

CHAMBER OF MINES OF SOUTH AFRICA
WRITTEN EXAMINATION FOR THE CERTIFICATE IN ROCK MECHANICS
METALLIFEROUS OPTION

PART 3 - GENERAL

15 May 1996

EXAMINER:

Mr F A F Hathorn

MODERATOR:

Mr W A Naismith

Maximum time allowed 3 hours (09:00 - 12:00)

An Afrikaans version of this paper is attached.

ANSWER ALL QUESTIONS.

A pass mark for this paper is 60 per cent.

References are not permitted.

Hand-held electronic calculators may be used. (No pre-programming.)

Put your examination number on the outside cover of each book used, and on any graph paper or other loose sheets handed in.

NB: Your name must not appear on any answer book or loose sheets.

Write on one side of the paper only.

Show all calculations on which your answers are based.

In answering these questions, full advantage should be taken wherever necessary of your practical experience as well as of the data given.

Graph paper is available from the invigilator.

NOTES FOR THE CANDIDATE

Read these notes carefully before you start answering the questions.

The problems are not always stated obviously in the questions. Part of your task is to determine from the question the precise nature of the problem. There are no "clear cut" answers. The questions demand that you draw on your formal, academic knowledge and on your experience. Also the questions require you to demonstrate your ability to think your way through a problem, much as you would have to in the real-life situation. You will disadvantage yourself if you work through the answers in a haphazard and unsystematic manner. You are more likely to gain the benefit of the doubt from the examiner and moderator if you approach the problem methodically than if you were to adopt an unstructured and sloppy approach.

Use large, clear, well labelled sketches when necessary. These will aid your thinking as well as make your answer clearer to the examiner and the moderator. Minute, poorly labelled and undimensioned sketches will not have the desired effect.

QUESTION 1

The attached plan (Figure 1) indicates some panels advancing in a remnant towards two 5 m down throw faults. To the north of the advancing panels, a seismically active dyke is present. In addition to the down throw faults, a roll is intersected by the lower panels. This roll displaces the reef downwards by approximately 9,0 metres. The reef dips from north-west to south-east.

The hanging wall is lava with a UCS of 200 MPa while the footwall is a quartzite with a UCS of 220 MPa. The reef channel in the area is a conglomerate with a channel width of 150 cm.

- | | | |
|-----|---|---------|
| (a) | The current situation is obviously not practical nor safe. What advice would you give to the mine manager in order to reduce average ERR and consequently seismicity? | 5 marks |
| (b) | Comment on the in-stope support systems needed to ensure the successful and safe extraction of the remaining reef via the faces still mining north-eastwards. | 5 marks |
| (c) | Comment on the mining sequence and approach of geological structures. | 5 marks |
| (d) | Considering your answers in a, b and c above, comment on what degree of extraction is considered achievable and what further precautions of a practical nature are deemed necessary to obtain the highest margin of safety. | 5 marks |
| (e) | Hand draw a section through A-A (not necessarily to scale). | 2 marks |
| (f) | Describe briefly the particular remnant management topics that you would include in a set of special area instructions for this working place. | 3 marks |

TOTAL 25 marks

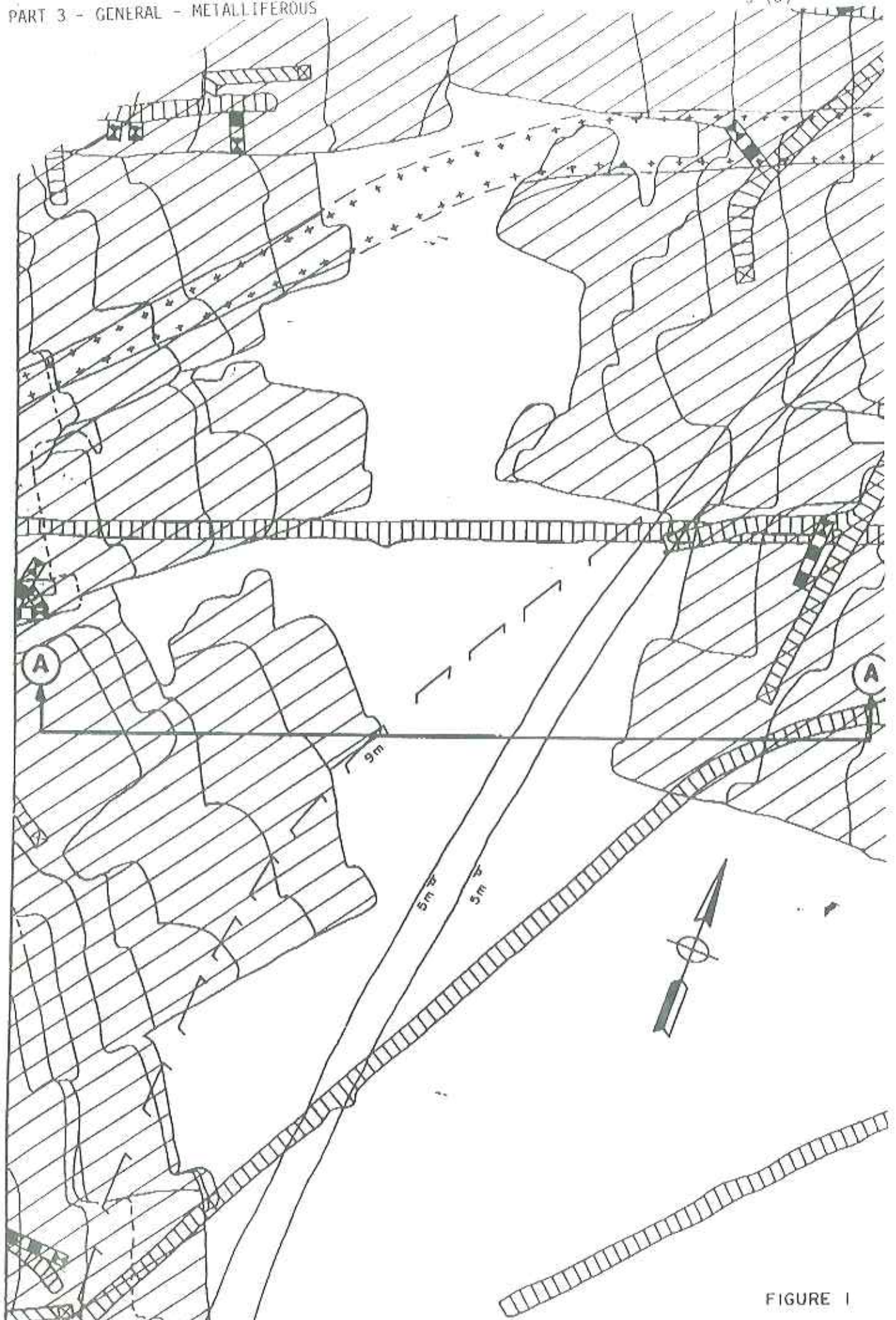


FIGURE 1

QUESTION 2

- (a) A weak shale band, 45,0 metres thick, lies 30,0 metres below a reef. The reef and the shale band are conformable.

Prospect drilling intersected the reef and information from this drilling revealed two minor dips of the reef, that is:

Hole 1 d = 35° Hole direction : East

Hole 2 d = 40° Hole direction : 40° East of South

The reef is located at a depth of 3 400 m below surface. It is intended to blind hole raise bore an ore pass of 1,8 metre diameter from a position of 120 metres vertically below reef. The inclination of the raise bored hole will be 90°.

- (i) Determine the true dip and strike of the reef. 10 marks

Assuming a typical k-ratio which could be expected at this depth, comment on the following:

- (ii) The proposed orientation of the raise bored hole in relation to the shale band. 1 mark.

- (iii) The support, if any, you would recommend in the raise bored hole. 2 marks

- (iv) If you had to recommend more preferable orientation of the raise bored hole, what strike and dip orientation would you recommend? 2 marks

- (b) A lateral development end needs to be mined through a 50 m wide "loss" zone at a depth of 2 500 m. Due to mining and geological geometry it is not possible to overstop the area and so de-stress the tunnel. It is absolutely essential that the tunnel be mined through what is in essence a highly stressed pillar. Suggest ways in which this could be done safely, illustrating your scheme with sketches, where necessary.

Comment on mining sequence and support methods to be employed.

10 marks

TOTAL. 25 marks

PART 3 - GENERAL - METALLIFEROUS

5.

QUESTION 3

A settler chamber is to be mined at depth in average to poor rock mass conditions and is sited within a properly designed shaft pillar layout.

The dimensions of the excavation are 12 m long x 8 m high x 6 m wide.

- (i) By means of sketches show the ideal mining sequence to be adopted, as well as the access points to the excavation considered by you to be the most advantageous for the mining process.
- (ii) Discuss the support requirements for the excavation, at each stage of the mining process, including the final support layout. Give reasons for your choice of each support type needed, as well as the specifications of the support elements.
- (iii) Certain measures employed before, during and after the mining and support of the excavation will ensure the long term viability of the excavation.

5 marks

5 marks

Comment on these measures.

5 marks

TOTAL 15 marks

QUESTION 4

- (a) Backfill characteristics, preparation and placement form an essential part of the rock mechanics practitioner's knowledge and experience. Discuss the following topics with respect to backfill performance.
- (i) Placed Porosity. 2 marks
 - (ii) Stopping Width. 2 marks
 - (iii) Percentage Area Filled. 2 marks
- (b) A new geo-textile to be used for retaining backfill appears on the market. What characteristics would you look for and how would you go about testing the geo-textile's performance? 4 marks
- (c) Describe three (3) different types of backfill for placement in tabular reef mining.
- Briefly describe an advantage and disadvantage for each type. 9 marks
- (d) You are to design a new pillar and backfill support system for a mine. Describe how you would see the following topics affecting your decisions in designing such a system:
- (i) In Situ Grade. 2 marks
 - (ii) Face Advance. 2 marks
 - (iii) Hanging and footwall rock types/structures. 2 marks

QUESTION 4 (Continued)

- (e) Quartzitic backfill is supplied underground at an s.g. of 1,75 by means of cycloning plant tailings.

A geo-textile backfill bag of 80 m^3 volume is filled at a backfill wet feed rate of $5,0 \text{ t/s}$.

Immediately on completion of filling, the placed s.g. of the fill is 2,2.

The geo-textile in question allows for 5% fines losses during the filling operation.

- (i) Calculate the amount of water which runs off during the filling, up to the time when the backfill achieves the s.g. of 2,2 within the bag.

7 marks

- (ii) Calculate the time required to fill the bag.

3 marks

TOTAL 35 marks

KAMER VAN MYNWESE VAN SUID-AFRIKA

SKRIFTELIKE EKSAMEN VIR DIE SERTIFIKAAT IN ROTSMEGANIKA

METAALKEUSE

<u>DEEL 3 - ALGEMEEN</u>	: 15 Mei 1996
<u>EKSAMINATOR</u>	: Mnr. F A F Hathorn
<u>MODERATOR</u>	: Mnr. W A Naismith

Maksimum tyd toegestaan: 3 uur (09:00 - 12:00)

'n Engelse weergawe van hierdie vraestel is aangeheg.

BEANTWOORD AL DIE VRAE.

Om te slaag moet u 60 persent in hierdie vraestel behaal.

Naslaanwerke mag nie gebruik word nie.

Elektroniese handrekenmasjiene kan gebruik word. (Geen voorafprogrammering nie.)

Skryf u eksamennommer buiteop elke antwoordboek wat u gebruik, en op alle grafiekpapier of ander los velle wat u inlewer.

L.W.: U naam moet nie op enige antwoordboek of los velle verskyn nie.

Skryf slegs op een kant van elke vel papier.

Toon alle berekenings aan waarop u antwoorde gegrond is.

Wanneer u hierdie vrae beantwoord, moet u u ondervinding van die praktiese sy van die onderwerp sowel as die gegewens ten volle benut waar dit ook al nodig is.

Grafiekpapier kan by die opsiener verkry word.

AANTEKENINGE VIR DIE KANDIDAAT

Lees hierdie aantekeninge sorgvuldig deur voordat u die vrac begin beantwoord.

Die probleme word nie altyd duidelik in die vrac gestel nie. 'n Deel van u taak is om die presiese aard van die probleem uit die vraag te bepaal. Daar is geen "klinkklare" antwoorde nie. Die vrac verg dat u u formele, akademiese kennis en u ervaring moet put. Die vrac vereis ook dat u u vermoë moet toon om 'n probleem goed deur te dink, baie soos u dit in die praktyk sal moet doen. Dit sal u niks baat as u die vrae en antwoorde op 'n lukrake en onstelselmatige manier deurwerk nie. Die eksaminator en die moderator sal u veel eerder die voordeel van die twyfel gee as u liever die probleem stelselmatig aanpak as om 'n ongestruktureerde en slordige benadering te volg.

Gebruik groot, duidelike sketse met goeie byskrifte wanneer dit nodig is. Dit sal u met u dinkwerk help en ook u antwoord vir die eksaminator en die moderator duideliker maak. Klein sketsies sonder afmetings en met swak byskrifte sal niks daartoe bydra om u te help nie.

VRAAG 1

Die aangehegte plan (Figuur 1) toon 'n paar panele wat in 'n restant na twee 5 m-afskuiwings vorder. Noord van die vorderende panele is 'n seismies aktiewe gesteentegang. Benewens die afskuiwings word 'n golwing deur die onderste panele gekruis. Hierdie golwing verdring die rif ongeveer 9,0 meter afwaarts. Die rif se helling is noord-wes na suidoos.

Die dak is lawa met 'n eenasdruksterkte van 200 MPa, terwyl die vloer kwartsiet is met 'n eenasdruksterkte van 220 MPa. Die rifspan in die gebied is 'n konglomeraat met 'n rifspanwydte van 150 cm.

- (a) Die huidige toestand is klaarblyklik nie prakties of veilig nie. Wat sal u by die mynbestuurder aanbeveel om die gemiddelde energievrylatingstempo en gevolglik die seismisiteit te verminder? 5 punte
- (b) Bespreek die afboubestuttingstelsels wat nodig is om die geslaagde en veilige uitmyning te verseker van die oorblywende rif deur die fronte wat nog noordooswaarts ontgin. 5 punte
- (c) Bespreek die mynbouvolgorde en die nadering van geologiese strukture. 5 punte
- (d) Met die oog op u antwoorde in (a), (b) en (c) hierbo, bespreek die ontginningsgraad wat as behaalbaar beskou word en watter verdere voorsorgmaatreëls van 'n praktiese aard nodig geag word om die hoogste veiligheids grens te bereik. 5 punte
- (e) Teken 'n deursnee aansig langs A-A met die hand (nie noodwendig op skaal nie). 2 punte
- (f) Beskryf kortliks die besondere restantbestuuronderwerpe wat u in 'n stel spesiale gebiedsinstruksies vir hierdie werkplek sal opneem. 3 punte

TOTAAL 25 punte

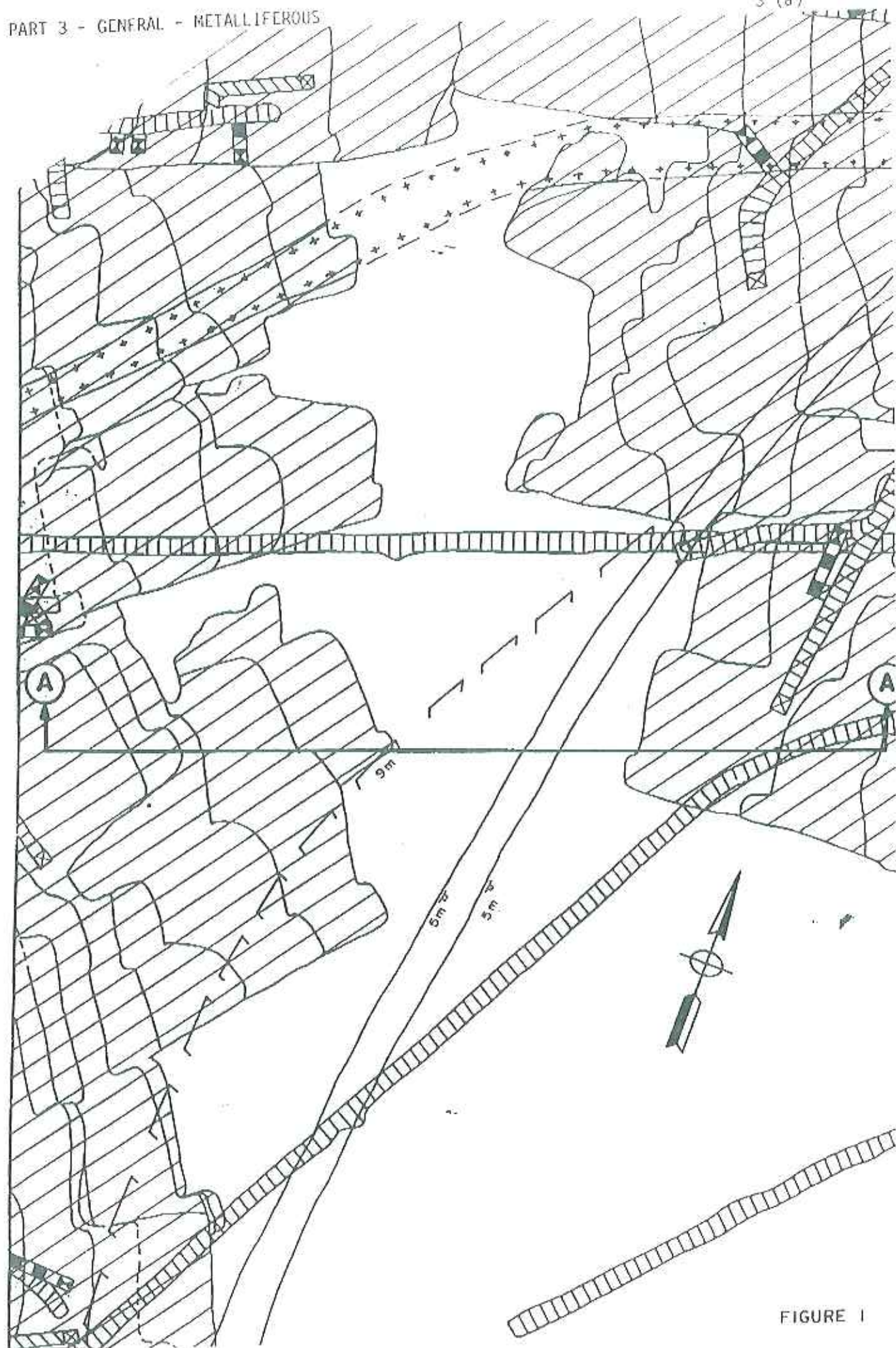


FIGURE 1

VRAAG 2

- (a) 'n Swak 45,0 meter dikke skaliestrook lê 30,0 meter onder 'n rif geleë. Die rif en die skaliestrook is ooreenkomend.

Prospekteerboorwerk het die rif gekruis, en inligting van hierdie boorwerk het twee geringe hellings van die rif getoon, naamlik:

Gat 1 $d = 35^\circ$ Gatrigting : oos

Gat 2 $d = 40^\circ$ Gatrigting : 40° oos van suid

Die rif is op 'n diepte van 3 400 m onder die oppervlak geleë. Daar word beoog om 'n ertsstortbaan met 'n diameter van 1,8 meter van 'n punt 120 meter vertikaal benede die rif met 'n blindegatboor te boor. Die helling van die styggangboorgat sal 90° wees.

- (i) Bepaal die ware helling en strekking van die rif. 10 punte

Veronderstel dat die k-verhouding kenmerkend is vir hierdie diepte, en bespreek die volgende:

- (ii) Die voorgestelde oriëntering van die styggangboorgat met betrekking tot die skaliestrook 1 punt

- (iii) Die bestutting (as daar is) wat u in die styggangboorgat sal aanbeveel. 2 punte

- (iv) As u gunstiger oriëntering van die styggangboorgat moes aanbeveel, watter strekkings- en hellingsoriëntering sou u aanbeveel? 2 punte

- (b) 'n Laterale ontsluitgang moet deur 'n 50 m breë "verlies"-sone op 'n diepte van 2 500 m gemyn word. Weens die mynbou- en geologiese uitleg is dit nie moontlik om bo-oor die gebied af te bou nie, en die tonnel sodoende te óntspan. Dit is absoluut onvermybaar dat die tonnel gemyn moet word deur wat in wese 'n pilaar onder groot spanning is. Maak voorstelle oor hoe dit veilig gedoen kan word, en illustreer u plan met sketse waar dit ook al nodig is.

Bespreek die mynbouvolgorde en bestuttingsmetodes wat gebruik moet word. 10 punte

TOTAAL 25 punte

VRAAG 3

'n Besinkkamer moet op diepte in gemiddelde tot swak rotsmassatoestande uitgegrawe word en is binne 'n behoorlik ontwerpte skagpilaaruitleg gelê.

Die afmetings van die uitgraving is 12 m lank x 8 m hoog x 6 m wyd.

- (i) Toon deur middel van sketse die ideale mynbouvolgorde om toe te pas, asook die toegangspunte tot die uitgraving wat u as die voordeligste vir die mynbouproses beskou. 5 punte
- (ii) Bespreek die bestuttingsvereistes vir die uitgraving op elke stadium van die uitgrawingsproses, insluitende die finale bestuttingsuitleg. Verstrek redes vir u keuse van elke soort bestutting wat nodig is, asook die spesifikasies van die bestuttingselemente. 5 punte
- (iii) Sekere maatreëls wat voor, tydens en na die uitgraving en bestutting van die uitgraving aangewend word, sal die langtermynbestaan van die uitgraving verseker.

Bespreek hierdie maatreëls.

5 punte

TOTAAL 15 punte

VRAAG 4

- (a) Die eienskappe, voorbereiding en plasing van terugvulsel maak 'n belangrike deel uit van die rotsmeganikama se kennis en ondervinding. Bespreek die volgende onderwerpe met betrekking tot die prestasie van die terugvulstelsel:
- (i) Plasingsporeusheid 2 punte
 - (ii) Afboudikte 2 punte
 - (iii) Gebiedspersentasie gevul 2 punte
- (b) 'n Nuwe geotekstiel wat gebruik word om terugvulsel terug te hou, verskyn op die mark. Watter eienskappe sal u soek, en hoe sal u te werk gaan om die geotekstiel se prestasie te toets? 4 punte
- (c) Beskryf drie (3) verskillende soorte terugvulsel vir plasing in tafelrifynbou. 9 punte
- Beskryf 'n voor- en nadeel van elke soort kortliks.
- (d) U moet 'n nuwe pilaar-en-terugvulsel-bestuttingstelsel vir 'n myn ontwerp. Beskryf hoe die volgende onderwerpe na u mening u besluite sal beïnvloed wanneer u so 'n stelsel ontwerp:
- (i) In situ-graad 2 punte
 - (ii) Frontvordering 2 punte
 - (iii) Dak- en vloerrotstipes/-struktuur 2 punte

VRAAG 4 (vervolg)

- (c) Kwartsitiese terugvulsel word ondergronds verskaf by 'n s.g. van 1,75 deur aanleguitskot met 'n sikloon te behandel.

'n Geotekstielterugvulselsak met 'n volume van 80 m^3 word teen 'n terugvulselnatvultempo van $5,0 \text{ l/s}$ gevul.

Onmiddellik na afloop van die vulling is die plasings-s.g. van die vulsel 2,2.

Die betrokke geotekstiel maak voorsiening vir 5% verlies van fynmateriaal gedurende die vulling.

- (i) Bereken die hoeveelheid water wat tydens die vulling afloop tot die tydstop wanneer die terugvulsel die s.g. van 2,2 in die sak bereik.

7 punte

- (ii) Bereken die tyd wat nodig is om die sak te vul

3 punte

TOTAAL 35 punte