Dilution of Sands by the Tails of Ephel Dumps During the Dredging of Placers

Victor E. Kislyakov, Pavel A. Zubov

***Abstract*—**The article describes one of the types of dilution - dilution with tailings of ephelian dumps in the bottom-hole zone. A specific method is given that allows one to determine this type of dilution. The classification of factors influencing dilution is shown. A simulation of the process in which the described type of dilution occurs was carried out. The initial data has been specified. As a result of calculations and modeling, graphs of the dependences of dilution on the thickness of the worked layer were obtained. The algorithm and conditions for applying the modeling process are described.

***Keywords*—**dilution, dredging of placers, modeling.

I. Introduction

The demand for gold retains the need to develop a production strategy for the development of mining enterprises in accordance with the achievements of scientific and technological progress [1]. The highest technical and economic indicators in the development of alluvial mineral deposits have a different method, which has a number of advantages, such as high productivity, minimum cost, the possibility of implementation in difficult hydrogeological conditions. The prospects for involvement in the development of man-made deposits create the need to update the approach to the features of the dredge method in order to reduce or completely eliminate the disadvantages of this method [2-8]. In 2020-2022 Russia mined 330-340 tons of gold, although in the early 2010s it was less than 300 tons. On the horizon of 10-20 years, there is a risk of encountering a shortage of raw materials. Recoverable reserves are 7.5-8 thousand tons of gold [9]. In 1964, the gold content in placers was 50 g/m^3, and nowadays it reaches 30 mg/m^3. With such low concentrations, the dilution problem is particularly acute.

With the draining method, various types of sand dilution are known [10-12], but the dilution of the tailings of ephel dumps is the most influential. The depth of the developed placers increases every year, which is why the relevance of this type of dilution is growing [13-18].

It is necessary to know the amount of dilution by rocks of ephel dumps at the stage of field design and development. This is necessary to develop measures that should completely eliminate or reduce the impact of dilution. Based on all of the above, the purpose of the work is to determine the amount of dilution depending on the depth of the layer of gold-bearing sands being developed.

The amount of sand dilution by the ephel dumps depends on the geological, technological and technical factors presented in Figure 1.

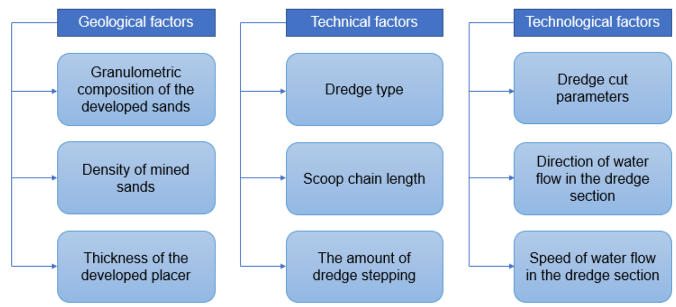

Fig. 1 Factors affecting the amount of dilution of sands by tailings of ephel dumps

The process by which the dilution of sands occurs in the bottom face should be evaluated in dynamics. Bottom-hole bleaching can occur at different depths of the worked layer, which changes during the development of subsequent approaches.

II. Process Modeling

The dilution process can be modeled in AutoCAD. It is necessary to build 3D models of the dredge section, dumps and the dredge scoop chain. The resulting models must be fulfilled for the following conditions.

Geological parameters:

- coarse-grained and fine-grained sands, the total yield of ephel fractions according to the granulometric composition of which is 68 and 100 %, respectively;
- the capacity of the developed sands H_p = 15 m (underwater capacity H_{p1} = 12 m, surface – H_{p2} = 3 m);
- the density of the sands is p = 2 t/m^3.

Technological parameters:

- the value of the layered lowering of the frame h_s = 0.25 m;
- the direction of movement of the process water flow in the section – from the dumps towards the face;
- the flow rate of process water V_n = 0.01 m/s;
- the angle of rotation is 90°, the width of the draw section is 73 m.

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Technological parameters:

- the standard size of the dredge is 250D;
- the size of the stride is 2-8 m in increments of 2 m;
- the length of the inner contour of the scoop chain in the idling section from L_{min} = 33.9 m to L max = 37.3 m.

The following indicators were selected as variable characteristics:

- at L_{max} = 37.3 m for fine-grained and coarse-grained sands, the walking distance a_w = 2; 4; 6; 8 m;
- at L_{min} = 33.9 m for fine-grained and coarse-grained sands, the amount of striding a_w = 2; 4; 6; 8 m.

The diagram of the scoop chain is shown in Figure 2.

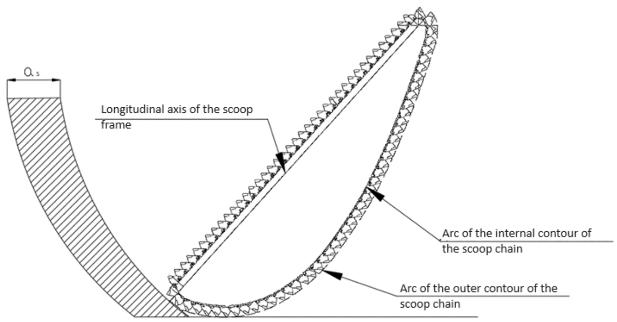

Fig. 2 Diagram of a ladle cap

Combining these parameters, 16 different models have been developed.

The modeling algorithm:

1) Determination of the volume of the layer in the dense mass removed by the dredge, starting from the surface;
2) Calculation of the actual volume of ephel fractions forming the ephel dump;
3) Construction of the longitudinal profile of the tunnel blade;
4) If the trajectory of the scooping chain crosses the surface of the shovel blade, then the geometric volume of sand inside the resulting contour is fixed;
5) Repeat the algorithm starting from 1 point for the underlying layer.

This calculation procedure allows you to obtain the volume of dilution by each layer of mining. To determine the value of the volume of dilution rocks in solid mass, a weighted average loosening coefficient was obtained.

The values of diluting rocks in solid mass to the volume of entry are shown in Figures 3, 4, 5 and 6 for coarse and fine-grained sands. The color of the lines shows the size of the drag stride. The maximum values were found on the lower layer of the developed sands.

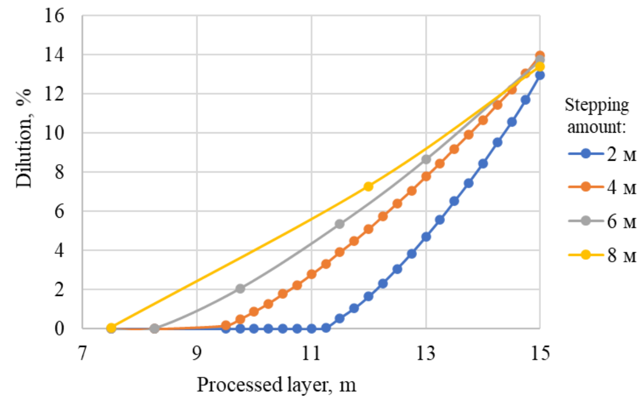

Fig. 3 illusion by working depth for fine-grained sands at L_{min}

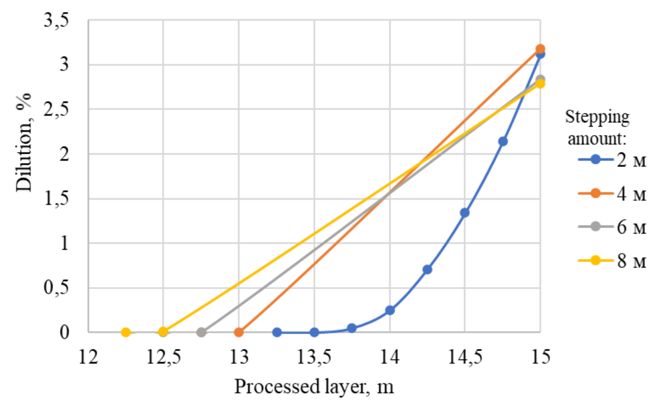

Fig. 4 Dilution by working depth for coarse-grained sands at L_{min}

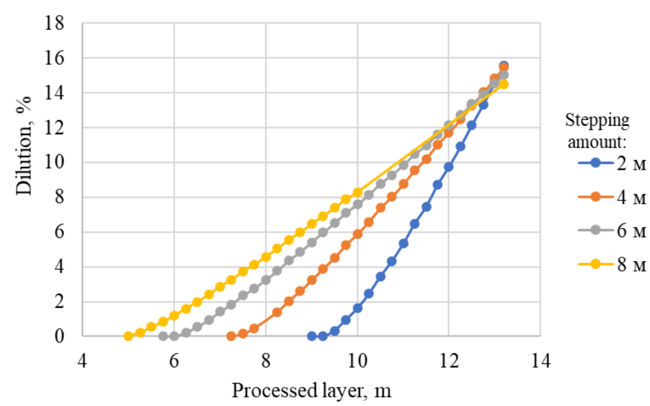

Fig. 5 Dilution by working depth for fine-grained sands at L_{max}

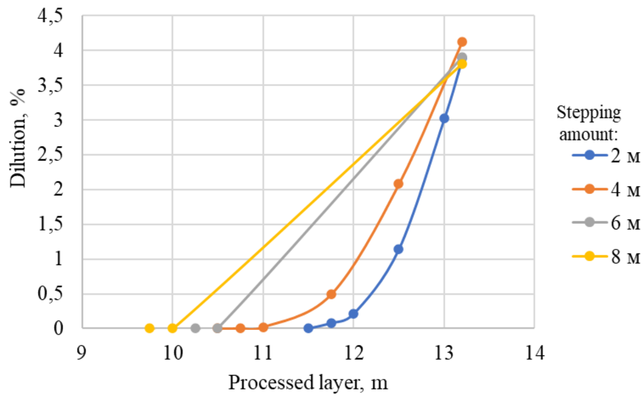

Fig. 6 Dilution by working depth for coarse-grained sands at L_{max}

At L_{max}, at a depth of 13.2 m, the placer raft is reached by a scoop chain.

The obtained values allow us to obtain an equation describing the dependence of the dilution value on the mining layer.

The conditions for using the model are as follows:

1) If the dilution is less than zero, then take the dilution equal to zero;
2) The layer from which dilution begins to occur depends on the size of the dredge step.

III. CONCLUSIONS

Thus, the obtained values make it possible to determine the dilution of sands in the zone of dredging by the tailings of landfills, depending on the depth of dredging, the composition of the sands, the dredge model, the length of the contour of the scoop chain and the magnitude of the dredge stride. The technique can help in determining dilution during the design and operation of dredge developments in placer deposits. Knowledge of the dilution value is necessary for the development of technological solutions that reduce or completely eliminate dilution by tailings of ephel dumps.

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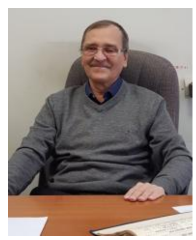

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