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大型水系稳定Sr同位素组成及其对海陆Sr同位素差异的制约

2013-07-16 | 作者: MSG | 【小中大】 【打印】 【关闭】

Sr是最经典的同位素体系之一, 通常认为其 $88\text{Sr}/86\text{Sr}$ 比值是恒定值, 并被用来校正质谱测量过程中的同位素分馏, 这也是高精度同位素测试的基准技术。然而, 在化学风化和碳酸盐结晶等表生过程中 $88\text{Sr}/86\text{Sr}$ 比值会发生明显的分馏, 这直接挑战了传统Sr同位素体系的基准前提假设。这些稳定Sr同位素的分馏对传统的认识产生多大的影响, 是当今同位素地球化学研究的一个重要前沿问题。中国科学院广州地球化学研究所的研究小组率先建立起基于MC-ICP-MS的高效率高精度稳定Sr同位素($\delta 88\text{Sr}$)的测试方法, 并结合西江河水的持续观测, 建立起第一个大型水系的持续时间超过一年的 $\delta 88\text{Sr}$ 时间序列, 并对化学风化过程中的稳定Sr同位素分馏开展研究。发现了河水中的 $\delta 88\text{Sr}$ 存在明显的季节性变化, 其中雨季 $\delta 88\text{Sr}$ 较高而旱季相对较低, 同时雨季硅酸盐化学风化的加强是引起河水 $\delta 88\text{Sr}$ 升高的主要原因。据此我们提出这些由于硅酸盐化学风化形成的高 $\delta 88\text{Sr}$ 的Sr被输送到海洋, 是引起海洋与陆地稳定Sr同位素差异的重要控制因素。这一结果对更准确了解全球Sr同位素循环具有重要价值。

该项成果发表于Wei G.J., Ma J.L., Liu Y., Xie L.H., Lu W.J., Deng W.F., Ren Z.Y., Zeng T., Yang Y.H., 2013. Seasonal changes in the radiogenic and stable strontium isotopic composition of Xijiang River water: Implications for chemical weathering. *Chemical Geology*, 343:67 – 75, 其英文摘要如下:

Seasonal changes in strontium (Sr) isotopic systematics in large rivers can effectively track temporal variations in regional chemical weathering, and help to better constrain the Sr isotopic budget of global oceans. However, such records are scarce. Here we present a year-long time-series of both radiogenic and stable Sr isotope measurements ($87\text{Sr}/86\text{Sr}$ and $\delta 88\text{Sr}$) from river water at Guiping, in the middle reaches of the Xijiang River, South China. Temporal changes in chemical weathering in the drainage basin were investigated by recording seasonal changes in the composition of both Sr isotopes and major ions in the river water. River water $87\text{Sr}/86\text{Sr}$ values range from 0.708487 to 0.710336, with most values being <0.7092 , indicating a dominant contribution from the weathering of carbonate rocks. High $87\text{Sr}/86\text{Sr}$ values (>0.7092) are generally accompanied by high Rb/Sr ratios, and low pH and $\delta 13\text{C}$ of dissolved inorganic carbon (DIC) and occur during periods of large river flux. This indicates that the contribution to the chemistry of river water from the weathering of silicate rocks is enhanced during rainy seasons. Seasonal variation in river water $\delta 88\text{Sr}$ is large, from 0.147‰ to 0.661‰, with higher $\delta 88\text{Sr}$ values generally corresponding to higher $87\text{Sr}/86\text{Sr}$ values. Again, low $\delta 88\text{Sr}$ values ($<0.3\%$) suggest a dominant contribution from the weathering of carbonate rocks, whereas the high $\delta 88\text{Sr}$ values may represent a contribution from intensive weathering of silicate rocks. Using the time-series data, we estimated the flux-weighted averages of Sr concentration, $87\text{Sr}/86\text{Sr}$, and $\delta 88\text{Sr}$ for the Xijiang River to be 1.00 mmol/L, 0.70960, and 0.38‰, respectively. The Sr concentration and $87\text{Sr}/86\text{Sr}$ results are close to previous estimates, while the $\delta 88\text{Sr}$ value is amongst the highest recorded for the large rivers of the world, and is close to that of seawater. Our results indicate that large rivers draining through tropical/sub-tropical regions could play an important role in regulating the stable Sr isotopic budget of global oceans.

>> 评论

