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The Optimization of Efficient Sampling Method Regarding the uses of the Portable XRF Analyses in the Field

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Abstract:- This research is divided to explain how the researcher can reduce the number of the field samples which will be sent to the laboratory for analysis. The implementation of the insitu results by using the portable X-ray fluorescence (XRF) device is a vital method to minimize the number of samples needed to be transported to the laboratory for XRF investigations and the consecutive ICP analyses. The comparison of the insitu results and the laboratory results emphasize this fact.in this study the number of the samples was 79 samples sent to the laboratory, were the number of samples can be reduced to 19 samples by using the portable XRF device in the field. The area was sub divided into equidimensional elements where, the nodes at each two line intersection are considered as a sample target.

Keyword:- *XRF, Portable XRF, Node.*

I. INTRODUCTION

The XRF analysis method depends on the characteristic that the X-rays fluorescent can be generated when X-rays irradiate a substance. These rays are electromagnetic waves that can be created when irradiated inner-orbit electrons of the constituent atoms moves to an outer orbit electron prompt. These fluorescent X-rays possess energies that are characteristic to each type of element enabling qualitative analysis by using Moseley's law and quantitative analysis by using the X-ray energy intensity of each element (number of photons) [1]. XRF analysis is a spectrochemical analysis within an X-ray region; it has the same characteristic as an atomic absorption spectrometry and optical emission spectrometry, except that the sample does not need to be dissolved in a solution to be analyzed [2].

The X-ray fluorescence device excites the sample to obtain information from X-ray emissions from different constituting atoms. Therefore, the XRF analyses are best for quality assurance and route control requirements across a diverse range of applications [3]. The non-destructive elemental analysis in solids by implementing the XRF technics can be utilized from beryllium (Be) to Uranium (U), the concentration range goes from (sub) ppm levels to 100%. XRF method is fast, safe, and clean. Precision and reproducibility of XRF analysis is very high, these analyses are applicable for liquids, powders and thin films [4].

In this research 79 samples were analyzed in the laboratory and the same samples were analyzed by portable XRF, both methods showed the same results .therefore we can use the portable XRF insitu to exclude the unpromising areas. Then the cost will be minimized. The commercial percentage of copper in its ore deposits should be more than 0.5%, but preferably more than 2%.

II. METHODOLOGY

The target area can be subdivided into regular or irregular mesh depending on the topography or/and the shape of the area with a suitable number of regular or irregular cells. Then the cells can be numbered in their center systematically in clockwise or anti clockwise order. By the same manner the intersection between any two lines represents a target node at which a sample may be taken (Fig 1). Therefore, the samples can be taken at each node or at the center of each element to reduce the number of samples depends on the desired accuracy [5].

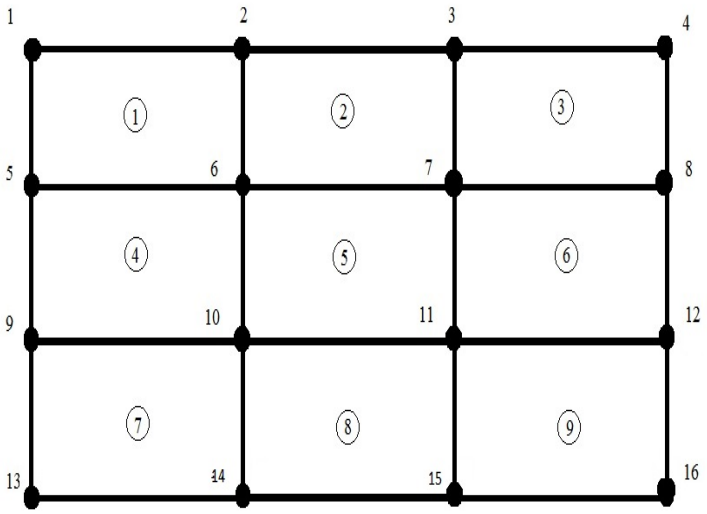

Fig 1:- The Regular Mesh Sampling Model

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The field analyses for in situ tests are the key for constructing a map, which contains the grid with the lattice points which, represents the target nodes for sampling process. The Bruker® handheld XRF analyzer is a practical elemental analysis requirement for many types of material. This equipment is an efficient tool to detect the presence of any target element, therefore, excluding the sampling of the grid elements with absence or have low percentages of the mineral under the scope of research.

Another sampling model is the propagating circles model in which a number of points are randomly chosen to be investigated either insitu or in the laboratory. Thereafter, the point with the high concentrations can be used as central points of a circle were its diameter increases continuously in a regular span until it intersect with other circle (Fig.2).

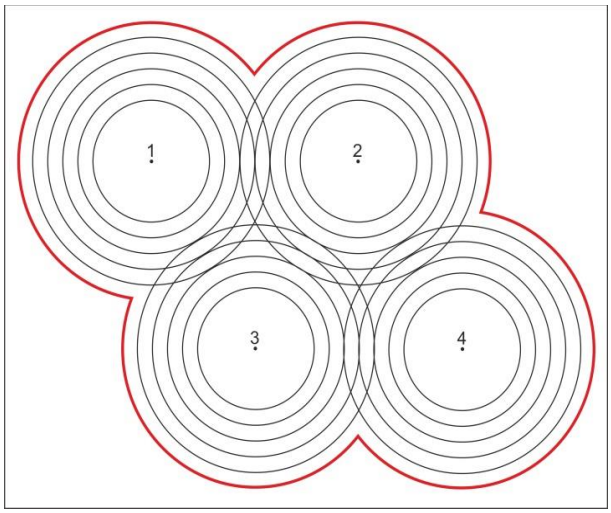

Fig 2:- The Propagating Circles Sampling Model

III. RESULTS AND DISCUSSION

The randomly sampled area of study with 200 samples which were sent to the laboratory, seventy nine of them were analyzed. The laboratory XRF analyses of the received samples from the sandstone deposits found in the southern part of Jordan were analyzed quantitatively [6] and the obtained results are shown in Figure 3.

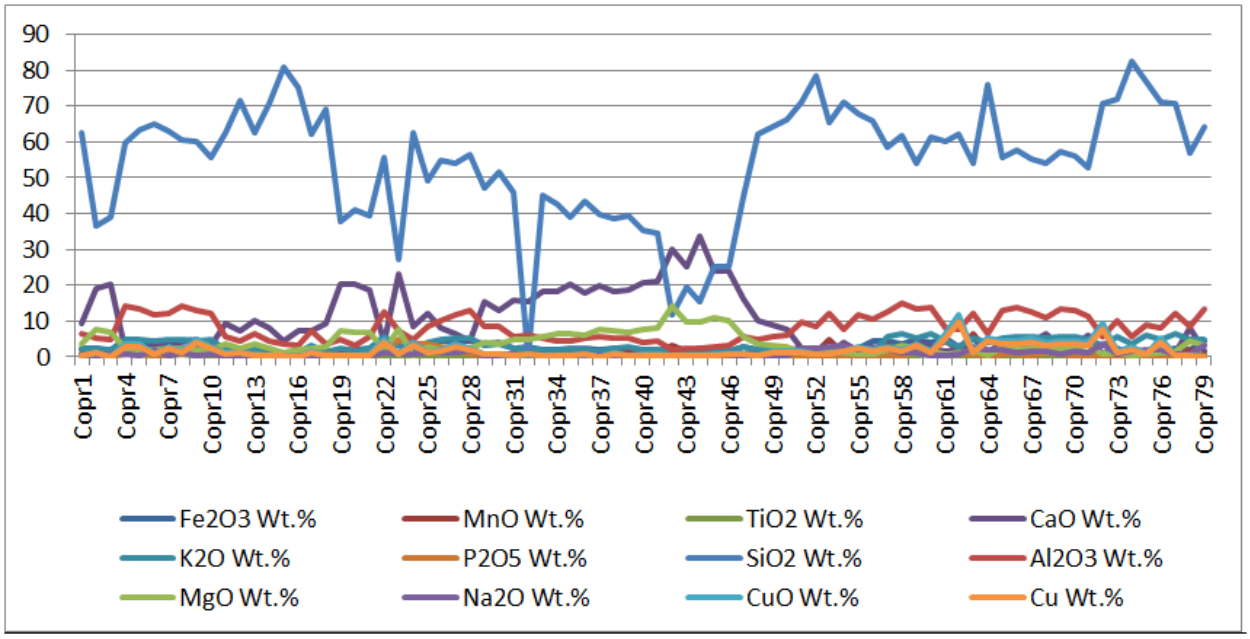

Fig 3:- The XRF Results of Oxides in 79 Samples

Generally, all the results drew in figure 1 show that many of the results are intersecting each other at different stages of the analyses. These results indicates that the relationship between these minerals differ according to the place of deposition. Therefore, these results are consistently increase or decrease in some places while they are intersecting in other areas, then these minerals can be excluded from the progressing study in the next stages. In this case study, it is obvious that TiO_2, P_2O_5 and Na_2O can be excluded from any succeeded investigations. It is clear that SiO_2 make many intersections with other minerals that mean to exclude it from proceeding study. Deeper investigation shows the irregular relation with many intersections between the MnO, CaO, K_2O and MgO.

These results were used to construct the relations between different elements by means of their oxides contents. Only 19 samples contains above 3% copper oxides (Table 1).

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S.ID.	Fe_2O_3	MnO	TiO_2	CaO	K_2O	P_2O_5	SiO_2	Al_2O_3	MgO	Na_2O	CuO
Copr04	4.92	0.83	0.59	1.78	4.99	0.62	59.6	14.3	2.21	0.68	3.68
Copr05	4.38	0.8	0.56	1.78	4.79	0.59	63.6	13.4	1.9	0.19	3.53
Copr09	4.89	1.01	0.55	2.41	4.34	0.87	60.3	12.8	1.88	0.49	5.02
Copr22	4.21	0.8	0.43	4.04	5.46	1.18	55.7	12.5	1.92	1.28	4.95
Copr24	1.51	1.7	ND	8.53	2.54	3.66	62.6	4.91	0.55	0.9	4.1
Copr27	4.34	0.99	0.35	6.29	5.21	2.27	54.2	11.8	1.93	1.13	3.62
Copr59	4.72	2.53	0.48	4.93	5.2	1.96	54.1	13.5	2.27	1.12	3.8
Copr61	5.16	4.52	0.09	1.58	4.27	0.62	60.2	8.21	0.93	0.44	6.5
Copr62	2.98	2.01	0.13	1.91	2.71	0.58	62.1	7.57	1.1	0.69	11.9
Copr64	1.02	0.99	0.1	0.72	4.14	0.12	75.9	6.31	0.41	2.09	5.32
Copr65	3.84	1.16	0.49	3.22	5.42	0.56	55.8	12.8	2.97	1.94	4.51
Copr66	4.05	1.04	0.49	2.62	5.59	0.62	57.8	13.6	2.25	1	4.4
Copr67	4.38	1.16	0.54	3.84	5.58	0.55	55.2	12.7	2.38	1.46	5.14
Copr68	3.63	1.29	0.45	6.29	5.37	1.03	54	11.1	2.48	1.4	3.92
Copr69	3.91	1.16	0.48	2.94	5.77	0.61	57.5	13.2	2.14	0.94	4.41
Copr70	4.1	1.41	0.51	3.21	5.52	0.55	55.9	13	2.42	1.48	4.42
Copr71	3.56	1.26	0.41	6.11	4.74	0.49	53	11.2	3.24	1.33	4.04
Copr72	0.71	0.11	0.08	0.89	3.25	0.09	70.8	5.64	0.74	3.46	9.38
Copr76	1.46	0.31	0.24	0.9	4.73	0.14	71.3	7.92	1.32	1.8	5.05

Table 1:- The XRF Analyses of Oxides % in the Sandstones in South Jordan

These results are distributed on three spatial districts of high CuO concentration. The first area covers the group of samples from sample 3 to sample 9, the second group of samples involves the samples 22 to 27 and the third group consist of the samples 62 to 72 (Fig. 4).

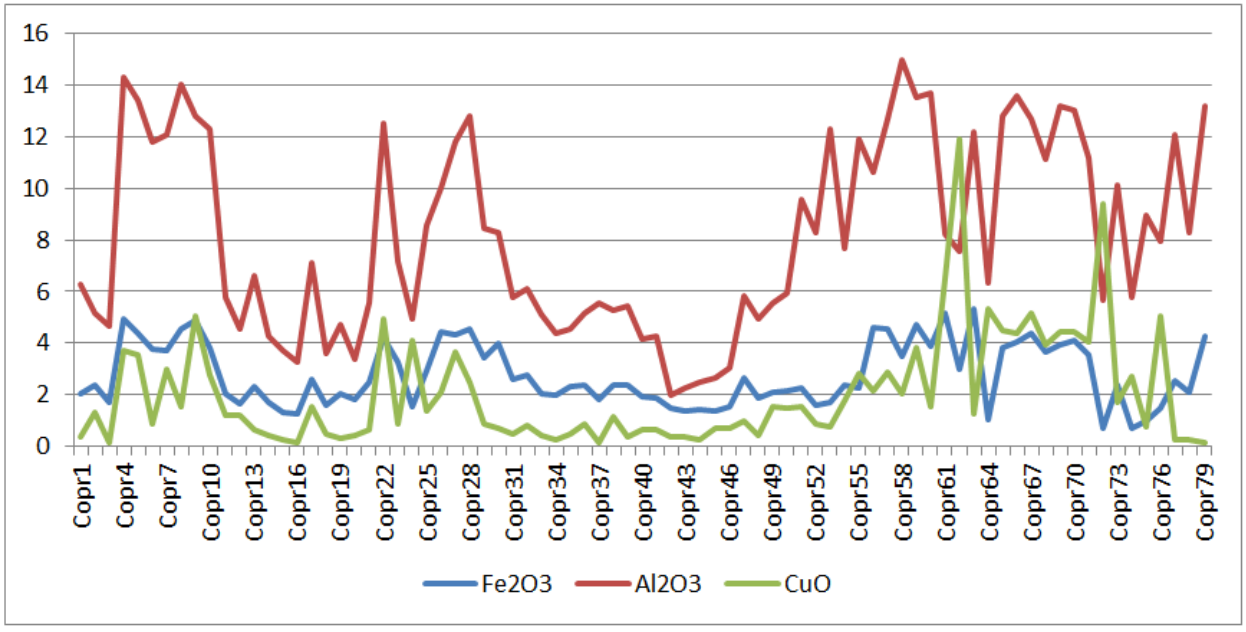

Fig 4:- The XRF Results of Fe, Al and Cu Oxides

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The field analyses results are forming the base of sampling scheme. The field areas with absence or with low values are excluded from sampling program. Then the isolation of the irregularly intersected results gives a more consistency in the results of the remained minerals, Figure 5. It is clear that Fe_2O_3, Al_2O_3 and CuO are compatible with each other in almost all deposition places. Therefore, iron and aluminum ores are considered as associated deposits with the cupper deposits. The comparison between the concentrations of CuO and the correlated Fe_2O_3 concentrations in the same samples shows that these two minerals are consistently comparable.

The same results can be found by analyzing the field samples taken from the whole area; therefore, the number of samples can be minimized in the field using the portable XRF (Fig. 5). This figure indicates the presence of the three different areas of high concentrations of CuO. This result is consistent with the previously found laboratory XRF results.

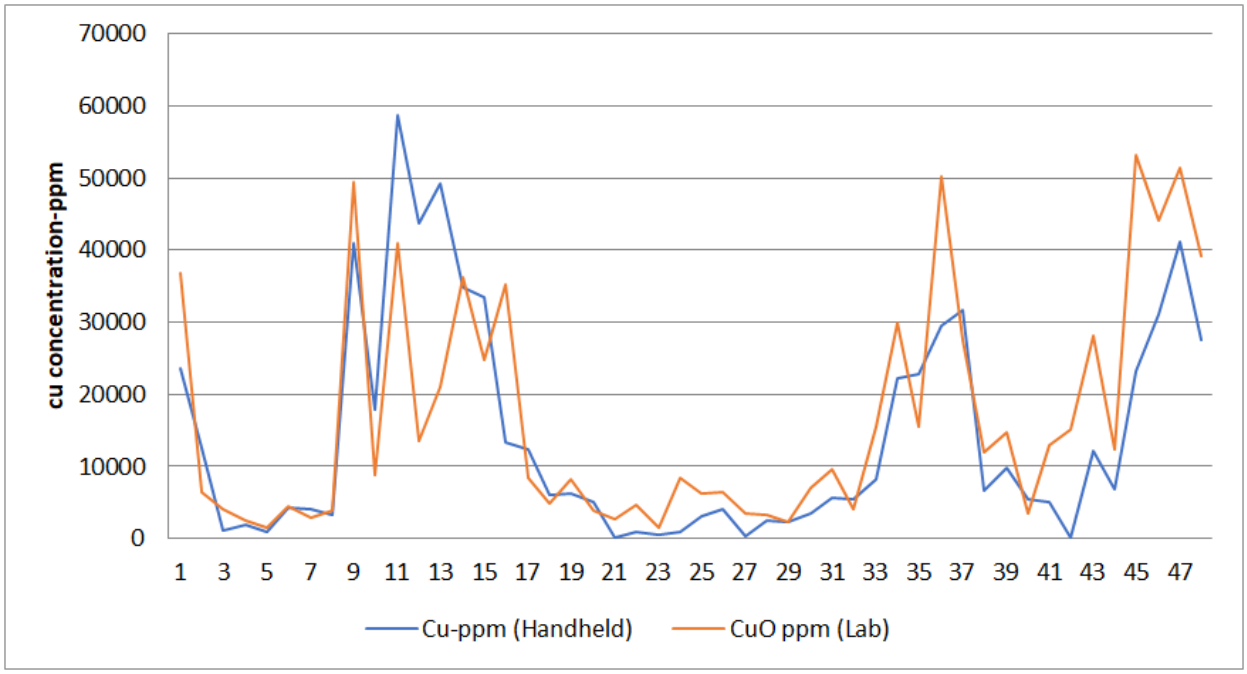

Fig 5:- The Comparison between the Laboratory and the Portable XRF Results

Forty eight samples of the seventy nine total samples were investigated by the portable XRF device. The result indicates that only eleven samples contain more than 3% CuO (Table 2).

Copr-1	3.68
Copr-19	4.95
Copr-19b	4.1
Copr-19e	3.62
Copr-2	3.53
Copr-4	2.98
Copr6	5.02
Copr-2-8	5.32
Copr-3-2	4.4
Copr3-3	5.14
Copr-3-4	3.92

Table 2:- The oxides % Results Obtained from Portable XRF Device

IV. CONCLUSIONS

The sampling model is effectively reducing the number of samples required to represent the study area from 79 to 19 samples. That is the target area can be discretized into a mesh with a number of elements where each node on the elements represent a probable sample site. The insitu test of each sampling node lead fixes or omits the sampling choice.

Depending on the results of the portable XRF analyses in the field the number of samples in the target area are the base to decide whether to proceed to ICP test or to exclude it.

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