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Radon and its progeny as geophysical tracers of surficial and atmospheric processes on Mars

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Radon-222 and its short- and long-lived decay products in the Martian atmosphere have not been considered yet as potential tools for filling some gaps in our current knowledge of the planet. However, they can provide important information on surface exchange processes and on the composition of the regolith. There is indeed an extensive literature about the application of these isotopes to Earth's atmospheric studies, and results of the same kind could be obtained on Mars. Here we present a review of the different scientific objectives that could be achieved by the measurement of the natural atmospheric radioactivity at the surface of Mars. This includes the uranium and water content of the first meters of the subsurface, below the penetration depth of cosmic rays and the sounding capability of the *Mars Odyssey* GRS, the atmospheric aerosol cycle, residence time and electrical charge, the atmospheric ^{4}He abundance, and the present planet outgassing, as sought on the Moon since the 1960's. The soil water content at a given location can be determined by measuring the local radon-222 exhalation rate by alpha spectroscopy, as first suggested by Sabroux *et al.* (2003; 2004). In places where advective transport through fractured rocks may dominate diffusive transport, measurement of this tracer gas, inert and easily measurable, could provide the magnitude of the outgassing flux. Other objectives can be achieved by measuring its decay daughters, especially the short-lived ones (^{218}Po, ^{214}Po) and long-lived one (^{210}Po) that are alpha emitters. For instance, measurement of the vertical gradients of these isotopes near the surface can provide deposition rates of ultrafine particles and information about the boundary layer dynamics. Due to the long half-life of its parent lead-210, polonium-210 radioactivity can be used to infer the global average radon flux, and thus to provide information on surface/atmosphere exchanges at a global scale. We present a simple box model relating radon and its progeny in the

Martian atmosphere to illustrate these mechanisms, and underline the main differences with the terrestrial and lunar cases.

References :

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