

Cosmogenic Ne in terrestrial quartz: How to correct the trapped component

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Stable cosmogenic ²¹Ne has been applied since its discovery [1] to a broad range of surface exposure studies, although some methodological aspects can still be improved. The identification and quantification of cosmogenic Ne in terrestrial quartz relies on its proper isolation from the other two components, trapped and nucleogenic, stored in the crystal. Of this three components, only the cosmogenic one has a well-defined isotopic signature [2], while the other two depend on the geological history and purity of the quartz. Although extraction procedures as stepwise heating or mechanical crushing release Ne depending on its location in the crystal lattice [3], a mixture of the three components is generally present and, therefore, must be resolved.

We have used stepwise heating for isolating the cosmogenic Ne in quartz samples from granite surfaces of various erosive origins: glacial, fluvial and etching from different Iberian sites. While in some cases the trapped Ne had atmospheric composition and little nucleogenic Ne was identified, in some others larger corrections were necessary. Non atmospheric trapped Ne was identified in some temperature steps, especially if the isotopic composition non-explainable by addition of either cosmogenic or nucleogenic Ne to an atmospheric component. In some cases, analyses of the top and bottom parts of a core can provide additional information, since the trapped Ne should be the same. This procedure also serves as check for the cosmogenic Ne amount as its bottom one has a lower concentration, according to the exponential attenuation law. Intercalibration of ¹⁰Be and ²¹Ne exposure ages were also carried out. While this calibration may be considered to be accurate, uncertainties about the origin of the sample can compromise it. Multiple exposure stages can be recorded by the cosmogenic ²¹Ne while muogenic ¹⁰Be can be present depending on the erosive history of the sample. Then, ages obtained by the two methods are not comparable and can lead to misinterpretation of the trapped Ne in order to make them agree.

We show that the evaluation of the nucleogenic component can also be used to identify the trapped Ne. If crustal Ne is present due to mica impurities, the slopes of the cosmogenic and crustal component must start from the same trapped component, serving then as check for its composition.

References

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The role of bacterial surfaces in chemical processes of metal ions in the environment

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The behaviour of bacteria as geochemically reactive solids can be inferred from extensive research documenting their performance as sorbents of dissolved metals, and nucleation templates for a wide range of authigenic minerals. This reactivity stems directly from the presence of acidic surface functional groups (i.e., carboxyl, phosphoryl, and amino constituents) that are associated with structural polymers in the cells walls and external sheaths or capsules of individual cells. Direct interactions between these surface functional groups and dissolved metals account for the sorptive properties of bacteria, while superficially sorbed metals may provide discrete sites for subsequent mineral nucleation and precipitation reactions. In order to usefully quantify the surface chemical reactivity of bacterial cells, it is necessary to determine predictive parameters for bacteria-metal interactions. At the most basic level these parameters can simply be empirical constants that describe metal-surface partitioning, but for a fundamental understanding of surface reactions more complex models are necessary. The most fundamental and ubiquitous surface reactions in nature are with protons. Determination of pK_a (proton dissociation constant) spectra derived from acid-base titration data, as well as electrostatic force microscopy, have established that a high degree of electrochemical heterogeneity exists within the cell wall and at the cell surface of individual bacterial cells. Recognition of variations in the nature and spatial distribution of reactive sites that contribute to charge development on bacteria implies further that the cell surface of bacteria functions as a highly differentiated interfacial system capable of supporting multiple intermolecular interactions with both solutes and solids. These include surface complexation reactions involving dissolved metals, as well as adherence to minerals through longer-range electrostatic interactions, and surface precipitation of secondary neogenic minerals. Exploration of such surface chemical processes is helping to build a quantitative understanding of the behavior of bacteria as reactive solids, and is a key step for the development of geochemical speciation models to evaluate the importance of bacterial-metal interactions in aqueous environments.

References

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