Dust composition as a guide to wind patterns and paleoclimates

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For several decades, fine-grained land-derived material recovered from appropriate deep-ocean locations (i.e., far from a continent) has been interpreted as windblown dust, and the input rate and the grain size of that material have been used as valuable indicators of continental aridity and of wind strength, respectively. Most of these studies, however, have not examined the composition of the dust, making it impossible to evaluate whether the entire dust assemblage was derived from a single continental source, or whether the seafloor dust assemblage was a mixture of components supplied from multiple continental source areas, each with its own paleoclimatic history. Analyses of the mineral composition of dust from ODP cores in the Indian Ocean and the western equatorial Pacific have demonstrated that the bulk dust assemblage can be partitioned into contributions from distinct continental sources, and that the dust supply from each source records a unique paleoclimatic history.

One example of such work is discussed here. The mineralogy of the dust assemblage deposited during the last 800,000 years at ODP Site 722 (located on Owen Ridge in the northern Arabian Sea) has been used to identify four distinct continental dust sources; these sources, and the inferred dust transport paths, are consistent with sources that supply dust to the region today. One of the most compositionally distinctive sources is evaporative settings along the margin of the Arabian Peninsula; this source supplies dust that is rich in palygorskite (see figure). Over the past 800,000 years, the supply of dust from three of these source areas increased when the source areas became more arid, whereas the supply of dust from the fourth source increased when the source areas became more humid. Changes in the various dust supplies have been identified using principal components analysis (see figure for an example); these changes do not correlate with global ice-volume fluctuations, but each dust record does exhibit significant variability at a primary Milankovitch frequency (100,000 year cycles, in the example shown). Future efforts will focus on identifying the ocean-atmosphere-land linkages that produced these relationships for each dust source.