RENÉ JUST HAÜY, FOUNDER OF STRUCTURAL CRYSTALLOGRAPHY

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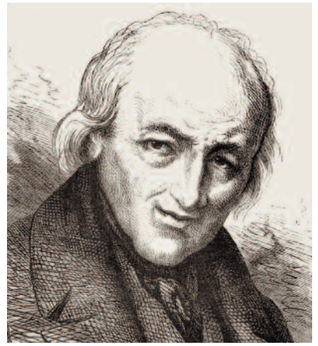

René Just Haüy (1743–1822)

René Just Haüy (1743–1822) was an outstanding French mineralogist and crystallographer, creator of the first theory of crystal structure, author of the rational indices law (Haüy law) and of basic ideas on crystal symmetry.

René Just Haüy was born at Saint-Just-en-Chaussée on February 28, 1743, near Paris in the family of a poor linen-weaver. In Paris, he became a student and then usher and regent of the College of Navarre. After his ordination, Haüy became regent (teacher) of the second class at the Collège du Cardinal-Lemoine, where he gave a lectures in humanities and then in physics for 20 years.

Haüy dedicated himself wholeheartedly to mineralogy and crystallography, influenced by the lectures of Louis-Jean-Marie Daubenton in the Paris Botanic Garden, with the exception of rare worships in the cathedral. He ardently studied minerals, first from private collections whose owners involved him for systematization and ordering of their mineralogical collections.

In 1783, the 40-year-old abbot and naturalist (remember that our outstanding compatriot N.V. Belov, well-known crystallographer, started to pursue his career at approximately the same age) published his famous book Essai d'une théorie sur la structure des crystaux (it was translated into Russian by O.S. Zabotkina and G.A. Stratanovsky in 1962). He finished the introduction to this book with the meaningful sentence: *"It is undoubted that this science (mineralogical crystallography, VP) will take its place among the diverse attainments, which enriched our century owing to the human mind"*. Since then, triumphant accent of the scientist has started. The great scientists A. Lavoisier, J. Lagrange, P. Laplace, C. Berthollet, A. Fourcroy and others attended his lectures at the Collège du Cardinal-Lemoine.

Then it was the time of the Revolution that changed much in the life of René-Just Haüy. In 1794, he became a professor of École des Mines (school of mines) in Paris, where he gave lectures in crystallography and mineralogy, and a member of the Commission on weights and measures. In 1801, he wrote his four-volume Traité de minéralogie that was based on his structural theory and original system of minerals, which preceded contemporary crystal chemical taxonomy. In 1802, by the order of Napoleon who sympathized with him, the scientist transferred to the Mineralogy Department at The Natural History Museum and at the insistence of the Emperor, he wrote "*Traité élémentaire de physique*" (1802), which was more simple to read.

During the Bourbon restoration, Haüy was attacked: he was not forgiven the favor shown to him by Napoleon and his success through the favor of the Emperor. The scientist was subjected to disgrace, suspended, and needed money. René Just Haüy passed away on 3 June 1822, but he kept up his creative energy until the day he died. In 1822, his two-volume Traité de cristallographie was published and Traité de mineralogy was reissued. Academician V.I. Vernadsky (1904) was appreciative of the Haüy works: "*...he approved an idea on the symmetry in the science of crystals and applied it not only to the shape of polyhedra but to physical properties. It had been clear to him that there was an inextricable link between them. He noted for the first time the regular recurrence of certain elements in polyhedra*".

The Haüy contribution to the science is enormous. In particular, he substantiated the refraction of light in crystals; proved that each crystalline material has an individual structure expressed in recurrent characteristic interfacial angles; and described many crystal forms especially those of calcite. He understood the pattern of isotropy of crystals containing high-symmetry (cubes, octahedral, and dodecahedra) integrant molecules; found a direction along which birefringent crystals are optically isotropic; and suggested the use of optical properties for identification of gems. The Haüy law derived from the crystal structure and formulated long before the theory of space lattice is unalterable. Although the Haüy conception of crystal structures has given way to the theory of crystal lattice substantiated by Bravais (1811–1863), the rational indices law (Haüy law) is still valid in crystallography. The similarity of this law to Dalton's (1766-1844) law of multiple proportions is not an accident. Haüy had an indisputable influence on Dalton who discovered one of the principle stoichiometric laws in chemistry (1809); this famous English naturalist was present for lectures of Haüy in Paris.

It is interesting to note that better results of the Haüy work were accomplished with modest instruments, which he used. These are the contact goniometer of Koranjo, although the precise reflection goniometer of Wollaston already existed, the loupe, and blowpipe. The hammer was a favorite device of Haüy. There is an unavoidable parallel with the geological emblem *"Mente et malleo"*.

The theory of crystal structure is the pivotal scientific contribution of Haüy. According to the insights of the scientist substantiated by the careful examination of crystal cleavage, the crystals consist of bricks (polyhedra) and are combination of small parallelepipeds, which are identical to each other and face-shared. He named these parallelepipeds integrant molecules. In other words, according to Haüy, crystalline bodies are laying of polyhedra (bricks, molecules). "That is what combination of molecules I name structure" wrote he at page 12 of the aforementioned Essai d'une théorie sur... The formula of molecules was modeled as cleavage fragments, into which crystals with cleavage are broken.

According to one version, Haüy looked into a magnificent prismatic crystal of Iceland spar, it dropped from his hands, and he saw that the crystal broke up into numerous fine cleavage rhombohedral fragments. The legend is, Haüy looking at those fragments of the same shape not depending on their size exclaimed: *"Eureka!"* Then, Haüy checked with hammer many calcite crystals and crystals of other minerals with regard to the shape of cleavage fragments. So, the scientist jumped to his theory of crystal structure. In is no coincidence that René Just Haüy is shown with a cleavage calcite rhombohedron in his hands on portraits and monument in Paris, in which he and his brother Valentine were immortalized.

This theory is described in the most detail in his classic courses in mineralogy and crystallography published in 1822 (see above). The scientist reported in detail his experiments in crushing of calcite crystals complementing this by figures, which illustrate sequential stages of this separation: from hexagonal prism with pinacoid to final core as a rhombohedron $\{10\bar{1}1\}$. He transits from calcite to other minerals and describes five more core types: cube, octahedron, tetrahedron, and hexagonal prism.

In terms of contemporary science, the Haüy theory of crystal structure is naive and ingenious at the same time. When his followers led by Bravais changed molecular bricks to their barycenters (points), they jumped to lattices, which are the basis for the concept of crystal structures.

The Haüy law that each substance is characterized by its own formula of integrant molecule is very important.

In Europe, including Russia, René Just Haüy is widely acknowledged. The mineral haüyne, $(Na,K)_6Ca_2[Al_6Si_6O_{24}](SO_4)_2$, from the sodalite group was named in his honor (Brunn-Neergard, 1807); V.M. Severgin, N.P. Shcheglov, E.S. Fedorov, V.I. Vernadsky, V.M. Goldschmidt, A.V. Shubnikov, I.I. Shafranovsky, V.A. Frank-Kamenetsky and other greatest scientists reviewed his essays from multiple viewpoints.

Haüy successfully examined minerals found in the Urals and Siberia. He discovered diaspore and provided the first crystallographic descriptions of dioptase, crocoite, chromite, *"sibirite"* (pink tourmaline) and other minerals from Russia.

On September 17, 1806 René Just Haüy was elected an honorary foreign member of the Russian Academy of Sciences and shortly after foundation of the Saint Petersburg Mineralogical Society he became its honorary member.

I shall conclude this essay with eloquent quotation of Nikolaiy I. Koksharov: "*... Haüy appears and almost all other previous luminaries are dwarfed. His Essai d'une théorie sur la structure des crystaux published in 1874 was a brilliant epoch in the history of mineralogy*" (Zapiski Mineral. O-va, 1876, v. 10, p. 143).