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The Main Reason for Mineral Loss in Gravity Dressing

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Abstract: Gravitational concentration (gravity dressing) is the oldest of all forms of mineral processing used by humanity more than 25 centuries. This method was the most widely applied procedure of mineral enrichment till the end of second millennium. Physically mineral concentration is based on separation of geological rocks and minerals of different specific density by their relative movement in response to the gravity and some additional forces. However, such an enrichment *a priori* cannot provide a high output of desired minerals. The authors have aimed to attract an attention to significant losses of native gold and diamonds by traditional scheme of their gravitational concentration. Detailed consideration of density and form of native gold and diamonds indicates that fragmental (placer generating) minerals with the different values of average density may have close and identical sizes (on two axes) in heavy concentrates (schlich) and middlings. These dense parameters essentially influence to conditions of these minerals accumulation in natural conditions and degree of their extraction in technological processes of gravitational concentration. The materials presented in the paper span the analyzed mineralogical data from about twenty economic deposits located in various regions of the world (mainly the authors' personal results).

INTRODUCTION

Gravity concentration (gravity dressing) methods have been used for the beneficiation of minerals with little change in the applied procedures more than 2,500 years [1, 2]. It is necessary to underline that the most part of old waste terraces (dumps) in the world are the cleaning rejects of gravity concentration methods.

Searching, prospecting and exploitation of gold and diamonds placer deposits is usually accompanied by a treatment of productive host sands. At the stages of searching and prospecting this treatment is realized by the methods of economic minerals extraction from heavy concentrate (schlich). Third stage (exploitation) is based on the processing of middlings. These stages, which are the traditional and usual technological operations, are based on distinctions of density of the abovementioned native minerals [3-5].

Density of minerals is a tabular value resulted in numerous reference books, textbooks on mineralogy, lithology, and other publications of geological and mining profiles (e.g., [1, 6-10]). As a rule, in the reference books and papers only values of averaged density of minerals are presented. It should be noted that many scientists indicate the significance of mineralogical characteristics of economic mineral grains for the enrichment process (for instance, [11-16]). Methods of mineralogical analysis indicate that in composition of heavy concentrates and middlings obtained from the productive sands (size of sand particles ranges from 0.05 to 2.5 (3.0) mm) of gold and diamond placers as well as from a set of spoil (terrace) rocks, from 7-10 up to 25-32 mineral kinds in a fragmental component was established (depending on a complexity of geological structure of areas and characteristics of native sources). Each mineral kind has some specific density and this average value formally distinguishes one mineral from another one. However, taking into account that according to genesis, the same mineral substantively has different values of density, it easy to see that this value has a spectrum of density, i.e. the maximal and minimal values for density of mineral and values between those are changeable ones. Moreover, for a lot of minerals derived from the heavy concentrates and middlings, their available spectra of density overlap for one or another part of spectrum. It leads to identical density for group of minerals differing by its average value [17].

The presented investigation is based on the detailed analysis of mineral grains (almost 3,000,000 units) performed by A.V. Surkov and group of geologists under his supervision. The studied minerals were withdrawn in Russia (regions of Altai, Archangelsk, Chukotka, Magadan, Primor'ye, Timan, Transbaikalian, Yral, Yakutia, etc.), Mongolia, Western Africa (Angola, Mali, Ghana and Guinea), Brazil, Venezuela and Israel.

DEFINITION OF A TERM "MINERAL"

Humanity has been studying minerals no less than last five thousands years (last 40 years by the use of electronic microscopy). During the last decades a group of new methods allowing cardinally increase our knowledge of minerals and their properties depending on the mineral origin, was developed.

Interestingly that in the beginning of the third millennium, in the such a fundamental geological science as mineralogy, definition of a term "mineral" does not formulate at a modern level. Allaby and Allaby [18] gave the following explanation of the term: "usually inorganic substance which

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occurs naturally, and typically has a crystalline structure whose characteristics of hardness, lustre, color, cleavage, fracture, and relative density can be used to identify it". Milovsky and Kononov [19] noted that mineral is "physically and chemically homogeneous crystalline body generating in the result of natural physical-chemical processes". Vasilyev [20] wrote that mineral is "natural body consisting of chemical elements existing in homogeneous structural relationships".

A group of scientists gave very similar description: "natural chemical composition or native element generating in the result of manifold physical-chemical processes arising in the Earth's crust and at its surface" [21-25]. The work [26] contains a lot of analogous definitions suggested by other authors [26].

At the website of Princeton University [27] the following definition is presented: "mineral – solid homogeneous inorganic substances occurring in nature having a definite chemical composition".

However, we believe that all the mentioned descriptions of mineral have a particular character and do not reflect its properties as a whole. At the same time the necessity of a general description of this term is obvious [9, 28, 29].

We propose the following formulation: "mineral is a natural chemical composition or native element (or group of native elements), generating in result of natural chemical reactions in the Earth's crust, in a number of cases in upper mantle (by definite *P*-*T* conditions), as well at the Earth's surface, under conditions of the Earth's land or bottom of the World Ocean, as well in water layers. Mineral is characterized by more or less constant chemical composition, typical lattice (sometimes it does not exist), elements-admixtures, hard-phase and gaseous-liquid inclusions generating micro-paragenesis in various degree regular and reflecting in its physical properties and external indicators of each mineralogical type".

Such components as chemical composition, elements-admixtures, hard-phase and gaseous-liquid inclusions, hollows and cracks in minerals, degree of perfection and defectiveness of crystal structure and the form of allocation in a nature – all these factors determine and influence to the value of mineral density (some physical-mathematical aspects of this phenomena were discussed in [30]).

A BRIEF DESCRIPTION OF THE GRAVITY CONCENTRATION PROCESS

The gravity concentrator is designed to concentrate and separate dense particles within slurry of lighter particles for maximum recovery. A classic example of this process is the concentration of gold from alluvial sand. The gravity concentration equipment operates by applying gravitational, centrifugal and frictional forces to fluid (particle-slurry) with components of varying specific gravities. A simplified scheme of centrifugal gravity separator is presented in Fig. (**1**).

These individual force vectors are applied with separate directions in such a way that the more dense particles will migrate to the bottom of concentration cone and the less dense particles will work their way upward and over the surface of a spinning cone to be discarded or collected [31].

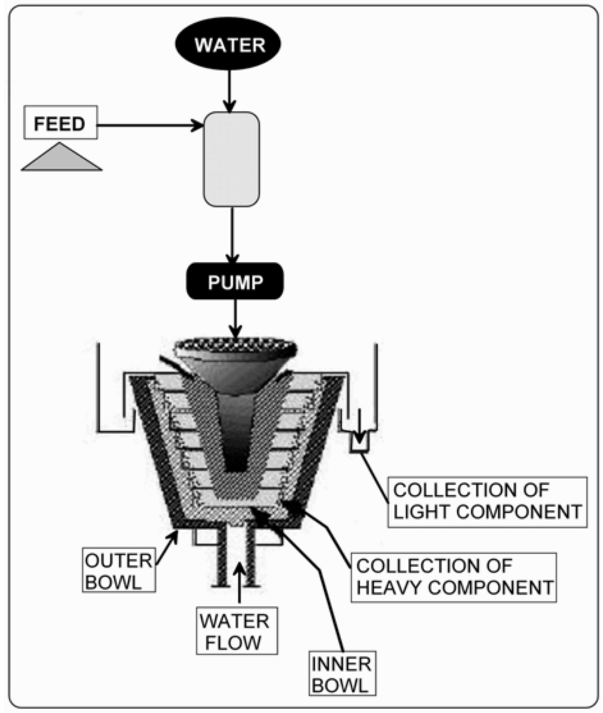

Fig. (1). Centrifugal gravity separator: A principal scheme.

The motion of a particle in a fluid is dependent not only on the particle's density, but also on its size and shape, large particles being affected more than smaller ones.

A mathematical model of this process is not that simple as it can be seen for a first view. For simulation of gravity thickeners today is accepted a phenomenological theory of sedimentation of flocculated suspensions [32-34]. Bürger *et al.* [35] considered simulation of continuous sedimentation in some ideal separator. The authors [35] proposed that settling of the solid particles under the influence of gravity could be described by an initial value problem for a nonlinear hyperbolic partial differential equation with a flux function that depends discontinuously on height.

The general model of gravity thickening is presented in [34]:

$$\begin{cases} \dfrac{\partial \phi}{\partial t} + \dfrac{\partial}{\partial z}\left[q(t)\phi + f_{\mathrm{bk}}(\phi)\right] = -\dfrac{\partial}{\partial z}\left(f_{\mathrm{bk}}(\phi) \dfrac{\sigma_e'(\phi)}{\Delta\rho\phi g} \dfrac{\partial \phi}{\partial z} \right), \\ 0 \le z \le L, \quad t > 0, \end{cases} \tag{1}$$

$$f_{\mathrm{bk}}(\phi) = u_{\infty}\phi\left(1 - \frac{\phi}{\phi_{\max}}\right)^{c}, \tag{2}$$

$$\sigma_e(\phi) = \begin{cases} 0 \ \text{ for } \ \phi \le \phi_c \\ \alpha e^{\beta\phi} \text{ or } \sigma_0\left[\left(\dfrac{\phi}{\phi_c}\right)^{n} - 1\right] \text{for } \phi > \phi_c \end{cases}, \tag{3}$$

$$q(t) \le 0 \ . \tag{4}$$

Here $\phi(z, t)$ is the volume fraction of solid, $f_{\mathrm{bk}}(\phi)$ is the Kynch solid flux density function, $q(t)$ is the volume average velocity, ϕ_c is the critical concentration, $\sigma_e(\phi)$ is the solid effective stress, and $\Delta\rho$ is the difference between solid and liquid material. α, β, σ_0, n, ϕ_{max} and c are the positive numbers, while $u_\infty < 0$.

We must note that even in the most detailed model (eqs. (1)-(4)) the following assumptions were made:

(1) All particles fall independently one from another and it is in consolidation when the particles touch each other permanently during the fall,

(2) All particles are small with respect to the container and have the same density,

(3) The solid and fluid components are incompressible,

(4) There is no mass transfer between the components,

(5) Suspension is completely flocculated before the sedimentation starts,

(6) All flocs settle at the same terminal velocity.

It is obvious that the abovementioned assumptions do not realizing in the enrichment practice. Besides this, this model does not calculate such important problem as intersection of spectrum of real mineral densities [36]. The last problem is considered in detail in the next Section.

STUDYING OF MINERALS DENSITY AND THE MAIN POINT OF THE PROBLEM

The density of mineral is one of properties depending on the exact understanding what it is a mineral on sum of all its properties (or at the least of information available at the present time) about this natural phenomenon representing a mineral kind or variety of this kind [28].

It is well known that prospecting works in placers during the stages of approbation and exploitation are based on utilization of (1) heavy concentrates and (2) middlings.

Stage (1) is used for definition of contents of economic minerals (gold, diamonds) and (2) – for obtaining a product of mining industry (gold and crude diamonds). The useful components on weight make for gold from 0.000004 % up to 0.0009 % for heavy concentrates and from 1 % to 5-8% for middlings. Thus, dense properties play an important role by the studying of minerals. The rest mass of material (for gold) is composed by minerals of heavy concentrates or middlings presented by magnetite, ilmenite, zircon, rutile, garnet, staurolite, pyroxenes, tourmaline, epidote, quartz, feldspars, micas, etc. [5]. For diamonds similar values for heavy concentrates are higher by one order and for middlings the values are close. The set of fragmental minerals is similar in many respects including both genetic and dynamic indicator minerals.

Genetic indicators (satellites) of diamond are, as a rule, high-baric minerals generated at the level of upper mantle and having different density and form of crystals [7, 37] (Table **1**).

Dynamic indicator minerals of diamond are the minerals of various genesis with the close density, added to diamond in alluvium by its transportation in water-alluvial environment after clearing (opening) of native rocks during destruction of indigenous deposits (kimberlite or lamproite pipes, and dykes). Part of genetic indicators, such as pyrope and chromediopside (which are the most easily identified) are destructing during these transportations (see Table **1**). Diamond, as a mineral kind, depending on the quality of crystals and their origin, also has different density (Table **2**).

Table 1. Genetic and Dynamic Indicator Minerals of Diamond

Genetic Indicator Minerals of Diamond			
Mineral	**Density, kg/m^3**		
	Minimal	**Maximal**	**Average**
Pyrope	3270	3750	3510
Picroilmenite	4510	4930	4720
Chromediopside	3270	3380	3320
Chromespinel	3500	3700	3600
Moissonite (rare)	3100	3220	3160
Corundum	3440	4100	3770
Olivine	3300	3500	3400
Zircon (pink, with marked singularity)	3970	4880	4425
Dynamic indicator minerals of diamond			
Mineral	Density, kg/m^3		
Staurolite	3600	3780	3690
Disthene	3560	3680	3620
Epidote	3240	3500	3370
Limonite	3150	4200	3670
Tourmaline	2890	3200	3050
Leucoxene	3490	4300	3890
Pyroxenes	3100	3600	3350
Sphene	3290	3600	3420
Diopside	3100	3420	3260

Table 2. Density of Diamond ([After 6 and 37], with Supplements)

Type of Diamond	**Density, kg/m^3**
Jeweler diamond from kimberlites	3510
Semi-jeweler	3520
Technical	3440
Impact	3050
Diamond containing hard elements	3610
Diamond containing gas-liquid inclusions	3010-3240

When diamond macrocrystals occur at large depths, the crystals by are accomplished by growth a variety of hard phases, which also are minerals. Size of these inclusions in diamond may consist from thousandth and hundredth part of weight % (volume) up to 12-16% (20%) from its volume (Table **3**).

Table 3. Density of Hard-Phase Inclusions in Diamond [After 7 and 37]

Mineral	Density, kg/m^3		
	Minimal	Maximal	Average
Chromite	4000	4800	4400
Olivine	3300	3500	3400
Garnet	3510	4300	3900
Clinopyroxene	3100	3380	3240
Graphite	2090	2230	2160
Ortho-pyroxene	3080	3420	3250
Pyrrhotine	4580	4700	4640
Pentlandite	4500	5000	4750
Rutile	4160	4300	4220
Coesite	–	–	2930
Diamond	3050	3610	3330
Ilmenite	4500	5000	4750
Picroilmenite	4510	4930	4720
Magnetite	4900	5200	5050
Disthene (kyanite)	3560	3680	3620
Biotite	2780	3160	2970
Phlogopite	2700	2850	2770
Enstatite	3100	3300	3200
Diopside	3100	3420	3260
Garnet-pyrope	3270	3750	3510
Spinel	3500	3700	3600

In other words, such economic minerals as gold and diamond make insignificant or rather small percentage on the total weight in the heavy concentrates and middlings. Interestingly that heavy concentrate of gold on its tabulated size of density sharply differs from other minerals of heavy concentrate and middlings. Diamond has smaller value of tabulated density than the most part of other minerals in heavy concentrate and middlings.

We should note that gold and diamonds might occur in the same placer. Similar examples are known in Venezuela and Brazil (unpublished materials of the authors), South Africa [38], Appalachian and Western goldfield regions in the USA [39], Russia (Ural region (unpublished materials of the authors) and Timan region (deposit Ichet-Yu) [40]) and Israel (Makhtesh Ramon, northern Negev) [41, 42].

Washing the exploring samples and sands by mining, in accordance with a physics of the process, must provide the possibility to divide the heavy part (heavy concentrate gold) from significantly more light (less dense) minerals. However, in mining practice this effect often does not exist.

Diamond is usually extracted from middlings where great bulk of minerals is denser than the diamond. Besides this, in both heavy concentrate and middlings occur minerals (in significantly larger amounts), which have lesser density than gold and diamond. Measurement of gold, diamonds and quartz from the deposit Ichet-Yu (Timan region, Russia) with the following weighing of grains of the mentioned minerals on a precise assay balance illustrates that these minerals have practically equal weight of particles (Table **4**). Presented example (in reality we may have tens of such intersections) displays that gravity concentration (dressing) will be not effective in such conditions. Besides this, quartz and diamond have very close geometrical parameters by two axes that fact complicates application of a lattice method.

Let's consider accomplished density characteristics for a native gold. This mineral consists of natural composition (alloy or hard solution) of gold and silver, occasionally with a copper admixture. Sometimes were observed cases when conventional magnet is attracting particles of gold (which theoretically is non-magnetic mineral).

Table 4. Comparison of Grains of Gold, Diamonds and Quartz from Placer Ichet-Yu (Timan Region, Russia) [After 40]

N/n	No of Samples	Gold	Diamond	Quartz
1	3	1.20x0.66x0.005 0.072 (18200)	0.28x0.28x0.26 0.072 (3510)	0.33x0.31x0.26 0.071(2640)
2	6	1.10x0.62x0.01 0.12 (18200)	0.36x0.32x0.30 0.12 (3510)	0.51x0.41x0.22 0.12 (2640)
3	6a	0.26x0.24x0.20 0.25 (18200)	0.46x0.41x0.40 0.26 (3510)	0.63x0.49x0.32 0.26 (2640)
4	10	1.23x0.69x0.03 0.46 (18200)	0.57x0.51x0.46 0.47 (3510)	0.71x0.52x0.47 0.46 (2640)
5	11	4.51x2.73x0.005 1.12 (18200)	0.75x0.71x0.61 1.14 (3510)	0.83x0.78x0.67 1.14 (2640)
6	12	4.51x2.45x0.02 4.02 (18200)	1.10x1.04x1.00 4.02 (3510)	1.37x1.14x0.98 4.04 (2640)
7	17	3.50x2.11x0.02 2.68 (18200)	0.96x0.92x0.86 2.67 (3510)	1.22x1.02x0.81 2.66 (2640)

Note: In numerator size is shown in mm, in denominator – weight of mineral in milligrams, in brackets – density in kg/m^3.

Careful studying of this phenomenon has depicted that small crystals of magnetite saturate the gold under study.

It is well known that density of placer gold depends on its fineness. Table **5A** illustrates data of this relationship for poor quality gold and medium quality gold and Table **5B** – for high quality gold.

Gold fineness may vary within one placer and even in individual gold unit within the same placer. A series of the following experiments was carried out: from one middlings were allocated gold particles identical on three dimensions (length, width and thickness), but sharply differing by the form of particles. Results of direct weighing gave different weight for all investigated gold particles. The heaviest gold particle in 6 times differs by its weight from the light particle while their calculated weight proceeding from their sizes and density was identical. The difference between the calculated weight and weight of the same gold particle, expressed in

Tables 5A & 5B. Density and fineness of gold (generalization of the author's materials from Russia: Yakutia region (Kular placers), Ural region (placers of Perm area), Altai region (placers of Murzinka area), Western Chukotka (inflow of r. Milkery), Transbaikalian region (placers of Zipikan node) and Southern Primor'ye region (placers of B. Rudnevka), as well Guinea, Mali and Mongolia)

Poor-Quality Gold (Billon)			Medium-Quality Gold		
Gold Fineness	Density, kg/m^3	Real Density, kg/m^3	Gold Fineness	Density, kg/m^3	Real Density kg/m^3
500	10330	10280	760	15710	15670
510	10540	10480	770	15910	15880
520	10750	10690	780	16120	16090
530	10950	10890	790	16330	16300
540	11160	11100	800	16530	16510
550	11370	11310	810	16740	16720
560	11570	11510	820	16950	16930
570	11780	11720	830	17150	17140
580	11990	11920	840	17360	17350
590	12190	12130	850	17570	17560
600	12400	12330	860	17770	17770
610	12610	12530			
620	12810	12740			
630	13020	12950			
640	13230	13160			
650	13430	13360			
660	13640	13570			
670	13850	13780			
680	14050	13990			
690	14260	14200			
700	14470	14410			
710	14670	14620			
720	14880	14830			
730	15090	15040			
740	15290	15250			
750	15500	15460			

Table 5B.

High-Quality Gold		
Gold Fineness	Density, kg/m^3	Real Density, kg/m^3
870	17980	17980
880	18190	18190
890	18900	18390
900	18600	18600
910	18810	18810
920	19010	19020
930	19220	19230
940	19430	19440
950	19630	19650
960	19840	19860
970	20050	20070
980	20270	20280
990	20460	20490

Note: We may explain a high density of gold with the fineness above 920 by presence of platinum as admixture.

percentage, has received the appellation "loss of weight". This value may consist from 1-3 up to 90 % and more for a prevailing part of gold particles extracted from placers [43]. Calculation and weighing of grains of garnet, zircon, ilmenite and some other minerals indicate that the minerals composing the main (on weight) part of middlings and heavy concentrates also have the property of weight loss [36].

The combination of the abovementioned losing with the form of particles of economic minerals complicates characteristics of fragmental particles during their transportation and re-deposition in the water-alluvial environment.

In technological chains, at washing and (or) jigging with obtaining the middlings, the abovementioned properties of gold and diamonds (variously for each mineral) affect the quality of the obtained middlings and losses of useful components. Unfortunately, usually technologists and dressers, as well as geologists do not consider the heavy concentrates and middlings from such a point of view. There is a wide field for further detailed investigations, since from the practical point of view placers with an equal composition of heavy concentrates and middlings do not exist. Commercial exploitation of each placer demands on a specific approach to studying of density and form (shape) of economic minerals and middlings. We may propose that significant part of losses of heavy concentrate gold and raw diamonds by industrial exploitation of these economic deposits is associated with the foregoing problems. For instance, Longley *et al.* [44] noted that application of gravity concentration at a Western Australian gold mine site offered very low recoveries – between 30 and 60 % much lower than expected.

Surkov [36] has been developed a modern methodology for treatment of selected samples (for both gold and diamond deposits) based on the procedure minimizing losses of useful components. The procedure, providing a bright ringing of withdrawn samples by their size and mineral types, has been effectively tested in numerous economic deposits in the former Soviet Union and Mongolia.

Experimental testing of the loose fragmental deposits using Surkov's methodology was performed in Canyon Makhtesh Ramon (Northern Negev desert, Israel). In this area alongside with a set of minerals (quartz, pyroxenes, rutile, leucoxene, zircon and tourmaline) typical for arid climate and many times re-deposited from the more ancient sediments (and having a shape of good polished minerals), a lot of "fresh" shape minerals were found (i.e., practically not polished and non-stable under conditions of weathering). List of these fresh shape minerals includes green pyroxenes, olivine, native silver, gypsum, calcite, barium sulfate and feldspars. Simultaneously with these two groups of fragmental (clastic) minerals in the sediments were found: diamond (small and comparatively large (up to 1.35 mm) crystals and their fragments), native gold, ilmenite (both polished and non-polished in different degree), as well as malachite, azurite and ventilated minerals of tantalum and niobium [41]. From the withdrawn samples a group of minerals having close size (by two axes) and weight of fragmental particles was selected (Table **6**). It is important to underline that densities of these minerals are different ones. Fig. (**2**) illustrates a variety of forms of some gold microplates discovered in the Canyon Makhtesh Ramon.

Table 6. Results of Some Minerals Examination in the Western Makhtesh Ramon Canyon, Southern Israel [After 42]

N/n	Mineral	Size in mm	Average Density, kg/m^3	Weight of Grain in mg
1	Olivine	1.36x1.20x0.72	3500	4.11
2	Diopside	1.34x1.19x0.79	3300	4.15
3	Diamond	1.35x1.15x0.75	3510	4.09
4	Ilmenite	1.36x1.16x0.55	4750	4.13
5	Gold	1.31x0.90x0.20	17400	4.18
6	Quartz	1.34x1.17x1.01	2650	4.19

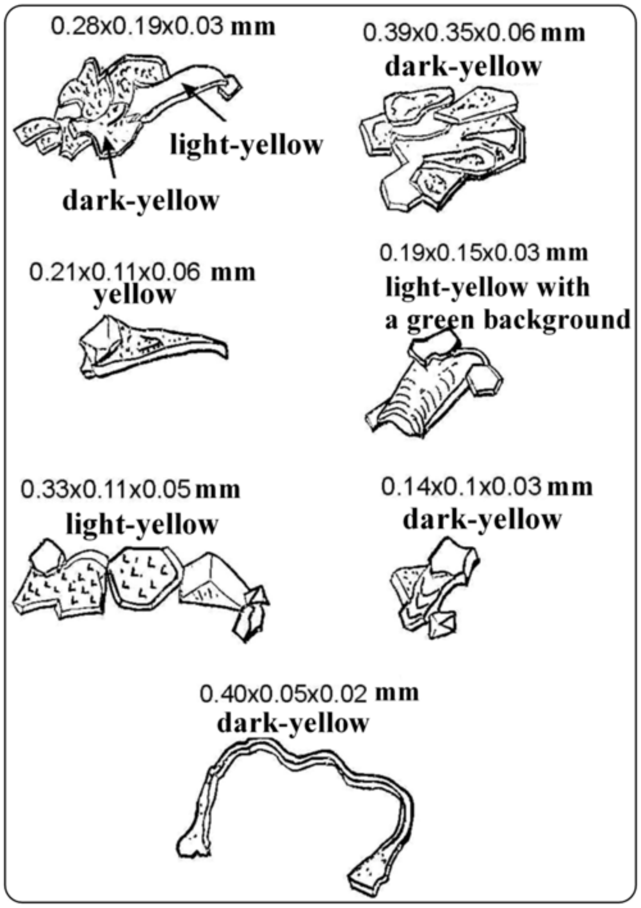

Fig. (2). Forms of the native gold plates discovered in the samples selected from channel deposits in the Canyon Makhtesh Ramon (northern Negev, Israel) (prepared by A.V. Surkov).

Table **7** demonstrates scopes of density variations for different minerals. Numbers 18-20 in this table illustrate the values of gold and quartz weighing, natural parts of which represent the non-conventional forms for gold and quartz with inclusions. Measurements of volumetric weight of these minerals give values, as a whole close to minerals mentioned in Table **7** under numbers 1-16. Exception makes No. 17, low-standard (minimal value) and high-standard (maximal value) gold in particles of dense composition without inclusions and porosity.

The latest publications point up a variety of methods for minerals treatment based on air, magnetic, electrostatic, biochemical and another methods of geological substance separation. For example, Dodbiba *et al*. [45] presented recently a perspective approach demonstrating effective combination of triboelectric and dry gravity separation. We propose that optimal secondary recovery of waste terraces (spoils) by the abovementioned methods may provide an enormous economic effect.

Table 7. Densities of Different Minerals Illustrating their Possible Closeness by Averaged Values (After [17], with Supplements)

N/n	Mineral	Density Variation, kg/m^3		
		Min	Max	Averaged Value
1	Diamond	3010	3610	3310
2	Pyrope	3270	3750	3510
3	Picroilmenite	4510	4930	4720
4	Chromespinel	3500	3700	3600
5	Moissonite	3100	3220	3160
6	Corundum	3440	4100	3770
7	Olivine	3300	3500	3400
8	Staurolite	3600	3780	3690
9	Disthene	3560	3680	3620
10	Epidote	3240	3500	3370
11	Limonite	3150	4200	3670
12	Tourmaline	2890	3200	3050
13	Leucoxene	3490	4300	3890
14	Microcline	3100	3600	3500
15	Sphene	3290	3560	3420
16	Diopside	3100	3420	3260
17	Native gold	10280	19100	14690
18	Native gold of specific form: filiform moss-like porous skeletal crystals	3130	4200	3970
19	Quartz	2640	2660	2650
20	Quartz with hard-phase inclusions and ore elements in the form of admixtures	3060	3720	3390

CONCLUSION

The results of performed investigations indicate that knowledge of some "thin" characteristics of density and form highly brings together in processes of transportation and deposition of fragmental minerals strongly differentiating on properties. Technological processes of gravitational concentration (dressing) of gold, diamonds, tinstone and other economic minerals are studied insufficiently.

Minerals with various densities occur in a form of particles with equal or close size (for two axes) among the fragmental (clastic) and mixed loose associations. The most significant characteristics of the particles identification are their density and form. However, these characteristics may change by influence of such phenomena as fracturing, degree of weathering, peculiarities of crystal structure and various admixtures for majority of minerals (excepting massive gold particles and, probably, platinoids). Integration of the mentioned effects may outcome to intersection of spectrums of real densities and as a result – to their equal and close values. The quoted data allow understand the main reasons of losses of gold, diamonds and other valuable minerals at searching, prospecting and exploitation in placers. Thus, we can conclude that known gravitation procedures in water principal cannot provide a high output of the valuable minerals.

Extraction of grains of the close sizes and density by the methods existing nowadays and widely distributed in the past (broadly applied in the periods of "gold fevers") – methods of water washing lead to accumulation in spoils of the fulfilled placers a great amount of useful components. We may propose that old terraces (spoils) contain no fewer amounts of economic minerals (which are the recoverable reserves) that were extracted from the exploitive placers. We suggest that the repeated processing of old terraces by another enrichment procedures (magnetic, electrostatic, biochemical or their optimal integration with the enhanced gravity concentration) may supply the world industry by some types of minerals for tens of years.

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