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Altered volcanic ashes in coal and coal-bearing sequences: A review of their nature and significance

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Abstract

Volcanic ashes in coal and coal-bearing sequences typically occur as persistent bands within coal seams (generally as tonsteins, but in a few cases as bentonites, K-bentonites, or as clay-free partings), as an intimate mixture with organic matter, as host rocks (such as roof and floor strata), or as thick layers in coal-bearing strata that are stratigraphically separated from coal seams, including those of thick, laterally persistent tuffs, and in the broader sense fragmental clay rocks and flint clays. Altered volcanic ashes have been found in numerous coals with rank ranging from lignite through various bituminous coals to anthracite, as well as in all the continents where coal beds are present.

The main primary minerals in volcanic ash that survive post-depositional alteration include high-temperature quartz, plagioclase, sanidine, zircon, apatite, monazite, micas, rutile, and anatase. Alteration of volcanic glass and less stable primary minerals may result in the formation of kaolinite, smectite, illite, mixed-layer I/S and, in some cases, chlorite and zeolites. In addition to mineralogical and petrographic characteristics, identification of

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