



Isotopes Project

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S.-C. Wu (deceased)

Isotope Project Activities

- Mass chain/Isotope evaluations
- Neutron cross section, k_0 evaluations
- DDEP decay data evaluation
- Basic research
- Applied research



Mass Chain, Isotope Evaluations

Permanent mass chain responsibility: $A=21-30, 59, 81, 83, 90-93, 166-171, 180-187, 189, 191-193, 210-217$

Published: $A=24, 81, 137^*, 166, 169, 214, 240^*$

In the pipeline: $A=25, 30, 93, 145^*, 179, 184, 187, 229^*, 230^*$

Isotope evaluations: $^{170}\text{Os}, ^{170}\text{Ir},$

“Island of Inversion” ($^{28}\text{Ne}, ^{29}\text{Ne}, ^{29}\text{Na}, ^{30}\text{Ne}, ^{30}\text{Na}, ^{30}\text{Mg}$)

Reviewed 3 mass chains

* Funded by the NNDC, $A=240$ in collaboration with McMaster



Evaluated Gamma-ray Activation File (EGAF)

EGAF is an LBNL/IAEA database of thermal neutron capture γ -ray cross sections. Evaluation of the second edition of EGAF is in progress and will include activation data and total radiative neutron cross sections.

Relevant publications:

- *Database of Prompt Gamma Rays from Slow Neutron Capture for Elemental Analysis*, R.B. Firestone, H.D. Choi, R.M. Lindstrom, G.L. Molnar, S.F. Mughabghab, R. Paviotti-Corcuera, Zs. Revay, V. Zerkin, and C.M. Zhou, IAEA STI/PUB/1263, 251 pp (2007).
- *Handbook of Prompt Gamma Activation Analysis with Neutron Beams*, Zs. Revay, T. Belgya, R.M. Lindstrom, Ch. Yonezawa, D.L. Anderson, Zs. Kasztovsky, and R.B. Firestone, edited by G.L. Molnar (Kluwer Publishers, 2004).

See the EGAF database at <http://www-nds.iaea.org/pgaa/pgaa7/index.html>



IAEA CRP - Reference Database for Neutron Activation Analysis

K_0 data from De Corte/Simonits [ADNDT 85, 47-67 (2003)], σ_0 data from Mughabghab (Atlas of Neutron Resonance), and new σ_γ measurements at the Budapest reactor are being evaluated to develop a new k_0/σ_γ database for Neutron Activation Analysis (NAA). See <http://www-nds.iaea.org/naa/index.htmlx> for more information

Cross Section Examples

Target	σ_0 (Mughabghab)	σ_0 (ADNDT)	σ_0 (Budapest)	Comments
^{40}K	30(8)	---	90(3) b	Other value 66(20) b
^{41}K	1.46(3)	1.42(2)	1.73(2) b	
^{55}Mn	13.36(5)	13.25(10)	13.35(14)	
^{79}Br	10.32(5)	7.97(5)	8.97(14) b	
^{70}Zn	0.083(5)	0.022(3) b	---	
^{107}Ag	0.33(8)	---	1.3(1) b	$^{107\text{m}}\text{Ag}$ $t_{1/2}$ 127→418 y



LLNL/LBNL ENDF Neutron Capture Gamma Library

Brad Sleafor Thesis (December, 2007, UC Berkeley) – (R.B. Firestone, advisor) *Improved Neutron Capture Data and Evaluation with Statistical Nuclear Structure Models for Transport Libraries – first nuclear data thesis?*

Neutron Capture Gamma Library project funded FY08-FY10 by NA-22. Data for Z=1-19, 74 completed. Fe and Gd evaluations in progress.

Thermal neutron capture cross sections of the Palladium isotopes, M. Krticka, R.B. Firestone, D.P. McNabb, B. Sleafor, U. Agvaanluvsan, T. Belgya, and Z.S. Revay, Phys. Rev. C 77, 054615 (2008).

New statistical model method developed for determining thermal neutron cross sections σ_0 from incomplete σ_γ data.

$$\sigma_0(^{102}\text{Pd})=1.1(4) \text{ b}$$

$$\sigma_0(^{108}\text{Pd})=0.36(10) \text{ b}$$

$$\sigma_0(^{108}\text{Pd})=0.185(11) \text{ b } (^{109}\text{Pd}^m)$$

$$\sigma_0(^{104}\text{Pd})=0.75(26) \text{ b}$$

$$\sigma_0(^{108}\text{Pd})=7.2(5) \text{ b } (^{109}\text{Pd}^g) \quad \sigma_0(^{110}\text{Pd})=0.34(10) \text{ b}$$

$$\sigma_0(^{105}\text{Pd})=21.7(5) \text{ b}$$



Decay Data Evaluation Project

Contributors 2004-2008 – M.-M. Bé, V. Chisté, C. Dullieu, **E. Browne**, **C. Baglin**, V. Chechev, N. Kuzmenko, R. Helmer, F. Kondev, D. MacMahon, K.B. Lee, A. Nichols, E. Schönfeld, R. Dersch, H. Xiaolong, W. Bausong, M. Galan, A Pearce, A. Luca

E. Browne, DDEP International Coordinator and Editor

Recommended values of nuclear and decay data for 145 radionuclides available from the Bureau International des Poids et Mesures

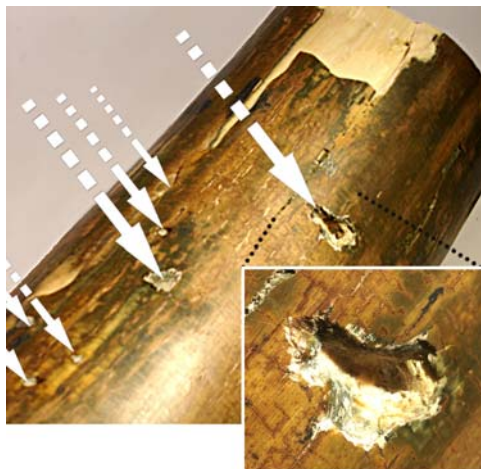
<http://www.bipm.org/en/publications/monographie-ri-5.html>



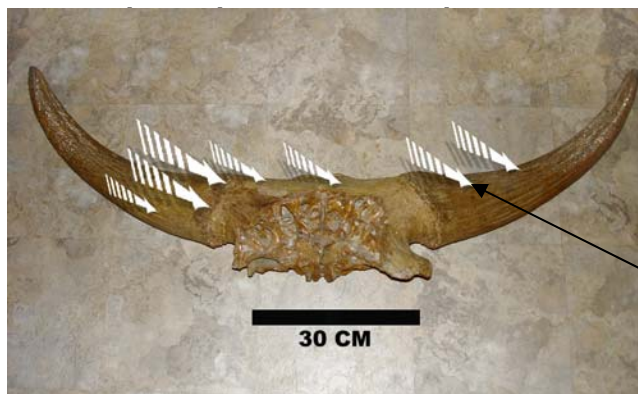
Research Highlight



Micrometeorite Impacts in Beringian Mammoth Tusks and a Bison Skull, R.B. Firestone, A. West, Zs. Stefanka, Zs. Revay, J.T. Hagstrum, 2007 AGU Fall Meeting, San Francisco.



7 mammoth tusks and bison skull dated to 34,000 BP



XRF/ICP-MS Analysis		
	(Ni/Fe)*	(Ti/Fe)*
Tusk 2	415	0.13
Tusk 3	190	0.20
Tusk 4	10	0.17
Tusk 5	22	0.24
Tusk 6	5.6	0.28
Bison	8.5	0.09
Average	109	0.20
Meteorite	110	2.3
Crustal	≅1	45

*Ratio to crustal ratio

PGAA Analysis of Bison Particle			
Z	El	Wt(oxide)	±(%)
1	H	9.0%	3.2
5	B	7.4 ppm	6
6	C	36%	5
7	N	8.4%	4.0
9	F	10.4%	5
11	Na	0.34%	5
14	Si	0.35%	13
15	P	14.5%	3.3
16	S	0.33%	9
17	Cl	82 ppm	5
19	K	250 ppm	20
20	Ca	19.2%	3.0
22	Ti	120 ppm	26
23	V	150 ppm	16
24	Cr	0.08%	14
25	Mn	0.109%	3.9
26	Fe	1.01%	4
28	Ni	400 ppm	18

Mass of Fe=360 μg
Radius of micrometeorite ≈1 mm



Tusk micrometeorite with characteristic burn ring

USNDP Meeting, Brookhaven National Laboratory, November 7, 2008



Research Publications

Nuclear Physics

Lifetime Measurement of the First Excited 2^+ State in ^{16}C , M. Wiedeking, P. Fallon, A.O. Macchiavelli, J. Gibelin, **M.S. Basunia**, R.M. Clark, M. Cromaz, M.-A. Deleplanque, S. Gros, H.B. Jeppesen, P.T. Lake, I.-Y. Lee, L.G. Moretto, J. Pavan, L. Phair, E. Rodriguez-Vietiez, L.A. Bernstein, D.L. Bleuel, J.T. Burke, S.R. Leshner, B.F. Lyles, and N.D. Scielzo, *Physical Review Letters* **100**, 152501, 2008.

Fission-product gamma-ray line pairs sensitive to fissile material and neutron energy, R.E. Marrs, E.B. Norman, J.T. Burke, R.A. Macri, H.A. Shugart, **E. Browne** and A.R. Smith; *Nuclear Instruments and Methods in Physics Research* **A592**, 463 (2008).

Evidence Against Correlations Between Nuclear Decay Rates and Earth-Sun Distance, Eric B. Norman, **Edgardo Browne**, Howard A. Shugart, Tenzing H. Joshi, and **Richard B. Firestone**. Submitted for publication in *Astroparticle Physics*, Elsevier Inc., October 2008.



Research Publications

Applications

Analyses of Oxyanion Materials by Prompt Gamma Activation Analysis, D.L. Perry, G.A. English, **R.B. Firestone**, K.-N. Leung, G. Garabedian, G.L. Molnar, and Zs. Revay, J. Radioanal. Nucl. Chem. **276**, 273-277 (2008).

Prompt gamma activation analysis (PGAA) and short-lived neutron activation analysis (NAA) applied to the characterization of legacy materials, G.A. English, **R.B. Firestone**, D.L. Perry, J.P. Reijonen, Ka-Ngo Leung, G.F. Garabedian, G.L. Molnár, and Zs. Révay, J. Radioanal. Nucl. Chem. **277**, 25-29 (2008).

Evidence for an extraterrestrial impact 12,900 years ago that contributed to the megafaunal extinctions and the Younger Dryas cooling, **R.B. Firestone** et al, Proceedings of the National Academy of Sciences (PNAS) **104**, 16016–16021 (2007). (LBNL-63274)



Invited Talks

- IAEA/ICTP "Workshop on Nuclear Structure and Decay Data: Theory and Evaluation"***, Trieste, 28 April - 9 May, 2008, **E. Browne** and **C.M. Baglin** invited lecturers.
- Study of the (3He,t) Charge Transfer Reaction as a Surrogate for Neutron Energy Between 10 to 20 MeV***, **M. S. Basunia**, CNR* 2007 Compound-Nuclear Reactions and Related Topics, Yosemite Ca, 22-26 October, 2007.
- New Methods for the Determination of Total Radiative Thermal Neutron Cross Sections (σ_0)***, **R.B. Firestone**, CNR* 2007 Compound-Nuclear Reactions and Related Topics, Yosemite Ca, 22-26 October, 2007.
- How Cosmic Catastrophes Killed the Mammoths***, **R.B. Firestone**, New Mexico Museum of Natural History & Science, Albuquerque NM, January 11, 2008.
- How Cosmic Catastrophes Killed the Mammoths***, **R.B. Firestone**, Friends of Archaeology, Santa Fe NM, January 12, 2008.
- How Cosmic Catastrophes Killed the Mammoths***, **R.B. Firestone**, Keynote Address to the Central New York Earth Science Student Symposium, Syracuse University, April 4, 2008.
- The history of recent cosmic impact and its potential role in Holocene rapid climate change***, W.B. Masse, D.H. Abbott, M. Baillie, G. Barrientos, K. Ernstson, **R.B. Firestone**, V.K. Gusiakov, S.K. Haslett, M. A. Rappenglück, International Conference 100 Years since Tunguska Phenomenon: Past, Present and Future, June 26-28, 2008, Moscow.

USNDP Meeting, Brookhaven National Laboratory, November 7, 2008