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The Orebody Characteristics and its' Metallogenic Regularities in Taochang Gypsum Mine, Anhui province, China

WU Shi-yong [1], Wang Yuan [1], HU Bao-lin [1], LIU Xin [2] and Sun Yuan-jin[3+]

[1] School of Earth Science and Environmental Engineering, Anhui University of Science & Technology, Huainan 232001, China

[2] School of survy Engineering, Anhui University of Science & Technology, Huainan 232001, China

[3] Anhui Hengtai New-type Building Material Co. Ltd, Hanshan 238100, China

Abstract. Taochang Gypsum Mine (TGM), Anhui province, China, is located in northeasten Yangtze Plate and east of the Tan-Lu fault zone. Its' complex geological structure seriously restricts the coal mine production and safety production. Based on the exploration and drilling data, the 3D geological entity mine model was obtained by the use of large modeling software which shows the distribution of three-dimensional morphology and geological structure. At the same time with regional tectonic evolution, it reveals that the formation of anhydrite was mainly controlled by NE-trending faults, while was destroyed by the latter part of NW faults. Study on the law of occurrence and formation of ore body, can be used to guide the exploration and development of coal mine production and later further work.

Keywords: 3D Simulation, Orebody Characteristics, Metallogenic Regularities, Taochang Gypsum Mine.

1. Introduction

Taochang Gypsum Mine (TGM), located in Hanshan county, Aanhui province, now is the biggest one of the same type in Asia. The area of ore deposit is about 5.2 km^2. The explored reserve is 5.8 billion tons. Since the mine put into production, the whole shape of the orebody and the accurate feature of geological structures have not been quite clear due to the style of exploiting while with exploration. So the 3D-simulation was taken to get the spatial distribution of the ore deposit and the rule of geological structure occurrence. Meanwhile with structural evolution, the general metallogenic regularities were analyzed to present comparatively systematical data for TGM.

2. Geologic Setting of the Mine

The regional tectonic of TGM is belong to Hanshan-Lujiang fold belt. The mine lies in the southeastern wing of mid Taochang Syncline which northern edge is Chenxia Anticline and the southern one is Taihushan Anticline (Fig. 1). The southern and northern side were respectively cut through by F_1 and F_2 extending in northeast while the eastern and western side by F_{13} and Pachishan (PCS) Fault striking at NW-SE direction. The exposed strata in TGM mainly contain lower Triassic、upper Cretaceous and Quaternary system (Table 1). The ore deposit exists in the middle of Triassic Dongma'anshan Formation.

3. 3D-Simulation of the Orebody

[+] Corresponding author. Tel.: +86-554-6668430.
E-mail address: shywu@aust.edu.cn.

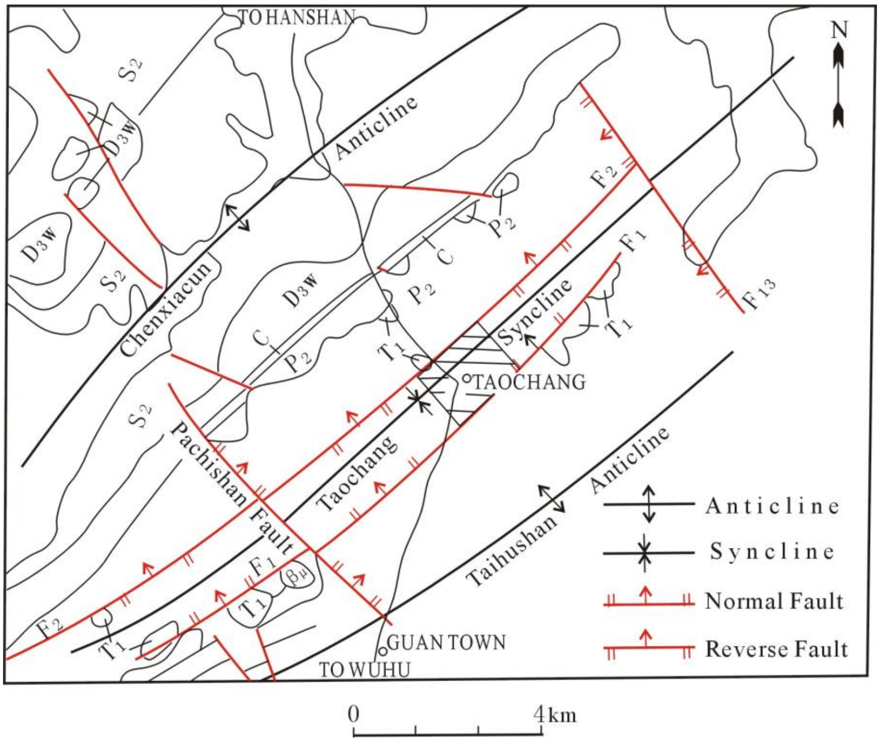


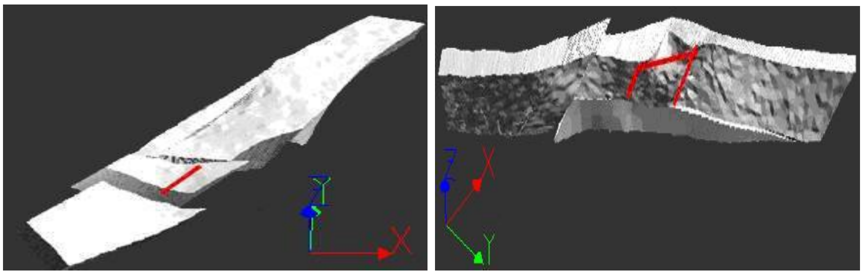
Fig. 1: Geological sketch map of the study area

Table 1: The brief table of exposed strata in GTM

Erathem	System	Series	Formation	Code	Thickness(m)	Lithologic description
Cenozoic	Quaternary			Q	11-43	a set of alluvial and diluvial deposits
Mesozoic	Cretaceous	upper		K_2	＞189	a set of red intraclast deposit which bottom is mixed-color conglomerate
	Triassic	middle	Tongtoujian	T_{2t}	400	a set of Purple-redish fragmentary rock with steel-grayish or gray- greenish – gray-brownish argillaceous crumb
			Yueshan	T_{2y}	40	a set of mixed-color interbedded siltstone 、 fine sandstone and mudstone, with a few of small pyrite crystals
			Dongma'anshan	T_2d	598-966	ore stratum, mainly composed by dol-omitic limestone 、 ciliceous limestone 、 limestone 、 hydrate plaster and anhydrite
		lower	Nanlinghu	T_1n	＞200	grayish or light grayish thickly-midthickly-bedded limestone, which bottom contains several layers of nod-ular limestone
			Helongshan	T_1h	140	grayish or steel-greyish thinly-midthickly-bedded limestone with so-me psephitic one
			Yinkeng	T_1y	91-148	a set of light-grayish or gray-yellowish or grayish limestone and ar-gillaceous limestone, which bottom with some light grayish or gray-yellowish ca-lcareous shale

Based on the drilling layer data of exploration and exploitation, the study used the large sophisticated program----GOCAD(Geological Object Computer Aided Design)which not only gratifies the need of complicated geological fields[1,2], but also improves efficiency of operation to build 3D full-scale model of the orebody[3,5]. The rectangle area, which is 7.0km long and 0.9km wide, was simulated, just as dashed area in Fig. 1.

The simulation results show the top surface of the orebody is approximate flat which inclined in the southeast (Fig.2a). Affected by Faults, the deposit was divided into four blocks. From northeast to southwest, these blocks nearly formed a falling step, and the altitude of southeastern part was higher than that of northwestern part. From the view of the deposit bottom (Fig.2b), Two blocks on the southwestern side of the orebody are generally flat which dipped to the southeast, but other blocks on the northeastern side dipping to the northwest are just different to the former. There are some humps down in the bottom just as the zone marked by red line in Fig.2b. It maybe relate to the underground in which the limestone collapsed with formation dissolution.



a b

Fig. 2: Shape of the orebody (a - top view; b – bottom view)

4. Discussion

The ore deposit of TGM is mainly controlled by faults (Fig.3). Its southeastern boundary is F_1 which is normal fault dipping NW at ＞70°. The fault parameter has a far more distance to the exploration stage. It was originally thought to extend in southwest, but the simulation model showed it was strongly bending among the zone confined by the third and fifth survey line, and lately proved by the drilling data. The opposite fault is F_{18} which is reversed fault with NW-SE-trending and dipping SW direction. The fault breaked F_1 and made it project over the orebody on the right hand of F_{18}. The reason might have two, one is affected by late fault action, another is by the ore bed floor. Beside this, the area circled by the red line in Fig. 4a widely waves and is discordant with the case exposed by other wells. It is just presumed that the phenomenon is affected by collapsing of corrosion limestone under the ore stratum.

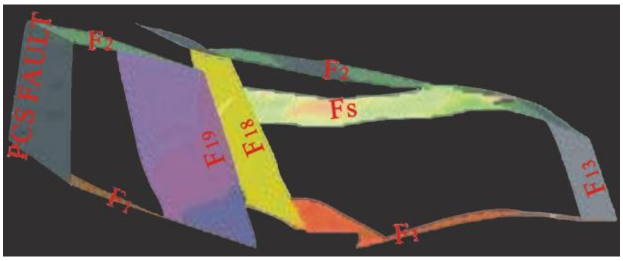
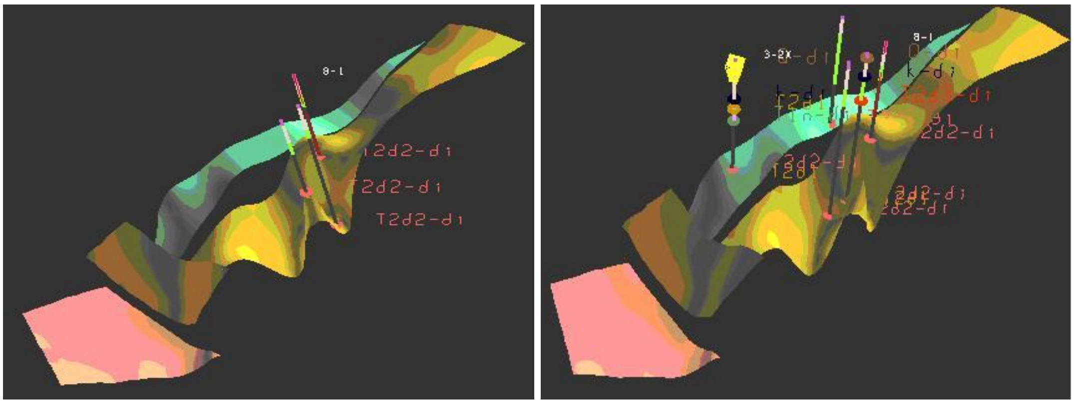


Fig. 3: 3D-simulation-model of geological structures of GTM

The northwestern boundary is controlled by F_2 which is the reversed fault extending in N45°E direction and dipping NW at 54°～63°. During the period of tunnel construction, the fault breccia was found at the head of return airway of $I_2$2 with elevation of -400m and at the deepness 446.74m of pour-5-well which ingredient is siliceous limestone with about 0.03～5cm grain diameter, and containing some anhydrite, and all of them were cemented by calcite. It can infer an normal fault crossing this site. This was proved by well 1-3. We named it F_s with 213° extension and dipping SE at up 60°. From the view of Fig. 4b, in the middle of F_s the thickness of two sides is very different, but other part is nearly identical. There is probably a karst cave but not proved by present data. Till now, it is not clear whether the fault extending SW was intercepted by F_{18} or not. But on west side of F_{18}, the height of the south and north side along red line in Fig. 2a is quite different. It must be crossed by a fault. Maybe this fault is west continuing section of the F_s.

F_{19} is also a discrepancy with the original data. According to the well 7-1, at the depth of 494.95~556.40m there is a stratum of fault breccia, upon it is T_2t's silt and calcareous mudstone and under it is anhydrite deposit. It is declared there must be a fault crossing this site. Combining data of physical log, the fault strike modified to NW-SE nearly paralleled to F_{19}. just made the ore deposit uplift along northeastern direction.



a b

Fig. 4: Characters of stereo-distribution of the orebody

5. Analysis on Metallogenic Regularities

According to the transverse relation of geological structures, NE faults formed earlier than that of NW ones. The former includes F_1、F_2 and F_s, while the latter includes F_{18}、 F_{19} and two boundary faults----PCS Fault and F_{13}. NE faults incised the understrata including the ore deposit, and all of these were covered by Cretaceous red stratum. So its forming time should be by the end of early Triassic system, and it mainly affected by Indosinian Movement [6,7]. In this epoch, the compression stress field from south to north in earth's crust (Hou et al., 2007; WU et al., 2010) made the sediment cover in lower Yangtze plate with north-south shortening and east-west extension[8,9], and finally formed a seres of NNE-trending sag basins which includes GTM. At the same time, NE reversed faults in the marginal areas of the basin were formed together with some matched extension faults. Lately the crust of earth uplifted, seawater gradually receded [10], only bounded in some bottom land. Affected by monsoon dry climate of north continent gypsum salt was finally generated [11]. During this time, the common plate between F_1 and F_2 continually was descending, so the thickness of the ore deposit constantly increased which was distinctly bigger than that of the same time, and then deposited inner fragmentary rock of Yueshan and Tongtoujian formations. The forming time of F_s is latter than that of F_1 and F_2 which was cut through by it. This was the result of local adjustment by the stress field of late Indosinian movement.

Late lower Jurassic, the pression from south to north at the boundary of Yangtze plate gradually weakened [12]. Affected by the eastern Pacific plate diving, the Pacific tectonism gradually played leading position [13-15]. The lower Yangtze Plate was in northwest-southeast tensile environment [16-17], and a set of NW extension fractures was generally formed such as F_{13}、F_{19} and PCS Fault. These faults cut through the orebody and early NE faults, and destroyed the continuity of the ore deposit. It made the gypsum stratum of the basin to construct the combination of graben-horst.

6. Conclusions

Combining physical prospecting data, the paper mainly applied 3D model to study the geological characteristics of the orebody in TGM, and obtained the following conclusions:

(1) The 3D model showed that the surface of the ore deposit waved more flat, and then sliced by inclined faults. All of these present the slit bed just like a step with northeast-southwest extension.

(2) The ore stratum was mainly controlled by two groups of faults trending separately in the NE and the NW, and these were results of Indosinian and Yanshan movement. NE faults such as F_1 and F_2 were syndepositional faults which controlled the formation and the shape of the orebody. NW faults cut through the former and destroy the continuity of the ore deposit.

(3) From the view of the 3D physical model, some local parts of the orebody intensively waved up and down, and this phenomenon is the same on the sites of hanging side or heading side of some faults. It was probably related with the collapsing of corrosion limestone under the ore stratum, but still need to be proved by the future survey.

7. Acknowledgements

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