Behavior of rock-forming minerals under simulated and actual lung conditions

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Theoretical and experimental data suggest that secondary minerals form in the lung. Reaction-path modeling for various rock forming minerals under physiologic conditions in a lung-fluid simulant gives dissolution times for these minerals as: calcite < chrysotile < anorthite < K-feldspar < talc < muscovite = kaolinite = albite = quartz. For each mineral reaction, hydroxylapatite and other secondary minerals were predicted to precipitate. Batch experiments using lung-fluid stimulant and a brucite/chrysotile mineral mixture confirm that hydroxylapatite forms during reactions in simulated lung-fluid while other minerals dissolve. SEM analysis of human lung tissue also confirms the formation of calcium phosphates in human lung tissue. Pleural plaques from 11 baboons involved in an inhalation study were examined using SEM, EDS, and powder XRD. XRD analysis revealed apatite in pleural plaques of six baboons. SEM-EDS analysis found small quantities of apatite in three additional baboons. XRD analysis identified calcite in two baboons and talc in baboons exposed to high doses of glass fibers, chrysotile, and grunerite. XRD analysis detected 2:1 expandable clays in baboons exposed to high levels of glass fibers, chrysotile, grunerite and riebeckite. XRD also detected amphiboles in baboons exposed to high levels of grunerite and riebeckite. SEM-EDS analysis revealed Mg-rich silicates in a control baboon and one baboon exposed to low doses of chrysotile. Asbestos bodies were detected in baboons exposed to high levels of grunerite and chrysotile. Iron-rich silicate fibers without coatings were identified in the baboon exposed to high levels of riebeckite using SEM-EDS. Because minerals other than those to which the baboons were exposed were detected in many of the baboons, the hypothesis that secondary minerals may form from primary mineral dissolution in the lung should be considered when addressing the health effects of minerals.

Oxygen exchange in Olivine

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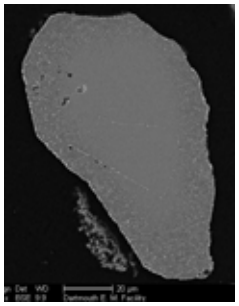
Micrometeorites, 30μm to 2mm extraterrestrial particles, are heated to varying degrees entering the Earth's atmosphere. Heating, melting and volatilization can change their chemical and isotopic composition; mass dependant isotopic fractionation is seen in severely heated micrometeorites [1]. We are interested in determining whether oxygen isotopic exchange during atmospheric entry could also alter a micrometeorite's oxygen isotopic composition.

To determine if a heated minerals exchanges oxygen with the atmosphere we heated grains of an olivine standard (174-1) for 30 s, 1min. and 2 min. at 1450°C. The tests were done at atmospheric pressure and the olivine grains introduced into a muffle furnace in a quartz tube. The heated olivines, and some unheated ones, were then mounted in epoxy, sectioned and ^{18}O and ^{16}O were measured from the rim to the core of the grains using the Cameca ims 7f-Geo at CalTech.

Our results show no difference between the heated ($\delta^{18}O$ =4.8 ± 0.6‰, n=25) and unheated grains or between the centers ($\delta^{18}O$ =4.8‰) and the rims ($\delta^{18}O$ =5.0‰) of the heated olivines within measurement error ($\delta^{18}O$ =0.7‰). The olivine which was originally light green became orange and then dark brown with increased heating time. These particles did not melt, the melting point for forsteritic olivines ~1890°C is higher than our maximum furnace temperature, but their color change suggests that magnetites formed near the surface from iron in the olivine.

Next we plan to analyze single mineral olivine micrometeorites that show heating effects at their periphery (Fig. 1). We expect micrometeorites that exchanged oxygen with the atmosphere to have an oxygen isotopic composition approaching $\delta^{18}O$ = 23.5‰, the atmospheric value [2].



[1]Alexander *et al*. (2002) *Geochim et Cosmochem Acta* **66**, 173-183. [2] Thiemens *et al*. (1995) *Science* **270**, 969–972.