

# Characteristics of Mining Geological Environment and its Effect on Deep Prospecting in Dachang Orefield

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**Abstract**—Mining development has resulted in resource destruction which as the representative of the destruction of land resources, landscape destruction in Dachang tin-polymetallic orefield, total size of destruction of land resources have exceed 90hm<sup>2</sup>, geological hazards caused by the performance of surface subsidence, collapse, landslides and tailings dam-break, forming Xinzhou's surface subsidence area and extend its landslides, etc; Environmental pollution caused by the performance of factor of excessive heavy metal pollution, such as Cd, As, Zn, Hg, Sb, Pb which come from surface water, groundwater and soil, especially seriously affected by surround area of both of the tailings and rock waste. The changes of geological environment not only undermine the ecological environment in mining and affect the sustainability of mining development, but also affect the methods implemented, which including mining geophysical prospecting, geochemical prospecting and exploration of deep geological remote sensing.etc

**Keywords**—deep prospecting; heavy metal pollution; geological hazard; mine geological environment; Guangxi's Dachang

## I. INTRODUCTION

Mining development create economic benefits to human beings, but also result in the destruction of mine geological environment, which including three types of resource destruction, geological hazard and environmental pollution(refer with table1). Dachang Orefield is a world famous super tin-polymetallic deposit (refer with Fig.1), which is made up of the Tongkeng Mine (Changpo and Tongkeng) and The Gaofeng Mine (Bali - Longtoushan, and Longxianggai), its environmental effects by mining development have been caused for concern, and affect the deep mining of mineral resources exploration also.

Table1. Classification of mining geological environment

classification	main form
Resource destruction	Destruction of occupying land and vegetation;Destruction of groundwater balance by dewatering and drainage;Reducing surface water;Geological relics destroyed;Topography and landform change;Destruction of cultural landscape,etc.
Geological hazard	Collapse;Landslides,Mudslides,Ground subsidence, Ground fissures, Ground sink, Water and soil loss, Land desertification, Tailings dam- break,etc
Environmental Pollution	Surface water pollution;Groundwater pollution;Soil pollution;Other environmental effects

## II. CHARACTERISTICS OF MINING GEOLOGICAL ENVIRONMENT OF DACHANG OREFIELD

### A. Resource destruction characteristics

Resources on mining development caused destruction mainly for land and vegetation resources in Dachang, that is, occupying destruction generated by accumulations of the long-term mining tailings and waste rock, followed by landscape changed because of the old pits and the opencast mining. According to incomplete statistics of size, the Tongkeng Mine have been destroyed land for 72.29 hm<sup>2</sup>, where subsidence area is 5.50hm<sup>2</sup>, waste rock dump occupy for 7.17h m<sup>2</sup>, Huiling Tailings Storage occupy for 48.79h m<sup>2</sup>, Lutang Tailings Storage for 10.83hm<sup>2</sup>. The Gaofeng Mine have been destroyed for 18.1309hm<sup>2</sup>. these resource destruction have been resulted in thinning of vegetation in mine.

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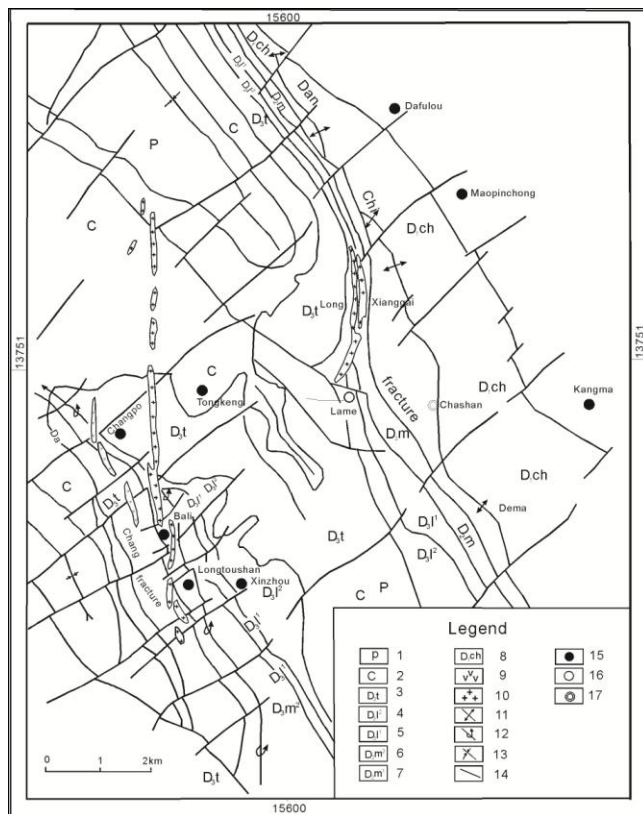


Figure 1 . Geological map of Dachang orefield

1. siliceous limestone 2. Limestone 3. Limestone interbedded with shales
4. Lenticular limestone 5. siliceous rock 6. Limestone, shale 7. biogenic limestone 8. Shale, sandstone 9. dioritic porphyrite 10. Granite 11. Anticline
12. overturned anticline 13. Syncline 14. Fault 15. tin mine 16. copper mine 17. Tungsten antimony

## B. Characteristics of geological hazards

Types of geological hazards in Dachang Orefield have high geo-stress, rib spalling and roof fall , surface subsidence, slope landslide, a large gob collapse, rockburst, geothermal, tailings dam-break, mine water inrush, landslides and so on. Dachang Orefield have formed a huge gob and caving empty area because of introducing method of open stoping and caving methods without sill pillar in the past 20 years, there is a risk of collapse for the mine now. The Tongkeng Mine have formed subsidence pits strip-shaped for 55,000 m<sup>2</sup> on surface ,where sink in depth of 10 ~ 60m, surface subsidence effects ranging 0.9k m<sup>2</sup>, subsidence of about 1.9 million m<sup>3</sup> in volume. Subsidence caused cracking, breakage in the plant building of concentrator and filling systems, and return air shaft, and it can cause secondary landslides and geological hazards surrounding subsidence pit also. With 92 # orebody mining, the pit corresponding to the upper extension of subsidence still occur, subsidence dashed area is expected to add at least 50,000 m<sup>3</sup>.

subsidence area in Bali - Longtoushan is only happened in Xinzhou District (in formerly Xinzhou prison hospital), indiscriminate digging by folk mining, the tunnels formed underground mine gob, and gradually developed a surface subsidence pits in Xinzhou for 26885m<sup>2</sup> from 1993 to 1997 ,

The maximum depth of the sinking is 40m, the entire subsidence pit affected area of 100,000 m<sup>2</sup>,where is the largest body of mines geological hazard in Dachang Orefield. And it was listed as serious safety hazard zone by national<sup>[1]</sup>.

Landslide is belong to engineering Landslide type, with moderate or less degree of harm and danger.Maximum landslide body in the Gaofeng Mine cause by ground subsidence in xinzhou, has been basically stable. Industrial sites of Tiebanxiao in the Tongkeng Mine has two landslide (H5 ~ H66); near Lutong Tailings dam has 4 Small landslide (H1 ~ H4), those landslides volume rang 300 ~ 20000m<sup>3</sup>. three small landslide have been found beside the Chehe Tailings Storage where body between 2000 ~ 13000 m<sup>3</sup> in volume. Natural landslide belonging to small landslide occurred less. Of which there are two natural landslides in Chehe, forming in slope area of right bank which composed by the clastic in reservoir bank, landslide volume range 3000 ~ 15000 m<sup>3</sup>. There is one natural landslides in bank slope zone of Lutong Tailings Reservoir which volume is in 1500 m<sup>3</sup>,

There are three kinds of collapses types in qualitative rock : first, four main collapses of qualitative carbonate rocks where located in the west bank of Lutong Tailings and south of the dam peak, rock falling are the main form of collapse; secondly, two small collapses of clastic rocks are found, one occur in east of Lutong Tailings Storage ,where is located in artificial slopes next to the middle of the road into the storage, collapse substance and their parent rock belong to fragmentation shaped siltstone , chert and shale, mudstone ,with character of hard to soft in thin layer rock of Heshan group in Permian Series, collapse volume is about 40m<sup>3</sup>, collapse is in form of slipped off and dropping block-based. Another is on northeast side slope of rough road in Xinzhou 1# subsidence area, slumping body is mainly chert, shale and marl, etc., a single block size is generally less than 0.8m<sup>3</sup>,collapse volume is in 600 ~ 800m<sup>3</sup> with width <6m, thickness <3m; third, small soil collapse occurred in north slope of # 2 valleys in the waste rock dump, collapse material is strongly weathered sandstone, mudstone and pebbly silty clay stone, with slope height 25m, width collapse <3m, collapsed thickness <1m, the collapse size is less than 5m<sup>3</sup>.

## C. Characteristics of environmental pollution

Heavy metal pollution is mainly affected the mine surface water, groundwater and soil systems

### Surface water pollution

Acidic waste water make pollution, the water which from the tailings piles or tailings storages rich in heavy metals released from acidic waste water through porous soil infiltration into the bottom pad or through surface runoff into the soil; or through the surface runoff into the lower reaches of the hydrological system and groundwater systems, it will result in pollution of mining area even larger pollution area of water and soil, thereby affecting the entire ecosystem<sup>[2]</sup>. research on characteristics and mechanisms of acidification of Bali's carbonate tailings shows that its surface has acidified conditions, and acidification increasing by the cross-section of the inner to the outer layer<sup>[3]</sup>; ore leaching toxicity tests by Analysis and Testing Research Center of Guangxi in 2010

showed that most of the indicators of leach mine water from the waste rock dumps and temporary heap are below the "Integrated Wastewater Discharge Standard GB8978-1996" of China in an emission standard limits, but Zn concentration exceeded, indicates ore has a similar nature with Class II general industrial solid waste, the main pollutants is leaching solution of Zn and Sb; according to discharge of water bodies monitoring (October 2010) for new outfall 5-9 # in creek of return slope side of Huangguadong by Hechi Municipal Environmental Protection Monitoring Station. The analysis results of each section superscalar factor of the environmental quality of surface water monitoring ,showing the factor exceeded standard in the surrounding metal surface water is As, Zn, Hg, Sb, Pb. Water pollution Performance of existing mines is mainly that Luyingtang Tailing Storage would have to take 25% of the sewage overflow, thus affecting the environmental quality of the river downstream Ping Village,because the flood control ditch for storage is damaged and clogged, and with river runoff by the upstream of Tongche River during the rainy season ;at the second hand,Lutang Tailing Storage leaks geological sewage and pollute downstream Ping Village river; At third hand, utilization of mine water exist pollution problems indirectly in Bali Concentrator also.

#### *Groundwater pollution*

Water Underground mine from geology seepage resulting in mining pit gushing water and mining water. As the existing main minerals deposits mined are as cassiterite, pyrrhotite, sphalerite, pyrite, jamesonite, arsenopyrite,etc, geological seepage through the mineral ore will be easy to dissolve substances out, after exposure to the metal sulfide minerals by air oxidation,it will accelerate the ions of mineral dissolution and infiltration and aquifer pollution of groundwater, the analysis shows that mine water is main pollutants of Zn, Sb, Cd and Pb, it would cause groundwater pollution when polluted surface water bodies runoff pathways in their proper geological conditions encountered another form of groundwater recharge can penetrate. Meanwhile, the mine water discharge can cause changes in groundwater levels, for the original anaerobic environment into oxidizing environment, it will promote the formation of sulfur-containing mineral oxidation occurs and contaminate groundwater. it will prone to dam karst ground subsidence and groundwater pollution, for poor geological conditions, the underlying karst formations in underground, karst fissure near the beginning of dam, sinkholes, caves developed in Lutang Tailings Storage,and fault crossing the reservoir area, make stagnant water infiltration and affect downstream water quality of the village.

#### *Soil pollution*

Research on heavy metal pollution of downstream in Dachang Orefield <sup>[4]</sup> show (2012): the average concentration of Sediment for element Cd, Cu, Ni, As, Zn, Pb and Cr, was 10.9 mg • kg-1, 204 mg • kg-1, 247 mg • kg-1, 19.3 mg • kg-1, 1 329 mg • kg-1, 44.0 mg • kg-1 and 101 mg • kg-1, the level of concentration of heavy metals in sediment were Zn> Ni> Cu > Cr> Pb> As> Cd. Cu, Cd, Ni and Zn content of sediment element exceeds the average national soil environmental

quality third class standards. Comparing 2010 data of soil environmental show that Cd, Zn, Pb, As in its regional soil exceeded the rate is higher. metal superscalar in 5 # waste rock dump instruct that leaching waste water in industrial sites and waste rock has contaminated the soil at the impact, in addition, since the Tang Dynasty mining and processing activities on surface soil constantly disturbed, mining waste inevitably affect surrounding soil environment, and soil environment contaminated area.

### III. EFFECT OF DEEP PRESPECTING FOR CHANGES IN MINE GEOLOGICAL ENVIRONMENT

First, landscape change caused destructions by mining development in Dachang, those destruction are include destruction of land and vegetation resources, and geological hazards which is as representative of subsidence, collapse , landslides, the landscape change , information extraction confusing of geological remote sensing under landscape changing is noteworthy. linear structure of the area and annular structure metallogenic significance can be studied by data fusion of satellite remote sensing image of SPOT-1 & Landsat-7 ETM +with 10-meter resolution ,in the processing of the research result integrated mine geological environment, granite magma activity and metallogenic structure information consisting of annular construction in Longxianggai Mine with R2 and R3 circular structure can be to identify with filtering through pseudo-information by field site verification of remote sensing data ,according to make full use of these information, which including the ring structure information in priority using, linear structure information, geophysical and geochemical information, and development characteristics of linear / fault structure in R2 and R3 and / or between the outer edge of ring R2, prospecting pridiction area may be delineated by features that mineralization element with regular distribution present geochemical anomalies, those above methods have been verified for prospecting in practice.

Geophysical prospecting practice through using the methods of EH4 Electromagnetic sounding, controlled source audio magnetotelluric method (CSAMT) for Wayao Mountain regions of Dachang by the author, shows that geological environment change causing by the mine resource dastruction, and geological hazards could seriously affect the effects of geological prospecting EH4 methods, as surface subsidence pits, landslide body, etc.those geological body even become important factors where EH4 electromagnetic sounding method can not implement for them; controlled source audio magnetotelluric method (CSAMT) and transient electromagnetic (TEM) have tiering capabilities to detect the low resistivity body of high resistance for deep prospecting purposes in Dachang Orefield, but terrain complexity caused by geological hazards, rock fragmentation will result in rock weathered in intensifies, thicken soil, vegetation developing, above change will effects TEM method implementation in difficulty. Although geological environmental damage on the implementation process of CSAMT field layout and quality of the information source has some impact, but failed to affect the implementation of the method, interference signal causing

uneven body by near-surface mining can be use spatial filtering method to eliminate. Prospecting practice shows that those rock formation, such as marlstone and mudstone ,shale interbedded containing small quantities sandstones of Tongche River Formation in Upper Devonian Series (  $D_3^3$  ) in Dachang Orefield, is a low-resistivity layer with great thickness,the layer having its the lowest resistivity of a few ohms • meters, is a logo strata for division; those of wide strip argillaceous limestone, thin banded siliceous limestone, lentils limestone, large lenticular limestone of Wuzhishan Formation in upper Devonian Series( $D_3^2$ ) are high-resistivity layer, those of marlstone, calcareous mudstone of Luofu Formation in middle Devonian Series (  $D_2^2$  )is low-resistivity layer. From the comprehensive geological data above,author suggest that the Luofu Formation of middle Devonian Series(  $D_2^2$  ) and Wuzhishan Formation is the main ore-bearing horizon, therefore, low-resistivity body in high-resistivity layer of may cause anomalies related to mineral deposit.

Geochemical prospecting practice shows that: trace elements of soil is developed in Dachang, trace elements demonstrated have good effect in geology, element anomalies spread in NE, NW direction, and the element anomalies concentrated mainly along the high values of fault distribution, trace majority zonation is clear. developmental abnormalities concentration centers of hydrocarbon components of soil is evident with clearly zonation, abnormal concentration hydrocarbon components has good effect. It is thus clear that although the mine environmental pollution affects formation of surface geochemical anomalies, but it can be used to make prospecting targets with soil geochemical anomalies combination of soil trace elements and soil hydrocarbon components

#### IV. CONCLUSION

From 1980'S nearly 20 years, since the disordered mining for Dachang Orefield has resulted in a serious waste of mineral resources, disorderly piled waste rock, occupying for large amount of land, resource destruction due to destruction of vegetation; most of ore stockpiles are not set ceiling, cutting around the flood is not set gutters, washed ore into rivers with rain during the rainy season , pit wastewater untreated or treated unqualified is discharged into nearby surface water bodies; AMD water from waste rock dump and tailings acidification of metal sulfides pollute surface water and groundwater bodies through rupture or karst funnel, waste rock and wastewater from tailing and dump contaminated soil, causing significant heavy metal pollution. mining development cause lot of geological hazards, such as surface subsidence, avalanches, landslides ,dam break of tailings, and other geological hazards. These not only affect the mining environment and sustainable development of mining industry, but also affect the implementation in deep exploration of geophysical, geochemical and remote sensing technology

#### REFERENCES

- [1] Huang Ying-meng , Deng Jin-can , Mao Jian-hua , Ye Yue-wen. Mined - out Area Treatment and Ground Pressure Monitoring for the No. 100 Orebody in Gaofeng Mine Section[J].Ming R & D. 2005,25(3):18~25
- [2] Qian Jian-ping,Jiang Wen-ying,Niu Yun-fei.Geochemistry of Heavy Metal Pollution in the Mine-river System[J], Bulletin of Mineralogy, Petrology and Geochemistry . 2010,29(1):74~82
- [3] Lei Liang-qi, Song Ci'an, Xie Xiang-li, Li Yan-hong and Wang Fei, Acidification characteristics and mechanism of carbonate-type tailings of Bali tailings storage, the Dachang tin-polymetallic orefield, Guangxi[J]. Acta Petrologica Et Mineralogica. 2011.30(1):141~149
- [4] Li Xue-hua, Xu Peng, Li Jun-qing, Cao Ruo-yu, Fan Hang, Gao Yuan-yuan, Heavy Metal Pollution of Surface Sediment in Dachang Mine Area of Guangxi and Its Ecological Risk Assessment[J]. Journal of North University of China(Natural Science Edition). 2012,33(2):190~196