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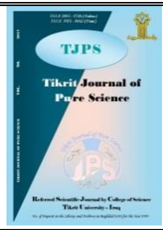

Serpentinite Rocks of Mawat Ophiolite Complex, Northeastern Iraq, Beetwat Village: 1-Petrography and Diffractometry

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Abstract

The Mawat ophiolite complex is of Cretaceous period as a residue of oceanic crust covers about 200 km^2, Northeastern Iraq.. The serpentinite rocks are exposed as a diapir in the northeastern suture Zagros zone of Iraq near Beetwat village, The field study and petrography reveal two types of serpentinite, the shear and massive, with three serpentine varieties. The serpentinite rocks are affected by secondary processes such as diagenesis, metamorphism and hydrothermal alteration in different degrees. Some common Textures in these rocks are pseudomorphic such as mesh or sieve textures, glass hour and bastite texture. Nonpsedomorphic textures appear also in these rocks such as interpenetrating fibrous, interlocking textures. Mineralogically, the massive serpentine minerals are lizardite and chrysotile that affected by recrystalization and replacement of lizardite. The (XRD) analysis explain that the serpentine is composed of lizardite, chrysotile, antigorite, in addition to amphibole minerals (anthophyllite and tremolite), chlorite talc, and opaque minerals as chromite.

Introduction

The Mawat ophiolite complex is one of the longest complexes in Iraqi Zagros suture zone in northeastern Iraq around Arabian shield [**1**]. The ophiolite section are composed from bottom to top of ultramafic rocks, gabbro, sub volcanic rock, with the radiolarian and chert sedimentary rocks and limestone of Gimo sequence.

The importance of the ophiolite complex come from its diribuion and its situation within the orogenic belts related to the plate tectonics. The Mawat ophiolite complex exists in northeastern Iraq about 30 km northeast Sulamania city (Fig. 1), with (25) km length and (12,7) km width at the area about (200) km^2 [**2**] between (35°48′, –35° 50′) Longitude, and (45°28′ – 45° 30′) Latitude. The sampling is from the outcrop of the serpentinites at Beetwat village (Fig. 2),F which is far from Sulamania by about 25 kms southeast of Mawat city. Geologically, the Mawat nappe as one of the structures in the area is composed of Mawat ophiolite complex and Gemo Sequence which situated on the top of Walash-Naoperdan rocks. The Mawat complex lithology from bottom to top is composed of tectonic peridotite, gabbro, dykes, metamorphic pillow lava that was affected by silicitization and radiolarian chart of marine sediment [**3**]. The allochthonous Mawat nappe contains also either ophiolite complex that is composed from bottom to top of ultramaphic rocks gabbro, diabase rocks and basaltic rocks with thickness (3000) m or Gimo sequence that is composed from metamorphic basalt and deep basinal sediments of about (600) m thickness [**4**].

The important formations exposed in the study area are Shiranish Formation, Tanjero clastic Formation and Aqra limestone Formation [**5**].

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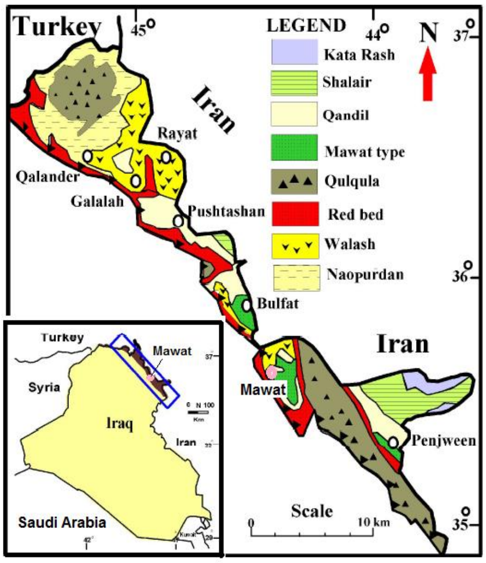

Fig.(1) Simplified geological map of Zagros Suture Zone (modified from GEOSERV) showing the location of the studied area at Mawat ophiolite complex.

Fig.(2) Massive serpentinite rocks of Mawat ophiolite complex at Beetwat village.

Methodology

(19) thin section are prepared for petrography using polarized microscope, and (5) samples are prepared for XRD analysis at Department of Applied Geology, Tikrit.

The XRD slides are prepared by crushing the chosen samples using (Tima Swing Mill) and then sieving the powder to (63) mm.

Textures of Serpentinites

1 - Sieve texture: Inherited texture, in which the olivine grains appear with high relief and rounded shape, while pyroxene grains appear with elongated prismatic (Fig3: a,b).

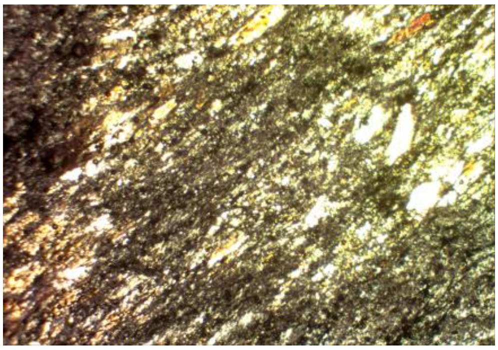

Fig. (3a): Mesh texture which has false Pyroxene crystals appearing in it within fine background of serpentine and this texture is descended from the original rocks

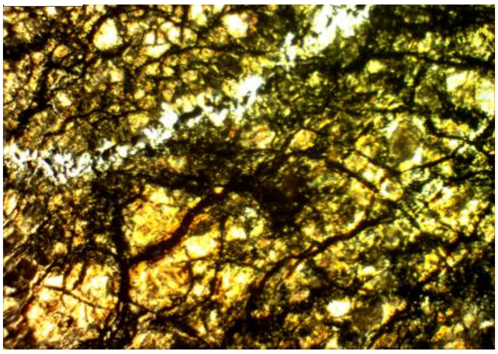

Fig (3b): Mesh texture in olivine crystals in fine background of serpentine. It is named hourglass texture (PPL)-(40X) .

2 - Fibrous texture: This texture is formed in the secondary minerals of serpentine and talc associated with inherited texture of the original minerals. This texture aligned as a fiber or lines with the same direction, with different sizes of opaque minerals, this texture is considered as the most common texture in this study (Figs. 4, 5).

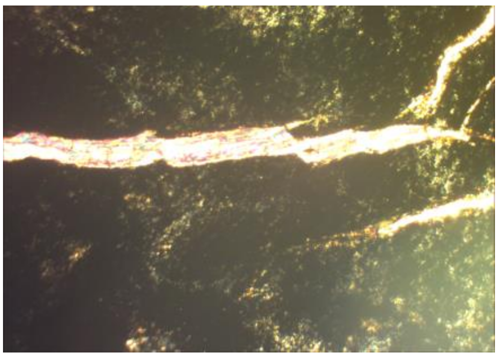

Fig.(4): Fibrous texture which appears a mixed background of talc and serpentine minerals cut by granules of magnetite that spread randomly within background (PPL)-(40X) .

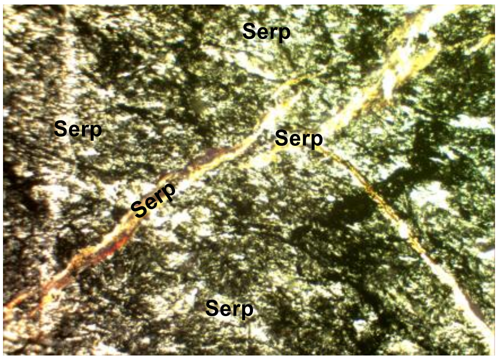

Fig.(5): Fibrous interlocking texture as rectangular canals of serpentine cut by veins of secondary serpentinite (PPL)-(40X) .

3 – Slaty-like texture: Metamorphic texture wavy or alternative texture (Fig. 6), in secondary serpentine texture which contain micro- folds or faults caused by tectonic effects.

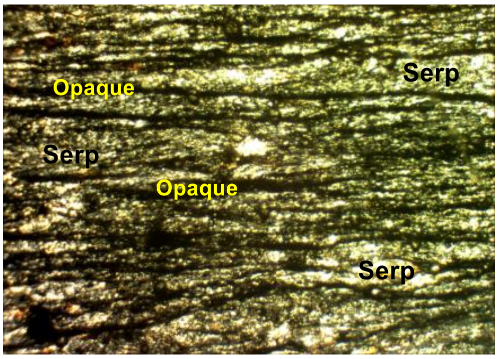

Fig.(6): Slaty-like texture which appears as canals or lines of serpentine and opaque minerals (PPL)-(40X) .

4 - Radial texture

This texture appears in amphibole minerals (anthophyllite) after pyroxene which appear as radial habit in fine matrix of serpentine representing one of the metamorphism stages. (Fig. 7).

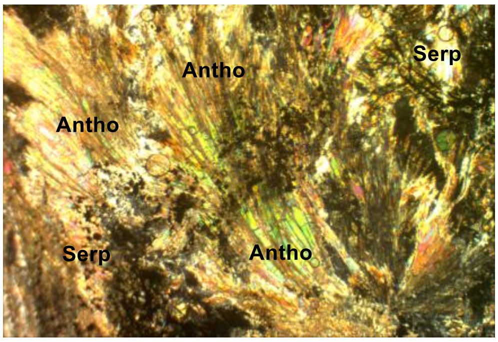

Fig.(7): Radial texture which appears as radial fibers for anthophyllite mineral (XN)-(40X) .

5 - Metamorphosed porphyritic texture

This metamorphose texture is found in volcanic rocks and some of ophiolite complex rocks like (Khoy) in Iran **[6]** and (Goksun) complex rocks in Turkey **[7]** . In the present study, this texture is developed from metamorphic and tectonic affects which show nodular extraction and spindle shape in the crystals and pyroxene that imbedded in fine matrix of serpentine and this texture considered as an inherited texture of original rocks (Fig. 8).

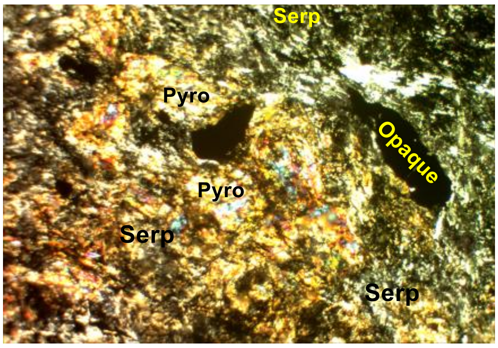

Fig.(8): Metamorphic porphyric (bastite) texture as big false pyroxene crystals within fine background of serpentine (PPL)-(40X) .

6 – Coarse- granule texture:

Coarse grains of euhedral to subhedral opaque minerals in fine matrix of serpentine that represented as mineral patterns associated and intercalated with serpentinite in study area (Fig. 9).

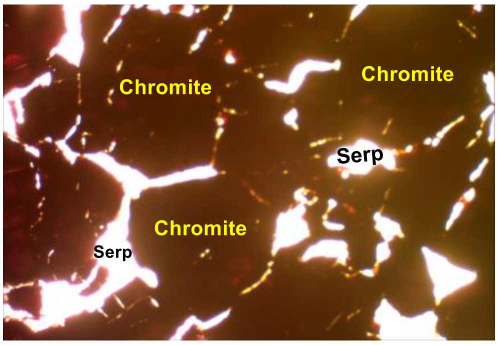

Fig.(9): Coarse granule texture: subhedral to anhedral opaque minerals within fine background of serpentine (PPL)-(40X)

Mineralogy of Serpentinites

1 - Serpentine: it is a green mineral formed by alternation of Mg-rich minerals like olivine and orthopyroxene. The high relief is of olivine origin whereas the lower relief is of pyroxene origin. Wavy extinction due to pressure is seen in non-cleaved chrysotile. Three varieties of serpentine are distinguished in the present work, they are lizardite, chrysotile and antigorite (Figs. 10,11,12).

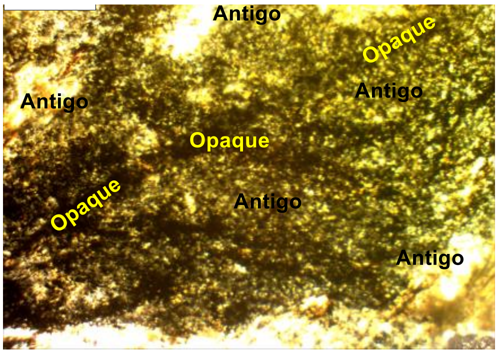

Fig. (10): The antigorite variety including opaque minerals as inclusions (XN)-(40X).

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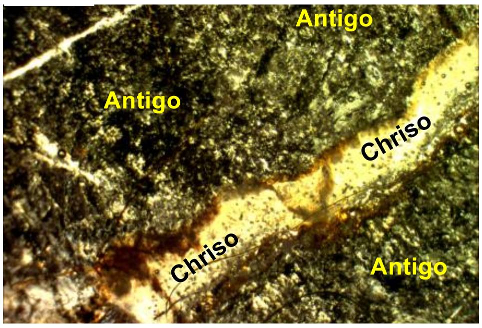

Fig. (11): The chrysotile variety as a vein (XN)-(40X)

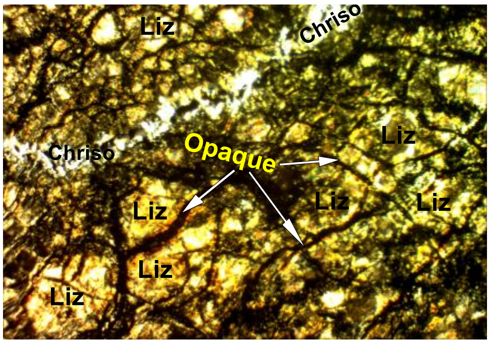

Fig. (12): The lizardite variety after olivine (XN)-(40X) .

2 – Pyroxene:

No distinct grain has been identified in the studied sample due to wholly alteration to serpentine, but very few minute relicts could be seen and the pseudomorphic habit are the indications for preexistence of pyroxene (Fig. 13).

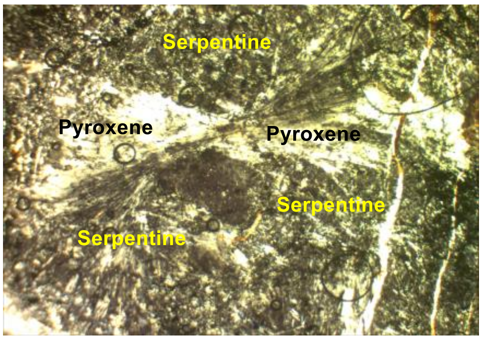

Fig. (13): pyroxene pseudomorphic serpentine (antigorite) (PPL)-(40X) .

3 – Olivine:

The olivine mineral grains as a relict or pseudomorph of its alteration product of serpentine is considered as the main constituent of the protolith dunite or peridotite.

It has high relief with fractures and undulated extinction (Fig. 12).

4 – Amphibole:

The amphibole after pyroxene results from uralitization at low temperature metamorphism [**8**]. Anthophyllite and tremolite are indicate a multi stage of metamorphism to form serpentinite (Figs. 14, 15).

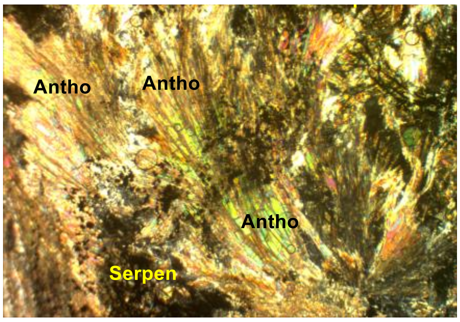

Fig.(14): the amphibole (anthophyllite) after pyroxene due to uralitization (XN)-(40X)

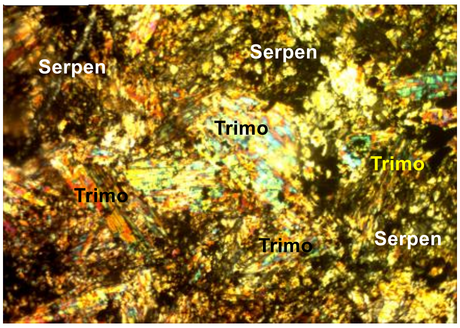

Fig.(15): the amphibole (tremolite) after pyroxene due to uralitization (XN)-(40X) .

5 – Talc:

At the later stage of serpentinization, the talc minerals are formed from the interaction between the silica and serpentine to form fine grained anhedral talc in serpentine matrix with high interference color,wavy extinction and without cleavage (Fig. 16).

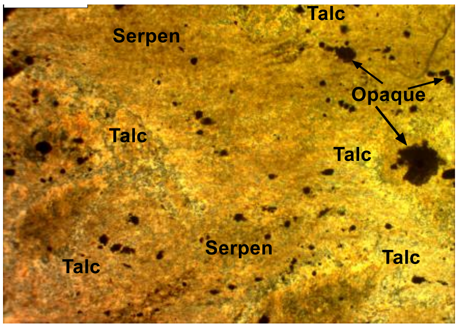

Fig.(16): Talc white color and smooth background of serpentine (XN)-(40X)

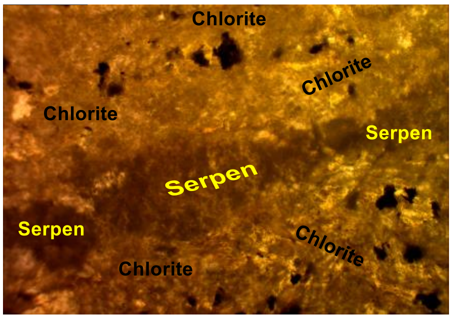

Fig.(17): Chlorite after pyroxene cut with serpentine (XN)(40X) .

6 - Iron oxides

The iron oxide minerals of the spinel group exist in two manners: either primary magmatic subhedral to anhedral grains, or secondary after alteration of the primary minerals occurring as disseminated fine

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grains. They are either chromite or magnetite (Figs. 18,19,20).

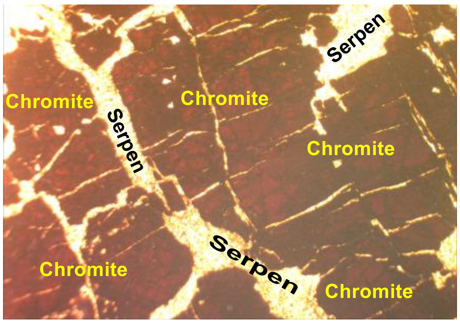

Fig.(18): Subhedral to anhedral primary chromite (XN)-(40X)

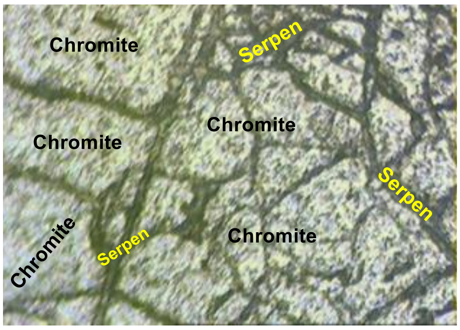

Fig.(19): Subhedral to anhedral chromite under ore microscope (polished section) cut by veins of serpentine.

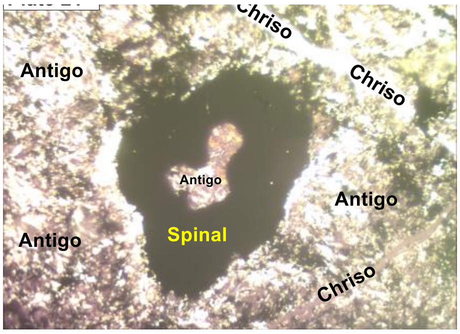

Fig.(20): Zoning of spinel mineral in a background of serpentine (PPL)-(40X)

Mineral Assemblages

Depending on the mineral constituents of the serpentinites of the present work, the following assemblages can be given Fig : 21(B2,B10,B7, B19, B9).

1 - Serpentine + Pyroxene + Opaque minerals:

This assemblage is considered as the most important one in this study which revealed fibrous texture as more common than the granular metamorphic porphyritic texture. The serpentine minerals are abundant, whereas pyroxene is less abundant with secondary opaque mineral.

2 – Serpentine + Pyroxene + Olivine + Opaque minerals:

This assemblage is present in most of the rocks of the study area, and serpentine minerals are the most common. The most common texture is the sieve texture and granular texture. The serpentine minerals here are results of alteration or metamorphism of pyroxene and olivine. Veins of secondary serpentine minerals with various sizes and shapes are found associated with opaque minerals.

3- Serpentine + Pyroxene + Amphibole + Olivine + Opaque minerals:

It is less common in this study with predominant serpentine minerals. Anthophyllite is seen as amphibole after pyroxene showing radial texture. Fibrous texture is common due to fibrous serpentine. Porphyritic texture is also distinguished. Some serpentine veins across this association are present with various shapes associated with opaque minerals disseminated frequently in this assemblage.

4 - Serpentine + Talc +Opaque minerals:

It is also less common assemblage in the study. It composes of fine matrix of serpentine and talc with fine fibrous texture. Talc is the important mineral formed at the later stage of metamorphism. Small and medium grains of opaque minerals are present.

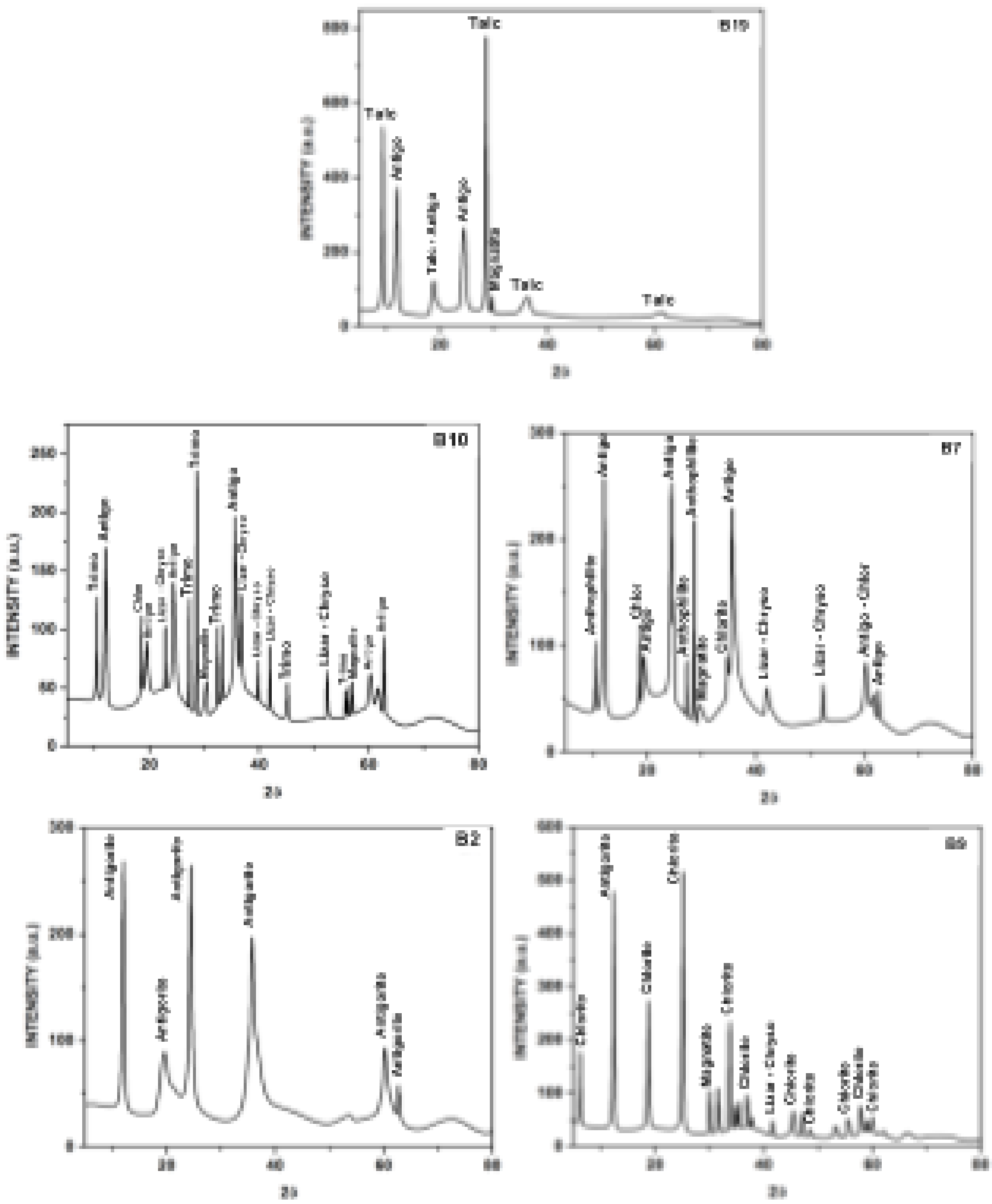

Fig.(21) Diffractograms of (XRD) Analysis for Samples (B2,B10,B7, B19, B9).

4 - The serpentinite rocks have mineral assemblages (1- Serpentine+Pyroxene +Opaque minerals; 2–Serpentine +Pyroxene+ Olivine +Opaque minerals; 3-Serpentine +Pyroxene +Amphibole +Olivine +Opaque minerals; 4- Serpentine+ Talc+Opaque minerals).

Recommendations

1 -Detailed study of serpentine rocks in all the out crop Iraq.

2 - Digging of drilling well in site of serpentine rocks to study the core of serpentine rocks .

3- Study the feasibility of serpentine rocks and its inclusion.

Conclusions

1 - The study area shows multi stage secondary processes represented by hydrothermal alteration, metamorphism interpreted from petrography and diffractometry of the studied samples.

2 - Some of common textures are explained in the study like pseudo texture that represented by sieve texture, hour-glass texture and bastite in addition to non pseudo textures.

3 –The serpentine group like massive type (lizardite and chrysotile) are affected by recrystallization and replacement lizardite, while the shear type is distinguished by replacement of antigorite and chrystolite instead of lizardite.

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صخور السربنتينايت في معقد أوفيولايت ماوات, شمال شرقي العراق، قرب قرية بيتوات:
1- البتروغرافية والمعدنية باستخدام الأشعة السينية الحائدة

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الملخص

يقع معقد أوفيولايت ماوات في الجزء الشمالي الشرقي من العراق وقد تكوَن هذا المعقد في الكريتاسي الأعلى ويمثل بقايا لغلاف صخري محيطي ويغطي مساحة بحدود 200 كم^2, وقد تم التركيز في هذا البحث على دراسة أصل ونشوئية صخور السربنتينايت المتحولة عن صخور فوق قاعدية وتشخيص بعض المكتفات المعدنية المترافقة معها.

ظهرت صخور السربنتينايت في أكثر من مكشف ضمن نطاق درز زاكروس شمالي شرق العراق وقد تبين من المعاينة الحقلية والدراسة البتروغرافية وجود نوعين من السربنتينايت هما القصبي والكتلي ووجود ثلاثة أنواع من معادن السربنتين وهي السربنتين الكتلي والقصبي والعروق, ومن خلال الدراسة الحقلية تبين وجود مكتفات معدنية مترافقة ومتداخلة مع صخور السربنتينايت. كذلك أظهرت الدراسة البتروغرافية بأن صخور السربنتينايت قد تأثرت بالعمليات الثانوية مثل التحلل والتحول والتغير الحرمائي وبدرجات مختلفة, وقد ظهرت بعض الأنسجة الشائعة في هذه الصخور وهي أنسجة الشكل الكاذب مثل النسيج الشبكي أو المنخلي ونسيج الساعة الرملية ونسيج الباستايت وكذلك ظهرت أنسجة الشكل غير الكاذب مثل النسيج الليفي الخارق أو المتقب والنسيج الليفي الممتلئ, ومن الناحية المعدنية فإن مجموعة معادن السربنتين من النوع الكتلي تتكون من معدن الليزردايت والكريسوتايل والتي تعرضت إلى عمليات إعادة التبلور وإحلال معدن الليزردايت, أما مجموعة معادن السربنتين من النوع القصبي فقد تميزت بإحلال معادن الأنتيكورايت والكريسوتايل محل الليزردايت, وقد إحتفظت بعض صخور السربنتينايت في منطقة الدراسة الحالية بالمكونات المعدنية الأولية مثل الأوليفين والبايروكسين والأمفيبول وبعض المعادن المعتمة, بينما أظهرت معظم صخور السربنتينايت في منطقة الدراسة المعادن الثانوية الناتجة عن عمليات تحلل وتحول المعادن الأولية وأهم هذه المعادن هي السربنتين والأمفيبول والكلورايت والتالك. ومن خلال نتائج تحليل الأشعة السينية الحائدة (XRD) لبعض النماذج المختارة فقد تبين أن السربنتين في صخور منطقة الدراسة يتكون من معادن الليزردايت والكريسوتايل والأنتيكورايت, وكذلك تبين أن معادن الأمفيبول تتكون من معدن الأنثوفيلايت والتريمولايت, أما معادن الكلورايت فإنها تتكون من التالك كلورايت, أما بالنسبة للمعادن المعتمة فإنها تحتوي على معدن الكرومايت.