NUMERICAL SIMULATIONS OF $^{81}$KR PRODUCTION RATES.
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Introduction: Trace analysis of radionuclides is an essential and versatile tool in modern science and technology. Due to their ideal geophysical and geochemical properties, long-lived noble gas radionuclides, among them $^{81}$Kr ($t_{1/2} = 2.3 \times 10^5$ yr.), have long been recognized to have a wide range of important applications in Earth sciences. In recent years, significant progress has been made in the development of practical analytical methods, and has led to applications of these isotopes. Their production, transport, and deposition processes have been extensively studied [1, 2]. The introduction of these radionuclides into the atmosphere occurs continuously at a rate that, in principle, can be determined both in space and time.

Model calculations: Cosmic-ray induced nuclear reactions in the atmosphere are simulated with computer codes based on atmospheric models and nuclear data in order to establish accurate description of the production rates and the distribution functions of various cosmogenic radionuclides. We used a purely physical model that has been well tested in calculations of particle fluxes in extraterrestrial objects [3]. Using calculated neutron and proton fluxes, the production rates of nuclides were calculated by integrating over energy the product of these fluxes and cross sections. The flux of charged particles in the upper atmosphere depends on the intensity of the geomagnetic field and so do therefore neutron flux and nuclide production rates. Therefore the correction factors for geomagnetic field variations in the past were calculated [4, 5]. Calculated production rates are compared with previous theoretical estimates and existing experimental data.

Results and discussion: The main nuclear reactions leading to cosmogenic $^{81}$Kr are proton- and neutron-induced spallation of stable $^{82}$Kr, $^{83}$Kr, $^{84}$Kr and $^{86}$Kr, as well as nuclear reactions $^{80}$Kr(n,$\gamma$)$^{81}$Kr and $^{82}$Kr($\gamma$,n)$^{81}$Kr. Three independent measurements gave an atmospheric $^{81}$Kr/Kr ratio (unweighted mean) of $(5.2 \pm 0.4) \times 10^{-13}$ [6]. Using this value and assuming a secular equilibrium in the atmosphere, the atmospheric production rate $(1.2 \pm 0.1) \times 10^6$ $^{81}$Kr atoms/cm$^2$/s can be determined. This value is in good agreement with the theoretical value obtained in this work $(1.35 \pm 0.2) \times 10^6$ atoms/cm$^2$/s. This value accounts also for corrections on geomagnetic field variations during last 800 000 years. Some differences in obtained results can be attributed to the cross sections, mainly for neutron induced reactions. This underscores the importance of their further investigations.