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IMAGES CONVERTER OF GEOLOGIC- LITHOLOGICAL PROFILES

Abstract. The article is devoted to the program "Converter", which allows you to translate the geologic-lithological profile of a mineral field into a digital format in the form of a two-dimensional array.

The object-oriented programming language Python was used to write the program. The NumPy, OpenCV, and MatPlotlib libraries are actively used. The implementation of this program is based on image segmentation and finding the prevailing colors in the OpenCV library. Image segmentation is a preliminary step in image processing. The obtained values allow you to find out the density distribution in the area under consideration. The program "Converter" has a good graphical representation of the results obtained using the MatPlotlib library. The program writes the final converted result as a two-dimensional array to a text file along the desired path. Thus, the matrix is easy to read for further use in conjunction with other programs.

The purpose of this work was to create a program that converts the geologic-lithological profile of the field into a digital format in the form of a two-dimensional array, for further use of this matrix as the distribution density of the oil field. The "Converter" program converts any geologic-lithological profile into a two-dimensional array in a matter of minutes.

Key words: geologic-lithographic profiles, Converter, density distributions, colors, pixel, matrix, invers problem.

Introduction. Long-term development of oil and gas fields can lead to negative consequences. For timely detection of various negative phenomena, gravimetric monitoring of deposits is regularly carried out with subsequent identification of experimental data. Gravimetric monitoring is a method in the complex of control tools for the development of oil and gas fields. The use of gravimetric monitoring complements and refines the results of standard methods. Gravimetric monitoring is based on gravimetric surveys. Gravimetric survey is a set of measurements of quantities that characterize the gravitational field of a given area. This survey allows you to solve geological problems. The final product of gravimetric survey is gravimetric maps. Based on changes in the gravimetric survey readings and other factors, conclusions are drawn about changes in the internal geological structure of the profile. You can do this by solving the inverse problem of gravimetry. But in the process of solving it, you will have to solve a direct problem. This requires a density distribution. Where can we get it? In particular, there are data of geologic-lithographic profiles (obtained during the initial exploration of the field). They are maps (drawings) in graphic form, which depict the location of certain materials in this area. This information allows you to find out the density distribution in the area at the initial stage. Knowing the density distribution, we can find the distribution of the gravitational field by solving the direct gravimetry problem [1-4]. To solve a direct problem, you need to have a density distribution in digital form rather than graphical. The purpose of this work is to create a program that automatically implements this procedure [5].

Problem statement. Figure 1 shows the geologic-lithological profile of the oil field. The drawing shows oil deposits in brown, gas deposits in yellow, and water deposits in blue. Around the minerals-the ground is white. The composition of the soil depends on the depth of the Deposit. The left side of figure 1 shows the depth scale in meters. Vertical lines in the form of arrows are drilled wells. Well numbers are written on the tops of the heads. Geologic-lithological profiles have different scales horizontally and vertically, which should be taken into account when implementing the program. The main object of research is to obtain a density distribution matrix in a given area by converting geological and lithological profiles. The drawing sets the distribution of materials by section.

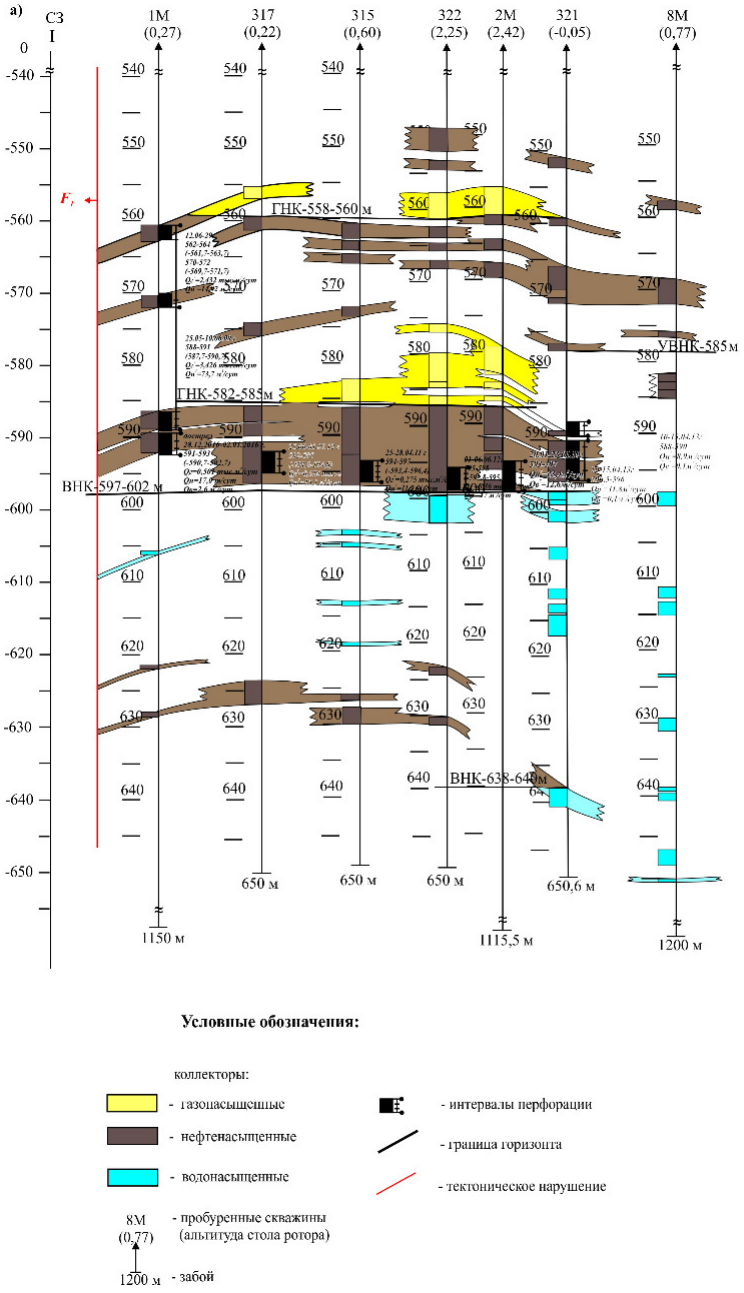

Figure 1 – Geological and lithological profile of the oil field.

We need to have geologic-lithological profiles in the form of initial information about the density of materials, to obtain a density distribution matrix. To do this, you must have a program that implements this transformation. We called this program "Converter". The program should be easily integrated with other parts of the global program and of course meet the latest requirements of the scientific community.

Research methods. Since Python is a modern and good choice for system integration in scientific computing. All calculations were performed in Python, an object-oriented language. The big advantage of an interpreted language is that programs can be tested and debugged quickly, which allows the user to focus more on the program principles and less on the programming itself. Since there is no need to compile, link, and execute after each fix, Python programs can be developed in a shorter time than equivalent programs in Fortran or C. On the negative side, interpreted programs do not create standalone applications. Thus, a Python program can only run on computers that have the Python interpreter installed [6]. Python has a rich standard library and a large number of extension modules for almost all the needs of the information technology industry. The program "Converter" used the libraries cv2 (library for working with graphic data and pixels), numpy (library for working with matrices), pyplot (library for plotting), and others. One of the fundamental aspects of NumPy is providing a powerful N-dimensional array object, ndarray, to represent a collection of items (all of the same type) [7].Thanks to the clear syntax, learning the language is not a big problem. Programs written in it are structured in form, and it is easy to follow the logic of their operation.

Algorithm of the program «Converter». The program **«Converter»** works according to the following algorithm:

1) To process images of geologic-lithographic profiles of deposits in digital format, an image is fed to the input. The program takes a drawing of a geologic-lithological profile, reads its width and height in pixels.

2) Divides the number of pixels into N parts, thus splitting the original pixel area into small rectangles.

3) In each small rectangle, we calculate the color distance of each pixel from the colors in the density table based on the Euclidean distance formula (in this case, we only have 4 colors – blue, brown, yellow, and white).

4) Having determined which of the four colors this pixel is closest to, it counts the number of each of the four colors in this rectangle. This is how the program determines how many pixels of a particular color (one of four colors) are contained in a small rectangle.

5) The Program determines the color that is most in this small rectangle. In addition, assigns this rectangle the color that is most there.

6) The Program goes through all the small rectangles, assigning each a certain color-the key number from the dictionary (brown, blue, yellow or white).

7) Using the color key, a density value corresponding to this color is requested, and the rectangle cell assigns this density value.

8) Running through all the rectangles, we get the density matrix, which is a digital format of the geological and lithological profile.

Note that the partition into N parts can be arbitrarily large. This allows you to get accurate interpretations down to pixels.

Dictionaries are useful for storing tables of information with a unique identify or for each record. Dictionaries provide a mapping from a set of keys to a set of values. In other words, given a key, a dictionary can look up the value associated with it [8]. In the Python programming language, dictionaries (the dict type) are another type of data structure, along with lists and tuples. This schema describes the syntax of a Python dictionary:

{key: value, key: value, key: value, …}

Therefore, each dictionary element consists of two objects: a key and a value. In our example, the key is the name 0,1,2,3 and color, name, density, the value is [255, 255, 255], [153, 204, 255], [204,150, 102], [255, 255, 0]; Earth, Water, Oil, Gas; [2.1], [1.55], [0.9], [0.00085]. Key identify dictionary item, the value is the data, which correspond to the given key. Key values is a unique, two identical keys in the dictionary cannot be.

OpenCV provides the *imread* function to load an image from a file and the *imwrite* function to write an image to a file. These functions support various file formats for still images. The supported formats vary – as formats can be added or removed in a custom build of OpenCV – but normally BMP, PNG, JPEG, and TIFF are among the supported formats [9]. An important feature of OpenCV is the

representation of images as multidimensional NumPy arrays and the saving of images in BGR colors. To return to standard RGB, use the cv2.COLOR_BGR2RGB function, which converts the BGR format to RGB format. This was necessary because the pixel colors were in RGB format.

As a result, *def converter_pix_to_massiv* function returns a matrix of densities of geological and geographical profiles of the field (figure 2).

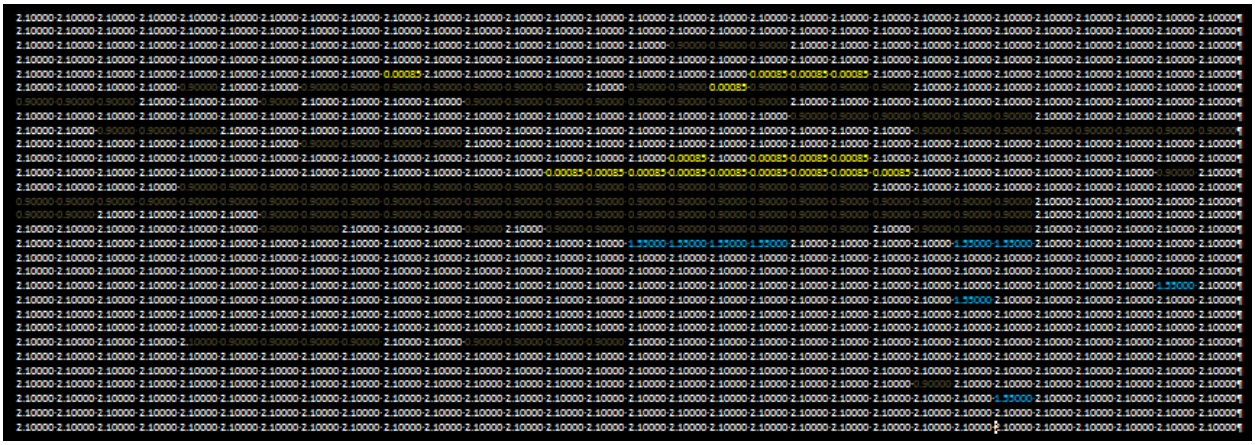

Figure 2 – Matrix of densities of geological and lithographic profiles of the Deposit.

Effective scientific and technical visualization of data requires a wide variety of graphing techniques. Matplotlib implements many types of plotting techniques as methods of the Axes object. For example, in the previous examples, we have already used the plot method, which draws curves in the coordinate system provided by the Axes object. As a consequence of the multilanguage model, scientific and technical computing with Python involves much more than just the Python language itself. In fact, the Python language is only a piece of an entire ecosystem of software and solutions that provide a complete environment for scientific and technical computing [10].

Conclusion. The developed program "Converter" actually converts the geological and lithographic profile of an oil field into a digital format in the form of an array in the Python environment. The results obtained will be used in the future to solve the main direct problem, which allows us to find out the distribution of the gravitational field, as if the structure of the field would be the same as indicated in those sections. And by monitoring deposits and identifying this information, it is supposed to solve the inverse problem in order to find out what changes have occurred in the reservoir compared to the distribution that is obtained in the process of solving a direct problem based on information from sections. Thus, the developed program becomes one of the key elements of the developed GIS project AP05135158 ”Development of geographic information system for solving the problem of gravimetric monitoring of the state of the subsoil of oil and gas regions of Kazakhstan based on high performance computing in conditions of limited experimental data”.

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КЕН ОРНЫНЫҢ ГЕОЛОГИЯЛЫҚ-ЛИТОЛОГИЯЛЫҚ КЕСКІНДЕРІНІҢ ГРАФИКАЛЫҚ БЕЙНЕЛЕРІН ТҮРЛЕНДІРУ

Аннотация. Мақала кен орындарының геологиялық-литографиялық кескіндерінің графикалық бейнесін екіөлшемді массив түрінде сандық форматқа түрлендіретін «Конвертер» бағдарламасына арналған.

Бағдарлама жазу үшін нысанға бағытталған Python бағдарламалау тілі қолданылды. NumPy, OpenCV, matplotlib кітапханалары белсенді түрде пайдаланылды. Пиксельдермен жұмыс істеу үшін OpenCV кітапханасының мүмкіндігін зерттеу мен қолдану жұмыстары іске асты, BGR және RGB форматтары, графикалық бейнелерімен жұмыс атқаруда қажетті форматты ұтымды қолдану жолдары қарастырылды. Бұл бағдарламаның іске асуы Python ортасында OpenCV кітапханасын пайдалану арқылы бейнені сегменттеуге және басым түсті табуға негізделген. Бейнені сегменттеу – бейнені өңдеудің бастапқы қадамы болып саналады. Жуық өлшемі ретінде Евклид қашықтығы қолданылады. Алынған мәндер қарастырылатын аймақта тығыздықтың таралуын анықтауға мүмкіндік береді. «Converter» бағдарламасы matplotlib кітапханасы арқылы алынған нәтижелерді көрнекті графикалық түрде бейнелеп береді. Бағдарлама екіөлшемді массив түрінде түрленген соңғы нәтижені таңдалған жол арқылы мәтіндік файлға жазып береді. Сөйтіп, алынған матрицаны болашақта басқа бағдарламаларда кешенді түрде қолдануға болады.

Түйін сөздер: геологиялық-литографиялық кескіні, Converter, тығыздықтың таралуы, түстер, пиксель, матрица.

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КОНВЕРТЕР ИЗОБРАЖЕНИЙ ГЕОЛОГО-ЛИТОЛОГИЧЕСКИХ ПРОФИЛЕЙ

Аннотация. Статья посвящена программе "Конвертер", позволяющей перевести геолого-литологический профиль месторождения полезных ископаемых в цифровой формат в виде двумерного массива.

Для написания программы был использован объектно-ориентированный язык программирования Python. Активно использованы библиотеки NumPy, OpenCV, matplotlib. Была проведена работа по изучению и применению возможности библиотеки OpenCV при работе с пикселями, изучен формат BGR и RGB и корректное использование нужного формата при работе с геолого-литологическими профилями месторождения. Реализация данной программы основана на сегментации изображении и нахождении преобладающих цветов в среде Python с использованием библиотеки OpenCV. Сегментация изображения является предварительным этапом обработки изображений. В качестве меры близости используется Евклидово расстояние. Полученные значения позволяет узнать распределение плотности в рассматриваемой области. Программа «Converter» имеет хорошее графическое представление полученных результатов при помощи библиотеки matplotlib. Конечный преобразованный результат в виде двумерного массива программа записывает в текстовый файл по желаемому пути. Таким образом, матрицу легко считывать для дальнейшего использования в комплексе с другими программами.

Ключевые слова: геолого-литографические профили, Converter, распределения плотности, цвета, пиксель, матрица, обратная задача, гравиметрия, прямая задача.

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REFERENCES

[1] Serovajsky S.Ya., Kenzhebayeva M.O. (2018) Modeling of the potential of the gravitational field at the upper boundary of the region with the existence of a subterranean anomaly // International Journal of Mathematics and Physics. Vol. 1. P. 20-26. (in Eng.).

[2] Serovajsky S.Ya., Azimov A.A., Kenzhebayeva M.O., Nurseitov D.B., Nurseitova A.T., Sigalovskiy M.A. (2019) Mathematical problems of gravimetry and its applications // International Journal of Mathematics and Physics. Vol. 1 (29). P. 29-35. ISSN 2409-5508 (Online), ISSN 2218-7987 (Print) (in Eng.).

[3] Marchenko M.A., Serovajsky S.Ya, Smirnov D.D., Kenzhebayeva M.O. (2019) Solving the inverse problem of gravimetry by the Monte Carlo method on a supercomputer using distributed computing [Reshenie obratnoi zadachi gravimetrii metodom Monte-Karlo na supercomputer s ispolzovaniem raspredelennih vichislenii] // Parallel computing technologies - XIII international conference, Pavt'2019. [Parallelnie vichislitelnie tehnologii – XIII mejdunarodnaya konferenciya, Pavt'2019], Kaliningrad, April 2-4 (2019). P. 327-338 (in Russ.).

[4] Serovajsky S.Ya., Kenzhebayeva M.O. (2018) Modeling of the potential of the gravitational field at the upper boundary of the region with the existence of a subterranean anomaly // International Journal of Mathematics and Physics. Vol. 1 (20). P. 20-26. ISSN 2409-5508 (Online), ISSN 2218-7987 (Print) (in Eng.).

[5] Toyganbaeva N., Kenzhebayeva M. (2020) Development of a program for converting graphic information of geological and lithographic profiles into digital information. Traditional international April mathematical conference in honor of the day of science workers of the Republic of Kazakhstan, dedicated to the 1150th anniversary of Abu Nasir al-Farabi and the 75th anniversary of the Institute of mathematics and mathematical modeling. Almaty. 143 p. (in Eng.).

[6] Jaan Kiusalaas (2005) Numerical methods in Engineering with Python, Cambridge University Press, ISBN –I3 978-0-511-12810-3. (in Eng.).

[7] Sandro Tosi (2009) Matplotlib for Python Developers, Published by Packt Publishing Ltd. UK. ISBN 978-1-847197-90-0 (in Eng.).

[8] Laura Tateosian (2015) Python For ArcGIS, Springer Cham Heidelberg New York Dordrecht London, ISBN 978-3-319-18397-8

[9] Joseph Howse, Joe Minichino (2020) Learning OpenCV 4 Computer Vision with Python 3, Third Edition, pp -26-28-3, ISBN 978-1-78953-161-9 (in Eng.).

[10] Robert Johansson (2019) Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, Urayasu-shi, Chiba, Japan. ISBN-13 (pbk): 978-1-4842-4245-2. https://doi.org/10.1007/978-1-4842-4246-9

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