Dating recent surface processes using cosmic ray generated 3He in rocks.

University of Manchester - Cosmic ray exposure histories of Apollo 14, Apollo 15, and Apollo 16 rocks (Conference)


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Production of ^{3}He in Rocks by Reactions Induced by Particles of the Nuclear-Active and Muon Components of Cosmic Rays: Geological and Petrological Implications

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Abstract

The paper presents data on the production of the ^{3}He nuclide in rocks under the effect of cosmic-ray particles. The origin of the nuclide in the ground in neutron- and proton-induced spallation reactions, reactions induced by high-energy muons, and negative muon capture reactions is analyzed. The cross sections of reactions producing ^{3}He and ^{3}H are calculated by means of numerical simulations with the GEANT4 simulation toolkit. The production rate of the ^{3}He nuclide in the ground is evaluated for the average level of solar activity at high geomagnetic latitudes and at sea level. It is proved that the production of ^{3}He in near-surface ground layers by spallation reactions induced by cosmic-ray protons may be approximately 10% of the total production rate of cosmogenic ^{3}He. At depths of 10-50 m.w.e., the accumulation of ^{3}He is significantly contributed by reactions induced by cosmic-ray muons. Data presented in the paper make it possible to calculate the accumulation rate of ^{3}He in a rock depending on depth that is necessary for the evaluation of the exposure time of the magmatic or metamorphic complex on the Earth's surface (^{3}He dating).

1 Introduction

Cosmogenic nuclides provide a principally important tool for studying processes on the Earth's surface. These nuclides are produced in situ in rocks composing the Earth's surface by reactions induced by cosmic radiation. Currently cosmogenic nuclides (^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, and others) are utilized to solve certain problems of geomorphology, glaciology, soil science, palaeoclimatology, and volcanology (Lal, 1991; Bierman, 1994; Gosse and Phillips, 2001; Dunai, 2010). Knowing the content of a nuclide in a mineral and the production rate of this nuclide, one can calculate the surface exposure time of the rock and determine when the magmatic or metamorphic complex was brought to the modern erosion surface.
A cosmogenic nuclide can be utilized as a geochronometer only if the concentration of this nuclide in the rock is very low, and hence, the cosmogenic component can thus be discernible compared to the component captured by the rock during its crystallization. For most rock-forming minerals, these nuclides are stable isotopes of noble gases whose concentrations are very low, such as ^{21}Ne, ^{22}Ne, ^{36}Ar, ^{38}Ar, etc., including the He isotope ^{3}He (Porcelli et al., 2002; Dunai, 2010). Although the content of ^{3}He on the Earth is very low, this isotope has long not been used for the purposes of cosmogenic geochronology (Farley et al., 2006) because He can easily migrate from the crystal lattices of rock-forming minerals (such as quartz and feldspars) even at room temperature (Shuster and Farley, 2005). The only exception is large 'perfect' quartz crystals of hydrothermal and/or metasomatic genesis, whose rates of He loss are relatively low because of the large size of the diffusion cells (Tolstikhin et al., 1974). Because of this, systems based on the cosmogenic ^{3}He isotope have been of little use until recently in evaluating the exposure tiles of rocks, except only for olivine and pyroxene xenocrysts in young lava sheets (Niedermann,

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Tags: #40 #Ar/ #39 #Ar #and #cosmic #ray #exposure #ages #of #plagioclase

Terrestrial Cosmogenic Nuclide Dating

A different interpretation by invokes continuous uplift of the southern Rocky Mountains as the cause for this spillover event and indirectly brackets the timing of spillover to ca. Cliver Simultaneous Observation of Solar Neutrons from the ISS and High Mountain Observatories in association with a flare on July 8 Y.

Seismic hazard reappraisal from combined structural geology, geomorphology and cosmic ray exposure dating analyses: the Eastern Precordillera thrust system (NW Argentina)

Individual fault planes and measured slip vectors at each site are plotted, arrows on fault planes point in directions of horizontal azimuth of the slip vectors. Marchenko A production scenario of Galactic strangelets and an estimation of their possible flux in solar neighborhood S.

Cosmic ray labeling of erosion surfaces: in situ nuclide production rates and erosion models

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These tests have been performed on what are thought to be the earth's oldest surviving rocks, meteorites, and moon rocks. Hahn The Denoised, Deconvolved, and Decomposed Fermi gamma-ray sky M. Because cadmium shielding was used during irradiation, 38Ar produced from 37Cl can be neglected.

Cosmic ray labeling of erosion surfaces: in situ nuclide production rates and erosion models

Along the three segments, inversion of fault slip data shows that the development of the Eastern Precordillera between 31°S and 32°S latitude is

dominated by a pure compressive reverse faulting stress regime characterized by a N110°± 10°E-trending compressional stress axis σ 1.

40 Ar/ 39 Ar and cosmic ray exposure ages of plagioclase

The approach of is based on 244 worldwide earthquakes, with magnitudes ranging between 4. Both sets of faults at the southern Sierra de Villicúm and the northern Sierra Chica de Zonda are bedding-parallel , and interpreted as flexural-slip faults. Indeed, those faults may generate destructive earthquakes that produce either conspicuous surface ruptures or small and questionable surface displacements, or even no evident surface rupture.

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The Tullum Valley, a large syncline structure is mainly deformed by bedding-slip faulting near the eastern piemont of Eastern Precordillera.

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