Alternative methods for flux parameter determination

Possibilities

Nuclear data for Activation Analysis

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Overview

- Once again the adapted Høgdahl convention
- The trouble with the standard methods
- Possible alternatives
  - Homemade mixtures
  - Available materials
  - The Delft - Sao Paulo option
- Conclusions

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Principles of the k_0 method

First conventional approach: adapted Høgdahl

$$R = \sigma_0 \Phi_s + I_0(\alpha)\Phi_e$$

$$= \sigma_0 \Phi_s \left(1 + {Q_0(\alpha)}\big/{f} \right)$$

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Principles of the k_0-IAEA software

Conventional approach: Blaauw + Westcott +threshold

$$R = \sigma_0 g(T)\Phi_t + I_0^*(\alpha)\Phi_e + \sigma_{fast}\Phi_{fast}$$

$$= \sigma_0 \Phi_t \left(g(T) + Q_0^*(\alpha) \big/ f^* \right) + \sigma_{fast}\Phi_{fast}$$

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Single-comparator standardization with detector flexibility and irradiation facility flexibility: The k_0 method

- Neutron capture cross section curve summarized in five parameters: σ_0, Q_0, E_r, σ_{fast} and g(T)
- Neutron spectrum also summarized in four parameters Φ_s, f, α, fast flux and T

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The trouble with the standard methods

- Cd-cover-method takes two samples of identical, complex composition - that's one too many.
- Bare triple-comparator method can only yield three parameters, we need five
- Adding Lu and e.g. Ni to the standard combination of Zr-Au seems a good option
- But foils and wires in one capsule are hard to count together (efficiency, decay, shielding)
- ^{97}Zr appear to be too extreme in its behavior, and not representative for the other high-Q nuclides

Possible alternatives

- Existing materials
  - available alloys that happen to be suitable
  - reference materials
  - SMELS
- Homemade mixtures
  - ground and mixed powders
  - solutions of suitable composition, pipetted on filter paper

An existing alloy

Element	Concentration	Uncertainty
Mn	4100	41
Ni	809300	8093
Mo	151600	1516
W	27600	276
Au	2900	29

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NIST Montana soil

Element	Concentration	Uncertainty
Na	11400	148
Mg	10500	200
Al	65300	457
Si	304400	943
S	420	5
K	24500	392
Ca	28800	403
Sc	9	2.25
Ti	3060	116
V	81.6	1.5
Cr	47	11
Mn	638	14
Fe	28900	289
Co	10	2.5

Element	Concentration	Uncertainty
Ni	20.6	0.55
Cu	114	1
Zn	350.4	2.4
Ga	15	3.75
As	105	4
Se	1.52	0.07
Br	5	1.25
Rb	110	27.5
Sr	245.3	0.34
Y	25	6.25
Zr	230	57.5
Mo	1.6	0.4
Ag	4.63	0.19
Cd	41.7	0.13

Element	Concentration	Uncertainty
In	1.1	0.275
Sb	19.4	0.89
I	3	0.75
Cs	6.1	1.5
Ba	726	18.9
La	40	10
Ce	69	17.3
Nd	31	7.8
Sm	5.9	1.5
Eu	1.1	0.28
Dy	5.6	1.4
Ho	1	0.25
Yb	2.7	0.68
Hf	7.3	1.8

Element	Concentration	Uncertainty
W	3	0.75
Au	0.03	0.0075
Hg	6.25	0.094
Pb	1162	15
Th	14	3.5
U	2.6	0.65

Home-made ground and mixed powders

- Too risky because of segregation
- To be tried only by experienced, trained, professional reference-material makers
- Don't even think of trying this at home!

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Home-made solutions pipetted on filter paper

Delft - Sao Paolo example