The early evolution of the Earth and Moon: Comparative chronology

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Lunar and early Earth zircon ages

The unique occurrence of detrital zircons with ages of 4.4-3.9Ga in metasediments from the Narryer Gneiss Terrane in Western Australia provides the only surviving material record of the early evolution of the Earth. So far the source rocks of the zircons have not been found so clues to the nature of the early Earth must be derived from the chemical, mineralogical and isotopic systems contained within the zircons. Studies of inclusions in the zircons (Maas et al. 1992) and Hf isotopic signatures (Amelin et al. 1999) have pointed to a crustal origin for the >4Ga zircons in accord with the model of Wilde et al.(2001) and Mojzsis et al. (2001), based on oxygen isotopic evidence, that the >4Ga zircons crystallised from granitic melts that had incorporated a significant proportion of supracrustal material formed in the presence of water near the Earth's surface. These conclusions place new constraints on the early history of the Earth. However, constraints on the early evolution of the Earth are also provided by observations on the early history of the Moon. In particular the intense bombardment of the Moon that ended about 3.9Ga ago. The discovery and the dating of zircon from Moon rocks using the ANU SHRIMP has provided new information on the chronology of lunar magmatic events (Meyer et al. 1996). The lunar and JackHills/Narryer zircon populations show the same age range from 4.33 to 3.9Ga, although the younger age spectrum from 3.7-3.0Ga in the detrital zircons from Jack Hills and Narryer is not found in the lunar zircons. Zircon age peaks in the lunar and terrestrial > 3.9Ga populations are at 4.01Ga, 4.09Ga, 4.25Ga and 4.3 Ga. The >3.9 Ga lunar zircons have been related to formation of granophyre, possibly by differentiation of more mafic magmas, whereas > 3.9 Ga terrestrial zircons have been attributed to crystallisation from granitic magmas.

References

Amelin Y., Lee D-C, Halliday A.N., and Pidgeon R.T., (1999), Nature 399, 252-255.

Maas R. and McCulloch M.T., (1991), Geochim. Cosmochim. Acta 55, 1915-1932.

Meyer C., Williams I.S. and Compston W.,(1996), Meteor. Planet. Sci. 31, 370-387.

Mojzsis S.J., Harrison, T.M. and Pidgeon R.T.,(2001), Nature 409, 178-181.

Wilde S.A., Valley J.W., Peck W.R. and Graham C.M., (2001), Nature 409, 175-178.

Enantiomeric excess of amino acids in hydrothermal environments

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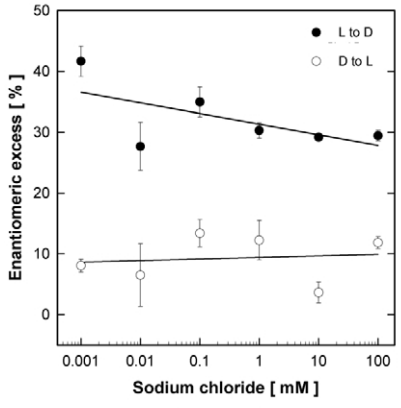
If prebiotic synthesis of amino acids proceeded without any use of chiral asymmetries, L- and D-amino acids could have been synthesized equally likely. Here, we report that hydrothermal environments on the primitive earth could have exhibited an enantioselectivity in favor of L-amino acids.

Methods

We prepared alanine solution by dissolving an optically pure alanine, L or D, in water, and examined time development of enantiomeric excess in a simulated hydrothermal environment. We used a flow reactor for the purpose. In the flow reactor, the reaction solution recycled between hot (503K) and cold (273K) regions. The pressure of the high temperature chamber was maintained at 25MPa. Analysis of the products was done by an HPLC supplemented by an OPA-NAC method.

Results and discussion

When sodium chloride was present in the solution, enantiomertic excess of the isomers of alanine measured 120 minutes after the start of the operation differed depending upon whether the initial isomer was L- or D-alanine. Enantiomeric excesses measured for various concentrations of sodium chloride are displayed in the figure. When the concentration of sodium chloride was low enough, the result of enantiomeric excess suggested that L-alanine was more stable than D-alanine. Racemization was also influenced by the types of metallic ions present in the reaction solution. In particular, when magnesium or ferrous ions were present, enantioslectivity in favor of L-alanine was significantly enhanced.



Enantiomeric excess 120 minutes of the start of the operation.

Conclusions

Hydrothermal environments could shift enantiomeric excess of amino acids spontaneously.

References

E. Imai et al., (1999). Science 283, 831-833

A. Nemoto et al., (2001). Viva Origino29, 168-173.