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ELEMENTAL ANALYSIS OF SOME WEST MALAYSIAN LIMESTONES USING NEUTRON ACTIVATION, DELAYED NEUTRON AND ELECTRON MICROPROBE ANALYSIS

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Abstract

Limestone stratigraphy in Malaya has been and is dependent almost entirely in palaeontology. However fossil localities are sporadic and as such a new fossil discovery mean the necessity for a complete re-appraisal of the stratigraphy. The almost complete dependence upon palaeontology results from the difficulties of stratigraphy correlation of isolated outcrops, from the cover of tropical vegetation and from the often complex folding and faulting which has been imposed on the geosyn-clinical rocks by the Indonesian-Thai-Malayan orogeny. So by studying the elemental composition of limestones accurately, we would be able to correlate outcrops and other stratigraphic samples independent of fossil finds. The used of delayed neutron analysis would also determined the concentration of uranium and thorium accurately. This study, in conjunction with thermoluminescence and fission tracks studies, would able us to date the age of the limestones.

Introduction

Thermoluminescence properties of an inorganic substance can be altered by the presence of impurities. The presence of impurities such as Fe^{2+} ions in appreciable amounts (a few thousand parts per million) can quench the luminescence (Pierson, 1981). In thermoluminescence dating, measurements on the natural thermoluminescence sensitivity (defined as light output per unit test dose) are necessary in determining the age of a particular rock. Elemental analysis of the limestone samples to be dated using thermoluminescence intensity can be reduced by the presence of certain types of impurities. The natural radiation dose can be calculated once the concentrations of uranium and thorium in the limestone samples are known.

Experimental Method

The limestone samples studied were obtained from different parts of West Malaysia. The origins of the limestone are given in Table 1. Elemental analysis was done on a Phillips EDAX PV9800 system. Uranium and thorium contents were analysed using Delayed Neutron Analysis (DNA) and Neutron Activation Analysis (NAA) at PUSPATI. A proportional counter filled with Boron trifluoride (BF_3) was used to detect delayed neutrons and a high purity Germanium detector was used in NAA.

Results and Discussions

The results obtained using the EDAX system on some of the limestones are shown in Figure 1. These graphs shows that the limestones are mainly made up of calcium carbonate except for the case of Kodiang A. The size of the calcium and magnesium peaks indicates that the sample Kodiang A is dolomite (calcium magnesium carbonate).

In most cases where impurities are present, the iron K_α line is detected. Detection of iron ions is important because its presence as Fe^{2+} can quench the luminescence. The presence of 2 weight % FeO in the sample Kodiang B may render it non-luminescent. However the presence of Al, Si, and Mg in the limestones studied will not be expected to alter its luminescence properties.

The concentration of uranium and thorium in the limestones studied are shown in Figure 2 and Figure 3. Uranium concentrations obtained using DNA are slightly lower than from NAA. The minimum detectable uranium concentration is about 0.3 parts per million. However DNA can be used to determine the thorium concentration accurately if the thorium concentration is higher than 7 ppm and higher than the uranium concentration. Results from DNA and NAA show that limestone from Kodiang contains the highest uranium and thorium contents with proximity of the limestone to igneous rocks. We would expect samples from Gua Musang (samples D,E,K,L,N and O) which lies close to igneous rocks to show higher uranium and thorium concentrations than the rest. However the activity of uranium and thorium in the limestone studied is in the range 0 to 0.05 Bq per gram and this is in agreement with that reported by Hutchinson (1968).

Conclusions

The elemental analysis show that the limestones are mainly calcium carbonates. Impurities detected are silicon, aluminium, magnesium, potassium and iron. These elements occur in low concentrations except for samples Kodiang A and Kodiang B where magnesium and silicon respectively occurs in appreciable concentrations. Uranium and thorium concentrations are very low in limestones and their respective activities are in agreement with previously published results.

References

[1] Pirson, B.J. *Sedimentology*, **28**: 601-610 (1981).
[2] Hutchinson C.S. in *Themoluminesence of Geological Materials,* D.J. Mc Dougall (ed.) Academic Press, New York (1968) p. 341-358

Table 1 Type and Origin of The Limestones Studied

Type of Sample	Label	source	Weigh used for irradiation g
Limestone	A	Kodiang	0.2123
	B	Kuala Perlis	0.2523
	C	Kodiang	0.2095
	D	Gua Musang (A1)	0.2205
	E	Gua Musang (AB)	0.2085
	F	Ampang	0.2385
	G	Langkawi	0.2266
	H	Kaki Bukit	0.2203
	I	Perlis	0.2201
	J	Cuping	0.2083
	K	Gua Musang (C)	0.2017
	L	Gua Musang (B)	0.2383
	M	Kala Bukit	0.2346
	N	Gua Musang (A2)	0.2070
	O	Kota Tinggi	0.2196
	P	Kuantan	0.2240

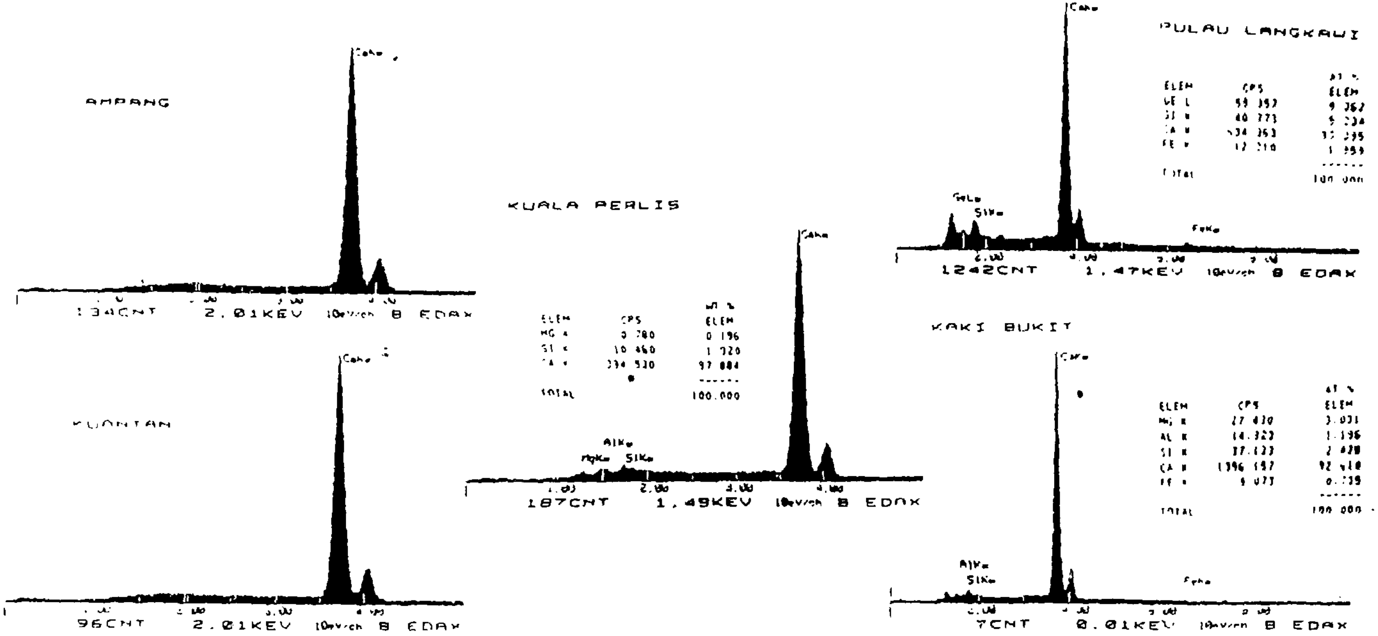
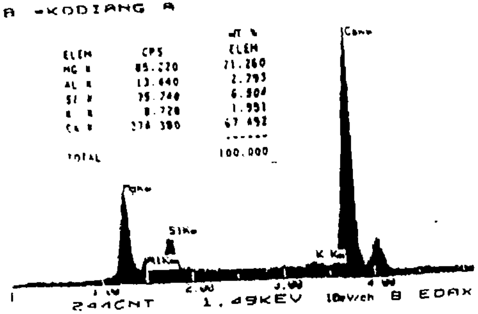
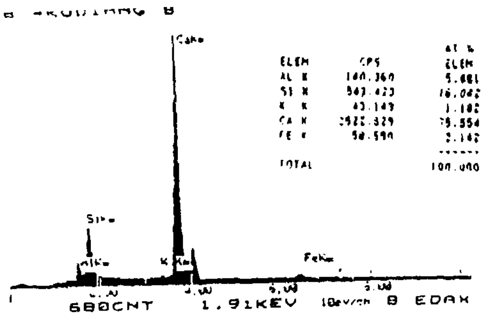
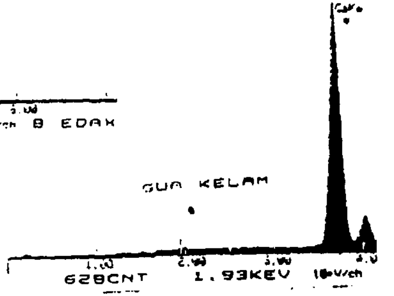
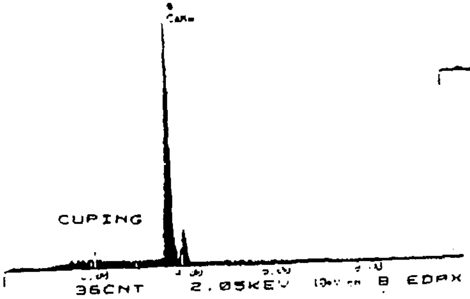


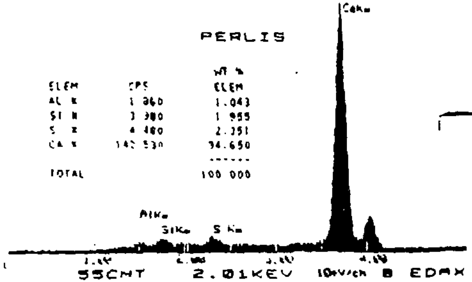
Fig. 1. Results of the EDX analysis on the limestone studied


A -KODIANG A
ELEM CPS WT % ELEM
MG K 85.220 21.260
AL K 13.640 2.793
SI K 35.740 6.504
K K 8.720 1.951
CA K 374.380 67.492
TOTAL 100.000
MgKα
SiKα
AlKα
K Kα
CaKα
244CNT 1.49KEV 10eV/ch B EDAX


B -KODIANG B
ELEM CPS AT % ELEM
AL K 140.360 5.881
SI K 543.423 16.042
K K 43.143 1.182
CA K 2925.329 75.554
FE K 58.590 2.142
TOTAL 100.000
CaKα
SiKα
AlKα
K Kα
FeKα
680CNT 1.91KEV 10eV/ch B EDAX


GUA KELAM
CaKα
628CNT 1.93KEV 10eV/ch


CUPING
CaKα
36CNT 2.05KEV 10eV/ch B EDAX


PERLIS
ELEM CPS WT % ELEM
AL K 1.860 1.043
SI K 3.380 1.955
S K 4.480 2.351
CA K 142.530 94.650
TOTAL 100 000
CaKα
AlKα
SiKα
S Kα
55CNT 2.01KEV 10eV/ch B EDAX

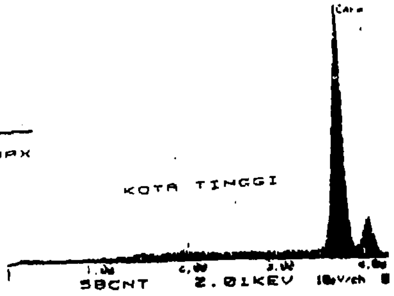

KOTA TINGGI
CaKα
58CNT 2.01KEV 10eV/ch

Fig.2. Concentration of Uranium and Thorium in Limestone obtianed using Neutron Activation Analysis.

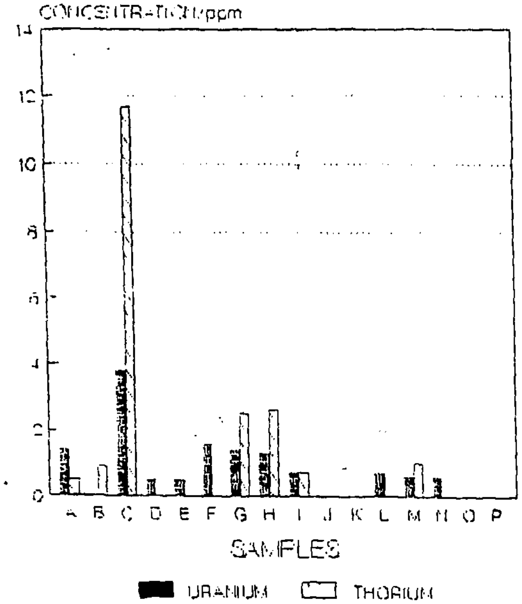


Fig.3. Concentration of Uranium and Thorium in Limestone obtained using Delayed Neutron Analysis.