Radionuclides: from Cosmochronology to Habitability

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Radionuclides with half-lives between 10^5 and 10^{10} years were present at the time of the birth of the Sun as inferred from high-precision meteoritic analysis. Their abundances provide us with a precise calibration for the clock of their radioactive decay, which allows us to measure time intervals between the birth of the Sun and the events that followed it (e.g., the formation of Solar System bodies) and that preceded it, e.g., the latest addition of material from stellar winds and supernova ejecta to the matter from which the Solar System formed, and the formation of the molecular cloud where the Sun was born. To achieve this, however, we need to rely on theoretical predictions of the production of radioactive nuclei in stars and supernovae. I will present the current state of the art in the effort of disentangling the "prehistory" of the Solar System and discuss its implications on our knowledge of the circumstances of the birth of our Sun. Radionuclides also provide important sources of heating. Specifically, the decay of Th, U, and K provides up to half of the total heat budget of the Earth, with implications on its surface habitability. Recent observations of solar twins show that most of these stars have larger Th abundances than the Sun. I will show that chemical evolution modelling of the elements produced by the *rapid* neutron captures are needed to establish the reason for this discrepancy, with implication on the habitability of extra-solar terrestrial planets. Furthermore, the heat generated in the early Solar System by the abundant, short-lived ^{26}Al (0.7 Myr) was responsible for the differentiation of early planetesimals and for the melting of ice and loss of water of those that were ice rich. Recent models show that an initial amount of ^{26}Al different than that in early Solar System leads to a different amount of water in terrestrial planets in the habitable zone, with crucial implications on the development of life. I will review the current scenarios for the presence of ^{26}Al in the early Solar System and their prediction of how common this presence may be in other planetary systems in the Galaxy.