Characterization of a metasomatic muscovite after pegmatitic potash feldspar with a soapstone appearence, Eastern Desert, Egypt

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Abstract— Metasomatic muscovite is found as massive and compact masses with luster and softness simulating soapstone. It represents a rarely encountered ultrafine- grained type of mica (sericite).It is originated as a result of hydrothermal alteration of highly pulverized potash feldspar along shear zones dissecting some pegmatite rocks in the Eastern Desert of Egypt. The metasomatic muscovite was investigated in comparison with the pegmatite muscovite using X-ray diffraction, differential thermal analysis and chemical analysis. The specific gravity and dielectric properties have been determined .The results indicate that ,the metasomatic muscovite characterized by lighter density, slightly larger in d-spacing (dÅ), lower K_2O and Al_2O_3 contents, higher in SiO2 and Na2O values , higher in dielectric value, and has higher dehydroxilation temperature

Index Terms— xrd, d.t.a., metasomatic muscovite.

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1 INTRODUCTION

Ultrafine-grained muscovite is known as sericite with chemical formula $KSi_3Al_3O_{10}(OH)_2$ and used to identify highly refractive natural mineral **[1]**.The study metasomatic muscovite represents one of a rarely encountered sericite with a luster and texture simulating soapstone .The coarse muscovite characterized by perfect cleavage, flexibility elasticity, low thermal conductivity, infusibility, and high dielectric strength, which makes it a valuable mineral widely used in industry. For better development and application of the mineral resource, the characterization of the rarely encountered ultrafine-grained metasomatic muscovite is necessary. The results of the characterization are presented in this paper. Sericite was changed into an interstratified structure in the presence of a small amount of $LiNO_3$ after prolonged treatment and in the presence of a considerable amount of $LiNO_3$ a similar structure was formed after3 hr of reaction **[2]**. Mica weathering in soils has been attributed to a loss of K and a gain in water. Loss of K changed micas into expanded layer silicates **[3].**

2 GEOLOGY

The metasomatic muscovite used in this study was obtained from granite pegmatite outcropping 40 km NW Safaga city in the Eastern Desert of Egypt. The pegmatite is composed of very coarse crystals of buff potash feldspar and milky- white quartz and shows different degrees of fracturing and granulation along the shear zones. The shear zones are occupied by pale- green compact masses of metasomatic muscovite, sometimes cementing angular fragments of buff feldspar and milky- white quartz. These fragments are also stained by greenish blue color of copper carbonate. The pale -green compact masses of metasomatic muscovite reach in size up to 3 m across with luster and softness simulating talc mineral. On the other hand, very coarse flacks of muscovite were collected from muscovite books occurring in the neighboring pegmatite. The muscovite flacks are colorless to pale- yellow and transparent.

3 MICROSCOPIC EXAMINATION

The metasomatic muscovite ore is composed of ultra fine–grains of sericite with few grains of iron oxides, albeit and quartz. Iron oxides are black with red mantle as a result of alteration to hydrous iron oxide. Albeit and quartz grains are very fine-grained and colorless. When the fragments of feldspar (perthitic microcline) are present, the sericite and iron oxides are found along the twin and fracture planes and along their grain boundaries. The spaces between the fragments are occupied by fibrous muscovite in association with sex-sided crystals of quartz.

4 EXPERIMENTAL

The metasomatic and the pegmatite muscovite samples are subjected to X-ray diffraction analysis (XRD), differential thermal analysis (DTA) and chemical analysis. The specific gravity and dielectricity of both samples are determined.

4.1 X-ray diffraction analysis

Three powdered samples (one from the coarse-grained pegmatite muscovite and two from the metasomatic fine-grained one) are subjected to X-ray diffraction at Central Laboratories Sector of the Egyptian Mineral Resources Authority, Cairo. The three diffractograms are shown in **Figs.1 a, b and c.** The interplaner spacings in Ångstrom (d Å) and the relative intensities (I/I0) are given in **Table2**. All samples are composed mainly of muscovite with minor constituents of albite and quartz. The comparison reveals that, there is a slight change in the positions of lines in the powder diffractograms, commensurate, the interplaner distances slightly differ accordingly **(Table1).** The fine-grained muscovite has larger interplaner spacings reflecting an expanding structure which attributed to its crystallization at higher temperature and lower water vapour pressure than those of coarse-grained one **[4]**. This is reflected in lighter specific gravity and also adsorption of some ions from their solutions as Cu, Zn, Fe, and Cr.

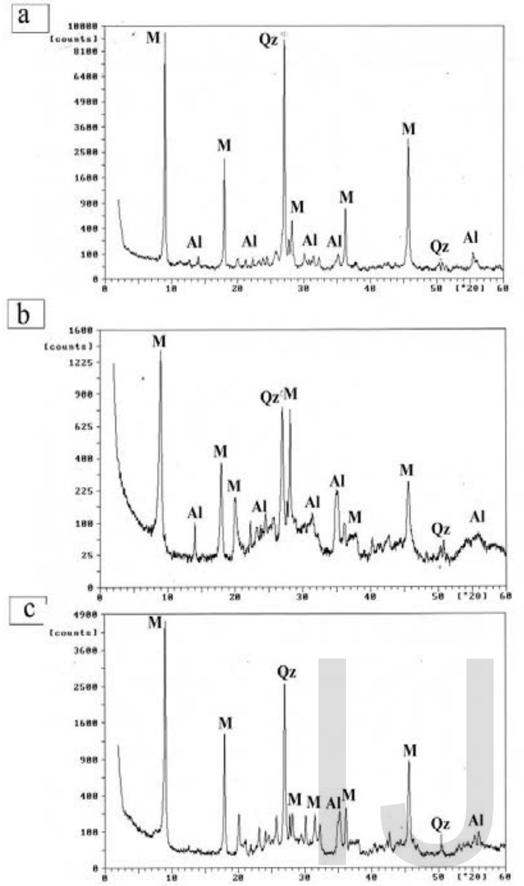

Fig. 1. XRD: (a) powder diffractogram of pegmatite muscovite. (b),(c) powder diffractograms of metasomatic muscovite. M= muscovite, Qz=quartz, Al=albite

4.2 Thermal analysis (DTA and TG)

One sample of the metasomatic muscovite and one sample of pegmatite muscovite were grounded with agate mortar and pestle and then sieved to less than 60 µm diameters and subjected to thermal analysis (d.t.a) and the thermo gravimetric analysis (t.g.a) at the Micro Analytical Centre, Cairo University, Egypt.

The thermal behavior was studied in nitrogen and the rate of heating is 10°C/min .for maximum temperature of 1200°C.

The results of analysis are shown in **figs (2,3).**The course of d.t.a and t.g.a curves of metasomatic muscovite **(fig.2 a,b)** indicates that the physically combined water is lost at nearly 80°C, with mass loss about 4%. The dehydroxilation starts at 650°C, and the maximum endothermic dehydroxilation reaction was at 927.3°C, with mass loss 2%, attributed to the removal of hydroxyl ions. The second endothermic peak temperature at 1121°C is related to the breaking up the muscovite crystal lattice.

TABLE 1
D-SPACING AND RELATIVE INTENSITIES OF FINE- AND COARSE-GRAINED MUSCOVITE

Coarse muscovite		fine – grained muscovite			
d (Å)	I / I $_0$	d (Å)	I / I $_0$	D (Å)	I / I $_0$
9.709	100	9.709	100	9.777	100
4.919	23.3	4.932	31.3	4.929	25.7
2.479	7.7	2.488	6.3	2.481	5.1
1.980	14	1.989	18.8	1.987	17.8

The thermal behavior of the pegmatite muscovite starts by removal of physically combined water at 86°C with loss of weight about 12.5 %. Then dehydroxilation reaction with endothermic peak at 845.6 °C, corresponding to liberation of the OH ions, with mass loss about 5 % **(Fig.3 a,b).**The second endothermic peak temperature is at 1094°C, corresponding to breaking the muscovite crystal lattice. **[5]** found that the ideal muscovite has tow endothermic peaks of reaction, the first at 845 °C, for dehydroxilation, and the second at 1100°C, for breaking the crystal lattice. The temperature of dehydroxilation and breaking up the crystal structure of the metasomatic muscovite are higher than those of the pegmatite Muscovite. This makes the metasomatic muscovite more valuable in industry.

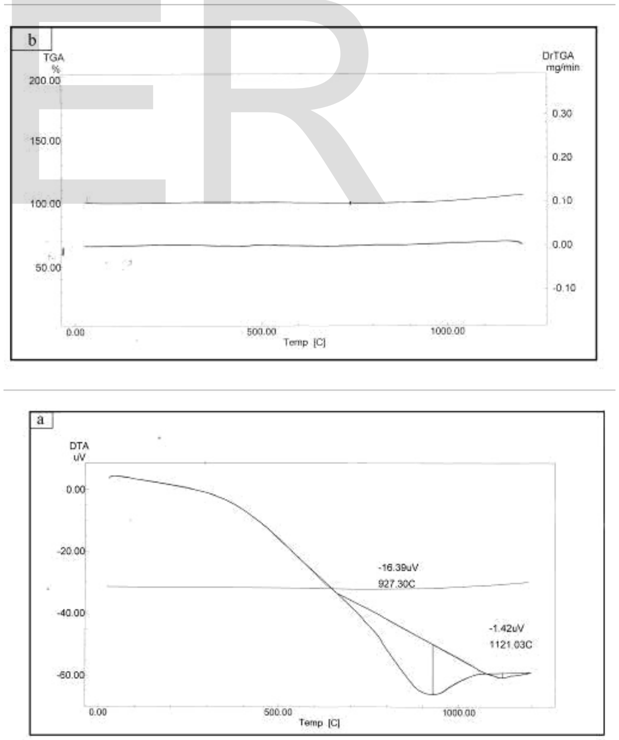

Fig. 2 (a) D.T.A and (b) T.G.A of metasomatic muscovite.

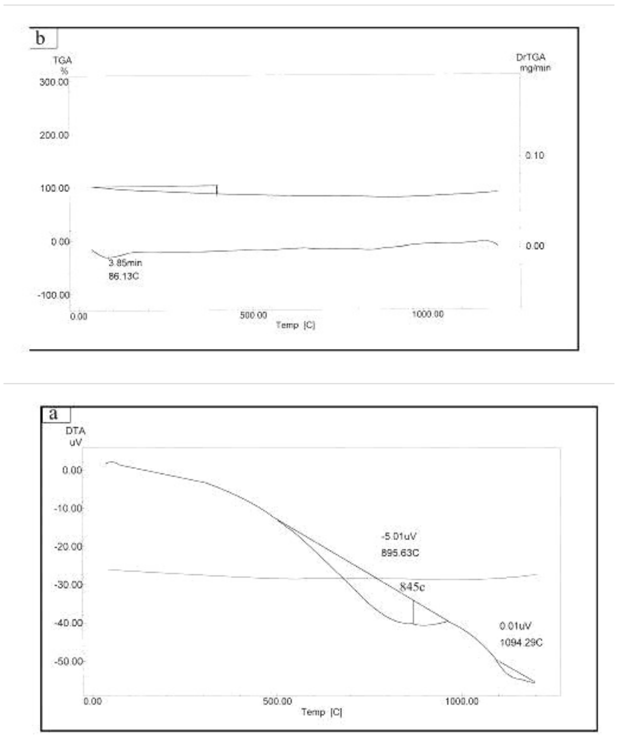

Fig. 3 (a) D.T.A and (b) T.G.A of metasomatic muscovite.

5 CHEMICAL ANALYSIS

Two representative samples, one from the metasomatic muscovite and one from the pegmatite muscovite were chemically analyzed for major elements. The results are presented in table (2).

From the table 2, the metasomatic muscovite has lower contents of K_2O, FeO, Al_2O_3, TiO_2, and L.O.I. and higher contents of SiO_2, Fe_2O_3 and Na_2O relative to the pegmatite muscovite.

TABLE 2
CHEMICAL COMPSITION OF STYDY MUSCOVITE

MAJOR OXIDES %	METASOMATIC MUSCOVITE	PEGMATITE MUSCOVITE
$Si\ O_2$	49.40	45.13
Al_2O_3	30.95	35.10
$Ti\ O_2$	00.03	00.09
Fe O	00.75	02.10
$Fe_2\ O_3$	03.70	00.80
Mn O	00.16	00.15
Mg O	00.76	00.98
Ca O	00.35	00.30
Na_2O	01.92	00.83
$K_2\ O$	09.21	10.20
L.O.I.	02.18	04.20
Total	99.41	99.88

6 DIELECTRIC PROPERTIES

At room temperature (25 °C) with different frequencies, the capacitance of the metasomatic muscovite and pegmatite muscovite was measured using LCR HITESTER. Model 3532 (Japan).The estimated values are 226 E and 54 E for the metasomatic and pegmatite muscovite respectively.

7 SPECIFIC GRAVITY

The specific gravity of the metasomatic and pegmatite muscovite has been measured by Pycnometer. The measured values are 2.7 and 2.9 for the metasomatic and pegmatite muscovite respectively. **[4],** attribute the light specific gravity to the expanded structure of mineral formed under high temperature and lower water vapor pressure.

8 CONCLUSIONS

The metasomatic muscovite characterized by 1) lower contents of K_2 O, Al_2 O_3, Fe O in comparison with the pegmatite muscovite, 2) lower density and higher dielectricity relative to the pegmatite muscovite, 3) higher peak temperature of dehydroxilation and breaking up of crystal structures than the pegmatite muscovite, 4) slightly larger in d- spacing (Å) with respect to the pegmatite muscovite.

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REFERENCES

[1] Shih,Y.J. and Shen ,Y.H.., Swelling of sericite by LiNO3-hydrothermal treatment ,Applied Clay Science, 43(2), PP.282-288, 2009.

[2] Tomita, K. and Sudo, T., Transformation of sericite into an interstratified mineral, Clays and Clay Minerals, 19, pp.263-270, 1971.

[3] Jackson, M. L. and Sherman, G. D. , Chemical weathering in soils, Advances in Agronoy, Academic Press, 5, pp. 19—318, 1953.

[4] Dana, D.J. , Mineral science, 23 rd edition, Wiley, 681 pp, 2007.

[5] Melboume,V.,A hydromuscovite with 2 M2 structure ,from ,(Mount Lyell ,Tasmania). American Mineralogist, 44, PP.488-494, 1959.