

HERBERT PÖLLMANN, XUAN LING

**SYMMETRIE UND DIE 32 PUNKTGRUPPEN IN DEUTSCHER
UND CHINESISCHER SPRACHE**

**SYMMETRY AND 32 POINTGROUPS IN ENGLISH AND
CHINESE LANGUAGE**

对称变换和32种点群中英译文



HALLE (哈雷) 2021

HALLESCHES JAHRBUCH FÜR GEOWISSENSCHAFTEN

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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. Also an important language is Chinese and this small booklet aims to give some overview on crystallography in English and Chinese language.

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 like German, French, Arabic, Russian, Swedish, Greek, Spanish and Mongolian, among others 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, may 2020

前言

本书主要论述了晶体学相关的基本知识点，已特别提供了英语与德语版本。本书着重论述了32个点群及空间群的相关知识，详细讲解了晶体学中具有代表性的矿物结构。

目前，国际科研工作者之间的合作与日俱增，由于不同语言引起的理解差异问题逐渐凸显，因而迫切需要专业的译文书籍帮助我们理解，有助于不同区域的学者与研究者之间沟通交流。本丛书中晶体学研究领域的第一本译文指导书籍以德文和葡萄牙文双语出版。

希望通过不同语言的译文能够有效帮助不同语言人群的理解。

因此，本丛书以通用语言英文作为基本语言，此外提供中文译文。本译文书籍旨在提供晶体学相关的基本理论知识概述，帮助学习者克服不同语言所带来的语言障碍。

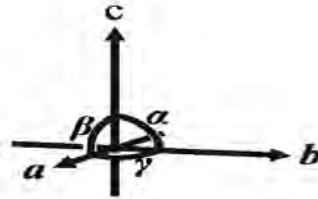
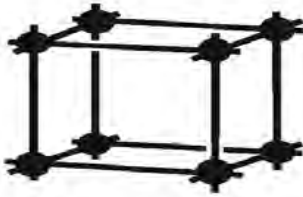
文中论述的内容精简，双语译文详细，可作为指导书籍使用。

本书籍为消除语言障碍，有意涵括了不同语言译文，内容上专注于晶体学理论知识论述。本书籍还将有其他译文，例如德语，法语，阿拉伯语，俄语，瑞典语，希腊语，西班牙语和蒙古语。此外，还将计划出版其他重要学术主题的丛书。

特别感谢Prof. Dr. Dorothee Mertmann在手稿译文方面提供的耐心帮助。

Herbert Pöllmann, 哈雷, 2020年5月

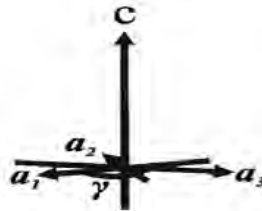
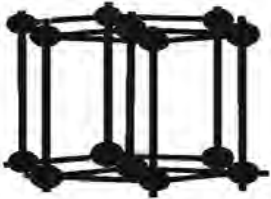
The 7 crystal systems



Cubic:

$$a_0 = b_0 = c_0$$

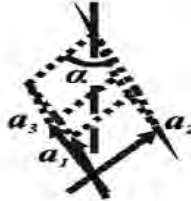
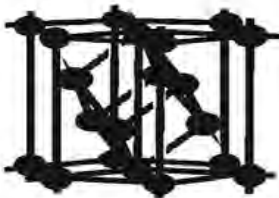
$$\alpha = \beta = \gamma = 90^\circ$$



Hexagonal:

$$a_1 = a_2 = a_3 \neq c_0$$

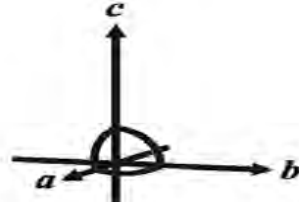
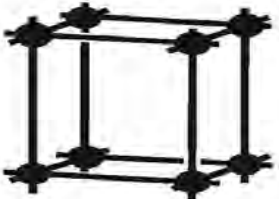
$$\alpha = \beta = 90^\circ; \gamma = 120^\circ$$



Rhombohedral:

$$a_1 = a_2 = a_3$$

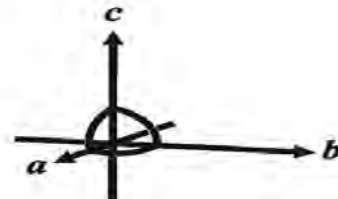
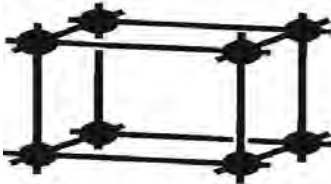
$$\alpha_1 = \alpha_2 = \alpha_3 \neq 90^\circ$$



Tetragonal:

$$a_0 = b_0 \neq c_0$$

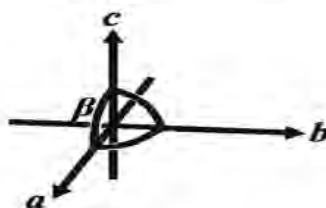
$$\alpha = \beta = \gamma = 90^\circ$$



Orthorhombic:

$$a_0 \neq b_0 \neq c_0$$

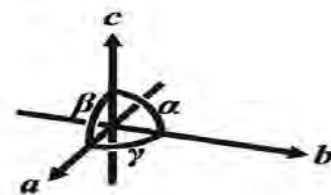
$$\alpha = \beta = \gamma = 90^\circ$$



Monoclinic:

$$a_0 \neq b_0 \neq c_0$$

$$\alpha = \gamma = 90^\circ; \beta \neq 90^\circ$$



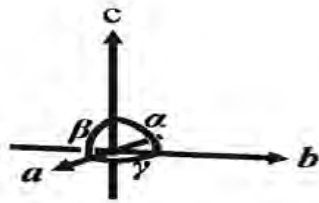
Triclinic:

$$a_0 \neq b_0 \neq c_0$$

$$\alpha \neq \beta \neq \gamma \neq 90^\circ$$

七种晶系

The 7 crystal systems

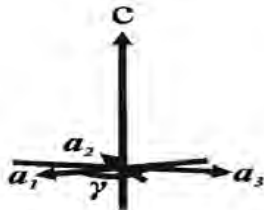
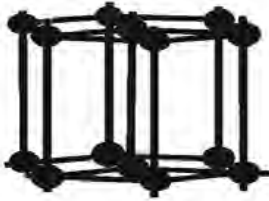


立方晶体

Cubic:

$$a_0 = b_0 = c_0$$

$$\alpha = \beta = \gamma = 90^\circ$$

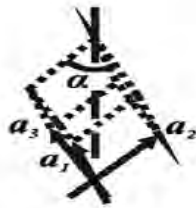
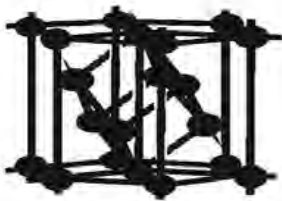


六方晶系

Hexagonal:

$$a_1 = a_2 = a_3 \neq c_0$$

$$\alpha = \beta = 90^\circ; \gamma = 120^\circ$$

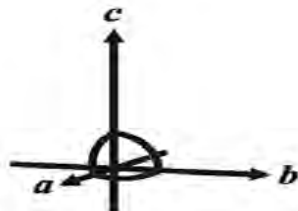
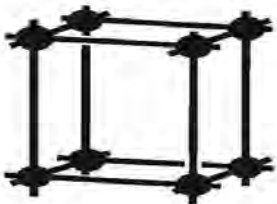


三方晶系

Rhombohedral:

$$a_1 = a_2 = a_3$$

$$\alpha_1 = \alpha_2 = \alpha_3 \neq 90^\circ$$

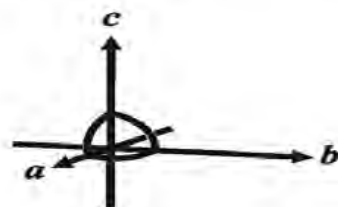
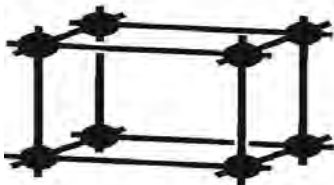


四方晶系

Tetragonal:

$$a_0 = b_0 \neq c_0$$

$$\alpha = \beta = \gamma = 90^\circ$$

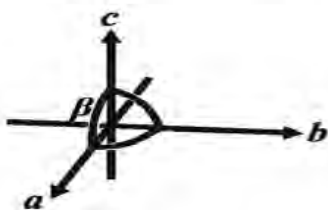
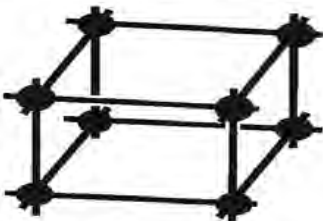


正交晶系

Orthorhombic:

$$a_0 \neq b_0 \neq c_0$$

$$\alpha = \beta = \gamma = 90^\circ$$

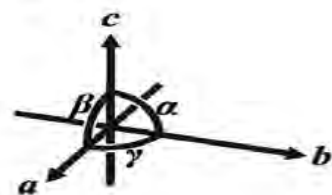
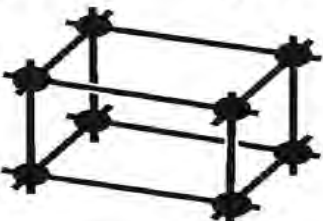


单斜晶系

Monoclinic:

$$a_0 \neq b_0 \neq c_0$$

$$\alpha = \gamma = 90^\circ; \beta \neq 90^\circ$$



三斜晶系

Triclinic:

$$a_0 \neq b_0 \neq c_0$$

$$\alpha \neq \beta \neq \gamma \neq 90^\circ$$

Occurrence frequency of minerals

Out of 3510 known minerals (dated May 1993) the following crystal systems are represented:

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	32,9%
Triclinic	2 Crystal Classes	332	9,5%

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

Now there are already about 5575 new minerals known (<http://cnmnc.main.jp/>).

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

已知矿物的数量及分类

3510种矿物的晶体结构分类 (截至1993.5):

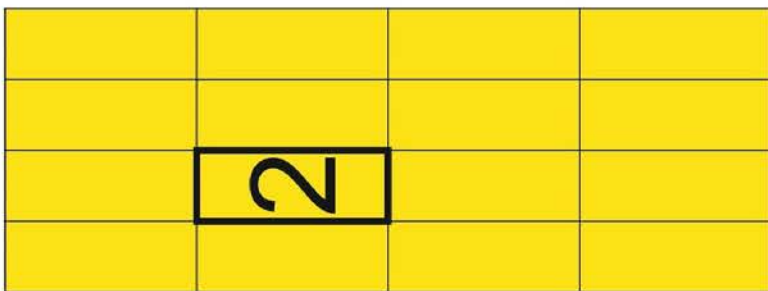
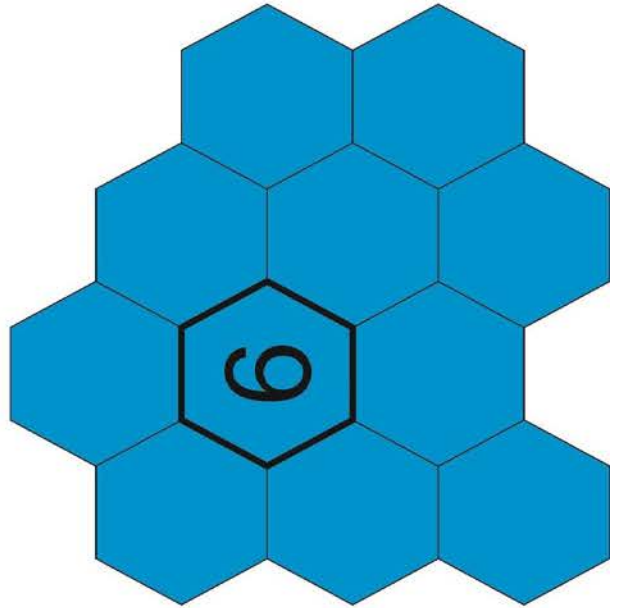
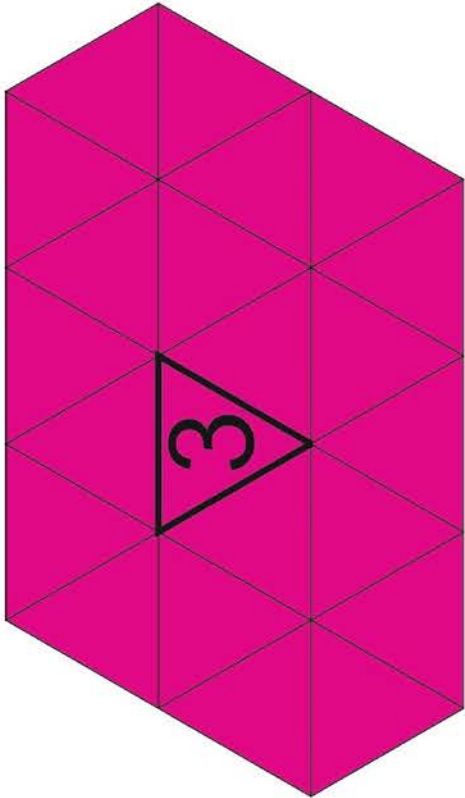
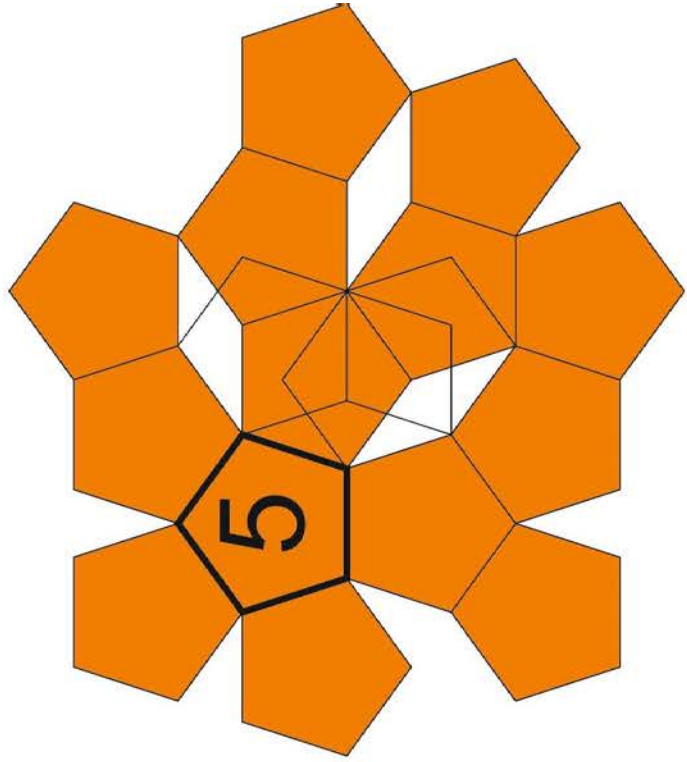
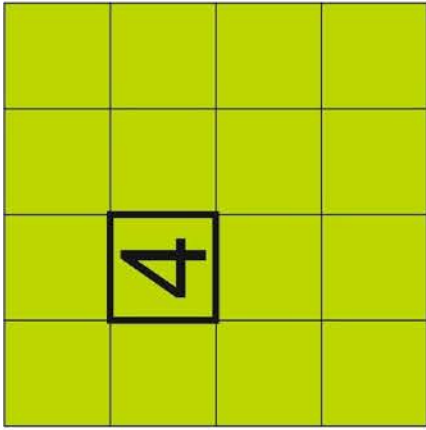
立方	5种晶体学点群	346	9,9%
六方	7种晶体学点群	326	9,3%
三方 – 菱形	5种晶体学点群	295	8,4%
四方	7种晶体学点群	278	7,9%
正交	3种晶体学点群	774	22%
单斜	3种晶体学点群	1129	32,2%
三斜	2种晶体学点群	332	9,5%

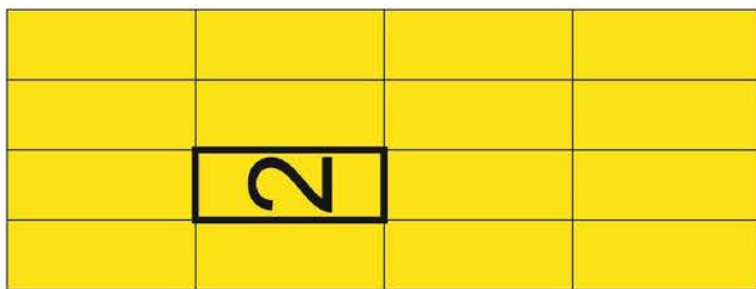
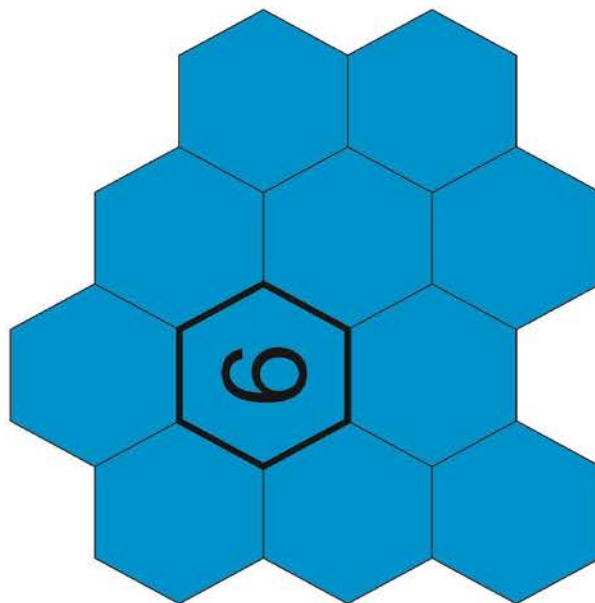
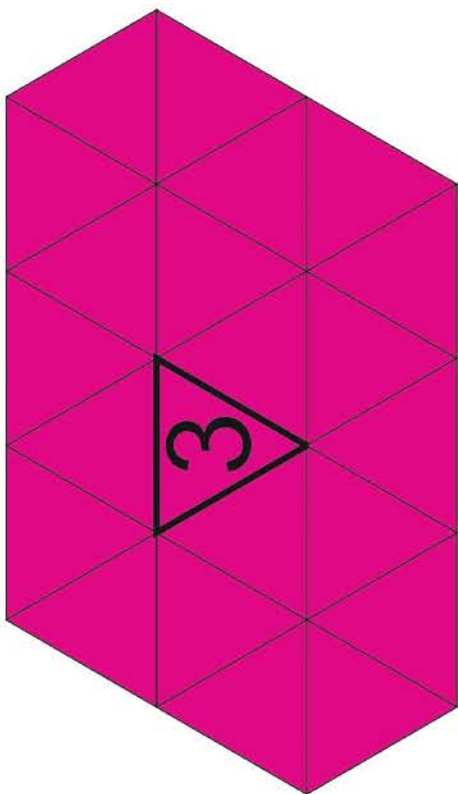
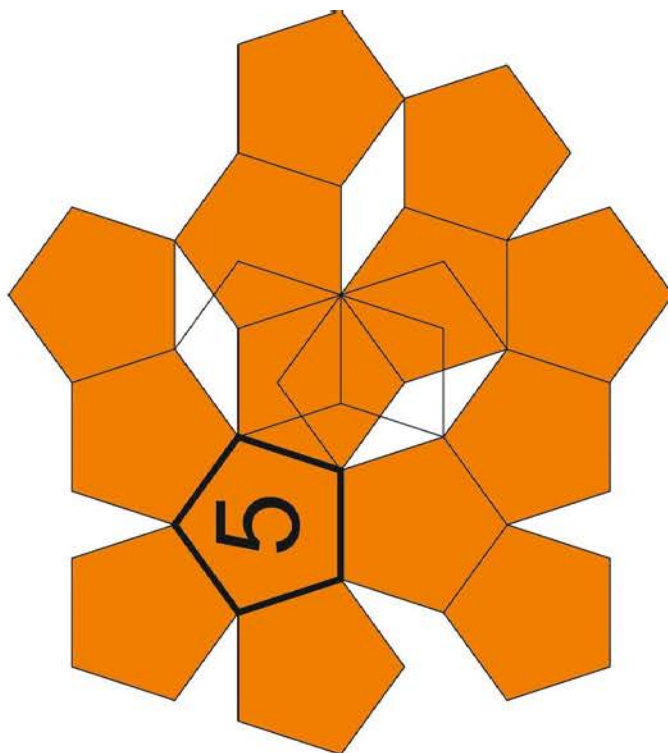
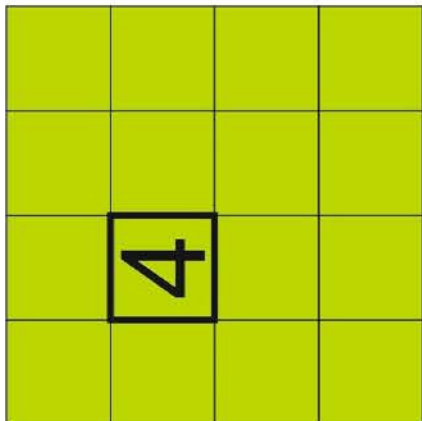
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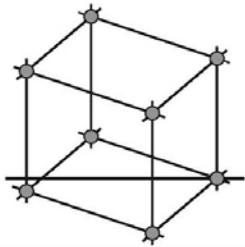
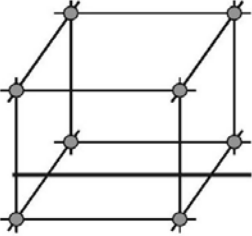
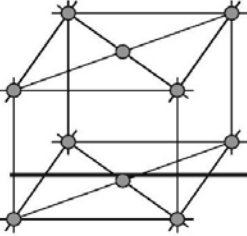
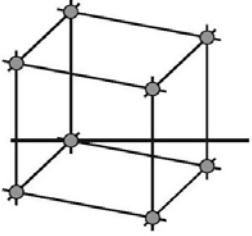
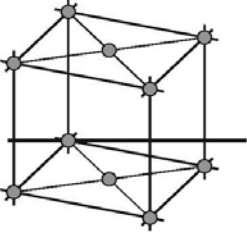
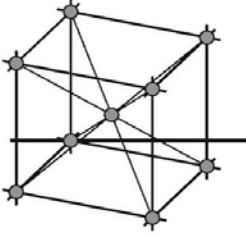
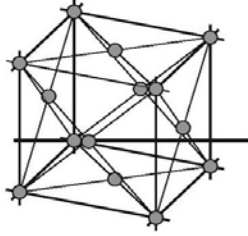
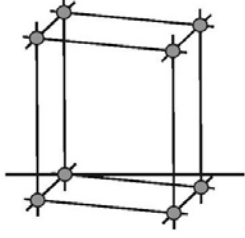
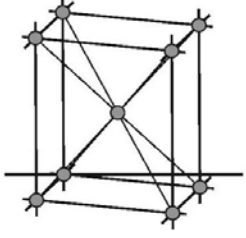
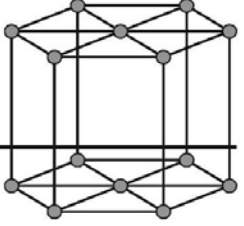
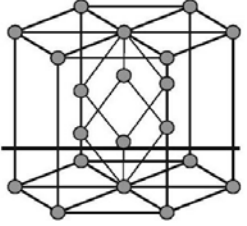
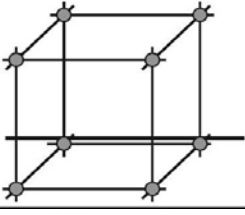
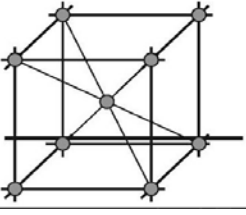
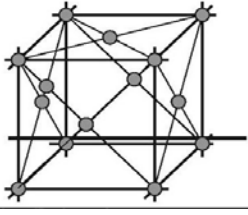
截至目前已发现有5575种矿物
(<http://cnmnc.main.jp/>) .

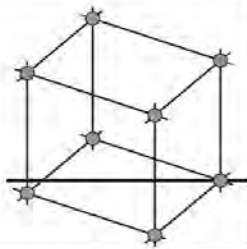
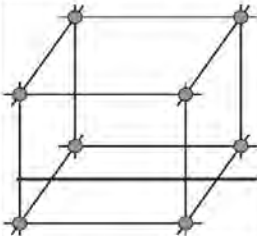
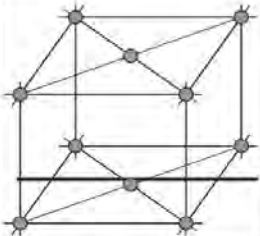
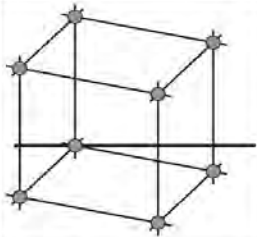
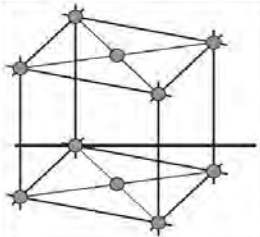
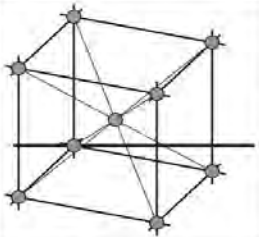
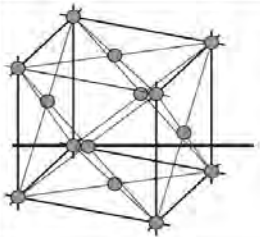
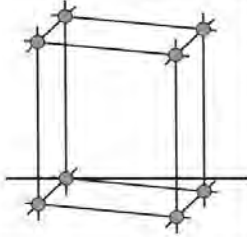
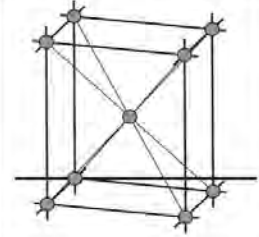
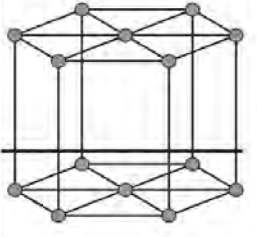
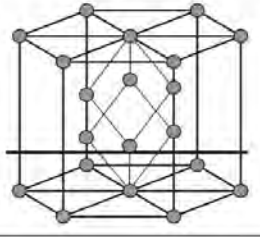
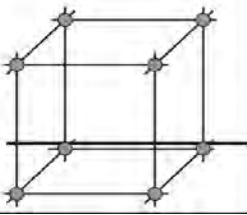
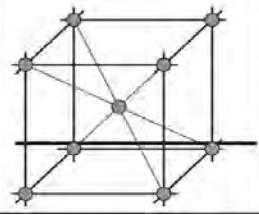
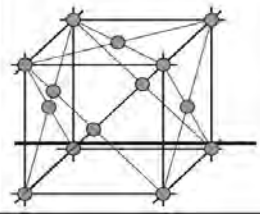
不同晶体对称轴作用规律

种类	符号	作用规律
反演	* / i	中心反转
2次对称轴	● / 2	旋转180°
镜面反演 或2次对称轴反演	m = $\bar{2}$	旋转180°后反演
3次对称轴	▲ / 3	旋转120°
3次对称轴反演	▲ / $\bar{3}$	旋转120°后反演
4次对称轴	◆ / 4	旋转 90°
4次对称轴反演	◆ / $\bar{4}$	旋转90°后反演
6次对称轴	● / 6	旋转 60°
6次对称轴反演	▲ / $\bar{6}$	旋转 60° 后反演





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

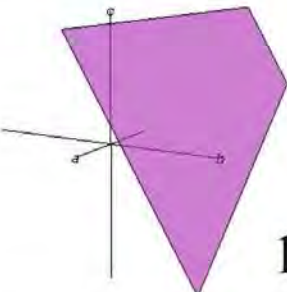
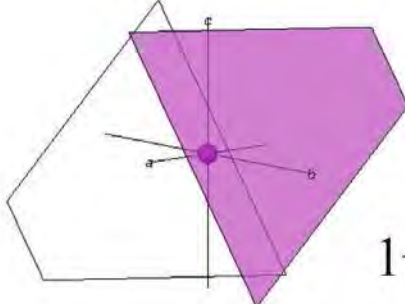
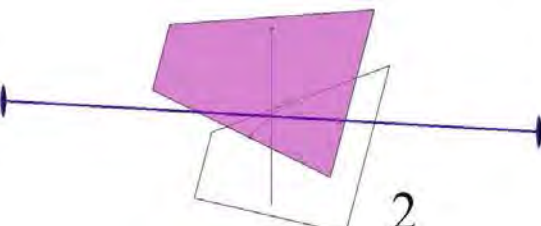

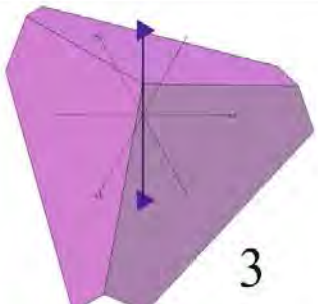
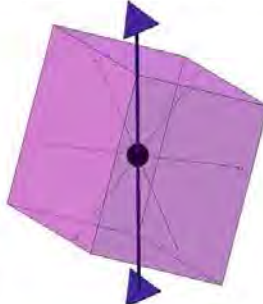
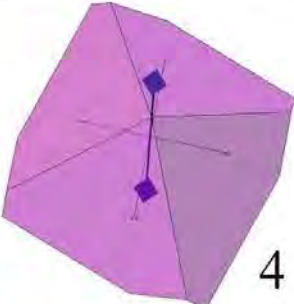

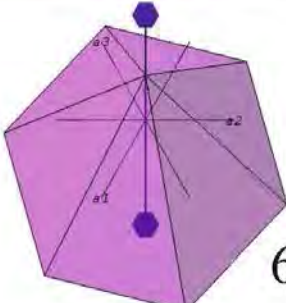
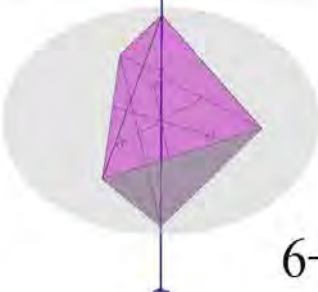
	P	C	I	F
三斜晶系				
单斜晶系			同C	同C
正交晶系				
四方晶系		同P		同I
三方晶系				
六方晶系				
立方晶系		不存在		

Symmetry elements

(normal rotation axes, rotation axes combined with inversion)

combined with
inversion center

normal

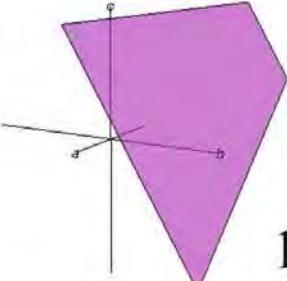
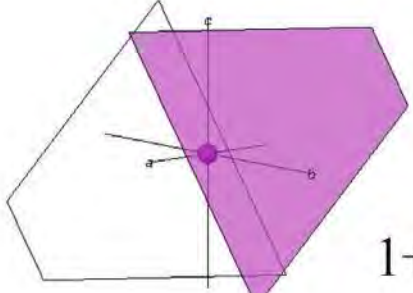
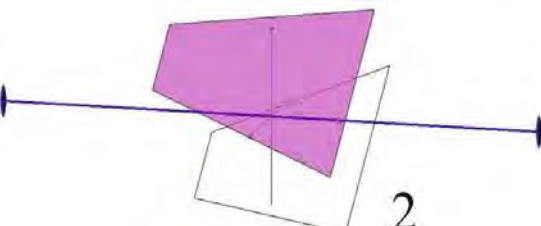

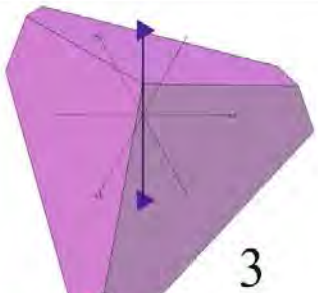

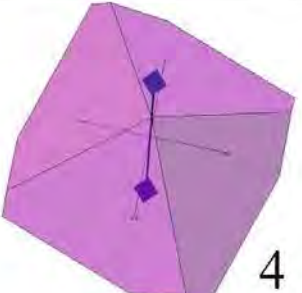

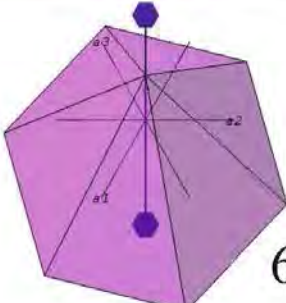
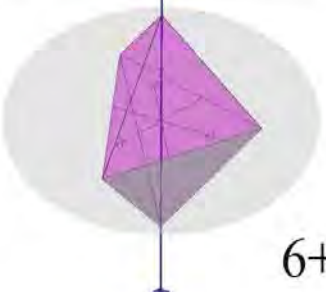
normal		combined with inversion center
 <p>1</p>	1	 <p>$1+i$</p>
 <p>2</p>	2	 <p>$2+i = m$</p>
 <p>3</p>	3	 <p>$3+i$</p>
 <p>4</p>	4	 <p>$4+i$</p>
 <p>6</p>	6	 <p>$6+i$</p>

对称元素

(旋转轴, 旋转轴结合反演)

标准

中心反演后

 <p>1</p>	1	 <p>$1+i$</p>
 <p>2</p>	2	 <p>$2+i = m$</p>
 <p>3</p>	3	 <p>$3+i$</p>
 <p>4</p>	4	 <p>$4+i$</p>
 <p>6</p>	6	 <p>$6+i$</p>

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

对称操作	符号依据	符号				
		*	●	▲	◆	◆
轴对称旋转	Schoenflies	C_1	C_2	C_3	C_4	C_6
	Hermann-Mauguin	1	2	3	4	6
轴对称旋转 + 平面反映	Schoenflies		C_{2h}	C_{3h}	C_{4h}	C_{6h}
	Hermann-Mauguin		$2/m$	$3/m (\bar{6})$	$4/m$	$6/m$
轴对称旋转 + 垂直对称面	Schoenflies	C_s	C_{2v}	C_{3v}	C_{4v}	C_{6v}
	Hermann-Mauguin	m	$mm2$	$3m$	$4mm$	$6mm$
轴对称旋转 + 水平和垂直对称面	Schoenflies		D_{2h}	D_{3h}	D_{4h}	D_{6h}
	Hermann-Mauguin		mmm	$\bar{6}2m$	$4/mmm$	$6/mmm$
2次对称旋转轴	Schoenflies		D_2	D_3	D_4	D_6
	Hermann-Mauguin		222	32	422	622
中心对称反演轴	Schoenflies	C_i		C_{3i}	S_4	
	Hermann-Mauguin	$\bar{1}$	$\bar{2} (m)$	$\bar{3}$	$\bar{4}$	$\bar{6} (3/m)$
				$\bar{3}m$	$\bar{4}2m$	$\bar{6}2m$

32 Crystallographic point groups

Crystal systems	Triclinic	Monoclinic	Orthorhombic	Trigonal	Hexagonal	Tetragonal	Cubic
Holoedry	$\bar{1}$	$\frac{2}{m}$	$\frac{2}{m} \frac{2}{m} \frac{2}{m}$	$\frac{2}{3} \frac{2}{m}$	$\frac{6}{m} \frac{2}{m} \frac{2}{m}$	$\frac{4}{m} \frac{2}{m} \frac{2}{m}$	$\frac{4}{m} \frac{3}{m} \frac{2}{m}$
Viewing direction	- keine-	[010]	[100] [010] [001]	[001] [100]	[001] [100] [110]	[001] [100] [110]	[001] [111] [110]
Point groups	1 $\bar{1}$	2 m $\frac{2}{m}$	2 2 2 m m 2 $\frac{2}{m} \frac{2}{m} \frac{2}{m}$	3 3 2 3 m $\bar{3}$ $\frac{2}{3} \frac{2}{m}$	6 6 2 2 6 m m $\bar{6}$ $\bar{6} 2 m$ $\bar{6} m 2$ $\frac{6}{m}$ $\frac{6}{m} \frac{2}{m} \frac{2}{m}$	4 4 2 2 4 m m $\bar{4}$ $\bar{4} 2 m$ $\bar{4} m 2$ $\frac{4}{m}$ $\frac{4}{m} \frac{2}{m} \frac{2}{m}$	2 3 4 3 2 $\frac{2}{m} \frac{3}{m}$ $\bar{4} 3 m$ $\frac{4}{m} \frac{3}{m} \frac{2}{m}$

32种晶体点群

晶系	三斜晶系	单斜晶系	正交晶系	三方晶系	六方晶系	四方晶系	立方晶系
中心对称和全对称 点群	$\bar{1}$	$\frac{2}{m}$	$\frac{2}{m} \frac{2}{m} \frac{2}{m}$	$\frac{2}{3} \frac{2}{m}$	$\frac{6}{m} \frac{2}{m} \frac{2}{m}$	$\frac{4}{m} \frac{2}{m} \frac{2}{m}$	$\frac{4}{m} \frac{3}{m} \frac{2}{m}$
轴方向	无	[010]	$\begin{matrix} [100] \\ [010] \\ [001] \end{matrix}$	$\begin{matrix} [001] \\ [100] \\ [1\bar{1}0] \end{matrix}$	$\begin{matrix} [001] \\ [100] \\ [1\bar{1}0] \end{matrix}$	$\begin{matrix} [001] \\ [100] \\ [1\bar{1}0] \end{matrix}$	$\begin{matrix} [001] \\ [111] \\ [1\bar{1}0] \end{matrix}$
点群	1 $\bar{1}$	2 m $\frac{2}{m}$	222 $mm2$ $\frac{2}{m} \frac{2}{m} \frac{2}{m}$	3 32 $3m$ $\bar{3}$ $\frac{2}{3} \frac{2}{m}$	6 622 $6mm$ $\bar{6}$ $\bar{6}2m$ $\bar{6}m2$ $\frac{6}{m}$ $\frac{6}{m} \frac{2}{m} \frac{2}{m}$	4 422 $4mm$ $\bar{4}$ $\bar{4}2m$ $\bar{4}m2$ $\frac{4}{m}$ $\frac{4}{m} \frac{2}{m} \frac{2}{m}$	23 432 $\frac{2}{m} \frac{3}{m} \frac{2}{m}$ $\bar{4}3m$ $\frac{4}{m} \frac{3}{m} \frac{2}{m}$

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	$2/m2/m/m$	mmm	Orthorhombic Dipyramidal
	$mm2$	$mm2$	Orthorhombic Pyramidal
	222	222	Orthorhombic Disphenoid
Tetragonal System			
7 Classes	$4/m2/m2/m$	$4/mmm$	Ditetragonal Dipyramidal
	$4mm$	$4mm$	Ditetragonal Pyramidal
	422	422	Tetragonal Trapezoedric
	$4/m$	$4/m$	Tetragonal Dipyramidal
	4	4	Tetragonal Pyramidal
	$4-2 m$	$4-2 m$	Tetragonal Scenoedric
	-4	-4	Tetragonal Disphenoidic
Hexagonal System:			
7 Classes	$6/m2/m2/m$	$6/mmm$	Dihexagonal Dipyramidal
	$6mm$	$6mm$	Dihexagonal Pyramidal
	622	622	Hexagonal Trapezoedric
	$6/m$	$6/m$	Hexagonal Dipyramidal
	6	6	Hexagonal Pyramidal
	$-6m2$	$-6m2$	Ditrigonal Dipyramidal
	-6	-6	Trigonal Dipyramidal
Trigonal System:			
5 Classes	$-3 2m$	$-3m$	Ditrigonal Scenoedric
	$3m$	$3m$	Ditrigonal Pyramidal
	32	32	Trigonal Trapezoedric
	3	3	Trigonal Pyramidal
	-3	-3	Trigonal Rhomboedric
Cubic System			
5 Classes	$4/m-3 2/m$	$m3m$	Hexakisoktaedric
	432	432	Pentagonikositetraedric
	$2/m -3$	$m\bar{3}$	Disdodekaedric
	$-4 3m$	$-4 3m$	Hexakistetraedric
	23	23	Tetraedric Pentagondodekaedric

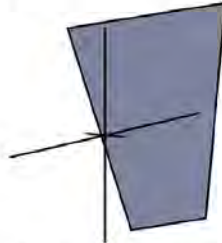
晶系种类	Hermann-Mauguin符号		点群名称
	全称	缩写	
三斜晶系			
2 种点群	1	1	三斜 单面体
	-1	-1	三斜 轴面类体
单斜晶系			
3 种点群	$2/m$	$2/m$	单斜 棱柱体
	m	m	单斜 坡面体
	2	2	单斜 楔形体
正交晶系			
3 种点群	$2/m2/m/m$	mmm	正交 双锥体
	$mm2$	$mm2$	正交 锥体
	222	222	正交 双楔体
四方晶系			
7种点群	$4/m2/m2/m$	$4/mmm$	复四方双锥体
	$4mm$	$4mm$	复四方单锥体
	422	422	四方梯面体
	$4/m$	$4/m$	四方双锥体
	4	4	四方锥体
	$4-2 m$	$4-2 m$	四方偏三角面体
	-4	-4	四方双楔体
六方晶系			
7 种点群	$6/m2/m2/m$	$6/mmm$	复六方双锥
	$6mm$	$6mm$	复六方锥
	622	622	六方梯面体
	$6/m$	$6/m$	六方双锥体
	6	6	六方锥体
	$-6m2$	$-6m2$	复三方双锥体
	-6	-6	三方双锥体
三方晶系			
5 种点群	$-3 2m$	$-3m$	复三方偏三角面体
	$3m$	$3m$	复三方锥体
	32	32	三方梯面体
	3	3	三方锥体
	-3	-3	三方菱面体
立方晶系			
5 种点群	$4/m-3 2/m$	$m3m$	己基八面体
	432	432	五角二十四面体
	$2/m -3$	$m3$	偏方复十二面体
	$-4 3m$	$-4 3m$	六四面体
	23	23	四面五角十二面体

Triclinic crystal system

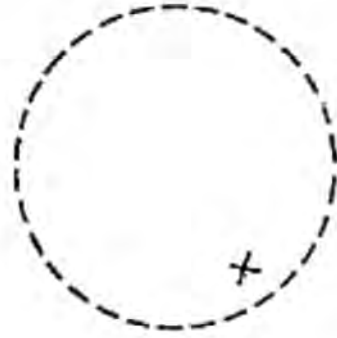
Triclinic hemiedry
Triclinic pedial class

Symbol: 1 or C_1

General form:
{hkl}



Pedien IV.pos.



{0kl}	{h0l}	{hk0}
<u>Pedien I.pos.</u>	<u>Pedien II.pos.</u>	<u>Pedien III.pos.</u>

{100}	{010}	{001}
<u>I. Pedion</u>	<u>II. Pedion</u>	<u>III. Pedion</u>

mineral examples:

Sinnerite $Cu_6As_4S_9$

Hartite $C_{20}H_{34}$

Nekoite $Ca_3[Si_6O_{15}] \cdot 7H_2O$

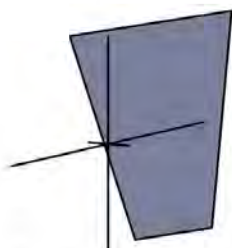
三斜晶系

三斜半面象

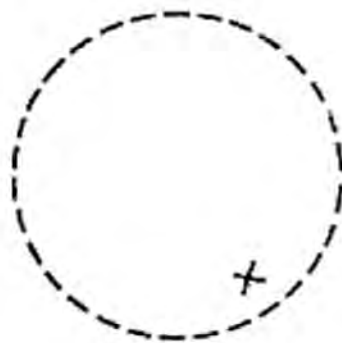
符号: 1 or C_1

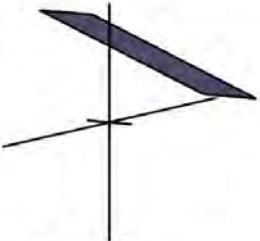
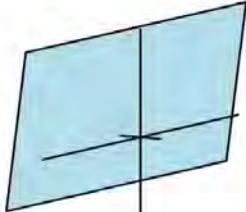

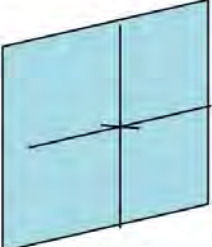


三斜单面体类

一般形:
{hkl}



单面 IV. 正形



$\{0kl\}$	$\{h0l\}$	$\{hk0\}$
		
单面 I. 正形	单面 II. 正形	单面 III. 正形
$\{100\}$	$\{010\}$	$\{001\}$
		
I. 单面	II. 单面	III. 单面

代表性矿物:

辛硫砷铜矿 Sinnerite $Cu_6As_4S_9$

晶蜡石 Hartite $C_{20}H_{34}$

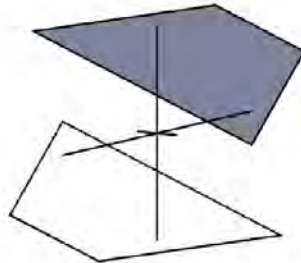
新硅钙石 Nekoite $Ca_3[Si_6O_{15}] \cdot 7H_2O$

Triclinic crystal system

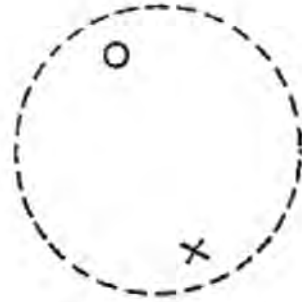
Triclinic holoedry
Triclinic pinacoidal class

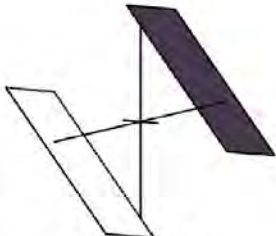
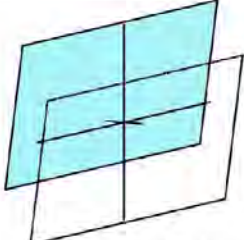
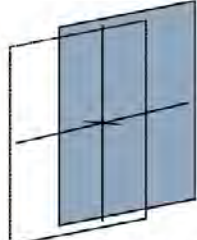
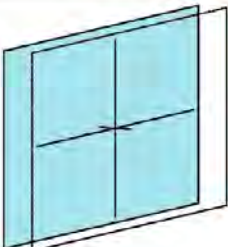


Symbol: $\bar{1}$ or C_i

General form:
{hkl}



Pinacoid IV.pos.



{0kl}	{h0l}	{hk0}
 <p>Pinacoid I.St.</p>	 <p>Pinacoid II.St.</p>	 <p>Pinacoid III.St.</p>
{100}	{010}	{001}
 <p>I. Pinacoid</p>	 <p>II. Pinacoid</p>	 <p>III. Pinacoid</p>

mineral examples:

Albite $\text{Na}[\text{AlSi}_3\text{O}_8]$

Kyanite/Disthene $\text{Al}_2[\text{O}/\text{SiO}_4]$

Wollastonite $\text{Ca}[\text{SiO}_3]$

Axinite $\text{Ca}_2(\text{Fe},\text{Mn})\text{Al}_2[\text{BO}_3\text{OH}/\text{Si}_4\text{O}_{12}]$

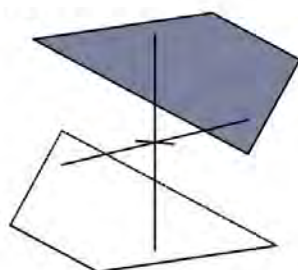
三斜晶系

三斜全面象

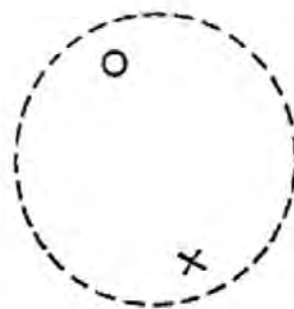
符号: $\bar{1}$ or C_1

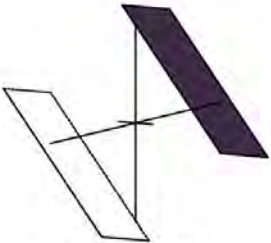
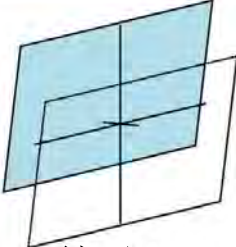
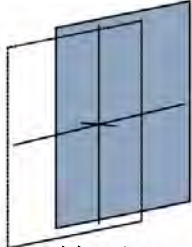
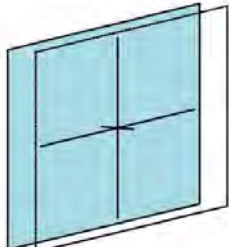

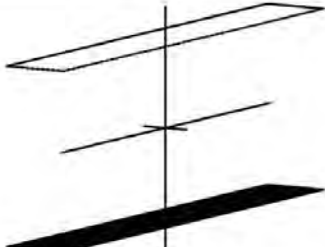
三斜轴面体类

一般形:
{hkl}



轴面IV.正形



{0kl}	{h0l}	{hk0}
 <p>轴面 I.</p>	 <p>轴面 II.</p>	 <p>轴面 III.</p>
{100}	{010}	{001}
 <p>I. 轴面</p>	 <p>II. 轴面</p>	 <p>III. 轴面</p>

代表性矿物:

钠长石 Albite $\text{Na}[\text{AlSi}_3\text{O}_8]$

蓝晶石 Kyanite/Disthene $\text{Al}_2[\text{O}/\text{SiO}_4]$

硅钙石 Wollastonite $\text{Ca}[\text{SiO}_3]$

斧石 Axinite $\text{Ca}_2(\text{Fe}, \text{Mn})\text{Al}_2[\text{BO}_3\text{OH}/\text{Si}_4\text{O}_{12}]$

Monoclinic crystal system

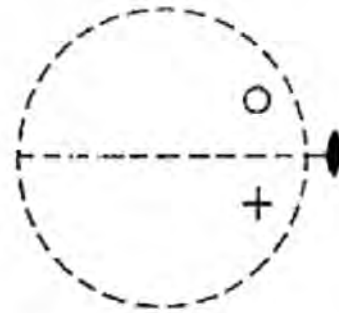
Monoclinic hemimorphy
Monoclinic sphenoidal class

Symbol: 2 or C_2

General form:
{hkl}



Sphenoid IV.pos.



{0kl}	{h0l}	{hk0}
<p><u>Sphenoid I.pos.</u></p>	<p><u>Pinacoid II.pos.</u></p>	<p><u>Sphenoid III.pos.</u></p>
{100}	{010}	{001}
<p><u>I. Pinacoid</u></p>	<p><u>II. Pedion</u></p>	<p><u>III. Pinacoid</u></p>

mineral examples:

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

Tartaric acid $C_4H_6O_6$

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

单斜晶系

单斜异极象

符号: 2 or C_2

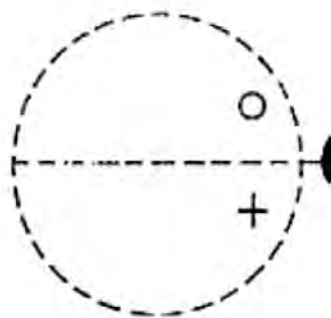
单斜楔形体类

一般形:

$\{hkl\}$



楔形 IV. 正形



$\{0kl\}$	$\{h0l\}$	$\{hk0\}$
<p>楔形 I. 正形</p>	<p>轴面 II. 正形</p>	<p>楔形 III. 正形</p>
$\{100\}$	$\{010\}$	$\{001\}$
<p>I. 轴面</p>	<p>II. 单面</p>	<p>III. 轴面</p>

代表性矿物:

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

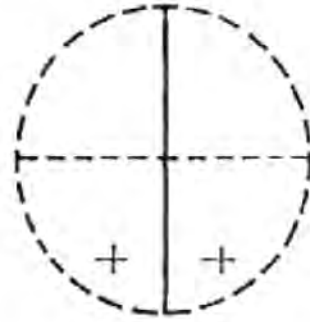
酒石酸Tartaric acid $C_4H_6O_6$

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

Monoclinic crystal system

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

General form:
 $\{hkl\}$



$\{0kl\}$	$\{h0l\}$	$\{hk0\}$
<p><u>Domen I.pos.</u></p>	<p><u>Pedien II.pos.</u></p>	<p><u>Domen III.pos.</u></p>
$\{100\}$	$\{010\}$	$\{001\}$
<p><u>I. Pedion</u></p>	<p><u>II. Pinacoid</u></p>	<p><u>III. Pedion</u></p>

mineral examples:

Posnjakite $Cu_4[(OH)_6/SO_4]*H_2O$

Hilgardite $Ca_2[Cl/B_5O_8(OH)_2]$

Scolecite $Ca[Al_2Si_3O_{10}]*3H_2O$

单斜晶系

单斜半面象 II
单斜坡面体类

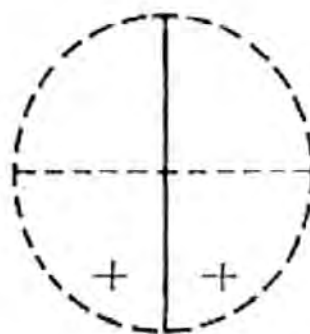
符号: m or C_s

一般形:

$\{hkl\}$



拱形 IV. 正形



$\{0kl\}$	$\{h0l\}$	$\{hk0\}$
拱形 I. 正形	单面 II. 正形	拱形 III. 正形
$\{100\}$	$\{010\}$	$\{001\}$
I. 单面	II. 轴面	III. 单面

代表性矿物:

水蓝铜矾 Posnjakite $Cu_4[(OH)_6/SO_4]*H_2O$

水氯硼钙石 Hilgardite $Ca_2[Cl/B_5O_8(OH)_2]$

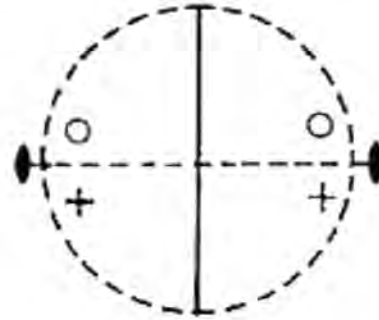
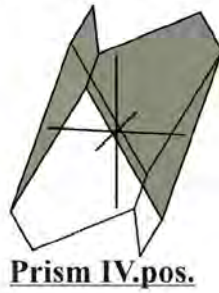
钙沸石 Scolecite $Ca[Al_2Si_3O_{10}]*3H_2O$

Monoclinic crystal system

Monoclinic Holoedry
 Monoclinic prismatic class

Symbol: $2/m$ or C_{2h}

General form:
 $\{hkl\}$



$\{0kl\}$	$\{h0l\}$	$\{hk0\}$
<p>Prism I.pos.</p>	<p>Pinacoid II.pos.</p>	<p>Prism III.pos.</p>
$\{100\}$	$\{010\}$	$\{001\}$
<p>I. Pinacoid</p>	<p>II. Pinacoid</p>	<p>III. Pinacoid</p>

mineral examples:

- most common crystal class
- see additional page

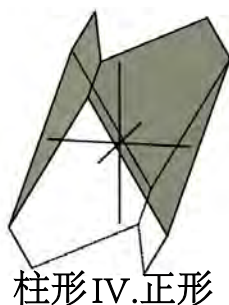
单斜晶系

单斜全面象

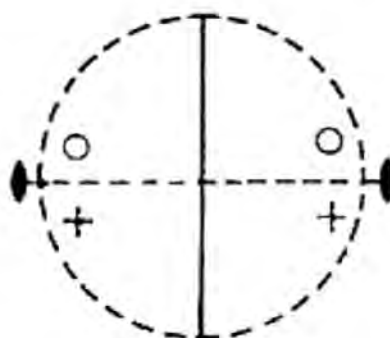
符号: $2/m$ or C_{2h}

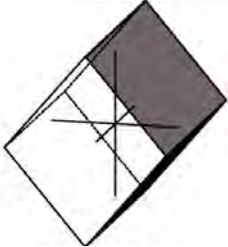
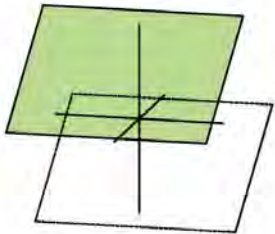
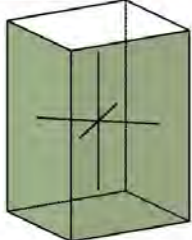
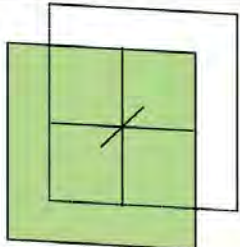
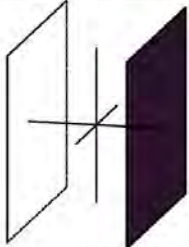
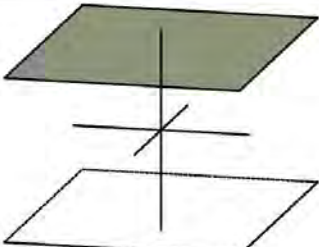
单斜柱体类

一般形:
{hkl}



柱形IV.正形



{0kl}	{h0l}	{hk0}
 <p>柱形I.正形</p>	 <p>轴面II.正形</p>	 <p>柱形III.正形</p>
{100}	{010}	{001}
 <p>I.轴面</p>	 <p>II.轴面</p>	 <p>III.轴面</p>

代表性矿物:

- 最常见的晶体类型
- 见下一页

mineral examples for 2/m: (most common crystal class)Gypsum $\text{Ca}[\text{SO}_4] \cdot 2\text{H}_2\text{O}$ Diopside $\text{Ca}(\text{Mg}, \text{Fe})[\text{Si}_2\text{O}_6]$ Orthoclase $\text{K}[\text{AlSi}_3\text{O}_8]$ Soda $\text{Na}_2[\text{CO}_3] \cdot 10\text{H}_2\text{O}$ Arsenopyrite FeAsS Azurite $\text{Cu}_3[(\text{CO}_3)_2/(\text{OH})_2]$ Biotite $\text{K}(\text{Mg}, \text{Fe}^{2+}, \text{Mn}^{2+})_3[(\text{OH}, \text{F})_2/(\text{Al}, \text{Fe}^{3+}, \text{Ti}^{3+})\text{Si}_3\text{O}_{10}]$ Borax $\text{Na}_2[\text{B}_4\text{O}_5/(\text{OH})_4] \cdot 8\text{H}_2\text{O}$ Chalcocite Cu_2S Epidote $\text{Ca}_2(\text{Fe}, \text{Al})_3[(\text{Si}_2\text{O}_7)/(\text{SiO}_4)_3/(\text{OH})_2]$ Hornblende $\text{Ca}_2(\text{Mg}, \text{Fe}, \text{Al})_5 [(\text{Al}, \text{Si})_8\text{O}_{22}/(\text{OH})_2]$ Cryolite Na_3AlF_6 Malachite $\text{Cu}_2[(\text{CO}_3)/(\text{OH})_2]$ Muscovite $\text{KAl}_2[\text{Si}_3\text{AlO}_{10}/(\text{OH}, \text{F})_2]$ Phlogopite $\text{KMg}_3[\text{Si}_3\text{AlO}_{10}/(\text{F}, \text{OH})_2]$ Realgar AsS Sanidine $(\text{K}, \text{Na})[\text{Al}_3\text{SiO}_8]$ Staurolite $(\text{Fe}^{2+}, \text{Mg}, \text{Zn})_2\text{Al}_9[(\text{Si}, \text{Al})_4\text{O}_{22}/(\text{OH})_2]$ Titanite $\text{CaTi}[\text{O}/\text{SiO}_4]$

属于 2/m 结构的代表矿物: (最常见的晶体类型)

石膏 Gypsum $\text{Ca}[\text{SO}_4] \cdot 2\text{H}_2\text{O}$

透辉石 Diopside $\text{Ca}(\text{Mg}, \text{Fe})[\text{Si}_2\text{O}_6]$

正长石 Orthoclase $\text{K}[\text{AlSi}_3\text{O}_8]$

纯碱(苏打) Soda $\text{Na}_2[\text{CO}_3] \cdot 10\text{H}_2\text{O}$

毒砂 Arsenopyrite FeAsS

蓝铜矿 Azurite $\text{Cu}_3[(\text{CO}_3)_2/(\text{OH})_2]$

黑云母 Biotite $\text{K}(\text{Mg}, \text{Fe}^{2+}, \text{Mn}^{2+})_3[(\text{OH}, \text{F})_2/(\text{Al}, \text{Fe}^{3+}, \text{Ti}^{3+})\text{Si}_3\text{O}_{10}]$

硼砂 Borax $\text{Na}_2[\text{B}_4\text{O}_5/(\text{OH})_4] \cdot 8\text{H}_2\text{O}$

辉铜矿 Chalcocite Cu_2S

绿帘石 Epidote $\text{Ca}_2(\text{Fe}, \text{Al})_3[(\text{Si}_2\text{O}_7)/(\text{SiO}_4)_3/(\text{OH})_2]$

角闪石 Hornblende $\text{Ca}_2(\text{Mg}, \text{Fe}, \text{Al})_5[(\text{Al}, \text{Si})_8\text{O}_{22}/(\text{OH})_2]$

冰晶石 Cryolite Na_3AlF_6

孔雀石 Malachite $\text{Cu}_2[(\text{CO}_3)/(\text{OH})_2]$

白云母 Muscovite $\text{KAl}_2[\text{Si}_3\text{AlO}_{10}/(\text{OH}, \text{F})_2]$

金云母 Phlogopite $\text{KMg}_3[\text{Si}_3\text{AlO}_{10}/(\text{F}, \text{OH})_2]$

鸡冠石 Realgar AsS

透长石 Sanidine $(\text{K}, \text{Na})[\text{Al}_3\text{SiO}_8]$

十字石 Staurolite $(\text{Fe}^{2+}, \text{Mg}, \text{Zn})_2\text{Al}_9[(\text{Si}, \text{Al})_4\text{O}_{22}/(\text{OH})_2]$

榍石 Titanite $\text{CaTi}[\text{O}/\text{SiO}_4]$

Orthorhombic crystal system

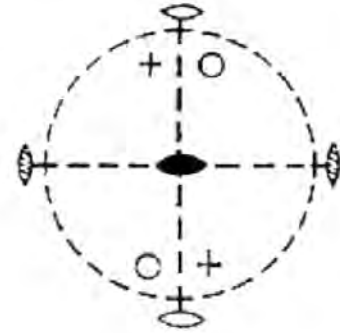
Rhombic hemiedry
Rhombic-disphenoidal class

Symbol: 222 or D_2

General form:
 $\{hkl\}$



Rhombic disphenoids



$\{0kl\}$	$\{h0l\}$	$\{hk0\}$
<p>Prism I.pos.</p>	<p>Prism II.pos.</p>	<p>Prism III.pos.</p>
$\{100\}$	$\{010\}$	$\{001\}$
<p>I. Pinacoid</p>	<p>II. Pinacoid</p>	<p>III. Pinacoid</p>

mineral examples:

Epsomite (Epsom salt) $MgSO_4 \cdot 7H_2O$

Zinc vitriol/ Goslarite $ZnSO_4 \cdot 7H_2O$

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

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

正交晶系

正交半面象

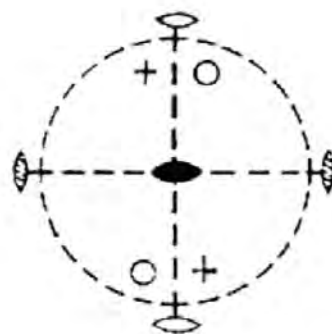
符号: 222 or D_2

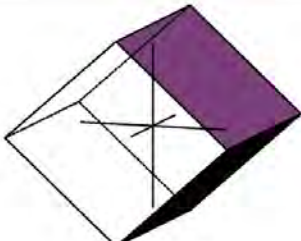
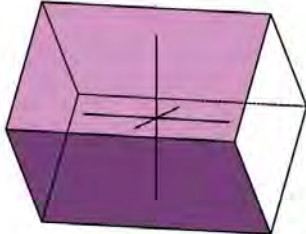
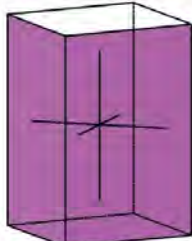
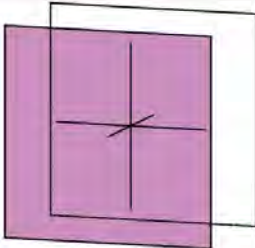

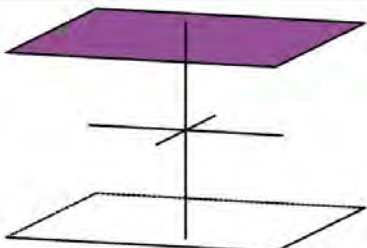
正交双楔体类

一般形:
{hkl}



正交双楔形



{0kl}	{h0l}	{hk0}
 <p>柱形I.正形</p>	 <p>柱形II.正形</p>	 <p>柱形III.正形</p>
{100}	{010}	{001}
 <p>I.轴面</p>	 <p>II.轴面</p>	 <p>III.轴面</p>

代表性矿物:

泻利盐 Epsomite (Epsom salt) $MgSO_4 \cdot 7H_2O$

皓矾 Zinc vitriol/ Goslarite $ZnSO_4 \cdot 7H_2O$

砷锌钙矿 Austinite $CaZn[(AsO_4)/(OH)]$

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

Orthorhombic crystal system

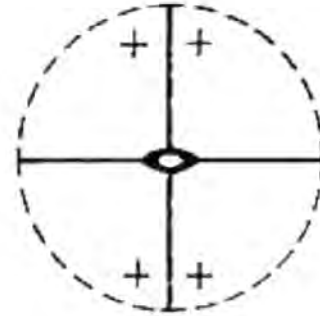
Rhombic Hemimorphy
Rhombic-pyramidal class

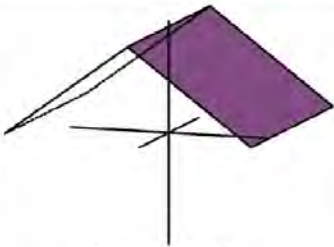
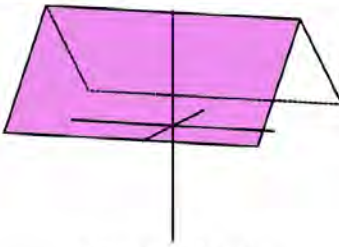

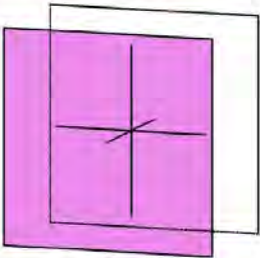
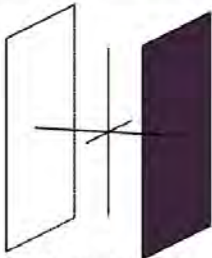

Symbol: $mm2$ or C_{2v}
(mm)

General form:
{hkl}



Rhombic pyramids



{0kl}	{h0l}	{hk0}
 <p><u>Domen I.pos.</u></p>	 <p><u>Domen II.pos.</u></p>	 <p><u>Prism III.pos.</u></p>
{100}	{010}	{001}
 <p><u>I. Pinacoid</u></p>	 <p><u>II. Pinacoid</u></p>	 <p><u>III. Pedien</u></p>

mineral examples:

Hemimorphite/Kieselgalmey $Zn_4[(OH)_2/Si_2O_7]*H_2O$

Struvite $MgNH_4[PO_4]*6H_2O$

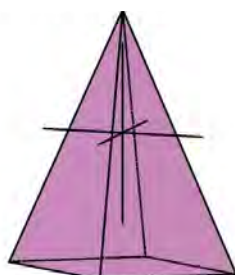
Prehnite $Ca_2Al_2[Si_3O_{10}/(OH)_2]$

正交晶系

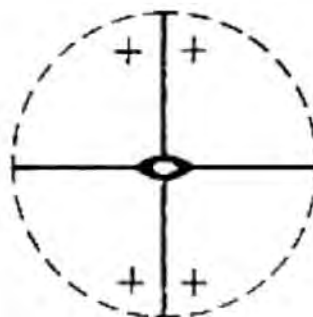
正交异极象
正交锥体类

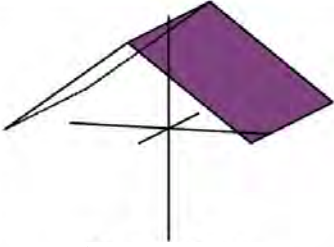
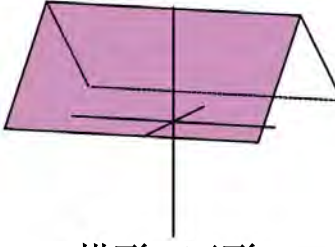

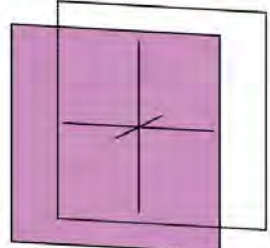
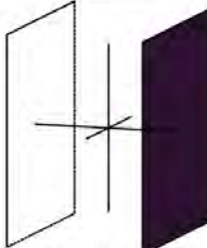

符号: $mm2$ or C_{2v}
(mm)

一般形:
{hkl}



正交锥形



{0kl}	{h0l}	{hk0}
 <p>拱形I.正形</p>	 <p>拱形II.正形</p>	 <p>柱形III.正形</p>
{100}	{010}	{001}
 <p>I.轴面</p>	 <p>II.轴面</p>	 <p>III.单面</p>

代表性矿物:

异极矿 Hemimorphite/Kieselgalmey $Zn_4[(OH)_2/Si_2O_7]*H_2O$

鸟粪石 Struvite $MgNH_4[PO_4]*6H_2O$

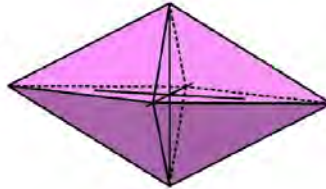
葡萄石 Prehnite $Ca_2Al_2[Si_3O_{10}/(OH)_2]$

Orthorhombic crystal system

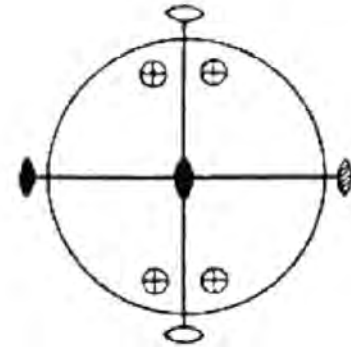
Rhombic Holoedry
Rhombic-bipyramidal class

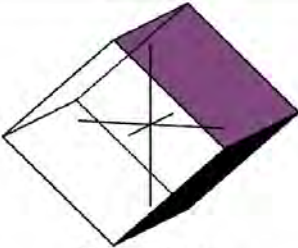
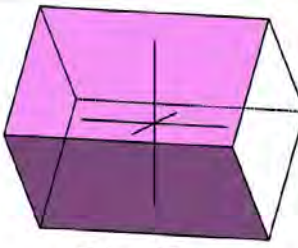

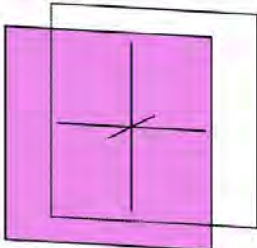
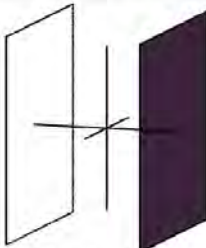
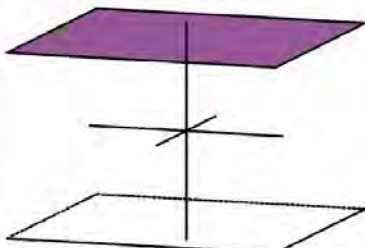
Symbol: $2/m\ 2/m\ 2/m$
(mmm) or D_{2h}

General form:
{hkl}



Rhombic bipyramid



{0kl}	{h0l}	{hk0}
 <p>Prism I.pos.</p>	 <p>Prism II.pos.</p>	 <p>Prism III.pos.</p>
{100}	{010}	{001}
 <p>I. Pinacoid</p>	 <p>II. Pinacoid</p>	 <p>III. Pinacoid</p>

mineral examples:

Sulphur S

Baryte $Ba[SO_4]$

Aragonite $Ca[CO_3]$

Topaz $Al_2[F_2/SiO_4]$

Anhydrite $Ca[SO_4]$

Olivine $(Mg,Fe)_2[SiO_4]$

正交晶系

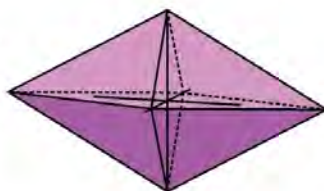
正交全面象

符号: $2/m\ 2/m\ 2/m$

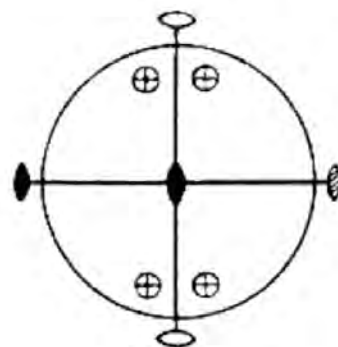
正交双锥体类

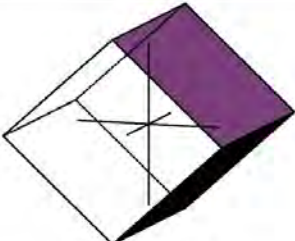
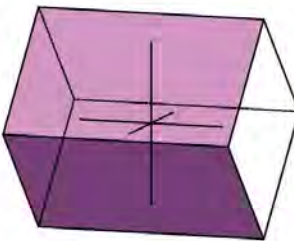

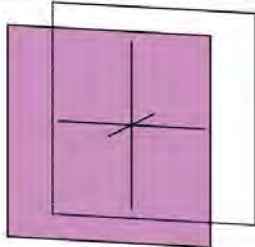
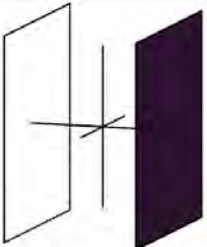
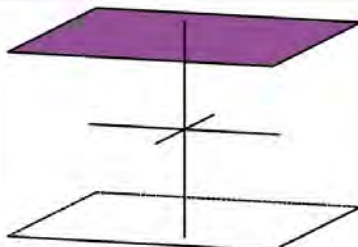
(mmm) or D_{2h}

一般形:
{hkl}



正交双锥体 I



{0kl}	{h0l}	{hk0}
 <p>柱形I.正形</p>	 <p>柱形II.正形</p>	 <p>柱形III.正形</p>
{100}	{010}	{001}
 <p>I.轴面</p>	 <p>II.轴面</p>	 <p>III.轴面</p>

代表性矿物:

硫 Sulphur S

重晶石 Baryte $Ba[SO_4]$

霏石 Aragonite $Ca[CO_3]$

黄晶 Topaz $Al_2[F_2/SiO_4]$

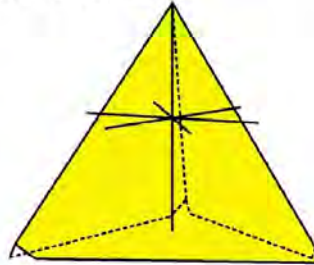
硬石膏 Anhydrite $Ca[SO_4]$

橄榄石 Olivine $(Mg,Fe)_2[SiO_4]$

Trigonal crystal system

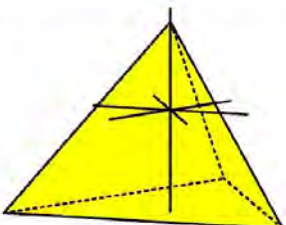

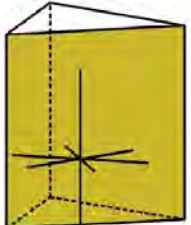
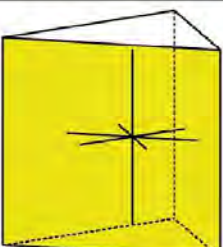
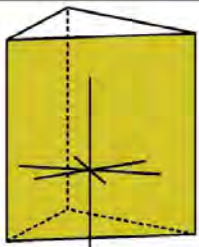
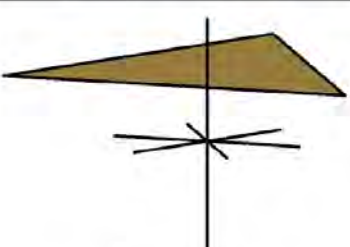
Hemimorphy of trig. Tetartoedry Symbol: 3 or C_3
 Trigonal pyramidal class

General form:
 $\{hkl\} / \{hkil\}$



Trigonal pyramid III. pos.



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
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

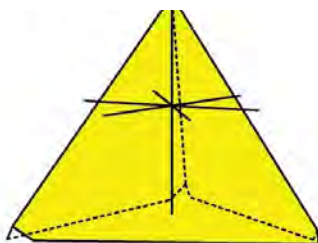
Lead germanate (low-temperature modification) $Pb_5Ge_3O_{11}$

三方晶系

三方四面体异极象
三方锥体类

符号: 3 or C_3

一般形:
 $\{hkl\} / \{hkil\}$



三方锥体III.正形



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
三方锥形I.正形	三方锥形II.正形	三方柱形III.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
三方柱形I.正形	三方柱形II.正形	底面

代表性矿物:

菱硫碳酸铅矿 Susannite $Pb_4[(SO_4)/(CO_3)_2/(OH)_2]$

硫铊矿 Carlinite TlS_2

锗酸铅

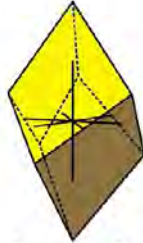
Lead germanate (low-temperature modification) $Pb_5Ge_3O_{11}$

Trigonal crystal system

Hexagonal trapezohedral tetartohedry
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

三方晶系

六方梯面四面体
三方梯面类


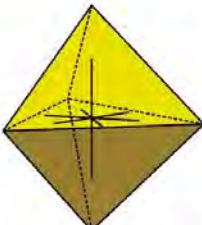
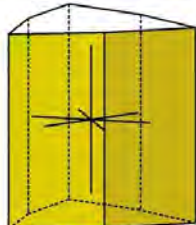
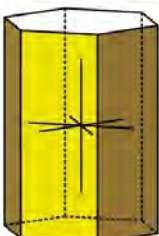
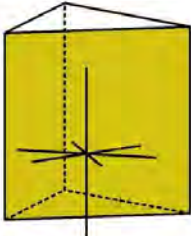
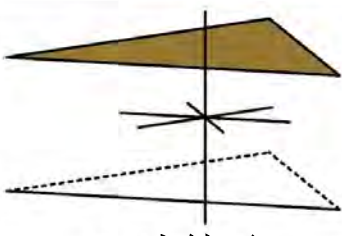
符号: 32 or D_3

一般形:
 $\{hkl\} / \{hkil\}$



三方梯面体



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
菱形体I.正形	三方双锥体II.正形	复三方柱形III.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
六方柱形I.正形	三方柱形II.正形	底轴面

代表性矿物:

辰砂 Cinnabar HgS

石英 Quartz SiO_2

硒 Selenium Se

碲 Tellurium Te

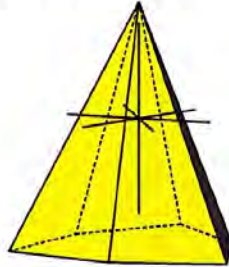
Trigonal pyramidal class

Hemimorphy of rhomboedric
hemiedry

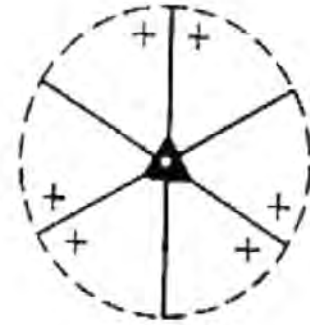
Symbol: $3m$ or C_{3v}

Ditrigonal-pyramidal class

General form:
 $\{hkl\} / \{hkil\}$



Ditrig. Pyramid I.pos.



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh2\bar{h}l\}$	$\{hk0\} / \{hki0\}$
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 $LiNbO_3$

三方晶系

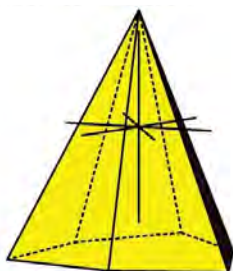
菱面体半面象异极象

复三方锥体类

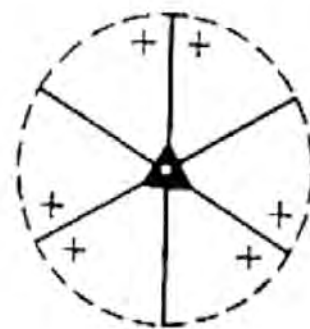
符号: $3m$ or C_{3v}

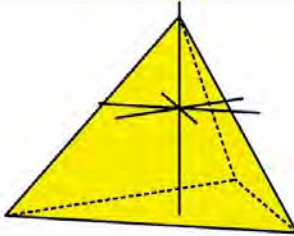
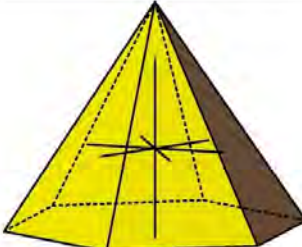

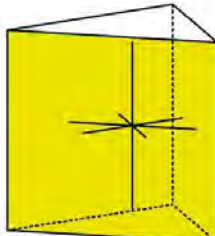

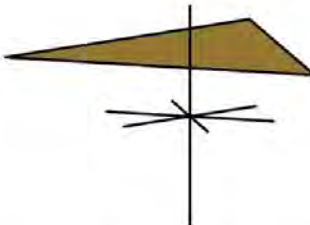
一般形:

$\{hkl\} / \{hkil\}$



复三方锥体I.正形



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
三方锥体I.正形	六方锥体II.正形	复三方柱形II.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
三方柱形 I.正形	六方柱形II.正形	底面

代表性矿物:

电气石 Tourmaline $(X)(Y_3)(Z_6)[Si_6O_{18}/(BO_3)_3/(V_3)(W)]$

硫砷银矿 Proustite Ag_3AsS_3

铌酸锂 Lithium niobate $LiNbO_3$

Trigonal crystal system

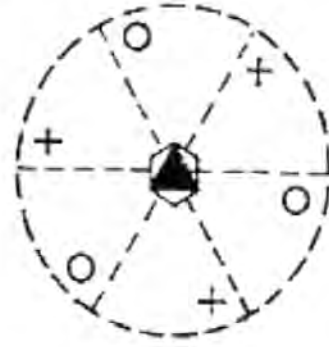
Hexagonal-rhomboedral
tetartoeidry
Rhombohedral class




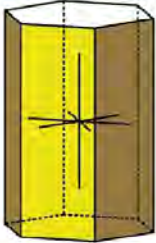
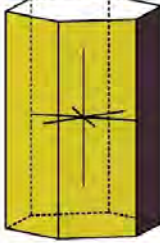
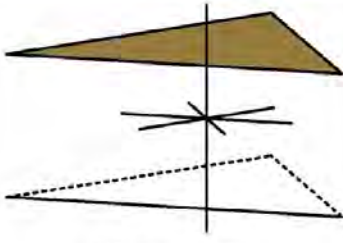
Symbol: $\bar{3}$ or C_{3i}

General form:
 $\{hkl\} / \{hkil\}$



Rhombohedron III.pos.



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
<u>Rhombohedron I.pos.</u>	<u>Rhombohedron II.pos.</u>	<u>Hex. Prism II.pos.</u>
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
<u>Hex. Prism I.pos.</u>	<u>Hex. Prism II.pos.</u>	<u>Basispinacoid</u>

mineral examples:

Dolomite $\text{CaMg}[(\text{CO}_3)_2]$

Diopside $\text{Cu}[\text{Si}_6\text{O}_{18}]$

Phenakite Be_2SiO_4

三方晶系

六方菱形四面体

符号: $\bar{3}$ or C_{3i}

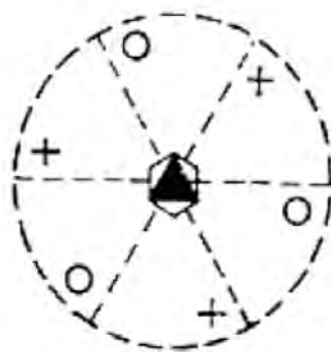
菱面体类

一般形:

$\{hkl\} / \{hkil\}$



菱面体III.正形



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
菱面体I.正形	菱面体II.正形	六方柱形II.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
六方柱形I.正形	六方柱形II.正形	底轴面

代表性矿物:

白云石 Dolomite $\text{CaMg}[(\text{CO}_3)_2]$

绿铜矿 Diopside $\text{Cu}[\text{Si}_6\text{O}_{18}]$

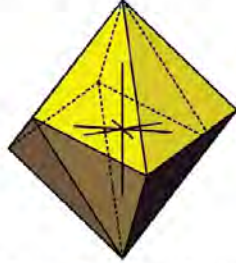
硅铍石 Phenakite Be_2SiO_4

Trigonal crystal system

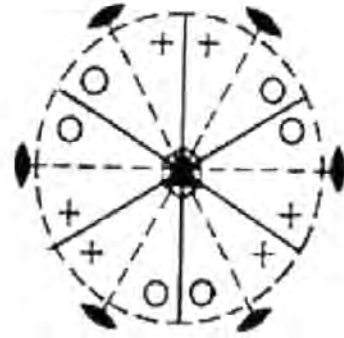
Hexagonal-rhombohedral
hemiedry
Ditrigonal-scalenohedral class

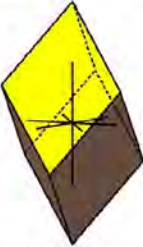
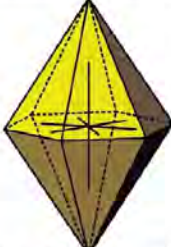
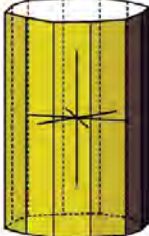
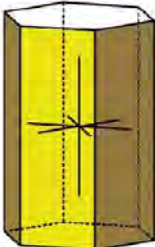
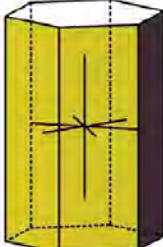
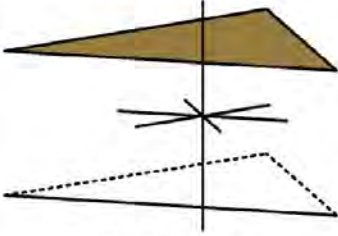
Symbol: $\bar{3} 2/m$ or D_{3d}
($\bar{3}m$)

General form:
 $\{hkl\} / \{hkil\}$



Ditrig. Scalenohedron



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
<u>Rhombohedron I.pos.</u>	<u>Hex. Dipyrmaid II.pos.</u>	<u>Dihex. Prism</u>
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
<u>Hex. Prism I.pos.</u>	<u>Hex. Prisma II.pos.</u>	<u>Basispinacoid</u>

mineral examples:

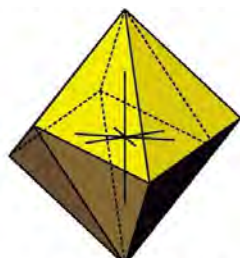
Calcite CaCO_3 Siderite FeCO_3
Corundum Al_2O_3 Rhodochrosite MnCO_3
Hematite Fe_2O_3

三方晶系

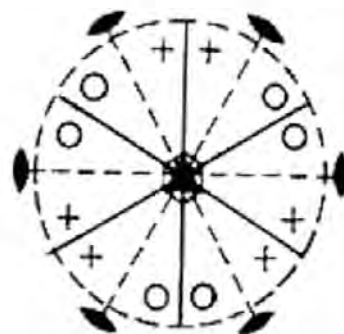
六方菱形四面体
复三方偏三角类

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

一般形:
 $\{hkl\} / \{hkil\}$



复三方偏三角体



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
菱面体I.正形	六方双锥体II.正形	复六方柱体
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
六方柱体I.正形	六方柱体II.正形	底轴面

代表性矿物:

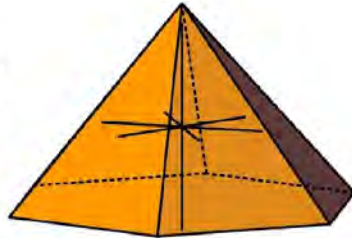
方解石 Calcite CaCO_3 菱铁矿 Siderite FeCO_3
刚玉 Corundum Al_2O_3 菱锰矿 Rhodochrosite MnCO_3
赤铁矿 Fe_2O_3

Hexagonal crystal system

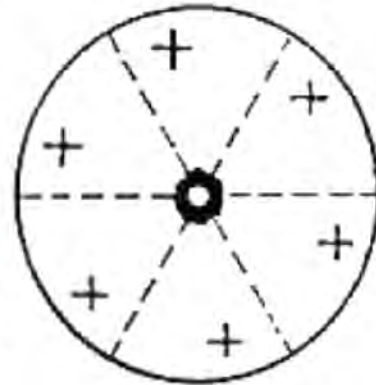
Hexagonal tetartoedry
Hexagonal-pyramidal class

Symbol: 6 or C_6

General form:
 $\{hkl\} / \{hkil\}$



Hexagonale Pyramiden III. St.



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
<u>Hex.Pyramid I.pos.</u>	<u>Hex. Pyramid II.pos.</u>	<u>Hex.Prism III.pos.</u>
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
<u>Hex.Prism I.pos.</u>	<u>Hex.Prism II.pos.</u>	<u>Basispedia</u>

mineral examples:

Lithium iodate α -LiIO₃

Nepheline (Na,K)[AlSiO₄]

Thaumasite Ca₃[SO₄/CO₃/Si(OH)₆]*12H₂O

六方晶系

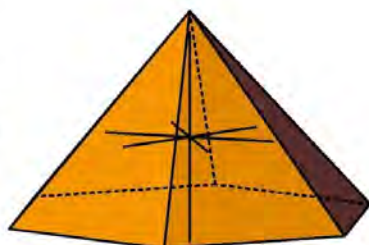
六方四面体

六方锥体类

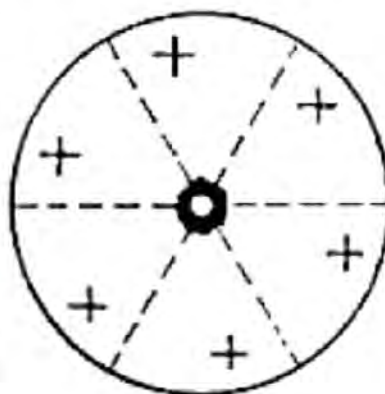
符号: 6 or C_6






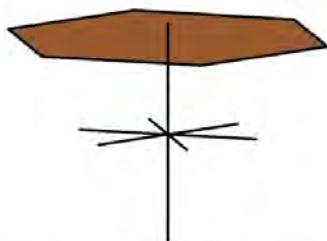
一般形:

$\{hkl\} / \{hkil\}$



三方锥体III



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
三方锥体I.正形	三方锥体II.正形	三方柱形III.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
三方柱形I.正形	三方柱形II.正形	底面

代表性矿物:

碘化锂 Lithium iodate $\alpha\text{-LiIO}_3$

霞石 Nepheline $(\text{Na},\text{K})[\text{AlSiO}_4]$

硅灰石膏 Thaumasite $\text{Ca}_3[\text{SO}_4/\text{CO}_3/\text{Si}(\text{OH})_6] \cdot 12\text{H}_2\text{O}$

Hexagonal crystal system

Hexagonal- trapezohedral
hemiedry

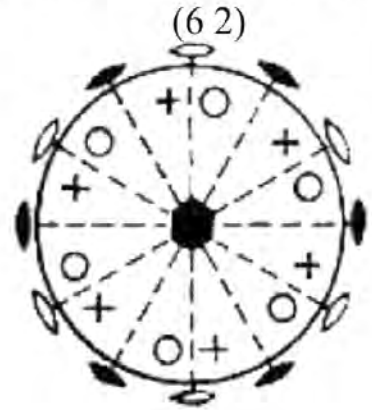
Hexagonal-trapezohedral Class

Symbol: 622 or D_6

General form:
 $\{hkl\} / \{hkil\}$



Hexagonal Trapezohedron



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
<u>Hex.Dipyramid I.pos.</u>	<u>Hex. Dipyramid II.pos.</u>	<u>Dihex. Prism</u>
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
<u>Hex.Prism I.St.</u>	<u>Hex. Prism II.pos.</u>	<u>Basispinacoid</u>

mineral examples:

Quartz-beta SiO_2

Virgilite $\text{LiAlSi}_2\text{O}_6$

Rhabdophane $(\text{Ce},\text{La})\text{PO}_4 \cdot \text{H}_2\text{O}$

六方晶系

六方梯形体半面象

六方梯面类

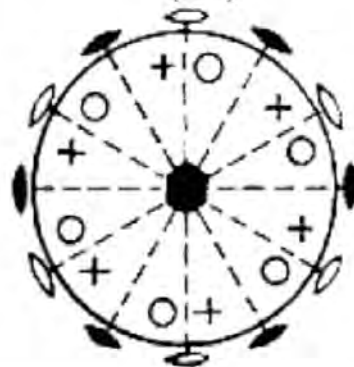
符号: 622 or D_6
(6 2)

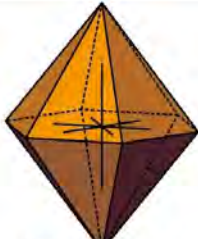

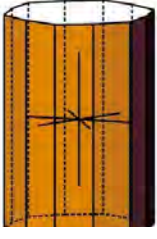


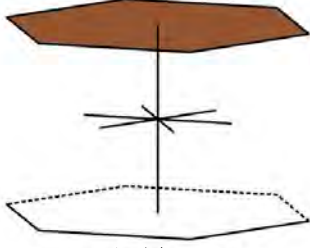
一般形:

$\{hkl\} / \{hkil\}$



六方梯面体



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
六方双锥体I.正形	六方双锥体II.正形	复六方柱形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
六方柱形I.	六方柱形II.正形	底轴面

代表性矿物:

高温石英 Quartz-beta SiO_2

紫锂辉石 Virgilite $\text{LiAlSi}_2\text{O}_6$

磷镧镨矿 Rhabdophane $(\text{Ce}, \text{La})\text{PO}_4 \cdot \text{H}_2\text{O}$

Hexagonal crystal system

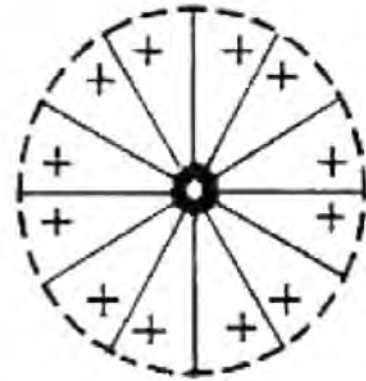
Hexagonal Hemimorphism
Dihexagonal-pyramidal class

Symbol: $6mm$ or C_{6v}

General form:
 $\{hkl\} / \{hkil\}$



Dihexagonal Pyramid



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
<p>Hex.Pyramid I.pos.</p>	<p>Hex. Pyramid II.pos.</p>	<p>Dihex.Prism</p>
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
<p>Hex.Prism I.pos.</p>	<p>Hex.Prism II.pos.</p>	<p>Basispedia</p>

mineral examples:

Wurzite ZnS

Zincite ZnO

Greenockite CdS

六方晶系

六方异极象

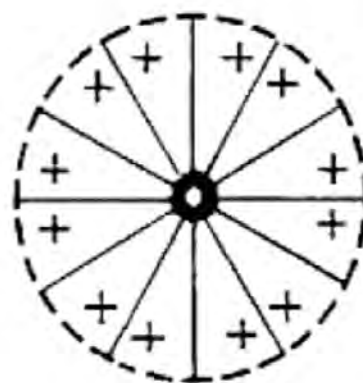
符号: $6mm$ or C_{6v}





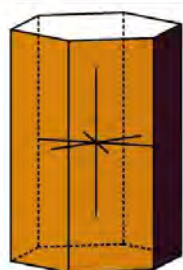

复六方锥体类

一般形:
 $\{hkl\} / \{hkil\}$



复六方锥体



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
六方锥体I.正形	六方锥体II.正形	复六方柱体
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
六方柱体I.正形	六方柱体II.正形	底面

代表性矿物:

闪锌矿 Wurtzite ZnS

红锌矿 Zincite ZnO

硫镉矿 Greenockite CdS

Hexagonal crystal system

Trigonal tetartodry

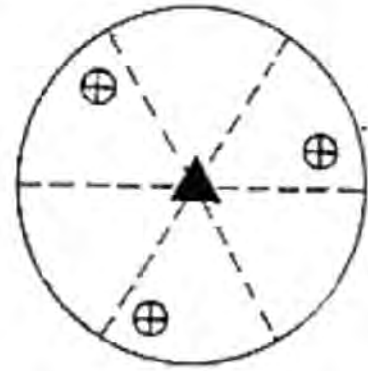
Symbol: $\bar{6}$ or C_{3h}

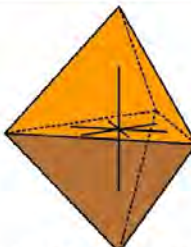
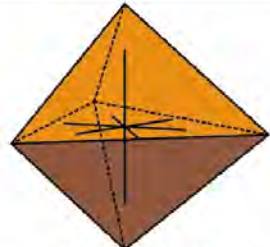

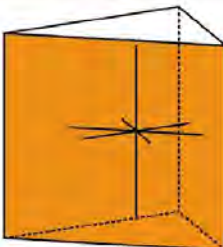
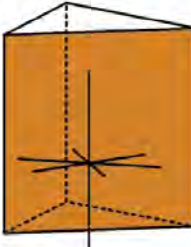
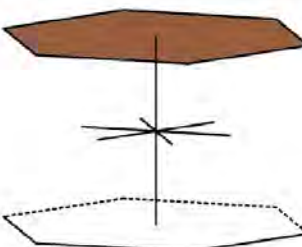
Trigonal-dipyramidal classe

General form:
 $\{hkl\} / \{hkil\}$



Trig. Dipyramid III.pos.



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
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 $Pb_9Ca_5Mn[(Si_2O_7)_3/(SiO_4)_3]$

六方晶系

三方四面体

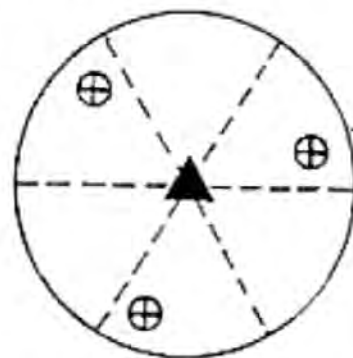
三方双锥类

符号: $\bar{6}$ or C_{3h}

一般形:
 $\{hkl\} / \{hkil\}$



三方双锥体III.正形



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
三方双锥体I.正形	三方双锥体II.正形	三方柱体III.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
三方柱体I.正形	三方柱体II.正形	底轴面

代表性矿物:

高温锗酸铅

Lead germanate (Hightemp. Modification) $Pb_5[Ge_3O_{11}]$

氯铅矿 Penfieldite $Pb_2[Cl_3/OH]$

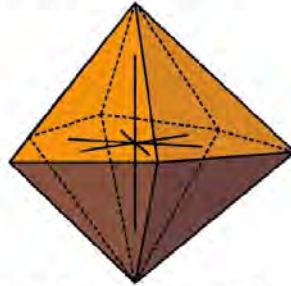
硅钙铅矿 Ganomalite $Pb_9Ca_5Mn[(Si_2O_7)_3/(SiO_4)_3]$

Hexagonal crystal system

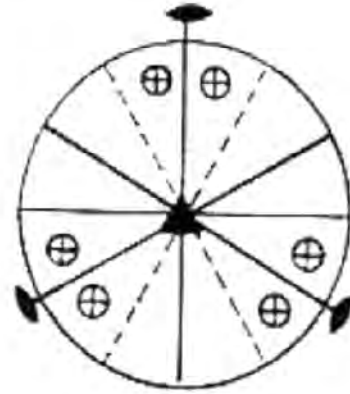
Trigonal Hemiedry
Ditrigonal-dipyramidal class

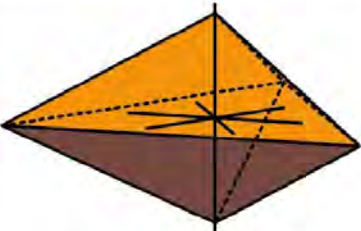


Symbol: $\bar{6}2m$ or D_{3h}

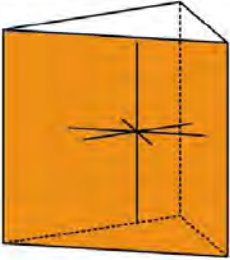

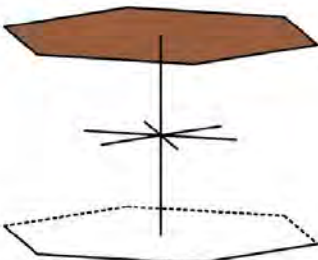
General form:
 $\{hkl\} / \{hkil\}$



Ditrig. Dipyramid



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

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

mineral examples:

Benitoite $BaTi[Si_3O_9]$

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

六方晶系

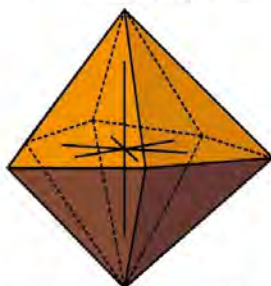
三方半面象

复三方双锥类

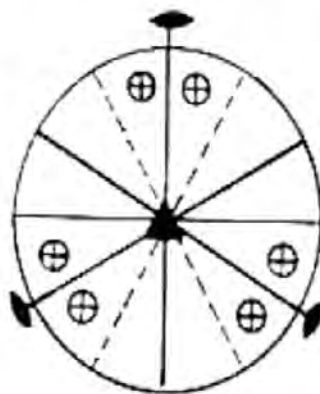
符号: $\bar{6}2m$ or D_{3h}

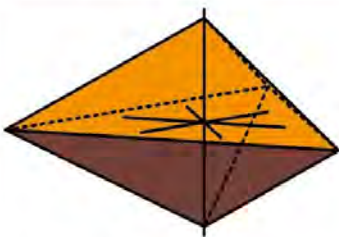


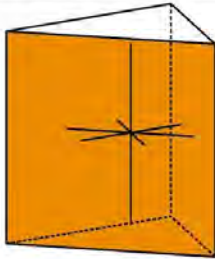
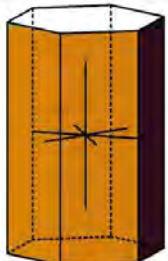

一般形:

$\{hkl\} / \{hkil\}$



复三方双锥体



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
		
三方双锥体I.正形	六方双锥体II.正形	复三方柱体III.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
三方柱体I.正形	六方柱体II.正形	底轴面

代表性矿物:

蓝锥矿 Benitoite $BaTi[Si_3O_9]$

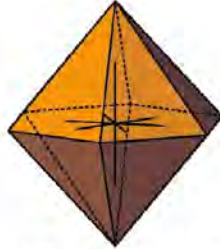
硅钡铌石 Belkovite $Ba_3(Nb,Ti)_6(Si_2O_7)_2O_{12}$

Hexagonal crystal system

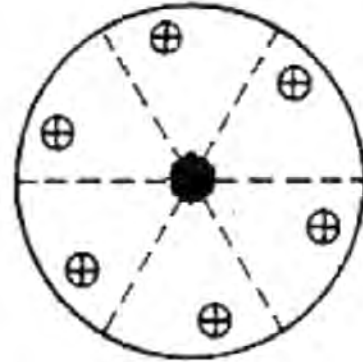
Hexagonal-pyramidal Hemiedry
Hexagonal-dipyramidal class

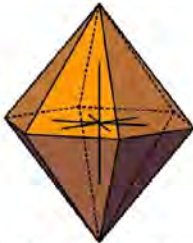



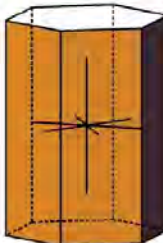
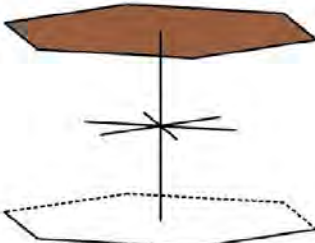
Symbol: $6/m$ or C_{6v}

General form:
 $\{hkl\} / \{hkil\}$



Hexagonal Dipyramid III.pos.



$\{h0l\} / \{h0\bar{h}l\}$	$\{hh1\} / \{hh\bar{2}h1\}$	$\{hk0\} / \{hki0\}$
		
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 $Pb_5[(VO_4)_3/Cl]$

六方晶系

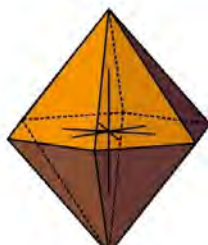
六方锥体半面象

六方双锥类

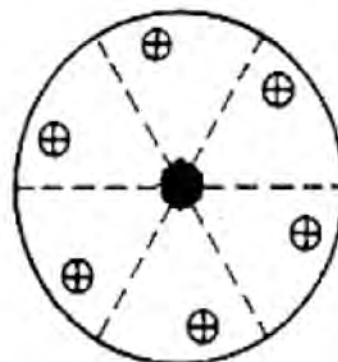
符号: $6/m$ or C_{6v}

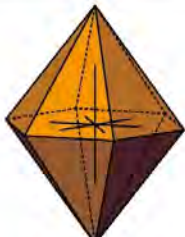



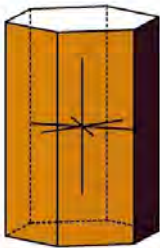
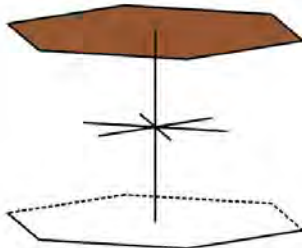
一般形:

$\{hkl\} / \{hkil\}$



六方双锥体III.正形



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh2\bar{h}l\}$	$\{hk0\} / \{hki0\}$
		
六方双锥体I.正形	六方双锥体II.正形	六方柱体III.正形
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
		
六方柱体I.正形	六方柱体II.正形	底轴面

代表性矿物:

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

磷氯铅矿 Pyromorphite $Pb_5[(PO_4)_3/Cl]$

钒铅矿 Vanadinite $Pb_5[(VO_4)_3/Cl]$

Hexagonal crystal system

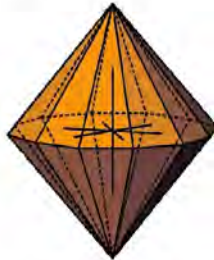
Hexagonal holoedry

Symbol: $6/mmm$ or D_{6h}

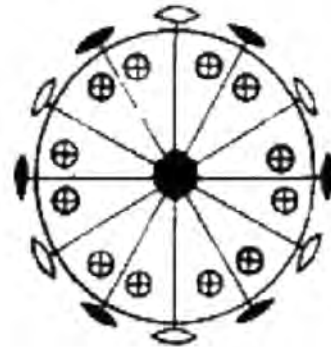
Dihexagonal-dipyramidal class

($6/m\ 2/m\ 2/m$)

General form:
 $\{hkl\} / \{hkil\}$



Dihexagonal Dipyramid



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
<u>Hex.Dipyramid I.pos.</u>	<u>Hex.Dipyramid II.pos.</u>	<u>Dihex.Prism</u>
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
<u>Hex.Prism I.pos.</u>	<u>Hex.Prism II.pos.</u>	<u>Basispinacoid</u>

mineral examples:

Beryl $\text{Be}_3\text{Al}_2[\text{Si}_6\text{O}_{18}]$

Covellite CuS

Graphite C

Ice H_2O

High tridymite SiO_2

六方晶系

六方全面象

复六方双锥类

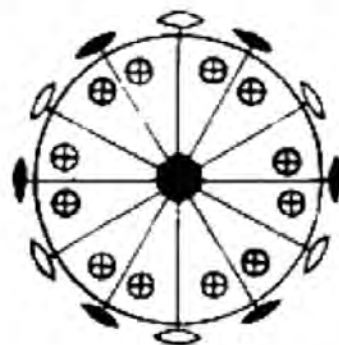
符号: $6/mmm$ or D_{6h}
($6/m\ 2/m\ 2/m$)

一般形:

$\{hkl\} / \{hkil\}$



复六方双锥体



$\{h0l\} / \{h0\bar{h}l\}$	$\{hhl\} / \{hh\bar{2}hl\}$	$\{hk0\} / \{hki0\}$
六方双锥体I.正形	六方双锥体II.正形	复六方柱体
$\{100\} / \{10\bar{1}0\}$	$\{110\} / \{11\bar{2}0\}$	$\{001\} / \{0001\}$
六方柱体I.正形	六方柱体II.正形	底轴面

代表性矿物:

绿宝石 Beryl $\text{Be}_3\text{Al}_2[\text{Si}_6\text{O}_{18}]$ 靛铜矿 Covellite CuS

石墨 Graphite C

冰 Ice H_2O

鳞石英 High tridymite SiO_2

Tetragonal crystal system

Hemimorphy of tetragonal -
pyramidal hemiedry

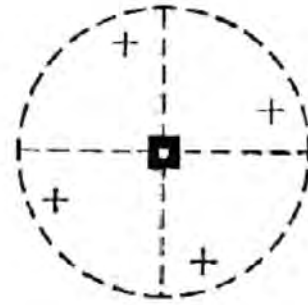
Symbol: 4 or C_4

Tetragonal-pyramidal class

General form:
 $\{hkl\}$



Tetrag. Pyramid III.pos.



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
<u>Tetrag. Pyramid II.pos.</u>	<u>Tetrag. Pyramid I.pos.</u>	<u>Tetrag. Prism III.pos.</u>
$\{100\}$	$\{110\}$	$\{001\}$
<u>Tetrag. Prism II.pos.</u>	<u>Tetrag. Prism I.pos.</u>	<u>Basispedia</u>

mineral examples:

Piypite $K_2Cu_2[O/(SO_4)_2]$

Pinnoite $Mg[B_2O_4]*3H_2O$

Percleveite-(Ce) $(Ce,La,Nd)_2[Si_2O_7]$

四方晶系

四方锥半面象异极象

符号: 4 or C_4

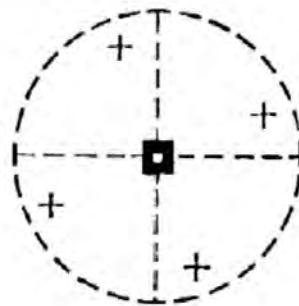
四方锥类






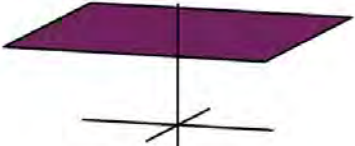
一般形:

$\{hkl\}$



四方锥体III.正形



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
		
四方锥体II.正形	四方锥体I.正形	四方柱体III.正形
$\{100\}$	$\{110\}$	$\{001\}$
		
四方柱体II.正形	四方柱体I.正形	底面

代表性矿物:

氯钾铜矾 Piypite $K_2Cu_2[O/(SO_4)_2]$

柱硼镁石 Pinnoite $Mg[B_2O_4]*3H_2O$

硅镧铈石 Percleveite-(Ce) $(Ce,La,Nd)_2[Si_2O_7]$

Tetragonal crystal system

Tetragonal-trapezohedral hemiedry

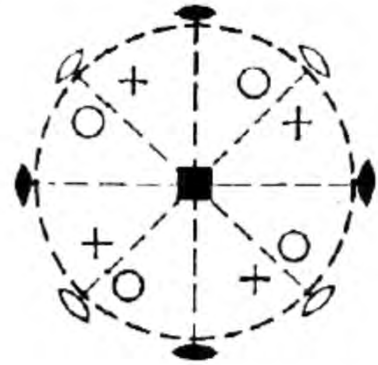
Tetragonal-trapezohedral class

Symbol: 422 or D_4

General form:
 $\{hkl\}$



Tetrag. Trapezohedron



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
<u>Tetrag. Dipyramid II. pos.</u>	<u>Tetrag. Dipyramid I. pos.</u>	<u>Ditetrag. Prism</u>

$\{100\}$	$\{110\}$	$\{001\}$
<u>Tetrag. Prism II. pos.</u>	<u>Tetrag. Prism I. pos.</u>	<u>Basispinacoid</u>

mineral examples:

Retgersite $\text{Ni}[\text{SO}_4] \cdot 6\text{H}_2\text{O}$

Maucherite $\text{Ni}_{11}\text{As}_8$

Cristobalite SiO_2

四方晶系

四方梯面半面象单
四方梯面体类

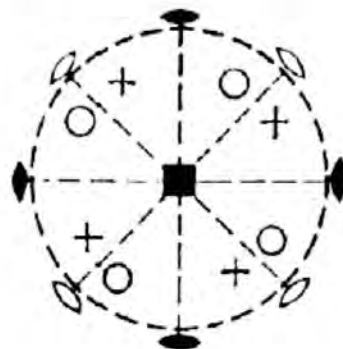
符号: 422 or D_4






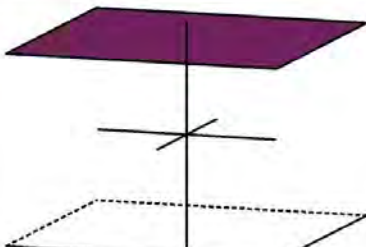
一般形:

$\{hkl\}$



四方梯面体



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
		
四方双锥体II.正形	四方双锥体I.正形	复四方柱体
$\{100\}$	$\{110\}$	$\{001\}$
		
四方柱体II.正形	四方柱体I.正形	底轴面

代表性矿物:

镍矾 Retgersite $Ni[SO_4] \cdot 6H_2O$

砷镍矿 Maucherite $Ni_{11}As_8$

方石英 Cristobalite SiO_2

Tetragonal crystal system

Hemimorphy of tetragonal
holoedry

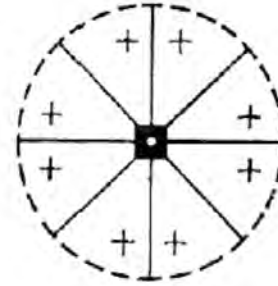
Symbol: $4mm$ or C_{4v}







Ditetragonal-pyramidal class

General form:
 $\{hkl\}$



Ditetrag. Pyramid



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
		
<u>Tetrag. Pyramid II.pos.</u>	<u>Tetrag. Pyramid I.pos.</u>	<u>Ditetrag. Prism</u>
$\{100\}$	$\{110\}$	$\{001\}$
		
<u>Tetrag. Prism II.pos.</u>	<u>Tetrag. Prism I.pos.</u>	<u>Basispedia</u>

mineral examples:

Diaboleite $Pb_2Cu[Cl_2/(OH)_4]$

Macedonite $PbTiO_3$

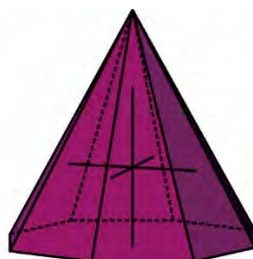
Nielsenite $PdCu_3$

四方晶系

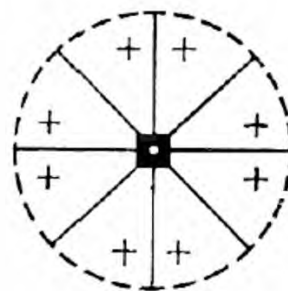
四方全面体异极
复四方锥体类

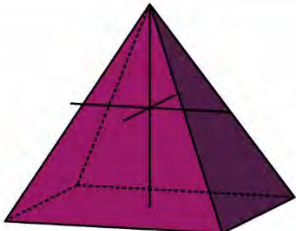
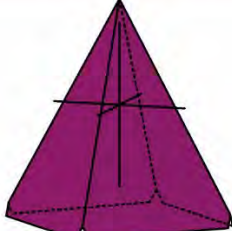
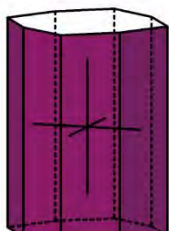

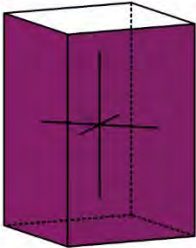
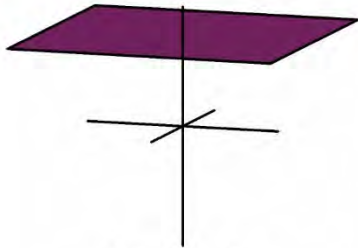
符号: $4mm$ or C_{4v}

一般形:
 $\{hkl\}$



复四方锥体



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
		
四方锥体II.正形	四方锥体I.正形	复四方柱体
$\{100\}$	$\{110\}$	$\{001\}$
		
四方柱体II.正形	四方柱体I.正形	底面

代表性矿物:

羟氟铜铅矿 Diaboleite $Pb_2Cu[Cl_2/(OH)_4]$

铅钛矿 Macedonite $PbTiO_3$

三铜钯矿 Nielsenite $PdCu_3$

Tetragonal crystal system

Tetragonal-sphenoidal tetartoeidry

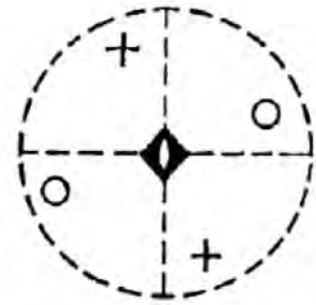
Tetragonal-disphenoidal class





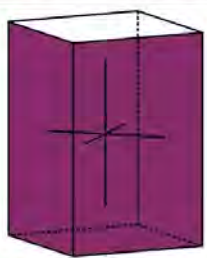
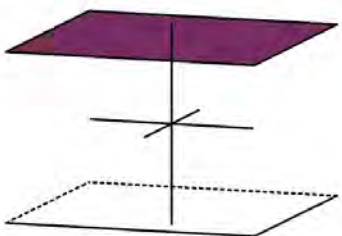
Symbol: $\bar{4}$ or S_4

General form:
 $\{hkl\}$



Tetrag.Disphenoid III.pos.



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
		
<u>Tetrag.Disphenoid II.pos.</u>	<u>Tetrag.Disphenoid I.pos.</u>	<u>Tetrag.Prism III.pos.</u>
$\{100\}$	$\{110\}$	$\{001\}$
		
<u>Tetrag.Prism II.pos.</u>	<u>Tetrag.Prism I.pos.</u>	<u>Basispinacoid</u>

mineral examples:

Cahnite $\text{Ca}_2[\text{AsO}_4/\text{B}(\text{OH})_4]$

Tugtupite $\text{Na}_8[(\text{AlBeSi}_4\text{O}_{12})_2/\text{Cl}_2]$

Schreibersite $(\text{Fe},\text{Ni})_3\text{P}$

四方晶系

四方楔形四面体

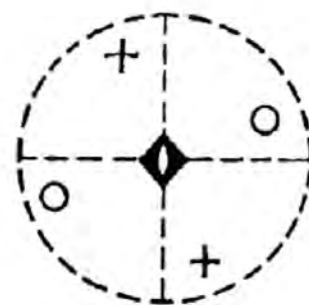
四方双楔形类

符号: $\bar{4}$ or S_4

一般形:
 $\{hkl\}$



四方双楔体III.正形



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
四方双楔体II.正形	四方双楔体I.正形	四方柱体III.正形
$\{100\}$	$\{110\}$	$\{001\}$
四方柱体II.正形	四方柱体I.正形	底轴面

代表性矿物:

砷硼钙石 Cahnite $Ca_2[AsO_4/B(OH)_4]$

硅铍铝钠石 Tugtupite $Na_8[(AlBeSi_4O_{12})_2/Cl_2]$

陨磷铁矿 Schreibersite $(Fe,Ni)_3P$

Tetragonal crystal system

Tetragonal-sphenoidal hemiedry

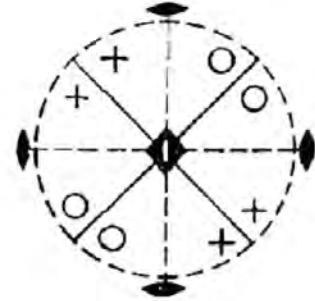
Tetragonal-scalenohedral class

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

General form:
 $\{hkl\}$



Tetrag. Scalenohedron



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
<p><u>Tetrag. Dipyramid II. pos.</u></p>	<p><u>Tetrag. Disphenoid I. pos.</u></p>	<p><u>Ditetrag. Prism</u></p>
$\{100\}$	$\{110\}$	$\{001\}$
<p><u>Tetrag. Prism II. pos.</u></p>	<p><u>Tetrag. Prism I. pos.</u></p>	<p><u>Basispinacoid</u></p>

mineral examples:

Chalkopyrite CuFeS_2

Mooihoekite $\text{Cu}_9\text{Fe}_9\text{S}_{16}$

Stannite $\text{Cu}_2\text{FeSnS}_4$

四方晶系

四方楔形半面象

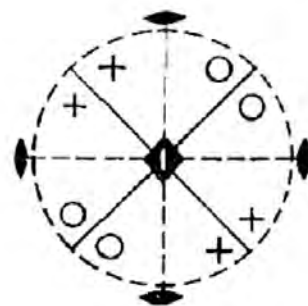
四方偏三角类






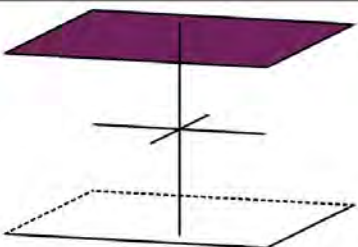
符号: $\bar{4}2m$ or D_{2d}

一般形:
{hkl}



四方偏三角体



{h0l}	{hhl}	{hk0}
		
四方双锥体II.正形	四方双楔体I.正形	复四方柱体
{100}	{110}	{001}
		
四方柱体II.正形	四方柱体I.正形	底轴面

代表性矿物:

黄铜矿 Chalkopyrite $CuFeS_2$

褐硫铁铜矿 Mooihoekite $Cu_9Fe_9S_{16}$

黝锡矿 Stannite Cu_2FeSnS_4

Tetragonal crystal system

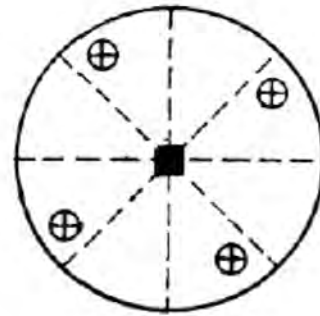
Tetragonal-dipyramidal hemiedry
Tetragonal-dipyramidal class






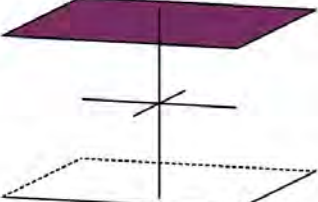
Symbol: $4/m$ or C_{4h}

General form:
 $\{hkl\}$



Tetrag.Dipyramid III.pos.



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
		
<u>Tetrag.Dipyramid II.pos.</u>	<u>Tetrag.Dipyramid I.pos.</u>	<u>Tetrag.Prism III.pos.</u>
$\{100\}$	$\{110\}$	$\{001\}$
		
<u>Tetrag.Prism II.pos.</u>	<u>Tetrag.Prism I.pos.</u>	<u>Basispinacoid</u>

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 $YNbO_4$

四方晶系

四方双锥体半面象

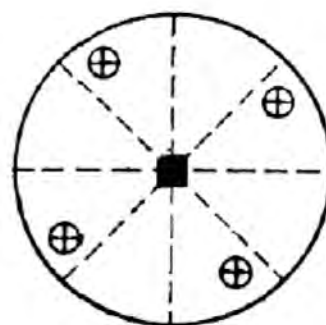
符号: $4/m$ or C_{4h}






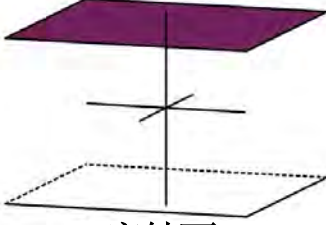
四方双锥类

一般形:
{hkl}



四方双锥体III.正形



{h0l}	{hhl}	{hk0}
		
四方双锥体II.正形	四方双锥体II.正形	四方柱体III.正形
{100}	{110}	{001}
		
四方柱体I.正形	四方柱体I.正形	底轴面

代表性矿物:

白钨矿 Scheelite $Ca[WO_4]$

符山石 Vesuvianite

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

褐钇铌矿 Fergusonite $YNbO_4$

Tetragonal crystal system

Tetragonal holoedry

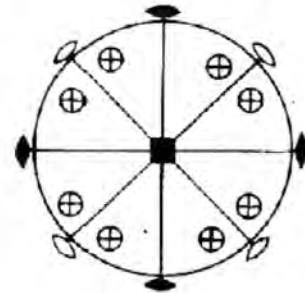
Ditetragonal-dipyramidal
class






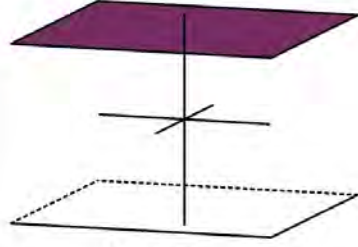
Symbol: $4/m \ 2/m \ 2/m$
($4/m \ m \ m$) or D_{4h}

General form:
{hkl}



Ditetrag. Dipyramid



{h0l}	{hhl}	{hk0}
 <p><u>Tetrag. Dipyramid II. pos.</u></p>	 <p><u>Tetrag. Dipyramid I. pos.</u></p>	 <p><u>Ditetrag. Prism</u></p>
{100}	{110}	{001}
 <p><u>Tetrag. Prism II. pos.</u></p>	 <p><u>Tetrag. Prism I. pos.</u></p>	 <p><u>Basispinacoid</u></p>

mineral examples:

Rutile TiO_2

Anatase TiO_2

Zircon $Zr[SiO_4]$

四方晶系

四方全面象

复四方双锥类

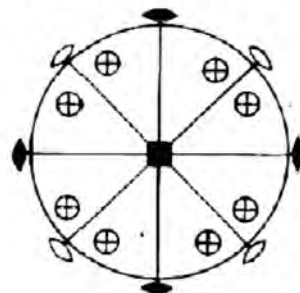
符号: $4/m\ 2/m\ 2/m$






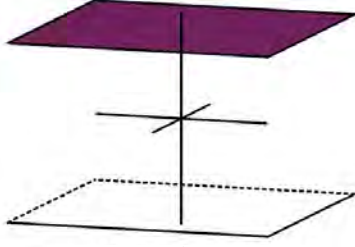
$(4/m\ m\ m)$ or D_{4h}

一般形:
 $\{hkl\}$



复四方双锥体



$\{h0l\}$	$\{hhl\}$	$\{hk0\}$
		
四方双锥体II.正形	四方双锥体I.正形	复四方柱体
$\{100\}$	$\{110\}$	$\{001\}$
		
四方柱体II.正形	四方柱体I.正形	底轴面

代表性矿物:

金红石 Rutile TiO_2

锐钛矿 Anatase TiO_2

锆石 Zircon $Zr[SiO_4]$

Cubic crystal system

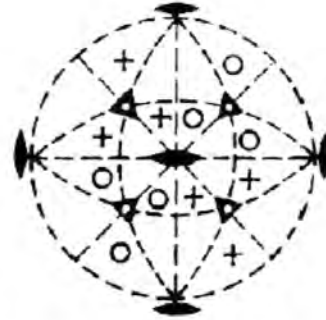
Cubic Tetartoedry
Tetrahedral-pentagon-
dodecaedric class

Symbol: 23 or T

General form:
 $\{hkl\}$



Tetrahedral Pentagondodecaeder



$\{hll\}$	$\{hhl\}$	$\{hk0\}$
<u>Pyramidal tetrahedron</u>	<u>Deltoidal dodecahedron</u>	<u>Pentagonal dodecaeder</u>
$\{111\}$	$\{110\}$	$\{100\}$
<u>Tetrahedron</u>	<u>Rhombic dodecahedron</u>	<u>Cube/Hexahedron</u>

mineral examples:

Langbeinite $K_2Mg_2[(SO_4)_3]$

Ullmannite NiSbS

Gersdorffite NiAsS

立方晶系

立方四面体

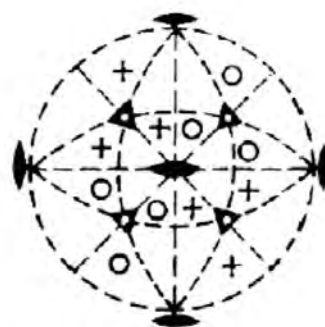
符号: 23 or T

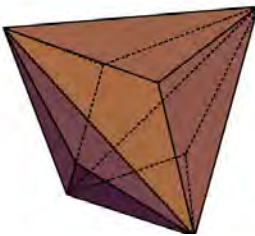
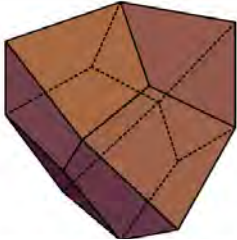
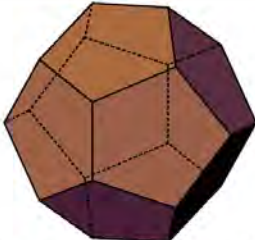
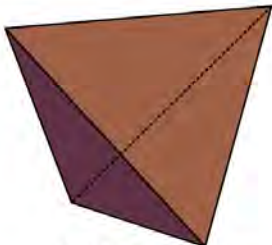
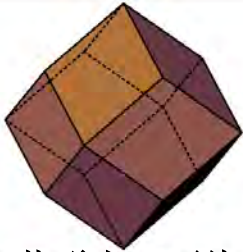
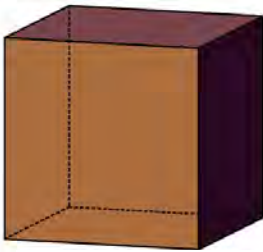
四方五角十二面体类

一般形:
{hkl}



四方五角十二面体



{hll}	{hhl}	{hk0}
		
锥形四面体	三角十二面体	五角十二面体
{111}	{110}	{100}
		
四面体	菱形十二面体	立方体/六面体

代表性矿物:

无水钾镁矾 Langbeinite $K_2Mg_2[(SO_4)_3]$

锑硫镍矿 Ullmannite NiSbS

辉砷镍矿 Gersdorffite NiAsS

Cubic crystal system

Gyroedric hemiedry

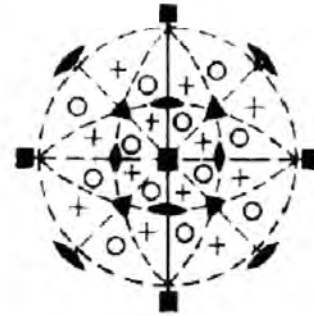
Symbol: 432 or O


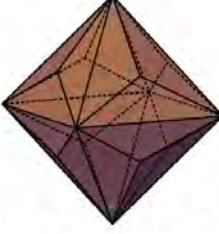

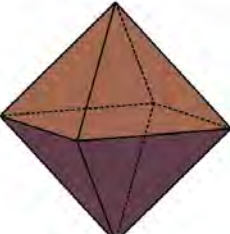

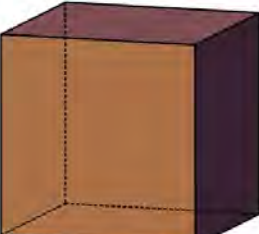
Pentagonal icositetrahedral class

General form:
{hkl}



Pentagonal icositetrahedron



$\{hll\}$	$\{hhl\}$	$\{hk0\}$
		
<u>Deltoidal icositetrahedron</u>	<u>Pyramidal octahedron</u>	<u>Pyramidal cube</u>
$\{111\}$	$\{110\}$	$\{100\}$
		
<u>Octahedron</u>	<u>Rhombic dodecahedron</u>	<u>Cube/ Hexahedron</u>

mineral examples:

Maghemite $\text{Gamma-Fe}_2\text{O}_3$

Choloalite $\text{CuPb}[(\text{TeO}_3)_2]$

Petzite Ag_3AuTe_2

立方晶系

五角二十四面体半面象

符号: 432 or O

五角三八面体类

一般形:
{hkl}



五角三八面体



{hll}	{hhl}	{hk0}
三角三八面体	锥形八面体	锥形立方体
{111}	{110}	{100}
八面体	菱形十二面体	立方体/六面体

代表性矿物:

磁赤铁矿 Maghemite $\text{Gamma-Fe}_2\text{O}_3$

水碲铜铅矿 Choloalite $\text{CuPb}[(\text{TeO}_3)_2]$

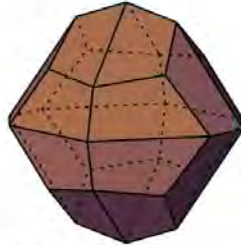
碲金银矿 Petzite Ag_3AuTe_2

Cubic crystal system

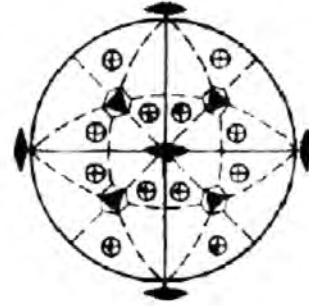
Parallel Hemiedry
Disdodecaedric class





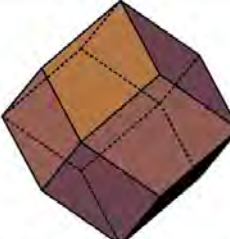
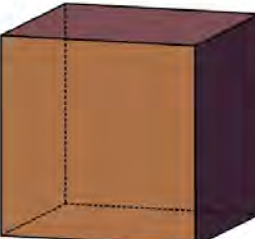
Symbol: $2/m\bar{3}$ or T_h
(m3)

General form:
{hkl}



Disdodecahedron



{hll}	{hhl}	{hk0}
		
<u>Deltoidal icositetrahedron</u>	<u>Pyramidal octahedron</u>	<u>Pentagonal dodecahedron</u>
{111}	{110}	{100}
		
<u>Octahedron</u>	<u>Rhombic dodecahedron</u>	<u>Cube/Hexahedron</u>

mineral examples:

Pyrite FeS_2

Cobaltite $CoAsS$

Alum, z.B. $KAl[SO_4]_2 \cdot 12H_2O$

Bixbyite $(Mn,Fe)_2O_3$

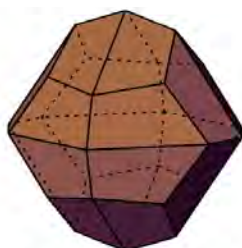
立方晶系

平行式半面象

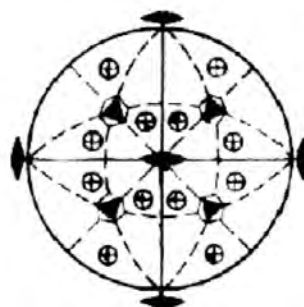
复方十二面体类


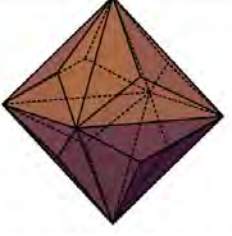



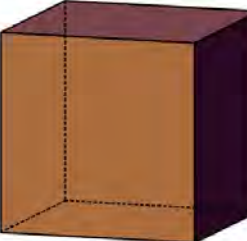
符号: $2/m\bar{3}$ or T_h
($m\bar{3}$)

一般形:
{hkl}



复方十二面体



{hll}	{hhl}	{hk0}
		
三角三八面体	锥形八面体	五角十二面体
{111}	{110}	{100}
		
八面体	菱形十二面体	立方体/六面体

代表性矿物:

黄铁矿 Pyrite FeS_2

辉钴矿 Cobaltite $CoAsS$

明矾 Alum, z.B. $KAl[SO_4]_2 \cdot 12H_2O$

方铁锰矿 Bixbyite $(Mn,Fe)_2O_3$

Cubic crystal system

Inclined Hemiedry
Hexacistetrahedral class

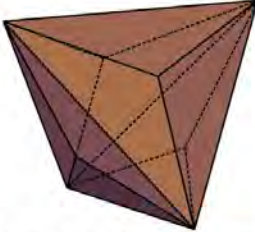
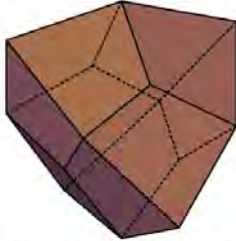



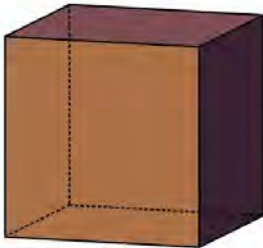
Symbol: $\bar{4}3m$ or T_d

General form:
{hkl}



Hexacistetrahedron



{hll}	{hhl}	{hk0}
		
<u>Pyramidal tetrahedron</u>	<u>Deltoidal dodecahedron</u>	<u>Pyramidal cube</u>
{111}	{110}	{100}
		
<u>Tetrahedron</u>	<u>Rhombic dodecahedron</u>	<u>Cube/Hexahedron</u>

mineral examples:

Sphalerite/Zinc blende ZnS

Tetrahedrite $(Cu,Fe)_{12}[Sb_4S_{13}]$

Sodalite $Na_8[(Cl)_2(AlSiO_4)_6]$

Mayenite $Ca_{12}Al_{14}O_{33}$

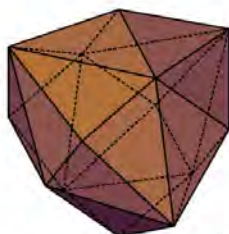
立方晶系

倾斜式半面象

符号: $\bar{4}3m$ or T_d

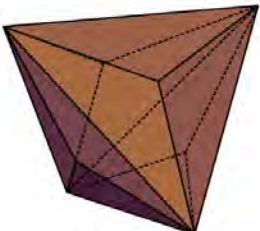
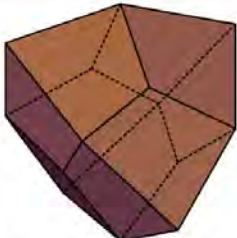


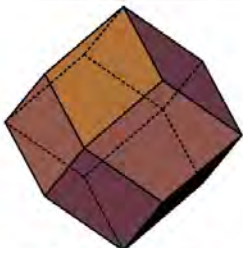
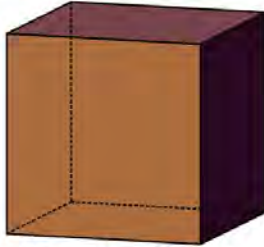
六四面体类

一般形:
{hkl}



六四面体



{hll}	{hhl}	{hk0}
		
锥形四面体	三角十二面体	锥形立方体
{111}	{110}	{100}
		
四面体	菱形十二面体	立方体/六面体

代表性矿物:

闪锌矿 Sphalerite/Zinc blende ZnS

黝铜矿 Tetrahedrite $(Cu,Fe)_{12}[Sb_4S_{13}]$

方钠石 Sodalite $Na_8[(Cl)_2(AlSiO_4)_6]$

钙铝石 Mayenite $Ca_{12}Al_{14}O_{33}$

Cubic crystal system

Cubic holoedry

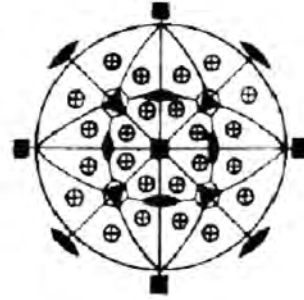
Disdyakis dodecahedral class




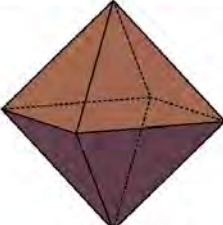

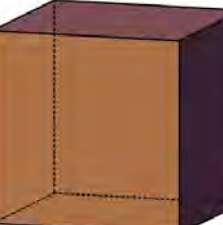
Symbol: $4/m \bar{3} 2/m$ or O_h
($m\bar{3}m$)

General form:
{hkl}



Disdyakis dodecahedron



{hll}	{hhl}	{hk0}
		
<u>Deltoidal icositetrahedron</u>	<u>Pyramidal octahedron</u>	<u>Pyramidal cubic</u>
{111}	{110}	{100}
		
<u>Octahedron</u>	<u>Rhombic dodecahedron</u>	<u>Cube/Hexahedron</u>

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 $Me^{II}_3Me^{III}_2[SiO_4]_3$

立方晶系

立方全面象

符号: $4/m\bar{3}2/m$ or O_h
($m3m$)

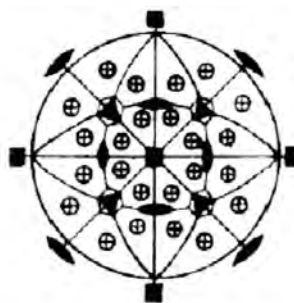
复偏方复十二面体类





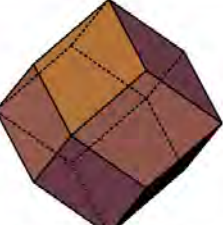
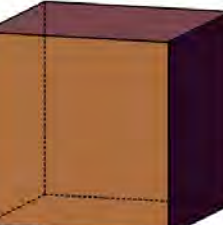
一般形:

$\{hkl\}$



复偏方复十二面体



$\{hll\}$	$\{hhl\}$	$\{hk0\}$
		
三角三八面体	锥形八面体	锥形立方体
$\{111\}$	$\{110\}$	$\{100\}$
		
八面体	菱形十二面体	立方体/六面体

代表性矿物:

金 银 铜 铂 铅

铁 钨 硅 金刚石

: Au, Ag, Cu, Pt,

Pb, Fe, W, Si, C(Diamond)

石盐 Halite/ Rock salt NaCl

方铅矿 Galena /Lead glance PbS

氟石 Fluorite/Flusse CaF_2

尖晶石 Spinel, z.B. $MgAl_2O_4$

石榴石 Garnet $Me^{II}_3Me^{III}_2[SiO_4]_3$

Examples for correlate crystal forms

Crystal forms

Positive – negative

Right – left

Up – down

Front - back

相关晶体形式的示例

晶体形式

正 - 负

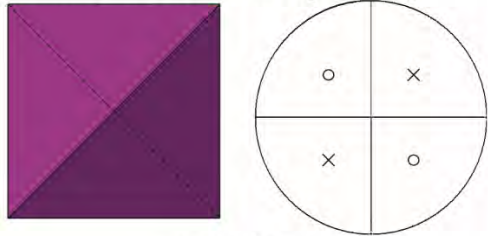
右 - 左

上 - 下

前 - 后

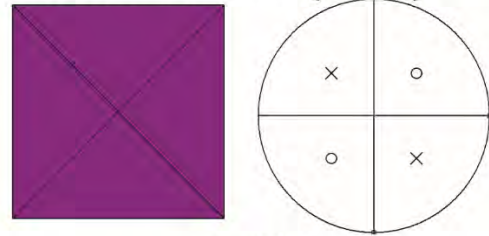
Cubic crystal system

Tetrahedron $\{\bar{111}\}$



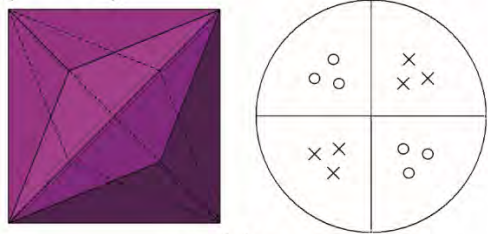
negative

Tetrahedron $\{111\}$



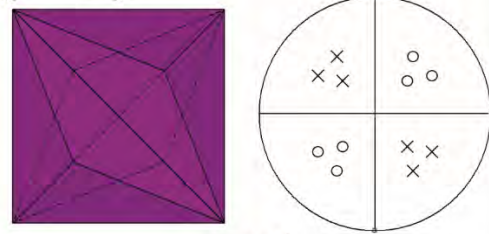
positive

Pyramidal tetrahedron $\{223\}$



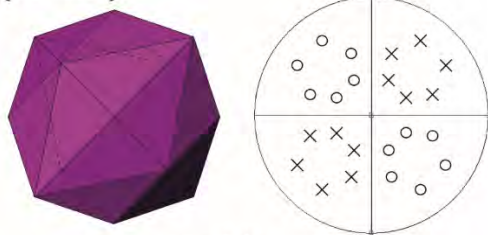
positive

Pyramidal tetrahedron $\{\bar{2}23\}$



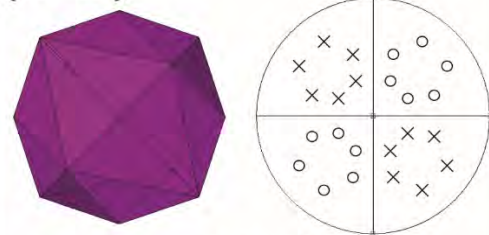
negative

Hexacistetrahedron $\{123\}$



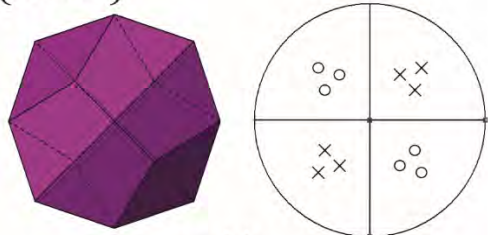
positive

Hexacistetrahedron $\{\bar{1}23\}$



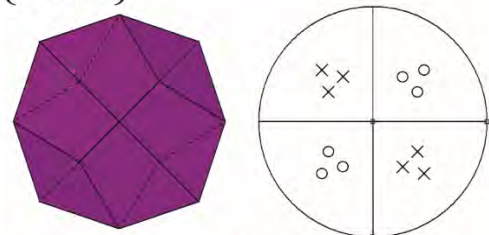
negative

Deltoid dodecahedron $\{332\}$



positive

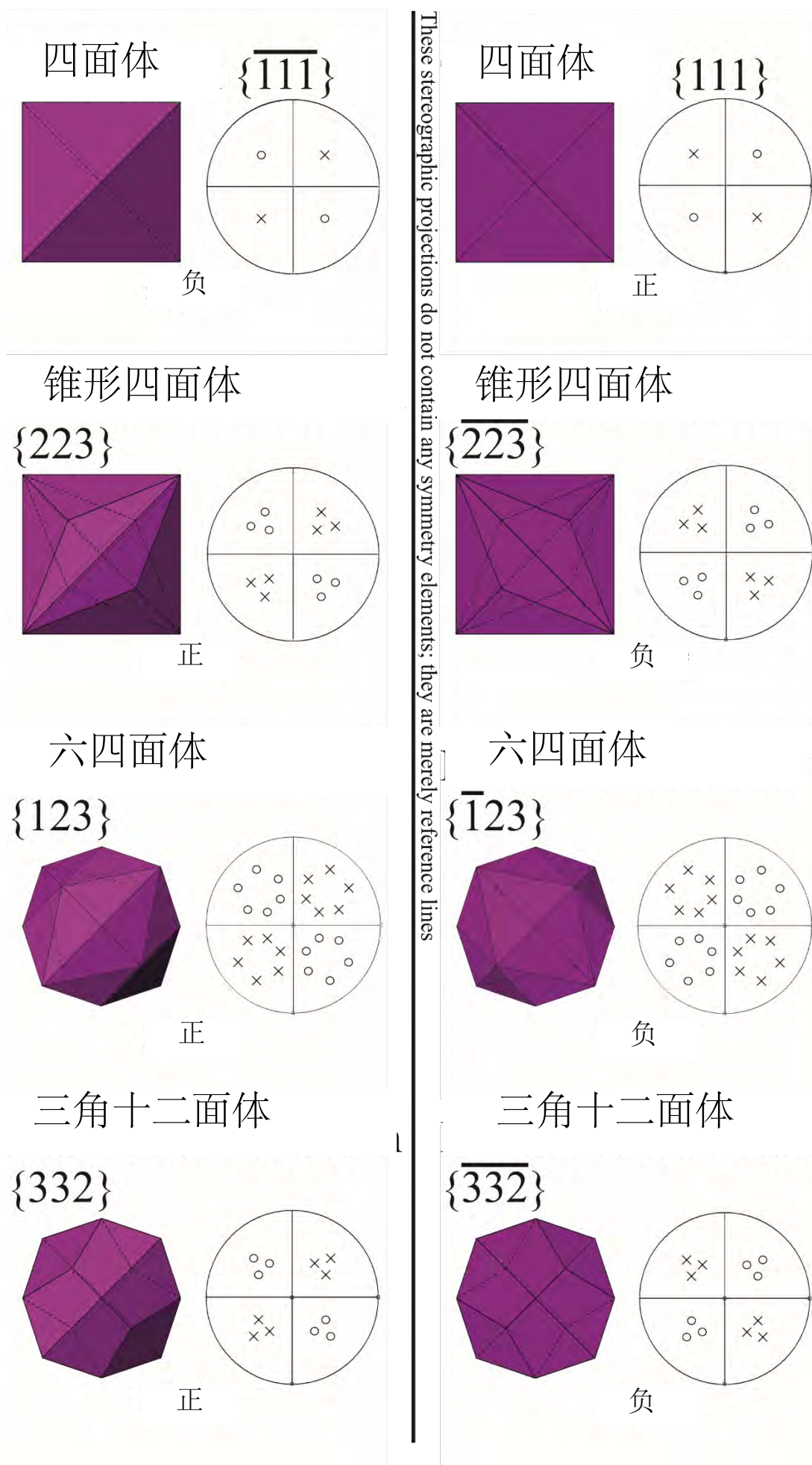
Deltoid dodecahedron $\{\bar{3}32\}$



negative

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

立方晶系

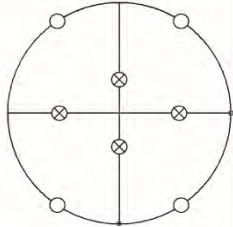
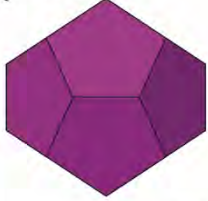


Cubic crystal system

Pentagonal

dodecahedron

{230}

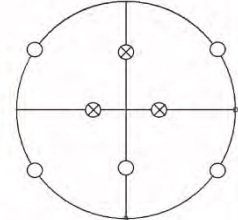


right
(positive)

Pentagonal

dodecahedron

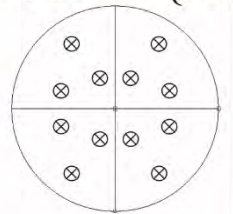
{320}



left
(negative)

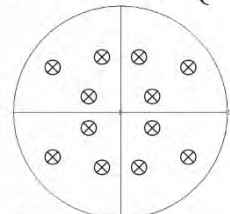
These stereographic projections do not contain any symmetry elements; they are merely reference lines.

Disdodecahedron {213}



left
(positive)

Disdodecahedron {123}



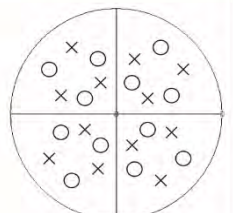
right
(negative)

Pentagonal

icositetrahedron

{123}

right

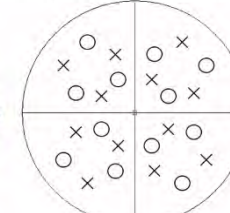


Pentagonal

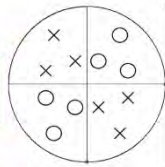
icositetrahedron

{213}

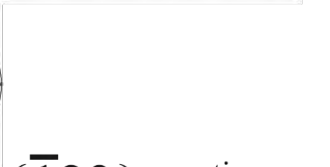
left



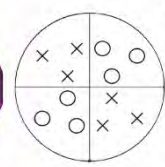
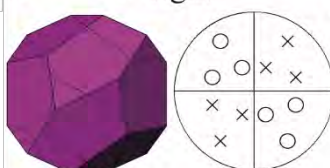
Tetrahedral pentagonal dodecahedron



{123} positive
right



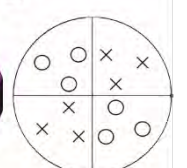
{123} negative
right



{213} positive
left

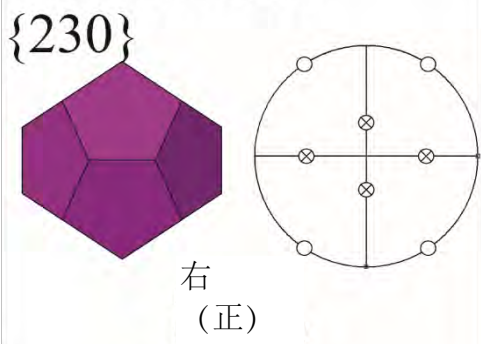


{213} negative
left

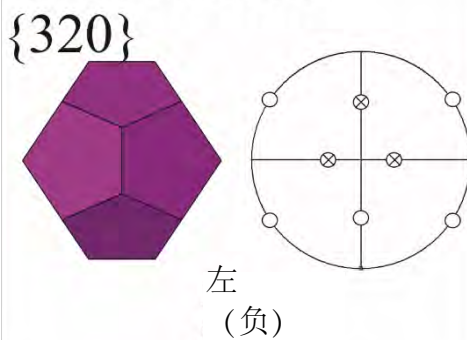


立方晶系

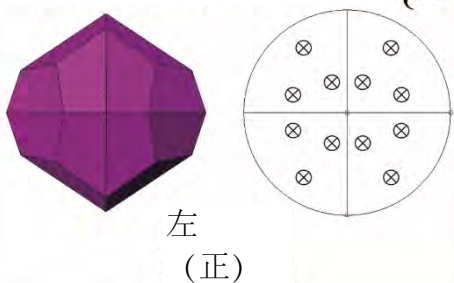
五角十二面体



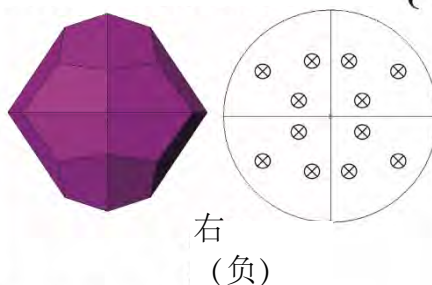
五角十二面体



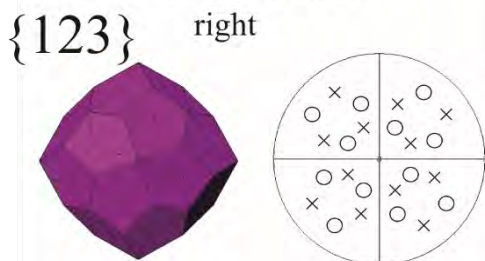
偏方十二面体 $\{213\}$



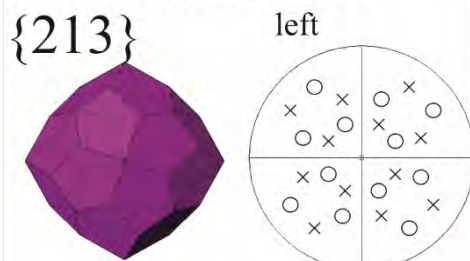
偏方十二面体 $\{123\}$



五角三八面体

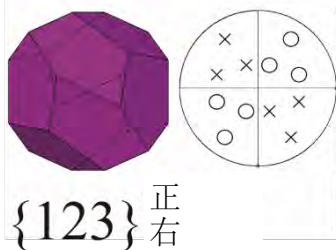


五角三八面体

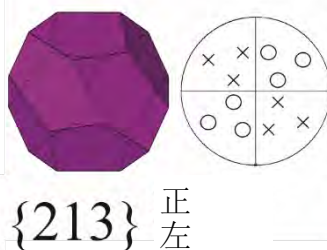
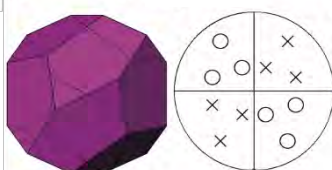


These stereographic projections do not contain any symmetry elements; they are merely reference lines

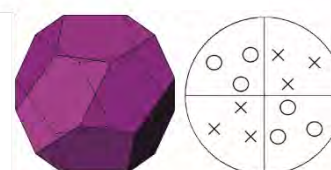
五角三四面体



$\{\bar{1}23\}$ 负右

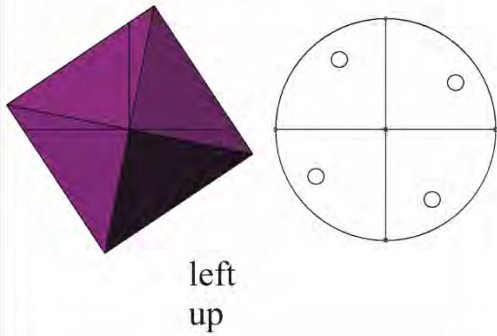


$\{\bar{2}13\}$ 负左

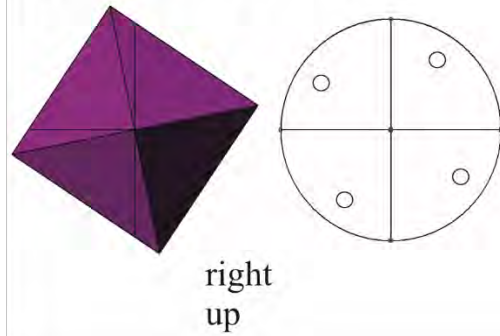


Tetragonal crystal system

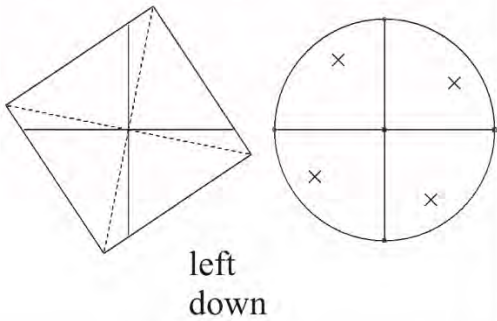
Pyramid {321}



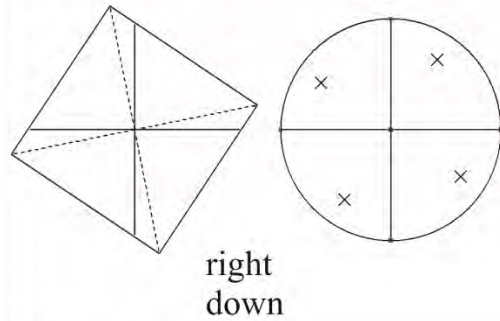
Pyramid {231}



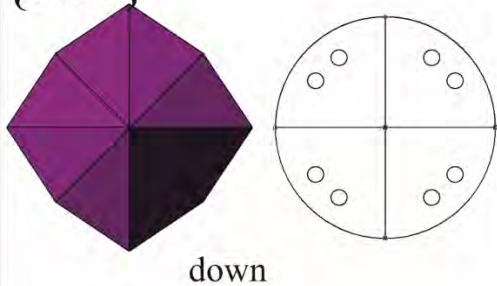
Pyramid {321̄}



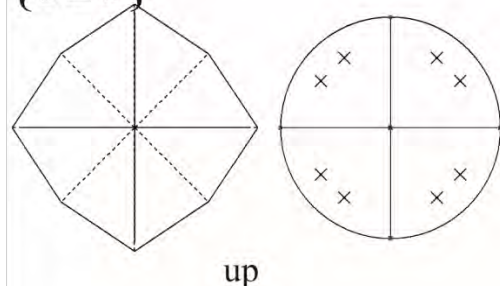
Pyramid {231̄}



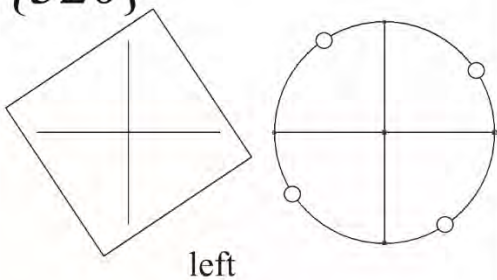
Ditetrag. Pyramid {321}



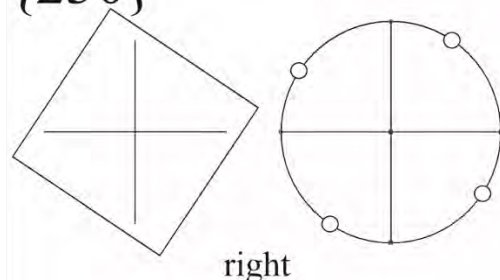
Ditetrag. Pyramid {321̄}



Prism III.Position {320}

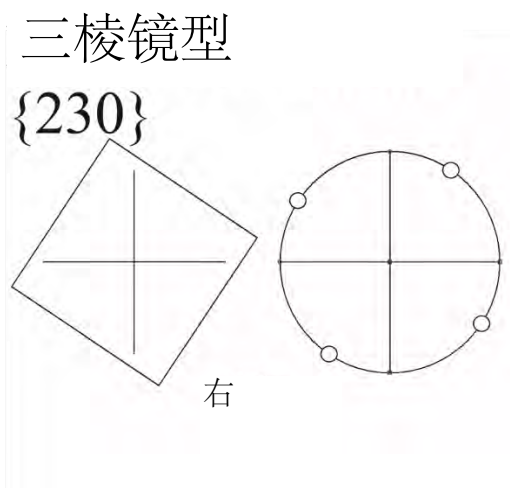
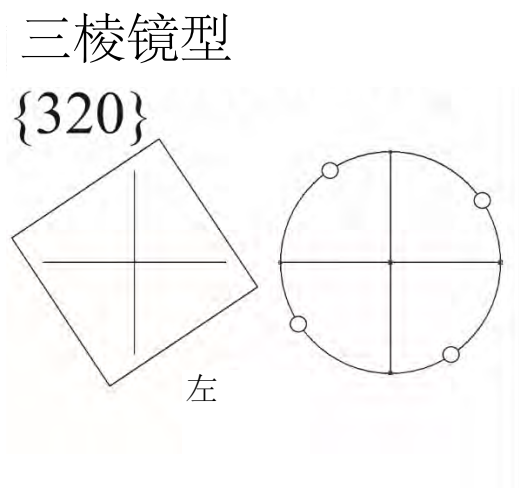
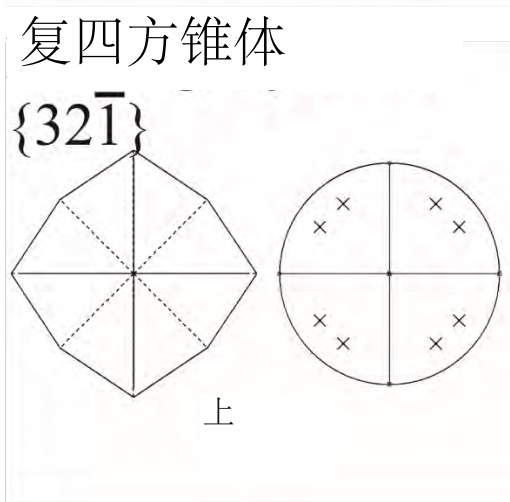
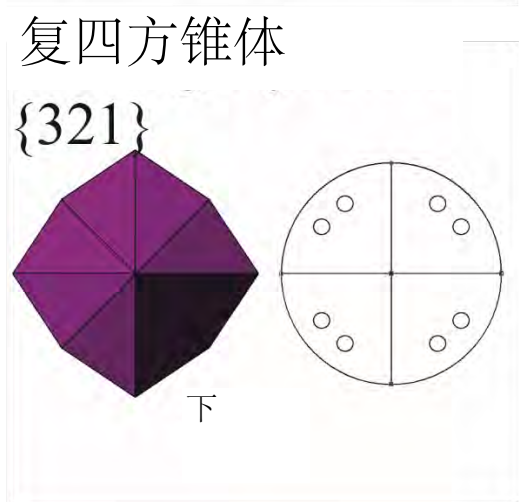
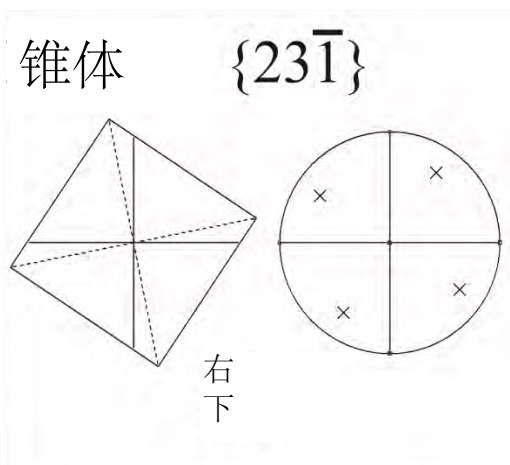
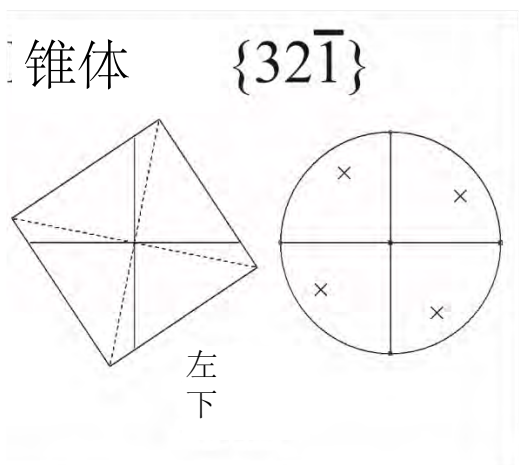
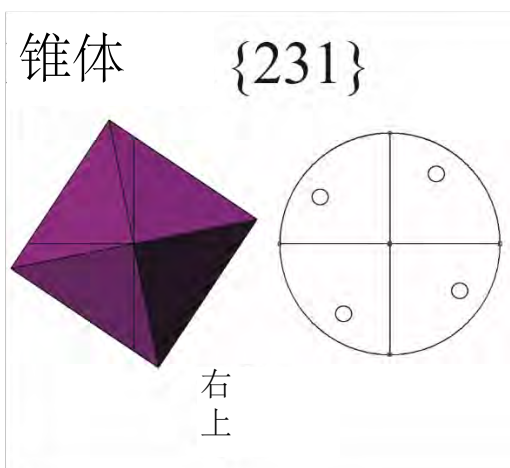
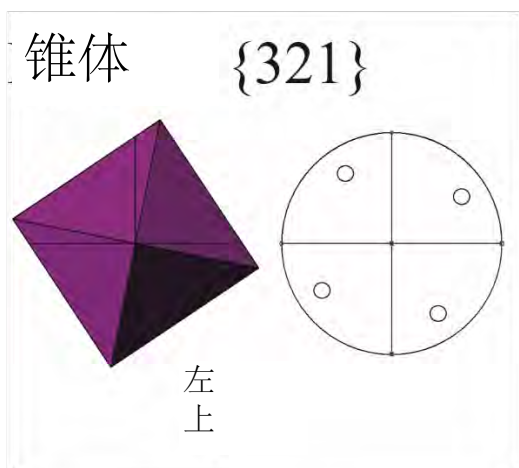


Prism III.Position {230}



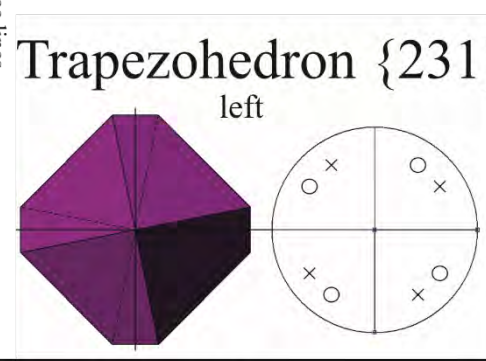
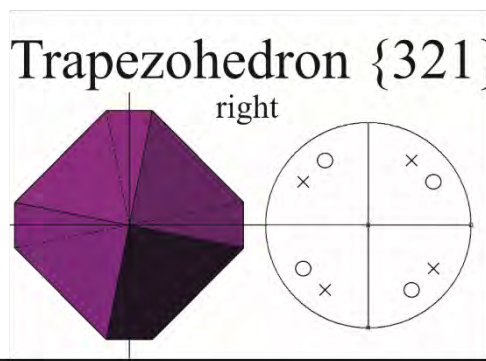
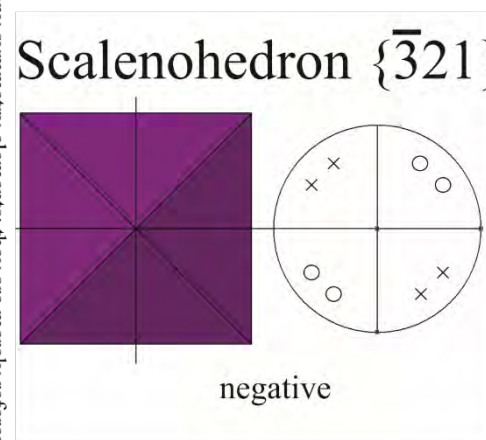
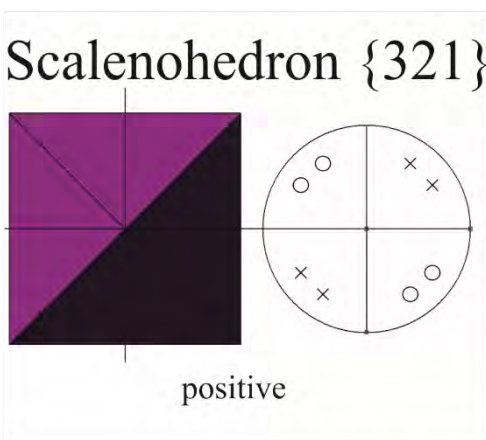
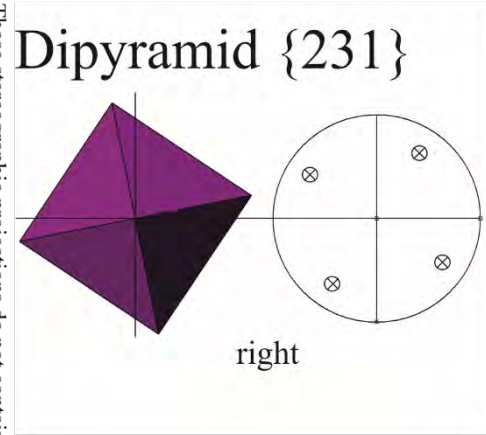
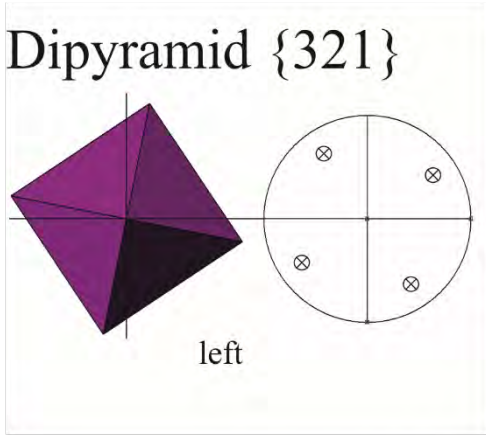
These stereographic projections do not contain any symmetry elements; they are merely reference lines

四方晶系



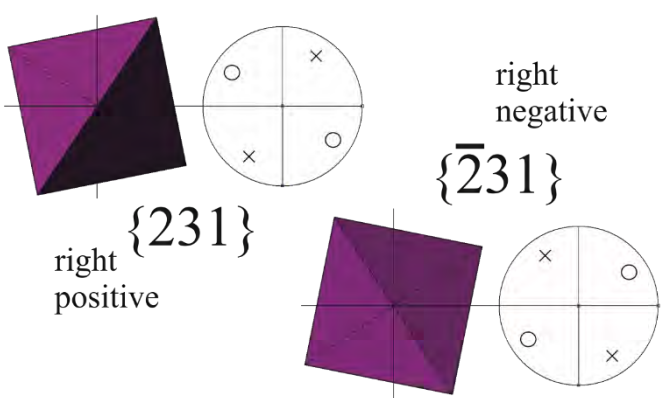
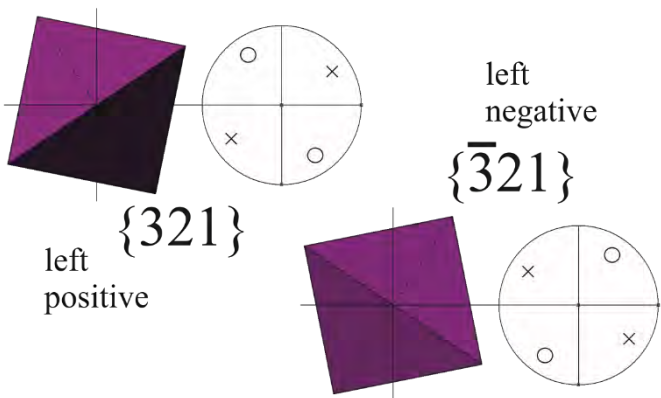
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Tetragonal crystal system

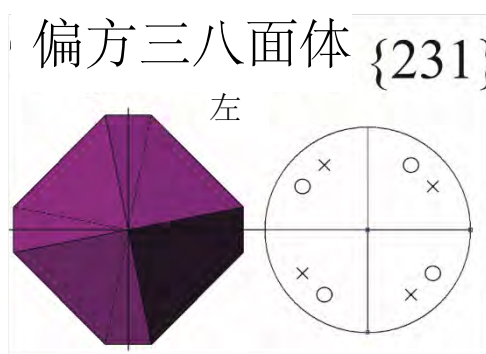
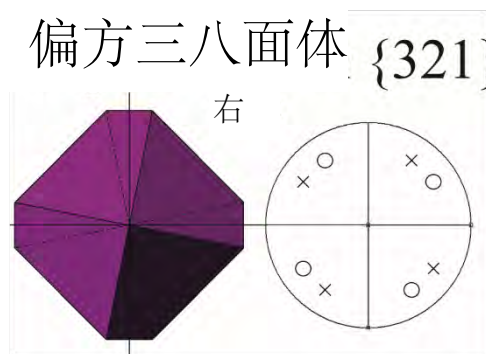
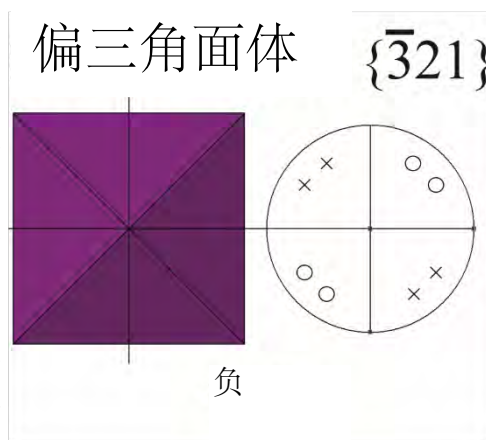
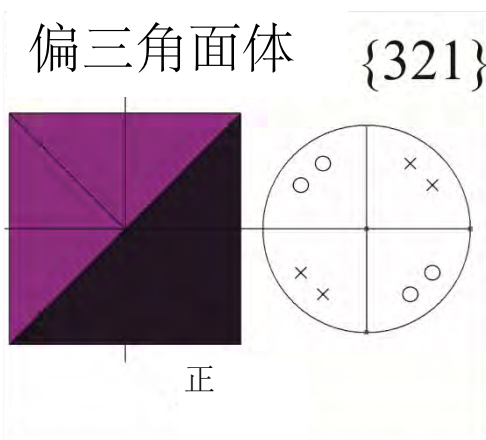
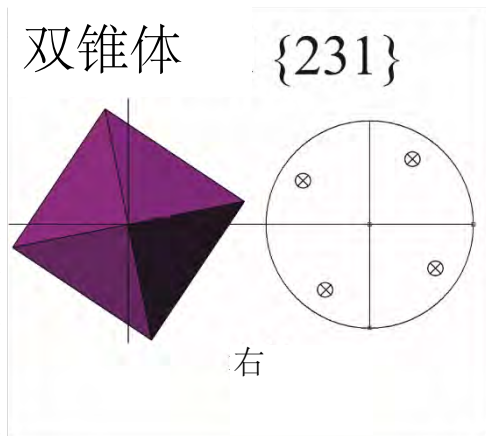
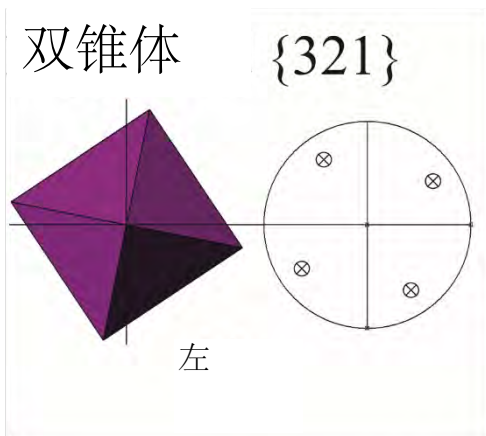


These stereographic projections do not contain any symmetry elements; they are merely reference lines

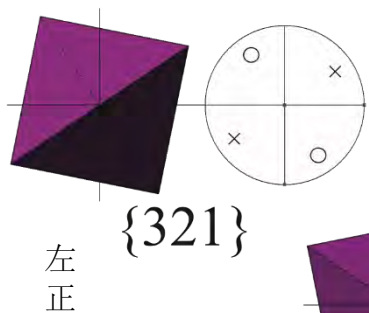
Tetragonal Disphenoid



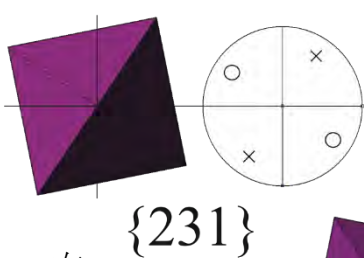
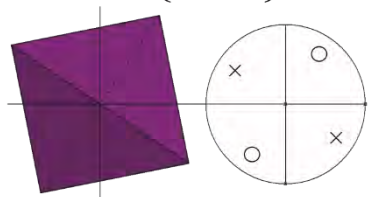
四方晶系



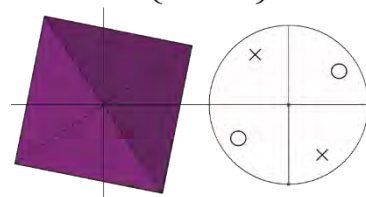
四方畸变



左负 $\{\bar{3}21\}$



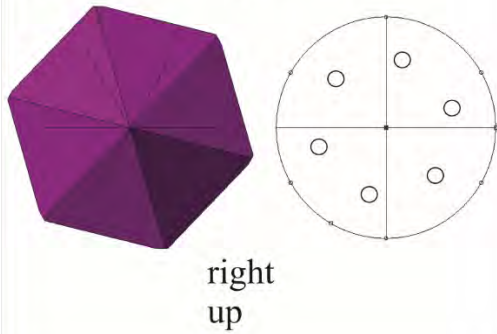
右负 $\{\bar{2}31\}$



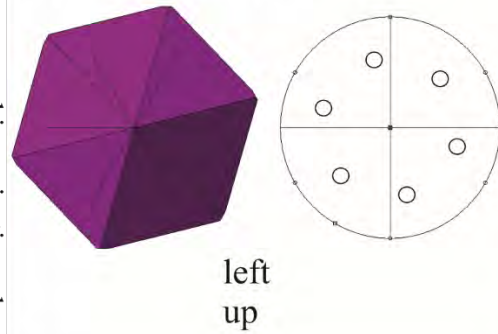
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Hexagonal crystal system

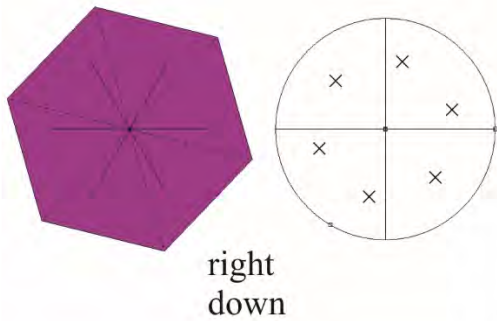
Pyramid {132}



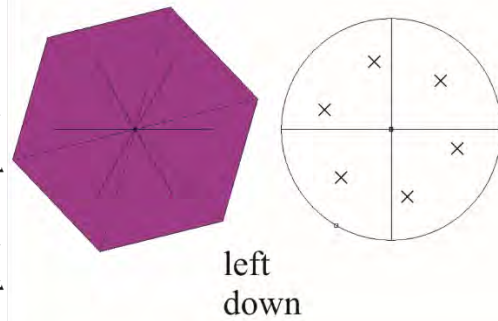
Pyramid {312}



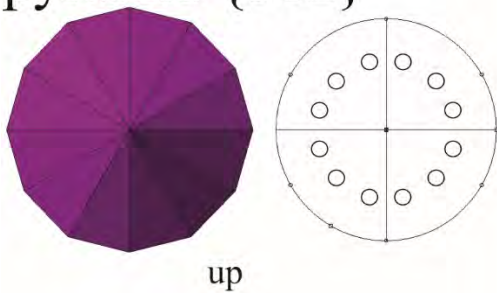
Pyramid {13 $\bar{2}$ }



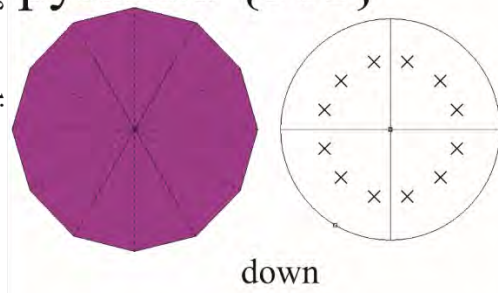
Pyramid {31 $\bar{2}$ }



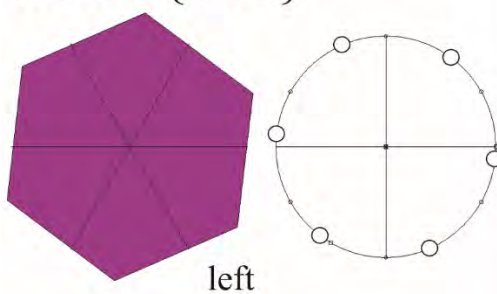
Dihexagonal
pyramid {312}



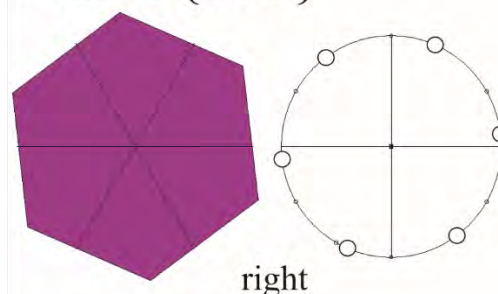
Dihexagonal
pyramid {31 $\bar{2}$ }



Prism {320}

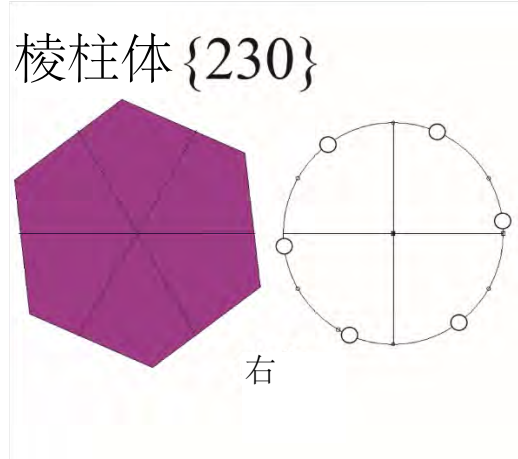
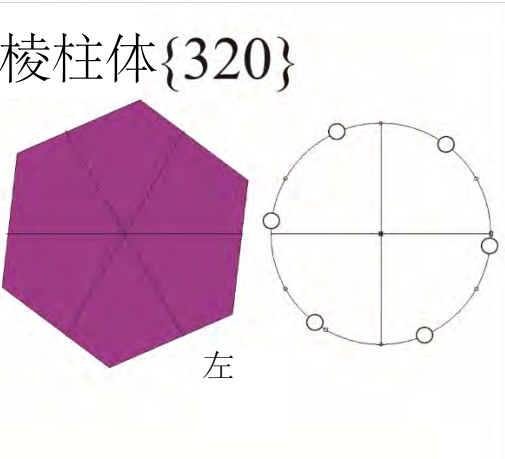
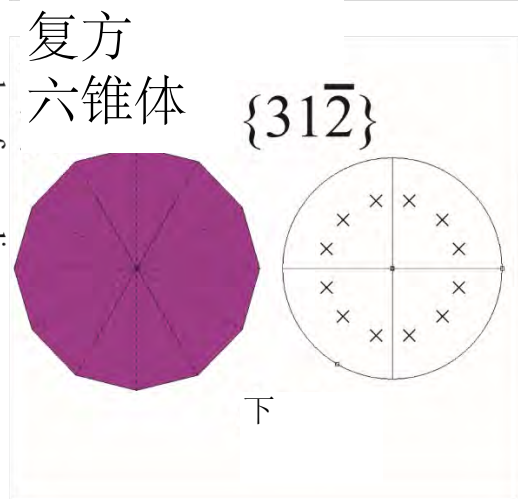
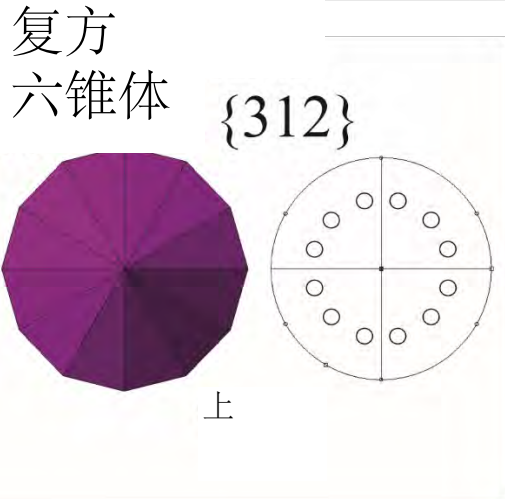
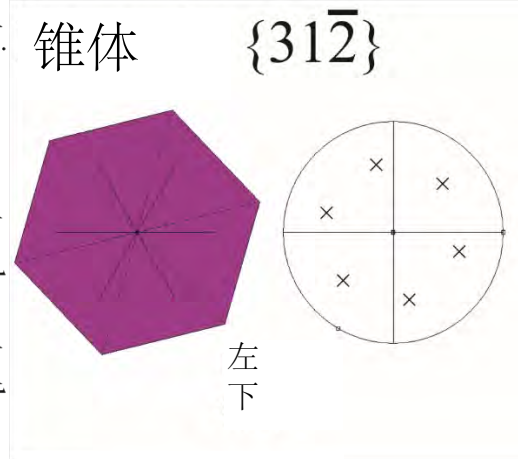
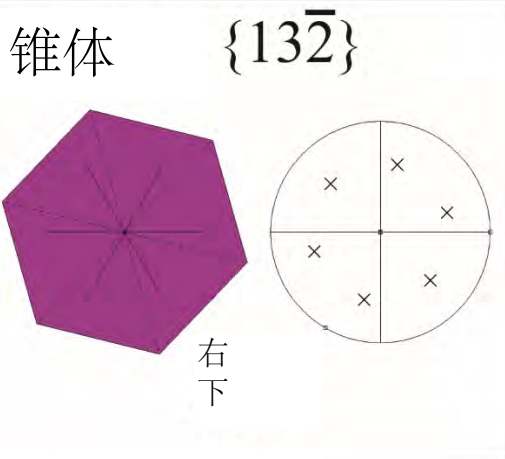
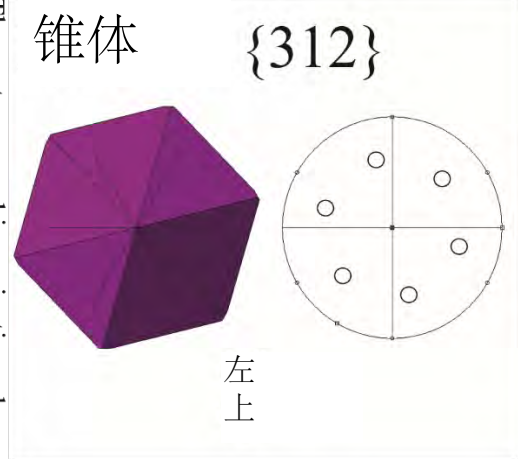
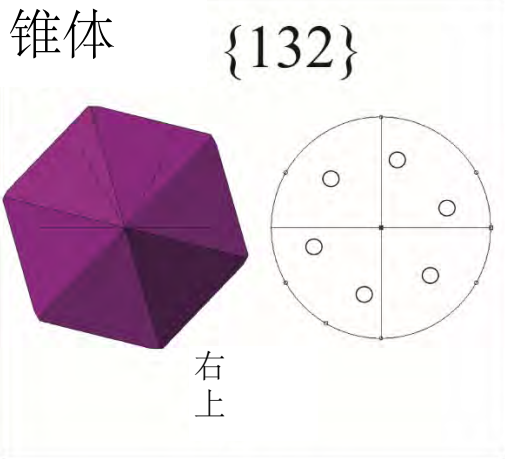


Prism {230}



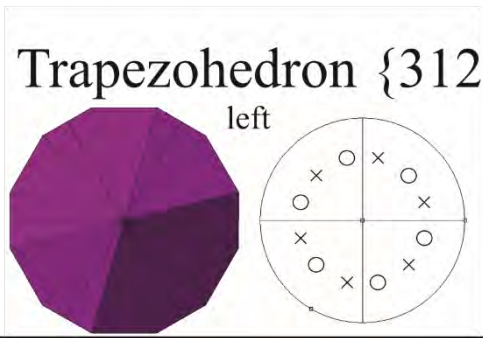
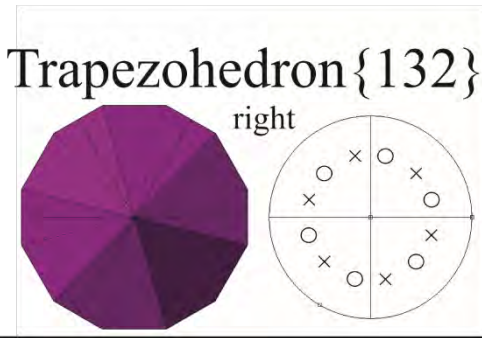
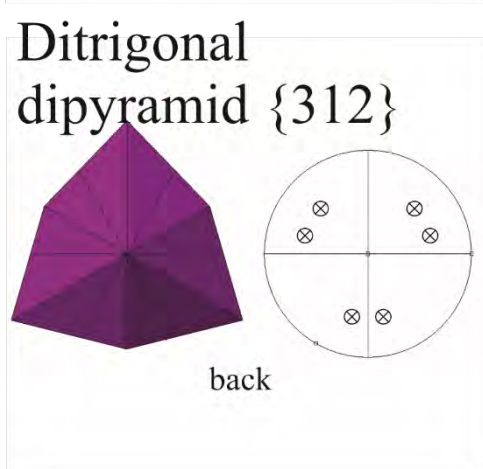
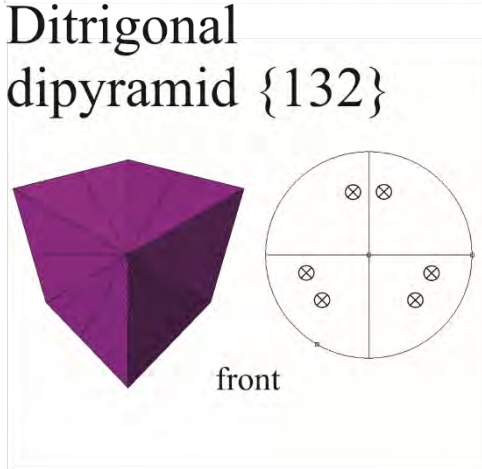
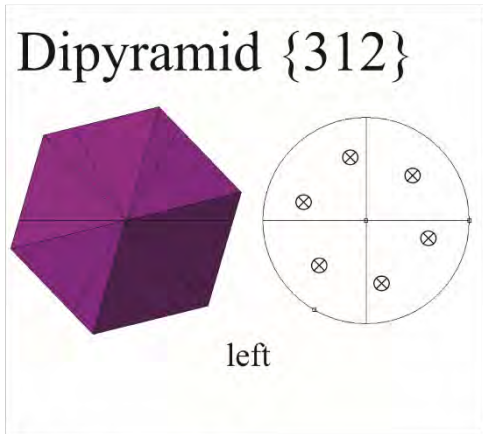
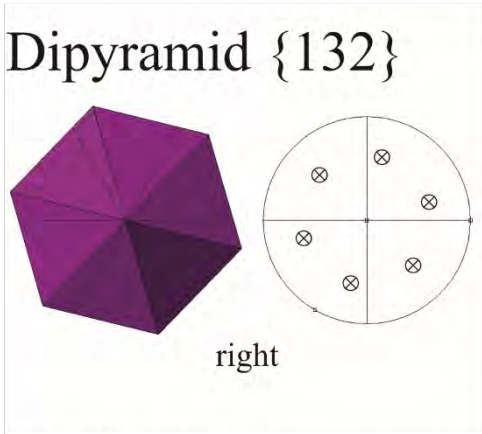
These stereographic projections do not contain any symmetry elements; they are merely reference lines

六方晶系



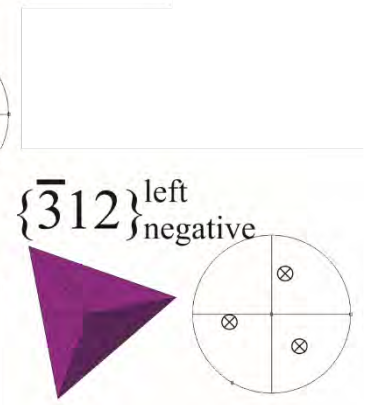
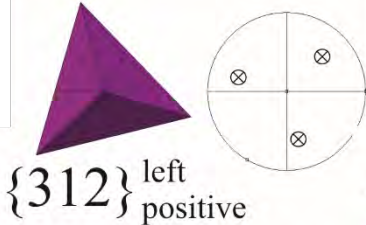
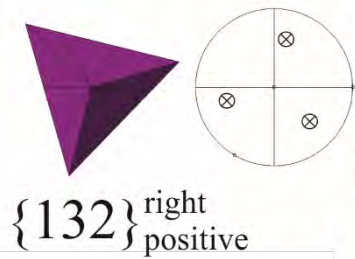
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Hexagonal crystal system



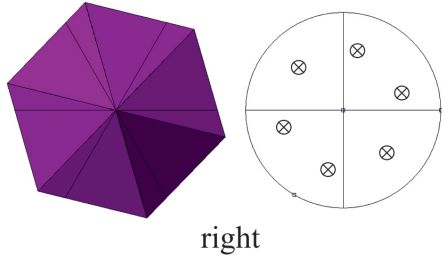
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Trigonal Dipyramid



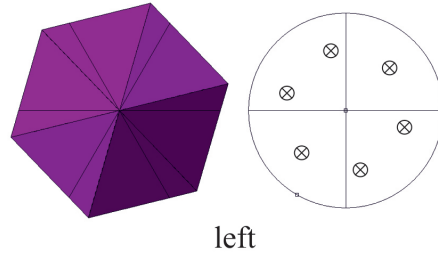
六方晶系 Hexagonal crystal system

Dipyramid {132}



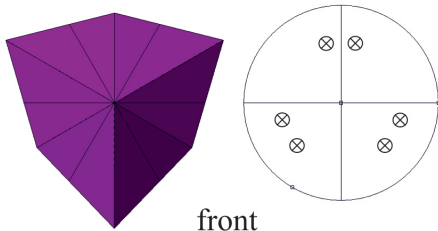
right

Dipyramid {312}



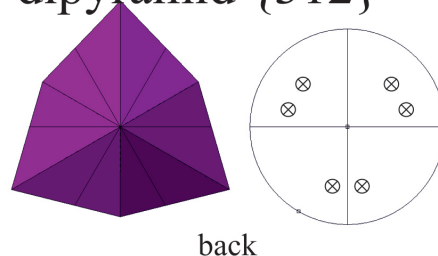
left

Ditrigonal dipyramid {132}



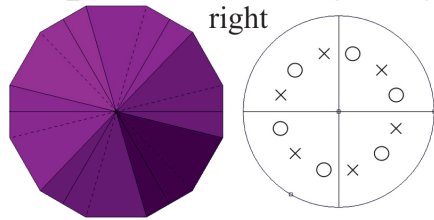
front

Ditrigonal dipyramid {312}



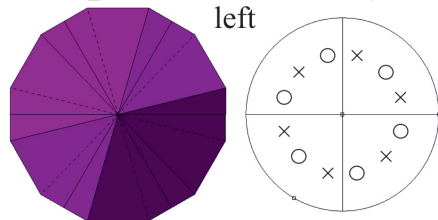
back

Trapezohedron {132}



right

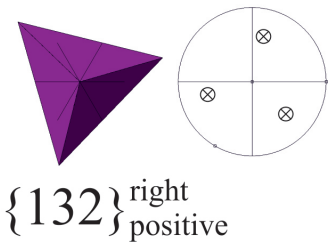
Trapezohedron {312}



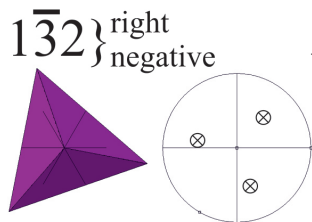
left

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

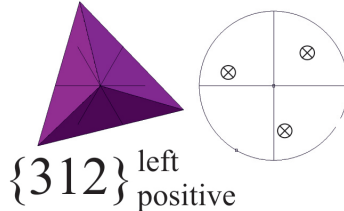
Trigonal Dipyramid



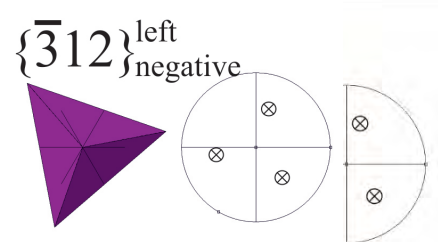
{132} right positive



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



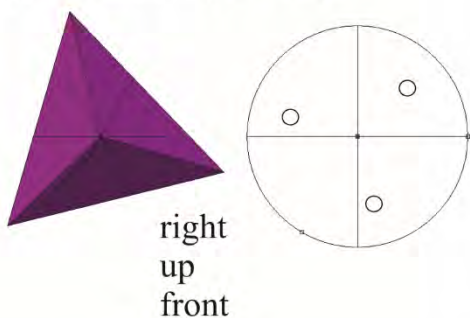
{312} left positive



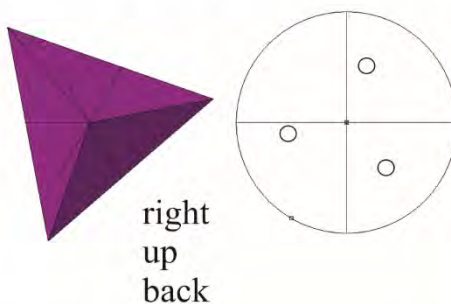
$\bar{3}\bar{1}2$ left negative

Tetragonal crystal system

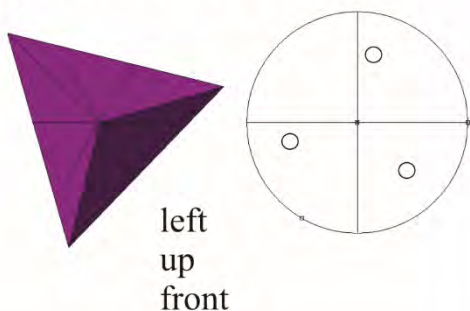
Pyramid {312}



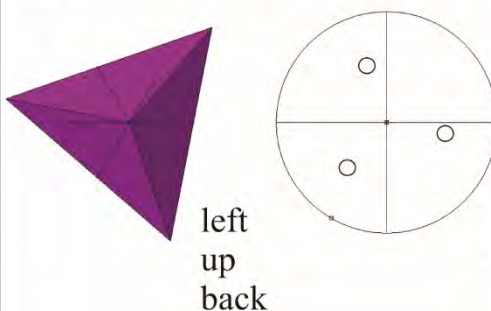
Pyramid { $\bar{3}12$ }



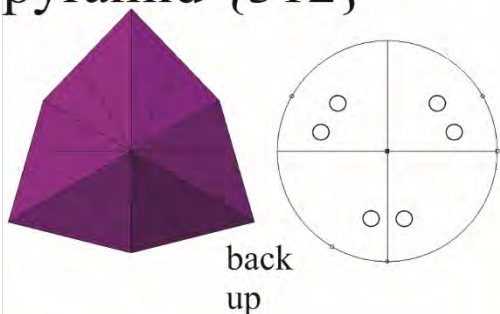
Pyramid {132}



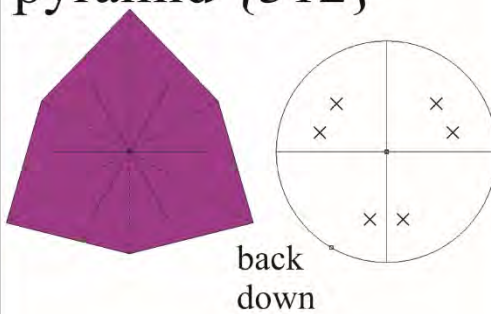
Pyramid { $\bar{1}32$ }



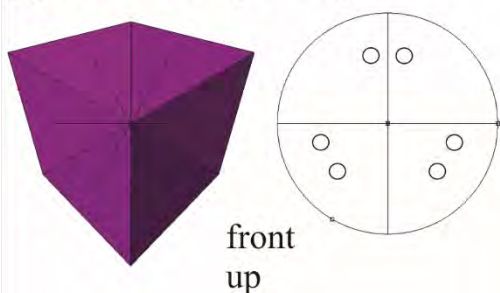
Ditrigonal pyramid {312}



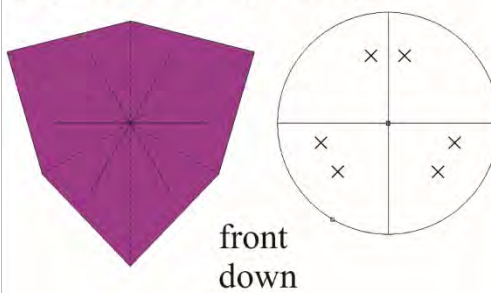
Ditrigonal pyramid { $3\bar{1}2$ }



Ditrigonal pyramid {132}



Ditrigonal pyramid { $1\bar{3}2$ }



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

analog to "down"

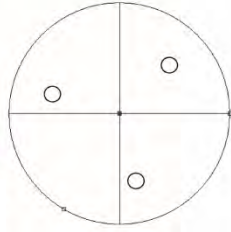
四方晶系

锥体

$\{312\}$



右上前

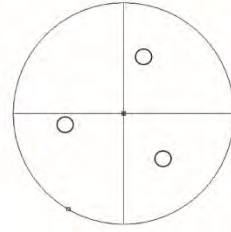


锥体

$\{\bar{3}12\}$

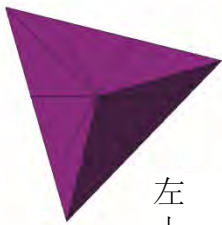


右上后

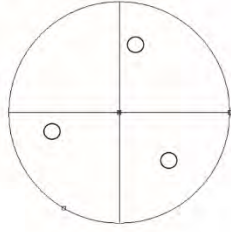


锥体

$\{132\}$



左上前

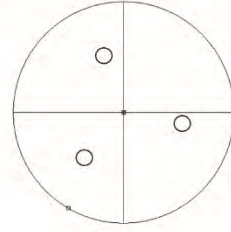


锥体

$\{\bar{1}32\}$



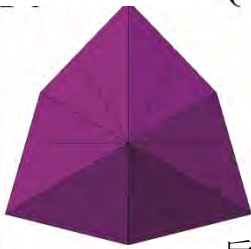
左上后



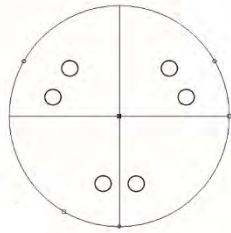
底面结果
与之类似

复三方
锥体

$\{312\}$

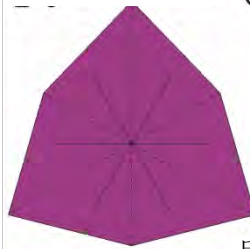


后上

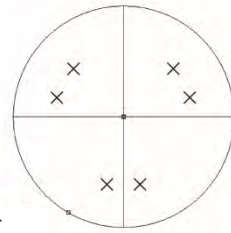


复三方
锥体

$\{31\bar{2}\}$



后下

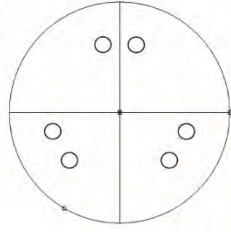


复三方
锥体

$\{132\}$



前上

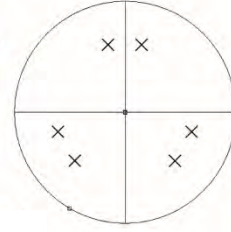


复三方
锥体

$\{13\bar{2}\}$



前下



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

Trigonal crystal system

Dipyramid $\{332\}$

right
(positive)

Dipyramid $\{\bar{3}32\}$

left
(negative)

Ditrigonal
scalenohedron $\{132\}$

positive
(right)

Ditrigonal
scalenohedron $\{312\}$

negative
(left)

Trapezohedron $\{132\}$

positive
(right)

Trapezohedron $\{\bar{1}32\}$

negative
(left)

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

Trigonal rhombohedron

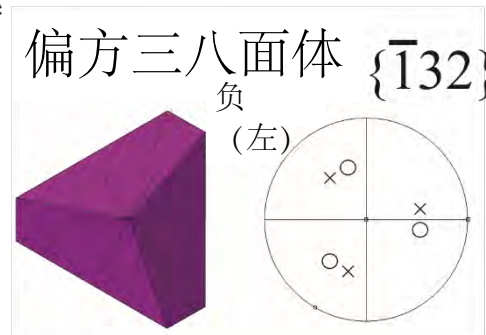
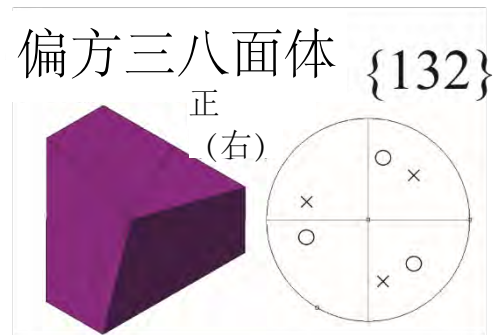
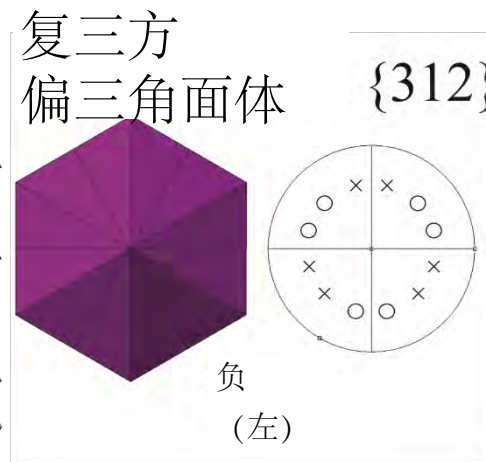
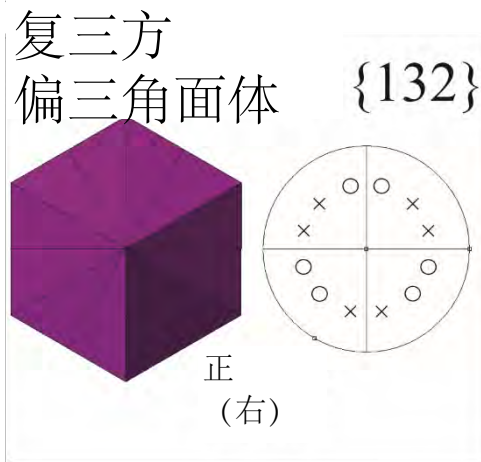
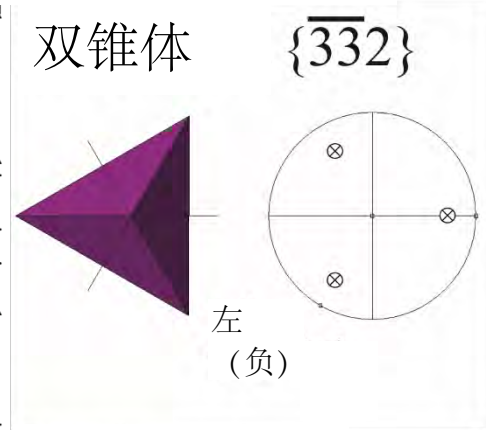
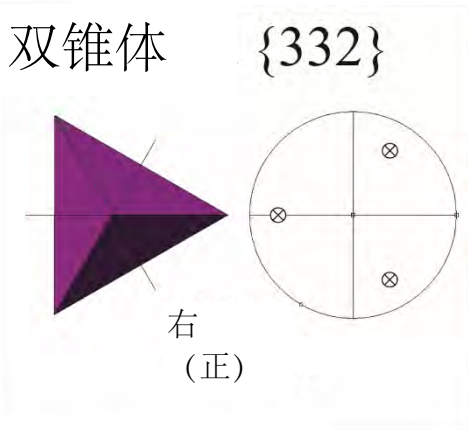
$\{132\}$ right
positive

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

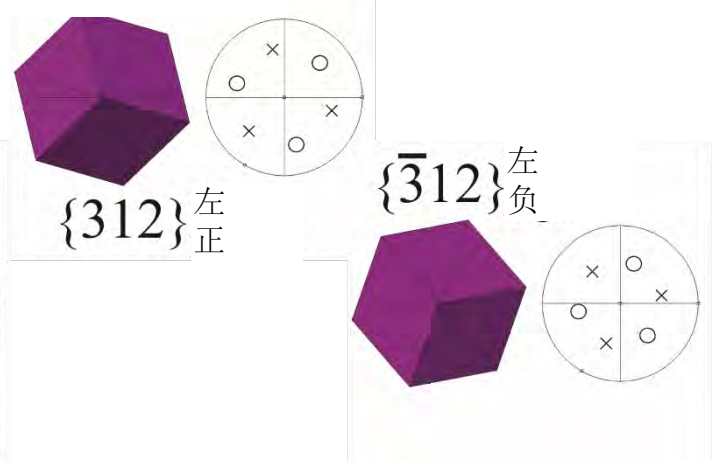
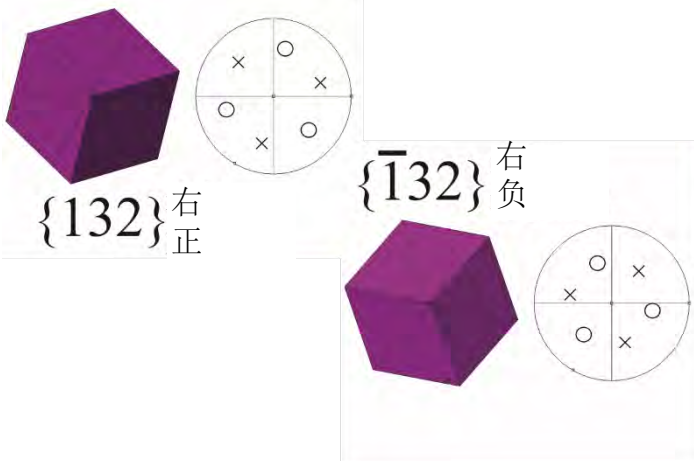
$\{312\}$ left
positive

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

三方晶系



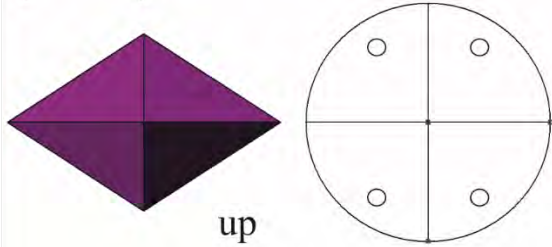
三角菱面体



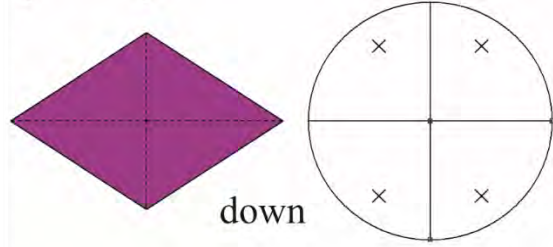
These stereographic projections do not contain any symmetry elements; they are merely reference lines

Orthorhombic crystal system

Rhombic pyramid
{321}

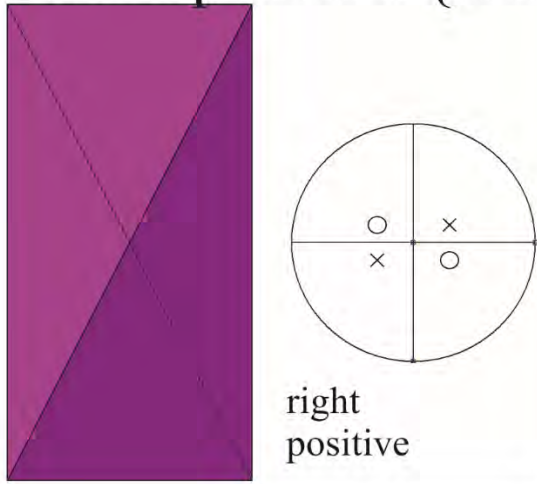


Rhombic Pyramid
{321}

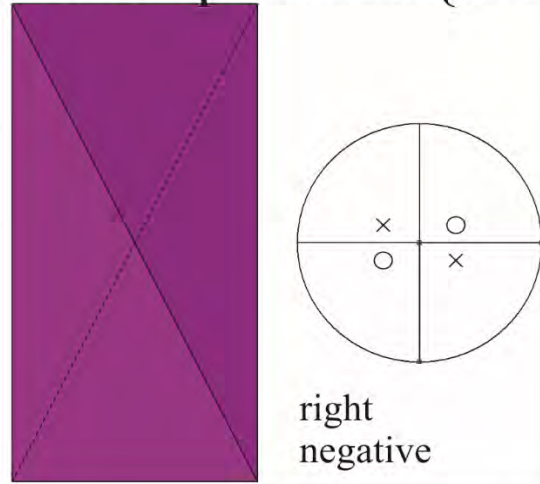


These stereographic projections do not contain any symmetry elements; they are merely reference lines

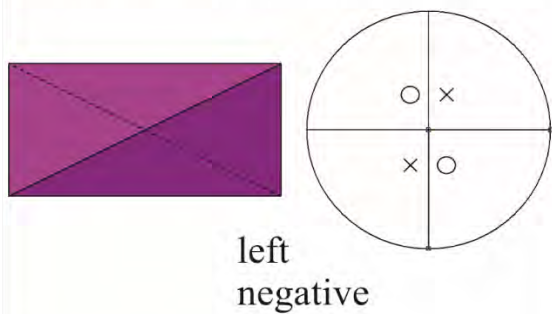
Rh. Disphenoid {123}



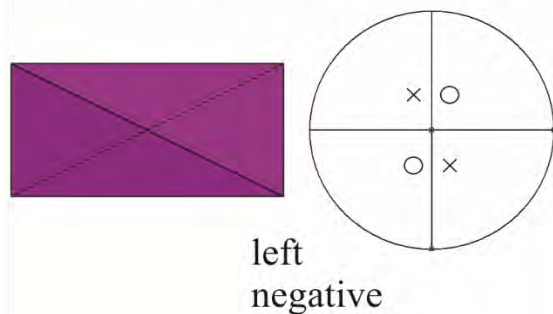
Rh. Disphenoid {1̄23}



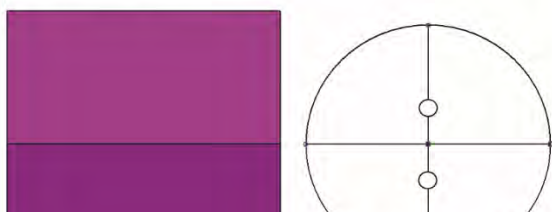
Rh. Disphenoid {213}



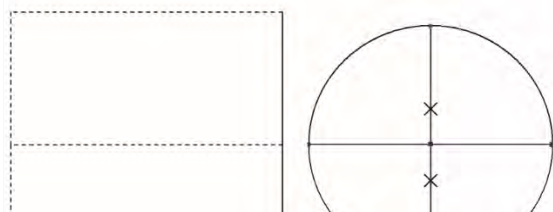
Rh. Disphenoid {2̄13}



Doma II. position
{203}



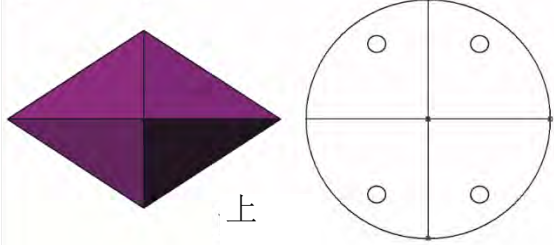
Doma II. position
{2̄03}



正交晶系

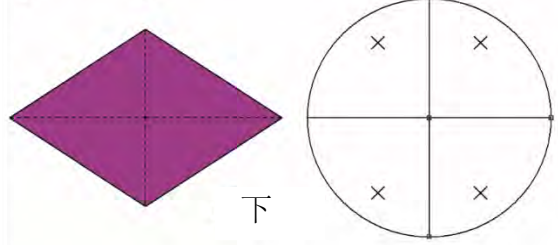
菱形锥体

{321}



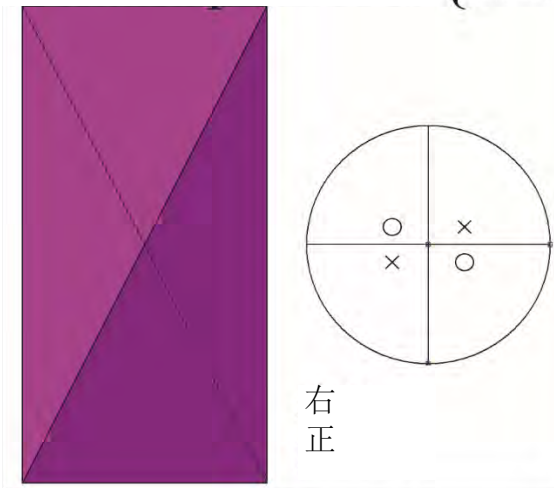
菱形锥体

{321}

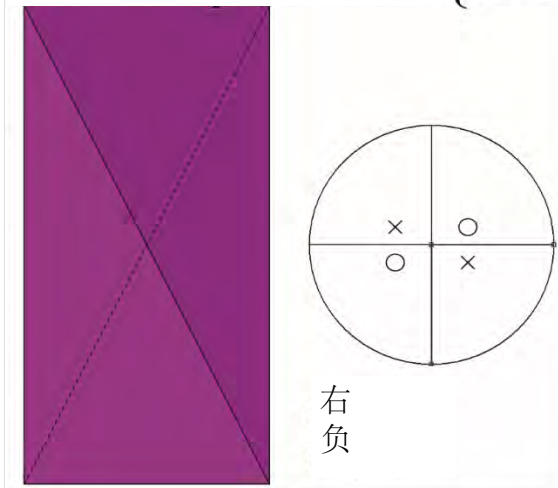


These stereographic projections do not contain any symmetry elements; they are merely reference lines

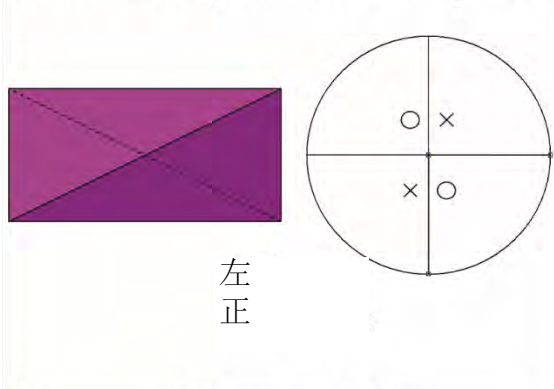
菱形斜方四面体 {123}



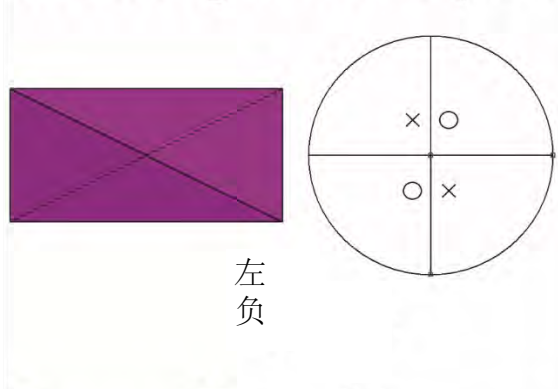
菱形斜方四面体 {1̄23}



菱形斜方四面体 {213}

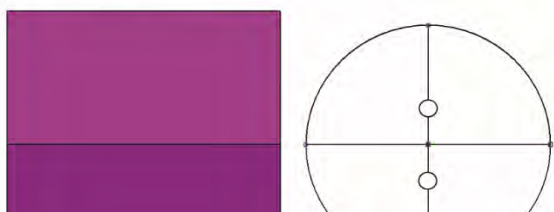


菱形斜方四面体 {2̄13}



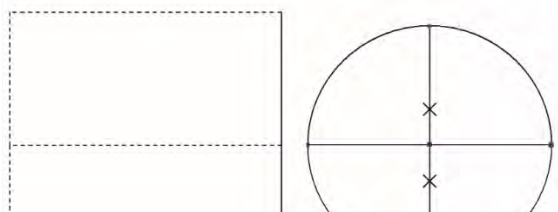
Doma II. position

{203}



Doma II. position

{2̄03}



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

晶系	类别	对称元素	晶体的极性方向	晶体的非极性方向
三斜	1	-	* 所有方向	无
单斜	2	$1 \vec{c}$	* b 轴	所有垂直b轴方向
	m	$1m (m \equiv \bar{2})$	a轴, c轴 以及 (010)方向	b轴
正交	mm2	$1 \vec{c} + 1m + 1m$	* c 轴	所有垂直c轴方向
四方	4	$1 \vec{c}$	* c 轴	所有垂直c轴方向
	4mm	$1 \vec{c} + 2m + 2m$	* c 轴	所有垂直c轴方向
三方	3	\vec{c}	* c轴 和所有垂直c轴 区域	无
	32	$1\# + 3 \vec{c}$	a_1, a_2, a_3 和所有垂直c轴 区域	所有垂直 a_1, a_2, a_3 的方向
	3m	$1\vec{c} + 3m$	* c 轴	a_1, a_2, a_3
六方	6	$1 \vec{c}$	* c 轴	所有垂直c轴方向
	$\bar{6}$	$1 \vec{c} \equiv \# + m$	* a_1, a_2, a_3 和所有垂直c轴 区域	c轴
	6mm	$1 \vec{c} + 3m + 3m$	* c 轴	所有垂直c轴方向
	$\bar{6}2m$	$1 \vec{c} + 3 \vec{c} + 3m$	所有方向 ●	a_1, a_2, a_3 和所有区域垂直 ● 或两者之间
立方	23	$3 \bullet + 4 \vec{c}$	a_1, a_2, a_3	所有垂直 a_1, a_2, a_3 的方向
	$\bar{4}3m$	$3 \vec{c} + 4 \vec{c} + 6m$	a_1, a_2, a_3	所有垂直 a_1, a_2, a_3 的方向

其他具有极性方向却无中心心类：222、4、422、42m，622、432 * =具有唯一极性轴且无等效轴的种类：铁电材料

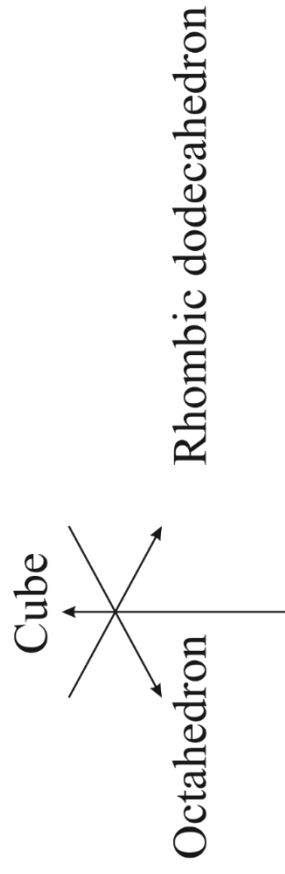
The combination of forms

Two forms: W Cube \leftrightarrow Octahedron



positive tetrahedron \leftrightarrow negative tetrahedron

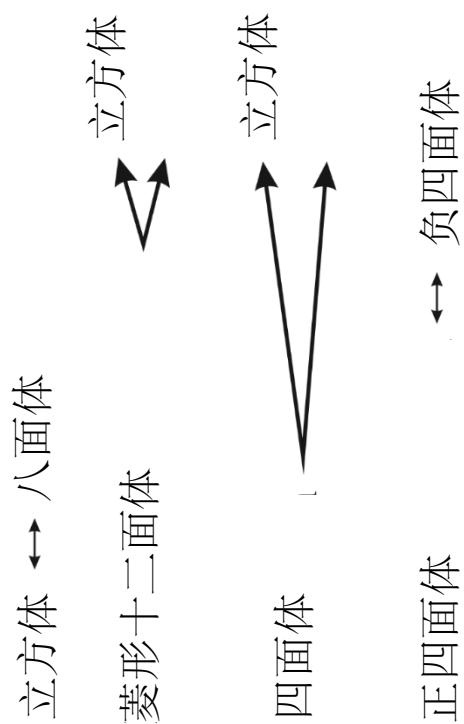
Three forms:



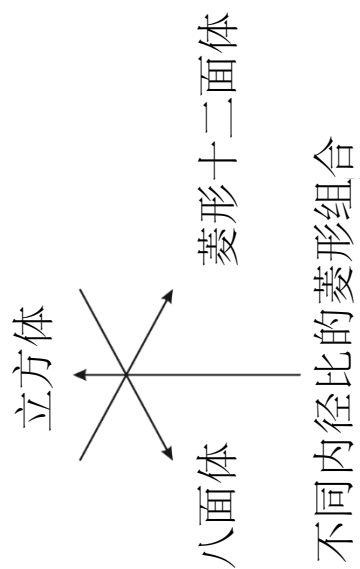
Combinations of flat and steep rhomboids

各种形状组合

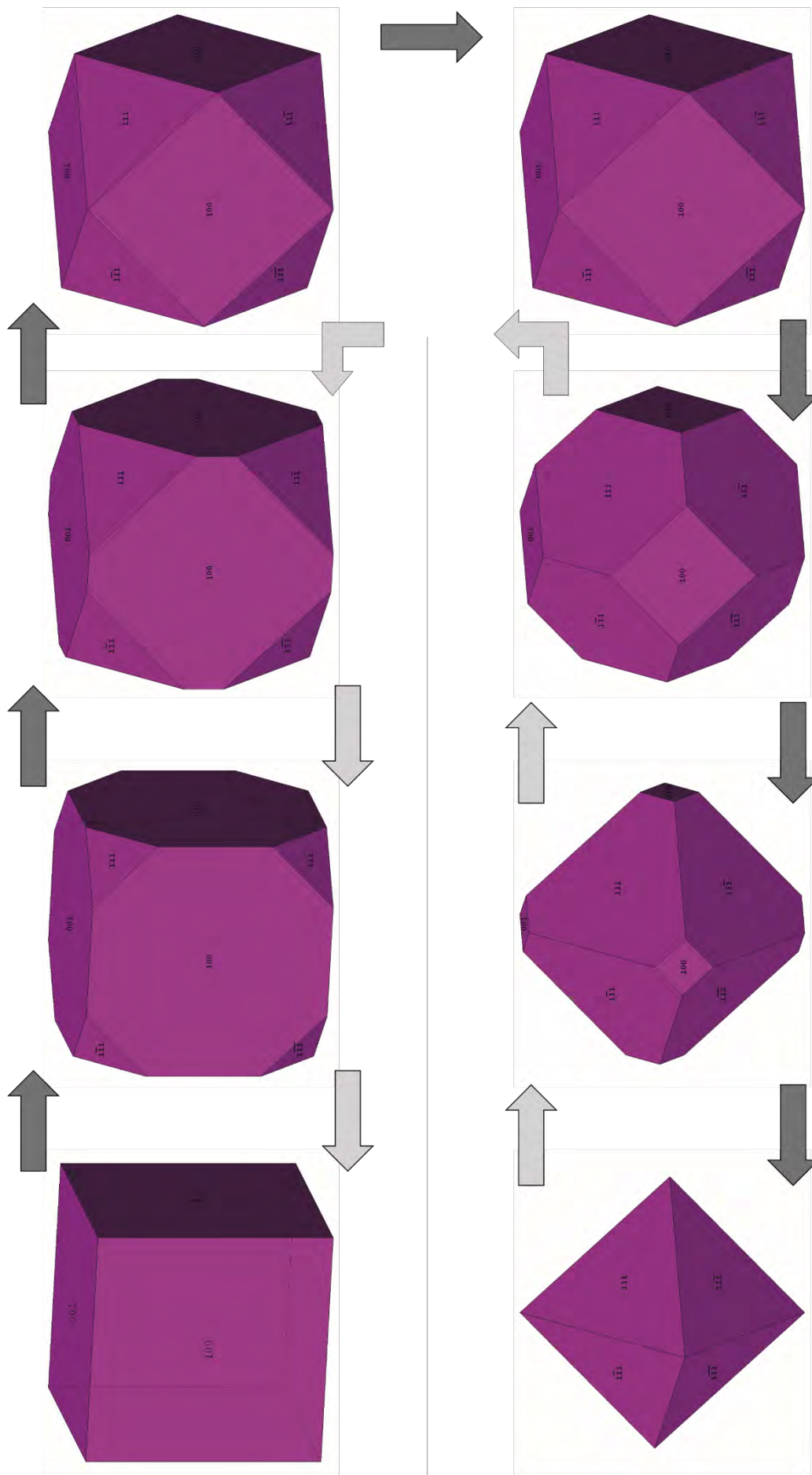
两种形状:



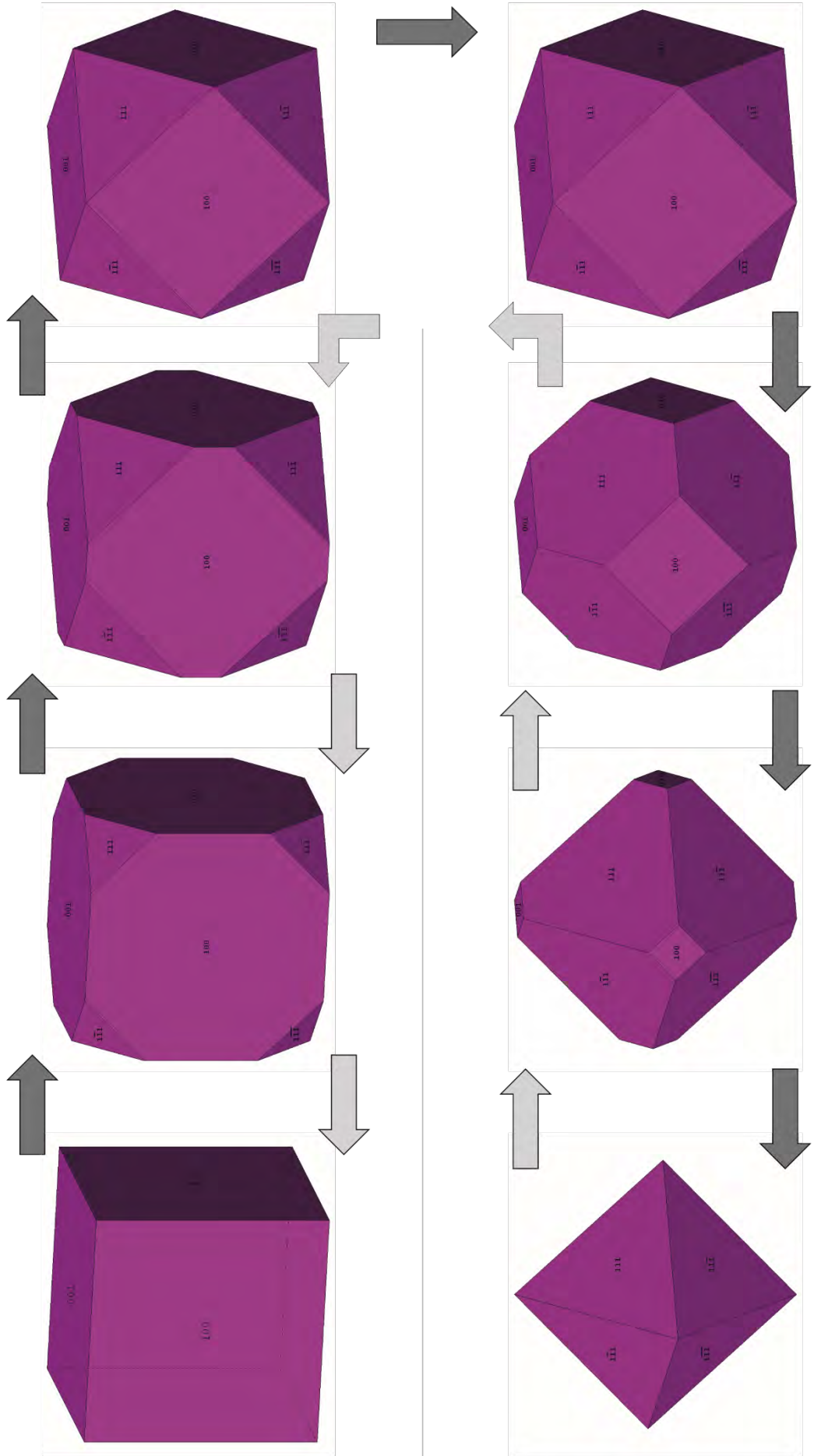
三种形状:



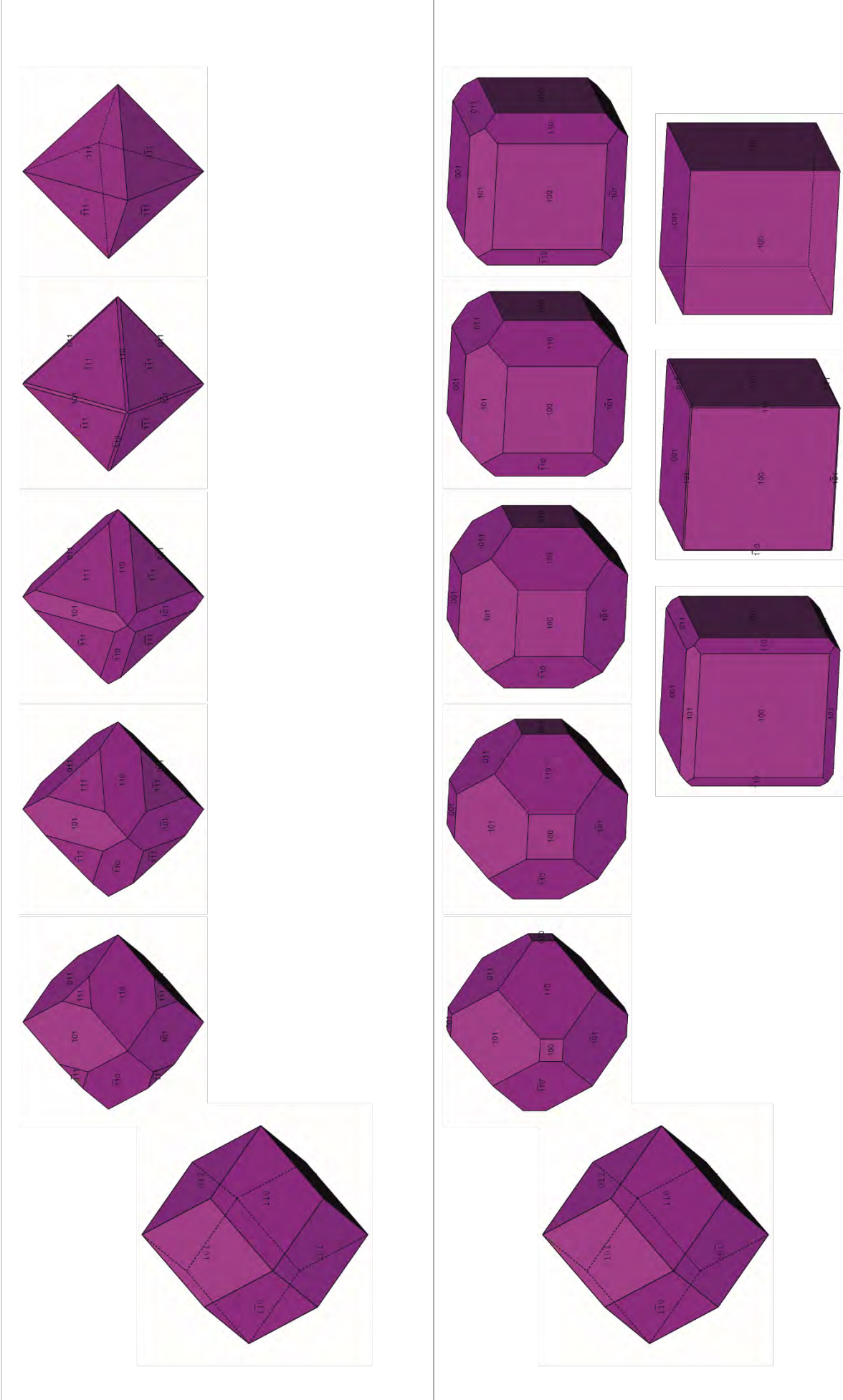
From cube to octahedron



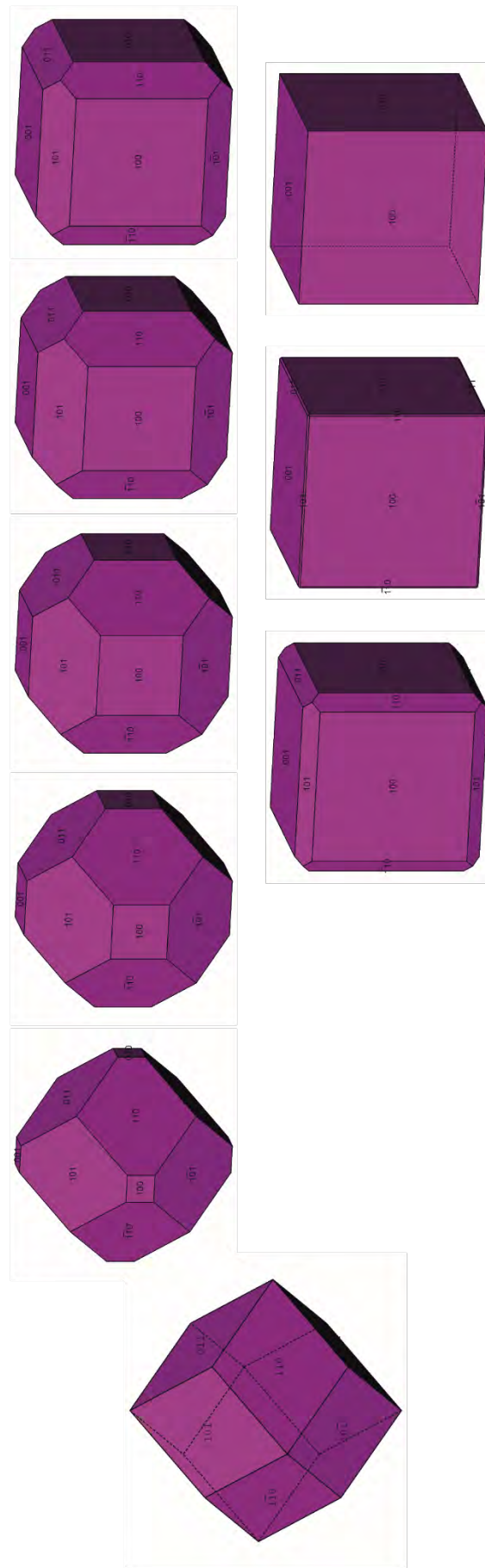
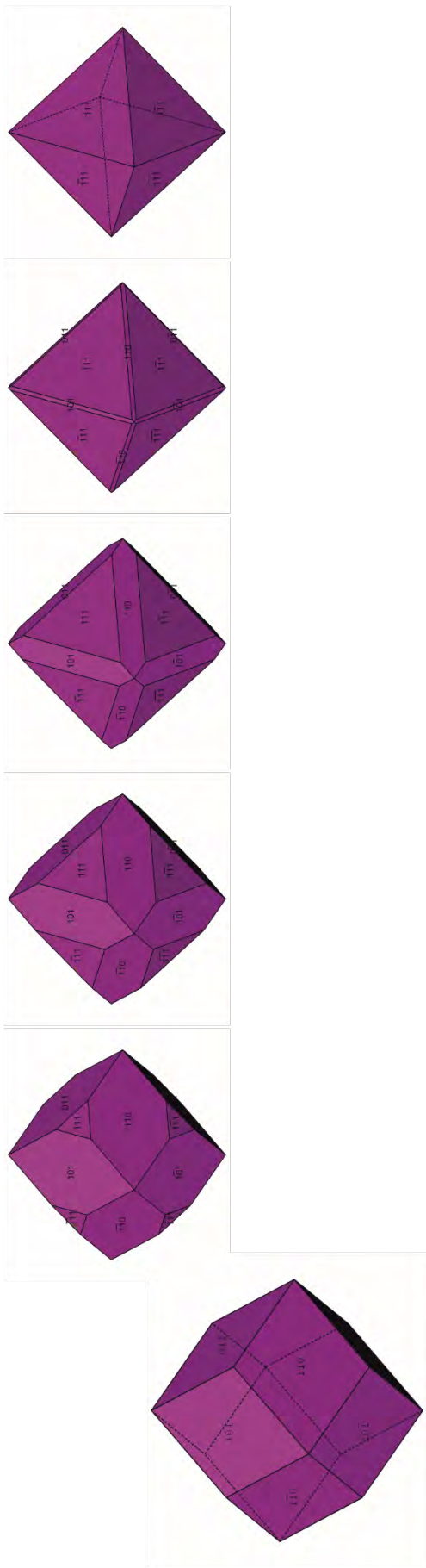
从立方体到八面体



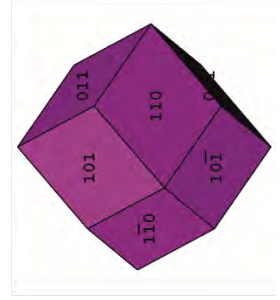
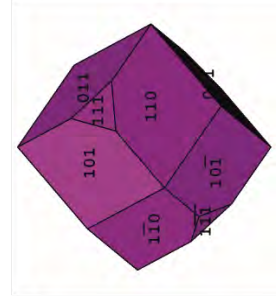
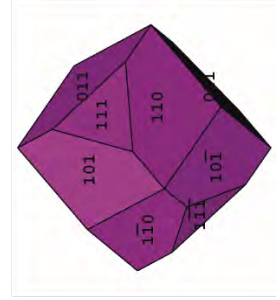
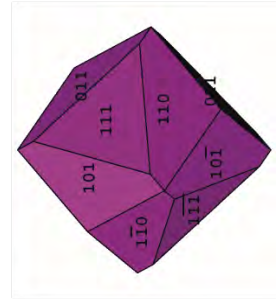
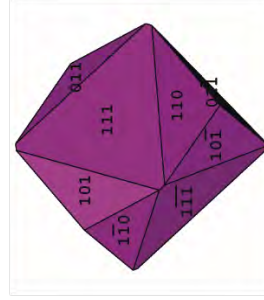
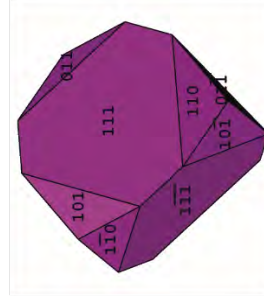
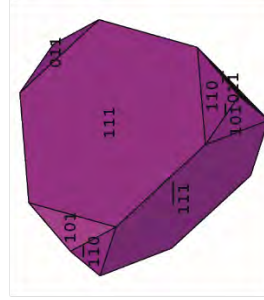
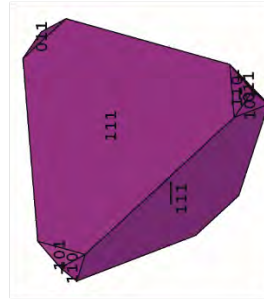
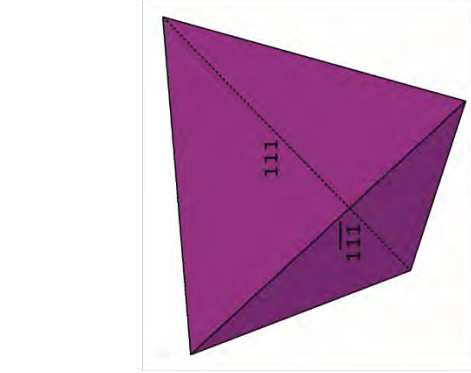
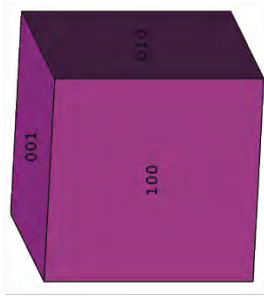
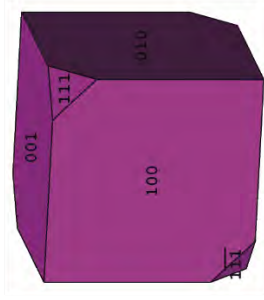
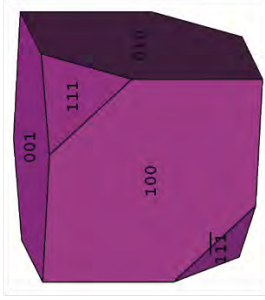
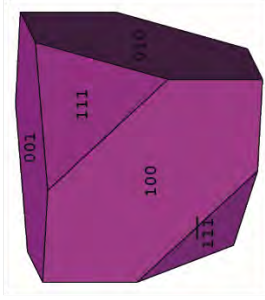
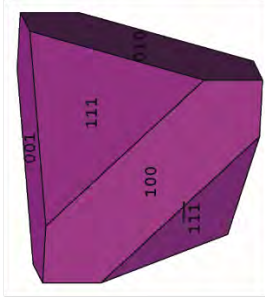
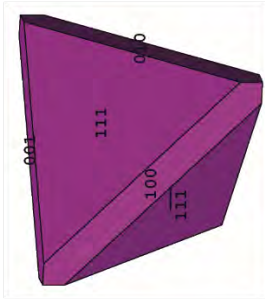
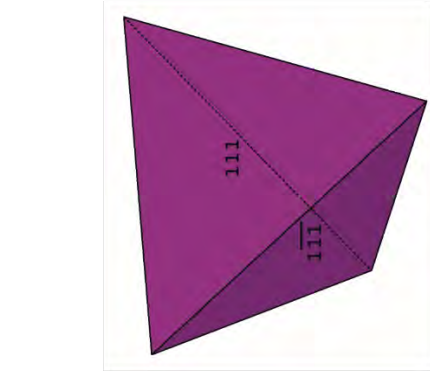
Combination of rhombic dodecahedron with octahedron and cube



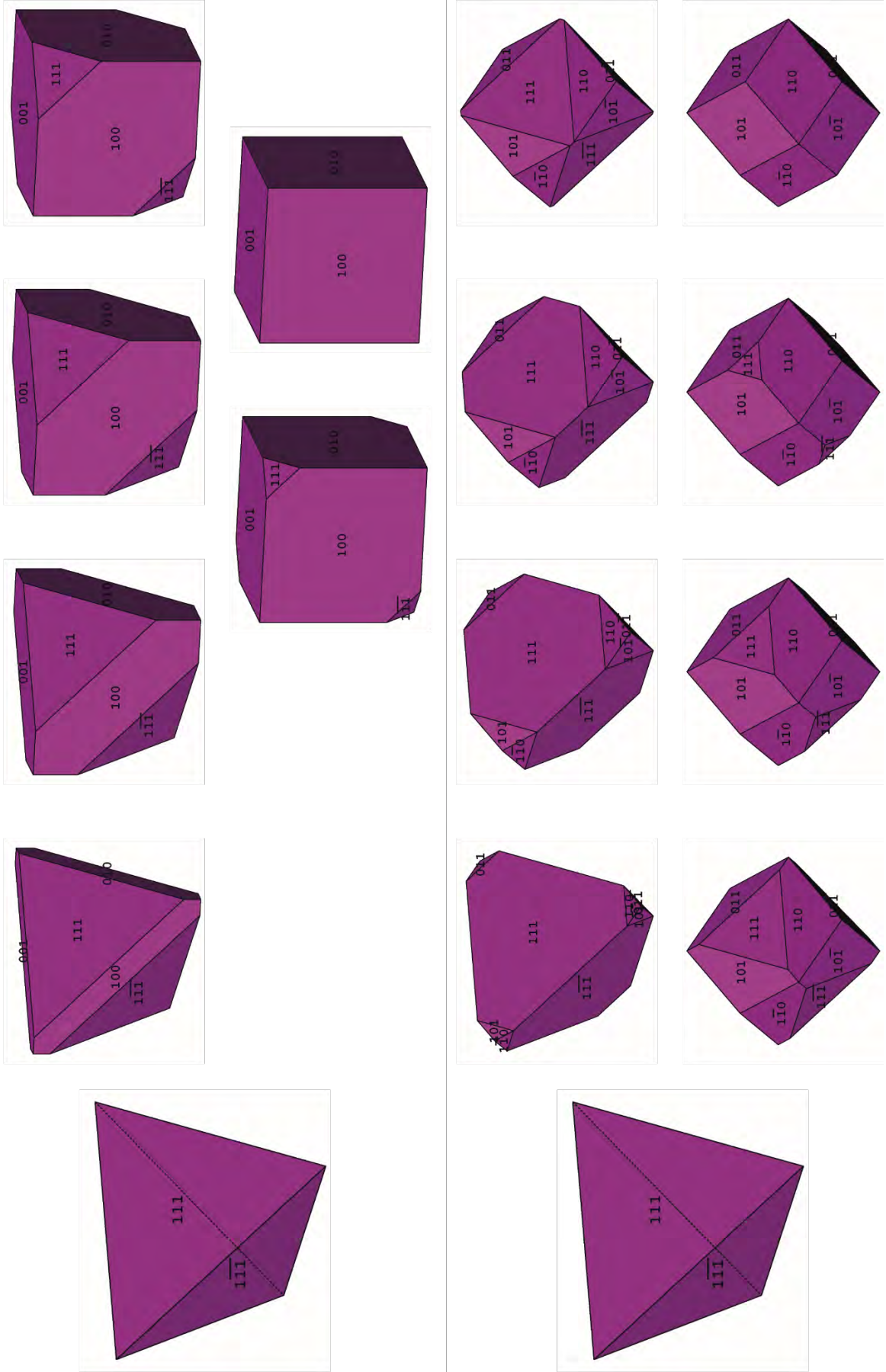
菱形十二面体与八面体和立方体的组合



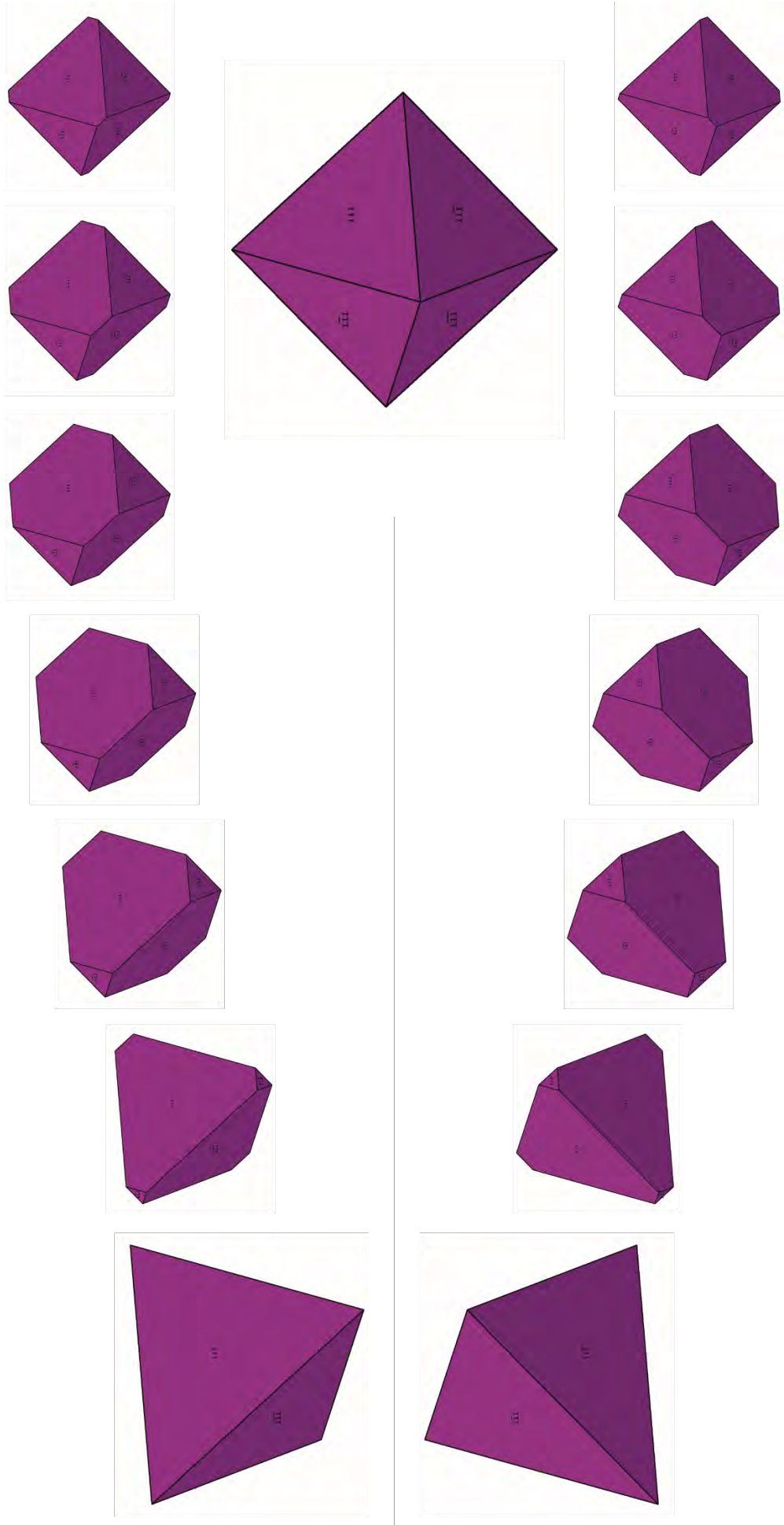
Combination of tetrahedron with cube and rhombic dodecahedron



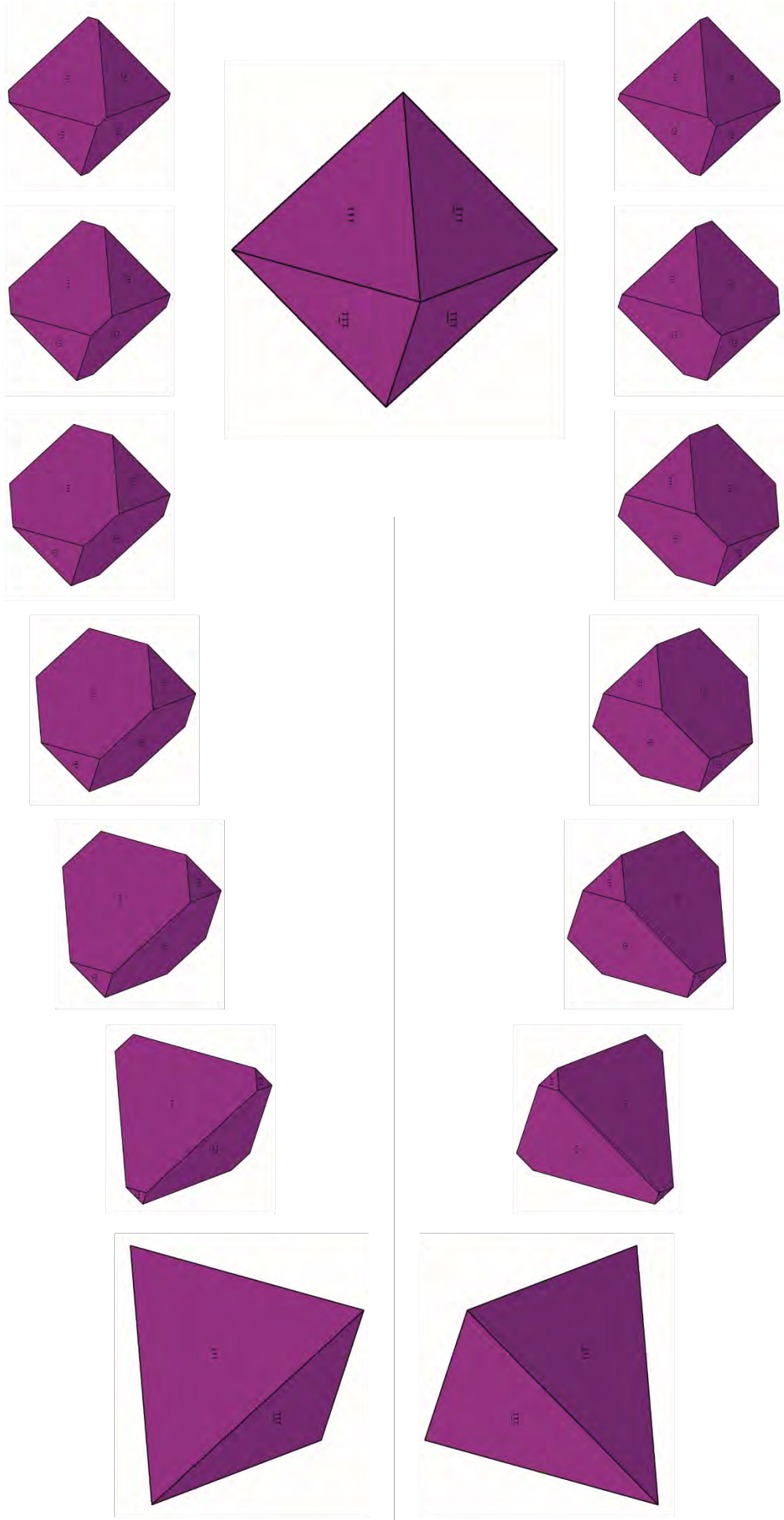
四面体与立方体和菱形十二面体的组合



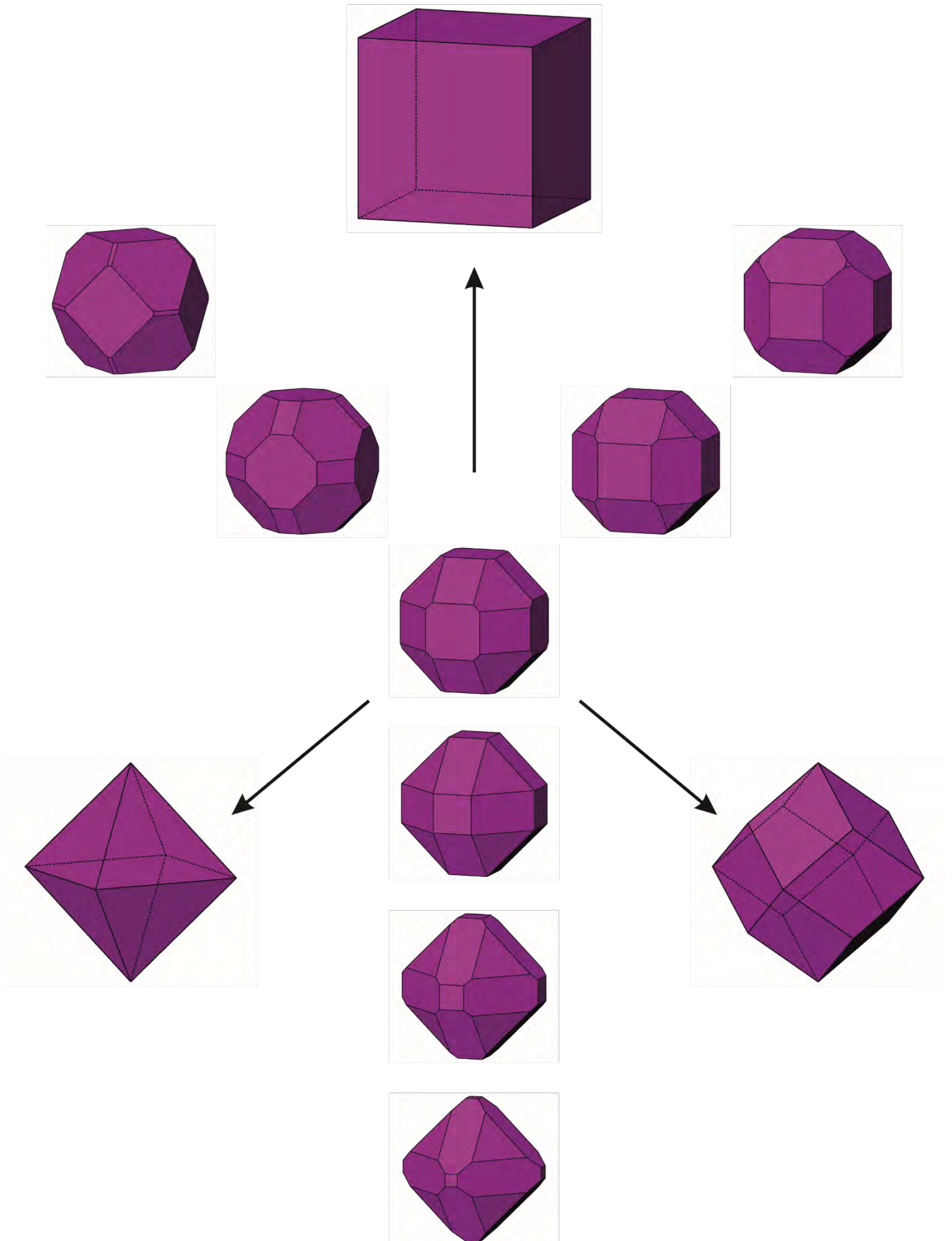
Combination of positive and negative tetrahedron



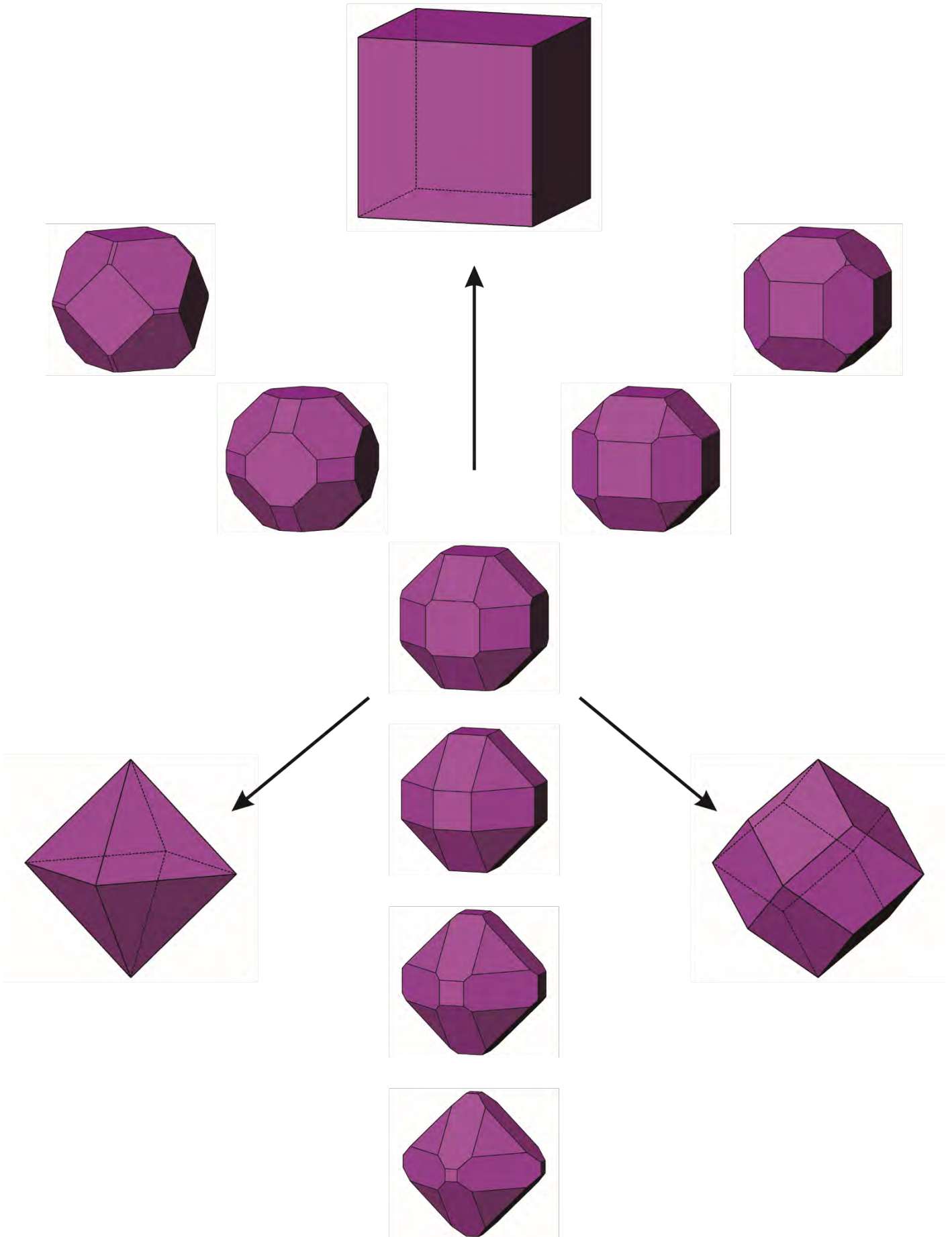
正负四面体组合



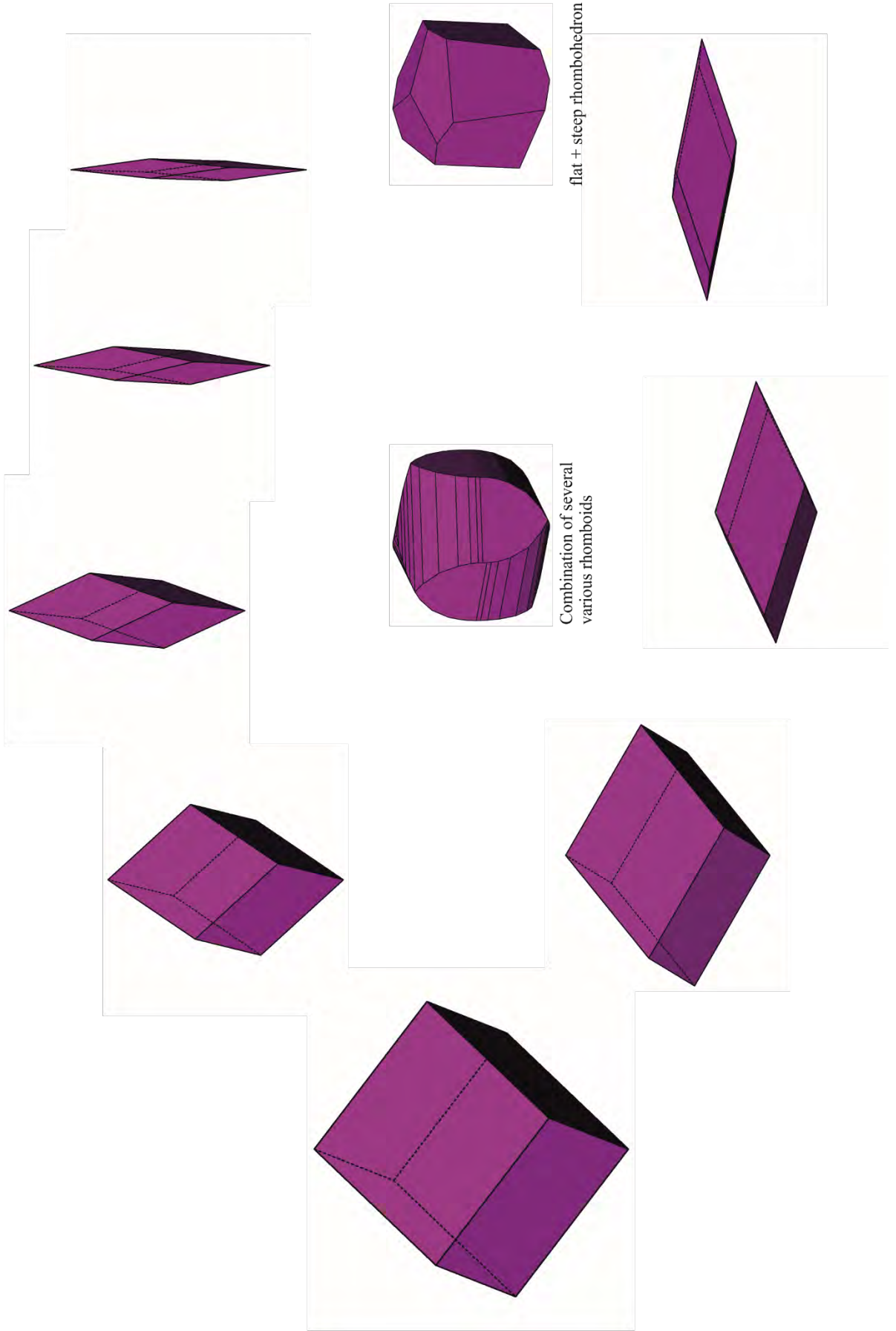
Combinations of cube, octahedron and rhombic dodecahedron



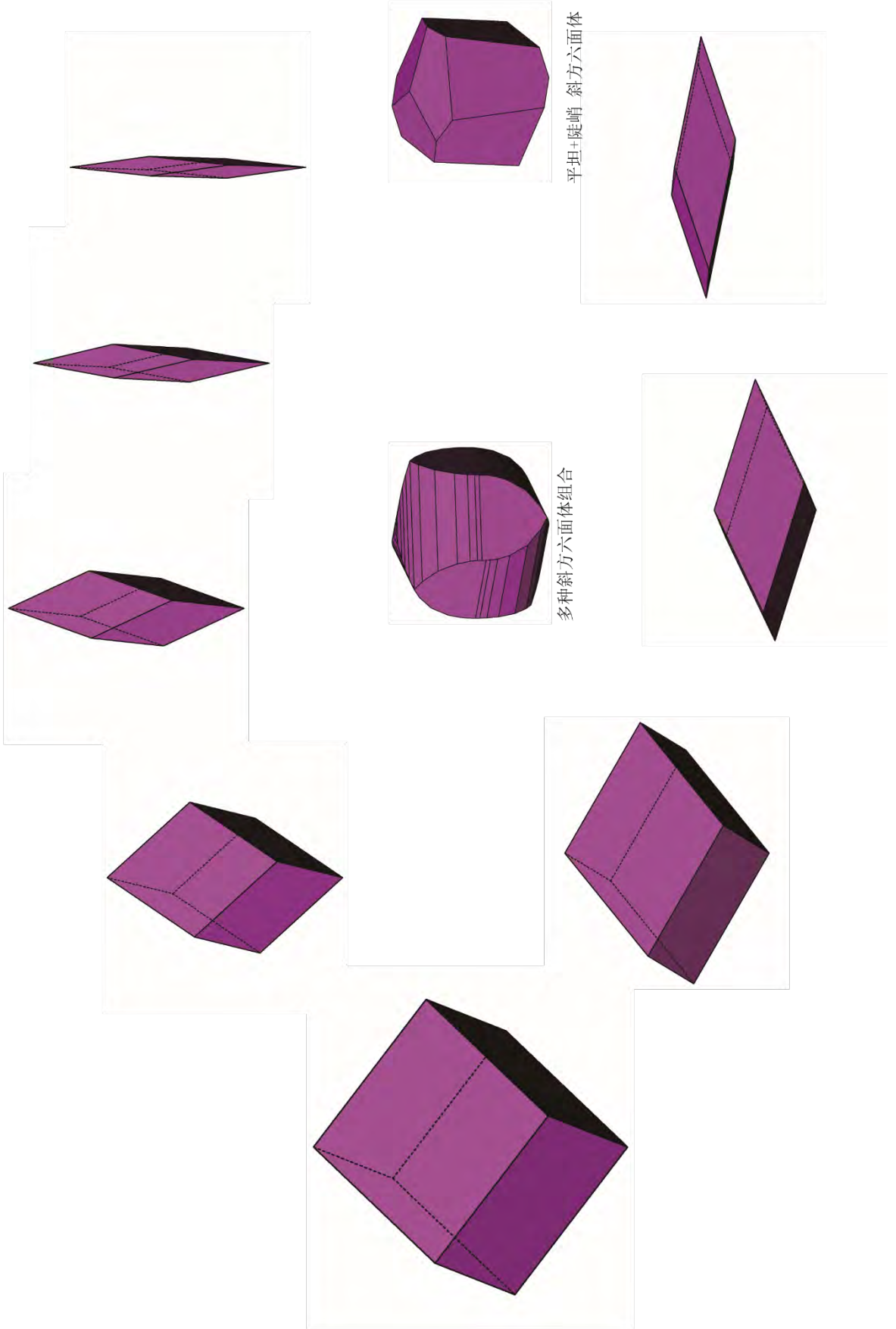
立方体，八面体和菱形十二面体的组合



Different steep and flat rhombohedron

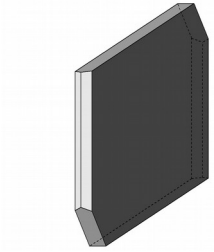


不同侧面倾斜程度的斜方六面体

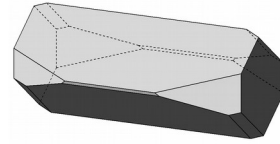


Some selected crystal forms and combinations using some mineral examples

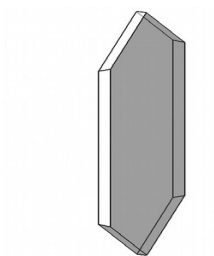
举例说明矿物中的晶体结构

Albite:

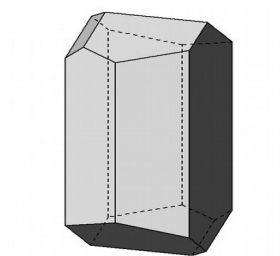
5 Pinacoids



8 Pinacoids



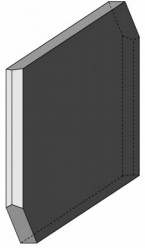
4 Pinacoids



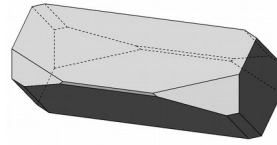
6 Pinacoids

Chemical composition	: Na[AlSi ₃ O ₈]
Crystal system	: triclinic
Elementary cell	: a = 8.14 Å, b = 12.79 Å, c = 7.1 Å, α = 94.27°, β = 116.58°, γ = 87.67°
Space group	: C1-
Forms	: platy, tabular, common multiple twins, member of plagioclase family

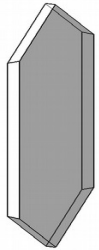
钠长石:



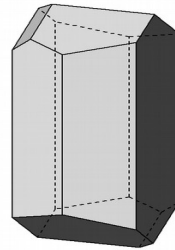
5 轴面体



8 轴面体



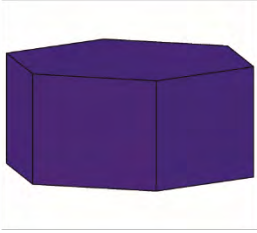
4 轴面体



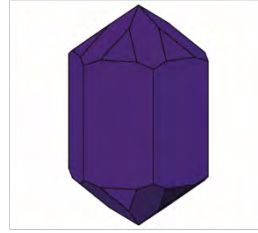
6 轴面体

化学组成
晶系
晶胞
空间群
形状

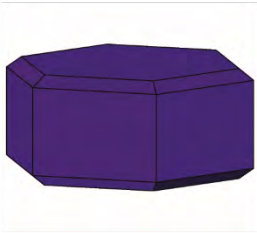
: $\text{Na}[\text{AlSi}_3\text{O}_8]$
 : 三斜
 : $a_0=8.14\text{\AA}$, $b_0=12.79\text{\AA}$, $c_0=7.1\text{\AA}$ $\alpha=94.27^\circ$, $\beta=116.58^\circ$, $\gamma=87.67^\circ$
 : C 1-
 : 片状, 板状, 常见的孪晶, 属于斜长石

Apatite:

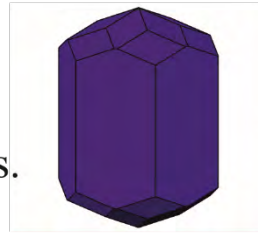
Hexagonal prism
Basispinacoid



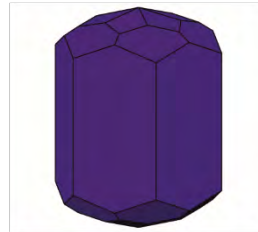
Hexagonal prism
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.



Hexagonal prism
Basispinacoid
Hex. dipyramid I. pos.

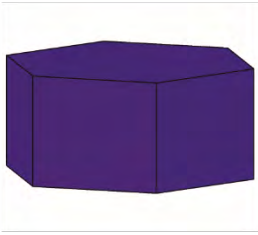


Hexagonal prism
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.

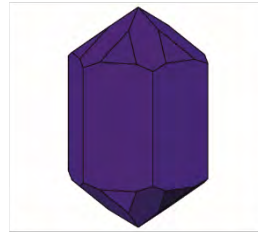


Hexagonal prism
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.

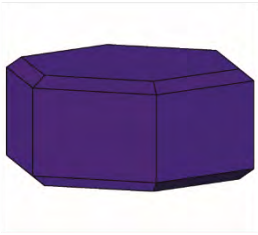
Chemical composition	: $\text{Ca}_5[(\text{PO}_4)_3(\text{F}, \text{Cl}, \text{OH})]$
Crystal system	: Hexagonal, 6/m
Elementary cell	: $a_0=9.38 \text{ \AA}$, $c_0=6.89 \text{ \AA}$
Space group	: P 63/m
Forms	: Massive, intergrown, granular, cryptocrystalline, crusts, xx columnar, tabular, needles

磷灰石:

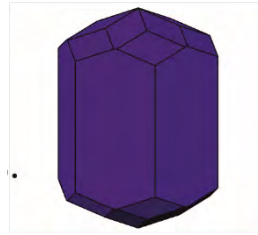
六方棱柱体
底面轴面体



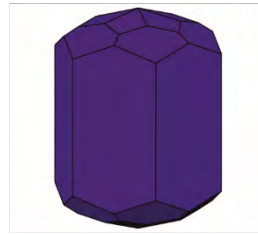
六方棱柱体
六方双棱锥体I正
六方双棱锥体II正



六方棱柱体
底面轴面体
六方双棱锥体I正



六方棱柱体
六方双棱锥体I正
六方双棱锥体II正



六方棱柱体
六方双棱锥体I正
六方双棱锥体II正

化学组成

: $\text{Ca}_5[(\text{PO}_4)_3(\text{F}, \text{Cl}, \text{OH})]$

晶系

: 六方, $6/m$

晶胞

: $a_0=9.38\text{\AA}$, $c_0=6.89\text{\AA}$

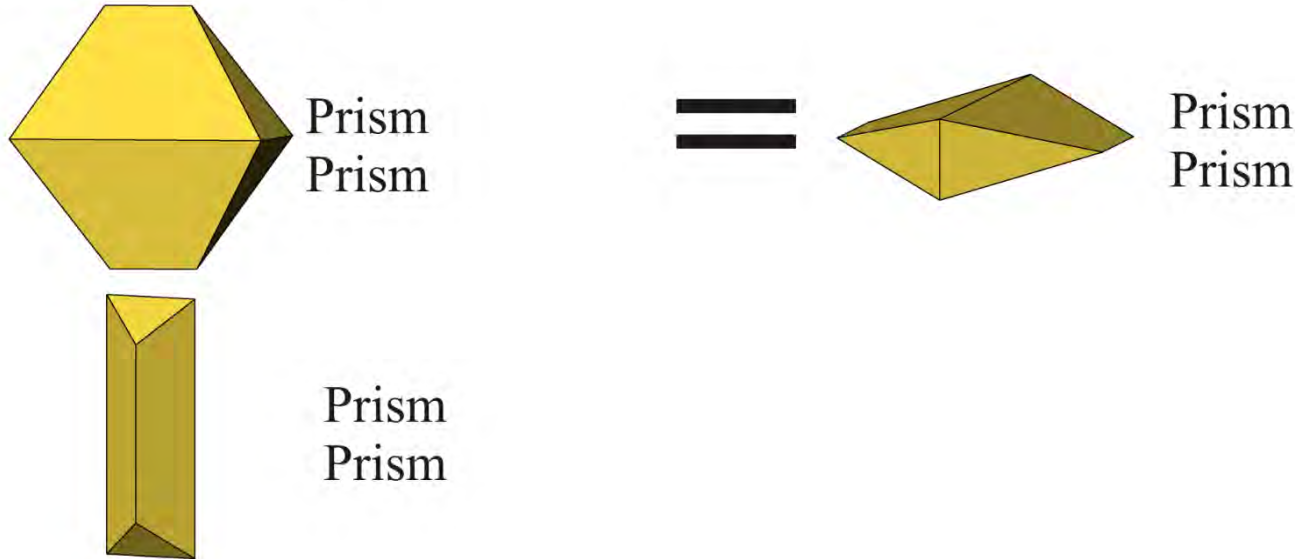
空间群

: $P 63/m$

形状

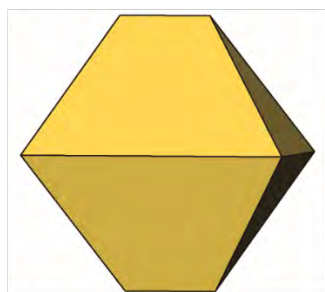
: 块状, 杂生状, 颗粒状, 隐晶状, 壳状, 柱状, 板状, 针状

Arsenopyrite:



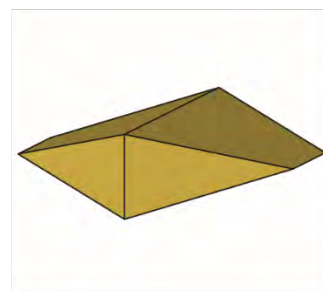
Chemical composition	: FeAsS
Crystal system	: Monoclinic, pseudorhombic
Elementary cell	: $a_0 = 5.74 \text{ \AA}$, $b_0 = 5.68 \text{ \AA}$, $c_0 = 5.79 \text{ \AA}$, $\beta = 112.17^\circ$
Space group	: P 21/c
Forms	: idiomorphic crystals, granular

含砷黄铁矿:

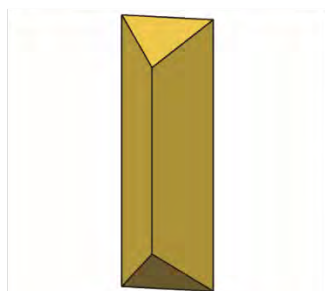


棱柱体
棱柱体

=



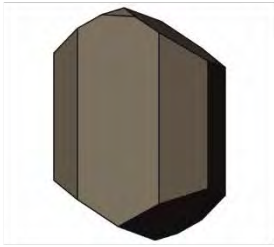
棱柱体
棱柱体



棱柱体
棱柱体

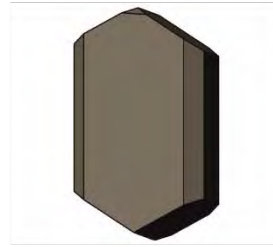
化学组成
晶系
晶胞
空间群
形状

: FeAsS
: 单斜, 伪菱形
: $a_0=5.74\text{\AA}$, $b_0=5.68\text{\AA}$, $c_0=5.79\text{\AA}$, $\beta=112.17^\circ$
: P21/c
: 独特的晶体, 粒状

Augite:

Pinacoid
Prism
Pinacoid
Pinacoid
Prism

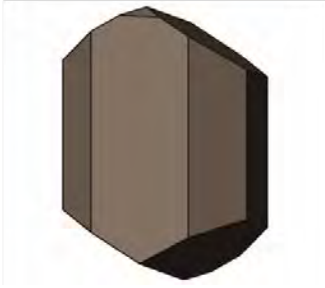
=



Pinacoid
Prism
Pinacoid
Pinacoid
Prism

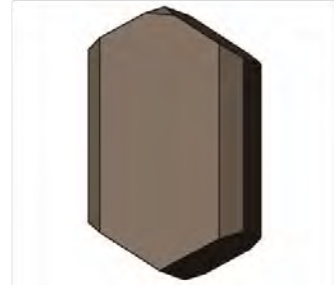
Chemical composition	: (Ca, Mg, Fe, Al, Ti) [(Si, Al) ₂ O ₆]
Crystal system	: monoclinic
Elementary cell	: a ₀ = 9.69 Å, b ₀ = 8,84 Å, c ₀ = 5.28 Å, β = 106.3°
Space group	: C 2/c
Forms	: short prismatic to tabular xx, 8-cornered cross section, often zonal

斜辉石:



轴面体
棱柱体
轴面体
轴面体
棱柱体

=



轴面体
棱柱体
轴面体
轴面体
棱柱体

化学组成
晶系
晶胞
空间群
形状

: (Ca, Mg, Fe, Al, Ti)[(Si,Al)₂O₆]

: 单斜

: $a_0=9.69 \text{ \AA}$, $b_0=8.84 \text{ \AA}$, $c_0=5.28 \text{ \AA}$, $\beta=106.3^\circ$

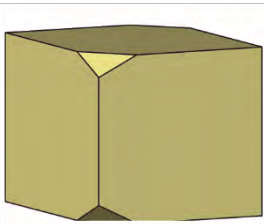
: C 2/c

: 短棱柱形到板状，8角形截面，通常带状

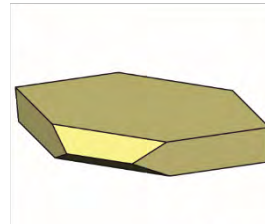
Baryte:



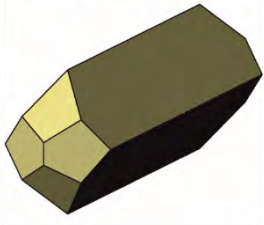
Basispinacoid
Prism



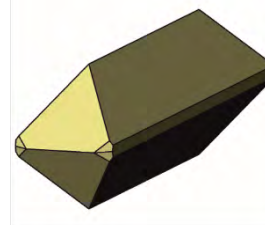
Basispinacoid
Prism
Prism



Basispinacoid
Prism
Prism



Prism
Prism
Prism



Prism
Prism
Pinacoid
Dipyramid

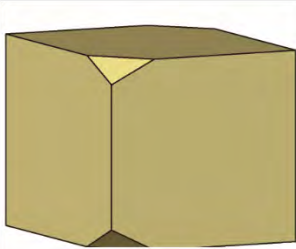
Chemical composition
Crystal system
Elementary cell
Space group
Forms

: BaSO₄
: Rhombic, 2/m 2/m 2/m
: a₀= 8.88Å, b₀= 5.45Å, c₀= 7.15Å
: P b n m
: compact, fine cristalline, spary, laminated, xx mostly
tabular or chisel form

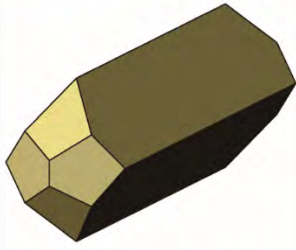
重晶石:



底面轴面体
棱柱体

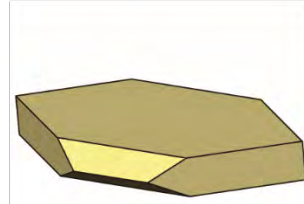


底面轴面体
棱柱体
棱柱体

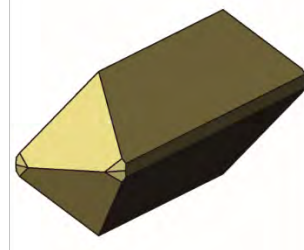


棱柱体
棱柱体
棱柱体

=



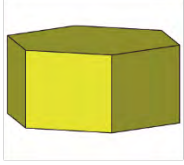
底面轴面体
棱柱体
棱柱体



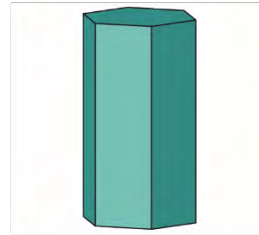
棱柱体
棱柱体
轴面体
双棱锥体

化学组成
晶系
晶胞
空间群
形状

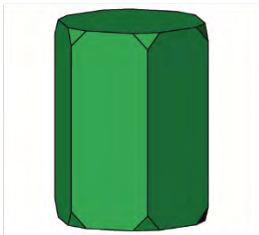
: BaSO_4
 : 菱形, $2/m\ 2/m\ 2/m$
 : $a_0=8.88\ \text{\AA}, b_0=5.45\ \text{\AA}, c_0=7.15\ \text{\AA}$
 : $P\ b\ n\ m$
 : 致密, 细晶, 喷雾状, 薄层的, 大多为板状或凿子形式

Beryl:

Hexagonal prism
Basispinacoid



Hexagonal prism
Basispinacoid



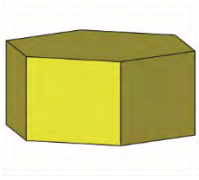
Hexagonal prism
Basispinacoid
Hex. dipyramid II. pos.



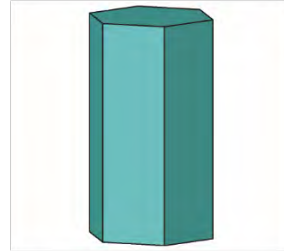
Hexagonal prisma
Basispinacoid
Hex. dipyramid I. pos.
Hex. dipyramid II. pos.

Chemical composition	: $\text{Be}_3\text{Al}_2 [\text{Si}_6\text{O}_{18}]$
Crystal system	: hexagonal
Elementary cell	: $a_0 = 9.22\text{\AA}$, $c_0 = 9.19\text{\AA}$
Space group	: P 6/m m c
Forms	: columnar, columnar, dominating Prism (1 0 – 1 0) and Pinakoid (0 0 0 1)

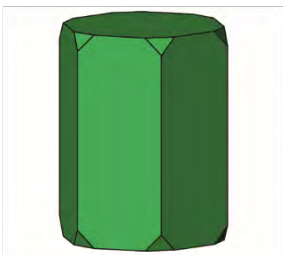
绿柱石:



六边棱柱体
底面轴面体



六边棱柱体
底面轴面体



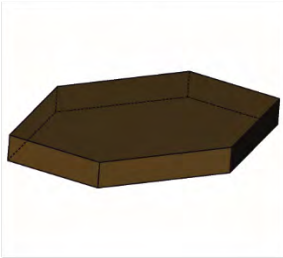
六边棱柱体
底面轴面体
六边双棱锥 II.



六边棱柱体
底面轴面体
六边双棱锥 I.
六边双棱锥 II.

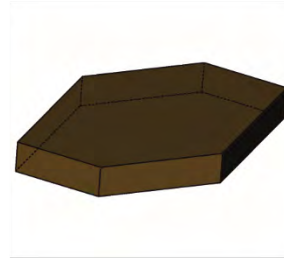
化学组成
晶系
晶胞
空间群
形状

: $\text{Be}_3\text{Al}_2[\text{Si}_6\text{O}_{18}]$
: 六方
: $a_0=9.22 \text{ \AA}$, $c_0=9.19 \text{ \AA}$
: $P 6/m m c$
: 柱状, 棱柱体 (1010) 和轴面体 (0001)

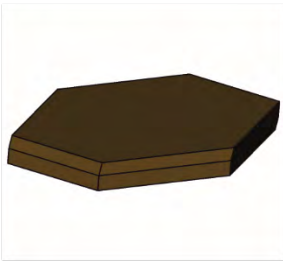
Biotite:

Basispinacoid
Prism
Pinacoid

=



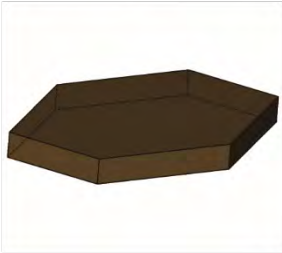
Basispinacoid
Prism
Pinacoid



Basispinacoid
Prism
Pinacoid
Prism

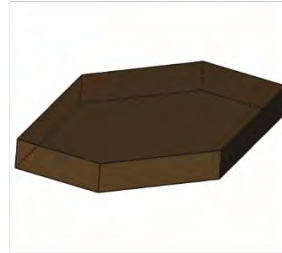
Chemical composition	: $\text{K}(\text{Mg}, \text{Fe})_3[(\text{OH})_2 / \text{AlSi}_3\text{O}_{10}]$
Crystal system	: monoclinic, trioktaedric 3-layered silicate
Elementary cell	: $a_0 = 5.35 \text{ \AA}$, $b_0 = 9.26 \text{ \AA}$, $c_0 = 10.23 \text{ \AA}$, $\beta = 100.3^\circ$
Space group	: C 2/m
Forms	: tabular, bladed, flaky

黑云母:

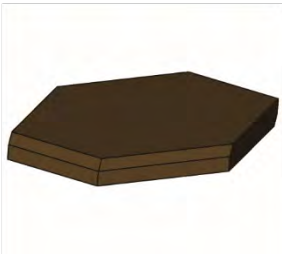


底面轴面体
棱柱体
轴面体

=



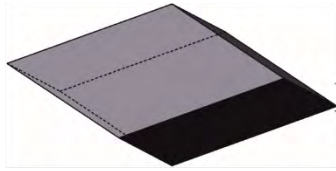
底面轴面体
棱柱体
轴面体



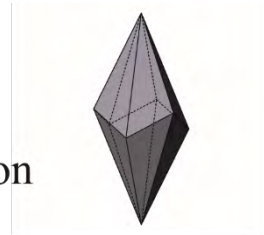
底面轴面体
棱柱体
轴面体
棱柱体

化学组成
晶系
晶胞
空间群
形状

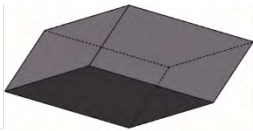
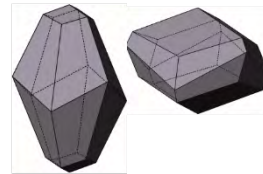
: $\text{K}(\text{Mg}, \text{Fe})_3[(\text{OH})_2/\text{AlSi}_3\text{O}_{10}]$
: 单斜,三八面体三层硅酸盐
: $a_0=5.35 \text{ \AA}$, $b_0=9.26 \text{ \AA}$, $c_0=10.23 \text{ \AA}$, $\beta=100.3^\circ$
: $C 2/m$
: 板状, 叶片状, 片状

Calcite:

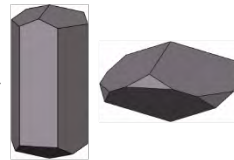
positive Rhombohedron



Scalenohedron

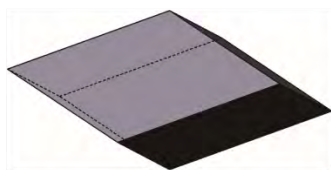
negative
RhombohedronSkalenoeder
(+) Rhombohedron

negative Rhombohedron

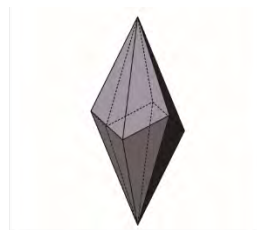
Prism
(-) Rhombohedronpos. Rhombohedron
Prism
ScalenohedronPrism
(+) Rhombohedron

Chemical composition	: CaCO_3
Crystal system	: trigonal, $-3m$
Elementary cell	: $a_0 = 4.99$, $c_0 = 17.06$
Space group	: $R-3c$
Forms	: Rock forming mineral, compact, oolitic, massive spaty, xx very different xx (different shapes of this Mineral!), example Rhombohedra and Scalenohedra, columnar xx a.o.

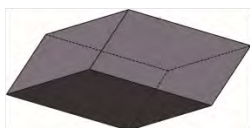
方解石:



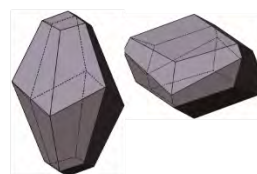
正斜方六面体



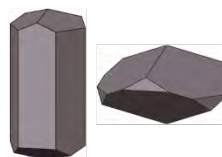
偏三角面体



负斜方六面体

偏三角面体
(+) 斜方六面体

负斜方六面体

棱柱体
(-) 斜方六面体正斜方六面体
棱柱体
偏三角面体棱柱体
(+) 斜方六面体

化学组成
晶系
晶胞
空间群
形状

: CaCO_3

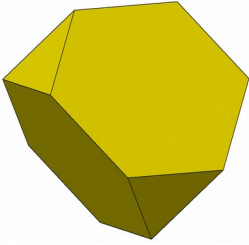
: 三方, $-3m$

: $a_0=4.99 \text{ \AA}$, $c_0=17.06 \text{ \AA}$

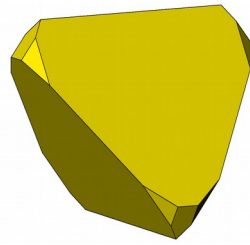
: $R -3c$

: 岩石质矿物, 致密结构, 卵石状, 稀疏状
矿物结构不同于晶胞结构形状,
例如菱形, 鳞片状, 柱状。

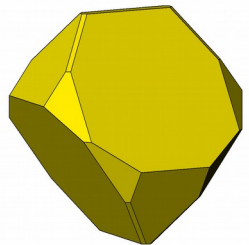
Chalkopyrite:



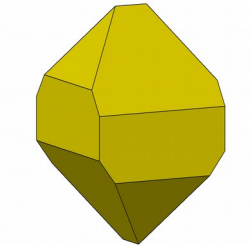
Disphenoid
Disphenoid



Disphenoid
Disphenoid
Scalenoeder



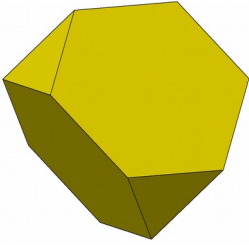
Disphenoid
Disphenoid
Dipyramide
Scalenoeder



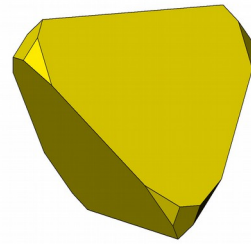
Prisma
Dipshenoid
Disphenoid

Chemical composition	: CuFeS ₂
Crystal system	: tetragonal
Elementary cell	: a = 5.29 Å, c = 10.42 Å
Space group	: I 4-2d
Forms	: massive, Penetration twins, asymmetrical „tetraheda“, tetragonal scalenohedral

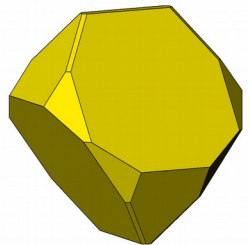
黄铜矿:



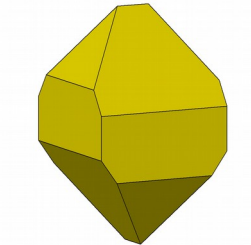
斜方四面体
斜方四面体



斜方四面体
斜方四面体
偏三角体



斜方四面体
斜方四面体
双棱锥体
偏三角体



棱柱体
斜方四面体
斜方四面体

化学组成

: CuFeS_2

晶系

: 四方

晶胞

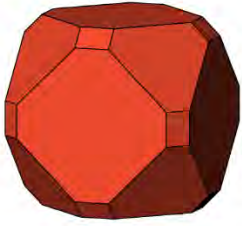
: $a_0=5.29 \text{ \AA}$, $c_0=10.42 \text{ \AA}$

空间群

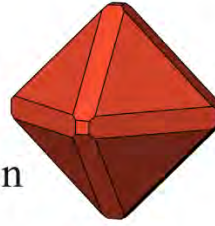
: $I4-2d$

形状

: 块状, 贯穿孪晶, 非对称的四面体, 四方偏三角面体

Cuprite:

Hexahedron
 Octahedron
 Rhombic dodecahedron



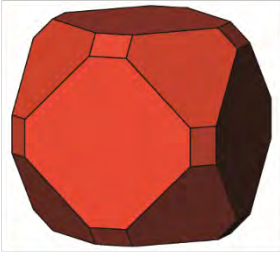
Hexahedron
 Octahedron
 Rhombic dodecahedron



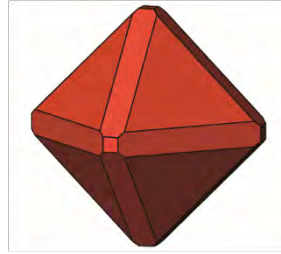
Hexahedron
 Octahedron
 Pentagonal icositetrahedron

Chemical composition	: Cu ₂ O
Crystal system	: cubic
Elementary cell	: a ₀ =4.27 Å
Space group	: Pn3m
Forms	: passive, disseminated, cubes, octahedra, needle x

赤铜矿:



六面体
八面体
菱形十二面体

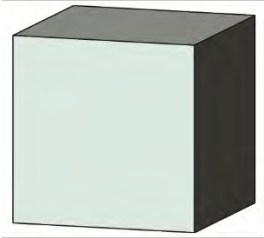


六面体
八面体
菱形十二面体

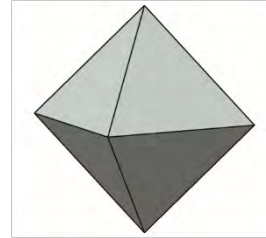


六面体
八面体
菱形十二面体

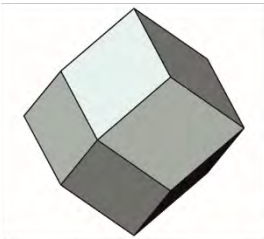
化学组成	: Cu_2O
晶系	: 立方
晶胞	: $a_0=4.27 \text{ \AA}$
空间群	: $\text{Pn}3\text{m}$
形状	: 散发状, 立方体, 八面体, 针状

Diamond:

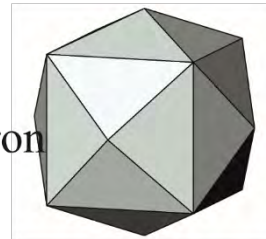
Hexahedron



Octahedron



Rhombic dodecahedron



Tetrakis hexaeder

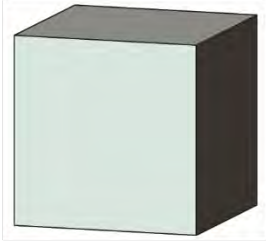


Hexakis octahedron

Octahedron
Hexakis octahedron

Chemical composition	: C
Crystal system	: cubic
Elementary cell	: $a_0 = 3.559 \text{ \AA}$
Space group	: F d3m
Forms	: octahedra, rhombic dodecaedron, cubes, xx mostly rounded

金刚石:



六面体



八面体



菱形十二面体



四角六面体



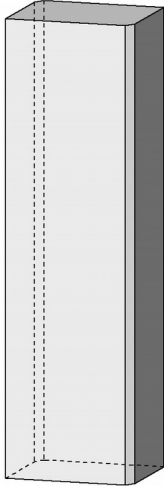
六角八面体

八面体
六角八面体

化学组成
晶系
晶胞
空间群
形状

: C
: 立方
: $a_0=3.559 \text{ \AA}$
: $F d3m$
: 八面体, 菱形十二面体, 立方体, 大多为圆形

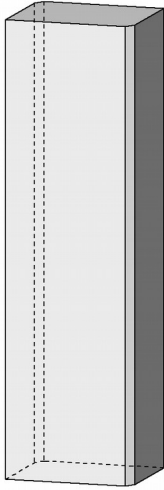
Cyanit / Disthen:



Pinakoid
Pinakoid
Pinakoid
Pinakoid

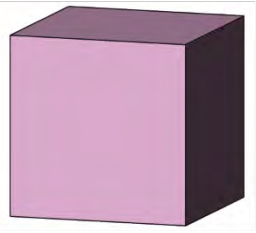
Chemical composition	: $\text{Al}_2 [\text{O}/\text{SiO}_4]$
Crystal system	: triclinic
Elementary cell	: $a_0 = 7.1 \text{ \AA}$, $b_0 = 7.74 \text{ \AA}$, $c_0 = 5.57 \text{ \AA}$, $\alpha = 90.1^\circ$, $\beta = 101.3^\circ$, $\gamma = 105.75^\circ$
Space group	: P 1-
Forms	: tabular, high hardness difference in varying directions

蓝晶石:

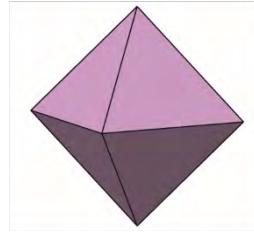


轴面体
轴面体
轴面体
轴面体

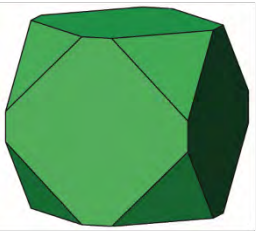
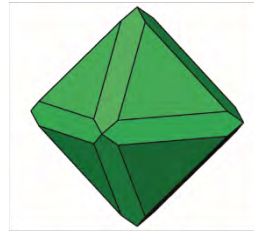
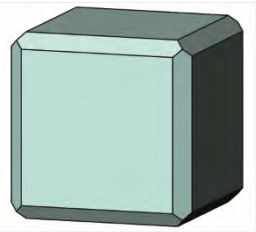
化学组成 : $\text{Al}_2[\text{O}/\text{SiO}_4]$
 晶系 : 三斜
 晶胞 : $a_0 = 7.1 \text{ \AA}$, $b_0 = 7.74 \text{ \AA}$, $c_0 = 5.57 \text{ \AA}$, $\alpha = 90.1^\circ$, $\beta = 101.3^\circ$, $\gamma = 105.75^\circ$
 空间群 : $P 1-$
 形状 : 块状, 不同晶向高硬度

Fluorite:

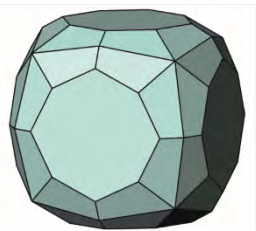
Hexahedron



Octahedron

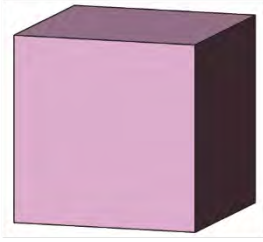
Hexahedron
OctahedronOctahedron
Rhombic dodecahedronHexahedron
Rhombic dodecahedron

Tetrakis hexahedron

Hexahedron
Hexakis octahedron

Chemical composition	: CaF_2
Crystal system	: cubic
Elementary cell	: $a_0 = 5.46 \text{ \AA}$
Space group	: $F m\bar{3}m$
Forms	: massive, grobspätig, cubes, octahedra, Rhombic dodecahedron, often cristalline.

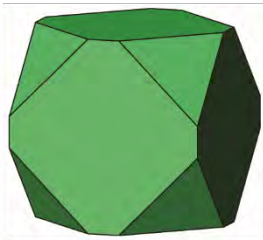
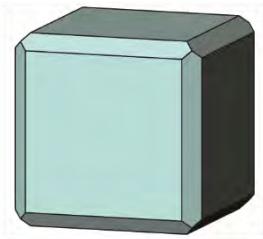
萤石:



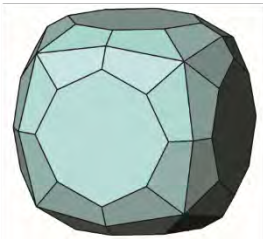
六面体



八面体

六面体
八面体八面体
菱形十二面体六面体
菱形十二面体

四角六面体

六面体
六角八面体

化学组成
晶系
晶胞
空间群
形状

: CaF_2
: 立方
: $a_0=5.46\text{\AA}$
: $Fm\bar{3}m$
: 块状, 粗糙, 立方, 八面体, 菱形十二面体,
通常为晶体

Galenite:

Octahedron



Cube

various
Cube-OctahedronCube
Octahedron
Rhombic dodecahedron

Chemical composition : PbS
 Crystal system : cubic, NaCl-lattice
 Elementary cell : $a_0 = 5.94 \text{ \AA}$
 Space group : F m 3 m
 Forms : massive, disseminated, cubes, octahedra,
 rhombic dodecahedron, often combinations

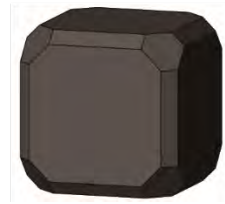
方铅矿:



八面体

两种
立方八面体

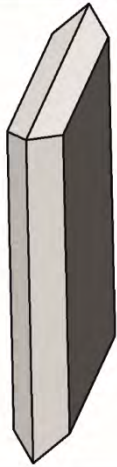
立方体

立方体
八面体
菱形十二面体

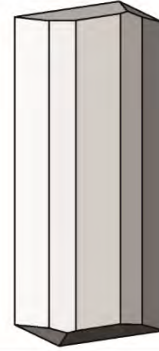
化学组成
晶系
晶胞
空间群
形状

: PbS
: 立方, NaCl 型点阵格子
: $a_0=5.94\text{\AA}$
: $Fm\bar{3}m$
: 块状, 散发状, 立方体, 八面体, 菱形
十二面体, 通常是组合状

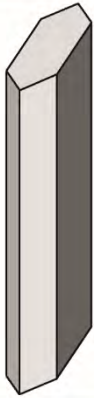
Gypsum:



Prism
Prism
Pinacoid



Prism
Prism
Prism
Prism
Pinacoid

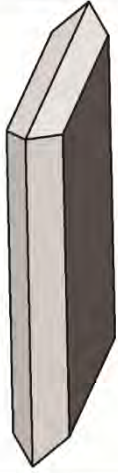


Prism
Basispinacoid
Pinacoid

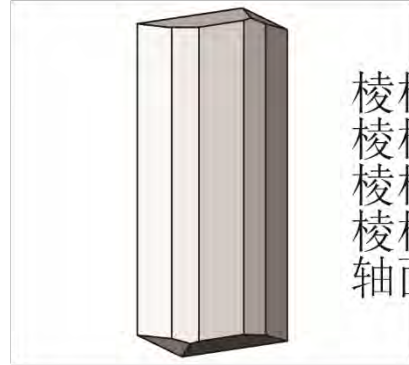
Chemical composition
Crystal system
Elementary cell
Space group
Forms

: $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
: monoclinic, $2/m$
: $a_0 = 5.68\text{\AA}$, $b_0 = 15.18\text{\AA}$, $c_0 = 6.89\text{\AA}$, $\beta = 113.83$
: $A 2/a$
: compact, finely granular, fibrous, xx needles, prismatic, tabular, often dove tail twins

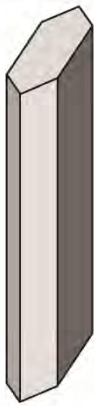
石膏:



棱柱体
棱柱体
轴面体



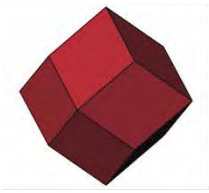
棱柱体
棱柱体
棱柱体
轴面体



棱柱体
底面轴面体
轴面体

化学组成
晶系
晶胞
空间群
形状

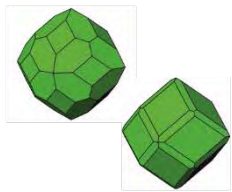
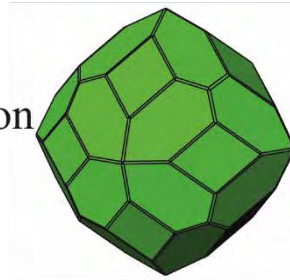
- : $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- : 单斜, $2/m$
- : $a_0=5.68 \text{ \AA}$, $b_0=15.18 \text{ \AA}$, $c_0=6.89 \text{ \AA}$, $\beta=113.83^\circ$
- : $A 2/a$
- : 致密结构, 细颗粒状, 纤维状, 针状, 棱柱状, 板状, 通常为双生鸽尾状

Garnet:

Rhombic dodecahedron



Deltoidal icositetrahedron

Rhombic dodecahedron
Deltoidal
icositetrahedronRhombic 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 dodecahedron (110), Deltoidalicositetrahedron (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: $Ca_3Fe_2 [SiO_4]_3$

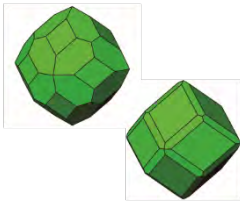
石榴石:



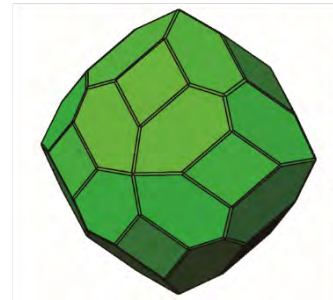
菱形十二面体



二十四面体



菱形十二面体
二十四面体



菱形十二面体
二十四面体
四角六面体
六角四面体
三角八面体

化学组成

: $X_3Y_2[(SiO_4)_3]$
 X: Mg, Fe^{2+} , Mn^{2+} , Ca (8配位)
 Y: Al, Fe^{3+} , Cr^{3+} , V^{3+} (6配位)
 (SiO_4) 被 (AlO_4) 或 (OH) 替代

晶系

: 立方

形状

: 菱形十二面体 (110) , 三角四面体 (211)

铝榴石

镁铝榴石 $Mg_3Al_2[SiO_4]_3$

铁铝榴石 $Fe_3Al_2[SiO_4]_3$

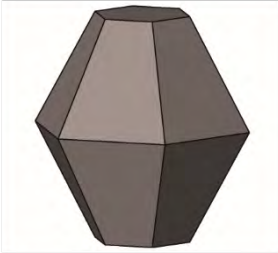
锰铝榴石 $Mn_3Al_2[SiO_4]_3$

钙榴石

钙铬榴石 $Ca_3Cr_2[SiO_4]_3$

钙铝榴石 $Ca_3Al_2[SiO_4]_3$

钙铁榴石 $Ca_3Fe_2[SiO_4]_3$

Hematite:Rhombohedron
BasispinacoidRhombohedron
BasispinacoidDipyramid
BasispinacoidRhombohedron
DipyramidRhombohedron
Dipyramid
Rhombohedron

Chemical composition	: Fe ₂ O ₃
Crystal system	: trigonal
Elementary cell	: a ₀ = 5.03Å, c ₀ =13.74Å
Space group	: R -3c
Forms	: earthy, flaky, radial, nodular, nierig, xx tabular, platy

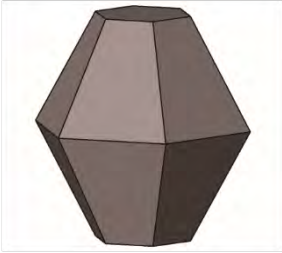
赤铁矿:



斜方六面体
底面轴面体



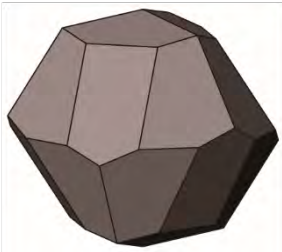
斜方六面体
底面轴面体



双棱锥体
底面轴面体



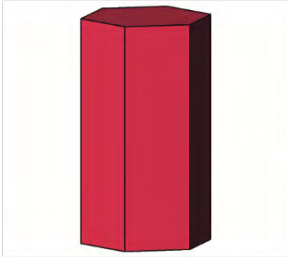
斜方六面体
双棱锥体



斜方六面体
双棱锥体
斜方六面体

化学组成
晶系
晶胞
空间群
形状

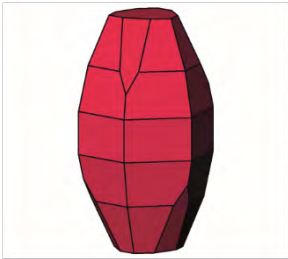
: Fe_2O_3
: 三方
: $a_0=5.03 \text{ \AA}$, $c_0=13.74 \text{ \AA}$
: $R -3c$
: 土状, 片状, 放射状, 结节状, 肾形, 板状, 扁平状

Corundum:

Prism
Basispinacoid



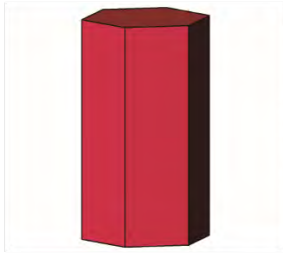
Prism
Basispinacoid
Dipyramid



Prism
Basispinacoid
Dipyramid
Dipyramid
Rhombohedron

Chemical composition	: Al_2O_3
Crystal system	: Trigonal
Elementary cell	: $a_0=4.75 \text{ \AA}$, $c_0= 12.98 \text{ \AA}$
Space group	: R-3c
Forms	: disseminated, columnar to barrel like forms xx, mostly with streaking

刚玉:



棱柱体
底面轴面体



棱柱体
底面轴面体
双棱锥体



棱柱体
底面轴面体
双棱锥体
双棱锥体
斜方六面体

化学组成
晶系
晶胞
空间群
形状

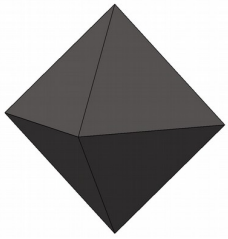
: Al_2O_3

: 三方

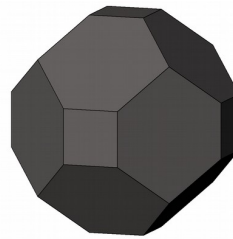
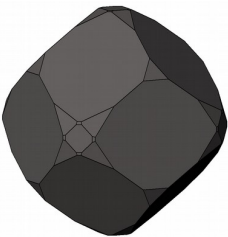
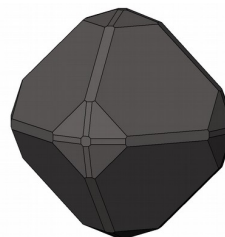
: $a_0=4.75 \text{ \AA}$, $c_0=12.98 \text{ \AA}$

: $R -3c$

: 散发状, 柱状至桶状, 主要带有条纹

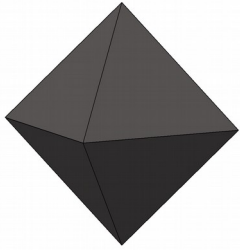
Magnetite:

Octahedron

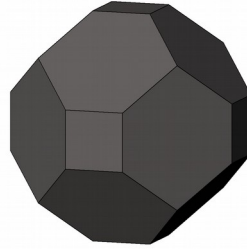
Hexahedron
RhombicuboctahedronRhombicuboctahedron
Hexahedron Octahedron
Deltoidicositetraeder
TetrakishexaederOctahedron
Rhombicuboctahedron
Tetrakisohedron
Hexahedron
Deltoidicositetraeder

Chemical composition	: Fe_3O_4
Crystal system	: cubic
Elementary cell	: $a_0 = 8.396 \text{ \AA}$
Space group	: F d3-m
Forms	: octahedral, common twinning acc. (111)

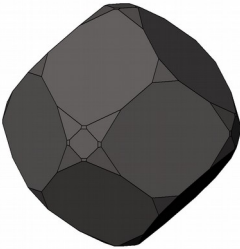
磁铁矿



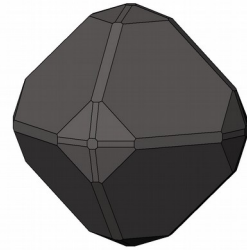
八面体



六面体
菱形十二面体



菱形十二面体
六面体
八面体
三角二十四面体
四角六面体

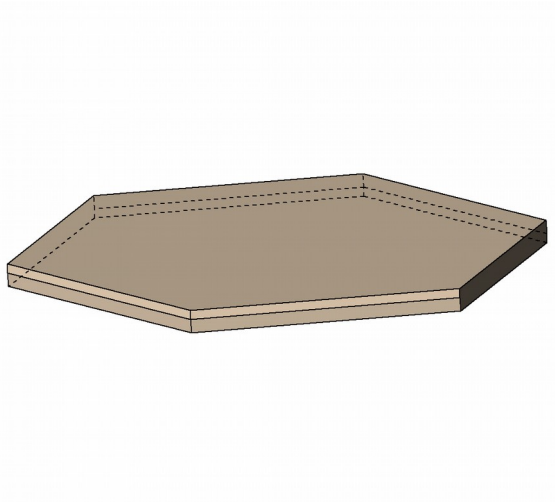


八面体
菱形十二面体
四角六面体
六面体
三角二十四面体

化学组成
晶系
晶胞
空间群
形状

: Fe_3O_4
: 立方
: $a_0=8.396 \text{ \AA}$
: $F d3-m$
: 八面体, 常见双晶acc (111)

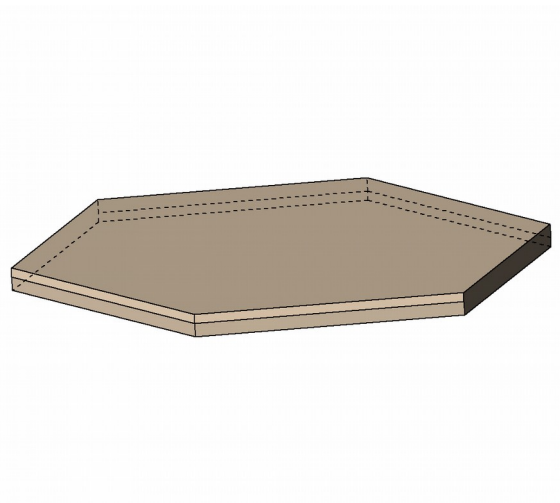
Muscovite:



Prisma
Prisma
Pinakoid
Pinakoid

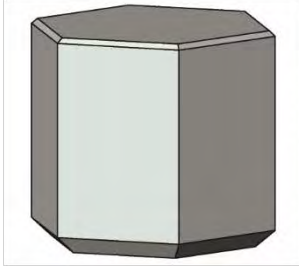
Chemical composition	: $\text{KA1}_2([\text{Si}_3\text{AlO}_{10}/(\text{OH},\text{F})_2])$
Crystal system	: monoclinic
Elementary cell	: $a_0 = 5.19\text{\AA}$; $b_0 = 9.03\text{\AA}$, $c_0 = 20.05\text{\AA}$, $\beta = 95.5^\circ$
Space group	: C 2/m
Forms	: platy, perfect cleavage acc. (001)

白云母:

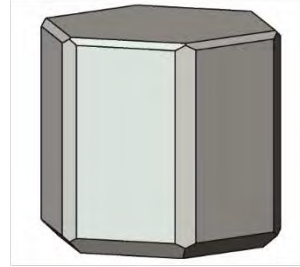


棱柱体
棱柱体
轴面体
轴面体

化学组成	: $\text{KAl}_2([\text{Si}_3\text{AlO}_{10}/(\text{OH},\text{F})_2])$
晶系	: 单斜
晶胞	: $a_0 = 5.19 \text{ \AA}$, $b_0 = 9.03 \text{ \AA}$, $c_0 = 20.05 \text{ \AA}$, $\beta = 95.5^\circ$
空间群	: $\text{C } 2/m$
形状	: 板状, 完全解理 $\text{acc } (001)$

Nepheline:

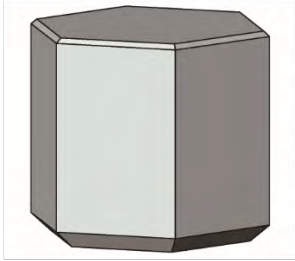
Prism
Basispedia
Basispedia
Pyramid
Pyramid



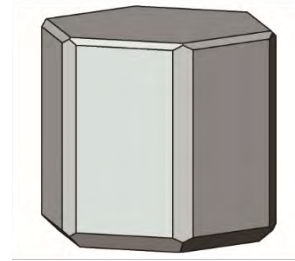
Prism
Basispedia
Basispedia
Pyramid
Pyramid
Prism

Chemical composition	: $\text{KNa}_3[\text{Al SiO}_4]_4$
Crystal system	: hexagonal
Elementary cell	: $a_0 = 9.99 \text{ \AA}$, $c_0 = 8.37 \text{ \AA}$
Space group	: $P 6_3$
Forms	: massive, rare column crystals xx

霞石:

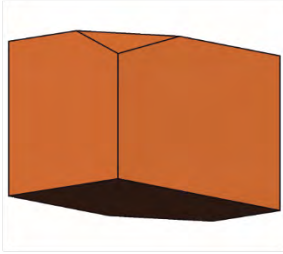


棱柱体
底面单面体
底面单面体
棱锥体
棱锥体

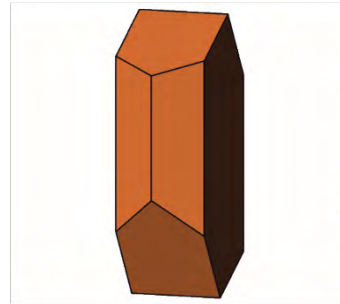


棱柱体
底面单面体
底面单面体
棱锥体
棱锥体
棱柱体

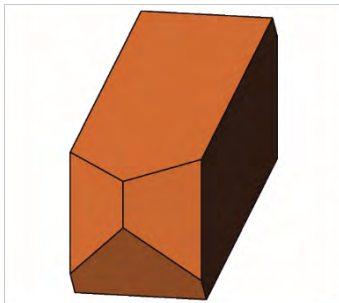
化学组成	: $\text{KNa}_3[\text{AlSiO}_4]_4$
晶系	: 六方
晶胞	: $a_0=9.99 \text{ \AA}, c_0=8.37 \text{ \AA}$
空间群	: $P 6_3$
形状	: 块状, 稀有的柱状晶体

Orthoclase:

Prism
Pinacoid
Pinacoid



Prism
Basispinacoid
Pinacoid
Pinacoid

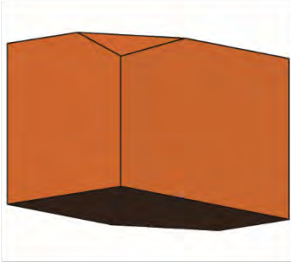


Prism
Pinacoid
Basispinacoid
Pinacoid

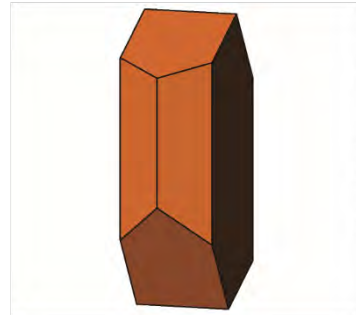
Chemical composition
Crystal system
Elementary cell
Space group
Forms

: $K[Al Si_3O_8]$ „Kalifeldspat“
: monoclinic
: $a_0 = 8.62 \text{ \AA}$, $b_0 = 12.99 \text{ \AA}$, $c_0 = 7.19 \text{ \AA}$, $\beta = 116.02^\circ$
: C 2/m
: rockforming mineral, xx tabular, prismatic, common twins (Karlsbader, Manebacher, Bavenoer twin law)

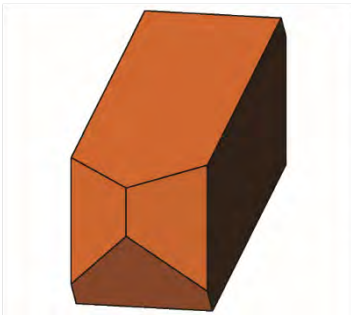
正长石:



棱柱体
轴面体
轴面体



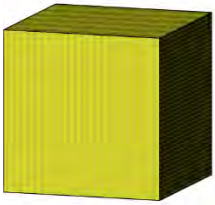
棱柱体
底面轴面体
轴面体
轴面体



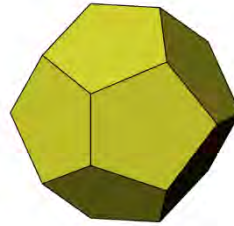
棱柱体
轴面体
底面轴面体
轴面体

化学组成
晶系
晶胞
空间群
形状

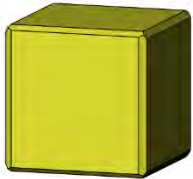
: $\text{K}[\text{AlSi}_3\text{O}_8]$ "钾长石"
: 单斜
: $a_0=8.62 \text{ \AA}$, $b_0=12.99 \text{ \AA}$, $c_0=7.19 \text{ \AA}$, $\beta=116.02^\circ$
: $C 2/m$
: 岩石质矿物, 板状, 棱柱形, 普通孪生
(Karlsbader, Manebacher, Bavenoer孪生定律)

Pyrite:

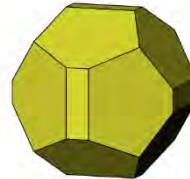
Cube (hexahedron) with
surface stripping



Pentagonal dodecahedron



Pentagonal dodecahedron
Cube (hexahedron)



Pentagonal dodecahedron
Cube (hexahedron)



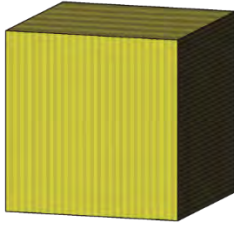
Pentagonal dodecahedron
Octahedron
= "Pseudo-icosahedron"



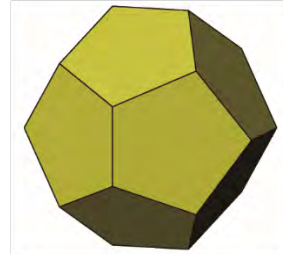
Pentagonal dodecahedron
Octahedron

Chemical composition	: FeS ₂
Crystal system	: cubic Structure; similar to NaCl, S ₂ -barbells parallel (1 1 1)
Elementary cell	: a ₀ = 5.42 Å
Space group	: P a 3
Forms	: massive, disseminated, cubes, (often with plane striations), octahedron, pentagonal dodecahedron

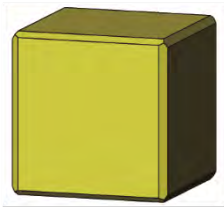
黄铁矿:



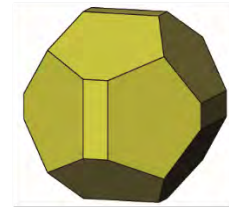
表面带条纹的立方体



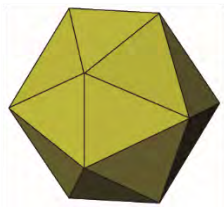
五角十二面体



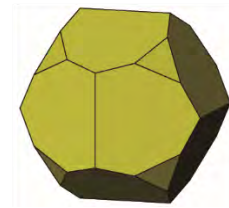
五角十二面体
立方体



五角十二面体
立方体



五角十二面体
八面体
=“伪-二十面体”

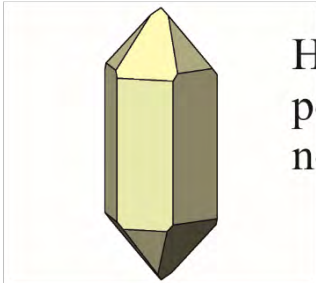


五角十二面体
八面体

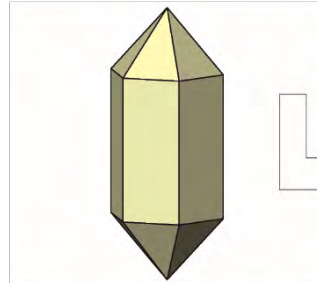
化学组成
晶系
晶胞
空间群
形状

: FeS_2
: 立方结构; 类似于NaCl, S_2 -平行杠铃(111)
: $a_0=5.42\text{\AA}$
: $P a 3$
: 块状, 散发状的立方体 (通常带有平面条纹), 八面体, 五边形十二面体

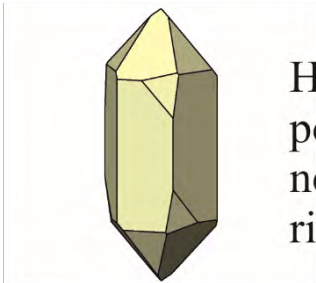
Quartz:



Hexagonal prism
pos. rhombohedron
neg. rhombohedron



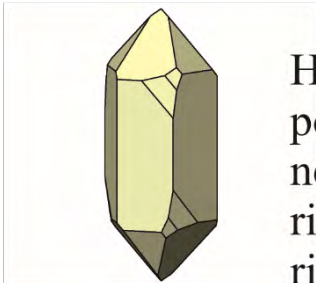
Hexagonal prism
Hex. dipyramid
↳ high quartz!
(other symmetry)



Hexagonal prism
pos. rhombohedron
neg. rhombohedron
right trapezohedron



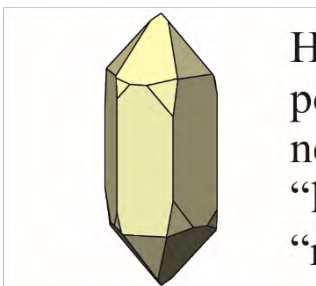
Hexagonal prism
pos. rhombohedron
neg. rhombohedron
left trapezohedron



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



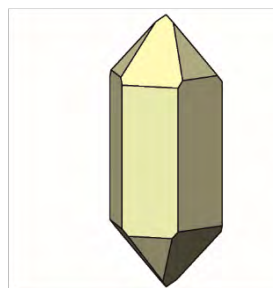
Hexagonal prism
pos. rhombohedron
neg. rhombohedron
left trapezohedron
left dipyramid



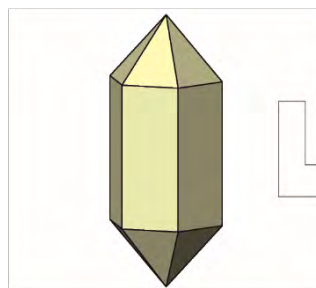
Hexagonal prism
pos. rhombohedron
neg. rhombohedron
“left”
“right” Trapezohedron

Chemical composition	: SiO ₂
Crystal system	: trigonal
Elementary cell	: a ₀ = 4.91 Å, c ₀ = 5.40 Å
Space group	: P 3 ₁ 2 1, P 3 ₂ 2 1
Forms	: massive, nice crystals, partially clear transparent

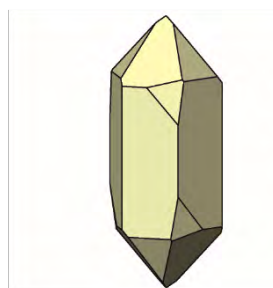
石英：



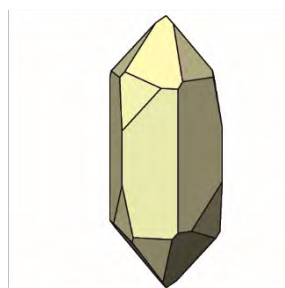
六棱柱
正斜方六面体
负斜方六面体



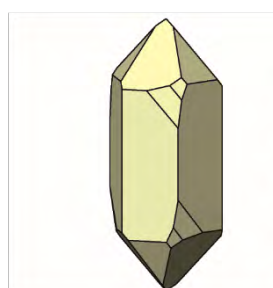
六棱柱
六边双棱锥体
高温石英!
(其他相等)



六棱柱
正斜方六面体
负斜方六面体
右偏方三八面体



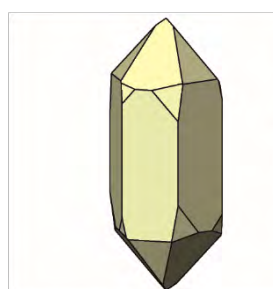
六棱柱
正斜方六面体
负斜方六面体
左偏方三八面体



六棱柱
正斜方六面体
负斜方六面体
右偏方三八面体
右双棱锥体

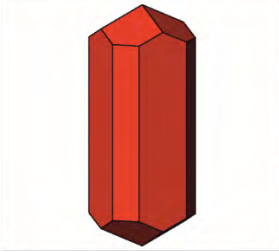


六棱柱
正斜方六面体
负斜方六面体
左偏方三八面体
左双棱锥体

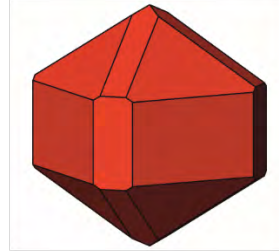


六棱柱
正斜方六面体
负斜方六面体
"左"偏方三八面体
"右"偏方三八面体

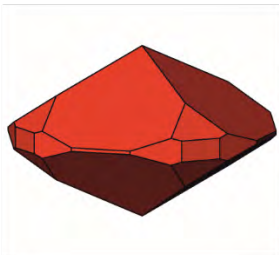
化学组成 : SiO_2
晶系 : 三方
晶胞 : $a_0=4.91 \text{ \AA}, c_0=5.40 \text{ \AA}$
空间群 : $P 3_1 2 1, P 3_2 2 1$
形状 : 块状, 漂亮的晶体结构, 部分透明

Rutile:

Prism
Prism
Dipyramid



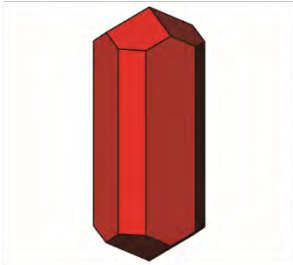
Prism
Prism
Dipyramid
Dipyramid



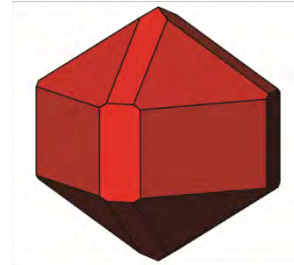
Prism
Prism
Dipyramid
Dipyramid
Ditetragonal prism

Chemical composition	: TiO ₂
Crystal system	: tetragonal
Elementary cell	: a ₀ =4.594Å, c ₀ =2.958Å
Space group	: P 4/ m n m
Forms	: massive, nadelige, columnar, common twins (angle 120°), gratlike aggregates

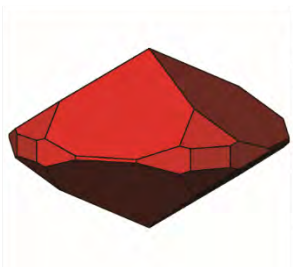
锐钛矿:



棱柱体
棱柱体
双棱锥体



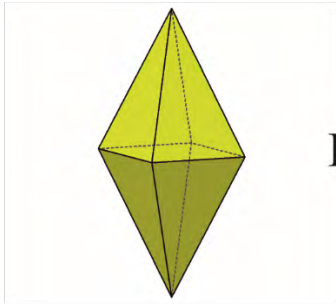
棱柱体
棱柱体
双棱锥体
双棱锥体



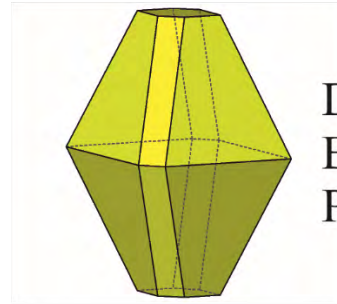
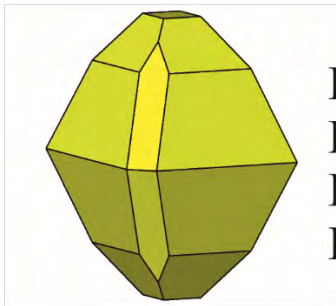
棱柱体
棱柱体
双棱锥体
双棱锥体
复四方棱柱体

化学组成
晶系
晶胞
空间群
形状

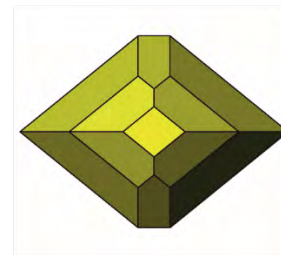
: TiO_2
: 四方
: $a_0=4.594 \text{ \AA}$, $c_0=2.958 \text{ \AA}$
: $P 4/m n m$
: 块状, 针状, 柱状, 普通孪生 (角度 120°),
呈颗粒状聚集体

Sulfur:

Dipyramid

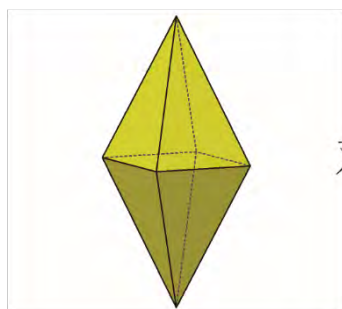
Dipyramid
Bispinacoid
PrismDipyramid
Dipyramid
Bispinacoid
Prism

=

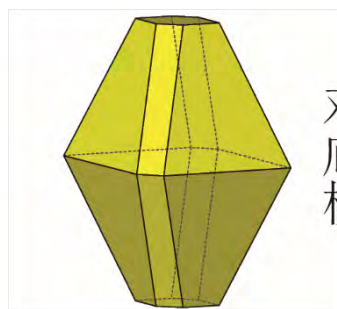
**Headshot**
Dipyramid
Dipyramid
Bispinacoid
Prism

Chemical composition	: S
Crystal system	: orthorhombic
Elementary cell	: $a_0 = 10.45 \text{ \AA}$, $b_0 = 12.85 \text{ \AA}$, $c_0 = 24.46 \text{ \AA}$
Space group	: F ddd
Specials	: up to 95° orthorhombic, ab 95° monoclinic, Melting point $119,2^\circ \text{C}$ Ringlike S_8 -Molecules, between molecules only Van-der-Waalsche Bonding
Forms	: massive, compact, earthy aggregates, pyramidal and sphenoidic xx

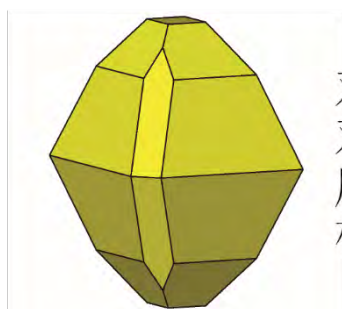
硫磺:



双棱锥体

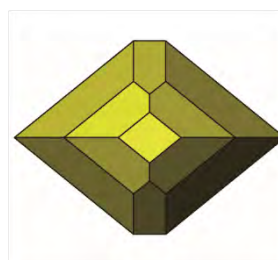


双棱锥体
底面轴面体
棱柱体



双棱锥体
双棱锥体
底面轴面体
棱柱体

=



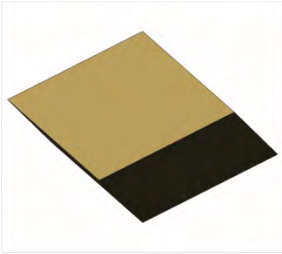
俯视图
双棱锥体
双棱锥体
底面轴面体
棱柱体

化学组成
晶系
晶胞
空间群
特点

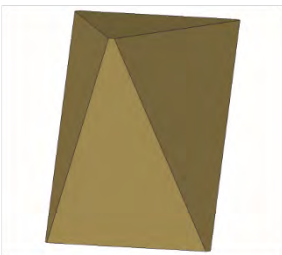
: S
: 正交
: $a_0=10.45 \text{ \AA}$, $b_0=12.85 \text{ \AA}$, $c_0=24.46 \text{ \AA}$,
: F ddd
: 至 95° 正交结构, 95° 时单斜结构
熔点 119.2° C

形状

如S8环状分子, 分子间仅范德华力作用
: 块状, 致密结构, 土状聚集体, 三角锥状, 蝶状

Siderite:

Rhombohedron

Rhombohedron
ScalenohedronRhombohedron
Scalenohedron
Scalenohedron
RhombohedronRhombohedron
BasispinacoidRhombohedron
Basispinacoid
Rhombohedron
Scalenohedron

Chemical composition

: FeCO_3

Crystal system

: trigonal, $-3m$

Elementary cell

: $a_0 = 4.72$, $c_0 = 15.46$

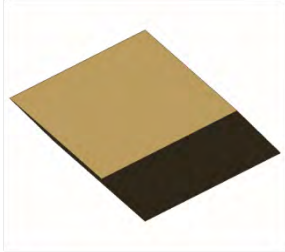
Space group

: $R -3c$

Forms

: Fine granular, spaty, rhomboedric xx

菱铁矿:



斜方六面体



斜方六面体
偏三角面体



斜方六面体
偏三角面体
偏三角面体
斜方六面体



斜方六面体
底面轴面体

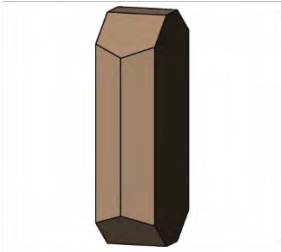


斜方六面体
底面轴面体
斜方六面体
偏三角面体

化学组成
晶系
晶胞
空间群
形状

: FeCO_3
: 三斜, $-3m$
: $a_0=4.72 \text{ \AA}$, $c_0=15.46 \text{ \AA}$
: $R -3c$
: 细颗粒状, 稀疏状, 菱形

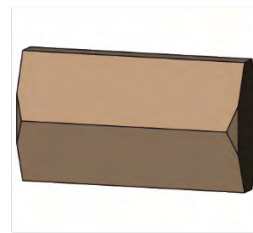
Staurolite:



Prism
Basispinacoid
Pinacoid
Prism



Prism
Basispinacoid
Pinacoid
Prism

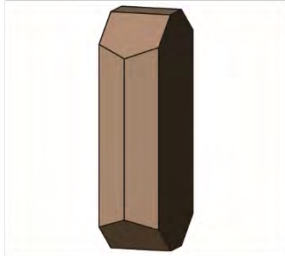


Prism
Basispinacoid
Pinacoid
Prism

Chemical composition
Crystal system
Elementary cell
Space group
Forms

: Staurolite $(\text{Fe,Mg})_2\text{Al}_9(\text{Si,Al})_4\text{O}_{20}(\text{O,OH})_2$
: monoclinic
: $a_0 = 7.863 \text{ \AA}$, $b_0 = 16.61 \text{ \AA}$, $c_0 = 5.65 \text{ \AA}$, $\beta = 90-93^\circ$
: C 2/m
: Rock forming mineral, xx tabular, prismatic, common

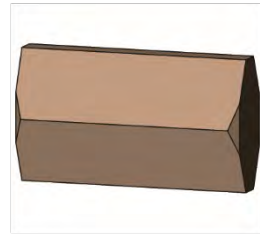
十字石:



棱柱体
底面轴面体
轴面体
棱柱体



棱柱体
底面轴面体
轴面体
棱柱体



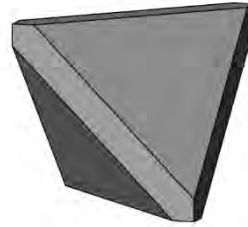
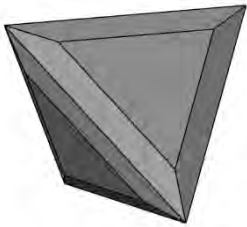
棱柱体
底面轴面体
轴面体
棱柱体

化学组成
晶系
晶胞
空间群
形状

: 十字石 $(\text{Fe, Mg})_2\text{Al}_9(\text{Si, Al})_4\text{O}_{20}(\text{O, OH})_2$
 : 单斜
 : $a_0=7.863 \text{ \AA}, b_0=16.61 \text{ \AA}, c_0=5.65 \text{ \AA}, \beta=90.93^\circ$
 : $C 2/m$
 : 岩石质矿物, 板状, 棱柱形, 常见

Tetraedrite:

Tetrahedron

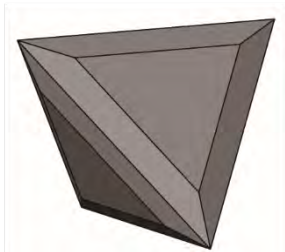
Tetrahedron
HexahedronTetrahedron
TristetrahedronTetrahedron
Tristetrahedron
Rhombohedron

Chemical composition	: $\text{Cu}_{12}\text{Sb}_4\text{S}_{13}$, z. T. with Ag-, Hg, Zn-Content
Crystal system	: cubic
Elementary cell	: $a_0=10.36 \text{ \AA}$
Space group	: $I-43m$
Forms	: massive, tetraedr. Forms, with calcite, quartz , intergrown

黝铜矿：



四面体

四面体
六面体四面体
三四面体四面体
三四面体
斜方六面体

化学组成

: $\text{Cu}_{12}\text{Sb}_4\text{S}_{13}$, 含Ag, Hg, Zn 掺杂

晶系

: 立方

晶胞

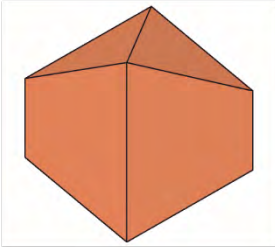
: $a_0=10.36\text{\AA}$

空间群

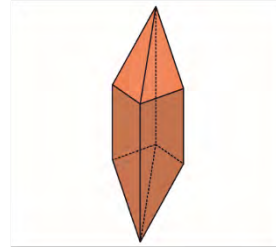
: $I-43m$

形状

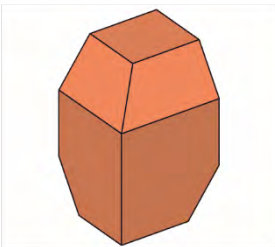
: 块状，四面体。常与方解石，石英掺杂。

Titanite:

Prism
Prism



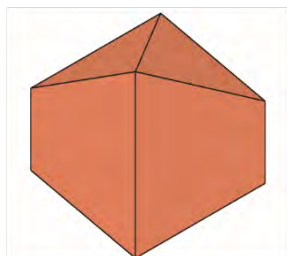
Prism
Prism



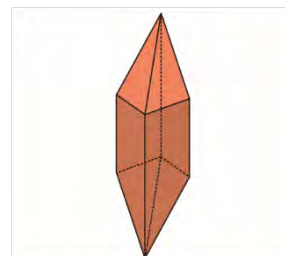
Prism
Basispinacoid
Prism

Chemical composition	: CaTi [O / SiO ₄]
Crystal system	: monoclinic
Elementary cell	: a ₀ =7.06Å, b ₀ =8,71 Å, c ₀ =6.56Å, β =113.8 °
Space group	: P2 ₁ /a
Forms	: disseminated, xx often envelope shape, columnar, tabular

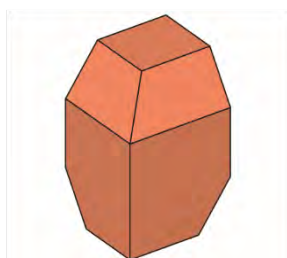
榧石:



棱柱体
棱柱体



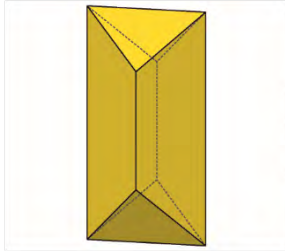
棱柱体
棱柱体



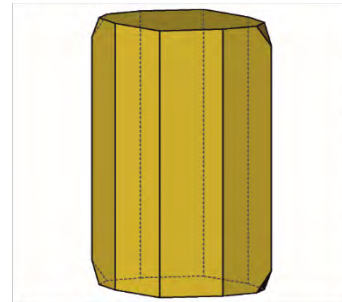
棱柱体
底面轴面体
棱柱体

化学组成
晶系
晶胞
空间群
形状

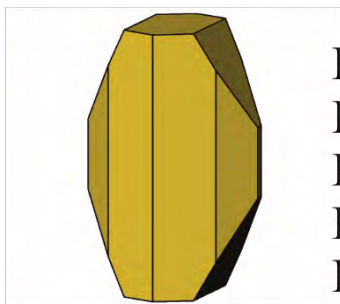
: $\text{CaTi}[\text{O}/\text{SiO}_4]$
: 单斜
: $a_0=7.06 \text{ \AA}$, $b_0=8.71 \text{ \AA}$, $c_0=6.56 \text{ \AA}$, $\beta=113.8^\circ$
: $P 2_1/a$
: 散发状, 通常为信封形状, 柱状, 板状

Topaz:

Prism
Basispinacoid

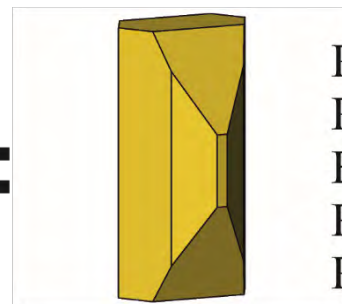


Prism
Prism
Basispinacoid
Prism



Prism
Prism
Basispinacoid
Prism
Pinacoid

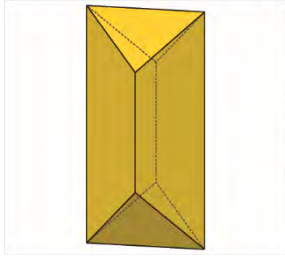
=



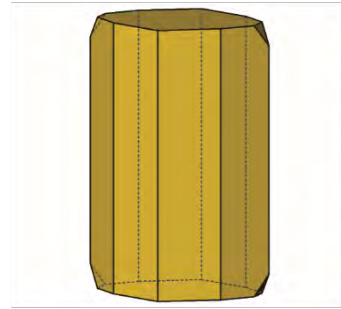
Prism
Prism
Basispinacoid
Prism
Pinacoid

Chemical composition	: $\text{Al}_2 [\text{F}_2 / \text{SiO}_4]$
Crystal system	: orthorhombic
Elementary cell	: $a_0 = 4.65 \text{ \AA}$, $b_0 = 8.8 \text{ \AA}$, $c_0 = 8.4 \text{ \AA}$
Space group	: $P b n m$
Forms	: grains, xx columnar, prismatic, chisel forms

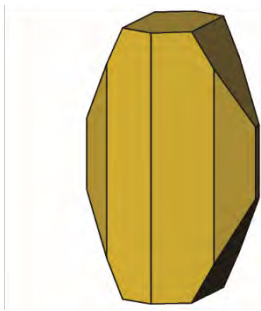
黄玉:



六棱柱体
底面轴面体

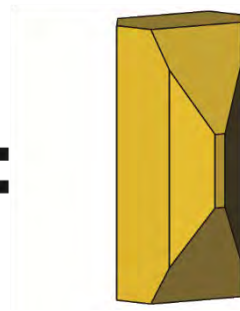


棱柱体
棱柱体
底面轴面体
棱柱体



棱柱体
棱柱体
底面轴面体
棱柱体
轴面体

=



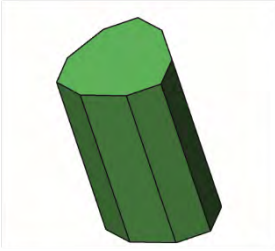
棱柱体
棱柱体
底面轴面体
棱柱体
轴面体

化学组成
晶系
晶胞
空间群
形状

: $Al_2[F_2/SiO_4]$
: 正交
: $a_0=4.65 \text{ \AA}, b_0=8.8 \text{ \AA}, c_0=8.4 \text{ \AA}$
: $Pbnm$
: 颗粒状, 柱状, 棱柱形, 凿形

Tourmaline:

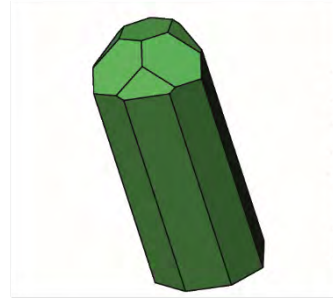
various heads:



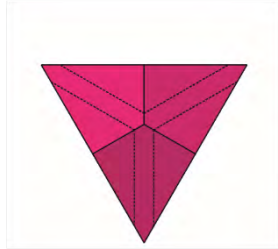
Basispedia
Trigonal prism
Hexagonal prism



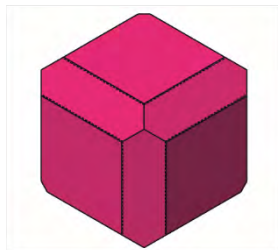
Pyramid
Pyramid
Trigonal prism
Hexagonal prism



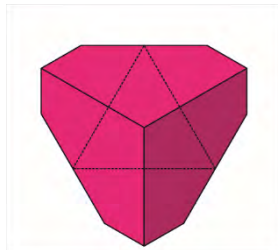
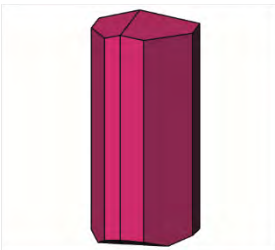
Pyramid
Pyramid
Trigonal prism
Hexagonal prism



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, polar c-Axes

Elementary cell

: $a_0 = 15.92 \text{ \AA}$, $c_0 = 7.19 \text{ \AA}$

Space group

: R 3 m

Forms

: Columnar, needles, radial, perfect columnar, needles, radial

电气石:

不同顶面:



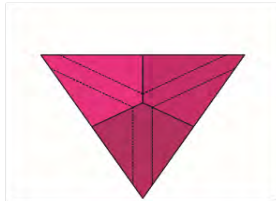
底面单面体
三棱柱体
六棱柱体



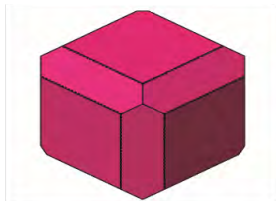
棱锥体
棱锥体
三棱柱体
六棱柱体



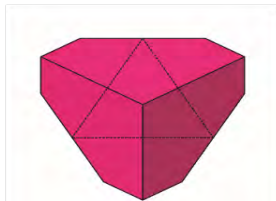
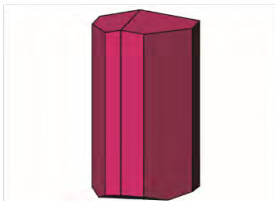
棱锥体
棱锥体
三棱柱体
六棱柱体



棱锥体
三棱柱体
棱锥体
棱锥体

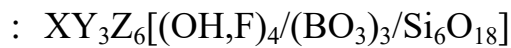


棱锥体
棱锥体
三棱柱体
棱锥体
棱锥体



棱锥体
三棱柱体
六棱锥体
棱锥体
底面单面体

化学组成



X:Na, Ca;

Y:Mg, Li, Fe, Mn, Al;

Z:Al, Fe, Cr

晶系

: 三方, 极轴-c

晶胞

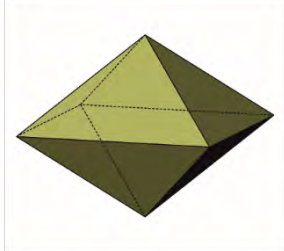
: $a_0=15.92 \text{ \AA}$, $c_0=7.19 \text{ \AA}$

空间群

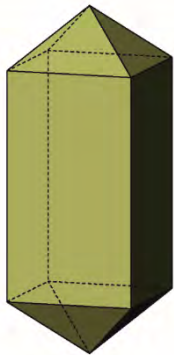
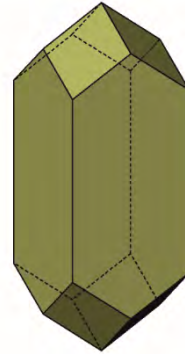
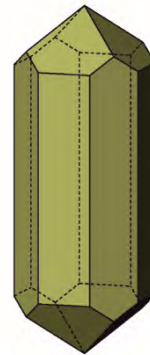
: R 3 m

形状

: 柱状, 针状, 放射状

Zircon:

Dipyramid

Dipyramid
and prism
II. positionDipyramid
and prism
I. positionDipyramid
Prism I. pos.
Prism II. pos.

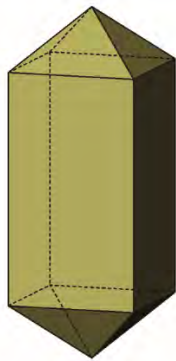
Chemical composition
Crystal system
Elementary cell
Space group
Forms

: $Zr[SiO_4]$, contains diadochic Hf, REE
: tetragonal
: $a_0 = 6.60 \text{ \AA}$, $c_0 = 5.98 \text{ \AA}$
: $I 4_1/a m d$
: grains, common idiomorphic xx, short columnar,
prismatic

锆石:



双棱锥体



双棱锥体
和
棱柱体 II



双棱锥体
和
棱柱体 I



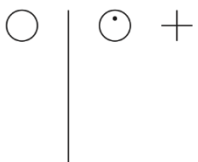
双棱锥体
棱柱体 I
棱柱体 II

化学组成
晶系
晶胞
空间群
形状

: $\text{Zr}[\text{SiO}_4]$, 包含重金属Hf, REE
: 四方
: $a_0=6.60 \text{ \AA}$, $c_0=5.98 \text{ \AA}$
: $I 4_1/a m d$
: 粒状, 短柱状, 棱柱形

Symbolism of symmetry planes

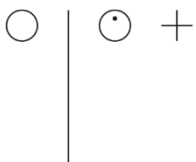
Symmetry-operation	Symbol	vertical lto drawing plane	parallel	remarks
mirror plane	m			when mirror plane is above drawing plane, the height is given in fractions of the lattice parameter $\frac{1}{4}$ = mirror plane lies in $\frac{1}{4}$ above the drawing plane in elementary cell
Glide plane, axial	a, b			Glide plane in $\frac{\bar{a}}{2} \parallel a$ -axis $\frac{\bar{b}}{2} \parallel b$ -axis $\frac{\bar{c}}{2} \parallel c$ -axis when glide plane is above drawing plane the height is given in fractions of the lattice parameters
	c		keines	
Glide plane, diagonal	n			$\frac{\bar{t}}{2} (\bar{a}+\bar{b})/2 \parallel (001)$ $\frac{\bar{t}}{2} (\bar{a}+\bar{c})/2 \parallel (010)$ $\frac{\bar{t}}{2} (\bar{b}+\bar{c})/2 \parallel (100)$ in tetragonal and cubic case $\frac{\bar{t}}{2} (\bar{a}+\bar{b}+\bar{c})/2 \parallel (111)$
Diamond-glide-plane	d			$\frac{\bar{t}}{4} (\bar{a}+\bar{b})/4$ $\frac{\bar{t}}{4} (\bar{a}+\bar{c})/4$ $\frac{\bar{t}}{4} (\bar{b}+\bar{c})/4$ in tetragonal and cubic case $\frac{\bar{t}}{4} (\bar{a}+\bar{b}+\bar{c})/4$



Effect of mirrorplane \perp to the projection plane:
Original- and image point are separated by commas. The position of the projection plane is given by + (above) or - (below).

对称平面符号

对称轴操作	符号	水平	平行	备注
镜面	m			当镜面高于绘图面时，高度为晶格参数的1/4，即镜面位于绘图面上方晶胞参数的1/4处
滑移面 轴向	a, b			当滑移面为 $\frac{a}{2} \parallel a$ 轴 $\frac{b}{2} \parallel b$ 轴 $\frac{c}{2} \parallel c$ 轴 当滑移面高于绘图面时，滑移距离小于一个晶胞参数
	c		无	
滑移面 对角线	n			$\bar{t}(\bar{a}+\bar{b})/2 \parallel (001)$ $\bar{t}(\bar{a}+\bar{c})/2 \parallel (010)$ $\bar{t}(\bar{b}+\bar{c})/2 \parallel (100)$ 在四方和立方体中 $\bar{t}(\bar{a}+\bar{b}+\bar{c})/2 \parallel (111)$
金刚石类 滑移面	d			$\bar{t}(\bar{a}+\bar{b})/4$ $\bar{t}(\bar{a}+\bar{c})/4$ $\bar{t}(\bar{b}+\bar{c})/4$ 在四方和立方体中 $\bar{t}(\bar{a}+\bar{b}+\bar{c})/4$



当镜面垂直于投影面时：

原点和投影点以逗号区分，投影面的位置以+代表高于；-代表低于。

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

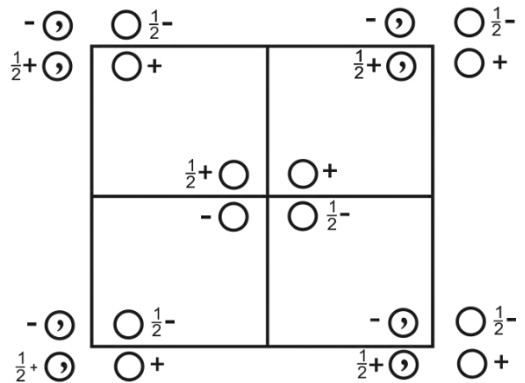
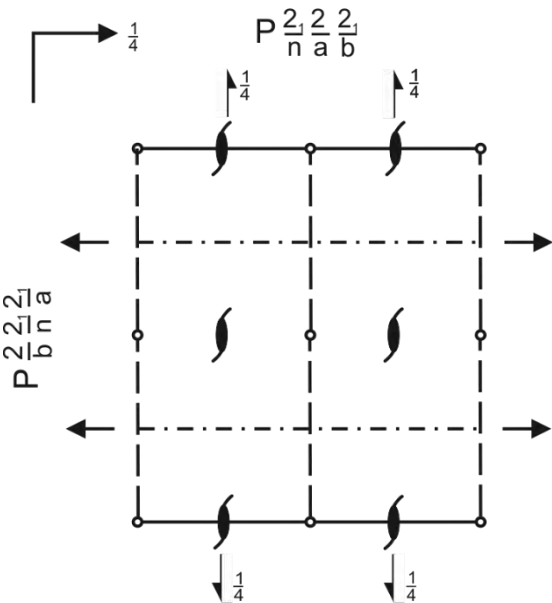
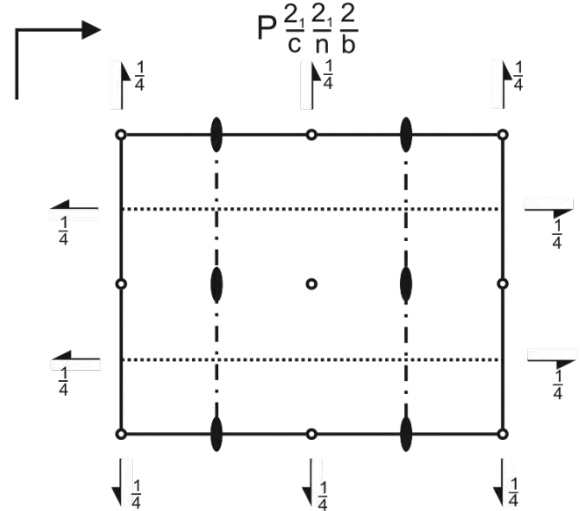
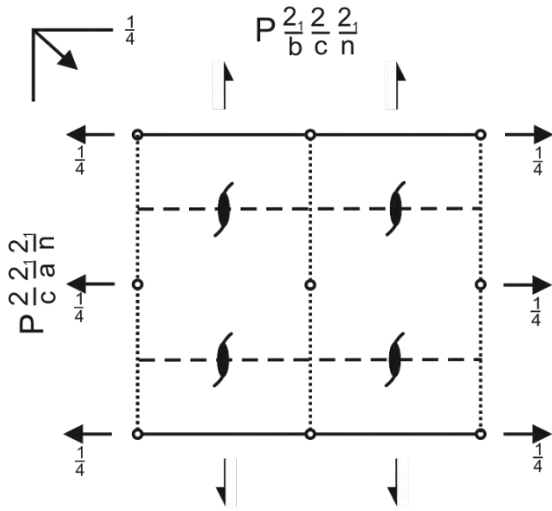
对称轴符号

对称轴	符号	图像符号	以右手为对称轴的对称操作演示
对称轴	1		无
中心反转轴	$\bar{1}$		无
2次轴-旋转	2		无
2次轴-螺旋	2_1		1/2
3次轴-旋转	3		无
3次轴-螺旋	3_1		1/3
	3_2		2/3
3次轴-反转轴	$\bar{3}$		无
4次轴-旋转	4		无
4次轴-螺旋	4_1		1/4
	4_2		1/2
	4_3		3/4
4次轴-反转轴	$\bar{4}$		无
6次轴-旋转	6		无
6次轴-螺旋	6_1		1/6
	6_2		2/6
	6_3		3/6
	6_4		4/6
	6_5		5/6
6次轴-反转轴	$\bar{6}$		无

Example of a space group **Pbcn**

Pbcn D_{2h}^{14} mmm
 $P 2_1/b 2/c 2_1/n$

Orthorhombic crystal system
 Patterson symmetry Pmmm



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

Asymmetric unit $0 \leq x \leq 1/2$ $0 \leq y \leq 1/2$ $0 \leq z \leq 1/2$

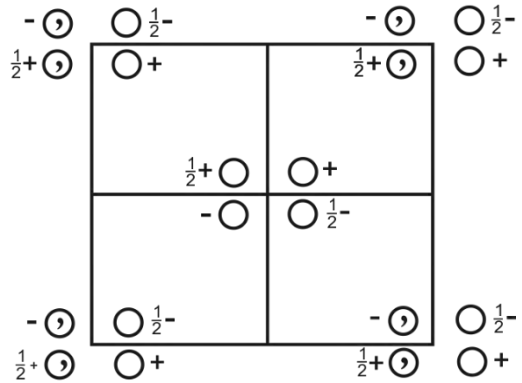
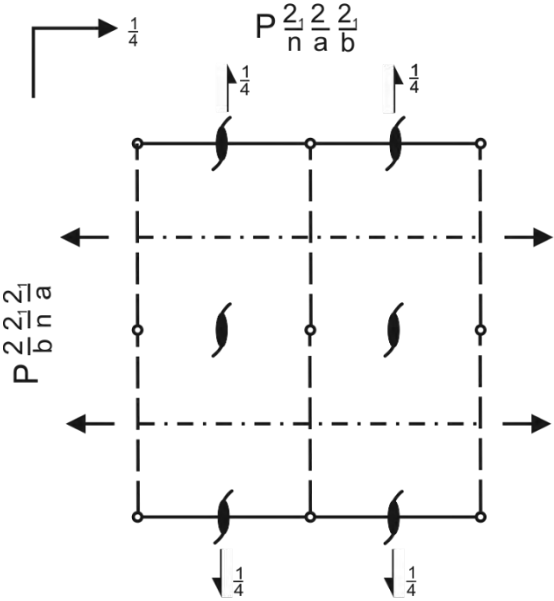
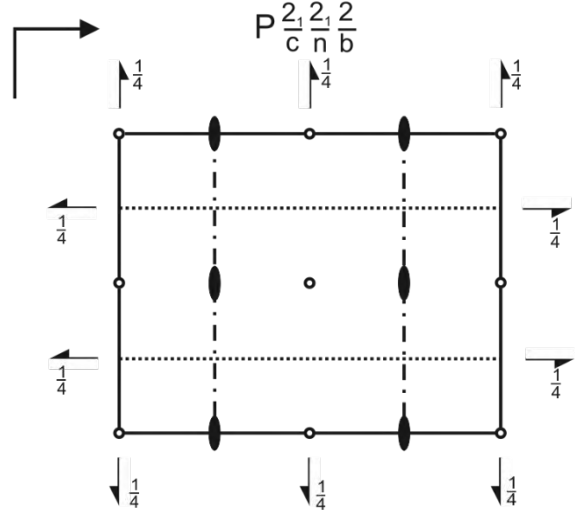
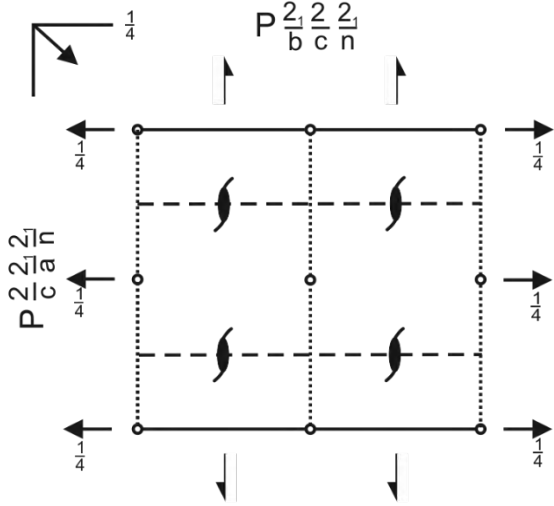
Symmetry operations

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

空间群 **Pbcn** 举例

Pbcn D_{2h}^{14} mmm
 $P 2_1/b 2_1/c 2_1/n$

正交晶系
 Patterson 对称 pmmm



初始 at $\bar{1}$ in 1 c 1

不对称单元 $0 \leq x \leq \frac{1}{2} \quad 0 \leq y \leq \frac{1}{2} \quad 0 \leq z \leq \frac{1}{2}$

对称操作

- | | | |
|--|--|--|
| (1) 1 | (2) $2(0,0,\frac{1}{2}) \quad \frac{1}{4},\frac{1}{4},z$ | (3) $2 \ 0,y,\frac{1}{4}$ |
| (4) $2(\frac{1}{2},0,0) \ x,\frac{1}{4},0$ | (5) $\bar{1} \ 0,0,0$ | (6) $n(\frac{1}{2},\frac{1}{2},0) \ x,y,\frac{1}{4}$ |
| (7) $c \ x,0,z$ | (8) $b \ \frac{1}{4},y,z$ | |

The 230 space groups

Crystal system	Point group	Space group					
triclinic	1	P1					
	-1	P1					
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 ₁ 2 ₁ 2	P2 ₁ 2 ₁ 2 ₁		
	mm2	C222 ₁	C222	F222	I222		
		I2 ₁ 2 ₁ 2 ₁					
		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		
	Pmnm		Pbcn	Pbca	Pnma		
	Cmcm		Cmca	Cmmm	Cccm		
	Cmma		Ccca	Fmmm	Fddd		
	Immm		Ibam	Ibca	Imma		
	P4		P4 ₁	P4 ₂	P4 ₃		
	tetragonal		4	I4	I4 ₁		
			P-4	I-4			
		-4	P4/m	P4 ₂ m	P4/n	P4 ₂ /n	
4/m		I4/m	I4 ₁ /a				
422		P422	P4 ₂ 2	P4 ₁ 22	P4 ₁ 2 ₁ 2		
		P4 ₂ 22	P4 ₂ 2 ₁ 2	P4 ₃ 22	P4 ₃ 2 ₁ 2		
4mm		I422	I4 ₁ 22				
		P4mm	P4bm	P4 ₂ cm	P4 ₂ nm		
		P4cc	P4nc	P4 ₂ mc	P4 ₂ bc		
		I4mm	I4cm	I4 ₁ md	I4 ₁ cd		
		-42m	P-42m	P-42c	P-42 ₁ m	P-42 ₁ c	
			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 ₁ /mcm	I4 ₁ /amd	I4 ₁ /acd			
trigonal	3	P3	P3 ₁	P3 ₂	R3		
	-3	P-3	R-3				
	32	P312	P321	P3 ₁ 12	P3 ₁ 21		
		P3 ₂ 12	P3 ₂ 21	R32			
		P3m1	P31m	P3c1	P31c		
	3m	R3m	R3c				
		P-31m	P-31c	P-3m1	P-3c1		
-3m	R-3m	R-3c					
hexagonal	6	P6	P6 ₁	P6 ₅	P6 ₂		
	-6	P6 ₄	P6 ₃				
		P-6					
	6/m	P6/m	P6 ₃ /m				
	622	P622	P6 ₁ 22	P6 ₅ 22	P6 ₂ 22		
		P6 ₄ 22	P6 ₃ 22				
	6mm	P6mm	P6cc	P6 ₃ cm	P6 ₃ mc		
	-6m2	P-6m2	P-6c2	P-62m	P-62c		
6/mmm	P6/mmm	P6/mcc	P6 ₃ /mm	P6 ₃ /mmc			
Cubic	23	P23	F23	I23	P2 ₁ 3		
	m-3	I2 ₁ 3					
		Pm-3	Pn-3	Fm-3	Fd-3		
		Im-3	Pa-3	Ia-3			
	432	P432	P4 ₂ 32	F432	F4 ₁ 32		
		I432	P4 ₃ 32	P4 ₁ 32	I4 ₁ 32		
	-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					

230个空间群

晶系	点群	空间群				
三斜	1	P1				
	-1	P1				
单斜	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			
正交	222	P222	P222 ₁	P2 ₁ 2 ₁ 2	P2 ₁ 2 ₁ 2 ₁	
		C222 ₁	C222	F222	I222	
		I2 ₁ 2 ₁ 2 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	Pnmn	
	Pmnn		Pbcn	Pbca	Pnma	
	Cmcm		Cmca	Cmmm	Cccm	
	Cmma		Ccca	Fmmm	Fddd	
	Immm		Ibam	Ibca	Imma	
	4		P4	P4 ₁	P4 ₂	P4 ₃
			I4	I4 ₁		
	-4		P-4	I-4		
			P4/m	P4 ₂ m	P4/n	P4 ₂ /n
	4/m		I4/m	I4 ₁ /a		
		P422	P4 ₂ 12	P4 ₁ 22	P4 ₁ 2 ₁ 2	
	422	P4 ₂ 22	P4 ₂ 2 ₁ 2	P4 ₃ 22	P4 ₃ 2 ₁ 2	
		I422	I4 ₁ 22			
	4mm	P4mm	P4bm	P4 ₂ cm	P4 ₂ nm	
		P4cc	P4nc	P4 ₂ mc	P4 ₂ bc	
		I4mm	I4cm	I4 ₁ md	I4 ₁ cd	
		-42m	P-42m	P-42c	P-42 ₁ m	P-42 ₁ c
	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 /nmm		
P4 ₂ /mbc		P4 ₂ /mnm	P4 ₂ /nmc	P4 ₂ /ncm		
I4/mmm		I4/mcm	I4 ₁ /amd	I4 ₁ /acd		
三方	3	P3	P3 ₁	P3 ₂	R3	
	-3	P-3	R-3			
	32	P312	P321	P3 ₁ 12	P3 ₁ 21	
		P3 ₂ 12	P3 ₂ 21	R32		
	3m	P3m1	P31m	P3c1	P31c	
		R3m	R3c			
-3m	P-31m	P-31c	P-3m1	P-3c1		
	R-3m	R-3c				
六方	6	P6	P6 ₁	P6 ₅	P6 ₂	
	-6	P6 ₄	P6 ₃			
		P-6				
	6/m	P6/m	P6 ₃ /m			
	622	P622	P6 ₁ 22	P6 ₅ 22	P6 ₂ 22	
		P6 ₄ 22	P6 ₃ 22			
	6mm	P6mm	P6cc	P6 ₃ cm	P6 ₃ mc	
	-6m2	P-6m2	P-6c2	P-62m	P-62c	
6/mmm		P6/mmm	P6/mcc	P6 ₃ /mm	P6 ₃ /mmc	
立方	23	P23	F23	I23	P2 ₁ 3	
	m-3	I2 ₁ 3				
		Pm-3	Pn-3	Fm-3	Fd-3	
		Im-3	Pa-3	Ia-3		
	432	P432	P4 ₃ 2	F432	F4 ₁ 32	
		I432	P4 ₃ 32	P4 ₁ 32	I4 ₁ 32	
	-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				

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