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Hydrothermal processes within mantle-dominated oceanic lithosphere.

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Last decades of ocean bottom exploration along mid-ocean ridges (MORs) have revealed an increasing variety of fluid-rock interactions within the oceanic lithosphere, and of hydrothermal systems forming diverse types of localised vents and pervasive diffuse outflows through the seafloor. These different systems are ubiquitous in mantle-dominated substrates uplifted by long-lasting detachment faults that may represent up to 25% of the seafloor, while being neglected so far in evaluations of ocean-lithosphere chemical exchanges. Dredged and drilled serpentinized mantle rocks in present-day oceanic lithosphere show that the main stage of mantle rock aqueous alteration (serpentinization) occurs at 250-350°C during rock exhumation and affects the first 4 to 5 km of the lithosphere while microseismicity incates fracturing down to 8-15 km-depth. Various chemical changes are attributed to this reaction that is also characterized by the generation of H_2. The link between tectonic extension and this background serpentinization allowed a first-order prediction of H_2 fluxes over geological times using plate tectonic reconstructions that may be applied to other chemical fluxes in the future. The H_2-rich fluids drive unique chemical environments for ecosystems and redox reactions involving redox sensitive elements, notably carbon, whose biogeochemical cycle has to be unravelled. The available dissolved inorganic carbon transported by fluids can reacts to form carbonates and/or abiotic organic compounds at various depth, in addition to be biologically used. Identification of organics within serpentinites revealed an unexpected diversity of abiotic forms that may contribute to the global carbon budget, and that opens new perspectives for abiotic organic synthesis on past and present-day Earth. The syntectonic background serpentinization can be overprinted by focused flow driven by magma emplacement at depth at any time near the ridge axis, leading to ephemeral hydrothermal sites on the footwall of detachment faults. Recent observations along the Mid-Atlantic Ridges (arc-en-sub cruise, 2022) revealed a complex spatio-temporal dynamics of fluid flow, resulting in a far more widespread hydrothermal activity of varied style, than expected on ultramafic-hosted environments. This opens questions regarding their impact on global chemical exchanges at the mantle-(sediment)-ocean interface and integration to global models.