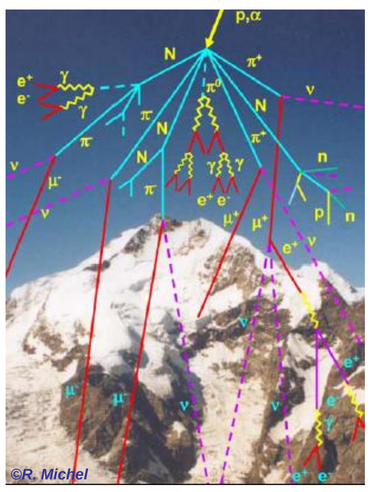
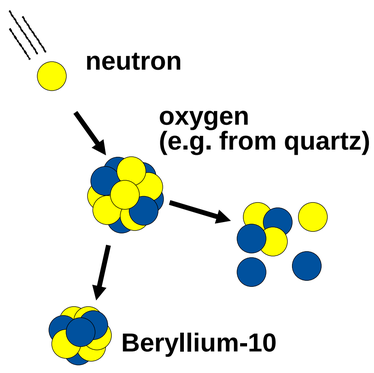
How to get a new accelerator mass spectrometry (AMS) facility running: The chemistry part

S. Merchel[1], M. Arnold[2], G. Aumaître[2], D. Bourlès[2], R. Braucher[2]

Cosmic radiation on Earth

- MeV/GeV particles (p, α, heavy ions)
- shielding (flux & energy) and transformation e.g. into neutrons by the Earth's magnetic field & atmosphere
- elemental conversion by nuclear reactions in the atmosphere ($^{14}N(n,p)^{14}C$) ››› radiocarbon-dating e.g. for archaeology or climate reconstruction from ice cores
- elemental conversion by nuclear reactions in terrestrial materials / rocks (so-called "in-situ"-production) ››› with time concentration of (radio-) nuclides increases
- irradiation of a "fresh" surface (e.g. after a volcanic eruption), reconstruction of "starting time" possible ››› "in-situ"-dating

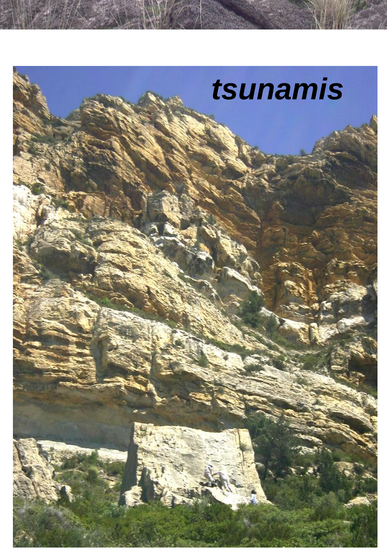




"In-situ"-produced cosmogenic nuclides (CN)

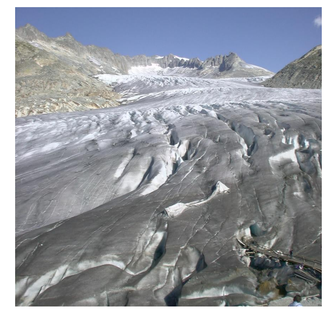
- everything having a "fresh" surface can be dated

volcanic eruptions



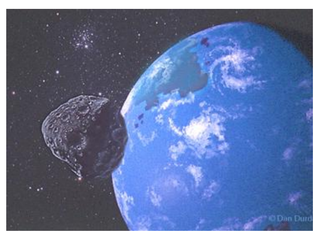
Indirect dating by CN

- climate change, e.g. via glacier movements



Special case (irradiation in space): Extraterrestrial material

- transfer times from the meteorite's parent body (asteroids, Moon, Mars)
  ››› irradiation age
- residence time at the place of discovery (e.g. hot desert, Antarctica) before somebody takes the meteorite home
  ››› terrestrial age



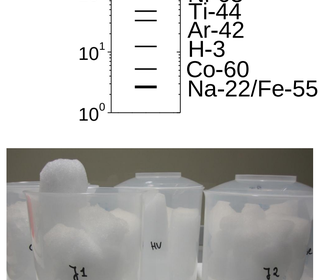
Sample preparation for accelerator mass spectrometry (AMS)

Definition of "good" AMS-chemistry

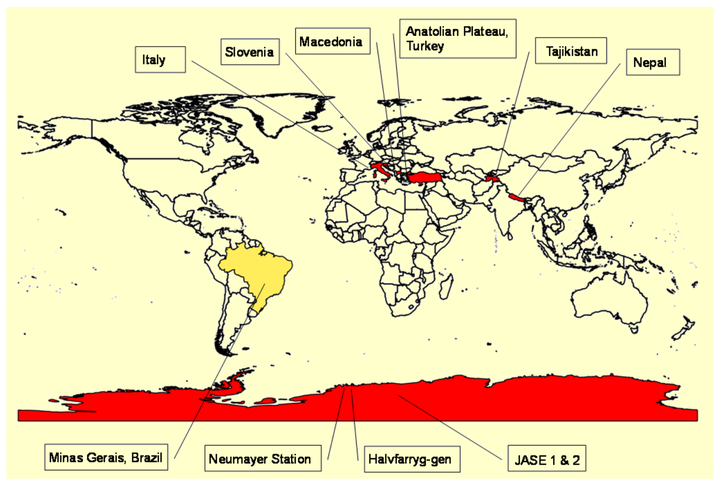
- "good " standards, i.e.
  - traceable
  - different ratios for volatile elements to avoid cross-contamination (^{36}Cl, ^{129}I)
- low machine blanks (^{10}Be)
- low stable nuclide carrier for chemistry blanks (^{10}Be)
- real sample chemistry for different matrices & nuclides
  - fast and low-cost (chemicals, man power, lab space)
  - safe (also for non-chemists)
  - low risk of cross-contamination & contamination
  - producing "pure" targets, i.e. high stable nuclide current & low isobar concentration
    ››› good statistics, detection limits & high sample throughput

Status @ DREAMS

- standards for ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{129}I traceable via round-robins or cross-calibration elsewhere [ARN10, MER04, MER09, MER11]
  - special case ^{10}Be: produced via $^{9}Be(n_{th},\gamma)^{10}Be$ @ TRIGA, Atominstitut Vienna ››› $(1.73\pm0.02)\cdot10^{-12}$ $^{10}Be/^{9}Be$
  - ^{26}Al, ^{36}Cl, ^{41}Ca & ^{129}I @ 3 different ratios each 10^{-9} – 10^{-13}
- "home-made" ^{10}Be carrier & machine blank from shielded Be-containing mineral (phenakite - Be_2SiO_4) [MER08]
- speeded-up ^{10}Be-chemistry for ice core sample (5 d → 24 h / 10 samples)
- development of ^{53}Mn-chemistry for "in-situ" samples (marcasite/pyrite/realgar)
- ^{10}Be & ^{36}Cl targets from "in-situ" samples (SiO_2 & $CaCO_3$) measured @ ASTER & VERA ››› chemistry blank at least one order of magnitude lower than samples & high current
- chemistry training of external partners (non-chemists) for ^{10}Be & ^{36}Cl from "in-situ" samples satellite labs @ U Rennes & U Freiberg

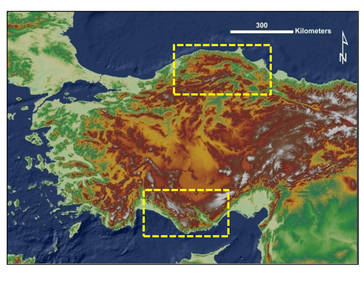


Selection of sample origins & applications

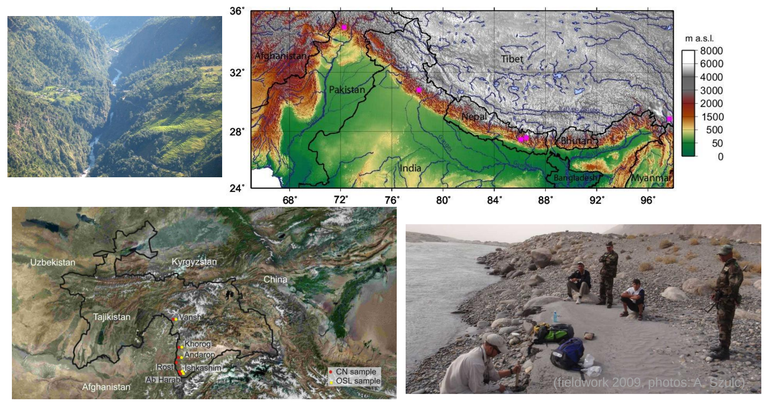


- Historical rock fall @ Veliki Vrh, Slovenia
  ››› Calibration site for production rate (^{36}Cl)

- Vertical Anatolian Movement Project
  ››› Uplift rates (^{36}Cl)



- Geomorphology @ Himalaya & Pamir
  ››› Basin-wide erosion rates (^{10}Be)



Summary & Outlook

- AMS chemistry are successfully running for routine sample preparation (^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{53}Mn) & satellite labs for pretreatment of "in-situ" samples are installed
- machine blanks and standards are prepared, measured elsewhere, and partially (^{10}Be, ^{26}Al, ^{36}Cl) measured @ DREAMS [AKH10]
- ^{41}Ca & ^{129}I will be measured @ DREAMS this week
- sophisticated multi-nuclide chemistry for extra-terrestrial material [MER99] such as Martian meteorites will start next week

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1) Forschungszentrum Dresden Rossendorf
PO Box 51 01 19 • 01314 Dresden • www.dresden-ams.de • s.merchel@fzd.de
2) CEREGE, Université Paul Cézanne Aix-Marseille III