The Software System of Searching the Optimized Location for the Dressing Plant on Treatment with Geographically-Closed Placer Accumulations of the Minerals

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Abstract

The rational and integrated development of the technogenic placers is possible only on the ground of the development of a new methodological and technological approach, innovative technologies based on the processing of significant volumes of technogenic rock mass with the use of high- production environment, providing integrated recovery of the commercial components. The necessity of searching the new methodological and technology-economic approaches has been substantiated to solve the problem of effective and large-scale integrated development of geographically-closed technogenic placer accumulations. The new strategic approach has been put forward to the effective reclamation of the geographically-closed technogenic placers and the small, natural placers adjacent to them: large-scale development of geographically-closed technogenic placers, complex extraction of valuable associated components on a washing device, the location of which minimizes operating and transportation costs and is determined with the use of the developed software system.

Key words: geographically-closed technogenic placers, software system, mathematical model, route retrieval algorithm, algorithm for searching the optimized location for the dressing plant.

1 Introduction

Currently the level of gold production capacity from the natural placers (with the exception of the Magadan Region) has fundamentally decreased in the Far East of Russia; it amounts to approximately 30% of the total production. It is connected to the large extent both with the mining of easy-to-reach and prolific placers, with the decrease in prospecting surveys for alluvial gold. The technogenic placers become a significant resource of placer gold mining under these conditions [1, 2].

The industrial mineral formations, which in current socio-economic settings make mush of the process facilities, are assigned to technogenic placers by the majority of explorationists [1-7].

Planning the development of technogenic placers, it is necessary to take into account this number of important factors: the nature of the location and combination of various technogenic complexes, the degree of its preservation in the exhaust space; the geological features of the formation and exploitation of primary placers; the geographical location of placer accumulations; the period of placer development; the technical features of the field operation; the national and world politics on the market of precious metals, etc. [8].

The need for the preliminary realignment of the separate complexes (the formation of the singular and sequentially organized rock mass) for their processing and enrichment at a stationary washing device or dressing plant is the singularity of the modern approach to the rational and large-scale reclamation of the technogenic placers.

The effel dumps, pebble dumps, heterochronous dumps, overburden mass, off-balance blocks, residual bedrock-adjacent blocks, dumpy- argillaceous deposits of filter beds, the tailings of placer gold-concentrating sites or “black sands”, - are related to the main composition of man-made and residual natural-man-made complexes formed in the course of mining the natural placer [3, 4, 6, 9].

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At the present time the reclamation of the placer accumulation technogenic complexes is carried out in small volumes in the Far East of Russia. There are a lot of reasons for that: limited financial and technologic resources of the small and medium-sized enterprises, the legislative deficiencies that restrict the opportunities of the plants to explore the placer accumulations especially previously formed, without fulfilling the exploration requirements in relation to the natural placers, legal and technological problems of extracting the whole complex of mineral deposits, etc.

2 The Strategic Approach

The facts just cited shows that the rational and integrated reclamation of the technogenic placers is possible only within the scope of the development of a new methodological and technological approach, innovative technologies based on the processing of significant volumes of technogenic rock mass with the use of high- production environment, providing integrated recovery of the commercial components. A new strategic approach to the development of technogenic placers being suggested by us is agreed with all these requirements: large-scale development of geographically-closed technogenic placers, complex extraction of valuable associated components on a washing device, the location of which minimizes operating and transportation costs.

Sorting out the problem of the development of the geographically-closed placer accumulations with the refinery of producing rock mass on the stationary washing device providing the accumulation of commercial components is a new and relevant scientific and technological challenge.

The following strategic sequence of adoption of the methodical, engineering and financial-economic decisions is applied for the reclamation of the geographically-closed technogenic placer objects.

The geographically-closed technogenic placer accumulations of a particular region are selected on the basic of the developed theory for the satellite images and (if available) for engineering documentation of exhaust geogenic placers. The Sophia ore-placer knot could be an example (Fig. 1).

The complete set of prospecting surveys is carried out upon including the selected fields in the register of developed ones or the appraisal surveys are proceeded in the course of operational work in order to clarify the complex resources of the fields.

The type of washing appliance, equipped with additional mineral processing equipment is selected, its productivity is calculated.

The rational (by economic, technological and environmental indicators) location of a stationary washing device is determined with the help of the software system developed at the Institute of Mining of the Far Eastern Branch of the Russian Academy of Sciences [10]. The procedure for the rock mass refinement is working out upon the condition that all the reserves of the fields would be equally depleted for the established planning period.

The main working principle of the program is the partitioning of the considered area of the terrain using a predetermined coordinate grid (Fig. 2), the sequential calculation of profitability at each grid point and the choice of grid coordinates, in which the calculation shows the greatest profitability.

The input of the initial data is made in several stages. At the first stage the matrix, on which the fields of interest and the areas inaccessible for the location of the dressing plant (DP) are indicated, is created by dint of the developed application with loaded map of the area of geographically close fields.

At the next stage, the following general data is imported from the Excel spreadsheet: the number of produced commercial components, the capacity factor of the rock mass delivered to the DP, the cost of transporting 1 ton of raw materials per 1 km, the technical characteristics of transport and excavation equipment, the duration and number of shifts, property tax, the coefficient of loosening and density of rocks, as well as the data characterizing the field - the volume of rock mass, the content of commercial components, processing losses, the price and the costs on the production of 1 gram of each commercial components.

Having performed necessary accounting, the program makes the economics heat map, which shows the profitability level change depending on its location in the study area (Fig. 3). The program creates the outbound file giving the opportunity to see the inaccessible areas and fields, the optimal plant location and approximate path from the field to the DP (Fig. 4).

3 Methods for Solving

The Matlab R2013b math package has been chosen to generate the mathematical model. The selected math package is well optimized for working with a matrix data type. The Matlab kernel allows you to work with matrices as quickly and easily as possible, which is an important factor for large amounts of data.

The main idea of creating a mathematical model is to split the study field (Fig. 1) into elementary sectors of a given size and present the resulting set of elementary areas and the whole territory into a matrix view (Fig. 2). After splitting the study field, each elementary sector is turned to the location for the dressing plant; the profit rating of a plant located on the selected elementary sector is calculated. Having calculated all the elementary sectors, the chosen one is that with the high profitability index. The obtained elementary sector is got to the desired optimal location for the DP.

The developed application, implemented in C ++, using the Visual Studio 2013 software environment operates to form the matrix that represents the study field.

The study field is divided into a matrix of a given size with each of its elements presenting the elementary sector of an area. Each sector is assigned to the identifier determined by the logic of the program, depending on the type of sector (Fig. 2). When forming the matrix type of the study area, the elementary sectors of the area are divided into several types:

- available area sectors – the sectors letting the DP be located, and making it possible to map a route from the deposit to the plant, the sector id 1;
- inaccessible area sectors – the sectors, where locating the DP and mapping the route (elevations, water) is not available, the sector id 0;
- deposits – places, from which the rock is transported to the DP, the sector id 4;
- the estimated optimal location for the DP, the sector id 3;
- the route from the deposit to the plant, the sector id 2. The corresponding sections are marked in the application forming the matrix.

The remaining sites are marked as available. The optimal location for the DP and the routes from the deposits to the plant are determined during the calculation of the mathematical model.

Figure 1: Plot Sophiysky ore-placer field

Figure 2: The position of deposits and inaccessible areas

4 Route Retrieval Algorithm

The algorithm for finding the shortest path has been developed to estimate the distance from the deposits to the intended location of the DP. The work of the algorithm is outlined as follows: starting from the chosen elementary sector with the deposit located, the distance from the neighboring available elementary sector to the intended location of the plant is calculated. The neighboring sectors are classified according to the Moore neighborhood: the eight sectors are considered to be the neighboring. If there are any inaccessible sectors, they are excluded from the calculation.

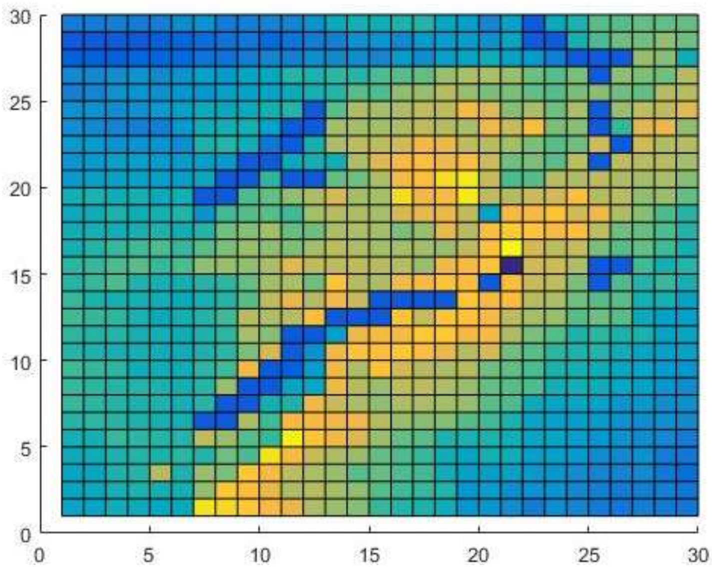

Figure 3: The profitability heat map

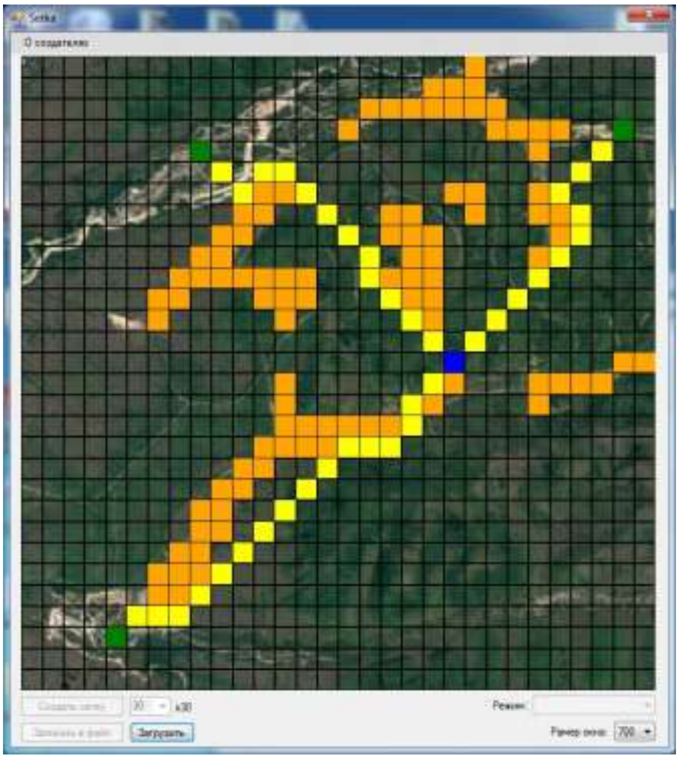

Figure 4: The position of DP and access roads to it

The smallest value of the distances is chosen from the obtained ones, the sector with the smallest distance is defined as the route to be laid. The following calculation is made between the adjacent elementary sectors obtained during the last calculation, and the resulting area with the shortest distance to the intended plant location becomes the next waypoint. The calculation is made before reaching the final sector.

The spontaneous shape of the inaccessible sectors could lead to the necessity to move away from the end point in order to avoid meeting with the inaccessible part of the field during the route calculation. To resolve such situations, the algorithm is supplemented with the appropriate logic. The idea of avoiding the spontaneous sectors involves searching the angle units of an inaccessible area and routing through the found angle units. It is enough to go round its angle to bypass the inaccessible area, and after turning, to continue the advance to the end point.

In such a manner, the route retrieval algorithm consists of the two adjacent algorithms and the trigger switching between them. At starting point the trigger is fixed to the initial position, making the first algorithm work by constantly approaching the end point. If the route was successful, the algorithm stops working. Otherwise, the program returns the calculations to the starting point, sets the trigger to the second position to activate the second algorithm, which starts seeking the angle units of inaccessible areas and selects the element with the minimum total distance from the starting point to the selected element and from the element to the ending point. Having chosen the angle units, it becomes the passing point, and the algorithm tries to make the route to it. If it is impossible, the program excluded the chosen element from the list of angle units, returns the calculations and makes the search for the new angle element by the similar principle. If the route was managed to be laid, the program saves all the results obtained to return the calculations when the algorithm will stop working during the further routing. The trigger sets into the initial position, and the program continue to lay the route using the first algorithm.

5 Finding the Optimal Location for the Dressing Plant

The available slot is selected at the beginning of the matrix map and is marked as the lot with the dressing plant located. The program estimates the shortest paths from the deposits to the intended site of the dressing plant and, using the formulas and the source data, calculates the profitability of the plant in case of its location in that specified lot. After that, the next available slot is selected, for which, by the same principle, the profitability of the plant is determined in the view of its placing in that specified slot. In such a way the calculation of all available slots is held. After calculation, a slot with the maximum profitability index is selected. The resulting slot is the best location for DP.

Based on the calculations the program makes the profitability heat map (Fig. 3), the map indicating the DP and the shortest paths to it (Fig. 4).

Thus, a software method has been developed for determining the optimal location for a flushing device or dressing plant for the efficient development of geographically-closed technogenic placer accumulations or small (possibly unprofitable) natural placers adjacent to them.

6 Conclusion

The analysis of the local and foreign efforts of research in the field of the exploration of natural and technogenic placer deposits shows that the strategic issues of developing geographically close technogenic gold-bearing deposits are poorly studied, but the importance of solving them in case of level decreasing of the placer gold mining increases.

The search for new methodological and technological-economic approaches to solving the problem of efficient and large-scale integrated development of geographically close technogenic placer accumulations is an important fundamental and applied task.

A number of methodic contributions have been developed to substantiate this approach; an algorithm and software system for ECM have been created to calculate technical and economic indicators of the simultaneous development of each selected geographically-closed gold-bearing deposits.

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