In situ cosmogenic nuclides: extraction and measurements

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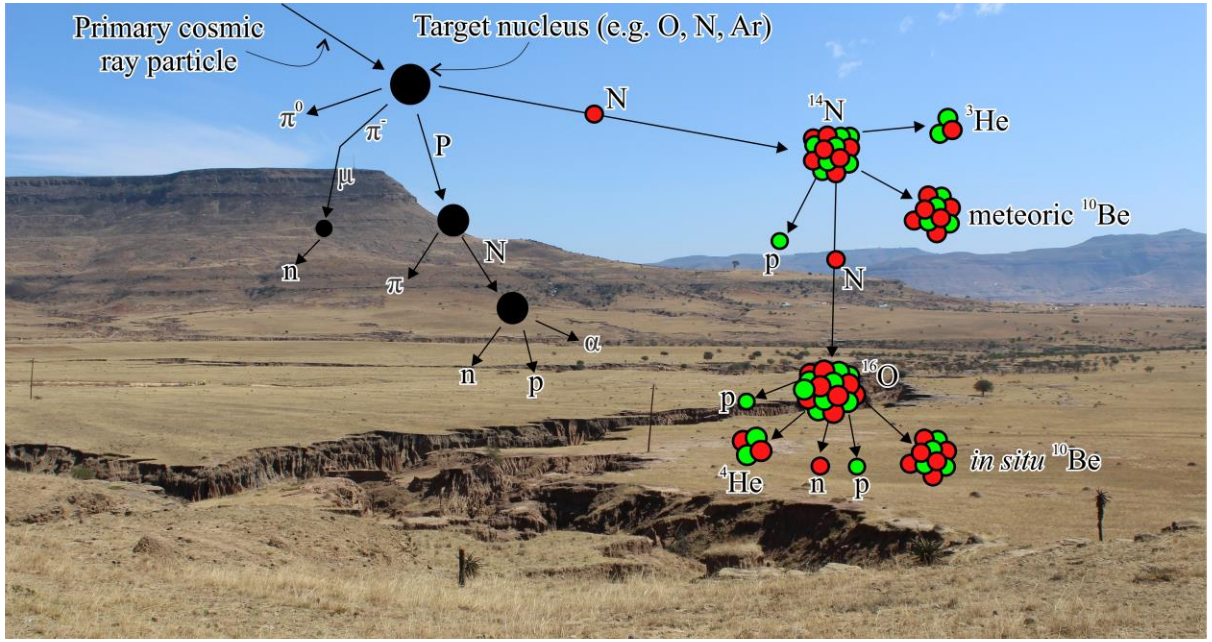
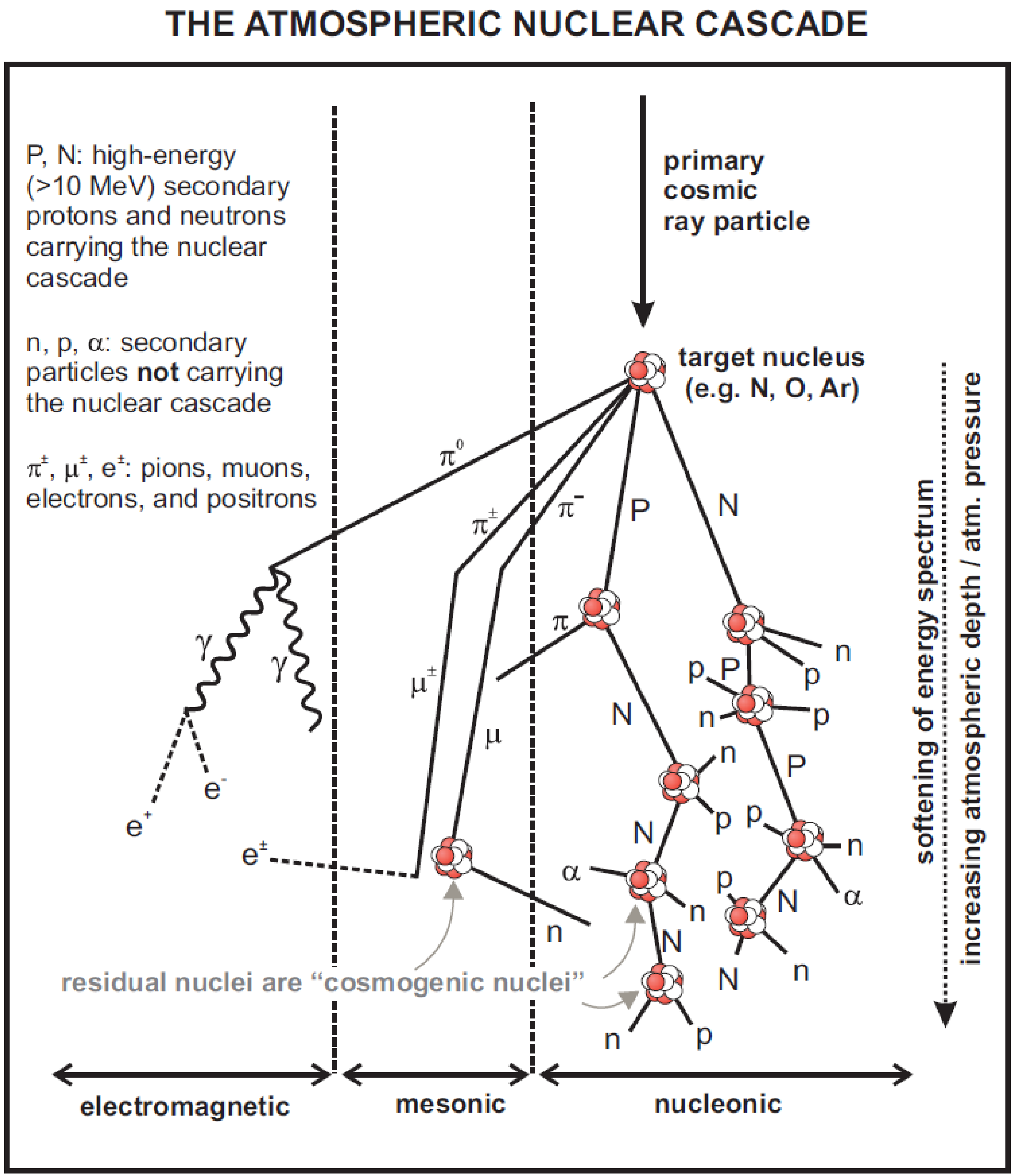
Production of cosmogenic nuclides





Commonly used cosmogenic nuclides in Earth Sciences

Table 1. Cosmogenic nuclides (CNs) commonly used in Earth science applications (adapted from Dunai, 2010).

Isotope	Half-life ($T_{1/2}$)	Main target minerals	Predominant target elements	SLHL production rate (at g^{-1} $year^{-1}$) [e]
^{3}He	Stable	Olivine, pyroxene, other He-retentive minerals	All major elements	75–120
^{10}Be	1.387 ± 0.012 Ma [a]	Quartz (rarely olivine, pyroxene)	O, Si (Mg)	4–5
^{14}C	5730 ± 30 a [b]	Quartz	O, Si	18–20
^{21}Ne, ^{22}Ne	Stable	Quartz, olivine, pyroxene	Mg, Al, Si	18–21
^{26}Al	708 ± 17 ka [c]	Quartz	Si	35
^{36}Cl	301 ± 2 ka [d]	Carbonates, feldspar, (rarely whole rock)	K, Ca, Cl, (Fe, Ti)	70 (Ca), 200 (K)

Half-lives from (a) (Chmeleff et al., 2010; Korschinek et al., 2010 (b) Lederer et al. (1978) (c) Nishiizumi (2004) (d) Holden, 1990). Abbreviations: a = annum, ka = kiloannum, Ma = Megaannum. SLHL (sea level-high latitude) production rates (e) from Von Blanckenburg and Willenbring (2014).

Are there other minerals than quartz (SiO_2) producing ^{10}Be and ^{26}Al by muons and neutrons?

Yes, ...

- Dolostone et al. (e.g. ankerite)
- Chert
- Sediments

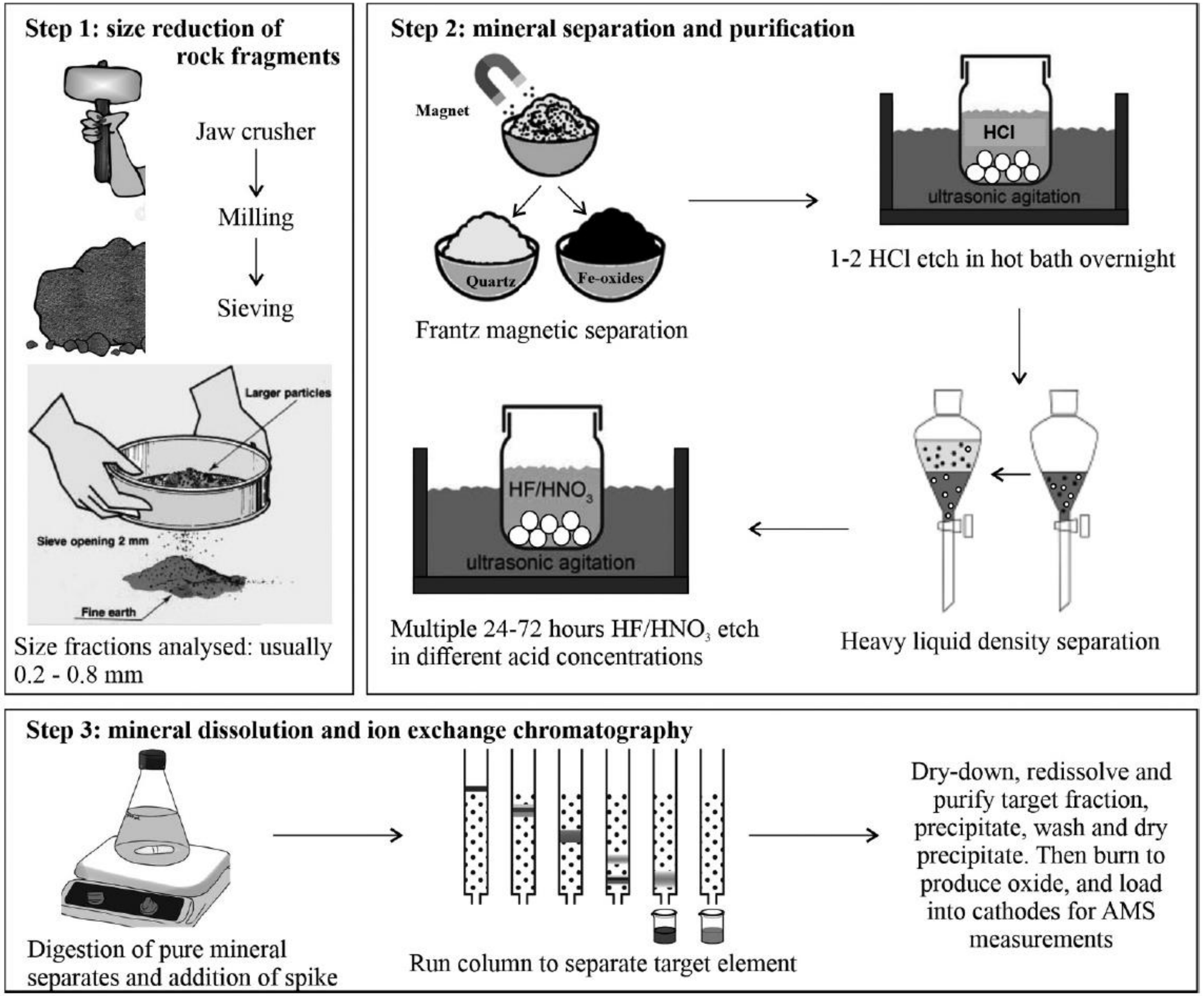
… but major reactions that matter for producing ^{10}Be and ^{26}Al:

Yes, but

Isotope	Primary spallation reactions	Thermal neutron capture	Negative muon capture
^{10}Be	$^{16}O(n,^{3}He\alpha)^{10}Be$ or $^{16}O(n,4p3n)^{10}Be$ $^{28}Si(n,x)^{10}Be$	$^{9}Be(n,\gamma)^{10}Be$	$^{16}O(\mu^{-},\alpha pn)^{10}Be$ $^{28}Si(\mu^{-},x)^{10}Be$
^{26}Al	$^{28}Si(n,2np)^{26}Al$		$^{28}Si(\mu^{-},2n)^{26}Al$

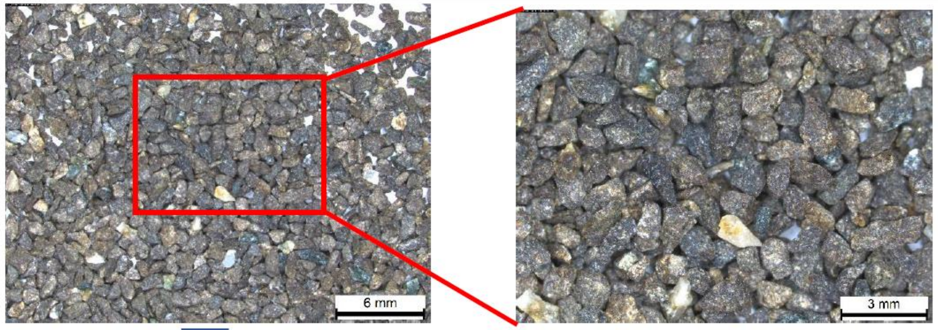
Dunai, 2010

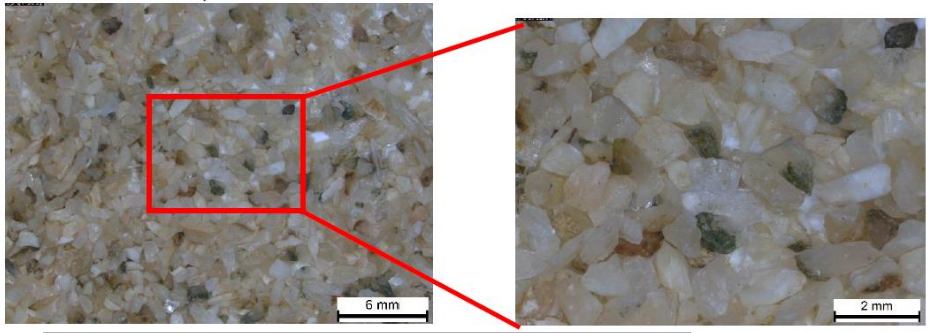
1) When we try to estimate p-values for instance for thermal neutrons we look also for cases where 10Be and 26Al could have been created from other minerals....does the above statement mean that this is irrelevant because the other minerals have been separated out? It is not completely clear to me.



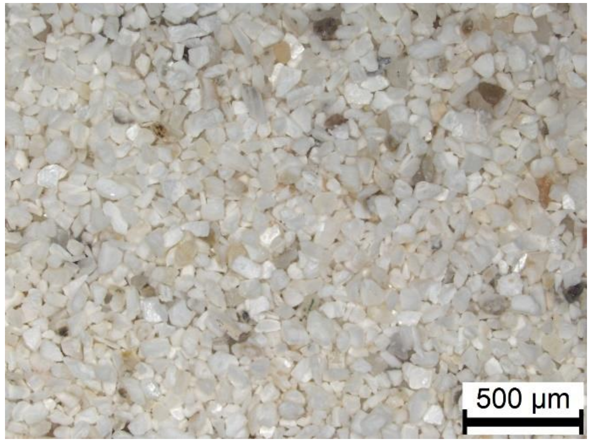
Sample after crushing before any treatment

Sample after crushing before any treatment under the microscope.





Sample after magnetic separation under the microscope. Non-magnetic fraction contains abundant quartz.



After numerous HF+HNO3 leaching. Even if all minerals are removed there is still quartz that contains contaminants within itself, but those contaminants are often negligible.

2) Also there are discussions to expose materials to the NTOF beam to try to study production of Be and A as function of the neutron energy... What samples should be used ...pure Silicon or?

I am not sure. Maybe pure SiO_2?