FEATURES OF REMOTE SENSING APPLICATIONS FOR ENSURING SAFE AND RATIONAL MINING OPERATIONS

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Due to the constant extraction of minerals, there is a gradual depletion of natural resources in existing enterprises. This fact forces mining companies to apply various measures in order to gain profit from enterprises. These measures include recalculation of the economically viable content for extracting and re-planning the extraction scheme in complicated conditions. Measures lead to profit from the implementation of projects that were previously considered completely unprofitable, but in view of the significantly increasing costs, the total income of the enterprise is significantly reduced. In order to reduce costs and ensure the rational use of mineral resources, enterprises are forced to reduce costs for certain types of work. This material describes a method for optimizing the control of mineral reserves using innovative free software products of remote sensing.

At any stage of the existence of a mining enterprise, it is necessary to monitor the current state of the rock mass. Open-pit mining requires constant monitoring of the position of the sides of quarries, with underground mining one of the main tasks is to observe the displacement of the earth's surface. Implementation of these types of control requires considerable time, human resources and money. The use of modern products will allow redistributing the resources of surveying and engineering services to perform other tasks with minimal costs. Currently, the method of monitoring the earth's surface by means of remote sensing is gaining popularity. The most popular are the synthetic aperture radars used in many systems ((SEASAT, (USA), ERS, ENVISAT (European Space Agency), RADARSAT (Canada), JERS-1 и PALSAR (Japan). These systems allow obtaining the information about the state of the earth's surface with the use of radar imagery taken from artificial earth satellites. Until recently, the serious disadvantages of this system were the complexity of software and the high cost of both the images themselves and the used software packages. Radar images received by satellites covered areas exceeding 40 thousand km2, which adversely affected the rationality of the application of these methods for mining enterprises. Since 2008, the Copernicus program, supervised by the European Space Agency, has started. The main idea of the program is the dissemination of open information about the Earth for the needs of ordinary users. One of the directions of the program development is remote sensing of the Earth's surface by radars with a synthetic aperture called Sentinel-1. The Sentinel-1 mission comprises a constellation of two polar-orbiting satellites, operating day and night performing C-band synthetic aperture radar imaging and working in a pre-programmed operation mode to avoid conflicts and to produce a consistent long-term data archive built for applications based on long time series. Sentinel-1 carries a single C-band synthetic aperture radar instrument operating at a centre frequency of 5.405 GHz. It includes a right-looking active phased array antenna providing fast scanning in elevation and azimuth, data storage capacity of 1 410 Gb and 520 Mbit/s X-band downlink capacity. The C-SAR instrument supports operation in dual polarisation (HH+HV, VV+VH) implemented through one transmit chain (switchable to H or V) and two parallel receive chains for H and V polarisation. Dual polarisation data is useful for land cover classification and sea-ice applications. [1]

Sentinel data products are made available systematically and free of charge to all data users including the general public, scientific and commercial users. Radar data can be delivered within an hour of reception for Near Real-Time (NRT) emergency response, within three hours for NRT priority areas and within 24 hours for systematically archived data. The shape of the orbits of satellites allows you to obtain information about the state of the earth's surface in virtually any part of the planet.

Figure 1 shows that for the main developed countries the information is updated every 12 days, in the main part of Europe the measurement period is 6 days. Thus, on the basis of satellite data, it is possible to obtain free information about the condition of the sides of large quarries or the earth's surface over subterranean maintenance sites with technical accuracy. This method of studying the change in the deposition of elements of the earth's surface will allow us to estimate the amount of work on quarries with minimal costs and predict the displacements of the earth's surface on the basis of statistics for the mine field. To directly assess the change in the position of the elements, there is no need for specially trained personnel. Engineer just needs two free radar images covering required area. The Tagebau Hambach brown-coal mine was used as an example in this research. It is a large open-pit mine in Niederzier and Elsdorf, North-Rhine Westphalia, Germany.

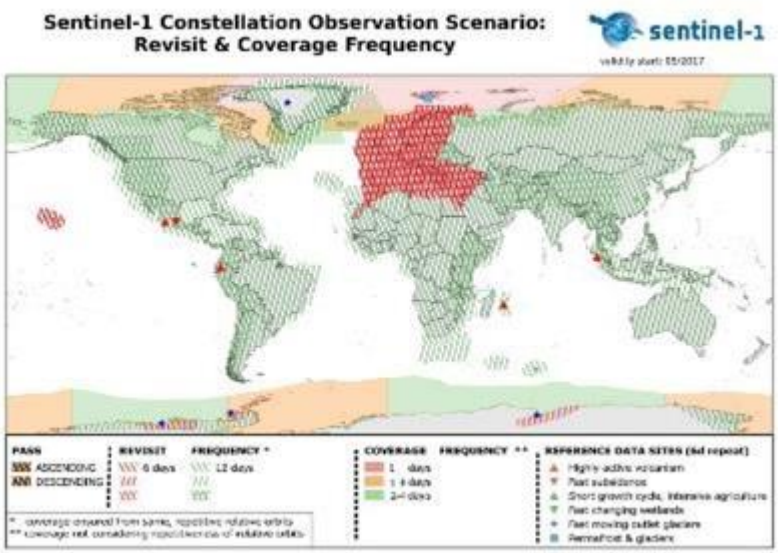

Fig. 1. Sentinel-1 program coverage frequency [1]

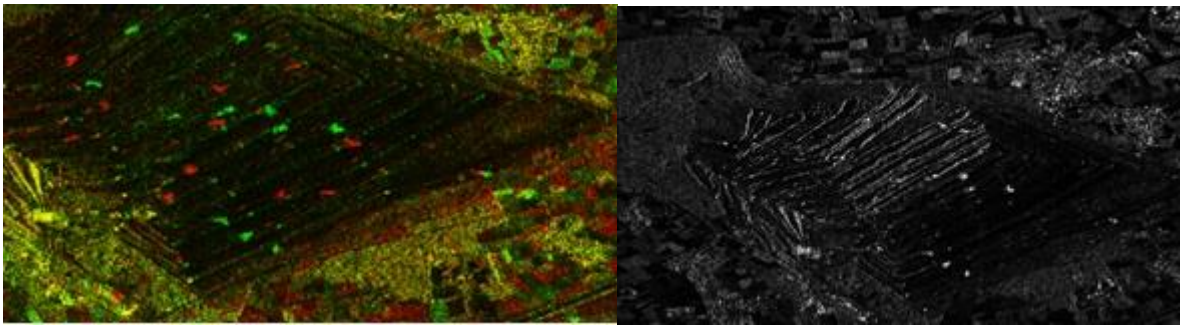

Fig.2. Radar image processing results

Figure 2 shows the results of processing the pit pictures from May 31, 2017 and October 3, 2016. Ehe RGB-image clearly shows the change in the position of the sides of the quarry (painted red and yellow). The interferogram formation from these images allows to determine the altitude differences in the position of the elements of the quarry with technical accuracy. This work can be done by one engineer with minimal costs.

REFERENCES

1. Information from the official Copernicus website.