Outline of Classical and Current Approaches to the Research of Morphology of Selected Mineral Crystals in China (CD-ROM)

WANG Wenkui, ZHAO Shanrong, LEI Xinrong and WU Youcai

China University of Geosciences, Wuhan 430074, Hubei

Abstract The research on morphology of mineral crystals in China includes classical goniometry of 100 minerals such as hsianghualite, orthobrannerite, jamesonite and bertrandite and surface microtopography of 20 minerals such as wolframite and diamond, among which 5 new minerals and 34 uranium minerals were discovered and measured by Chinese mineralogists. These have enriched mineralogy and crystal morphology and strengthened the study of information of morphological genesis.

Key words: Chinese mineral, crystal morphology, classic goniometry

1 Introduction

In the latter half of the 20th century, China had leapt over a period equivalent to 200 years of world's development course in the study of morphology of mineral crystals and during this period studies of classical goniometry of 100 minerals, such as hsianghualite, orthobrannerite, jamesonite and bertrandite and surface microtopography of 20 minerals, such as wolframite and diamond, have been done. The former was conducted in terms of the method developed by V. Goldschmidt, while the latter by recent optical and electric microscopes. These studies have been done mainly by Peng Zhizhong, late professor of China University of Geosciences, and his colleagues.

The morphology of 5 new mineral species as hsianghualite and orthobrannerite and 20 known minerals as jamesonite and boulangerite is new to the world. Moreover, relevant study revealed that hsianghualite belongs to the isometric tetartoidal class with a complex form composed of 25 simple forms of 7 types, thus serving as the best representative of natural minerals of this class. The evolution series of aegirine forms and the goniometry of 34 uranium minerals are also valuable.

Various screw patterns of wolframite indicate the significant role of the spiral growth mechanism in natural hydrothermal crystallization and depict the structural feature of mosaic spiral blocks in crystals as well as the sequence of growing and diminishing of crystal faces during crystallization.

Since the early 1980s, crystal morphology (involving surface microtopography) has been introduced as a complement course in classroom teaching in China University of Geosciences (Wuhan) and established a laboratory equipped mainly with the STOE goniometer and Nikon DIC microscope. Presently, papers studying the morphology of wolframite, aegirine and heulandite and both natural and artificial diamonds have been published. The rough non-molecular growth spiral on (001) of arfvedsonite and (111) of zircon indicate the spiral growth mechanism of fine-grained adsorption on the hydrothermal solid-liquid interface at the late water-enrichment stage of silicate melts and it is also seen from the spiral pattern that crystals grow along the main symmetrical axis. Such growth mode is even more notable in the crystallization of wolframite. In addition, mainly quadrilateral outlines are formed on the faces of garnet crystals with minute particles of {110}+{hkk} regularly arranged in the interior, exhibiting spiral or concentric forms. {100} cannot construct smooth faces due to particular crystal structures and growth dynamics.

2 Contents of the CD-ROM

(1) Introduction
(2) Minerals of native elements
  Diamond (natural and artificial)
  Gold
  Bismuth
  Osmium
(3) Sulfides
  Pyrites (natural and artificial)
  Cinnabar
  Realgar
  Orpiment
  Stibnite
  Arsenopyrite
  *Omeiite
  Bournonite
  Jamesonite
(4) Oxides
  *Pengzhizhongite
  *Orthobrannerite
(5) Silicates
  Zircon
  Topaz
  Garnet
  Visuvianite
  Beryl
  Aegirine
  Arfvedsonite
  Bertrandite
  Hydroxyappophyllite
  Feldspar
  *Hsianghualite
  Heulandite
(6) Other oxygen salt minerals
  Mn-tantalite
  Wolframite
  Wulfenite
  Vanadinite-Mimetite
  Celestite-Chrysanthemum stone
  Cerussite
  *Xitieshanite
(7) Artificial crystals
  LBO (LiB_3O_5)
  KTP ($KTiOPO_4$)
  Y, Ba, Cu, O super-conductor
(8) Uranium Minerals (34)

Conclusion
References

Note: * denotes minerals newly discovered by Chinese mineralogists.

3 Examples of Selected Species

Hsianghualite The first new mineral discovered by the Chinese mineralogist (Huang, 1958): isometric, tetartoidal class ($3L^24L^3$, 23), space group T_5-$I2_13$, $Ca_3Li_2[BeSiO_4]_3F_2$, occurring in white Be-bearing perthitic rocks in the contact zone between Devonian limestone and Mesozoic granite. Crystals appear as two types: one is milk white in colour, 5–7 mm in length, formed only by n{211} and d{110}; the other is colorless, transparent, 0.2–2 mm in length with complex crystal form that is composed of totally 25 simple forms of all 7 types of this class (Peng, 1964). Crystal faces of the ideal form might up to 290 in number. It is the best representative species of natural minerals in this class.

Jamesonite (Niu and Wang, 1986) It is usually fibrous and well-developed crystals are very rare. Since 1825 when it was discovered, no complete crystals have been reported except two simple top-view figures by Miller in 1852 and Slavik in 1914, which were introduced by Goldschmidt (1918). Some perfect short prismatic jamesonite crystals (2–5 mm) are found in a large quantity of fibrous jamesonite in the Dachang cassiterite-sulfide deposit in Guangxi and fairly good pictures of both practical and ideal crystals were drawn based on the measurement by the method proposed by V. Goldschmidt, which filled the gap in the drawing of jamesonite crystals.

Aegirine (Wang et al., 1990; Zhao and Wang, 1990) Numerous beautiful aegirine crystals occur in the Mesozoic miarolitic granite. The goniometrical study of 70 crystals points out that they are usually eucentric prisms composed of d{131} and g{692} simple forms, from pupa-like prismatic to simple prismatic forms with flat end faces. Other typical forms are closing twins and twins with reentrant angle. These forms are also very beautiful. This series of aegirine morphs greatly enriches the research report completed by V. Goldschmidt in 1922.

Orthobrannerite (Zhao Fengmin et al., 1998) This is a new mineral, $(U^{6+}_{0.5}, U^{4+}_{0.5})Ti_2O_6(OH)$, discovered in biotite-augite syenite in Yunnan Province in 1976. Cell parameters: a:b:c=0.632:1:0.543; linear axial ratio: a:b:c=0.653:1:0.5495. the prismatic crystals are composed mainly of f {021} and I{120} and there are striations on prismatic faces parallel to axis c. Professor Zhang measured 34 varieties of uranium mineral forms existing in China and conducted relevant studies.

Wolframite (Wang et al., 1992) A great number of beautiful wolframite crystals occur in some famous hydrothermal W-Sn deposits in southern China. They appear usually as druses of different sizes, 1 mm–30 cm, in quartz veins. Wolframite occurring in the Doloshan W-deposit are tabular crystals parallel to {100} and the end faces are mainly (102), (121), (001) and (011). Twins on (100) are very common and sometimes single crystals may show two opposite end faces. According to statistics, the descending order of morphological importance of faces is (100)–(110)–(010)–(102)–(121)–($\bar{1}$21)–(001)–(011)–(111)

Clear DIC figures, especially on (010) and (102), show characteristics of spiral growth mechanism in hypothermal solutions and the growth versus diminishing sequence of different faces. The form {102} on the top end of the prism is the index face of wolframite.

In the main quartz vein of the deposit, wolframite distributes vertically from the ground surface, 400 m below the surface, downwards to the top of the mother rock, i.e. biotite granite boss. In the upper part, wolframite appears usually as large simple prismatic crystals with rough surfaces, up to 30 cm in size sometimes and associate mainly with oxides such as cassiterite and scheelite. In the lower part, the crystals become smaller and more complex in form with shinning surfaces and they are associated mainly with Pb-Zn sulfides, pyrite etc. Abundant information about crystal growth is contained in the (102) and (010) faces of wolframite.

Beryl (Yu et al., 1996) It usually occurs as hexagonal prisms. Beryl crystals discovered in granite pegmatite in Sichuan Province are tabular in form and many of them are colourless and transparent, belonging to the gem class. Their diameter are 1–10 cm and the thickness is 1–2 cm. Commonly, it is composed of $c\{0001\}$, $m\{10\bar{1}0\}$, $a\{11\bar{2}1\}$, $p\{10\bar{1}1\}$, $n\{31\bar{4}1\}$, and $v\{2\bar{1}31\}$. The faces of most simple forms show beautiful growth patterns, such as spirals and symmetrical hillocks, indicating their structural and growth condition.

Super-conductor crystals of Y, Ba, Cu and O In 1987, Prof. Shen Jinchuan of China University of Geosciences (Wuhan) synthesized a superconducting crystal: $YBa_2Cu_3O_{6.67}$, belonging the orthorhombic system: $a_0$3.823 nm, $b_0$3.8745 nm, $c_0$11.6721 nm. Zero resistance temperature>91°K. Crossed twining parallel to {110} could be seen clearly on (001) under the reflection differential interference microscope.

Functional mineral—bertrandite (Peng et al., 1961; Wang et al., 1994) Crystals of bertrandite occurring in typical hypothermal wolframite quartz-vein deposit in Hunan Province show high piezoelectricity (2.4×10^{-12} CN^{-1}) and high thermal electricity. It is a photoelectric mineral material of practical significance.

Chrysanthemum stone A radiographic aggregate like chrysanthemum. Traditionally it was considered to be composed of andalusite aggregate. This paper, however, deals with the chrysanthemum stone composed of Celestite or calcite radiographic aggregate occurring in Permian sedimentary marl in Hunan, Guangxi, Jiangxi and Hubei. It has been used as a raw material for handicrafts for over 100 years in China, but studied in detail only in recent years. This chrysanthemum stone has various forms. The ratio of nuclear diameter to the length of petal may serve as an index of its growth environment (Zhao Shanrong et al., 1998). Its growth shows fractal characteristics and the fractal dimension (FD) is $1\leq f\leq \ln\alpha/\ln 2\beta$ ($\beta\geq1$, related to growth conditions) (Zhao Shanrong et al., 1999).

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About the first author

Wang Wenkui Born in 1925; graduated from Department of Geology, Peking University in 1948. He worked as teaching assistant, lecturer and associate professor in Beijing College of Geology since 1952. Prof. Wang works now in China University of Geosciences (Wuhan) and has long been engaged in teaching and research work in mineralogy. E-mail: dxb@dns.cug.edu.cn