

**REPORT ON THE RADIOMETRIC  
ANALYSIS OF THE GHAR DALAM FOSSIL  
SPECIMENS  
prepared for the Ghar Dalam Museum**

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**METHOD:** <sup>238</sup>Uranium is a radioactive element emitting mainly alpha rays, but its daughter elements <sup>234</sup>Th and <sup>226</sup>Ra are gamma ray emitters. A high resolution gamma ray spectrometry system can be used to determine gamma-emitting radionuclides with energies ranging from 1 keV to 10 MeV depending on the type of detector in a large variety of sample matrices. The simultaneous detection of several gamma radionuclide emitters in the sample material was carried out with a coaxial germanium detector of high resolution connected to a multichannel analyser. Automatic processing of the collected spectral data was controlled by a computer system with selected software. Sources of error in the technique may be caused by improper spectral identities, changes in background, errors in calibration and/or geometry, and lack of homogeneity in samples. Since the samples tested were not in a standardised geometry, some variation in the readings could be expected due to the difference in sample homogeneity. The results obtained for the various samples were standardised as a ratio of <sup>40</sup>K, on the assumption that the high solubility of potassium salts would result in a steady equilibrium in all samples.

Several fossil specimens kept in the Ghar Dalam Museum were borrowed by courtesy of Dr. G. Zammit Maempel. The specimens had unfortunately no information as to the level they were excavated from, and their provenience could not be reliably confirmed. The samples were grouped according to apparent morphology. These included (a) specimens of small cervine species teeth (n=2) and phalanxes (n=2); (b) specimens of large cervine species teeth (n=3) and phalanxes (n=3); (c) a specimen of cervine phalanx with

intermediate proportions; (d) specimens of small hippopotamus species teeth (n=3) and phalanxes (n=3); and specimens of large hippopotamus species teeth (n=3) and phalanxes (n=3). A list of the specimens is tabulated in Table 1. The means and standard deviation of the results grouped by morphological appearances were calculated. Because of the small number of specimens, no statistical evaluation could be reliably undertaken. The results grouped according to morphology are given in Table 2 and 3.

**RESULTS:** Table 2 showing the mean values by morphological size and type of specimen apparently shows no particular pattern between the mean readings obtained for dentine and for bone.

Table 2&3 suggests that both for the *Hippopotamus* and *Cervus* specimens, the larger specimens show a higher reading for the specimens belonging to the larger forms than for those belonging to the smaller forms. This was evident for both Th/K and Rd/K readings.

**INTERPRETATIONS:** There does not appear to be any differences in the absorption of uranium oxide by dentine or bone - any differences noted are probably due to the variability in the results obtained.

Since the Uranium levels in buried bone specimens increase with time, it appears that both for the *Hippopotamus* specimens and for the *Cervus* specimens, the large forms preceded the small forms. In addition, according to the ratios assayed the sequence could have been *Cervus* large, *Cervus* intermediate, *Hippopotamus* large, *Cervus* small, and *Hippopotamus* small. Unfortunately, the absence of information regarding the strata originally excavated from cannot help elucidate the accuracy of these observations.

These observations are based on the assumptions of:

- (1) reliability of the technique in sub-fossils; and
- (2) that the samples originate from the same locality (ie Ghar Dalam).

TABLE 1: Specimen characteristics

<b>Specimen</b>	<b>Sample no.</b>	<b>Weight</b>	<b>Run Time</b>	<b>Date of test</b>
<i>Hippopotamus</i> large - teeth	GD 769	127.113 g	20 hrs	04/06/98
<i>Hippopotamus</i> large - teeth	GD 703	117.471 g	18 hrs	02/06/98
<i>Hippopotamus</i> large - teeth	GD 762	122.581 g	18 hrs	03/06/98
<i>Hippopotamus</i> large - phalanx	GD 7045	44.945 g	2 days	07/08/98
<i>Hippopotamus</i> large - phalanx	GD 7110	54.025 g	4 hrs	24/06/98
<i>Hippopotamus</i> large - phalanx	GD 5793	45.720 g	5 days	12/08/98
<i>Hippopotamus</i> small - teeth	GD 663	52.93 g	20hrs	12/06/98
<i>Hippopotamus</i> small - teeth	GD 678	54.877 g	20 hrs	11/06/98
<i>Hippopotamus</i> small - teeth	GD 573	52.239 g	22 hrs	05/06/98
<i>Hippopotamus</i> small - phalanx	GD 6221	16.901 g	24 hrs	22/05/98
<i>Hippopotamus</i> small - phalanx	6222	10.211 g	24 hrs	27/05/98
<i>Hippopotamus</i> small - phalanx	GD 6077	12.436 g	24 hrs	26/05/98
<i>Cervus</i> large - teeth	GD 332	10.903 g	2 days	10/07/98
<i>Cervus</i> large - teeth	GD 333	11.771 g	2 days	26/06/98
<i>Cervus</i> large - teeth	GD 341	9.873 g	3 days	03/08/98
<i>Cervus</i> large - phalanx	19700	8.109 g	20 hrs	30/04/98
<i>Cervus</i> large - phalanx	19701	11.246 g	22 hrs	20/05/98
<i>Cervus</i> large - phalanx	19702	9.234 g	20 hrs	05/05/98
<i>Cervus</i> small - teeth	GD 19706 (1)	5.023 g	3 ½ days	30/06/98
<i>Cervus</i> small - teeth	GD 19707 (2)	5.451 g	2 days	05/08/98
<i>Cervus</i> small - teeth	GD 19708 (3)	5.229 g	10 days	27/07/98
<i>Cervus</i> small - phalanx	GD 19703	3.456 g	3 days	01/06/98
<i>Cervus</i> small - phalanx	GD 19704	2.065 g	3 days	25/05/98
<i>Cervus</i> intermediate - phalanx	GD 19705	6.316 g	22 hrs	21/05/98

TABLE 2: Results grouped by morphology and type of bone - mean values

<b>Specimen</b>	<b>Th/K</b>	<b>Rd/K</b>
<i>Cervus</i> large specimens - teeth	9.22 (n=3)	3.34 (n=3)
<i>Cervus</i> large specimens - phalanxes	13.28 (n=3)	7.18 (n=3)
<i>Cervus</i> intermediate specimens - phalanx	10.69 (n=1)	3.12 (n=1)
<i>Cervus</i> small specimens - teeth	7.54 (n=3)	2.40 (n=3)
<i>Cervus</i> small specimens - phalanxes	4.59 (n=2)	1.63 (n=2)
<i>Hippopotamus</i> large specimens - teeth	9.25 (n=3)	5.06 (n=3)
<i>Hippopotamus</i> large specimens - phalanxes	6.47 (n=3)	2.74 (n=3)
<i>Hippopotamus</i> small specimens - teeth	3.38 (n=1)	1.46 (n=1)
<i>Hippopotamus</i> small specimens - phalanxes	4.97 (n=3)	2.13 (n=3)

TABLE 3: Results - mean + sd values

<b>Specimen</b>	<b>Th/K</b>	<b>Rd/K</b>
<i>Cervus</i> large specimens	mean 11.25 sd 7.35 (n=6) (range 5.99-25.61)	mean 5.26 sd 4.84 (n=6) (range 2.30-14.93)
<i>Cervus</i> intermediate specimens	10.69 (n=1)	3.13 (n=1)
<i>Cervus</i> small specimens	mean 6.38 sd 2.65 (n=5) (range 4.83-10.33)	mean 2.09 sd 0.91 (n=5) (range 1.56-3.57)
<i>Hippopotamus</i> large specimens	mean 7.86 sd 4.65 (n=6) (range 2.14-14.54)	mean 3.90 sd 2.25 (n=6) (range 1.24-7.66)
<i>Hippopotamus</i> small specimens	mean 4.57 sd 1.51 (n=4) (range 3.16-6.05)	mean 1.96 sd 0.90 (n=4) (range 1.12-3.17)

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