Early to middle Eocene Arctic paleoceanography from Nd-Sr isotope study of fossil fish debris, Lomonosov Ridge

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A Strontium-Neodymium radiogenic isotope study of well-preserved, early-middle Eocene fish debris at Lomonosov Ridge (IODP Arctic Coring Expedition - ACEX) confirms extremely limited connections between the Arctic Basin and surrounding oceans 55 to 45 Ma. Epsilon Neodymium of pre-cleaned ichthyoliths varies from -5.7 to -7.8, suggesting significant REE inputs from Arctic rivers draining primiarly the Siberian platform [1]. $^{87}Sr/^{86}Sr$ ratios of pre-cleaned ichthyoliths (0.7079 to 0.7087) are consistently more radiogenic than Eocene seawater [2], indicating brackish or fresh water environments at the surface of the Arctic Ocean between 55 and 45 Ma. Reduced organic-rich coatings on ichthyoliths and bulk detritus are more radiogenic ($^{87}Sr/^{86}Sr >$ 0.7090) than pre-cleaned ichthyoliths, indicating different Sr sources for the organic component. $^{87}Sr/^{86}Sr$ variations may record changes in river inputs of Sr to the Eocene Arctic Basin, or possibly a shifting halocline, consistent with a dynamic Arctic hydrologic cycle superimposed on eustatic-tectonic controls of seawater exchange with the world ocean. Low salinity waters during the ~55 Ma PETM do not correspond to large excursions in $^{87}Sr/^{86}Sr$ ratios, nor is there a shift in $^{87}Sr/^{86}Sr$ during the ~48.5 Ma Azolla salinity minimum [3]. $^{87}Sr/^{86}Sr$ and Nd isotope data reinforce evidence for low salinity surface waters of dominantly Asian continental provenance within the photic zone over much of the early-middle Eocene at this site, stabilizing a poorly ventilated, anoxic water column that saw only intermittent exchange with the world ocean.

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Analysis of chloride salt deposits on Mars

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Data from the 2001 Odyssey THEMIS and the MGS-TES instruments are consistent with the presence of chloride-rich salt deposits dispersed throughout the southern hemisphere of Mars. We will discuss the detection and identification of these deposits as well as the geologic settings in which they occur and the implications they hold for geochemistry and climate on ancient Mars.

These deposits exhibit unique false-color characteristics in THEMIS infrared decorrelation-stretched (DCS) images and a prominent blue slope in both TES and THEMIS spectral data. A survey of all publicly released THEMIS DCS imagery indicates that most of the salt deposits occur in the Noachian southern highlands of Mars, while a few are present in Hesperian terrains. The deposits generally occur in local topographic lows (such as crater floors and channel beds) and exhibit a higher thermal inertia than the surrounding terrain. High resolution imagery from the MOC and HiRISE cameras indicate that that the deposits are light-toned, polygonally fractured, and up to tens of meters in thickness.

Chloride salts form in a variety of depositional settings on Earth. Chemical precipitation from evaporating saline lakes, groundwater, or hydrothermal brines is common, as is formation at volcanic fumaroles and by efflorescence. While the presence of these deposits in ancient, heavily cratered terrain likely rules out precipitation from an ancient salty ocean, the global extent and geological context of the deposits also makes a fumarolic depositional setting unlikely. Our favored depositional mechanism is precipitation from near-surface brines. The prensence of these deposits primarily in ancient Noachian terrains suggests abunant near-surface water in early Martian history and climatic conditions necessary for the stability of liquid water at the surface.