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Distribution of Beryllium-10 in top soils from the Tibetan Plateau and its climatic implications

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The Qinghai-Tibet Plateau is simultaneously influenced by the westerlies and the Asian monsoon, and the variations in monsoon moisture have significant impacts on the entire Qinghai-Tibet Plateau and Asian climate system. Among the interesting tracers of atmospheric circulation, the Be-10 isotope deposited in soils can be a potential one. The dominant atmospheric production, relatively long tropospheric residence time (a few weeks) and adsorption to aerosols make the isotope an excellent tracer of airmass circulation. The fallout of the isotope on the Earth ' s surface is mainly linked to wet (precipitation) deposition and consequently, the isotope can also provide information on moisture sources. Once in the soil, the isotope has a relatively stable chemistry and is incorporated or adsorbed onto soil particles without extensive alteration. These properties, together with relatively long half-life (1.39 Myr), make Be-10 a valuable tracer for the reconstruction of past climate changes on long and short-time scales. In our study, we use soil samples from a depth of 0˜30 cm taken in the southeastern Qinghai-Tibet Plateau, including 5 profiles of layered soil samples. The sampled soils were extracted from plain areas that are unaffected by human activity, to avoid extensive effects of soil erosion and mixing of the surface layer. The chemical extraction of Be-10 from sediment samples includes the stepwise precipitation and separation of other sediment components through pH adjustments, and the measurements were performed at the ETH AMS facility. We have combined our new Be-10 data with about 60 surface soil samples covering the majority of China. The results indicate that the concentrations of Be-10 in the surface soil of the Qinghai-Tibet Plateau range from 0.40 to 8.36×108 atoms/g, around an average of 2.37×108 atoms/g, while those from the northwestern and eastern parts of China vary between 0.56-3.62×108 atoms/g and 0.12-10.42×108 atoms/g, with averages of 1.50×108 atoms/g and 3.56×108 atoms/g, respectively. The samples are distributed in non-permafrost regions and changes in soil texture and mineralogy were not significantly affecting the Be-10 distribution. The general higher Be-10 concentration in the soils of the Qinghai-Tibet Plateau compared to those from the northwestern parts and at a lower level than those from the eastern parts of China reflects the medium precipitation amount received by Tibet. For the samples from the Tibet, the Be-10 concentrations are positively correlated with the mean annual rainfall over the past decades (ranging from 50 to 1300 mm/y) after excluding a maximum value ($R2 = 0.34$, $p = 0.01$). This is consistent with our previous findings, which showed a significant positive correlation between Be-10 in soil and annual precipitation in areas with rainfall less than 1200 mm/y. The results suggest that Be-10 in this region is mainly derived from wet deposition, and the amount of Be-10 retained in soil reflects information about precipitation changes. In addition, integrating a global Be-10 deposition model, the retention time of Be-10 in soils from this region has been calculated to be several hundred to three thousand years (the late Holocene), indicating the spatial distribution characteristics of precipitation patterns in the southeastern Qinghai-Tibet Plateau during the period. It was also found that the data from the profile-layered samples collected in this study show little vertical variation in the distribution of Be-10 at different depths of surface soil (0.3% to 20.6%, with an average of 6.5%). The uniformity of the Be-10 distribution proves relatively stable precipitation patterns in the study area over the past several hundred years or even longer periods and indicates that the soils are relatively old and have not been severely affected by erosion. The Be-10 data from soils of the Qinghai-Tibet Plateau will be coupled to atmospheric transport and depositional models to further expand the data base and also include more information from remote regions like the Tibet Plateau that will promote our understanding of historical climate changes in this region.

Student Submission

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