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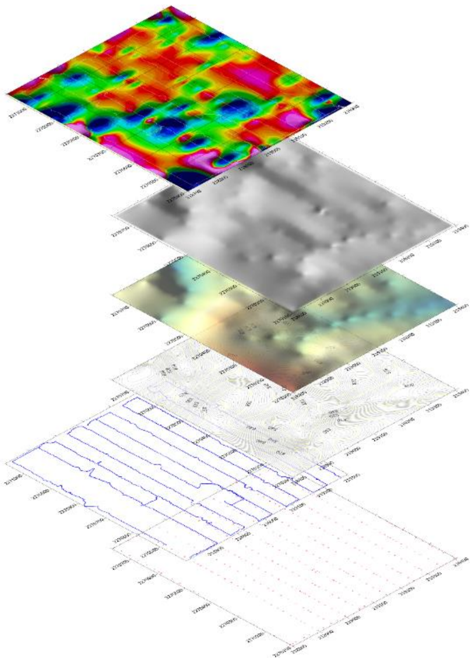
Ministry of Natural Resources and Environmental Conservation

Forest Department

The Utilization of Magnetic Anomaly in Mineral Exploration



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Abstract

Various mining for subsurface resources has an intensely effect on the focus and style of geophysical prospecting. It is rich from the table that the geological environments of most ore deposits can be predicted Geo-physically. There are many inventive products of the wide changes of geophysical method in two-way, direct or indirect detection. Whereas any knowledge can be kept to search directly for gold but to locate structures and environments in which gold is most likely to occur. Direct detection of gold deposits using the geophysical method is very difficult due to its low amount in the subsurface but then other geophysical methods may lead to the indirect investigation of gold deposits. Besides that, the problem stem is to apply meaningful geophysical responses from the variety of geological characteristics associated with its individual class of gold deposit. Therefore, the only way for gold exploration using the geophysical methods is carried out indirectly. As a categorically, the job of looking for a favorable gold environment would be quite impossible without such a geophysical outlook. The concepts play a leading to more precise mineral resource and exploration programs and then the objectives will have been given and suggested the idea that should be applied in all relevant permit area of mineral explorations. In this study, the characteristics that represent the significant of magnetic anomalies, geophysical magnetometer methods and detective strategies are described, and illustrated by magnetic intensity map from a variety of potential occurrences.

Keywords: Mining, geophysical method, magnetometer, detection, magnetic anomalies

သံလိုက်စက်ကွင်းထူးခြားရပ်ဝန်းများ ဖြစ်ပေါ်ပျံ့နှံ့မှုအား ဘူမိရူပနည်းလမ်းများဖြင့် စမ်းသပ်တိုင်းတာ၍ သတ္တုတွင်းထွက် သယံဇာတရင်းမြစ်များ ရှာဖွေစမ်းသပ် တူးဖော်ထုတ်လုပ်ရေးလုပ်ငန်းများတွင် အကျိုးရှိစွာအသုံးချခြင်း

ဒေါက်တာဇော်ဇော်သိန်း*၊ လက်ထောက်သုတေသနအရာရှိ
အောင်မင်း၊ ဒုတိယညွှန်ကြားရေးမှူး
ဘူမိဗေဒလေ့လာရေးနှင့်ဓာတ်သတ္တုရှာဖွေရေးဦးစီးဌာန

အကျဉ်းချုပ်

ဘူမိရူပစမ်းသပ်တိုင်းတာခြင်း နည်းလမ်းများသည် တွင်းထွက်သယံဇာတရင်းမြစ်များ ရှာဖွေစမ်းသပ်တူးဖော်ထုတ်လုပ်ရေး လုပ်ငန်းများအတွက် အရေးပါအသုံးဝင်လှပါသည်။ ဘူမိရူပစမ်းသပ်တိုင်းတာခြင်းမှ ရရှိလာသောအချက်အလက်များသည် သတ္တုသိုက်များ၏ ဖြစ်ထွန်းတည်ရှိရာနယ်ပယ်ဝန်းကျင်များကို ဘူမိဗေဒပညာရပ်ရှုထောင့်မှ အချိန်တိုအတွင်း တိကျမှန်ကန်စွာ ကနဦးခန့်မှန်းပုံဖော်လေ့လာနိုင်ပါသည်။ ဘူမိရူပနည်းပညာနယ်ပယ်တွင် ခေတ်မီတိုင်းတာရေး စက်ကိရိယာများ အချိန်နှင့်အမျှ ပြောင်းလဲတိုးတက်လာသော်လည်း အခြေခံအားဖြင့် တိုက်ရိုက်စမ်းသပ်တိုင်းတာပုံဖော်လေ့လာခြင်းနှင့် သွယ်ဝိုက်စမ်းသပ်တိုင်းတာပုံဖော်လေ့လာခြင်းဟူ၍ နှစ်မျိုးရှိပါသည်။ ပညာရပ်နယ်ပယ်အသီးသီးတွင် သတ္တုဖြစ်ထွန်းမှုကို တိုက်ရိုက်ရှာဖွေထိတွေ့ကြည့်ရှုကာ လေ့လာမှုများပြုလုပ်နိုင်ကြသော်လည်း မြေအောက်ရှိ သတ္တုသိုက်၏ ဖြစ်ပေါ်တည်ရှိမှု၊ နေထားဘူမိဗေဒ၊ စီးပွားဖြစ်ထုတ်ယူနိုင်မည့်ပမာဏ စသည့်တို့ကို တိုက်ရိုက်ပုံဖော်လေ့လာနိုင်ရန် ခက်ခဲနေဆဲပင်ပါသည်။ အဘယ့်ကြောင့်ဆိုသော် သတ္တုသိုက်တစ်ခုချင်းစီ၏ ဆက်စပ်ဖြစ်ထွန်းပေါ်ပေါက်မှု အရင်းခံအကြောင်းတရားများနှင့် သတ္တုသိုက်အတန်းအစားများမှာ အမျိုးမျိုးအဖုံဖုံ ကွဲပြားခြားနားနေရုံသာမဟုတ်ဘဲ ထိုသတ္တုသိုက်တို့၏ ဘူမိရူပဆိုင်ရာ စမ်းသပ်ချက်တုန့်ပြန်မှုရလဒ်ရုပ်ဂုဏ်သတ္တိများကို အလုံးစုံနားလည်သဘောပေါက်နိုင်ရန် လိုအပ်ချက်များစွာ ရှိနေခြင်းပင်ဖြစ်ပါသည်။ ဥပမာအားဖြင့် ဘူမိရူပနည်းပညာဖြင့် ရွှေကို တိုက်ရိုက်စမ်းသပ်တိုင်းတာ၍ မဖြစ်နိုင်ခြင်းမှာ သတ္တုသိုက်ဖြစ်ပေါ်မှု မူလသဘာဝ၌ပင် ရွှေပါဝင်မှုပမာဏ အလွန်နည်းပါးသောကြောင့်ဖြစ်ပါသည်။ ထို့ကြောင့် ရွှေရှာဖွေရာတွင် သွယ်ဝိုက်သောနည်းလမ်းဖြင့်သာ

စမ်းသပ်တိုင်းတာ၍ ပုံဖော်လေ့လာကြခြင်းဖြစ်ပါသည်။ မည်သို့ပင်ဆိုစေကာမူ ဘူမိရူပဆိုင်ရာ စမ်းသပ်တိုင်းတာမှုများ ပြုလုပ်ပြီးမှသာ ပိုမိုခိုင်မာတိကျသော သတ္တုသိုက်ဖြစ်စဥ်သဘောကို လေ့လာသိရှိဖော်ထုတ်နိုင်မည်ဖြစ်ပါသည်။ နိုင်ငံအတွင်းရှိသက်ဆိုင်ရာခွင့်ပြုမိန့်ရ သယံဇာတ ရှာဖွေစမ်းသပ်တူးဖော်ထုတ်လုပ်ရေးလုပ်ငန်းစဥ်များတွင်လည်း ဘူမိရူပဆိုင်ရာနည်းလမ်းများ အသုံးပြု၍ စမ်းသပ်တိုင်းတာရေးလုပ်ငန်းများအား ပိုမိုပေါင်းစပ်ပြုလုပ်သင့်သည်ကို အကြံပြု တင်ပြခြင်းဖြစ်ပါသည်။ ယခုစာတမ်းတွင် မိမိတို့ဌာနရှိ ခေတ်မီနောက်ဆုံးပေါ် သံလိုက်စက် ကွင်းပြင်းအားတိုင်း စက်ကိရိယာအသုံးပြုကာ တိုင်းတာခဲ့သည့်နည်းဗျူဟာ၊ ဖော်ထုတ် တွေ့ရှိ ရသောထူးခြားသည့် သံလိုက်စက်ကွင်းပြင်းအားဇုံများအား ပုံဖော်ရေးဆွဲ၍ ဖြစ်ထွန်းပေါ် ပေါက်နိုင်သည့်သတ္တုသိုက်၊ ဘူမိဖြစ်စဥ်နှင့် နယ်ပယ်ဝန်းကျင်များ၏ သိသာထင်ရှားမှုများအား ဘူမိဗေဒပညာရပ်ဆိုင်ရာအခြေပြု ခန့်မှန်းဖော်ထုတ် လေ့လာသုံးသပ်မှုများအား ရေးသား တင်ပြထားခြင်း ဖြစ်ပါသည်။

The Utilization of Magnetic Anomaly in Mineral Exploration

1. Introduction

Various mining for subsurface resources has an intensely effect on the focus and style of geophysical prospecting. It is rich from the table that the geological environments of most ore deposits can be predicted geo-physically. There are many inventive products with the wide changes of geophysical method in two-way, direct or indirect detection. Whereas any knowledge can be kept to search directly for gold but to locate structures and environments in which gold is most likely to occur. Direct detection of gold deposits using the geophysical method is very difficult due to its low amount in the subsurface but then other geophysical methods may lead to the indirect investigation of gold deposits. Besides that, the problem stem is to apply meaningful geophysical responses from the variety of geological characteristics associated with its individual class of gold deposit. Therefore, the only way for gold exploration using the geophysical methods is carried out indirectly.

Field-work option was carried out for the purpose of technical experience in geophysical assessment to young scientists of our department. The focus of prospecting is taking a look at the magnetic sensitivities over some parts of study area. The entire duration of field investigation is sixteen days within Feburuary17th to March 3rd, 2024.Throughout the field period, morning and evening touch with actual freeze, warm to hot during the day and the air is relatively dry that is getting too bad for well-being.

2. Objectives

As a categorically, the job of looking for a favorable gold environment would be quite impossible without such a geophysical outlook. The concepts play a leading to more precise mineral resource and exploration programs and then the objectives will have been given and suggested the idea that should be applied in all relevant permit area of mineral explorations. In this study, the characteristics that represent the significant of magnetic anomalies, geophysical magnetometer methods and detective strategies are described, and illustrated by magnetic intensity map from a variety of potential occurrences.

3. Geology

Gold is one of the most active economic minerals and gold mining contributes largely to the economy of the country. Regionally, the gold deposits of Myanmar comprise six major north-south trending geological linkages or tectonic terranes. Among them, the Mergui Belt (MB) also known as the Slate Belt in Central Myanmar is largest and most economically important gold provinces in Myanmar.

Numerous orogenic gold deposits have been discovered by diverse style of mineralization in the Mergui Belt (MB), that formed in response to stratigraphic and structural controls on the flow of Au-bearing fluid through metasedimentary rocks, (Mitchell, 2004).

Orogenic gold deposits are one of the main groups of gold deposits making up a major source of gold produced worldwide (Groves et al., 1998; Dubé and Gosselin, 2007). The most common structures present in orogenic gold deposits are brittle to ductile in nature and subsequent structural reworking cause veins to be discontinuous, and for original mineralization to be displaced by later structural events (Groves et al., 1998).

The geology of the detected area involves in the northern portion of the gold district, central Myanmar (Mitchell, 2004). The main showings are at an elevation about 1200 m above sea level with rugged terrain. It is mainly composed of Carboniferous to Lower Permian metasedimentary rocks of the Mergui Belt (MB), the metamorphosed Lower Paleozoic rocks, Mogok Metamorphic Belt (MMB) and granites (Jurassic-Cretaceous). Mogok Metamorphic Belt (MMB), medium to high grade metamorphic rocks, tightly folded, consists of phyllite, schist, gneiss and calc-silicate rocks and intruded by calc-alkaline dykes and granites. The Mergui Belt (MB) consists very largely of argillaceous rocks, and consists of two formations: the Kogwe mudstone and the Polokkale pebbly-wacke.

Two major thrust faults, the Sakhanya Taung Fault to the west and the Pan Laung Fault to the east were occurred at the area that can be determined in tectonically complex. In the western region of the area where the Mergui Belt (MB) between the Mogok Metamorphic Belt (MMB) is the Sakhanya Taung fault is divided. The fault dip is steeply west with Mogok Metamorphic Belt (MMB) in the hanging wall overlying Mergui Belt (MB), (Mitchell, 2004). Granite intrusion can be found in the eastern part of the area.

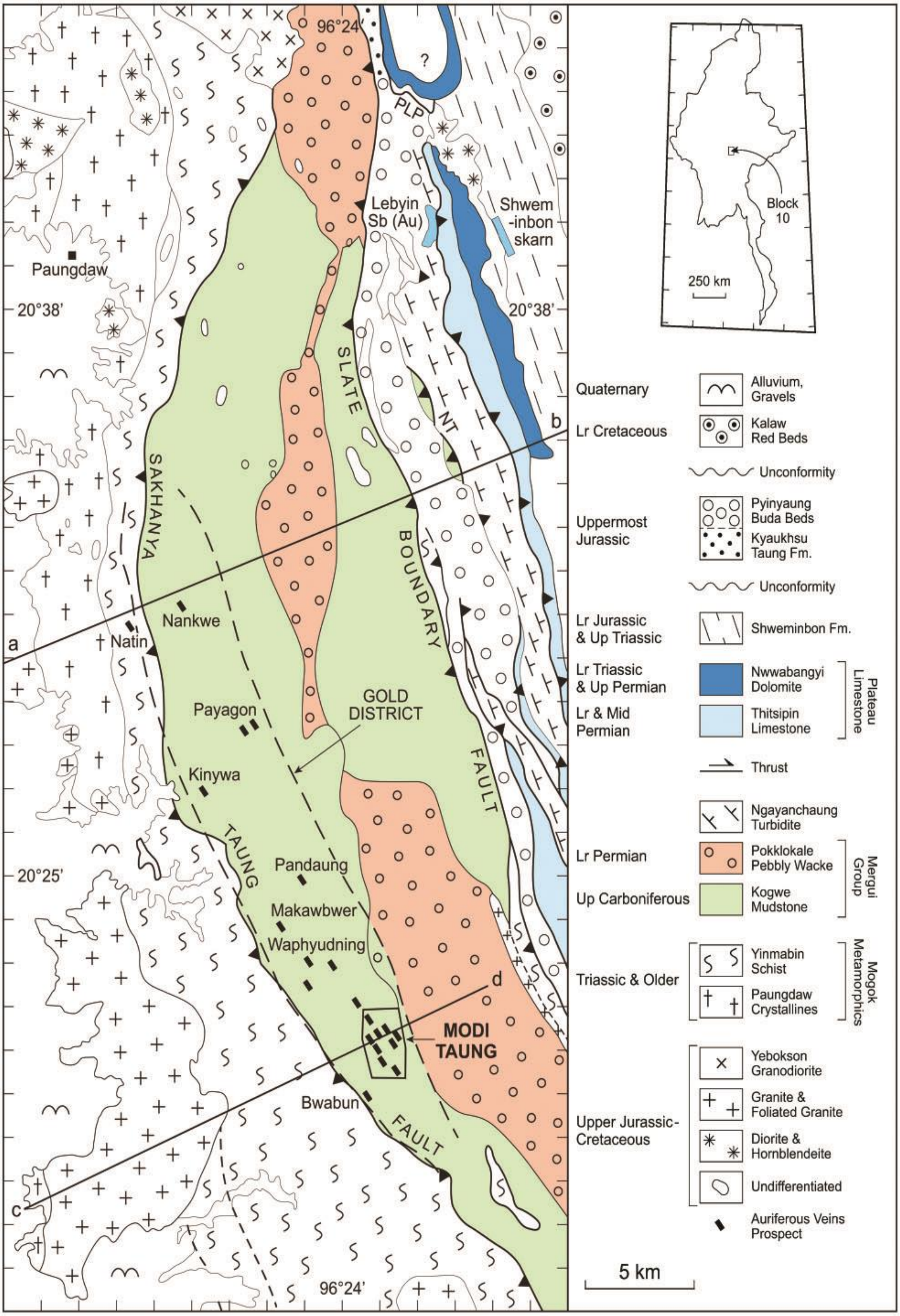

Figure 1 Geological map of the study area, (Mitchell, 2004).

4. Materials and Methods

First of all, detailed topographic surveying is established with line cutting. The base line for geophysical survey is preferred a true-west cutting 600 m long, tied in to the legal corner post of study block. The starting coordinate of the base line point is taken by GPS, Myanmar Datum 2000. There are twelve traverse lines cutting by extensive grid from the base line to the true-north and each line is 650 m elongated and 50 m interval. Detailed surveying was accomplished with the using of Ushikata Surveying Compass (LS-25, Japan). All stations were mounted on Zero-Back setting and then easily measured with tape to true north or true west.

Geophysical surveying was agreed with using of G-864 SX Cesium Backpack Magnetometer over the site covering in official lease area. The GPS system is automatically fixed with magnetic reading to measure along the arrays lines which were in turn used to generate the anomaly maps for the measured area with the aid of mapping software, Surfer and Geosoft. The arrays lines were oriented in an N-S direction, forming a rectangular area. A series of magnetic readings were transferred to a laptop computer and the data were corrected using trend analysis to remove all contributions to the observed magnetic field caused by sub-surface magnetic sources. The residual anomaly magnetic data were planned against distance to obtain magnetic field plots as well as against the Longitude and Latitude to obtain the 2D contour map and 3D surface distribution map of the whole survey area. Half-width method was used to estimate the depth of the significant anomaly zone forming in magnetic profiles. The findings showed that the assigned area had the magnetic susceptibility occurrences, which would be of economic importance, if exploited. In geophysics, the anomalous magnetization might be associated with local mineralization that is potentially of commercial interest. Hence, a magnetic surveying was carried out in study area.

Figure 2. Surveying Compass (Ushikata, LS-25, Japan).

Figure 3. Germin (64s).

Figure 4 Magnetometer *G-864 SX* (left) and magnetic surveying in the field (right).

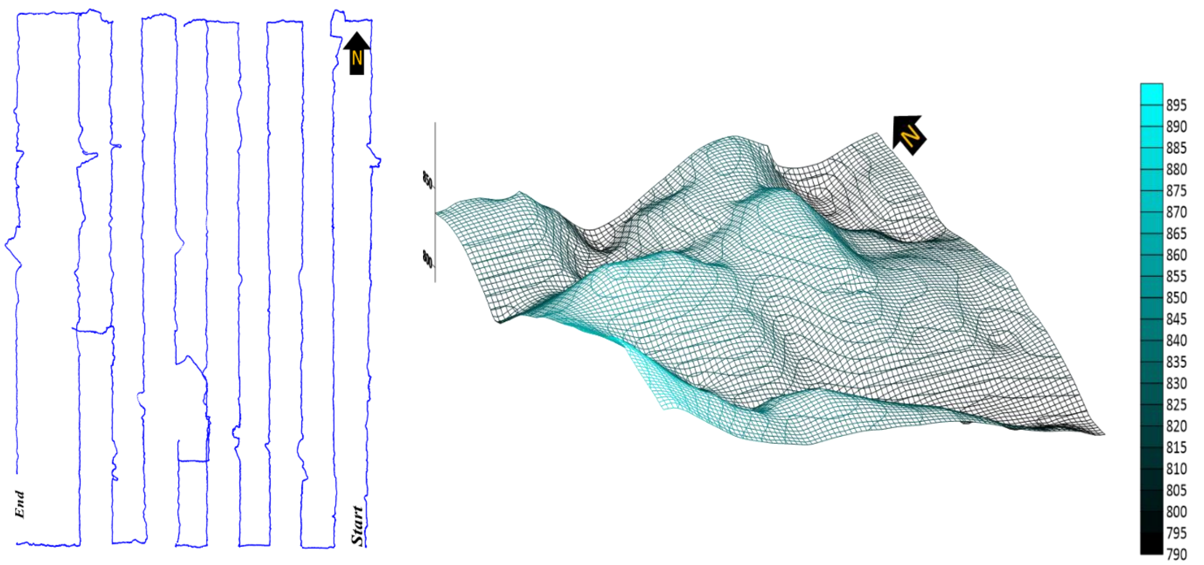

Figure 5. Magnetometer arrays (left) and 3D contour map of study area (right).

5. Results and Discussions

Geophysical traverse lines were run across the area of both known geological unit Mergui Belt (MB) and Mogok Metamorphic Belt (MMB). In the study area, wide range of magnetic intensity had a notably magnetic response between the range of 26215 nT to 46808 nT (Nanotesla). The total magnetic intensity values at a series of magnetic readings were processed to obtain the relative corrected intensity with the aid of Surfer and Geosoft. The world background magnetic value of the central Myanmar is about 45000 (nT) which satisfied for the value of lease area. By magnetic readings, the average background magnetic value in this region is evaluated in 45341.03 nT. By examining the different maps based on corrected data such as total magnetic intensity map (TMI), residual intensity map (RMI) and reduced to pole map (RTP). There is a typical low magnetic anomaly zones are formed as the continuous alignment feature from northwest to southeast direction approximately about 315º in azimuth. The length of alignment is at least 800 m in total magnetic intensity map (TMI). But, the extent of alignment is changed in RMI and RTP, the direction of alignment is not oriented. These anomalies zones can be interpreted as geological significant zone, presumably mineralized zones, structural weakness, alteration zone and somethings of these.

The magnetic anomalies are always shown in the irregular profiles. Anomalies occurring over the profiles with varying intensity and dimensions have been analyzed from the contour maps and profiles across the anomalous zones. It is an indication of the nature of the basement and the extent of inhomogeneity of the subsurface, which could be as a result of basement structural feature.

In this detected area, the pacing along six profiles on TMI map were acquired by four east-west lines and two NW-SE diagonal lines. Magnetic profiles are envisioned for a purpose of depth representing the anomalous zones. The depth of anomalous zone can also be evaluated in each profiling by consuming half-width method. According to this way all profiles were evaluated measuring data at the target zone.

The target zones are characterized by low intensity and all profiles are labelled in L1, L2, L3, L4, L5 and L6. However, the profile L1 cannot evaluated the depth estimation but the other profiles are produced in depth valuation. The example evaluation of depth estimation profile-L3 is found in Figure (7) and the value of depth estimation and their locations are tabulated as follow.

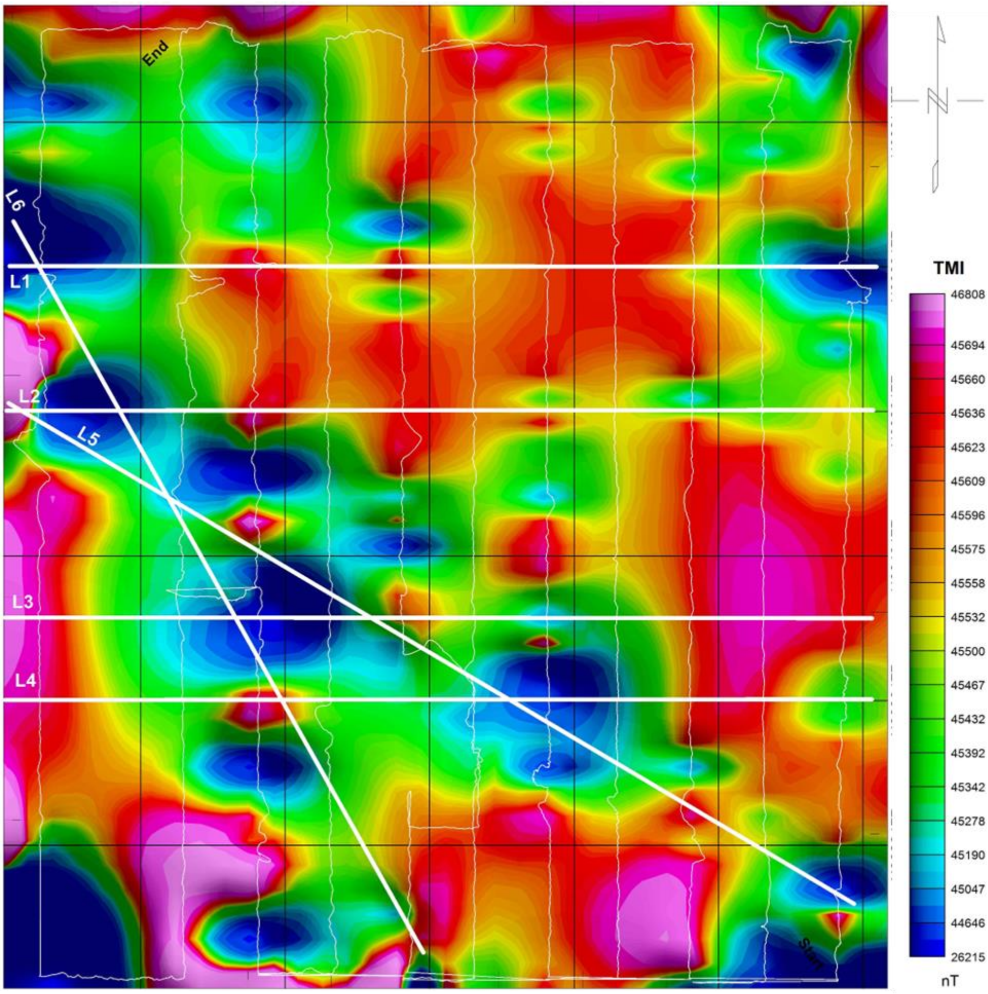

Figure 6. Total Magnetic Intensity (TMI) and profile lines of study area.

Table 1. Half-width method calculation results of all profiles

Profile	Geometry Value	
	Width	Depth
L1	---	---
L2	95 m	45 m
L3	95 m	35 m
L4	102 m	36 m
L5	65 m	30 m
	45 m	25 m
L6	30 m	20 m
	35 m	20 m
Average	**66.7**	**30 m**

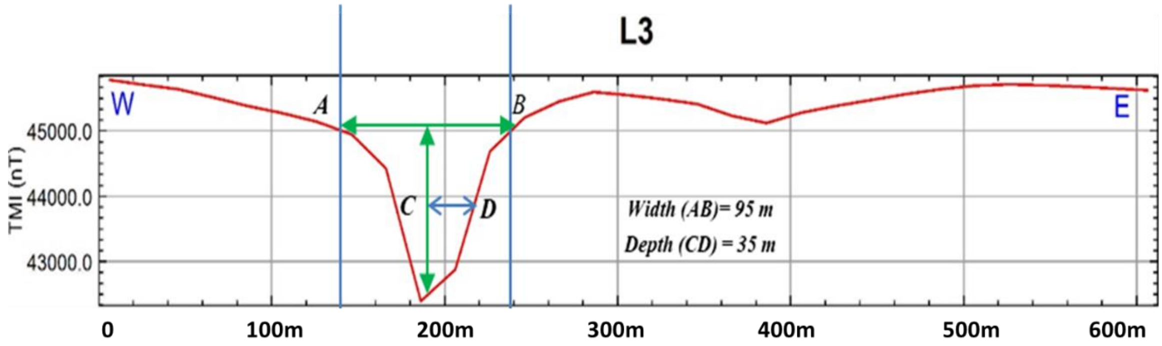

Figure 7. Magnetic anomaly profile of L3 and depth evaluation by half-width method.

6. Conclusions and Recommendations

The geophysical prospecting of investigated area is a wide variety of magnetic field area. In the study area, the western and the southern portion are strongly low magnetic intensity responded as an alignment. It can be assumed that to each low intensity along the alignment is quite adequate to mark the zone favorable for mineralization traps because the alignment is greatly shown in relation of known mineralized quartz veins on the surface geological map, figure (2). Otherwise, these are probably caused by veins or faults, and each of depth intensities were evaluated to identify particularly that can see relatively thick in average about 30 m, so that any anomaly could indicate the presence of a potentially-important vein. Drilling is recommended to determine the cause of each such low anomaly zone after fault evidences have been detail seeking. It should be intended for first priority target in following phase.

In addition, structural weakness as fracture zone or altered zone are reflected with a low magnetic anomaly in the eastern part of the area that occurred like to a trend between the two strong anomaly area. It is presumably that the trend will undoubtedly correspond to the basement geology in the area because the eastern part of the area is involved in slate belt (MB). It is possible that the occurrence alignment may be a structural weakness such as fault or mineralized zone within the same unit and alignment existing between the two strong anomaly area.

Furthermore, four continuous magnetic low zones were formed as a trend with nearly north-south direction. It is parallel to the thrust fault so that it may be structural weakness such as fault related shear zone or a parallel fault wherein mineralization may be trapped and then potentially of commercial interest.

As a suggestion, the information regards low magnetic intensity zones was only interpreted as possible causes and probability of low magnetization. No one, geologists or geophysicists cannot say exactly whether gold is associated or not. In order to explore successes mining program, additional geophysical method, detail surface geological test data such as geochemical data, structural geometry and localized lithological distribution will be integrated.

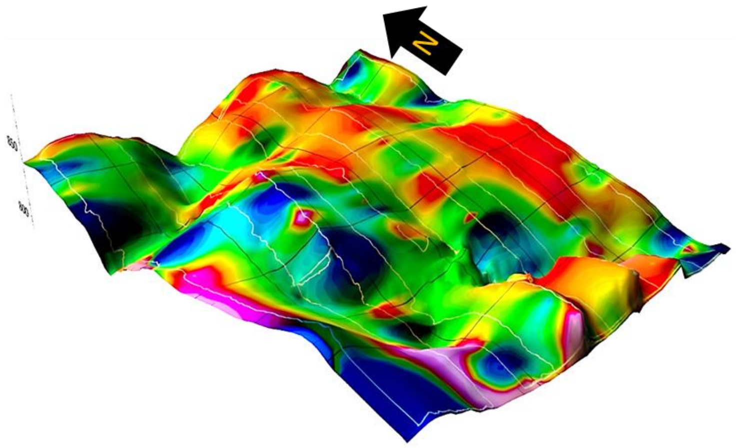

Figure 8. 3D view of Total Magnetic Intensity (TMI) map.

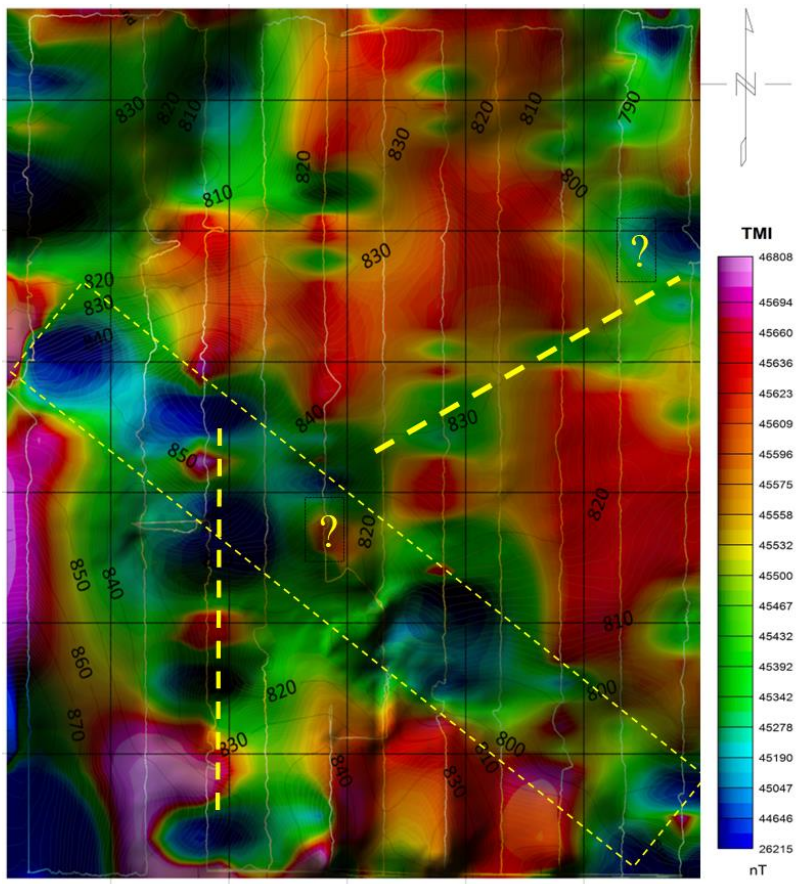

Figure 9. Idealized sketch map for study area.

7. Acknowledgement

The author wants to thank Dr. Thet Tin Nyunt, Director General of Department of Geological Survey and Mineral Exploration, Ministry of Natural Resources and Environmental Conservation and each contributor in the team of field operation for their help and invaluable advices to become with more insightful discussion on this study.

8 References

Ali, A., Rehman, K., Tayyab, O., Zaman, T., Jameel, M., Khan, A., Ahmad, R., Irfan, M., (2020). Exploring Placer Gold Deposits through Integrated Geophysical and Geochemical Techniques at the Confluence of the Indus and Kabul Rivers, NW Pakistan. Acta Geologica Sinica (English Edition), 2020, 94(5): 1440–1450

Breiner, S., (1999). Applications manual for portable Magnetometer. Copyright by Geometrics, U.S.A.

Groves, D.I., Goldfarb, R.J., Gebre-Mariam, M., Hagemann, S.G., Robert, F., (1998). Orogenic gold deposits--a proposed classification in the context of their crustal distribution and relationship to other gold deposit types. Ore Geol. Rev., 13 (1998), pp. 7-27

Hlaing, M. K., Yonezu1, K., Zaw, K., Myint, A. Z., Aye M. T., Watanabe K., (2021). Original and characteristic of the Shwetagun deposit, Moditaung-Nankwe gold district and the Kunzeik and Zibyaung deposits, Kyaikhto gold deposit and Mergui belt, Myanmar: Implications for fluid source and orogenic gold mineralization. Frontiers in Earth Science, www. Frontiersin.org.Vol-9, Article 772083

Mitchell, A. H. G., Ausa, C. A., Deiparine, L., Hlaing, T., Htay, N., and Khine, A. (2004). The Modi Taung-Nankwe Gold District, Slate Belt, central Myanmar: Mesothermal Veins in a Mesozoic Orogen.

Myo, N., (2012). Geology and Gold Mineralization of the Yamethin Area, Yamethin Township, Mandalay Region. Dagon University Research Journal 2012, Vol. 4.

Ozegin, K. O., Alile, O. M., (2021). Exploit of Ground Magnetic Survey Data for Solid Mineral Exploration. International Journal of Earth Sciences Knowledge and Applications (2021) 3 (3) 208-216

R.J. Goldfarb, C.J.R. Hart, G. Davis, D.I. Groves., (2007). East Asian gold deciphering the anomaly of Phanerozoic gold in Precambrian cratons. Econ. Geol., 102 (2007), pp. 341-346