

## **CERTIFICATE OF ANALYSIS**

**Certificate Number:** 23GAM109  
**Company / Organisation:** Davoren Environmental  
**AM Request Number:** 2301874  
**Sample Identification:** Newcrest Copper Concentrate (T-383T B LP COMP)  
**AM Identification:** DAV-150823-1  
**Analysis Requested:** Natural Radioactivity  
(U-238, U-235, Th-232 Decay Chains plus K-40)

One (1) sample of Newcrest copper concentrate was received on 15 August 2023. The sample was dried and pulverised prior to assay, in accordance with controlled documents:

*Gamma Spectrometry (U-238, U-235, Th-232 decay chain progeny and K-40)*

AM-I-052-003 Preparation of Powdered Samples for Gamma Ray Analysis, AM-I-052-004 Counting Procedure using Maestro and AM-I-005 Gamma Spectrum Analysis of Solid Samples using GammaVision.

*Delayed Neutron Activation Analysis (DNAA) (U-238)*

P-4246v4 OPAL DNAA Procedure.

*Alpha Spectrometry (Po-210)*

I-5942 Dissolution of Solid Samples for Radiochemical Analysis and I-3482 Analysis of Samples for Pb-210 and Po-210.

Elemental concentrations, used for self-absorption corrections in gamma spectrometry, were supplied by the client.

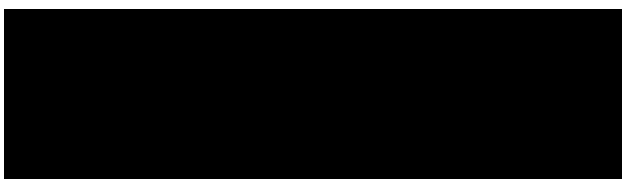
The radionuclide results for the long-lived decay progeny in each of the decay chains, together with K-40, are given in Table 1. The activity concentrations of parent U-238 and Th-232 were calculated from the measured U and Th concentrations using the respective specific activities.

The copper concentrate contained low levels of naturally occurring radionuclides. The U-238 decay chain was not considered to be in secular equilibrium<sup>1</sup>, since the concentrations of Pb-210 and Po-210 were higher than those for U-238 and Ra-226. This is commonly observed in copper concentrates. In the Th-232 decay chain, Ra-228 and Th-228 were considered to be in secular equilibrium, however, the activity concentration of parent Th-232 was lower. It should be noted that XRF is not suitable for low concentrations of thorium in

<sup>1</sup> Secular equilibrium is described as the state at which the activity concentrations of decay progeny are the same as the activity concentrations of the respective parent radionuclides.

copper concentrate, as evidenced by the high error, and Th-232 would be expected to be the same as its progeny in a copper concentrate sample.

The total contained activity in the sample was calculated from the measured radionuclide activity concentrations for the long-lived decay progeny in each of the U-238, U-235 and Th-232 decay chains, together with K-40, as reported in Table 1. The value does, however, include the contribution of all radionuclides in the sample, both long- and short-lived. A less than value assumes zero activity concentration for that particular radionuclide in the calculation.



**Date: 18 September 2023**

**Table 1**  
**Radionuclide Results (Bq/g)**

Client ID	T-383T B LP COMP
ANSTO ID	DAV-150823-1
<i>U-238 Decay Chain</i>	
U-238 (a)	0.038 ± 0.003
Th-230 (b)	< 0.083
Ra-226 (c)	0.034 ± 0.003
Pb-210 (b)	0.072 ± 0.007
Po-210 (d)	0.071 ± 0.016
<i>U-235 Decay Chain</i>	
U-235 (e)	0.0018 ± 0.0001
Pa-231 (b)	< 0.020
Ac-227 (f)	< 0.0037
<i>Th-232 Decay Chain</i>	
Th-232 (g)	0.02 ± 0.01
Ra-228 (h)	0.040 ± 0.004
Th-228 (i)	0.040 ± 0.004
K-40 (b)	< 0.048
Total Contained Activity (j)	1.0
U (ppm) (a,k)	3.1 ± 0.3
Th (ppm) (g, k)	4 ± 2

- (a) DNA.  
(b) Gamma spectrometry.  
(c) Gamma spectrometry. Based on the measured activity concentrations of Pb-214 and Bi-214, assuming secular equilibrium.  
(d) Alpha spectrometry.  
(e) Below gamma spectrometry detection limit. Calculated from the measured U-238 activity concentration, assuming natural abundance.  
(f) Gamma spectrometry. Based on the measured activity concentration of Th-227, assuming secular equilibrium.  
(g) XRF - Client.  
(h) Gamma spectrometry. Based on the measured activity concentration of Ac-228, assuming secular equilibrium.  
(i) Gamma spectrometry. Based on the measured activity concentration of Pb-212, assuming secular equilibrium.  
(j) Calculated from the measured activity concentrations for the long-lived radionuclides, plus K-40. Value includes the contribution of all radionuclides in the sample, both long- and short-lived. Less than values assume zero activity concentration for those radionuclides in the total activity calculation.  
(k) Calculated from the U-238 and Th-232 activity concentrations using the respective specific activities.