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TRANSLATORS' NOTE

The two translations presented here are papers from Russian cave science that have proven to be particularly influential in the study of cave mineralogy. The Russian system of mineralogy is conceptually very different from that of the West, with particular attention being given to the study of single crystals (termed *mineral individuals*) and their aggregates. This branch of genetic mineralogy is known as *ontogeny* and is already a classic science in Russia; it is largely unknown in the West, even by name. For an overview, see Maltsev (1997).

In the papers presented here, two topics deserve a more general discussion than can be given in footnotes. We therefore use the opportunity afforded by the editorial page to explain these concepts in more detail.

Geometric Selection

A mineral aggregate growing on a substrate organizes itself by means of *competition* between the individual crystals comprising the aggregate. This competition may be for growth space, for materials supply, or for loss of solvent. As growth of the aggregate proceeds, there is often a reduction in the number of competing individuals. This reduction in numbers is termed *selection* and unsuccessful individuals are "selected out".

A number of different selection mechanisms exist, of which *geometric selection* is particularly important because of its role in restricting the possible orientations of successful individuals during the early stages of aggregate growth. As described by Grigoriev (1961, 1965), the crucial elements of geometric selection are: (1) nucleation of a number of separate crystallites of different orientation on the substrate, (2) the beginning of competition between these separately growing crystals as they contact each other, (3) selection according to some geometric rule and a reduction in the number of competing individuals, (4) continued group growth as a parallel-columnar aggregate (known in the West as "palisade fabric").

The most common geometric rule is that of perpendicularity. Specifically, crystals are selected out if their direction of fastest growth is not perpendicular to the substrate. This rule is responsible for druse growth in mineral veins and also for the texture of many common speleothems. For illustrations of this, see Onac (1997). For acute rhombohedra of calcite this direction of fastest growth coincides with the triad axis, but Dixon (1993) has shown that for other habits it is the dyad axis. This observation contradicts the widely-held but erroneous view that calcite druse crystals always grow with their "c-axes" perpendicular to the substrate.

Geometric selection as a concept has evolved since the early description by Grigoriev. Slyotov (in this issue) has shown that competition does not need physical contact between crystal individuals, but can proceed indirectly through the environment. We can also note that other factors, such as flow vectors in the crystallization medium, can alter the geometric rule so that crystal growth is not perpendicular to the substrate. Studies in the West (e.g. Gonzalez *et al.*, 1992; Dickson, 1993) have largely concentrated on calcite druse growth and these papers use a different terminology, failing even to mention the term "geometric selection".

Our current understanding of geometric selection is thus: "the mineral individual whose greatest growth vector is best aligned for mass transfer with the environment will continue its growth at the expense of neighboring individuals of other orientations".

We should note here that Grigoriev (1961, 1965), in a later part of his book, used the term "geometric selection" to describe the group growth of spherulites. While it is true that crowded spherulites develop a parallel-columnar texture similar to that of druse growth, the selection mechanisms are quite different (and in some instances there is no selection, some parts of each spherulite remaining at the growth front). Spherulites are single crystals of rounded form, divided into many sub-individuals by crystal splitting; their growth vectors are equal in all directions. As currently formulated, geometric selection for spherulites is impossible. However, spherulites which grow on substrate protrusions have an advantage compared with those growing in hollows, whose growth is restricted and often suppressed. This is now known as *substrate selection*. Slyotov (in this issue) describes substrate selection between separately growing aggregates in the capillary film environment, though he does not use this name.

The other main selection mechanisms are *primogeniture selection* (an advantage is gained by nucleating on a substrate first) and *random selection* (when some crystals in an aggregate stop their growth for no obvious reason).

Kora

Kora is a Russian word meaning "crust" in a broad sense. In Russian mineralogy it has two meanings, one of which corresponds to the speleothem term *crust*, as used in the West. In its other meaning it is a hierarchy level in minerals ontogeny, used to describe assemblages of aggregates. To avoid confusion, texts written in English use *kora* as a hierarchy term and *crust* as a speleothem term. In this text we are only discussing koras.

A kora is an assemblage of texturally-similar aggregates, growing together at the same time and in the same crystallization space and forming from the same environmental conditions. The concept was first suggested by Fersman and Shcherbikov (1925), as a term uniting the different

forms of stalactites, stalagmites, and flowstone that grow together in the dripping water environment.   This they called the stalactite-stalagmite kora of calcite.   Stepanov's great contribution was to extend the use of the term *kora* to other assemblages of aggregates. Examples include the tufaceous calcite kora, the corallite kora, the antholite kora, etc. (Stepanov, in this issue; Stepanov 1997).

In Stepanov (1997), a very strict definition of kora is offered: "an association of aggregates that appear in all the space of synchronous crystallization, during episodes of the crystallization cycle when the phase state of the crystallization mediums remain constant for significant intervals of time".   The latter part of this definition directly refers to the long-term periodicity of crystallization processes (Stepanov, in this issue). Combining the findings of these two Stepanov papers, we can say that long-term change in the cave environment results in the growth of new and different koras on the surface of earlier koras.

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Translation No. 19

CONCERNING THE ONTOGENY OF CRYSTALLICTITE AND HELICTITE AGGREGATES OF CALCITE AND ARAGONITE FROM THE KARST CAVES OF SOUTHERN FERGANA.

by V.A. Slyotov

This paper was translated from the Russian by V. N. Koulanin. The English text was prepared for publication by C. A. Self. Footnotes 1, 4, and 5 were written by the author and are included in the published Russian text. The other footnotes have been added by C. A. Self and V. A. Maltsev.

Translator's Notes:

The term prisypki has no single-word equivalent in the English language. In my Russian/English dictionary, the term is defined rather than translated. Prisypki are small crystals of the same mineral (or sometimes another mineral) accumulated in large quantities on the upward-facing surfaces of growing crystals. Prisypki can be cemented to or incorporated into the growing crystal, and may have different origins.

Block crystals are complex crystals, consisting of subparallel blocks distorted in direction by a few degrees from each other.   Block crystals may have different origins, but generally they appear when spatial nucleation continues during growth, and additional several-molecule sized crystallites are incorporated into the growing crystals as almost perfectly aligned elements, continuing their growth together with the main crystal.

Slyotov's descriptions of helictite tips may be compared to Cobrol's drawings and photographs of "cut" helictites in CMW2 (Figure 288 and 288B). These illustrations clearly show the structure of 2-bunch, 3-bunch, and 4-bunch helictites).

Comments by George W. Moore [Department of Geosciences, Oregon State University]
Slyotov's helictite observations are excellent. My thin sections of an aragonite helictite from Cave of the Winds, Colorado are identical with his - appears in Hill and Forti, ed. 1, p. 45. His observations of calcite helictites are reminiscent of mine in 1950 when my brother dropped me into Soldiers Cave, California, for 10 hours of study. I wasted much time measuring helictite tip azimuths. They proved to be random.

Originally published in Russia as:
Slyotov (alternative spelling - Sletov), V.I. 1985. *On the ontogeny of crystallictite and helictite aggregates of calcite and aragonite from the caves of southern Fergana.* (in Russian) Novye Dannye o Mineralakh CCCP (New Data on Minerals), **32**, 119-127. Moscow, Nauka (Science).

CONCERNING THE ONTOGENY OF CRYSTALLICTITE AND HELICTITE AGGREGATES OF CALCITE AND ARAGONITE FROM THE KARST CAVES OF SOUTHERN FERGANA.

V.A. Slyotov

Analysis of the composition of mineral aggregates in karst caves, in order to reveal the conditions of their origin, growth, and dissolution, is especially interesting since the process of mineral formation proceeds rather directly before our eyes. The products of crystallization can be studied simultaneously with the conditions where this crystallization occurs. Particularly valuable results are found by studying the role of gravity on crystallization in karst caves - the influence of this factor here is great, is outstandingly variable, and deserves special attention.

It is possible to select three main types of crystallization environments in caves: 1) static cave pools, 2) water drips and streams trickling down under the influence of gravity, and 3) capillary films of liquid covering the walls of the moderately wet parts of caves. A special case is helictites which have their own "internal" source of supply by a central axial capillary channel.

The literature contains numerous data about crystallization products in cave pools (Chickishev, 1973) and on those from freely flowing (gravitational) solutions - joined together under the title "stalactite - stalagmite kora" by Stepanov (1971). Aggregates formed in capillary film solutions have been much less studied; they have only attracted the attention of mineralogists in recent years. They were given the name crystallictite (corallite) kora. Here we shall examine features of these aggregates more closely.

The crystallictite (corallite) kora of calcite

Considered here are the products of crystallization from non-moving capillary films covering the walls of caves above the horizontal level of reservoirs. Such products may be either aggregates of crystals and crystalline dendrites (crystallictites) or aggregates composed of dissymmetrical spherulites and their aggregates - spheroidalites and spheroidalite dendrites[1] (corallites) (Figure 1). It would seem that aggregates of ice dendrites formed by direct condensation of H_2O from the air should be considered here. In their structural-textural properties, these aggregates do not differ from crystallictite aggregates of calcite.

The terms "corallite" and "crystallictite" were first proposed by Shcherban *et al.* (1961). On the basis of a study of calcite aggregates from Khaidarkan caves, as well as from a range of experimental material, Moroshkin (1976) showed that the growth of crystallictite aggregates

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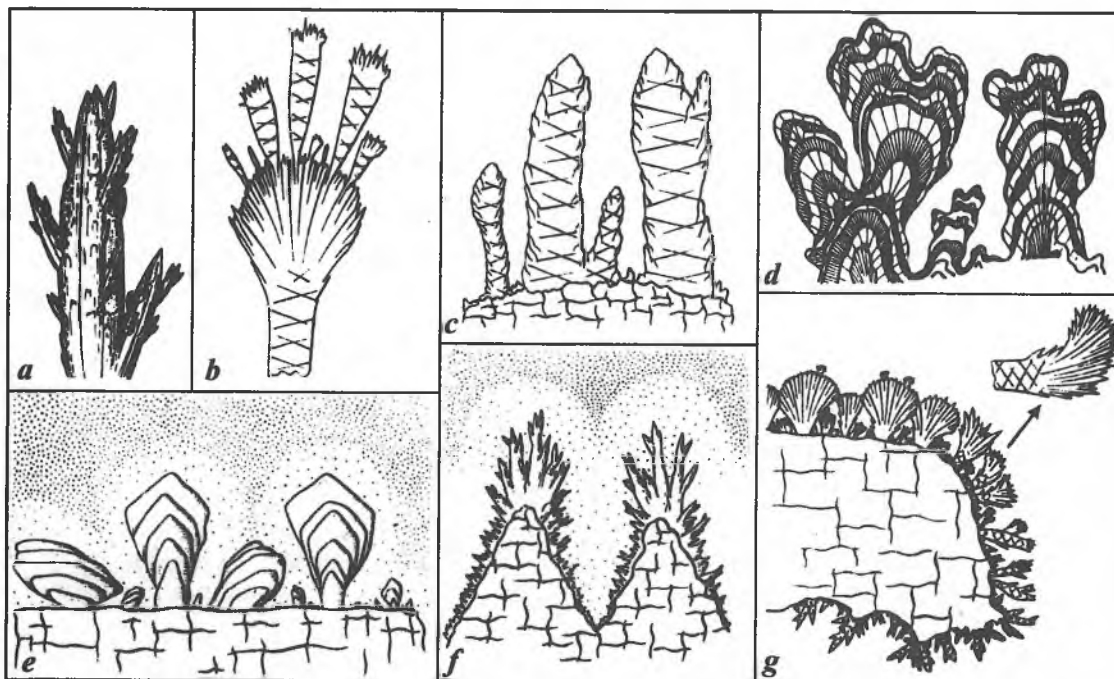[1]   The term was proposed by Dymkov (1970) and Stepanov (1971)

Figure 1. The composition of crystallictite and corallite aggregates of calcite (details): a - scaleno-rhombohedric dendrite crystal; b - spllitting of a scaleno-rhombohedric crystal; c - intermediate forms "crystallictite-corallite"; d - corallites; e - scheme of geometric selection at the primery stage of growth of the crystallictite kora; f - characteristic composition of the crystallictite kora; g - sketch of part of a crystallictite kora with a clearly expressed gravitational texture.

occurs by crystallization of matter from a thin capillary film of solution by evaporation of the solvent or by extraction of carbon dioxide formed by the decay of bicarbonate. Such films have a condensation origin or arise from slow spreading of water under very weak drips (Stepanov, 1971).

The question of structure and texture of crystallictite aggregates is specially considered in Moroshkin (1976).

The structure of kora aggregates is seen by the relative orientation in space of the composing individuals and in the way they overgrow the substrate. A very characteristic structural feature of crystallictite and corallite aggregates is the tendency for isolated growth of non-accreting separate dendrite branches and their "bushes": between neighboring "bushes" there is usually a gap. The explanation is that as growing individuals approach each other, vaporization of solvent (or loss of carbon dioxide) from the surface of the capillary film covering them slows down sharply, because molecules of either H_2O or CO_2 having left one surface immediately stick to another. This is why crystals stop growing before they touch.

A second feature of structure of crystallictite type aggregates is a specific appearance of the Rule of Geometric Selection[2], here realized without direct contact between individuals. Originally, crystals are born on a substrate with arbitrary orientation. However during further growth there is obviously an advantage for those among them whose direction of fastest crystal growth coincides with the direction of most intensive mass-transfer, i.e. with a direction usually perpendicular to the surface of the substrate. The crystals (or crystal parts) jutting out most are in the best of all conditions for mass-exchange with the medium and grow faster. This is why in crystallictite aggregates of calcite only crystals oriented with the L3 axis[3] perpendicular to the substrate grow into large dendrites and bushes. (For the scaleno-rhombohedric crystals of calcite which are dominant in caves, this is the direction of their length and consequently of the fastest growth speed).

Crystals oriented with their length perpendicular to the substrate grow significantly faster, so their "supply spheres"[4] overstep and capture the "supply spheres" of neighboring crystals, which stop their growth. Moreover, because of this, a sharp distortion of crystal shape is observed. At the boundaries of every crystal, those whose growth pyramids have a face-base falling within a "blocked" supply area stop or considerably slow down their growth. Relating to this, the zonality of crystals at the primary stage of growth is revealing. It shows that the growth of each crystal only goes in a direction towards "supply spheres" that are not blocked by neighbors (Figure 1e). In cases when calcite crystals appear singly with a considerable distance (2-3 cm) between, an even growth of both "standing" and "lying" crystals is observed. Numerous observations show no consistency in the critical distance between crystals which is necessary for mutual suppression of their growth.

In connection with the foregoing, it is impossible to agree with the statement of Moroshkin (1976) about originally normal overgrowth of crystallictite kora crystals over a substrate.

For aggregates of crystallictite type, their position (with respect to jutting elements of the substrate, relief of the substrate, and the direction of gravity) appears in the texture.

The most characteristic feature of a crystallictite kora is a sharp increase in thickness on various substrate protrusions. In hollows, small holes, and cracks the thickness of the crystallictite kora is minimal. This rule is independent of the position of the crystallictites (or corallites) on the cave walls, ceiling, or floor. On the one hand, this is an effect of the different intensity of solvent vaporization from a surface of variable curvature. The process of vaporization, and consequently crystallization, occurs most intensively on protrusions.

On the other hand, and also important, is the simple advantage for an aggregate to grow on protruding regions because here the mass-transfer with the medium occurs more intensively. The mass-transfer spheres of protruding areas of an aggregate overlap the mass-transfer spheres of neighboring crystals in hollows, whose growth is suppressed (Figure 1f).

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[2] This is a significant re-interpretation of the Rule of Geometric Selection, compared with that of Grigoriev (1961). This topic is dealt with in more detail by Maltsev and Self (this issue).

[3] This is the triad crystallographic axis and, for calcite, corresponds to the c-axis of conventional crystal drawings.

[4] Or "mass-removing spheres", which has the same meaning in this case. An interesting fact is that spheroidalite dendrites of pitchblende, niccolite, and other minerals in hydrothermal ore veins develop in an analogous way and also don't tough each other (Drymkov, 1973).

This noted textural feature of a crystallictite kora does not contradict the possibility of a condensation mechanism for its deposition. For example, condensation dendrites of ice (frost) having an analogous texture may serve as convincing evidence. Condensation from the gas phase is similar to fast crystallization where vaporization of solvent (CO_2) from the surface of a capillary film takes place. In each case, the position of crystals on substrate protrusions is more advantageous in relation to mass-transfer with the medium.

The influence of gravity on the composition of crystallictite aggregates, and consequently the role of gravitational mass-transfer during their growth, has not been noted until now. However, crystallictite koras in most of the Khaidarkan caves have a clearly expressed gravitational dissymmetry. If observations are made over a selected small area of cave surface a gravitational texture[5] is often not revealed. Only a sharp unevenness of development of crystallictites on juts and in hollows of the substrate attracts attention. Nevertheless the thickness and composition of the crystallictite kora over the cave ceiling and the floor are different, if taken as a whole.

For karst cavities, shaped as subvertical slots or tubes, the characteristic locality of a crystallictite kora is in the cave's lowest parts (Figure 2a). Figure 2b shows a sketch of a small cave with a crystallictite kora of characteristic composition.
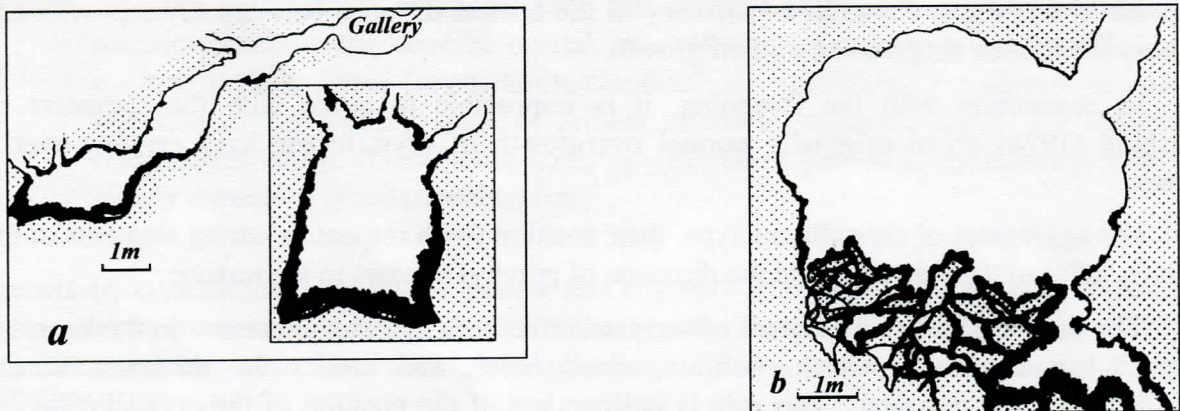

Figure 2. Karst caves with crystallictite kora. Kapitalnaya gallery, Khaidarkan.

Our attention is drawn to a change of kora thickness conforming to an established rule: it is thickest over the cave floor. Up the walls the thickness of the kora lessens and the cave ceiling lacks crystallictite formations. On upwards facing surfaces of boulders and wall protrusions, the crystallictite kora is more dense and thicker than on surfaces facing down. The kora areas growing upwards are often composed of aggregates of intensively split crystals, making transition forms to globular spheroidalites (corallites), while the kora areas growing on downwards-facing surfaces are composed of separate, more perfect, less split crystals (Figure

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5   Terminology after Dymkov (1970). A general classification has been given by Zhabin (1979).

1g). On the upwards-facing areas of crystallictite kora there are constantly seen prisypki[6] in the form of aggregates of tiny randomly accreted calcite crystals.

In general, on wall protrusions at the transition from their lower to upper surfaces, the following trend of kora composition change is seen: aggregates of separate crystals - aggregates of split crystals - spheroidalite aggregates - spheroidalites with crystal prisypki making the origin for new spheroidalites and for intensive branching of the old ones. Thus the crystallictite kora has an inherent gravitational texture which shows up more intensely the larger the scale on which it is examined.

In places, a gravitational texture is also observed on individual crystallictite "bushes", because of preferential growth of calcite crystals in the upwards direction (Figure 3). Such crystallictites are characteristic for Rosovaya Cave.
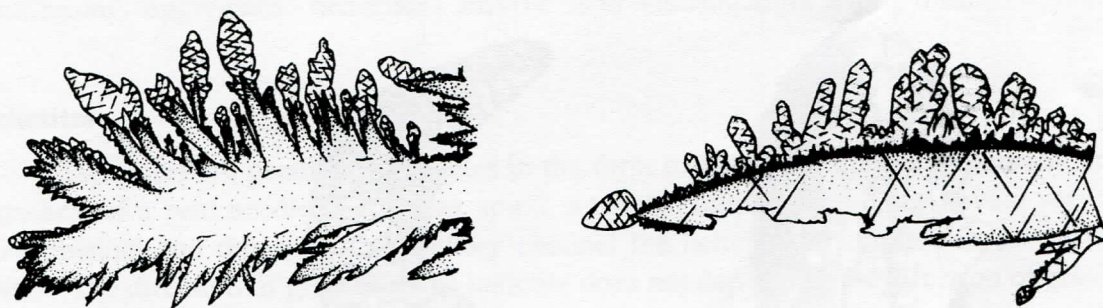
Figure 3. Gravitational texture of crystallictites.

Among crystallictite formations, abnormal crystallictites stand out in the form of calcite crystals, unusually and intensively grown around the direction of the main axis of the crystal and independent of the direction of gravity.

In Tachka Cave such formations generously cover the ceiling and, here and there, the walls of the cavity. These are elongated (up to 15 - 20 cm in length with thickness of 4 - 8 mm) prismatic crystals with rhombohedron heads. Here are seen transition forms from monocrystals to regular dendrites (Figure 4a). The internal composition of the crystals is roughly blocked[7]. Because of the erratic disorder of subindividuals, growth of block crystals has in places led to arbitrary twisting of the crystal in space. Branching of abnormal crystallictites is often observed because of the birth and growth on the main crystal of parasite crystals of another orientation.

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[6] The term prisypki has no single-word equivalent in the English language. Prisypki are small crystals of the same mineral (or sometimes another mineral) accumulated in large quantities on the upward-facing surfaces of growing crystals. Prisypki can be cemented to or incorporated into the growing crystal, and may have different origins.

[7] Block crystals are complex crystals, consisting of subparallel blocks distorted in direction by a few degrees from each other. Block crystals may have different origins, but generally they appear when spatial nucleation continues during growth, and additional several molecule sized crystallites are incorporated into the growing crystals as almost perfectly aligned elements, continuing their growth together with the main crystal.

Spiral-like twisted abnormal crystallictites (Figure 4b) can be found. It is supposed that the twist is due to screw dislocated growth.

Abnormal crystallictites need to be distinguished from helictites which have a central axial capillary channel and which grow by solution supply along this channel to the tip of the helictite. The cause of the appearance of abnormal crystallictites is, obviously, analogous to the cause of growth of whisker crystals in solutions (Berejhkova, 1969; Punin, 1973). If there are causes which brake the tangential motion of growth laminae (usually it is impurities in the solution), then the accumulation of macroscopic steps happens near the source of the laminae. When the speed of overgrowth significantly exceeds the speed of growth of laminae, a steep growth cone is formed and afterwards the crystal is abnormally stretched in this direction.
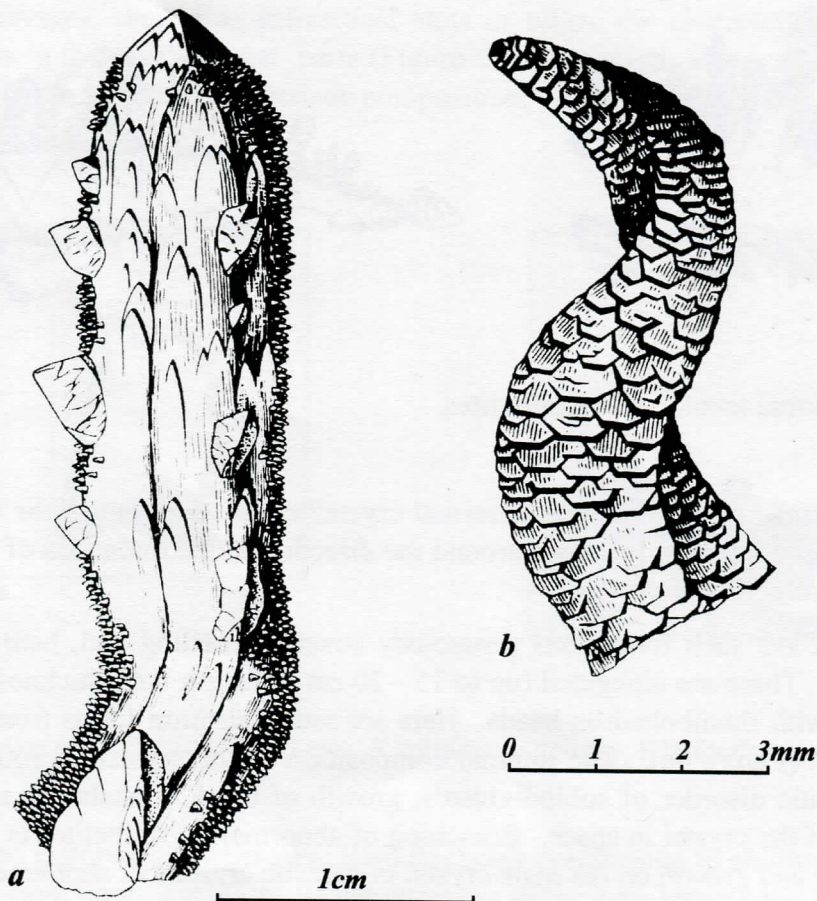
Figure 4. "Abnormal" crystallictites.

Cser and Maucha (1968) showed by physical-chemical experimental studies the possibility of calcite deposition from the atmosphere of a cave, which can also initiate growth of

crystallictites, particularly their abnormal forms. Air with a relative humidity of 90 - 95% supersaturated with the smallest droplets of water and calcium bicarbonate turns into an aerosol. Hence in conditions when the dispersion medium is matter occurring in a gaseous state, crystallictites can grow by diffusion and condensation of matter from the aerosol they are surrounded with ("aerosol effect"). Crystallictite aggregates of such origin have the name "cave frost".

For aggregates formed from a capillary film, lack of even the slightest sign of recrystallization is characteristic. Recrystallization does not occur because an extremely small volume of capillary film covers a considerably large area of crystal matter (in contrary to what happens in a bulk solution). Indeed, because of the slightest fluctuations in temperature or other parameters which occur during recrystallization, growth alternates with slight dissolution on the crystal faces which finally leads to a complete dissolution of small individuals and the transfer of their matter onto bigger ones. Unlike a bulk solution, a capillary film almost doesn't have "mass-capacity" and its dissolving capability is insignificantly small. Consequently, even uphill "non-equilibrium" aggregates - dendrites - survive there unchanged for a long time.

Helictites

Helictites are peculiar aggregates in the form of fancifully curved cylindrical and conical branches, of a bent needle, a complex spiral, a twisted ellipse, etc. They have a very fine inner axial channel and through this capillary channel the helictite is supplied in its growth (Prinz, 1908). The direction of growth of the helictite does not depend on the direction of gravity.

Helictites are found in slightly wet areas in caves and are located in groups along cracks in the substrate rock. In Khaidarkan the helictites are best developed in Zelenaya Cave, where calcite helictites (earlier phase) are combined with helictites of blue aragonite (later ones, developed over the calcite helictites)[8].

Helictites of aragonite represent unusual excentric spherulite formations, composed of fine-acicular splitted crystals. Along the axis of the helictite these crystals are parallel to each other and to the capillary channel surface, but as the helictite widens they bow out from this direction because of splitting. On the surface of the helictite the needles are at an angle to the axis of the helictite. The axial channel in cross section is usually in the shape of a lens or (more rarely) of an isosceles triangle. The width of the channels in different helictites is nearly similar, being about 1 x 0.1 mm, and does not depend on their inconstant external diameter. The channel comes out at the tip of the helictite forming a small, but as a rule visible, crack-like stria. There are also branching helictites; for aragonite helictites, branching in one plane is very characteristic, in exactly that plane where the channel of the helictite is flattened. In this way the basis of helictite branching is the formation of cross walls inside the channel slot, which makes it divide into parts.

The relationship between aragonite helictites and obstacles they meet during the process of growth are rather specific. Primary calcite helictites are usually these obstacles. Numerous

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[8] The greenish-blue coloring of the aragonite was studied in the cave Polunochnaya and found to be due to the presence of Ni and Co. Cu appears in other Khaidarkan caves as small hemispherical spots of malachite upon calcite.

examples of such relationships are grouped into four variants: 1) growth of the helictite is stopped when the tip comes up against an obstacle (this takes place where the collision is nearly perpendicular); 2) a change of growth direction, the helictite being "repulsed" from the obstacle (Figure 5a); 3) rounding the obstacle (Figure 5b); 4) the helictite adheres to the obstacle; after collision the helictite moves along the surface of the obstacle clinging to it (Figure 5c), but might move away from this surface and grow further in its own direction (Figure 5d).

The described phenomena become understandable if to take into account that helictites, while having their own source of supply on the tip, at the same time grow like divergent spherulites. The phenomenon of rounding a mechanical obstacle is usual for spherulites; it's principal possibility comes from a crucial detail of the composition of spherulites, i.e. that they are built of fibres splitting during growth (Maleev, 1971). The peculiarity of helictites is in the presence of their own source of supply on the tip which is the cause of their oriented growth. When the helictite tip contacts an obstacle on one side, growth of the fiber sub-individuals composing it is stopped in this direction only. Simultaneously, growth becomes more intensive on the opposite side of the tip and the helictite changes its direction of growth. Whether the helictite will move further on the obstacle surface or grow in a new independent direction is, apparently, due either to the nature of wetting of the obstacle surface or the orientation of the plane of the capillary channel relative to it.

The basic construction of calcite helictites is analogous to the aragonite ones, but they have a less definite shape of the axial channel as well as of the helictite as a whole.

Figure 5. Helictites.

One should also class as helictites, formations on the cave roof in the form of protuberances with very elongated sides (of aragonite, more rarely calcite), more or less gently sloping, from 1 to 10 cm in width at the base. Over their surface along the tip there usually is a visible stria, extending along all their length. Investigation of the composition of these formations reveals their spherulite radiating structure. The stria observed proves to be nothing but an exit for an aggregate of channels located one after another at an almost constant distance from each other and having form and sizes corresponding to the helictites described above. During their development these protuberances or "small ridges" often split into parts, growing

into groups of conical helictites extended in one plane (like the palm of a hand with fingers spread wide)[9].

Based on these observations, one apparently should consider a helictite to be an accretion of two spherulite bunches of aragonite. The slot-like channel is located in the plane of this accretion and formed by the loosely connected bunches. It is proven by the presence of less common helictites which have a channel which in cross-section has the shape of an isosceles triangle with slightly concave sides, corresponding to the accretion of three spherulite bunches. Analogous mechanisms apply to the composition of calcite helictites, but their significant difference from aragonite helictites is that these are more complex accretions of three or more spherocrystals, hence the channel's section has the shape of accordingly a three-, four- or five-ray irregular star[10].
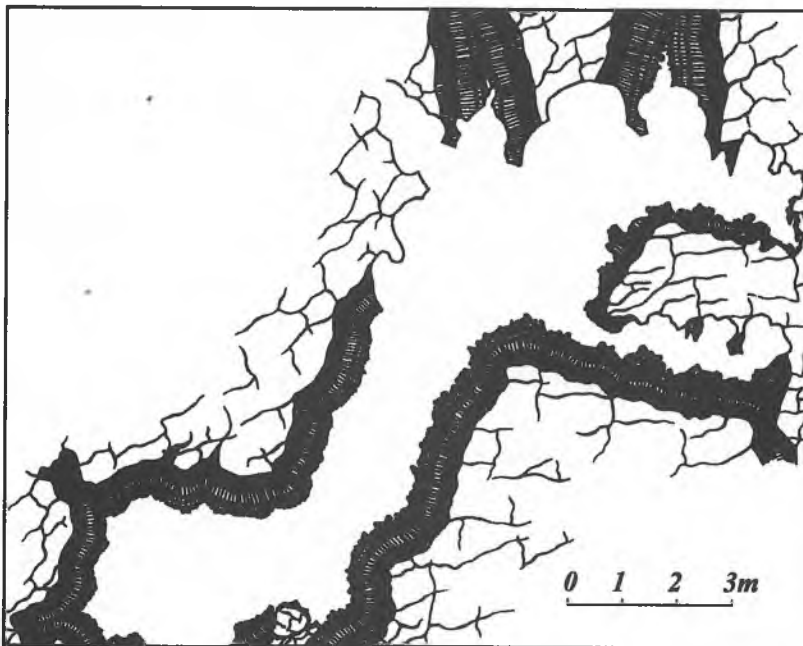

Figure 6. The composition of Krasnaya Cave, Uch-Kurgon region, with characteristic development of the karst along a hydrothermal carbonate vein.

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[9] Similar formations have been reported form the Blue Cave in France, where they are described as aragonite shields (Cabrol, in Hill and Forti, 1997). When built from calcite, thsy are quite common in caves, appearing as small shields and welts.

[10] Calcite helictites usually appear as three-bunch accretions because a triangle is the simpllest solid construction. In "spur" helictites, which are originally four-bunch accretions, one bunch "dies" almost immediately. This structure caused some confusion for many years: when the bunches are spherocrystals, an accretion of three looks very similar to a monocrystal with slightly curved faces of the scalenohedron or rhombohedron, but these three faces belong to three different almost parallel spherocrystals.

Dissolution of calcite aggregates

In the karst cavities of Khaidarkan, signs of dissolution are most typical for the cave ceilings. The ceilings of cave halls are of a characteristic dome-like shape. They have been formed of numerous spherical corrosion surfaces with convex side turned into the host rock (Figures 2 and 6). At first glance these surfaces cut or "truncate" equally calcite aggregates of any composition and graininess (limestone, onyx, stalactite kora). At a more detailed examination they prove to be rough and splintery, formed of much corroded relics of calcite grains.

The dissolution is intensively revealed also on the surfaces of downward-facing cave wall protrusions. Similarly, dissolution of separate crystallictites (corallites) is most clearly revealed in their downward-facing parts. Moreover, there have been observed cases of intensive corrosion of the sides of crystals facing down simultaneously with intensive crystallization on the sides facing up (Figure 3b).

Signs of dissolution are also observed on stalactite aggregates. It is interesting that not only growth but the very existence of stalactites on a corroding cave ceiling continues only while solution from the crack in the ceiling flows over the stalactite surface. Once the supply is stopped, the dried stalactite immediately starts to dissolve. Dissolution continues until the place where the stalactite was reaches the level of the general corrosion front. There are cases observed when only one side of a stalactite becomes dry, while solution is still seeping over the opposite side. This leads to corrosion of the dried side of the stalactite simultaneously with development of the opposite one. As a result, peculiar stalactites are formed in the shape of sails full of wind, with a much eaten concave surface of corrosion[11].

The observations made are in contradiction to the asserted opinion of a strict succession of dissolution processes, with formation of the caves themselves and crystallization processes in them (Chikishev, 1973). In the caves of Khaidarkan and nearby areas, dissolution of the ceiling (i.e. formation and development of the cavity itself) is syngenetic to calcite deposition[12]. Also this draws attention to a regular selectivity of dissolution processes in caves depending on the direction of gravity, a regular correlation between dissolution in the upper parts of cavities and crystallization accumulation in the lower.

Assuming only one cause of gravitational dissymmetry of dissolution processes on cave ceilings and deposition of crystallictite kora, and taking into account the data (Cser and Maucha, 1968) about the mechanism of calcite crystallization from an aerosols, it is expedient to suggest

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[11] In Vladimir Maltsev's own collection there are several stalactites which in cross-section do not contain the usual stalactite core with a soda-straw. The angles between crystals show that the stalactite has moved about 20-50 cm from its original location.

[12] Khaidarkan is an extensive Hg-Sb-As deposition of hydrothermal origin (also containing a little Cu and some other elements). Hot water is no longer present, but there is a lot of highly mineralized water, some containing heavy metals. With one exception, the caves have all been opened by mines. The caves seem to have been formed in the deep phreas and then were first-generation mineralized in the shallow phreas. Their non-thermal development continues above the water table.

an oriented mass-transfer of calcium carbonate by the air of caves[13]. Calcite dissolved from the cave ceiling may by this way redeposit in the cave's lower parts[14].

Such a mechanism of mass-transfer seems to play a significant part in geological processes, appearing in the gas as well as liquid mediums. A preferred confinement of dissolution traces to crystal faces turned down, together with advantageous growth for the faces turned up, was repeatedly observed by us in vugs of Iceland Spar spread across the territory of Khaidarkan mines. The mechanism of gravitational distortion of the shape of crystals in solutions has been studied in detail by Yushkin (1971). The influence of gravity on the localization of dissolution in pegmatite cavities has been noted by Dymkov and Dymkova (1970). Numerous facts of this kind indicate the significant role of the gravitational descent of mineral particles breaking off the turned down surfaces of crystals during corrosion, and the participation of these particles in supplying the surfaces of aggregates turned up and the top faces of separate crystals.

In conclusion, it is relevant to recall similar gravitational elements in the composition of aggregates of minerals in hydrothermal veins, appearing due to matter supply being directed under the influence of gravity in a heterogenious solution (Dymkov et al, 1970). This similarity once more points to a common character of the laws of formation of aggregates of various minerals in endogenetic as well as exogenetic conditions, and allows the use of visually observed crystallization in caves as a model of formation for a range of aggregates and textures in endogenetic deposits.

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[13] The formation of mineral deposits in caves from aerosols is a contentious subject and has not yet been adequately provenb. Cigna and Hill (in Hill and Forti, 1997) give an overview of the current debate.

[14] The above description of multi-level textures of crystallictites more likely refers to the upwards circulation of water via the air, and downwards circulation via capillary films. Generally speaking, the cavity works as a convectional heat machine based on the presence of a pair of phase boundaries on the route of the geothermal heat flow. This completely explains the phenomena of syngenetic dissolution and crystallization, with gravitational dissymetry, appearing on upper texture levels.

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