

THE SERPENTOSPHERE

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The Serpentosphere consists of an earth-wide nearly continuous layer (or spherical shell) of rock dominated by serpentine group minerals (serpentinite). The Serpentosphere is typically about two kilometers thick beneath ocean basins where it is mainly composed of lizardite. Beneath continents, the Serpentosphere is mainly composed of antigorite (alpine peridotite/serpentinite) and may be several kilometers thick. The base of the Serpentosphere coincides with the gravity and high-velocity seismically defined transition beneath both continents and ocean basins commonly referred to as the Moho. Beneath ocean basins and adjacent to spreading centers, oceanic Serpentosphere is continuously generated by the interactions of deep circulating marine composition water – partly in super-critical state – with harzburgitic peridotite in a process referred to as serpentinization. Conversion of the harzburgite to lizarditic serpentine under supercritical condition is texturally preservative and probably induces about 40% volume expansion. The volume expansion provides an excellent mechanism to expel and propel fluid products – including hydrocarbons – from the area of serpentinization to seep sites at the crust hydrosphere/atmosphere interface. A downward diffusing, super-critical serpentinization front is present beneath every ocean basin and is more active where it originally formed near oceanic ridge thermal anomalies.

When ocean Serpentosphere is subducted beneath continental or oceanic crust areas, it converts to antigorite-dominated serpentinite rock (generally coincident with greenschist facies metamorphism). During flat subduction, the relatively lowdensity antigorite ‘floats’ and is underplated to the base of the continental crust at the Moho geophysical interface.

In effect, both oceanic and continental Serpentospheres reflect a deep ‘weathering’ process that consists of the interaction of deep crustal and oceanic, water-dominated fluids with the upper portion of a mainly harzburgitic peridotite at the top of the earth’s lithospheric mantle. The process is analogous to the formation of the pedosphere through interactions of the earth’s hydrosphere-atmosphere layer with the top of the earth’s lithospheric crustal layer. In this context, the Serpentosphere may be viewed as a thin membrane that separates water-absent, life-free abiogenetic processes in the mantle from water-present, life-related processes above the Serpentosphere in the oceanic crust.

The Serpentosphere has enormous and novel implications for four major geologic problems that are of current interest to the geologic and social community: the driving mechanism for plate tectonics, the origin of life, the origin of hydrocarbons, and contributions to global climate. A close relationship between trace elements in crude oils and serpentinite has been found. Migration of the serpentine-associated hydrocarbons to seep sites on the ocean floor and in subaqueous continental environments is essentially the base of the food chain for the biosphere and provides a nutrient and energy source for life in these environments. Heat, methane and carbon dioxide generated during the serpentinization reaction provide a major thermal and greenhouse effect to the earth’s hydrosphere-atmosphere system that is overlooked and underappreciated by the current global climate science. The ductility of the serpentine group minerals provides the tectonic “grease” that allows crustal plates to be able to slide and glide around on the earth’s crust at the Serpentosphere/Moho interface.

Because Serpentosphere has been continuously generated since the beginning of geologic time it must be considered as one of the fundamental entities of our water-surfaced planet – the only water-planet we know of.