CHAPTER II B. - THE CENTRAL BELT

I. INTRODUCTION

The rocks of this E-W belt occupy most of the Lilani valley over a width of up to 1 mile. Eastwards of the confluence of the Lilani and Hlimbitwa rivers the belt is reduced to a width of only a few hundred yards. To the north, this belt is bordered by the red granite sheet; to the south, the writer has drawn its limit a few hundred yards south of the confluence of the Lilani and Hlimbitwa rivers, where more acid rocks extend farther down the Hlimbitwa river.

The best outcrops are to be found in the bed of the Lilani river and in the deep gulleys on each side of the valley.

GEVERS (1963) has described in detail the tectonics of this area and has shown the Lilani river to have been incised along a post-T.M.S. fault zone.

II.- DESCRIPTION

A) STRATIGRAPHY

Though the majority of these rocks are interbedded, the stratigraphic sequence is difficult to unravel : outcrops are discontinuous, often small, and their relationships are obscured by complex folding and faulting. By far the most abundant rocks are banded amphibolites, within which occur other rock types. A series of marble lenses was traced along the Lilani valley by GEVERS (1963); the writer located a few additional lenses in this zone, which he traced eastwards beyond the confluence of the Lilani and Hlimbitwa rivers.

The only rocks not interstratified are a body of serpentinite and some crosscutting veins and dykes of pegmatite and aplite.

B) STRUCTURE

Most layers in the banded amphibolites and gneisses are rather thin, down to 1 cm. In some outcrops in the Lilani valley, the writer has observed as many as 6 layers made of different rock types over a total thickness of 2 ft. The layering has an E-W strike and a vertical to subvertical dip. Though the bedding seems undisturbed in horizontal exposures, vertical sections (which are few) often show more or less symmetric small folds whose limbs are frequently drag-folded. These folds plunge 30° to the west. One of these is shown in Photo 32, Plate XVII.

Boudinage is rather common (Photo 33, Plate XVII). It affects massive rocks such as hornblende-plagioclase amphibolites interbedded with banded gneiss. The amphibolite has been elongated and broken up into individual lenses (boudins) and the zones between the boudins are often filled with pegmatitic material (Photo 33, Plate XVII). In some layers the stage of rupturing, with separation into individual lenses, has not been reached, but the layers show constrictions at intervals without loosing their continuity (pinch-and-swell structures). The banded gneiss is much more plastic than the massive amphibolite and it can be seen on Photo 33, Plate XVII, how it "moulds" the basic rock and yields plastically in the zones between the two boudins. Though it occurs in layers up to 10 ft. in thickness, tremolite schist is also affected to a certain extent by boudinage. However, it does not break up into lenses like the amphibolite, but into more or less rectangular or polygonal blocks. In one remarkable instance, the plastic gneiss interbedded with the tremolite schist has flowed like molten lava into the fracture separating two blocks of tremolite schist. (Photo 34, Plate XVIII).

Lenses of marble show remarkable features described in detail by GEVERS (1963). These rocks gained considerable plasticity during metamorphism and have often been extremely contorted. They frequently behaved like intrusive rock, breaking the country rock and injecting it so that the marginal portions of the marble layers are often crowded with inclusions from adjacent layers, from large blocks down to small grains a few millimetres in diameter (Photo 35, Plate XVIII).

Pegmatites occur in conformable or cross-cutting bodies. The conformable pegmatites present features similar to those encountered in the accretion or exsudation pegmatites in the adjacent southern metasedimentary belt. They are 'interbedded' with other layers and reach a thickness of 30 cm. Their margins are often diffuse and "mixed up" with wall rock, so that there is no clear-cut boundary. Photo 36, Plate XIX shows an initial stage of pegmatite formation. Whenever folding is present, these pegmatites are folded like the normal layers (Photo 32, Plate XVII).

Cross-cutting pegmatites are often massive dykes up to 3 or 4 feet thick. Their colour is a light pink but there are no visible traces of feldspathization in their wall-rocks ; they look rather similar to the thick pegmatites of the last stage emplaced in the southern metasedimentary belt. They cut all the other structures, including conformable pegmatites. Occasionaly, offshoots fill typical fracture patterns in the country rock (Photo 35, Plate XVIII). These pegmatites are, in turn, cut by aplitic dykes up to 1 ft. in thickness.

A lenticular body of serpentinite, elongated E-W and several hundred yards long and up to several dozen yards wide, occurs below the Matimatolo Mountains. It has been opened up by trenches in search for chrysotile fibre. Otherwise, it is not well exposed.

C) PETROGRAPHY

(a).- Amphibolites : Tremolite schist
Hornblende-plagioclase amphibolite
Hornblende-diopside amphibolite"

(b).- Gneisses : Biotite gneiss
Muscovite-biotite gneiss
Hornblende-biotite gneiss

(c).- Schists : Sillimanite-almandine schist
Quartzofeldspathic schist
Anthophyllite schist

(d).- Granulites
(e).- Marbles
(f).- Serpentinite
(g).- Pegmatites and aplites

(a).- Amphibolites

The tremolite schists are grey coarse-grained rocks occurring in layers up to 10 ft. in thickness. They are composed up to 95 % of colourless to greenish tremolite (2V = 82° , Z/c = 20°), whose prismatic crystals reach 8 to 20 mm. in length. This mineral is usually slightly altered to talc and prehnite which make up the rest of the rock.

The hornblende-plagioclase amphibolites are abundant in layers up to 3 ft. in thickness. When enclosed in gneiss, they often show boudinage. The rock is black and medium-grained. Modal compositions of two samples are given in table I2.

TABLE I2

	1	2
Plagioclase	13.4	24.1
Hornblende	78.0	72.8
Quartz	8.6	3.1
	100.0	100.0

The hornblende occurs in hypidiomorphic prismatic crystals 2.0 mm. long and its optical properties are :

2V (-) = 78°		Z = green to bluish green
Z/c = 18°		Y = olive green
		X = light yellow

These are the properties of common hornblende. The plagioclase may reach 1.5 mm. in diameter and is amoeboid. It is completely saussuritised (sericite and epidote) and unidentifiable. Scarce diopside crystals may be seen in some of the specimens. They are 2.0 mm. in diameter and exhibit alteration to hornblende, which rims the pyroxene and is sieved with "droplets" of quartz. Rare quartz is disseminated in the groundmass; its grains do not reach 0.5 mm.

The banded hornblende-diopside "amphibolite" is a complex rock composed of thin (a few centimetres) alternations of grey gneissic and dark amphibolitic layers. As amphibolitisation has taken place in the gneissic layers, the writer has prefered to give this rock the general name of banded "amphibolite". These rocks are most abundant in the vicinity of the confluence of the Lilani and Hlimbitwa rivers.

The layers of amphibolite consist of greenish brown hornblende (1.5 mm.) with a little andesine and quartz.

In the gneissic layers, plagioclase is amoeboid and its composition is andesine $43An_{43}$. Quartz occurs in medium to small quantities ; it is interstitial and its grains are up to 2 mm. in diameter. Abundant crystals of light green diopside are dispersed in the groundmass. They are 3 mm. in diameter and are rimmed with small grains of hornblende, showing partial replacement by amphibole.

(b).- Gneisses

The biotite gneiss is a grey fine- to medium-grained rock. Modal compositions of two specimens are given in table I3.

T A B L E I3

	1	2
Plagioclase	30.4	62.9
Quartz	41.0	28.8
Biotite	28.6	8.3
	100.0	100.0

In addition to plagioclase, quartz and biotite, occasional pink garnets (almandine), up to 1 cm. in diameter, and sillimanite-rich laminae may be observed.

The plagioclase may reach 1.0 mm. and its composition varies from andesine $41An_{41}$ to oligoclase $21An_{21}$. It is albite-twinned and amoeboid. Biotite occurs in layers and is 1.0 mm. long ; it is partially altered into sphene and bluish chlorite. Quartz grains are 1.0 mm. in diameter and are concentrated in aggregates. Occasional schistose laminae may be seen : they are rich in sillimanite, biotite and almandine. The sillimanite crystallizes in long needles often altered to unidentifiable micaceous material (sericite ?). It is intimately associated with biotite and almandine. The latter is fractured and partially replaced by chlorite.

The muscovite-biotite gneiss is a grey fine- to medium-grained rock. Plagioclase (0.2 mm.) is heavily saussuritised (sericite and epidote). Muscovite and biotite occur in layers parallel to the bedding. Biotite is altered into chlorite and sphene and may contain inclusions of sagenite. Residual grains of almandine (8 mm.) may be seen and are heavily fractured. Biotite, muscovite and chlorite have crystallized in its fissures. Rather abundant quartz (4 mm.) is dispersed in the groundmass.

The hornblende-biotite gneiss is fine- to medium-grained. Its principal minerals are plagioclase, hornblende, quartz and biotite (table I4).

TABLE I4

	1	2	3
Plagioclase	31.9	45.9	42.8
Hornblende	35.0	13.1	29.6
Quartz	17.6	36.1	26.2
Biotite	15.5	4.9	1.4
	100.0	100.0	100.0

The plagioclase, 2.0 mm. in diameter, is often completely sericitised. It ranges in composition from andesine An_{32} to oligoclase An_{23}. The amphibole (2.0 mm.) is often hypidiomorphic and parallel to the bedding. Its optical properties are :

$2V\ (-) = 72$ to $78°$ Z = green to bluish green
$Z/c = 15$ to $21°$ Y = olive green
X = yellow

It is a common hornblende. The biotite is 3.0 mm. long and brown to reddish brown. It partly replaces the amphibole and is often altered to sphene and chlorite. Quartz occurs in aggregates of grains 0.5 mm. in diameter. Some sphene, ore and epidote are associated with hornblende and biotite.

(c).- Schists

The sillimanite-almandine schist is a fine- to medium-grained rock. Its principal minerals are sillimanite, almandine, biotite and quartz. The sillimanite occurs in long blades or in swarms of needles. Most blades are broken perpendicularly to their elongation and these fractures are filled with secondary micaceous material (sericite ?). Biotite is constantly associated with sillimanite and grows interstitially to the latter. Its flakes are more or less altered to chlorite and sphene. Garnets are of the almandine type (microscopic and X-ray identification) and are up to 1 cm. in diameter. During their growth, they have included numerous small needles of sillimanite from the groundmass. They are fissured and these fractures are filled with biotite. Quartz occurs in aggregates and its grains reach 1.0 mm.

The quartzofeldspathic schists are grey fine- to medium-grained rocks. They have a strong schistosity and consist mostly of plagioclase, microcline and quartz with subsidiary biotite (table 15.

T A B L E 15

Plagioclase	41.6
Microcline	24.3
QUARTZ	31.9
Biotite	2.2
	100.0

The plagioclase (1.5 mm.) is oligoclase An_{25}. It is strongly granulated and associated with microcline grains (1 mm.). Quartz is interstitial ; flakes of subsidiary biotite occur in the groundmass.

The anthophyllite schist consists of long blades of anthophyllite slightly altered to talc.

(d).- Granulites

The granulites are readily distinguished from the quartzofeldspathic schists by their typical granulite fabric : layers of flattened or lenticular quartz grains alternating with layers of plagioclase and microcline. Modal analyses carried out on three samples are shown in table 16.

T A B L E 16

	1	2	3
Plagioclase	64.0	34.8	41.1
Quartz	27.0	55.0	29.1
Microcline	9.0	10.2	29.8
	100.0	100.0	100.0

The plagioclase (0.5 mm.) ranges in composition from oligoclase An_{28} to andesine An_{32}. It is associated with microcline (0.1 mm) Quartz is flattened and its grains reach 0.8 mm. in diameter. Subsidiary muscovite and biotite occur in the groundmass.

(e).- Marbles

The main mineral is calcite ; it is associated with subsidiary tremolite and diopside. The grains of carbonate are very granulated ; (01$\bar{1}$2) lamellae exhibit a good deal of curvature. In some intensely granulated specimens, calcite has recrystallized into small strain-free grains which concentrate in patches. Though tremolite and diopside are usually subsidiary, they may develop locally to form up to 10 % of the rock. Diopside has been found particularly to the east of the confluence of the Lilani and Hlimbitwa rivers. Occasional microscopic fragments of country rocks (gneiss, amphibolite, etc.) may be seen. Some marbles are impure and laminae of rounded quartz, potash feldspar and plagioclase more or less mixed up with muscovite are interspersed in them.

(f).- Serpentinite

This rock consists of flakes of antigorite, up to 2 mm. in length which are arranged in a parallel way, together with some chrysotile.

(g).- Pegmatites and aplites

The conformable pegmatites consist essentially of plagioclase and quartz. The diffused veins often consist of quartz only. The composition of the plagioclase is oligoclase 25 An to 28An.

The cross-cutting pegmatites are coarser and much more homogeneous than the former, which are "mixed up" with country rock material. They have the following average modal composition (table ~~16~~ 17):

TABLE ~~16~~ 17

Plagioclase	43.5
Microcline	10.1
Quartz	39.7
Muscovite	5.7
Biotite	1.0
	100.0

The plagioclase reaches 6.0 mm. and its composition is oligoclase ~~28~~ An_{26}. It is albite-twinned. The microcline is 8.0 mm. in diameter and corrodes the plagioclase with formation of myrmekite. Flakes of muscovite are 4 mm. long and are partially replaced by small grains of tourmaline. Quartz crystallizes in large grains (1 to 2 cm.). Biotite is subsidiary.

The aplites are fine-grained (1.0 mm.) and consist of small grains of microcline in large quantity, plagioclase (oligoclase 26An) and quartz with subsidiary mica.

III.- PETROGENETIC CONSIDERATIONS.

A.- REGIONAL FACIES.

Mineralogical associations such as hornblende-plagioclase, sillimanite-almandine-biotite, etc. characterize the rocks of this area. These assemblages are typical of the almandine-amphibolite facies (TURNER and VERHOOGEN, 1960). From the petrographic description of these rocks, the writer has attempted to classify the assemblages observed in the region as follows :

(1)	Basic	: (a) Hornblende-plagioclase-(diopside-biotite-quartz)
		(b) Hornblende-diopside-plagioclase
		(c) Plagioclase-hornblende-quartz
(2)	Magnesian	: (a) Anthophyllite
		(b) Tremolite
(3)	Pelitic and quartzofeldspathic	; (a) Sillimanite-almandine-biotite (quartz)
		(b) Quartz-plagioclase-biotite-(sillimanite-almandine)
		(c) Quartz-muscovite-biotite-plagioclase (microcline)
		(d) Plagioclase-microcline-quartz
(4)	Calcareous	: Calcite-tremolite-diopside

TURNER and VERHOOGEN (1960) have divided the almandine-amphibolite facies into four subfacies, namely : staurolite-almandine ; kyanite-almandine-muscovite ; sillimanite-almandine-muscovite ; and sillimanite-almandine-orthoclase. Common associations in the Lilani valley, such as sillimanite-almandine, prove that the metamorphic grade reached by these rocks is beyond the grade of the first two subfacies. Beyond the staurolite zone, TURNER and VERHOOGEN have given four reactions characteristic of the progressive metamorphism of pelitic rocks :

(1) Staurolite + quartz = kyanite + almandine + H_2O

(2) Staurolite + quartz = sillimanite + almandine + H_2O

(3) Kyanite = sillimanite

(4) Muscovite + quartz = sillimanite + orthoclase + H_2O.

As no transition stages are observable here, it is only possible to state the reactions which have, or have not, taken place. Reaction (1) cannot be applied here ; reactions (2) and (3) have been completed while the metamorphic grade required for reaction (4) has not been reached : orthoclase has not been found associated with sillimanite. If the hypothetical curves of the univariant equilibria of these reactions are plotted on a $P(H_2O)$ vs. temperature diagram (fig. 1, after TURNER and VERHOOGEN, 1960), it is seen that the rocks of the Lilani valley have reached a metamorphic grade represented by a point in the central area of the diagram. The sillimanite isograd and the sillimanite-almandine association have been reached but not the sillimanite-orthoclase association, potash having been combined into biotite and not potash feldspar in diagnostic assemblages such as sillimanite-almandine-biotite.

This demonstrates that these rocks have reached an intensity of metamorphism comparable with that of the sillimanite-almandine-muscovite subfacies which is the third subfacies of the almandine amphibolite facies. The higher grade of the sillimanite-almandine-orthoclase subfacies has not been reached since potash feldspar never occurs in association with sillimanite and almandine in these rocks.

B.- PETROGENESIS AND ORIGIN.

(a).- Basic and magnesian rocks

Most basic rocks of this belt are amphibolites with a hornblende-plagioclase assemblage. In actual fact, all gradations can be seen between hornblende-plagioclase and plagioclase-hornblende-quartz rocks. All basic rocks are interstratified. No relic textures (ophitic) could be found. Also, many amphibolites show banding and layering. In consequence, the writer thinks that most of these basic layers are of sedimentary origin. Typical sedimentary rocks which could yield such amphibolites on metamorphism are impure argillaceous or ferruginous limestone or dolomite (lime-magnesia sediments, in general).

The presence of tremolite schist is unusual in the environment of the almandine amphibolite facies, where it should have disappeared (COOPER, 1957) after reacting with excess silica or dolomite to form diopside or forsterite. It is significant that the only occurrence of tremolite in large quantity in this area is in a rock made up of 95 % of this mineral. There is thus very little excess material with which tremolite could have reacted to yield higher grade minerals. Thus, tremolite remained chemically inert throughout metamorphism. In rocks composed of a variety of minerals, no tremolite has ever been found except in marbles : (paragraph (e)) ; this may be the origin of the diopside in some gneissic assemblages by the reaction tremolite + calcite + quartz = diopside (RAMBERG, 1952).

The hornblende-diopside amphibolite is a complex rock formed by the alternation of amphibolitic layers with diopside-bearing layers. It presents an interesting problem : the diopside is systematically partially replaced by amphibole. The main difference between amphibole and pyroxene lies in the Fe/Mg ratio (MICHOT, 1938) which is much higher in the former mineral. It is conceivable that diopside and hornblende be at equilibrium at a certain ratio above, or under, which hornblende, or diopside, only would be stable. It may be supposed that Fe/Mg ratios differed sensibly in the rocks which yielded the hornblende and the diopside under metamorphism. The writer thinks that amphibolitic layers had excess iron and that, under metamorphic conditions, this slowly diffused into the diopside-bearing layers. As a result the Fe/Mg ratio in these layers was brought somewhere near the critical ratio where hornblende can coexist with diopside. Thus, hornblende formed-to a certain extent-from diopside. It must be emphasised that, the thickness of these layers being small (a matter of a few centimeters), diffusion took place easily.

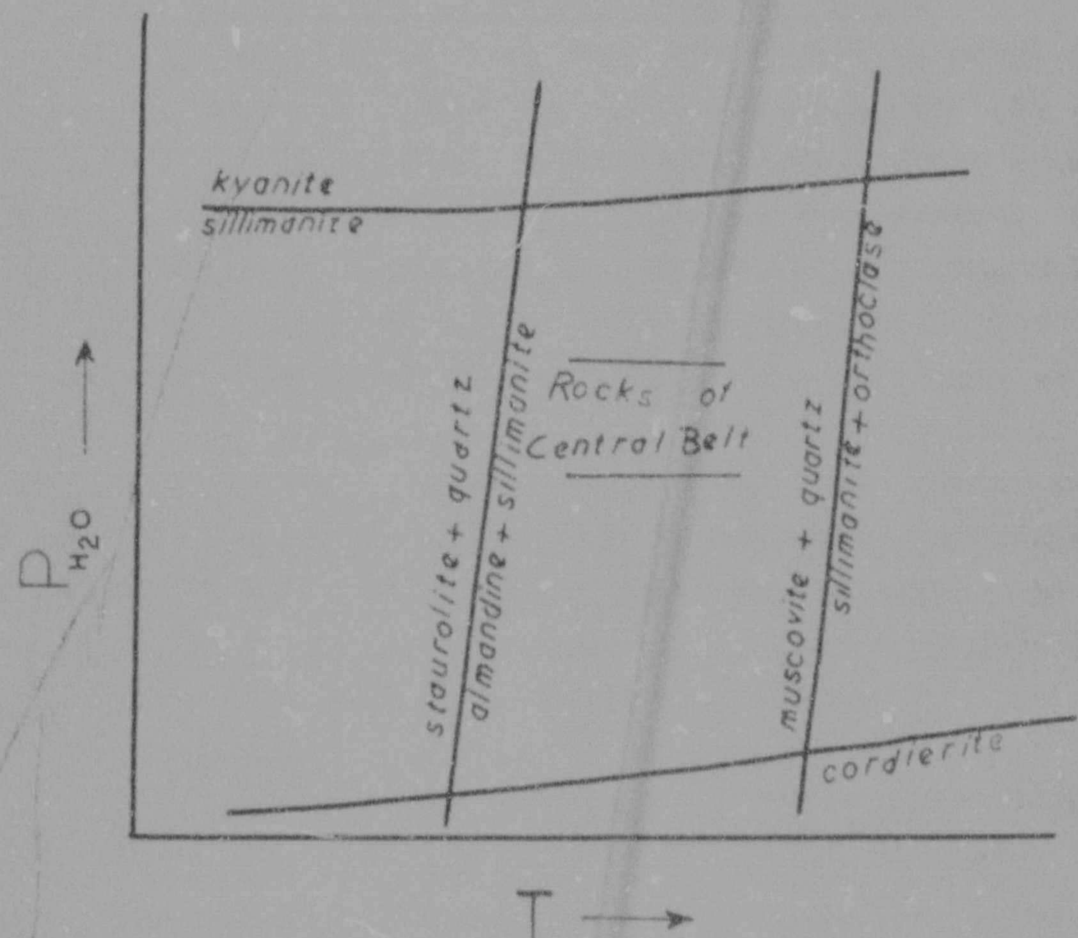

Fig. 1

Hypothetical curves of univariant equilibrium leading to formation of sillimanite (after TURNER and VERHOOGEN, 1960). The rocks of the Central Belt have reached a metamorphic grade represented by the central area of the diagram.

The formation of amphibole from pyroxene requiring the presence of water, it is likely that the diffusion occured in a wet way.

Serpentinite and anthophyllite schists are rather poorly displayed in the area, but obviously derive from the alteration or metamorphism of ultrabasic rocks.

(b).- Pelitic and quartzofeldspathic rocks

Pelitic schists of this belt are typically metasedimentary : they consist of laminae of biotite, muscovite and sillimanite-almandine interlayered with quartzofeldspathic rock. Very aluminous rocks, such as the sillimanite-almandine-biotite schists, originate from argillaceous rocks (containing some potash, magnesia and iron oxide which combined into biotite).

Though some quartzofeldspathic rocks are rich in microcline, the writer does not think this to be the result of potash metasomatism. These plagioclase-microcline- quartz assemblages could readily be obtained by simple recrystallization of arenaceous rocks of the arkose type (pre-containing all the minerals of the actual rock). Besides, no traces of potash metasomatism were recorded in other rock types.

(c).- Marbles

The characteristic assemblage of these rocks is calcite-tremolite-diopside. For this an excess SiO_2 is necessary (Turner and VERHOOGEN, 1960). The first mineral to form is tremolite, according to the reaction :

dolomite + quartz + H_2O = tremolite + calcite + CO_2.

Diopside will form in the following way :

$$\underset{}{2SiO_2} + 3CaCO_3 + \underset{\text{tremolite}}{Ca_2Mg_5Si_8O_{22}(OH)_2} = 5\ \underset{\text{diopside}}{CaMgSi_2O_6} + 3\ CO_2 + H_2O$$

(after RAMBERG, 1952).

According to TURNER and VERHOOGEN (1960), if an excess silica had not been available, assemblages such as diopside-forsterite-calcite or forsterite-dolomite-calcite would have been observed.

(d).- Pegmatites and aplites

Pegmatites observed in the central belt are similar to those encountered in the southern metasedimentary belt, though developed on a lesser scale:accretion or exsudation pegmatites formed "in situ" and pink intrusive cross-cutting pegmatites. However, the latter type has been emplaced late in the metamorphic history of the area and has produced no metasomatic action in the country rock. It corresponds to the thick red dykes of pegmatites seen in the southern metasedimentary area. The aplite dykes seen in some places seem to be a fine-grained variety of the pink pegmatites.

C.- DEFORMATION.

S-surfaces are very well developed in the area and are the result of pre-metamorphic anisotropism (stratification) emphasised by recrystallization and movement. Some plastic folding has occured in the vertical plane. Differences in competence between rock types have caused boudinage : for instance, the frictional drag of the plastic incompetent gneiss upon the competent hornblende-plagioclase amphibolite has caused the latter to stretch and disrupt. Details have been described at some length in chapter II A dealing with metasedimentary rocks of the southern area.

The marble is the most incompetent rock type of the area. Indeed, laboratory work by GRIGGS, TURNER and HEARD (1959) has demonstrated that, under high pressure and temperature, marble is an extremely ductile and plastic material : at 5000 bars confining pressure and 800° C, local elongation of 1000 % has been achieved in a marble sample without rupture. Some samples of Lilani marble have shown a tendency to recrystallise : some patches consist of small clear and unstrained grains of calcite. This is comparable with the annealing process described by the above authors : annealing (recrystallization) takes place when a cold-worked fabric is heated and transforms strained minerals into unstrained crystals. Thus, granulation of the marble was probably caused by tectonic stresses at low temperature and subsequent metamorphism induced recrystallization by annealing.

The general evidence is that the rocks of the area were submitted to a good deal of post-metamorphism granulation: broken garnets, broken sillimanite needles, and biotite flakes. In each of these cases, fracturing is accompanied by secondary alteration : alteration of garnet to chlorite and biotite, sillimanite to sericite, biotite to chlorite. Thus fracturation occurred nearer to the surface than the general metamorphism and when the regional rocks were submitted to pressure and temperature conditions equivalent to that of low-grade metamorphism.

IV.- CONCLUSIONS

The rocks of the central area are mostly derived from sedimentary rocks which have been subjected to a metamorphism of the intensity of the almandine amphibolite facies (sillimanite-almandine-muscovite subfacies). Folding in the vertical plane and of the plastic type has occured. Differential movements and differences in competence have been emphasised by the formation of boudinage and by the extreme plasticity of some marble layers. A serpentinised ultrabasic instrusion has been emplaced amongst the metasedimentary rocks.

CHAPTER III.- T H E   O R T H O - A M P H I B O L I T E S

I.- INTRODUCTION

This east-west belt of amphibolitic rocks begins at about 1,000 yards to the north of the confluence of the Lilani and Hlimbitwa rivers. The northern rim of the belt is in contact with the northern "granitic" massif while, along its southern border, the younger sheet of red granite has been emplaced. Thus, the belt is located between two granitic bodies (of different ages). Its width is variable; though it may reach 800 yards west of the Hlimbitwa river, elsewhere it may be constricted to only 100 yards or even be completely absent in the line of strike, as east of the Hlimbitwa river.

The actual contact of the amphibolites with the northern "granitic" massif was nowhere observed, though modification of the amphibolites in the vicinity of the massif has taken place. The contact with the red granite sheet to the south is clean-cut and no modifications of the amphibolites have occured.

The ortho-amphibolites will be shown to be of igneous origin.

II.- DESCRIPTION

The average amphibolite of this belt is a massive, hard, black fine-grained rock. In many occurrences no structure could be discerned. However, complex features often occur. These are, in chronological order: (a) Xenoliths in the fine-grained amphibolite; (b).- Modifications and transformations of the fine-grained amphibolite itself; (c).- Dykes cutting across the fine-grained amphibolite.

(a).- Xenoliths occurring in the fine-grained amphibolites

These have only been observed in a few outcrops. The maximum dimension of the fragments is 2 or 3 ft. They are usually clearly circumscribed and have mostly rectangular outlines (Photo 38, Plate XX). They are made of a light, medium to coarse-grained amphibolitic rock and have sharp contacts with the fine-grained amphibolites.

These xenoliths are grouped in clusters which have never been observed to be wider than a dozen yards.

(b).- Modifications of the fine-grained amphibolite

Modification of the fine-grained amphibolites occur mostly in the vicinity of the northern "granitic" massif, i.e. along the northern margin of the belt. In places, the amphibolites merge progressively into light coarser patches several feet in diameter. All types of gradation can be seen between these two rock types. Often, these patches form at the intersection of veins filled with the same coarser material and cutting across the amphibolite.

In another modification, the amphibolite itself is brecciated. The amphibolite fragments are up to 1 ft. in length and are cemented by a light material. These cementing veins are rather narrow and never wider than a few inches max. The outlines of some of these fragments are smoothed and they seem to have been corroded by the light material (Photo 39, Plate XX).

(c).- Dykes

A few dykes of black, medium-grained rock cut the amphibolites in the upper Lilani valley. In the Hlimbitwa valley, the same type of dykes show typical cavity-, or fracture-, filling features.

A few dykes of granitic rock have been emplaced in the amphibolites in the vicinity of the northern "granitic" massif. They are several feet in width and are usually parallel with the regional E-W trend of the belts. Offshoots from the red granite sheet, in the south, are readily distinguished from these dykes by their red colour and their extremely fine grain.

These offshoots usually strike E-W, but occasionally also obliquely or perpendicular to the general regional trend.

Rare dykes of black massive dolerite, up to 3 ft. in thickness, have been seen cutting all other rocks.

III.- PETROGRAPHY

(a).- Xenoliths

Though light in colour by comparison with the regional fine-grained amphibolites, this rock type is also an amphibolite, but of rather coarse grain-size (5 mm.) and rich in plagioclase feldspar (table I8.