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NEW APPROACH FOR REDESIGNING THE INGASSANA CHROMITE MINE IN SUDAN

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ABSTRACT

The present article deals with the use of a computer program which has been used to design the methods of minerals extraction. The work was carried out on the chromite deposits at Ingassana in Sudan, in order to improve the working, i.e. increasing the extraction ratio of the ore and increasing the safety at the stopping areas. The (ARMPS) computer program which being universally used to design metallic and non-metallic ores mining methods, was applied on the Sudanese chromite ores at Ingassana.

Using this program the stope and pillar mining method which its pillars are irregularly shaped and sized and either randomly located or located in low grade ore, was changed to room and pillar method having sequre cross sectional pillars (sized and shaped) instead of rectangular cross section pillars. An increase in the extraction ratio of 12% was achieved at a safe factor of 1.6 which is usually adopted in the extraction of mineral ores and coal.

هذا العمل يتصل باستخدام برنامج الكمبيوتر الذي تم تصميمه للاستخدام في طرق استخراج المعادن. وتم تطبيقه على رواسب الكروميت بأنقسنا بالسودان، وذلك لتحسين العمل، أي لزيادة نسبة الاستخراج وتحسين معدل الأمان. باستخدام هذا البرنامج في طريقة الحجرة والعمود، حيث كان شكل الأعمدة غير منتظم في الشكل والحجم، ويتواجد عشوائياً في المناطق ذات تركيز المنخفض. وتم تغيير هذه الطريقة بالحصول على أعمدة مربعة الشكل بدلاً من المستطيلة، وأدى ذلك إلى زيادة معدل الاستخراج بحوالي ١٢% وذلك بالحصول على معدل أمان يصل إلى ١,٦ الذي يكون مستهدفاً في استخراج الخامات والفحم

1. INTRODUCTION:

The Ingassana Hills which contain the chromite ore are composed of ridges of serpentines, dunites, peridoies, pyroxemites and talc-carbonate rocks [1 and 2]. This area is near El Damazin town. The ores are extracted their by the stope and pillars method and in some areas by open cast method. Approximately 150 chromite ore bodies and occurrences are discovered in this area. The proved ore reserves were estimated to reach 700,000 ton chromate ore, [3].

These ore bodies vary considerably in sizes; generally they are 20 to 25 meters along the strike and have thickness ranges from 1 to 3 meter [1 and 3].

Due to the use of stope and pillar method, it was observed that in the twenty old mines there, from 10 to15 caverns every year resulted from the excavation of the ore by this method ,particularly, during rainy season (March to November), where it is the time of heavy rainfall with an annual precipitation from 650 to 750 mm, [3].

Room and pillar method which is suggested to substituted the stope method has the main following advantages: fair to good recovery with pillar extraction (70 to 90%); Suitable to mechanization; Versatile for variety of roof conditions; Ventilation enhanced with multiple openings.

The strata above the cavities which resulted from the use of stope and pillar method consist mainly of soft rocks, as weathered and fractured talc. The roofs (strata) always deteriorate and collapse. The pillars also may be crushed with the time. The roofs collapses may eventually migrate to the surface and cause caveins. This phenomenon results in severe social and economical problems at Ingassana, [3].

The adoption of using the computer designed room and pillar would successfully overcome the abovementioned problems.

2. METHODOLOGY

A computer program which is known as analysis of retreat mining pillar stability (ARMPS) which was produced by the National Institute for Occupational Health and Safety (NIOSH), [4 and 5]. It was used to design the pillars for room and pillar retreat mining at Ingassana. This program was developed by NIOSH to face the problems such as pillar squeezes, massive pillar collapses and bumps in the extraction of coal by room and pillar method, [6].

The ARMPS program calculates the stability factor (SF) based on the estimation of the loads applied on the pillar and the bearing capacity of pillars during retreat mining operations. The program can model the significant features of most retreat mining layouts, including angled crosscuts, varied spacing between entries, barrier pillars between the active section and old gobs and slab cuts in the barrier on retreat [7].

The stability factors are obtained by dividing the total load-bearing capacity of the pillars by the total load applied on them.

The following parameters should fed into the computer having this program: Entry Height; Depth of Cover; Entry Width; Crosscut Spacing; Crosscut Angle; Number of Entries; Entry Spacing; the In Situ chromite ore strength (in MPa); the Breadth of the active mining zone and the unit weight of the over-burden (in kN/m^3), [8 and 9].

3. RESULTS AND DISCUSSION:

Prior to presentation of the results, it is worth noting that the factors of safety for the pillars of the chromite ores in Ingassana were evaluated as the stresses of pillars materials of the chromite divided by the stresses imposed on them.

A simple method of calculating an average pillar stress is by the three dimensional tributary concept. Stress is calculated by assuming that pillars uniformly support the entire load of rock overlying both pillars and the mined rooms. In this case, the effects of deformation and failure in the roof strata resulting from the mining operation are disregarded. Using the characteristics of both the chromite ores and the overburden rocks, the stability factor for these ores (safe stability factor) was determined it was found to be 1.6 which agrees with the published ones, [10].

This stability factor is used to evaluate the room and pillar method suggested to be used in Ingassana instead of the stope and pillar method. It is calculated by dividing the bearing capacity of the pillars by the stresses imposed on the pillars; hence this optimum value (1.6) was used to find out the design parameters of the mining method in Ingassana.

Figures 1 to 3 show the results yielded from the use of the ARMPS program. The safe stability factor is related to the depth of the rocks cover, the crosscut spacing, and the entry height (in meter) using the ideal model (3-4-3), which is deduced from the work, where the pillar width, the room width and the pillar height are 3,4 and3 meters, respectively. The twelve other models gave poor results (i.e., lower stability factors and lower extraction ratios); therefore those are not reported here. They have the following dimensions, (Pillar width, Room span and Entry height):

No.	Cross section area of pillar	Height of pillar
1.	4×3	5
2.	4×3	3
3.	4×3	2.5
4.	4×2	3.5
5.	5×2	3.5
6.	3×3	3.5
7.	3×2	4.5
8.	4×2	4.5
9.	5×2	4.5
10.	3×3	4.5

The properties of chromite ore were taken from the reports of the mine at Ingassana. They are3.9 t/m^3, 205MPa, 500KPa, 0.22 and 13.5 for the bulk density, compressive strength, young's, modouls, poison's ration and coefficient of strength, respectively. They are in agreement with those determined in the laboratory.

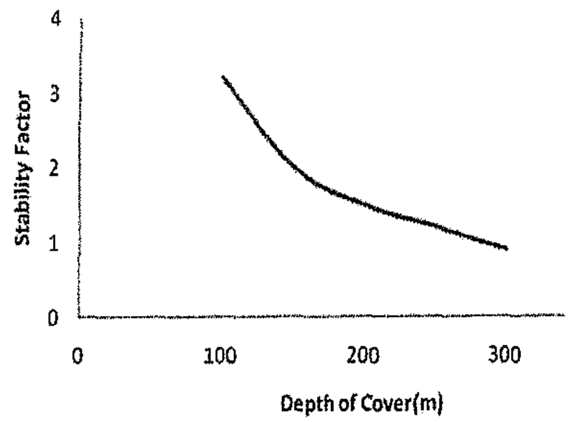

Fig. 1. Shows the relation between the stability factor and depth of cover.

Inspection of Figures 1 to 3 shows that the working in the mine will be safe because the stability factor is larger than the optimum one (1.6) for the suggested model pillar of square cross section, 3m and room of 4m span and 3m pillar height.

Reading out the figures shows that this safe stability factor (1.6) will be at depth of the cover of 250 m, however the maximum depth of the cover at Ingassana is 160m. Both the crosscut spacing and entry height gave stability factors larger than 3, approximately is twice the figure given for extraction of minerals.

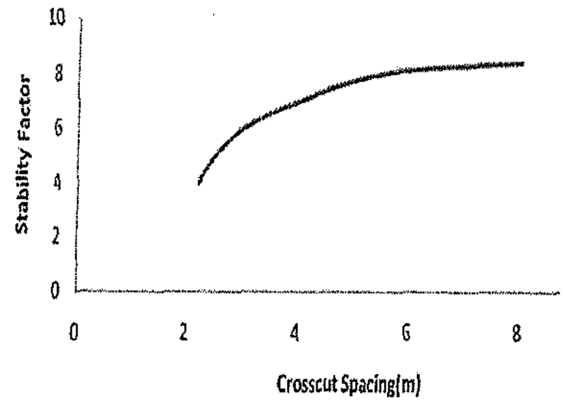

Fig. 2. Shows the relation between the stability factor and crosscut spacing

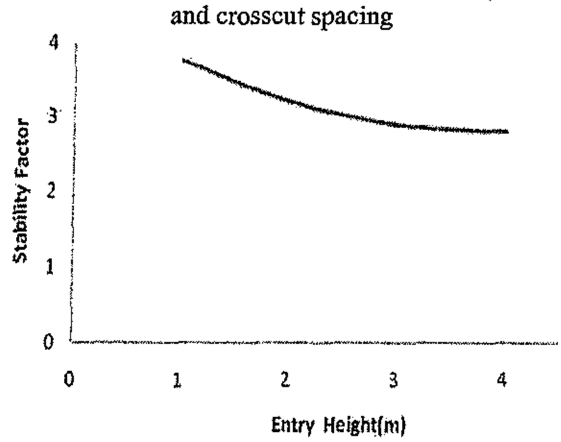

Fig. 3. Shows the relation between the stability factor and entry height.

4. CONCLUSIONS:

From the results which have been demonstrated above, the kung mine for the chromite ore at Ingassana could be redesigned with the use of a Retreat Mining Pillar Stability Program (ARMPS). This program was developed by NIOSH the Bureau of mines in the USA. Pillars having square cross section area of $9m^2$ and rooms having span of 4m were yielded from the program which was fed by the properties of the Ingassana chromite ores and the overburden rocks.

The extraction ratio was increased to 82% which is at present 70% and a stability safety factor over 2.

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