Upper limits on the irradiation-induced short lived nuclei in comets

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The first results from the STARDUST mission [1] strengthen theoretical frameworks such as the *x-wind* model [2] in which high temperature minerals processed at a close distance to the nascent star have been transported to the comet forming region. Within the *x-wind* framework, several authors proposed that irradiation at close distance from the building star could account for the production of several short-lived radionuclei (SLR) that were once alive in the early solar system [3, 4]. We address here the issue of the total amount of nuclei that can be synthesized within such a process. Using global energetic constraints obtained from X-ray observations of young stellar objects and an updated nuclear reactions survey, we calculated upper limits on the amount of SLR that can be produced by nonthermal nucleosynthesis in the early solar system [5]. We show that ^{10}Be and ^{41}Ca can be produced by *in situ* irradiation of bare solids at levels reported in asteroidal material (meteorites) up to the comet forming region. ^{53}Mn and ^{36}Cl cannot be co-produced by irradiation together with ^{10}Be and ^{41}Ca at the canonical values currently reported (see Ref. [6] for a recent review). If future works confirm the high ^{7}Be/^{10}Be ratio inferred by [7] it may point toward the irradiation of a gas phase. Finally, we show that the maximum amount of irradiation-induced ^{26}Al can barely account for a maximum homogeneous rocky reservoir of 2-3 Earth mass (i.e equivalent to the inner solar system). Moreover, if CAIs did form in the embedded stellar stage, the well-defined canonical ^{26}Al/^{27}Al ratio observed in these objets is difficult to reconcile with an irradiation origin. The search for extinct ^{26}Al in STARDUST samples is of great importance since its discovery at a level similar to the one reported in meteorites would indicate a nucleosynthetic origin external to the solar system. This work was supported by ANR grant 05-JC05-51407 and by AGAUR grant 2006-PIV-10044.

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Experimental study of biomineralization processes relevant to CO_2 geological sequestration

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Geological storage of CO_2 is an important option envisaged to mitigate enhanced CO_2 atmospheric greenhouse effect in the coming decades. It requires however the ability to model the behavior of carbon dioxide into deep geological reservoirs and to predict its fate for thousands of years following the injection. For this purpose, identification of the critical controlling processes and a proper understanding of their physics and chemistry are strongly required. The discovery of extensive and active microbial populations in deep environments had also lead to consider biologically mediated processes potentially critical to CO_2 sequestration itself. Of particular importance is the potential of microorganisms to promote mineral trapping of CO_2 through biomineralization. Little is known, however, about the biochemical processes involved and consequently, biocomponents are rarely taken into account in numerical modeling. In accordance, a joint experimental and numerical study was carried out to shed light on these interactions. Three different microorganisms, known as reference in biomineralization process (*Bacillus pasteurii*) or as endogenous species of potential storage sites (*Desulfovibrio longus* & *profondus*) were used for this purpose. Strains were exposed to various temperatures, salinities and gas compositions in an artificial minimal media representative of deep groundwaters from the basin of Paris (France), a potential location for CO_2 sequestration. A newly developed biomineralization control cell (BCC) allowed continuous measurement of pH, temperature, pressure, ORP, conductivity, $\{Ca^{++}\}$ and optical density at 600nm. Sequences of biomineralization (i.e. nucleation and growth) were established by means of SEM, TEM investigations together with X-ray absorption spectroscopy and Raman confocal imaging. First results demonstrate the important role of gas transfers in these processes as well as the specific influence of calcium ions on general metabolism. Overall, these developments bring new methodology to integrate experimental and computational approaches to finally better predict and interpret biogeochemical processes in the subsurface.