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Stability Study of the Mining Methods by Rooms and Pillars of the Chaabet EL Hamra Mine Ain Azel (Algeria)

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Abstract: The underground working of the horizontal layers and slightly inclined by the room and pillar method generates significant buildings which can be at the origin of a depression on the surface. The width of this depression depends on the structure of the layer, the worked seams number, the pillars superposition, lodging depthand the degree of stripping. If safety measures and technological often prohibitory are not taken into account, the environment will be considerably affected. This study deals with a contribution being able to be brought by the method known as surface tributary for a pillars dimensioning applied to the chaabet el hamra Ain Azel (Algeria) case. Calculation carried out is based on the geological parameters and geotechnics of the layer. The results obtained enabled us to have a rate of maximum extraction and an acceptable factor of pillars stability.

Key words: Chaabet el hamra mine, underground working, room and pillar method, Method of the tributary surface, depression, optimization and environment

INTRODUCTION

Algeria's undergrounds working mining methods do not cease recording a fast development during these last decades. Nevertheless this development was centered on the quantitative aspect and the increase in the production while adopting necessary measures on the qualitative and quantitative plans of abandoned useful minerals. Conscious of this problem, the Algerian companies registered the factor of ore losses as well as the depressions problem like the priority axes. Basing on this practical concern, we tried to determine by various methods based on real conditions of a standard layer in particular Chaabet el hamra. This last characterized by a significant variation lithological poses problems in particular.

Stability, physico and mechanical properties, state of space empties relative with the method by rooms and pillars used and other natural factors. In this present article we considered it useful to analyze certain influential parameters on the dimensioning of the pillars and the space exploited width in order to have a extraction maximum ore rate and a safety stability factor of the suitable pillars. Thus we proposed to study the technological aspect, considering its topicality not only throughout the world but also in Algerian mining industry.

Site presentation and layer caracterisation: The mine of chaabet el hamra exploited the zinc layer by the method of the given up pillars, is located near the town of Ain Azel (Algéria).

Geologically, the layer area was the object by various authors, in particular (Villa, 1977). The studies undertaken showed that the area is characterized by outcrops belonging to sorted, Jurassic cretaceous and tertiary sector.

From the stratigraphy point of view the layer of chaabet el hamra is of hydrothermal origin. it is consisted rocks carbonated of the lower cretaceous forming Brachy anticline of direction sublatitudinale having a 3 km length and a width of 1,2 km. The formations plunge towards the west. Deposits of the valencians primarily made up of marl, marly limestones and dolomite having a power varying from 80-100 m.

The study of tectonics shows that the limits of the blocks are represented by breakable dislocations is and Western athwartship is central in most significant for the formation of structure of layer.

Geological parameters of the layer:

- N°1 Body: of average power 4,89 m, length 2700 m, width 300 with 600 m.
- N°2 Body: of power of 3,16 with 3,62 m, length 2700 m, width 80 m.

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Operating data: The layer is presented in the form of two superimposed mineral-bearing layers, intercalated by dolomite rocks of a power varying of 0,2 with 10 m and sometimes of 12 m. With the layer roof, the presence of a layer of marne of a variable power of 03 m with 09 m and its wall a dolomite bench. The layer is a depth of 80 m with 100 m, of a power of 02 m with 06 m, an average behaviour of ore and immediate strata according to physical properties' and mechanical of the rock mass. The method used is that by rooms and pillars, which the length of the panel varies 50 m with 200 m and the width of 20 with 100 m. The pillars are of square form of variable size of 2×2, 3×3 and 4×4 m.

After analysis of the complexity and structure of the solid mass in the presence of the cracks, faults and subsoil waters: the parameters calculation of the method used in the mine are very variable and can cause movements of ground which are translated into depression of surface following the great empty space.

MATERIALS AND METHODS

The tributary surface method (Brady and Brown, 1985), allowed thi author Poulard and Salmon (2002), to calculate the total request starting from óp on the basis of phenomenon possible of overload due to the exploitation near the zone considered. It is about the faults presence, pillars superposition, the pillars size and regularity, the sensitivity to submergence, depth and maximum amplitude of awaited depression.

By using a method pseudo-analytique for the pillars analysis, the worked mines the salt layer, Laouafa and Ghoreychi (2006), considers that the rock salt presents a viscoplastic behavior without threshold responsible for the creep of the pillars. The method suggested, makes a significant correction to the method of the surface tributary by adopting the power law of Lemaitre (1988).

$$\frac{\partial \varepsilon^{vp}}{\partial t} = Ae^{\left(\frac{-Q}{R.T}\right)}\left(\frac{\sigma_{eq}}{\sigma_0}\right)^n \left(\varepsilon_{eq}^{vp}\right)^m \frac{\partial \sigma_{eq}}{\partial \sigma} \quad (1)$$

After correction of coercion evaluéé by the method of the area and dependent coefficients CP (related frettage) and CRE (related to the contribution of recovery), the author has obtained axpression corrected (mono-dimensionnelle) Lemaitre of the law as expressed in the following manner

$$\varepsilon(t) = \frac{C_p \times \sigma_{AT}}{E} + Ae^{\left(\frac{-Q}{R.T}\right)}\left(\frac{\sigma_{TAH} - [(1-C_p)\times\sigma_{AT}]}{\sigma_0}\right)^{\beta} t^a \quad (2)$$

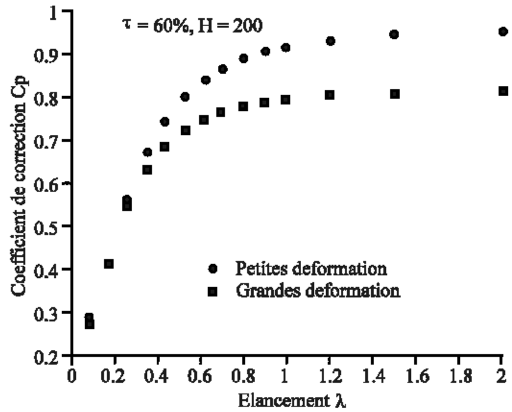

Fig. 1: Correction factor depending on the slenderness of the pillar (numerical computation in small and large deformations)

Beyond this author abacuses proposed correction, function of the pillars twinge (Fig. 1).

Géoderis Method of risks evaluation and the potential consequences relating to depressions of surface in the Lorraine iron-bearing basin, defined by this author: Fahurst (2005), to the 4 criteria:

- The collapse followed upon a seismic phenomenon a sufficient magnitude to be recorded by the Earth Institute of Physique or, for older collapses, to be felt by the population in surface.
- The phenomenon causes an air blast inside the mine.
- After collapse, surface presents a very stiff inclined profile with steps at the edge of depression.
- Collapse occurs in a very short lapse of time (less than 1 h).

Model calculation description: The new proposal: taking as a starting point the method of the tributary surface (Brady and Brown, 1985), which can determine the rate of extraction and the safe factor in the chaabet el hamra case mine whose model is presented (Fig. 2).

Where:

L : Panel Length, m
L : Panel Width, m
A : Exploited space Width, m
a : Pillar Width,m
H : Exploitation Depth, m
h : Power,m
Pzz : Pre-mining stress, MPa

It is noticed that we characterized the mine's rock solid mass question in order to lead to what follows:

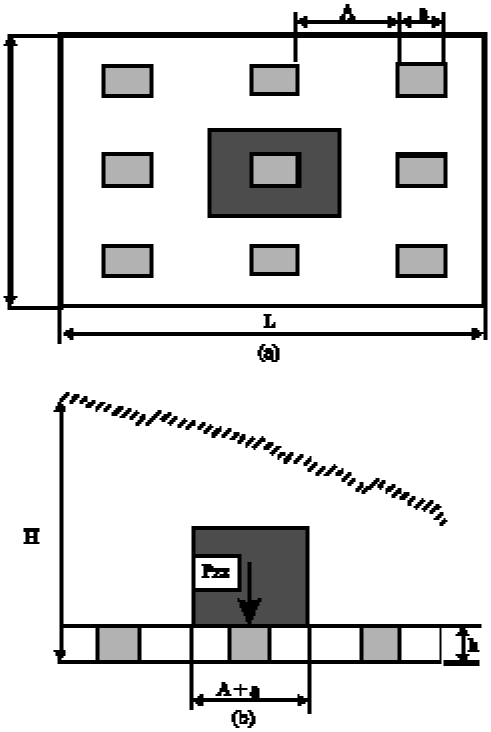

Fig. 2 : Model calculation

Mechanical tests and physical were carried out in geotechnics Annaba university laboratory , limestone rocks samples and dolomite taken on the level of the mine, prepared and cut out of cylindrical test-tube of twinge of 02. Fig. 3: (a) Dolomites, (b) Dolomites and Marls, (c) Zinc ore). The results of tests are given in Table 1.

We accurately carried out following calculations by respecting the formulas adaptable to the model of the mine in question:

Pre-minning stress:

$$Pzz = \sum_{i=1}^{n} \gamma i.Hi \qquad (3)$$

Average axial pillar stress:

$$\sigma p = Pzz\left(\frac{A+a}{a}\right)^2 \qquad (4)$$

Compressive strength of pillars:

$$Rp = 7.18.h^{-0.46}.a^{0.46} \qquad (5)$$

Factor of Safety

$$Fs = \frac{Rp}{\sigma p} \qquad (6)$$

Table 1: Physical and mechanical characteristics of zinc ore and rock

Rocks	Density t/m^3	Compressive strength MPa	Tensité strength MPa	Cohésion Mpa
Dolomite and marls	2.50	12.50	01.02	15
Zinc ore	03.00	120	120	21

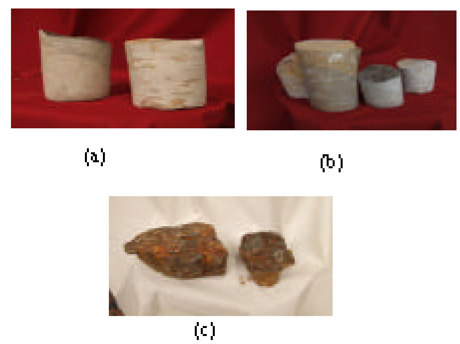

Fig. 3: Limestone rocks samples and dolomite

Area extraction ratio:

$$T = \frac{(A+a)^2 - a^2}{(A+a)^2} \qquad (7)$$

Synthesis: While varying the width of the room of 06 m with 04 m, the power of the layer of 02 m with 06 m, the width of the pillar of 02 m with 06 m for a depth of 80 m (Table 2), we obtained the safety factor and the rate of extraction. These results are translated into curves. (Fig. 4).

RESULTS AND DISCUSSION

The international cumulated experiment, as well as scientific, technique in connection with research on stability of the spaces exploited by the mining methods by rooms and pillars, impose the following parameters:

- Extraction Rate 40% à 70%;
- Sécurity factor Fs > 1.

Figure 4 presents the extraction rate variation according to the safety factor. It is noted that the results of the following cases, show that the power of the mineral-bearing layers and the exploited space width influence considerably the dimensioning of the pillars and thus the safety factor.

Case 1: For h = 02 m and A = 05 m gives r = 0, 7 Where 70% and Fs = 1, 53
Case 2: For h = 02 m and A = 4 m gives r = 0, 64 Where 64% and Fs = 1, 85

Table 2: Twenty five modality of calculation

Modality	Depth m	Power m	Density of the rocks g/cm^3	Form pillars	Width of the pillar m	Section of the pillars	Width of the room (m)	Section of the roof supported by a pillar (m)
01	80	02	2.5	Carrée	02	04	06	64
02	"	02	"	"	02	04	05	49
03	"	02	"	"	02	04	04	36
04	"	02	"	"	04	16	06	100
05	"	02	"	"	04	16	05	81
06	"	02	"	"	04	16	04	64
07	"	02	"	"	06	36	06	144
08	"	02	"	"	06	36	05	121
09	"	02	"	"	06	36	04	100
10	"	04	"	"	02	04	06	64
11	"	04	"	"	02	04	05	49
12	"	04	"	"	02	04	04	36
13	"	04	"	"	04	16	06	100
14	"	04	"	"	04	16	05	81
15	"	04	"	"	04	16	04	64
16	"	04	"	"	06	36	06	144
17	"	04	"	"	06	36	05	121
18	"	04	"	"	06	36	04	100
19	"	04	"	"	06	36	03	81
20	"	06	"	"	04	16	06	100
21	"	06	"	"	04	16	04	64
22	"	06	"	"	06	36	06	144
23	"	06	"	"	06	36	04	100
24	"	06	"	"	08	64	06	196
25	"	06	"	"	08	64	04	144

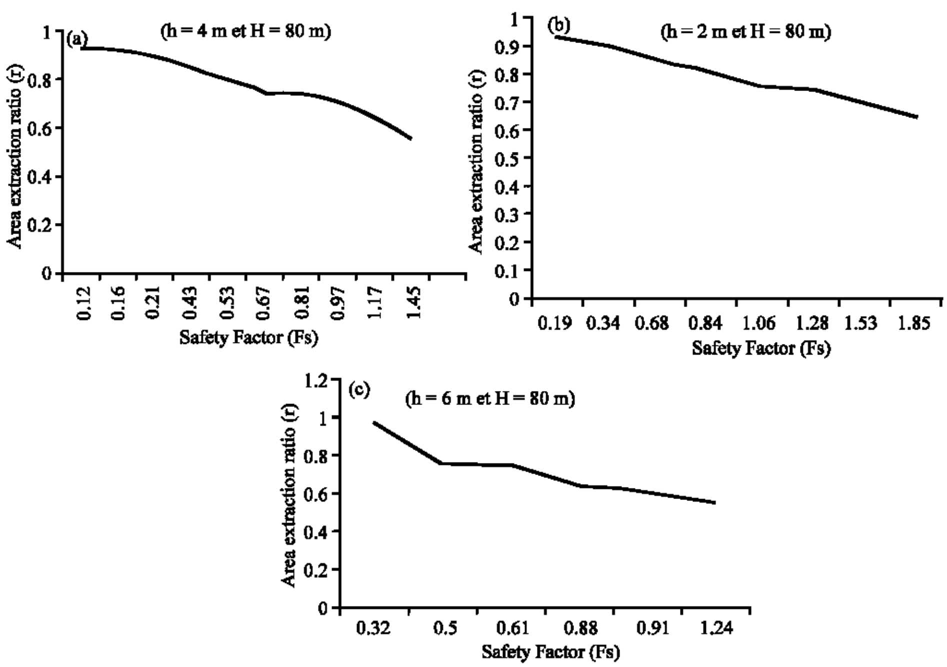

Fig. 4: Variation of area extraction with safety factor

Case 3: For h = 04 m and A = 4 m gives r = 0, 64 Where 64% and Fs = 1, 17

Case 4: For h = 04 m and A = 03 m gives r = 0, 55 Where 55% and Fs = 1, 40

Case 5: For h = 06 m and A= 03 m gives r = 0, 55 Where 55% and Fs =1, 24

CONCLUSION

The management study undertaken of the metal layer poly of the chaabet el hamra mine enabled us to lead to significant results. This research shows that the values of the rate of extraction and the safety factor relating to the stability of the pillars holds considerably count factors quoted below:

The geology of the layer, especially its lithological and structural aspect, the state of the rock solid mass, the space provision of the layer, physical properties and mechanical of the rock mass, geometric standards of the mineralized layers, parameters of the mining method and empty space.

While being based on the results obtained considered acceptable in the case of a rational exploitation in the field of safety and the economy.

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