JET WEST
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Uranium Ore Logging

Introduction

The goal of Uranium ore logging is to determine where the ore is located and what quantity is in place. We run a combination Gamma Ray/SP/SPR tool to spot the radioactive Uranium ore (U_3O_8) zones. U_3O_8 percentage ranges are as follows:

Extra High Grade:	2% or higher (40 pounds/ton) Uranium ore
High Grade:	0.5 – 2% (10-40 pounds/ton)
Medium Grade:	0.1 – 0.5% (2-10 pounds/ton)
Low Grade:	0.05 - 0.1% (1-2 pounds/ton)

Since the ore can be highly radioactive we need to calibrate the tools in known standards, orders of magnitude higher than normal background radiation. The standards we use are located in Grand Junction, Colorado. They are owned by the United States Department of Energy (DOE) and are maintained by Stoller Corporation, a private contractor. We utilize five calibration pits with increasing concentrations as seen below:

GRAND JUNCTION PIT PARAMETERS: **(Current Values as of June 1994 DOE/ID/12584-179) Rust Geotech Inc.**

Pit	Grade	Thick(ft)	Grade Thickness
U1	2.6360	4.0600	10.7022
U2	1.2290	4.0100	4.9283
U3	0.4516	4.0100	1.8109
N3	0.2310	4.1900	0.9679
BA	0.0220	3.9900	0.0878

Calibration Procedure

Currently our probe of choice for Uranium ore logging is the Mount Sopris Industries 2PGA/2PEA Polyprobe. The Gamma Ray section of this tool is calibrated in each pit by lowering and raising the probe through the enriched zone at a logging speed of 5 feet per minute. Samples are collected at 0.1-foot intervals with **NO** averaging or filtering. The peak count-rate for the down and up runs are then averaged as follows:

Pit	Peak #1	Peak #2	Peak (Avg.)
U1	86917.71	86847.05	86882.38
U2	58023.90	58061.90	58042.90
U3	29069.71	29000.19	29034.95
N3	16990.67	16984.38	16987.52
BA	1979.81	2006.56	1993.19

Dead Time Calculation

To adjust for electronic signal loss and inefficiencies we use the “two-pit” method to calculate dead time as seen below:

DEAD TIME CALCULATION:

Ratio (R) = Grade Low / Grade High **Dead Time = (1 / (PeakAvg.High Pit * (1 - R))) - (R / (PeakAvg.Low Pit * (1 - R)))**

			Calibration Date:
Ratio (R)	**Grade Ratio**	**GT Ratio**	**NEW Dead Time**
U2/U1	**0.466237**	**0.460495**	**6.514E-06**
U3/U1	**0.171320**	**0.169210**	**6.769E-06**
N3/U1	**0.087633**	**0.090439**	**6.961E-06**
BA/U1	**0.008346**	**0.008202**	**7.384E-06**
U3/U2	**0.367453**	**0.367453**	**7.230E-06**
N3/U2	**0.187958**	**0.196395**	**7.591E-06**
BA/U2	**0.017901**	**0.017811**	**8.398E-06**
N3/U3	**0.511515**	**0.534475**	**8.864E-06**
BA/N3	**0.095238**	**0.090692**	**1.225E-05**

K Factor Determination

The “K” factor or “Constant of Proportionality” is a factor we calculate for each probe to account for count-rate loss due to tool inefficiency. The K factor is calculated on an industry standard 0.5-foot interval and is defined by the following equation:

$$K=G/2N$$

Where: G = Radiometric Grade of U_3O_8
N = Peak Corrected for Dead Time = PeakRaw / (1-(DeadTime*PeakRaw))

K-FACTOR CALCULATION:

Peak Corrected = Peak Raw / (1 - (Dead Time * Peak Raw)) K-Factor = Grade / (2 * Peak Corrected)

			Calibration Date:	September 19, 2007
U1 (Raw)	Dead Time (U2/U1)	Grade (U1)	U1 (Corrected)	**NEW K-Factor (ft)**
86882.38	6.51E-06	2.6360	200186.92	**6.584E-06**
U2 (Raw)	Dead Time (U3/U2)	Grade (U2)	U2 (Corrected)	**NEW K-Factor (ft)**
58042.90	7.23E-06	1.2290	100010.08	**6.144E-06**
U3 (Raw)	Dead Time (N3/U3)	Grade (U3)	U2 (Corrected)	**NEW K-Factor (ft)**
29034.95	8.86E-06	0.4516	39097.62	**5.775E-06**
N3 (Raw)	Dead Time (BA/N3)	Grade (N3)	N3 (Corrected)	**NEW K-Factor (ft)**
16987.52	1.225E-05	0.231	19365.93	**5.964E-06**

Following is an example Calibration Sheet:

Grand Junction DOE Calibration Sheet

CALIBRATION DATE: September 19, 2007 **OPERATOR\LOGGER:** M.Peterson

WINCH/PROBE COMBINATION:

MGX System (Serial Number)	Tool	Probe Serial Number
Truck #280	Polyprobe	**3476**

GRAND JUNCTION PIT PARAMETERS: **(Current Values as of June 1994 DOE/ID/12584-179) Rust Geotech Inc.**

Pit	Grade	Thick(ft)	GT
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U2	1.2290	4.0100	4.9283
U3	0.4516	4.0100	1.8109
N3	0.2310	4.1900	0.9679
BA	0.0220	3.9900	0.0878

DATA FILE INFORMATION: Calibration Date: September 19, 2007

Pit	Peak #1	Peak #2	Peak (Avg.)
U1	86917.71	86847.05	86882.38
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DEAD TIME CALCULATION:

Ratio (R) = Grade Low / Grade High

Dead Time = (1 / (PeakAvg.High Pit * (1 - R))) - (R / (PeakAvg.Low Pit * (1 - R)))

Calibration Date: September 19, 2007

Ratio (R)	Grade Ratio	GT Ratio	**NEW Dead Time**
U2/U1	0.466237	0.460495	6.514E-06
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N3/U3	0.511515	0.534475	8.864E-06
BA/N3	0.095238	0.090692	1.225E-05

K-FACTOR CALCULATION:

Peak Corrected = Peak Raw / (1 - (Dead Time * Peak Raw))

K-Factor = Grade / (2 * Peak Corrected)

Calibration Date: September 19, 2007

U1 (Raw)	Dead Time (U2/U1)	Grade (U1)	U1 (Corrected)	**NEW K-Factor (ft)**
86882.38	6.51E-06	2.6360	200186.92	**6.584E-06**

U2 (Raw)	Dead Time (U3/U2)	Grade (U2)	U2 (Corrected)	**NEW K-Factor (ft)**
58042.90	7.23E-06	1.2290	100010.08	**6.144E-06**

U3 (Raw)	Dead Time (N3/U3)	Grade (U3)	U2 (Corrected)	**NEW K-Factor (ft)**
29034.95	8.86E-06	0.4516	39097.62	**5.775E-06**

N3 (Raw)	Dead Time (BA/N3)	Grade (N3)	N3 (Corrected)	**NEW K-Factor (ft)**
16987.52	1.225E-05	0.231	19365.93	**5.964E-06**

Ore Grade and Grade Thickness Determination

In the field when ore is encountered (see log at end of document) the end result is going to be determination of the Ore Grade and its corresponding Grade Thickness. To obtain this data the Gamma Ray curve will have to be converted to text (*.TXT) data in 0.5-foot interval and imported into our Excel spreadsheet ***Ore grade & grade thickness calc.xls*** (see below). The spreadsheet also requires the date, well name, tool number, hole diameter, liquid and/or casing in the hole, dead time and K factor for that specific probe. The spreadsheet also requires a minimum of seven data points or three feet of data to function properly.

ORE GRADE & GRADE THICKNESS CALCULATION
(background - to - background method)

Given Data
Data Input by Logger
Calculated Data

DATE:	1/1/2007
WELL NAME:	Sample
LOGGING ENGINEER:	D. Walker
UNIT #	280
PROBE #	3476
INTERVAL: ft.	0.50
BIT SIZE: in inches	5.125
WATER IN HOLE? (Y/N)	y
WATER CORRECTION:	1.14861875
STEEL PIPE IN HOLE? (Y/N)	n
THICKNESS: in inches	1
STEEL CORRECTION:	1
DEAD TIME:	1.22517E-05
K FACTOR:	5.96408E-06

GRADE = 0.14028639 %eU3O8

GRADE THICKNESS = 0.42085918

Interval of Interest: 749.60 to 752.60

DEPTH	GAMMA-HI CPS PROBE COUNTS		GAMMA-HI CPS, CORRECTED	GRADE PER UNIT	HOLE SIZE AND WATER CORR.	STEEL CASING CORRECTION
749.60	7792.50		8614.98	0.1028	0.1180	0.1180
750.10	9224.00		10399.21	0.1240	0.1425	0.1425
750.60	10516.00		12071.25	0.1440	0.1654	0.1654
751.10	8674.00		9705.41	0.1158	0.1330	0.1330
751.60	8757.00		9809.44	0.1170	0.1344	0.1344
752.10	7267.00		7977.24	0.0952	0.1093	0.1093
752.60	2761.00		2857.67	0.0341	0.0392	0.0392
	AREA		61435.18			
752.60	DEPTH MAX					
749.60	DEPTH MIN					

K factors and Dead Times are chosen from the Calibration Sheet by determining the Peak Raw Gamma Ray count-rate from the log. Then we determine where the count-rate lies in relation to the corresponding Raw count-rates for each calibration pit. Select a pit ratio that bounds the count-rate and utilize the corresponding Dead Time and K factor.

If the count-rate is above the U1 Raw pit count-rate or below the BA Raw pit count-rate select the U1/U2 or BA/N3 ratios respectfully to determine an approximate ore grade.

The Ore Grade is determined by the following:

$$G=KA/T$$

Where: G = Radiometric Grade of U_3O_8
A = Area obtained by numerical integration of count rate over interval of interest
K = Constant of proportionality
T = Thickness of zone