7KH HIIHFW RQ ULYHU DQG HDUWK GDP FDX LQ XQGHUJURXQG FRDO PLQH ² D FDVH LQ ,

Jianghua /L Ling /L DQG ;X

0LQH 6DIHW\ 7HFKQRORJ\ %UDQFK RI &KLQD &RDO 5HVHDUFK ,QVWLWXWH &KLQD
6WDWH .H\ /DERUDWRU\ RI &RDO 0LQH 6DIHW\ 7HFKQRORJ\

$EVWUDFW &RDO VHDPV ORFDWHG LQ WKH VWHHS PRXQWDLQ DUHDV RI &KLQD 7KHUH PD\ EH VRPH HIIHFWV RQ WKH ULYHU DQG HDUWK GDP KHLJKW PLQLQJ +\GUDXOLF FRQQHFWLRQ H[SORUDWLRQ UHVXOWV DIWHU DQDO\]LQJ WKH VWUHQJWK SUREDELOLW\ LQ WKH V\VWHP DTXLIHU EHORQJV WR WKH ZLWK WKH <RXIDQJ 5LYHU XQLD[LDO FRPSUHVVLYH HIIHFW RQ <RXIDQJ 5LYHU DIWHU VXEVLGHQFH UHDFKHG P DQG WKH WKHUH ZRXOG EH VRPH HIIHFW RQ GRQH

,QWURGXFWLRQ

&RDO GLVWULEXWHV ZLGHO\ EXW WKH K\GURJHRORJLFDO FRQGLWLRQ LV YHU\ FRPSOH[LQ &KLQD 0DQ\ FRDO PLQHV DUH WKUHDWHQHG E\ GLIIHUHQW DTXLIHUV >@ DQG VXUIDFH ZDWHU ERGLHV D JUHDW GHDO RI H[SHULPHQWDO LQYHVWLJDWLRQV DERXW WKH PLQLQJ XQGHU ZDWHU ERGLHV VWXG\ DQG SURGXFWLRQ SUDFWLFH LQGLFDWHG FRDO ZDV PLQHG VDIHO\ XQGHU ULYHUV ODNHV VHDV DQG GLIIHUHQW DTXLIHUV +RZHYHU LQ V ODUJH PLQLQJ KHLJKW DQG IXOO PHFKDQL]HG FDYLQJ PLQLQJ PHWKRGV ZLWK WKH GHYHORSPHQW RI WKH PLQH SUHVVXUH DSSHDUHG RYHUEXUGHQ IDLOXUH EURXJKW DGYDQFHG WKH WKHRU\ ZLWK WKH GHYHORSPHQW RI ODUJH PLQLQJ WHFKQRORJ\ WKH]RQH KDYH EHHQ XQGHUJURXQG PLQLQJ 7KH HPSLULFDO]RQH DQG ILVVXUH]RQH KHLJKWV VFLHQWLILFDOO\ LQVWUXFWHG WKH VDIHW\ PLQLQJ XQGHU ZDWHU ERGLHV >@

7DNLQJ :RWXJRX FRDO PLQH DV DQ H[DPSOH K\GUDXOLF FRQQHFWLRQ ZDV UHVHDUFKHG WKURXJK DQDO\]LQJ WKH K\GURJHRORJLFDO FRQGLWLRQ DQG DGGLWLRQDO H[SORUDWLRQ UHVXOWV (PSLULFDO IRUPXODV ZHUH XVHG WR SUHGLFW RYHUEXUGHQ IDLOXUH KHLJKW DIWHU DQDO\]LQJ WKH VWUHQJWK W\SH RI RYHUO\LQJ URFNV DQG WKH HIIHFW RQ WKH <RXIDQJ 5LYHU

ZDV HYDOXDWHG XQGHU ODUJH KHLJKW RI HDUWK GDP ZDV SUHGLFWHG WKURXJK PHWKRG DQG XQGHU WKH HIIHFW RI HYDOXDWHG XQGHU KLJK VWUHQJWK PHDVXUHV DUH WKUHDWHQHG

*HRORJLFDO VLWXDWLRQ RI UHVHDUFK

0LQLQJ VWDWXV

7KH :RWXJRX FRDO PLQH KDV WKH SURGXFWLRQ DQG H[FDYDWHG LQ 0RQJROLD 7KH PLQH H[SORLWV VHDP DQG HOHPHQWV RI WKLFNQHVV DYHUDJH WKLFNQHVV LV P DQG GLS DQJOH EHORQJV WR QHDUO\ IODW VHDP 7KH ORQJ ZDOO FRPSUHKHQVLYH PHFKDQL]DWLRQ KHLJKW DQG WKH PDQDJHPHQW RI DOO 1HLJKERUKRRG FRDO PLQHV DUH VKRZQ

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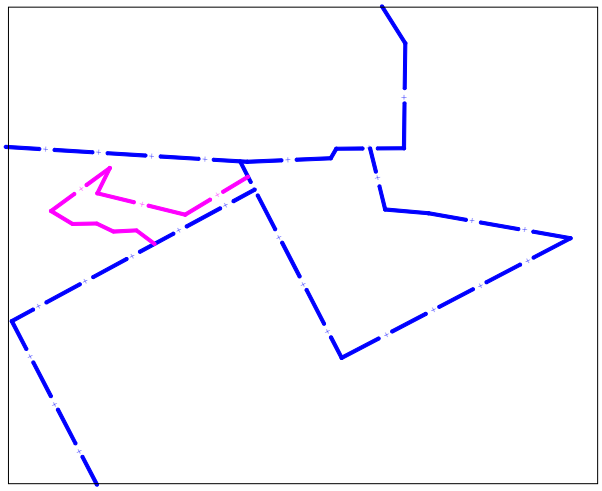

Fig. 1. Neighborhood coal mines of Wotugou mine

The terrain in this area is badly cut. oufang iver is a north south ravine on the surface of mining area and the flo direction is from south to north. An earth dam ith the top idth of 5.0 m bottom idth of 20.0 m and height of 3～

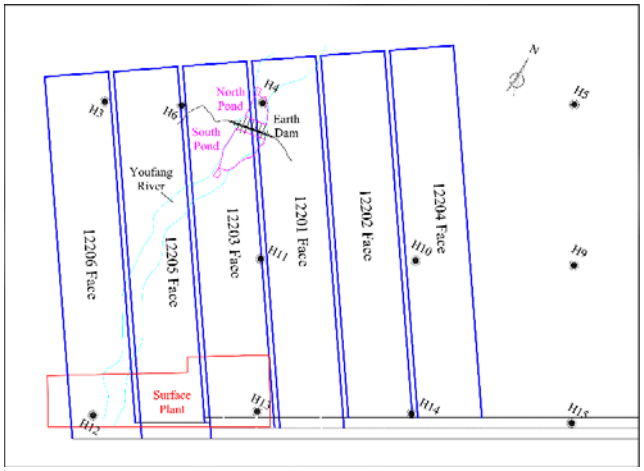

Fig. 2. The mining faces near oufang iver

Fig. 3. eality images of river and earth dam

2.2 Hydrogeological condition

According to the hydrogeological condition and additional exploration results the hydraulic connection of a uifers are as follo s

(1) Quaternary system aquifer

Q QJ
Q Q
QQ
QJQJ
QQQ
Q QJ3
QQQ
QQ

(2) Cretaceous system aquifer

Q QJ
QQ
QQ
QJ
Q QQQ
JQ QJ Q
QQ Q Q

QQQQJ

(3) Jurassic system aquifer

Q
Q Q Q Q Q
QQ Q QJ
～
～

Table 1. Test results of physical and mechanical properties for overlying rock

Sample No.	Depth (m)	Lithology	Uniaxial compressive strength (MPa)	Softening coefficient
1	213.16 225.03	Siltstone	23.84	0.27
2	226.12 230.66	Sandy mudstone	20.84	0.22
3	231.10 232.96	Siltstone	34.73	0.35
4	233.75 236.81	Mudstone	13.89	

Table 2. Partitioning method of overlying rock

Types	Uniaxial compressive strength （MPa）	Main rocks
Hard	40～	
	～	
	～	

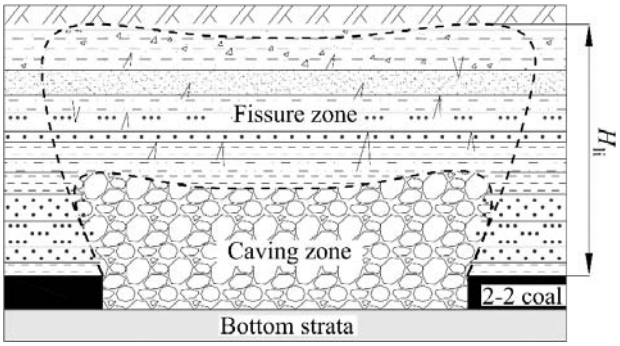

Fig.4. Characteristics of overburden failure

Table 3. Empirical formulas of t o zones

Overlying rock types		Empirical formulas（m）
Caving zone height	Hard	H_k 7M 5
	0HGLX PKOU	H_k M
	:HDN	H_k M

		H ─ M/M ─ r	H_{li} M
	0HGLX P KDUG	H_{OL} ─ M/M ─ r	H_{li} M
	:HDN	H_{OL} ─ M/M ─ r	H_{li} M

:KHUH 0 LV PLQLQJ KHLJKW P

$FFRUGLQJ WR WKH GDWD RI ERUHKROHV LQ WKH UHVHDUFK DUHD WKH WKLFNQHVV RI FRDO VHDP LV IURP P P ZLWK DYHUDJH WKLFNQHVV RI P %DVHG RQ DERYH DQDO\VLV WKH RYHUO\LQJ URFN EHORQJ WR PHGLXP KDUG W\SH 7KH ILVVXUH]RQH KHLJKWV RI GLIIHUHQW ERUHKROHV DUH VKRZQ LQ 7DEOH 7KH PD[LPXP KHLJKW RI ILVVXUH]RQH LV P LQ ERUHKROH +

7KURXJK DERYH DQDO\VLV 4XDWHUQDU\ V\VWHP DTXLIHU KDV DQ LQWLPDWH K\GUDXOLF FRQQHFWLRQ ZLWK WKH <RXIDQJ 5LYHU 7KH DYHUDJH GHSWK RI FRDO VHDP LV P DQG WKH PLQLPXP GHSWK LV P 7KH PD[LPXP ILVVXUH]RQH KHLJKW RQO\ LV P ZKLFK FDQ¶W UHDFK WKH 4XDWHUQDU\ V\VWHP DTXLIHU 7KDW LV <RXIDQJ 5LYHU ZRQ¶W EH DIIHFWHG WKURXJK WKH ODUJH KHLJKW PLQLQJ LQ FRDO PLQH

Table 4. Fissure zone height of research area

Boreholes	Coal depth (m)	Thickness of coal (m)	Fissure zone height 1 (m)	Fissure zone height 2 (m)
H3	244.63	3.96	66.90	89.20
H4	230.35	3.66	63.14	83.20
H5	211.49	4.12	68.88	92.40
H6	271.47	4.11	68.76	92.20
H9	234.38	3.95	66.78	89.00
H10	232.64	3.52	61.36	80.40
H11	265.45	4.04	67.89	90.80
H12	262.52	3.6	62.38	82.00
H13	291.44	3.47	60.72	79.40
H14	224.17	3.73	64.03	84.60
H15	260.16	4.08	68.39	91.60
Average	251.46	3.84	65.41	86.80

4 The effect on earth dam under large height mining

4.1 mpact assessment to the river after mining

For the prediction of surface movement and deformation many experts from domestic and overseas have put for ard different methods. After systematic research and practice for more than 40 years the la of surface movement and deformation have been mastered. Probability integral method negative exponential method Weibull function method and typical curve method are usually used to predict surface movement and deformation in China [13]. Parameters are easily determined and practicability is high for the probability integral method so it is used idely. For that reason probability integral method as used to predict the deformation of earth dam under large height mining.

Subsidence and horizontal deformation formulas of every point and every direction in the surface subsidence trough are as follo s

(1) Surface subsidence computation

$$W(x,y) = W_{cm} \iint \frac{1}{r^2} e^{-\pi \frac{(\eta-x)^2+(\xi-y)^2}{r^2}} d\eta d\xi$$

(2) Horizontal deformation computation

$$\varepsilon_x(x,y) = U_{cm} \iint \frac{2\pi}{r^3} (\eta - x) e^{-\pi \frac{(\eta-x)^2+(\xi-y)^2}{r^2}} d\eta d\xi$$

$$\varepsilon_y(x,y) = U_{cm} \iint \frac{2\pi}{r^3} (\xi - y) e^{-\pi \frac{(\eta-x)^2+(\xi-y)^2}{r^2}} d\eta d\xi$$

$$r = H / tg\beta$$

ZKHUH U LV PDLQ LQIOXHQFH UDGLXV GHSWK DQG WKH PDLQ LQIOXHQFH DQJOH DUHD LV UHODWLYH FRRUGLQDWHV RI PD[LPXP VXEVLGHQFH LV WKH PD[LPXP KRUL]RQWDO PRYHPHQW RI PP

7KH UDQJHV RI VXUIDFH PRYHPHQW SDUDPHWHUV IRU GLIIHUHQW GLVWULFW KDYH EHHQ VXPPDUL]HG LQ &KLQD 7KH SDUDPHWHUV LV YHU\ KLJK EHFDXVH PRQLWRULQJ :RWXJRX FRDO PLQH PLQH DV VKRZQ LQ)LJ KDV WKH FRQGLWLRQ PLQLQJ PHWKRG DQG SDUDPHWHUV RI %XOLDQWD FRDO PLQH WKH HDUWK GDP GHIRUPDWLRQ 'HIRU EH GUDZQ DIWHU FRPSXWDWLRQ ZKH PLQLQJ LQIRUPDWLRQ DUH LPSRUWD LQWHJUDWLRQ PHWKRG VRIWZDUH 7K VKRZQ LQ 7DEOH

Table 5. Parameters for surface deformation prediction

Subsidence coefficient	Horizontal movement coefficient	Propagation angle (°)	Tangent of main influencing Angle
0.55	0.20	89	2.2

4.2 Earth dam deform ation computation

The relevant orking faces for the earth dam deformation computation are sho n in Table 6. Subsidence value as computed through orking faces mined one by one. Subsidence contour maps for 3 orking faces (12201 12202 and 12203) and 6 orking faces (12201 to 12206) mined are sho n in Fig. 5 and Fig. 6 respectively. Subsidence of 10 mm as taken as the boundary of influence range caused by mining. The surface subsidence increased ith the expansion of mining range. The maximum surface subsidence reached 1.7 m after 3 orking faces mined and the maximum value tended to be

Table 6. Working faces in the research area

Working faces	Length (m)	Width (m)	Mining thickness (m)
12201	1700	300	3.84
12202	1700	300	3.84
12203	1400	300	3.84
12204	1700	300	3.84
12205	1435	300	3.84
12206	1435	300	3.84

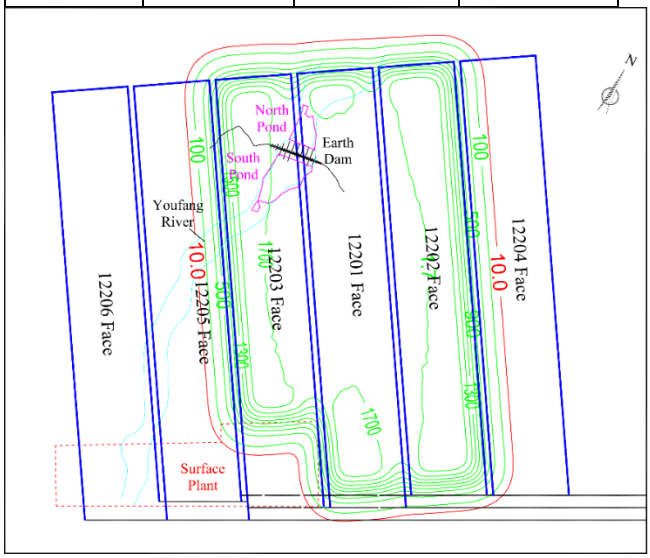

Fig. 5. Subsidence contour map for 3 orking faces mined

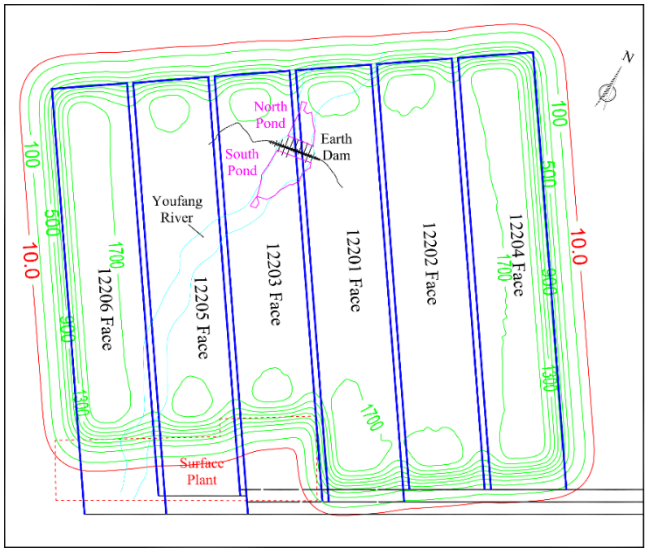

Fig. 6. Subsidence contour map for 6 orking faces mined

Horizontal deformation contour maps for 3 orking faces (12201 12202 and 1203) and 6 orking faces (12201 to 12206) mined are sho n in Fig. 7 and Fig. 8 respectively. Horizontal deformation increased ith the orking faces mined one by one. The maximum horizontal deformation in the strike and incline directions reached 4.0 mm m after 3 orking faces mined and the maximum value tended to be stable after 6 orking faces mined.

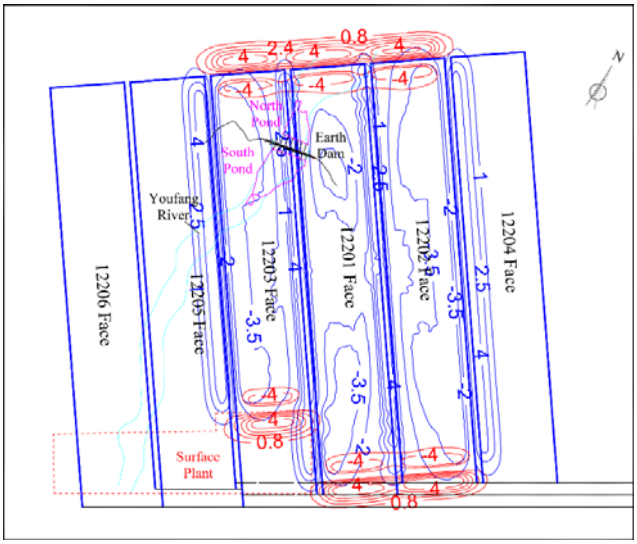

Fig. 7. Horizontal deformation contour map for 3 orking faces mined

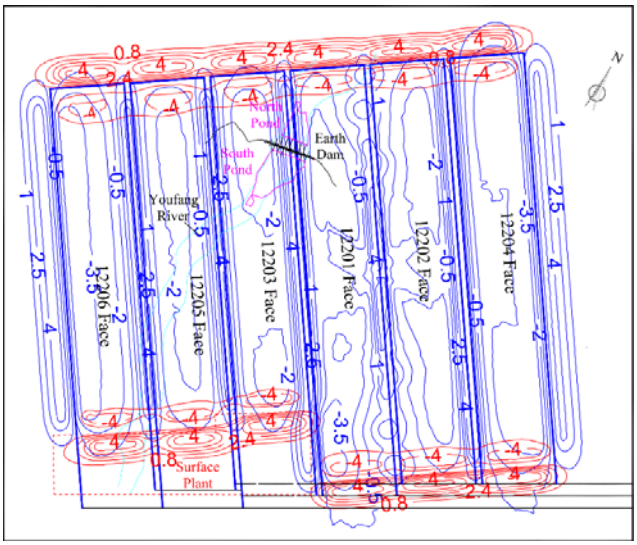

Fig. 8. Horizontal deformation contour map for 6 orking faces mined

According to The coal pillar design and mining standard for construction ater body rail ay main shaft and road ay earth dam under the allo able maximum value 4.0mm m. To a certain extent the earth dam as affected by the underground mining so some safety measures needed to be done as follo s

(1) The height and idth of the dam should be increased and reinforcement measure should be used because of the earth dam subsidence

(2) The slope of dam made a difference caused by the incline deformation then skid resistance decreased the measures of decreasing the slope and increasing the idth should be used to improve the anti sliding ability.

(3) Fractures ere generated in the dam because of the horizontal deformation. The fractures should be governed through backfill and grout methods.

(4) Earth dam should be monitored and maintained during mining especially in the rainy season.

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