GEO-ELECTRICAL RESISTIVITY INVESTIGATION OF IRON ORE MINERAL DEPOSITS IN MBEU AREA, MERU COUNTY, KENYA

JASPER MUJUMBE KINYUA

A Thesis Submitted to the Graduate School in Partial Fulfillment of Requirements for the Award of the Degree of Master of Science in Physics of Chuka University

CHUKA UNIVERSITY

OCTOBER 2024

DECLARATION AND RECOMMENDATIONS

Declaration

This thesis is my original work and has not been presented for an award of a diploma or conferment degree in any institution.

Signature..... Date 24/10/2024

Jasper Mujumbe
SM19/40091/19

Recommendation

This thesis has been examined, passed and submitted with our approval as University supervisors.

Signature..... Date 24/10/2024

Dr. Antony Odek (Ph.D.)
Chuka University

Signature..... Date 24/10/2024

Dr. Zipporah Wanjiku (Ph.D.)
Chuka University

CHUKA UNIVERSITY
24 OCT 2024
P.O. Box 109-60400, CHUKA
DIRECTOR BOARD OF POSTGRADUATE STUDIES AND RESEARCH

DEDICATION

This work is dedicated to my dear wife Mary Karithi, my son Liam Murimi, my brother Utycus Koome, my wonderful sister Hellen Nkatha, and Denis Mawira.

ACKNOWLEDGEMENT

I would like to take this opportunity to sincerely thank everyone who helped me finish my thesis study. It has been a long and challenging journey, but with the support and encouragement of many, I have finally reached this milestone.

First and foremost, I would like to thank the almighty God for granting me strength and good health to accomplish this work.

I am also deeply grateful to my supervisors Dr Odek Antony and Dr Zipporah Wanjiku, for their invaluable guidance, support, and expertise. Their insightful feedback, constructive criticism, and constant encouragement have been instrumental in shaping my research and improving the quality of my thesis. I am truly fortunate to have had such dedicated and knowledgeable mentors.

I would also like to acknowledge the support of the chief laboratory technologist Mr. Gitonga for his assistance and support in conducting the research

I would also like to extend my gratitude to my colleagues Evans Kimathi and Moses Gatobu for their friendship, camaraderie, and support offered during the strenuous data collection exercise. The countless discussions and brainstorming sessions we had together have enriched my understanding of the subject and have served as an inspiration and source of encouragement. I am appreciative of my friends and family for their support, love, and unshakeable faith in me. Their unwavering compassion and support have been a source of inspiration during these trying times.

Finally, to everyone who has shared in this adventure, my deepest thanks is extended. This thesis would not have been possible without your help. I sincerely appreciate all of the support and motivation I have been given.

ABSTRACT

Global demand for iron or its products has risen over the years due to the growing housing, road, and railway industry and the manufacture of machinery. Studies leading to the location of more iron ore fields need to be performed in order to determine the suitability of available iron ore as a raw material for iron production. Earlier, studies carried out within Mbeu and Kimaachia areas in Meru County, Kenya, using gravity and magnetic Geophysical methods did not pick shallow deposits and discontinuous magnetite mineralization occurring in rocks and veinlets. This was attributed to relatively low density contrast and magnetic susceptibility on shallow deposits and unevenly distributed magnetite rich rocks. This, therefore, necessitated the need to integrate an electrical resistivity geophysical method that can detect isolated electrical conductors in the subsurface. This research involves the use of electrical resistivity along the areas identified around 0^0 06' 24''N and 37^0 50' 49''E. By taking measurements on the ground surface, the electrical resistivity method calculates the true resistivity of the subsurface. The potential difference that results from injecting current into the earth is measured at the surface. The ground resistivity measurements were performed by the use of the LS 2 ABEM terrameter. RES2DINV software was employed in the quantitative interpretation of the data by generating models of apparent resistivity pseudo-sections. The software carried out a least square inversion on the measured apparent resistivities and induced that the true resistivity of alluvium, rocks, and clay saturated with water ranges from 2.21 Ωm to 487 Ωm, 212 Ωm to 3000 Ωm and 2.21 Ωm to 65 Ωm respectively. A comparison between electrical resistivity levels and chargeability factors guided a quantitative characterization of the subsurface. The characterization established that the subsurface ore distribution is divided into two portions: alluvium and rocks enriched with iron ore and alluvium and rocks containing disseminated deposits of iron ore. The regions of the model identified by resistivity and chargeability values of 17.4 Ωm to 406 Ωm, 208 Ωm to 886 Ωm and 0.01 msec to 3 msec, 0.091 msec to 4.64 msec are inferred as alluvium and rocks enriched with iron ore deposits, respectively; the other regions characterized by resistivity and chargeability of 110 Ωm to 487 Ωm, 542 Ωm to 995 Ωm and 3.326 msec to 7.87 msec, 4 msec to 7.07 msec are of alluvium and rocks containing disseminated deposits of iron ore, respectively. This study has established that Mbeu iron deposits are an extensive resource occurring at deep and shallow depths in the form of grained magnetite mixed with alluvium and rocks containing magnetite. It has also been found that magnetite is the main ore in the geological formations. The ore-bearing rocks and alluvium appear at an approximate depth of 1.25 m to 65.6 m in most of the profiles and extend deep beyond the terra-meter probe depth. These results on the presence of iron ore deposits will be essential to society in that mining and extraction of mineral ores will provide employment opportunities to the locals. Taxes and royalties generated will contribute to the economic growth of the region and country.