Ca-Al-rich inclusions in the Ningqiang carbonaceous chondrite: Condensation, sintering, melting and alteration

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A systematic study of petrography, mineral chemistry, bulk compositions, rare earth and other trace elements, O and Mg isotopic compositions has been conducted on Ca-Al-rich inclusions (CAIs) in the Ningqiang carbonaceous chondrite. Our main purposes are to clarify condensation trajectory with regard to mineral assemblages, REE and other trace element patterns, and to evaluate any time differences between various events related to formation and evolution of the inclusions.

Abundant CAIs in Ningqiang are fluffy assemblages of condensates. They represent a wide range of condensation in the nebula, from hibonite-bearing Type A at high temperatures, melilite-spinel-rich, spinel-pyroxene-rich, to spinel-bearing amoeboid olivine aggregates (AOA) at low temperatures. Typical coarse-grained compact Type A (CTA), melilite-pyroxene-rich (Type B), plagioclase-pyroxene-rich (Type C), and plagioclase-olivine-rich (POI) inclusions were also found in Ningqiang, and they were sintered or melted by heating certain condensate assemblages in the nebula. Both CTAs and Type Bs can form through melting fluffy Type As (FTA), but precursors of CTAs are melilite-predominant and those of Type Bs contain more Ca-pyroxene. Type C inclusions crystallized from liquids that were probably produced by melting anorthite-spinel-rich inclusions (ASI). ASIs were found in Ningqiang, and they are alteration products of Type As, which took place at high temperatures. Spinel-bearing AOAs may be precursors of POIs,.

Analyses of Mg isotopes of plagioclase in two POIs and one Type C inclusion in Ningqiang indicate absence or small excesses of ^{26}Mg (≤ 2‰). In addition, the preliminary data reveal secondary events after crystallization of these inclusions. More analyses of trace elements, O and Mg isotopes are going on.

Pb and Nd isotope evolution of the Central Pacific Ocean over the Cenozoic: implication for contrasting source dominance

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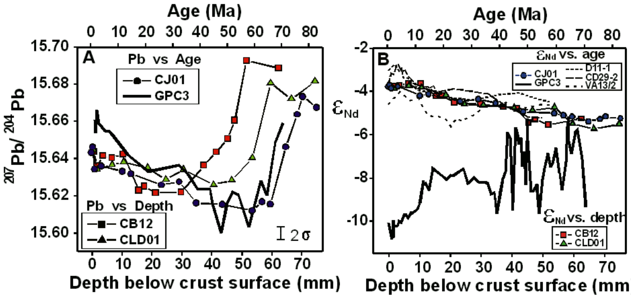
In the past decades, isotope data of seawater and hydrogenetic ferromanganese crusts and nodules, ridge hydrothermal venting and riverine loads, have provided strong evidence on terrigenous sources for oceanic Pb and Nd. However, the ways for terrigenous Pb and Nd input into the ocean are not well constrained and are highly controversial. Here we present new Pb and Nd isotope data for three ferromanganese crusts (two with and one without phosphatization) from the central North Pacific. The three crusts, no matter phosphatized or not, display similar Pb isotope variation trends against depth, suggesting similar ages and different growth rates for these crusts. Estimation by constant Co flux model dating yields late Cretaceous age for the non-phosphorized crust (CJ01) whose variation pattern of Pb isotopes with time agrees well with the Pb isotope evolution of the silicate of eolian dust extracted from the central North Pacific Core (LL44-GPC3) whose sedimentation ages have been well constrained (Fig. A) (Pettke et al., 2002). Hence, we suggest that the central North Pacific seawater Pb as recorded in these crusts over the Cenozoic period should have a major eolian dust origin, and the Pb isotope record in the crusts has not been affected by phosphatization. In contrast, the Nd isotopic variations of the crusts studied and other Pacific crusts (Ling et al., 1997) are by no means similar to the Nd isotopic evolution of the core silicate (Fig. B), suggesting negligible contribution of eolian dust Nd to the central Pacific seawater Nd budget. The rise of Nd isotope ratio in the Pacific during the Cenozoic is likely due to an increase in volcanism and erosion in the Pacific rim.



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