Calcium isotopes in human urine under simulated microgravity conditions

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Living under microgravity in space leads to a migration of bodily fluids into the upper parts of the body and mechanical unloading of the weight-bearing muscles and bones. The latter results in bone loss, which remains a key physiological issue for astronauts during long-duration space flights. Many of the physiological effects of microgravity can be simulated on Earth by a head-down-tilt bed rest (HDTBR) study, in which the head is tilted down at 6° during prolonged bed rest.

In order to evaluate the response of Ca metabolism during HDTBR, we analyzed the Ca isotopic composition of urine taken at different phases of such a study. This involved 7 test subjects, and consisted of two sessions, of 35 days each, comprising four phases: adaptation, bed rest, inpatient and outpatient regeneration.

The Ca isotopic composition of urine reflects a balance between bone loss and bone gain and/or kidney function [1]. During bone gain, blood gets enriched in heavy Ca, while during bone loss, light Ca is released from bones into the blood without further fractionation, and passes into the urine from the blood via the kidneys.

Preliminary data show that large differences of about 0.8‰ exist in the Ca isotopic composition ($\delta^{44/42}Ca$) of urine between subjects, which reflect individual Ca metabolism. The time-evolution of $\delta^{44/42}Ca$ during the course of the study is similar for all subjects, however. During the adaptation phase, $\delta^{44/42}Ca$ increases and reaches a peak at the beginning of the bed-rest phase. This can be explained in terms of a changed diet. During the bed rest period, $\delta^{44/42}Ca$ decreases and returns to values seen at the start of this phase. This decrease indicates that loss of bone mass takes place during the bed-rest period, and persists during the early regeneration phase. Towards the end of outpatient regeneration, $\delta^{44/42}Ca$ increases, returning to values at the study onset, closing the overall cycle.

This study confirms that Ca isotopes in urine are a valuable noninvasive tool for investigating Ca metabolism in humans, and presumably other vertebrates as well, whether or not the body is functioning normally or adapting to new, imposed conditions.

[1] Heuser & Eisenhauer (2010) *Bone* **46**, 889–896.

The origin of an oceanic plateau: Isotope geochemistry (Sr, Nd, Pb and Hf) of volcanic rocks from IODP Site U1347 on the Shatsky Rise (Northwest Pacific)

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The submarine Shatsky Rise plateau is a unique large igneous province (LIP) in the northwest Pacific Ocean ca. 1500 km east of Japan. It is the only large intraoceanic plateau, which formed during the Late Jurassic to Early Cretaceous at a time period with numerous reversals of the Earth's magnetic field. The magnetic reversals combined with bathymetric data allow a detailed reconstruction of the tectonic history. Accordingly the three main volcanic edifices Tamu, Ori and Shirshov massifs formed by massive volcanism during a short time span along a southwest - northeast trending, rapidly spreading triple junction. Therefore, the magnetic and bathymetric data suggest that the Shatsky Rise formed through the interaction of a mantle plume head with a ridge [1, 2].

We present new Sr-Nd-Pb and for the first time Hf isotope data from volcanic rocks of relatively fresh basaltic lava flows from the southernmost drill site U1347 on Tamu massif. Initial $^{176}Hf/^{177}Hf$ and $^{143}Nd/^{144}Nd$ isotopic compositions are fairly uniform throughout the entire hole ranging between 0.283076 to 0.283100 and 0.512909 to 0.512981 respectively, showing neither distinct MORB nor intraplate (plume) affinity. Relatively unradiogenic $^{87}Sr/^{86}Sr$ data ranging from 0.70276 to 0.70296 mostly overlaps with Pacific MORB like values. Combined Nd and Hf isotopic compositions form a tight cluster at the edge of the Pacific MORB field below the present-day Hf-Nd mantle array. Although initial Pb double spike $^{206/204}Pb$ and $^{208/204}Pb$ isotopic compositions range from 18.13 to 18.46 and 37.71 to 37.96 respectively and overlap with MORB-like compositions, they trend towards more intraplate-like values. Whereas combined initial Pb double spike $^{207/204}Pb$ and $^{206/204}Pb$ and Hf values form clusters within the Pacific MORB field.

[1] Nakanishi *et al*. (1999), *J Geophys. Res*. **104**, 7539-7556.
[2] Sager *et al*. (1999), *J Geophys. Res*. **104**, 7557-7576.