QUANTIFYING PERIODS OF DIFFUSION IN MARINE AND NONMARINE VERTEBRATE FOSSILS USING RARE EARTH ELEMENTS

A Thesis Submitted

To Temple University Graduate Board

In Partial Fulfillment

of the Requirement for the Degree

MASTER OF SCIENCE

By

Amanda E. Drewicz

May 2012

Dr. Dennis O. Terry, Jr., Advisor

Dr. David E. Grandstaff, Committee Member

Dr. Allison R. Tumarkin- Deratzian, Committee Member

ABSTRACT

Concentrations of rare earth (REE), U, Th, and other trace elements (TE) were measured using LA-ICP-MS along transects across five Late Eocene brontothere bones from the terrestrial Late Eocene Chadron Formation of Nebraska and four Miocene marine mammals from the Atlantic Coastal Plain. Samples were analyzed to determine REE diffusion periods, and to determine if histological factors affect post mortem uptake of REE/TE.

In terrestrial fossil bones, concentrations of REE are highest at the bone surface and decrease with depth into the trabecular bone, consistent with diffusion-limited models. Histology may affect REE incorporation. An outer circumferential layer (OCL) is preserved along the outer 1 mm of the brontothere rib (F08-10) and femur (F08-09). REE concentrations in the OCL are much lower than in the underlying bone, indicating either lower incorporation or post fossilization leaching. REE concentrations are sometimes elevated in trabecular bone and Haversian systems, which may act as secondary diffusion pathways.

REE concentration gradients are generally steeper in marine fossils than in terrestrial fossil bones, indicating longer periods of REE uptake in terrestrial fossils. Calculated periods of diffusion in terrestrial environments are 2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka (based on a wetness factor of 0.5 $\pm$ 0.1). Periods of diffusion for marine environments range from ca. 0.9 $\pm$ 0.2 to 2.8 $\pm$ 0.6 ka. However, within some terrestrial samples U is introduced into the bone over a much longer time span, possibly as a function of fluctuating redox conditions. If these values are representative, diffusion-fossilization

periods are shorter in marine/lacustrine/spring/channel environments due to constant water saturation. Saturation of a bone during diffusion may also affect the morphology of REE signatures within the bone. In terrestrial bones, REE are strongly fractionated with depth, producing signatures varying from light-REE enriched at the surface to middle-REE depleted at depth. However, depth fractionation of REE is much less pronounced in marine bones, which may result from the introduction of fluid unreactive. These differences in REE fractionation are consistent with a greater influence of multiple secondary REE/TE diffusion paths in marine samples.

Periods of diffusion for terrestrial samples differed within a single bonebed accumulation (2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka). However, REE signatures are internally consistent with one another within the bonebed indicating that groundwater chemistry did vary during fossilization. If groundwater chemistry changes during diffusion, bone could be recording different signals, which has implications for using post-mortem REE/TE/Isotopes for paleoenvironmental reconstruction. Previous studies of soft tissue preservation in fossilized bone have inferred shorter periods of diffusion and suggested that the rate of diffusion must outpace the rate of decay. Diffusion periods in bone from well drained terrestrial settings are too long to preserve soft tissue. However, periods of diffusion in marine fossil bones are much shorter, suggesting the possibility for bio-molecule preservation.

ACKNOWLEDGMENTS

First, I would like to sincerely thank my advisor, Dr. Dennis Terry (DT) for your guidance and patience with me through both undergraduate and graduate school. I can honestly say that you converted me to the “dark side”. I would also like to especially thank Dr. David Grandstaff (G) for going above and beyond as a committee member. You spent far more time with me and my research then you probably had planned when you agreed to be on my committee, and thank you. I would like to thank Dr. Allison Tumarkin- Deratzian for the crash courses on histology. Other faculty members that inspired me through my years at Temple University were Dr. George Myer and Natalie Flynn. Thank you for making me a better teacher and for teaching me. I would also like to thank the rest of the faculty for their help through this process and Shelah and Jim for always taking care of the graduate students.

I would like to thank the undergraduate and graduate students as well. The friendships I have made at Temple will last a lifetime, and those friendships are what kept me going. I would especially like to acknowledge Alyssa Finlay for being the only other lady in the graduate department and for keeping me sane these past two years. Another special person I would like to thank would be Grzesiek Czapla. You are my best friend and my best motivator. The first year of graduate school was a rough one, but you were always there encouraging me. I would like to thank my parents and my brother as well for your love and support.

I would also like to thank Ted Daeschler and Academy of Natural Sciences of Drexel University in Philadelphia for leading us our marine samples used in this study. Lastly, I would like to thank Bill Lukens for field collections and for being a great friend.

This project was funded from the National Nebraska Forest cost-sharing agreement 05-PA-11020700 to Dr. Dennis Terry and Temple University undergraduate research fund.

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CHAPTER 1

INTRODUCTION

The process of fossilization and the amount of time needed for vertebrate bones to fossilize is poorly understood. In living organisms, concentrations of rare earth (REE), uranium (U) and many other trace element (TE) concentrations in the skeleton are low. During fossilization REE/TE are incorporated into bone by the processes of diffusion and adsorption onto apatite crystallites. Diffusion gradients of U, REE, and other TE can be used to calculate the period of diffusion within fossil bones (e.g., Millard and Hedges, 1996; Hinz and Kohn, 2010; Suarez et al., 2010). The period of diffusion should correlate with the most intense period of apatite diagenesis within the bone and generally marks the period of fossilization (Trueman and Palmer, 1996; Trueman et al., 2004). Previous research using stable isotopes (Kohn and Law, 2006) and U diffusion gradients (Suarez et al., 2010) suggests that diffusion and incorporation of TE and isotopes in terrestrial environments occurs over thousands to tens of thousands of years. Therefore in unsaturated terrestrial settings, unless the water table is exceptionally shallow or sedimentation rapid, most TE incorporation in terrestrial environments should occur in the unsaturated, vadose zone. The diffusion process is allowed by water in bone pore spaces. Because vadose zone pore spaces are only intermittently saturated, diffusion periods in persistently saturated environments such as marine or lacustrine settings should be much shorter than diffusion periods in unsaturated terrestrial environments.

REE signatures in fossil bone reflect redox, pH, and the degree of sediment/water interaction during fossilization, which varies as a function of depositional environment. In previous studies, REE signatures have been used to determine taphonomy and reworking of fossil remains, stratigraphic correlation, paleoenvironments, and the fossilization process (e.g., Trueman and Benton, 1997; Trueman, 1999; Staron et al., 2001; Trueman and Tuross, 2002; Metzger et al., 2004; Patrick et al., 2004, 2007; Martin et al., 2005; Trueman et al., 2006; Anderson et al., 2007; Grandstaff and Terry, 2009; Suarez et al., 2007, 2010).

1.2 Objective

The objectives of my research are to better understand the fossilization process and implications for REE/TE interpretations, through examination of: periods of diffusion in marine vs. nonmarine settings, the effect of histology on the uptake of REE/TE, degree of heterogeneity of REE/TE signatures, period of diffusion within a single bonebed, and the fidelity of REE/TE/isotope signatures for paleoenvironmental and paleoclimate reconstruction.

Previous studies have proposed different models for diffusion. Crank (1975) derived a solution to a second order differential equation for calculating diffusion periods based on Fick's second law of diffusion through a homogeneous medium. Millard and Hedges (1996) applied a diffusion-adsorption (DA) model to incorporation of U in fossil bone. Concentrations of REE/TE in the DA model will lie along a single diffusion gradient which results from one uniform diffusion pathway (Figure 1). However, bones

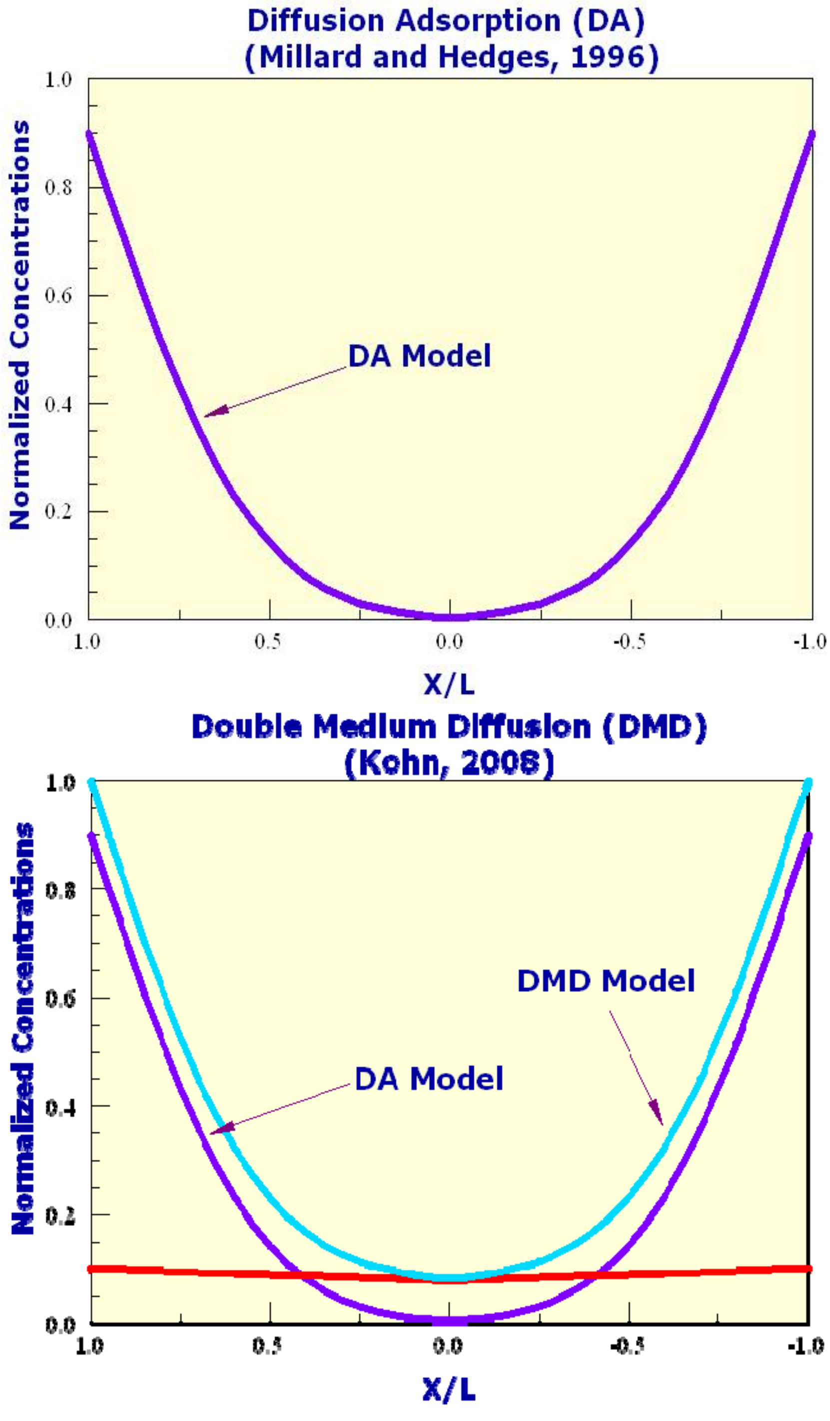


Figure 1. Graph of Millard and Hedges (1996) DA model for diffusion (top) which assumes a homogeneous diffusion pathway within the bone, vs. the DMD model of Kohn (2008) which states that diffusion is not homogeneous and that there are secondary diffusion pathways. In the figure 90% of REE are brought into the bone through slow diffusion pathways (purple gradient), while 10% are brought into the bone through a fast diffusion pathways (red gradient) with a diffusion coefficient 10 times faster. This causes concentrations in the center of the bone to be higher than predicted.

are not homogeneous solids due to Haversian systems, which distribute blood throughout bone (Junqueira and Carneiro, 2003; Figure 2). After death and burial, groundwater can flow freely throughout the bone via these Haversian systems. Kohn (2008) therefore proposed an alternative model for diffusion, the double medium diffusion (DMD) model, in which at least two diffusion pathways are present within the bone having different diffusion coefficients. Pore spaces, such as Haversian systems within the bone act as fast diffusion pathways, while denser bone produces slow diffusion pathways; this causes concentrations in the center of the bone to be greater than expected from the DA model (Figure 1). Both models were used in this study to determine if Haversian systems influence uptake of REE within bone. Other histological features may influence REE incorporation as well, such as the outer circumferential layer (OCL). The OCL is comprised of dense bone without Haversian systems (Chinsamy-Turan, 2005). The lack of Haversian systems within the OCL may affect the uptake of REE/TE within bone as well.

Determining the period of diffusion in fossil bone has several implications. TE (e.g., Sr, Ba, and Pb) and stable isotopes (e.g., phosphate oxygen) in teeth and bones are commonly used as proxies to infer paleodiet and physiology of ancient animals (e.g. Cerling and Sharp, 1996; Lee-Thorp and Sponheimer, 2006). Recently, REE ratios in terrestrial bones have been used as a climate proxy for near surface paleoenvironmental variations produced by changes in climate. Grandstaff and Terry (2009) used spectral analysis of REE ratios from Paleogene bones in Toadstool Park, Nebraska to test for periodicities and found that REE recorded multiple periodicities similar to Milankovitch

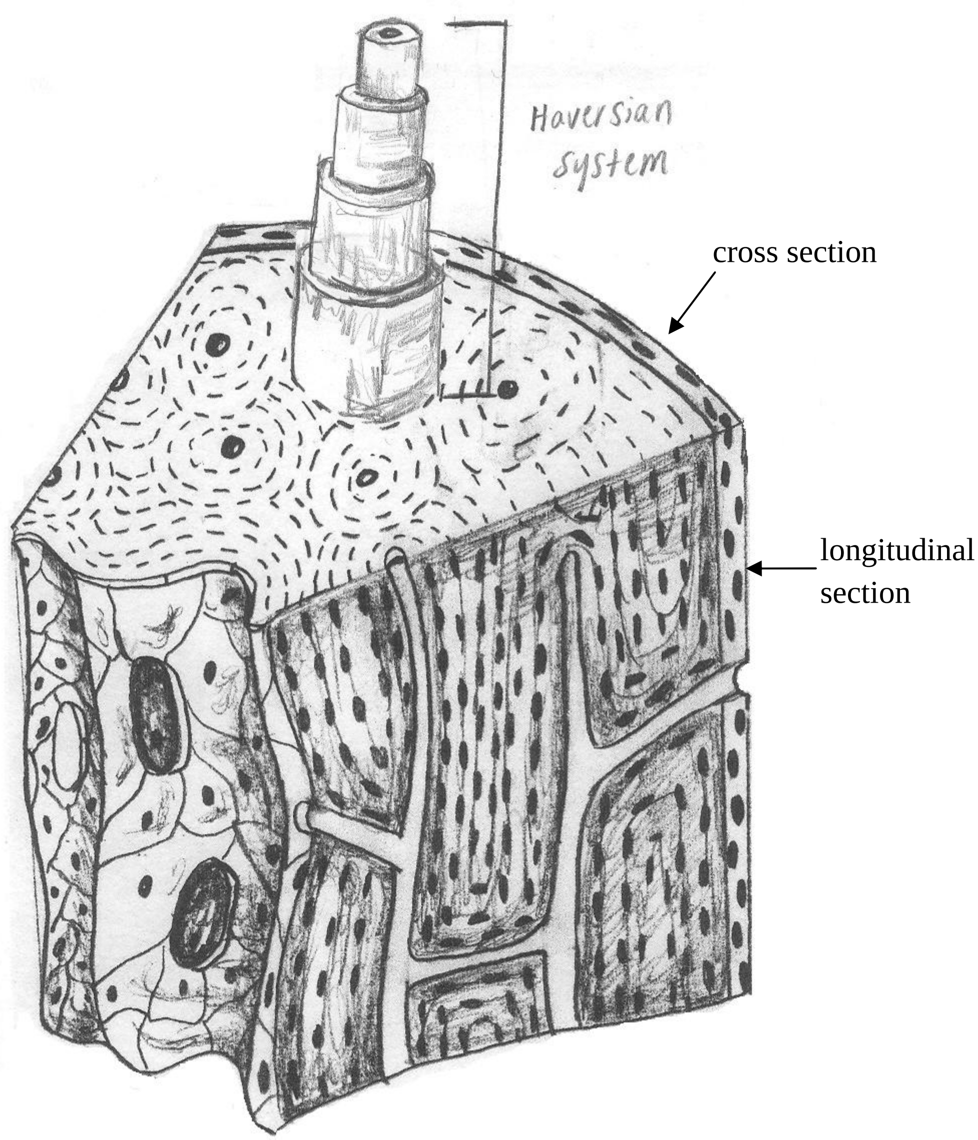


Figure 2. In living organisms, Haversian systems bring blood into bone. Haversian canals act as fluid conduits for groundwater after an organism has died. After Junqueira and Carneiro (2003).

cycles. Calculating diffusion periods for REE/TE will help to refine temporal resolution of geochemically based paleoenvironmental reconstructions.

Previous studies of soft tissue preservation in fossilized bone have implied shorter fossilization periods and suggested if the rate of diffusion outpaces the rate of decay, soft tissue could be preserved (Schweitzer et al., 2006). If marine bones do have shorter periods of diffusion, biomolecule preservation within these bones could be plausible.

CHAPTER 2

METHODS

2.1 Field Sites

Five brontothere bones from a smectitic overbank mudstone of the late Eocene Chadron Formation from northwest Nebraska (Figure 3, 4) were analyzed for REE/TE. Four of the bones were collected from the same bonebed accumulation (F08-10, F08-08, F08-09, and F08-915-R) at the Orella Road site (Figure 3). The fifth bone was collected from the Benedict Buttes, which is located stratigraphically above the Orella Road bonebed within the Peanut Peak Member. All brontothere samples were found broken in situ. Details of the bones analyzed in this study are listed in Table 1.

The Academy of Natural Sciences of Drexel University in Philadelphia provided four marine vertebrate bones from collection for destructive analysis (Figure 4; Table 1). PAS11-02 and PAS11-03 are from inter-bedded phosphatic sands, clays, limestones and dolostones of the Early Miocene Pungo River Formation from Aurora, North Carolina. PAS11-01 was collected from interbedded fine-grained argillaceous sand and sandy clay of the Miocene Calvert Formation near Calvert Cliffs, Maryland. Lastly, PAS11-04 was collected from unconsolidated clayey sand and poorly consolidated silty clay of the Miocene Torreya Formation in Florida (Figure 5).

For the marine bones, vertebrates were used to calculate REE diffusion periods. Most marine vertebrate bones have a greater amount of trabecular bone then terrestrial

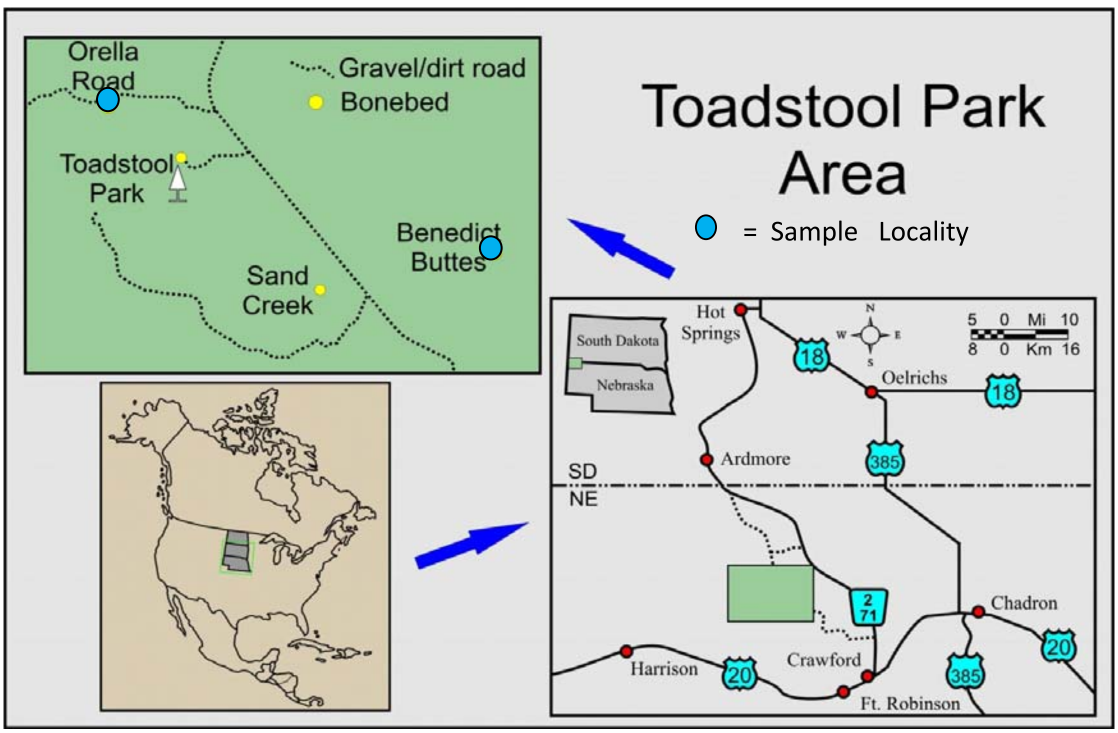


Figure 3. Map of Toadstool Park and the location of the Orella Road and Benedict Buttes bonebed sites. Modified from Terry (2001).

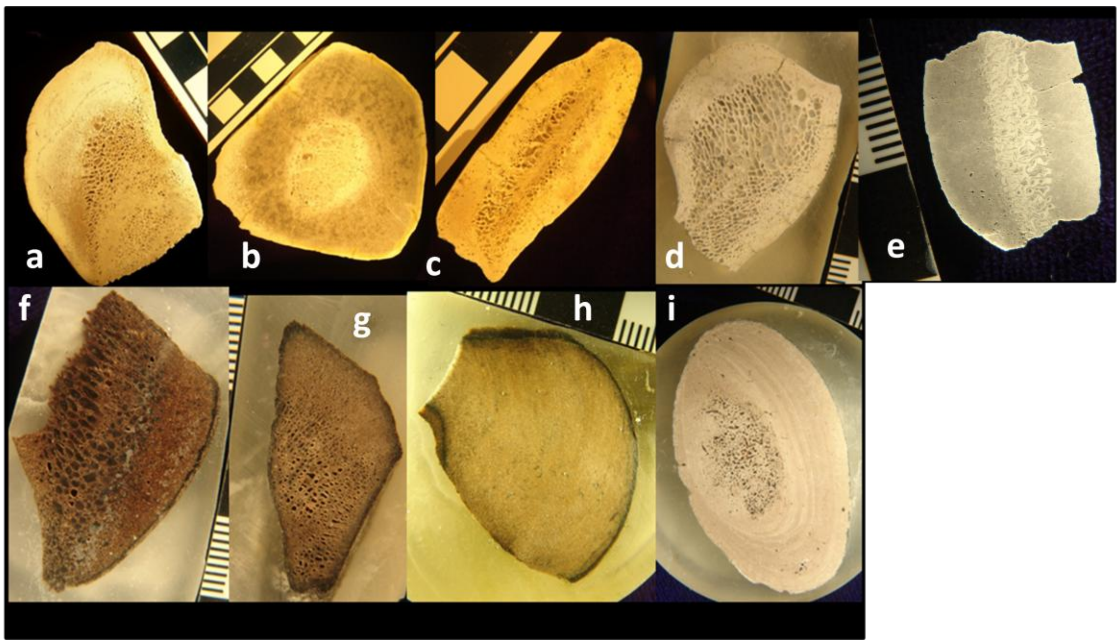


Figure 4. Images of cut and polished marine and terrestrial fossil bones that were used in this study. The top row consists of the five brontothere samples from the Peanut Peak Member, which are: a.) brontothere metapodial (F08-08), b.) brontothere femur (F08-09), c.) brontothere rib (F08-10), d.) brontothere scapula (F08-915-R), and e.) brontothere rib (F08-80). The bottom row consist marine vertebrates, which are: f.) cetacean rib (PAS11-01), g.) cetacean atlas vertebra (PAS11-02), h.) cetacean auditory bulla (PAS11-03), and i.) dugongid rib (PAS11-04).

Table 1. Bone samples analyzed in this study including, sample numbers, along with bone types, locations were the bones were found, and length of laser ablation transects used for calculating diffusion periods.

Sample #	Description	Location	Transect Length (mm)
F08-08	brontothere metapodial	Orella Road, NE	10.9
F08-09	brontothere femur	Orella Road, NE	3.7
F08-10	brontothere rib	Orella Road, NE	8.8
F08-915-R	brontothere scapula	Orella Road, NE	30
F08-80	brontothere rib	Benedict Buttes, NE	13.1
PAS11-01	cetacean rib	Calvert Cliffs, MD	3.2
PAS11-02	cetacean vertebra	Aurora, NC	4.6
PAS11-03	cetacean auditory bulla	Aurora, NC	8.9
PAS11-04	dugongid rib	Polk County, FL	18.1

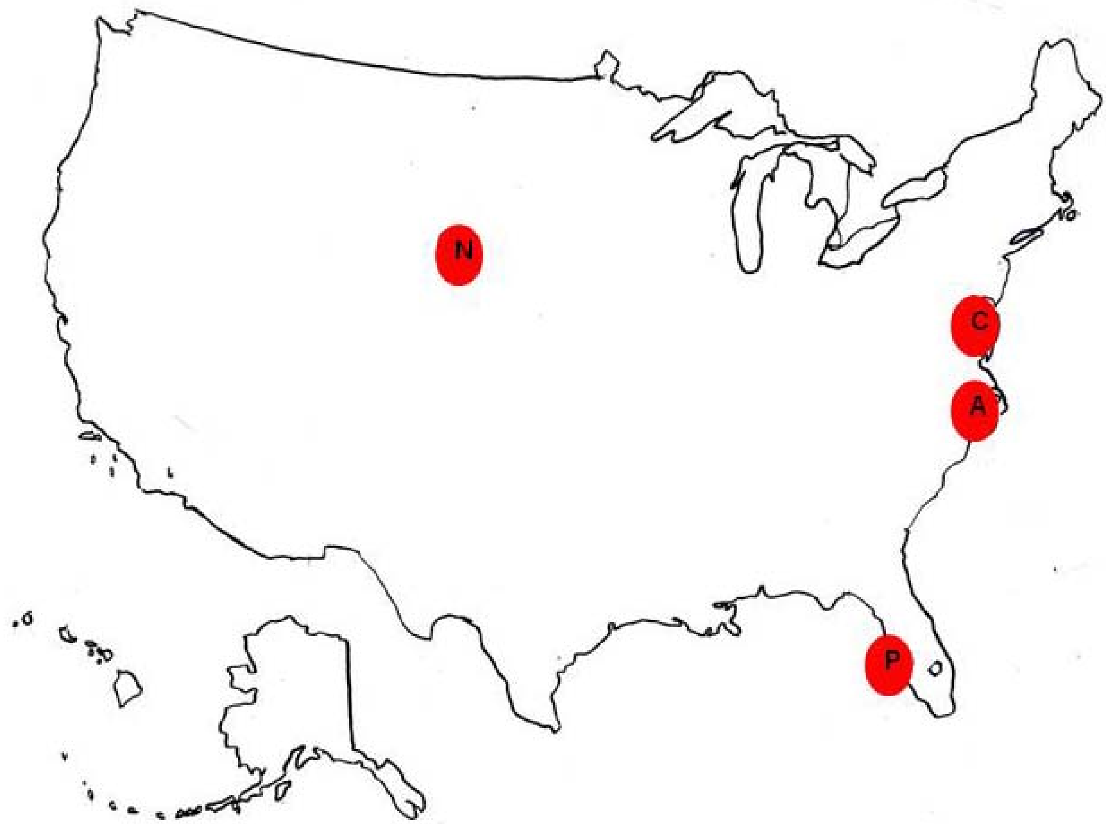


Figure 5. Map of the United States showing the location of samples used in this study. The fossil bones from this study were collected from NW Nebraska (N), Polk County Phosphate Mines, Florida (P), Aurora, North Carolina (A), and Calvert Cliffs, Maryland (C).

vertebrates for buoyancy purposes. Because critical data is obtained from the cortical bone, denser marine bones with thick cortical layers were selected for analysis.

2.2 Petrographic Preparation/Analysis

Fossil bones were cut and polished to 1000 µm, mounted on slides, and analyzed with a Nikon Eclipse E600 POL microscope in plane-polarized, cross-polarized, and reflected light. Diagenetic mineralogy, bone texture, and histological features were identified based on the criteria of Chinsamy-Turan (2005).

2.3 Laser Ablation Preparation/Analysis

REE/TE abundances were determined in the Geology Department at the University of Maryland using a Thermo Finnigan Element 2 single collector High Resolution Sector ICP-MS coupled with a New Wave ESI UP 193 Laser Ablation System operating at ~ 2 J/cm^2 and calibrated with a NIST 610 glass standard. An 8-15 µm spot size was used for specific areas of interest (around Haversian systems), and a 15-40 µm spot size for transects across the bones. Full transects were completed on a brontothere rib (F08-80) and scapula (F08-915-R), starting on the outer edge of the bone, through the trabecular bone, and back through cortical bone to the opposite margin. Other transects also started at the edge of the bone, but ended when the laser reached trabecular bone (Figure 6). For some bones, multiple laser ablation transects were taken parallel to

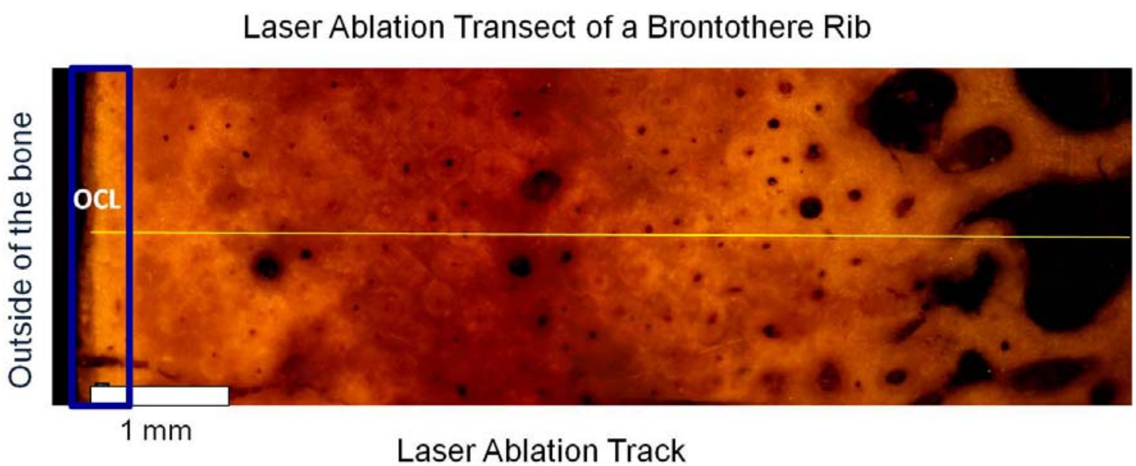


Figure 6. Picture of a laser ablation transect through a brontothere rib (F08-10) under reflected light. The laser ablation transect started at the outer edge of the bone (cortical bone) and went toward the center (trabecular bone). The OCL was found on the outer portion (left) of two samples and is denser than the underlying cortical bone (center). Trabecular bone is porous, spongy bone found in the center of the bone (right).

one another to test lateral variations. For the brontothere samples, laser ablation transects ranged from 3.7 mm (F08-09) to 30.0 mm (F08-915-R). Transects ranged from 3.2 mm (PAS11-01) to 8.1 mm (PAS11-04) for the marine samples (Table 1). Concentrations on edges of Haversian systems were collected moving from the edge of the canal outwards.

Concentrations were converted from counts per second to parts per million (ppm) with standard NIST 610, normalized to the North American Shale Composite (NASC; Gromet et al., 1984), and plotted as spider and ternary diagrams. Periods of diffusion were calculated using methods of Millard and Hedges (1996) and compared for all sample sets, and influences on REE/TE signatures (e.g. terrestrial vs. marine environments, histology, and taphonomy) were evaluated. Ternary/spider diagrams were created to show the evolution of REE with depth into bone and help to determine if geochemical signatures of bones from a particular bonebed accumulation are similar.

Diffusion into bone will follow Fick's second law of diffusion (Crank, 1975; Millard and Hedges, 1996). The basic differential equation for diffusion in one dimension is:

$$\frac{\partial C}{\partial t} = D\,\frac{\partial^2 C}{\partial x^2} \qquad (1)$$

where *C* is the concentration, and *D* is the effective diffusion coefficient of an element. Solving equation (1) assuming a constant boundary concentration gives:

$$C = C_o erfc\left(\frac{x}{2\sqrt{Dt}}\right) \qquad (2)$$

where *erfc* is the complementary error function and *t* is time. Rearranging equation (2), we can solve for time (*t*) from measured concentration gradient (*C/Co*) and the inverse complementary error function ($erfc^{-1}$)

$$t = \frac{\left(\frac{x}{2erfc^{-1}\left(\frac{C}{C_O}\right)}\right)^2}{Dt} \qquad (3)$$

If the diffusion coefficient is known, the period of diffusion within the bone can be calculated. This equation works best with larger bones because it assumes diffusion through the bone from a single surface. However, for smaller bones, if diffusion comes from two sides, the diffusion period calculated for a single surface would be longer than the actual diffusion period. Crank (1975) derived a solution to the second order differential equation to be used to calculate periods of diffusion from two opposite planes. Millard and Hedges (1996), modified this equation in terms of three dimensionless parameters: *Z', X', t',* where *Z'* is equal to the concentrations normalized to the average surface concentrations, *X'* is equal to depth normalized to the half length of the bone, and *t'* is the diffusion reduced time.

$$Z' = \frac{C_{x',t'}}{C_o} \qquad x' = \frac{x}{L} \qquad t' = \frac{tD_{bone}}{(R+1)L^2} \qquad (4)$$

A steep gradient indicates a short period of diffusion, whereas a shallower gradient indicates a longer period of diffusion (Figure 7). When calculating *t'* values for actual periods for diffusion within marine and terrestrial fossil bones, the outer gradient *t'*

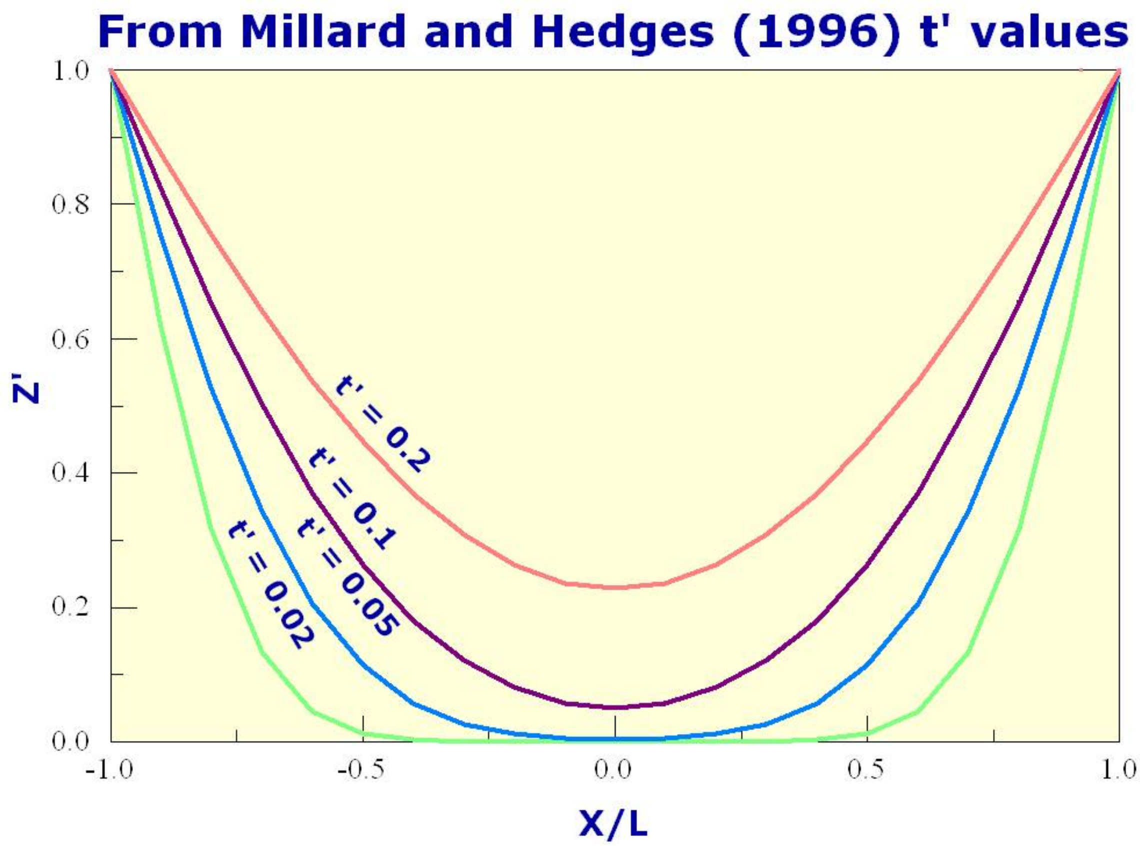


Figure 7. Graph showing normalized concentrations (y-axis) vs. normalized depth into a bone (x-axis) from Millard and Hedges (1996). Reduced time is represented by t' gradients. The t' = 0.02 indicates a short period of diffusion, while t' = 0.2 indicates a longer period of diffusion.

values were used since they were less affected by rapid diffusion through pore spaces. Equation (5) takes into account two diffusion pathways within the bone, and can be used to calculate diffusion periods for smaller bones (Millard and Hedges, 1996), where L is ½ the bone diameter.

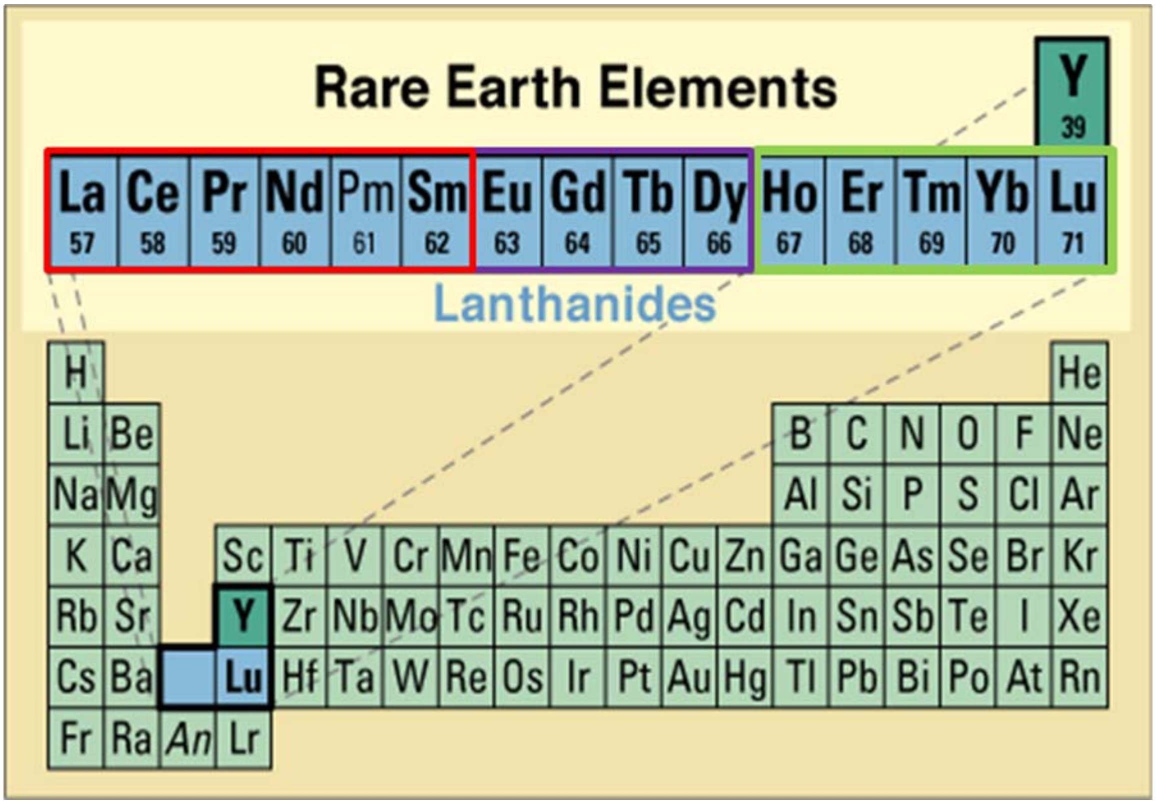
$$Z' = \left(1 - K_1 exp(K_2 t') cos(K_3 x')\right) \tag{5}$$

When calculating diffusion coefficient, if porosity and tortuosity are held constant throughout the bone, the diffusion coefficient can be calculated. With the adsorption values for REE (R), diffusion values for water and the bone (D_o), wetness factor of the soil (W), volume of the bone (V), tortuosity (τ), the steric factor ($f(a)$), and half length of the bone (L) along with the calculated reduced time (t'), the period of diffusion can be determined from equation (6). The steric factor $f(a)$ is the difference between the radii of REE and the radii of the pore spaces found within the bone. The steric factor $f(a)$ will change due to REE complex radii (a). LREE will have smaller radii and will adsorb more readily onto the surface of the bone.

$$t = \frac{t'(R+1)L^2}{\frac{D_O\, WVf(a)}{\tau^2}} \tag{6}$$

If soil wetness (W) increases, REE/TE will diffuse more readily into bone, which is shown in equation (7):

$$D_m = \frac{D_o VW}{\tau^2}\left(f(a)\right) \tag{7}$$



United States Geological Survey

Figure 8. REE (lanthanide series) are divided into three groups within the periodic table of elements. Red = LREE (La-Sm), Purple = MREE (Eu-Dy), and Green = HREE (Ho-Lu).

Periods of diffusion were calculated based on diffusion equations of Crank (1975), Millard and Hedges (1996) and Kohn (2008). Methods were then developed by which periods of diffusion can be calculated using REE/TE. Based on previous work that analyzed the diffusion periods of U (Millard and Hedges, 1996; Suarez et al., 2010), I calculated diffusion periods for selected lanthanides, including light-REE (LREE) such as: La, Ce, Nd; middle-REE (MREE): Gd; and heavy-REE (HREE): Yb (Figure 8). REE adsorption constants were taken from Koeppenkastrop and DeCarlo (1992), diffusion coefficients for water from Kerisit and Liu (2010), and the diffusion coefficients for bone from Li and Gregory (1974), which was based on the Stokes-Einstein equation (Table 2). The time in which REE/TE uptake is completed was calculated using the methods of Millard and Hedges (1996).

2.4 Environmental Constraints for Marine/Nonmarine Settings

Based on propagation of error calculations, the greatest uncertainty in calculating periods of diffusion is the soil wetness factor. Reverse PHREEQC modeling at $25^{o}C$ was used to determine speciation of REE within marine and nonmarine environments (Wright et al., 1987; Barrick and Fischer, 1993) and to calculate the pH of Late Eocene groundwater. Previous paleosol data were also used to determine groundwater pH and environmental conditions (Grandstaff and Terry, 2009).

Table 2. Values used for calculating the periods of diffusion.

Period of diffusion

Values used in calculations

Element	log K_d	log R (K_d/ρ)	Do (water)	D (bone) w = 0.5 $\pm$ 0.1	D (bone) w = 1
			x10^6 cm^2 s^{-1} ($\pm$ 0.07)	x 10^{-8}cm s^{-1} ($\pm$ 0.06)	x 10^{-7}cm s^{-1} ($\pm$ 0.06)
La	5.85 (3)	6.3	6.17 (2)	9.27	1.85
Ce	5.8 (3)	6.25	6.16 (2)	9.26	1.85
Pr	5.9 (3)	6.35	6.15 (2)	8.72	1.74
Nd	6 (3)	6.47	6.14 (2)	8.71	1.74
Gd	5.7 (3)	6.15	5.9 (2)	7.88	1.58
Yb	5.28 (3)	5.69	5.82 (2)	7.78	1.56
U	5.7 (1)	6.15	6.80 (4)	1.01	2.03

1. Millard and Hedges (1996)
2. Li and Gregory (1974)
3. Koeppenkastrop and DeCarlo (1992)
4. Kerisit and Liu (2010)

CHAPTER 3

RESULTS

3.1 Influences of Histology on Diffusion

LREE concentrations in terrestrial brontothere bones are highest at the surface and decrease toward the center of the bone (Figure 9, 10, 11). The same trend occurs in MREE (Gd), with concentrations decreasing towards the center of the bone (Figure 10, 11). However, HREE concentrations remain relatively constant with depth into the bone (Figure 11). Strontium (Sr) concentrations (Figure 12) also remain relatively constant with depth into the bone. However, concentrations for other elements, such as thorium (Th), are very high at the surface of the bone and immediately decrease with depth (Figure 13) Exceptions are seen in bones with an OCL preserved along the outer margin (Figure 11).

An OCL was preserved along the outer 1 mm of a brontothere rib (F08-10) and a distal femur (F08-09). The OCL is comprised of thin layers of parallel-fibered bone that are slowly accreted over time at the outermost edge of the bone when the organism has reached full maturity and growth has ceased (Chinsamy-Turan, 2005; Junqueira and Carneiro, 2003; Millard and Hedges, 1995). Concentrations of REE gathered from the OCL were much lower (ca. 2,750 ppm for La) than the underlying cortical bone (ca. 5,000 ppm for La); this pattern was not noted in bones where an OCL was not present.

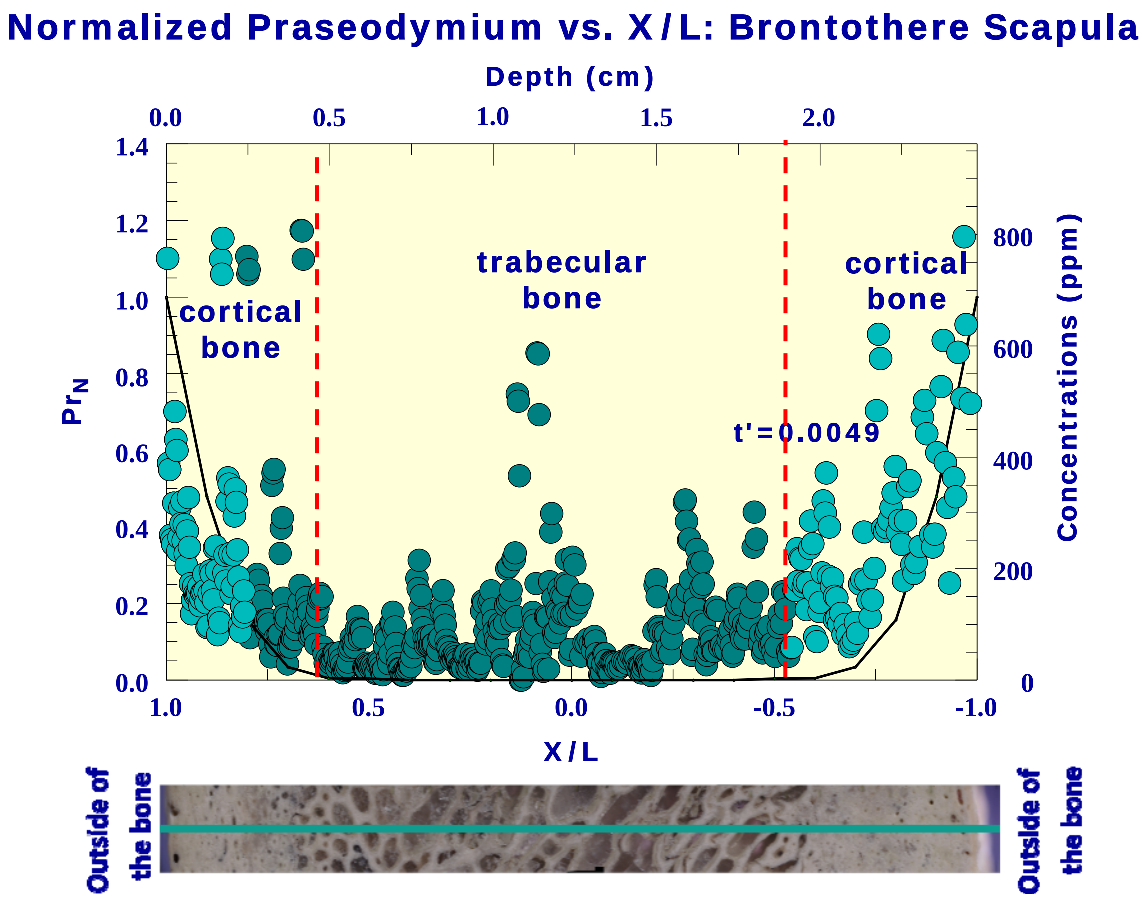


Figure 9. Full transect of a brontothere scapula (F08-915-R) showing normalized Pr vs. normalized depth into the bone (actual concentrations and depth are also shown). Concentrations in the center of the bone are nearly as high as concentrations found at the surface of the bone. The calculated outer diffusion gradient is shown by lighter data points. Differing bone textures (cortical vs. trabecular bone) are specified within the graph.

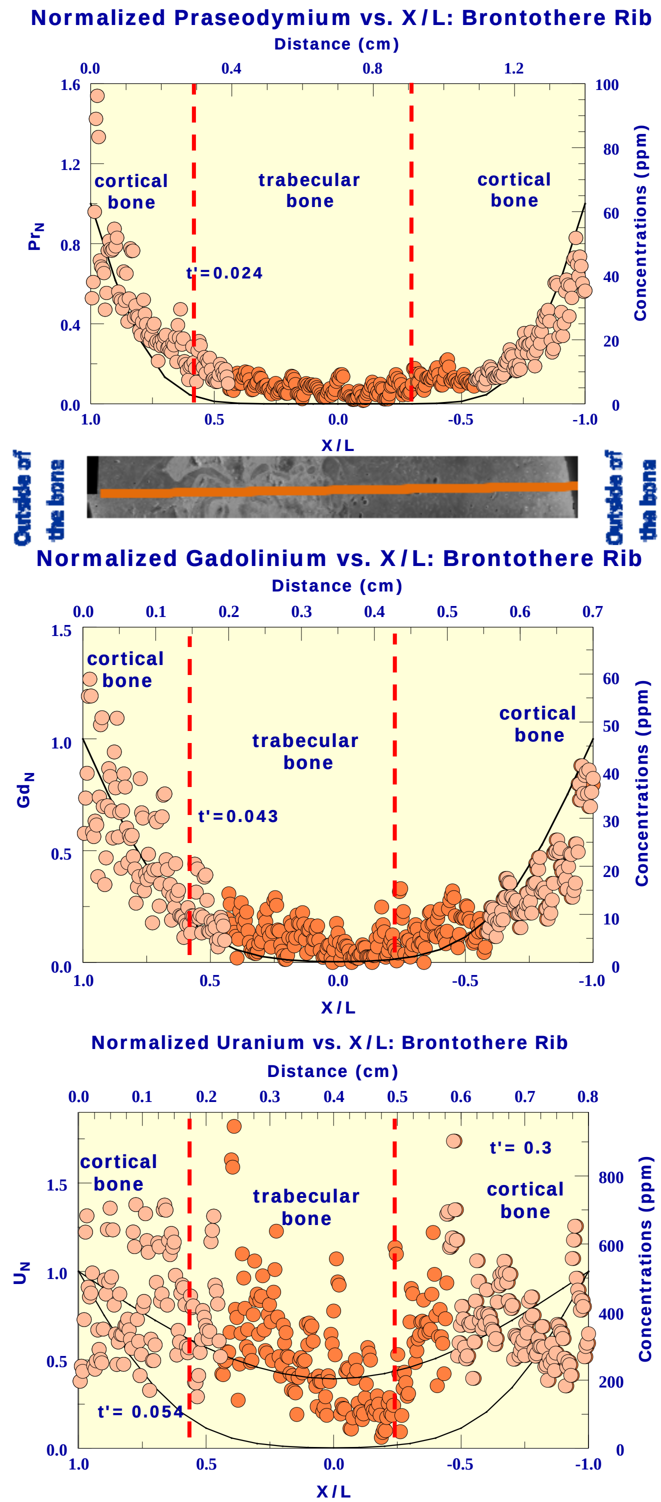


Figure 10. Full transect of a brontothere rib (F08-80) showing normalized Pr/Nd/U vs. normalized depth into the bone (actual concentrations and depth are also shown). REE concentrations are highest at the surface of the bone and decreases towards the center of the bone. The calculated outer diffusion gradient is shown by lighter data points. Differing bone textures (cortical vs. trabecular bone) are specified within the graph.

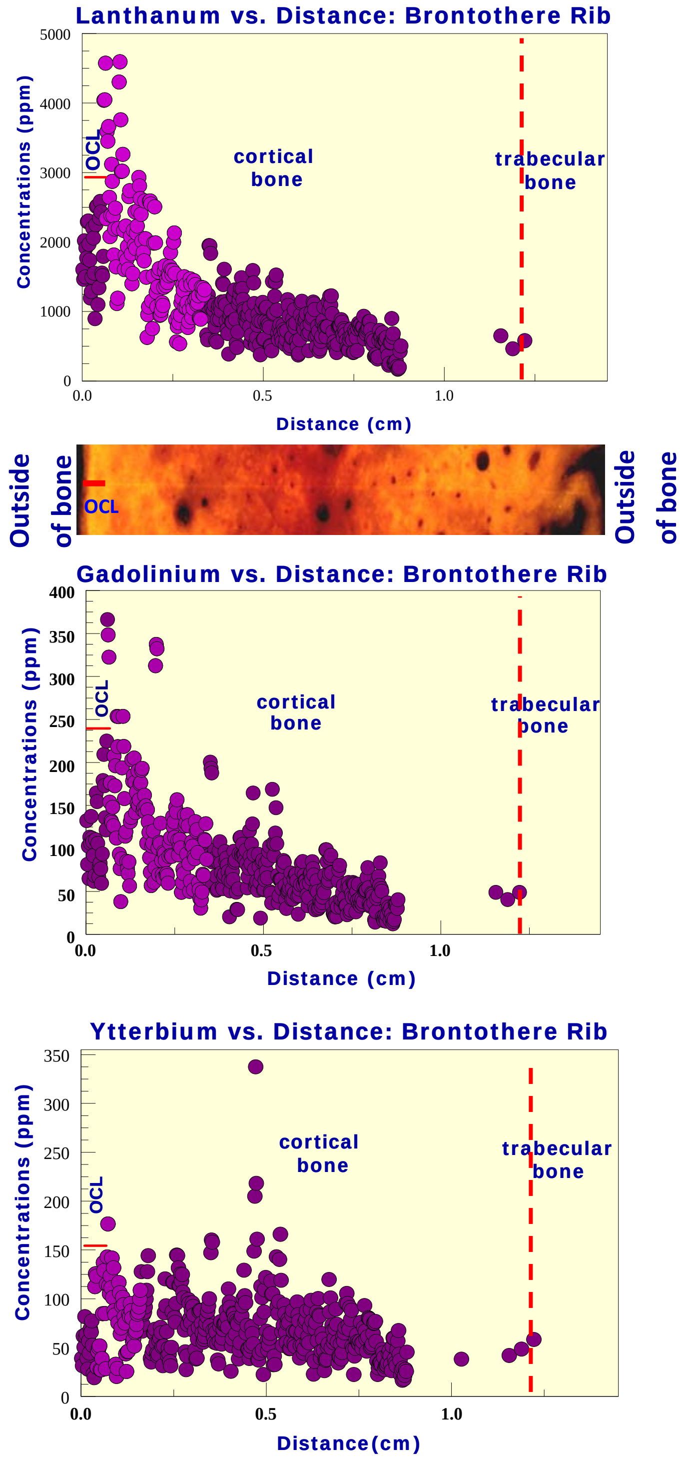


Figure 11. Various REE concentrations within a brontothere rib (F08-10) vs. distance into the bone. La (LREE) and Gd (MREE) concentrations are high at the surface but decrease rapidly with depth, whereas Yb (HREE) concentrations remain relatively consistent with depth. The calculated outer diffusion gradient is shown by lighter data points. Concentrations within the OCL are lower than the underlying bone. Differing bone textures (cortical vs. trabecular bone) are specified within the graph.

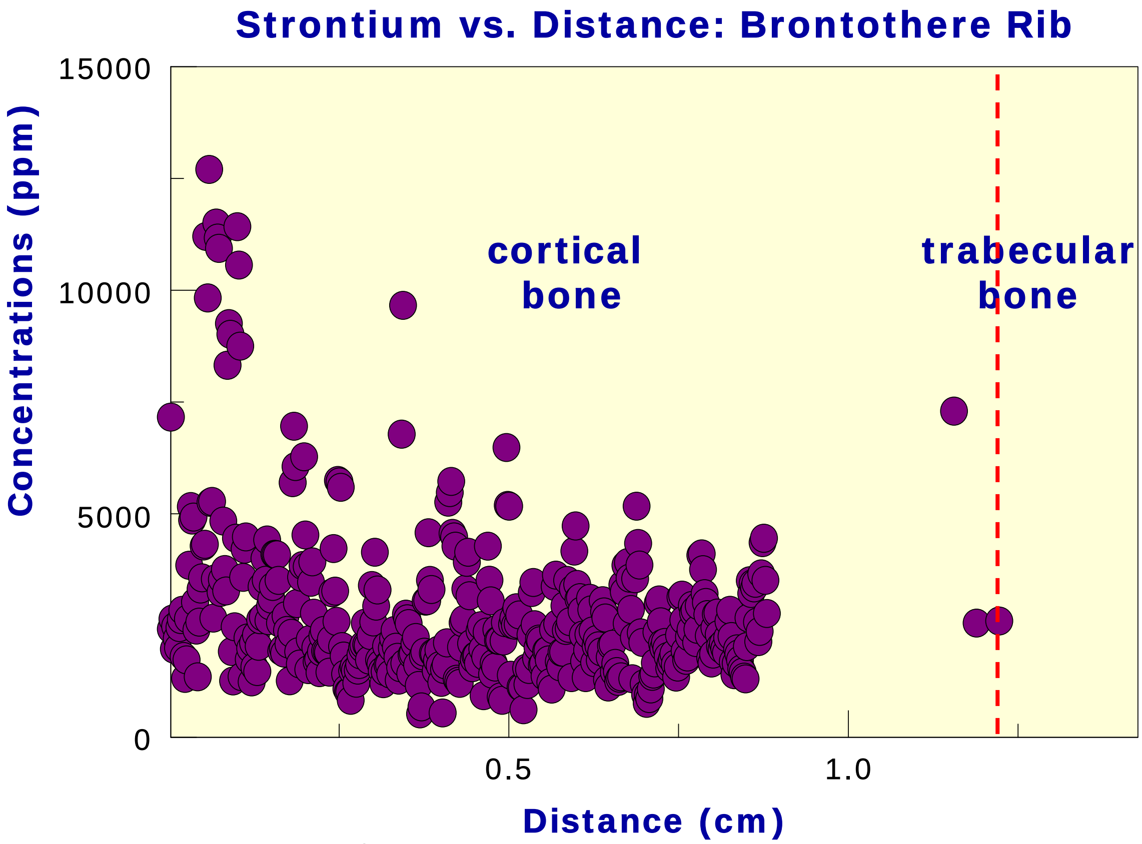


Figure 12. Graph of Strontium concentrations with depth, note relatively constant values with distance into a brontothere rib (F08-10). Strontium has a low adsorption coefficient and concentrations stay relatively similar throughout with depth into the bone. Differing bone textures (cortical vs. trabecular bone) are specified within the graph.

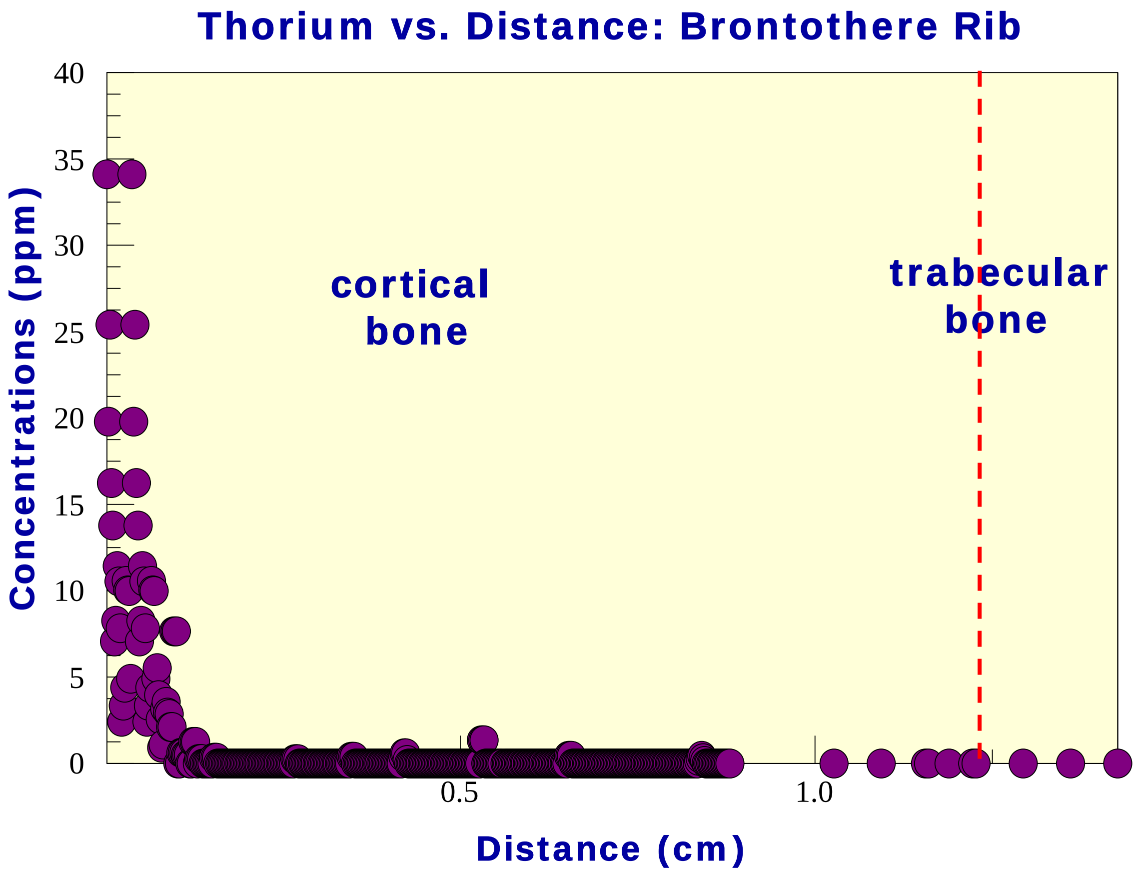


Figure 13. Graph of Thorium as a function of depth into a brontothere rib (F08-10). Thorium concentrations are high at the surface of the bone and immediately decrease with distance due to its higher adsorption value. Differing bone textures (cortical vs. trabecular bone) are specified within the graph.

In terrestrial brontothere bones, LREE and MREE concentrations are greater at the surface and decrease with depth into a bone. However, HREE concentrations remain relatively constant with depth (Figure 14). Analysis of REE in and around osteons of terrestrial bones showed similar results (Figure 15). Signatures are LREE enriched and concentrations are higher around some Haversian channels. The REE concentration spikes were also correlated to osteons from laser ablation transect data (Figure 11). The *t'* gradients for terrestrial samples varied with depth into the bone (Figure 16).

3.2 Marine vs. Terrestrial Settings

The present mean annual precipitation (MAP) in northwest Nebraska is ca. 388 mm/yr (Terry, 2001). However, the Late Eocene ecosystem was forest-dominated, which differs from present day grassland conditions. Previous estimates of MAP for the Late Eocene are 855 $\pm$ 282 mm/yr (Terry, 2001). The saturation (groundwater) of the environment in which bones are fossilizing enables diffusion of REE/TE within bone. Bones are constantly saturated during fossilization and diffusion (W=1) in marine environments. Bones within terrestrial environments are only intermittently saturated in the vadose zone. Previous studies (Suarez et al., 2010) have used a soil saturation of 0.3, which is an average value for modern day soil saturation (Millard and Hedges, 1996). However, paleoeclimates of the Northern Great Plains during the Late Eocene were very different than modern day, based on data from Terry (2001). Soil saturation data for the United States gathered by the National Oceanic and Atmospheric Administration (NOAA) shows that soil saturation in present day northwest Nebraska is

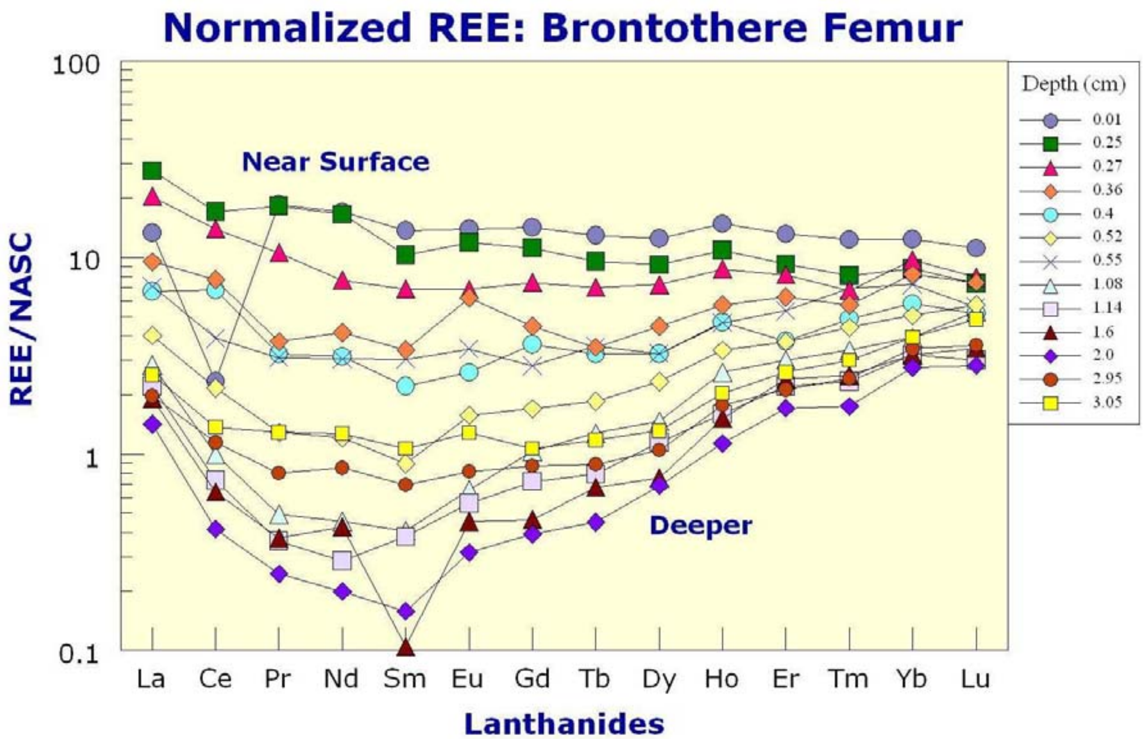


Figure 14. Normalized REE concentrations of a brontothere femur (F08-09). LREE/MREE are enriched at the surface of the bone and become depleted with depth into the femur. HREE remain fairly constant with increasing depth into the bone.

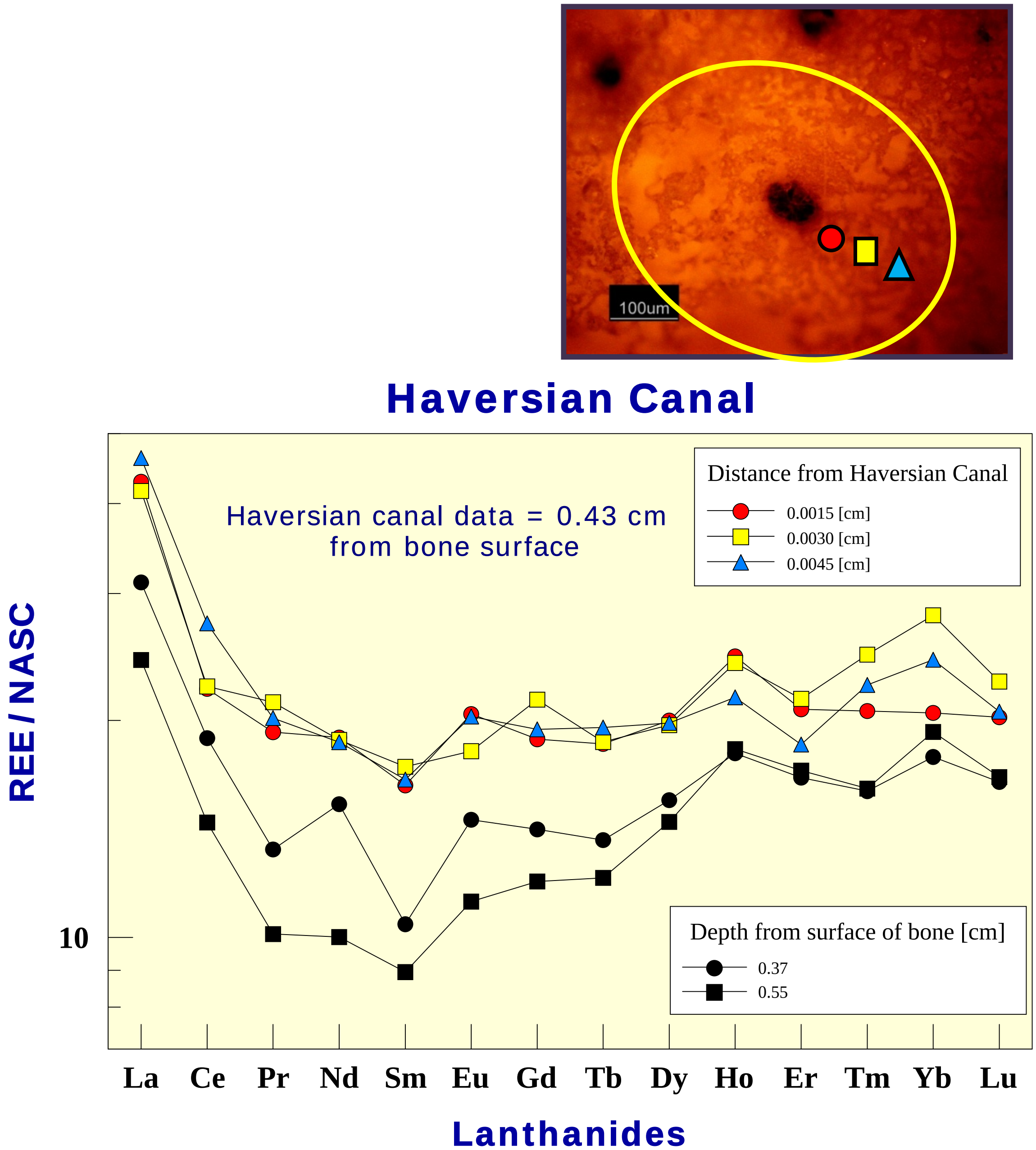


Figure 15. Normalized REE signatures surrounding an osteon within a brontothere rib (F08-10). Concentrations of REE surrounding the Haversian systems are higher than the REE concentrations of the surrounding bone. Signatures show LREE/MREE-enrichment, which is only usually seen at the surface of the bone.

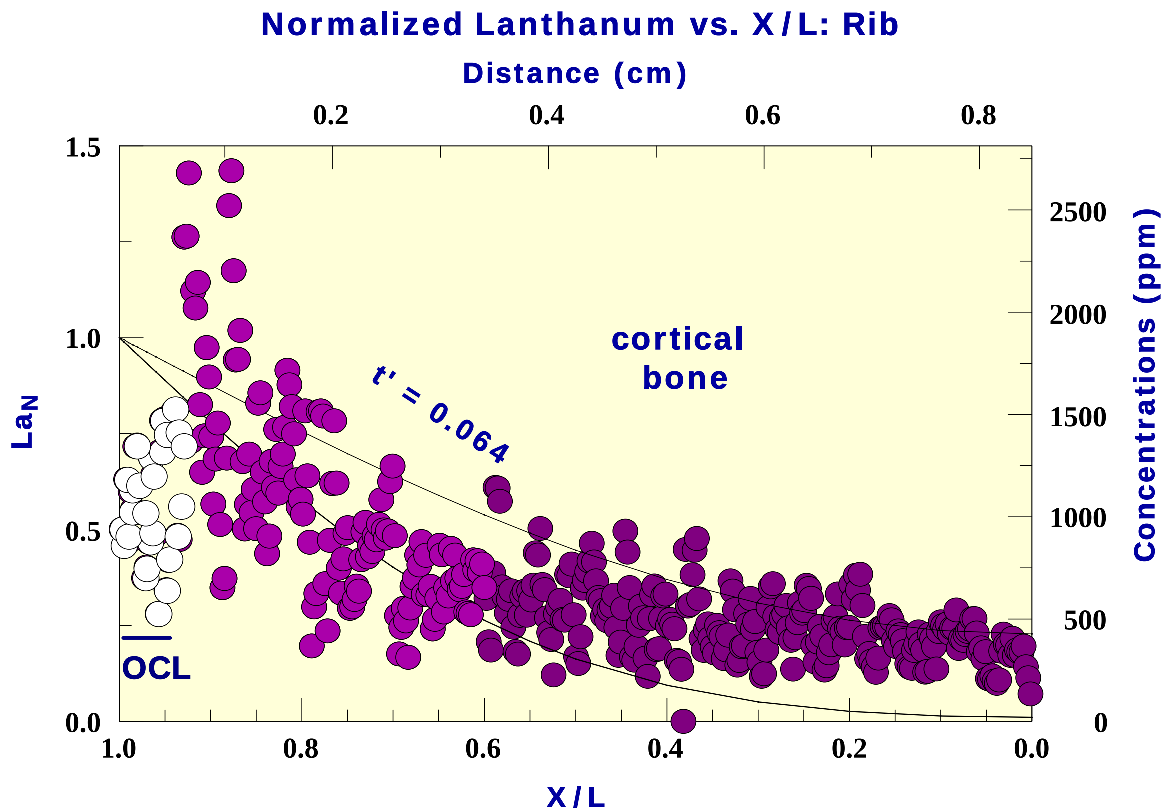


Figure 16. Normalized La (LREE) vs. normalized depth into a brontothere rib (F08-10). The white data points indicate the OCL (outer 1mm). Concentrations within the OCL are lower than the underlying cortical bone. Note that calculated gradient of t' = 0.064 in the outer part of the bone does not fit concentrations found deeper within the rib. The calculated outer diffusion gradient is shown by lighter data points. Concentrations used to calculate the outer diffusion gradient were gathered within the cortical bone.

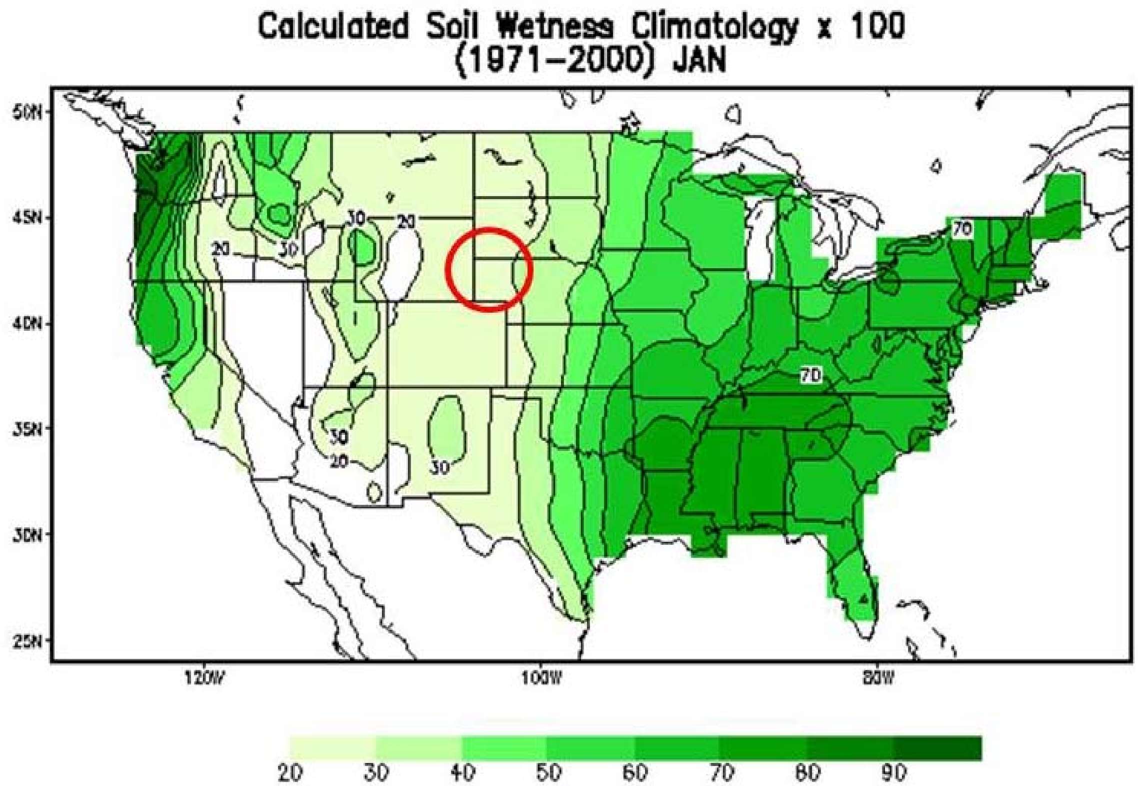


Figure 17. Soil saturation map for the month of January across the contiguous United States (NOAA, 2000). Present day soil saturation of NE is not representative of Late Eocene NE. Therefore, soil saturation in modern day sub-tropical environments was used to calculate diffusion periods.

only 0.2-0.3 throughout the year (Figure 17). Soil saturation may fluctuate slightly seasonally (e.g. in summer months soil saturation increases); however, soil wetness stays relatively constant. Using modern MAP and soil saturation a soil saturation of 0.5 $\pm$ 0.1 was calculated for the Late Eocene (Table 2).

The overbank sediments in which the brontothere fossils were found were smectite, illite, calcite, chalcedony, and geothite, as well as bioapatite. Inverse PHREEQC modeling was used to determine the probable lanthanide and actinide speciation and solution pH (Wright et al., 1987; Barrick and Fischer, 1993). The calcite and smectite suggest that the groundwater was generally neutral to basic. Depending on the modeled soil PCO_2, the vadose pH ranged from 7.35 to 8.40. Since the Eocene paleoclimate of the Northern Great Plains was subtropical, a temperature of 25^{o}C was used for determining speciation of REE/pH within terrestrial environment.

The periods of diffusion for the lanthanide series in the five terrestrial brontothere samples ranged from ca. 2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka, whereas periods for U varied from ca. 11.8 $\pm$ 5.6 to 704.2 $\pm$ 166 ka (Figure 18). The average lanthanide R^2 values for reduced time in brontothere samples were ca. 0.39. Calculated diffusion periods for U and REE from terrestrial and marine bones are found in Table 3 and Figures 18 and 19. Diffusion periods and R^2 values for elements used in this study can also be found in Table 3.

The periods of diffusion for the lanthanide series and for U in the marine fossil bones ranged from 0.9 $\pm$ 0.2 to 2.8 $\pm$ 0.6 ka (Figure 19). Diffusion periods could not be obtained from the cetacean auditory bulla (PAS11-04) because a diffusion gradient could

Table 3. t', $\pm$ t', t, $\pm$t, and R^2 values for all marine and nonmarine bones used in this study.

Terrestrial

		t'	(±) t'	t (years)	(±) t (years)	R^2
F08-08						
	La	0.0047	0.0001	34,310.50	7,673.00	0.610
	Ce	0.0069	0.0003	44,965.85	10,101.00	0.210
	Pr	0.0031	0.00004	27,002.76	6,025.00	0.660
	Nd	0.0028	0.0001	30,754.68	6,757.00	0.630
	Gd	0.0046	0.0001	27,966.45	6,259.00	0.480
	Yb	0.017	0.0011	39,834.40	9,129.50	0.010
	U	0.149	0.02	704,167.52	166,420.10	0.017
F08-09						
	La	0.00028	0.00001	3,495.41	782.60	0.630
	Ce	0.00032	0.00002	3,566.11	819.10	0.520
	Pr	0.0003	0.00001	4,468.68	998.90	0.560
	Nd	0.00019	0.00001	3,568.77	810.80	0.650
	Gd	0.00025	0.00001	2,599.15	583.80	0.600
	Yb	0.00056	0.0001	2,243.92	534.90	0.210
	U	0.00348	0.069	28,124.20	7,328.30	0.025
F08-10						
	La	0.064	0.002	31,958.05	8,829.68	0.510
	Ce	0.076	0.004	33,878.05	8,945.20	0.330
	Pr	0.059	0.0015	35,689.83	9,832.91	0.460
	Nd	0.073	0.003	54,846.28	1,513.03	0.370
	Gd	0.093	0.004	38,675.29	1,069.07	0.250
	Yb	0.4	0.03	20,035.04	5,809.15	0.012
	U	0.017	0.02	48,490.00	14,798.37	0.065
F08-915-R						
	La	0.0082	0.0001	12,751.43	3,039.60	0.520
	Ce	0.0081	0.0001	10,272.62	2,446.14	0.160
	Pr	0.0049	0.0001	18,413.81	1,373.42	0.300
	Nd	0.0074	0.0001	24,606.45	4,390.86	0.450
	Gd	0.019	0.001	9,091.98	5,999.54	0.240
	Yb	0.023	0.0005	11,480.28	2,766.75	0.067
	U	0.019	0.001	19,127.54	4,663.67	0.880
F08-80						
	La	0.041	0.001	13,884.89	4,146.75	0.220
	Ce	0.053	0.001	16,022.82	4,778.83	0.068
	Pr	0.024	0.001	9,698.11	2,886.68	0.310
	Nd	0.034	0.001	17,324.53	5,181.90	0.270
	Gd	0.043	0.001	12,127.67	3,622.54	0.800
	Yb	0.049	0.0001	5,326.41	1,589.40	0.230
	U	0.054	0.006	11,838.94	3,551.08	0.041

Marine

		t'	(±) t'	t (years)	(±) t (years)	R^2
PAS11-01						
	La	0.0021	0.0001	2,222.43	528.10	0.74
	Ce	0.0017	0.0001	1,606.06	385.65	0.77
	Pr	0.0014	0.0001	1,767.88	430.51	0.71
	Nd	0.0013	0.00005	2,070.03	507.16	0.72
	Gd	0.0011	0.0001	969.51	243.30	0.57
	Yb	0.0033	0.0003	1,120.99	280.16	0.62
	U	0.0028	0.0002	1,781.32	1,639.15	0.6
PAS11-02						
	La	0.014	0.001	2,370.59	1,155.00	0.55
	Ce	0.016	0.001	2,418.54	850.80	0.47
	Pr	0.013	0.001	1,833.25	1,254.10	0.44
	Nd	0.0067	0.0001	2,828.62	563.60	0.61
	Gd	0.013	0.002	1,706.98	515.30	0.17
	Yb	0.0019	0.0002	907.66	286.02	0.25
	U	0.0037	0.0003	4,165.55	1,282.80	0.12
PAS11-03						
	La	N/A	N/A	N/A	N/A	0.0006
	Ce	N/A	N/A	N/A	N/A	0.0006
	Pr	N/A	N/A	N/A	N/A	0.018
	Nd	N/A	N/A	N/A	N/A	0.048
	Gd	N/A	N/A	N/A	N/A	0.018
	Yb	N/A	N/A	N/A	N/A	0.0083
	U	N/A	N/A	N/A	N/A	0.063
PAS11-04						
	La	0.0012	0	1,061.58	250.10	0.62
	Ce	0.00108	0.00001	867.29	204.70	0.68
	Pr	0.00089	0.00001	939.46	225.30	0.78
	Nd	0.00116	0.00001	1,544.03	364.03	0.67
	Gd	0.0015	0.00003	1,134.60	268.30	0.63
	Yb	0.0036	0.0001	1,022.24	241.20	0.71
	U	0.13	0.01	2915.08	1,639.20	0.26

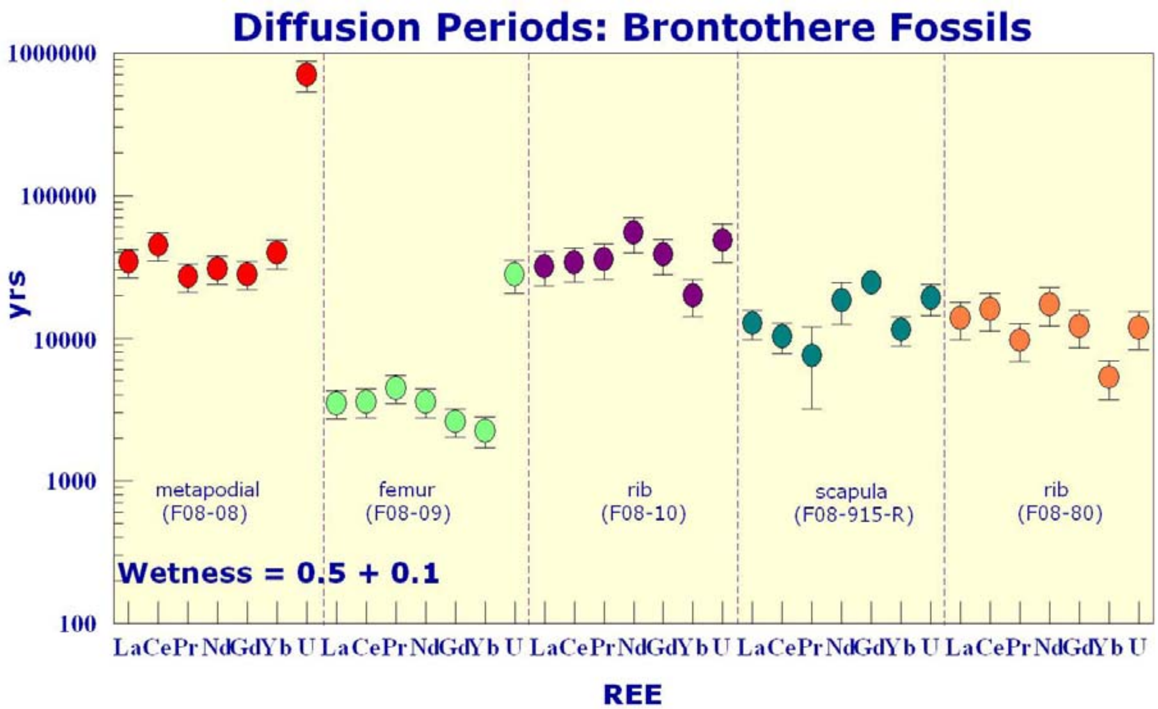


Figure 18. Diffusion periods for selected lanthanides and U in terrestrial brontothere bone samples from the Late Eocene Peanut Peak Member of NE. The orange data points represent a brontothere rib (F08-80) collected from the Benedict Buttes bonebed (Figure 3). All other data points are associated bones found within the same bonebed accumulation (Orella Road). Periods of diffusion for REE within the terrestrial brontothere bones ranged from 2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka.

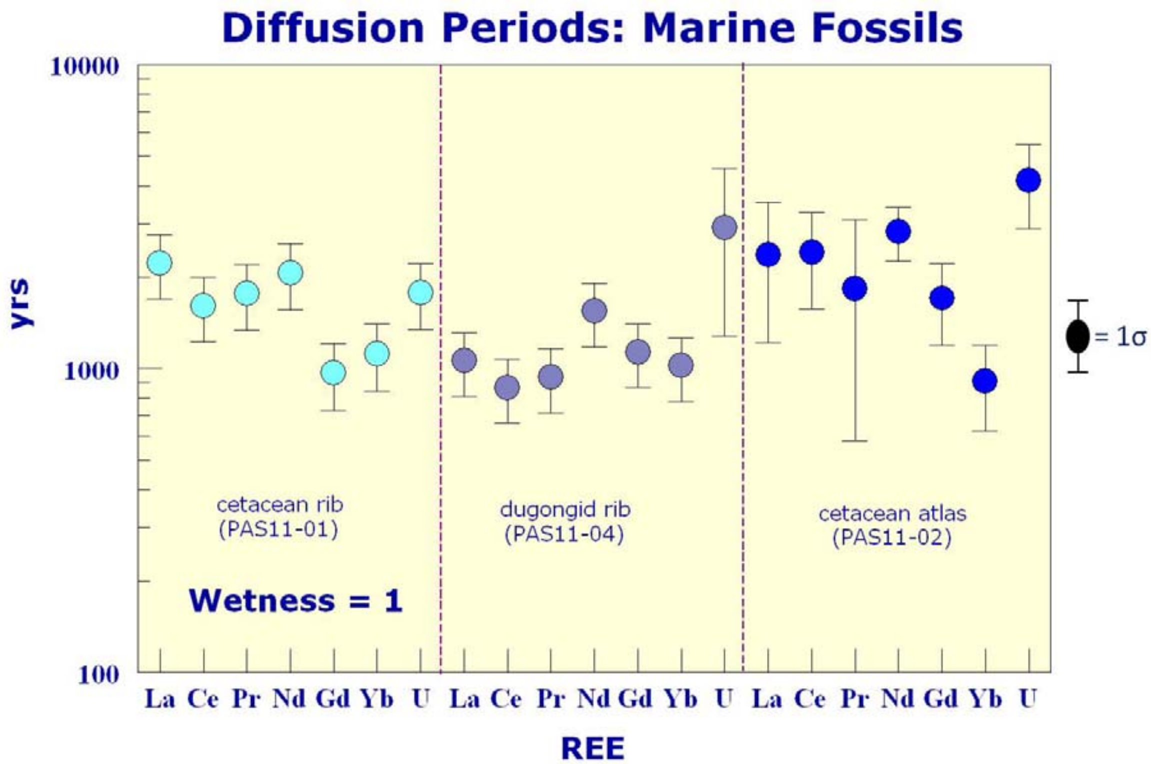


Figure 19. Diffusion periods for marine bone samples ranging from 0.9 ± 0.2 to 2.8 ± 0.6 ka. PAS11-01 was collected from Aurora, NC, PAS11-02 was collected from Calvert Cliffs, MD, and PAS11-04 was collected from Polk County, FL (Figure 5). All marine samples are from the Miocene.

not be calculated from the data. The average lanthanide R^2 values for reduced time in marine bones (with the exception of the auditory bulla) were ca. 0.62. The average lanthanide R^2 value for reduced time in the auditory bulla was ca. 0.026 (Table 3). The error within values of terrestrial and marine bones was calculated from the one sigma uncertainty based on propagation of error.

Within the terrestrial samples Ce had the highest concentrations (ca. 5,900 ppm). However, in marine bones concentrations of lanthanides were much lower, with the highest concentrations ca. 800 ppm (Ce; Figure 20).

Calculated average diffusion periods for the five terrestrial brontotheres (0.9 $\pm$ 0.2 to 2.8 $\pm$ 0.6 ka) [and a dinosaur bone from Crystal Geyser in Utah from Suarez et al. (2010)] were greater than the three marine mammals (2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka; Figure 21). Even with the saturation factor set to 1 for the terrestrial fossils, diffusion periods in marine fossils are shorter (Figure 22).Within each bone, REE diffusion periods are internally consistent with one another. However, elements from the lanthanide series diffuse into the four bones from the same terrestrial bonebed (Orella Road) over different periods of time (Figure 18, 21). The femur (F08-09) has an average period of diffusion of ca. 3 ka, which is much shorter than the other bones from the Orella Road site (Figure 18, 21).

In the samples, REE signatures differ with depth in marine and terrestrial fossil bones (Martin et al., 2005; Patrick et al., 2007; Grandstaff and Terry, 2009). In terrestrial bones NASC-normalized REE signatures are LREE enriched at the surface and MREE depleted with depth within terrestrial bones (Figure 14). HREE, remain constant with

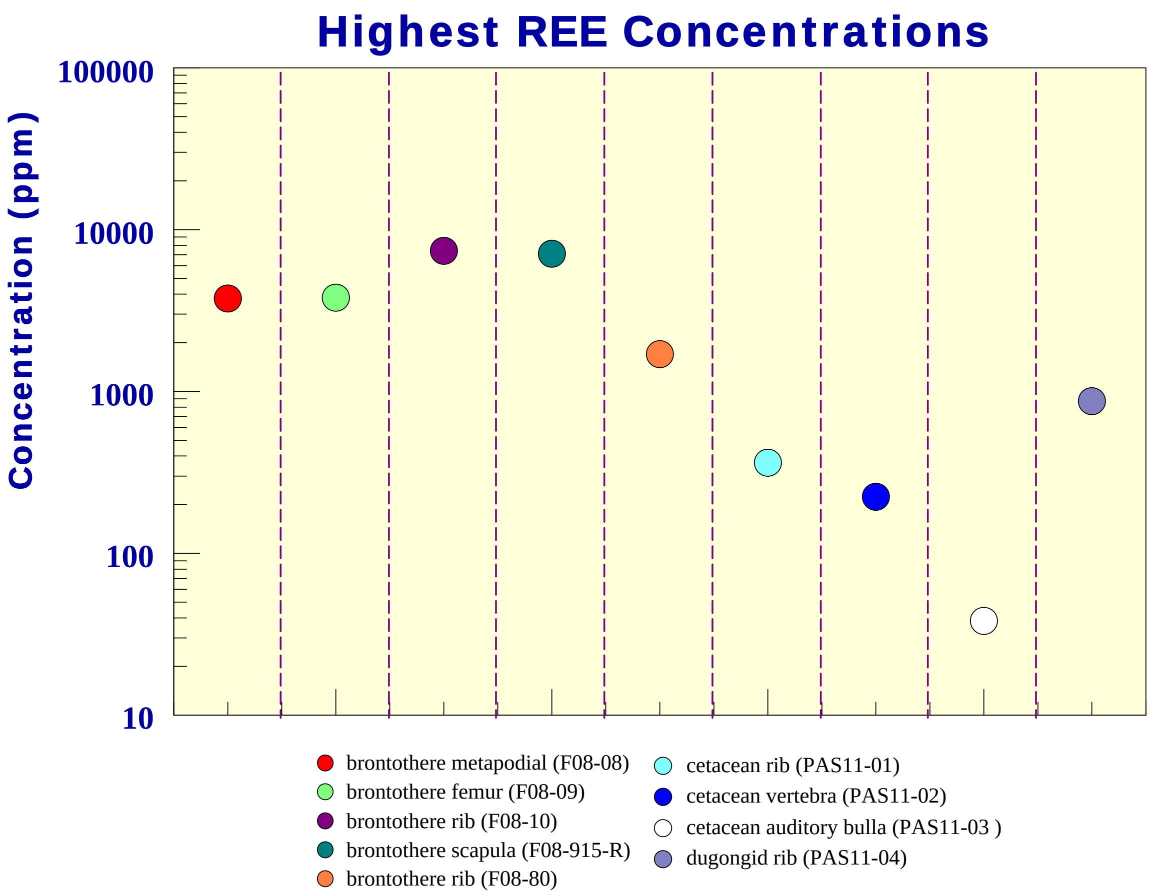


Figure 20. Highest concentrations (ppm) of REE within each bone analyzed. REE concentrations in solution are much higher in terrestrial environments than in marine settings.

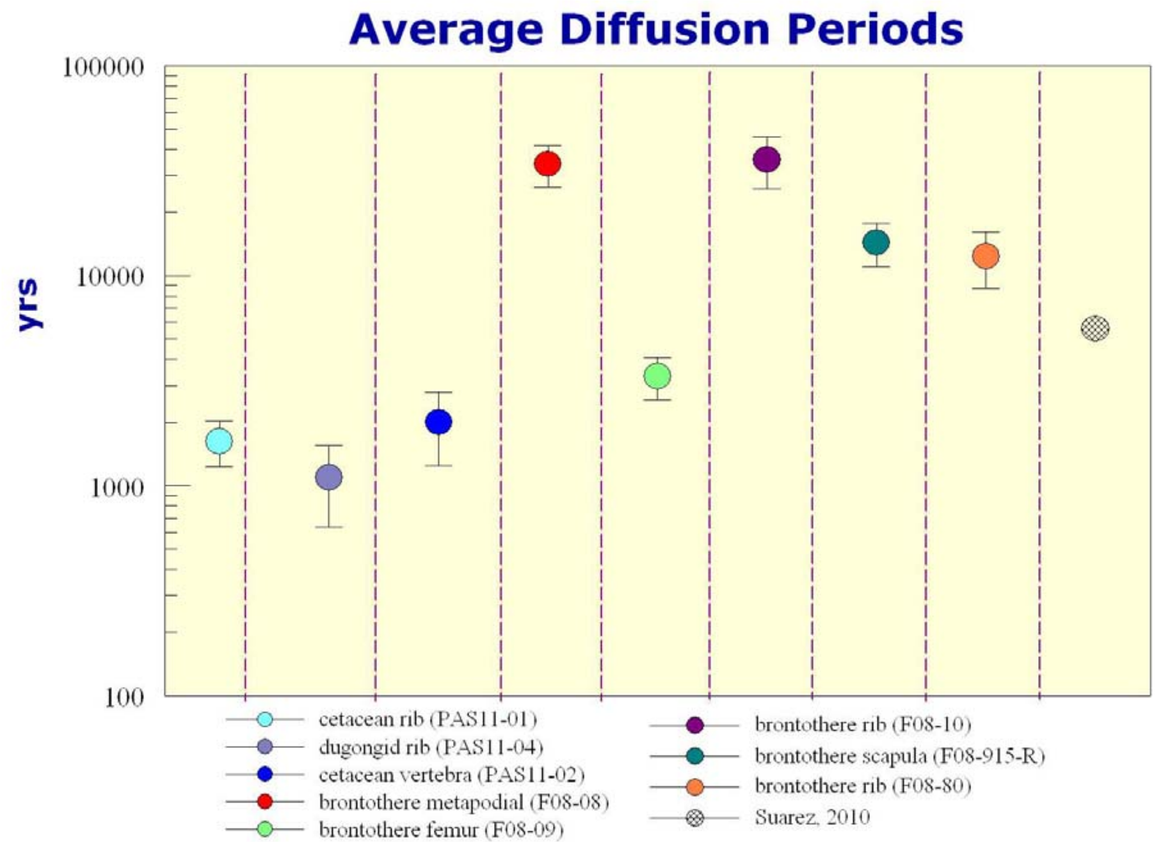


Figure 21. Average lanthanide diffusion periods for both marine and terrestrial bones. Data from Suarez et al. (2010) is a dinosaur bone from the Crystal Geyser locality in southeast Utah. Periods of diffusion in terrestrial samples tend to be much longer than in bones that fossilized in marine settings.

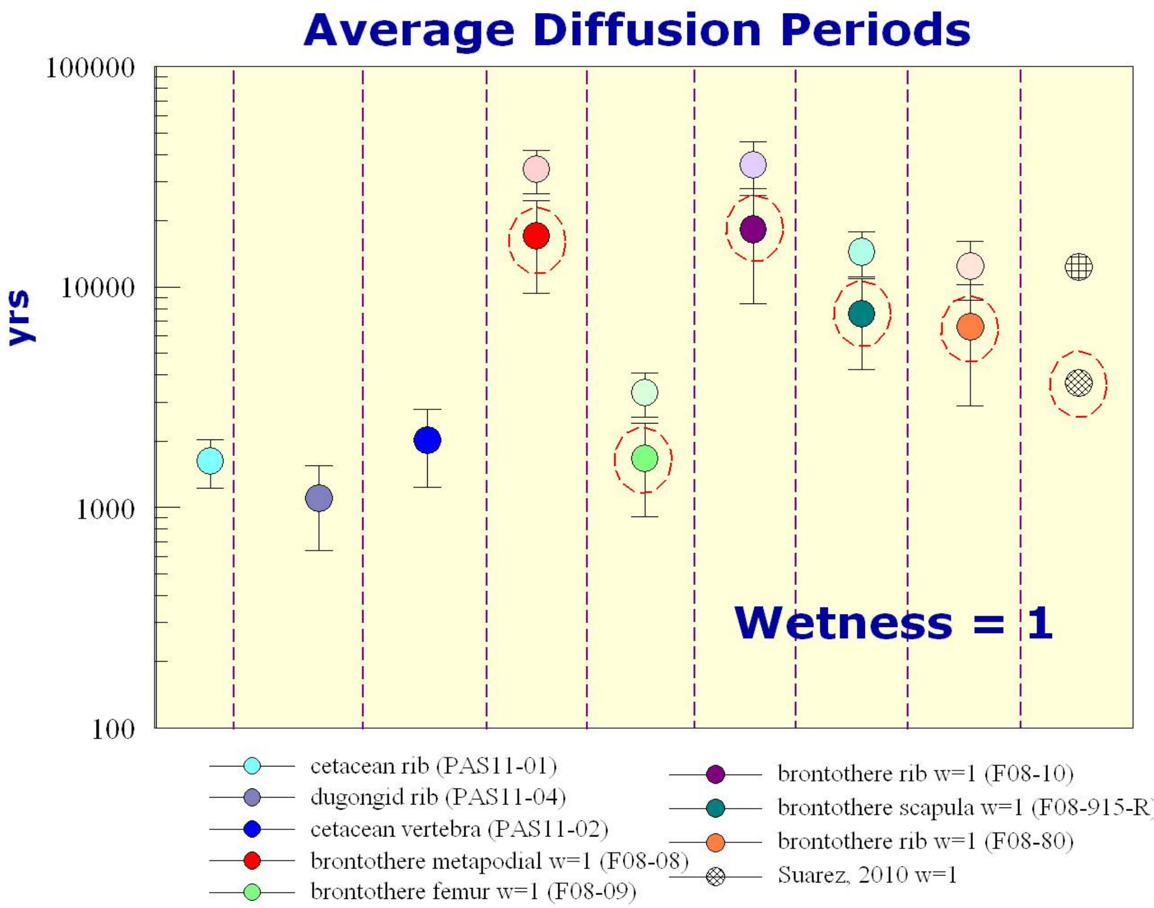


Figure 22. Comparison of average periods of diffusion of the lanthanides series when terrestrial brontothere samples are assumed to have fossilized under fully saturated conditions (*W*=1). Circled data are terrestrial diffusion periods for a saturated setting. In general, diffusion periods in terrestrial settings are still longer, than in marine settings, indicating that other environmental factor beside *W* will affect diffusion periods.

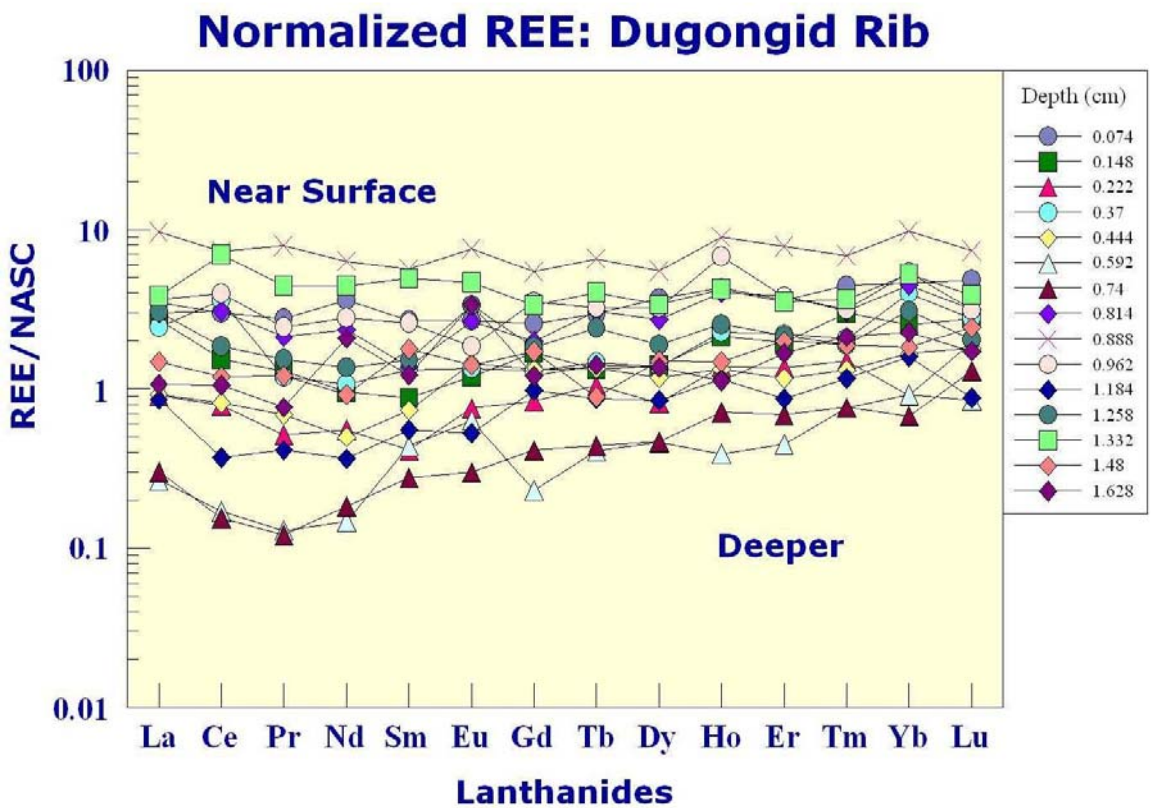


Figure 23. Spider diagram of normalized REE signatures for a dugongid rib (PAS11-04) show little to no enrichment/depletion with depth into the bone. Concentrations found within the center of the bone are higher than concentrations found at the surface of the bone, indicating that constant saturation affects fossilization within a bone.

depth. However, REE signatures within marine fossils are not strongly depleted in either LREE or MREE with depth into the bone, which generates a flatter REE signature (Figure 23). Although concentrations vary with depth within marine samples, signatures remain similar. REE concentrations found at the center of the dugongid bone are much higher than the concentrations found at the surface of the bone. Elevated concentrations at the center of the bone were also noted within the altas vertebra (PAS11-02).

CHAPTER 4

INTERPRETATIONS/DISCUSSION

4.1 Influences of Histology on Diffusion

REE concentrations were lower in the OCL than in the underlying cortical bone. Unlike the surrounding cortical bone the OCL does not contain Haversian systems, which should inhibit fluid flow through the bone. Two scenarios could explain the anomalously low concentrations within the OCL; REE/TE are not incorporated as well as in the surrounding cortical bone, or subsequent leaching reduced concentrations. Lower concentrations within the OCL could potentially bias analysis of REE since the outermost portion of the bone is used.

In terrestrial fossil bones, REE signatures evolve as a function of depth as REE/TE diffuse inward from the surface to the center of a bone. Enrichment and depletion of REE is directly affected by the adsorption coefficient of a particular lanthanide. LREE and MREE will be preferentially adsorbed near the surface of a bone due to their higher adsorption coefficients (Figure 14, Table 2). This is reflected by LREE and MREE enrichment at the surface and depletion with depth into a bone. HREE have strong aqueous complexes with CO_3^{2-} in solution and therefore will have lower adsorption coefficients (Figures 11, 14). MREE atomic radii are similar to calcium, which is a major constituent of apatite. MREE will readily replace calcium within bone causing depletion of MREE with depth into bone (Figure 10, 11, 14).

The spot analyses around osteons imply that histology may affect REE/TE uptake within bone. Spot analyses around Haversian systems illustrate that concentrations surrounding Haversian systems are greater and more LREE-enriched than that of the surrounding bone. LREE-enrichment is usually seen at the surface of a bone, which suggests that Haversian systems are acting as fluid conduits, bringing unreacted fluid into the bone (Figure 15). The areas of high concentrations within the brontothere rib (F08-10) and scapula (F08-915-R) from Orella Road are possibly the result of fast diffusion through Haversian systems (Figure 9, 11).

Two *t'* gradients were required to fit the outer and inner normalized REE concentrations for the fossil bones. Only one diffusion gradient is expected for the DA model (Millard and Hedges, 1996). This indicates that multiple diffusion pathways were present during fossilization, which supports the DMD model (Kohn, 2008). REE concentrations were plotted and qualitatively examined. Approximately 70-90% of REE are introduced through slow diffusion through the surface of the bone, following Millard and Hedges (1996). The remaining10-30% of the REE introduced through fast diffusion pathways (Haversian systems). This again suggests that that the DMD model of Kohn (2008) is more representative for REE diffusion (Figure 16).

4.2 Marine versus Terrestrial Settings

Paleosols from the Orella Road site contain carbonate glaebules and smectite (Grandstaff and Terry, 2009), indicating that the terrestrial bones fossilized under basic conditions, similar to the bones in marine environments (Langmuir, 1997). Diagenetic minerals such as calcite and chalcedony infilled pore spaces within the terrestrial samples, further suggesting basic conditions during fossilization. Inverse PHREEQC modeling showed mono- and di-carbonate species as the dominant species in both the Miocene marine and Late Eocene terrestrial environments. The modeled pH of the groundwater in the vadose zone at the Orella Road site was ca. 7.9, indicating neutral-basic conditions. Since environmental conditions are similar, adsorption values from Koeppenkastrop and DeCarlo (1992) for seawater may be used in diffusion calculations.

The diffusion periods calculated for the lanthanide series in the brontothere bones are similar within each bone. However, periods of diffusion differ between bones (Figure 18). The brontothere femur (F08-10) had diffusion periods of ca. 3 ka, which is much shorter than the other brontothere bones. The femur was particularly silicified, which could have influenced the period of diffusion (Suarez et al., 2010). The variability in calculated diffusion periods suggests that in associated bones diffusion may not occur over the same time period. In most bones, lanthanides and U diffusion periods are similar. However in the femur (F08-10) and the metapodial (F08-09), U was introduced into the bone over a much longer period of time, possibly as a function of fluctuating redox during fossilization (Figure 18).

With the exception of the cetacean bulla, marine bones had internally consistent periods of diffusion for the lanthanides and U within each bone (Figure 19), suggesting that lanthanides and U are introduced into the bones over the same time period. Differences in the diffusion periods for the lanthanides and U within the cetacean bulla may be the result of the dense, non-cortical bone which does not contain Haversian systems, and suggests that the presence of Haversian systems may play an important role in REE/TE uptake within bone.

Terrestrial bones have much longer periods of diffusion when compared to marine bones due partially to constant saturation during diffusion within marine settings (Figure 21); however soil saturation is not the only driving force behind diffusion. Calculations for terrestrial brontothere samples assuming fully saturated conditions should yield diffusion periods similar to marine samples; this is not seen (Equation 6; Figure 22). This suggests there are other processes that are affecting diffusion in marine and terrestrial fossil bones. Marine samples are not strongly fractionalized with depth when compared to terrestrial bones, possibly as a function of constant saturation (Figure 23).

Past studies have assumed that periods of diffusion within a single bonebed are similar and that bones are recording the same geochemical signature (Grandstaff and Terry, 2009). However, data from my research shows that REE diffusing into bones from the same bonebed assemblage do not incorporate over the same time periods (Figure 18, 21). This has implications for using bulk solution analyses for paleoenvironmental reconstruction, because diffusion periods cannot be obtained using this method (Grandstaff and Terry, 2009). If a bone has a different geochemical signature than other bones within the bonebed accumulation, it is assumed that the bone has been reworked. However, if that bone has a shorter period of diffusion than the other bones within the bonebed accumulation, the geochemical environmental conditions may have changed and the bone in question could be recording a different geochemical signature (Suarez et al., 2010). If REE/TE are being used for paleoenvironmental reconstruction, laser ablation should be used instead of bulk solution and the periods for diffusion within the bones should be calculated (Koenig et al., 2009). All four brontothere bones within the Orella Road bonebed have the same internal geochemical trend (Figure 24), which suggests that the chemistry of the groundwater did not change during fossilization (2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka).

According to Schweitzer et al. (2006), pre-Pleistocene bones will more likely have soft tissue preservation if fossilization occurred within sandstone/fluvial environments instead of mudstone/marine environments. However, cell preservation has been noted in Late Miocene-Early Pliocene marine bone samples (Schweitzer et al., 2006). Schweitzer et al. (2006) also hypothesize that in order to preserve soft tissue; the rate of fossilization must outpace the rate of decay. They also note a correlation between the preservation of soft tissue within bone and the taphonomic setting (saturated environments). The diffusion periods for the terrestrial brontothere fossils are too long for biomolecule preservation, but the diffusion periods for marine fossil bones are much shorter, which supports the notion that saturated environments (channel, lacustrine, marine) favor biomolecule preservation in deep time (Figure 19, 21).

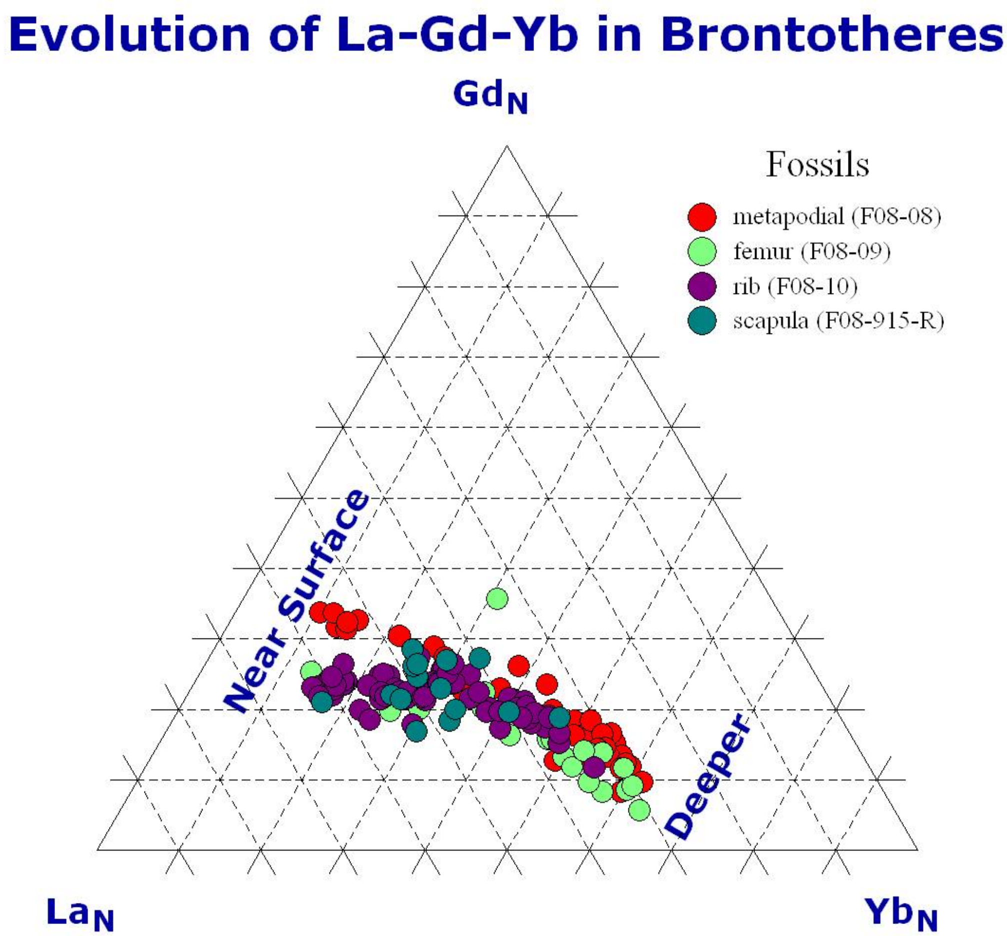


Figure 24. Evolution of REE with depth into bone for the associated brontothere bones from the Orella bonebed. The internal geochemical signatures are similar to one another indicating that the groundwater chemistry did not change during fossilization within the bones.

CONCLUSION

Bone histology affects the incorporation of REE/TE into fossilizing bones. The outermost part of a fossilized bone should have the highest REE concentrations; however bones with an OCL did not follow this trend. REE may not be easily incorporated within the dense OCL, or post-fossilization leaching may be responsible for lower concentrations. Concentrations of REE surrounding some Haversian systems deeper within the fossil bone were elevated and had LREE enriched signatures suggesting that Haversian systems act as fluid conduits and fast diffusion pathways. REE concentrations in trabecular bone of the brontothere scapula (F08-915-R) were almost as high as concentrations found at the surface of the bone.

The depositional environment in which a bone fossilizes affects REE/TE diffusion periods. In terrestrial environments, periods of diffusion ranged from 2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka. However, in marine environments diffusion periods for REE ranged from 0.9 $\pm$ 0.2 to 2.8 $\pm$ 0.6 ka. Due to the constant saturation during fossilization, marine fossil bones have a much shorter period of diffusion than terrestrial fossil bones. Four of the terrestrial samples from the same bonebed accumulation showed dissimilar periods of diffusion (2.2 $\pm$ 0.5 to 54.8 $\pm$ 1.5 ka). Bones within a specific bonebed accumulation may not fossilize together. Differentiation in diffusion periods have been noted in previous studies as well (Suarez et al., 2010). Data from this study has implications for the temporal resolution of REE/TE/isotopes in paleoenvironmental reconstructions. Being able to put time constraints on the use of REE/TE/isotopes will give better resolution for paleoenvironmental reconstruction. The fossilization process is strongly affected by paleoenvironmental and hydrologic conditions. If periods of diagenetic stable isotope incorporation in bone are similar to those of trace element diffusion, paleoenvironmental interpretations based on these post-mortem isotopes must consider potential paleohydrologic influences.

Even when the soil wetness factor for terrestrial samples was set to full saturation (W=1) periods of diffusion were still much longer (1 $\pm$ 0.1 to 26.7 $\pm$ 0.8 ka) in terrestrial bones than those in marine fossil bones, suggesting that the degree of saturation is not the only environmental control on diffusion periods.

The possibility of biomolecule preservation within bone has been noted by previous researchers, and is based on a model of fossilization outpacing the rate of organic decay. My research suggests that saturated marine environments generate relatively short periods of diffusion, which in turn suggest that saturated terrestrial environments (lakes and channels) would have the greatest potential to preserve biomolecules in deep time. Additional data are required to test the fossilization conditions required for the preservation of bio-molecules in deep time.

REFERENCES

Anderson, P.E., Benton, M.J., Trueman, C.N., Paterson, B.A., and Cuny, G., 2007, Paleoenvironments on the southern shore of Tethys: The nonmarine Early Cretaceous of Tunisia. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 243, p. 118-131.

Barrick R.E., and Fischer A.G., 1993, Paleotemperatures versus sea level: oxygen isotope signal from fish bone phosphate of the Miocene Calvert Cliffs, Maryland. Paleoceanography, v. 8, p. 845-858.

Cerling, T.E., and Sharp Z.D., 1996, Stable carbon and oxygen isotope analysis of fossil tooth enamel using laser ablation. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 126, p. 173-186.

Chinsamy-Turan, A., 2005, The Microstructure of Dinosaur Bone: Deciphering Biology with Fine Scale Techniques. Johns Hopkins University Press, Baltimore.

Crank, J., 1975, The Mathematics of Diffusion. Oxford University Press Inc., New York.

Grandstaff, D.E., and Terry, Jr., D.O., 2009, Rare Earth Element Composition of Paleogene vertebrate fossils from Toadstool Geologic Park, Nebraska, USA. Applied Geochemistry, 24, 733-745.

Gromet, L.P., Dymek, R.F., Haskin, L.A., Korotev, R.L., 1984, The North American shale composite: its composition, major, and trace element characteristics. Geochimica et Cosmochimica Acta, v. 48, p 2467-2472.

Hinz, E.A., and Kohn, M.J., 2010, The effect of tissue structure and soil chemistry on trace element uptake in fossils. Geochimica et Cosmochimica Acta, v. 74, p. 3213-3231.

Junqueira L.C., and Carneiro, J., 2003, Basic Histology Text and Atlas. McGraw-Hill Companies Inc., United States.

Kerisit, S. and Liu, C., 2010, Molecular simulation of the diffusion of uranyl carbonate species in aqueous solution. Geochimica et Cosmochimica Acta, v. 74, p. 4937-4952.

Koenig, A.E., Rogers, R.R., and Trueman, C.N., 2009, Visualizing fossilization using laser ablation-mass spectrometry maps of trace elements in Late Cretaceous bones. Geology, v. 37, p. 511-514.

Koeppenkastrop, D. and DeCarlo, E.H., 1992, Sorption of rare-earth elements from seawater onto synthetic mineral particles: An experimental approach. Chemical Geology, v. 95, p. 251-263.

Kohn, M.J., 2008, Models of diffusion-limited uptake of trace elements in fossils and rates of fossilization. Geochimica et Cosmochimica Acta, v. 72, p. 3758-3770.

Kohn, M.J. and Law J.M., 2006**,** Stable isotope chemistry of fossil bone as a new paleoclimate indicator. Geochimica et Cosmochimica Acta, v. 70, p. 931-946.

Langmuir, D., 1997, Aqueous Environmental Geochemistry. Prentice-Hall Inc., Upper Saddle River.

Lee-Thorp, J., and Sponheimer, M., 2006, Contribution of biogeochemistry to better understanding hominin dietary ecology. American Journal of Physical Anthropology, v. 131, p. 131-148.

Li Y-H and Gregory S., 1974, Diffusion of ions in sea water and in deep-sea sediments. Geochimica et Cosmochimica Acta, v. 38, p. 703-713.

Martin J.E., Patrick, D., Kihm, A.J., Foit, F.F., and Grandstaff, D.E., 2005, Lithostratigraphy, tephrochronology, and rare earth element geochemistry of fossils at the classical Pleistocene Fossil Lake area, South Central Oregon. The Journal of Geology, v. 113, p. 139-155.

Metzger, C.A., Terry, D.O., and Grandstaff, D.E., 2004, Effect of paleosol formation on rare earth element signatures in fossil bone. Geology, v. 32, p. 467-500.

Millard, A.R., and Hedges, R.E.M., 1995, The role of the burial environment in uranium uptake by buried bone. Journal of Archaeological Science, v. 22, p. 239-250.

Millard, A.R., and Hedges, R.E.M., 1996, A diffusion-adsorption model of uranium uptake by archeological bone. Geochimica et Cosmochimica Acta, v. 60, p. 2139-2152.

Patrick, D., Martin, J.E., Parris, D.C. and Grandstaff, D.E., 2004, Paleoenvironmental interpretations of rare earth element signatures in mosasaurs (Reptilia) from the Upper Cretaceous Pierre Shale, central South Dakota, USA. Palaeogeography, Palaeoecology, Palaeoclimatology, v. 212, p. 277 – 294.

Patrick, D., Martin, J.E., Parris, D.C. and Grandstaff, D.E., 2007, Rare earth element determination of the stratigraphic position of the holotype of Mosasaurus missouriensis (Harlan), the first named reptile fossil from the American west. Geological Society of America Special Papers, v. 427, p. 155-165.

Schweitzer, M.H., Wittmeyer, J.L., and Horner, J.R., 2006, Soft tissue and cellular preservation in vertebrate skeletal elements from Cretaceous to the present. Proceedings of the Royal Society, v. 274, p. 183-197.

Staron, R., Grandstaff, B., Gallagher, W., and Grandstaff, D.E., 2001, REE signals in vertebrate fossil from Sewel, NJ: Implications for location of the K-T boundary. PALAIOS, v. 16, p. 255-265.

Suarez, C.A., Macpherson, G.L., González, L.A., and Grandstaff, D.E., 2010, Heterogeneous rare earth element (REE) patterns and concentrations in a fossil bone: Implications for the use of REE in vertebrate taphonomy and fossilization history. Geochimica et Cosmochimica Acta, v. 74, p. 2970-2988.

Suarez, C.A., Suarez, M.B., Terry, D.O., and Grandstaff, D.E., 2007, Rare earth element geochemistry and taphonomy of the Early Cretaceous Crystal Geyser Dinosaur Quarry, east-central Utah. PALAIOS, v. 22, p. 500-512.

Terry, Jr., D.O., 2001, Paleopedology of the Chadron Formation of Northwest Nebraska: Implications for paleoclimate changes in the North American midcontinent across the Eocene – Oligocene boundary. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 168, p. 1-38.

Trueman, C.N., 1999, Rare earth element geochemistry and taphonomy of terrestrial vertebrate assemblages. PALAIOS, v. 14, p. 555-568.

Trueman, C.N., and Benton, M.J., 1997, A geochemical method to trace the taphonomic history of reworked bones in sedimentary settings. Geology, v. 25, p. 263-266.

Trueman, C.N., and Palmer, M. R., 1996, Diagenetic origin of REE in vertebrate apatite: A reconsideration of Samoilov and Benjamini. PALAIOS, v. 5, p. 495-497.

Trueman, C.N., and Tuross, N., 2002. Trace elements in recent and fossil bone apatite, in Kohn, M.J., et al. (eds.) Phosphates: Geochemical, Geobiological, and Materials Importance. Reviews in Mineralogy and Geochemistry, v. 48, p. 489-521.

Trueman, C.N., Behrensmeyer A.K., Potts R., Tuross N., 2006, High-resolution records of location and stratigraphic providence from the rare earth element composition of fossil bones. Geochimica et Cosmochimica Acta, v. 70, p. 4343-4355.

Trueman, C.N., Behrensmeyer A.K., Tuross N., and Weiner S., 2004, Mineralogical and compositional changes in bones exposed on soil surfaces in Amboseli Nation Park, Kenya: diagenetic mechanisms and the role of sediment pore fluids, Journal of Archaeological Science. v. 31, p.721-739.

Wright, J., Schrader, H., and Holser W.T., 1987, Paleoredox variations in ancient oceans recorded by rare earth elements in fossil apatite. Geochimica et Cosmochimica Acta, v. 51, p. 631-644.

APPENDIX

Appendix A. Concentrations (parts per million) for REE (La, Ce, Pr, Nd, Gd, and Yb) used to calculate periods of diffusion and to access the effects of histology on REE uptake for each bone examined in this study. The depths (cm) of the laser ablation transects into the bones are also present. Missing data points are a result of concentrations being too high/low and they were not properly read by the mass spectrometer.

Brontothere Rib (F08-80): Benedicts Buttes

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
657.24	1494.98	119.80	312.65	31.29	20.16	715.06	0.00
623.17	1765.85	159.81	268.23	29.46	24.21	548.21	0.01
606.60	1158.65	137.19	209.86	37.14	26.32	573.57	0.01
691.50	1342.61	143.07	239.87	46.48	28.08	568.03	0.01
788.83	1093.25	111.11	258.09	48.81	23.84	488.34	0.02
591.77	866.57	63.68	196.60	35.85	20.60	313.42	0.02
571.03	748.19	64.17	212.74	30.77	16.14	295.30	0.02
436.26	743.05	69.50	211.89	25.06	17.18	368.14	0.03
574.45	874.55	88.73	287.69	26.80	24.29	367.55	0.03
663.04	967.78	102.88	308.98	33.03	26.27	454.06	0.03
697.13	973.70	90.78	276.94	28.51	30.87	362.99	0.04
635.01	675.66	74.49	247.15	33.76	34.83	498.02	0.04
499.08	634.69	52.17	189.53	24.64	37.83	404.32	0.04
463.51	575.32	74.58	195.02	31.64	36.87	815.37	0.05
351.16	723.28	65.60	140.33	19.77	23.02	651.50	0.05
318.53	539.78	60.69	124.66	21.40	23.19	630.84	0.05
325.43	513.85	43.41	154.26	21.36	16.37	221.65	0.06
369.47	573.51	41.49	176.49	23.50	21.34	327.50	0.06
395.90	538.21	41.15	172.67	17.86	15.46	334.00	0.06
322.20	445.16	38.75	129.96	14.54	15.50	366.51	0.07
381.74	893.70	51.42	180.80	16.21	11.85	506.38	0.07
635.35	1064.32	71.75	234.73	26.83	27.67	786.71	0.07
825.09	1158.96	86.64	293.23	30.91	39.71	848.85	0.08
842.76	790.49	87.33	287.38	29.54	39.44	655.32	0.08
683.96	1580.16	74.58	271.42	21.70	27.92	462.82	0.08
671.51	1827.62	66.44	263.50	25.13	20.84	422.88	0.09
692.95	1802.54	75.59	311.57	30.00	27.59	492.80	0.09
630.12	948.65	104.37	305.87	38.20	28.51	458.93	0.09

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
573.46	729.06	97.64	295.49	31.58	29.66	419.01	0.10
628.37	969.15	86.46	283.29	42.15	30.43	228.88	0.10
604.77	1049.34	60.18	261.79	38.97	23.79	213.54	0.10
548.64	977.11	53.03	233.59	35.27	25.96	253.33	0.11
698.22	1252.39	85.91	171.09	21.56	32.40	455.70	0.11
724.89	1081.33	86.85	155.48	18.05	40.60	521.29	0.11
777.89	1080.48	90.88	149.15	27.15	38.37	501.97	0.12
529.25	613.61	54.52	134.27	28.66	27.65	509.14	0.12
521.31	945.39	48.96	193.99	28.32	28.22	530.10	0.12
538.61	1006.35	50.61	203.15	27.72	30.62	564.11	0.13
494.28	916.60	65.80	206.23	26.08	32.88	646.55	0.13
495.08	614.25	61.80	150.75	29.70	29.56	450.58	0.13
386.23	542.12	57.04	139.50	24.86	26.15	469.08	0.14
366.41	481.00	40.71	113.29	22.01	19.43	273.47	0.14
316.12	429.71	58.22	104.15	17.87	19.83	402.41	0.14
416.67	589.14	59.11	96.69	24.49	16.79	557.52	0.15
422.61	606.11	56.79	95.74	20.97	24.01	596.69	0.15
420.76	716.58	37.05	96.55	14.13	23.65	679.70	0.15
439.55	612.25	42.87	126.74	8.09	24.24	559.91	0.16
402.01	510.22	34.11	110.94	10.97	17.68	424.37	0.16
524.64	510.28	54.60	122.00	15.42	17.96	367.35	0.16
417.63	538.76	50.41	102.74	11.34	22.46	241.10	0.17
431.14	739.94	49.63	103.46	9.02	23.37	241.10	0.17
281.71	589.63	28.50	77.17	9.84	18.32	165.02	0.17
250.34	614.23	24.55	60.68	10.33	19.93	239.62	0.18
319.93	506.33	34.47	95.58	16.45	29.51	442.87	0.18
454.80	756.55	46.41	121.71	22.67	37.45	545.37	0.18
461.49	746.20	46.04	126.31	20.19	31.83	517.52	0.19
388.60	718.98	35.57	88.32	16.78	25.12	443.15	0.19
325.32	522.91	26.21	94.17	19.72	23.57	402.98	0.19
362.26	386.49	24.92	100.46	30.99	31.77	709.64	0.20
388.05	532.18	24.54	107.70	29.64	35.10	717.38	0.20
367.46	567.42	34.94	88.63	20.73	38.82	693.70	0.20
374.00	738.57	43.90	91.51	10.56	31.09	435.15	0.21
388.35	569.04	48.82	104.62	7.94	27.31	451.72	0.21
342.96	492.50	34.22	103.09	7.77	20.14	417.43	0.21
371.89	303.40	33.88	90.55	13.14	26.29	424.18	0.22
323.84	268.51	28.22	71.07	15.91	22.87	387.69	0.22

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
358.95	306.86	30.31	61.67	12.78	24.17	414.63	0.22
246.43	284.31	17.30	65.74	7.56	20.03	348.54	0.23
285.05	294.04	24.29	57.98	14.48	20.39	390.45	0.23
281.83	218.44	21.96	56.44	14.51	21.13	402.36	0.23
285.22	190.31	35.24	41.27	14.02	20.79	393.56	0.24
296.62	231.80	33.61	53.57	9.20	25.87	422.40	0.24
347.64	256.24	33.88	71.64	9.98	28.80	480.16	0.24
431.95	363.05	31.16	99.27	24.59	34.21	569.88	0.25
397.82	345.99	26.56	86.85	21.49	35.79	565.54	0.25
390.62	354.31	24.97	75.25	22.26	39.78	553.65	0.25
297.85	233.61	14.40	43.45	9.64	33.58	475.74	0.26
338.40	586.08	14.65	54.27	20.46	42.08	497.42	0.26
311.08	551.27	12.97	41.42	23.09	35.80	499.11	0.26
320.47	561.91	14.61	49.22	23.64	38.25	505.13	0.27
244.66	195.70	11.31	33.36	13.60	26.77	480.20	0.27
208.24	250.14	16.39	36.92	8.05	24.65	501.10	0.27
229.15	232.88	13.86	33.21	5.99	21.50	490.37	0.28
251.05	176.26	13.74	39.79	3.44	17.66	544.64	0.28
252.21	201.22	9.90	50.24	9.77	20.11	630.28	0.28
219.76	225.55	10.26	45.51	9.56	20.74	619.79	0.29
251.71	259.57	10.32	46.21	18.29	24.32	545.67	0.29
259.14	180.74	8.30	43.61	13.89	22.25	492.57	0.29
254.41	171.92	6.83	40.11	11.53	24.75	535.71	0.30
244.37	155.60	10.30	38.29	9.77	26.56	596.32	0.30
239.34	168.11	10.09	28.58	9.28	26.32	494.45	0.30
314.02	169.80	11.04	34.06	14.75	23.34	541.26	0.31
315.53	183.51	11.15	35.46	12.29	24.85	484.55	0.31
309.63	186.39	12.27	39.10	17.00	23.89	649.06	0.31
330.52	337.22	14.04	47.28	20.10	26.80	705.61	0.32
398.79	319.61	14.03	60.96	21.37	30.43	883.14	0.32
383.09	283.56	12.84	51.83	17.20	28.67	958.75	0.32
356.07	176.17	12.79	53.10	11.62	31.02	857.11	0.33
279.13	212.51	9.67	35.90	9.05	23.74	647.90	0.33
265.90	233.01	14.65	41.02	7.26	24.08	383.03	0.33
231.46	221.76	16.44	28.48	10.42	15.12	467.98	0.34
262.35	239.27	18.95	61.50	7.22	11.80	637.69	0.34
277.35	214.88	13.35	57.37	10.31	12.89	630.56	0.34
258.19	188.26	10.96	72.66	7.56	15.77	713.36	0.35

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
257.59	157.13	9.08	38.00	10.12	20.38	894.84	0.35
283.81	173.05	9.57	37.94	9.26	20.34	1032.12	0.35
302.41	173.89	7.67	28.24	8.40	21.54	809.73	0.36
268.63	130.02	9.58	49.82	5.84	37.04	538.10	0.36
260.04	146.97	9.31	60.63	3.52	42.49	592.62	0.36
219.26	116.64	9.27	54.27	0.98	40.33	636.62	0.37
263.26	287.83	10.38	41.77	6.29	25.10	601.49	0.37
242.49	290.46	9.97	29.27	10.13	24.39	475.66	0.37
277.51	302.58	11.01	25.94	12.62	21.36	571.45	0.38
242.09	137.25	21.00	11.31	9.39	21.41	609.18	0.38
286.70	192.59	24.10	14.83	9.76	24.46	626.12	0.38
251.08	206.46	25.25	13.70	10.44	23.87	472.30	0.39
200.18	190.38	10.50	15.62	9.50	19.73	321.96	0.39
181.24	116.99	8.38	13.72	5.76	12.57	299.39	0.39
189.45	98.12	7.23	15.10	3.11	11.61	294.84	0.40
226.51	159.63	7.79	21.38	5.89	15.31	412.50	0.40
175.88	143.95	6.57	18.77	5.00	12.92	373.91	0.40
199.40	181.11	10.30	23.74	4.49	13.51	532.33	0.41
175.41	196.53	11.54	22.98	6.05	12.19	541.61	0.41
192.95	241.18	11.37	30.44	11.23	14.88	677.85	0.41
178.46	195.45	5.91	24.52	12.51	15.55	529.64	0.42
137.82	162.27	2.82	18.26	7.46	15.61	438.22	0.42
123.85	140.91	2.21	9.75	2.57	13.47	285.52	0.42
170.36	95.88	4.70	20.21	3.82	20.34	323.12	0.43
189.78	110.43	6.61	26.56	9.41	18.63	363.58	0.43
216.81	251.61	7.74	26.10	7.01	17.45	528.86	0.43
223.71	240.14	7.66	22.31	6.29	16.75	480.39	0.44
231.27	260.92	6.84	19.82	0.74	13.84	488.73	0.44
202.44	132.92	5.49	23.58	1.61	13.82	391.66	0.44
207.87	127.71	6.07	27.01	0.73	15.82	440.08	0.45
215.45	109.82	8.46	26.83	9.95	17.70	486.24	0.45
245.61	149.96	9.98	22.81	12.14	24.94	490.87	0.45
331.89	192.15	12.28	27.90	14.18	31.16	585.70	0.46
247.31	155.27	9.47	17.48	6.21	30.90	380.38	0.46
391.83	306.08	13.65	25.56	11.22	29.34	682.70	0.46
308.50	311.61	10.35	22.29	11.25	22.43	752.00	0.47
406.85	343.27	13.87	28.71	14.82	28.22	936.97	0.47
236.70	146.29	8.76	21.33	7.71	25.76	725.39	0.47

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
261.14	116.28	9.56	21.32	8.65	26.43	521.44	0.48
211.51	85.42	6.80	30.49	7.02	23.20	645.15	0.48
234.06	88.90	7.21	34.26	6.06	21.29	579.23	0.48
222.24	119.72	9.00	37.95	4.16	14.97	794.89	0.49
208.02	153.19	10.05	27.87	2.35	13.19	579.98	0.49
325.59	255.82	16.27	38.63	8.28	17.84	738.51	0.49
322.20	257.34	14.61	31.43	8.19	21.48	819.21	0.50
296.34	245.50	12.30	26.24	8.84	17.43	742.77	0.50
143.70	133.94	4.40	12.47	3.33	13.18	659.68	0.50
140.04	98.62	3.98	12.21	2.30	17.37	356.43	0.51
150.64	80.41	4.70	17.00	1.65	20.46	527.82	0.51
169.77	92.64	5.61	16.21	2.49	20.82	516.42	0.51
188.84	132.22	5.18	19.82	2.48	19.70	631.73	0.52
219.74	148.75	6.18	20.70	4.39	19.95	476.96	0.52
275.55	173.30	9.48	28.51	5.47	22.84	718.53	0.52
231.48	117.90	9.38	28.25	7.31	20.24	591.77	0.53
168.04	84.41	6.95	23.17	4.06	14.09	503.41	0.53
95.72	65.23	5.57	21.58	2.59	7.64	131.08	0.53
94.86	91.87	6.99	18.56	3.04	5.28	143.08	0.54
159.14	140.68	10.75	30.05	9.07	15.57	348.13	0.54
206.12	185.14	10.48	29.04	12.46	18.64	769.47	0.54
268.02	259.13	12.22	35.04	13.66	24.05	940.10	0.55
229.72	219.75	9.37	24.72	9.18	19.49	747.66	0.55
179.62	155.64	8.56	18.23	5.75	15.72	413.00	0.55
214.86	83.17	10.23	25.42	4.87	19.76	300.01	0.56
223.58	106.62	10.11	29.21	3.30	19.52	411.37	0.56
360.04	212.04	17.35	39.03	7.01	37.32	369.48	0.56
384.89	277.67	18.27	58.97	12.21	33.86	779.87	0.57
365.62	284.78	18.39	55.00	16.00	30.97	702.68	0.57
237.33	207.00	14.22	46.75	15.46	24.92	1028.11	0.57
185.05	129.11	10.06	20.08	7.64	22.08	687.16	0.58
204.47	248.74	12.40	28.49	7.07	22.30	668.20	0.58
214.01	233.72	9.44	34.05	9.23	13.70	680.00	0.58
176.97	246.24	8.66	28.72	10.50	14.27	575.43	0.59
271.91	241.94	9.37	32.84	12.79	15.59	763.03	0.59
278.73	241.86	10.01	27.78	7.27	17.53	448.09	0.59
288.60	433.53	10.56	32.97	6.01	13.56	454.43	0.60
209.03	355.56	8.66	31.44	1.30	18.73	276.76	0.60

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
167.60	349.91	6.45	34.45	1.77	14.89	206.37	0.60
150.45	137.36	7.41	31.55	5.29	21.80	171.74	0.61
111.02	67.71	6.46	24.70	4.50	14.24	119.84	0.61
106.04	53.90	5.80	18.10	4.48	12.30	115.33	0.61
74.53	45.29	5.32	17.88	1.90	2.89	144.35	0.62
56.57	42.37	3.83	14.79	1.90	1.43	169.25	0.62
67.87	48.82	5.56	20.50	3.54	3.33	189.93	0.62
80.78	77.59	6.23	19.39	6.94	4.27	146.48	0.63
98.77	82.02	7.11	17.08	6.90	9.45	165.33	0.63
109.87	84.15	7.03	16.49	5.03	10.16	171.29	0.63
90.27	61.03	6.12	14.65	2.59	9.76	186.82	0.64
130.13	118.20	9.85	50.38	8.82	4.69	254.40	0.64
116.63	117.02	9.23	48.51	9.63	8.20	326.42	0.64
115.67	112.03	6.97	50.56	7.71	10.69	434.22	0.65
98.04	62.64	5.42	18.50	4.39	17.32	377.51	0.65
109.70	88.65	5.81	20.74	2.69	12.63	338.68	0.65
167.60	349.91	6.45	34.45	1.77	14.89	206.37	0.60
150.45	137.36	7.41	31.55	5.29	21.80	171.74	0.61
111.02	67.71	6.46	24.70	4.50	14.24	119.84	0.61
106.04	53.90	5.80	18.10	4.48	12.30	115.33	0.61
74.53	45.29	5.32	17.88	1.90	2.89	144.35	0.62
56.57	42.37	3.83	14.79	1.90	1.43	169.25	0.62
67.87	48.82	5.56	20.50	3.54	3.33	189.93	0.62
80.78	77.59	6.23	19.39	6.94	4.27	146.48	0.63
98.77	82.02	7.11	17.08	6.90	9.45	165.33	0.63
109.87	84.15	7.03	16.49	5.03	10.16	171.29	0.63
90.27	61.03	6.12	14.65	2.59	9.76	186.82	0.64
130.13	118.20	9.85	50.38	8.82	4.69	254.40	0.64
116.63	117.02	9.23	48.51	9.63	8.20	326.42	0.64
115.67	112.03	6.97	50.56	7.71	10.69	434.22	0.65
98.04	62.64	5.42	18.50	4.39	17.32	377.51	0.65
109.70	88.65	5.81	20.74	2.69	12.63	338.68	0.65
186.75	194.69	13.14	55.10	7.22	13.78	481.88	0.72
128.28	130.86	10.03	42.46	4.23	8.52	272.90	0.73
103.19	120.94	9.51	39.97	6.71	9.27	237.71	0.73
55.59	49.94	3.46	22.72	5.71	5.42	153.66	0.73
56.47	47.45	4.13	22.25	6.07	5.93	133.48	0.74
45.82	40.07	3.81	13.50	3.94	8.11	183.90	0.74

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
74.47	61.48	5.58	15.55	8.24	10.80	269.44	0.74
95.62	103.25	7.68	29.10	8.35	6.11	330.36	0.75
87.40	108.08	7.28	29.01	7.02	4.65	276.82	0.75
136.26	124.87	11.58	42.68	3.73	5.81	258.11	0.75
131.72	106.39	9.32	29.62	1.42	8.32	316.11	0.76
149.27	101.39	12.62	30.83	2.87	11.33	326.86	0.76
92.05	95.11	9.89	24.28	1.24	6.98	298.20	0.76
77.28	76.51	10.07	22.80	1.28	7.71	171.24	0.77
70.93	75.06	7.02	20.71	3.49	5.64	175.14	0.77
70.95	57.99	5.17	16.37	4.77	10.10	171.54	0.77
76.28	62.18	4.40	15.24	4.75	7.46	211.13	0.78
81.26	72.04	4.67	15.75	1.89	7.26	212.89	0.78
63.94	81.44	4.25	10.05	1.37	4.03	139.60	0.78
52.72	80.34	4.72	11.39	2.71	4.95	106.81	0.79
32.08	62.27	3.47	9.03	1.91	4.25	73.09	0.79
35.36	49.12	3.87	11.38	2.12	5.75	96.11	0.79
60.19	73.03	5.76	11.41	3.11	8.33	152.09	0.80
76.60	93.61	6.59	15.92	4.18	9.01	164.63	0.80
165.66	125.45	10.47	28.67	4.74	10.32	411.25	0.80
194.74	129.19	11.17	33.08	9.69	18.05	639.40	0.81
213.71	116.36	12.79	31.48	9.12	19.10	714.01	0.81
198.34	112.43	10.12	23.05	9.37	18.83	547.34	0.81
156.92	89.50	7.53	17.43	2.67	7.99	273.72	0.82
122.29	80.60	5.34	14.33	2.16	6.35	198.75	0.82
56.29	49.17	3.79	16.05	3.07	3.14	133.83	0.82
55.11	74.49	6.05	25.49	4.04	3.48	159.46	0.83
295.91	217.86	15.65	54.69	12.03	17.30	403.13	0.83
447.57	291.29	18.53	50.76	9.36	27.45	588.51	0.83
640.38	365.74	22.57	58.76	11.81	39.20	782.34	0.84
94.13	63.86	6.34	17.15	2.67	5.96	318.86	0.84
333.49	597.05	27.64	201.38	1.39	17.88	910.06	0.84
321.57	602.18	28.04	202.16	2.27	17.16	873.88	0.85
370.38	624.19	32.60	212.31	6.66	26.44	1284.80	0.85
325.63	162.54	77.36	51.41	12.93	14.40	796.90	0.85
337.48	284.58	76.71	66.76	12.11	14.45	955.73	0.86
361.08	363.92	78.66	91.44	11.30	10.34	692.11	0.86
193.86	368.97	12.73	70.63	7.49	21.35	470.33	0.86
							0.87

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
							0.87
							0.88
46.93	124.71	4.02	16.72	1.81	5.64	64.00	0.88
65.38	186.36	8.00	23.85	1.87	11.31	280.11	0.88
92.12	447.29	10.03	17.80	1.43	15.00	404.86	0.89
103.32	371.94	9.64	21.45	2.44	14.68	437.10	0.89
87.43	324.88	5.18	15.90	0.82	6.92	239.34	0.89
70.37	54.49	3.77	18.16	3.13	3.53	125.99	0.90
64.86	60.71	4.34	12.06	2.64	7.51	180.96	0.90
76.14	65.49	6.97	12.45	5.95	12.07	364.55	0.90
89.58	73.08	8.07	16.56	4.36	11.09	443.37	0.91
129.50	93.34	9.58	19.18	6.12	34.99	528.89	0.91
208.68	214.27	19.14	40.01	13.40	40.22	479.62	0.91
213.18	250.90	18.71	37.75	15.40	43.30	440.90	0.92
221.03	285.31	18.05	57.88	13.09	20.42	527.56	0.92
145.30	174.13	6.11	38.98	4.99	12.09	485.94	0.92
199.31	255.64	11.64	47.61	5.59	11.89	612.52	0.93
221.75	300.68	24.91	39.16	9.93	16.06	528.00	0.93
299.60	335.22	26.28	44.17	9.06	24.79	554.39	0.93
272.42	230.56	22.22	43.82	5.77	25.97	613.98	0.94
230.13	149.33	9.25	28.59	5.08	22.64	527.06	0.94
186.56	121.72	9.25	23.28	5.40	19.64	600.49	0.94
234.05	144.20	8.80	19.36	9.65	19.26	535.73	0.95
308.65	178.07	10.05	29.14	6.95	25.32	672.47	0.95
375.26	249.72	10.17	37.29	9.72	30.83	717.64	0.95
350.01	261.01	10.46	37.44	8.56	47.33	671.85	0.96
339.28	279.08	11.03	35.28	10.97	41.91	763.92	0.96
269.39	214.66	13.25	27.66	11.33	29.91	607.42	0.96
281.51	211.22	12.98	31.75	12.22	18.74	654.43	0.97
227.14	213.04	10.18	28.37	8.89	19.13	497.35	0.97
294.32	207.83	8.51	26.92	5.91	27.36	668.61	0.97
278.71	223.16	9.87	28.43	5.08	37.76	679.11	0.98
321.72	203.84	12.27	31.02	7.60	35.41	673.98	0.98
270.02	241.91	13.37	37.90	8.42	31.19	520.37	0.98
273.22	224.16	11.84	34.24	9.04	20.98	436.79	0.99
300.53	210.86	13.14	36.10	8.97	33.52	461.79	0.99
291.20	187.98	11.26	33.12	10.65	43.64	606.67	0.99
352.81	249.47	18.22	42.50	8.03	39.74	737.96	1.00

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
417.11	290.17	19.02	75.23	5.52	31.59	803.16	1.00
391.96	253.55	21.83	72.49	0.93	20.91	753.87	1.00
272.91	146.75	13.03	55.28	1.20	18.36	571.43	1.01
166.19	219.60	12.54	27.61	6.32	13.65	704.15	1.01
244.81	263.38	10.52	31.75	11.89	17.97	591.33	1.01
281.92	313.64	14.30	40.12	12.69	28.17	708.94	1.02
271.94	167.58	10.98	34.21	8.74	23.59	441.83	1.02
279.47	190.60	10.90	38.42	5.31	24.32	465.07	1.02
311.09	262.39	12.56	38.48	5.57	26.86	277.08	1.03
327.10	283.67	18.68	49.98	11.90	37.81	446.88	1.03
306.93	306.18	19.99	50.84	12.97	33.00	514.41	1.03
310.09	338.90	19.76	50.78	12.96	31.82	748.69	1.04
325.26	376.33	14.65	38.08	6.76	24.41	753.08	1.04
300.55	295.08	12.35	27.72	4.12	23.28	615.62	1.04
293.80	206.45	8.79	26.63	3.39	16.68	530.02	1.05
260.01	201.34	10.03	33.99	3.31	17.40	550.77	1.05
274.12	258.48	21.92	46.56	13.05	25.76	679.37	1.05
300.89	247.11	22.55	52.34	14.38	29.74	663.73	1.06
380.93	228.20	22.76	55.91	16.56	36.42	552.11	1.06
358.91	256.97	18.31	52.05	8.43	30.31	605.36	1.06
332.15	225.71	18.10	57.20	10.65	25.54	663.13	1.07
254.35	301.52	16.11	49.95	8.06	19.59	595.73	1.07
238.89	258.43	12.31	45.56	5.86	20.08	564.87	1.07
196.67	272.79	13.01	36.04	2.93	17.27	554.60	1.08
255.90	211.37	21.60	46.17	3.50	19.76	741.68	1.08
281.10	180.63	22.02	51.56	7.95	17.90	730.71	1.08
273.02	150.29	19.26	47.55	7.78	17.13	634.24	1.09
252.08	204.05	18.45	79.83	10.94	16.59	633.40	1.09
247.69	212.34	14.81	78.48	6.49	16.51	525.91	1.09
460.95	316.11	28.10	129.59	7.04	18.33	732.98	1.10
449.89	258.16	20.65	93.53	8.30	11.45	637.66	1.10
432.35	275.38	23.52	87.93	9.71	10.36	781.34	1.10
326.85	307.63	20.72	85.37	15.95	27.26	856.23	1.11
328.05	509.53	22.49	93.51	11.19	31.50	896.56	1.11
350.87	518.05	21.87	98.66	12.03	32.19	872.96	1.11
358.85	513.29	18.50	69.78	4.49	27.66	801.11	1.12
349.37	312.86	20.97	63.15	8.31	26.60	662.28	1.12
348.76	301.60	22.25	71.81	7.86	31.75	562.96	1.12

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
453.94	517.21	31.34	105.17	16.40	42.28	649.12	1.13
457.81	544.52	31.46	105.34	17.68	46.92	766.83	1.13
409.96	509.32	29.33	94.11	16.98	40.98	772.78	1.13
307.40	260.83	24.03	61.64	7.95	27.01	632.41	1.14
285.93	211.71	19.36	54.95	2.98	20.58	465.96	1.14
387.20	239.00	24.27	54.99	5.79	22.52	414.26	1.14
310.84	243.83	22.89	57.49	10.13	22.32	307.92	1.15
273.45	237.10	22.77	57.34	9.47	22.62	322.09	1.15
201.32	236.20	21.27	67.31	6.85	27.92	454.77	1.15
266.02	275.80	22.51	68.18	5.63	19.39	598.49	1.16
301.69	449.44	22.86	65.44	9.57	24.31	615.06	1.16
297.99	444.12	20.83	61.40	13.01	19.92	547.35	1.16
218.01	469.08	13.47	52.41	10.71	16.93	415.80	1.17
396.03	707.02	31.45	96.34	8.01	21.80	705.07	1.17
539.88	1177.83	38.78	118.41	5.31	44.45	1102.58	1.17
604.66	1110.47	46.57	142.91	7.77	54.57	954.61	1.18
473.57	940.06	40.77	111.16	10.53	52.54	954.61	1.18
390.05	563.48	39.60	91.91	15.97	25.70	571.88	1.18
381.42	612.57	37.21	89.10	17.09	27.45	525.40	1.19
389.81	424.72	31.51	124.58	23.78	23.06	424.27	1.19
444.55	504.07	31.38	179.34	39.48	35.96	873.24	1.19
519.08	557.96	37.36	188.80	42.99	35.73	1349.28	1.20
532.85	706.95	56.96	195.83	41.62	42.46	1402.12	1.20
559.31	640.40	61.37	163.15	18.37	54.33	1148.44	1.20
425.34	500.50	50.03	130.31	10.40	49.40	596.13	1.21
535.56	571.90	44.91	108.28	0.46	48.25	696.00	1.21
437.29	630.14	36.56	98.39	3.69	27.65	554.72	1.21
546.82	748.86	53.96	138.86	14.93	32.77	741.89	1.22
506.66	564.77	47.86	178.01	14.97	33.01	633.78	1.22
463.51	385.33	45.04	163.99	14.20	32.89	456.12	1.22
504.60	596.89	66.46	196.03	9.57	36.91	393.03	1.23
417.70	621.31	68.33	150.74	11.20	30.46	233.36	1.23
514.04	756.93	79.71	185.57	10.17	27.26	309.23	1.23
387.45	405.23	45.67	123.73	4.60	17.74	283.95	1.24
494.40	424.02	67.40	125.11	14.12	12.30	639.70	1.24
440.78	326.74	66.81	94.49	24.63	17.93	618.70	1.24
506.69	757.04	89.14	141.31	32.45	26.58	645.08	1.25
566.89	856.91	79.14	177.49	32.92	34.61	499.36	1.25

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
673.49	955.44	79.00	192.07	24.22	32.35	510.90	1.25
753.92	662.62	72.54	199.14	21.65	36.31	614.97	1.26
687.26	574.29	61.17	186.56	15.36	42.41	607.39	1.26
1070.29	2976.09	103.24	452.32	62.45	39.15	668.41	1.26
1047.16	2769.51	122.49	422.37	58.20	37.03	530.74	1.27
780.82	2619.00	113.64	220.16	17.31	21.71	427.43	1.27
674.91	1307.37	108.53	161.81	17.06	38.41	666.17	1.27
621.25	1096.41	100.57	198.61	31.12	47.25	709.94	1.28
899.87	1412.21	120.32	282.80	40.45	70.82	889.40	1.28
882.25	1000.34	90.45	313.94	39.37	57.42	594.85	1.28
768.72	785.57	80.63	223.88	18.24	54.29	408.72	1.29
521.17	637.09	72.06	189.22	10.67	31.62	277.47	1.29
413.00	489.49	62.14	152.62	18.55	18.96	179.33	1.29
450.57	775.43	67.83	207.05	26.05	15.04	325.27	1.30
349.52	678.33	49.68	242.45	32.52	14.13	395.87	1.30
435.96	865.69	65.51	291.76	25.91	15.04	521.18	1.30
556.70	723.55	97.77	288.20	28.19	16.43	817.89	1.31
641.42	943.58	102.92	279.21	29.28	18.98	849.32	1.31
659.78	1060.48	97.43	298.98	31.08	20.43	760.54	1.31
493.74	976.06	48.52	241.62	20.39	20.08	464.89	1.32
510.30	841.14	53.93	188.29	15.05	17.19	365.35	1.32
587.88	1237.12	73.80	181.22	24.21	25.77	773.25	1.32
612.00	1262.73	99.45	203.47	35.48	25.97	765.45	1.33
918.83	1648.77	150.24	302.53	50.09	35.47	918.91	1.33
870.11	1129.81	136.39	294.31	41.32	30.56	599.35	1.33
1303.35	1421.37	127.79	390.29	54.68	34.02	651.13	1.34
1062.33	1581.42	94.49	362.46	43.93	24.59	521.87	1.34
1068.46	1654.44	96.22	380.17	49.70	25.32	483.40	1.34
728.41	1779.28	95.26	310.62	36.66	25.85	544.55	1.35
856.90	1511.32	100.35	270.34	44.86	29.56	585.18	1.35
963.89	1451.31	123.23	731.36	42.48	28.99	394.11	1.36
1326.48	1407.59	262.01	810.08	38.72	24.90	357.01	1.36
1129.94	1228.31	219.53	692.66	27.16	13.20	320.88	1.36
983.05	1535.68	213.75	340.09	23.73	13.77	319.43	1.37
984.10	1497.29	59.47	237.57	16.04	47.41	243.83	1.37
1005.72	1437.98	131.92	520.61	7.95	90.81	289.45	1.37
1268.64	1171.00	133.72	514.78	5.65	82.82	320.08	1.38
698.44	870.18	114.73	610.92		43.40	326.29	1.38

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1243.20	763.95	107.21	240.52	28.36		272.03	1.38
952.13	610.19	92.15	177.72	28.36	12.57	128.84	1.39
980.28	662.32	93.54	27.65	28.36	47.30	136.74	1.39
462.90	936.32	55.75	27.65		47.30	168.48	1.39
444.39	796.15	63.71			34.72	222.34	1.40
546.64	1143.88	138.68	279.47	112.70		954.73	1.40
561.76	1010.21	145.05	419.20	144.06		1304.62	1.40
970.96	1668.98	259.70	328.40	148.11		2442.59	1.41

Brontothere Metapodial (F08-08): Orella Road

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1561.92	2903.79	276.04	1026.95	145.92	63.12	456.02	0.00
2021.51	3240.20	393.61	1285.68	168.04	26.55	179.61	0.00
2014.52	2080.93	516.47	1352.13	152.52	23.45	138.11	0.00
1979.92	2535.46	543.97	1527.57	175.41	22.02	87.51	0.01
2740.66	1261.70	787.41	2418.03	287.73	53.28	134.08	0.01
3413.25	1261.69	740.00	2566.53	313.60	52.87	198.60	0.01
4065.91	3270.85	794.23	2756.26	339.70	76.08	203.31	0.01
3144.36	4200.70	583.02	1865.45	285.75	52.04	159.18	0.01
2439.81	4200.71	540.76	1471.30	242.64	54.21	239.98	0.01
1965.15	929.81	672.76	2039.20	368.86	36.08	385.43	0.02
4436.44		801.29	2907.13	481.47	62.16	460.82	0.02
5908.59		1209.88	5404.77	627.48	84.61	378.75	0.02
5561.40		1100.12	4455.46	448.48	94.06	359.88	0.02
3536.00		1009.36	3989.92	288.24	71.47	349.74	0.02
2003.41		600.47	1567.90	251.70	59.90	325.91	0.02
3525.10	4324.42	834.93	2856.78	324.36	62.65	149.67	0.02
3137.23	5090.28	799.03	2418.16	336.80	70.37	52.68	0.03
3431.09	5090.28	826.09	2697.55	258.90	59.04	75.54	0.03
2462.84	765.82	718.92	2429.23	363.80	61.47	141.85	0.03
2404.36		598.02	2197.85	319.88	44.40	155.92	0.03
2480.54	959.42	550.76	2346.60	290.65	45.70	218.81	0.03
2351.29	959.43	320.79	1457.24	193.17	43.35	220.75	0.03
2289.44	959.43	406.19	1803.72	230.98	46.87	248.99	0.04

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
2070.92	1988.39	465.71	1554.54	256.34	53.96	151.14	0.04
2238.46	4944.37	541.92	1866.56	233.60	42.02	107.59	0.04
2766.36	5986.94	478.74	1562.22	220.81	55.23	115.38	0.04
2833.85	3998.52	513.80	1758.74	199.39	50.63	104.44	0.04
3631.68	4621.17	846.87	2552.63	326.59	123.56	199.80	0.04
3879.34	3578.59	1007.79	3021.41	353.39	117.23	208.92	0.05
4191.09	3578.58	917.72	2952.49	356.92	112.66	207.69	0.05
2715.82	594.26	587.38	1705.88	221.43	74.55	652.38	0.05
3276.87	594.25	623.03	2880.75	429.83	84.96	1046.35	0.05
3045.85	2024.03	608.71	2550.20	415.19	89.69	1066.58	0.05
3272.80	1429.72	578.02	2784.41	385.23	56.85	564.79	0.05
2302.72	2746.26	414.30	1507.44	170.78	71.35	218.51	0.05
1422.06	1316.50	418.24	1587.87	174.45	68.63	274.03	0.06
1482.70	1316.50	357.25	1590.98	185.69	71.54	231.57	0.06
2992.62		716.62	2222.38	192.41	52.18	192.16	0.06
4232.12	2163.55	967.83	2761.25	328.10	59.57	208.35	0.06
4030.49	2947.92	965.84	2524.15	296.82	56.63	296.81	0.06
2801.43	2947.91	649.98	1768.59	392.67	59.05	343.87	0.06
2379.44	784.33	321.56	1137.15	241.87	45.81	258.29	0.07
2208.97		304.43	1219.99	253.38	36.27	162.70	0.07
1884.28		251.78	1129.36	132.35	33.22	158.50	0.07
2787.61		474.64	1780.11	161.09	42.64	168.83	0.07
3158.87		526.69	1921.58	182.15	42.86	183.78	0.07
4156.24		636.06	2543.89	217.54	47.47	126.23	0.07
2950.03	847.68	472.23	1897.86	197.17	39.03	125.70	0.07
2763.03	1694.83	396.65	1604.10	162.26	37.04	124.66	0.08
1254.58	2305.22	228.50	670.06	109.29	17.63	97.86	0.08
2419.88	1457.50	234.93	1055.55	132.15	39.53	139.46	0.08
2311.25	1256.39	289.49	1115.76	152.93	43.44	156.43	0.08
2356.54	1074.66	273.35	1139.91	152.99	45.99	207.25	0.08
2180.86	4327.15	469.16	2355.66	328.45	62.27	417.29	0.08
1746.71	4596.09	351.62	2313.33	334.96	63.05	390.07	0.09
2161.99	8738.05	720.42	2653.58	375.06	94.24	389.94	0.09
1183.75	6173.99	522.61	1018.38	240.32	66.84	250.65	0.09
2407.80	5259.01	713.66	1775.52	248.11	83.30	342.78	0.09
2337.31	2614.07	593.94	2236.67	453.11	74.50	342.30	0.09
3325.24	1925.64	748.90	2895.10	460.22	80.78	277.10	0.09
2641.53	3081.79	673.35	2298.24	509.79	71.39	205.53	0.09

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
2588.12	2087.88	448.12	1607.29	258.75	50.47	282.10	0.10
1818.02	5113.86	510.21	2097.61	272.14	48.04	387.86	0.10
2045.48	3957.70	529.96	2141.89	215.62	60.64	444.34	0.10
2528.61	5064.39	744.52	2436.37	265.85	64.17	324.33	0.10
2306.31	3006.60	497.52	1328.69	215.47	63.74	283.00	0.10
2152.60	3006.62	451.30	1353.36	192.59	45.59	208.77	0.10
2214.15	2900.90	294.36	1425.31	210.64	66.89	281.82	0.11
1692.61	3300.29	318.47	1542.29	186.83	55.21	158.31	0.11
2024.97	7121.87	624.53	1519.67	286.08	82.64	253.18	0.11
1571.32	5749.35	575.72	1275.81	211.19	61.68	209.45	0.11
2029.14	4980.63	567.41	1162.33	252.74	62.22	219.43	0.11
2520.52	1159.05	421.40	1439.44	215.58	46.05	160.12	0.11
2967.03	5426.97	708.09	1976.71	288.39	63.66	667.27	0.11
2934.80	5655.59	689.10	1865.23	216.43	71.78	733.29	0.12
1867.42	6557.84	558.35	1631.42	189.89	64.16	711.76	0.12
1322.39	2585.75	268.70	1119.19	137.78	66.23	195.40	0.12
1936.89	1758.25	535.51	1522.66	232.42	74.31	162.83	0.12
1566.41	856.01	522.47	1427.36	202.15	83.23	174.60	0.12
2328.20	1758.19	573.13	1901.20	236.50	70.29	191.19	0.12
2006.07	3007.82	394.05	2017.20	189.45	51.09	309.87	0.13
3545.88	5701.26	463.43	2574.11	235.68	50.13	389.36	0.13
3255.15	3943.02	341.02	3019.45	347.70	58.60	464.52	0.13
2902.42	2693.39	229.33	2476.44	307.01	58.08	298.71	0.13
2981.66		356.29	2691.26	408.63	61.85	323.63	0.13
2347.35	751.66	436.76	1583.84	273.56	56.62	212.75	0.13
2765.32	751.66	550.17	1907.33	321.99	55.53	251.11	0.14
1984.05	1823.06	349.38	1117.50	187.79	63.64	187.96	0.14
2114.30	1613.02	329.55	1198.06	171.14	56.10	202.16	0.14
2216.22	3019.80	474.82	1178.52	200.67	74.15	278.89	0.14
2709.52	1948.41	596.19	1198.13	217.45	77.53	308.22	0.14
3622.04	2780.38	1007.15	1847.81	409.89	97.79	508.87	0.14
3079.99	1373.60	754.41	1591.79	350.63	86.30	440.46	0.14
2900.26	2649.45	670.08	1758.39	364.60	85.92	406.35	0.15
2049.24	4037.89	272.29	1118.09	190.40	64.25	536.37	0.15
2079.14	4694.18	349.80	1072.49	167.84	68.78	503.38	0.15
1460.58	4215.59	264.85	955.29	140.88	65.76	459.43	0.15
3014.33	5405.52	428.85	2003.88	185.49	114.69	246.95	0.15
2954.38	5225.72	339.22	2129.77	188.88	114.41	249.57	0.15

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
3505.90	6507.96	416.69	2157.39	247.15	93.51	289.59	0.16
2687.78	2555.91	339.87	1354.20	342.72	54.32	310.21	0.16
4151.20	2079.41	444.29	1579.47	403.51	80.74	342.55	0.16
3225.52	401.98	357.03	1250.07	319.51	73.54	283.82	0.16
2273.42	1077.89	224.94	803.73	151.50	55.26	120.29	0.16
777.24	1495.87	120.45	634.24	118.29	21.04	100.30	0.16
848.22	1659.03	111.26	802.39	108.84	20.57	113.10	0.16
2277.68	3098.32	472.98	1461.54	176.59	45.82	289.84	0.17
2472.99	2680.36	475.03	1246.83	152.76	48.53	270.96	0.17
2636.36	2775.99	495.17	1134.02	170.33	78.58	398.48	0.17
1341.65	660.82	155.24	609.62	177.42	58.09	290.68	0.17
2022.28	2339.66	265.75	977.68	246.44	79.52	296.96	0.17
2429.97	3040.16	383.98	2168.33	398.13	80.21	194.92	0.17
3286.60	6056.28	527.51	3055.67	389.03	148.35	273.31	0.18
5111.33	7743.59	886.62	4357.52	693.34	151.53	488.80	0.18
4657.93	6905.57	760.30	3094.82	539.55	126.03	459.49	0.18
4992.30	5834.18	849.13	2962.31	669.50	71.85	433.37	0.18
1804.52	2949.48	207.35	907.64	186.30	58.00		0.18
3584.27	5821.41	483.86	1454.18	186.46	75.47	244.62	0.18
3417.61	5347.24	459.85	1544.96	218.24	71.36	254.26	0.18
2670.20	4334.02	399.09	1083.21	163.37	68.63	165.63	0.19
1507.09	2407.87	216.88	965.82	153.32	62.38	188.63	0.19
1929.40	2740.69	231.45	903.29	162.46	59.43	280.74	0.19
2012.72	2047.17	376.07	1745.81	257.16	64.99	504.51	0.19
1692.13	1084.59	322.32	1609.84	215.42	63.93	440.35	0.19
1589.08		319.74	1592.46	180.28	59.27	528.00	0.19
1898.76		289.96	959.24	154.79	135.24	469.59	0.19
1883.47	295.58	283.97	777.10	149.92	136.67	470.75	0.20
1409.32	914.44	235.43	700.82	124.37	126.69	322.80	0.20
1735.26	914.44	181.42	569.77	125.10	54.58	317.00	0.20
2028.67	1468.31	216.35	731.33	238.42	77.50	381.19	0.20
2166.27	849.48	267.03	717.95	256.14	82.86	348.34	0.20
1742.59	849.49	249.93	1043.95	425.14	90.42	208.15	0.20
1540.65	437.75	246.49	896.82	308.30	66.52	160.10	0.21
1676.82	437.74	359.82	945.37	337.62	108.42	219.61	0.21
1217.87	437.76	286.48	546.37	121.61	85.72	242.44	0.21
1257.02	689.57	320.20	549.21	137.73	94.17	190.71	0.21
1202.27	1629.83	195.13	680.37	121.91	78.40	195.98	0.21

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
2731.21	1629.81	334.02	955.66	161.03	84.36	233.24	0.21
2537.19	1267.83	269.92	972.22	162.80	73.94	268.44	0.21
2604.83	2217.35	295.34	824.22	142.75	44.39	211.13	0.22
2209.31	2217.34	307.25	634.89	143.89	64.36	196.53	0.22
2217.43	2553.19	307.39	604.64	128.41	63.90	185.36	0.22
2446.92	1976.76	329.39	1150.14	237.00	126.05	327.98	0.22
1074.93	2639.93	213.78	1040.38	230.10	107.36	264.34	0.22
1617.37	3170.75	295.23	1237.73	289.36	144.75	424.67	0.22
1087.87	2133.77	225.66	618.06	182.10	106.66	352.46	0.22
1606.32	2188.83	213.52	690.26	155.93	111.58	408.15	0.23
1270.66	2563.53	141.63	525.64	112.41	78.70	262.30	0.23
1356.40	2793.69	133.49	618.71	98.61	78.42	361.99	0.23
1197.35	2075.48	155.82	606.73	156.99	69.48	410.68	0.23
950.94	1150.45	134.57	553.54	140.99	66.96	493.93	0.23
1115.49	1589.03	191.37	704.62	163.14	57.11	328.16	0.23
1017.56	1925.87	158.06	551.26	78.47	38.35	203.85	0.23
1064.22	1533.46	156.71	606.74	76.23	39.80	141.31	0.24
632.07	763.50	118.15	292.18	59.61	25.38	103.18	0.24
794.29	1098.10	163.98	644.16	77.34	43.56	132.23	0.24
742.74	1325.90	181.39	673.75	90.88	50.62	137.67	0.24
1216.71	1933.67	171.53	843.80	99.97	60.40	173.44	0.24
1041.00	1473.21	110.89	612.10	95.52	63.55	167.56	0.24
1132.99	1347.32	95.96	521.82	80.47	55.28	128.01	0.24
882.88	1303.02	72.10	448.59	105.27	55.03	195.82	0.25
867.73	1300.59	172.55	310.92	82.64	40.98	198.03	0.25
834.14	1200.25	180.73	345.63	86.32	36.23	240.39	0.25
642.39	703.23	170.71	263.73	49.42	39.89	183.97	0.25
656.27	1224.03	99.35	354.26	59.22	39.28	187.57	0.25
469.69	1031.38	70.90	253.56	48.91	37.75	164.00	0.25
511.47	1031.65	66.29	263.95	61.78	23.95	96.05	0.26
647.76	1908.27	83.10	271.35	90.29	50.21	165.15	0.26
822.70	1847.74	124.20	386.49	129.31	65.12	351.50	0.26
876.54	1605.89	148.52	726.73	129.79	83.30	472.28	0.26
923.72	482.17	103.95	724.80	104.04	77.97	411.45	0.26
950.58	855.30	85.20	726.54	91.21	76.22	288.90	0.26
889.55	855.30	85.97	421.88	74.09	77.08	215.81	0.26
630.88	373.06	98.17	327.54	66.34	46.50	204.37	0.27
1087.96	748.24	331.05	478.96	75.03	44.57	138.14	0.27

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
952.87	921.07	306.73	467.38	71.98	29.36	104.65	0.27
789.48	1011.55	276.59	389.34	55.50	28.10	58.20	0.27
							0.27
							0.27
							0.27
927.85	1003.28	121.34	275.94	131.02	71.54	136.23	0.28
607.63	781.32	137.88	295.74	97.41	73.79	118.24	0.28
690.35	944.31	147.78	439.10	121.36	60.72	157.54	0.28
710.88	955.08	149.09	397.51	100.97	57.50	162.39	0.28
560.00	833.70	95.31	297.28	71.91	34.61	133.67	0.28
364.70	397.15	69.01	125.14	33.59	18.78	59.25	0.28
199.51	250.21	24.52	64.91	16.94	8.18	24.96	0.28
85.32	181.12	16.12	35.22	7.34	3.68	13.73	0.29
							0.29
							0.29
							0.29
73.30	75.01	5.77	8.08	5.48	2.62	11.43	0.29
93.76	102.89	6.61	24.68	1.59	5.26	18.73	0.29
92.37	102.88	6.68	30.92	1.27	5.37	107.08	0.30
60.35	84.09	4.95	32.16		3.94	145.71	0.30
23.49	38.87	4.34	17.28		2.37	140.43	0.30
620.88	712.57	69.16	216.91	43.24	77.22	107.87	0.30
780.03	981.81	87.79	291.83	54.67	93.72	145.33	0.30
1005.72	1152.66	98.61	359.76	67.99	125.75	181.76	0.30
689.87	1007.82	72.45	323.33	49.91	66.87	176.24	0.30
942.08	1191.22	80.33	414.73	66.44	75.59	325.30	0.31
967.31	1546.40	112.58	425.05	78.36	61.96	381.77	0.31
1166.43	1742.85	113.93	508.64	89.88	73.24	468.43	0.31
892.55	1277.02	109.52	413.59	73.80	78.08	353.77	0.31
716.90	833.65	85.03	385.55	58.22	66.66	283.35	0.31
640.73	519.01	70.74	297.47	54.30	70.95	200.22	0.31
805.99	1153.19	86.47	390.53	76.98	65.26	182.52	0.31
991.01	1429.05	160.40	406.96	74.86	82.85	297.71	0.32
824.35	1248.66	152.10	333.86	65.51	60.62	375.74	0.32
745.64	898.29	173.18	223.44	46.13	50.04	364.17	0.32
644.22	789.03	136.04	205.48	54.12	36.58	264.31	0.32
779.62	950.56	138.75	273.14	53.20	56.23	272.69	0.32
698.39	887.88	99.49	268.43	54.12	54.15	231.32	0.32

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
611.74	751.04	49.26	261.43	64.11	49.66	222.05	0.32
400.77	639.68	49.44	161.22	67.02	40.09	219.70	0.33
594.47	818.75	52.91	227.15	73.68	49.00	245.24	0.33
736.51	1824.05	74.25	256.12	71.87	57.16	292.64	0.33
813.88	2006.56	78.35	305.47	70.27	50.57	231.94	0.33
848.08	2298.60	98.56	267.20	70.42	48.39	216.87	0.33
1433.38	1159.90	169.74	398.72	102.10	91.26	213.73	0.33
1339.03	1119.90	173.15	408.83	119.62	98.81	300.62	0.33
1165.21	737.29	153.08	379.53	129.85	106.27	295.07	0.34
604.73	1087.46	82.83	278.56	117.59	67.78	339.64	0.34
677.43	943.94	75.89	210.53	94.32	70.02	209.86	0.34
678.36	1233.68	74.46	299.77	109.62	64.46	329.04	0.34
612.97	1095.12	67.95	279.09	80.23	57.52	245.72	0.34
1067.42	1715.10	121.37	492.39	157.06	84.42	289.75	0.34
1059.72	1425.35	118.08	413.43	140.32	99.08	311.40	0.35
1091.02	1525.63	147.53	477.09	140.03	99.56	395.27	0.35
652.38	1043.11	105.05	341.44	84.36	88.29	519.96	0.35
473.89	803.86	87.19	293.57	57.39	57.32	345.45	0.35
488.15	754.42	50.01	248.80	84.27	72.39	252.40	0.35
339.12	443.15	36.49	151.57	50.07	48.80	90.47	0.35
645.22	882.06	48.77	245.38	79.20	75.34	283.13	0.35
602.51	813.26	49.28	230.48	49.81	70.67	341.52	0.36
687.93	934.61	52.33	249.74	52.72	66.96	342.60	0.36
430.78	549.01	53.48	167.25	30.62	50.40	158.20	0.36
443.26	844.26	61.83	134.86	32.18	45.60	138.66	0.36
536.08	4030.53	63.64	258.91	39.69	57.39	378.97	0.36
688.82	5860.29	71.02	345.00	42.30	65.07	529.29	0.36
450.22	986.18	59.18	166.35	75.78	79.72	169.92	0.36
401.82	595.37	51.70	153.51	59.70	70.33	133.88	0.37
451.42	626.37	46.37	201.91	63.55	80.01	256.34	0.37
507.06	757.61	47.21	244.14	73.60	76.43	279.91	0.37
552.21	1076.45	89.99	244.18	72.38	69.31	285.79	0.37
389.73	848.55	75.29	173.32	43.63	40.21	124.47	0.37
507.82	885.90	90.06	201.57	42.35	43.76	143.75	0.37
592.98	699.93	53.22	226.66	62.25	68.29	216.09	0.37
743.57	806.30	66.23	264.98	64.30	72.36	237.92	0.38
601.98	691.12	50.24	218.20	67.27	70.38	226.61	0.38
741.31	994.33	70.09	261.38	98.70	100.96	219.15	0.38

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
761.71	1132.81	93.13	314.06	115.59	113.47	357.04	0.38
775.50	1190.27	117.93	322.77	112.14	119.34	360.61	0.38
570.50	784.22	103.72	287.88	70.00	65.23	291.03	0.38
475.18	692.38	80.07	230.64	48.01	56.03	152.66	0.39
423.08	602.93	51.11	205.24	44.01	48.75	127.74	0.39
340.92	518.83	41.21	152.36	33.86	45.55	158.19	0.39
490.62	561.93	53.25	211.96	54.17	59.88	212.52	0.39
534.72	583.01	68.05	229.68	55.81	60.63	238.94	0.39
627.77	666.34	75.10	270.00	56.47	69.35	268.05	0.39
386.95	458.23	57.46	173.55	37.36	47.29	195.56	0.39
391.01	449.82	47.45	151.41	28.09	42.46	152.81	0.40
281.58	360.37	38.17	106.79	30.72	35.60	108.31	0.40
322.32	374.68	38.76	119.14	23.03	54.69	135.08	0.40
379.29	879.66	54.60	190.12	39.25	69.80	112.18	0.40
	777.21						0.40
	801.04						0.40
	521.43						0.40
475.67	742.07	69.49	165.84	52.33	57.04	368.34	0.41
538.03	846.74	79.19	198.07	66.58	80.03	536.49	0.41
398.79	510.51	62.86	132.05	40.25	54.85	318.46	0.41
840.59	774.08	92.65	309.54	49.76	110.23	559.46	0.41
852.90	939.31	101.78	294.05	52.14	110.88	417.24	0.41
952.37	1176.91	113.70	365.06	61.58	127.36	494.93	0.41
588.93	989.85	78.43	228.75	51.07	76.57	320.45	0.42
669.55	1078.70	74.08	239.19	49.74	65.78	614.73	0.42
681.51	994.96	67.85	247.09	66.52	66.19	619.13	0.42
608.00	951.53	58.19	228.93	81.94	71.81	604.25	0.42
472.01	665.95	52.18	230.39	84.85	69.09	396.98	0.42
530.59	678.35	56.73	225.77	74.26	73.60	371.09	0.42
520.91	712.53	63.32	237.00	62.73	71.02	377.89	0.42
446.29	601.68	53.59	189.71	43.51	62.53	236.05	0.43
511.64	858.34	46.78	190.67	39.98	72.81	272.64	0.43
530.95	905.07	46.42	156.08	41.03	69.32	303.69	0.43
622.16	1248.77	59.98	196.57	52.95	81.12	359.99	0.43
518.37	1162.41	69.44	179.40	51.92	82.99	335.73	0.43
467.90	1069.22	57.82	188.43	33.04	66.23	211.66	0.43
534.64	846.86	53.08	168.78	27.77	63.38	212.11	0.43
712.64	731.79	56.35	164.83	40.25	82.66	226.09	0.44

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
704.07	620.84	57.58	124.58	53.45	94.58	209.13	0.44
636.21	652.94	65.55	141.33	46.70	98.81	203.74	0.44
370.05	608.69	54.64	171.55	29.87	58.68	167.18	0.44
290.61	536.61	50.85	160.21	20.41	44.33	163.19	0.44
356.34	971.30	52.45	204.41	41.67	58.00	274.47	0.44
410.35	947.06	43.73	159.82	48.50	56.62	321.76	0.44
716.14	888.65	70.71	237.81	62.88	102.01	440.43	0.45
629.84	438.63	62.46	200.31	48.62	78.78	576.15	0.45
582.88	491.55	61.51	311.29	49.94	79.68	513.96	0.45
473.57	491.55	108.24	272.31	64.24	65.39	558.97	0.45
408.55	373.88	98.81	238.84	56.55	61.64	341.82	0.45
427.65	346.99	116.51	114.22	49.39	65.64	548.75	0.45
229.36	430.46	39.22	79.34	21.78	34.65	409.00	0.46
414.23	631.31	63.54	141.17	38.14	72.30	553.50	0.46
350.45	515.67	43.80	130.39	36.53	66.85	377.02	0.46
392.07	432.20	44.51	137.43	35.14	69.52	354.35	0.46
244.55	274.49	29.78	91.75	24.77	37.20	113.08	0.46
374.74	360.28	30.54	122.18	26.20	40.29	98.60	0.46
463.59	1003.08	42.36	189.54	46.03	58.72	127.40	0.46
394.63	896.73	31.02	164.64	38.63	48.17	137.34	0.47
412.31	680.85	50.86	244.91	78.41	57.73	389.12	0.47
535.53	596.26	57.80	235.04	70.80	60.66	449.64	0.47
589.83	767.07	62.07	242.41	73.18	71.25	484.42	0.47
475.09	900.85	43.27	147.29	30.51	49.85	336.84	0.47
611.58	342.64	61.13	212.50	31.28	71.67	299.24	0.47
664.45	133.79	70.92	205.53	31.07	67.52	352.21	0.47
672.97	357.77	71.81	216.05	32.62	78.21	234.57	0.48
343.60	508.50	43.56	123.27	29.26	53.43	289.32	0.48
360.49	760.52	34.32	183.92	28.78	50.81	370.14	0.48
430.44	1122.25	40.38	194.08	34.32	51.02	404.09	0.48
422.58	1069.02	33.61	185.77	32.53	42.60	318.09	0.48
387.02	1075.74	42.93	186.30	35.84	64.59	212.19	0.48
374.46	499.62	51.92	160.97	41.85	68.61	218.02	0.48
367.96	494.92	53.08	153.60	35.63	64.95	203.57	0.49
317.33	523.96	43.77	109.12	35.20	48.94	193.43	0.49
336.56	628.01	35.80	116.41	25.91	40.19	184.64	0.49
354.54	723.66	46.17	121.87	36.78	49.06	281.78	0.49
492.72	1085.76	56.24	169.12	36.04	53.94	292.51	0.49

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
525.53	1426.31	53.45	213.68	45.84	64.69	294.02	0.49
713.66	1533.47	56.26	239.37	48.67	74.18	260.83	0.50
637.43	1148.91	51.33	213.50	61.74	96.64	322.75	0.50
504.74	560.91	46.17	162.92	56.72	87.42	310.89	0.50
358.78	667.76	39.98	164.07	46.93	78.46	318.71	0.50
411.68	869.19	39.46	157.51	33.62	60.78	282.50	0.50
462.39	1119.85	44.26	166.40	31.09	67.07	253.71	0.50
476.64	1229.22	44.33	213.59	37.53	74.96	228.08	0.50
445.14	989.65	54.37	216.92	39.82	65.55	182.82	0.51
368.56	883.03	49.38	192.42	29.02	52.65	212.58	0.51
262.13	477.20	44.25	105.42	16.61	35.99	165.88	0.51
291.99	567.91	34.92	114.45	25.69	61.98	189.93	0.51
428.43	649.57	49.81	195.38	44.69	74.58	199.52	0.51
609.65	1094.02	62.86	232.30	58.77	107.78	238.11	0.51
554.74	928.71	57.93	206.78	54.39	81.54	160.42	0.51
497.39	864.87	51.35	146.35	45.78	74.67	156.52	0.52
325.76	377.82	34.58	102.76	33.75	35.94	125.71	0.52
337.69	475.20	46.32	103.22	37.13	52.49	206.74	0.52
369.06	651.89	61.89	133.50	43.47	64.48	245.63	0.52
463.26	766.56	75.26	166.51	53.09	73.49	348.62	0.52
395.67	594.84	64.34	159.71	41.25	50.14	326.19	0.52
334.12	432.59	52.75	136.68	28.57	42.77	338.12	0.53
274.13	398.40	54.41	111.93	21.21	41.76	280.13	0.53
349.99	561.04	60.06	138.74	30.04	58.45	363.78	0.53
455.07	555.05	66.47	148.95	36.06	65.81	318.07	0.53
441.57	508.86	54.46	140.72	33.79	59.27	294.50	0.53
408.66	415.86	49.04	124.14	29.58	57.08	244.40	0.53
358.21	471.33	34.72	102.40	34.12	54.30	443.79	0.53
401.31	518.28	34.96	115.16	37.16	63.96	433.76	0.54
461.68	596.85	35.63	125.49	43.17	64.57	402.67	0.54
432.44	517.66	31.67	130.84	41.29	57.72	262.10	0.54
383.53	588.27	30.22	163.97	39.01	49.31	253.79	0.54
352.85	571.30	31.13	171.97	30.28	61.29	269.50	0.54
338.72	609.49	32.43	208.12	33.64	63.93	222.98	0.54
417.95	601.89	38.10	181.74	35.34	83.35	249.80	0.54
405.99	588.63	37.56	181.55	40.95	74.36	259.63	0.55
415.23	677.68	50.76	123.48	39.04	57.88	299.69	0.55
459.87	701.70	56.95	128.36	42.08	58.71	323.41	0.55

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
424.85	689.24	52.31	116.25	33.96	54.56	286.10	0.55
363.35	639.31	44.09	109.59	24.83	51.83	226.94	0.55
261.44	572.32	31.40	97.68	15.35	42.42	225.00	0.55
223.53	462.56	25.98	97.97	14.80	40.31	267.36	0.55
198.94	377.25	21.62	84.00	16.21	35.45	329.37	0.56
217.81	342.31	22.06	73.63	18.24	31.56	278.83	0.56
223.09	422.34	25.14	62.04	17.77	30.47	231.99	0.56
245.38	542.21	28.26	65.62	19.85	33.23	179.46	0.56
265.27	623.38	30.59	68.95	23.24	40.42	197.02	0.56
274.52	550.25	27.31	72.12	24.28	40.36	194.84	0.56
257.82	501.06	25.06	77.42	21.03	39.28	188.80	0.57
231.88	449.77	23.14	85.27	18.50	35.80	165.74	0.57
205.67	478.73	22.60	90.44	17.18	34.54	167.32	0.57
186.89	399.33	20.87	82.50	17.45	29.76	170.41	0.57
164.67	305.05	17.34	71.81	15.47	27.68	176.05	0.57
180.36	340.25	18.61	69.13	16.63	32.38	163.39	0.57
231.58	480.10	24.89	82.27	18.24	41.65	160.09	0.57
283.27	649.81	31.06	87.96	19.47	47.12	156.04	0.58
297.09	574.42	30.77	84.88	18.01	46.27	157.60	0.58
259.15	540.61	23.54	69.70	17.94	45.83	154.91	0.58
241.18	499.82	19.38	68.79	18.49	49.70	165.65	0.58
225.72	574.79	17.93	77.18	18.24	52.98	167.41	0.58
238.01	496.33	20.77	92.72	17.73	54.75	178.27	0.58
242.83	451.39	22.93	105.04	20.88	53.73	184.66	0.58
287.53	447.67	27.10	112.08	26.32	55.27	220.84	0.59
328.85	514.93	30.58	110.38	30.73	57.98	283.66	0.59
357.33	516.02	30.97	106.97	29.91	60.44	347.20	0.59
342.78	476.99	31.56	113.95	27.94	62.24	395.15	0.59
352.02	446.47	32.34	142.33	25.35	63.13	360.66	0.59
355.23	473.88	38.70	162.56	25.20	64.01	302.20	0.59
361.78	518.97	40.83	154.39	26.12	66.81	224.88	0.60
321.09	562.73	40.13	119.25	28.19	65.96	181.72	0.60
310.91	577.91	36.25	101.97	32.75	65.38	225.10	0.60
302.45	551.52	33.87	103.78	37.87	58.76	274.75	0.60
318.64	508.88	33.67	113.95	41.23	54.28	338.94	0.60
301.78	432.96	29.29	104.18	35.74	46.18	278.52	0.60
281.16	364.13	23.86	89.58	25.83	39.88	224.67	0.60
265.47	494.35	19.64	77.04	21.93	34.97	175.62	0.61

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
260.54	647.77	18.50	69.30	25.88	33.47	189.85	0.61
							0.61
							0.61
							0.61
							0.61
							0.61
383.93					55.00	244.09	0.62
358.51	565.79	22.55	95.56	31.81	53.35	234.55	0.62
334.14	497.10	22.74	86.78	27.88	54.02	233.20	0.62
305.88	458.32	23.62	81.74	23.75	50.74	221.37	0.62
256.65	360.48	23.52	78.95	19.89	50.04	189.81	0.62
249.19	335.43	28.09	86.43	17.64	47.13	181.17	0.62
235.23	343.48	32.62	87.63	15.03	47.55	201.28	0.62
253.46	382.42	35.20	98.43	13.62	50.44	264.24	0.63
243.66	446.28	32.02	95.28	13.40	54.50	294.69	0.63
259.53	512.29	28.99	104.91	14.76	56.28	295.73	0.63
267.75	567.63	26.55	92.54	18.15	48.17	236.75	0.63
243.09	427.16	21.80	81.46	17.03	34.24	169.02	0.63
210.67	337.49	16.38	53.06	14.61	26.90	107.79	0.63
224.63	263.66	16.01	49.45	16.34	32.07	105.21	0.64
293.16	359.15	21.26	65.85	21.77	45.44	140.68	0.64
348.78	363.34	26.82	90.84	27.89	50.27	228.33	0.64
297.68	350.58	28.46	98.53	26.50	45.46	288.98	0.64
261.05	289.30	28.88	89.52	24.66	38.32	362.87	0.64
254.90	283.06	30.62	86.24	24.57	39.25	378.71	0.64
307.75	291.29	28.09	82.46	27.90	43.51	358.31	0.64
323.46	334.71	23.59	77.12	32.43	53.45	282.91	0.65
322.22	383.87	21.27	72.92	38.36	63.23	234.04	0.65
320.65	418.62	22.84	75.15	38.04	71.07	211.77	0.65
294.37	395.08	25.79	79.58	32.68	66.35	209.23	0.65
250.04	348.05	23.56	76.76	21.94	53.77	187.57	0.65
220.37	347.29	24.74	84.22	16.66	48.32	193.23	0.65
223.25	368.72	26.78	95.60	17.03	50.18	217.45	0.65
248.70	389.90	30.11	108.90	21.05	56.16	251.86	0.66
251.45	360.50	28.27	104.04	25.86	54.59	270.72	0.66
272.88	369.36	26.21	95.69	30.80	54.14	284.97	0.66
294.24	394.53	25.69	90.14	35.02	60.90	322.46	0.66
315.35	418.32	25.62	91.62	36.30	66.56	337.15	0.66

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
306.02	411.22	24.40	91.70	35.08	71.24	326.27	0.66
277.84	354.53	21.52	84.28	32.58	64.67	265.89	0.66
277.07	334.93	22.51	78.93	37.86	62.58	235.28	0.67
279.67	299.28	24.58	79.31	39.24	59.07	237.16	0.67
336.85	346.84	28.17	82.50	40.51	57.77	330.84	0.67
358.77	361.17	27.44	74.98	31.36	56.91	403.79	0.67
391.27	405.36	24.78	62.10	28.52	55.48	493.25	0.67
364.18	407.97	22.65	73.95	27.03	66.43	479.63	0.67
349.32	411.01	22.67	102.30	29.69	70.83	460.61	0.68
320.30	486.12	25.39	133.32	28.08	75.34	359.18	0.68
293.14	547.31	26.23	123.37	25.77	56.81	272.66	0.68
265.13	619.65	25.83	101.59	22.76	42.85	227.19	0.68
279.08	498.46	23.06	81.17	24.02	32.58	247.17	0.68
329.18	494.24	20.53	80.61	26.70	41.47	301.76	0.68
378.63	490.04	18.80	81.46	28.96	49.73	296.90	0.68
355.67	590.25	16.65	75.04	24.39	49.93	255.43	0.69
317.66	568.75	15.93	70.64	22.09	46.34	234.49	0.69
294.22	550.39	15.70	70.08	22.45	45.81	245.58	0.69
297.96	525.70	16.56	71.71	27.71	51.15	277.95	0.69
301.12	454.03	18.71	65.01	26.74	51.58	244.34	0.69
315.15	389.31	21.80	61.38	23.56	48.32	252.29	0.69
343.58	383.45	25.03	63.70	19.01	44.50	264.01	0.69
338.94	443.17	25.95	65.64	14.80	42.44	299.68	0.70
339.70	503.94	25.42	66.52	14.61	49.21	268.48	0.70
349.19	480.51	25.83	68.14	15.51	58.69	249.74	0.70
385.75	442.73	24.81	79.31	22.37	66.64	248.92	0.70
394.85	382.27	30.84	90.83	23.65	66.61	277.27	0.70
396.81	345.92	35.59	94.82	26.33	63.43	276.47	0.70
382.26	286.46	39.97	87.17	22.21	59.16	250.78	0.71
450.67	241.17	30.42	72.84	23.36	50.94	216.30	0.71
521.58	211.67	20.79	64.25	23.94	37.78	197.73	0.71
647.63	270.88	18.49	72.22	28.74	31.53	215.45	0.71
557.41	303.26	22.68	74.52	26.08	28.84	224.55	0.71
467.35	364.35	30.51	75.40	20.59	39.50	250.71	0.71
319.28	400.50	29.44	60.66	15.97	48.72	251.66	0.71
336.85	512.21	31.20	60.77	18.80	63.44	279.83	0.72
318.79	546.58	27.38	55.49	24.59	64.28	262.60	0.72
377.12	525.49	27.85	65.35	27.71	62.56	257.12	0.72

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
377.18	425.62	24.93	65.84	29.47	55.86	240.69	0.72
419.16	397.35	25.08	73.07	29.57	54.19	250.88	0.72
359.12	389.28	23.56	70.21	33.19	54.29	268.70	0.72
377.86	385.12	21.40	99.75	46.20	52.84	288.41	0.72
406.54	334.97	17.24	145.48	66.40	55.05	324.75	0.73
469.53	302.41	14.68	183.51	80.70	54.42	338.63	0.73
504.49	274.85	12.56	210.39	90.87	58.77	365.41	0.73
320.29	347.58	20.31	67.43	25.54	32.82	234.68	0.73
286.00	510.38	22.33	55.75	22.91	49.42	280.45	0.73
353.12	605.46	28.59	60.31	26.80	77.91	323.00	0.73
246.26	401.42	18.82	38.47	21.89	68.92	281.43	0.73
244.35	203.10	16.84	43.24	27.40	64.24	186.54	0.74
231.76	140.05	14.08	58.18	29.69	48.25	204.94	0.74
187.37	267.07	18.09	57.59	25.16	42.18	164.68	0.74
177.98	273.38	20.61	52.83	24.64	34.53	219.54	0.74
288.66	281.77	28.61	50.62	18.77	31.76	279.19	0.74
387.00	483.48	27.10	65.32	21.07	54.47	398.68	0.74
394.68	635.00	26.52	67.41	23.67	58.82	422.41	0.75
282.89	654.39	19.66	73.22	29.90	67.38	386.90	0.75
329.15	412.54	16.93	72.06	21.49	52.29	301.46	0.75
337.54	356.50	14.35	75.27	11.37	59.58	240.94	0.75
342.52	349.22	12.43	68.56	9.05	54.10	201.91	0.75
281.54	400.76	14.65	69.65	16.85	72.59	252.39	0.75
255.96	279.90	13.63	57.56	19.12	55.50	250.62	0.75
272.19	305.76	19.70	58.07	26.82	63.22	266.31	0.76
253.98	284.82	22.22	56.11	22.25	52.25	256.96	0.76
319.94	397.47	28.83	56.85	24.06	67.17	313.09	0.76
314.77	365.75	24.44	64.82	16.78	55.59	360.85	0.76
291.02	347.38	20.84	67.05	18.74	52.30	373.95	0.76
292.46	308.50	18.97	86.84	26.05	53.23	349.88	0.76
282.12	301.41	19.82	70.35	25.62	62.47	293.67	0.76
282.53	344.35	18.94	64.44	28.07	62.35	255.98	0.77
276.26	439.60	18.18	49.90	17.98	53.99	268.29	0.77
409.66	471.69	47.66	66.72	21.54	57.68	346.81	0.77
402.79	595.46	48.39	71.73	19.65	49.40	312.67	0.77
388.26	467.13	46.10	81.01	23.55	49.21	255.58	0.77
325.24	582.26	19.53	86.46	30.40	56.49	351.31	0.77
347.46	408.67	19.65	75.06	32.63	70.96	423.36	0.78

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
313.94	403.52	20.12	63.27	28.29	64.53	495.51	0.78
238.69	244.75	14.44	45.79	19.65	53.21	328.68	0.78
234.04	330.93	14.14	56.51	18.95	51.01	336.36	0.78
268.38	327.00	18.25	71.68	24.62	61.36	338.48	0.78
257.59	317.39	20.37	72.61	20.00	48.30	307.82	0.78
333.58	138.66	21.96	65.14	22.31	41.63	268.08	0.78
301.75	131.45	28.89	45.20	17.47	37.68	250.16	0.79
308.68	222.39	29.93	55.24	25.20	46.57	200.31	0.79
291.62	373.14	31.60	72.45	13.81	67.02	514.21	0.79
322.88	384.25	25.04	80.74	23.39	75.99	487.03	0.79
332.49	298.81	24.09	85.99	15.45	78.18	552.80	0.79
233.97	214.51	18.13	64.54	16.33	53.68	193.55	0.79
235.67	207.64	19.08	60.93	7.80	50.63	230.22	0.79
231.27	261.71	15.23	42.22	13.55	42.17	241.10	0.80
248.67	466.62	17.26	56.45	15.38	55.86	330.48	0.80
205.99	784.32	9.96	55.10	16.30	48.34	248.38	0.80
192.56	832.54	11.32	57.95	13.01	47.28	248.75	0.80
184.92	695.89	9.53	46.50	10.46	33.10	177.82	0.80
191.03	336.69	10.81	49.94	12.79	33.91	190.70	0.80
167.59	226.18	9.92	39.66	11.38	38.17	150.32	0.81
182.07	218.31	12.30	49.98	19.50	43.73	339.01	0.81
155.37	293.68	10.72	42.16	16.39	37.04	331.45	0.81
190.52	343.45	10.74	53.38	20.92	40.19	376.38	0.81
215.81	358.40	18.98	58.02	17.81	40.83	524.40	0.81
271.27	323.32	25.96	78.54	23.84	58.97	620.23	0.81
305.86	370.08	31.41	69.03	28.81	58.55	678.07	0.81
252.37	288.60	21.68	52.72	31.59	50.39	333.80	0.82
242.84	274.91	16.45	37.17	32.00	36.42	262.47	0.82
249.19	191.53	10.96	49.44	23.98	30.34	189.15	0.82
295.64	212.26	15.26	57.39	20.86	31.40	229.58	0.82
248.16	248.88	12.29	53.92	13.05	28.23	204.51	0.82
215.14	300.67	20.72	40.31	14.60	28.94	229.61	0.82
156.72	322.00	14.54	42.81	9.99	25.34	189.28	0.82
191.08	337.09	16.93	47.40	13.65	31.08	241.39	0.83
150.66	313.75	10.06	51.78	10.61	28.07	294.86	0.83
143.60	262.94	10.76	46.88	14.54	29.35	283.18	0.83
188.74	216.72	10.54	41.56	13.10	36.75	258.81	0.83
244.41	191.68	12.03	47.98	20.33	40.79	176.21	0.83

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
331.11	292.69	22.27	76.73	21.62	61.89	189.07	0.83
317.40	617.26	32.56	88.41	36.97	56.58	162.27	0.84
315.64	1303.22	28.73	81.80	39.27	70.46	340.59	0.84
216.80	1170.74	17.31	39.17	34.37	45.40	339.53	0.84
198.56	948.26	11.31	31.43	17.52	47.04	402.06	0.84
152.57	218.45	12.00	25.39	5.27	21.63	193.32	0.84
279.25	285.94	15.08	52.72	8.81	45.29	209.46	0.84
258.95	140.03	9.91	46.49	6.44	37.47	164.44	0.84
287.88	221.97	15.37	52.38	7.27	45.39	186.88	0.85
175.24	176.08	11.85	29.61	3.27	25.51	152.18	0.85
178.51	218.16	15.01	38.42	5.23	32.07	181.46	0.85
129.46	169.09	8.89	36.22	5.24	31.10	158.54	0.85
177.69	200.13	19.20	49.12	6.37	46.25	211.22	0.85
218.83	301.29	17.70	41.37	4.87	47.69	175.11	0.85
228.38	288.48	17.75	41.16	8.33	46.91	247.94	0.85
208.65	295.79	14.85	34.00	12.78	44.82	201.39	0.86
160.98	206.15	16.39	52.54	16.70	47.04	242.15	0.86
165.92	217.56	16.68	61.23	14.44	47.41	179.55	0.86
180.45	205.30	12.80	67.67	10.04	36.33	230.98	0.86
176.14	186.25	8.96	47.20	8.18	25.66	191.07	0.86
184.78	214.45	9.10	43.43	9.21	26.70	202.49	0.86
197.98	303.64	9.25	59.75	14.66	28.94	219.28	0.87
198.07	291.41	10.89	58.59	11.57	30.84	263.09	0.87
254.04	278.65	14.55	108.28	9.50	33.54	396.56	0.87
211.31	203.94	12.11	81.45	5.31	33.35	343.06	0.87
223.26	217.74	13.31	84.51	8.13	41.36	329.02	0.87
186.00	206.16	9.50	33.98	12.48	38.92	203.22	0.87
223.10	300.17	15.39	33.15	14.06	50.50	286.74	0.87
225.26	287.92	13.88	36.66	19.60	42.40	293.43	0.88
220.26	339.70	20.48	43.54	17.21	44.05	392.59	0.88
227.57	229.13	16.36	48.84	11.78	39.17	325.60	0.88
227.34	254.51	17.91	50.94	11.70	39.44	305.08	0.88
255.93	251.57	17.04	48.05	17.23	42.86	237.02	0.88
288.31	321.73	20.31	53.39	23.60	47.89	273.03	0.88
304.93	305.33	25.55	50.87	21.68	50.33	282.64	0.88
246.33	237.48	20.00	39.46	16.49	43.29	220.91	0.89
169.85	188.67	14.69	35.18	11.50	25.66	172.08	0.89

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
167.39	269.51	10.23	43.53	20.50	27.88	170.51	0.89
226.01	313.10	10.60	61.71	28.04	33.23	236.13	0.89
269.78	326.94	13.61	63.18	28.68	39.07	250.15	0.89
297.50	263.42	13.40	54.33	14.79	45.47	324.78	0.89
261.41	240.47	14.03	49.53	11.03	44.90	287.88	0.90
289.75	238.78	21.02	64.87	12.53	50.54	309.42	0.90
217.57	232.53	19.53	67.91	15.78	43.09	210.42	0.90
314.63	289.15	22.46	66.91	20.43	56.05	430.47	0.90
270.26	317.46	12.94	48.29	20.55	60.55	469.33	0.90
341.65	358.06	14.38	57.03	40.72	70.16	622.91	0.90
290.48	352.86	11.81	61.91	38.40	69.95	590.26	0.90
316.90	298.40	13.45	68.89	47.58	56.69	505.59	0.91
280.89	219.55	10.71	47.40	23.62	44.88	332.49	0.91
284.17	298.36	14.59	30.62	22.20	45.01	233.02	0.91
243.76	272.62	12.78	33.96	16.16	44.92	323.65	0.91
258.47	359.64	15.24	47.87	22.83	49.74	430.30	0.91
228.28	261.87	14.62	49.83	21.51	49.37	230.45	0.91
248.26	235.56	16.96	48.98	14.37	61.26	239.74	0.91
243.12	210.49	13.96	48.48	19.65	48.57	201.70	0.92
228.75	164.68	11.27	45.09	15.60	53.08	213.78	0.92
282.37	164.36	8.07	47.41	20.72	46.43	305.07	0.92
310.85	183.74	11.94	52.28	14.82	45.31	329.20	0.92
283.03	166.24	9.86	44.34	11.34	38.37	288.63	0.92
213.97	352.10	10.80	50.33	11.52	35.83	213.11	0.92
246.21	399.88	11.54	39.38	13.60	32.53	206.70	0.92
324.41	457.21	14.84	55.24	15.98	43.12	291.97	0.93
323.24	249.39	15.15	48.36	20.40	38.82	323.96	0.93
257.06	187.67	10.87	63.29	20.42	44.02	309.97	0.93
282.40	243.46	10.13	57.38	23.85	43.26	275.82	0.93
417.96	344.66	28.15	53.71	23.14	47.06	267.19	0.93
413.10	486.73	26.54	35.95	29.16	46.95	707.62	0.93
339.44	506.96	27.37	41.28	24.38	42.72	735.67	0.94
234.65	443.39	16.64	63.49	25.46	46.92	735.31	0.94
298.32	365.37	21.69	89.26	16.21	55.84	347.38	0.94
336.01	287.65	20.94	86.38	18.71	58.26	406.28	0.94
342.38	257.88	21.79	57.96	14.55	55.38	429.91	0.94
267.45	172.42	17.85	31.28	13.68	35.29	382.83	0.94

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
251.28	166.22	16.47	25.98	14.83	42.67	310.31	0.94
205.71	172.80	7.74	31.04	9.64	29.41	205.80	0.95
233.00	184.98	10.85	34.17	15.43	40.77	371.31	0.95
205.83	169.35	14.06	31.16	13.47	28.69	376.63	0.95
247.31	202.75	13.93	34.04	16.20	36.58	426.60	0.95
207.26	183.42	9.73	30.21	11.52	26.11	232.86	0.95
195.18	163.63	7.54	31.79	8.95	27.00	175.49	0.95
210.49	147.62	9.10	32.87	11.04	36.88	287.28	0.95
261.01	188.81	10.43	46.12	17.14	52.24	365.15	0.96
313.97	222.34	11.75	61.15	26.04	60.85	396.55	0.96
288.70	258.34	9.90	71.23	27.49	59.91	284.34	0.96
258.34	244.23	11.01	67.94	20.07	47.94	231.43	0.96
251.45	237.11	9.44	71.80	11.79	46.53	366.39	0.96
195.40	167.92	8.50	50.41	9.46	35.71	323.14	0.96
170.82	130.44	7.91	43.97	7.59	29.85	282.04	0.96
156.87	312.24	8.16	33.25	10.52	30.35	172.99	0.97
212.21	401.92	21.45	49.68	23.74	42.75	492.43	0.97
207.15	419.70	20.54	47.39	26.43	47.43	521.66	0.97
236.14	261.75	25.55	47.61	28.81	60.75	514.17	0.97
230.47	178.73	14.55	33.71	12.66	42.58	177.36	0.97
339.62	256.37	17.48	99.55	12.23	33.49	219.97	0.97
273.91	191.95	11.12	90.38	6.31	8.19	162.74	0.97
292.74	354.01	23.80	115.76	22.15	13.56	342.26	0.98
227.98	604.13	22.89	81.02	19.09	30.64	460.51	0.98
313.50	689.96	25.91	82.36	16.90	43.70	478.45	0.98
269.02	561.03	19.86	62.30	13.31	81.73	466.71	0.98
388.80	378.32	21.56	88.92	12.91	131.32	581.93	0.98
406.44	492.72	22.66	162.13	24.94	159.12	670.62	0.98
401.03	492.99	15.89	166.47	16.76	128.63	615.66	0.98
382.88	390.51	22.76	136.85	21.39	85.31	414.07	0.99
359.55	299.26	21.32	87.37	11.25	74.02	461.26	0.99
334.04	245.19	19.13	74.92	9.58	67.63	350.54	0.99
288.36	281.57	15.56	66.37	7.14	62.97	454.97	0.99
239.26	263.25	13.40	47.16	10.57	47.17	353.80	0.99
332.96	370.20	23.91	100.80	8.23	52.33	543.44	0.99
274.51	312.93	24.48	92.28	13.60	58.03	503.75	0.99
316.28	272.53	30.68	91.61	11.88	60.96	534.23	1.00

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
256.06	399.69	25.27	50.13	11.40	53.09	436.88	1.00
232.51	361.81	19.64	39.91	6.29	29.49	272.48	1.00
196.15	348.43	14.44	36.82	9.83	13.33	286.40	1.00
202.31	140.38	11.98	35.10	14.02	22.41	250.89	1.00
221.06	200.67	11.05	37.61	16.43	32.20	338.73	1.00
202.06	194.47	10.01	32.47	11.07	35.05	253.92	1.00
195.06	250.97	8.67	34.15	25.78	37.29	364.13	1.01
154.17	193.27	6.17	25.84	22.08	32.45	282.10	1.01
169.78	194.90	7.54	31.66	22.38	31.75	280.44	1.01
140.04	116.86	5.96	18.45	2.94	19.92	112.21	1.01
163.98	201.42	9.68	28.11	2.39	22.23	129.59	1.01
210.44	225.77	9.56	32.01	4.28	32.63	147.53	1.01
295.41	260.03	13.14	40.91	17.66	32.33	316.54	1.01
292.09	196.28	12.50	40.84	23.47	36.74	333.71	1.02
235.68	188.05	13.40	35.29	20.76	26.96	456.15	1.02
150.92	160.01	11.67	26.96	10.45	29.38	308.93	1.02
196.57	293.43	12.86	25.86	10.43	43.00	417.68	1.02
268.52	365.13	12.10	29.92	12.75	51.91	320.80	1.02
281.84	324.75	10.32	35.29	9.94	52.57	324.15	1.02
251.36	178.44	8.22	41.15	11.53	45.99	184.79	1.03
257.16	98.71	9.99	33.20	8.20	49.12	240.26	1.03
273.72	235.24	13.74	35.02	14.30	41.47	320.82	1.03
278.70	265.73	17.20	28.67	11.33	40.96	349.93	1.03
193.86	261.91	14.22	31.37	13.47	36.42	259.14	1.03
206.49	164.79	13.02	25.92	12.78	59.97	197.56	1.03
206.47	153.07	9.86	30.21	10.61	56.74	252.75	1.03
224.14	143.11	9.71	42.42	11.14	56.35	274.80	1.04
187.86	132.26	6.86	41.87	5.25	34.99	242.08	1.04
179.56	127.97	10.13	35.09	11.26	30.61	230.52	1.04
175.95	123.98	9.37	24.04	17.52	25.00	212.26	1.04
198.28	153.05	11.99	27.71	26.51	30.95	256.19	1.04
209.77	194.12	10.80	41.45	32.95	40.01	275.28	1.04
231.78	243.72	12.50	49.58	30.31	49.63	380.25	1.04
236.56	255.68	38.44	50.38	27.77	50.33	386.76	1.05
272.30	232.19	37.15	62.79	27.04	51.47	385.70	1.05
330.40	241.62	43.79	77.51	24.41	73.63	461.61	1.05
344.68	241.64	17.96	86.50	32.94	86.46	491.84	1.05

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
323.02	275.37	18.36	62.11	27.14	77.53	442.23	1.05
245.89	242.33	17.56	53.11	32.48	63.28	319.84	1.05
226.13	518.53	17.02	40.19	18.70	47.40	240.56	1.05
245.01	474.29	18.54	38.79	13.01	49.07	310.45	1.06
222.87	449.45	12.71	26.12	9.58	26.90	258.75	1.06
182.95	156.65	10.75	21.11	8.86	26.69	252.53	1.06
125.68	134.88	7.75	20.50	8.40	20.70	143.05	1.06
172.34	157.28	7.43	26.39	6.37	23.82	154.90	1.06
259.96	207.59	11.21	46.25	9.92	38.41	307.76	1.06
279.06	225.23	11.12	49.80	13.87	42.40	342.21	1.06
264.90	212.23	10.46	46.50	10.35	51.09	340.35	1.07
223.07	168.63	8.06	33.23	6.89	37.64	215.91	1.07
266.12	240.81	12.82	39.72	2.62	36.79	335.82	1.07
248.46	265.93	15.40	39.54	9.50	28.92	334.07	1.07
313.58	309.92	15.89	40.70	19.51	40.67	444.95	1.07
283.80	321.67	13.52	52.32	24.77	60.97	406.36	1.07
266.83	299.61	9.72	44.44	24.37	59.10	400.58	1.07
182.24	271.50	8.53	48.26	16.61	52.72	317.37	1.08
154.44	194.30	6.86	33.64	20.94	32.16	217.02	1.08
189.00	230.59	11.33	39.09	20.62	42.04	332.58	1.08
253.73	365.02	15.77	30.60	23.67	48.21	466.31	1.08
238.92	332.70	18.97	23.88	13.98	44.02	444.75	1.08
262.90	311.61	16.99	21.24	10.26	34.65	336.01	1.08
196.45	138.12	13.04	18.80	11.00	26.49	172.74	1.08
227.76	206.19	7.66	21.78	15.69	24.81	173.22	1.09
338.00	211.94	8.96	33.03	28.00	45.67	237.61	1.09
327.08	237.05	15.00	37.80	24.20	37.59	298.36	1.09
286.92	164.60	14.52	34.11	17.96	36.21	254.17	1.09
253.89	287.55	16.05	25.05	18.19	46.93	264.38	1.09
314.60	339.29	10.84	24.14	22.34	62.43	207.11	1.09
536.33	594.41	18.84	28.22	44.78	114.16	416.27	1.09

Brontothere Distal Femur (F08-09): Orella Road

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1414.46	2655.57	351.75	2584.78	111.47	45.31	123.72	0.00
1774.39	2344.29	457.33	2757.99	170.04	65.99	131.21	0.00
2388.68	2700.80	591.67	1237.40	177.45	70.34	132.07	0.01
2534.35	2887.75	736.58	1239.98	202.93	67.08	140.71	0.01
3138.19	3794.26	683.42	1516.49	100.25	62.02	133.26	0.01
2159.35	1834.05	368.13	940.79	105.75	43.00	148.65	0.01
2356.89	2392.97	300.74	1237.48	134.41	64.20	191.95	0.01
1752.21	3039.34	678.04	1208.19	176.86	65.02	257.04	0.02
1891.93	3474.64	728.51	1246.97	180.66	48.94	213.96	0.02
2210.29	3385.07	695.88	1250.54	139.86	53.77	199.83	0.02
2106.17	2322.40	312.32	877.94	107.22	42.89	152.12	0.02
1889.63	1908.93	207.18	788.77	101.80	64.12	164.03	0.02
1355.30	1919.48	185.66	705.03	146.21	60.76	174.69	0.03
1448.29	2382.03	256.75	1020.66	150.55	72.93	189.19	0.03
1307.01	2234.82	288.99	995.56	167.07	63.83	172.18	0.03
2476.81	2933.51	346.26	1068.58	85.40	57.85	165.23	0.03
1974.05	2262.92	213.39	671.67	73.41	37.37	108.92	0.03
2116.39	2291.17	212.20	1208.49	65.32	41.60	87.02	0.04
1107.86	1255.32	109.84	871.70	95.73	23.66	174.28	0.04
1272.93	1445.32	139.12	944.88	111.32	60.81	233.82	0.04
1924.21	1035.90	120.73	416.91	200.19	75.90	260.94	0.04
2436.93	1267.42	273.59	806.63	188.28	104.70	362.55	0.04
2813.60	1318.27	278.17	892.79	177.27	113.27	365.23	0.05
2055.16	2429.02	266.58	971.68	75.03	84.90	330.86	0.05
1196.96	1841.84	106.95	518.84	64.57	56.75	112.95	0.05
760.34	1559.29	79.96	406.47	50.62	10.79	63.35	0.05
688.02	896.84	50.22	389.73	63.68	10.41	79.70	0.05
1441.98	1549.72	136.21	572.37	72.36	24.95	248.22	0.06
1809.81	1941.99	148.19	935.41	70.76	26.14	341.45	0.06
1742.89	1635.61	147.09	813.98	36.87	23.49	356.45	0.06
887.31	925.23	50.79	608.13	18.96	9.81	186.79	0.06
768.95	1369.46	90.03	244.37	20.47	34.92	139.08	0.06
789.86	1636.92	86.07	184.84	81.76	48.88	219.39	0.07
1308.38	3168.75	117.06	316.60	112.86	51.00	197.61	0.07
1064.49	2091.78	98.71	340.79	103.64	30.02	163.96	0.07
961.97	1839.79	103.90	356.89	55.52	15.82	42.28	0.07
405.13	495.79	82.70	256.92	28.23	17.64	82.67	0.07
258.43	603.77	40.98	223.95	31.31	15.23	90.43	0.08

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
274.98	540.94	36.94	170.61	46.61	23.65	138.91	0.08
892.75	431.23	46.70	170.57	88.70	32.89	126.79	0.08
1192.77	667.64	108.42	369.15	88.06	61.25	212.49	0.08
1144.71	622.76	109.67	372.15	74.30	52.06	172.89	0.08
806.23	915.13	118.03	427.18	34.61	51.90	249.45	0.09
466.29	791.66	60.03	175.30	43.27	22.68	173.77	0.09
756.76	1248.02	93.99	243.26	44.99	28.67	346.46	0.09
1054.57	1605.87	71.09	203.44	48.81	26.95	420.08	0.09
1174.16	1598.62	76.14	296.81	39.52	27.08	414.95	0.09
896.92	1130.65	53.79	227.21	42.84	25.84	262.44	0.10
531.12	850.34	69.31	474.26	40.01	26.28	211.16	0.10
736.39	1740.54	78.21	475.95	53.67	44.82	443.79	0.10
1619.84	2095.33	104.51	605.82	33.56	54.66	600.19	0.10
1482.05	1755.94	99.10	363.25	27.67	52.07	518.99	0.10
1188.53	870.20	87.87	272.93	21.37	31.30	263.16	0.11
580.82	753.64	131.27	206.96	30.15	33.61	231.63	0.11
497.09	645.91	115.79	163.71	34.03	31.77	308.29	0.11
556.71	527.34	124.09	205.27	24.29	45.41	327.70	0.11
440.16	311.59	60.88	142.87	32.83	36.20	199.73	0.11
550.87	657.69	270.57	258.43	46.49	48.32	1116.90	0.12
492.92	640.46	262.97	255.09	53.29	40.65	1133.03	0.12
432.61	579.91	246.02	274.89	30.28	30.41	1170.34	0.12
275.05	148.32	32.41	141.86	13.63	9.08	149.16	0.12
309.62	98.98	29.58	121.13	20.10	2.87	138.65	0.12
283.56	710.03	46.23	160.79	19.46	17.52	100.39	0.13
274.85	343.45	29.92	89.91	25.31	16.91	110.59	0.13
531.30	573.22	65.56	96.76	32.21	57.76	416.96	0.13
696.74	1894.82	62.80	99.08	34.45	78.39	495.97	0.13
651.97	1849.93	65.84	94.98	41.64	76.31	702.98	0.13
543.61	2127.78	46.98	175.09	39.95	40.46	477.00	0.14
371.26	726.02	55.14	185.20	36.31	36.15	356.59	0.14
353.54	788.17	50.35	183.92	25.06	32.21	158.69	0.14
252.10	325.29	46.19	107.93	19.02	31.55	243.28	0.14
238.35	691.47	30.18	108.58	19.58	38.91	306.87	0.14
288.53	695.04	39.15	94.07	15.80	46.21	318.01	0.15
217.66	779.41	49.56	121.43	31.86	39.98	163.65	0.15
405.44	702.66	74.80	217.48	31.25	23.55	155.17	0.15

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
390.27	632.90	74.95	266.76	38.19	17.01	153.54	0.15
428.30	743.95	66.97	265.32	26.35	15.46	246.10	0.15
224.94	801.46	44.42	191.56	22.10	18.34	217.24	0.16
150.15	813.19	31.58	133.46	11.92	17.24	160.52	0.16
127.25	501.83	13.10	83.68	12.77	15.69	42.12	0.16
186.51	304.43	33.05	76.82	10.35	5.73	153.96	0.16
334.52	302.37	36.72	89.87	11.01	9.93	171.90	0.16
348.00	298.60	38.66	94.84	13.66	10.56	224.93	0.17
420.66	179.93	18.83	62.85	52.86	15.32	160.36	0.17
411.87	780.85	36.29	105.08	52.17	22.90	755.12	0.17
356.17	838.37	35.01	95.80	65.45	27.29	710.25	0.17
283.35	863.97	36.84	116.71	38.81	37.60	705.86	0.17
396.72	455.56	21.27	120.59	62.41	58.74	281.65	0.18
495.59	478.84	42.84	138.98	44.58	58.49	307.01	0.18
643.99	939.35	48.57	219.58	47.78	41.59	353.17	0.18
488.16	779.22	46.13	234.83	27.32	7.72	189.11	0.18
440.27	820.61	49.03	241.00	23.17	12.80	183.41	0.18
227.96	579.05	36.57	124.36	5.97	13.58	78.53	0.19
237.60	663.66	39.38	158.95	19.63	26.97	131.72	0.19
263.65	1640.39	35.27	424.74	37.86	24.52	419.36	0.19
385.75	1597.73	48.50	480.18	50.46	61.70	511.83	0.19
328.09	1497.01	44.12	382.90	40.35	49.50	443.02	0.19
300.04	472.86	62.88	159.06	21.22	43.45	217.84	0.20
146.87	252.17	47.15	106.37	26.94	6.21	136.67	0.20
232.99	319.40	72.09	121.82	32.29	25.08	165.14	0.20
300.39	538.03	80.57	94.66	61.73	26.77	875.20	0.20
548.99	765.61	84.91	128.82	47.33	40.43	1599.59	0.20
404.90	663.33	56.58	99.79	49.18	22.29	1565.86	0.21
398.18	439.53	13.92	96.04	39.99	32.50	810.67	0.21
464.92	221.52	12.87	77.33	39.80	22.57	105.61	0.21
555.85	298.38	18.60	121.74	29.35	18.82	137.90	0.21
538.07	268.14	21.50	116.90	10.28	11.05	133.40	0.21
235.02	247.26	21.49	107.21	11.02	10.31	116.75	0.22
218.23	237.15	24.89	78.25	16.54	18.88	108.42	0.22
140.62	457.48	16.55	71.17	17.02	20.97	91.48	0.22
163.00	469.68	17.05	77.09	27.71	24.18	137.66	0.22
180.70	490.69	20.21	75.92	29.64	44.56	148.80	0.22

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
245.43	353.12	21.27	79.54	34.63	47.38	208.42	0.23
268.32	436.38	26.87	69.38	19.46	40.47	175.09	0.23
168.71	308.45	14.99	55.82	18.77	12.00	131.83	0.23
137.49	2334.53	18.28	99.11	47.96	44.02	144.44	0.23
225.46	2326.10	20.96	109.44	69.60	50.95	262.75	0.23
336.56	2482.05	34.61	123.41	81.61	50.47	300.01	0.24
663.00	1419.16	76.72	123.70	62.09	21.79	382.14	0.24
556.20	1397.11	68.74	119.06	50.71	17.55	289.87	0.24
552.96	1305.38	68.03	115.53	80.47	22.44	285.49	0.24
321.85	476.03	64.59	170.60	63.40	48.14	354.15	0.24
290.24	399.20	62.19	165.57	60.54	52.95	310.81	0.25
364.94	525.06	56.73	176.76	4.45	55.13	349.83	0.25
216.28	411.94	20.92	57.45	8.86	11.63	272.29	0.25
455.30	557.97	34.86	81.71	16.08	7.32	1108.75	0.25
622.47	670.65	43.19	128.37	20.36	21.39	1168.92	0.25
483.09	397.12	34.12	128.83	22.82	25.23	1037.37	0.26
295.51	273.90	18.16	107.87	13.91	32.64	506.76	0.26
285.08	270.14	25.11	98.32	12.77	26.85	618.84	0.26
340.36	301.02	30.92	118.62	2.39	25.91	853.91	0.26
322.39	320.71	34.16	115.40	5.62	29.90	515.61	0.26
207.29	245.23	20.81	88.16	24.89	20.38	654.25	0.27
224.39	309.29	40.57	118.80	91.34	26.01	413.86	0.27
306.12	703.88	45.09	114.62	88.02	32.75	469.09	0.27
455.94	1112.14	53.06	145.49	86.52	53.15	279.31	0.27
466.60	1087.64	49.20	138.74	46.31	44.62	456.26	0.27
418.90	852.40	67.66	140.23	65.59	44.41	597.67	0.28
279.44	445.30	58.22	97.16	67.88	20.96	466.32	0.28
305.46	543.17	45.11	116.31	73.78	32.05	347.89	0.28
267.46	424.21	37.54	124.65	54.48	51.12	219.94	0.28
398.96	520.98	55.79	170.63	43.31	48.10	288.93	0.28
352.87	399.90	56.18	139.19	28.99	43.81	257.97	0.29
399.06	416.29	39.83	174.94	55.43	19.61	208.04	0.29
679.60	464.82	23.13	185.14	51.95	86.76	192.90	0.29
657.26	496.71	31.59	250.60	34.19	83.96	227.02	0.29
634.73	380.43	28.58	210.71	7.91	84.67	207.00	0.29
205.37	306.13	30.23	192.46	15.53	20.82	148.79	0.30
225.39	363.90	18.20	143.08	18.59	42.68	243.18	0.30

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
261.18	438.51	22.48	140.24	34.35	29.15	523.69	0.30
262.47	379.85	20.67	132.33	19.64	25.86	580.63	0.30
223.76	247.33	16.76	83.87	28.34	6.08	464.42	0.31
168.36	319.54	26.61	74.02	12.53	15.06	164.71	0.31
218.74	336.27	28.44	101.61	14.27	19.07	177.27	0.31
259.54	379.72	31.98	132.21	8.20	15.98	167.21	0.31
283.63	307.88	30.03	151.89	13.74	6.99	226.34	0.31
307.08	363.08	26.16	133.34	10.37	2.98	224.21	0.32
387.85	418.21	115.20	134.66	4.62	20.19	366.34	0.32
637.83	395.24	128.07	133.84	24.19	38.20	399.90	0.32
620.15	384.74	129.99	130.92	38.27	41.59	447.41	0.32
654.47	529.15	63.92	184.92	38.23	75.28	579.93	0.32
434.00	615.42	90.86	258.94	17.71	57.27	557.13	0.33
401.33	507.20	89.90	237.52	30.83	62.43	458.12	0.33
511.57	356.87	68.98	153.42	34.15	49.90	263.63	0.33
484.96	264.18	20.61	49.44	29.75	51.41	246.16	0.33
475.60	291.96	17.48	35.12	3.70	42.86	232.47	0.33
201.82	183.36	12.74	28.38	1.61	7.96	150.11	0.34
163.46	182.33	9.57	28.43	6.19	15.63	101.25	0.34
145.22	193.24	12.95	26.12	5.30	31.18	108.94	0.34
216.59	267.22	13.00	76.08	8.81	41.60	116.68	0.34
248.99	272.93	21.22	103.99	4.11	50.95	207.00	0.34
291.81	268.08	17.76	155.60	22.63	44.65	341.12	0.35
270.12	251.31	18.43	231.23	21.81	50.02	305.78	0.35
224.93	208.85	13.41	219.68	24.00	40.61	222.68	0.35
207.65	173.21	16.01	183.32	5.58	37.47	106.20	0.35
162.63	144.08	17.94	65.20	9.15	17.98	138.92	0.35
306.07	196.53	19.28	89.93	6.92	19.62	593.40	0.36
297.95	296.89	25.62	93.14	6.93	31.15	631.17	0.36
312.96	295.20	21.99	104.89	1.68	35.10	622.32	0.36
185.00	280.69	24.76	71.10	2.44	24.35	174.50	0.36
119.57	149.51	14.42	43.67	4.28	8.34	95.42	0.36
143.45	157.04	22.22	58.58	2.23	12.39	126.41	0.37
99.43	83.85	13.82	47.15	8.12	15.99	97.46	0.37
216.57	201.63	36.24	106.39	22.37	17.51	203.05	0.37
192.06	202.25	35.77	77.49	33.62	11.15	420.48	0.37
259.72	280.19	50.87	108.66		11.32	601.57	0.37

Appendix A. (continued)
Brontothere Rib (F08-10): Orella Road

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1601.65	2980.10	393.99	1316.93	132.20	38.98	494.93	0.00
1463.28	1797.35	203.40	810.65	81.34	31.41	279.15	0.00
2017.54	2995.23	228.86	1110.30	102.63	61.89	401.96	0.01
1497.71	2551.05	180.77	717.83	64.89	50.46	338.93	0.01
1917.19	4355.10	281.29	1044.51	113.03	81.87	258.96	0.01
1769.87	3427.54	302.70	1147.89	106.08	60.96	192.90	0.01
2292.41	3765.00	335.97	1258.34	137.16	63.79	228.97	0.01
2304.32	3844.50	333.57	1228.13	111.95	38.99	277.27	0.02
1967.43	3347.89	231.21	752.52	107.73	27.97	230.53	0.02
1739.31	4545.58	407.82	1299.82	91.62	56.65	307.88	0.02
1194.55	2713.47	310.34	991.30	61.84	44.40	230.17	0.02
1287.05	3047.25	400.69	1129.76	68.29	69.35	301.57	0.03
1493.68	2243.43	273.46	735.50	110.16	65.99	390.77	0.03
2200.64	4240.15	498.88	1674.80	164.39	77.45	400.16	0.03
2056.59	4012.09	545.49	1615.69	154.48	52.35	333.43	0.03
1550.77	3530.23	466.11	1491.85	105.88	23.22	167.27	0.03
897.72	1804.98	269.10	617.30	67.00	19.21	137.50	0.04
2250.29	4310.89	310.41	1355.09	78.84	112.37	264.35	0.04
2510.49	3578.82	401.95	1651.66	82.79	125.61	256.57	0.04
2523.03	3401.42	374.85	1632.74	76.23	123.32	268.17	0.04
1098.97	1862.56	196.54	755.61	59.29	29.72	122.51	0.04
1341.60	3164.66	284.35	1000.50	93.61	46.04	349.75	0.05
2345.67	4034.78	464.66	1281.73	179.08	49.78	462.09	0.05
2583.25	3198.83	786.17	1787.72	209.24	51.81	534.69	0.05
2432.56	2649.54	631.03	1278.83	172.94	27.69	258.69	0.05
1551.62	2506.36	475.50	979.72	135.65	27.30	176.54	0.05
1516.35	3357.32	169.80	632.40	121.51	38.83	165.82	0.06
1792.93	3966.07	229.20	1667.35	224.86	84.73	247.83	0.06
4039.77	7409.99	617.06	2834.29	366.20	136.98	679.42	0.06
4047.27	6318.75	666.65	2716.65	348.39	128.98	626.01	0.06
4574.74	6231.71	609.45	1814.37	322.48	84.99	585.86	0.06
2335.25	2856.52	248.33	723.32	153.95	28.36	130.69	0.07
3589.35	5603.25	342.86	1352.55	176.21	114.87	331.67	0.07
3448.79	5642.50	631.46	1560.49	132.02	142.89	377.81	0.07

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
3661.71	5776.20	679.95	1807.20	130.19	176.65	675.82	0.07
2642.56	3625.03	600.08	1553.32	147.95	113.24	688.18	0.08
2078.24	3266.60	358.34	1434.57	126.25	105.12	620.57	0.08
2382.29	5147.66	424.24	1728.80	207.39	123.11	367.32	0.08
3117.54	5048.37	371.53	1539.45	172.77	111.16	196.83	0.08
2871.70	4628.92	485.85	1341.11	196.05	141.79	259.50	0.08
2374.64	1395.20	382.85	884.71	112.07	101.14	326.22	0.09
1811.81	1889.28	1040.81	1296.26	253.68	131.76	432.67	0.09
2188.30	2192.66	871.49	1290.59	218.29	87.71	351.78	0.09
2488.03	3019.61	822.36	1198.67	253.25	83.51	450.27	0.09
1642.18	1733.76	102.16	507.63	93.28	32.98	274.85	0.09
1114.11	1140.56	72.71	317.24	76.36	20.56	301.43	0.10
1191.33	1241.24	181.39	316.28	38.11	28.75	145.56	0.10
2196.93	2335.35	340.15	1098.91	87.96	75.47	216.87	0.10
4302.33	2089.27	449.88	1433.17	193.68	116.58	744.20	0.10
4593.88	2540.51	429.33	1618.77	253.58	106.08	893.66	0.10
3758.61	1378.87	297.33	942.35	218.64	64.09	848.40	0.11
3014.99	2505.92	279.31	950.17	157.92	70.09	334.01	0.11
3018.93	1127.06	278.80	972.52	114.22	92.43	222.31	0.11
3261.82	1475.27	280.80	1018.36	119.30	101.43	264.44	0.11
2166.32	1179.73	221.17	737.74	84.85	93.89	232.80	0.11
1605.00	1983.90	174.40	578.18	76.63	81.68	246.53	0.12
1809.14	1830.79	239.85	514.22	70.65	75.08	208.28	0.12
2229.87	1634.45	283.87	519.27	84.37	43.58	213.10	0.12
1741.65	936.89	208.10	302.48	56.38	25.64	115.77	0.12
1936.31	1389.78	184.49	414.26	130.98	45.67	158.82	0.13
1607.38	1689.16	213.21	471.86	136.01	46.28	145.14	0.13
2653.60	2700.77	278.31	1109.47	203.06	84.21	310.32	0.13
2740.41	3045.31	308.57	1167.80	178.18	81.54	311.27	0.13
2079.19	3486.46	345.13	1284.56	184.77	95.31	361.56	0.13
1830.23	3172.46	345.24	834.22	205.08	87.89	374.71	0.14
1399.24	3109.57	379.36	877.72	176.88	80.41	447.53	0.14
1545.54	1896.61	235.11	600.54	141.69	56.16	384.37	0.14
2169.08	3619.42	324.80	974.91	165.31	58.84	595.19	0.14
1952.73	2689.78	228.36	781.15	152.22	51.67	547.12	0.14
2434.76	3306.61	298.22	945.86	190.09	65.28	603.96	0.15
1905.08	2478.36	265.62	863.35	150.01	66.79	1372.89	0.15

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
2125.94	3196.86	269.80	1001.45	156.34	73.77	1390.76	0.15
2229.28	4358.38	247.45	987.03	174.88	84.23	1459.27	0.15
2452.88	3778.43	186.53	830.16	176.33	86.45	428.95	0.15
2929.17	4114.04	231.88	1094.23	190.78	91.55	396.77	0.16
2806.67	2897.07	240.52	1166.59	193.01	99.84	343.31	0.16
2624.84	2594.61	231.33	1047.23	144.38	108.77	349.97	0.16
2399.14	2310.75	210.28	773.29	147.17	127.84	392.60	0.16
2013.74	1064.30	279.96	878.66	161.84	66.79	472.96	0.16
1790.07	789.63	260.02	846.54	142.04	73.77	450.10	0.17
1852.32	1022.09	261.62	1349.73	149.47	84.23	571.18	0.17
1728.33	1436.08	148.63	838.24	105.91	86.45	386.79	0.17
2591.10	1961.31	216.32	1122.83	144.88	91.55	381.92	0.17
2048.37	1702.21	166.60	619.34	130.80	99.84	209.49	0.18
1492.99	1617.69	140.11	560.24	118.52	108.77	162.20	0.18
628.93	941.03	77.56	278.66	89.12	127.84	132.10	0.18
955.41	1002.54	79.33	267.66	72.28	144.28	179.42	0.18
1066.16	1022.43	93.10	254.46	56.80		304.75	0.18
2584.03	3336.42	291.66	690.51	102.72		404.19	0.19
2590.89	3313.34	315.55	814.38	106.15	38.98	501.70	0.19
2547.18	3504.65	320.37	968.53	120.07	35.19	550.06	0.19
1148.80	1583.68	124.86	541.05	60.53	44.09	435.12	0.19
753.89	1418.43	125.09	397.36	77.51	47.92	247.59	0.19
1510.75	1998.19	220.04	1019.01	312.45	64.74	985.41	0.20
1984.47	2124.99	266.28	1257.25	337.35	64.43	996.72	0.20
2507.51	2405.32	250.18	1357.41	332.18	68.87	1057.64	0.20
1988.45	2174.45	149.71	751.98	100.21	54.58	165.02	0.20
1278.47	1562.44	74.55	489.66	69.30	43.58	158.13	0.20
1069.35	2574.42	112.14	532.77	107.06	41.20	151.34	0.21
1354.44	3043.04	196.77	588.21	105.38	43.01	221.65	0.21
1568.17	3978.91	217.17	843.60	129.31	56.80	235.65	0.21
1615.83	2884.21	179.77	804.55	85.74	59.91	205.66	0.21
943.70	1654.30	76.79	522.60	69.44	70.93	101.87	0.21
954.10	1283.95	93.06	461.91	65.08	65.26	89.51	0.22
1016.15	1422.38	130.03	519.44	95.87	51.01	147.59	0.22
1127.57	1832.81	145.38	592.59	93.94	31.59	183.30	0.22
1087.18	1341.10	132.27	464.65	86.10	51.60	196.48	0.22
1349.02	1359.22	159.69	437.54	69.10	85.73	225.13	0.23

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1579.74	1263.72	145.42	457.23	70.89	120.43	281.77	0.23
1659.18	1417.02	150.07	473.28	68.43	92.88	450.07	0.23
1371.79	1331.74	111.52	551.86	59.61	66.36	416.67	0.23
1466.63	1833.95	168.72	689.76	90.73	41.85	487.57	0.23
1417.45	1814.15	157.33	769.73	106.30	49.21	380.95	0.24
1545.49	2067.73	180.03	683.31	112.15	43.09	544.93	0.24
1514.30	1679.33	174.83	679.35	92.05	35.60	450.08	0.24
1643.91	1715.35	200.27	675.22	90.85	31.27	449.28	0.24
1849.28	944.17	224.26	1111.38	136.63	50.29	542.10	0.24
1597.84	716.64	177.48	906.39	125.07	86.85	536.26	0.25
1529.18	724.20	193.58	948.50	130.83	116.90	603.07	0.25
1588.60	1870.15	234.36	971.99	112.94	116.98	419.36	0.25
1999.98	2848.03	277.24	1140.65	147.81	80.78	457.74	0.25
2130.28	3161.84	283.67	1378.66	142.31	76.07	420.43	0.25
1548.92	2580.56	183.76	982.10	156.54	95.37	348.71	0.26
881.00	1442.48	127.63	796.16	109.35	144.80	251.48	0.26
562.45	1065.67	69.78	376.83	92.45	144.26	153.80	0.26
783.79	1033.80	77.49	369.37	102.85	131.67	372.21	0.26
942.99	1041.84	82.91	362.60	110.47	113.82	396.23	0.26
837.99	798.73	81.47	314.42	100.62	113.13	373.21	0.27
534.72	859.43	54.89	296.05	48.90	125.35	189.31	0.27
946.90	1247.74	102.14	536.22	60.32	118.03	259.37	0.27
1125.59	1509.72	117.99	663.58	75.50	124.90	309.43	0.27
1192.66	1405.77	131.45	648.62	70.67	106.87	292.42	0.28
1386.61	1572.81	117.51	572.36	138.52	101.00	266.58	0.28
1305.91	1382.36	97.61	489.27	126.18	68.07	303.57	0.28
1499.35	1272.41	105.61	441.04	129.41	45.69	368.13	0.28
1057.36	1141.88	101.30	426.96	93.39	27.43	413.59	0.28
1384.83	1558.67	139.56	491.01	139.34	41.60	395.02	0.29
1054.35	1554.54	107.70	438.21	126.31	73.60	284.69	0.29
1124.58	1519.67	110.76	579.24	82.17	99.38	230.98	0.29
771.06	1457.65	70.59	501.25	50.06	95.58	188.09	0.29
851.84	1413.76	96.18	498.12	61.75	80.09	206.19	0.29
1025.67	1741.21	121.70	317.70	104.20	75.54	265.58	0.30
1467.91	2011.79	166.84	439.38	107.46	87.98	315.46	0.30
1389.53	2046.82	166.33	460.85	102.57	95.92	311.40	0.30
913.49	1272.41	103.00	319.44	51.85	92.34	187.50	0.30

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1113.60	1311.46	119.95	460.23	90.99	83.55	293.87	0.30
1045.83	1232.86	109.98	421.78	88.03	66.78	246.57	0.31
1444.03	3036.97	173.25	561.31	131.08	48.10	347.93	0.31
1169.21	3059.85	226.04	481.51	119.87	38.30	279.23	0.31
1387.58	3027.34	221.73	542.36	121.87	39.20	311.98	0.31
1195.81	1586.14	176.49	515.38	95.21	58.72	266.17	0.31
1098.74	1560.10	99.49	512.88	60.06	70.68	177.49	0.32
1125.82	1546.57	105.29	502.61	52.14	87.02	198.26	0.32
1225.13	1262.59	100.88	431.09	41.59	88.25	160.81	0.32
912.19	603.51	66.06	218.92	30.41	87.87	133.18	0.32
901.55	804.59	64.09	256.79	40.13	74.82	155.77	0.33
889.98	1260.34	98.10	395.07	49.35	65.13	217.79	0.33
1346.57	1769.70	163.47	644.13	69.81	55.56	347.51	0.33
1262.62	1938.00	158.91	583.83	68.60	58.60	311.66	0.33
1340.88	1726.41	153.72	644.94	110.43	61.25	315.85	0.33
1239.67	1054.77	110.49	517.00	109.29	68.61	223.85	0.34
1311.83	1072.56	125.04	530.60	128.70	74.93	272.28	0.34
1117.17	827.64	98.04	431.72	87.17	81.48	213.26	0.34
1025.85	1139.39	106.72	452.75	100.29	87.41	220.58	0.34
664.96	510.24	68.34	334.80	58.79	92.61	105.58	0.34
593.75	467.63	66.14	264.04	61.55	100.05	95.83	0.35
1239.19	1865.24	129.58	451.66	92.27	72.28	227.53	0.35
1950.48	5889.69	200.42	468.42	200.37	147.23	469.19	0.35
1945.31	5989.20	179.11	432.66	193.13	160.23	442.60	0.35
1836.55	5920.02	244.12	478.27	187.73	157.91	459.53	0.35
1121.70	1505.94	153.70	339.07	84.34	67.89	171.68	0.36
1043.48	1725.26	166.62	414.97	91.87	60.16	276.40	0.36
904.41	1312.78	76.58	317.49	86.35	55.27	260.62	0.36
1018.46	1644.31	115.38	370.27	98.22	69.08	305.21	0.36
1090.28	1624.82	135.22	329.45	88.91	65.98	219.78	0.36
786.25	1176.18	117.87	313.14	67.62	54.35	169.03	0.37
582.78	790.18	71.02	251.12	51.20	37.42	117.65	0.37
561.33	485.79	32.81	237.02	52.58	33.28	136.15	0.37
885.13	991.82	54.34	288.59	83.51	56.27	165.02	0.37
1042.45	1374.63	88.03	380.12	97.19	71.89	209.24	0.38
1084.93	1673.24	104.34	417.42	107.73	76.61	188.62	0.38
886.22	1377.79	115.61	407.86	82.94	53.60	234.32	0.38

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1089.24	1471.45	117.67	439.61	71.39	59.76	471.29	0.38
1012.53	1233.46	112.77	460.25	55.30	68.49	536.19	0.38
1136.34	822.00	119.01	496.81	53.22	73.89	484.47	0.39
1405.44	716.20	111.08	478.47	67.43	74.28	250.06	0.39
1387.49	678.15	118.20	470.19	70.28	75.30	204.71	0.39
1608.10	1724.12	106.09	486.83	96.39	87.80	318.91	0.39
1142.09	1537.49	97.40	413.08	85.20	80.91	340.75	0.39
1097.81	1533.84	95.53	364.32	88.75	70.98	317.13	0.40
863.97	967.85	102.80	346.26	80.50	110.08	290.29	0.40
741.00	847.58	91.77	319.81	72.85	96.58	233.87	0.40
682.93	699.61	73.80	249.04	63.61	91.24	254.51	0.40
387.52	414.07	34.55	121.44	20.42	25.79	117.46	0.40
895.48	723.86	97.74	312.80	50.54	51.90	175.92	0.41
954.61	832.48	104.00	320.76	61.56	59.19	173.66	0.41
1009.85	1062.07	135.18	576.00	71.24	85.15	220.88	0.41
850.34	1258.67	112.85	521.43	73.07	84.45	252.91	0.41
844.28	1221.63	105.35	538.89	63.74	79.94	229.43	0.41
1225.13	1797.56	131.82	527.28	96.63	63.72	335.08	0.42
1213.31	1771.73	125.21	494.14	84.16	77.50	370.21	0.42
1311.51	1883.90	130.15	480.86	86.50	75.45	440.44	0.42
890.40	1010.29	76.00	232.30	48.98	74.08	302.99	0.42
538.77	515.93	37.81	109.62	29.23	38.47	173.97	0.43
481.88	389.40	38.11	104.41	28.75	47.56	151.92	0.43
705.25	540.19	50.95	181.05	52.92	54.80	177.86	0.43
1111.22	958.97	112.26	294.39	93.71	80.66	225.94	0.43
1175.53	1075.34	128.62	357.70	112.30	82.89	210.63	0.43
1250.87	1358.56	150.37	413.22	112.84	92.77	207.13	0.44
1336.21	1724.37	136.35	470.90	93.24	100.55	242.52	0.44
1485.40	1880.73	181.91	565.19	90.83	129.33	331.81	0.44
1330.45	1759.72	170.89	563.91	104.91	103.19	320.05	0.44
1171.65	1420.59	158.14	475.43	92.69	96.01	294.76	0.44
1032.56	1373.48	96.60	400.29	93.24	64.69	189.77	0.45
1007.07	1212.09	80.85	340.81	86.44	72.76	200.44	0.45
880.02	959.52	77.12	364.01	97.97	48.73	197.97	0.45
931.96	724.44	102.15	275.70	82.14	48.14	168.01	0.45
839.19	602.30	101.30	225.90	54.00	38.82	190.53	0.45
929.80	846.72	106.87	228.98	66.95	46.02	221.70	0.46

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
959.65	1263.38	93.63	308.35	76.92	51.56	352.49	0.46
1051.91	1321.53	93.78	311.27	120.59	71.30	361.25	0.46
781.83	923.07	60.63	223.89	90.52	64.45	300.14	0.46
551.12	497.56	53.24	138.13	81.96	53.83	187.54	0.46
661.18	2146.29	75.79	232.57	104.94	148.81	240.67	0.47
943.07	2619.79	107.10	511.31	128.42	205.04	260.75	0.47
1587.83	3235.43	132.86	873.29	164.39	337.37	348.05	0.47
1411.64	1372.73	116.87	823.24	92.76	218.17	257.87	0.47
1116.81	922.82	96.65	555.63	75.86	161.03	218.30	0.48
538.07	413.86	77.98	252.55	55.06	37.79	142.61	0.48
510.09	793.91	63.86	212.71	58.84	37.27	175.04	0.48
624.94	816.16	54.00	201.72	61.81	44.30	199.79	0.48
801.90	1307.71	71.07	371.33	51.19	80.01	195.13	0.48
961.99	1574.10	112.50	534.83	93.17	112.86	312.65	0.49
864.64	1496.24	116.67	521.72	78.79	101.16	275.48	0.49
528.12	797.66	78.35	266.86	60.72	47.57	248.80	0.49
376.23	315.93	37.77	74.67	18.89	22.59	72.08	0.49
855.74	892.70	72.99	214.53	68.99	86.50	181.87	0.49
1055.86	1117.03	84.67	300.59	84.28	109.21	200.22	0.50
1130.03	1190.95	94.41	377.70	86.24	121.91	245.00	0.50
599.70	591.76	52.17	259.48	51.78	66.90	136.18	0.50
605.40	639.27	69.47	229.06	52.80	58.07	151.58	0.50
859.01	400.63	81.55	187.18	63.41	47.32	145.16	0.50
1047.01	1485.51	101.61	284.44	82.68	52.90	209.69	0.51
1061.48	1521.39	108.08	305.17	73.46	59.69	209.08	0.51
798.36	1692.39	85.68	292.20	65.75	64.64	222.93	0.51
850.93	862.07	85.10	353.69	86.74	118.14	259.12	0.51
810.36	647.75	57.71	337.68	96.34	104.65	231.97	0.51
772.88	733.91	66.88	372.84	102.31	105.10	272.47	0.52
508.37	551.12	55.02	189.35	49.51	32.51	198.14	0.52
499.43	801.76	60.53	230.95	47.79	41.33	214.01	0.52
433.30	816.91	56.65	201.39	36.36	32.71	147.75	0.52
1433.70	1092.95	141.08	205.61	168.69	142.92	320.41	0.53
961.72	851.01	67.09	258.68	105.73	92.63	222.06	0.53
975.48	908.52	69.09	430.77	91.48	85.04	227.33	0.53
1222.96	1414.04	120.49	546.87	104.88	97.08	239.19	0.53
1427.23	1753.63	144.02	594.98	117.86	140.27	321.60	0.53

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1525.76	1725.56	152.01	417.10	147.35	166.09	356.96	0.54
1021.50	1067.91	99.20	279.90	105.46	118.97	299.67	0.54
691.13	708.89	70.80	247.56	68.56	66.34	195.22	0.54
591.70	678.91	75.04	326.42	37.05	52.30	150.48	0.54
762.61	985.85	77.70	354.13	44.85	72.79	177.49	0.54
813.53	1159.80	95.28	282.94	63.61	93.91	178.85	0.55
691.80	982.37	82.92	235.94	63.84	84.96	202.96	0.55
623.19	730.53	86.18	259.66	63.63	65.95	190.92	0.55
569.95	710.26	66.28	350.26	53.22	55.19	230.94	0.55
800.96	578.78	87.96	318.15	79.26	74.75	291.31	0.55
739.23	558.14	76.86	264.03	86.02	78.88	355.25	0.56
705.50	365.44	81.80	227.14	83.79	75.73	300.49	0.56
524.39	572.95	70.62	264.23	56.66	48.78	256.46	0.56
595.85	402.34	71.38	297.33	40.86	49.15	196.68	0.56
719.70	637.32	80.66	395.16	30.08	56.02	281.34	0.57
1170.94	1330.65	116.16	376.45	48.95	83.42	291.35	0.57
1086.83	1598.65	113.12	372.62	50.70	88.01	292.00	0.57
930.71	1539.94	111.72	327.57	51.55	66.40	221.06	0.57
468.18	898.30	70.69	340.23	54.17	54.12	162.59	0.57
507.25	874.08	72.35	361.68	62.53	51.11	162.20	0.58
621.86	891.34	67.47	320.77	71.43	66.60	171.11	0.58
630.18	1009.77	66.67	418.50	40.99	66.96	210.57	0.58
897.83	1358.04	105.05	346.04	53.55	96.71	347.51	0.58
811.39	1079.66	84.87	316.82	41.10	83.72	302.98	0.58
1024.60	1007.74	76.94	199.59	64.40	77.40	310.10	0.59
769.73	415.68	43.08	306.86	48.02	39.32	231.00	0.59
832.23	498.22	61.89	289.45	69.35	52.31	235.83	0.59
575.45	443.92	72.33	345.28	70.01	62.69	183.64	0.59
494.15	646.31	64.36	262.70	62.42	66.62	141.73	0.59
375.34	675.92	81.63	264.73	44.48	52.91	196.30	0.60
397.10	854.70	74.75	312.13	23.52	44.55	204.65	0.60
593.63	1065.61	96.11	453.61	45.08	48.78	189.31	0.60
949.35	1269.91	103.15	482.60	52.63	76.29	294.34	0.60
1121.82	1071.44	98.91	468.50	57.77	78.58	357.32	0.60
1147.56	1076.23	93.16	312.90	82.66	87.61	379.61	0.61
876.11	844.48	59.76	259.73	72.66	56.28	220.89	0.61
764.48	798.23	59.62	222.03	84.73	61.45	192.57	0.61

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
740.27	837.44	58.35	339.92	57.97	54.81	184.17	0.61
862.73	1003.40	77.18	354.92	68.81	71.18	230.97	0.62
893.65	1142.58	82.66	407.06	62.39	89.12	306.03	0.62
965.54	1009.81	80.48	295.59	62.28	98.46	390.21	0.62
781.03	760.67	72.00	252.02	57.59	77.21	325.38	0.62
676.15	580.03	58.16	123.39	46.17	39.44	224.18	0.62
434.94	432.15	41.13	304.53	33.13	22.84	118.74	0.63
697.69	642.39	48.01	379.13	42.77	35.91	159.55	0.63
822.07	821.74	87.80	433.61	59.55	69.14	202.33	0.63
987.53	884.71	103.45	302.54	70.26	75.68	221.33	0.63
902.48	989.18	109.63	279.03	71.70	86.48	215.96	0.63
924.97	1023.56	82.92	344.04	64.59	57.15	168.07	0.64
1135.41	1233.52	85.65	388.49	84.63	100.19	218.33	0.64
1108.61	1093.39	85.02	367.89	76.68	83.50	306.30	0.64
1027.14	735.67	78.94	264.72	69.22	82.43	350.57	0.64
634.99	437.68	70.46	187.24	32.39	39.52	274.79	0.64
494.23	419.97	59.04	191.02	28.60	46.41	170.52	0.65
660.56	746.54	84.68	296.10	51.81	64.53	211.80	0.65
793.18	801.85	84.87	272.78	62.44	58.72	251.99	0.65
712.87	664.67	72.42	248.97	49.66	47.35	229.37	0.65
427.87	479.72	42.85	184.32	29.51	26.33	140.23	0.65
464.29	549.55	56.73	203.31	31.27	38.15	193.80	0.66
573.29	625.37	65.05	230.08	38.91	37.07	215.64	0.66
639.20	752.76	62.66	237.99	36.56	38.03	207.34	0.66
838.08	1529.33	49.55	218.36	33.32	50.87	173.98	0.66
873.36	1481.42	41.91	261.62	36.89	53.69	249.38	0.67
1063.71	1622.12	60.10	205.23	43.34	119.82	358.30	0.67
777.67	748.02	54.65	216.54	51.98	86.49	306.37	0.67
747.74	744.79	54.42	260.30	48.54	100.95	255.05	0.67
637.81	1088.90	73.21	317.80	68.74	49.81	190.57	0.67
780.55	1265.20	97.51	424.34	98.53	73.10	279.40	0.68
784.32	1265.41	91.50	335.82	98.63	67.57	253.76	0.68
1142.22	761.87	75.82	362.57	84.56	55.15	361.72	0.68
1018.46	1053.45	55.62	261.16	60.68	59.48	325.17	0.68
1218.73	1202.52	89.07	336.74	62.79	69.40	339.98	0.68
1094.39	1161.49	74.20	283.20	70.45	89.21	231.98	0.69
1225.87	1081.18	88.73	248.79	88.51	73.97	304.49	0.69

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
966.35	1037.78	53.75	320.70	91.98	56.07	293.74	0.69
707.47	1042.07	61.56	324.42	71.48	34.30	330.79	0.69
521.84	700.64	43.68	407.13	32.92	40.87	201.57	0.69
565.57	598.71	55.33	280.64	24.40	40.08	221.22	0.70
501.95	604.19	61.34	220.45	22.81	53.97	150.85	0.70
451.71	493.04	60.44	162.86	21.02	38.46	127.33	0.70
409.48	499.85	63.61	228.92	20.22	45.05	88.23	0.70
527.74	519.97	54.29	205.81	37.14	61.79	293.89	0.70
778.68	434.86	45.26	252.09	20.68	56.76	251.25	0.71
789.12	1526.99	55.67	194.97	31.85	65.11	323.99	0.71
794.96	1634.20	52.13	379.39	62.17	70.53	260.52	0.71
784.17	2446.13	92.48	335.97	74.73	95.71	361.78	0.71
883.08	1544.33	103.38	302.54	80.28	105.46	966.69	0.72
845.80	1333.70	95.56	120.95	40.37	95.12	952.70	0.72
673.03	555.85	62.79	182.55	31.57	72.97	856.73	0.72
624.39	471.22	65.05	231.80	39.55	68.65	204.95	0.72
753.79	977.33	71.42	345.43	48.63	91.12	184.37	0.72
725.15	999.09	84.84	298.59	56.86	78.85	217.89	0.73
673.29	919.20	60.39	245.99	37.55	88.44	217.88	0.73
584.64	468.87	78.93	140.58	42.30	51.62	321.21	0.73
481.37	446.17	61.07	107.73	33.11	48.65	332.96	0.73
450.92	431.51	57.61	127.86	33.28	22.55	289.96	0.73
443.05	397.78	39.95	189.29	22.86	41.24	157.94	0.74
591.85	468.75	42.30	194.01	55.10	49.43	119.39	0.74
644.82	622.79	47.07	205.19	60.41	58.70	124.06	0.74
746.70	681.00	50.30	184.03	55.42	63.27	157.87	0.74
645.85	612.97	48.43	182.89	25.45	56.35	177.69	0.74
594.40	484.77	39.92	177.02	28.17	54.52	189.26	0.75
410.03	482.14	41.08	142.21	47.36	53.66	154.11	0.75
416.88	452.13	40.24	420.08	42.98	56.71	131.69	0.75
727.97	686.42	82.45	415.73	60.48	75.81	183.34	0.75
691.43	643.52	70.53	392.59	58.85	54.63	194.98	0.75
624.16	617.43	65.31	189.51	57.99	49.47	186.51	0.76
437.00	1025.38	36.02	189.35	44.23	55.69	138.06	0.76
750.12	1061.97	94.68	205.31	26.27	70.62	178.76	0.76
831.23	1208.61	102.71	154.00	49.82	93.07	230.08	0.76
799.47	600.21	95.56	189.85	39.44	67.08	220.65	0.77

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
771.35	656.17	52.61	208.65	58.37	58.81	193.27	0.77
815.03	843.96	71.63	236.36	36.01	46.49	250.57	0.77
733.95	830.51	203.39	293.18	41.23	61.09	288.51	0.77
778.47	967.55	261.00	296.39	33.00	80.56	308.21	0.77
778.52	691.68	248.44	262.90	36.56	79.69	230.68	0.78
929.94	822.77	124.49	186.19	41.07	79.04	282.75	0.78
607.42	609.22	61.75	187.19	35.03	49.99	224.30	0.78
690.34	640.38	136.83	236.30	38.09	51.19	226.04	0.78
675.11	700.06	157.33	244.90	52.39	53.41	172.06	0.78
723.66	934.97	156.20	250.76	49.76	64.42	163.55	0.79
751.17	1011.13	87.75	216.34	51.09	74.78	187.76	0.79
769.49	1241.53	79.42	184.40	51.45	75.29	177.05	0.79
856.49	1029.48	82.89	181.30	66.28	76.91	248.65	0.79
857.41	959.30	77.36	162.91	77.67	56.32	208.29	0.79
738.15	497.38	55.11	157.14	54.29	36.32	181.68	0.80
580.62	410.98	52.53	237.32	35.65	22.53	106.97	0.80
611.91	586.25	54.89	231.42	32.90	29.26	161.22	0.80
522.50	577.80	50.31	261.77	34.06	33.50	138.02	0.80
580.65	611.10	45.43	230.81	47.74	34.71	164.16	0.80
356.73	447.59	49.13	242.61	46.57	34.77	109.66	0.81
351.29	728.60	55.31	231.64	44.16	32.12	109.27	0.81
378.23	928.41	53.44	141.31	36.80	48.22	100.03	0.81
336.35	837.65	36.33	109.24	16.81	44.63	84.00	0.81
317.06	482.81	28.71	178.85	14.30	40.06	90.91	0.82
344.70	306.57	30.55	269.40	26.36	27.36	90.53	0.82
585.26	630.12	41.13	312.95	41.87	30.64	136.18	0.82
727.66	854.92	65.25	265.96	62.32	32.01	305.63	0.82
644.48	843.78	62.01	264.13	44.94	31.71	304.50	0.82
633.66	801.49	75.44	262.66	67.96	34.35	672.19	0.83
550.90	735.98	63.86	264.20	57.02	43.86	539.76	0.83
692.19	1171.05	66.23	186.12	83.27	47.04	566.15	0.83
550.91	898.92	51.45	172.73	53.34	41.65	167.33	0.83
595.17	830.15	49.34	124.04	50.09	33.08	135.26	0.83
578.65	452.63	102.56	157.35	20.22	26.33	325.78	0.84
577.78	552.52	99.34	219.86	17.34	51.59	345.02	0.84
627.13	653.10	116.86	219.56	15.91	59.97	404.68	0.84
455.30	517.95	62.93	186.31	21.99	59.56	203.69	0.84

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
363.80	385.25	55.63	105.33	17.30	38.49	177.30	0.84
227.95	376.74	30.44	112.61	15.23	34.43	126.65	0.85
253.11	629.16	25.51	176.73	22.22	31.47	108.86	0.85
548.75	1190.63	38.32	196.37	36.59	47.83	351.11	0.85
553.27	1125.68	41.36	214.77	31.67	56.77	340.69	0.85
899.77	1184.00	73.23	147.58	27.27	67.58	413.73	0.85
631.85	718.07	54.15	126.93	16.66	43.28	149.12	0.86
681.07	740.24	60.38	69.17	30.11	36.97	190.05	0.86
255.20	366.96	30.52	90.54	23.41	21.79	108.54	0.86
272.90	583.40	33.70	80.24	17.41	27.60	118.46	0.86
236.99	513.19	22.08	95.14	12.25	16.62	70.36	0.87
288.57	571.53	38.89	70.07	15.09	29.01	67.88	0.87
208.72	217.03	34.77	72.39	17.15	17.72	70.30	0.87
170.97	383.35	35.89	97.06	34.94	21.72	79.21	0.87
178.75	455.75	33.39	88.23	33.58	27.79	88.79	0.87
197.28	509.07	44.52	134.81	36.17	25.82	86.27	0.88
425.53	658.36	58.90	128.78	30.31	45.34	126.71	0.88

Brontothere Scapula (F08-915-R): Orella Road

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
3456.57	5589.17	660.86	1763.40	224.21	72.53	803.39	0.00
3030.57	6087.37	340.03	2146.57	220.27	139.03	791.29	0.01
2051.98	4333.14	329.76	1858.36	190.63	127.31	790.43	0.01
1584.16	3455.92	226.96	1304.97	117.48	112.88	320.40	0.02
1463.26	1784.97	220.09	755.47	102.73	34.34	248.14	0.02
2249.66	5606.85	212.94	760.85	93.96	30.78	257.54	0.03
2885.23	6431.97	277.40	844.02	123.47	40.57	312.62	0.03
2385.54	7459.63	420.94	1096.39	137.99	53.17	387.07	0.04
2641.80	3722.69	377.08	893.35	105.63	32.38	262.70	0.04
2156.28	4170.28	360.01	2359.35	138.82	32.06	319.10	0.05
3299.19	3406.18	202.68	2224.32	136.25	27.04	551.65	0.05
2964.10	3448.05	223.18	2185.91	155.25	40.39	555.84	0.06
2578.12	7009.79	270.73	1065.75	163.10	53.80	697.53	0.06
1802.53	6288.50	245.39	868.61	157.80	45.98	373.55	0.07

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1295.60	6893.92	279.73	1004.01	162.55	84.57	558.26	0.07
1572.57	2107.29	218.19	868.73	93.59	71.75	439.47	0.07
1457.45	3022.01	243.76	962.65	76.34	72.23	440.07	0.08
1306.25	2290.46	198.05	937.57	68.54	27.61	308.17	0.08
1516.18	4676.60	179.99	570.36	62.95	40.80	227.12	0.09
1464.92	4068.89	233.57	558.08	70.12	44.32	258.37	0.09
1634.61	4453.10	286.17	585.14	44.74	75.97	374.46	0.10
1576.62	2537.48	208.15	585.52	69.63	85.18	382.06	0.10
1500.48	2454.58	151.51	705.35	106.66	90.50	381.04	0.11
1560.44	1876.64	104.13	570.03	135.78	67.63	375.84	0.11
1476.64	2209.30	125.35	604.42	137.83	80.50	356.44	0.12
1377.89	2307.32	147.03	570.11	100.57	99.00	352.46	0.12
1365.74	2270.50	135.17	558.16	76.59	93.26	333.64	0.13
1365.76	1552.23	131.69	504.64	80.03	68.52	337.88	0.13
1351.27	1429.66	134.73	452.50	136.34	48.58	731.98	0.14
1277.25	1323.47	135.53	589.05	128.22	51.16	657.09	0.14
1100.36	1317.33	146.53	778.12	127.11	44.40	735.00	0.15
1204.53	1178.30	116.72	861.33	88.03	47.59	616.74	0.15
1385.02	2111.49	126.99	797.60	105.25	61.23	595.25	0.15
1419.25	2863.42	136.69	710.22	104.90	71.94	581.20	0.16
1433.80	2564.78	137.89	614.02	89.71	67.20	354.43	0.16
1153.28	2016.18	165.76	666.21	104.68	58.01	339.20	0.17
881.13	1150.40	140.60	687.31	106.93	64.19	280.53	0.17
1987.26	1213.61	121.40	551.95	81.03	55.82	193.69	0.18
2193.68	3538.03	82.62	405.32	69.84	75.45	618.36	0.18
2681.56	4286.89	84.96	306.65	94.06	47.48	1114.21	0.19
1460.39	4223.68	135.69	493.32	137.37	103.70	1265.16	0.19
1107.85	2124.22	171.23	537.76	137.51	100.81	979.57	0.20
1164.17	1140.04	166.09	442.76	91.37	111.07	509.56	0.20
1095.78	1910.59	140.44	388.50	104.53	58.72	571.73	0.21
2157.02	1173.13	125.59	354.09	84.29	44.39	546.11	0.21
1829.25	1694.63	206.73	705.69	123.18	60.44	682.27	0.22
1777.66	1199.22	209.94	668.42	123.34	81.23	562.85	0.22
590.38	1394.26	171.73	597.81	120.44	65.76	430.29	0.22
496.57	976.06	71.25	243.11	71.76	41.80	270.15	0.23
582.01	1230.38	97.04	197.16	51.59	29.79	243.25	0.23
914.22	1014.52	90.26	243.37	53.21	25.70	203.91	0.24

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1137.10	1157.43	659.76	319.59	98.54	29.89	232.99	0.24
2308.94	1210.08	636.17	398.78	102.20	34.32	234.55	0.25
2212.26	1634.54	692.10	500.48	128.77	82.60	443.71	0.25
2196.03	1620.62	167.87	437.05	87.11	113.30	541.03	0.26
1006.18	1459.62	195.60	338.94	46.44	100.32	647.55	0.26
1016.13	883.66	155.08	323.35	23.05	52.27	614.99	0.27
707.36	885.04	280.13	475.19	56.59	47.44	529.31	0.27
625.89	1288.32	317.00	510.17	68.85	61.09	412.16	0.28
933.15	1465.02	307.19	418.03	87.04	65.38	342.38	0.28
1258.06	1701.75	198.17	367.07	74.05	49.63	384.28	0.29
1210.90	1147.88	135.20	409.76	76.52	59.61	381.64	0.29
731.05	1040.63	146.47	364.45	54.21	57.10	265.79	0.29
904.14	600.52	196.32	210.38	41.82	39.80	188.50	0.30
1188.59	1710.40	257.40	368.37	96.50	59.75	409.21	0.30
1115.10	3138.34	299.48	439.02	111.15	96.77	511.28	0.31
792.29	3132.86	278.64	524.18	103.74	103.32	455.44	0.31
714.83	2330.74	204.15	341.58	34.08	66.11	265.32	0.32
888.24	1050.55	161.65	315.71	29.61	35.62	268.44	0.32
989.81	982.86	85.89	255.82	18.97	34.60	292.11	0.33
1134.92	706.94	75.81	226.66	46.35	45.02	260.65	0.33
882.32	489.74	116.42	526.06	43.56	90.54	235.40	0.34
915.26	379.54	99.10	515.76	50.69	84.49	199.80	0.34
900.01	2157.05	139.77	601.21	68.01	79.23	408.22	0.35
1212.66	2911.60	106.36	291.12	70.34	53.21	399.30	0.35
1136.70	3516.72	126.23	458.66	124.46	118.21	593.12	0.36
907.00	1826.40	663.96	510.72	92.48	98.97	686.79	0.36
927.37	1272.91	636.21	491.54	83.39	74.71	653.70	0.37
1135.96	962.48	643.12	409.08	45.40	33.76	545.93	0.37
1278.15	894.27	66.49	379.68	38.79	65.36	281.24	0.37
1177.52	1252.43	105.67	467.72	71.74	110.94	443.18	0.38
988.49	1322.72	100.77	369.06	62.62	92.46	387.79	0.38
872.85	1579.77	128.48	236.43	143.07	78.93	459.46	0.39
804.88	1232.97	101.62	189.65	139.93	39.34	340.90	0.39
884.33	1854.24	94.44	285.37	143.42	62.26	387.04	0.40
1345.86	1954.58	107.10	487.80	97.72	89.75	298.46	0.40
1347.15	1742.17	165.63	816.77	189.09	130.66	435.04	0.41
1077.86	999.69	156.54	815.01	177.98	112.69	463.97	0.41

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
664.08	724.25	117.51	663.20	154.73	80.44	534.69	0.42
711.42	1119.71	126.95	345.89	72.66	47.89	495.35	0.42
761.75	1210.90	132.59	442.51	93.95	37.67	473.20	0.43
968.81	807.58	123.59	378.72	86.07	55.13	403.82	0.43
914.98	1343.46	88.36	673.63	120.97	59.24	634.55	0.44
826.83	1509.20	94.22	518.91	130.27	64.44	718.83	0.44
790.03	1629.27	93.06	509.48	131.41	37.45	724.44	0.44
614.14	1004.97	77.03	313.42	52.37	103.12	469.71	0.45
545.32	476.80	94.86	253.50	21.37	99.41	299.17	0.45
181.50	437.89	87.72	227.33	10.22	97.81	232.78	0.46
310.48	189.28	56.59	56.88	12.06	9.47	70.18	0.46
524.33	513.90	36.38	60.76	5.88	13.37	119.65	0.47
695.21	743.82	305.22	170.68	23.53	23.50	328.36	0.47
609.25	969.75	324.67	232.11	29.91	53.74	448.04	0.48
516.60	916.47	330.09	265.99	50.19	49.44	426.17	0.48
350.74	908.68	65.83	197.03	80.84	40.86	280.16	0.49
653.24	670.26	55.83	135.73	76.91	8.60	162.98	0.49
1057.62	788.59	54.59	236.74	111.18	30.12	242.27	0.50
1330.86	755.04	71.44	289.75	72.45	26.37	247.05	0.50
1135.35	849.56	72.19	327.09	74.86	41.64	351.95	0.51
721.10	1004.44	198.23	237.25	66.80	26.72	499.56	0.51
1174.26	1646.62	237.97	209.43	64.83	55.89	749.88	0.51
1198.01	4012.76	254.72	258.71	112.05	65.92	734.37	0.52
1063.21	3669.20	128.29	282.52	115.24	108.95	518.34	0.52
522.80	2902.21	102.15	326.05	126.03	84.71	504.65	0.53
444.65	1114.87	92.71	345.80	81.24	73.33	972.65	0.53
254.76	1296.27	97.92	381.96	44.74	28.97	1364.01	0.54
581.19	504.40	25.46	199.43	11.19	14.39	160.88	0.54
729.32	861.32	52.32	266.59	10.76	12.51	199.98	0.55
629.88	932.41	59.76	329.13	14.98	17.63	177.18	0.55
420.84	650.74	51.90	260.65	17.19	12.08	111.59	0.56
306.17	264.65	66.13	210.44	24.89	13.36	170.90	0.56
478.74	365.91	64.52	72.28	32.54	16.95	191.37	0.57
421.55	675.42	73.69	121.99	63.34	29.76	227.44	0.57
464.76	1291.83	63.91	128.54	61.37	38.96	185.19	0.58
804.33	1517.88	79.24	176.19	51.99	40.36	193.08	0.58
816.44	1373.23	90.93	240.65	43.90	51.27	202.13	0.59

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1061.59	893.28	104.39	275.01	41.61	58.07	178.61	0.59
731.61	795.90	121.96	404.34	113.80	108.27	424.49	0.59
860.81	747.99	148.43	573.51	100.75	94.95	536.77	0.60
767.45	871.10	704.61	683.13	93.81	88.00	607.45	0.60
633.77	667.52	703.81	581.08	19.14	46.73	363.13	0.61
855.00	554.47	659.51	302.32	14.73	33.89	228.81	0.61
825.09	1879.19	101.56	421.97	22.03	41.47	249.61	0.62
894.54	1913.33	86.82	510.63	39.42	36.46	257.64	0.62
697.40	2052.13	129.52	593.29	79.97	48.72	339.06	0.63
840.41	717.81	115.83	376.12	99.05	34.86	279.85	0.63
1101.23	1492.14	107.15	306.35	124.95	40.24	366.35	0.64
1181.97	1752.53	69.23	261.31	86.68	41.73	594.81	0.64
964.93	2213.27	76.57	236.61	78.70	39.15	596.50	0.65
687.77	1313.24	71.47	169.98	43.19	30.20	502.27	0.65
519.00	1174.98	84.81	170.73	56.81	41.69	270.68	0.66
553.07	923.11	78.00	264.38	47.93	57.74	337.33	0.66
581.25	999.67	72.40	275.58	52.36	66.97	302.04	0.66
566.59	1040.21	56.42	309.26	42.98	55.09	305.15	0.67
714.42	763.82	100.01	215.15	45.21	52.87	249.20	0.67
875.13	920.73	112.16	271.87	79.29	107.99	381.34	0.68
1227.19	859.66	127.01	388.08	97.16	108.86	429.32	0.68
990.71	1151.24	135.81	513.44	112.84	130.74	416.15	0.69
840.44	875.31	127.92	471.45	74.51	68.80	292.76	0.69
425.66	886.28	130.87	315.45	54.11	79.78	255.60	0.70
367.31	529.60	51.83	226.80	25.45	56.42	247.38	0.70
331.74	519.07	40.56	174.28	20.18	43.53	212.64	0.71
458.48	380.38	26.58	167.48	17.24	33.31	149.44	0.71
476.73	496.84	23.07	245.28	44.79	42.65	134.14	0.72
352.94	614.16	33.84	286.21	42.10	47.80	163.10	0.72
245.52	528.62	21.80	272.42	31.52	44.67	115.64	0.73
394.48	404.86	28.68	154.18	6.55	24.50	126.76	0.73
360.48	348.26	26.51	133.65	33.69	35.78	147.52	0.73
393.80	289.65	30.25	115.47	34.90	22.70	145.46	0.74
265.44	283.91	32.90	72.00	28.35	17.41	112.81	0.74
351.95	269.70	41.43	92.13	12.90	15.16	72.95	0.75
278.16	638.32	41.28	124.13	27.68	14.18	107.03	0.75
206.67	624.01	34.88	146.24	46.70	29.54	97.93	0.76

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
185.53	515.17	18.18	115.02	36.46	17.70	95.66	0.76
254.44	217.75	24.95	82.62	26.00	22.18	71.26	0.77
385.86	200.08	31.41	91.48	24.26	6.82	102.77	0.77
384.29	393.49	42.79	75.85	66.03	11.40	128.40	0.78
378.99	343.39	32.48	65.66	68.32	13.25	107.05	0.78
299.78	341.39	24.46	90.10	61.62	13.25	108.94	0.79
337.21	254.31	11.69	92.69	28.46	22.61	80.17	0.79
248.72	308.05	17.17	158.77	26.74	16.29	100.25	0.80
212.51	274.17	15.04	100.70	16.16	16.29	62.93	0.80
148.80	301.14	16.83	87.72	8.84	4.43	122.97	0.80
704.01	281.26	21.42	29.10	4.99	4.43	107.37	0.81
840.45	389.60	28.27	116.46	36.29	24.65	225.42	0.81
870.88	386.68	46.34	154.39	40.99	32.25	287.55	0.82
400.78	540.75	51.87	361.91	50.01	59.61	779.84	0.82
483.41	521.55	66.62	311.13	33.24	41.72	714.18	0.83
646.58	506.29	57.39	288.48	32.63	37.04	675.69	0.83
787.65	467.09	56.08	125.96	53.64	12.27	226.28	0.84
816.27	580.62	51.73	154.35	62.10	39.63	229.94	0.84
818.21	745.20	63.48	219.49	77.96	36.83	236.38	0.85
788.75	816.90	81.30	205.92	64.11	49.14	378.90	0.85
669.13	1103.74	99.70	241.37	70.51	43.18	622.45	0.86
617.04	918.57	81.51	211.92	79.41	53.91	573.69	0.86
555.44	792.00	65.87	265.82	97.70	68.69	498.14	0.87
391.86	557.76	79.71	338.20	68.32	122.94	343.82	0.87
279.89	452.98	78.58	287.89	39.85	109.33	287.11	0.88
187.70	420.86	66.67	276.05	3.11	96.39	183.04	0.88
230.39	234.83	19.43	110.06	10.24	41.62	52.68	0.88
199.97	288.36	19.00	125.17	20.46	48.02	63.02	0.89
189.60	211.30	18.41	42.12	20.46	38.18	61.62	0.89
168.54	152.50	26.57	48.74	21.60	35.05	75.49	0.90
142.73	138.48	24.24	41.43	8.28	26.98	69.44	0.90
317.60	477.38	22.14	110.27	15.59	26.00	71.06	0.91
332.13	900.78	18.90	220.96	22.62	43.25	215.26	0.91
352.06	945.45	21.48	238.65	32.17	48.38	227.35	0.92
189.02	756.27	24.12	206.19	24.85	51.34	232.26	0.92
150.54	316.33	19.75	79.05	12.13	18.19	68.34	0.93
158.91	231.23	15.73	53.36	3.77	14.01	53.14	0.93

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
243.04	91.00	10.74	20.49	3.77	5.15	48.93	0.94
323.90	163.44	12.65	107.80	23.02	5.33	42.77	0.94
296.66	221.44	25.04	146.37	21.83	24.42	63.96	0.95
213.72	232.60	30.50	164.37	25.69	27.53	66.89	0.95
202.47	217.97	27.04	75.81	3.85	23.16	70.86	0.95
333.09	266.47	20.15	82.05	15.10	3.11	74.09	0.96
247.09	412.88	13.27	105.20	11.25	8.55	96.16	0.96
492.24	327.30	8.36	98.01	11.25	8.78	76.43	0.97
984.15	382.48	16.24	103.18	12.41	8.78	117.40	0.97
2284.01	368.75	52.21	83.02	19.99	18.73	128.26	0.98
2027.74	533.69	74.97	234.36	44.51	18.50	162.00	0.98
1503.51	536.89	65.58	240.90	40.78	25.51	191.93	0.99
247.57	425.31	35.14	249.94	49.47	20.15	178.24	0.99
261.27	530.94	25.85	136.72	32.26	26.06	234.74	1.00
338.32	912.69	41.31	265.66	39.35	40.31	209.78	1.00
349.80	1080.64	88.61	375.73	41.41	79.08	307.18	1.01
450.08	903.53	88.42	389.71	48.34	73.17	242.04	1.01
383.23	553.05	106.33	338.03	62.83	91.00	242.17	1.02
406.46	665.99	76.69	300.04	60.77	58.83	202.15	1.02
364.08	666.45	83.32	289.71	50.87	62.34	219.08	1.02
360.34	575.58	57.40	261.18	25.38	27.10	195.62	1.03
439.37	300.14	36.61	209.14	27.21	44.01	146.80	1.03
677.21	490.66	26.36	186.89	22.87	59.05	140.12	1.04
573.82	566.49	17.98	107.82	25.16	60.90	135.95	1.04
431.41	527.68	17.57	51.75	7.06	24.26	95.82	1.05
112.47	265.43	9.09	49.52	7.06	5.70	69.38	1.05
140.03	136.40	7.62	42.40			70.59	1.06
217.55	251.65	7.47	93.74			92.59	1.06
186.70	334.15	15.20	103.85			101.33	1.07
137.22	299.18	17.13	92.26		2.31	58.11	1.07
146.96	150.10	14.35	47.92	3.96	2.31	35.59	1.08
199.88	149.66	18.98	68.13	10.76	2.31	43.52	1.08
270.60	242.70	24.14	129.99	36.05		113.69	1.09
254.97	321.21	26.00	147.87	32.09	4.51	126.46	1.09
306.11	303.24	21.32	186.08	42.56	4.51	154.91	1.10
341.87	385.59	36.86	148.35	33.91	4.51	154.95	1.10
356.62	408.92	54.47	178.05	41.57	6.19	153.18	1.10

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
331.83	459.72	59.38	122.72	50.83	13.28	125.86	1.11
571.38	377.68	51.15	128.78	51.29	19.93	71.43	1.11
843.16	3489.26	67.19	368.62	81.98	44.28	308.33	1.12
725.38	4095.08	159.31	453.86	161.83	55.03	336.48	1.12
844.57	2543.75	143.48	371.53	123.66	59.11	888.91	1.13
715.01	1280.33	187.82	484.32	177.94	72.29	970.93	1.13
797.99	1002.30	112.36	443.34	105.54	60.31	962.05	1.14
645.10	1017.14	132.85	442.03	131.25	23.63	684.71	1.14
747.16	769.36	95.47	308.26	89.72	9.87	572.24	1.15
595.80	567.70	82.08	280.51	81.99	3.80	553.94	1.15
578.47	593.38	66.60	312.74	49.77	8.50	170.15	1.16
831.77	626.39	54.13	272.70	34.47	11.50	126.23	1.16
756.14	868.62	65.22	333.32	19.20	40.69	263.26	1.17
710.51	763.18	55.28	177.93	15.63	35.99	255.98	1.17
363.28	765.97	68.91	221.49	14.11	34.84	295.66	1.17
362.14	420.85	54.21	128.21	14.39	51.28	142.42	1.18
396.56	394.89	56.24	139.11	6.27	56.21	129.32	1.18
304.96	292.95	70.38	123.64		50.56	154.48	1.19
312.68	279.10	55.99	155.83	6.22	4.93	149.84	1.19
253.78	346.09	56.83	198.47	11.26	12.21	138.95	1.20
194.59	297.16	28.12	160.56	16.43	16.21	121.87	1.20
204.99	307.96	26.16	100.51	18.97	18.71	127.26	1.21
391.59	374.48	32.01	90.93	32.02	10.12	222.60	1.21
452.25	531.49	46.74	118.98	72.93	12.84	226.45	1.22
576.50	543.79	64.29	127.26	69.81	22.93	354.68	1.22
652.13	526.81	66.05	195.94	89.24	25.35	312.03	1.23
642.25	740.46	107.85	249.66	51.83	32.42	341.21	1.23
558.52	752.98	115.51	259.37	52.48	32.74	329.55	1.24
763.67	798.76	140.19	212.46	23.25	36.69	361.27	1.24
968.99	750.95	101.13	216.68	35.37	49.55	633.75	1.24
975.72	865.77	86.29	462.91	54.81	79.20	556.09	1.25
637.87	790.42	62.50	608.35	63.42	77.35	781.52	1.25
463.59	689.29	53.15	679.31	76.41	58.45	640.09	1.26
390.08	707.46	50.45	606.25	64.87	15.89	594.80	1.26
376.04	703.97	40.00	459.00	60.06	10.96	372.11	1.27
301.15	561.60	43.11	323.53	31.28	7.15	198.97	1.27
274.17	370.99	31.52	112.93	23.70	7.15	243.56	1.28

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
186.54	269.61	37.32	81.35	20.81	8.83	159.02	1.28
182.90	209.02	33.85	133.82	33.46	9.59	135.53	1.29
242.04	812.69	41.17	262.63	58.02	9.59	117.32	1.29
265.90	831.91	37.10	289.91	48.74	18.29	126.69	1.30
333.66	895.52	32.72	287.18	58.27	42.90	225.85	1.30
242.66	310.20	29.52	157.64	42.12	42.90	193.01	1.31
213.26	246.34	20.65	107.11	42.35	29.30	158.65	1.31
143.24	235.64	20.56	40.10	18.99	8.92	48.08	1.32
205.10	240.68	18.91	62.36	20.59	27.54	36.05	1.32
213.63	262.45	20.96	71.50	28.68	30.83	61.07	1.32
287.18	224.95	18.55	88.94	42.23	31.19	89.42	1.33
300.59	256.16	39.37	112.23	24.85	12.57	109.05	1.33
308.88	283.13	38.88	189.10	23.25	9.28	117.84	1.34
213.74	302.95	41.14	185.81	13.58	6.19	112.24	1.34
199.25	210.08	18.66	142.20	13.75	9.27	98.83	1.35
252.49	220.84	16.99	61.72	7.12	13.68	86.82	1.35
300.97	203.08	22.18	96.15		7.49	86.99	1.36
278.80	276.45	32.45	109.11	6.86	10.47	109.87	1.36
187.46	271.50	40.31	143.36	11.12	6.06	112.25	1.37
147.54	236.45	33.60	96.83	18.03	8.79	85.85	1.37
202.63	234.06	24.49	120.03	10.54	2.73	69.76	1.38
237.72	275.87	34.38	95.14	24.27	32.04	74.80	1.38
285.94	343.65	29.28	94.00	17.32	35.70	93.40	1.39
225.78	305.93	30.29	86.78	17.35	45.70	96.07	1.39
277.04	228.75	15.50	83.36	7.13	16.39	75.44	1.39
322.39	201.61	19.36	107.02	7.15	21.47	78.44	1.40
303.46	216.81	27.41	119.75	30.58	11.47	193.16	1.40
1128.62	300.39	26.64	109.43	28.62	11.47	296.28	1.41
1131.52	971.42	108.22	123.59	48.09	23.74	319.03	1.41
1162.92	1001.89	124.21	159.50	52.40	50.57	914.20	1.42
561.84	934.58	121.08	161.24	47.78	57.20	843.27	1.42
483.23	324.43	77.47	165.69	60.18	79.77	944.97	1.43
681.78	290.72	56.65	127.38	41.26	58.19	243.46	1.43
531.25	1335.82	92.40	308.11	67.33	66.22	264.87	1.44
1524.23	1349.80	64.36	324.62	59.74	19.92	214.38	1.44
1620.69	2924.98	121.25	744.54	89.09	26.97	271.09	1.45
1588.20	2122.97	126.61	806.42	168.30	27.46	302.93	1.45

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
800.82	2136.18	139.90	874.34	188.22	34.56	247.17	1.46
750.85	726.90	111.51	587.04	243.22	64.12	215.27	1.46
643.67	741.71	93.39	721.51	168.56	78.92	152.71	1.46
566.75	657.07	76.66	612.66	129.52	71.83	317.26	1.47
328.91	796.66	64.31	664.17	56.60	29.95	298.11	1.47
345.53	537.54	50.91	275.15	43.72		272.69	1.48
1160.24	578.86	58.12	273.38	38.23	13.83	171.35	1.48
1370.71	2253.74	4033.60	421.21	134.22	70.36	236.36	1.49
1532.22	2382.39	4037.17	476.04	136.02	87.03	308.11	1.49
560.62	2575.70	4032.57	570.51	143.34	73.19	360.20	1.50
420.79	594.96	81.21	192.87	58.94	23.06	313.93	1.50
248.71	580.57	88.43	225.36	38.23	15.75	260.72	1.51
239.67	285.53	81.12	105.50	39.21	15.75	138.27	1.51
149.05	253.26	32.38	103.11	7.35	9.36	82.41	1.52
450.65	241.25	23.62	29.64	71.44		174.86	1.52
585.20	530.98	21.60	323.88	62.33		233.87	1.53
877.17	1076.96	88.59	893.52	300.31		641.34	1.53
1117.51	1441.45	117.06	899.05	258.13	73.08	587.24	1.54
1331.56	1305.83	174.51	765.87	289.68	73.08	707.58	1.54
1722.34	1025.02	122.20	184.32	84.25	73.08	316.64	1.54
1294.79	1226.16	178.04	734.31	98.51		498.73	1.55
1031.25	1100.22	126.31	623.40	74.28	35.07	307.42	1.55
571.19	919.41	140.82	747.69	81.85	39.08	353.99	1.56
829.41	401.62	93.06	464.32	110.22	70.44	170.22	1.56
824.93	656.78	190.55	499.80	206.30	174.39	686.50	1.57
876.96	676.39	188.67	418.93	173.10	170.38	665.90	1.57
557.06	851.28	199.60	341.63	123.88	139.03	733.13	1.58
668.70	734.34	99.52	300.52	25.18	2.79	200.29	1.58
506.65	585.40	448.37	1439.63	36.31	92.73	225.08	1.59
51.72	298.33	436.88	1245.09	103.04	92.73	98.69	1.59
176.67		320.26	1036.45	105.73			1.60
441.47				87.75			1.60
581.16				5.79			1.61
476.56	167.21	17.29	20.02	2.74		35.36	1.61
299.49	496.00	5.25	52.00	2.40		62.28	1.61
358.12	732.83	39.78	186.57	1.84		101.47	1.62
389.07	2655.92	47.02	227.44		31.92	101.73	1.62

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
635.94	2238.27	63.57	200.90		35.91	96.94	1.63
692.32	2141.10	36.98	107.52	9.98	35.91	83.92	1.63
1004.31	263.49	48.08	104.49	14.68	7.56	66.88	1.64
824.43	268.59	36.12	134.35	17.58	3.57	138.76	1.64
670.29	375.59	62.38	200.25	11.80	3.57	187.95	1.65
815.89	615.42	71.73	426.57	56.13	24.65	419.83	1.65
658.60	1303.98	106.19	556.89	63.79	33.19	392.83	1.66
1840.05	1365.44	94.03	574.68	71.31	46.59	588.24	1.66
1632.76	1190.76	86.22	356.14	31.52	34.49	356.59	1.67
2413.95	724.12	151.44	437.80	20.19	25.95	518.68	1.67
666.24	899.78	512.71	518.64	7.18	12.55	269.13	1.68
647.31	967.04	511.16	508.45		77.44	1607.00	1.68
192.79	1457.87	415.85	252.70	122.46	77.44	1788.65	1.68
341.91	1443.00	44.18	59.84	184.75	116.16	2642.56	1.69
1208.94	420.80	56.15	239.03	35.62	16.05	152.27	1.69
1202.73	278.85	24.74	52.17	11.51	15.91	94.67	1.70
1069.50	281.25	13.85	59.79	23.72	26.54	83.94	1.70
201.98	430.69	16.66	149.45	42.05	30.55	104.41	1.71
418.97	1110.20	99.79	719.28	55.92	54.50	486.70	1.71
744.98	1032.24	101.00	703.67	55.21	43.09	457.65	1.72
1187.78	840.81	98.05	602.28	27.95	46.86	441.36	1.72
1010.19	176.38	17.58	48.05	21.06	21.25	55.32	1.73
672.49	445.60	154.32	143.07	40.49	33.99	164.54	1.73
266.67	2407.48	231.86	360.89	80.67	34.65	255.94	1.74
302.54	2759.07	261.13	452.95	95.99	35.46	323.95	1.74
392.51	2600.80	128.77	442.54	76.22	21.28	323.32	1.75
535.26	671.17	74.13	246.82	38.98	14.07	237.09	1.75
672.41	773.11	67.22	214.11	39.84	45.89	397.44	1.76
632.70	1228.13	74.84	216.64	28.69	45.77	312.57	1.76
1118.30	1377.80	110.28	219.01	37.65	49.66	381.66	1.76
1045.24	1224.55	106.04	229.56	63.82	22.37	315.91	1.77
2292.67	1029.67	143.23	382.23	137.06	45.28	462.84	1.77
1866.89	917.15	89.85	387.06	126.24	41.27	424.57	1.78
1803.28	1073.82	133.95	743.82	187.05	81.28	510.12	1.78
1238.19	816.99	103.49	525.31	120.85	59.78	387.59	1.79
937.84	1097.92	130.85	656.66	165.08	65.03	393.16	1.79
1195.27	831.19	104.98	259.34	128.64	62.55	474.12	1.80

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
479.07	4225.87	152.36	345.29	121.59	76.77	640.20	1.80
690.63	4421.41	189.13	267.16	133.05	94.09	1033.72	1.81
530.51	4138.15	148.66	231.61	60.53	43.35	690.18	1.81
747.23	734.77	101.03	194.86	103.29	23.21	516.48	1.82
557.66	272.60	38.98	109.58	50.70	15.96	76.44	1.82
386.21	381.78	48.21	207.39	76.22	15.26	254.76	1.83
257.03	683.93	101.49	240.66	124.11	14.33	452.01	1.83
388.84	1635.31	192.53	289.17	117.37		887.75	1.83
511.60	1585.35	180.47	254.34	90.65		767.40	1.84
521.81	1413.73	111.72	389.35			554.98	1.84
1009.02	580.16	122.10	394.76	72.16	111.97	364.77	1.85
1381.09	788.03	121.76	308.29	72.16	164.48	320.47	1.85
1331.92	1513.04	134.56	132.17	72.16	237.01	401.61	1.86
770.98	1411.51	37.57	118.99	13.18	132.27	243.46	1.86
294.58	1490.89	58.37	716.39	26.79	136.11	498.54	1.87
472.57	887.03	57.60	675.43	34.90	71.85	424.44	1.87
669.37	1169.13	64.41	682.16	21.72	67.35	341.66	1.88
711.17	864.80	57.20	149.30	8.10	12.06	137.99	1.88
607.43	683.58	46.86	179.85	18.83	20.69	108.81	1.89
379.77	466.63	63.71	238.67	18.83	14.57	128.83	1.89
263.48	513.39	68.55	232.66	23.58	22.38	264.12	1.90
132.84	473.23	61.26	178.47	14.99	7.38	269.09	1.90
168.74	929.83	41.16	124.78	33.34	28.17	391.69	1.90
186.08	1002.07	29.00	90.56	30.25	24.57	198.96	1.91
282.84	846.95	27.76	95.50	20.00	26.10	178.51	1.91
338.28	766.85	9.03	43.00	3.82	8.93	26.97	1.92
355.94	640.38	5.73	25.94	10.36	8.14	31.80	1.92
251.39	666.87	11.92	64.61	10.36	6.53	56.36	1.93
180.26	167.59	25.66	84.20	15.40	14.58	72.36	1.93
181.69	320.18	41.68	167.92	7.21	17.80	102.52	1.94
175.22	343.10	41.23	132.53	25.73	17.79	103.78	1.94
155.86	327.77	30.73	119.70	18.51	6.18	95.68	1.95
311.51	196.54	16.99	353.51	25.59	11.07	71.95	1.95
240.44	229.35	15.67	358.68	12.84	11.04	72.00	1.96
190.26	225.72	12.60	354.06	20.01	11.09	58.98	1.96
205.21	196.60	10.78	50.98	12.94	0.00	42.77	1.97
190.26	310.94	29.01	94.81	50.67	35.19	147.03	1.97

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
144.36	243.22	28.54	125.49	7.21	35.44	143.43	1.97
144.36	214.89	27.73	118.44	7.21	32.32	126.88	1.98
178.38	300.10	26.55	170.41	39.88	8.58	77.42	1.98
176.43	222.73	18.84	143.55	38.41	8.70	59.24	1.99
178.71	255.68	25.43	134.23	38.41	5.12	98.82	1.99
153.82	182.14	18.26	112.59	25.74	10.51	90.04	2.00
199.06	202.27	22.60	94.63	50.66	10.45	82.63	2.00
207.75	231.42	30.11	71.41	50.66	11.90	80.97	2.01
264.90	216.38	28.88	34.41	30.68	6.52	90.62	2.01
202.67	311.22	26.66	48.78		6.44	110.22	2.02
217.55	380.46	33.24	88.31	13.36		122.40	2.02
169.90	400.31	38.43	77.37	13.36	22.62	126.68	2.03
194.30	280.08	36.73	63.09	13.36	22.75	97.23	2.03
155.57	212.43	30.15	39.26		22.87	78.12	2.04
145.22	216.15	36.05	22.03			94.41	2.04
184.29	286.57	32.91	49.11			107.62	2.05
341.70	283.02	20.67	57.62			95.74	2.05
342.13	273.64	15.86	72.57			74.01	2.05
247.04	318.10	22.52	45.06	10.77	16.81	123.98	2.06
135.24	270.88	20.99	26.06	10.77	16.84	115.26	2.06
179.60	197.20	11.43	11.78	12.35	17.04	89.78	2.07
255.14	109.27	15.27	47.50	1.58		47.59	2.07
243.63	155.76	20.67	76.75	1.58	14.86	50.82	2.08
179.84	267.23	32.03	106.14		14.71	123.60	2.08
182.12	276.66	25.73	174.48	22.01	14.78	142.59	2.09
151.12	251.01	27.23	152.17	22.01		130.01	2.09
131.31	194.67	24.08	214.07	31.37		71.49	2.10
86.17	149.25	21.21	114.08	13.38		41.63	2.10
196.63	106.93	12.94	117.48	15.72		48.24	2.11
273.38	110.91	7.34	39.38	13.90		49.61	2.11
484.26	2187.55	15.39	64.02	9.89	0.00	61.78	2.12
585.20	2269.84	30.23	135.93	68.96	20.22	109.00	2.12
672.45	2484.31	76.81	267.82	75.09	25.64	149.94	2.12
644.57	607.52	149.09	374.90	91.20	45.19	230.22	2.13
710.60	924.12	157.36	549.33	88.43	52.87	618.00	2.13
567.17	1017.14	130.66	478.19	88.72	55.92	599.12	2.14
506.17	1300.04	84.40	515.89	139.62	44.75	575.61	2.14

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
265.67	920.86	81.21	265.69	82.57	16.51	134.33	2.15
349.67	852.41	74.22	281.29	97.67	25.55	208.67	2.15
456.02	479.24	43.66	124.53	34.32	29.20	146.67	2.16
406.03	494.09	47.52	174.97	43.97	47.27	702.53	2.16
312.40	899.57	74.36	568.68	36.47	70.35	682.11	2.17
318.94	791.07	72.39	565.94	35.08	60.34	667.15	2.17
606.39	772.70	50.84	518.37	27.37	42.24	135.58	2.18
688.06	601.97	41.38	256.68	47.70	1.39	245.46	2.18
683.12	1097.22	64.98	378.07	45.43	6.99	346.10	2.19
746.85	1192.36	89.67	444.39	57.27	10.02	392.42	2.19
1002.88	1391.43	110.24	1181.75	26.15	45.15	350.57	2.19
1256.45	1099.25	118.28	1258.90	39.09	63.78	361.17	2.20
1270.92	1580.20	134.26	1278.93	60.64	70.35	481.79	2.20
1060.53	1835.98	117.24	799.43	78.92	58.80	416.93	2.21
623.54	2245.70	278.51	868.61	78.63	52.96	454.83	2.21
669.38	1776.79	282.27	789.67	62.17	49.54	277.30	2.22
741.91	970.86	249.16	342.86	38.80	30.85	204.35	2.22
853.76	1020.29	138.35	291.31	102.06	27.83	142.94	2.23
513.50	1095.22	219.14	408.21	97.61	47.44	168.11	2.23
338.38	1205.39	221.11	466.74	149.64	51.86	196.32	2.24
212.83	922.70	157.40	374.08	73.73	34.33	172.15	2.24
730.71	783.54	38.65	268.88	66.42	20.26	144.31	2.25
674.00	729.70	48.33	266.69	13.07	16.98	138.73	2.25
654.13	307.47	102.22	317.56	62.20	45.37	290.24	2.26
700.37	532.64	129.33	342.91	55.58	45.14	296.60	2.26
782.31	1073.75	112.89	368.16	47.65	53.55	187.90	2.27
692.51	1376.57	204.85	328.21	76.88	43.72	494.08	2.27
419.46	1727.62	183.27	308.89	98.65	50.32	626.60	2.27
478.42	1349.80	175.27	230.30	90.90	71.17	596.02	2.28
613.73	1517.92	92.32	214.78	40.31	62.31	381.01	2.28
617.30	1651.65	145.26	367.66	75.37	68.22	441.64	2.29
972.16	1784.84	184.87	440.57	74.00	43.67	439.52	2.29
809.07	1108.43	150.39	385.35	83.27	36.75	297.81	2.30
812.19	743.86	87.64	246.50	23.71	17.62	133.61	2.30
470.19	527.89	40.50	137.78	23.99	20.27	109.99	2.31
523.34	496.43	24.16	145.37	21.46	28.48	142.35	2.31
644.38	472.42	38.78	124.28	37.88	22.33	234.98	2.32

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
805.55	647.45	46.26	97.32	57.72	20.73	239.50	2.32
768.35	879.97	62.54	162.72	50.98	23.88	241.58	2.33
801.10	1790.99	68.04	150.10	79.70	34.05	335.16	2.33
557.76	1599.58	61.26	223.07	58.65	52.45	354.15	2.34
789.91	1519.36	45.76	252.27	77.77	39.62	369.82	2.34
705.83	681.82	45.24	491.72	55.79	57.98	253.59	2.34
723.65	1197.80	111.30	662.96	203.23	106.44	344.60	2.35
541.29	1125.75	114.34	582.69	196.18	103.32	313.71	2.35
451.10	914.43	109.20	333.04	184.46	83.33	289.36	2.36
487.29	431.17	51.88	93.70	26.18	15.36	283.80	2.36
433.50	356.84	55.20	68.02	19.15	15.38	289.62	2.37
427.58	477.57	48.11	102.61	13.41	17.74	252.75	2.37
798.16	544.93	47.53	135.50	13.41	13.01	141.50	2.38
988.50	574.94	63.54	132.48	8.38	30.70	167.44	2.38
958.33	553.23	75.08	142.90	22.61	26.11	227.08	2.39
507.93	718.45	79.19	230.67	29.81	90.68	316.38	2.39
329.71	732.78	54.73	232.76	33.86	79.62	297.08	2.40
730.53	631.01	37.30	220.39	52.06	97.09	786.67	2.40
746.15	672.19	42.77	131.25	52.69	42.15	686.74	2.41
1089.60	1123.74	89.74	191.26	101.38	77.89	768.95	2.41
899.36	1019.18	94.92	298.76	63.56	58.86	183.18	2.41
915.86	2021.41	118.94	334.57	135.23	65.21	321.13	2.42
725.66	2185.32	134.75	470.66	123.50	33.56	543.14	2.42
952.16	2503.24	128.43	396.61	142.00	50.52	581.82	2.43
791.46	1272.07	95.55	425.94	73.54	50.30	461.40	2.43
1100.83	1312.76	71.41	399.26	41.11	81.30	219.76	2.44
754.47	988.12	64.68	319.30	25.04	60.76	166.12	2.44
1294.51	3268.67	88.20	346.40	23.00	66.95	255.16	2.45
1131.69	2842.21	64.53	383.67	51.27	54.78	486.93	2.45
1698.91	2772.73	84.21	537.36	45.84	75.96	720.74	2.46
1590.58	480.72	82.13	506.84	36.84	65.25	678.36	2.46
1430.06	1891.67	94.57	546.01	43.22	42.51	419.56	2.47
913.49	2135.59	114.39	428.37	96.67	23.62	247.50	2.47
483.23	2550.76	208.39	513.41	103.05	38.40	611.04	2.48
870.46	789.31	263.23	505.55	116.51	31.57	588.44	2.48
700.83	653.66	221.09	472.54	63.05	27.79	529.66	2.49
931.43	596.54	138.59	785.59	99.89	8.70	353.89	2.49

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
382.92	649.48	58.19	550.17	47.76	13.94	305.24	2.49
472.93	998.29	72.83	671.10	63.04	27.14	545.75	2.50
860.73	802.27	42.68	223.68	54.92	33.44	331.21	2.50
940.72	894.11	49.72	255.26	66.12	36.23	375.08	2.51
946.99	841.24	73.33	1141.82	89.02	36.02	237.26	2.51
494.80	677.96	78.56	1114.76	68.03	34.32	213.14	2.52
656.25	785.24	84.59	1182.73	85.60	36.98	517.20	2.52
591.11	744.76	54.65	251.64	71.06	53.51	594.67	2.53
459.87	1407.77	57.39	324.79	94.44	41.88	652.22	2.53
492.99	1233.95	44.96	211.73	67.77	34.51	303.19	2.54
613.04	988.90	36.93	135.39	58.68	9.34	310.63	2.54
662.70	1652.28	52.43	595.09	51.41	9.40	432.92	2.55
597.01	6497.08	82.80	800.97	88.49	34.23	609.85	2.55
985.27	7246.09	103.34	875.10	91.33	41.68	449.41	2.56
1397.34	6229.74	88.86	417.76	74.54	47.15	299.73	2.56
1153.67	1740.53	138.45	504.22	61.00	43.27	291.61	2.56
929.11	1125.58	134.07	560.51	107.67	46.37	396.90	2.57
723.96	727.13	111.32	467.09	97.32	42.63	347.24	2.57
968.82	653.16	44.85	300.13	91.72	68.05	1032.42	2.58
687.63	488.47	37.23	217.57	34.84	62.57	1107.16	2.58
1131.25	754.78	50.88	270.14	76.18	60.91	1248.93	2.59
1458.74	482.07	51.24	163.35	53.39	18.71	444.93	2.59
1543.21	1579.05	141.50	200.76	142.76	123.83	1390.15	2.60
1062.07	1560.76	140.45	250.14	124.52	134.39	1719.02	2.60
664.99	1714.80	205.99	312.67	143.46	136.97	1761.66	2.61
1365.47	1101.22	154.68	359.26	111.61	49.14	716.66	2.61
1115.36	2085.86	191.36	319.34	112.33	41.76	313.96	2.62
1174.42	2225.90	189.65	399.63	158.93	61.85	447.74	2.62
521.54	1834.28	146.45	307.42	101.70	35.99	345.90	2.63
790.75	1014.58	153.24	351.72	94.44	44.76	328.56	2.63
1868.64	888.00	110.66	270.72	43.32	36.47	224.20	2.63
2265.02	1196.20	152.11	370.72	61.32	47.10	277.07	2.64
2238.45	1883.71	206.61	656.60	160.86	87.48	408.11	2.64
1208.99	2335.03	249.38	788.25	181.67	77.47	473.58	2.65
697.64	2108.36	213.81	731.15	184.60	73.58	471.23	2.65
455.90	1634.10	139.38	425.73	75.02	44.60	357.63	2.66
381.26	1090.78	68.03	249.51	49.97	40.09	185.75	2.66

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1034.30	977.34	60.36	178.18	38.56	31.03	135.44	2.67
2228.24	661.94	107.90	180.38	64.75	24.26	103.76	2.67
2352.74	809.79	121.88	319.11	87.66	33.75	74.61	2.68
1692.16	1593.84	167.95	387.81	104.00	38.25	287.88	2.68
844.92	5173.15	280.87	462.19	82.64	64.49	425.99	2.69
920.44	5127.96	261.95	314.30	57.31	53.92	530.71	2.69
1317.49	4782.83	324.64	439.02	58.14	96.78	452.49	2.70
1674.84	2107.60	162.76	455.57	122.16	101.37	405.76	2.70
1766.41	2248.18	239.95	550.90	154.56	119.32	467.26	2.71
1392.15	2086.82	147.60	468.13	136.89	80.01	395.37	2.71
936.25	1859.12	159.60	567.51	197.65	56.59	591.75	2.71
499.53	1729.72	131.61	487.72	168.24	57.83	464.50	2.72
854.03	1600.54	128.76	539.66	165.61	67.68	416.08	2.72
849.98	1084.88	94.13	332.61	51.46	46.65	134.00	2.73
1131.28	1976.60	97.19	506.73	83.15	28.19	199.78	2.73
920.53	1807.79	88.20	354.43	75.51	24.64	189.72	2.74
828.85	3147.80	104.85	368.84	113.40	44.81	339.94	2.74
473.09	2345.93	71.17	258.20	95.46	71.80	315.69	2.75
310.39	2932.41	87.20	361.13	135.00	83.05	394.35	2.75
482.98	1208.77	71.38	275.21	74.93	65.84	216.77	2.76
546.80	982.44	52.37	216.18	51.68	41.90	157.61	2.76
668.69	1187.80	57.90	221.34	30.94	32.40	124.74	2.77
521.86	1261.67	62.69	321.66	40.49	34.61	154.46	2.77
690.70	1277.31	90.41	321.88	48.71	54.29	166.25	2.78
884.26	531.32	73.47	306.97	62.60	71.49	167.47	2.78
1060.68	610.32	150.74	353.04	77.92	81.31	478.21	2.78
1031.69	1186.74	158.06	433.07	144.39	98.67	562.35	2.79
695.76	2530.20	232.00	589.99	117.66	69.44	583.63	2.79
651.33	3235.96	156.30	546.07	136.21	59.01	250.89	2.80
591.70	2544.14	125.62	437.47	58.44	17.48	149.35	2.80
652.98	1770.36	98.15	266.41	46.27	12.26	242.67	2.81
462.88	1196.29	125.70	373.33	23.61	23.84	1067.10	2.81
1427.01	1325.51	174.89	670.39	128.15	48.72	881.60	2.82
1348.50	1338.73	422.31	614.48	92.06	60.22	811.34	2.82
1401.71	1232.20	541.83	625.75	61.02	51.11	705.40	2.83
1421.67	1820.54	504.09	548.90	62.03	36.74	487.97	2.83
1224.62	1744.14	237.95	469.10	58.69	32.03	465.57	2.84

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1668.34	2112.28	232.79	544.54	84.44	50.13	622.15	2.84
1527.74	2852.47	238.83	836.44	89.35	100.85	504.89	2.85
1723.26	2611.40	250.31	852.29	97.89	101.28	578.40	2.85
1366.13	2496.92	270.03	853.66	68.33	71.18	414.27	2.85
1482.84	1710.45	293.34	553.52	90.30	29.34	372.22	2.86
1574.40	2456.51	334.81	803.41	93.27	48.63	325.35	2.86
1177.39	2827.94	231.20	748.03	182.55	59.02	513.21	2.87
1248.40	4241.31	250.24	774.03	208.99	108.28	521.71	2.87
932.17	3467.97	212.91	526.33	220.62	88.72	587.18	2.88
1061.01	2605.67	155.87	327.82	139.26	77.39	347.44	2.88
612.04	2281.83	249.54	408.13	86.41	46.31	427.14	2.89
745.12	2199.71	303.21	436.91	85.16	39.19	342.16	2.89
783.27	2229.47	312.26	474.76	65.99	38.70	339.06	2.90
768.30	1515.27	180.86	309.14	69.88	25.22	198.74	2.90
2785.56	2249.23	167.03	387.13	114.55	25.76	334.43	2.91
3024.02	3027.91	184.40	496.32	128.91	38.04	563.42	2.91
4590.34	4033.53	209.83	656.45	241.95	79.34	672.71	2.92
2659.47	3682.70	411.88	602.35	166.05	94.11	582.11	2.92
3616.07	3678.86	438.37	821.53	186.41	91.04	450.07	2.93
2109.47	1755.85	386.19	687.24	60.33	38.62	280.03	2.93
2085.61	1263.39	227.87	702.69	82.46	39.58	222.42	2.93
1669.45	1057.76	208.57	672.34	82.04	55.55	285.77	2.94
2626.44	2832.20	228.79	757.00	138.40	94.81	410.00	2.94
3849.55	4648.37	356.39	1336.57	255.79	83.44	772.02	2.95
3535.13	5448.85	459.88	1525.35	265.68	68.48	648.41	2.95
3551.35	5390.97	532.27	2040.94	268.86	82.98	586.37	2.96
2830.26	4157.69	340.69	1675.42	188.81	86.96	429.63	2.96
2731.19	3231.66	270.73	1289.64	155.73	113.95	479.79	2.97
1560.11	2451.43	152.25	688.27	110.03	69.63	407.60	2.97
1876.32	3118.25	317.09	955.96	78.56	93.80	270.57	2.98
1772.86	2517.85	287.27	984.19	103.99	59.77	218.32	2.98
2817.65	2676.64	513.59	1426.20	147.87	78.35	274.83	2.99
3203.84	3129.25	441.54	1170.44	161.70	69.09	238.98	2.99
4403.17	7111.57	694.68	1248.66	193.58	76.93	274.35	3.00
3909.08	7055.86	557.19	1052.48	206.08	70.61	273.11	3.00
2520.17	5368.11	433.77	762.95	172.97	38.88	209.91	3.00

Appendix A. (continued)
Cetacean Rib (PAS11-01): Calvert Cliffs

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
170.06	272.59	28.87	120.35	16.77	14.08	539.64	0.01
170.37	294.01	26.54	121.20	22.28	14.17	627.27	0.01
143.50	326.10	26.16	117.85	28.78	13.85	673.69	0.01
124.30	323.44	27.42	123.18	33.26	12.89	683.49	0.01
93.64	261.09	23.37	95.02	25.20	10.01	618.39	0.02
90.76	200.36	24.14	76.20	17.93	10.20	669.62	0.02
81.84	163.37	21.52	54.46	11.29	9.86	700.50	0.02
88.47	190.68	23.11	53.07	11.55	11.84	873.52	0.02
80.81	193.66	18.06	48.33	9.87	9.15	893.24	0.03
77.47	198.96	15.05	47.63	8.61	8.03	956.97	0.03
67.80	180.71	11.94	51.42	7.60	4.94	741.65	0.03
68.08	176.19	12.11	56.64	7.82	5.04	589.03	0.03
70.99	192.16	12.73	61.86	8.37	4.60	416.00	0.04
69.40	202.31	12.37	52.45	8.03	5.33	496.16	0.04
73.78	223.87	12.59	49.25	10.18	6.84	587.91	0.04
76.10	208.63	12.69	46.14	12.45	7.69	657.92	0.04
82.54	189.87	12.35	49.32	13.87	8.98	636.25	0.05
71.51	151.33	10.99	41.51	11.10	7.87	564.57	0.05
60.25	131.70	9.31	32.72	7.12	7.21	499.72	0.05
48.76	118.36	8.04	24.26	4.27	5.52	408.92	0.06
45.33	103.15	6.44	19.74	2.89	5.08	341.67	0.06
36.58	84.21	4.56	13.94	2.82	4.93	301.47	0.06
33.37	73.21	3.81	11.30	3.34	6.21	327.04	0.06
31.20	66.18	3.84	10.54	3.79	6.80	371.11	0.07
34.81	60.19	4.33	13.13	3.99	6.96	401.75	0.07
32.29	49.61	3.82	15.01	3.83	5.38	385.07	0.07
30.90	44.41	3.47	17.17	4.31	3.89	374.57	0.07
29.34	42.54	3.30	16.17	4.27	2.44	352.75	0.08
30.69	44.57	3.83	13.79	3.91	1.62	367.26	0.08
28.99	41.34	3.88	9.82	3.02	1.55	342.70	0.08
26.13	37.59	3.67	8.04	3.09	1.69	322.31	0.08
23.93	33.06	3.11	6.34	2.88	2.36	279.03	0.09
22.94	32.19	2.64	6.08	2.81	2.36	267.37	0.09
23.32	31.64	2.33	5.43	2.22	2.57	243.48	0.09

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
23.14	31.75	2.13	8.44	2.17	2.94	236.81	0.10
25.38	35.48	2.14	11.73	2.21	4.22	230.80	0.10
27.20	39.93	2.27	14.79	1.69	5.78	270.00	0.10
26.74	41.82	2.15	12.39	0.88	5.95	301.16	0.10
25.00	40.47	3.94	8.51	0.68	4.90	335.88	0.11
21.40	35.84	5.48	4.27	1.25	3.19	349.33	0.11
20.15	31.76	7.72	3.85	3.38	2.58	338.95	0.11
19.19	32.64	6.33	5.67	4.74	2.94	319.33	0.11
22.25	38.06	5.32	9.82	6.29	3.13	344.49	0.12
23.62	44.09	3.53	11.70	5.15	2.94	375.00	0.12
23.54	40.60	3.29	11.45	3.88	2.15	403.97	0.12
19.59	35.04	2.65	16.31	1.67	1.78	339.00	0.12
18.85	30.18	2.02	22.69	0.80	1.70	311.57	0.13
18.66	35.16	1.60	29.64	0.66	2.08	272.10	0.13
20.72	36.79	1.36	21.42	1.06	2.77	270.49	0.13
19.93	37.14	1.39	13.01	1.47	3.04	233.12	0.13
18.87	25.53	1.22	4.67	1.20	3.15	211.28	0.14
16.16	16.82	0.95	5.41	0.77	2.38	206.80	0.14
13.87	9.56	0.69	4.49	0.65	2.05	204.68	0.14
12.83	9.65	0.62	3.47	0.73	1.80	210.96	0.15
11.90	9.94	0.62	1.28	0.94	2.20	211.96	0.15
10.76	9.46	0.64	0.50	0.53	2.65	227.72	0.15
8.49	8.78	0.60		0.22	2.94	238.60	0.15
6.88	7.14	0.56		0.01	2.82	224.70	0.16
5.79	5.67	0.39		0.11	2.23	207.87	0.16
4.94	3.87	0.23		0.21	1.57	175.84	0.16
4.32	3.26	0.09		0.10	0.79	171.85	0.16
3.86	2.85	0.04		0.00	0.62	177.18	0.17
3.66	2.50	0.06			0.88	188.90	0.17
3.37	2.09	0.09	0.32	0.04	1.45	192.23	0.17
3.20	2.22	0.13	0.48	0.18	2.17	183.37	0.17
3.72	2.97	0.11	0.92	0.32	2.46	183.05	0.18
4.72	4.43	0.25	1.92	0.42	2.76	188.40	0.18
5.49	5.47	0.47	3.36	0.53	1.86	188.75	0.18
5.12	5.75	0.70	4.25	0.63	1.13	179.83	0.19
4.57	4.56	0.57	3.22	0.42	0.40	164.76	0.19
4.07	3.27	0.32	1.61	0.21	0.41	153.55	0.19

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
4.11	2.53	0.12	0.29		0.28	147.16	0.19
3.29	2.17	0.11	0.01		0.14	140.15	0.20
2.69	1.90	0.18	0.01			141.67	0.20
2.39	2.44	0.29		0.13		145.62	0.20
2.46	3.55	0.35	0.66	0.26		148.29	0.20
2.43	4.82	0.39	1.45	0.39		147.51	0.21
1.63	6.96	0.31	2.24	0.26		143.88	0.21
1.23	9.15	0.25	1.58	0.13	0.21	152.88	0.21
0.86	11.27	0.20	0.79		0.43	157.32	0.21
1.00	8.68	0.14		0.24	0.64	178.04	0.22
0.81	5.35	0.12		0.49	0.43	177.44	0.22
1.05	2.66	0.34		0.73	0.42	184.31	0.22
2.48	3.92	0.79	1.07	0.78	0.95	158.54	0.22
5.32	8.19	1.51	3.59	1.13	1.70	150.32	0.23
9.53	14.56	2.15	7.72	1.48	2.29	159.85	0.23
12.39	19.99	2.57	9.51	1.46	1.98	186.04	0.23
13.43	22.32	2.45	8.91	1.03	1.84	212.05	0.24
10.89	19.66	1.82	5.26	0.61	1.40	190.13	0.24
7.62	16.79	1.11	2.99	0.51	1.26	173.25	0.24
4.45	12.76	0.65	1.54	0.34	0.91	138.72	0.24
2.73	9.97	0.53	1.98	0.17	0.81	127.07	0.25
2.32	7.04	0.51	2.33		0.62	110.67	0.25
2.70	5.62	0.47	2.63		0.55	109.71	0.25
3.63	5.90	0.50	2.14	0.12	0.49	110.43	0.25
3.84	6.28	0.63	1.61	0.25	1.26	120.96	0.26
3.57	6.82	0.71	1.10	0.38	1.77	125.86	0.26
6.28	10.63	1.03	1.90	0.96	2.27	134.57	0.26
10.68	14.63	1.21	2.90	1.53	1.39	125.93	0.26
16.02	20.70	1.48	4.02	2.10	0.69	132.90	0.27
15.47	18.83	1.21	2.86	1.58		143.18	0.27
12.63	19.14	1.18	1.95	1.06	0.55	168.78	0.27
8.35	15.50	1.06	1.98	0.55	1.11	175.82	0.28
6.46	15.30	1.16	3.78	0.37	1.66	166.11	0.28
5.50	10.45	0.90	5.24	0.18	1.11	144.59	0.28
5.02	7.30	0.68	5.52		0.82	123.15	0.28
5.38	5.06	0.49	4.73		0.52	127.77	0.29
5.44	5.01	0.50	2.79		0.79	157.26	0.29

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
5.70	6.62	0.84	1.12		0.52	215.33	0.29
5.28	7.47	1.17	0.36	0.44	0.82	261.06	0.29
5.32	8.20	1.51	0.77	0.91	1.11	265.06	0.30
5.29	6.36	1.14	1.25	0.91	1.66	239.08	0.30
4.80	4.86	0.76	0.77	0.46	1.11	207.27	0.30
3.53	4.54	0.31	0.64		0.55	201.28	0.30
2.38	5.19	0.25	0.54		0.19	195.35	0.31
1.62	6.49	0.16	2.09	0.30	0.39	199.54	0.31
1.42	6.59	0.13	3.61	0.61	0.58	207.17	0.31
0.89	6.54	0.10	5.22	0.91	0.39	206.51	0.31
0.68	5.47	0.12	5.18	0.61	0.19	190.08	0.32
0.44	4.96	0.13	5.02	0.46		170.33	0.32
0.58	4.32	0.16	4.04			156.78	0.32

Cetacean Vertebra (PAS11-02):
Aurora

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
18.57	37.05	3.77	11.65	3.19		119.79	0.00
16.84	26.24	4.19	10.79	2.96	1.78	108.00	0.01
13.18	25.19	2.06	7.53	2.64	2.67	107.38	0.01
11.86	15.85	1.89	5.71	1.81	3.39	93.40	0.01
10.04	17.70	1.17	6.73	1.30	1.61	122.50	0.02
8.25	15.49	1.24	6.84	0.28	1.97	120.00	0.02
7.09	18.34	0.96	6.79		1.24	112.15	0.03
7.87	14.24	0.90	5.74	0.89	1.63	86.23	0.03
9.29	14.52	0.95	7.90	2.17	0.38	103.76	0.03
10.19	12.94	1.44	9.42	2.76	1.40	140.64	0.04
8.59	12.45	1.49	6.45	1.87	1.02	139.15	0.04
9.92	12.07	2.32	3.21	0.59	1.53	112.95	0.04
8.45	13.64	1.49	1.67	1.34	0.89	79.95	0.05
9.22	13.92	1.56	1.63	1.72	0.89	75.74	0.05
7.19	13.71	1.21	3.87	1.72	1.41	76.23	0.05
8.09	10.09	1.28	2.61	0.38	2.14	86.17	0.06
7.97	8.40	0.88	3.98		2.14	112.77	0.06
10.05	10.15	0.85	3.59		1.11	135.08	0.06

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
10.48	12.97	1.27	4.33	0.39		130.11	0.07
9.43	15.02	1.62	3.02	2.20		111.31	0.07
6.52	14.77	1.00	14.35	2.20		84.84	0.08
4.31	10.25	0.54	13.61	1.81		66.95	0.08
4.24	14.31	0.26	14.05	0.45		63.17	0.08
3.72	11.14	0.25	0.86	0.45		59.48	0.09
5.52	11.37	0.34	0.86	0.45		75.27	0.09
5.81	12.88	0.20	0.54		0.49	78.39	0.09
7.15	13.93	0.17	1.24		1.46	81.79	0.10
6.02	25.95	0.13	2.49		1.84	83.75	0.10
5.68	19.15	0.25	2.34		1.70	71.69	0.10
4.69	17.63	0.30	1.64		1.33	70.08	0.11
4.89	5.58	0.32	0.39		0.95	69.95	0.11
4.28	3.29	0.99			0.59	65.73	0.12
3.69	3.40	0.89	1.86		0.42	65.48	0.12
2.53	2.57	0.88	1.86		0.42	87.75	0.12
2.24	2.45	0.07	1.86		0.42	90.91	0.13
1.87	2.02	0.17		0.63		90.00	0.13
3.87	3.94	0.10	0.59	1.25	0.54	75.52	0.13
4.52	4.40	0.10	0.59	1.64	0.54	69.16	0.14
4.98	5.99	0.09	0.59	1.01	0.54	81.85	0.14
5.08	5.05	0.35	0.38	0.39	0.71	87.28	0.14
4.02	5.68	0.35	0.38		0.71	94.84	0.15
4.37	3.60	0.31	0.75		1.38	90.13	0.15
3.94	2.73	0.28	0.36		0.67	85.82	0.15
6.15	1.81	0.80	1.41		1.63	82.96	0.16
5.87	2.48	1.00	1.84		1.32	77.69	0.16
4.20	2.56	1.02	1.84		1.59	56.73	0.17
2.79	2.71	0.51	1.25		0.63	59.59	0.17
2.64	3.31	0.25	0.45		0.27	66.41	0.17
3.17	3.08		1.48			77.88	0.18
2.70	2.74	0.19	1.02	0.41	0.70	75.48	0.18
2.80	1.78	0.19	1.02	0.41	1.05	63.97	0.18
2.71	2.14	0.29		0.41	1.05	56.08	0.19
2.47	1.55	0.14			0.34	47.10	0.19
2.54	1.49	0.14			0.25	41.75	0.19
2.24	1.86	0.04			0.25	64.56	0.20

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
3.05	2.60			1.76	0.25	80.94	0.20
3.47	2.87	0.13		2.19	1.49	94.62	0.21
3.43	2.12	0.52		2.19	1.49	61.97	0.21
2.87	3.56	0.61	1.10	0.43	1.49	50.26	0.21
3.53	3.75	0.94	1.10			51.48	0.22
4.49	4.54	0.64	1.10		0.89	90.15	0.22
4.18	3.90	0.55			1.60	94.28	0.22
2.41	5.94	0.26		0.39	1.60	86.94	0.23
1.65	32.24	0.70	0.45	0.39	0.71	74.91	0.23
1.92	32.91	0.70	0.87	0.39		77.28	0.23
2.63	30.91	0.68	1.19			83.56	0.24
2.39	4.04	0.16	0.74			78.22	0.24
3.54	2.40	0.36	0.73	0.44	0.76	81.91	0.24
2.88	1.67	0.37	0.41	0.98	0.99	71.27	0.25
3.19	1.88	0.57	0.41	0.98	0.99	70.92	0.25
3.40	2.57	0.51	0.89	0.54	0.23	77.36	0.26
3.95	3.07	0.41	2.09			103.59	0.26
3.88	2.83	0.29	2.09		1.82	106.61	0.26
2.95	1.97	0.15	1.20		2.25	100.15	0.27
2.50	7.08	0.08	0.60		3.63	86.09	0.27
3.07	6.81	0.37	1.16		2.32	88.76	0.27
3.11	6.54	0.37	1.16		2.79	87.17	0.28
3.93	1.29	0.51	0.56		1.41	101.72	0.28
3.52	1.87	0.31			0.90	82.98	0.28
6.76	1.70	0.36			0.26	72.93	0.29
6.27	1.65	0.47			0.26	47.91	0.29
6.10	2.27	0.29			0.26	70.60	0.30
2.29	2.62	0.25			0.37	73.24	0.30
2.13	3.77	0.38	0.91		0.79	90.41	0.30
2.30	2.70	0.43	0.91		0.79	76.23	0.31
2.94	3.18	0.61	1.97		0.42	92.27	0.31
2.99	1.90	0.30	1.05			81.80	0.31
3.31	2.74	0.48	2.04			95.80	0.32
3.97	5.00	0.68	3.60		1.37	83.35	0.32
5.25	9.83	0.61	4.68		1.85	89.25	0.32
15.43	17.23	0.45	4.21		1.85	76.25	0.33
14.58	14.32	0.15	2.78		0.49	75.59	0.33

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
13.73	9.33	0.22	2.11			75.72	0.33
2.86	1.33	0.38	3.08			84.34	0.34
2.27	1.39	0.39	2.35		0.41	84.70	0.34
1.33	1.65	0.44	1.95		0.41	82.28	0.35
1.78	2.68	0.66	1.40		0.85	73.45	0.35
2.19	2.71	0.59	2.42		0.43	114.60	0.35
2.65	2.82	0.58	3.79		0.43	107.98	0.36
5.53	5.16	6.73	5.08			112.37	0.36
44.28	61.39	9.76	12.84	0.72	0.94	74.46	0.36
56.52	74.34	11.40	21.49	1.05	2.37	69.62	0.37
71.04	111.60	7.62	59.61	2.40	4.71	66.62	0.37
63.43	73.15	7.20	52.87	2.20	4.68	61.06	0.37
68.05	113.55	6.35	44.67	1.87	3.25	64.09	0.38
55.32	77.99	4.40	8.74	1.04	1.81	54.09	0.38
25.90	62.41	2.61	6.59	0.52	1.51	54.80	0.39
10.38	10.67	1.94	5.58	0.52	1.51	46.15	0.39
5.76	8.84	1.09	1.14		0.61	47.48	0.39
5.16	7.79	0.33	2.04	0.86		45.88	0.40
4.34	10.78	0.66	7.27	1.57		79.62	0.40
5.16	8.98	0.62	8.62	1.57		87.33	0.40
4.71	8.48	0.98	7.39	1.25	0.47	83.56	0.41
4.83	4.53	0.91	2.81	0.55	0.47	62.51	0.41
4.44	3.99	0.91	1.46	0.55	2.34	66.32	0.41
			1.46		1.86		0.42
				3.14	1.86		0.42
			7.94	4.02			0.42
87.12	141.32	7.72	21.49	5.32		92.34	0.43
99.90	186.45	6.70	30.55	4.23	1.77	86.32	0.43
107.96	224.08	9.32	41.15	5.64	2.76	87.30	0.44
236.01	117.32	6.95	33.78	5.97	8.41	79.86	0.44
317.13	108.72	9.73	30.04	3.92	6.64	62.56	0.44
328.15	83.20	10.13	32.68	1.62	5.65	56.25	0.45
145.56	100.14	10.71	31.25	5.01		75.29	0.45
66.53	81.25	51.23	65.67	5.01		68.78	0.45
45.38	85.23	70.88	66.73	7.52		75.77	0.46

Appendix A. (continued)
Cetacean Bulla (PAS11-03): Aurora

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
5.81	5.47	1.43	18.42	1.83	2.07	135.10	0.01
8.23	6.06	0.40	0.61		1.12	128.11	
6.45	5.99	0.58	0.97		1.12	75.42	0.01
6.08	6.05	0.32	1.21	0.67	0.00	51.51	0.02
3.40	8.01	1.43	2.34	0.71	1.03	55.34	0.02
12.38	25.34	2.38	5.40	1.72	1.03	93.76	0.03
12.91	30.81	3.29	8.27	0.81	1.52	134.01	0.03
16.27	38.30	2.71	10.07	1.60	1.82	121.09	0.03
9.31	22.78	2.03	8.53	1.17	1.82	87.65	0.04
11.52	24.10	2.54	7.80	1.18	1.34	59.40	0.04
7.17	17.72	2.25	5.17	0.42	0.55	63.32	0.04
6.85	17.49	2.02	5.40	0.41	0.79	68.91	0.05
6.49	14.73	0.64	3.97	0.40	0.79	85.68	0.05
6.06	10.89	0.50	5.17	0.60	0.39	89.05	0.05
8.32	17.75	1.12	3.07	0.92	0.15	122.96	0.06
6.83	16.24	1.12	2.11	0.96	0.15	97.44	0.06
7.41	18.96	1.24	1.21	1.21	0.37	103.84	0.06
8.16	13.44	0.96	1.52	0.33	0.65	127.11	0.07
9.06	13.98	0.93	2.04	1.21	0.65	146.04	0.07
11.18	13.15	0.74	3.22	0.77	0.98	169.44	0.08
11.24	15.90	1.39	5.18	1.93	1.21	174.57	0.08
10.21	14.34	1.44	4.35	1.35	1.21	176.52	0.08
9.21	13.70	2.19	5.98	1.33	0.51	189.51	0.09
5.40	9.31	1.21	3.99	0.18		159.28	0.09
4.58	7.94	1.07	4.76	0.61	0.65	231.53	0.09
3.03	8.94	0.55	1.34	0.61	0.65	221.24	0.10
2.14	7.32	0.36	1.25	0.63	0.65	206.89	0.10
2.62	7.81	0.75	0.19			158.35	0.10
2.22	4.92	0.53	0.19			180.82	0.11
2.39	4.34	0.72				190.27	0.11
1.73	2.09	0.32				186.14	0.11
1.47	1.94	0.28	1.23			183.15	0.12
1.55	3.01	0.05	1.23			195.19	0.12
1.12	3.18		1.23			193.00	0.13
2.03	3.98	0.18				181.33	0.13

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1.68	2.90	0.24				165.43	0.13
1.55	2.36	0.24	0.23	0.69		136.17	0.14
0.46	1.02	0.10	0.23	0.73		110.48	0.14
0.51	1.06	0.04	0.23	0.35		161.75	0.14
0.85	0.88	0.04	0.49			187.00	0.15
1.01	1.20	0.15	1.40			217.45	0.15
0.78	0.80	0.15	1.40			157.57	0.15
1.34	1.15	0.15	0.92			244.32	0.16
1.29	0.80					216.98	0.16
1.30	0.68					235.02	0.16
0.48	0.40	0.06				157.51	0.17
0.33	0.39	0.06				148.87	0.17
0.47	0.70	0.06		0.67		158.37	0.18
0.50	0.91	0.04		0.68		114.21	0.18
0.39	0.72	0.04	0.68	0.67		128.97	0.18
0.16	0.42	0.09	0.68			112.53	0.19
0.27	0.21	0.04	0.68			131.30	0.19
0.38	0.07	0.04				120.86	0.19
0.73	0.33	0.14				123.24	0.20
0.66	0.26	0.14				123.68	0.20
0.63	0.52	0.14	0.42			117.59	0.20
0.28	0.31	0.09	0.42			110.37	0.21
0.08	0.31	0.09	0.42	0.27		102.38	0.21
0.12	0.30	0.09		0.28		95.08	0.21
0.26	0.25	0.06		0.27		80.92	0.22
0.26	1.30	0.06			0.43	48.56	0.22
0.29	1.13	0.06			0.43	54.37	0.23
0.15	3.06	0.00			0.43	107.01	0.23
0.92	2.27		0.86			137.32	0.23
1.48	2.78	0.28	0.86			159.99	0.24
1.67	0.91	0.28	0.86			119.99	0.24
1.19	0.65			0.88		142.45	0.24
0.48	0.42			0.87		133.33	0.25
0.29	0.36	0.18		0.87		134.82	0.25
0.16	0.67	0.18				122.53	0.25
0.22	1.06	0.18				117.44	0.26
0.78	1.41					151.03	0.26
1.01	1.72					131.74	0.26

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1.56	1.41					129.21	0.27
1.04	1.30					101.45	0.27
0.92	0.82	0.05				121.13	0.28
0.32	0.58	0.05				152.05	0.28
0.34	0.56	0.05				151.20	0.28
0.30	0.65					140.76	0.29
0.52	1.14	0.06				128.83	0.29
0.52	1.13	0.09				97.63	0.29
0.41	1.52	0.09				94.48	0.30
0.81	0.91	0.03				91.27	0.30
0.96	1.22	0.12	0.75			123.53	0.30
1.04	0.86	0.12	0.75			123.63	0.31
0.84	0.96	0.48	0.75			123.12	0.31
0.61	1.92	0.35				99.40	0.31
0.43	1.72	0.35			0.21	97.34	0.32
0.22	1.75				0.21	99.38	0.32
0.22	0.54	0.06			0.21	106.12	0.32
0.52	0.91	0.06			1.87	115.23	0.33
0.55	0.69	0.06			1.87	78.68	0.33
1.01	2.05				1.87	97.17	0.34
0.90	1.77	0.11				101.18	0.34
1.21	2.05	0.11		0.78		114.82	0.34
1.20	0.41	0.11	0.45	0.80		125.88	0.35
1.37	0.55		0.45	0.78		118.17	0.35
2.97	0.87		0.45	0.76		184.22	0.35
2.69	1.17			1.10		142.37	0.36
2.40	1.42			1.12		140.46	0.36
0.64	1.38			0.19		65.74	0.36
1.00	1.63	0.07				90.70	0.37
2.60	1.94	0.07		0.22		88.74	0.37
2.75	1.93	0.13		0.20		105.59	0.37
3.19	1.88	0.06		0.22		96.54	0.38
2.98	1.59	0.06		0.73		111.18	0.38
2.79	1.65	0.15		0.74		100.05	0.39
2.06	3.30	0.15		0.73		128.08	0.39
0.77	2.92	0.28				124.80	0.39
1.46	2.56	0.14				112.93	0.40

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
1.42	1.45	0.31	1.03		0.47	79.25	0.40
1.64	2.30	0.17	1.03		0.47	67.83	0.40
0.75	2.85	0.17	1.03		0.47	98.09	0.41
0.96	1.92			0.30	0.94	104.55	0.41
1.32	2.42		0.42	0.30	1.32	97.02	0.41
1.59	1.73	0.09	0.42	0.34	2.29	69.76	0.42
1.96	2.95	0.09			1.35	84.74	0.42
1.21	2.01	0.09			0.97	87.33	0.42
1.05	5.69					99.49	0.43
237.63	11.45	0.72	4.38			146.88	0.43
239.97	11.54	0.72	4.38			205.38	0.44
239.89	9.60	0.79	4.38			198.77	0.44
3.92	3.83	0.49	1.00			133.18	0.44
2.12	3.38	0.49	1.00			87.36	0.45
2.15	1.63	0.41	1.00			82.54	0.45
1.90	1.38	0.26	1.05			84.17	0.45
2.04	1.75	0.39	1.57			74.48	0.46

Dugonid Rib (PAS11-04): Torreya Formation

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
389.10	578.81	67.89	455.64	51.28	59.35	313.38	0.00
261.86	315.31	48.52	384.34	32.37	39.15	293.49	0.01
200.27	218.11	35.89	344.34	26.48	33.90	272.80	0.01
149.07	409.49	29.31	139.57	20.84	19.93	287.78	0.01
131.78	407.15	23.30	125.87	19.85	19.64	325.63	0.02
142.34	395.70	28.94	117.41	16.33	14.93	353.16	0.02
110.68	145.51	34.28	46.05	15.53	11.57	368.83	0.03
96.58	173.63	32.49	48.30	15.52	12.03	334.36	0.03
129.60	206.64	34.26	61.23	16.74	16.64	383.17	0.03
127.13	203.13	24.67	67.20	15.02	14.51	353.21	0.04
110.67	150.73	22.43	53.36	10.31	12.73	350.28	0.04
49.81	114.58	12.52	38.89	8.74	11.18	297.21	0.04
34.02	138.67	8.82	22.13	5.87	7.53	255.69	0.05

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
36.56	119.76	9.26	22.93	6.35	4.13	226.18	0.05
29.72	96.03	7.64	14.54	3.13	0.82	213.27	0.06
33.56	52.69	8.19	16.32	3.57	1.37	217.80	0.06
38.77	59.04	6.21	18.99	2.24	2.53	220.84	0.06
51.08	121.32	4.83	26.84	1.87	3.97	322.58	0.07
60.47	134.81	3.97	29.70	2.37	3.41	349.02	0.07
45.25	111.69	8.05	26.30	2.55	2.26	290.96	0.07
35.73	52.03	7.53	21.38	3.08	2.07	165.10	0.08
22.40	34.32	6.54	17.74	2.96	3.49	179.16	0.08
87.98	61.07	7.87	53.62	16.34	12.16	263.19	0.08
189.37	119.51	18.31	63.56	22.13	18.36	299.79	0.09
268.35	160.22	34.85	72.91	23.47	18.46	265.26	0.09
252.75	169.35	35.14	41.22	12.41	12.94	238.67	0.10
172.30	120.19	28.62	36.67	9.22	6.88	194.06	0.10
92.81	185.73	12.38	35.53	6.98	7.37	174.28	0.10
60.03	182.02	7.52	32.13	4.48	5.90	137.73	0.11
38.76	168.84	3.64	22.88	2.17	5.01	158.10	0.11
88.55	89.76	3.93	12.90	9.65	3.86	281.78	0.11
79.49	92.87	3.21	11.61	10.86	6.12	363.49	0.12
86.65	119.04	3.87	12.58	14.71	7.39	372.24	0.12
37.29	131.30	4.13	14.04	9.09	7.86	292.85	0.12
30.88	94.90	4.44	13.19	7.91	7.45	228.55	0.13
24.85	87.05	4.17	10.99	4.28	8.42	251.02	0.13
30.94	61.63	6.98	11.09	5.11	9.42	276.62	0.14
35.73	65.13	6.08	16.64	6.12	6.60	383.86	0.14
35.46	48.18	6.30	17.13	6.00	3.79	334.19	0.14
28.70	25.70	3.40	17.75	2.48	1.97	282.69	0.15
21.51	21.20	3.18	9.05	0.77	1.26	173.96	0.15
20.37	29.83	2.47	12.86	3.88	0.52	273.54	0.15
19.40	32.61	2.39	12.36	3.89	0.46	316.89	0.16
25.21	52.31	4.73	14.62	4.37	2.78	322.78	0.16
28.24	73.71	5.99	17.35	2.50	5.45	287.93	0.17
39.23	84.09	6.90	17.11	5.24	5.55	379.23	0.17
42.73	69.75	5.21	18.07	5.93	3.87	386.41	0.17
51.29	63.61	7.74	32.26	7.90	3.26	495.92	0.18
44.88	79.70	10.51	35.08	8.26	2.69	371.91	0.18
42.03	103.47	11.12	33.42	7.10	2.06	360.73	0.18

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
33.77	85.72	7.18	14.93	4.46	1.25	240.71	0.19
29.13	65.49	2.62	10.46	2.35	1.25	223.73	0.19
27.41	41.59	1.21	13.24	2.35	4.17	243.22	0.19
26.77	45.97	1.85	17.31	2.50	3.60	218.64	0.20
30.55	43.16	2.25	15.95	2.17	4.71	250.66	0.20
25.49	50.37	2.53	12.31	3.83	2.47	200.56	0.21
21.37	41.85	1.57	6.34	5.26	2.42	222.64	0.21
15.77	36.90	1.08	7.06	5.68	1.31	190.00	0.21
15.24	22.59	1.04	5.16	4.04	1.20	196.04	0.22
16.13	16.36	1.31	3.99	0.98	2.38	181.87	0.22
14.16	14.84	1.24	4.47		4.62	192.64	0.22
17.14	15.89	2.40	6.76		6.81	210.04	0.23
20.62	19.92	2.79	8.33	3.42	9.41	197.40	0.23
21.22	19.47	2.54	5.98	4.89	8.39	184.43	0.24
20.64	20.19	1.09	3.74	4.87	7.51	185.24	0.24
17.45	15.36	0.47	1.52	1.32	4.76	177.89	0.24
17.42	14.52	0.53	1.91		3.91	186.23	0.25
14.34	11.13	1.14	1.88	0.56	3.83	180.03	0.25
11.15	10.94	1.37	2.14	0.59	4.33	157.84	0.25
13.39	13.62	2.89	6.52	6.02	4.86	183.33	0.26
24.82	19.01	2.23	8.00	5.27	6.08	308.25	0.26
25.57	18.95	2.38	10.85	5.25	6.95	366.61	0.26
30.41	20.34	1.57	6.87		6.05	385.08	0.27
20.83	15.36	2.15	9.33		3.65	324.32	0.27
20.62	17.82	2.29	5.35	0.42	0.62	312.85	0.28
13.75	14.59	1.46	5.49	2.04	0.62	282.16	0.28
13.63	14.46	1.59	0.92	2.49		226.60	0.28
12.93	14.22	5.61	1.51	1.91	0.56	288.84	0.29
16.18	14.78	6.06	3.18	0.30	3.03	275.73	0.29
17.08	14.89	6.31	3.70		4.03	268.53	0.29
17.33	11.90	2.30	4.27	0.52	4.02	152.05	0.30
17.06	14.23	2.13	3.88	1.35	2.95	139.21	0.30
18.15	16.20	1.46	5.43	2.92	3.26	149.52	0.30
20.36	54.06	1.28	4.27	3.38	5.60	230.29	0.31
16.01	50.26	1.44	3.11	2.97	4.87	228.39	0.31
15.66	52.54	1.62	2.01	2.48	6.34	268.05	0.32
13.40	15.02	1.80	2.01	1.35	3.45	242.21	0.32

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
22.85	19.57	1.70	2.24	3.81	5.22	339.06	0.32
17.38	13.14	1.25	1.27	2.75	2.43	253.61	0.33
51.63	41.13	7.56	5.75	13.01	32.34	514.67	0.33
151.98	761.41	15.71	46.35	12.98	35.08	640.83	0.33
195.75	867.91	21.12	71.61	15.53	39.83	704.31	0.34
212.90	969.91	30.74	113.20	5.27	24.15	447.10	0.34
117.95	309.35	29.56	80.03	3.55	23.59	223.38	0.35
122.25	373.43	28.74	65.61	3.30	21.42	285.17	0.35
100.54	363.22	13.98	40.32	7.26	10.49	275.63	0.35
116.93	332.32	7.76	42.26	9.54	7.57	292.32	0.36
77.62	234.54	3.39	42.17	7.20	5.77	334.06	0.36
81.77	123.64	5.51	24.55	8.04	3.47	354.71	0.36
77.60	126.56	4.99	18.61	13.66	2.52	402.95	0.37
70.87	54.74	5.17	8.87	14.84	3.19	260.24	0.37
40.09	46.85	3.73	21.11	10.74	2.19	271.85	0.37
16.88	13.37	4.15	18.35	2.46	2.06	234.48	0.38
16.02	64.73	4.28	18.96	1.30	2.68	274.31	0.38
10.34	67.00	1.95	3.96	0.61	3.80	235.69	0.39
11.30	66.41	3.45	2.68		3.82	266.15	0.39
13.79	71.53	3.44	3.63	0.86	2.58	215.99	0.39
35.36	105.72	10.18	6.60	4.70	9.77	140.09	0.40
61.08	133.04	12.61	13.94	8.11	11.14	99.48	0.40
82.28	125.54	16.07	31.29	12.21	14.02	141.57	0.40
94.61	149.68	19.20	46.28	9.15	9.73	226.27	0.41
92.82	176.48	21.34	57.40	8.68	11.58	241.61	0.41
10.09	3.19	0.55	6.33	11.72	1.67	301.46	0.42
9.74	6.52	1.13	8.07	11.72	1.87	316.30	0.42
11.41	8.81	1.48	5.11	11.72	6.08	285.32	0.42
8.55	10.02	0.92	1.74		3.26	234.73	0.43
7.80	8.71	0.48			4.17	195.94	0.43
7.92	8.82	0.47	1.03		4.24	280.83	0.43
8.56	8.16	0.47	3.14		4.24	281.20	0.44
9.69	8.94	1.36	5.22	3.58	3.44	355.18	0.44
23.31	7.85	1.15	4.18	5.47		324.88	0.44
24.58	8.76	1.43	3.19	5.47	0.13	295.51	0.45
22.68	8.28	1.02	1.11	2.75	2.32	255.56	0.45
8.78	11.90	1.78	1.88	1.74	5.27	189.40	0.46
6.98	15.45	1.69	1.88	1.74	4.74	213.61	0.46

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
7.03	17.13	1.17	2.49	0.88	3.20	226.41	0.46
7.24	25.75	0.65	1.72	1.28	0.82	229.56	0.47
7.38	21.70	0.97	0.60	1.28	0.78	337.88	0.47
7.24	20.49	1.01	0.43	1.28	0.23	309.17	0.47
5.43	7.20	0.77	0.69		0.00	279.46	0.48
6.22	9.35	0.39	3.63		2.81	193.45	0.48
7.15	8.59	0.62	3.95		3.18	191.39	0.48
9.28	11.49	0.71	5.03	0.77	3.50	290.15	0.49
7.57	10.98	1.00	3.34	0.77	0.75	349.78	0.49
8.05	10.23	0.81	5.62	0.77	0.75	326.71	0.50
7.44	10.33	0.87	4.84		0.13	260.98	0.50
7.25	8.44	0.63	3.59		0.64	162.03	0.50
5.74	9.00	0.49	0.56		0.90	157.90	0.51
4.66	6.95	0.46	0.75		3.01	165.41	0.51
5.38	5.80	0.37	0.75	0.48	2.50	187.10	0.51
7.34	5.99	0.49	1.27	0.48	2.36	295.56	0.52
7.45	5.14	0.35	2.48	0.48	2.10	256.88	0.52
8.30	5.83	0.78	4.39		4.66	230.46	0.53
15.24	9.66	1.35	5.66		4.95	254.45	0.53
17.03	27.83	1.54	5.52		4.76	330.21	0.53
19.95	31.63	2.49	4.40		2.14	363.10	0.54
12.31	27.43	1.75	4.17	0.59	1.84	269.82	0.54
9.13	9.20	1.77	2.36	1.13	1.09	171.19	0.54
5.05	5.98	0.78	1.56	1.13	1.79	201.90	0.55
4.87	7.79	1.17	3.17	2.35	1.25	262.46	0.55
6.00	7.48	1.94	3.17	1.82	0.86	279.05	0.55
6.13	15.79	1.46	5.15	2.57	0.81	269.91	0.56
5.82	14.14	1.65	4.33	1.42	0.84	175.10	0.56
6.20	16.49	0.69	5.78	1.42	2.38	178.33	0.57
9.17	6.68	0.69	7.37	0.67	6.21	182.31	0.57
8.88	6.71	0.19	5.46	1.01	6.24	196.36	0.57
8.52	7.03	0.20	4.77	1.01	4.15	210.59	0.58
5.23	7.76	0.26	1.59	1.01		141.51	0.58
4.50	7.04	0.44	2.66	0.86	3.29	195.03	0.58
3.09	4.43	0.45	2.32	0.86	3.74	184.70	0.59

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
3.34	3.84	0.45	4.04	0.86	3.74	190.28	0.59
5.96	5.43	0.36	3.47	1.08	0.10	167.31	0.60
8.21	7.62	0.95	4.54	1.93		203.43	0.60
8.30	9.07	1.24	2.95	1.93	1.18	234.98	0.60
6.51	8.36	1.81	5.79	0.84	1.23	226.05	0.61
5.78	7.55	1.29	4.32	2.00	1.69	196.42	0.61
6.68	9.01	1.70	5.10	2.00	1.38	199.29	0.61
12.58	9.69	1.98	3.77	4.82	1.28	271.56	0.62
11.71	8.66	1.92	5.18	2.81	2.21	289.61	0.62
13.42	9.64	1.28	6.11	2.81	4.52	345.76	0.62
7.00	7.66	0.28	5.33	0.47	4.66	289.34	0.63
8.40	7.23	0.25	6.29	0.47	3.70	280.88	0.63
5.55	6.35	0.85	4.76	1.31	0.18	192.41	0.64
9.72	16.97	1.36	6.22	2.02	1.06	240.29	0.64
10.23	17.97	1.79	3.85	2.80	1.93	314.19	0.64
12.44	17.89	1.29	4.44	1.96	1.88	318.79	0.65
8.91	8.38	0.95	2.92	0.78	1.99	235.99	0.65
10.12	8.37	0.94	2.92		3.05	151.30	0.65
8.70	8.16	0.92	4.01		3.06	189.79	0.66
9.83	7.79	0.83	2.41	0.60	3.04	218.31	0.66
6.13	6.94	0.44	3.36	1.14	0.73	195.95	0.66
6.15	6.60	0.24	3.37	1.83	1.30	222.94	0.67
4.74	6.46	0.48	5.36	1.23	1.54	275.76	0.67
7.01	7.39	0.33	6.09	0.69	1.53	344.42	0.68
6.12	5.58	0.33	4.43	1.32	1.72	324.25	0.68
6.00	5.87		3.10	2.85	1.09	338.08	0.68
5.12	7.12	0.25	4.48	4.02	2.07	306.50	0.69
7.25	9.30	0.62	6.56	4.66	2.39	371.24	0.69
7.22	9.84	0.97	6.96	3.13	2.29	345.31	0.69
8.70	9.77	1.34	5.32	1.96	3.12	346.70	0.70
7.76	11.33	1.31	4.55	0.47	3.65	290.65	0.70
9.18	11.85	1.18	4.47	0.85	4.12	222.04	0.71
9.47	11.43	0.88	5.03	1.75	3.08	217.42	0.71
10.97	11.13	1.28	6.92	3.23	3.10	233.60	0.71
11.29	14.05	1.58	7.73	2.85	2.13	235.54	0.72
11.05	16.34	1.40	6.60	1.95	1.38	327.46	0.72
10.13	15.00	1.35	3.62	1.12		276.75	0.72

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
10.88	11.70	1.15	2.46	1.12	0.44	279.76	0.73
15.68	10.77	1.38	2.97	1.63	1.29	223.65	0.73
15.13	10.98	1.19	2.76	2.26	2.37	220.33	0.73
16.76	13.76	1.84	7.37	3.77	2.94	258.96	0.74
11.51	13.63	2.74	7.12	3.25	2.59	202.08	0.74
13.52	20.83	2.59	7.43	5.20	3.01	225.27	0.75
9.86	18.54	1.87	3.72	4.04	3.00	178.83	0.75
10.87	22.61	0.94	3.29	4.82	5.06	418.23	0.75
15.68	22.48	2.76	4.21	4.17	11.06	450.96	0.76
44.28	72.72	5.10	10.29	7.86	14.87	520.44	0.76
185.56	388.70	19.21	75.69	13.41	20.14	441.40	0.76
226.79	422.11	25.18	89.82	12.91	17.46	537.27	0.77
232.26	570.21	28.50	156.76	12.06	14.65	524.73	0.77
122.91	405.82	19.35	101.61	13.51	9.78	406.70	0.78
118.13	382.29	16.46	103.78	11.85	8.95	290.97	0.78
89.97	199.80	12.06	35.07	10.43	9.12	234.43	0.78
71.56	75.42	8.29	36.14	2.65	7.27	280.72	0.79
34.85	85.10	5.21	23.69	1.77	6.78	314.95	0.79
28.26	72.91	4.75	19.38	0.25	5.08	290.76	0.79
15.46	40.92	3.63	10.54	1.87	4.98	243.55	0.80
22.12	19.36	4.59	8.78	6.27	5.15	145.84	0.80
105.78	199.60	30.45	99.80	24.39	10.82	374.24	0.80
137.82	321.46	47.74	146.61	31.10	10.85	314.11	0.81
359.55	726.08	93.45	337.37	35.31	103.34	1172.92	0.81
348.50	725.66	89.64	320.71	23.27	104.55	1053.41	0.82
504.68	872.52	80.73	363.41	21.70	109.76	1213.69	0.82
310.52	495.76	36.01	174.33	15.56	14.28	450.86	0.82
263.32	433.45	19.61	106.46	13.55	10.81	420.65	0.83
130.07	381.07	21.57	98.83	15.93	16.86	364.27	0.83
109.33	362.60	19.65	98.68	16.29	20.46	415.36	0.83
184.91	428.42	18.59	120.96	17.37	22.59	347.78	0.84
240.46	487.54	52.45	76.01	21.38	15.57	493.08	0.84
254.74	524.21	52.08	96.89	18.56	12.14	600.06	0.84
243.74	476.24	129.83	94.52	20.30	11.67	977.70	0.85
344.30	197.18	146.41	194.85	32.36	35.60	1025.63	0.85
366.43	326.07	159.78	203.67	36.05	36.11	892.32	0.86
388.70	270.90	81.79	185.73	34.03	36.72	686.09	0.86

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
240.35	292.87	26.29	123.87	34.38	14.08	596.35	0.86
203.24	122.01	11.64	100.94	32.16	17.58	503.88	0.87
186.62	140.53	13.14	119.64	30.22	12.27	441.91	0.87
419.54	683.59	51.69	173.19	37.82	21.44	660.62	0.87
499.41	954.18	84.34	260.96	54.36	26.67	604.65	0.88
498.17	993.72	95.76	322.82	58.12	33.01	745.77	0.88
265.73	540.60	63.40	230.68	30.34	22.67	289.53	0.89
245.93	385.72	45.27	195.83	18.51	18.96	434.29	0.89
220.52	122.23	20.71	87.67	16.84	20.43	410.90	0.89
73.78	147.99	13.51	60.58	23.48	16.91	407.57	0.90
89.34	94.33	14.79	63.11	20.80	22.87	480.71	0.90
82.05	76.86	12.15	59.02	21.58	17.56	343.04	0.90
69.33	69.08	10.51	42.27	19.77	16.28	345.58	0.91
34.27	51.24	8.52	25.91	17.68	3.24	442.49	0.91
28.02	48.96	7.13	34.25	21.13	3.41	481.25	0.91
105.74	267.96	9.87	58.70	14.03	19.79	575.18	0.92
195.67	653.17	27.69	165.90	38.33	28.94	451.31	0.92
299.10	971.39	58.51	229.84	36.31	40.49	611.42	0.93
268.75	846.76	57.33	206.40	30.94	26.51	493.41	0.93
216.01	672.88	42.28	107.34	21.84	22.11	588.65	0.93
111.70	350.69	12.01	33.45	18.10	8.82	368.82	0.94
74.26	265.81	10.41	28.21	18.12	15.33	436.69	0.94
36.02	58.11	7.86	24.23	3.92	13.00	261.44	0.94
30.07	50.67	6.34	21.61	2.00	13.62	244.20	0.95
21.26	37.20	5.77	11.91	2.72	7.38	181.31	0.95
23.60	41.62	6.10	24.62	8.73	4.96	212.92	0.96
48.55	63.94	8.50	47.37	10.96	7.60	819.16	0.96
57.62	78.97	8.98	59.86	13.88	8.26	852.77	0.96
59.62	73.34	7.90	43.86	8.02	9.22	812.54	0.97
43.49	61.90	6.80	22.46	9.01	5.82	248.80	0.97
30.29	41.50	5.11	9.16	5.15	3.62	245.06	0.97
26.92	49.98	5.17	5.93	3.94	4.00	263.44	0.98
19.77	37.54	3.35	6.71	1.55	4.02	231.67	0.98
16.97	31.73	2.83	5.66	2.68	2.63	212.14	0.98
14.53	22.23	2.84	8.48	7.05	4.87	402.33	0.99
84.94	181.37	8.65	19.59	7.07	4.89	479.73	0.99
144.83	257.17	9.98	52.17	9.67	4.26	598.58	1.00

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
189.72	506.32	57.64	69.20	7.91	4.18	426.08	1.00
354.40	833.15	104.84	162.97	34.36	27.74	302.39	1.00
758.64	1122.30	166.70	277.49	76.37	48.41	986.82	1.01
798.88	919.48	135.38	275.17	77.49	47.99	1181.51	1.01
601.71	451.31	82.92	175.09	51.06	25.19	1269.90	1.01
142.51	92.84	19.24	34.96	4.17	4.51	533.19	1.02
58.86	43.23	1.77	14.64	2.32	2.20	324.25	1.02
22.10	22.48	0.82	12.70	1.39	0.74	360.09	1.02
19.64	16.03	0.44	11.58	1.33	2.96	351.86	1.03
21.22	16.40	1.14	15.75	1.44	3.01	404.67	1.03
17.44	23.95	2.40	15.86	4.83	3.01	421.58	1.04
17.54	24.07	3.11	12.21	4.89	0.79	382.78	1.04
13.71	24.08	2.66	11.58	3.03		280.31	1.04
16.86	29.42	6.54	16.54	10.23	10.30	352.32	1.05
25.39	317.99	6.74	22.20	16.62	13.50	467.54	1.05
28.93	321.81	7.64	31.46	18.99	13.50	544.19	1.05
28.81	318.66	2.72	24.30	8.39	5.51	485.56	1.06
17.26	37.19	3.63	16.46	2.90	2.31	345.18	1.06
15.30	36.18	4.11	9.81	0.48	3.15	307.42	1.07
13.04	25.64	4.75	8.28	0.55	2.84	313.47	1.07
35.11	20.50	3.47	15.01	0.43	7.33	369.67	1.07
34.43	16.68	3.13	16.53	0.44	8.12	484.96	1.08
33.62	19.28	3.95	18.41	0.44	6.12	402.04	1.08
12.18	21.02	3.50	11.68	0.41	2.85	337.29	1.08
12.09	23.05	2.82	5.48	0.43	3.36	205.11	1.09
16.73	20.84	2.49	3.82	1.68	4.46	294.05	1.09
16.75	25.17	2.39	11.85	1.77	4.63	459.43	1.09
14.06	18.72	1.65	12.67	2.13	2.73	413.23	1.10
8.83	18.11	0.63	15.24	0.89	3.38	407.81	1.10
12.96	15.83	1.17	11.86	0.11	2.31	234.87	1.11
16.35	23.61	2.60	10.59	2.11	7.07	365.15	1.11
14.41	23.27	2.24	7.01	2.64	7.00	259.53	1.11
9.59	19.55	2.43	3.10	6.00	8.81	320.62	1.12
10.16	18.99	2.51	2.95	4.65	4.66	318.60	1.12
13.68	25.09	2.51	3.44	9.27	3.84	354.82	1.12
12.69	22.44	2.13	3.00	6.61	2.58	315.31	1.13
9.07	15.22	0.63	3.32	5.66	2.88	190.64	1.13

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
9.02	22.65	1.30	4.86	1.42	4.41	176.28	1.14
42.69	28.48	2.19	22.13	7.37	5.93	175.10	1.14
99.44	61.68	5.16	25.28	12.34	6.86	249.88	1.14
100.65	50.94	5.38	34.71	14.14	9.79	224.47	1.15
70.81	49.38	4.76	22.13	7.35	8.58	287.19	1.15
16.07	17.10	2.60	18.48	2.34	7.18	291.61	1.15
12.82	13.50	2.42	6.88	0.29	2.41	290.29	1.16
10.36	13.12	2.06	2.64	1.24	4.15	211.45	1.16
13.83	17.74	5.18	1.93	3.76	3.47	199.11	1.16
22.41	23.06	6.23	3.08	4.33	4.02	262.05	1.17
23.00	20.46	6.86	5.22	3.51	1.49	278.97	1.17
21.25	20.13	4.51	9.02	6.42	1.49	292.20	1.18
14.88	16.50	3.37	8.03	5.16	2.95	222.13	1.18
16.22	24.88	4.11	10.81	7.56	3.23	226.03	1.18
16.79	23.33	3.76	11.62	3.15	4.10	166.79	1.19
15.59	23.55	3.84	13.76	3.12	4.03	234.25	1.19
17.98	20.50	3.76	14.37	1.82	5.35	324.40	1.19
43.34	46.60	6.29	22.26	2.32	6.98	350.00	1.20
176.52	104.38	9.24	46.99	21.28	4.50	413.99	1.20
186.68	166.61	9.73	54.67	30.70	5.46	359.97	1.20
172.43	152.73	6.38	42.17	30.93	14.01	323.95	1.21
67.59	130.64	6.70	16.14	11.94	18.18	303.35	1.21
87.16	234.17	7.47	34.21	6.06	17.25	353.79	1.22
159.65	282.40	18.31	73.09	4.00	8.82	536.38	1.22
163.16	253.00	26.61	79.32	5.67	7.32	562.86	1.22
156.96	153.76	27.87	54.58	2.53	9.46	739.14	1.23
94.52	143.59	23.12	42.12	6.58	11.46	773.51	1.23
162.52	247.46	28.88	71.99	15.96	20.95	806.50	1.23
159.63	212.02	27.36	75.08	15.16	17.40	575.17	1.24
134.93	157.95	21.09	50.47	12.30	14.50	357.63	1.24
33.81	46.89	3.08	13.74	2.54	3.83	184.24	1.25
12.65	23.09	2.11	6.88	3.77	5.72	137.51	1.25
14.73	24.69	2.77	8.63	2.86	6.54	170.93	1.25
15.28	22.75	3.87	8.85	1.66	6.75	165.45	1.26
17.09	14.46	2.79	7.35		4.25	233.09	1.26
23.20	21.56	4.43	10.29	0.84	1.70	326.35	1.26
22.37	22.64	3.56	9.96	0.85	0.46	348.19	1.27

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
20.48	19.59	3.33	9.57	4.58	2.76	316.76	1.27
12.82	15.00	1.05	6.58	3.42	2.76	199.01	1.27
13.57	16.51	2.46	8.36	4.13	5.39	267.97	1.28
17.40	30.86	3.99	17.70	3.84	4.04	253.83	1.28
58.06	168.91	8.44	33.65	5.27	13.01	263.98	1.29
83.50	179.36	12.01	59.83	6.49	10.99	267.85	1.29
186.01	233.75	16.03	53.18	7.99	11.07	287.41	1.29
161.09	153.48	19.84	48.09	6.41	3.60	300.85	1.30
142.91	170.40	18.52	21.74	4.08	2.53	237.11	1.30
58.48	120.89	16.59	49.02		1.51	248.21	1.30
136.58	91.34	10.37	43.50	3.22	1.40	541.18	1.31
176.87	221.87	11.70	60.65	4.97	4.15	626.35	1.31
213.94	272.28	19.00	75.04	15.34	8.53	660.39	1.32
243.05	551.29	44.59	139.91	22.14	14.24	516.38	1.32
217.14	436.92	43.12	155.71	26.03	13.24	610.40	1.32
164.13	429.29	39.27	112.79	17.77	9.69	574.07	1.33
54.06	264.15	14.54	45.74	10.50	3.84	521.89	1.33
33.63	222.48	12.09	10.99	5.76	2.90	386.75	1.33
30.10	176.04	7.32	17.72	5.79	3.93	539.71	1.34
71.30	305.41	13.39	42.63	9.98	11.83	515.28	1.34
187.73	524.94	44.02	126.91	15.15	19.55	501.32	1.34
267.69	756.68	62.20	175.73	21.27	26.54	368.12	1.35
388.50	982.32	114.49	431.66	25.92	23.60	315.73	1.35
276.12	970.72	112.87	415.93	25.33	34.46	253.83	1.36
274.99	1026.86	128.72	302.77	25.95	36.28	253.83	1.36
117.14	455.27	42.65	135.71	19.79	28.34	312.87	1.36
116.33	293.63	35.21	85.57	9.32	8.88	59.04	1.37
95.66	812.47	18.05	90.10	34.83	14.53	549.91	1.37
78.97	757.13	12.94	76.73	34.79	10.94	555.18	1.37
47.99	774.42	6.76	75.32	37.71	15.26	637.82	1.38
33.28	35.84	3.03	30.46	11.18	14.06	442.16	1.38
26.73	35.77	3.51	21.52	12.63	15.26	452.78	1.38
19.58	30.07	4.31	8.68	11.58	10.35	503.36	1.39
26.69	48.63	5.81	8.45	3.15	7.70	466.17	1.39
69.97	92.67	18.01	85.89	4.31	6.47	610.31	1.40
169.05	672.89	38.01	231.07	25.08	28.41	804.78	1.40
441.98	977.91	78.87	482.77	32.87	142.22	846.13	1.40

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
422.66	974.11	70.22	430.80	37.58	143.46	775.10	1.41
329.92	401.13	49.63	292.03	14.92	125.19	506.89	1.41
44.66	94.93	8.36	39.51	11.56	8.38	274.47	1.41
21.52	52.64	3.71	10.25	4.25	12.75	230.93	1.42
12.14	34.72	3.20	3.84	4.25	11.22	231.83	1.42
16.04	17.49	3.72			9.11	288.06	1.43
18.28	39.13	3.54	3.56		5.79	261.78	1.43
24.25	61.24	3.91	3.56		7.23	543.88	1.43
18.97	57.44	1.82	4.51		6.61	479.95	1.44
16.66	32.80	1.83	0.95	2.62	7.80	525.11	1.44
19.81	19.09	2.67	0.95	2.64	5.51	235.82	1.44
18.61	16.97	2.61	3.98	4.47	5.37	204.11	1.45
15.07	17.02	2.39	6.24	1.70	2.99	121.50	1.45
6.87	8.69	1.27	6.24	2.82	3.58	92.97	1.45
8.16	7.13	1.85	6.11	2.45	5.25	135.58	1.46
8.87	9.26	1.58	7.00	3.18	4.79	94.81	1.46
35.16	117.88	16.59	16.81	3.66	25.67	139.29	1.47
43.36	231.45	17.72	27.87	6.09	26.00	82.57	1.47
61.25	243.54	26.17	40.49	8.84	27.20	147.47	1.47
78.99	171.82	19.55	58.85	11.12	6.40	295.46	1.48
129.49	189.65	24.08	73.31	16.02	5.84	407.51	1.48
180.90	221.33	38.12	76.14	20.48	9.94	441.01	1.48
148.77	354.33	35.27	51.73	18.73	11.57	371.24	1.49
88.60	226.22	29.67	25.51	11.75	13.14	294.00	1.49
59.00	180.08	8.06	8.40	3.80	15.79	281.06	1.50
47.32	11.02	2.07	9.12	2.96	12.23	181.10	1.50
46.03	9.88	1.34	8.04	1.14	8.46	189.85	1.50
10.07	18.73	1.20	6.55	5.60		192.19	1.51
8.84	19.09	1.02	3.26	4.32		243.78	1.51
15.17	19.25	0.85	12.65	4.29	1.67	333.52	1.51
9.39	8.40	0.81	18.21	1.99	3.46	270.36	1.52
8.91	7.96	1.28	21.31	2.00	3.47	231.78	1.52
18.47	35.81	4.96	34.33	18.42	5.54	352.44	1.52
21.09	36.80	4.99	30.48	18.21	5.36	421.19	1.53
20.83	42.47	5.29	28.53	19.53	5.35	438.77	1.53
5.25	13.92	1.61	10.25	4.90	1.48	270.00	1.54
6.99	14.62	0.77	10.55	2.97	0.83	244.12	1.54

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
8.35	8.74		9.04	1.64	0.84	219.02	1.54
8.67	7.79	0.51	7.49		0.84	201.68	1.55
4.39	7.71	1.22	11.30			288.10	1.55
3.55	7.31	1.57	11.16		1.89	289.51	1.55
8.04	4.75	2.72	10.55	2.16	3.79	468.90	1.56
8.57	8.55	2.69	8.87	2.16	3.80	424.65	1.56
9.35	10.23	2.84	12.79	2.13	4.69	443.07	1.56
4.60	13.75	1.58	9.95	1.24	5.13	304.38	1.57
4.19	9.00	1.33	6.70	3.25	6.80	275.72	1.57
3.23	8.76	1.03	2.08	6.17	11.12	358.90	1.58
3.87	5.09	1.84	1.53	6.33	9.44	328.96	1.58
5.93	7.94	1.81	3.07	5.26	7.79	310.56	1.58
5.58	6.55	2.29	3.91	3.33	0.56	227.63	1.59
4.62	7.33	1.41	3.24	2.54	1.17	183.02	1.59
5.94	4.22	1.67	0.83	1.62	1.94	188.83	1.59
13.49	9.43	2.49	2.61	0.64	5.66	218.09	1.60
15.12	8.40	2.33	6.73		5.38	280.68	1.60
12.51	9.62	1.91	9.64		5.97	280.04	1.61
7.27	7.37	0.74	9.06	2.20	2.24	229.75	1.61
5.94	9.43	1.09	4.94	2.18	1.25	205.50	1.61
5.89	9.69	2.97	7.90	3.53	0.99	213.25	1.62
4.41	8.19	3.95	7.86	3.50	5.77	220.71	1.62
5.21	8.48	3.43	8.73	3.52	8.28	181.55	1.62
4.49	6.32	1.32	3.44	2.21	7.74	123.87	1.63
4.20	6.81		1.44		12.74	251.18	1.63
4.61	5.81	0.17	1.64		11.27	291.73	1.63
4.44	8.78	1.03	7.57		10.69	334.15	1.64
5.54	7.68	1.36	8.56	2.18	4.74	206.28	1.64
4.59	5.80	2.17	8.99	5.62	3.71	184.33	1.65
8.71	3.29	2.07	9.38	8.20	3.68	286.11	1.65
7.35	2.23	1.87	10.00	5.90	0.62	261.98	1.65
6.71	3.70	1.36	8.51	4.11	0.62	294.81	1.66
3.47	4.41	1.09	1.62	1.56	2.08	146.27	1.66
3.71	4.41	1.15	13.39	2.93	1.30	205.11	1.66
5.34	7.65	1.12	14.75	1.28	6.51	203.19	1.67
14.71	25.80	2.18	27.27	1.23	6.56	337.68	1.67
27.39	35.02	2.71	19.14		14.95	297.71	1.68

Appendix A. (continued)

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Gd (ppm)	Yb (ppm)	U (ppm)	Distance (cm)
37.59	189.72	3.99	28.37		15.75	451.35	1.68
47.33	228.52	3.14	24.27	14.29	14.19	352.17	1.68
125.04	282.87	21.89	187.32	13.94	5.53	1076.92	1.69
173.35	276.24	27.48	296.49	13.97		974.50	1.69
166.44	293.92	35.23	456.34	13.13	1.45	1397.34	1.69
83.08	235.53	17.66	295.96	13.48	1.74	690.41	1.70
175.94	110.95	21.24	259.40	17.20	14.36	790.85	1.70
215.50	1341.55	166.89	593.76	101.28	38.19	2118.30	1.70
283.57	2284.00	235.17	706.86	117.07	57.83	2723.89	1.71
198.38	2427.43	232.94	659.84	120.46	47.74	2579.78	1.71
154.75	1177.98	79.62	167.80	28.19	25.43	935.01	1.72
101.94	239.35	9.80	50.32	12.40	5.80	285.26	1.72
65.44	78.46	1.38	26.88	5.28	4.76	306.14	1.72
59.50	31.12	0.73	21.69		2.14	228.22	1.73
37.33	30.98	2.04	23.17	2.18	4.04	263.15	1.73
8.40	24.84	2.21	10.44	2.19	2.55	183.93	1.73
8.84	21.65	4.61	12.73	2.16	3.25	158.41	1.74
9.71	15.65	2.96	9.91		1.33	152.11	1.74
9.95	18.20	2.72	16.00	1.24	4.81	197.95	1.74
7.44	13.12	3.74	9.57	2.70	5.78	203.65	1.75
6.36	10.42	3.74	13.08	4.01	6.86	204.88	1.75
4.25	4.96	3.54	9.14	7.58	5.44	188.16	1.76
6.85	12.27	0.42	9.15	6.13	13.99	206.68	1.76
10.17	121.34	6.61	17.86	8.65	16.08	212.71	1.76
101.48	136.40	11.61	24.74	6.28	19.41	329.25	1.77
183.72	171.59	13.37	67.20	6.28	10.96	712.01	1.77
183.45	64.22	10.30	65.82	2.46	7.79	700.60	1.77
116.01	58.89	10.53	63.16	4.71	4.39	572.11	1.78
75.04	106.12	8.36	31.80	18.51	1.52	1623.35	1.78
224.61	348.67	45.68	112.74	23.87	5.07	2063.48	1.79
336.13	594.55	61.63	135.37	24.28	19.91	2167.70	1.79
367.99	503.00	81.91	142.50	13.04	23.88	754.81	1.79
242.18	283.59	45.73	71.92	9.70	23.66	338.74	1.80
125.78	168.25	26.30	54.59	5.57	13.33	287.19	1.80
54.47	175.70	7.19	69.27	7.59	11.99	244.28	1.80
39.04	224.55	4.39	68.78	8.42	13.05	252.76	1.81