

An evolutionary system of mineralogy, Part VI: Earth's earliest Hadean crust (>4370 Ma)

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ABSTRACT

Part VI of the evolutionary system of mineralogy catalogs 262 kinds of minerals, formed by 18 different processes, that we suggest represent the earliest solid phases in Earth's crust. All of these minerals likely formed during the first tens of millions of years following the global-scale disruption of the Moon-forming impact prior to ~4.4 Ga, though no samples of terrestrial minerals older than ~4.37 Ga are known to have survived on Earth today. Our catalog of the earliest Hadean species includes 80 primary phases associated with ultramafic and mafic igneous rocks, as well as more than 80 minerals deposited from immiscible S-rich fluids and late-stage Si-rich residual melts. Earth's earliest crustal minerals also included more than 200 secondary phases of these primary minerals that were generated by thermal metamorphism, aqueous alteration, impacts, and other processes. In particular, secondary mineralization related to pervasive near-surface aqueous fluids may have included serpentinization of mafic and ultramafic rocks, hot springs and submarine volcanic vent mineralization, hydrothermal sulfide deposits, zeolite and associated mineral formation in basaltic cavities, marine authigenesis, and hydration of subaerial lithologies. Additional Hadean minerals may have formed by thermal metamorphism of lava xenoliths, sublimation at volcanic fumaroles, impact processes, and volcanic lightning. These minerals would have occurred along with more than 180 additional phases found in the variety of meteorites that continuously fell to Earth's surface during the early Hadean Eon.

Keywords: Philosophy of mineralogy, classification, mineral evolution, Hadean Eon, igneous rocks, aqueous alteration, magma ocean, mineral networks