Exploratory Research on the Relationship Between open Pit of Building Sand and Typical Socio-Economic Factors Based on Satellite Remote Sensing Survey in Shigatse

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Abstract: Based on the 2019 satellite remote sensing data, the survey was conducted on the open-pit stopes of the building sand mines in Shigatse, Tibet, and the relationship between the number of stopes and the area, population and population density of the district/county, as well as the distribution characteristics between the main built-up areas, administrative villages and traffic roads at the county level were analyzed. This study tentatively links the open pit of building sand mine with human aggregation and human activity space, analyzes the possible correlation, distribution rules and change characteristics between it and the typical elements of social economy, and provides a research basis for improving the efficiency of mining administration in western China.

1 INTRODUCTION

Tibet Autonomous Region is located in the southwest border of China, covering an area of 1.22 million square kilometers, accounting for about one eighth of the total area of the country. Tibet, as the main body of the Qinghai-Tibet Plateau, borders Nepal, Sikkim, Bhutan and India in the south and Kashmir in the west. It is an important gateway to the southwest frontier of China, and has rich natural resources, fragile ecological environment and unique national culture [1]. Especially during the "13th Five-Year Plan" period, the GDP growth rate of the Tibet Autonomous Region has always been at the forefront of the country. With the rapid development of the economy of the whole region, municipal roads and bridges, relocation of poverty relief from other places, construction of affordable housing, and new urbanization have also made great progress, and to a certain extent led to the expansion of the mining scale of building materials mineral resources. Disordered mining, blind mining, extensive mining and other problems have followed, which may lead to a series of ecological and geological environmental negative impacts such as landscape destruction, environmental pollution and geological disasters [2], as a result, the contradiction between social and economic development and ecological environment protection has intensified [3].

As the main type of non-metallic mineral resources of building materials, building sand has the universality of resource distribution. At the same time, due to the low threshold of mining technology, it is often difficult to predict the mining behavior and location of such minerals. The Tibet Autonomous Region is vast, and it is difficult to supervise such mineral resources through field inspection.

This study is fully based on the previous survey and research results, exploring the possible correlation between the mining situation of building sand and human activities, and providing a research basis for the future monitoring of the mining order of non-metallic mines for building materials in the autonomous region.

In recent years, the survey and research on mining activities in Tibet Autonomous Region have mainly focused on the restoration and treatment of mining environment and land occupation for mining development. Wang Haiqing et al. took Shigatse as the research object, used 2 years of satellite remote sensing data to find out the area of mine restoration and governance in Shigatse districts/counties, and analyzed the effect of restoration and governance in areas of special concern [4]; Chen Ling took the restoration and treatment of the mining environment in the whole autonomous region in 2016 and 2017 as the research object, compared various restoration and treatment measures, and proposed the mine environment restoration and treatment strategy suitable for the western region [5]; Wang Haiqing and others analyzed the change of land area in use of production mines in Tibet Autonomous Region in 2016 and 2017, and reached the conclusion that the land area occupied by building sand mine increased the most [6]; Li Li and others investigated the distribution of copper mines and the land occupation of various types of mines in the autonomous region, analyzed the main land types damaged by copper mine development, and put forward suggestions for restoration and treatment [7]. At present, the relevant research with mining development and human activities as the starting point is slightly insufficient. According to the Manchu and

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Han archives of the Qing Dynasty, Jia Jianfei analyzed the relationship between the rise and change of Xinjiang's coal mining industry and the mutual promotion of population flow during the Qianjia period [8].

Taking Shigatse as the research object, this paper makes use of the advantages of satellite remote sensing monitoring technology such as macro, fast and efficient [9-10] to investigate the distribution of open-pit stopes of non-metallic mines for building materials in the city in 2019, and explore the correlation between the distribution location of stopes for building sand and human aggregation and human activity space.

2 Overview of the Research Area

Shigatse is located in the southwest border of China, the southwest of Tibet Autonomous Region, the northern foot of the Himalayas, the eastern part of Gangdise, and the the Yarlung Zangbo River running from east to west. Due to natural factors such as geology and topography, the ecological environment in this area is fragile. Shigatse has 1 municipal district and 17 counties, with a total area of 182000 km^2.

3 Remote Sensing Survey

Based on the full collection of Shigatse's basic geography, previous relevant survey results, satellite remote sensing data and other relevant data, the research has fully established the satellite remote sensing image interpretation mark for the building sand mine open-pit stope, and adopted the method of combining remote sensing image information extraction with field survey, finally forming the 2019 survey results of Shigatse's building sand mine mining.

3.1 Satellite remote sensing data

This study collected the satellite remote sensing data of Shigatse in 2019, including GF1, ZY3, and GF6, of which GF1 coverage accounted for 46.90%, ZY3 accounted for 30.69%, and GF6 accounted for 22.41%. The above three kinds of satellite remote sensing data are all of 2 meters resolution, and the data time items are mainly concentrated from late August to the end of December 2019, to ensure the consistency of the understanding and translation effect. As shown in Figure 1.

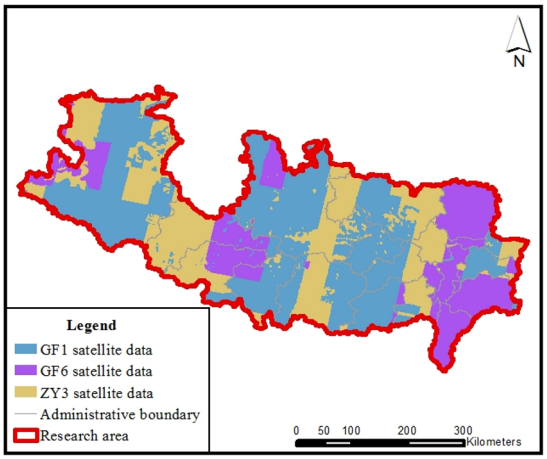

Fig.1 Schematic Diagram of Satellite Remote Sensing Data Quality

3.2 Field survey

The field survey work mainly carried out field investigation on more than 50 doubtful spots in Sangzhuzi, Nanmulin, Renbu, Saga, Lazi, Xietongmen and other areas. After the confirmation and the supplementary correction of the question pattern, the accuracy of the indoor interpretation pattern has been further improved.

3.3 Survey results

Using the 2019 satellite remote sensing image, a total of 790 open pits for building sand were interpreted in Shigatse. There are open pits for building sand in 18 districts/counties, of which Sangzhuzi area has the largest number of quarries, accounting for 15.06% of the total; the second is Angren, accounting for 8.99%. Xietongmen has the least number of stopes, accounting for 1.39% of the total; the second is Jilong, accounting for about 1.52%.

According to the statistics of mining status, there are 208 stopes, accounting for 26.33% of the total, which are mainly concentrated in Zhongba, Sanzhuzi, Saga. The main judgment basis for mining is based on remote sensing image or field survey that the excavation surface is relatively new, there are mining and beneficiation equipment or related facilities near the stope, the access road to the mining area is clear or has obvious rut marks, etc. There are 582 abandoned stopes, accounting for 73.67%, mainly concentrated in Sangzhuzi, Anren, Dingjie.As shown in Figure 2.

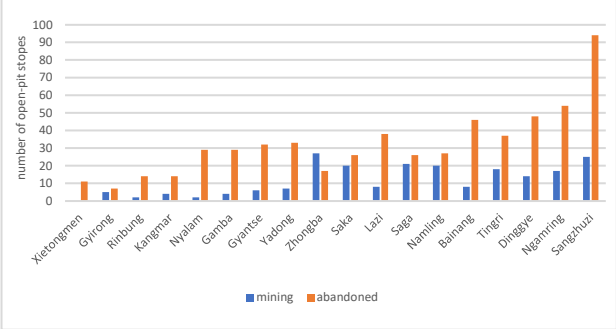

Figure.2 Diagram of Status and Distribution of Building sand Stope

4 CORRELATION ANALYSIS

4.1 County area

Zhongba has the largest area of 45900 square kilometers, accounting for 25.22% of the total area of the city, and its number of open-pit mines accounts for 5.57% of the total area of the city; Angren takes the second place, with an area of 27600 square kilometers, accounting for about 15.16% of the total area, and the number of stopes accounting for about 8.99%; The area of Sangzhuzi is relatively small, less than one tenth of the area of Zhongba, accounting for only 2.03% of the total area, but the number of open-pit mines is relatively large, accounting for about 15.06% of the total number, far higher than that of Zhongba and Angren, which have a large area. As shown in Figure 3.

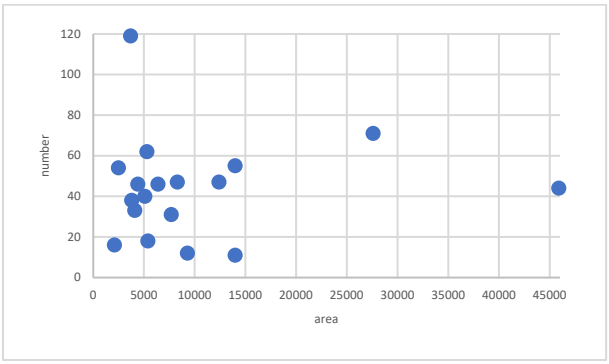

Figure.3 Diagram of Stope Quantity and Area

4.2Population

The population of Shigatse is about 798200, and there is a large gap in the population of each district/county. Sangzhuzi, with the largest population, accounts for about one fifth of the city's total population; however, Gangba, with the smallest population, only accounts for 1.41% of the total population of the city. The total population of Gangba, Yadong, Saga and other eight counties is still lower than that of Sangzhuzi. As shown in Figure 4.

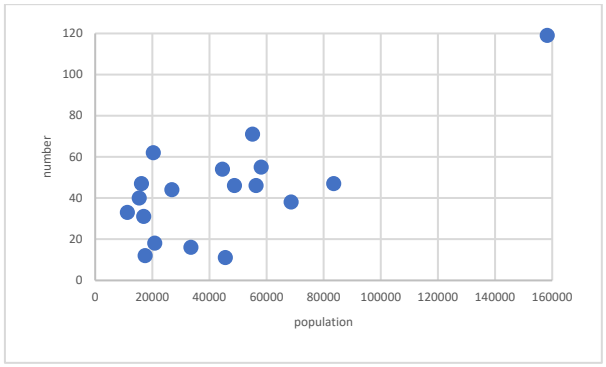

Figure.4 Diagram of Stope Quantity and Population

4.3 population density

The population density of Shigatse is about 4.39 people/km^2, and the population density of each district/county is quite different. Zhongba, with the largest area, has the lowest population density, only 0.59 people/km^2; the popilation density of Sangzhuzi, which has a relatively small area, is the highest among all districts/counties, with 42.78 people/km^2. As shown in Figure 5.

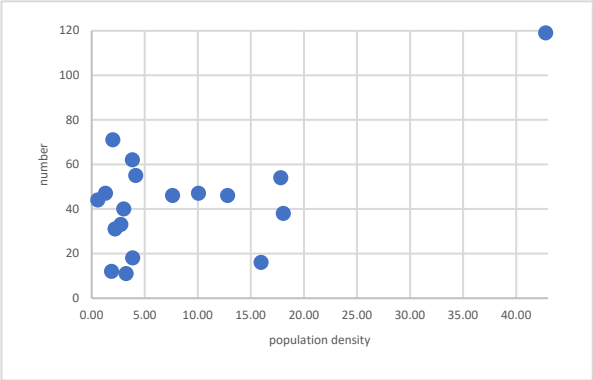

Figure.5 Diagram of Stope Quantity and Population Density

4.4 Correlation analysis

In the above scatter diagram, the corresponding change relationship between the number of open pits of building sand mines and the area of the district/county, the number of permanent residents and the population density is not obvious. This study further carries out mathematical analysis on its correlation.

Pearson bivariate correlation test showed that the P value between the number of open pit and the area of the district/county was greater than 0.05, and the correlation coefficient was less than 0.2, which was not statistically significant. The P value with the number of permanent residents and population density is less than 0.01, the correlation coefficient is positive, and 0.5<r<0.8, which is moderately significant positive correlation(Table 1).

Table.1 The results of Pearson Correl

		Number of open-pit stopes
Area	Pearson Correlation	.055
	Sig. (2-tailed)	.829
	N	18
Population	Pearson Correlation	.727**
	Sig. (2-tailed)	.001
	N	18
Population density	Pearson Correlation	.619**
	Sig. (2-tailed)	.006
	N	18

5 ANALYSIS OF STOPE DISTRIBUTION POSITION

Building sand is widely distributed in Shigatse, and mineral resources development, as an important part of human activities, its distribution is bound to be related to the main human activity areas. Based on the results of the

annual satellite remote sensing survey, this study selected the main urban areas, rural towns and traffic roads as the research objects, and analyzed the possible distribution rules of the open pit (geometric center store) of building sand in the main human activity areas.

Based on the 2019 satellite remote sensing image, combined with the basic geographic data collected in the early stage and the public data of the Internet geographic information software, the administrative villages (points) of the county-level administrative units are marked, and the highways, national highways, provincial highways, urban and rural roads (lines) that have been built near the stope (excluding the roads under construction or formed by long-term rolling of the mining and transportation of mineral resources) are mainly supplemented and corrected.

5.1Location analysis of administrative village

In 2019, there were more than 1660 administrative villages in Shigatse, and the distance between the geometric center of the open pit and the nearest administrative village was calculated. The results show that the nearest distance is about 0.02 km and the longest distance is about 35.72 km. This study analyzes the number of stopes in the interval from 1km and 0.5km.

In the interval of 1km, the number of stopes increases first and then decreases with the increase of distance, with an upward trend in the range of 0-2km and a downward trend in the range of 2-19km. Although there are fluctuations in each area after 19km, it only accounts for 3.54% of the total, which has little impact on the overall change(Figure 6); in the interval of 0.5km, the change trend of the number of stopes is similar to that of the interval of 1km, with the overall trend of first rising and then falling, with an upward trend in the range of 0-1.5km and a downward trend in the range of 1.5-11km, with some fluctuations(Figure 7).

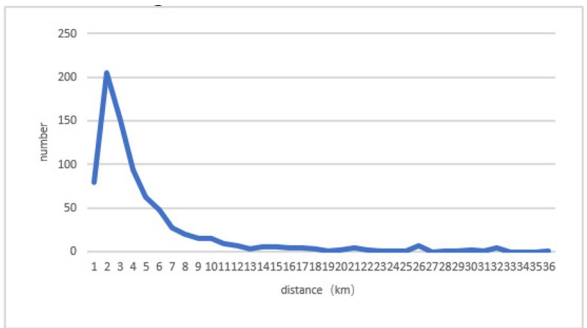

Figure.6 Diagram of Open Stops Distribution in 1km Interval

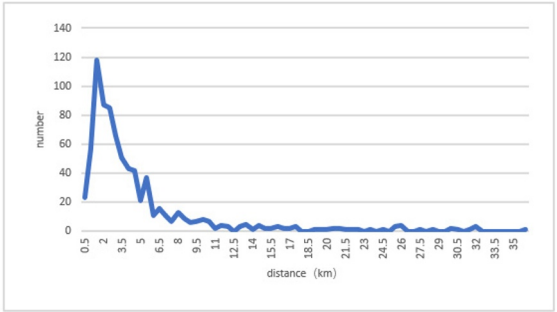

Figure.7 Diagram of Open Stops Distribution in 0.5km Interval

5.2 Traffic road location analysis

Based on the analysis of the vertical distance between the central point of the spot and the nearest traffic road, the minimum distance between the spot and the traffic road is 0.73m and the maximum distance is 3.57km. This paper analyzes the number of stopes in the interval from three levels of 0.2km, 0.1km and 0.05km.

In the interval of 0.2km, the number of stopes gradually decreases with the increase of distance. The number of stopes within the range of 0-1.6km accounts for 97.97% of the total number. After the interval of 1.6km, the number of stopes fluctuates but accounts for a relatively small proportion(Figure 8); in the statistics of 0.1km interval, there is a trend of first rising and then falling, rising in the range of 0-0.2km, and falling in the range of 0.2-1.3km. Although the number of stopes after 1.3km interval fluctuates, it only accounts for 2.78% of the total, and has little impact on the overall trend of change(Figure 9); in the interval statistics of 0.05, the change trend of stope quantity is still rising first and then falling, the rising interval is refined into the range of 0-0.1km, and the falling interval is refined into the range of 0.1-0.8km, with relatively obvious fluctuations(Figure 10).

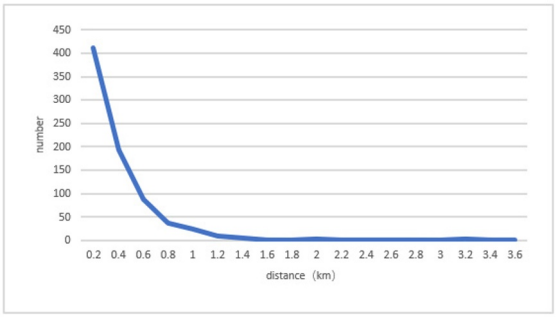

Figure.8 Diagram of Open Stops Distribution in 0.2km Interval

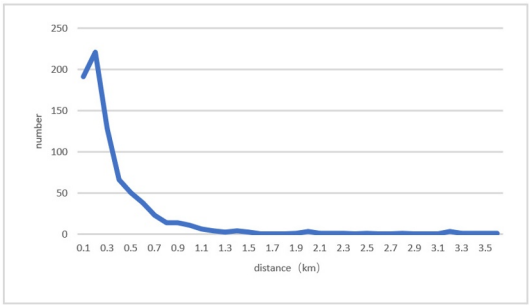

Figure.9 Diagram of Open Stops Distribution in 0.1km Interval

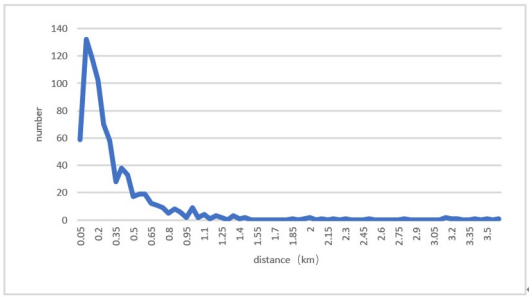

Figure 10 Diagram of Open Stops Distribution in 0.05km Interval

6 Conclusion and Analysis

1) Based on satellite remote sensing data, the development order of building sand mines in Shigatse was relatively good in 2019, and the open stopes of building sand mines in mining only accounted for 26.33% of the total; however, a large number of abandoned open pits indicate that the effective implementation of mine environment restoration and treatment needs to be further promoted in this area, and the effect of restoration and treatment needs to be strengthened.

2) In 2019, the number of open pits of building sand mines in Shigatse had no significant correlation with the area of each district/county, but had a moderate positive correlation with the population number and population density of each district/county. Considering that the building sand mines in the city are mostly small-scale open-pit mining, their mining scale and socio-economic impact are far less than the impact of the mining community formed by large energy and metal minerals, so the positive correlation between the building sand mines and the population is mostly shown as the population and population density growth promoting the mining of building sand mines, rather than the building sand mining promoting the increase of population/population density. In the future survey and monitoring work, the population/population density can be used to a certain extent as the judgment basis for predicting the mining degree of building sand mines;

3) Taking the whole city as a whole, in the analysis of the location between the administrative village and the traffic road, there is a certain degree of regularity in the change of the number and distance of the stopes. This result reflects the aggregation and variability of the open-pit stopes of the building sand mines within a certain range of the actual human activities. According to the characteristics of distribution and change, the key area of mine development is demarcated according to the standard of 95% of the number of existing stopes. According to the administrative villages (points), the key area is demarcated about 147700 square kilometers, accounting for 81.15% of the total area of Shigatse City. The area is too large to effectively improve the monitoring efficiency; the area of the key monitoring area demarcated by traffic roads (lines) is about 27800 square kilometers, accounting for 15.27% of the total area of the city. Because of the linear traffic characteristics of the traffic roads themselves, it is more operable and practical to carry out field inspection or plan aerial inspection of unmanned aerial vehicles on this basis.

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