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Authigenic anatase nanoparticles as a proxy for sedimentary environment and porewater pH

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Abstract

Titanium (Ti) has long been considered to be immobile during weathering and diagenetic processes, and it is widely used for the normalization of elemental concentrations in weathering profiles. However, our study demonstrates that authigenic titania is commonly formed in fine-grained siliciclastics of a wide variety of facies through weathering of Ti-bearing silicates, authigenic euhedral anatase is present ubiquitously as nanoparticles, and its morphology varies in a predictable manner over a range of depositional environments. The crystal habit of authigenic anatase nanoparticles is controlled primarily by porewater pH during the early diagenetic alteration of Ti-bearing silicates. Authigenic anatase nanoparticles exhibit a distinct tetragonal tabular morphology in deep-marine facies, a tetragonal bipyramidal shape in shallow-marine facies, an irregular morphology with sponge-like aggregates in terrestrial-marine transitional to paludal facies, and euhedral short tetragonal prisms in lacustrine facies. Also, authigenic anatase is observed to form in organic-free glacial deposits, attesting its formation as an inorganic precipitate and demonstrating diagenetic remobilization of titanium in the absence of organic matter. Our findings suggest that authigenic anatase could be a sensitive proxy for the sedimentary environment and sedimentary porewater chemistry, and it will likely prove useful in depositional facies analysis.

Keywords: Anatase, nanoparticle, morphology, sedimentary facies, porewater chemistry