N.D. DRONOVA, I.E. KUZMINA

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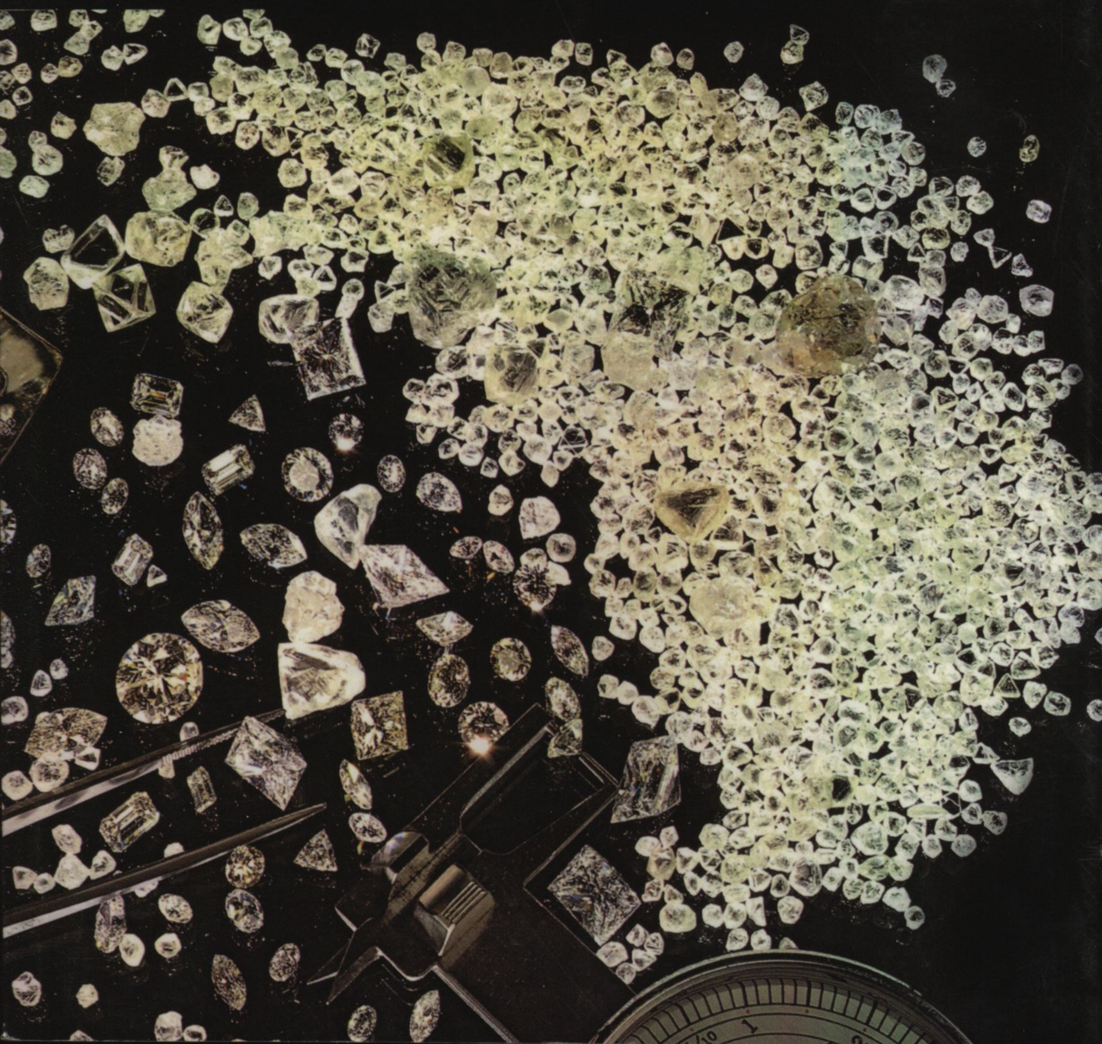
CHARACTERISTICS AND EVALUATION OF DIAMOND RAW MATERIALS



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CHARACTERISTICS AND EVALUATION OF DIAMOND RAW MATERIALS

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The present teaching aid observes characteristics and principles for evaluation of diamond raw material. The authors sorted out and discussed basic defects, peculiar to diamonds, their nature and classification. There are technical specifications for jewelry diamonds in this aid as well.

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INTRODUCTION

Diamond is one of the most beautiful minerals, created by nature itself.

Diamond is a mineral, which owing to its peculiar unique features, such as exceptional esthetic beauty, bright shining, wonderful light refraction, strong light dispersion, unordinary chemical resistance inertness, unsurpassed hardness, has occupied the leading position among all the precious stones for years. Brilliant, created as a result of skilled faceting of a diamond, is a unique adornment for women.

Average content of diamonds in kimberlites constitutes about 0,5 carats per 1 m^3 of mining rock, in placer – about 0,25-0,5 carats per 1 m^3. Basic diamond kimberlites are located in Russia and SAR. In general African continent is rich in natural and gravel deposits of diamonds (including offshore fields). In addition to SAR there are diamonds in Zaire, Botswana, Angola, Namibia, Ghana, Sierra-Leone and other countries. Gravel deposits and natural rich fields are located in Australia. There natural fields are represented as tube-like vertical bodies, but filled in with lamproite – magnetic rock, which in its content is similar with potassium high-alkali basalts (content of K_2O up to 10% and more).

The name of the fields is usually associated with the names of large kimberlitic pipes, with diameter of 0,5 km. For instance, "Kimberly" is a group of diamond fields in SAR. It has been developed since 867. The area is up to 195 thou. m^2; including 15 kimberlitic pipes. Basic center of production is Kimberly city.

"Premier" is a diamond field in SAR. Kimberlitic pipe is 880x500m. By the way, it is there that the largest diamond "Kuhllinan" of 3106 carats was produced.

In Tanzania there is a huge pipe "Mvadui" with diameter of 1,5 km being developed; pipes with diameters of more than 1 km are known in Botswana; large "Mote" pipe is located is Lesotho.

In Yakutiya large pipes are being developed in Mirny, Udachny and Aikhala. The largest mine of Australia "Argail" is engaged is development of lamproite pipes and associated placers.

Diamonds are produced in 20 countries. At the stage the production is executed by open-cut method from open pits. As soon as open pit reaches certain depth, underground operations start. Due to erosion of pipes, taking place for millions of years, diamonds were washed out with water, so now they can be found on the river bottoms and along the sea coasts.

State-of-art mining methods have caused the increase the production, but the process is still labor-intensive and expensive.

For diamonds from all the fields it is peculiar to have various crystals, that is caused not really by the richness of crystal forms but mainly by various character of facets' construction in crystals with equal forms and also by unusual variety of deviations of this or that forms of isometric habitus, which is usually called the demography of a crystal. Besides, exclusive peculiarity of diamond's crystals is extremely large circulation of curved-facet forms of rounded habitus and flat-facet-forms on which instead of direct sharp edges there are rounded surfaces. Due to strong deformation of crystals' habitus and development of complex sculptures on there facets, accurate identification of forms with polyhedrons, known in geometrical crystallography can be hard or impossible. When describing specific rounded and flat-facet forms of a diamond and various sculptures they have to use special terminology unusual for other rocks.

Almost in every country there are in-house classifications of diamond raw materials. Lately due to introduction of new methods and devices for sorting of diamonds the classifications are constantly improving.

1. FORMS OF CRYSTALS

All existing crystal forms of diamonds can be brought to sic crystallographic systems, that are different from one another by the degree of symmetry; the latter is determined by geometric correlation of certain lines, called crystallographic axes.

1. ***Cubical*** or ***regular*** system. Crystals with three equal axes, forming angles of 900 in between, are attributed to it. Plain and combination forms of this system are introduced in Figures 1-19.

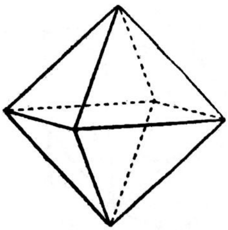


Fig. 1

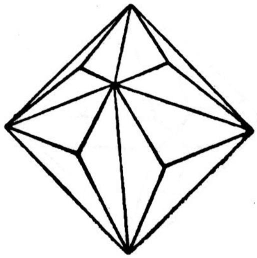


Fig. 2

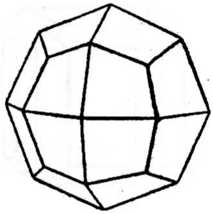


Fig. 3

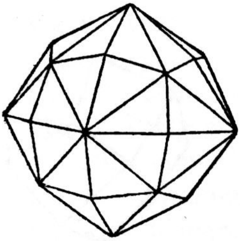


Fig. 4

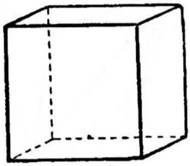


Fig. 5

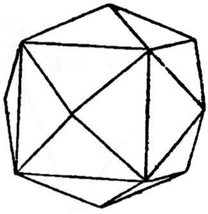


Fig. 6

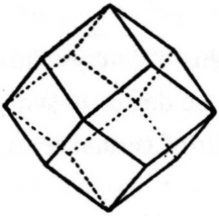


Fig. 7

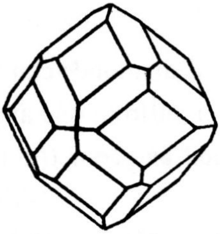


Fig.8

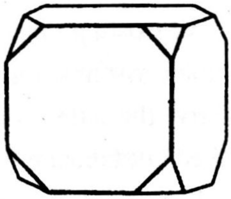


Fig. 9

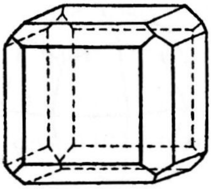


Fig. 10

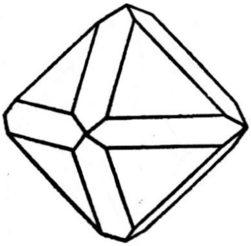


Fig. 11

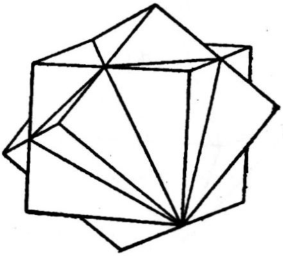


Fig. 12

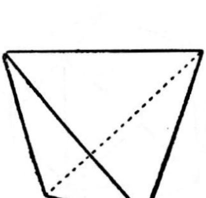


Fig. 13

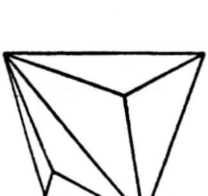


Fig. 14

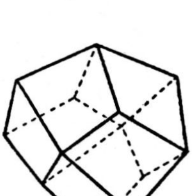


Fig. 15

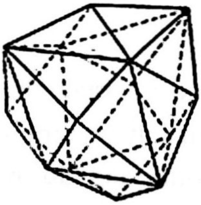


Fig. 16

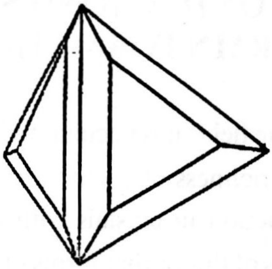


Fig. 17

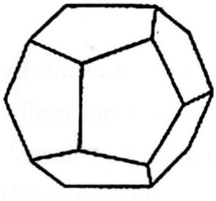


Fig. 18

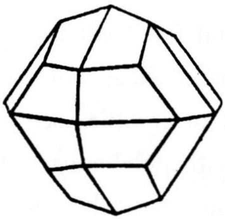


Fig. 19

Cubic crystals:
Fig. 1 – octahedron
Fig. 2 – pyramid octahedron
Fig. 3 – trapezohedron
Fig. 4 – hexoctahedron
Fig. 5 – cube
Fig. 6 – pyramidal cube;
Fig. 7 – rhombic dodecahedron
Fig.8 – combination of rhombic dodecahedron and trapezohedron
Fig. 9 – combination of cube and octahedron
Fig. 10 – combination of cube and rhombic dodecahedron
Fig. 11 – combination of octahedron and rhombic dodecahedron
Fig. 12 – cube germination twin
Fig. 13 – tetrahedron
Fig. 14 – pyramidal tetrahedron
Fig. 15 – deltohedron
Fig. 16 – fractured pyramidal tetrahedron
Fig. 18 – pentagonal dodecahedron
Fig. 19 – fractured pentagonal dodecahedron

2. MORPHOLOGY OF DIAMOND'S CRYSTALS AND ITS GRAIN FORMATIONS

For diamonds from all the fields it is peculiar to have various crystals, that is caused not really by the richness of crystal forms but mainly by various character of facets' construction in crystals with equal forms and also by unusual variety of deviations of this or that forms of isometric habitus, which is usually called the demography of a crystal. (Fig. 20-23). Besides, exclusive peculiarity of diamond's crystals is extremely large circulation of curved-facet forms of rounded habitus and flat-facet-forms on which instead of direct sharp edges there are rounded surfaces. Due to strong deformation of crystals' habitus and development of complex sculptures on there facets, accurate identification of forms with polyhedrons, known in geometrical crystallography can be hard or impossible. When describing specific rounded and flat-facet forms of a diamond and various sculptures they have to use special terminology unusual for other rocks.

Crystals of octahedral form with sharp direct edges and ideally flat facets are comparatively rare among diamonds.

On the tops of octahedral crystals instead of sharp direct edges there are usually rounded surfaces, which slightly blunt the tops and are separated from one another with clearly represented curved edges, as seen on a crystal.

In majority of crystals direct sharp edges are practically absent and instead of the there are narrow rounded surfaces getting wider towards the tops of the crystal. Due to this fact crystals get the form of octahedron with wide rounded edges. On the tops of such crystals, excluding curved edges, at the top there are curved lines, usually called n-hedral seam. N-hedral seams are developed in the middle of rounded edge or can be shifted towards one of the topes of axes to a variable extend.

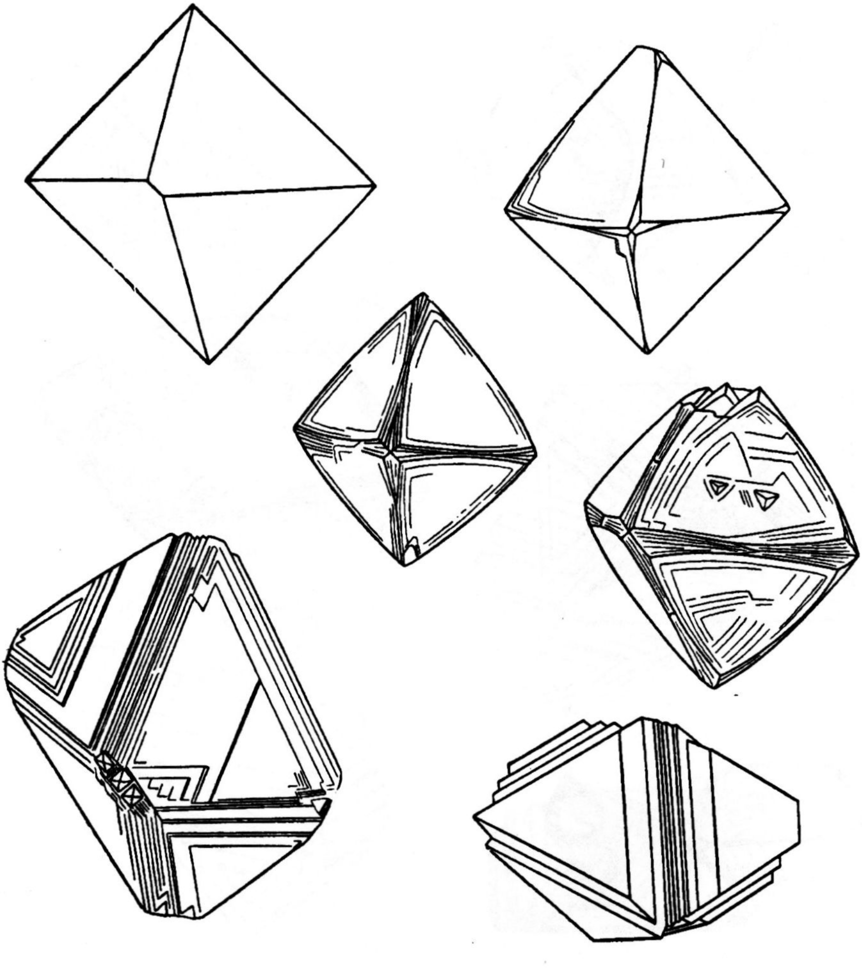


Fig. 20. Octahedral crystals of diamond

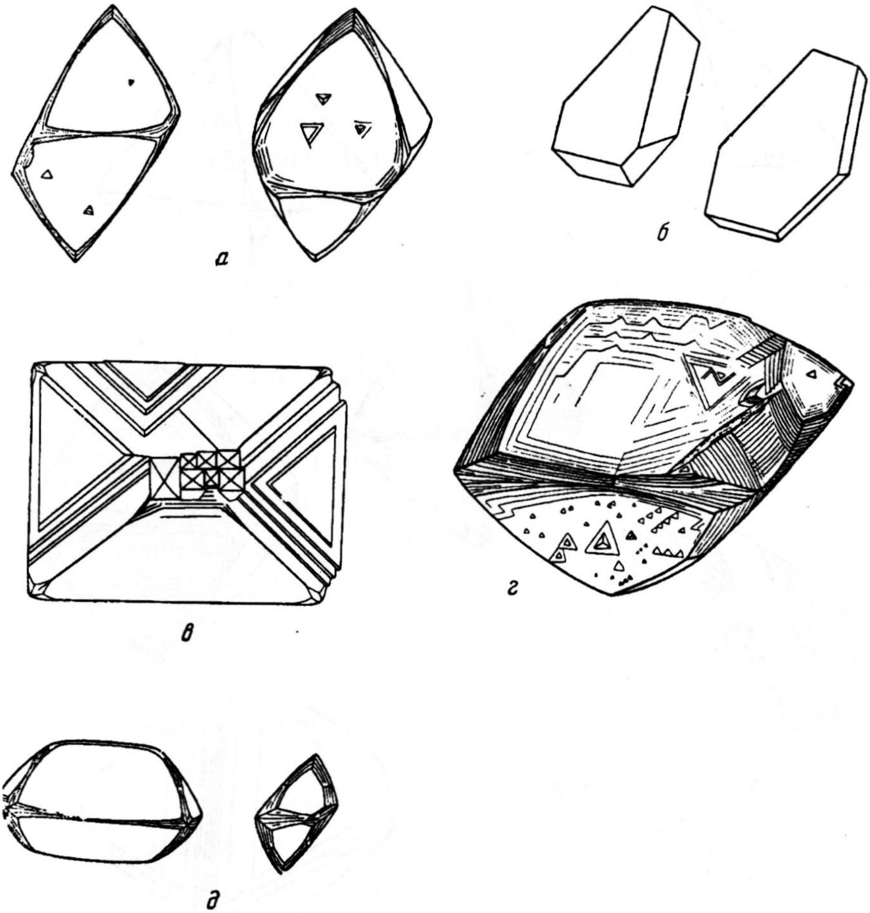


Fig. 21 Deformed octahedral crystals of diamonds

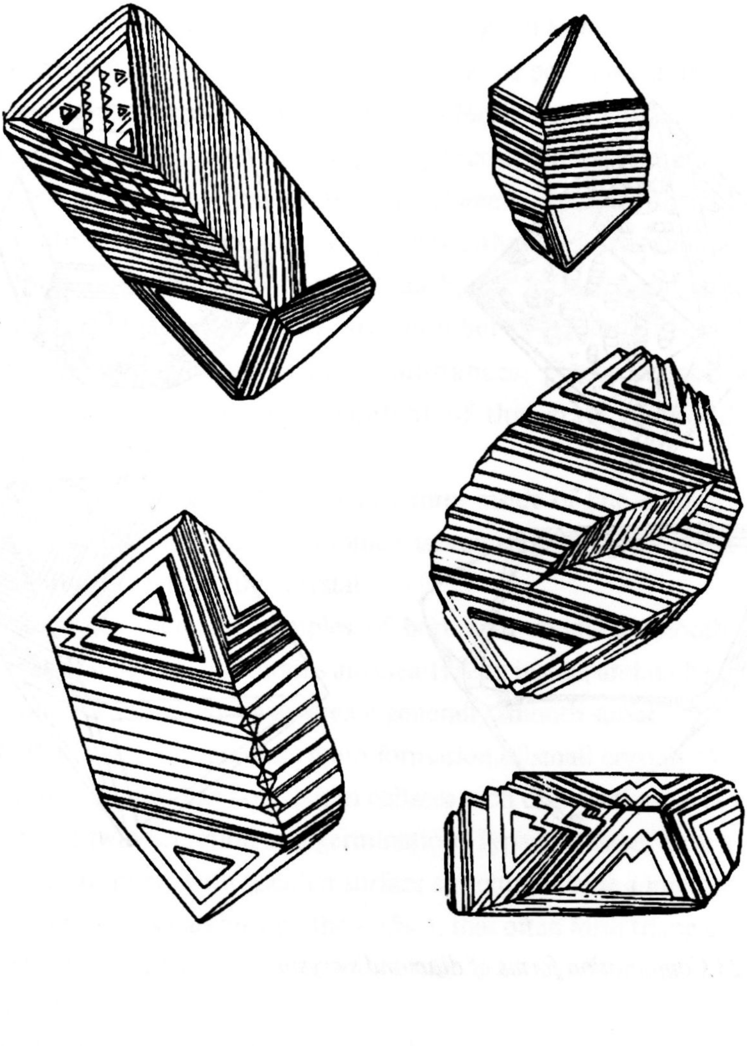


Fig. 22 Deformed octahedral crystals of diamonds with lamellar development of facets.

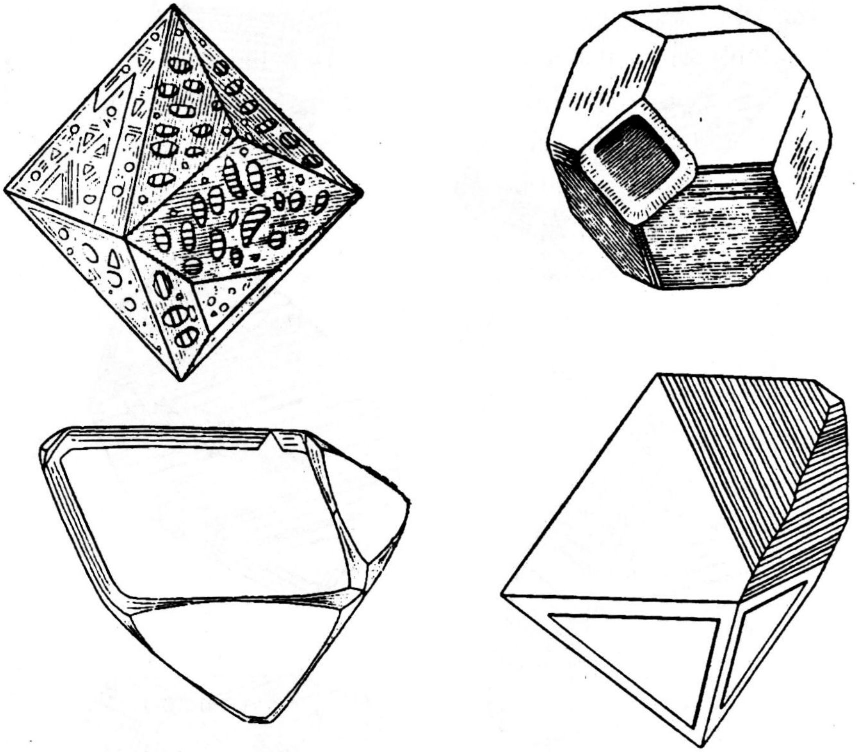


Fig. 23 Combination forms of diamond's crystals

3. GRAIN FORMATIONS OF A DIAMOND – BORT, BALLAS AND CARBONADO

They single out three types of diamond's grain formations – bort, ballas and carbonado. Each of these varieties has some peculiar features.

Bort (Fig. 24) is a joint of small (clearly seen with a bear eye or using microscope) crystals and poorly facetted diamond grains, either oriented or disorderly accreted in between, forming irregular-form aggregate. Many crystals grow together either as spire twins or in parallel position. As a rule, bort has dark, sometimes completely black coloring, that is explained by large number of graphite insertions into diamonds, and mixture of other substances, pieces of stratums and rocks, that makes chemical content of this grain diamond variety much more complex.

Bort often has unevenly grain structure; inside of fine-grain mass there are more or less large grains; in some cases small grains grow in the form of a shell around a single large crystal.

Sometimes there are samples of bort with rounded smooth surface. Outlines of separate small grains are clearly seen inside, and such grains look like polished and in aggregate create generally smooth surface.

Ballas (Fig. 25) represents grain formation of small crystals clearly seen in microscope, just like bort, but in ballases such crystals are places primarily in cyclic twin accretion and germination. Typical ballases have a form of almost ideal sphere with peculiar surface structure. Using a microscope one can see a complex hatching on the surface, that often form triangle and pentagonal rings just like on star-shaped cyclic twins consisting of five octahedral crystals.

Ballases can be semi-transparent and opaque. They feature milk color due to the presence of numerous microscopic insertions of diamond grains present in the top area. Due to insertion of tiny flake graphite forms in the top area of a crystal ballases often have gray and sometimes completely black color.

Usually inside ballases there are large grains or one comparatively large crystal, which is covered by small-grained shell. Crystals covered with small-grained shells located in the form of a nucleus inside a ballas have octahedral form. When such shell is thin there are cases when tops of transparent diamond monocrystals protrude from small-grained mass. On the uneven surface of rounded grain of ballas sometimes one can more or less clearly see lines, coming towards edges of curved-faceted crystals. These lines are the continuation of clearly represented edges on tops of monocrystals protruding from fine-shaped mass.

Carbonado (Fig. 26) represents microscopic grain or cryptocrystalline formations of a diamond. Their grains are often small and have form of angular splinters. Angles and tops are not sharp, and rounded to various extent. In some cases carbonado grains get rounded in case of intense smoothing of angles.

Carbonado has peculiar smooth and sometimes intensely shining surface. When using microscope with great magnification one sees distinguishable separate diamond grains, it can be notices that unified smooth rounded surface of carbonado is formed with an aggregate of rounded surfaces of single grains, having table-cut form.

Surface of carbonado always has a bit different or sharply different color if comparing with the color of internal mass and is colored from dark-brown to black, dark-violate, green-gray, brownish and light-gray color. Sometimes there are green pigmentation spots notices.

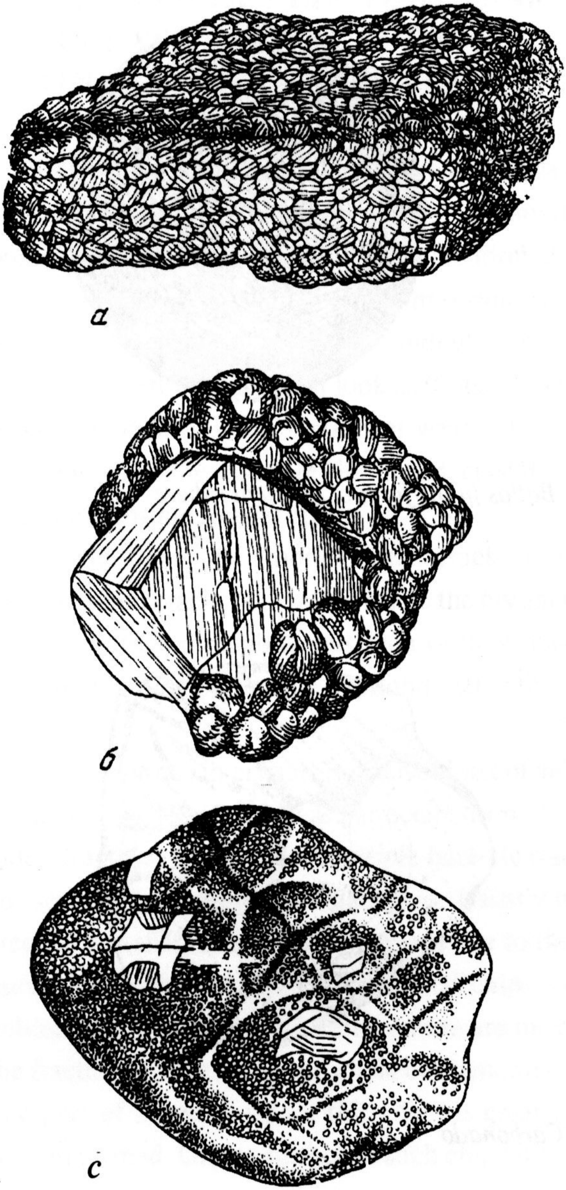


Fig. 24. Irregular concretions of small diamond crystals – bort

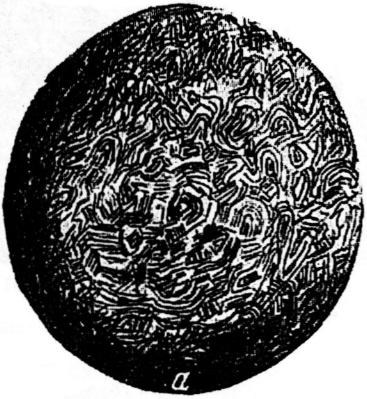


Fig. 25. Ballas in the form of an ideal sphere

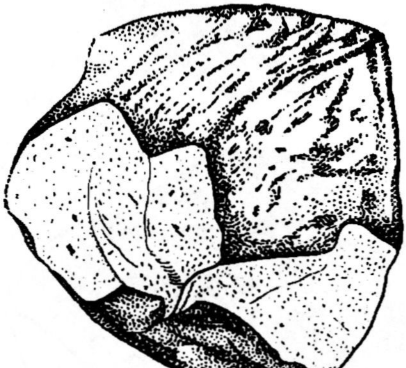


Fig. 26 Carbonado

4. CHARACTER OF ALLUVIAL WEAR, CLEAT AND FRACTURE ON DIAMOND CRYSTALS

On diamond crystals from gravel deposits in some cases one can notice traces of alluvial wear. During the transportation of diamonds in water streams due to bumps tops and edges chip, and dents are formed on the surface. In the result edges and tops get blunter and faint opaqueness is formed on the facets. With small rate of cleat only tiny roundness of edges and tops can be marked, and the facets of the crystal look as if dusted when looking though a microscope. In case of more significant wear the tops get more rounded and even blunter, and the edges are eliminated; crystal gets the form of sphere-like grain with opaque rough surface.

When bumping on the facets of diamond crystals cracks of various sizes and nature are formed. Such cracks penetrated inside the crystal to different depth. Cracks follow cleavage directions, but such of them have blistered nature as well. In case of strong bumps the diamonds get cracked, forming splinters of various size.

Nature of chips and fractures in crystals is diverse. First of all their morphology is determined by perfect cleavage as per octahedron.

Complex graded fractures in forms of multiple bare cleavage flats are created in one or several directors on the diamonds. Usually on the bare flats of chips direct or fan-shaped hatching is formed due to thin interlayer fracture. In some cases one notices ideal blistered chips with smooth surface, but combined ships of graded-blistered nature are most common. The nature of the fracture is affected by the grade of diamond deformation flexibility. On the part of a crystal where this effect is greatly developed blistered chip is often formed. On the surface of such chip curved stripes of glide lines are seen.

In some cases fracture of diamond crystals take place when they are still in mother rock. Development of corrosion opaque "film" on the surface, having peculiar mechanical ships, speaks for this fact. Fracture of crystals within the rock happen due to various reasons. Quite often there are strong tensions near insertions that cause the formation of cracks and sometimes fracture of a crystal. Cracks around insertions develop sometimes in the form of single disks, most commonly in several directions, crossing with one another. That is why when they are studied one notes that they look like a bunch of radial nature. Walls of cracks are often subject to graphitization and are clearly seen inside a diamond. In some cases they have blistered nature that results in graphite developing according to such cracks has a form of curves petals.

When studying crystals with the help of polarization microscope they always find tensions in areas of flexible deformation. They become apparent in the form of areas of abnormal double-refraction, subordinate to octahedral glide planes.

In same cases due to uneven development of flexible deformation spontaneous fracture of crystal into two halves takes place strictly according to the border of intensely and faintly deformed part of a crystal. The border is visible due to the fact that intensively deformed part of a crystal is colored in smoked-brown color, while the other part remains colorless. Although such cases are quite seldom but quite authentic, as were observed by experts on sorting of diamond crystals.

Strong internal tensions in diamond crystals are sometimes meet without any clear signs in their flexible deformation. Diamonds with large internal tension can easily get cracked when polished, or slightly bumped, heated and etc.

5. BASIC CHARACTERISTICS OF DIAMONDS, WAYS AND CRITERIA OF THEIR MEASUREMENT

Specialists claim that there aren't two equal diamonds in the world. Through "De Birs" company more than 500 million pieces of diamonds go annually and each has its own "face". Some have cracks the others are with various insertions, which shall be eliminated from the stone thus loosing the weight of a diamond. They have various colors. No doubt "the best" diamonds of "pure water" are those getting invisible in water. There are few of them, the majority has these or that color shades from light-yellow to black. Stones are various in form and size. All individual properties of diamonds later on influence the quality and price of final "product"- brilliant, jewelry.

Diamond raw materials are sorted as per several thousand categories, in particular there are fourteen of them is CSO. Each category has its listed price. The range of prices is incredibly high from several dollar to many tens of thousand of dollars per carat. For instance diamonds, produced by well-known Australian company "Argail", that according to the weight of raw material produces more than one third of all the world extraction, are evaluated in average as ten dollars per carat. And if one takes the cheapest diamonds, then the price decreases down to tens of cents only.

So, each diamond has its specific features, determining its value: weight (size), pureness (quality), color, form of crystal. International unit for measurement of gems' weight, including diamonds, is metric carat, equal to 200 mg. The size of diamond raw material is expressed in conventional screen classes, determined by the number of screed with the size of hole in mm ***(Table 1)***.

Dimension of diamond raw materials (conventional screen classes)

No of a screen	*Size of screen's hole, mm*	*Conventional screen class*
-	-	-3
3	1,47	-5+3
5	1,82	-6+5
6	2,15	-7+6
7	2,46	-9+7
9	2,84	-11+9
11	3,45	-12+11
12	4,09	-13+12
13	4,52	-21+13
21	7,93	-23+21
23	10,31	+23

Weight of diamonds is determined with electronic scales with the accuracy up to 0,001 of carat, and the dimensions – through screening of diamonds.

Pureness or quality of crystals is determined by the number of sizes and contrast of insertions, as well as physical defects such as cleat/ Determination of this parameter is executed with the help of 10-fold magnifying glass and for smaller sorts with the help of microscope.

Color of crystal is determined by the fact that each stone has a feature of selective absorption of light, coming through it and greatly depend on additions of metal oxides, which are not included into chemical formula, however are present in tiny quantities, that can hardly be stated even with the most accurate chemical analysis. Such diamonds, without any color shade, excluding a blue one, are the most highly estimated. Stones with faint yellowish shade are evaluated much lower. Yellow diamonds with various degree of color from faint-yellow to canary-yellow shade are the most widely spread. Green, brown, sometimes pink diamonds are also quite common.

The scarcest are ruby-red, pink-lilac and dark blue diamonds. Color of a diamond is determined visually against the background of white sheet of paper at the daylight.

Form of diamonds influences the price of raw materials. The most precious are diamonds in the form of octahedron with ideal facets. However such crystals are grown in ideal conditions. Natural crystals quite seldom are formed by means of ideally symmetrical growth; most commonly they are more or less disfigured. Sometimes instead of each facet of octahedron three or six facets develop and the stones gets almost spherical form. Surfaces of facets' crystals are often covered with equilateral triangles with hollows that are formed due to etching and dissolving.

By forces of soviet and foreign scientists classification of some varieties of macro- and microsculptures of a diamond's facets was elaborated. They offered to differentiate the following types of macrosculpture:

- ***trigonal growth layers*** – have directly rectilinear outlines with clearly visible strictly parallel hatching on the place of octahedron's edges.
- ***ditrigonal growth layer*** – thin growth layers of curvilinear outlines;
- ***polycentrism of facets*** – multiple real clearly layered ditrigonal scales, appearing due to migration of crystallization centers;
- ***block structure*** – multiple secluded curvilinear surfaces, connected with one another with smoothly curved lines,
- ***rounded-stepped facets*** – formed with edges of recessive thick layers of scales.

Ruggedness of microrelief characterized the amount of crystal's roughness:

- ***reversed parallel triangle dents*** on the facets of octahedron represent triangle dents in the form of truncated trihedral pyramids, created due to etching of crystals. Triangle dents on the facets of octahedron can be placed as single, or in groups forming regular linear pattern, and sometimes cover the entire octahedral facet. Sometimes in crystals one can see triangle dents of another nature, created by think triangles of scales protruding from one another;

- *fastigiated triangle projections* – are crystal growth wafers of octahedron's facet, located eccentrically in relation to it and oriented with its sides of the basis parallel to the edges of octahedron. Such projections have various heights from highly visible with slanting light beam to large trihedral, usually truncated, pyramids;
- *hexagonal dents* with facets of octahedron are placed in groups, covering sometimes the entire facet. They are more rare than triangle dents. Sides of hexagonal dents are usually parallel to corresponding sides of octahedron's facets;
- *tetragonal dents* on the place of octahedron's tops (negative tops) are most common on smooth-facet and rough-layered crystals of diamond. Such dents have an appearance of acute pyramid, in some crystals tops of such pyramid is truncated.

Besides the peculiarities of macro- and microsculptures, crystals of diamond are characterized by the presence of a large number of insertions of minerals, cracks and mechanical damages.

Olivine. Insertion of olivine are met in crystals in the form of isometric or equally prolonged (length/width ration 1:3) and flatted crystals with well-marked facets, as well as in the from of parallel and knee concretions. The size of insertions 0,5-1 mm as per long axes. Orientation of olivine's insertions in relation to crystallographic axes of a diamond is different. One sees single crystals and their groups of 5-10 pcs. of various sizes. Olivine insertions are usually colorless, transparent and that is why can be recognized as gas bubbles.

Garnets. Insertions of garnets are met in the form of isometric crystals with well-marked single facets, but mostly often in the form of grains of deformed and irregular form. The sizes of insertions are up to 0,2 mm.

Insertions of garnet are met in the form of single crystals and multiple grains, various in form spread inside of the crystal. The color of insertions is orange (Arizona ruby – almandine) or lilac-red (Arizona ruby).

Chromspinelides. Insertions of chromspinelides are met in diamonds more often than those of olivine and Arizona ruby; look like grains of dark, brown-cherry color. Form of insertions is octahedral, drop-, sphere-, dumb-bell-shaped, irregular. There are about 10-15 grains in one crystal. The sizes of insertions of chromspinelides vary with wide ranges from 1mm to tiny grains, barely noticeable at the large multiplication of microscope.

Sulphides. The most common insertions in a diamond are sulphides, represented in the form of point-like, lamellar, disc-like insertions, sometimes surrounding some insertion (as a rule, olivine). Quite often they form the so-called "rosettes", set up in disk-like cracks, located angularly to one another. In the content of such sulphide insertions there is pentlandite, pirrotine, chalcopirite.

Diamond. In crystals of a diamond quite often insertions of smaller diamond crystals can be met. Such insertions have a form of isometric sharp-edged or flattened, complex-deformed octahedrons. Orientation of insertions of a diamond in relation to master diamond can be various. Around such insertions, as a rule, there aren't any cracks, due to this fact they are not clearly seen.

Graphite. Graphite is met in a diamond most commonly in the form of thin black surface layer as per cleavage face.

Sometimes there are insertions of other minerals: diopsidae, ensthatite, koesite, rutile, ilmenite, zircon and others.

Special attention among defects in diamonds, influencing the processing, shall be paid to cracks, mechanical damages, caverns. The cracks are formed due to mechanical influences on the crystal or appear around insertions of other minerals, having ration of heat expansion different from the diamond. Sometimes there are deep rectangular or curved cracks, filled with brown ferric oxides and other secondary minerals. They can look like etching channels. The sizes of cracks are different: from submicroscopic to those crossing all areas of the crystal. Sometimes the crystals of diamonds have mechanical damages in the form of tops' chips and edges, indent of facets. As per sizes such damages are different: from tiny to really large. Usual chipping takes place according to cleavage flats, edges of chips often have stepped nature. Sometimes chips have blistered fracture.

Caverns usually look like dents or holes and most commonly develop as curved-faceted surfaces. Sometimes there are complex needle-shaped cracks, getting deep inside the crystal.

6. CHARACTERISTIC OF DIAMONDS' PECULIARITIES

So then the classification of jewelry diamonds as per shape is not homogeneous, and inevitably connected with the elements of subjectivism. This leads to the fact that one and the same crystals can be attributed to various groups.

After sorting of crystals as per shape their classification as per defects, quality, and presence of mixtures-insertions is carried out.

Defectiveness (quality) – number, nature and location of defects in a stone are evaluated. To specify location of a defect the crystal is conventionally divided into three (equally thick) areas: central, interim, peripheral. Although there isn't any common classification as per defectiveness, let us describe the outlines of such classification as per groups, the numbers of which increase as quality and value of the stone decrease.

1. Clear stones – during research with the 6-fold magnifying glass the defects are not see.
2. Minor defects – hardly seen with 6-fold magnifying glass.
3. Small defects – hardly seen with bear eye, but clearly seen with 6-fold magnifying glass.
4. Large defects – clearly seen with bear eye, there are insertions smaller than 0,5 of one area's thickness and cracks of small length.
5. Extremely large defects – insertions can be of the size not more than the thickness of one area of the crystal, there are cracks of decent length.

Here one should pay attention to ambiguity of the classification, presence of subjective element, as its most important tool is a human's eye.

After sorting as per defectiveness they carry out classification of stones as per color and its intensity.

As per color diamond raw materials is divided into six groups:

1. Colorless diamonds (without shades)
2. Diamonds with insignificant coloring (with slight shades)
3. Diamonds with small coloring (with more noticeable shades)
4. Diamonds with coloring (with clear shades of various colors)
5. Colored diamonds (have yellow, green, violate and other coloring)
6. Brown diamonds (have clearly seen brown shade).

Coloring is any shade, deferent from the color of purely white paper. Coloring of diamonds is determined by means of their comparing with the reference shades, and there are special devices for this purpose. However one should remember of ambiguity of classification here as well, and the presence of subjective element.

7. TECHNOLOGICAL PROPERTIES OF DIAMOND CRYSTALS

7.1. Cleavage

Cleavage is an ability of crystals to fracture or split under the influence of applied forces as per certain crystallographic flats.

Together with striking hardness, proper to diamond during its polishing, it is highly fragile, and cannot stand some significant load impacts and cracks as per cleavage flats. Cleavage is determined by force and number of connections as per one unit of area of flat network

In a diamond crystal the cleavage flats are parallel to flat networks and facts of octahedron.

Perfect cleavage of a diamond explains it high sensitivity to load impacts (in spite of the high harness of diamond). Due to crystals' chipping as per cleavage flats there are tiny figures in the form of octahedrons and tetrahedrons and sometimes tiny discs and columns.

7.2. Shining

Nature of shining is influenced by the state of reflecting surface. If there are even tiny pimples reflected light is partially dispersing and shining gets worse. If the flatness has opaque surface, its reflecting capability (shining) gets worse as well.

Optical features of a diamond determine parameters of processing for complete determination of sparkling and shining of a diamond.

The shining is determined by the ability of surface to reflect the falling light flow.

7.3. Transparency

Transparency is an ability of a body to transmit light rays.

As per the rate of transparency diamond crystals are divided into transparent, through which an image is clearly seen; semitransparent, through which subjects are hardly seen (gypsum); semi-transparent, transparent in thin layers only; opaque, does not allow light going through even in thin layer.

For the production of brilliants only transparent crystals are used.

7.4. Coloring

As per coloring natural diamonds can be divided into five groups: colorless, yellow, brown, gray and black. In each of four last groups there are shifts of coloring from light to dark shades. It is necessary to single out diamonds of various shades: greenish, bluish, violet and so on. In nature there are (quite seldom) diamonds with gorgeous dark-blue, red and green coloring (black diamonds of Orlova princess, blue diamond of Brunevik, Dresden green diamond, pink diamond "Pavel I" and others) they are highly evaluated. Black, the so-called Savoy, are also quite sparse. Many diamonds have uneven distribution of color: spots, stripes, connected with the presence of various mixtures in a crystal. Diamond crystals of rhombic-dodecahedron shape, extracted in mines of South Africa, have yellowish color, and the crystals of octahedron shape are colorless.

Nature of crystal's coloring has not been studies in full yet. Some researches attribute it to the presence of mixtures, the others think it is due to defects of crystal grill. According to the results of some studies the color of diamonds greatly depends on content of nitrogen atoms. Coloring in this case is determined by the replacing of carbon's atoms with nitrogen's atoms in diamond grill that causes he formation of "free" electrons, which absorb light power. Crystals of a diamond with insignificant nitrogen concentration have yellowish color, and with the increase of nitrogen concentration the diamond get brownish shade. Colorless diamonds do not contain nitrogen.

7.5. Luminescence

Luminescence is an ability of some bodies to glow under the influence of heating, pressure, ultraviolet radiation, cathode and X-ray beams, while some diamonds do not give visible glowing. As per the nature and intensity of glowing all diamonds can be divided into three groups: highly luminescent with various colors, slightly luminescent and non-luminescent.

Luminescence is one of the most important features of diamonds as per practical application. Under the pressure of visible light and especially cathode, ultraviolet and X-ray beaming, as well as in case luminescing, i.e. glowing with various colors. It is stated that under the influence of cathode and X-ray beaming all types of diamonds are glowing, while under ultraviolet rays only some diamonds can glow. Color of luminescence is various in diamonds and depends on stimulation way. For instance, when stimulating with ultraviolet rays some crystals glow with light blue color the others with yellow and greenish shade. Diamonds luminescing with various color in ultraviolet rays, can glow equally under X-ray beaming. Color of X-ray luminescence of natural diamonds is strikingly equal as a rule it is white-blue glowing. Taking into account the fact, that X-ray beaming gives one hundred percent glowing of diamonds, they are used to define and extract diamonds. Photoluminescence (glowing under radiation of ultraviolet rays) of diamonds is connected with their abrasive ability. It is stated that abrasive capacity of diamonds with blue and yellow luminescence, as well as diamonds, which do not show visible luminescence is significantly different. The hardest are non-glowing diamonds, and less hard are diamonds with blue glowing. Diamonds with yellow glowing take interim position. On the basis of optical features of diamonds there was classification of diamonds offered, the grounds of which were differences in spectrum of their luminescence, at the same time coloring and morphological peculiarities of diamonds, content of mixtures and degree of crystal grill. Non-luminescent diamonds, transparent up to 255 nm, are chemically the most pure, and their crystal grill has minimal quantity of defects. Such diamonds are united into the first group. The second group includes diamonds with the boundary of transparency 285-290 nm. Diamonds is other groups (totally 10 groups) differ in content of mixtures, degree of crystal grid's perfection and etc.

When sorting diamonds as per color of luminescence one can apply mercury-quarts lamp SVD-120A with light filter UFS-3 as the source of stimulation, and for observance, one can use binocular microscope MBS-2 with blanking light filter ZH-3.

7.6. Double-refraction phenomenon

Diamond is an optical isotropic mineral and does not produce double refraction. When watching the crystal of a diamond, free from any tension, in polarized light, the crystal looks dark. But if any part of a crystal is in tensed condition, with light coming through such spot they see something similar to double-refraction. When discovering effect, typical of double-refraction, one can claim that the crystal has some insertion (even if it was not found with the held of an ordinary microscope).

Basic reasons for double-refraction of a diamond are zonal-sector distribution of mixtures and action of external dynamic loads.

Chips of edges, facets and tops provide the presence of local tensions. If there are insertions in a crystal the double-refraction pattern has rather complex nature, and if there are chips there are chips one sees combination f several double-refraction patterns.

Study of diamond crystals under microscope gets a bit complicated due to high index of refraction that is why research is carried out with the help of polarized microscope.

As per the nature and intense of interference pattern's coloring, received during the research of a crystal in polarized lights in terms of crossed nicols. According to such feature tensions are divided into those of 1st rank and 2nd rank. Classification of tensions per patterns of double refraction, reasons for their appearance and influence on processing in general is shown in Table 2.

Determination of nature, location and amount of tension greatly influences further processing of a diamond. That is why some foreign companies make researches and sorting out of diamonds prior to cutting as per tensions.

Table 2

Influence of various tensions on processing of diamond crystals

Characteristics of double-refraction pattern	***Influence of tensions, caused by corresponding double refraction, on the processing of diamonds***
Isoclines of various pattern and color, caused by several types of tensions (volumetric cracks due to foreign insertions and etc)	When cutting such crystals, and in case the cutting plane goes through tension center or within immediate proximity of it, semi-finished products can have new cracks, or old cracks can grow to the sizes, making further processing inexpedient without prior cracking. In some crystals tensions can decrease after curring.

Table 2 (continuation)

Characteristics of double-refraction pattern	**Influence of tensions, caused by corresponding double refraction, on the processing of diamonds**
Dark or colored isoclines, caused by tensions, located at the top of cracks, chips of edges, tops, facets, formed due to impact of external mechanical forces.	New cracks, as a rule, are not formed : sometimes when cutting device is going through them old cracks are formed. There can be risks, in this case cutting process is decreased.
Dark or colored isoclines, forming various pattern, caused by tensions, due to hard insertions of foreign minerals.	In terms of bright colors of interferential pattern during curring near insertions of semi-finished products the cracks can be formed, making it necessary to perform cutting prior to further processing. If cutting devices goes along outlines of tension, some minor cracks can be formed, while the order of tension can decrease.
Dark isoclines, caused by tensions, connected with zonal-sector distribution of mixtures.	Do not have serious influence on cutting process.
Bright white and dark, sometimes colored areas – "phantoms "	When cutting device goes through light " phantoms : intensity of the process gets decreased, and deep risks can appear.
Black and white or colored patterns, caused by tensions of plastic deformations along glide plane	If a crystal with patterns of double refraction is cut some risks or even cracks can be formed.

8. CLASSIFICATION OF DIAMOND RAW MATERIALS

Exclusive position of diamonds in a row with other precious stones draws special attention to the development of evaluation classifications both for non-facetted diamonds, and for brilliants. Variety of forms, weight classes, purity and color groups of diamond crystals, as well as permanently changing market situation introduce peculiar difficulties when developing evaluation classifications and price formations. At present in many countries there are different variant of diamonds' classification depending of their form, weight, types of defects and color.

All diamonds are divided into two categories: jewelry and technical. Below is a classification of diamonds depending on the intended use:

1) ***Jewelry diamonds***

2) ***Technical diamonds*** for tips of measuring devices; drawing machines; drills; cap jewels in marine chronometers; glass cutters; wheel dressing and for well-drilling devices

Inside classification groups diamonds are subdivided into great number of groups and subgroups, characterizing diamonds as per shape, weight, number of defects and color.

When sorting diamond raw materials as per shape, they usually take into account the rate of deformation (distortion) of crystals' shapes, preservation of natural crystal form and the rate of facets' sculpture.

As per the rate of a crystal's deformation diamonds are divided into the following groups:

Regular form............................ 1:1
With tiny distortion .... up to 1,5:1
with small distortion........................ 2:1
distortion.............................. 3:1
with significant distortion 4:1
Lamellar and needle-shaped .... more than 4:1

Degree of deformation is the amount, characterizing the ration of crystal's sizes as per crystallographic axes. Relation of sizes as per axes of maximum prolongation is taken as an amount of distortion.

As per preservation of natural form, crystals are divided into whole and fragments. Whole crystals are undamaged diamonds, as well as crystals, chipped for not more than 1/3 of the original form provided such chips do not significantly distort the original form of the crystal. A fragment of a crystal is its part, constituting not less than 2/3 of its original volume.

As per the development rate of facets' sculpture, diamonds have the following features:

- crystals with smooth facets;
- with insignificant gradation
- with small gradation;
- graded and crystals with sharp gradation.

In order to clarify the location of defects, crystals are divided into three areas: central, interim and peripheral. Thickness of areas is conventionally equal.

To determine the size of defects in crystal of a diamond the following classification is implied:

- ***pure crystals*** – when watching with six-fold magnifying glass defects are not noticeable;
- ***insignificant defects*** – with six-fold magnifying glass defects are hardly seen;
- ***small defects*** – defects are hardly seen with bare eye, but clearly seen with six-fold magnifying glass;
- ***large defects*** – defects clearly seen with bare eye, insertions have size not more than ? of thickness of one crystal's zone, cracks can cross all peripheral area of a crystal or cut off (parallel to the facet) not more than one half of peripheral area;
- ***huge defects*** – insertions can be not more than the thickness of one

of crystal's areas; cracks can cross not more than the half or cut off (parallel to the facets) not more than one thickness of peripheral area.

In addition to the form and quality (types of defects) diamonds are characterized by color. ***Coloring*** is any shade, deferent from the color of purely white paper. As per floor diamond raw materials are divided into the following colors:

- ***colorless diamonds*** (do not have any color)
- ***diamonds with insignificant coloring*** (have hardly noticeable shades)
- ***diamonds with small coloring*** (have more noticeable shade);
- ***diamonds with coloring*** (have clearly seen shades of various colors);
- ***colored diamonds*** (have yellow, green, violate and other shades)
- ***brown diamonds*** (have clearly seen brown shade; depending on the intensity of a shade there are two colors).

Coloring of diamonds is determined comparing with reference shades.

Depending on the view of a diamond they are divided into transparent, semi-transparent and opaque.

Let's observe classification of diamonds according to Central sorting organization (CSO) of Diamond syndicate of "De Beers" group and some other peculiarities of national classification.

In this classification the main features are:

- weight of a single diamond
- its form;
- character of surface (presence or absence of roughness, grades, sharp edges on the surface)
- color;
- defectiveness (flaws of quality, namely cracks, internal insertions of foreign substances, for instance graphite, chrysolite and etc)
- presence of joints and ingrown diamonds into diamonds.

Jewelry diamonds are sorted firstly into two categories:

1) Size – stones of 1 carat and more are attributed here;
2) Mele – crystals less than 1 car.

In "Size" category stones are sorted into greater number of size groups due to their great value in comparison to "Mele". When sorting per forms, each group has its own name, according to decreasing value.

1. Diamonds of jewelry form "Stones" – crystals of regular or slightly distorted form, 1-10 carats.
2. Diamonds of jewelry form "Shapes" – crystals with significantly distorted form, 1-10 carats.
3. Diamonds with jewelry form "Cleavage" – crystals with large chips and fragments of crystals, 1-10 carats.
4. Diamonds with jewelry form "Macles" – spinel twins and their fragments, 1-10 carats.
5. Diamonds with jewelry form "Flats" – highly flattened crystals and their fragments of 1-10 carats.
6. Diamonds of jewelry form "Mele" – crystals of regular and slightly distorted form, of 0,10-0,99 carats.
7. Diamonds of jewelry form "Cleavage mele" – crystals, with large chips and fragments of crystals, of 0,10-0,99 carats.
8. Diamonds of jewelry form "Macles mele" – spinel twins and highly flattened crystals and their fragments of 0,10 to 0,99 carats.
9. Jewelry diamonds "Small mixed" of 0,10 carats.

"Cleavage" group is the most numerous. Not all the crystals, attributed to it, are fragments according to crystallographic notion, there are diamonds in this group, which are of imperfect form or have cracks.

"Macles" group includes twins with thickness, significant for production of round brilliants.

"Flats" category includes diamonds, which are too thin for the production of large brilliants. Sometimes "Flats" and "Macles" diamonds are united into one category.

After selection of crystals as per shade they are divided into groups of various quality.

There are ten categories of quality, numbered from 1 to 10. Of them only five categories of stones attributed to "Stones" and "Shapes" are considered to be jewelry, however taking into account great demand, up to seven categories can be attributed to jewelry.

The following stage is sorting of diamonds as per color. Here are ten classes as well. Crystals from 1st to 6th-7th classes are considered jewelry, the others are technical.

Other classifications are based on the same main principles. Only gradations can vary. Besides, for unusual (for Russia) diamonds the following terms are used:

- ***coated*** – pure diamond, covered with low-quality crust;
- ***frozen*** – diamond, covered with microcrystals hoarfrost;
- ***fancy*** – fantasy (i.e. highly unusual) diamonds.

International dealers also use "geographical" terms for classification of diamonds' types. For instance, Angolan diamond or Brazilian diamonds.

For instance, diamonds from placers are usually rounded, smooth. Stones from African field Kleinsee have matt surface, and from neighboring field in Namibia they are less matt but shining and glowing. Yakutiya diamonds, even from placers, have polygonal forms with sharp edges (as they say "well shaped") there are a lot of colorless stones with soft shining. Such diamonds are primarily crystals with octahedral rhombic dodecahedral and transferable (from octahedron to rhombic dodecahedron) habitus. Much more seldom there are crystals of cubic appearance. The peculiarity of Yakutsk diamonds is their lamellar structure.

Australian diamonds are usually brown. Surface is rough, as if covered with tiny caverns. On the facets one can see tiny pattern consisting of groups of polygons, most commonly rhombs and hexagons. Quite often whole crystals have interrupted layer of diamond grains, grown in, during ancient times during crystallization process. Such diamonds reminded Australians sweets, and that is why they often use "sugary diamonds" term.

Brazilian diamonds have rounded smooth-facet form, in which decagon is seen. Matt or shagreen surface is not typical. Stones are light and transparent. By the way Ural diamonds are quite similar with Brazilian ones.

8.1. Technical specifications of jewelry diamonds

Classification of diamond raw materials in former USSR is a bit different from that international and was determined by technical specifications, introduced since January 1st 1975. (Diamond raw materials. TU-47-2-73. M: Ministry of finances of the USSR, 1974). To correctly determine the most optimal structure of range for exported diamonds and compare with international classification of diamonds below is the general outline of interunion classification of diamond raw material, which is practically in force even in nowadays.

Depending on the types and intended use, diamond raw material is classified according to nine categories:

I – jewelry diamonds;

II – light diamonds of lower quality for jewelry production;

III – technical diamonds for instruments made of crystals;

IV- technical diamonds for drilling instruments and single-point diamonds;

V- technical diamonds of lower quality for preliminary processing;

VI – diamond concentrates;

VII – diamonds for special purposes;

VIII – technical diamonds, preliminary processes for instruments made of diamond crystals;

IX – mechanically rounded or fragmented diamonds;

Of the above nine categories mainly diamonds of the first and second groups are used for the purpose of jewelry production.

Each category of diamond raw materials is subdivided into groups and subgroups. Groups of diamond raw material of the first category determine the size of diamond crystals, while subgroups determine the form of crystals. Groups of diamond raw material of the second – nine categories determine its intended use, while subgroups determine its specific target application.

Range of exported diamonds in the former USSR and nowadays is represented mainly by diamond of the first and second categories.

The dimension of diamond raw material in these categories is expressed similar with the international classification, in carats and conventional screen classes.

Diamonds of the first category depending on their size are subdivided into three groups.

The first group is represented by diamonds of conventional screen classes 9-3. Here are diamonds different as per shape: whole crystals, smooth faceted, rounded and with grade, fragments of crystals and spinel twins. Degree of defectiveness of diamonds attributed to the first group is insignificant, there are pure diamonds, with tine defects or singular large defects (i.e. of the highest and average quality characteristics).

The second group is represented by diamonds of conventional screen classes – 13+9. The group consists of three subgroups. Subgroup "A" is represented by whole crystals of regular shape, small distortions and gradation are permitted. Subgroup "B" is represented by isometric fragments of smooth-facet crystals and crystals with small gradation and ingrown elements. Subgroup "C" – whole crystals with severally distorted and spinel twins. As per quality content the group is also represented by diamonds of high and average quality features.

The thirds group includes diamonds of weight groups from 1 to 20 carats. As per the shape of diamonds five subgroups are singled out. Subgroup "A" is represented by whole crystals of diamonds, regular form and with small gradation or insignificant distortion. Subgroup "B" consists of whole crystals with the large rate of distortion and gradation. Subgroup "C" is represented by whole crystals with sharp gradation and isometric fragments of smooth-facet and graded crystals, ingrown elements. Subgroup "D" includes whole, greatly flattened crystals of diamonds and their fragments, while subgroup "E" – spinel twins and their fragments. As per quality content diamonds of the thirds group are represented by the raw material of high and average quality features.

Second category of diamond raw material includes one group – i.e. fourth, which is represented by diamonds of conventional screen classes +12 + 3 (includes all size groups, embraced into the first category). Depending on the shape of diamonds they single out "A" and "C" subgroups represented by the whole crystals, smooth-facet, rounded and with sharp gradation, and subgroups "B" and "D" represented by isometric fragments of smooth-facet and sharply graded crystals, spinel twins and their fragments, ingrown elements of crystals, distorted fragments, distorted spinel twins and their fragments. As per quality content the latter includes jewelry diamonds of the lowest quality properties and close-to-jewelry diamonds, for which high rate of graphitization and fracturing are typical.

Each category of jewelry diamonds depending on the weight, form and types of defects of crystals is divided into three groups: crystals of weight up to 1,15 carats, crystals weighing from 0,15 to 0,99 carats; crystals from 1,00 carats and more.

Three groups for division of diamonds as per weight are subdivided into smaller weight groups.

Weight group in carats.

Ist group	up 0,03	IIIrd group	1,00-1,79
	0,03-0,05		1,80-2,79
	0,05-0,07		3,80-3,79
	0,07-0,11		4,80-5,79
	0,11-0,15		5,80-6,79
IInd group	0,15-0,30		etc.
	0,30-0,50		
	0,50-0,99		

1,2 and 3 groups are divided into subgroup. Each subgroup characterizes a shape of crystals:

a) whole crystals of regular shape with tiny distortions; smooth-facet, with small gradation;

b) whole crystals with small distortion and with gradation of facets;

c) whole crystals, fragments, parallel joints, crystals with irregular ingrown elements and sharp gradation

d) whole crystals – flattened, their fragments with small gradation;

e) spinel twins and their fragments, whole crystals with twin germination and gradation

In all subgroups (excluding "E" subgroup) the presence of cut, split and polished crystals is allowed.

Classification of jewelry diamonds depending on the amount and location of defects is shown in ***Table 3.***

Table 3.

Classification of diamonds depending on the amount and location of defects

Group	*Subgroup*	*Number of quality*	*Quality characteristic of diamonds*
1	a	1	Pure diamonds with insignificant defects in peripheral area of crystal or on the surface of a crystal
		2	Diamonds with single small defects in peripheral area of a crystal
		3	Diamonds with small defects or single large ones
2	a	1	Pure diamonds and with single insignificant defects in peripheral area
		2	Diamonds with single insignificant defects in central area of a crystal or single small defects in peripheral area of a crystal.
		3	Diamonds with single small defects in central area of a crystal or single small defects in peripheral area or several insignificant defects in various areas of a crystal.
		4	Diamonds with single large defects in the central area or several small defects in various parts of a crystal.
	b	1	Diamonds with single small defects in peripheral area of a crystal
		2	Diamonds with single large defects in various areas of a crystal
	c	1	Diamonds with single small defects in peripheral area
		2	Diamonds with single large defects in various areas of a crystal

Table 3 (continuation)

Group	*Subgroup*	*Number of quality*	*Quality characteristic of diamonds*
3	a,b	1	Pure diamonds or with insignificant defects in peripheral are
		2	Diamonds with one insignificant defect in central area or single small defects in peripheral area
		3	Diamonds with one small defect in central area or single large defect in peripheral area of a crystal
		4	Diamonds with multiple insignificant defects or several small, or with a single large defect in the central area, or several large defects in peripheral area of a crystal
		5	Diamonds with multiple small defects, or several large, or with one huge defect in various areas of a crystal
	c	1	Pure diamonds or with insignificant defects in peripheral area
		2	Diamonds with one insignificant defect in central area, or with several small defects, or with one large defect in peripheral area
		3	Diamonds with single large defects or several small defects in various areas of a crystal
		4	Diamonds with huge defects in various areas
	d	1	Pure diamonds or with insignificant defects in peripheral area
		2	Diamonds with insignificant defects in central area or single small defects in peripheral area
		3	Diamonds with small defects in central area or with large defects in peripheral area of a crystal
		4	Diamonds with large and single huge defects

9. PECULIARITIES FOR SORTING OF JEWELRY DIAMONDS

9.1.Weight of diamonds

Weight of diamonds is often measured in carats (1 carat is equal to 0,1 grams) and is marked briefly ct in English: smaller measurement unit is grainer (equal to 0,25 carat) is marked as GR.

"Carat" comes from ancient Indian "carob" – carob tree, the seed of which were used as the measurement of homogeneous parameters. The size of diamond was measured in millimeters.

As per the weight (they often say "as per size") diamonds are divided into five large groups (see. Table 4); in some of them there is internal division into screen classes (for small stones) or weight groups and "sizes" (for large stones) (see. Table 4). Screen class corresponds to the size of screen's cells, with the help of which small diamonds are screened.

Weight is the only parameter in classification of diamonds, which can be determined by unprepared human independently. He needs to weight a crystal with the help of jewelry balance (accuracy 0,002 grams). Among diamantiars (diamantiar is a specialist in the field of jewelry diamonds, from French diamantiar) special works are quite common. Small diamonds are called "points" i.e. number of diamonds in 1 carat. For instance when they say "goods-thirty points" it means: 30 equal crystals totally weigh 1 carat. In general all tiny diamonds are commonly called "minus nine".

Average diamonds all over the world are measured in grainers: "two grainers", "three grainers"... Large stones are determined like this: "one-carat", "five-carat", "ten size" (see. last line in Table 4).

In international practice diamonds, depending on the weight, are sorted into four large groups:

- ***large*** (2-10,8 carats) – group "+1,8", term :"Large Stone"
- ***average*** (0,7 -1,8 carats) group "3-6 CR" term "Mele"
- ***small*** (0,15-0,66 carats) group "+9-2GR", term "Small Stones"
- ***tiny*** (0,01 – 0,15 carats) group "-9" term "Indian goods"

This classification does not include rare large diamonds. They are evaluated individually, with free description, as a rule, by the group of authorized specialists. Conventionally such diamonds are divided into "Special", which weigh within the range of 10,8 – 50 carats, and "Name" weighing more than 50 carats. All Name diamonds, no doubts, have named (for instance Orlov) and are entered into special catalogues.

An issue of weight determination is highly important, as the cost of diamonds especially jewelry diamonds greatly depends on their weight. It is seen from the following example: price of one carat of average quality-color features, weight group 1,00-1,24 car. is higher than the price per carat of similar brilliant of weight group 0,90 -0,99 car by more than 30% and this difference can reach 140% if speaking about colorless brilliants of the highest quality possible (such brilliants are highly sparse). ***(Table 4)***.

Table 4

Sorting of unprocessed diamonds into groups per weight

Item l/l	*Basic group*	*Screen class*	*Weight of single diamond, carat*
		-2	less than 0,01
		-3+2	0,01-0,02
		-4+3	0,02-0,03
1	Group "9"	-5+4	0,03 – 0,05
		-6+5	0,05 – 0,07
		-7+6	0,07 – 0,10
		-9+7	0,10 – 0,15
2	Group "4-9"	-11+9	0,15 – 0,30
3	Group	-12+11	0,30 – 0,65
	"+11 – 3GR"		3 GR (0,66-0,89 ct.)
			4GR (0,90 – 1,19ct)
4	Group		5GR (1,20 – 1,39 ct.)
	"4 – 6GR"		6GR (1,40 – 1,79 ct.)
			8GR (1,8 – 2,49 ct.)
			10GR (2,5 -2,79 ct.)
			3rd size (2,80 – 3,79 ct.)
			4th size (3,80 – 4,79 ct.)
5	Group "+1,8"		5th size (4,80 – 5,79 ct.)
			6th size (5,80 – 6,79 ct.)
			7th size (6,80 – 7,79 ct.)
			8th size (7,80 – 8,79 ct.)
			9th size (8,80 – 9,79 ct.)
			10th size (9,80 – 10,8 ct.)

9.2. FORM OF DIAMONDS

Second classification feature is a form of a diamond. Stones are sorted into whole crystals and fragments. Whole crystals include undamaged diamonds and crystals, chipped for not more than 1/3 from the original volume provided such chips insignificantly distort original form of a diamond. Under chips they imply a part of a crystal, constituting less than 2/3 of its original volume. They take into account the rate of form's distortion, i.e. numerical ration of the longest part of a crystal to the shortest. Within the given terms diamonds are divided into the following groups:

1. STONES – whole smooth-facet and with insignificant gradation crystals of regular and significantly distorted form (8 g. – 10,805 ct.)
2. SHAPES – whole smooth-facet and with insignificant gradation crystals of distorted form (8 g – 10, 806 ct; 4-6g; 3g – + 11; – 11+9).
3. CLEAVAGE – sharply graded crystals, fragments of crystals (8g – 10,805 ct)
4. FLATS – whole or severally flattened crystals with chips in peripheral area (8g – 10,805 ct)
5. MACCLES – spinel twins and their fragments, crystals with double germination (8g – 10,805 ct; 4-6 g; 3g -+11; -11 +9)
6. SAWABLES – whole crystals of regular form with insignificant distortion and flattening, insignificant gradation (4-6g; 3g -+11; -11+9; -9+3).
7. IRREGULARS – graded and sharply graded crystals, crystals with chips (4-6g; 3g -+11; -11+9).
8. CHIPS – fragments of crystals (4-6g; 3g-+11; -11+9)
9. FLAT SHAPES – severally flattened crystals (4-6g; 3g-+11)
10. FLAT CHIPS – flat fragments (4-6g; 3g-+11)
11. CRYSTALS – whole crystals or regular form and with insignificant distortion, sharp-edged, smooth-facet (-11+9;-9+3).
12. MAKEABLES – sharply graded and severally flattened crystals, twins, fragments of crystals and twins (-9+3).

Stones are sorted as per form visually with the help of 6-fold magnifying glass. ***(Table 5).***

Table 5

Rate of distortion in a diamond's shape

Item No	*Character of the shape*	*Length/width ration*
1	Regular shape	1:1
2	With insignificant distortion	1.5:1
3	With small distortion	2:1
4	Distorted	3:1
5	with big distortion	4:1
6	needle-shaped and lamellar	more than 4:1

Below is the example of difference between the prices of diamonds close in their shape to "stones" category and cheaper "shapes" in terms of fixed quality and color ***(table 6).***

Table 6

Dimension, ct	*Average weight, ct*	*Difference between the prices of diamonds of "stones" and "shapes" categories, %*
10	10,30	5,4
9	9,30	4,3
8	8,30	4,4
7	7,30	5,9

9.3. Character of facets' surfaces

Diamonds are divided into smooth, with insignificant gradation, with small gradation, graded and with sharp gradation.

9.4. Color and its shades

Color (and its shades). Color – yellow, brown, black, more seldom pink, green, light blue, violet, canary. Especially marked are colorless diamonds and those dyed in rare color – light blue, grass-green, pink.

There are many diamonds with yellow shade up to brown. That is why they use conventional color scale for the; for instance, they say "third color", that means diamonds with insignificant yellow or gray shade; or "eight color" – intensely yellow diamonds. Color is usually determined at the daylight without direct sun rays, that is why classification is carried out in rooms, facing the earth pole: in north hemisphere – to the North, and in south hemisphere – to the South. Shades of the color are determined only comparing with reference samples.

10. PRICE OF DIAMONDS

Price of a diamonds is an index, which does not only take into account the labor costs for production, enrichment and sorting, but characterizing relation of some its features with the others. The prices differ as per weight classes, shape of diamonds, their quality and color.

Prices for diamonds are set in compliance with their quality characteristics, set in classification for diamonds raw materials. The basis is the weight of a crystal.

In production commercial transactions each category of diamonds has its own price. However in case of wholesale delivery small diamonds are usually sold unsorted in the mixed for. In case large batches are sold on the long-term basis, the partners usually use more or less constant price lists.

For instance, when exporting Russian unprocessed diamonds, to the diamond monopoly "De Beers" they apply the so-called wholesaling CSO Russian Price-book. This price-book is big, that they have to use an English word book instead of price of it. Prices for each category of diamonds are set in USD. The variety of prices is huge: from 6000 USD to 0,8 USD per ct.

With all the variety of diamonds and difference of prices it is highly useful to have a view of approximate relation of their sorts. More 50% of physical deliveries in the world market is occupied by the lowest quality small diamonds with the average price about 1 USD/ct. About 35% is low quality diamonds (Indian goods) at the average price of 50 USD/ct. Diamonds of average and high quality (average price 350 USD/ct) are about 15%, not too much.

Thus, natural diamonds are comparatively complex goods, that only a specialist can sort into 6000 categories, moreover the error in evaluation (minimal amount is set in 5%, in practice it can reach 15%) can cause serious financial losses.

Modern methods for evaluation of diamonds raw materials are taken into account when determining the price of large crystals, primarily the cost of brilliants, that can be produced from such raw materials.

ATTACHMENT

Variety of diamond raw materials

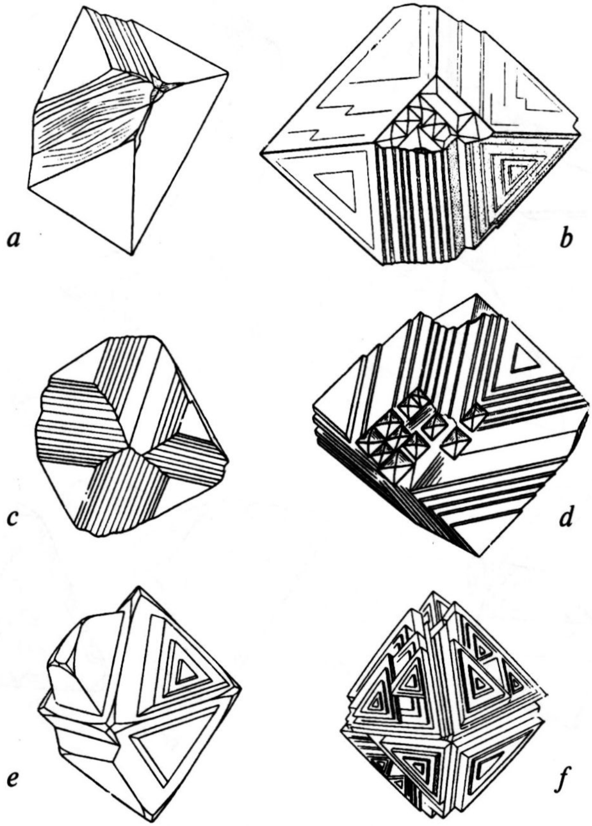


Figure 27. ***Octahedron crystal of a diamond:***

a. - crystal with lamellar development of one facet;

b. crystal with lamellar development of two adjacent facets;

c. lamellar octahedron with combined surfaced instead of facets;

d. lamellar crystal with uneven surface, blunting the top of G$ axis;

e. thick-lamellar crystal with tetrahedron blocks on facets;

f. crystal with polycentric development of facets;

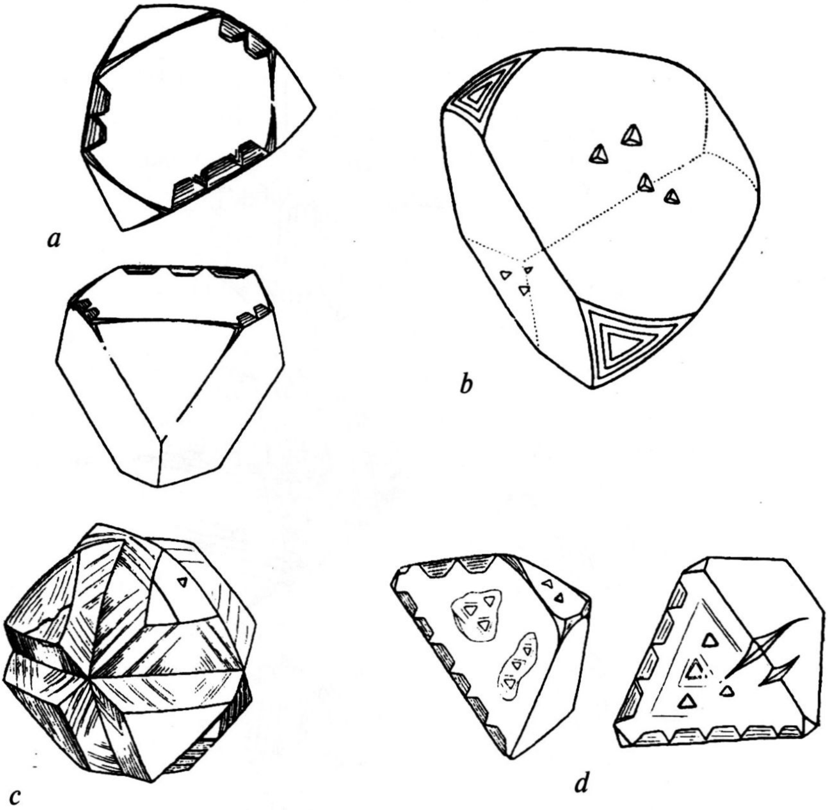


Figure 28. ***Crystals of diamonds of tetrahedral habitus:***

a – crystals with highly truncated tops;

b – crystal with slightly truncated tops;

c – germination of two crystals with truncated tops;

d – crystal with one highly truncated top

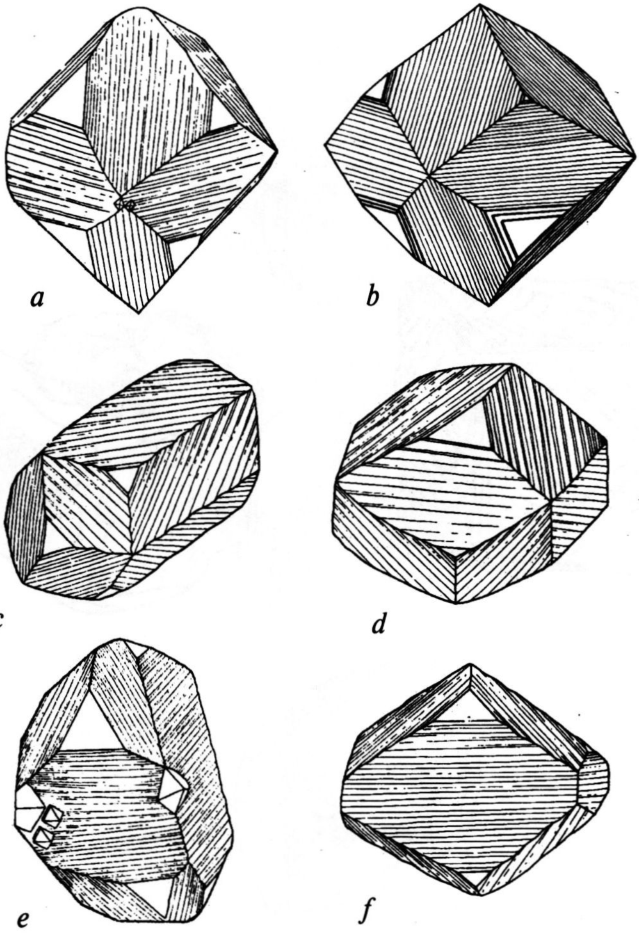


Figure 29. ***Crystals of diamonds of rhombic dodecahedral habitus***

a. - crystal with octahedron facets, blunting the tops of GS axes (overgrowing of lamellar octahedron into pseudo rhombic dodecahedron form)

b. crystal, similar to that of Figure "a"

c. prolonged crystal;

d. prolonged crystal;

e. prolonged crystal;

f. slightly prolonged crystal and flattened

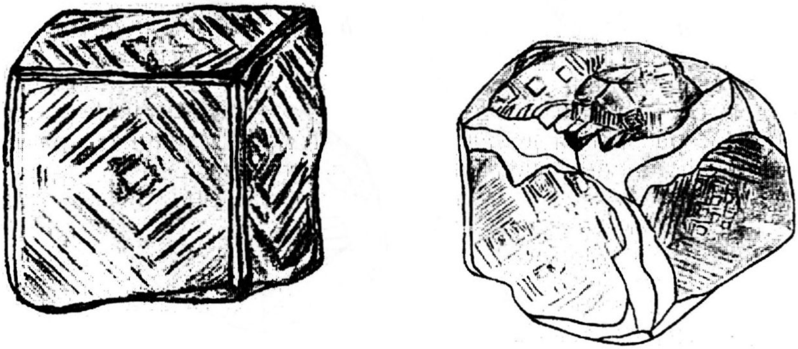
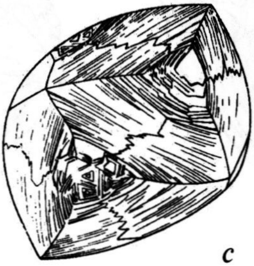


*Figure 30. **Crystal of diamond of cubic habitus:***

Crystal with etching facets. They see irregular formed rising relicts of original surface.

a

b



c

Figure 31. ***Combined flat-curved-faceted crystals of diamonds of octahedral habitus:***

a. - prolonged crystal of slightly developed curved-faceted surfaces;

b. crystal with highly expressed sheaf-like shading on the rounded surfaces;

c. crystal with widely developed rounded surfaces.

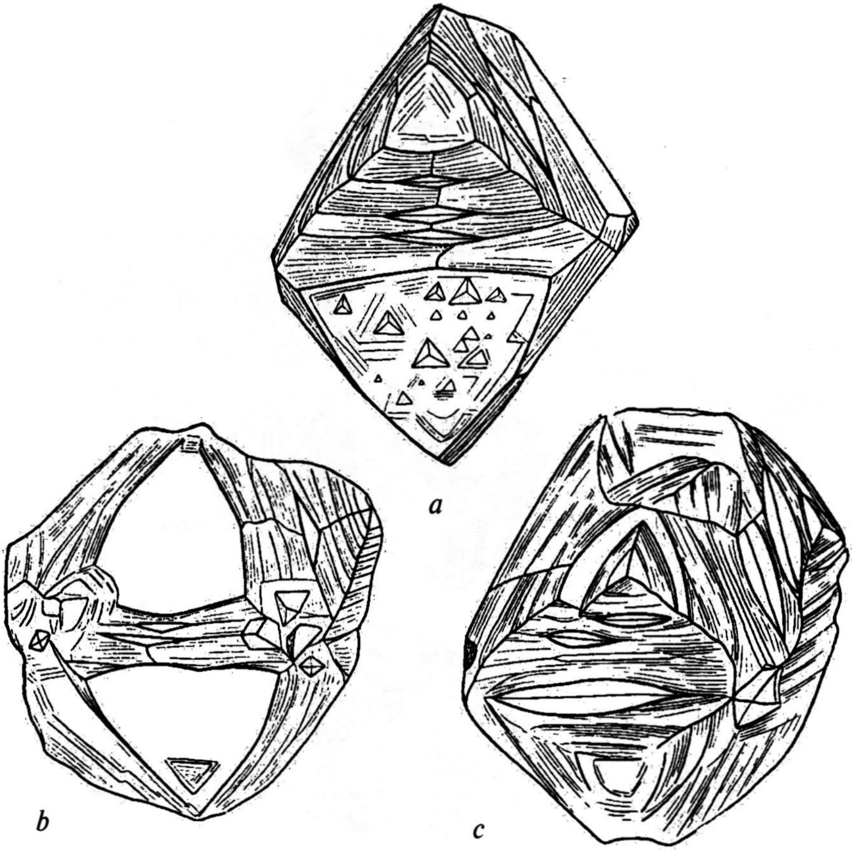


Figure 32. ***Combined flat-curved-faceted crystals of diamonds of octahedral habitus:***

a. - crystals with thick-lamellar development of one facet;

b,c. – similar crystal with tetrahedron blocks on some facets.

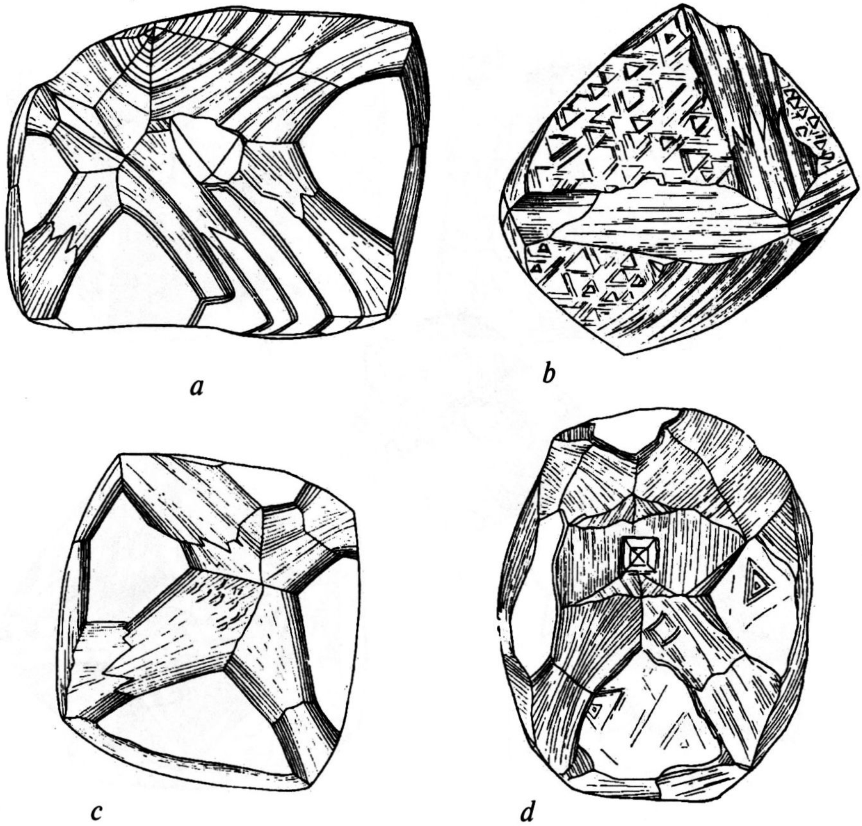


Fig. 33. ***Combined flat-curved-faceted crystals of diamonds of octahedral habitus:***

a. - prolonged crystal with graded-lamellar development of facets;

b. crystal with uneven development of curved-faceted surfaces;

c. crystal with octahedral facets, rising in the form of detrigonal flats

d. crystal, similar to one, shown in Figure "c", but with irregular octahedral flats

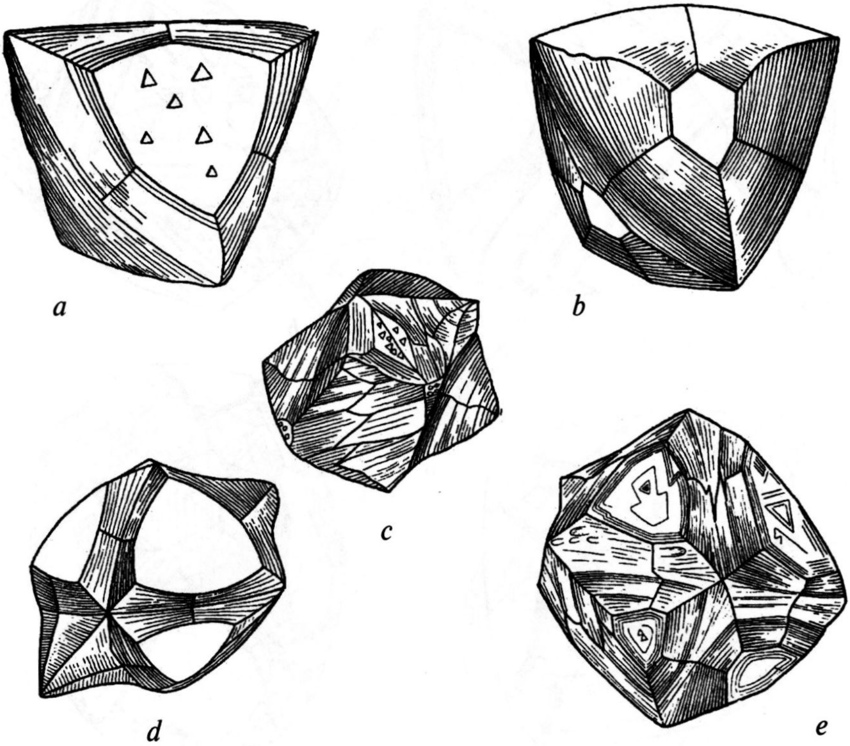


Fig. *34.* ***Combined flat-curved-faceted crystals of diamonds of tetrahedral habitus:***

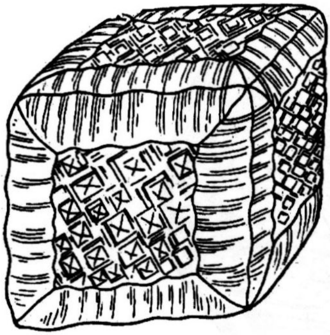
a. - crystal with sharp tops

b. crystal with hexatetrahedral habitus with wide development of curved-faceted surfaces;

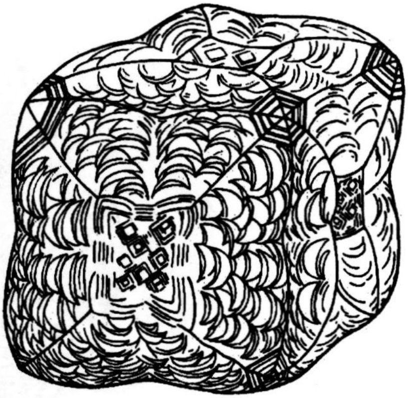
c. diamonds, having an appearance of two ingrown crystals;

d. diamond, in the form of two ingrown tetrahedrons with blunted and sharp tops;

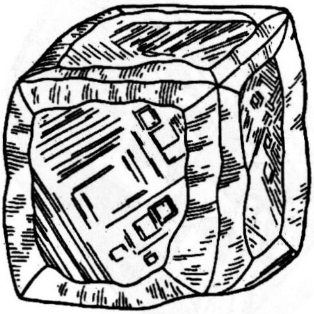
e. crystal in the form of two ingrown tetrahedrons with truncated tops.



a



b



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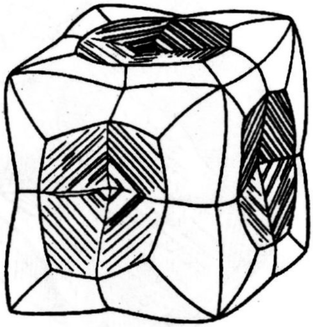


d

Fig. 35 ***Combined flat-curved-faceted crystals of diamonds of cubic habitus:***

a. - crystal with wavy curved-faceted surfaces and facets, covered with multiple quadrangular dents;

b. crystal with curved-faceted surfaces, where relief rounded blocks are developed, cut from the side of cube's facets in the form of falcate steps;

c. crystal with large quadrangular dents on the facets of a cube;

d. crystal similar to that in Fig. "c" but with deeper development of rounded surfaces.

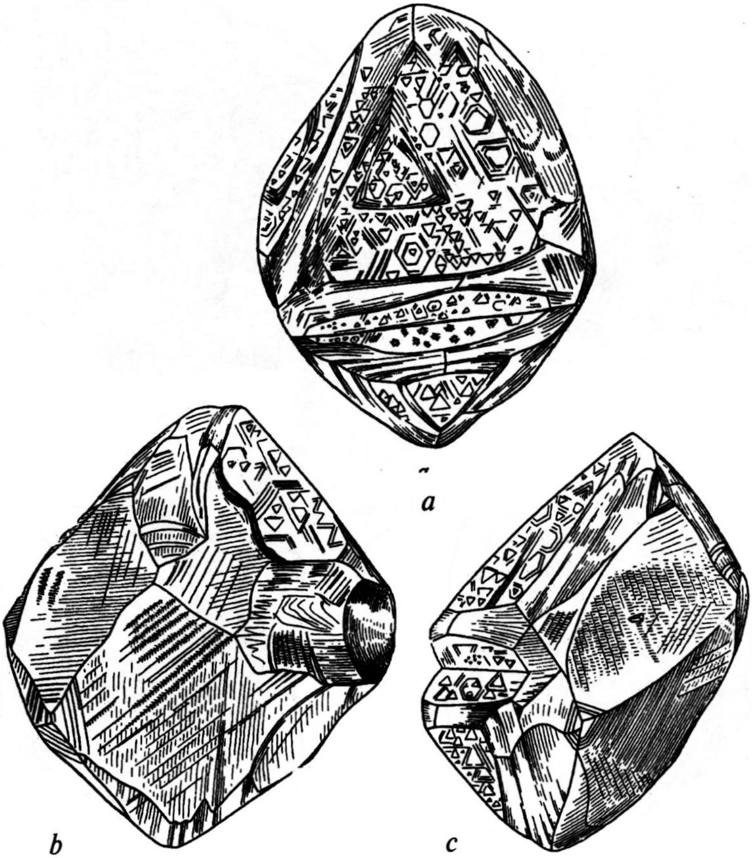


Fig. 36 Curved-faceted crystal of diamond:

a. *- view of the crystal from the side of octahedral facets;*

b. *- view of the crystal when turning into 1800 in relation to the first position;*

c. *view of the crystal when turning into 900 in relation to the first position.*

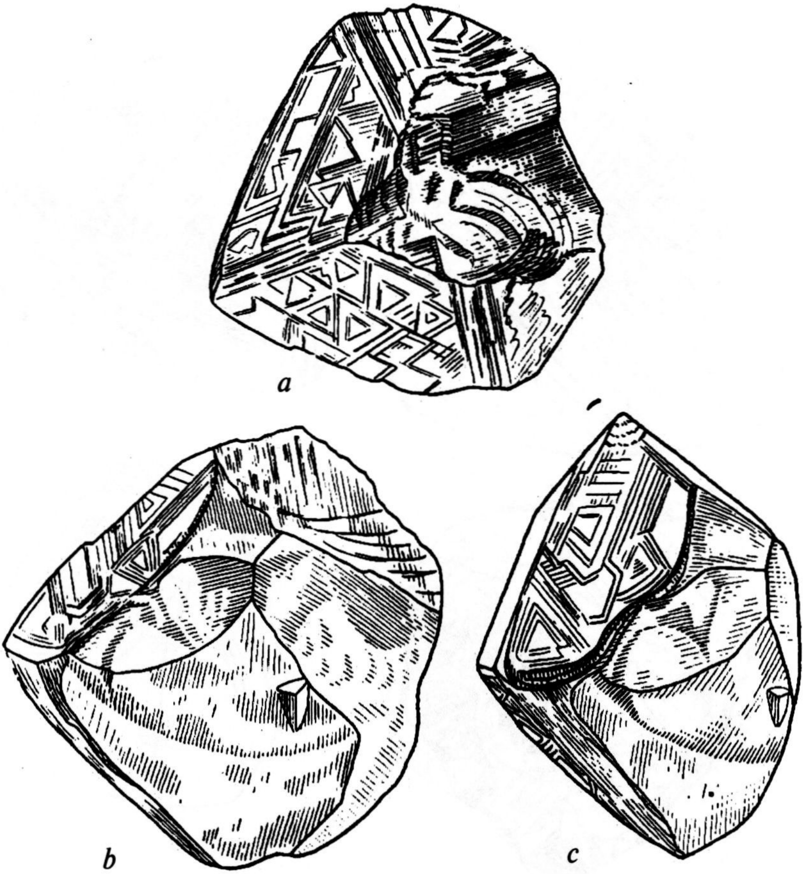


Fig. 37. ***Combined diamond crystal:***

a. - view of crystal from the side of octahedral facets, top and one side of crystal are chipped;

b. view of the crystal when turning into 1800 in relation to the first position;

c. view of the crystal when turning into 900 in relation to the first position.

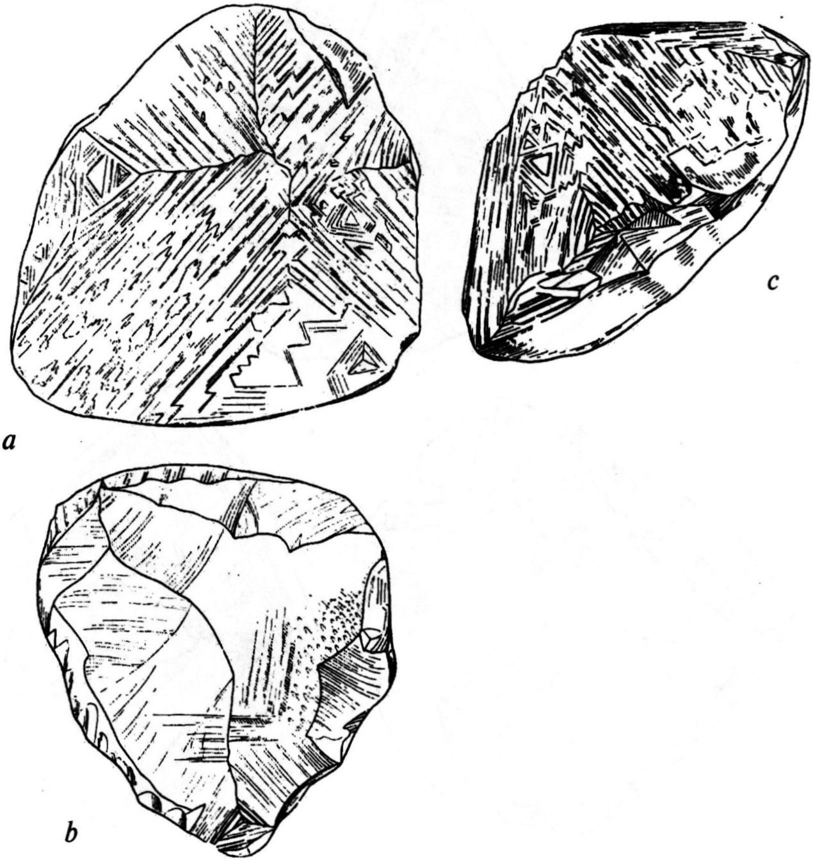


Fig. 38 ***Combined flat-curved-faceted crystal;***

a. view of a crystal from the flat-facet form;

b. view of the crystal when turning into 1800 in relation to the first position;

c. view of the crystal when turning into 900 in relation to the first position.

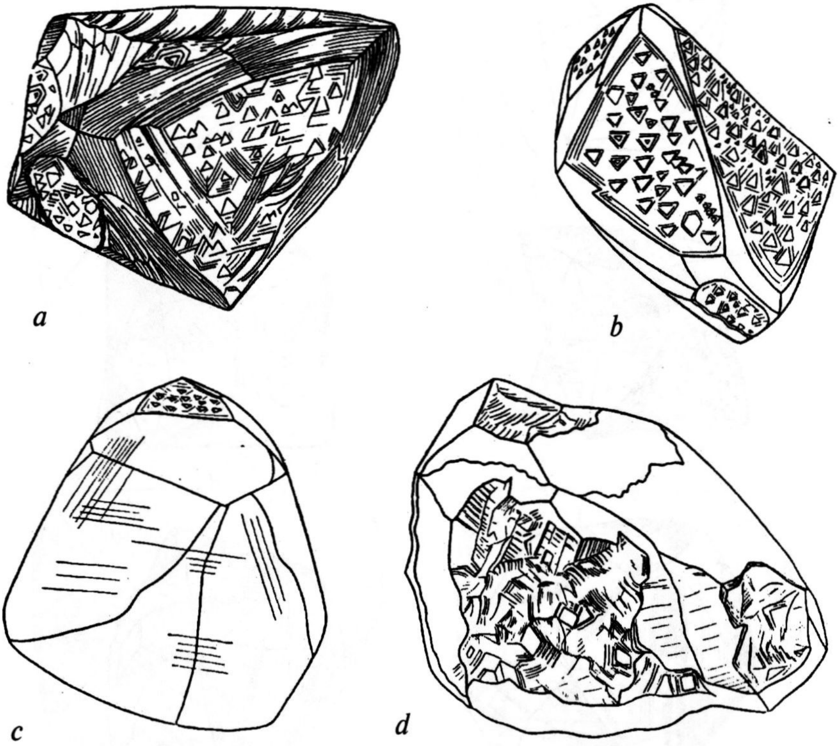


Fig. 39. ***Combined flat-curved-faceted crystal of diamond:***

a. - crystal, octahedral habitus of which is highly changed due to homogeneous development of rounded surfaces;

b,c – crystal, habitus of which is changed due to wide development of rounded surfaces instead of one facet.

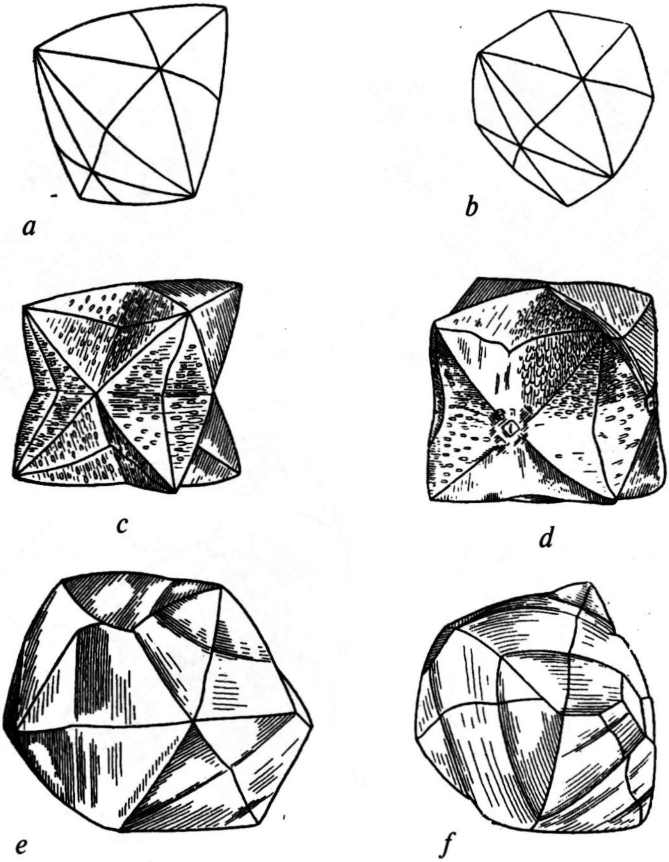


Fig. 40. ***Curved-faceted crystal of diamonds of tetrahedral habitus - tetrahedroids***

a. - form of crystal of tetrahedral habitus;

b. form of crystal of hexatetrahedral habitus;

c. diamond, having a view of two ingrown tetrahedrons;

d. diamond, similar to that in Fig. "c" with small flats of a cube;

e. curved-faceted crystal with small sharp tops;

f. crystal, similar to that in Fig "e"

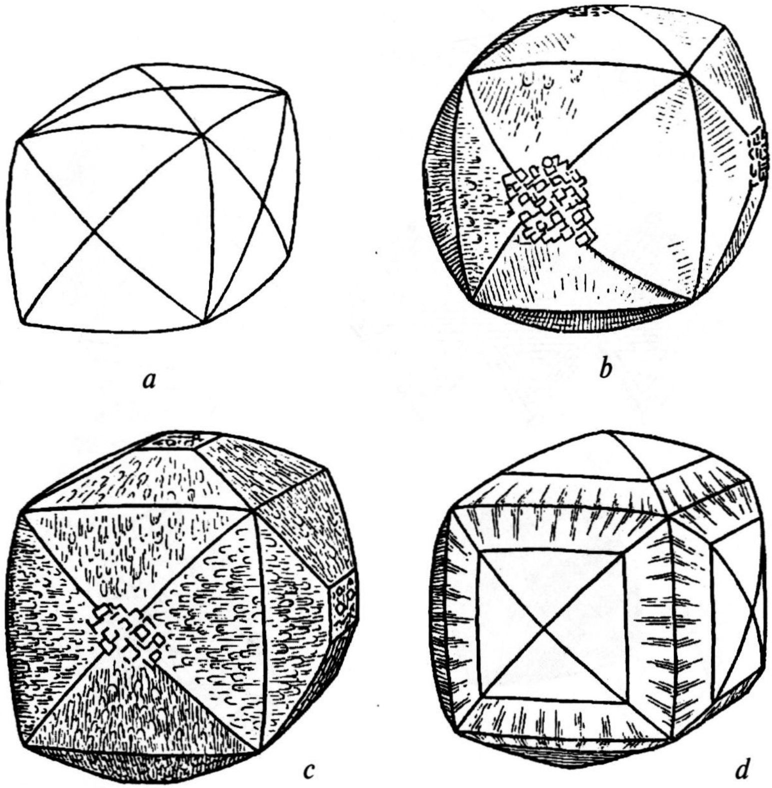


Fig. 41. ***Curved-faceted crystal of diamonds of cubic habitus – cuboids (hexahedroid)***

a. - ideal form of cuboid;

b. isometric crystal;

c. isometric crystal with drop-shaped hills in curved-faceted surfaces:

d. crystal with complex nature of rounded surfaces' development

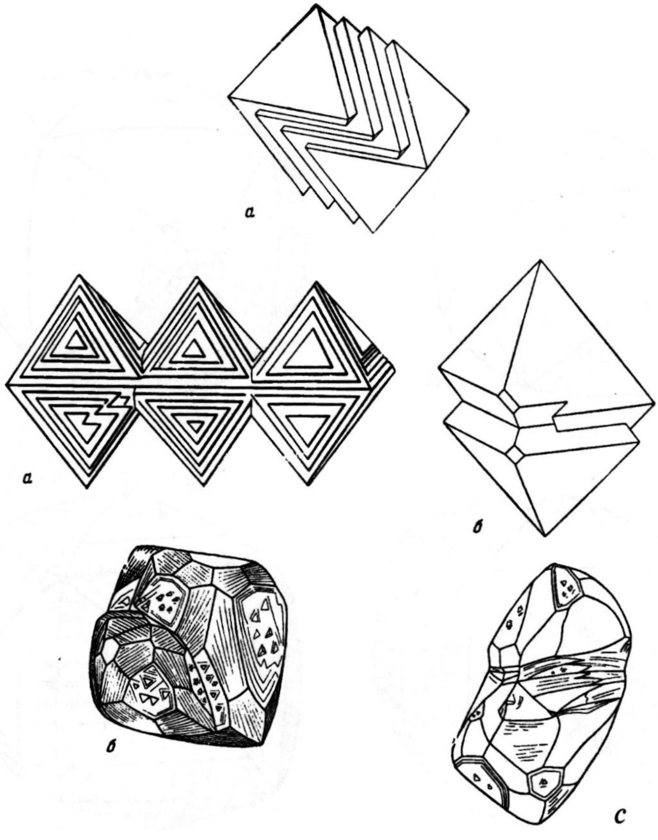


Fig. 42. ***Parallel germinations of diamond's crystals:***

a. close germination of octahedrons;

b. germination of octahedrons;

c. germinations of various combined flat-curved-faceted crystals of octahedral habitus;

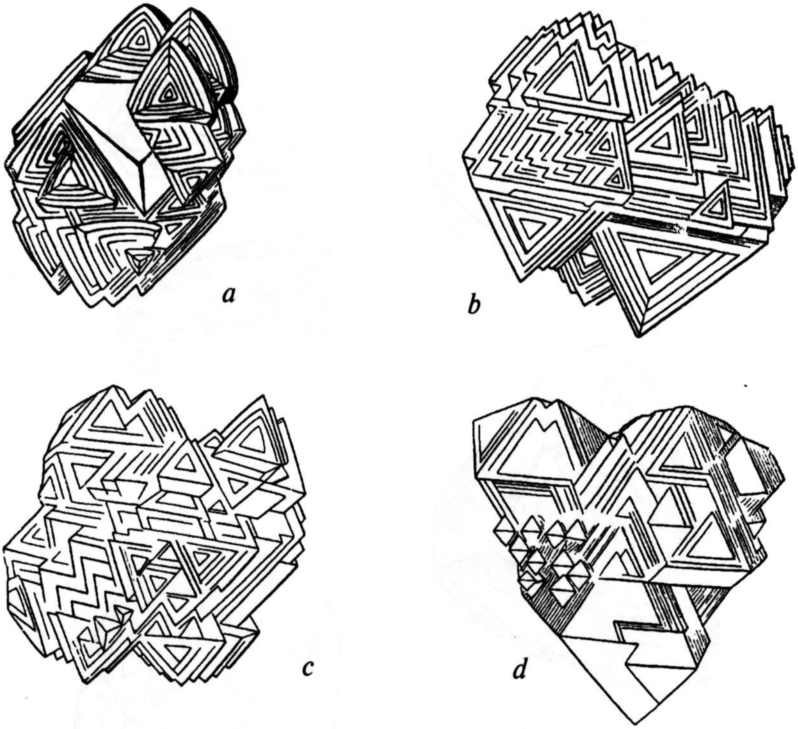


Fig. 43. ***Parallel germinations of diamond crystals:***

a. - irregular-shaped germination of octahedrons. In the center there is deep triangle hole;

b. prolonged germination of octahedrons with polycentric development of facets;

c. germination of octahedrons, close to cube by shape;

d. germination of octahedrons

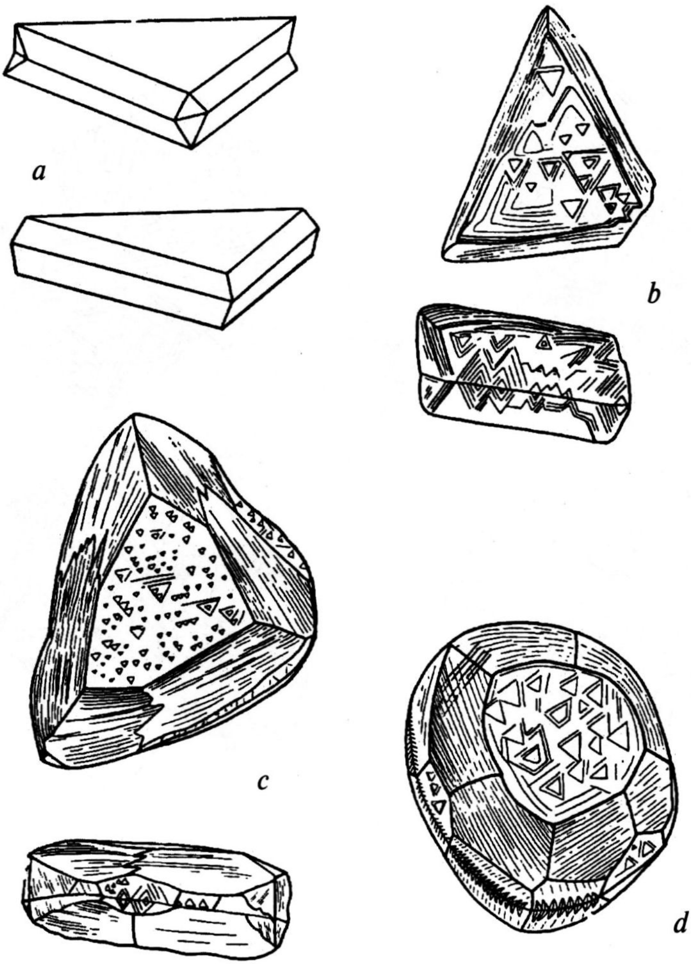


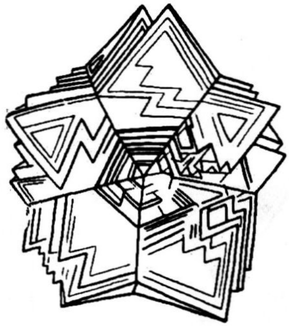
Fig. 44. ***Spinel twins of diamond crystals' germination***

a. germination of highly flattened octahedrons, having triangle form in plan;

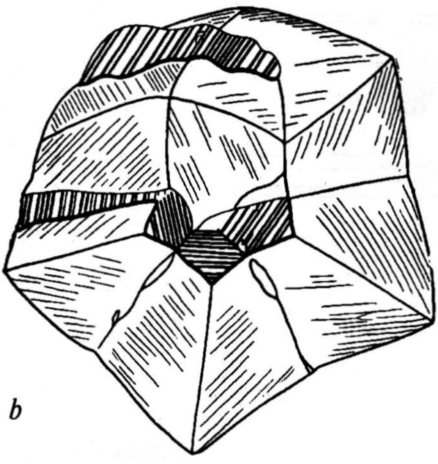
b. similar germination of octahedrons with rounded edges;

c. germination of flattened combined flat-curved-faceted crystals, having triangle form;

d. germination of combined crystals, having in plan rounded form



a



b

Fig. 45 ***Star-shaped twins of diamond crystals:***

a. cyclic twinning of octahedral crystals in the form of pentactinal star;

b. similar germination of curved-facetted crystals.

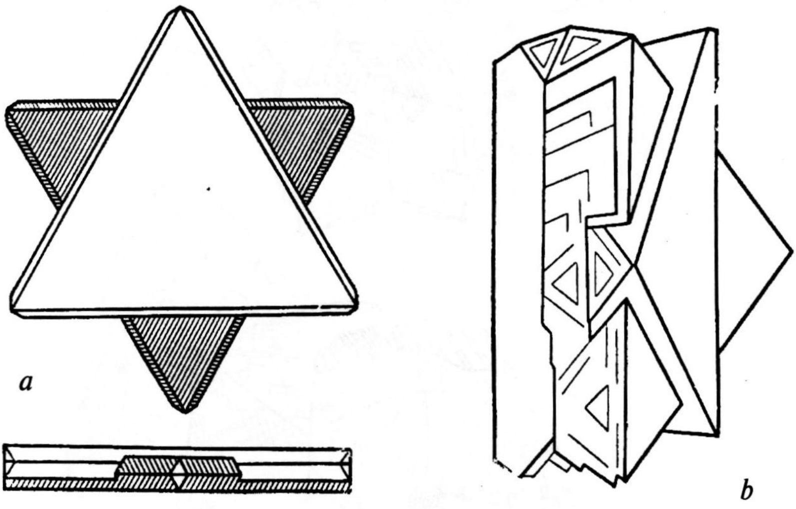


Fig. 46. ***Star-shaped twins of diamond crystals:***

a. flattened parallel germination of spinel twins of octahedral crystals in the form of hexactinal star;

b. hexactinal germination of octahedral crystals.

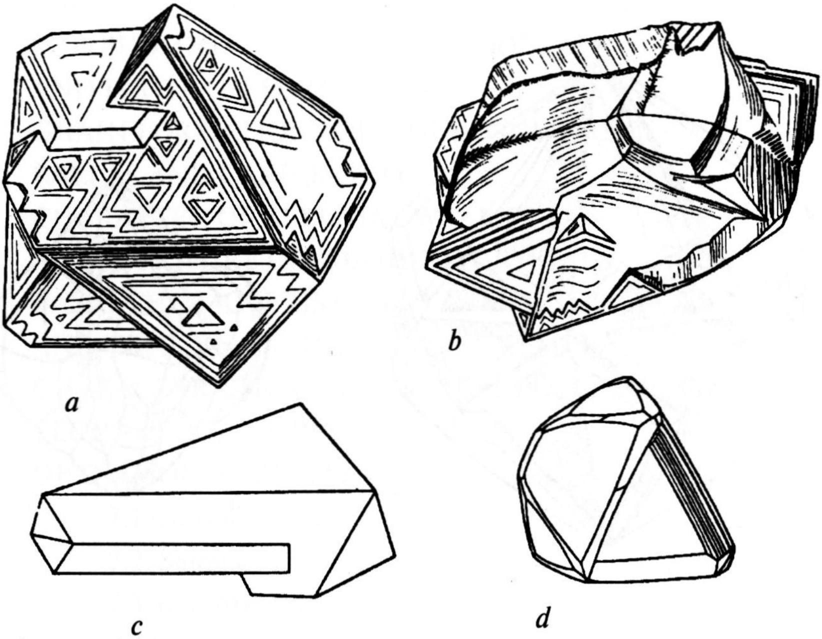
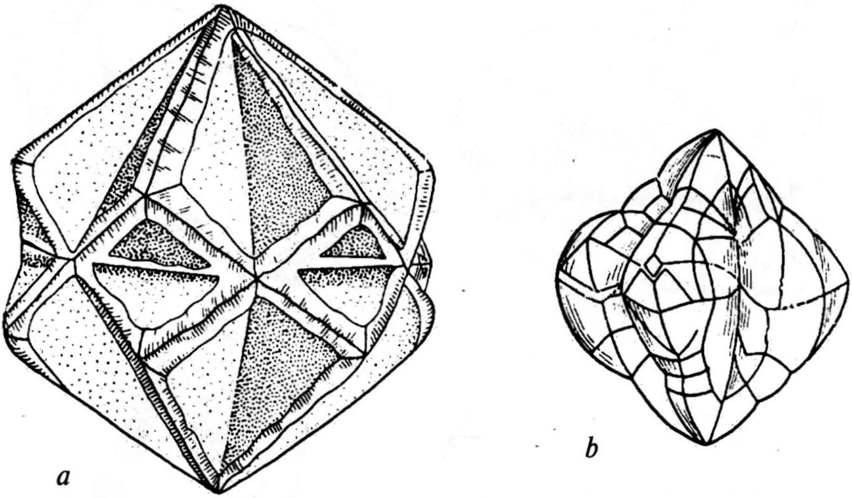


Fig. 47. ***Twins of diamond crystals:***

a,b – spinel twins of ingrown pseudohemimorphic combined crystals. View of diamond from the side of flat-faceted part when turning into 1800. One sees curved-faceted surface, divided by two-sided stitch and having complex construction;

c,d – flattened spinel twins of germination and partial germination of octahedral crystals;



Fid. 48 ***Twins of diamond crystals:***

a – spinel twins of germination of cubic crystals with rounded edges;

b – curved-faceted analogue of twin germination of cubic crystals

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