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Diagenetic bias and misled provenance reconstructions: mineralogy of Cenozoic Nile Delta sediments and the origin of the Nile

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The study of the Nile Delta sedimentary succession provides quantitative information on a process that we must understand and consider in full before attempting provenance interpretation of ancient clastic wedges. Petrographic and heavy-mineral data on partly lithified sand, silt, and mud samples cored from the up to 8.5 km-thick post-Eocene succession of the offshore Nile Delta document systematic unidirectional trends. With increasing age and burial depth, quartz increases at the expense of feldspars and especially of mafic volcanic rock fragments. Heavy-mineral concentration decreases drastically, transparent heavy minerals represent progressively lower percentages of the heavy fraction, and zircon, tourmaline, rutile, apatite, monazite, and Cr-spinel relatively increase at the expense mainly of amphibole in Pliocene sediments and of epidote in Miocene sediments. The entire succession of the Nile Delta was deposited by a long drainage system connected with the Ethiopian volcanic highlands similar to the modern Nile since the lower Oligocene (Fielding et al., 2017). The original mineralogy should thus have resembled that of modern Delta sand (Garzanti et al., 2015) much more closely than the present quartzose residue containing only chemically durable heavy minerals (Garzanti et al., 2018). Stratigraphic compositional trends, although controlled by a complex interplay of different factors, document a selective exponential decay of non-durable species through the cored succession that explains up to 95% of the observed mineralogical variability. Our calculations suggest that heavy minerals may not represent more than 20% of the original assemblage in sediments buried less than ca. 1.5 km, more than 5% in sediments buried between 1.5 and 2.5 km, and more than 1% for sediments buried more than 4.5 km. No remarkable difference is detected in the intensity of mineral dissolution in mud, silt, and sand samples, which argues against the widely held idea that unstable minerals are prone to be preserved better in finer-grained and therefore presumably less permeable layers. Intrastratal dissolution, acting through long periods of time at the progressively higher temperatures reached during burial, can modify very drastically the relative abundance of detrital components in sedimentary rocks. Failure to recognize such a fundamental diagenetic bias leads to grossly mistaken paleogeographic reconstructions, as documented paradigmatically by previous provenance studies of ancient Nile sediments.

CITED REFERENCES

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