Low gamma activity measurement of meteorites using HPGe-NaI detector system

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Crystal HPGe (~3 kg) coaxial close-end

- p type
- relative efficiency = 147%
- for γ 1332.5 keV for 60Co: resolution (FWHM) = 1.85 keV
- peak to compton ratio = 104

- Scintillator NaI(Tl): cylindrical crystal (annulus) and plug
- total mass ~90 kg
- 6+1 photomultiplier

- Shielding: 20 cm lead
- 1 mm of Cadmium
- 5 cm of OFHC
- polyethylene in order to fill the empty spaces (radon)

- The apparatus is placed in the underground (70 m.w.e.) Laboratory of Monte dei Cappuccini (INAF), Torino, Italy

Meteorite measurements

- Torino was the first meteorite measured at Laboratory of Monte dei Cappuccini in Torino
- The full peak efficiency, FPE, was determined by making a mould of the sample filled with labelled sediment (known amounts of 60Co, 40K, 137Cs) mixed with Fe powder to match density
- In other chondrites, γ activity of 40K fraction of potassium amount in sample gives FPE estimate
- From 40Ti measurement in 19 chondrites, we inferred galactic cosmic ray flux decline and periodicities in the last 300 y [Taricco et al. 2006]

Gebel Kamil Ge-Nal 2-dim. spectrum in the 1750-1830 keV Ge energy region shows (T1/2: 1274.54 + 511 keV ← cosmogenic 26Na (2.6 y)

NIST data Hubbell and Seltzer

Mass attenuation coefficients for elements relevant in meteorite composition: mould technique relies on the fact that γ attenuation in range 0.3-3 MeV depends only on density

- On October 6, 2008, a small asteroid, named 2008 TC3, was telescopically seen in space and predicted to impact Earth next day in the Nubian Desert, Sudan (JPL Pasadena, California). Many fragments recovered in search campaigns
- As 40K γ emission in Almahata Sitta was below detection level, we made a mould to determine FPE
- Cosmogenic isotopes 26Si, 40Ca, 26Mn, 26Na, 40Ca, 40Al were identified and activity measured
- From 40Ti and depth production profiles we estimated depth of fragment inside asteroid.

26Na high activity level corresponds to the last prolonged solar minimum [Taricco et al. 2010]

- During a Google Earth survey, V. De Michele discovered the Kamil Crater (45 m diameter). It is the first rayed crater found (similar to Moon craters), then it should be relatively recent. It is due to impact of an iron meteorite, Gebel Kamil
- Many explosions fragments recovered
- Again, making of a mould was necessary to estimate FPE, but 7.9 g/cm2 density cannot be achieved by mixing iron powder: a set of different-density moulds was made and self-absorption effects estimated to correct FPE
- We detected cosmogenic 26Al in G.K. SE36
- From 26Al activity and depth production profiles we estimated ~1 m meteoroid radius and sample position close to the center
- Absence of 40Ti signal in meteorite suggests minimum crater age of ~250 years
- In preparation: 26Al activity of non explosion-fragmented Gebel Kamil specimen (Individual)

Reference


