Impact-induced early differentiation of terrestrial planets

YU.P.DIKOV[1], M.V.GERASIMOV[2], O.I.YAKOVLEV[3], AND F.WLOTZKA[4]

[1] IGEM, RAS, Moscow, Russia; dikov@igem.ru
[2] Space Research Inst., RAS, Moscow, Russsia; mgerasim@mx.iki.rssi.ru
[3] Vernadsky Inst. of Geochemistry, Moscow, Russia; yakovlev@geokhi.ru
[4] Max-Planck-Inst. for Chemistry, Mainz, Germany; wlotzka@mpch-mainz.mpg.de

The formation of terrestrial group planets was characterized by a processing of planetesimals in hypervelocity impacts. This could lead to the first stage differentiation of planetary material due to a separation of volatile and refractory elements between the vapor and the residual melt phases. We propose that the re-evaporation of the volatile-rich material by subsequent impacts and its concentration in the surface layers of a growing planet could result in an early impact-generated protocrust.

Experimental investigations of the chemistry of impact-induced vaporization were done for decades using hypervelocity gun facilities and a laser pulse impact simulation installation (Gerasimov et al., 1999). The general trends of impact-induced differentiation show a significant volatility of silica and alkalies from ultra-mafic and mafic silicates. Experiments indicate an efficient reduction of iron during an impact-related high-temperature heating of silicates. Nearly all high-temperature melts show droplets of metallic iron with dimensions ranging from nanoscale to micron-size. The sink of iron into metallic particles seems to account for the loss of iron from both melt and condensate. The formation of metallic iron droplets was efficient for minerals (e.g., olivine), which do not have reasonable amounts of reducing agents. This fact indicates that the reduction of iron proceeds mainly as thermal reduction rather than by chemical reactions. The presence of hydrogen in the system increases the efficiency of reduction of iron. A segregation of siderophile elements into metallic iron droplets with subsequent ejection of these into the forming plume during an impact can be an efficient mechanism for the separation of siderophiles from silicate melts. Experiments also demonstrate an enrichment of impact vapors in REE.

Acknowledgement.

This research was supported by the RFBR 01-05-64564 grant.

References

Gerasimov M.V. et al. (1999) Physics and Chemistry of Impacts. In: *Laboratory Astrophysics and Space Research*, P. Ehrenfreund et al. (eds.), KAP, 279-329.

Si, O and H Isotopic Compositions of Water and Suspended Materials in the Yangtze River, China

T. DING, D. WAN, C. WANG AND F. ZHANG

Institute of Mineral Resources, CAGS, Beijing 100037, P. R. China (tding@cags.cn.net)

A systematic investigation on silicon, oxygen and hydrogen isotope compositions of water and suspended materials in the Yangtze River was undertaken in this study.

The δD and $\delta^{18}O$ values of the Yangtze River water both increase from the upper reaches to the lower reaches, consistent with the variation trend of meteoric water. High d values are observed in water samples from upper reaches of the Yangtze River, indicating their water source of arid region. In contrast, normal d values are observed in water samples from middle and lower reaches of the Yangtze River, consisting with large input of the water originated from high humidity region.

The $\delta^{30}Si$ values of dissolved silicon in all Yangtze water sample are positive and vary in a wide range from 0.7 to 3.4. The highest $\delta^{30}Si$ value of 3.4 has reached the upper limit of observed natural variation of silicon isotopes. This enlarges the $\delta^{30}Si$ range of dissolved silicon in riverine water from 0.8 (0.4-1.2) to 3.0 (0.4-3.4). The $\delta^{30}Si$ values of suspended materials in the Yangtze River vary from 0 to –0.7. The $\Delta^{30}Si_{Sol\text{-}Susp}$ values in the Yangtze water vary from 1.0 to 3.7. These can be explained by kinetic isotope fractionation in weathering processes of silicate minerals. The correlation between $\delta^{30}Si$ of dissolved Si and the $\delta^{30}Si$ of suspended materials is poor, reflecting that they are not in isotopic equilibrium. The $\delta^{30}Si$ value of dissolved silicon output from the Yangtze River to the Pacific Ocean is estimated to be 3.0, much higher than the reported values of other rivers.

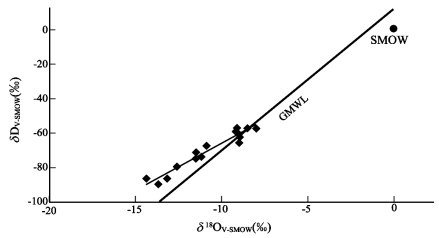

Fig.1: δD vs. $\delta^{18}O$ relation of water in the Yangtze River, China

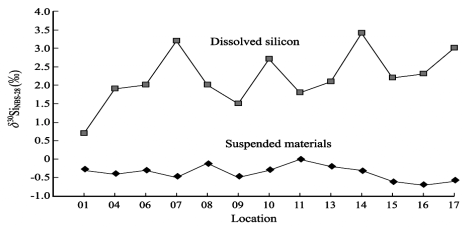

Fig.2: The $\delta^{30}Si$ variation of water and suspended materials in the Yangtze River, China