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 km², 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 serpentinite 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 orogenetic 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) km² [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), 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 Gimo 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 ultramafic 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].
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).

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).
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.

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).

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).

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).

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).
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).

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).

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).

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
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 granulat 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. Anthophyllit 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 t alc 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).

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 represented by sieve texture, hour-glass texture and basite 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 chrysolite instead of lizardite.

Recommendations
1. Detailed study of serpentine rocks in all the outcrop 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.

4. The serpentine 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).
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