Linne's Mineralogie und Kristallographie - erschienen in: "De Crystallorum Generatione" 1747

On Linnaeus's Mineralogy and Crystallography - in "De Crystallorum Generatione" 1747

Von / by

Toshio KUTSUKAKE [205]

mit 2 Abb. / with 2 Fig.

Schlüsselworte:

KÄHLER Martinus
Kristallographie
LINNAEUS, Carolus ("Carl VON LINNÉ")
Mineralogie (Geschichte)
Mineralreich

Abstract:

This small article is of Martinus KÄHLER's thesis supervised by Prof. LINNAEUS at Uppsala. However, its main part schould have been written by LINNAEUS, so his idea on mineral and crystal systematics is inferable. This booklet, 15.5 cm x 19.5 cm in size, contains 40 pages, of which 30 pages are texts, and one folded plate of the illustrations of mineral-crystals. The texts consists of Introduction and five chapters. Introduction describes the objectives of mineral-crystal study: to inquire their genesis through the examination of morphology and physical properties.

Ch.I is adapted to the etymology and definition of *"crystals"*.

Ch.II: On the genesis of minerals by the impregnation of exhalations in the rocks.

Ch.III: All minerals are composed of "salts" (elements), and their crystallization takes five types of form.

Ch.IV: On the purpose of crystal study.

Ch.V is the essence of this thesis: description of mineral-crystals. The subdivision of five classes into ca. 30 species. The characteristic features of each species are described.

I. Introduction

Carolus LINNAEUS (1707 - 1778), usually known as Carl VON LINN,, Swedish naturalist and botanist, is called *"The prince of botanists"*. He established the new systems for the three kingdoms of nature to facilitate the description of Plant, Animal and Mineral Kingdom. His classification system and binomial nomenclature, proposed in 1753 in such as *"Species Plantarum"* etc., have been accepted by international agreement among botanists. However, Linnaeus's system of the mineral kingdom had little influence. He attached great importance to crystal morphology, but had no feeling for the chemical composition of the minerals. Therefore, he stood outside of the fruitful contemporary trends in mineral systematics.

"De crystallorum Generatione" 1747, is a small article and Martinus Kähler's dissertation, supervised by Prof. LINNAEUS at Uppsala. In those days it was custom of the University for dissertations usually written in large part by the professors of the students who proposed them, and subsequently printed at the expenses of the proposers. Therefore, the main part of this article should have also been written by LINNAEUS, himself. So, his idea on mineral and crystal systematics is inferable.

II. De Crystallorum Generatione

This booklet, 15.5 cm x 19.5 cm in size, contains 40 pages, of which 30 pages are texts, and one folded plate of the illustrations of mineral-crystals. The texts consist of Introduction and five chapters.

"Introduction" describes the objectives of study: to inquire the genesis of mineral-crystals through the examination of morphology and physical properties. "In mineral kingdom, crystals are the best manifestation of the Creator, appeared in such as, their transparency, brightness and well-ordered shape. Beautiful mineral-crystals are valuable as gems, and the diamond is a representative.

It is one of the most important subjects in the study of natural history to elucidate how the exquisite shapes of crystals are formed. Crystallography is the subject to examine the external shape of minerals in detail, however, we are far from satisfactory. It is not clear where the symmetrical forms and the brilliancy of crystals come from.

The mineral specimens stored in the cabinets of the Academy are useful for the crystallographic study. To the study of crystals, the knowledges of mineralogy, chemistry and physics are essential. However, their detailed examination through the observations are also important. The author is not eligible for the crystal study, and he would only present an intiation for further study.

The author has already written on crystallography in the section of natural history in the Memoirs of the Academy. It is of some use to present this *"De Crystallorum Gene*

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ratione" through the courtesy of the President" [206]

Chapter I describes on the etymology of crystals.

§ I . *"The term of Crystallus or Crystallum is of Greek origin, and composed of ..... (freeze) and ..... (contraction)".* The author cited the terminology by the classic Roman naturalist PLINIUS and the contemporary authors of SAUMAISE (Salmasius in Solin) and Dr Herman BOERHAAVE, the most famous physician and chemist of his day. All of them are common in usage of the term *"crystal"* and it originally denotes the ice.

§ II . *"A crystal is a solid body of geometrical polyhedron, surrounded by many plane faces intersected with specific interfacial angles".*

§ III . *"Generally four types of of crystals have been known: I : O Crystals of salts, soluble in water. II: O mineral-crystals, frequently transparent and do not burn. These are crystals sensu stricto. III: O Sulfur or orpiment crystals, burn and emit the gas. IV: O Crystals of metals, such as lead, iron and silver, melt in the fire."*

§ IV . *"Crystallization is a miracle phenomenon related to the natures of salts, and it is not well understood at present".* The author says that the salts (elements) come together to form crystals under the natural law regulated by the Creator.

§ V . *"Salts are soluble in water, and the solutions have some particular taste. They crystallize in the form of polyhedron".*

§ VI . "From the above descriptions, it is evident that the crystals are formed by the gathering of salts and aggregation into a solid body. Always they crystallize in a specific form, proper to the constituent salt".

§ VII . *"The following hypotheses are laid down: I: O The crystallization takes a form specific to each salt and it never does another form (*§ IV*). II: O Every crystallization takes place in the water (§ V). Another hypotheses are added to each mineral- crystal".*

D. D

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VIRI CELEBERRIMI & EXPERIENTISSIMI,

DN. DOCT. CAROLI LINNÆI,

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MED. & BOTAN. PROFESS. REG. & ORD.

ACAD. IMPERIAL. MONSPEL. BEROLIN.

STOCKHOLM. UPSAL. SOCII,

PUBLICO EXAMINI MODESTE SUBMITTIT

MARTINUS KAHLER,

STOCKHOLMIENSIS.

IN AUDIT. GUST. MAJ. D. XXII. DECEMB.

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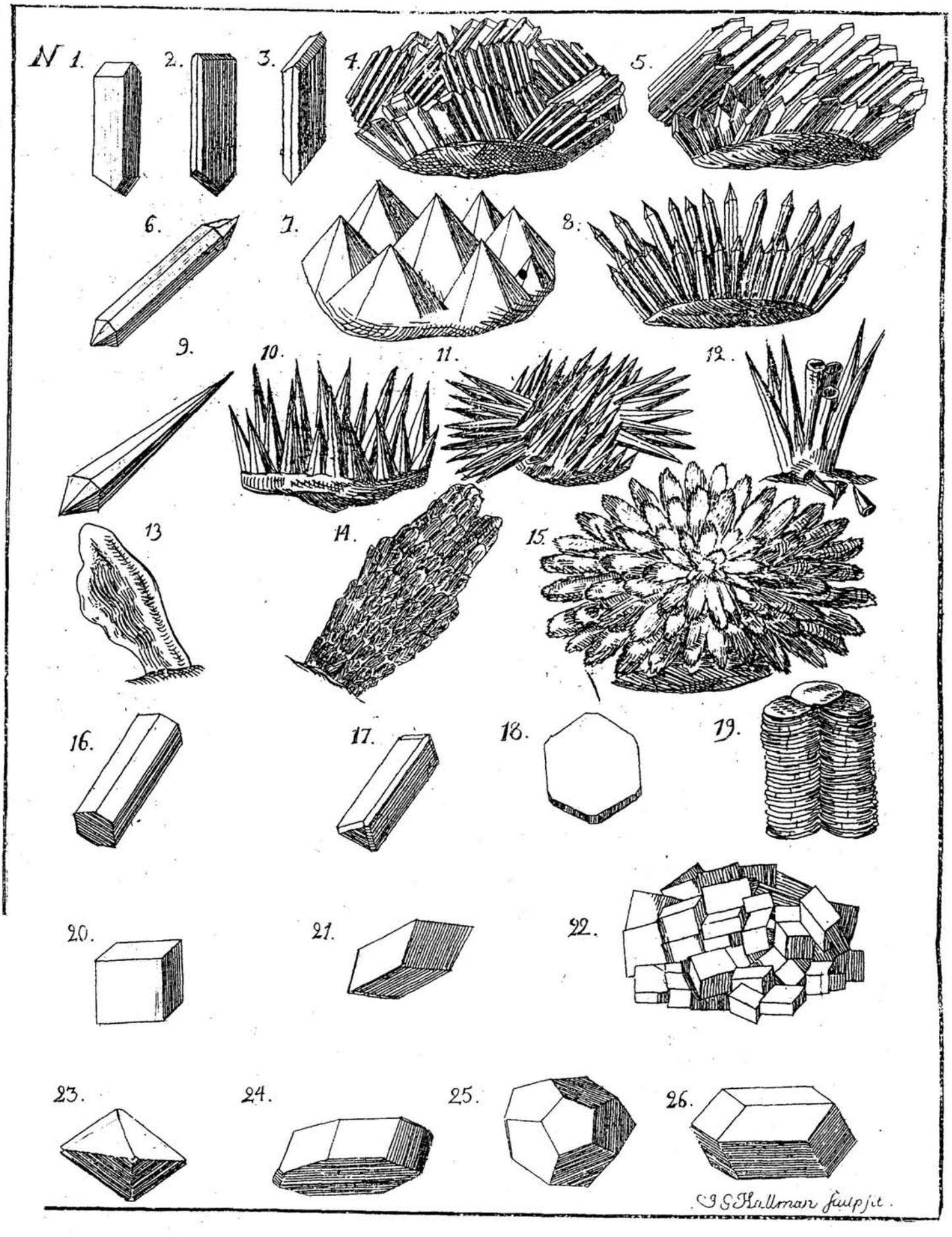
UPSALIÆ.

<--- Fig. 1:
Title - page of: 1747:
"De Crystallorum Generatione"

Fig. 2: --->
Folded plate of the sketches of mineral-crystals

[206] (* "..." indicates the rough translation from the original)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Chapter II

"Every quartz-like (and spar) crystal is parasitic on the rock. Therefore, analysis reveals the crystal to be generated and grown in the cabities of other mineral. In the captured water in the fractures of rocks, the impregnation of the exhalations from the rock with the aid of air favour the growth of crystals on the surface of rock. They form a crust over the rock. The primary crystals formed in the running water sometimes includes grass. It adhered inside the host mineral".

§ I . *"Every quartz-like crystal (and spar) is parasitic on the rock. For examination, it is necessary to disintegrate and take off from the rock".*

§ II . *"It was generated and grown in the cavities of other mineral".*

§ III . *"The minerals, grown from the captured water in the fractures of rock, are linked one another".*

§ IV . *"The impregnation of the exhalations from the rock".*

§ V . *""With the aid of the air".*

§ VI . *"A mineral starts to grow and becomes larger on the surface of rock".*

§ VII . *"It becomes the crust".*

§ VIII . *"The crystal, generated primarily in the running water, sometimes includes grass. It adhered inside the host mineral".* The last description should imply such as a green aventurine quartz, and in truth fine crystallites of actinolite, mica or chlorite etc. are included.

Chapter III

"In the mineral kingdom, every solid body of polyhedron is composed of salts. The salt crystallizes due to the following cause : it can dissolve into water thereafter take place the crystallization. The mineral-crystals take two types of form; of quartz-like (quartzum) and spar (spatum). Every crystal is generated in the solution. Natrum and nitrum resemble each other, therefore every mineral is composed of the salts. The following descriptions are on matrix, occurence, color, characteristic nature, shape, species, urolith, tartrate and stalactite".

§ I . *"In the mineral kingdom* (excluding rocks), *every solid body of polyhedron consists of salts".*

§ II . *"Crystallization of salt can be attributed to the ultimate cause. There are no doubts that it took place in the primodial water".*

§ III . *"Salts are soluble exclusively in water".*

§ IV . *"Mineral-crystals are classified into the quartz-like and spar crystals, distinguished by their physical properties." "Quartz-like crystals are transparent, broken into the unequigranular and angular fragments, and they spark when scratched with the steel". "Spar crystals are translucent, broken into the rhombohedrons, and easy to be scarred when scratched with steel, but do not spark".*

§ V . *"All crystals are generated from the solutions".*

§ VI . *"Crystal morphology of the natrum and nitrum".* Almost all of the nitrum crystals take the form of quartz-like or mountainous. Most of the natrum crystals take a spar-like or spathaceous form . These are quite few and the most salts and halite take the forms like those of Nos. 20 & 22. Alum or diamond takes other form. Sulphates (or sulphide) usually take other different forms. Their forms somewaht deviate according to the differences in their constituent sulphur and metal ratios. Pyrite, cobaltites and metallic minerals are excluded.

§ VII. *"Therefore, all mineral-crystals are composed of salts".*

§ VIII. *"To prove the above-mentioned statements, we need to accumulate further examples and observations".*

§ IX . Matrix. *"Spar-crystal of fluorite was generated in the limestone or marble. Whereas, in these rocks quartz-like and mountainous crystals do not occur. Why these crystals do occur in other rocks ?"*

§ X . Occurence. *"The crystals found in the metal-bearing rocks are always pyrite. On the other hand, if the rocks include no metals, the crystals are mountainous or spar".*

§ XI . Color. *"The color of a mineral is attribute to its including metal".* For example, *"Iron is called virid vitriol. Golden ochre on burning changes to red, and is called ruby. Cupper is called blue vitriol. Green ochre changes to emerald by acid. Blue vitriol changes to sapphire through the reaction with alkali. Cyanide changes to beryl by the effect of alkaline vapour. Lead is called white vitriol. Pale yellow ochre is topaz. Bithmus is red ocher, and so-called hyacinth. As it is seen in these examples, the color of crystal is caused by the include metal itself, whereas, the form can be attributed to the constituting salts".*

§ XII . *"Transparency. The crystals without sulphate or sulphide of metals are transparent".* The degree of transparency depends on the constituting salt, for both quartz-like and spar crystals. *"The spar including iron or stained by it is called feldspar. Most of the spars are not completely transparent".*

§ XIII . Characteristics. *"Natrum sometimes takes a form of spathaceous. It occurs in the limestone or marble. Salts before burning takes the same form as natrum".* Nitrum occurs in the quartz-like or mountainous form. Vitriolum usually occurs as pyrite, but, it takes various types of form according to its including metal.

§ XIV . Morphology. The morphology of crystals depend on the constituting salts, also depends on crystallization process and variety.

§ VI . *"Species. The mineral take the form of natrum, nitrum, muriam, alumen and vitriolum, according to their constituting salts. Even for the unidentified crystal, it is inferable to be a derivative of the above-mentioned forms".*

§ XVI . Urolith. An exceptional mineral-crystal.

§ XVII . Stalactite. It occurs in the wine-barrel.

§ XVIII . *"From the above-mentioned facts, it is evident that the crystal morphology depends on its constituent salt".*

Chapter IV

This chapter describes on the objective of crystal study and its application to the mining and metallurgical practices. Objectives are as follows:

§ I . To elucidate the relationships between the salt and its crystal morphology.

§ II . Chemical investigations of the artificial glasses (or crystals) are very important to inquire the nature of salts which constitute the crystals.

§ III . It is useful for mining ad refining works to know what kind of metal is contained in the mineral.

Chapter V

This chapter forms the main part of this article: the discriminations of the crystal morphology and classification into many types. It presents the result of the examination of the diversity and characteristic features of the representative specimens of mineral-crystal (*"more than 150 superior specimens stored in the cabinets of the President of the Academy"*). The minerals are essentially divided into the following five classes: natrum, nitrum, alumen and vitrolum. Further subdivisions of each type of mineral-crystal are possible as regards their morphology. In § II, natrum is described. These mineral-crystals are of quadrilateral prism, the interfacial angle differs each other. The terminals are not of tapering. Like those of Nos. 1, 2, 4 & 5 in the Plate and their deviated ones. All of these crystals are natrum and spar and classified into the following five types:

1. *"Natrum-type spar crystal: in random orientation, mottled milky translucent crystal".*

2. *"Ditto: horizontally elongated, mottled and glass-like transparent crystal".*

3. *"Ditto: horizontally elongated with the parallel crystal faces , and dark colored crystal".*

4. *"Ditto: vertically elongated with the parallel crystal faces, white translucent crystal".*

5. *"Ditto: vertical with the parallel crystal faces, glasslike crystal".*

§ III : *"Nitrum: dodecahedral (rhombic faces), No. 3 is the representative.*

6. *"Nitrum crystal: colorless translucent, and rhombohedral single crystal".*

7. *"Ditto: colorless translucent, prismatic semi-single crystal".*

§ IV . *"Nitrum hexagonal prism with the tapered pyramids".*

8. *"Single crystal of nitrum-type and quartz-like crystal with bipyramids (No.6)".*

9. *"Nitrum-type quartz-like and elongated crystal".*

10. *"Ditto: stout aggregated crystals (No.7)".*

11. *"Nitrum-type spar, stout bipyramidal crystal: the pyramids are tapered (No.9)".*

12. *"Ditto: aggregated crystals: the pyramids are inclined (No.10)".*

13. *"Ditto: horizontal and bundled aggregates (No.11)".*

14. *"Aggregate of tabular crystals of nitrum-type and quartz-like (No.12)".*

15. *"Pseudo-nitrum-type single crystal of sword-shape (No.13)".*

16. *"Ditto: striated crystals in aggregate, imbricated in three directions (No.14)".*

17. *"Ditto: crystals in aggregate, imbricated in a hemisphere (No.15)".*

18. *"Ditto: a crystal with flat terminals (No.16)".*

19. *"Ditto: a crystal with flat triangle-terminals (all three angles are acute) (No.17)".*

20. *"Ditto: a crystal with oval-shaped hexagonal terminals (No.18)".*

21. *"Ditto: three joined piles of stacked platy crystals (No.19)".*

It is very peculiar to see 15 again. There is a sketch of a bipyramidal crystal without prism (this is only one sketch in the text). One can read the following explanation.

15. *"Ditto: Stout crystal, joint of two same pyramids".*

§ V . *"Muriam or ordinary salts. Cubic like that of No. 20. These types of mineral-crystals should be as follows: 16. (Number is lacking in the text) "Muriam-type spar, aggregate of white crystals".*

17. *"Ditto: aggregate of yellow crystals (No.22)".*

18. *"Ditto: aggregate of purple crystals".*

19. *"Muriam-type, aggregate of green crystals".*

20. *"Muriam-type, rhombohedral spar and semi-single crystal (No. 21)".*

§ VI. *"Alumen; this sometimes occurs in the restricted types of mineral-crystal. Granular crystals surrounded by the eight triangle faces (at right angles each other). Rarely there occur the crystals with rounded edges like that of No.23".*

21. *"Alumen-type, grey ~ black bottle shaped single crystal".*

22. *"Alumen-type spar, not so regularily stacked imbricate crystals".*

§ VII . Vitrolum originally means sulphates, however, in this section the descriptons are mainly on the sulphides. These crystals differ in shape according to the including metal-species of Fe, Cu, Zn or Pb. To inquire the diversity of these forms belongs to a new field of crystallography, and called *"Pyritologia"*.

At last a description on garnet can be seen. Garnet is a deep reddish colored polyhedral and saccharoidal crystal. There are following three types:

1. *"Dodecahedral garnet surrounded with the pentagonal faces"*.
2. *Dodecahedral single crystal of garnet (rhombic faces)"*.
3. *"Dodecahedral garnet with the rhombic faces"*.

"The end"

VI. Situation of *"De Crystallorum Generatione"* in the history of mineralogy.

LINNAEUS has discriminated and classified the mineral-crystals from the points of morphology and appearances. Accordingly, now we can not identify the most of the mineral species from the descriptions in this article. In Linnaean time, the knowledges about the chemistry of minerals are quite poor. Precise determinations of the chemical composition of mineral were half a century later from his time, in the era of KLAPROTH and BERZELIUS. In this article, the mineral-constituent elements are regarded to be such as *"salts"* and *"sulphur"*, bearing an alchemical vestige. Also, the distinction between the metallic elements and their ore minerals was vague. In his time quite a small number of elements had been recognized. About 50 years later, LAVOISIER's, a pioneer of the modern chemistry, *"Trait, ,l,mentaire de chimie"* (1789) appeared, in which 33 elements (including light and heat) are enumerated. Therefore, it is no wonder that we find poor chemistry of minerals in this article. A modern mineral-classification system based on the chemical composition was set up in late 19th Century in contempory with or after the establishment of modern concept of elements by DALTON. LINNAEUS's mineralogy remained antique and stood outside of the fruitful historical trends in mineral systematics. It is very important to compare the crystal forms, as the morphological similarities of the chemical compounds would reflect their chemical affinities, as is seen in the MITSCHERLICH's law of isomorphism. He has no intentions on this subject, although this article is very suggstive. His view of natural history is to be central to the recognitions of forms in nature, and also to see an eternal wisdom of God through His wonderful creatures.