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Aleppian Belon Analysis with X-ray Diffraction

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Abstract

The results of an X-ray diffraction experiment performed on the Aleppian Belon have shown that the natural and the processed Belon with solvents LiCl, KCl and NaCl are composed of Ankerite, Leucite, Halloysite, Quartz and $CO_2AL_2O_5.8H_2O$. The proportion of these found components varies depending on the quality of the solution which treated the Belon. An unusual growth in the presentation of the peak 001 and the disappearance of some basic reflection curves 00L are noticed. The results have also shown that the Belon is made of layers in a random arrangement and different nature. It is composed of sheets of thickness 8A° approximately with weak binding forces. This explains the many applications of the this material in different areas and its effectiveness in securing open areas of interface between sheets to assist in the detention of a lot of different materials between them.

Introduction

Clay argyle is a raw material used since ancient times due to its flexibility and its water absorption in manufacturing statues and in ceramic industry used in daily life, particularly in collecting and preserving beverages and preservation of grain. Now all eyes are turned towards the use of clay in underground reservoirs for storage of nuclear waste.

Clay materials play an important role as a result of their distinct physical and chemical properties. They are composed of sheets similar to the Mica sheets. They are subject to swelling and disintegration when injected with water or some organic molecules. This is due to the differences in the intensity of the strong bonds between atoms at the level of the same sheet and the weak bond elsewhere. The infiltration of certain molecules or ions to the space interface causes important disorders and helps in obtaining new materials with many applications such as in the manufacturing of thin film, reflectors, coloring, optical and mediation in the petrochemical industry, ceramics, paints, pharmaceutical industry, agricultural and the oil industry. Clay plays a key role with its absorbance ability of organic compounds and composition of organic dissolved material. It is the material of the future and at the present time scientists are concentrating their research in the field of clay silicate materials to find new compounds with new features and properties by adding one or more material in different proportions to the basic raw material and studying the impact of these additions (pressure, temperature, humidity) on its properties (electrical, magnetic, mechanical, thermal, physical and chemical). The area of physical chemistry has achieved the most important development of these innovations. It gave these silicates a distinctive economic importance because of its characteristics, qualities, abundance and multiple areas of use [1-4].

Aleppian Belon is a clay material, found in abundance in the Syrian Arab Republic and in particular in areas of the city of Aleppo. It has large surface structure. It has many uses and wide applications due to its abundance and its porous properties and, especially in the field of cosmetics, liquid and gas chromatography and in industrial contaminated water treatment, where it is highly effective in detaining and removing suspended material in contaminated water by heat and acid treatment. Aleppian Belon is a mud-rock made of Silica in the shape of small particles of diameters less than 2 microns. It is a very complex clay material; it consists of layers of different nature and characteristics. The examination of the differential thermal analysis of the natural purified and processed Aleppian Belon show that it consists of: Montmorillonite, Nontronie, Palygorskite and Illite [5,6].

The Aleppian Belon has a mix structure of eight faces in some of its components and four faces in others. When subjected to X-ray in a diffraction experiment, the reflections 00L and the disappearance of some peaks with an abnormal increase in the presentation of the peak 001 is noticed.

The essential dimension **d** is found using the Prague relationship:

$$d = \frac{\lambda}{2 \sin \theta}$$

Where θ: Prague angle and λ: the ray wave length.

The average number of sheets **M** making the sample and derived from the experimental curve of the reflection 001 is determined from the following relationship:

$$M = \frac{0.9\lambda}{d.\Delta(2\theta)\cos\theta} (Cuinier\ ,1964)$$

Where: $\Delta(2\theta)$ measured in radians, represents the angular width of half the height of the top 001 reflection.

The objective

The objective of this study is to determine the components of the natural Aleppian Belon, compare the results to past studies and then determine the effect of positive ions on the Aleppian Belon interface and calculate its thickness by finding the average number M of sheets [7].

Preparation of the sample

The Aleppian Belon Powder samples were prepared from a selection of pure solid pieces after removing all impurities from them. The results were then treated in ordinary solvents such as LiCl, KCl and NaCl according to the following chemical reactions:

$NaCl + Belon\text{-}Ca^{2+} \Leftrightarrow CaCl_2 + Belon\text{-}Na^{+}$

$KCl + Belon\text{-}Ca^{2+} \Leftrightarrow CaCl_2 + Belon\text{-}K^{+}$

$LiCl + Belon\text{-}Ca^{2+} \Leftrightarrow CaCl_2 + Belon\text{-}Li^{+}$

In each reaction, the balance shifts towards the formation of Belon sodium, Belon potassium and Belon lithium. After the deposition phase to remove the resulting solution $CaCl_2$ through sedimentation, the samples were subjected to dialysis with distilled water. The process is then repeated more than a dozen times. The samples are dried outdoors and finally mashed into a powder ready for the study [8, 9,10].

Procedure

Samples were studied using an X-ray diffraction apparatus JDX-3530 with radiation Cu $K_{\alpha 1}$ of wavelength $\lambda = 1{,}5405\ \overset{o}{A}$. At room temperature and with a rate of increase in angle of 0.02, count measurements are taken every second at each increase in order to do a component analysis of the Belon, identify its metal components, and show the role of the Cation solution in the proportion of its elements and components. These samples were also submitted to an X-ray Mo $k_{\alpha 1}$ radiation using X-ray apparatus 55481 of wavelength $\lambda = 0{,}71\ \overset{o}{A}$. The 001 reflection, the fundamental spatial distance $\mathbf{d}_{001}$ and the average number of sheets **M** in each sample are measured and finally the thickness of the Belon is determined by the known relation: **H** = **M**x**d**.

Results

The following graphs and tables show the various results of the Belon experiments in its natural form and processed with LiCl , KCl and NaCl solvents using X-ray diffraction JDX-3530 under the same conditions (time, voltage, current intensity):

Figure 1 shows the Belon in natural powder form (Sample Name: Ca):

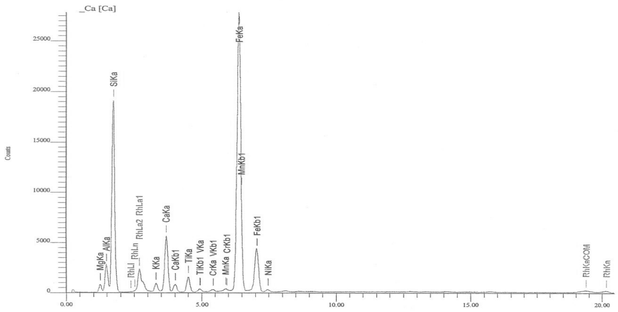

Figure 1: Sample – Ca.

It is made of:
(%5.9134) Mg, (%9.046) Al, (% 42.2363) Si, (% 2.0165) K , (%10 .0816) Ca, (% 2.1792) Ti, (% 0.0909) V, (% 0.1858) Cr, (% 0.2809) Mn, (% 27.6517) Fe, (% 0.3173) Ni.

The following table shows the various components making the Belon in its natural powder form (Sample Name: Ca):

Table 1

No.	Chemical formula	wt(%)	Mineral name
1	$Ca(Fe.Mg)(CO_3)_2$	21%	ANKERITE
2	SiO_2	46%	QUARTZ
3	$Ca_2Al_2O_5.8H_2O$	15%	-
4	$K\ Al\ Si_2\ O_6$	7%	LEUCITE
5	$Al_2\ Si_2\ O_5\ (OH)_4$	12%	HALLOYSITE-7A

Figure 2 shows the Belon in processed form (Sample Name: Na):

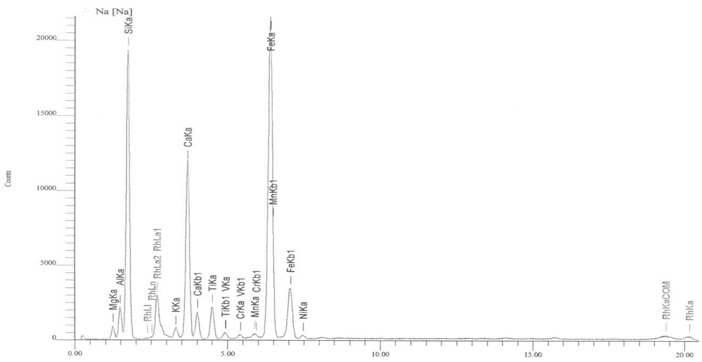

Figure 2: Sample – Na.

It is made of:
(%6.2206) Mg, (%6.2232) Al, (% 38.0023) Si, (% 1.5453) K, (%20.5649)Ca, (% 3.4873) Ti, (% 0.1183) V, (% 0.2591) Cr, (% 0.3648) Mn, (%22.9163) Fe, (% 0.2979) Ni.

The following table shows the various components making the Belon in its processed form (Sample Name: Na)

Table 2

No.	Chemical formula	wt(%)	Mineral name
1	$Ca(Fe.Mg)(CO_3)_2$	34%	ANKERITE
2	SiO_2	52%	QUARTZ
3	$Ca_2Al_2O_5.8H_2O$	7%	-
4	$K\ Al\ Si_2\ O_6$	5%	LEUCITE
5	$Al_2\ Si_2\ O_5\ (OH)_4$	2%	HALLOYSITE-7A

Figure 3 shows the Belon in processed form (Sample Name: K):

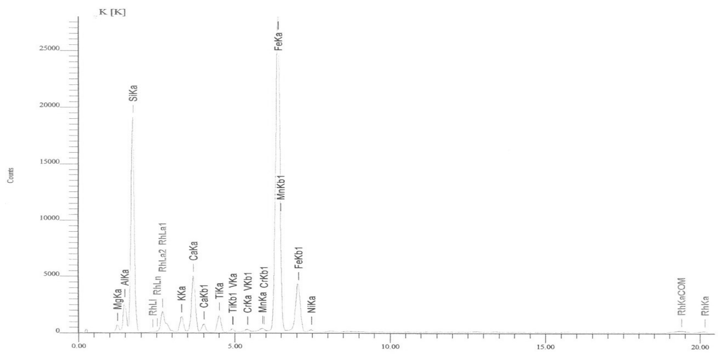

Figure 3: Sample – K.

It is made of:

(%5.1066) Mg, (%8.9408) AL, (% 41.9556) Si, (% 3.3784) K, (% 9.2607) Ca, (% 2.2093) Ti, (% 0.0685) V, (% 0.1970) Cr, (% 0.3230) Mn, (% 28.2611) Fe, (% 0.2990) Ni.

The following table shows the various components making the Belon in its processed form (Sample Name: K)

Table 3

No.	Chemical formula	wt(%)	Mineral name
1	$Ca(Fe.Mg)(CO_3)_2$	20%	ANKERITE
2	SiO_2	46%	QUARTZ
3	$Ca_2Al_2O_5.8H_2O$	17%	-
4	K Al Si_2 O_6	5%	LEUCITE
5	Al_2 Si_2 O_5 $(OH)_4$	12%	HALLOYSITE-7A

Figure 4 shows the Belon in processed form (Sample Name: Li):

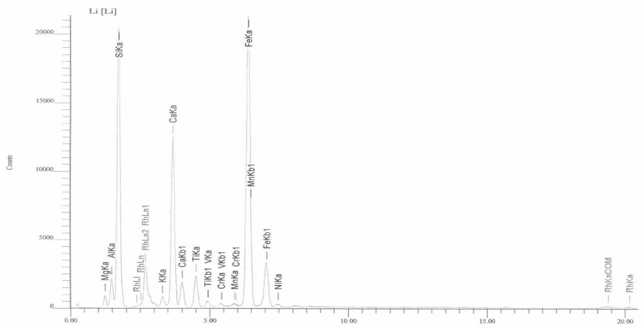

Figure 4: Sample – Li.

It is made of:
(%6.2038) Mg, (%5.8727) Al, (% 38.7130) Si,(% 1.5967) K, (% 20.9673) Ca , (% 3.7228) Ti,(% 0.1105) V, (% 0.2330) Cr, (% 0.2497) Mn,(% 22.0808) Fe, (% 0.2496) Ni.

The following table shows the various components making the Belon in its processed form (Sample Name: Li)

Table 4

No.	Chemical formula	wt(%)	Mineral name
1	$Ca(Fe.Mg)(CO_3)_2$	27%	ANKERITE
2	SiO_2	64%	QUARTZ
3	$Ca_2Al_2O_5.8H_2O$	9%	-

It is clear from the foregoing that the proportion of the constituent elements of the processed Belon with LiCl, KCl and NaCl is different than the natural Belon with respect to the Cation rate, since the radii of these Cations are: R_{Na} = 0.98 A°, R_K = 1.33 A° and R_{li} = 0.68A° and the components of the samples (Sample Name: Ca), (Sample Name: Na) and (Sample Name: K) are all similar and different in proportions. The sample (Sample Name: Li) lacks the metals: LEUCITE and HALLOYSITE-7A and differs from the other samples by its components.

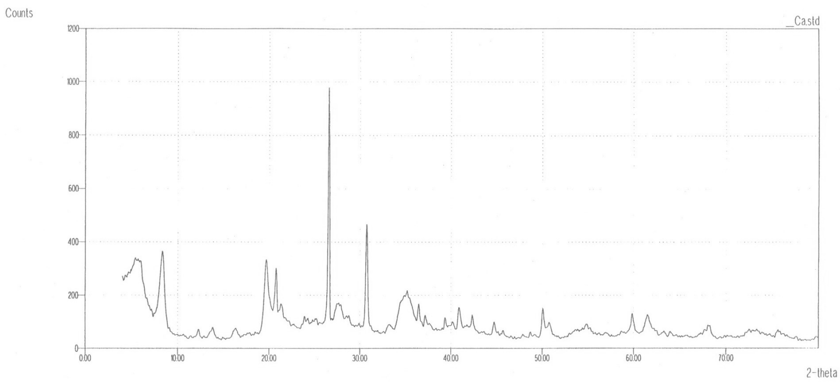

Figure 5: Sample – Ca.

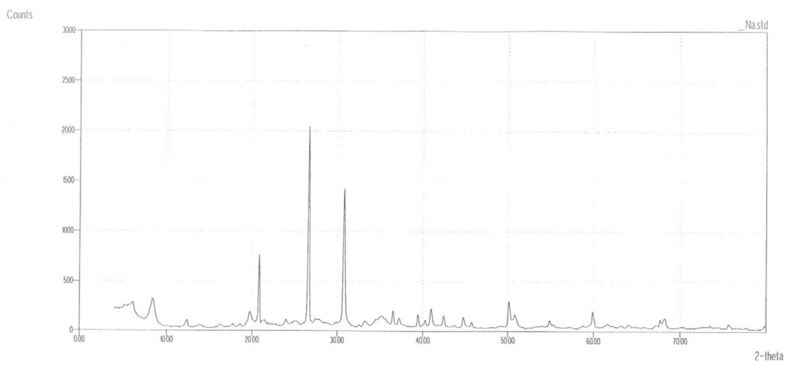

Figure 6: Sample – Na.

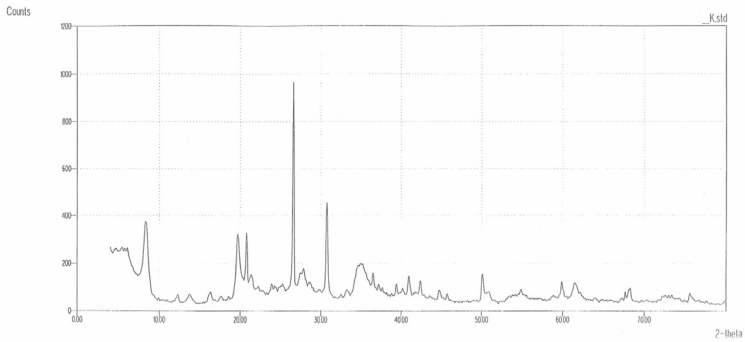

Figure 7: Sample – K.

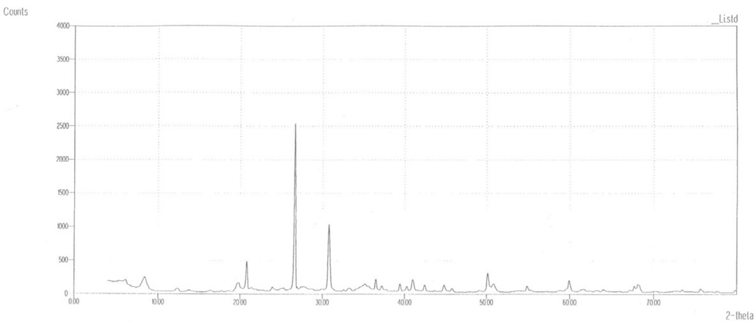

Figure 8: Sample – Li.

The above figures (5), (6), (7) and (8) show that there are differences in the intensity of the peaks in the natural and processed Belon. Some peaks are not there in the processed Belon compared to the natural one.

The following figures (9), (10), (11) and (12) were obtained using X-ray apparatus 55481

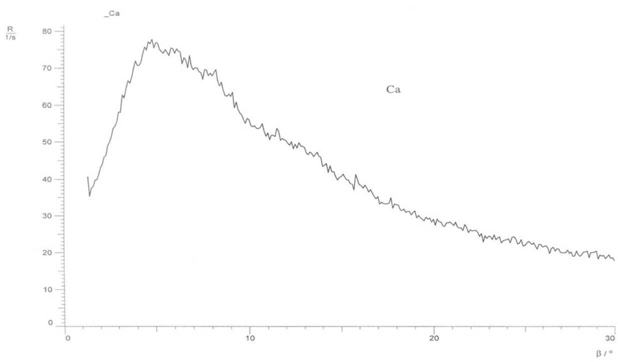

Figure 9: Sample – Ca.

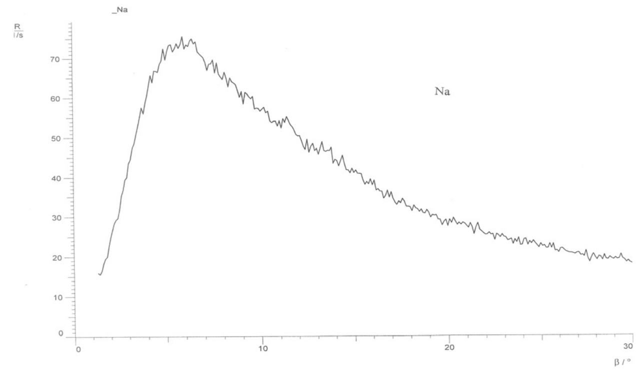

Figure 10: Sample – Na.

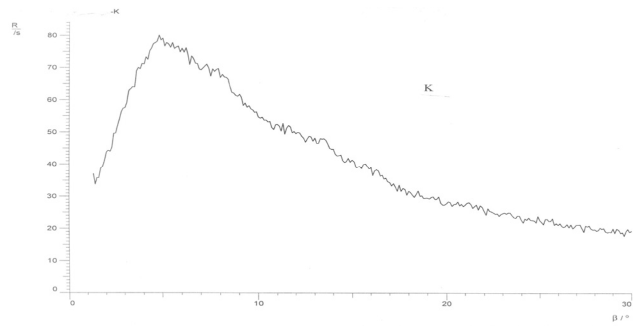

Figure 11: Sample – K.

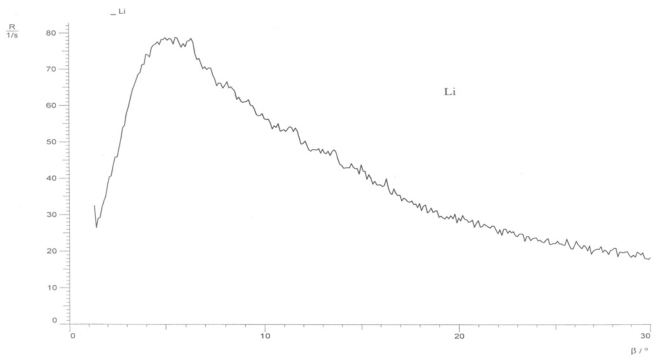

Figure 12: Sample – Li.

They show that the essential spatial distance corresponding to the central peak (001) is approximately **d** = 8 A ° with the disappearance of the rest of the peaks and the abnormal increase in the width of the central peak (001). From the experimental (001) reflection curve, we find that the average number of sheets constituting the sample is around 1 and the values of θ and $\Delta(2\theta)$ [7] are as shown in Table No. (5):

Table 5

Parametre / Sample Name	$^{\circ}\theta$	Rad $\Delta\ (2\theta)$	d(A$^{\circ}$)	M	H(A$^{\circ}$)=Md
Ca	2.5	0.087	8.14	1	8.14
Na	2.5	0.087	8.14	1	8.14
K	2.5	0.087	8.14	1	8.14
Li	2.5	0.087	8.14	1	8.14

Discussion

Comparing the study of the natural and processed Belon using X-ray with previous differential thermal analysis studies have demonstrated that there are major differences in its components. The X-ray study has shown that it consist of: Ankerite, Leucite, Halloysite, Quartz and $CO_2AL_2O_58H_2O$, whereas, the studies of the differential thermal analysis has shown that the Belon consists of: Montmorillonite, Nontronie, Palygorskite and Illite. This difference is due to the different areas from which such samples were chosen in the city of Aleppo in Syria.

The study has also shown that the Belon processed with the solvents LiCl, KCl and NaCl display major differences. This is due mainly to the irregular space between the sheets, the negative charge source which is far from the interface and to the positive monovalent ions on the hexagonal [11]. The difference is also due to the components of Belon and their proportions in addition to the essential spatial distance which is approximately d = 8A $^{\circ}$ and to the disappearance of most of the peaks of 00L in the graphs of the processed Belon used. There is an irregular increase in the width of the Summit 001 due to lower average number of sheets making the sample and measured experimentally around one approximately. This number is small because of the weakness in the mutual attraction of the sheets and has no significant impact on the basic reflection curves 00L [12]. However its effect is in the width the top 001; as the number of leaflets consisting of the sample increases, the width of the summit decreases. Given that the sample is composed of one sheet, this explains the high efficiency of the Aleppian Belon in the removal of materials in industrial water withheld in the spaces between the sheets that are bound together by weak forces and hence the multiplicity of its uses in different areas.

Since the monovalent Cations Na^+, K^+ and Li^+ of the solvents used in the treatment of the natural Belon replace the Cation Ca^{+2} they cause a re-arrangement of the coordinates in the distribution of the ions. This explains some of the differences between the spectrum of the natural Belon and the processed one, in addition to the difference in the proportion of metals in the Belon samples.

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