ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2521-0890 (Print)
ISSN: 2521-0491 (Online)
CODEN: GBEEB6

Geological Behavior (GBR)

DOI: http://doi.org/10.26480/gbr.01.2023.22.29

CrossMark

RESEARCH ARTICLE

PETROGRAPHY AND THERMODYNAMIC REACTIONS OF SOME OF THE ROCKS IN THE BANKET SERIES OF THE TARKWAIAN SUPERGROUP

Matthew Coffie Wilson, Lydia Nnipaa Osei Opuni

Kwame Nkruma University of Science and Technology, Department of Geological Engineering, University Post Office, Kumasi-Ghana.
****Corresponding Author Email: regimatt2003@yahoo.co.uk; mcwilson.coe@knust.edu.gh***

ARTICLE DETAILS

Article History:

Received 24 November 2022
Revised 27 December 2022
Accepted 30 January 2023
Available online 03 February 2023

ABSTRACT

The Banket Series, which is a paleoplacer deposit, is the third formation in the stratigraphy of Tarkwaian Supergroup. This project seeks to study petrographically; the lithologies in the banket series to confirm the rocks identity as already known or state otherwise. Two different photomicrographs of each of the rock samples, coupled by their petrographic descriptions were obtained from the laboratory. The main areas of our arguments were based in Bowen's reaction series, metamorphic facies of the rocks, the earth structure and thermodynamic phase diagrams. The sampled rocks can be confirmed with the help of thin sections and mineral facies to be conglomerate, dolerite and quartzite. The minerals in the banket series range in temperature between 200°C and 800°C. The abundance of silica (SiO_2) in the rocks conglomerate, dolerite and quartzite are of crustal origin, whereas pyroxene and olivine originate from the upper mantle. The common stable minerals in the studied rocks, namely, amphibole, chlorite and plagioclase are less likely to change compared to the other minerals in the rocks. The three (3) different metamorphic facies of the rocks conglomerate, dolerite and quartzite are respectively greenschist, epidote-amphibolite and amphibolite facies.

KEYWORDS

Stratigraphy, metamorphic facies, mineral stability, meta-volcanics, ternary plot, phase diagram

1. INTRODUCTION

A branch of geology that deals with the description and systematic classification of rocks, especially by means of microscopic examination is termed petrography (McGraw-Hill, 2003). Various methods have been established to classify lithology based on the rock type. This classification is based on their genesis, their elemental composition, textural features as well as location in which they are found. Lithology also involves the description of its physical characteristics visible at outcrop, in hand lens or in core samples or with low magnification microscopy (petrography). The lithological characteristics are accessed by study of the mineralogical composition of the various rock units, the degree of weathering, structural discontinuities, the degree of alteration (metamorphism). This provides the basis on which a correlation can be made between the various lithologies in the pit (American Heritage Dictionary, 2005).

The Banket series is the third formation in the stratigraphy of the Tarkwaian moving downwards, after which we have the Kawere conglomerate at the bottom. The predominant rocks in the Banket Series stratigraphic unit in the Tarkwaian Supergroup are conglomerate, quartzite and dolerite (Table 1). This project seeks to characterize these rocks once again to confirm their names or state otherwise. Metamorphism has also occurred in the area over the years which have altered some of the minerals initially deposited within the formation. The project also seeks to understand very well the stability of the minerals in the rocks considering temperature and pressure. The main objective is to study petrographically, the lithologies in the Banket Series stratigraphic unit in the Tarkwaian Supergroup (Table 1). The specific objectives to arrive at the main aim are to: macroscopically study the composition of the minerals in the various rocks in the stratigraphic unit; analyze the thin section microscopically to determine the mineralogical composition of the various rocks; determine the stability of minerals in the rocks; determine the source of the minerals identified in the rocks. The name of a rock is very significant in gold extraction right from the mineral exploration through mining stage to the extraction stage. The study will help geologists to identify the minerals in the study area and the temperature and pressure required for the various minerals to be stable unto mining.

2. GEOLOGIC SETTING

2.1 Regional Geology

The Tarkwaian sediments are believed to be approximately 2.1 billion years old sediment consisting of deformed rudaceous, arenaceous and argillaceous rocks of the Tarkwaian Series. The Tarkwaian is underlain by the Birimian volcano sedimentary lithologies and associated granitoids. The Tarkwaian unconformably overlies the Birimian and is characterised by lower intensity metamorphism and the predominance of coarse grained, immature sedimentary units which is from oldest to youngest (Kesse, 1985). Tarkwaian is a syncline that rests on a folded and metamorphosed rock sequence of early Proterozoic age called the Birimian, which play host to the famous Obuasi gold deposits near Kumasi. This sequence consists of NNE-SSW trending alternations of meta-sediments and meta-volcanics called "basins" and "belts" respectively. The volcanic belts are typically up to 40 km wide and 90 km apart, and dominated by volcanic rocks (Kaperta, 2001).

Rocks of the Tarkwaian Group are concentrated mainly at the south-western part of Ghana in the Tarkwa area where they outcrop in a NE-SW trending belt. The belt stretches from near Axim to the edge of the Voltaian

Quick Response Code	Access this article online	
	Website: www.geologicalbehavior.com	**DOI:** 10.26480/gbr.01.2023.22.29

Cite The Article: Matthew Coffie Wilson, Lydia Nnipaa Osei Opuni (2023). Petrography And Thermodynamic Reactions of Some of the Rocks in The Banket Series of the Tarkwaian Supergroup, *Geological Behaviour 7(1): 22-29.*

basin near Agogo, a distance of about 250km. It has a width of about 16 km. Elsewhere in Ghana, the Tarkwaian occupies a portion of the Bui Syncline parallel to the Cote d'Ivoire border at 8°N latitude. This other belt running from near Bepoasi in Bono Region to Banda-Nkwanta in the Northern Region is about 140 km and of average width of 0.8 km. The Tarkwaian Supergroup is considered to be of shallow water continental origin derived from the Birimian and associated granites. It is believed that the rocks were deposited in elongated intra-cratonic basins bordered by granite-greenstone belts of the Birimian Supergroup. The sediments were deposited in high-energy alluvial fans entering a steep-sided basin filled with fresh water. They consist of coarse-grained, poorly sorted, immature sediments with low roundness, typical of a braided stream environment. The Tarkwaian is thought to rest unconformably on the Birimian, though in some places, the metasedimentary Birimian and the Tarkwaian are inter-folded due to post Tarkwaian orogenic activity. In some localities no angular unconformity can be observed between the Birimian and the Tarkwaian (Kesse, 1985).

2.2 Local Geology

The Tarkwaian Supergroup consists of four series of formations and these include Kawere conglomerate at the bottom, overlain by the Banket Series, the Tarkwa phylite and finally the Huni sandstone from bottom to top as vividly explained in Table 1 (Kesse, 1985). The local geology is dominated by the Banket Series which can be further sub-divided into a footwall and hanging wall barren quartzite separated by a sequence of mineralized conglomerates and pebbly quartzites (Strogen, 1991). The main lithology types according to the mine in the pit are conglomerate, quartzite and dolerite. The stratigraphy of the individual quartzite units is well established with auriferous reefs interbedded with barren immature quartzites. The units thicken to the west and current flow parameters indicate a flow from the east and north-east. Presently, the Tarkwa operation exploits narrow auriferous conglomerates, similar to those mined in the Witwatersrand Basin of South Africa, de Serra Jacobbina (Brazil) and Blind River of Canada (Kaperta, 2001).

Table 1: Stratigraphy of Tarkwaian Supergroup in Ashanti Belt (Kesse, 1985)

Supergroup	Series	Thickness (m)	Lithology
Tarkwaian	Huni Sandstone	1,370	Quartzite, minor phyllite
	Tarkwaian Phyllite	120 – 400	Chloritic and sericitic phyllite and schist
	Banket	120 – 160	Quartzite, grits and conglomerates
	Kawere	250 – 700	Quartzite, grits and conglomerates
Major Unconformity			
Birimian	Birimian		Meta-volcanics, volcaniclastics and sediments

3. Materials and Methodology

3.1 Samples Description

This is visual observation and recording of the physical properties of the samples with the aid of the hand lens. The hand lens provides a magnification of ×10 which makes it easier for the identification of the various minerals in the rocks (Mervin, 2015). The physical properties observed include texture, colour, mineralogy and presumed genesis of the rocks.

3.2 Thin Section Preparation

A petrographic thin section is a 30 micrometers thick slice of rock mounted on a glass microscope slide and either covered with a cover glass or left uncovered but polished.

3.2.1 Procedure

First, the sample has to be dried out in a vacuum chamber. While it is drying, it gets entered into the logbook. The sample then goes into a plastic tray. Epoxy from the dispenser is added to the samples in their trays. The samples soak in epoxy and dry on hot plate overnight. The epoxy soaks in and keeps the samples from crumbling. Hand grinding takes skill and practice to acquire the smooth surface as possible. After grinding, quick drying with pressurized air is done. Now, thorough cleaning with alcohol to remove any oils is also done. The samples are placed back to the hot plates for another overnight stay. The samples are stuck to an etched slide using the same epoxy it was soaked in. the Hillquist thin section machine cutting equipment-slabs saw and successive abrasive papers from 60 to 1200 grit sizes were used to achieve a perfectly smooth and flat surface section of approximately 30 microns in thickness. A cover glass is then mounted with the help of a Canada balsam before placing it under the petrographic microscope.

3.3. Petrographic Microscope

A petrographic or polarizing microscope is equipment used for viewing and analyzing thin sections of rocks in details. The microscope operates using some basic optical properties such as birefringence, interference colours, refractive index of minerals, etc.

Figure 1: Petrographic microscope used to analyze the minerals present in the rocks.

4. Results and Discussion

4.1 Macroscopic Description

Table 2: Hand Specimen Description (Macroscopic Description of The Rock Types in The Banket Series in The Tarkwaian Supergroup)

Label	Sample picture	Description
Sample A		Texture: coarse quartz grains embedded in fine matrix composed dominantly by quartz. Quartz pebbles are rounded, poorly sorted grains. Mineralogy: quartz. Colour: grey green and brown History: transportation of clasts from a distance deposited and cemented together.
Sample B		Texture: medium grain minerals interlocking and are uniformly of the same sizes. Mineralogy: olivine, quartz, pyroxene, plagioclase feldspars. Colour: green and dark History: formed closed to earth surface (subvolcanic) by moderate cooling of magma.
Sample C		Texture: medium grains, uniformly distributed particles and are foliated. Mineralogy: quartz, plagioclase feldspar, pyroxene. Colour: grey and dark. History: formed by metamorphism of sandstone due to high temperature and pressure.

4.2 Microscopic Description of the Rock Samples

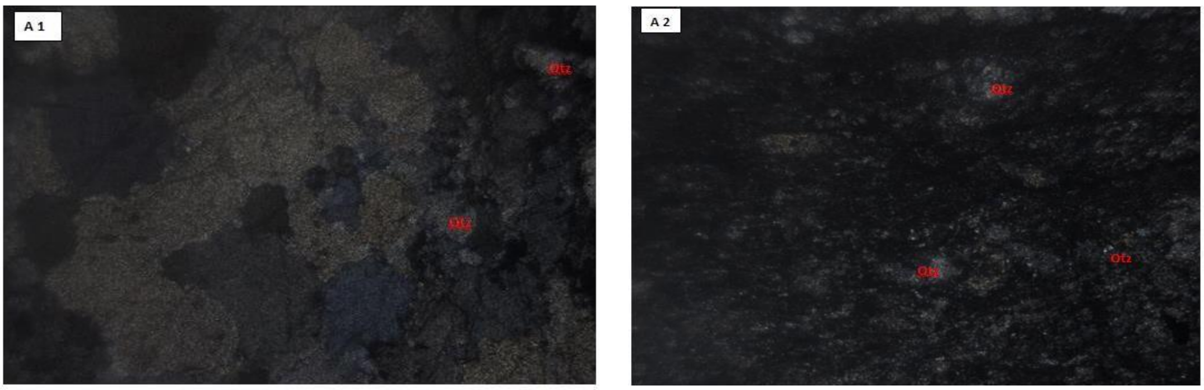

Figure 2: Photomicrographs of rock samples A1 and A2 showing minerals of pebbles and medium-grained quartz, chlorite, sericite, and ore mineral in the banket series

SAMPLE A

Very coarse grained with glassy quartz pebbles, coarse grained grey glassy quartz with medium grained pebble, moderately sorted, surrounded grains occurring in the matrix.

A 1

Sugary quartz pebble showing medium re-crystallized texture and deformation. The re-crystallized pebble is a sheared pebble and shows weak shear. 250µm=2cm, cross nicols.

A 2

Sheared matrix showing elongated medium grained quartz pebbles marked by chlorite. The quartz pebbles are recrystallized and show undulose extinction. Conglomerates showing late ore minerals overprint chlorite and quartz. 250µm=2cm, cross nicols.

Table 3: Modal Analysis of Sample A	
Minerals	**Modal %**
Quartz	
Pebbles	32
Medium quartz	40
Matrix	
Chlorite	20
Sericite	5
Ore minerals	3

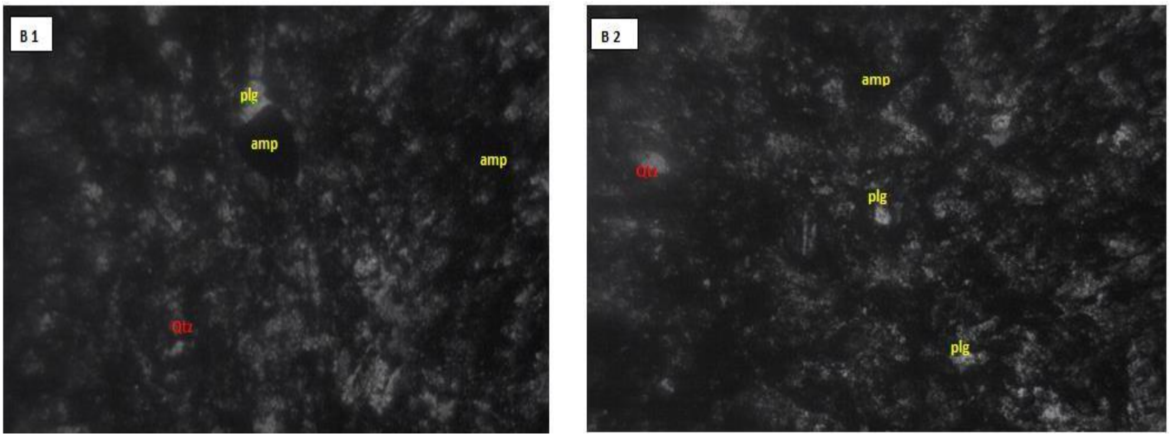

Figure 3: Photomicrographs of rock samples B1 and B2 showing minerals of granular quartz grains and plagioclase, amphibole, chlorite, sericite, epidote and ore minerals in the Banket Series

SAMPLE B

The rock is dark green, fine to medium-grained and shows granular quartz and plagioclase and irregular alignment of amphiboles and plagioclase.

B1

Irregular alignment of plagioclase and amphiboles with the amphiboles showing inclusions of plagioclase and destroys margin plagioclase. 250 µm = 2 cm, cross nicols.

B2

Carlsbad-albite twinning in plagioclase.

×5 cross nicols

Table 4: Modal Analysis of Sample B	
Mineralogy	**Modal %**
Plagioclase	30
Amphiboles	45
Quartz	5
Chlorite	10
Sericite	5
Epidote	3
Ore mineral	2

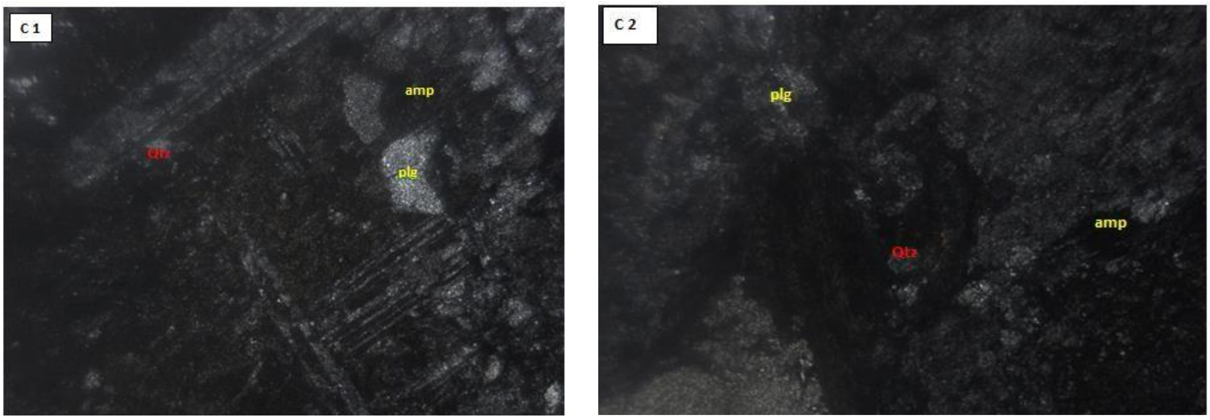

Figure 4: Photomicrographs of rock samples C1 and C2 showing minerals of quartz, plagioclase feldspar, alkali feldspar, chlorite and amphibole in the banket series

Table 5: Modal Analysis of Sample C	
Mineralogy	**Modal %**
Quartz	60
Plagioclase	10
Alkali Feldspar	10
Amphibole	15
Chlorite	5

Sample C

Green, medium-grained, sub-rounded and moderately sorted with irregular alignment of minerals in the rock. Amphiboles are corroded by plagioclase and quartz which is recrystallized. Plagioclase, quartz and amphiboles occur as inclusions in alkali feldspar which shows polysynthetic twinning.

C 1

Alkali feldspar showing polysynthetic twinning and inclusions of plagioclase, amphiboles and quartz. Amphibole corrodes by partially altered plagioclase and quartz. 250μm=2cm

C 2

In the rock, twisted amphiboles are truncated by subhedral amphibole. 250 μm = 2 cm, cross nicols.

4.3 Discussion of Results

4.3.1 Sample A (Conglomerate)

Sample A consists of very coarse-grained glassy quartz, moderately sorted and sub-rounded pebbles and occur in a matrix. The modal results also show quartz pebbles and medium grained quartz matrix as described from the thin section photomicrographs, with minimum amount of chlorite and sericite which have been overprinted by the ore mineral. This description makes it fit to be a conglomerate.

4.3.2 Sample B (Dolerite)

The rock is dark green with medium grained texture. It contains granular quartz grains and plagioclase and shows irregular alignment of amphiboles and plagioclase. It contains minerals such as plagioclase, amphibole, quartz, chlorite, sericite, epidote and ore minerals. The epidote, sericite and ore mineral occur in minute quantities. The presence of chlorite, quartz and epidote which are of greenschist facies with green rocks because of the presence of chlorite. The green colour of sample B, coupled with its mineralogical composition and textural description confirm the rock to be dolerite.

4.3.3 Sample C (Quartzite)

Contains minerals such as quartz, plagioclase, alkali feldspar, amphiboles and chlorite. The rock is grey in colour and portrays medium-grained, sub-rounded and moderately sorted textures with irregularly aligned minerals. The recrystallization of quartz in the rock as observed from the thin section analysis with inclusions of plagioclase, quartz, amphibole and alkali feldspar which also shows polysynthetic twinning all confirm that the rock is a quartzite (metamorphic rock). The principle of crystallization and stability of minerals as discussed in the Bowen reaction series can similarly be used to explain the stability of minerals in the rock types C, B and A. For rock sample C, the most stable mineral that can be mentioned is quartz, followed by alkaline feldspar, the amphiboles and then the calcium-rich plagioclase.

For rock sample B, the most stable is quartz (framework silicate), followed by sericite and chlorite (phyllosilicate), epidote (sorosilicate), amphibole (inosilicate) and finally calcium-rich plagioclase in accordance with the Bowen reaction series. For rock sample A, the stable mineral is quartz with sericite and chlorite (phyllosilicate) being the next stable minerals. Both rock samples C and B have amphiboles occurring in them. With increasing temperature and pressure over a period of time, the amphiboles will become unstable at such conditions and new minerals of pyroxene and subsequently olivine will be formed. Similarly, in rock sample A which is a mixture of fine-grained quartz matrix and clasts of quartz pebbles; chlorite (a sheet silicate) and sericite (a sheet silicate) both occur on the discontinuous arm of the series. Quartz, pyroxene and subsequently olivine will thus be formed around that temperature where pyroxene and olivine will be formed in rock samples B and C.

4.4 Metamorphic Facies

An assemblage of minerals in rocks at a certain temperature and pressure define facies for rocks under such temperature and pressure conditions. Different rock facies are recognized in these rocks and three of such facies are relevant in this study as far as the rocks and their constituent mineralogy are concerned. These facies are the greenschist, epidote – amphibolite and amphibolite rock facies (Table 6). The table below shows the three facies and their associated minerals.

Table 6: Facies and Their Mineral Assemblages of Rock Samples A, B And C (After Spear, 1995)

Facies	Mineral Assemblages
Greenschist	Chlorite + albite + epidote(or zoisite+quartz +actinolite)
Amphibolite	hornblende + plagioclase(Oligoclse-andesine) +/- garnet
Epidote-Amphibolite	hornblende + (Oligoclase-andesine) + epidote +/- garnet

4.4.1 Sample A (Conglomerate)

Minerals present in the conglomerate are quartz, chlorite, sericite and ore minerals. Chlorite + quartz present are of Greenschist facies. Similar conditions of temperature and pressure formed the chlorite and quartz assemblages.

4.4.2 Sample B (Dolerite)

The minerals present in the dolerite are plagioclase, quartz, chlorite, sericite, epidote and ore minerals. The amphiboles (hornblende) + plagioclase + epidote present in the dolerite are of epidote-amphibolite facies with reference to the Table 6 above. The different minerals present in the epidote-amphibolite facie are formed at conditions of similar temperature and pressure. Chlorite + epidote + quartz also present in the dolerite are of Greenschist facies and the different minerals present are also formed at similar temperature and pressure conditions. Therefore, the dolerite consists of two different metamorphic facies; the Greenschist and Epidote-amphibolite facies.

4.4.3 Sample C (Quartzite)

Minerals present in the quartzite are quartz, plagioclase, alkali-feldspar, amphiboles and chlorite. The amphibole (hornblende) + plagioclase is of amphibolite facies and are formed at similar conditions of temperature and pressure. Chlorite + quartz present are greenschist facies. The chlorite and the quartz present are formed at similar temperature and pressure conditions.

4.4.4 Ternary Plot and Phase Diagrams for Rock Samples

Conglomerate

Chlorite

$Mg_{10}Al_4Si_6O_{20}(OH)_{16} = 10MgO + 2Al_2O_3 + 6SiO_2 + 8H_2O$

$X_{MgO} = 10/12 = 0.8$ and $X_{Al2O3} = 2/12 = 0.2$

Sericite

$2KAl_2(AlSi_3O_{10})(OH)_2 = K_2O + 3Al_2O_3 + 6SiO_2 + 2H_2O$

$X_{K2O} = 1/4 = 0.3$ and $X_{Al2O3} = 3/4 = 0.7$

Taking H_2O and SiO_2 as surplus, the ternary plot for conglomerate is shown above.

$Mg_{10}Al_4Si_6O_{20}(OH)_{16} = 10MgO + 2Al_2O_3 + 6SiO_2 + 8H_2O$

$X_{MgO} = 10/12 = 0.8$ and $X_{Al2O3} = 2/12 = 0.2$

Epidote

$2Ca_2Al_3Si_3O_{12}OH = 4CaO + 3Al_2O_3 + 6SiO_2 + H_2O$

$X_{CaO} = 4/7 = 0.6$ and $X_{Al2O3} = 3/7 = 0.4$

Sericite

$2KAl_2(AlSi_3O_{10})(OH)_2 = K_2O + 3Al_2O_3 + 6SiO_2 + 2H_2O$

$X_{K2O} = 1/4 = 0.3$ and $X_{Al2O3} = 3/4 = 0.7$

Taking H_2O and SiO_2 as surplus, the ternary plot for dolerite is shown below in Figure 6

[Ser]: Chl + Pl + Epi = Amp

[Plg]: Ser + Chl + Epi = Amp

[Epi]: Ser + Chl + Plg = Amp

[Amp]: Chl + Plg = Epi + Ser [Chl]: Amp + Epi = Ser + Plg

Quartzite

Plagioclase (Anorthite)

$CaAl_2Si_2O_8 = CaO + Al_2O_3 + 2SiO_2$

$X_{CaO} = 0.5$ and $X_{Al2O3} = 0.5$

Amphibole

$Ca_2Mg_3Al_2Al_2Si_6O_{22}(OH)_2 = 2CaO + 3MgO + 2Al_2O_3 + H_2O + 6SiO_2$

$X_{CaO} = 2/7 = 0.3$, $X_{MgO} = 3/7 = 0.4$ and $X_{Al2O3} = 2/7 = 0.3$.

Chlorite

$MgAl_4Si_6O_{20}(OH)_{16} = 10MgO + 2Al_2O_3 + 6SiO_2 + 8H_2O$.

$X_{MgO} = 10/12 = 0.8$ and $X_{Al2O3} = 2/12 = 0.2$

Alkali – feldspar (orthoclase)

$2KAlSi_3O_8 = K_2O + Al_2O_3 + 6SiO_2$

$X_{K2O} = 0.5$ and $X_{Al2O3} = 0.5$

Taking H_2O and SiO_2 as surplus, the ternary plot for quartzite is also shown below in Figure 8.

4.4.5 Thermodynamic Reactions for Quartzite

[Chl]: Alk F + Amp = Plg

[Alk F]: Chl + Plg = Amp

[Amp]: Chl + Plg = Alk F

[Plg]: Alk F+ Amp = Chl

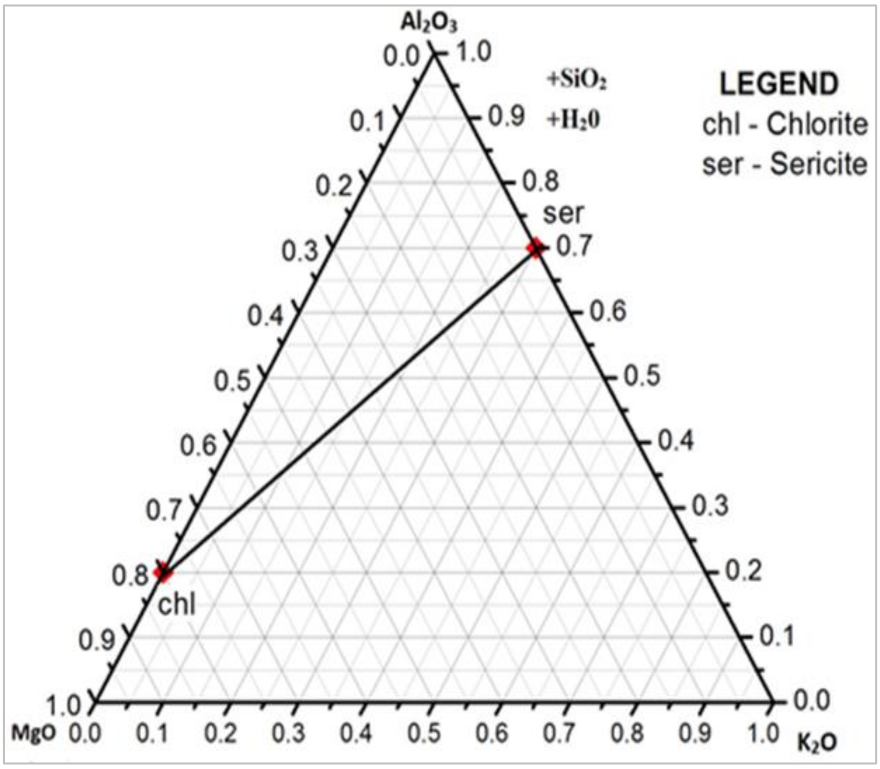

Figure 5: Ternary plot of conglomerate thermodynamic reactions

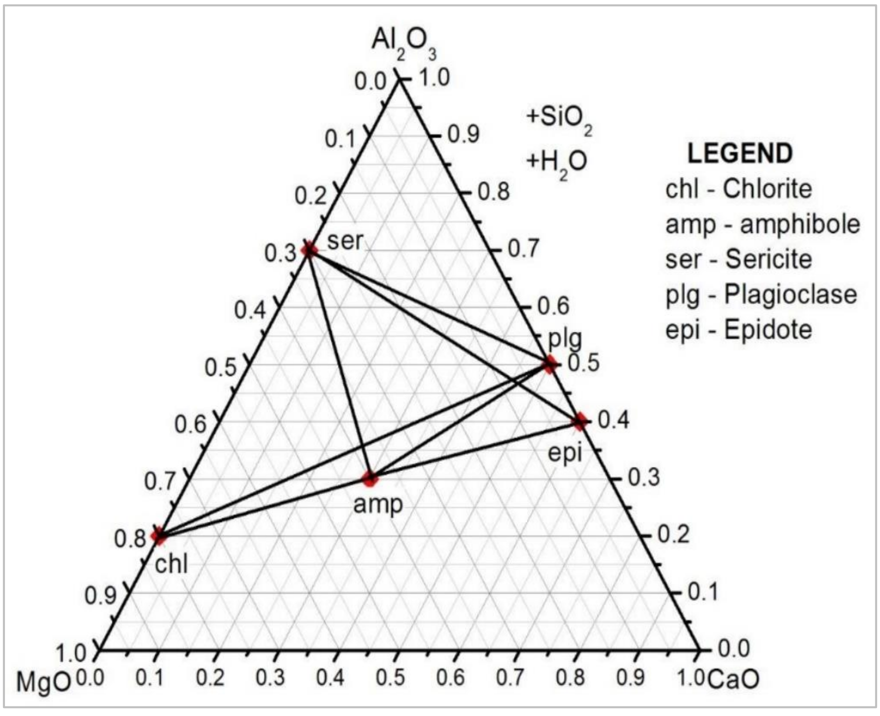

Figure 6: Ternary plot of dolerite thermodynamic reactions

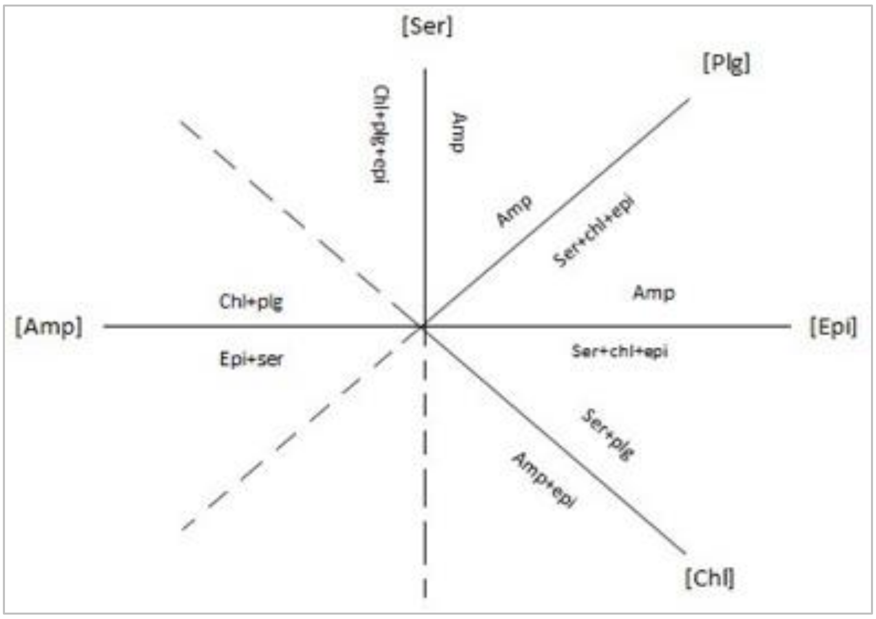

Figure 7: Phase diagram for dolerite

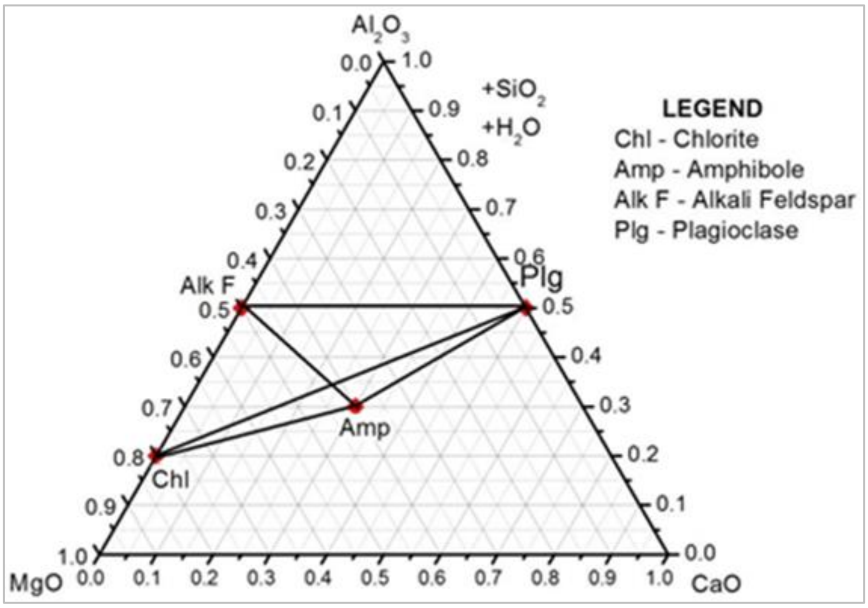

Figure 8: Ternary plot for quartzite

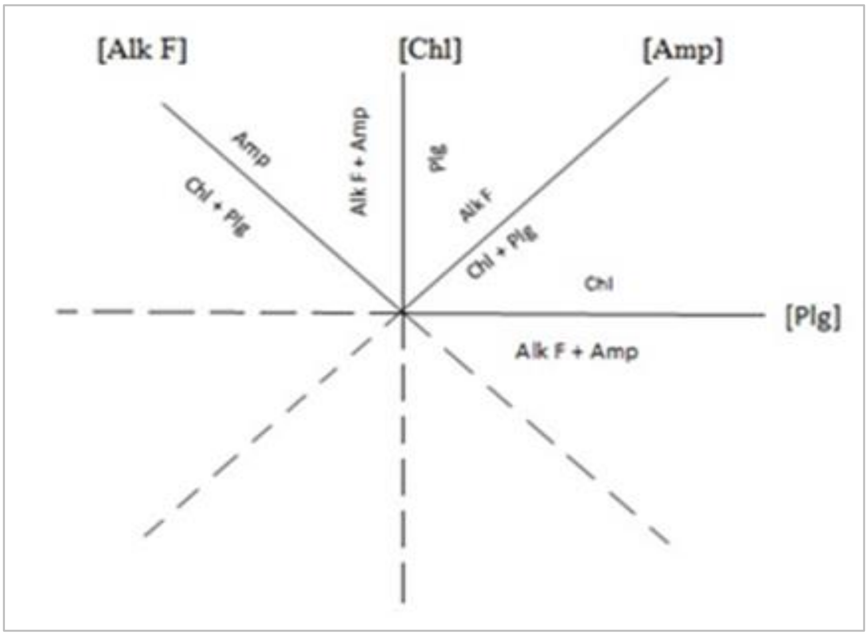

Figure 9: Phase diagram for quartzite

4.4.6 Analysis of the Thermodynamic Reaction Plots

Considering the dolerite, the facies and axis of amphibole yielded stable chlorite and plagioclase with an unstable equilibrium of epidote and sericite. Amphibole was more stable compared to the sericite, chlorite and epidote minerals. The stable minerals are at the upper arm of the particular axis. However, stability reduces when a new mineral mixes with the already existing mineral. Example, on adding epidote to the amphibole at the chlorite axis, sericite and plagioclase becomes more stable. Addition of any other mineral dilutes and thus reduces the stability and strength of the phase of the existing minerals. Moreover, considering the epidote axis, the more stable mineral is the amphibole. This occurs at the upper arm of the axis. The less stable minerals are sericite, chlorite and epidote. Combination of the chlorite and epidote to the sericite causes dilution and makes all the phases unstable having low strengths.

Similarly, considering the thermodynamic reaction diagram for quartzite, several interpretations can be made. The more stable amphibole at the alkali feldspar axis and chlorite at the plagioclase axis become unstable at the chlorite axis with addition of alkali feldspar and addition of plagioclase at the amphibole axis respectively. According to thermodynamic laws, addition of any other mineral reduces the stability of the equilibrium reaction. Moreover, considering the plagioclase axis, the more stable mineral is the chlorite. This is because; it appears on the upper arm of the axis. On the same axis, amphibole mineral is unstable due to addition of the alkaline feldspar. The reduction in stability is due to the addition of the alkaline feldspar to the amphibole. Only two minerals are plotted on ternary diagram of the conglomerate and hence no equation can be deduced from it. As a result, no further thermodynamic interpretation can be done for the conglomerate.

5. Conclusions

From combination of the hand specimen description, thin section descriptions and the respective facies of the samples can be concluded and confirmed that sample A, B, and C are conglomerate, dolerite and quartzite respectively. Moreover, the stability and occurrence of minerals in the various rocks with increasing temperature and pressure were analyzed. Minerals alter in passage of time with increase in temperature and pressure. The temperature range for the existence of the three main facies also suggest that current temperature of the deposit ranges from 200 – 800 °C. Knowledge of the behaviour of minerals in the deposit should be able to help any mine working in this stratigraphic unit to plan for the future in terms of how well they will manage temperature and pressure to increase yield.

Study of the earth structure with respect to minerals and elements occurring in the earth suggest that the minerals in the conglomerate, dolerite and quartzite are of crustal origin with probably olivine and pyroxene originating from upper mantle. This is confirmed with the abundance of SiO_2 in all the three samples. From the Phase diagram of the quartzite and dolerite, stable minerals for the quartzite from the analysis are seen to be amphibole, plagioclase, alkali-feldspar and chlorite. Also, the stable minerals occurring in the dolerite are chlorite, plagioclase, sericite and amphibole. From the two groups, amphibole, chlorite and plagioclase repeat themselves from the two different rocks making them more stable among all the other minerals in the rocks. So, with changes in temperature and pressure, we expect that these three minerals, amphibole, chlorite and plagioclase will be less likely to change compared to the other minerals in the rocks.

Recommendation

1. Mineral chemistry should be applied to determine and identify the different types of pebbles in the conglomerate and some grains in the other rocks.

2. Similar and detailed work should be carried out on the other three (3) stratigraphic units of the Tarkwaian Supergroup, namely, Huni sandstone, Tarkwa phyllite, Kawere conglomerate and make comparison of the different stratigraphic units.

3. Study to identify, analyze and compare the different mineralogical composition and characteristics of the same rock types (conglomerate, grits, quartzite) in the Kawere group of the Tarkwaian Supergroup.

Acknowledgement

I hereby acknowledge the tireless effort and effective contribution of my co-author towards the production of this article.

References

American Heritage Dictionary, 2005. American Heritage Science Dictionary. Houghton Mufflin Harcourt. pp. 364. ISBN 978-0-618-45504-1.

Mervin, E., 2015. American Geophysical Union. http://blogs.agu.org/georneys/2015/01/01/geology-word-week-h-hand-lens/. Accessed 24th April, 2022.

Spear, F.S., 1995. Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths. Bookcrafters, Inc., Chelsea, Michigan, USA.

Karpeta, W.P., 2001. The structural evolution of the Tarkwaian basin: A review of the Geology, Mining and Exploration of the Tarkwa Mine Area, Bastillion Limited.

Kesse, G.O., 1985. The Mineral and Rock Resources of Ghana. AA Balkema Publishers, Netherlands.

McGraw-Hill, 2003. Dictionary of Scientific and Technical Terms. 6th Ed. The McGraw Hill Companies, Inc.

Strogen, P., 1991. The sedimentology and structure of the Tarkwaian, Western Region and its relevance to gold exploration and development: In proceedings of International Conference of the geology with special emphasis on gold, pp. 34-45.