9(Si,Al)_4O_{20}(O,OH)_2$
Kristallsystem	: Monoklin
Elementarzelle	: a_o= 7.863 Å, b_o= 16.61 Å, c_o= 5.65 Å, ß =90-93°
Raumgruppe	: C 2/m
Ausbildung	: Gesteinsbildend, tafelig, prismatisch, häufig

Staurolite:

Prism
Basispinacoid
Pinacoid
Prism

Prism
Basispinacoid
Pinacoid
Prism

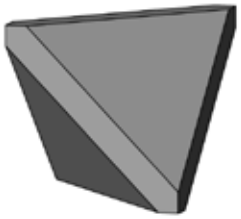
=

Prism
Basispinacoid
Pinacoid
Prism

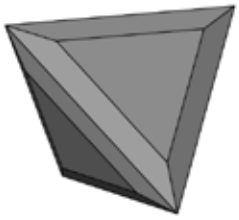
Chemical composition	: Staurolite $(Fe,Mg)_2Al_9(Si,Al)_4O_{20}(O,OH)_2$
Crystal system	: monoclinic
Elementary cell	: a_o= 7.863 Å, b_o= 16.61 Å, c_o= 5.65 Å, ß =90-93 °
Space group	: C 2/m
Forms	: Rock forming mineral, xx tabular, prismatic, common

Tetraedrit:

Tetraeder



Tetraeder
Hexaeder



Tetraeder
Tristetraeder

Tetraeder
Tristetraeder
Rhomboeder

Chemische Zusammensetzung	: $Cu_{12}Sb_4S_{13}$, z. T. mit Ag-, Hg, Zn-Gehalten
Kristallsystem	: kubisch
Elementarzelle	: a_o=10.36 Å
Raumgruppe	: I -4 3 m
Ausbildung	: derb, tetraedr. Ausbildung, mit Calcit, Quarz verwachsen

Tetraedrite:

Tetrahedron

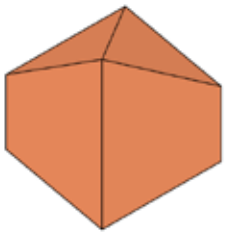
Tetrahedron
Hexahedron

Tetrahedron
Tristetrahedron

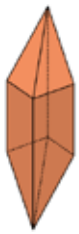
Tetrahedron
Tristetrahedron
Rhombohedron

Chemical composition	: $Cu_{12}Sb_4S_{13}$, z. T. with Ag-, Hg, Zn-Content
Crystal system	: cubic
Elementary cell	: a_o=10.36 Å
Space group	: I -4 3 m
Forms	: massive, tetraedr. Forms, with calcite, quartz , intergrown

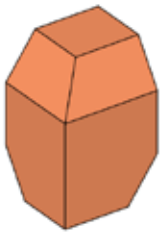
Titanit:



Prisma
Prisma



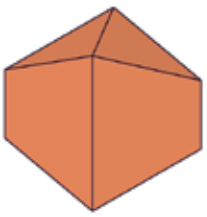
Prisma
Prisma



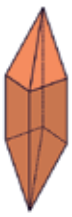
Prisma
Basispinakoid
Prisma

Chemische Zusammensetzung	:	CaTi [O / SiO_4]
Kristallsystem	:	Monoklin
Elementarzelle	:	a_o=7.06Å, b_o=8,71 Å, c_o=6.56Å, ß =113.8 °
Raumgruppe	:	$P2_1/a$
Ausbildung	:	Eingesprengter, oft Briefkuvertförmig, stengelig, tafelig

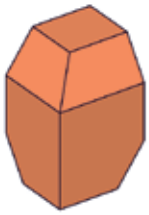
Titanite:



Prism
Prism



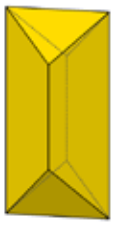
Prism
Prism



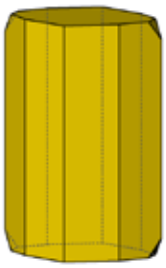
Prism
Basispinacoid
Prism

Chemical composition	:	CaTi [O / SiO_4]
Crystal system	:	monoclinic
Elementary cell	:	a_o=7.06Å, b_o=8,71 Å, c_o=6.56Å, ß =113.8 °
Space group	:	$P2_1/a$
Forms	:	disseminated, xx often envelope shape, columnar, tabular

Topas:



Prisma
Basispinakoid



Prisma
Prisma
Basispinakoid
Prisma

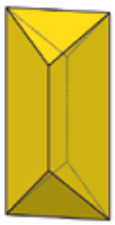
Prisma
Prisma
Basispinakoid
Prisma
Pinakoid

=

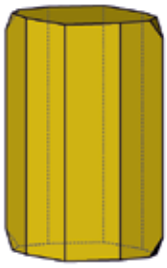
Prisma
Prisma
Basispinakoid
Prisma
Pinakoid

Chemische Zusammensetzung	:	$Al_2 [F_2 / SiO_4]$
Kristallsystem	:	Orthorhombisch
Elementarzelle	:	a_o= 4.65Å, b_o= 8.8Å, c_o= 8.4Å
Raumgruppe	:	P b n m
Ausbildung	:	Körnig, stengelig, prismatisch, meißelförmig

Topaz:



Prism
Basispinacoid



Prism
Prism
Basispinacoid
Prism

Prism
Prism
Basispinacoid
Prism
Pinacoid

=

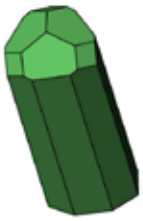
Prism
Prism
Basispinacoid
Prism
Pinacoid

Chemical composition	: Al_2 [F_2 / SiO_4]
Crystal system	: orthorhombic
Elementary cell	: a_o= 4.65Å, b_o= 8.8Å, c_o= 8.4Å
Space group	: P b n m
Forms	: grains, xx columnar, prismatic, chisel forms

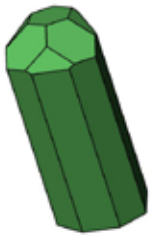
Turmalin:

versch. Köpfe:

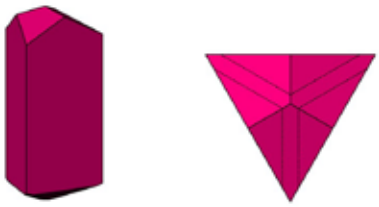
Basispedion
Trigonales Prisma
Hexagonales Prisma



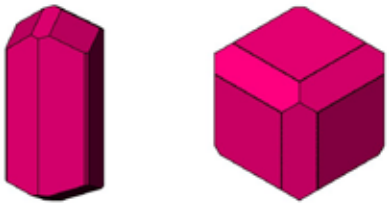
Pyramide
Pyramide
Trigonales Prisma
Hexagonales Prisma



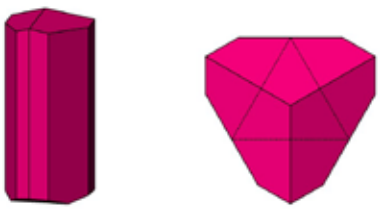
Pyramide
Pyramide
Trigonales Prisma
Hexagonales Prisma



Pyramide
Trigonales Prisma
Pyramide
Pyramide



Pyramide
Pyramide
Trigonales Prisma
Pyramide
Pyramide



Pyramide
Trigonales Prisma
Hexagonales Prisma
Pyramide
Basispedion

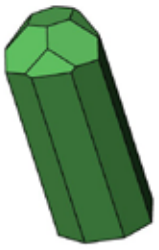
Chemische Zusammensetzung	: XY_3Z_6 [$(OH, F)_4$ / $(BO_3)_3$ / Si_6O_{18}] X: Na, Ca; Y: Mg, Li, Fe, Mn, Al; Z: Al, Fe, Cr
Kristallsystem	: Trigonal, polare c-Achse
Elementarzelle	: a_o= 15.92Å, c_o= 7.19Å
Raumgruppe	: R 3 m
Ausbildung	: Säulige, Stängelige, nadelige xx, radialstrahlig deutl. erkennbare Längsstreifung

Tourmaline:

various heads:

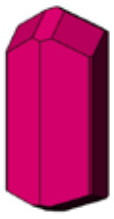
Basispedia
Trigonal prism
Hexagonal prism

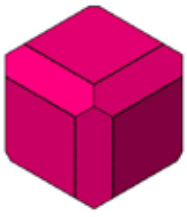
Pyramid
Pyramid
Trigonal prism
Hexagonal prism



Pyramid
Pyramid
Trigonal prism
Hexagonal prism

Pyramid
Trigonal prism
Pyramid
Pyramid



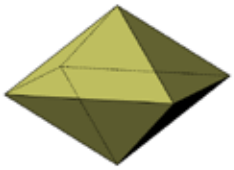


Pyramid
Pyramid
Trigonal prism
Pyramid
Pyramid

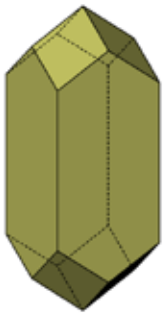
Pyramid
Trigonal prism
Hexagonal prism
Pyramid
Basispedia

Chemical composition	: XY_3Z_6 [$(OH, F)_4$ / $(BO_3)_3$ / Si_6O_{18}] X: Na, Ca; Y: Mg, Li, Fe, Mn, Al; Z: Al, Fe, Cr
Crystal system	: Trigonal, polare c-Achse
Elementary cell	: a_o= 15.92Å, c_o= 7.19Å
Space group	: R 3 m
Forms	: columnar, needles, radial, perfect columnar, needles, radial

Zirkon:



Dipyramide



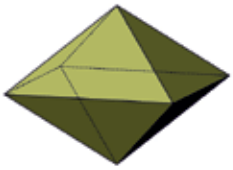
Dipyramide
und Prisma
I. Stellung

Dipyramide
und Prisma
II. Stellung

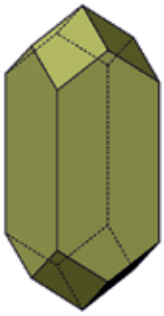
Dipyramide
Prisma I. St.
Prisma II. St.

Chemische Zusammensetzung	:	$ZrSiO_4$, enthält diadoch Hf, SEE
Kristallsystem	:	Tetragonal
Elementarzelle	:	a_o= 6.60 Å, c_o= 5.98Å
Raumgruppe	:	I 4_1/a m d
Ausbildung	:	Körner, häufig idiomorph, kurzsäulig, prismatisch

Zircon:

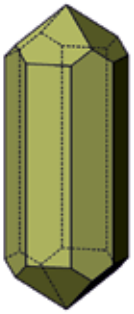


Dipyramid



Dipyramid
and prism
I. position

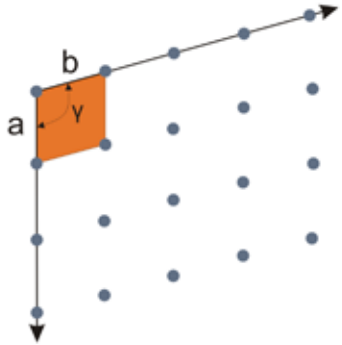
Dipyramid
and prism
II. position

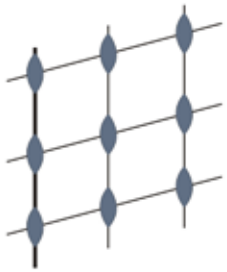


Dipyramid
Prism I. pos.
Prism II. pos.

Chemical composition	: $Zr[SiO_4]$, contains diadochic Hf, REE
Crystal system	: tetragonal
Elementary cell	: a_o= 6.60 Å, c_o= 5.98Å
Space group	: I 4_1/a m d
Forms	: grains, common idiomorphic xx, short columnar, prismatic

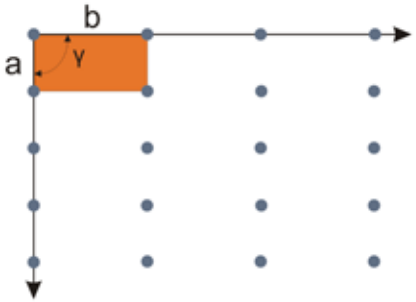
Schiefes Netz
a ≠ b
γ ≠ 90°

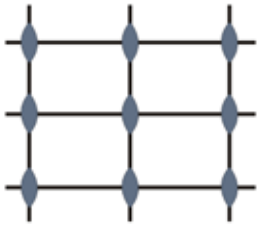




p2

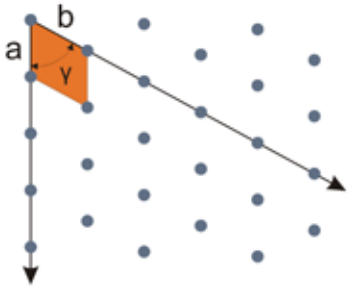
Rechtwinkliges Netz
a ≠ b
γ = 90°

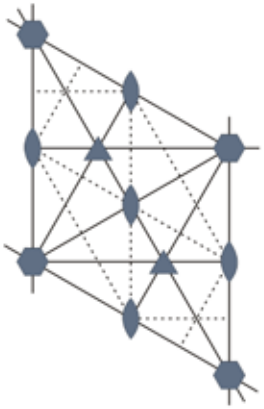




p2mm

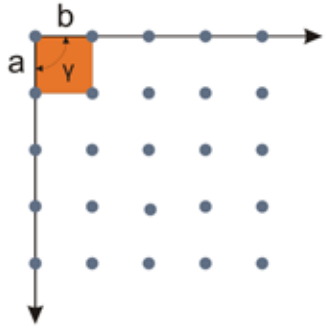
Hexagonales Netz
a = b
γ = 60°

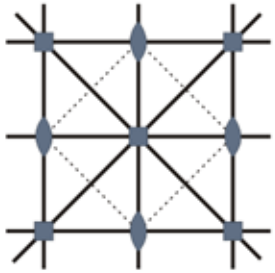




p6mm

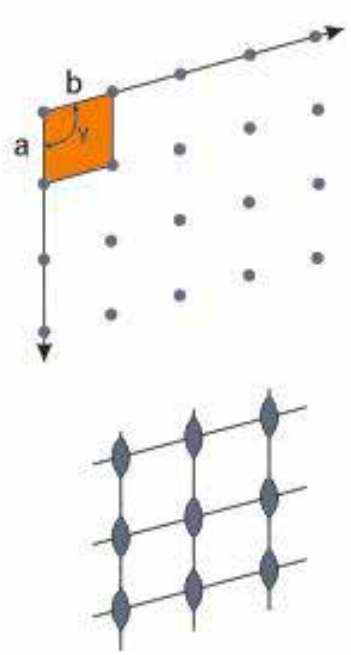
Quadratisches Netz
a = b
γ = 90°





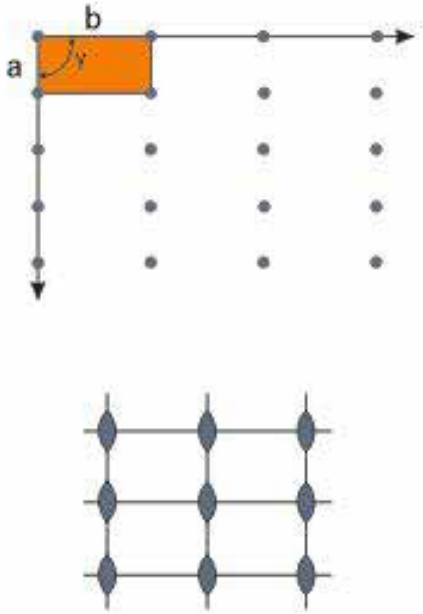
p4mm

skewed grid
a ≠ b
γ ≠ 90°



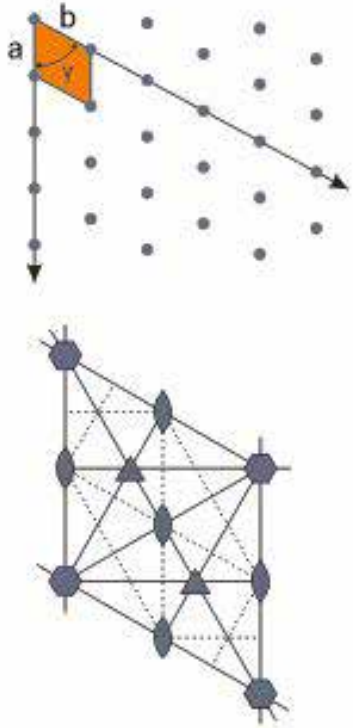
p2

rectangular grid
a ≠ b
γ = 90°



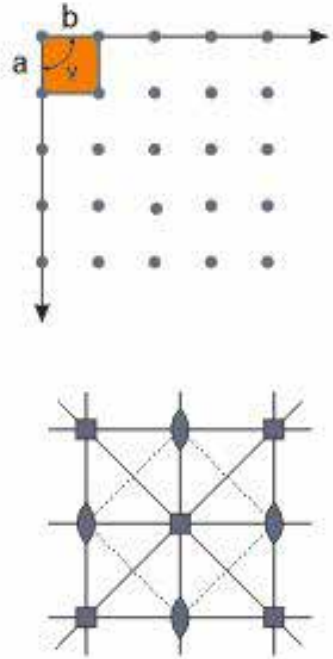
p2mm

hexagonal grid
a = b
γ = 60°



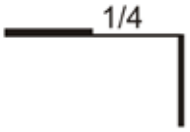
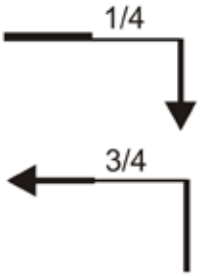
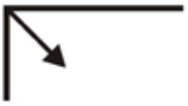
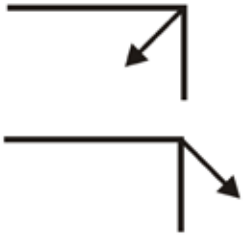
p6mm

quadratic grid
a = b
γ = 90°



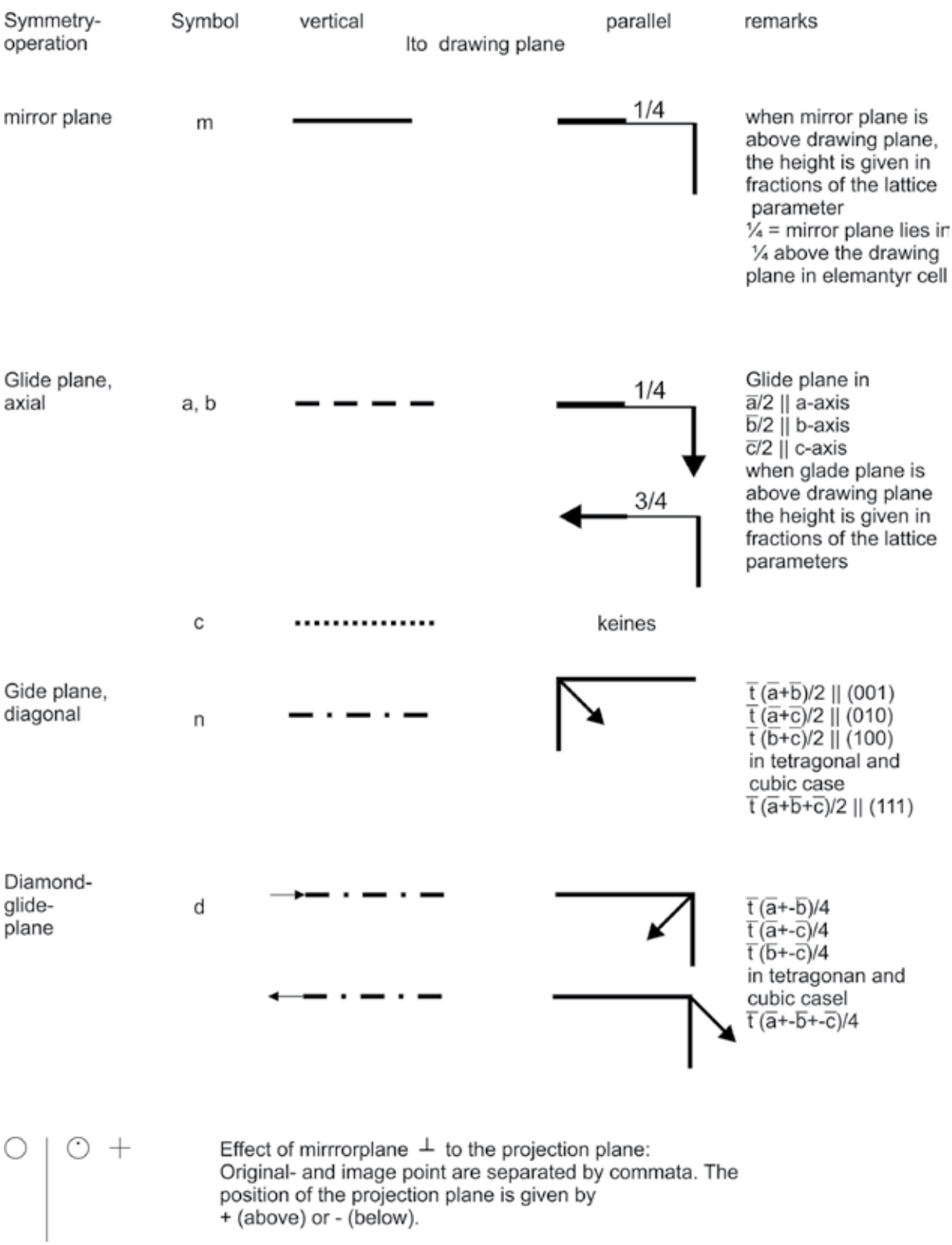
p4mm

Symbolik der Symmetrieebenen

Symmetrie-operation	Symbol	Symbol senkrecht zur Zeichenebene	Symbol parallel	Bemerkung
Spiegelung	m			falls die Spiegelebene über der Zeichenebene liegt, wird die Höhe in Bruchteilen der Gitterkonstante angegeben ¼ = Spiegelebene liegt um ¼ über der Zeichenebene in der Elementarzelle
Gleitspiegelung, achsial	a, b			Gleitspiegelung um $\bar{a}/2$ || a-Achse $\bar{b}/2$ || b-Achse $\bar{c}/2$ || c-Achse falls die Spiegelebene über d. Zeichenebene liegt, wird die Höhe in Bruchteilen der Gitterkonstante angegeben
	c		keines	
Gleitspiegelung, diagonal	n			$\bar{t}\,(\bar{a}+\bar{b})/2$ || (001) $\bar{t}\,(\bar{a}+\bar{c})/2$ || (010) $\bar{t}\,(\bar{b}+\bar{c})/2$ || (100) im tetragonalen und kubischen Fall $\bar{t}\,(\bar{a}+\bar{b}+\bar{c})/2$ || (111)
Diamantgleitspiegelung	d			$\bar{t}\,(\bar{a}+\text{-}\bar{b})/4$ $\bar{t}\,(\bar{a}+\text{-}\bar{c})/4$ $\bar{t}\,(\bar{b}+\text{-}\bar{c})/4$ im tetragonalen und kubischen Fall $\bar{t}\,(\bar{a}+\text{-}\bar{b}+\text{-}\bar{c})/4$

Wirkung einer Spiegelebene ⊥ zur Projektionsebene:
Original- und Bildpunkt werden durch ein Komma voneinander unterschieden. Die Lage der Projektionsebene wird durch + (oberhalb) oder - (unterhalb) beschrieben.

Symbolism of symmetry planes



Effect of mirrrorplane ⊥ to the projection plane:
Original- and image point are separated by commata. The position of the projection plane is given by
+ (above) or - (below).

Symbolik der Symmetrieachsen

Symmetrieachse	Symbol	graphisches Symbol	Translation II Symmetrieachse bei rechtshändiger Symmetrieoperation
Symmetrieachse	1		keine
Inversionszetrum	$\bar{1}$		keine
2-zählige Drehung	2		keine
2-zählige Schraubung	2_1		1/2
3-zählige Drehung	3		keine
3-zählige Schraubung	3_1		1/3
	3_2		2/3
3-zählige Inversionsdrehachse	$\bar{3}$		keine
4-zählige Drehung	4		keine
4-zählige Schraubung	4_1		1/4
	4_2		1/2
	4_3		3/4
4-zählige Inversionsdrehachse	$\bar{4}$		keine
6-zählige Drehung	6		keine
6-zählige Schraubung	6_1		1/6
	6_2		2/6
	6_3		3/6
	6_4		4/6
	6_5		5/6
6-zählige Inversionsdrehachse	$\bar{6}$		keine

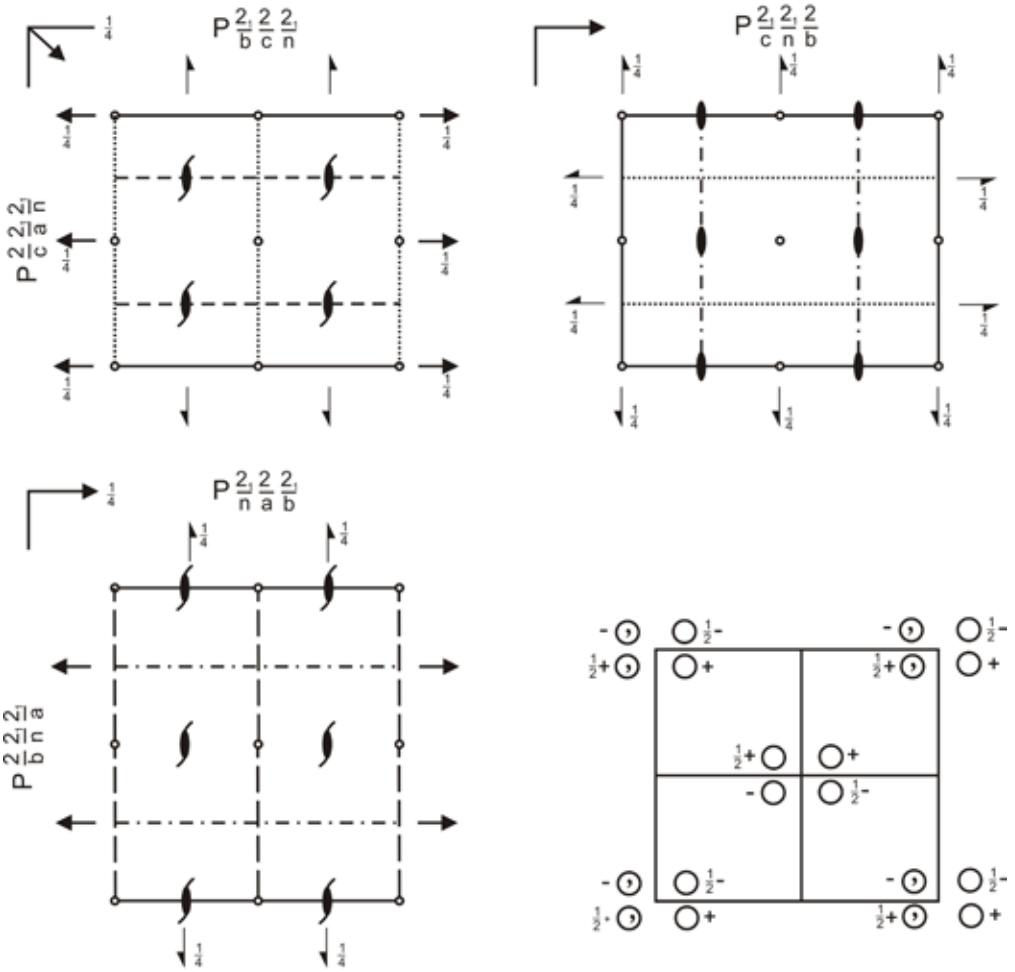
Symbolism of the symmetry axes

Symmetry axes	Symbol	graphic symbol	Translation parallel to symmetry axis of right-handed symmetry operation
Symmetry axis	1		none
Inversion center	$\bar{1}$		none
2-fold rotation	2		none
2-fold screw	2_1		1/2
3-fold rotation	3		none
3-fold screw	3_1		1/3
	3_2		2/3
3-fold inversion axis	$\bar{3}$		none
4-fold rotation	4		none
4-fold screw	4_1		1/4
	4_2		1/2
	4_3		3/4
4-fold inversion axis	$\bar{4}$		none
6-fold rotation	6		none
6-fold screw	6_1		1/6
	6_2		2/6
	6_3		3/6
	6_4		4/6
	6_5		5/6
6-fold inversion axis	$\bar{6}$		none

Beispiel einer Raumgruppe **Pbcn**

Pbcn D_{2h}^{14} mmm Orthorhombisches Kristallsystem

$P\,2_1/b\,2/c\,2_1/n$ Patterson-Symmetrie Pmmm



Ursprung bei $\bar{1}$ in 1 c 1

Asymmetrische Einheit $0 \leq x \leq ½ \quad 0 \leq y \leq ½ \quad 0 \leq z \leq ½$

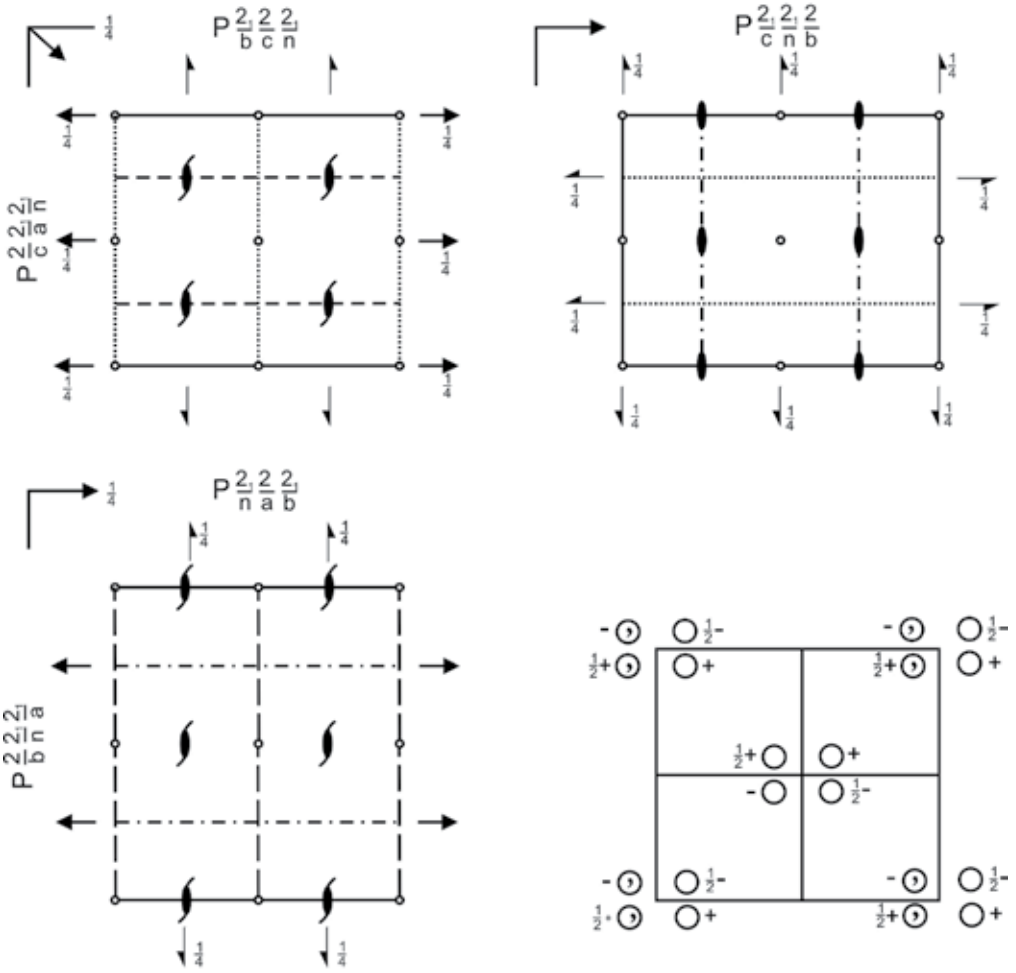
Symmetrie Operationen

(1) 1	(2) 2(0,0,½) ¼,¼,z	(3) 2 0,y,¼
(4) 2(½,0,0) x,¼,0	(5) $\bar{1}$ 0,0,0	(6) n(½,½,0) x,y,¼
(7) c x,0,z	(8) b ¼,y,z	

Example of a space group **Pbcn**

Pbcn D_{2h}^{14} mmm Orthorhombic crystal system

$P\ 2_1/b\ 2/c\ 2_1/n$ Patterson symmetry Pmmm



Origin at $\bar{1}$ in 1 c 1

Asymmetric unit $0 \leq x \leq ½\ \ 0 \leq y \leq ½\ \ 0 \leq z \leq ½$

Symmetry operations

(1) 1
(2) 2(0,0,½) ¼,¼,z
(3) 2 0,y,¼
(4) 2(½,0,0) x,¼,0
(5) $\bar{1}$ 0,0,0
(6) n(½,½,0) x,y,¼
(7) c x,0,z
(8) b ¼,y,z

Die 230 Raumgruppen

Kristallsystem	Punktgruppe	Raumgruppen			
Triklin	1	P1			
	-1	P$\bar{1}$			
Monoklin	2	P2	$P2_1$	C2	
	M	Pm	Pc	Cm	Cc
	2/m	P2/m	$P2_1/m$	C2/m	P2/c
		$P2_1/c$	C2/c		
Orthorhombisch	222	P222	$P222_1$	$P2_12_12$	$P2_12_12_1$
		$C222_1$	C222	F222	I222
		$I2_12_12_1$			
	mm2	Pmm2	$Pmc2_1$	Pcc2	Pma2
		$Pca2_1$	Pnc2	$Pmn2_1$	Pba2
		$Pna2_1$	Pnn2	Cmm2	$Cmc2_1$
		Ccc2	Amm2	Abm2	Ama2
		Aba2	Fmm2	Fdd2	Imm2
		Iba2	Ima2		
	mmm	Pmmm	Pnnn	Pccm	Pban
		Pmma	Pnna	Pmna	Pcca
		Pbam	Pccn	Pbcm	Pnnm
		Pmmn	Pbcn	Pbca	Pnma
		Cmcm	Cmca	Cmmm	Cccm
		Cmma	Ccca	Fmmm	Fddd
		Immm	Ibam	Ibca	Imma
Tetragonal	4	P4	$P4_1$	$P4_2$	$P4_3$
		I4	$I4_1$		
	-4	P-4	I-4		
	4/m	P4/m	$P4_2m$	P4/n	$P4_2/n$
		I4/m	$I4_1/a$		
	422	P422	$P42_12$	$P4_122$	$P4_12_12$
		$P4_222$	$P4_22_12$	$P4_322$	$P4_32_12$
		I422	$I4_122$		
	4mm	P4mm	P4bm	$P4_2cm$	$P4_2nm$
		P4cc	P4nc	$P4_2mc$	$P4_2bc$
		I4mm	I4cm	$I4_1md$	$I4_1cd$
	-42m	P-42m	P-42c	$P-42_1m$	$P-42_1c$
		P-4m2	P-4c2	P-4b2	P-4n2
		I-4m2	I-4c2	I-42m	I-42d
	4/mmm	P4/mmm	P4/mcc	P4/nbm	P4/nnc
		P4/mbm	P4/mnc	P4/nmm	P4/ncc
		$P4_2/mmc$	$P4_2/mcm$	$P4_2/nbc$	$P4_2/nnm$
		$P4_2/mbc$	$P4_2/mnm$	$P4_2/nmc$	$P4_2/ncm$
		I4/mmm	I4/mcm	$I4_1/amd$	$I4_1/acd$
Trigonal	3	P3	$P3_1$	$P3_2$	R3
	-3	P-3	R-3		
	32	P312	P321	$P3_112$	$P3_121$
		$P3_212$	$P3_221$	R32	
	3m	P3m1	P31m	P3c1	P31c
		R3m	R3c		
	-3m	P-31m	P-31c	P-3m1	P-3c1
		R-3m	R-3c		
Hexagonal	6	P6	$P6_1$	$P6_5$	$P6_2$
		$P6_4$	$P6_3$		
	-6	P-6			
	6/m	P6/m	$P6_3/m$		
	622	P622	$P6_122$	$P6_522$	$P6_222$
		$P6_422$	$P6_322$		
	6mm	P6mm	P6cc	$P6_3cm$	$P6_3mc$
	-6m2	P-6m2	P-6c2	P-62m	P-62c
	6/mmm	P6/mmm	P6/mcc	$P6_3/mm$	$P6_3/mmc$
Kubisch	23	P23	F23	I23	$P2_13$
		$I2_13$			
	m-3	Pm-3	Pn-3	Fm-3	Fd-3
		Im-3	Pa-3	Ia-3	
	432	P432	$P4_232$	F432	$F4_132$
		I432	$P4_332$	$P4_132$	$I4_132$
	-43m	P-43m	F-43m	I-43m	P-43n
		F-43c	I-43d		
	m-3m	Pm-3m	Pn-3n	Pm-3n	Pn-3m
		Fm-3m	Fm-3c	Fd-3m	Fd-3c
		Im-3m	Ia-3d		

The 230 space groups

Crystal system	Point group	Space group			
triclinic	1	P1			
	-1	P$\bar{1}$			
monoclinic	2	P2	P2_1	C2	
	M	Pm	Pc	Cm	Cc
	2/m	P2/m	P2_1/m	C2/m	P2/c
		P2_1/c	C2/c		
orthorhombic	222	P222	P222_1	P2_12_12	P$2_12_12_1$
		C222_1	C222	F222	I222
		I$2_12_12_1$			
	mm2	Pmm2	Pmc2_1	Pcc2	Pma2
		Pca2_1	Pnc2	Pmn2_1	Pba2
		Pna2_1	Pnn2	Cmm2	Cmc2_1
		Ccc2	Amm2	Abm2	Ama2
		Aba2	Fmm2	Fdd2	Imm2
		Iba2	Ima2		
	mmm	Pmmm	Pnnn	Pccm	Pban
		Pmma	Pnna	Pmna	Pcca
		Pbam	Pvvn	Pbcm	Pnnm
		Pmmn	Pbcn	Pbca	Pnma
		Cmcm	Cmca	Cmmm	Cccm
		Cmma	Ccca	Fmmm	Fddd
		Immm	Ibam	Ibca	Imma
tetragonal		P4	P4_1	P4_2	P4_3
	4	I4	I4_1		
		P$\bar{4}$	I$\bar{4}$		
	-4	P4/m	P4_2m	P4/n	P4_2/n
	4/m	I4/m	I4_1/a		
		P422	P42_12	P4_122	P4_12_12
	422	P4_222	P4_22_12	P4_322	P4_32_12
		I422	I4_122		
		P4mm	P4bm	P4_2cm	P4_2nm
	4mm	P4cc	P4nc	P4_2mc	P4_2bc
		I4mm	I4cm	I4_1md	I4_1cd
		P$\bar{4}$2m	P$\bar{4}$2c	P$\bar{4}2_1$m	P$\bar{4}2_1$c
	-42m	P$\bar{4}$m2	P$\bar{4}$c2	P$\bar{4}$b2	P$\bar{4}$n2
		I$\bar{4}$m2	I$\bar{4}$c2	I$\bar{4}$2m	I$\bar{4}$2d
		P4/mmm	P4/mcc	P4/nbm	P4/nnc
	4/mmm	P4/mbm	P4/mnc	P4/nmm	P4/ncc
		P4_2/mmc	P4_2/mcm	P4_2/nbc	P4_2/nnm
		P4_2/mbc	P4_2/mnm	P4_2/nmc	P4_2/ncm
		I4/mmm	I4/mcm	I4_1/amd	I4_1/acd
trigonal	3	P3	P3_1	P3_2	R3
	-3	P$\bar{3}$	R$\bar{3}$		
	32	P312	P321	P3_112	P3_121
		P3_212	P3_221	R32	
	3m	P3m1	P31m	P3c1	P31c
		R3m	R3c		
	-3m	P$\bar{3}$1m	P$\bar{3}$1c	P$\bar{3}$m1	P$\bar{3}$c1
		R$\bar{3}$m	R$\bar{3}$c		
hexagonal	6	P6	P6_1	P6_5	P6_2
		P6_4	P6_3		
	-6	P$\bar{6}$			
	6/m	P6/m	P6_3/m		
	622	P622	P6_122	P6_522	P6_222
		P6_422	P6_322		
	6mm	P6mm	P6cc	P6_3cm	P6_3mc
	-6m2	P$\bar{6}$m2	P$\bar{6}$c2	P$\bar{6}$2m	P$\bar{6}$2c
	6/mmm	P6/mmm	P6/mcc	P6_3/mm	P6_3/mmc
Cubic	23	P23	F23	I23	P2_13
		I2_13			
	m-3	Pm$\bar{3}$	Pn$\bar{3}$	Fm$\bar{3}$	Fd$\bar{3}$
		Im$\bar{3}$	Pa$\bar{3}$	Ia$\bar{3}$	
	432	P432	P4_232	F432	F4_132
		I432	P4_332	P4_132	I4_132
	-43m	P$\bar{4}$3m	F$\bar{4}$3m	I$\bar{4}$3m	P$\bar{4}$3n
		F$\bar{4}$3c	I$\bar{4}$3d		
	m-3m	Pm$\bar{3}$m	Pn$\bar{3}$n	Pm$\bar{3}$n	Pn$\bar{3}$m
		Fm$\bar{3}$m	Fm$\bar{3}$c	Fd$\bar{3}$m	Fd$\bar{3}$c
		Im$\bar{3}$m	Ia$\bar{3}$d		

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