daily change in the variation, somewhat analogous to the daily range of the barometer, although the daily minimum of variation at Washington occurs at about 8 a.m., and the maximum between 1 and 2 p.m. It is proposed to continue the publication of these curves on this Chart for at least three months, and any questions regarding them will receive immediate consideration and reply. The attention of masters of vessels is called to the form issued by this Office for the record of observations of variation at sea, and to the general importance of the subject in connection with vessels' compasses and the variation curves plotted on our charts."]

The Alpine Flora.

IN connection with this subject (see NATURE, vol. xliii. p. 581) it may be well to draw the attention of botanists to the fact that a young vigorous strawberry plant, in an exposed garden, will, during the winter season, place all its leaves in a perfectly horizontal position, some even close to and resting on the ground, in striking contrast to its summer habit of erect growth, whereby it is often damaged by strong winds.

Whether direct climatal conditions be the sole cause of this peculiarity, or whether inherited, I cannot determine; presumably, in its natural surroundings, the continual crowding and consequent struggle would not necessitate the adoption of dwarfing as a means of survival. J. LOVEL.

May 13.

Magnetic Anomalies in Russia.

THE magnetic disturbances in England and Wales as communicated to NATURE, vol. xliii. p. 617, by M. Mascart and A. W. Rücker, are of great interest, but the size of the disturbances between Charkov and Kursk in Russia is of much higher value. More than 150 stations with magnetic elements have proved that in the above region there are points where the declination differs by 86°, the inclination by 29°, and the magnetic total force by 0·39 el. un. The principal centres are distant from each other not more than 12 kilometres. The m. elements are :—

Principal centres of disturbance.	Decl. °	Incl. °	Total force, e. u.
Nepchaevo	+ 48	+ 81	0·84
Visloe	− 33	+ 52	0·65
Kisselevo	− 38	+ 63	0·72
Sobinino	+ 30	+ 60	0·75
Petropavlovka	− 20	+ 76	0·80
Belgorod	− 36	+ 71	0·64

The normal values are − 1° Decl. ; + 64° Incl. ; 0·48 total force. The districts are covered by sedimentary rocks.

St. Petersburg, April 30. A. DE TILLO.

THE REJUVENESCENCE OF CRYSTALS.[1]

VERY soon after the invention of the microscope, the value of that instrument in investigating the phenomena of crystallization began to be recognized.

The study of crystal-morphology and crystallogenesis was initiated in this country by the observations of Robert Boyle; and since his day a host of investigators—among whom may be especially mentioned Leeuwenhoek and Vogelsang in Holland, Link and Frankenheim in Germany, and Pasteur and Senarmont in France—have added largely to our knowledge of the origin and development of crystalline structures. Nor can it be said with justice that this field of investigation, opened up by English pioneers, has been ignobly abandoned to others; for the credit of British science has been fully maintained by the numerous and brilliant discoveries in this department of knowledge by Brewster and Sorby.

There is no branch of science which is more dependent for its progress on a knowledge of the phenomena of crystallization than geology. In seeking to explain the complicated phenomena exhibited by the crystalline masses composing the earth's crust, the geologist is constantly compelled to appeal to the physicist and chemist; from them alone can he hope to obtain the light of experiment and the leading of analogy, whereby he may hope to solve the problems which confront him.

But if geology owes much to the researches of those physicists and chemists who have devoted their studies to the phenomena of crystallization, the debt has been more than repaid through the new light which has been thrown on these questions by the investigation of naturally-formed crystals by mineralogists and geologists.

In no class of physical operations is *time* such an important factor as in crystallization; and Nature, in producing her inimitable examples of crystalline bodies, has been unsparing in her expenditure of time. Hence it is not surprising to find that some of the most wonderful phenomena of crystallization can best be studied—some, indeed, can only be studied—in those exquisite specimens of Nature's handiwork which have been slowly elaborated by her during periods which must be measured in millions of years.

I propose to-night to direct your attention to a very curious case in which a strikingly complicated group of phenomena is presented in a crystalline mass: and these phenomena, which have been revealed to the student of natural crystals, are of such a kind that we can scarcely hope to reproduce them in our test-tubes and crucibles.

But if we cannot expect to imitate all the effects which have in this case been slowly wrought out in Nature's laboratory, we can, at least, investigate and analyze them; and, in this way, it may be possible to show that phenomena like those in question must result from the possession by crystals of certain definite properties. Each of these properties, we shall see, may be severally illustrated and experimentally investigated, not only in natural products, but in the artificially-formed crystals of our laboratories.

In order to lead up to the explanation of the curious phenomena exhibited by the rock-mass in question, the first property of crystals to which I have to refer may be enunciated as follows :—

Crystals possess the power of resuming their growth after interruption; and there appears to be no limit to the time after which this resumption of growth may take place.

It is a familiar observation that if a crystal be taken from a solution and put aside, it will, if restored after a longer or shorter interval to the same or a similar solution, continue to increase as before. But geology affords innumerable instances in which this renewal of growth in crystals has taken place after millions of years must have elapsed. Still more curious is the fact, of which abundant proof can be given, that a crystal formed by one method may, after a prolonged interval, continue its growth under totally different conditions and by a very different method. Thus, crystals of quartz, which have clearly been formed in a molten magma, and certain inclosures of glass, may continue their growth when brought in contact with solutions of silica at ordinary temperatures. In the same way, crystals of felspar, which have been formed in a mass of incandescent lava, may increase in size, when solvent agents bring to them the necessary materials from an enveloping mass of glass, even after the whole mass has become cold and solid.

It is this power of resuming growth after interruption, which leads to the formation of zoned crystals, like the fine specimen of amethyst enclosed in colourless quartz, which was presented to the Royal Institution seventy years ago by Mr. Snodgrass.

The growth of crystals, like that of plants and animals, is determined by their environment; the chief conditions affecting their development being temperature, rate of growth, the supply of materials (which may vary in

[1] The Friday Evening Discourse, delivered at the Royal Institution on January 30, 1891, by Prof. John W. Judd, F.R.S.

quality as well as in quantity), and the presence of certain foreign bodies.

It is a very curious circumstance that the form assumed by a crystal may be completely altered by the presence of infinitesimal traces of certain foreign substances—foreign substances, be it remarked, which do not enter in any way into the composition of the crystallizing mass. Thus there are certain crystals which can only be formed in the presence of water, fluorides, or other salts. Such foreign bodies, which exercise an influence on a crystallizing substance without entering into its composition, have been called by the French geologists "mineralizers." Their action seems to curiously resemble that of diastase, and of the bodies known to chemists as "ferments," so many of which are now proved to be of organic origin.

Studied according to their mode of formation, zoned crystals fall naturally into several different classes.

In the first place, we have the cases in which the successive shells or zones differ only in colour or some other accidental character. Sometimes such differently coloured shells of the crystal are sharply cut off from one another, while in other instances they graduate imperceptibly one into the other.

A second class of zoned crystals includes those in which we find clear evidence that there have been pauses, or, at all events, changes in the rate of their growth. The interruption in growth may be indicated in several different ways. One of the commonest of these is the formation of cavities filled with gaseous, liquid, or vitreous material, according to the way the crystal has been formed—by volatilization, by solution, or by fusion; the production of these cavities indicating rapid or irregular growth. Not unfrequently it is clear that the crystal, after growing to a certain size, has been corroded or partially resorbed in the mass in which it is being formed, before its increase was resumed. In other cases, a pause in the growth of the crystal is indicated by the formation of minute foreign crystals, or the deposition of uncrystallized material along certain zonal planes in the crystal.

Some very interesting varieties of minerals, like the Cotterite of Ireland, the red quartz of Cumberland, and the spotted amethyst of Lake Superior, can be shown to owe their peculiarities to thin bands of foreign matter zonally included in them during their growth.

A curious class of zoned crystals arises when there is a change in the habit of a crystal during its growth. Thus, as Lavalle showed in 1851 (*Bull. Géol. Soc. Paris*, 2me. sér., vol. viii. pp. 610–13), if an octahedron of alum be allowed to grow to a certain size in a solution of that substance, and then a quantity of alkaline carbonate be added to the liquid, the octahedral crystal, without change in the length of its axes, will be gradually transformed into a cube. In the same way, a scalenohedron of calcite may be found inclosed in a prismatic crystal of the same mineral, the length of the vertical axis being the same in both crystals.

By far the most numerous and important class of zoned crystals is that which includes the forms where the successive zones are of different, though analogous, chemical composition. In the case of the alums and garnets, we may have various *isomorphous* compounds forming the successive zones in the same crystal; while, in substances crystallizing in other systems than the cubic, we find *plesiomorphous* compounds forming the different enclosing shells.

Such cases are illustrated by many artificial crystals, and by the tourmalines, the epidotes, and the felspars among minerals. The zones, consisting of different materials, are sometimes separated by well-marked planes; but in other cases they shade imperceptibly into one another.

In connection with this subject it may be well to point out that zoned crystals may be formed of two substances which do not crystallize in the same system. Thus, crystals of the monoclinic augite may be found surrounded by a zone of the rhombic enstatite; and crystals of a triclinic felspar may be found enlarged by a monoclinic felspar.

Still more curious is the fact that, where there is a similarity in crystalline form and an approximation in the dominant angles (plesiomorphism), we may have zoning and intergrowth in the crystals of substances which possess no chemical analogy whatever. Thus, as Senarmont showed in 1856, a cleavage-rhomb of the natural calcic carbonate (calcite), when placed in a solution of the sodic nitrate, becomes enveloped in a zone of this latter substance; and Tschermak has proved that the compound crystal thus formed behaves like a homogeneous one, if tested by its cleavage, by its susceptibility to twin lamellation, or by the figures produced by etching. In the same way, zircons, which are composed of the two oxides of silicon and zirconium, are found grown in composite crystals with xenotime, a phosphate of the metals of the cerium and yttrium groups.

These facts, and many similar ones which might be adduced, point to the conclusion that the beautiful theory of isomorphism, as originally propounded by Mitscherlich, stands in need of much revision as to many important details, if not, indeed, of complete reconstruction, in the light of modern observation and experiment.

The second property of crystals to which I must direct your attention is the following:—

If a crystal be broken, or mutilated in any way whatever, it possesses the power of repairing its injuries during subsequent growth.

As long ago as 1836, Frankenheim showed that, if a drop of a saturated solution be allowed to evaporate on the stage of a microscope, the following interesting observations may be made upon the growing crystals. When they are broken up by a rod, each fragment tends to re-form as a perfect crystal; and if the crystals be caused to be partially re-dissolved by the addition of a minute drop of the mother liquor, further evaporation causes them to resume their original development (*Pogg. Ann.*, Bd. xxxvii., 1836).

In 1842, Hermann Jordan showed that crystals taken from a solution and mutilated gradually became repaired or healed when replaced in the solution (*Müller Archiv. für* 1842, pp. 46–56). Jordan's observations, which were published in a medical journal, do not, however, seem to have attracted much attention from the physicists and chemists of the day.

Lavalle, between the years 1850 and 1853,[1] and Kopp, in the year 1855, made a number of valuable observations bearing on this interesting property of crystals (*Liebig Ann.*, xciv., 1855, pp. 118–25). In 1856 the subject was more thoroughly studied by three investigators who published their results almost simultaneously: these were Marbach (*Compt. rend.*, xliii., 1856, pp. 705–706, 800–802), Pasteur (*ibid.*, pp. 795–800), and Senarmont (*ibid.*, p. 799). They showed that crystals taken from a solution and mutilated in various ways, upon being restored to the liquid became completely repaired during subsequent growth.

As long ago as 1851, Lavalle had asserted that, when one solid angle of an octahedron of alum is removed, the crystal tends to reproduce the same mutilation on the opposite angle, when its growth is resumed! This remarkable and anomalous result has, however, by some subsequent writers been explained in another way to that suggested by the author of the experiment.

In the same way the curious experiments performed at a subsequent date by Karl von Hauer, experiments which led him to conclude that hemihedrism and other pecu-

[1] *Bull. Géol. Soc. Paris*, 2me sér., vol. viii. pp 610–13, 1851; Moigno, *Cosmos*, ii, 1853, pp. 454–56; *Compt. rend.*, xxxvi., 1853, pp. 493–95.

liarities in crystal growth might be induced by mutilation,[1] have been asserted by other physicists and chemists not to justify the startling conclusions drawn from them at the time. It must be admitted that new experiments bearing on this interesting question are, at the present time greatly needed.

In 1881, Loir demonstrated two very important facts with regard to growing crystals of alum (*Compt. rend.*, Bd. xcii. p. 1166). *First*, that if the injuries in such a crystal be not too deep, it does not resume growth over its general surface until those injuries have been repaired. *Secondly*, that the injured surfaces of crystals grow more rapidly than natural faces. This was proved by placing artificially-cut octahedra and natural crystals of the same size in a solution, and comparing their weight after a certain time had elapsed.

The important results of this capacity of crystals for undergoing healing and enlargement, and their application to the explanation of interesting geological phenomena has been pointed out by many authors. Sorby has shown that, in the so-called crystalline sand-grains, we have broken and worn crystals of quartz, which, after many vicissitudes and the lapse of millions of years, have grown again and been enveloped in a newly formed quartz-crystal. Bonney has shown how the same phenomena are exhibited in the case of mica, Becke and Whitman Cross in the case of hornblende, and Merrill in the case of augite. In the felspars of certain rocks it has been proved that crystals that have been rounded, cracked, corroded, and internally altered—which have, in short, suffered both mechanical and chemical injuries—may be repaired and enlarged with material that differs considerably in chemical composition from the original crystal.

It is impossible to avoid a comparison between these phenomena of the inorganic world and those so familiar to the biologist. It is only in the lowest forms of animal life that we find an unlimited power of repairing injuries: in the Rhizopods and some other groups a small fragment may grow into a perfect organism. In plants the same phenomenon is exhibited much more commonly, and in forms belonging to groups high up in the vegetable series. Thus, parts of a plant, such as buds, bulbs, slips, and grafts, may—sometimes after a long interval—be made to grow up into new and perfect individuals. But in the mineral kingdom we find the same principle carried to a much farther extent. We know, in fact, no limit to the minuteness of fragments which may, under favourable conditions, grow into perfect crystals—no bounds as to the time during which the crystalline growth may be suspended in the case of any particular individual.

The next property of crystals which I must illustrate, in order to explain the particular case to which I am calling your attention to-night, is the following:—

Two crystals of totally different substances may be developed within the space bounded by certain planes, becoming almost inextricably intergrown, though each retains its distinct individuality.

This property is a consequence of the fact that the substance of a crystal is not necessarily continuous within the space inclosed by its bounding planes. Crystals often exhibit cavities filled with air and other foreign substances. In the calcite crystals found in the Fontainebleau sandstone, less than 40 per cent. of their mass consists of calcic carbonate, while more than 60 per cent. is made up of grains of quartz-sand, caught up during crystallization.

[1] *Wien. Sitz. Ber.*, xxxix., 1860, pp. 611–22; Erdmann, *Journ. Prakt. Chem.*, lxxxi. pp. 356–62; *Wien. Geol. Verhandl.*, xii. pp. 212–13, &c.; Frankenheim, *Pogg. Ann.*, cxiii, 1861. Compare Fr. Scharff, *Pogg. Ann.*, cix., 1860, pp. 529–38; *Neues Jahrb. für Min.*, &c., 1876, p. 24; and W. Sauber, *Liebig Ann.*, cxxiv., 1862, pp. 78–82; also W. Ostwald, "Lehrbuch d. Allg. Chem.," 1885, Bd. i. p. 738; and O. Lehmann, "Molekular Physik.," 1888, Bd. i. p. 312.

In the rock called "graphic granite," we have the minerals orthoclase and quartz intergrown in such a way that the more or less isolated parts of each can be shown, by their optical characters, to be parts of great mutually interpenetrant crystals. Similar relations are shown in the so-called micro-graphic or micro-pegmatitic intergrowths of the same minerals which are so beautifully exhibited in the rock under our consideration this evening.

There is still another property of crystals that must be kept in mind, if we would explain the phenomena exhibited by this interesting rock:—

A crystal may undergo the most profound internal changes, and these may lead to great modifications of the optical and other physical properties of the mineral; yet, so long as a small—often a very small—proportion of its molecules remain intact, the crystal may retain, not only its outward form, but its capacity for growing and repairing injuries.

Crystals, like ourselves, grow old. Not only do they suffer from external injuries, mechanical fractures, and chemical corrosion, but from actions which affect the whole of their internal structure. Under the influence of the great pressures in the earth's crust, the minerals of deep-seated rocks are completely permeated by fluids which chemically react upon them. In this way, negative crystals are formed in their substance (similar to the beautiful "ice-flowers" which are formed when a block of ice is traversed by a beam from the sun or an electric lamp), and these become filled with secondary products. As the result of this action, minerals, once perfectly clear and translucent, have acquired cloudy, opalescent, iridescent, avanturine, and "schiller" characters; and minerals, thus modified, abound in the rocks that have at any period of their history been deep-seated. As the destruction of their internal structure goes on, the crystals gradually lose more and more of their distinctive optical and their physical properties, retaining, however, their external form; till at last, when the last of the original molecules is transformed or replaced by others, they pass into those mineral corpses known to us as "pseudomorphs."

But while crystals resemble ourselves in "growing old," and, at last, undergoing dissolution, they exhibit the remarkable power of growing young again, which we, alas! never do. This is in consequence of the following remarkable attribute of crystalline structures:—

It does not matter how far internal change and disintegration may have gone on in a crystal—if only a certain small proportion of the unaltered molecules remain, the crystal may renew its youth and resume its growth.

When old and much-altered crystals begin to grow again, the newly-formed material exhibits none of those marks of "senility" to which I have referred. The sand-grains that have been battered and worn into microscopic pebbles, and have been rendered cloudy by the development of millions of secondary fluid cavities, may have clear and fresh quartz deposited upon them to form crystals with exquisitely perfect faces and angles. The white, clouded, and altered felspar-crystals may be enveloped by a zone of clear and transparent material, which has been added millions of years after the first formation and the subsequent alteration of the original crystal.

We are now in a position to explain the particular case which I have thought of sufficient interest to claim your attention to-night.

In the Island of Mull, in the Inner Hebrides, there exist masses of granite of Tertiary age, which are of very great interest to the geologist and mineralogist. In many places this granite exhibits beautiful illustrations of the curious intergrowths of quartz and felspar, of which I have already spoken. Such parts of the rock often abound with cavities (druses), which I believe are not of original but of secondary origin. At all events, it can be shown that these cavities have been localities in which crystal growth has gone on—they constitute indeed veritable laboratories of synthetic mineralogy.

Now, in such cavities the interpenetrant crystals of quartz and felspar in this rock have found a space where they may grow and complete their outward form; and it is curious to see how sometimes the quartz has prevailed over the felspar and a pure quartz-crystal has been produced; while at other times the opposite effect has resulted, and a pure felspar individual has grown up. In these last cases, however much the original felspar may have been altered (kaolinized and rendered opaque), it is found to be completed by a zone of absolutely clear and unaltered felspar-substance. The result is that the cavities of the granite are lined with a series of projecting crystals of fresh quartz and clear felspar, the relations of which to the older materials in an altered condition composing the substance of the solid rock, are worthy of the most careful observation and reflection.

Those relations can be fully made out when thin sections of the rock are examined under the microscope by the aid of polarized light, and they speak eloquently of the possession by the crystals of all those curious peculiarities of which I have reminded you this evening.

By problems such as those which we have endeavoured to solve to-night, the geologist is beset at every step. The crust of our globe is built up of crystals and crystal fragments—of crystals in every stage of development, of growth, and of variation—of crystals undergoing change, decay, and dissolution. Hence the study of the natural history of crystals must always constitute one of the main foundations of geological science; and the future progress of that science must depend on how far the experiments carried on in laboratories can be made to illustrate and explain our observations in the field.

BRITISH INSTITUTE OF PREVENTIVE MEDICINE.

A VIGOROUS attempt is being made by ignorant and prejudiced persons to prevent the establishment of a National Hygienic Institute worthy of the United Kingdom. A deputation will wait upon Sir Michael Hicks-Beach, President of the Board of Trade, on Friday, June 5, to submit to him an exact statement of the facts relating to the matter. Meanwhile, the Executive Committee has issued the following circular:—

On Monday afternoon, July 1, 1889, a meeting was held at the Mansion House, under the Presidency of Sir James Whitehead, Bart., then Lord Mayor of London, "for the purpose of hearing statements from Sir James Paget, and other representatives of scientific and medical opinion, with regard to the recent increase of rabies in this country, and the efficacy of the treatment discovered by M. Pasteur for the prevention of hydrophobia."

Although convinced of the advantages likely to accrue to the community at large by the founding of a Bacteriological Institute in England, the Committee felt that the time was not then come for establishing in England an institute similar to the "Institut Pasteur" in Paris, or the "Hygienische Institut" in Berlin. The idea, however, was not abandoned, and on December 5, 1889, an Executive Committee was appointed to take measures for the purpose of establishing in England a British Institute of Preventive Medicine.

Acting on the advice of their solicitors, Messrs. Hunters and Haynes, the Executive Committee decided to incorporate the Institute as a limited liability company, with the omission of the word "Limited," in order to impress the public with the fact that the Institute was not established for purposes of gain, but for purely charitable and scientific objects.

The application was lodged at the Board of Trade on February 13, 1891, and, shortly afterwards, a number of petitions were sent in asking the Board of Trade to withhold its license, as the objects of the Institute "clearly pointed to experiments on living animals." As Chairman of the Committee, Sir Joseph Lister then wrote to the President of the Board of Trade, showing why, in the opinion of the Committee, their opponents should not gain their point. In the first place, he pointed out that the granting of a vivisection license is not within the province of the Board of Trade, but under the control of the Secretary of State for the Home Department. In the second place, he clearly proved that it is absolutely necessary that the Institute should be licensed in the manner described, for it could not be registered under the Companies Act, 1862, without most seriously interfering with its prospects. From counsel's opinion it is evident that, should the Institute be registered as an ordinary limited liability company under the Act, it would at any time be possible for the members to wind up the company and divide the funds of the Institute; whereas the Board of Trade, in granting the license asked for, would make it a condition that all the property of the Institute should be applied to the advancement of science and kindred subjects only, and not be distributed among the members. In this way only could security be given that the funds would be applied for the purposes intended.

This letter was posted by one of the secretaries on May 12, 1891; but on the same day the solicitors to the Executive Committee received a letter from the President of the Board of Trade, who, without giving any reason whatever for his decision, declined to grant the application. On the next day, however, Sir Joseph Lister received a letter in answer to that posted on May 12, in which the President of the Board of Trade intimated his willingness to receive a deputation on June 5 at 11 a.m.

Workers in bacteriological science are now labouring under considerable difficulties, as there is no place in the United Kingdom specially fitted for such research. By the establishing of this Institute, they would be placed in the best possible conditions for carrying out original investigations. Moreover, a central Institute for the systematic teaching of bacteriology would be provided, not only for medical men, but also for veterinary surgeons, chemists, agriculturists, &c.

At present, in spite of the efforts made in this direction by several medical schools, most of the English workers who wish to gain special knowledge in bacteriology, are compelled to go to the Continental laboratories for their instruction. The question, therefore, which the Board of Trade will have to decide is, whether such a state of things should continue, or whether England should have its own national bacteriological Institute. Similar Institutes have been endowed by the State in other countries; and the Board of Trade, by refusing to grant their application, would prevent a body of private gentlemen from doing what has been done at great expense by the Governments of other nations.

NOTES.

WE are informed that Kew has recently acquired by purchase from Mr. F. Curtis, a descendant of William Curtis, the founder of the *Botanical Magazine*, about 1650 original drawings, chiefly of figures which appeared in that publication. They belong partly to the first series and partly to the second, from 1800 to 1826—that is to say, during the period that the magazine was edited by Dr. Sims. Many of these drawings are very beautiful, and very carefully coloured, especially those done by James