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Updating the biogeochemical cycle of silicon in the modern ocean

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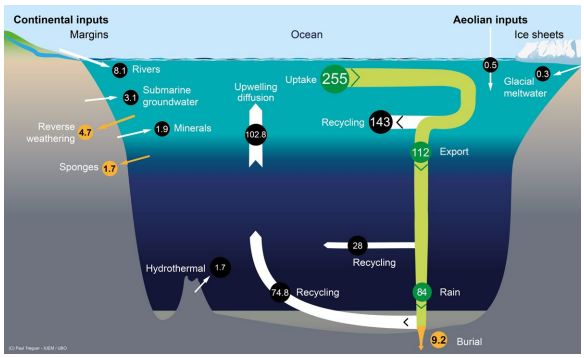

The element silicon (Si) is required for the growth of silicified organisms in marine environments, such as diatoms. These organisms consume vast amounts of Si together with N, P, and C, connecting the biogeochemical cycles of these elements. Thus, understanding the Si cycle in the ocean is critical for understanding wider issues such as carbon sequestration by the ocean's biological pump. Here, we show that recent advances in process studies indicate that total Si inputs (14.8 ±2.6 Tmol-Si yr^{-1}) and outputs (15.6 ±2.4 Tmol-Si yr^{-1}), to and from the world ocean, are 57 % and 37 % higher, respectively, than previous estimates. We also update the total ocean silicic acid inventory value, which is about 24% higher than previously estimated. These changes are significant, modifying factors such as the geochemical residence time of Si, which is now about 8,000 years, two times faster than previously assumed. In addition, we present an updated value of the global annual pelagic biogenic silica production (255 ±52 Tmol-Si yr^{-1}) based on new data from 49 field studies and 18 model outputs, and provide a first estimate of the global annual benthic biogenic silica production due to sponges (6 Tmol-Si yr^{-1}). Given these important modifications, we hypothesize that the modern ocean Si cycle is at approximately steady state with inputs = 14.8 (±2.6) Tmole-Si yr^{-1} and ouputs = 15.6 (±2.4) Tmole-Si yr^{-1}. Potential impacts of global change on the marine Si cycle are discussed.