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Investigating and Detecting the Collapse Columns in the Datong Coalfields of Shanxi Province, China

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Abstract : *In this study, we investigate the collapse columns in the Datong coalfields of Shanxi Province, China. In these coalfields, collapse columns are often found in the limestone of the coalbed floor, forming unexpected geological anomalies. Early warning and accurate identification of collapse columns, along with the timely security measures, are critically important technical guarantees of the safety of coal mines production. When projecting the spatial distribution of potential collapse columns, the impacts of collapse columns and other such geological structures must be well managed to reduce the risks associated with production and collection, increasing economic benefits while ensuring safe production. This study reveals the impacts of various geological structures on coal mining and production, illustrating how to investigate and detect collapse columns in the limestone of the coalbed floor in coal mines via case studies, informing efforts to ensure the safety of coal mine production in the Datong coalfields of Shanxi Province, China.*

Keywords: *Collapse columns, coalfields, geological structure, karst limestone*

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I. INTRODUCTION

The well-known Datong coalfield is located in northern part Shanxi Province, China. Geologically, it belongs to the North China Plate and is connected to the Mongolian platform. A dual-period coalfield, it comprises upper Jurassic and lower Carboniferous coalfields [1-3], featuring many coal seam deposits. Because such coal seams frequently fork and merge, the local geological structures are complex and marked by magmatic rocks, seriously affecting coal mine production. Collapse columns, though difficult to locate ahead of time, threaten the very safety of coal mine production, damaging shearer when cutting hard rock during exploitation, degrading coal quality, causing breakage and leaking of the roof, allowing water to rush in from upper and same-level sandstone aquifers, letting pressured water burst from the ao-ash crevice aquifers, and causing accumulation of gas. For these reasons, accurate identification and prediction of collapse columns' spatial distribution is needed to avoid and reduce their effects when designing coal mining areas, allowing comprehensive investigation and timely responses through security measures that can ensure the safety of coal mine production while increasing economic benefits.

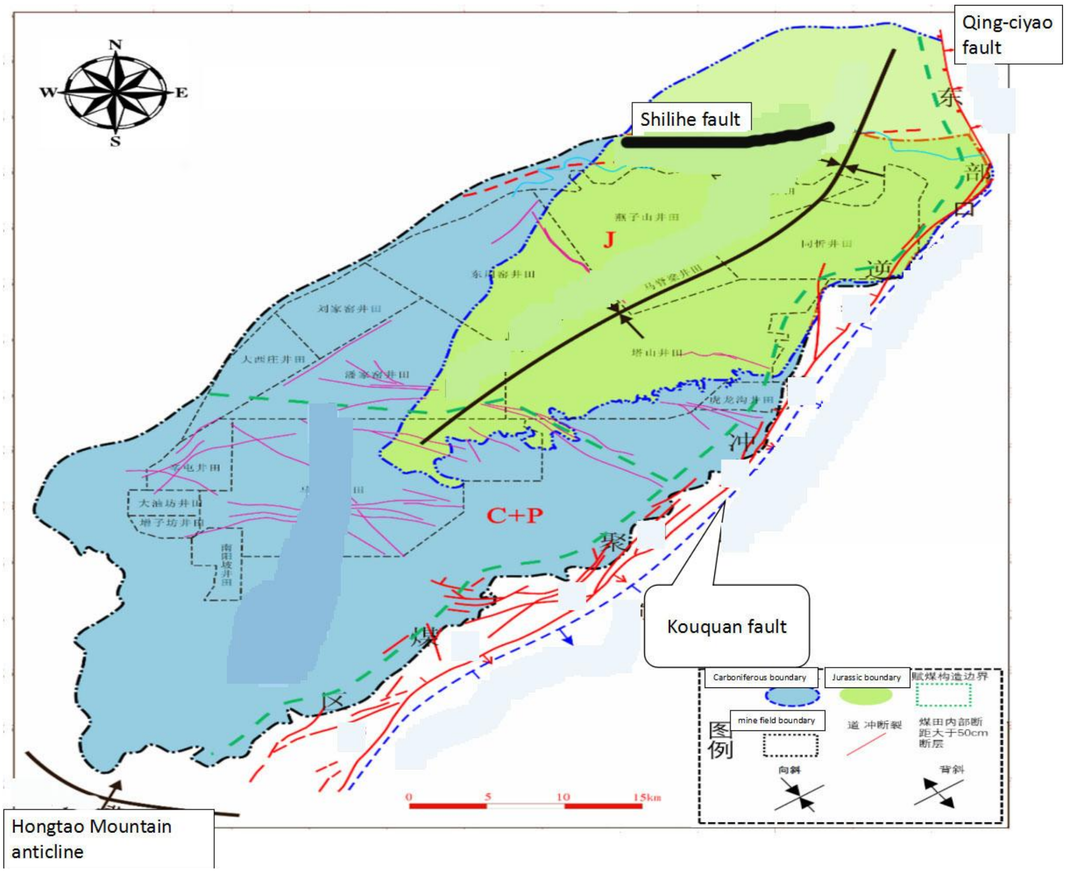


Figure 1: The background of geological structure in the study area.

1.1 The Datong coalfield in brief

The Datong coalfield is so called a dual-period coalfield, containing mainly Late Paleozoic Carboniferous Permian and Mesozoic Jurassic coalfields. Among these coalfields, the coal area of the Carboniferous Permian coalfields is approximately 1,739 km², and that of Jurassic coalfields covered 772 km². Both coalfields overlapped an area of 684 km², encompassing a coal reserve of 36.7 billion tons with many coal seams and notably thick coal [4-6].

1.1.1 Sedimentary characteristics of the Datong coalfields

The Datong coalfield has the gneiss of the Archean Jining Group as its basis. Its sedimentary caprocks from, old to new, are as follows: Cambrian Middle and Upper Ages, Ordovician Lower Age, Carboniferous Middle and Upper Age, Permian, Jurassic Lower and Middle Ages, Cretaceous, and Tertiary, without Quaternary.

The sedimentary characters of the Datong coalfield’s stratum is based on a Jurassic and Upper Paleozoic contacted relationship with regional unconformity, partially angular unconformity. The early Jurassic Yongdingzhuang is sequenced from south to north, respectively from the Permian Shihezi Formation to the Shanxi Formation and then the Carboniferous Taiyuan Formation. As Yongdingzhuang is more than 100 m thick in the southern Kouquangou region but grow thinner towards the north. In comparison, its bottom can be seen only in Yunlangou, and it finally disappears in the north. Similarily, from south to north, the Ordovician Liangjiashan Formation, Yeli Formation, and Cambrian strata underlie the Late Palezoid Benxi Formation. In all these eras, the Datong coalfield strata became thinner from south to north, being overly developed. This phenomenon occurs because the paleotopography of the Jurassic coal-bearing strata was a paleo slant, high in the north and low in the south.

The Datong coalfield is located at the junction of the North China Plate and the Mongolian Platform, where an axially northeastward syncline tectonic basin is found. The Datong Carboniferous Permian coalfield is a continental, lacustrine, and sedimentary environment with materials sourced from the west and northwest. The coal-forming basin, which extends from the northeast to the Kouquan and Yuanbaozi fault zones, is controlled by the Hongtanshan anticline to the east and the Shilihe fault zone to the west. Coal seam thickness varies and is controlled mainly by the northeast and northwest structures, and the secondarily by the east-west and south-north structures. From the bottom strata to the top, their coal depositing seams gradually step down from north to south.

Similarly, the Datong Jurassic coalfield is a continental river-lake-faces sedimentary environment, with sedimentary materials deposited from the east and northeast. The coal-forming basin is jointly controlled by the Kouquan and Panjiayao fault zones to the northeast and by the Qingciyao fault zone to the northwest. These coal layers feature very thick material depositions on both sides of the river banks, but fork frequently in the middle reaches of the river. They are controlled mainly by the underlying structure networks, so that the main depression of the coalfield controls the overall pattern of its coal seam development [7-9].

In general, the Datong Jurassic coalfield moved towards an east-west tectonic unit compared with the Datong Carboniferous Permian coalfield.

1.1.2 Geological structures in the Datong dual-period coalfield

As background into research of regional geotectonic has revealed, the deep structure of the Datong coalfield created a notable difference in the formation and transformation of coal-bearing basins in these different eras. The coalfield is controlled by Kouquan fault zone in northeast (NE) direction, by the Qingciyao fault zone in northwest (NW) direction, and by the secondary east-west (EW) and south-north (NS) structures. Since the Wutai period, the Datong coalfield has squeezed and stretched periodically. At the beginning of Yanshan movement, the late Paleozoic-Triassic exhibited mainly slow evaluating and landing effect. In the late Indo-China, lava movements refigured the inner coalfield, generating EW and NW faults. Affected by the strong tectonic movement caused by Yanshan during the late Jurassic, the east part of the coalfield was tilted precipitously, to the point of being upright and inverted. The fold structure developed to produce more complex geotectonic structures, with full faults in the east and southeast. To the west and northwest, secondary faults and folds were developed, with complex structures. In comparison, the structure in the north and northeast was relatively simple, with small faults and folds, mainly wide and slow folds.

Obviously, the tectonic basement network formed by multiple geological tectonic movements has significantly affected the formation of coal layers, with later tectonic movements superimposed on the basement structure. Consequently, data on the coal seam deposition environment, such as a coal beam thickness map, ash, sulphur, and caloric contour map, and thickness contour map of porphyry, all aid in the search for the underlying structure network and the request to predict potential geological structures.

1.1.3 Magmatic rocks in the Datong dual-period coalfield

Globally, since 1800 Ma, the spatial distribution of rock wall groups has been concentrated mainly in 1800~1600 Ma,1200~1100 Ma,800~600 Ma,230~120 Ma, and 50~30 Ma. Lamprophyre rocks developed through later thermal events caused by an extensional tectonic background in the late Triassic first stage in the Datong region. The northern and middle parts of the coalfield are well developed, showing gray, light yellow, green and gray, dark gray and gray, and black block shapes with typical lamprophyric texture. Carbonation petrification is obvious in the lamprophyric texture, with changes in the Yuhuang porphyry texture and a lightening of color. The main types and characteristics differ according to the different coalfields where they developed. They developed mainly in the NE 30° compression fault and derived EW direction, as well as in the NW 30° shear conjugate fault zone. Secondarily, they also developed in the NW 60° compression fault and derived NS direction and the NE 60° shear conjugate fault zone, which exists mainly in the form of concealed anticlines. Rock walls (which are several meters to tens of meters thick) appear at the junction of local structures or form to rock beds, invaded along with coal seams. In some areas, the porphyry wall was invaded another time by later greenish rocks. According to the reaction and age testing results of K-Ar and Rb-Sr, the emplacement age of the lamprophyre is about 229 Ma. The intrusion of lamprophyre has severely damaged the coal seam and significantly affected the mining of Carboniferous Permian coals through quality deterioration and decreases in calorific values.

Developed in the Jurassic and Cretaceous Yanshan periods, the intrusive rocks have the main constituent of diabase. They appear as rock walls south of the Shili river, developed mainly in the NW 60° compression fault and derived NS direction and in the NE 60°, which has little impact on the mining of Jurassic coal seams. North of the Shili river, they developed mainly in the NE 30° compression fault and derived EW direction and NW 30° shear conjugate fault zones as rock walls and rock beds, which strongly affect the mining of Jurassic coal seams. The age of diabase isotopes is 105.3~138.7 Ma (K1-J3).

II. SPATIAL DISTRIBUTION OF COLLAPSE COLUMNS IN JURASSIC COALFIELDS

2.1 Distribution of collapse columns in the Jurassic coalfield

Collapse columns were drawn that were exposed from 15 pairs of coal mines in the Datong Jurassic coalfield on the contour map of the floor of the No. 11 coal seam of the Datong Jurassic coalfield. Taking together their geological structure as developed in the coalfields and the occurrence of strata, we found that their spatial distribution of subsidence columns had the following characteristics:

1) Spatial distribution of collapse columns is exposed in Jurassic Datong coalfield mainly in the middle and north of the coalfield. These columns are more developed in the northern part, where they are fewer but larger. In Jinyungong, Yungang and Sita in particular, these three idas exceeded 77% of the whole amount of those columns.

2) The characteristics of collapse columns in the coalfield are distributed as stripes in two directions, with 7 stripes running NE and 9 running near SN. The angle between the two bands is 30°-60°. In the north of the coalfield are 4 NE-oriented bands in the range of the Shitai and Yungang idas, with a spacing of 3,000 m and a bandwidth of around 1000 m. Three NE-oriented stripes in the southeast of the coalfield, near SN-oriented stripes at about 2,500 m apart.

3) The collapse columns are located in the tectonic intersection of NE and NW orientations, indicating that the fault is in control of the development of collapse columns. Along with the longer axis of collapse columns, those running NE and NNE account for 36% of the total number, NW- and NNW- oriented collapse columns for 24%, SN-oriented for 21% and EW-oriented for 19%.

4) The development of many small collapse columns in idas in the northern part of coalfield (especially in the Shili river) and the largeness of a few collapse columns in the south are related directly to the distance between the Jurassic and Cambrian strata, below Ordovician soluble limestone. The collapsing scales of karst collapse columns extend mostly to just the Jurassic coal stratum, with only a few of them reaching to the earth's surface. There are two reasons for this phenomenon: the difficulty of observing due to the cover of loess, and the relationship with the rigidity of the K21 marked layer of the hard thick glutenite layer at the bottom of the Yungang Formation on the roof of the No. 2 coal seam in the upper Jurassic.

2.2 Collapse columns exposed in the Carboniferous Permian coalfield

Taking together geological data, including the geological structure development characteristics of the coalfield and occurrence of strata, the distribution characteristics of the subsidence columns in the Datong Carboniferous Permian coalfield are as follows:

1) The spatial distribution of collapse columns exposed in the Datong Carboniferous coalfields are mainly in the north-central part of the coalfield and in the NE direction parallel to the main axis of the coalfield. Many subsidence columns are in the structure belt parallel to the Qingciyao structure in NE, strongly associated with the intrusion structure of the porphyry. In the Carboniferous, ten-million-ton mines such as Tashan, Tongxin, Mataotou, Tongfa Dongzhou Kiln, Yanzishan, Majiliang, and Sitai all have many subsidence columns.

2) The characteristics of subsidence columns in the coalfield are distributed in stripes running NE and NW.

3) Collapse columns are developed at the intersection of the NE and NW tectonic structures, indicating that the fault structure of the Datong coalfield controls development of collapse columns. Collapse columns with a long axis make up 56% of the total number of exposed collapse columns running NE and NNE, 34% of those running NW and NNW and 10% of those running SN and EW.

4) Relatively small collapse columns are present in the northern coalfields, whereas those in the southern part of the coalfield are large. The 8228 working face of the Tashan Second Panel exposed collapse columns, causing accidents related to ao-ash water burst, whereas fewer accidents were associated with other collapse columns.

2.3 Origin of collapse columns

Collapse columns belong to a special type of fault depression, with all karst or non-karst formations technically described as collapse columns. Clearly, collapse columns formed by karst collapse predominate. Many scholars have investigated their causes and sought to classify them, primarily out of a belief that crustal lifting movement is the main origin of collapse columns, controlling the laws of water [10-14], water enrichment, and conductance in regional collapse columns. Many differences in the water conductivity of karst collapse pillars are seen in coalfields with crustal rise. Broadly speaking there are four basic views on the origin of collapse pillars: paste collapse theory, gravity collapse theory, hydrothermal genesis theory, and vacuum ablation collapse theory. Thus far collapse columns have been widely exposed in the coal seams of different periods in the Datong coalfield. The authors believe that changes in geological structure types give rise to different types of collapse columns, with certain types of collapse column actually the product of multiple movements of multiple structures. In this study, collapse columns exposed in the production of the Datong coalfield are classified in the structural form so as to better instruct the safe production of coal mines.

III. SPATIAL DISTRIBUTION OF KARST COLLAPSE COLUMNS

3.1 Columns formed by karst collapse

There are two basic conditions for a collapse column formed by karst collapse in coal-bearing strata: presence of soluble rocks (e.g., limestone, dolomite, and gypsum) in the underlying stratum, which have the function of flowing groundwater, and complex formation of collapse columns. Geological historical events are affected by many factors, such as the development history of regional geological structural changes, the control of the lifting and lowering movement of stress fields, development of karst runoff belts, the degree of column material compaction and cementation, and rock and mineral composition.

Based on the analysis of the distribution characteristics of the subsidence columns exposed in the Jurassic and Carboniferous coalfields, we believe that, as a product of the late karst development, column formation not only has certain specificity on the stratigraphic horizon, but also is severely affected by geological structures, which are multi-phase tectonic controlled, specifically the late Triassic Indosinian movement, late Jurassic, early Cretaceous Yanshan movement, and Xishan movement. It can be seen from stratigraphic occurrence characteristics of the Datong coalfield that the distribution of the Cambrian stratigraphic coalfields and the distribution of Ordovician limestones are over large areas. Strata above the Carboniferous develop overlying to the north, and the farther north the Jurassic coal measures are, the closer the underlying soluble limestones are, especially north of the Shilihe structure, where the Jurassic strata are directly deposited on the Cambrian strata. Under the action of tectonic movement, the integrity of limestones and the overlying strata was destroyed, forming faults and leading to the intrusion of groundwater, which was more developed than the collapse columns in other areas of the mine. The collapse columns formed by karst collapse columns in the middle and north of the coalfield in the Jurassic coal-bearing strata are many but small, whereas others, formed in the south are a few but large. The Carboniferous coal-bearing seam collapse pillars are parallel to the northsouth main diagonal axis of the coalfield and the cracked Qingciyao tectonic structure, with coalfields scarece in the south, but relatively large where present.

3.1.1 Columns formed by shear tectonic nuclei

The Datong coalfield comprises two orthogonal extrusion structures of NE 30° (Kouquan fault) and NW 60° (Qingciyao fault). Many shear cores are formed in the coalfield. During the periods of extensional movements in NE and NW, underground karst zone squeezed the extensional axial compression zone. Fragmentation of the core rock promoted development into a collapse column. The shape of this type of collapse column is mainly a round or low-flatness (2:1 small axis: long axis) oval.

More than 70% of these types of collapse columns are found in the Datong coalfields. They are small (usually tens of meters to hundreds of meters), and develop along the NE, SN, and NW tectonic belts with poor cementation properties, such as in the Sitai, Yanzishan, and Yungang minefields. This kind of subsidence columns has a greater impact on coal mine production, often causing geological disasters such as roof breakage and leaking, water inrush from the upper and same sandstone aquifers, bursts of pressured water from the ao-ash crevice aquifers, and gas accumulation [15-17]. If these eventualities arises during the digging process, horizontal detection should be used to find coal.

These collapse columns are widely presnt in various periods in the Datong coalfield, such as in the Permian Tongxin Mine (Dadougou Minefield) and Mataotou Mine, filled with porphyry that likely dates to before Triassic.

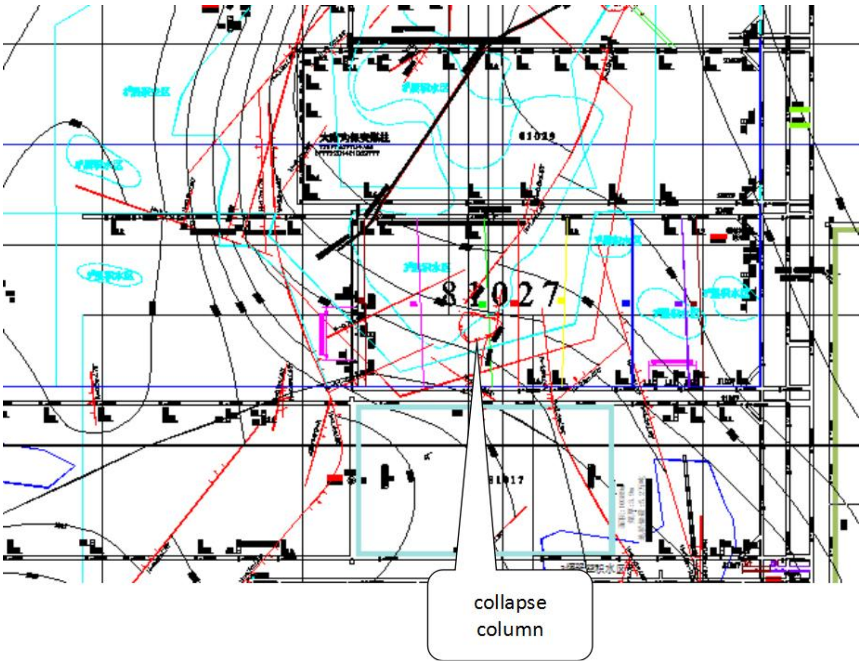


Figure 2: A collapse column in the the working face No. 81027.

By contract, the Jurassic Yanzishan, Sitai, and other sinking pillars likely formed earlier than the late Jurassic. The Sitai and Qinshui coalfield northwest mines have loess-filled sinking pillars, which are likely modern-development sinking pillars.

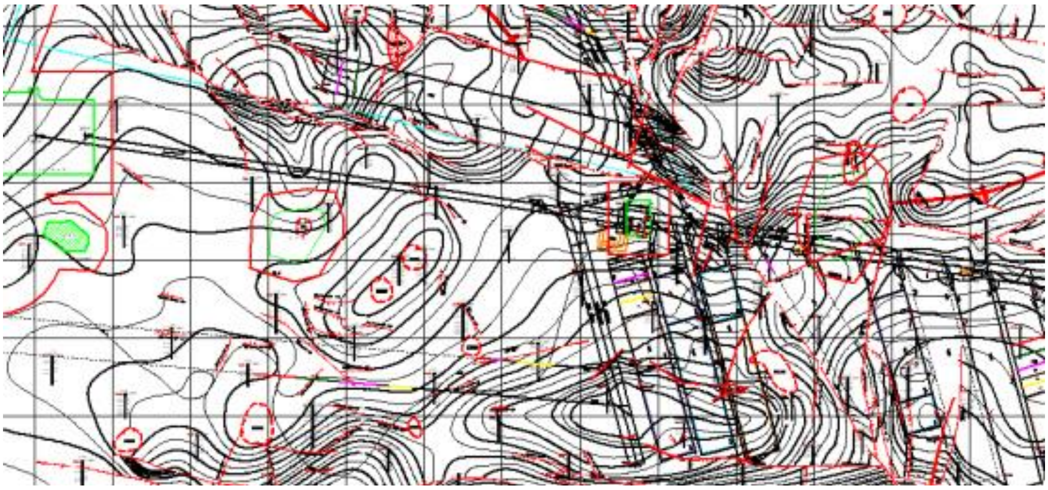


Figure 3: Three collapse columns in Madaotou wellfield.

3.1.2 Columns developing on large fault planes

This type of collapse columns usually develops on the upper side of a fault, with the short axis usually overlapping the orthogonal structure, even with the same deposition phenomenon [3]. The development of the collapse columns is asymmetric, with the depression angle on the upper side of the fault small but the lower one is relatively steep. This type of collapse columns usually extends northeast and northwest, with east-west tectonic development; such column's size is positively related to their structural scale but witha huge difference (up to several times) between the long and short axes. Presence of such collapse columns on the upper side of the fault strongly affects mine production, often causing such geological disasters as the roof breakage and leaking, conducting of water from the fault section due to multiple tectonic movements, water inrush in upper and same-leval sandstone aquifers, and bursts of pressured water in the lower ao-ash fracture aquifers. When these problems arises during the excavation process, accurate knowledge is needed of the propertie of the upper and lower side of the fault where the roadway is located. After detecting the fault drop, the location must be found using corresponding detection methods. Such collapse columns form continually as time passes. The upper Jurassic coal mine mouth has been revealed, but the lower Carboniferous coal seam was accompanied with a porphyry intrusion, likely formed before the Triassic, that continued to be developed in the late Jurassic.

For example, the radio wave tunnel of the 81003 working face of the Yungang Mine No. 12 layer detected a geological anomaly 80 meters long and 15 meters wide, which formed collapse columns with a chasm of two meters long.

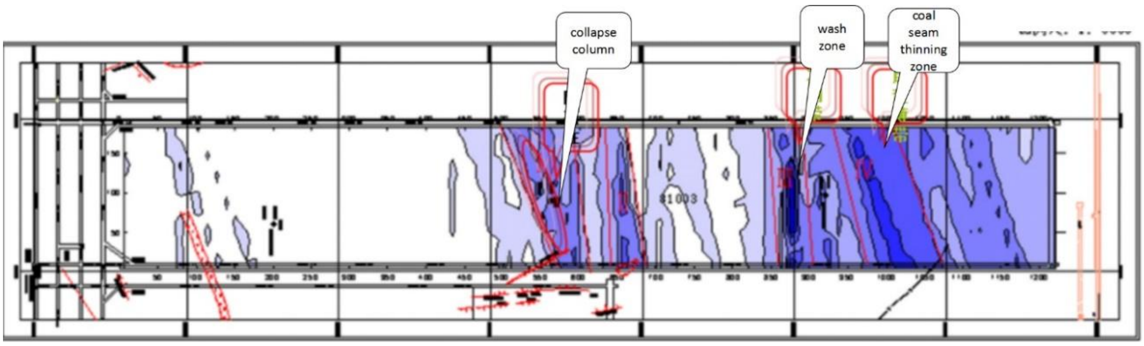


Figure 4: Collapse column in the working face of No. 12 coal seam.

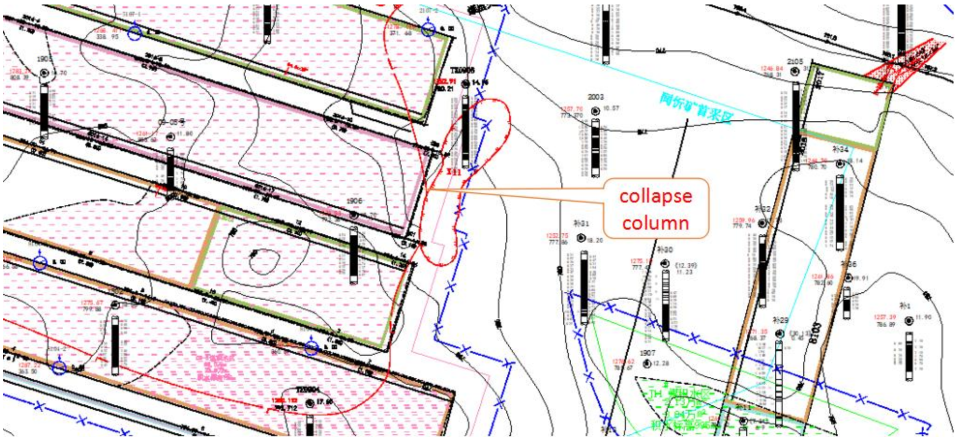


Figure 5: A large collapse column with 400 m long in Tongxin coal mine.

3.2 Collapse column formed by karst collapse

The Datong Carboniferous coalfield coal seams were greatly affected by the lamprophyry intrusion. During the excavation and production process, an analogous collapse column structure is often exposed, which is a slump upper lithologic breccia with serious burning phenomenon. Lamprophyric intrusion veins and even shaped multi-level annular collapses range in size from tens of meters to more than 1,000 m. Such subsidence columns are often distributed along the basement structure belt without substantial subsidence difference but cause many mine disasters, such as roof and coal seam burning and braking, anomalous gas accumulation, spontaneous coal seam combustion, and presence of complicated structure. With the karst collapse column exposed in the head section of Lane 2112 of the No. 5 floor of Xinxin Mine, for example, obvious coal seam burning and breakage were found.

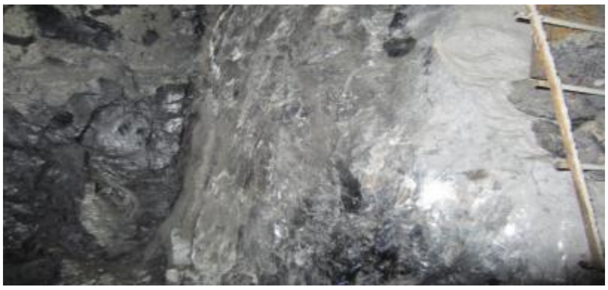


Figure 6: A Karst collapse column in No. 2112 Lane of Tongxin coal mine.

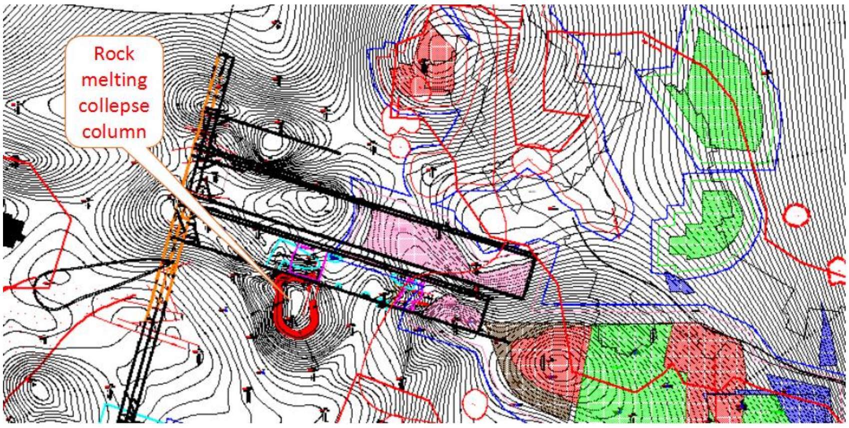


Figure 7: A series collapse column along NW in Tongxin coal mine.

A 900-m annular fault depression structure is found at Madaotou, with a depression height difference of 120 m, but the central coal-bearing stratum structure has not been damaged. Obviously, this type of collapse column intrudes from the core of the porphyry extensional structure, leading to the formation of the central depression after cooling and shrinking.

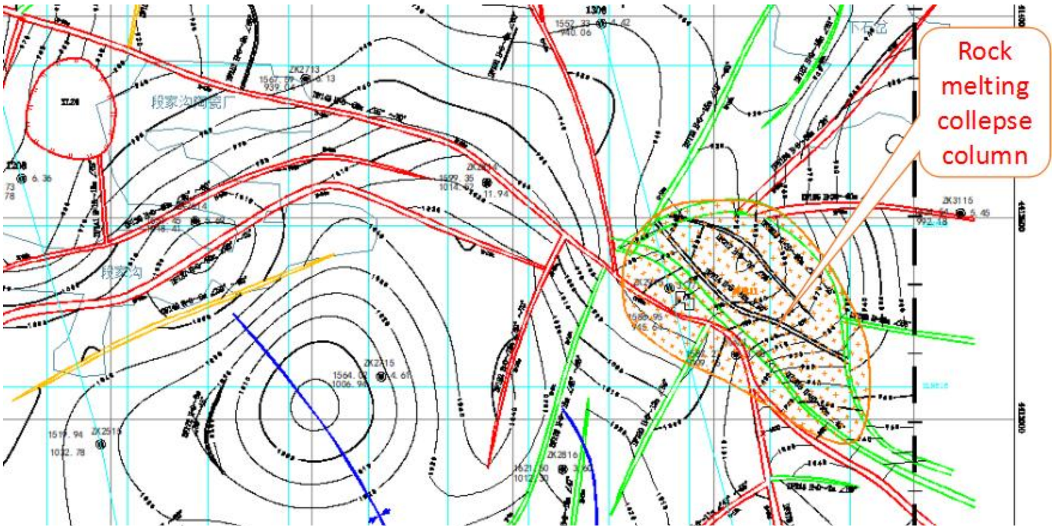


Figure 8: A circle collapse column in Madaotou coal mine.

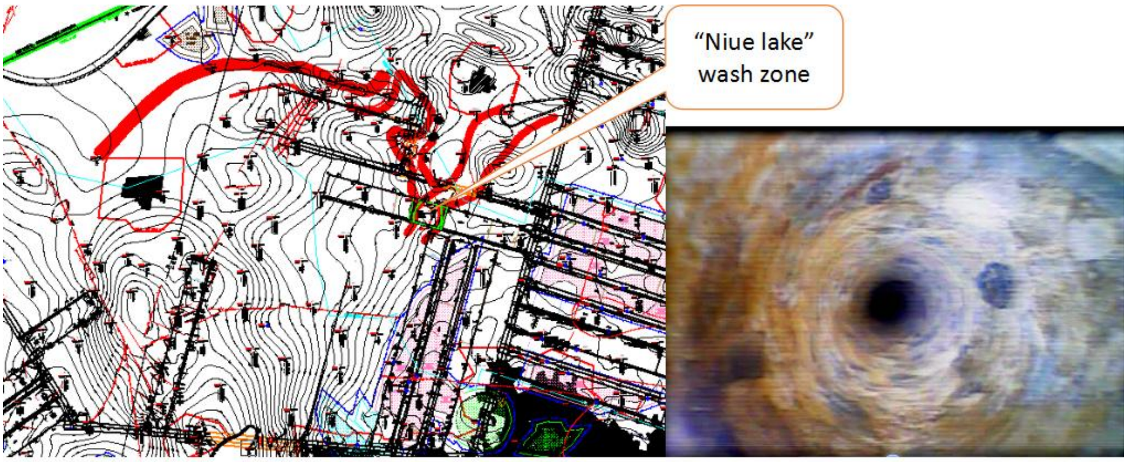
Figure 9: A collapse column uncovered nearby No. 8 fault.

The collapse column-like structure was exposed when the tunneling system of the No. 8 layer of the Tiefeng Zengzifang Mine passed a 48-m fault. Based on the analysis of the area and the field structure, multiple phases of magmatic rock activity are expected in the area, forming the collapsed column. Invasive subsidence occurred after cooling, with diabase later invading in the center and carrying the lower limestone breccia upward.

3.3 Collapsed columns formed by multiple large structure tectonic movements

After multiple movements of large structures, collapsed structures developed at the intersection of the tectonic structures. During mine observation, these are often treated as collapse columns, but owing to their complicated origins, it should be determined accurately in advance in conjunction with careful analysis of the regional structure and the mine structure, to guide safe mining production.

Like the 8101 working face of coal seams the Nos. 3-5 in the western area of Xin Mine, a collapse column structure was exposed that was accompanied by scouring, agglomerate, and other structures. Drilling a 27-m bottom hole revealed that the lower No. 8 coal seam had undergone complete sedimentation. Analysis of the sand body map of coal seams Nos. 3-5 suggest that the presence of an X-shaped base structure in this area. The late Carboniferous tectonic movement formed erosion along the X-shaped base structure, and formed a "Niue Lake"-like scour in the core, 27 m below the floor of the No. 5 coal seam, which caused the upper rock to collapse. Obviously, the collapse column has nothing to do with karst.



a: "Niue lake" wash zone b: The profile map of collapse column

Figure 10: Collapse column as (a) Niue lake was zone and (b) the profile map.

During the excavation of the south wing system of the Beixin Kiln Mine, a similar collapse column structure was discovered, exposing a range of more than 100 m, with water inrush occurring. However, the column body was corroded limestone breccia instead of roof lithology. Based on the regional and well field structures, it is believed that there is a northwestward nappe structure in this region. The bottom limestone crushes upward in the tectonic zone. After the of tectonic zone stretched, a collapsed structural zone was formed. Analysis of the sample of water inrush for quality, isotope determination, trace element analysis, and hydrological holes observation indicate that the source of the water inrush is tectonic water [18-20], with the collapse column formed by a nappe structural fracture zone.

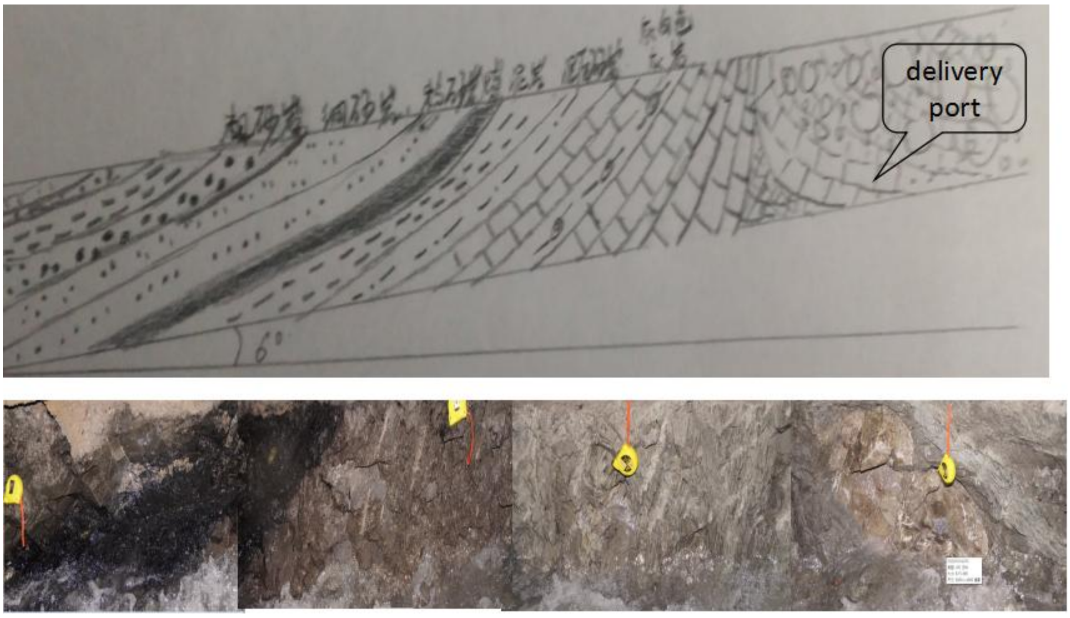


Figure 11: Collapse column formed by a geological structure in Beixinyao Coal Mine.

Collapse columns in the No. 11 coal seam in the Huokou Coal Mine Kaikou Mine have developed along the northeast compression zone but are small in the lower part and large in the upper part. Especially in the anticline structure, a large number of collapse columns were found. This type of collapse columns is seen only in the bottom, in the limestone of the No. 9 coal seam. Clearly, the distance and range are limited. Analysis of regional and minefield structures indicates that this type of collapse columns is only formed only by structural compression and tension, independent of the lower karst.

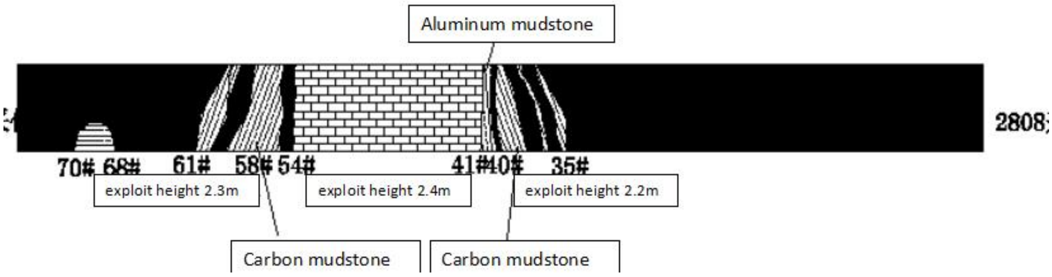


Figure 12: The profile of collapse column in the working face No 2808 in No. 11 coal seam.

Figure 13: A collapse column in northeast axis of syncline.

IV. DISCUSSION

4.1 Satellite and aerial remote sensing technology to detect collapse columns

Using satellite and aerial geological images to detect study geological structures in the coalfield gives a broad perspective on the field, with strong three-dimensional sense and generality. As a result, tectonic forms and their combinations, as well as spatial changes in the entire large-scale structural coalfield [21-23] and the surrounding regions, can be found easily, allowing ready detection of regional tectonic grids in the region of the coalfield and mine field, then identification of core and large-scale tectonic developed areas, providing accurate data for use in predicting collapse columns. Even the collapse columns exposed outside the surface can be directly identified, with concealed and deep down structures sometimes identifiable by their hue and geographical conditions. Satellite images are used to detect the geological structure of the coalfield.

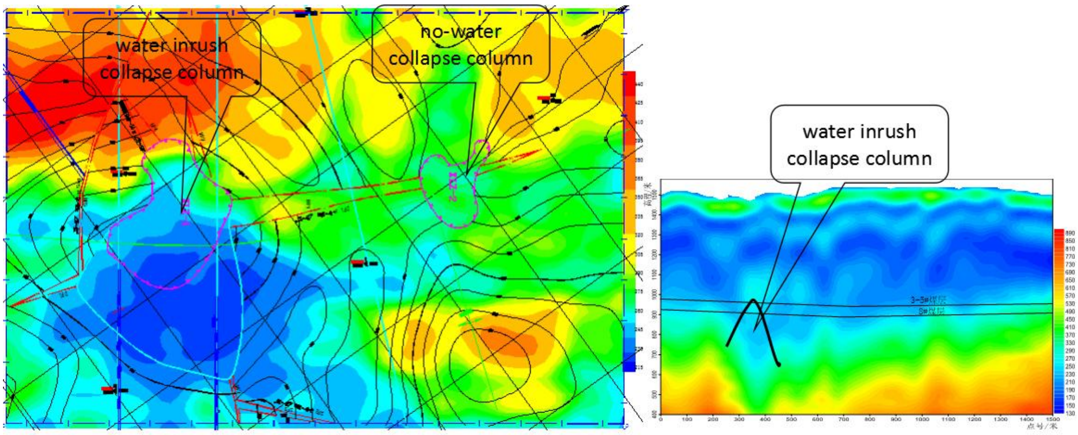
4.2 Collapse columns found in regions and by mine geological work

Taking advantage of regional and mine geological data and excavation, using mathematical statistics, fuzzy mathematics, and geographic information system and so on to quantify the thickness changes of coal seam and changes in floor contours, while analyzing and forecasting possible areas of collapse columns timely to guide the arrangement of the mining area and the safe production of comprehensive collection face.

4.3 Collapse column detected by integrated geophysical detection technology

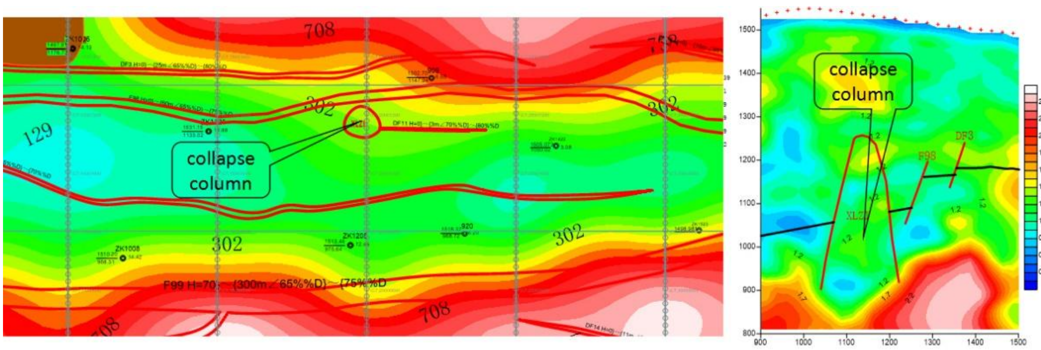
Application of 3D seismic surveys based on CSAMT (controlled course audio magnetotelluric sounding), transient electromagnetics, and high-density direct current methods can effectively detect the collapsed columns, particularly through 3D seismic surveys and CSAMT joint exploration, effectively detecting the scope of the collapse columns and combining CSAMT on the basement structure and its water-containing fissure to effectively prevent water inrush for coal mine limestone karst.

For example, among the collapse columns detected by CSAMT and 3D seismic joint detection in the Erpan area of the Tashan Mine, collapse column S1 is a water inrush collapse column and S2 is a non-conducting water collapse column.



a: planimetric map b: profile map

Figure 14: 3D collapse column (a) planimetric map and (b) profile map.



a: planimetric map b: profile map

Figure 15: 3D collapse column in Madaotou coal mine: (a) planimetric map and (b) profile map.

4.4 Collapse columns detected by mine geophysical exploration technology

Collapse columns can be detected underground using underground trench wave seismic and elastic wave tomography (CT) technologies. In the range of working face in coalwell lanes, technical methods include the underground trench wave seismic technology, tunnel radio wave perspective, and DC method perspective, including high-density electrical method, and mine geological radar. Based on comprehensive analysis of geological structures and multimethod comprehensive geophysical exploration, collapse columns can be accurately detected in the mining area and the working face, guiding safe coal mine production.

V. CONCLUSION

In this study, we investigated geological anomalies often unexpectedly occurred in coal production. In particular, accurate identification of collapse columns and timely implementation of security measures are utmost important technical guarantees with which to ensure of the security of safe production in coal mines. If the spatial distribution of collapse columns is predicted beforehand, so that the influences on collapse columns and such geological structures are managed, whether by being avoided or reduced, while designing mining areas and conducting comprehensive collection work, substantial economic benefits as well as safe production guarantees can be had from coal mining. In combination with mine geological work and production, this study presents various geological structures and illustrates how to investigate and detect collapse columns in coalfields via case studies to promote safe coal mine production in China.

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