Radiogenic isotopes investigation of cenozoic environmental changes in the Arctic Ocean

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Knowledge of the Arctic Ocean geological history has been much improved through the ACEX coring expedition which retrieved a long sedimentary record from the Lomonosov Ridge (central Arctic Ocean) in 2004. During this unique operation, a 56 Myr-long core was collected that allowed the investigation of striking geological changes including (1) the tectonic shoaling of the Lomonosov Ridge at ca. 44 Myr (leading to a 26 Myr sedimentation hiatus in the sequence), (2) the subsidence of the ridge and (3) the opening of the Fran Strait. This later prompted the ventilation of the basin by North Atlantic water during the Miocene (Jacobson *et al*. 2007).

We have examined these changes in the Lomonosov sedimentary sequence with the use of metallic elements, lead and osmium. These are characterized by different chemical behaviour, input sources and residence times in the ocean (Pb ~ 50 yr and Os ~10-30 Kyr). They have the potential to carry complementary information when measured on a sedimentary sequence. Here, the coupling our Os and Pb isotopic data provide a consistent view of the evolution of the basin, with specific information on water masses origin and ventilation (Os) and sources of particulate supplies (Pb) of importance to document transitional episodes.

Os isotopes found in the ACEX core sediments suggest high river input (with radiogenic continental imprint) during the Paleogene lake-stage of the Arctic followed by a thorough ventilation of the basin by North Atlantic waters at 17.5 Myr. Pb isotopes show that this transition from an enclosed lacustrine basin to well established marine condition is accompanied by changes in regional riverine input sources from a dominantly North-American source during the lake-stage (similar to present-day McKenzie River) to a more European sources (Lena River like) after North Atlantic water ventilation.

Effect of core-mantle differentiation on Fe isotopes

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Whether iron isotope fractionation occurs during core-mantle differentiation remains debated because of conflicting evidence: the change in redox state between iron metal in the core and mostly divalent iron in the lower mantle should favor fractionation, while the very high temperatures involved should minimize it.

To address this question, we conducted piston-cylinder and multi-anvil metal-silicate melting experiments under conditions inferred for core differentiation in an early terrestrial silicate magma ocean. Despite variable pressures, starting compositions, experimental durations and metal-silicate separation methods, no iron isotope fractionation was observed in our experiments to within ±0.063‰ in $\delta^{57}Fe$ [1].

In contrast, calculations conducted on minerals at the conditions of the current terrestrial core-mantle boundary lead to the conclusion that very high pressures may have a notable impact on Fe isotope signatures between lower mantle minerals [2]. In this case, a heavier Fe isotope composition of the silicate Earth relative to its metallic core is predicted. This finding is used by Polyakov [2] to reinterpret the heavier Fe isotope composition of the Earth relative to meteorites [3] as resulting from core-mantle fractionation at very high pressures (~130GPa), instead of fingerprinting the Moon-forming giant impact.

However, the interpretation of [2] cannot explain the observed heavier isotopic composition of the Moon relative to the Earth [3], nor the reason why basalts from hot-spot are not isotopically heavier than those originating from shallower sources. More work should therefore be conducted to improve our knowledge of the Moon mean Fe isotope composition, on iron isotope fractionation processes in the mantle as well as on the effect of very high pressures on non-traditional stable isotope fractionation between minerals.

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