BUSITEMA UNIVERSITY

Pursuing Excellence

FACULTY OF ENGINEERING

DEPARTMENT OF MINING AND WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT

Investigation of the Causes of Stope Failure

Case Study of Tiira Gold Mine in Busia Uganda

By

OBEL ISAAC

BU/UG/2012/111

Email: o.iscbel.mgks001@gmail.com Mob: +256 785 308 482

SUPERVISOR: Eng. Wangi M.

A final year project submitted to the department of Mining and Water Resources Engineering as a partial fulfilment of the Requirements for award of a Bachelor of Science degree in Mining Engineering

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EXECUTIVE SUMMARY

The most prominent underground extraction techniques in Ugandan metalliferous mines are self and semi-artificially supported open stope mining. Taking a closer look at this, the integral part of the global stability of underground metal mines with numerous working levels and old workings within the same reef puts the crown pillars that stands in the vertical plane between the two open stopes on analysis, because they are significantly affected by the mechanical and physical properties of the rock mass, structural weakness, initial state of the horizontal stress and geometry of the pillar in fresh working zones, however in areas with old developments, new activities are affected by conditions of abandoned excavations.

Considering stope development at Green Stone Resources Limited in Busia Eastern Uganda no integrated design and failure assessment criterion was available in its domain up to the date of this project but, generally development and failure mitigation criterion relied on the past experiences and rule of thumb. That led to short termed life of bored tunnels and continuous risky failure at stopes in the new shaft's ore extraction level 54m by the year 2014/2015.

In this report practical identification of the causes of stope failure at GRL has been discussed and method(s) which will aid engineers in designing stopes with optimum life at any level in GRL considering all the local conditions has been developed. Country rock failure criterion, blast fragmentation extent, geometry of influential pre-existing excavations, and in-situ rock mass classification are principled parameters which has been assessed in detail.

Chapter 2 of this work covers the basic failure theories, modified empirical and theoretical methods of stable stope design and failure assessment. These methods were used in determination of theoretical values for stope span and thickness of crown pillars and wall rocks required on ground and also computation of stress levels in pillars for the average 2.2m span of the new shaft drives and 6m crown pillar thickness between the old and new drives.

Chapter 3 has the four phases that sighted techniques used for gathering and reducing field and laboratory data essential for stope failure analysis. The scaneline surveying used in the field to determine the structural formation of the rock mass and laboratory tests which were conducted to determine the mechanical properties of the rock mass.

Chapter 4 entails results and discussion for surface excavation, old and new shafts mappings, natural rock structure joint survey and stereography, precipitation and dewatering, point load test and TCS, rock drilling, explosive strength and fragmentation analysis. That identified a fault zone striking the mine at 165^0 at a bearing of 015^0 with width >5m as the actual cause of stope failure.

Chapter 5 is the derived conclusions and recommendations basing on the computed results from the analysis.

DECLARATION

I hereby affirm that this project is my own work; it is being submitted as a requirement for award of a Bachelors degree of Science in Mining Engineering at Busitema University. It has not been submitted before for any degree at any University.

Obel Isaac (BU/UG/2012/111)	....	27th May 2016
(Candidate)	Signature	Date

APPROVAL

This final year research project for Mining Engineering is submitted to the Department of Mining and Water resources engineering for examination with approval from the following supervisor(s):

Departmental supervisor

Eng. Wangi M.

Signature ....

Date ....

Head of Final Year Project's Panel for Mining Engineering 2015/2016

Eng. Tugume W.

Signature ....

Date ....

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LIST OF ACRONYMS

Acronyms

CIL – Carbon in leach

DCDs – Diamond Core Drills

ESR - Excavation Support Ratio

GRL - Greenstone Resources Limited

ML – Mining Lease

MRMR – Modified Rock Mass Rating

NGO – Non Governmental Organization

RC – Reverse Circulation

RMR – Rock Mass Rating

RQD – Rock Quality Designation

SF - Stope Failure

SRF -The stress reduction factor

UIRI – Uganda Industrial Research Institute

UN – United Nations

UNBS – Uganda National Berue of Standards

LIST OF SYMBOLS

τ – Tensile cut-off

σ – stress

S_i – cohesion

θ – angle of friction

P_{cr} – critical pore pressure

cr- Critical

P_f – Ground fluid pressure

ρ – Rock Density

g – Gravitational constant

J_n, - The joint set number

J_r, - The joint roughness number

J_a, - The joint alteration number

J_w, - The joint water reduction factor

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CHAPTER ONE

INTRODUCTION, PROBLEM DESCRIPTION, OBJECTIVES AND SCOPE

1.1 INTRODUCTION TO STOPE FAILURE AND ITS COURSE AT GRL

Green Stone Resources, Tiira mineral inventory underground gold ore extraction was leaving vertical and horizontal components of the deposit between two open stopes; the old abandoned levels and the new shaft drive i.e. the supporting wall and crown pillars respectively. These pillars stands on rock suspensions of undefined multi-directional stresses that was constituting the critical parameters of analysis in this document because of associated failure disasters. These two pillars were prone to developing a four dimensional time factor aspects of undesired collapse into underground openings, a condition known as stope failure, and a catastrophic event which was human initiated and due to natural ground movements.

Failure of this nature carried a great liability to Green Stone Resources mining company, because falling stopes were inaccessible, and coupled with extensive mucking of unplanned waste the associated accidents on machines and personnel reduced run-of mine and available labor goodwill (Agyeman, 2015).

As an implicit auxiliary operation in underground ore production, SF has in-sighted development of monitoring systems to analyze gradual unintended span and widths variation in underground excavations in well establish mining countries like Australia and South Africa, but even so no actual causes of rock failure can be derived without field observations and laboratory analysis, instead monitoring can only be applied after conclusion on a specific failure cause derived from the study (Handley, 2004).

In Uganda, mining operations were nailed out by political unrest during the 1970s, however in 1980s relative political stability sighted series of gold discovery prompting artisanal mining and gradual growth of domestic metallic mineral extraction industry, but as mining advances in reefs deep down the ground with undefined geological certainties, this terrifying occurrence has a potential to soon crop in mines. Early mineral developments in Uganda included Tiira Gold mine in Busia that was rebuilt between 1990s and 2000s, mining herein

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