Implications of Fe/Mn ratios in Fe-Mn crusts for paleoclimate changes

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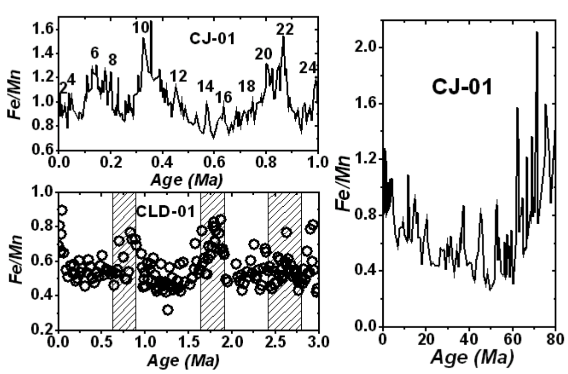
Contents of Fe, Mn and other elements in two ferromanganese crusts recovered from the Central North Pacific were analyzed with electron microprobe for the study of the possible relationship between the deposition of Fe and Mn and the climate changes. Mn (IV) in hydrogenetic Fe-Mn crusts is mainly supplied as colloidal precipitates from the Oxygen Minimum Zone (OMZ), which concentrated high amount of dissolved Mn (II). The iron is derived from carbonate dissolution and silicate particles of eolian dust. Increase in paleoproductivity during a cooling period would lead to an expanded OMZ which would store more Mn (II), and thus to a decrease in Mn deposition. On the other hand, not effected by the OMZ, the iron depositing into the Fe-Mn crust would increase with the surface productivity and eolian dust input at glacial stages. As a result, the increasing Fe/Mn ratio should indicate a cooling climate. In the past 1 Ma profiles, Fe/Mn ratio fluctuates with glacial-interglacial cycles and roughly corresponds to 24 oxygen isotope stages. Within the past 3 Ma three episodes with high Fe/Mn ratios, approximately at 2.6, 1.8, 0.8 Ma, are detected and coincide with major climate transitions and cooling events: (1) the change of glacial cycles from 41 kyr to100 kyr at about 0.6~0.8 Ma (Rutherford 2000; Williams et al., 1997); (2) a major cooling episode at Plio-Pleistocene boundary (1.6~1.8 Ma) (van Couvering 1997); and (3) another major cooling episode in Central Asia (Williams et al., 1997) at 2.8 to 2.6 million years ago. The secular evolution pattern of Fe/Mn ratio is broadly consistent with global deep-sea oxygen isotope records (Zachos et al., 2001), supporting that, during the last 80 Ma, Earth's climate system has drifted from expansive warmth to extremes of cold, with the transition at about 55 Ma.



References

Rutherford S. and D'Hondt S., 2000. *Nature* **408**, 72-75.

van Couvering J., 1997 The Pleistocene boundary and the beginning of the Quaternary, *Cambridge Univ. Press.*

Williams D., et al. 1997. *Science* **278**, 1114-1117.

Zachos, J.C., et al., 2001. *Science* **292**, 686-693.

Origin of water on Earth and Mars

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Morbidelli et al. (2000) demonstrated on dynamical and chemical grounds that more than an Earth's ocean worth of water could have been delivered by large "planetary embryos" which grew in the asteroid belt during terrestrial planet formation. The source is consistent with current understanding of the water content of the asteroid belt (as informed by the chondritic meteorite record), early growth of the giant planets (especially Jupiter), and the isotopic record of D/H and the oxygen isotopes in Earth and chondritic meteorites (though the latter does cap the amount of water that could be delivered in this fashion). Alternative distal sources of Earth's water are ruled out on isotopic or dynamical grounds (especially, comets), and a local (1 AU, astronomical unit) source of water for the Earth would require very low nebular temperatures and seems to contradict the meteoritic evidence suggesting that material inward of 2 AU-3 AU was too dry to supply an ocean or more of water. Subsequent simulations (Raymond et al., 2003) confirm the essential details of this picture.

Mars' history is found to be different; to explain the present mass of Mars requires that it suffer essentially no giant collisions and the bulk of its growth is through addition of smaller bodies. Asteroids and comets from beyond 2.5 AU provide the source of Mars' water, which totals 6-27% of the Earth's present ocean (1 Earth ocean = 1.5×10^{21} kg), equivalent to 600-2700 meters depth on the Martian surface (Lunine et al., 2003). The D/H ratio of this material is 1.2-1.6 times Standard Mean Ocean Water, the smaller value obtaining for the larger amount of water accreted. The total water accreted, while many times less than that acquired by the Earth, is consistent with geological data on Mars, and the D/H value is that derived for Martian magmatic water from SNC meteorites. Both together are consistent with an interpretation of the high D/H in present-day Martian atmospheric water in terms of water loss through atmospheric escape.

References

Lunine, J.I., Chambers, J., Morbidelli, A., and Leshin, L. 2003. *Icarus*, submitted.

Morbidelli, A., Chambers, J., Lunine, J. I., Petit, J. M., Robert, F., Valsecchi, G. B., and Cyr, K. E. 2000. *Meteoritics and Planetary Science* **35**, 1309-1320.

Raymond, S. Quinn, T. and Lunine, J.I. 2003. *Astrobiology*, submitted.