Steps towards a global chemical weathering model framework: The role of erosion and supply limitation

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Chemical weathering is an integral part of the rock cycle, and its relationship with physical erosion has been a subject of long-standing interest. Empirical correlations between erosion and weathering have been observed for headwater catchments [1] but such correlations have been more difficult to identify at the scale of Earth's largest river basins [2]. This may be the result of the many different factors that influence weathering, including the strong observed dependence on runoff [2, 3].

In this study, we explore the hypothesis that low rates of erosion and associated development of deeply weathered soils, particularly in the humid tropics, reduces chemical weathering over large spatial scales, significantly influencing fluxes from large river basins. As a starting point, we use functional equations for chemical weathering that have been trained empirically based on data from the Japanese Archipelago [3], across a range of different lithologies [4]. These equations were applied to large catchments in tropical areas, and the importance of supply limited weathering was assessed in two ways: (i) using a correction factor based on maps of the distribution of deeply weathered soils and wetlands, and (ii) by comparing weathering fluxes with modeled physical erosion rates [5].

In general, weathering fluxes calculated using the island arc model are significantly over-estimated for the low-lying tropical river basins. An average soil correction factor of 90% was found to account for this supply limited effect. The reduction in chemical weathering rates scales with calculated physical erosion in a comparable pattern to that identified for headwater catchments with felsic lithologies [1].

The results of this study highlight the importance of accounting for the scaling of chemical weathering with erosion at the scale of Earth's largest river basins. Weathering fluxes from island arcs are among the globally highest, because of the young and fresh mineral surfaces, but the weathering equations derived in these settings can be applied to estimate weathering fluxes globally by accounting for supply limitation based on physical erosion rates.

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Ocean-like water in Jupiter-family comet 103P/Hartley 2

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Abstract

For decades, the source of Earth volatiles, especially water, has been a subject of debate. Proposed explanations include accretion of material in the vicinity of the Earth orbit or delivery by impacts of asteroids or comets during the late heavy bombardment (LHB). The source of water reservoirs can be accurately traced by measurements of the deuterium-to-hydrogen isotopic ratio (D/H). Previous measurements of this ratio in several Oort cloud comets resulted in a value twice as high as that in the Earth oceans, leading to the generally accepted conclusion that comets are unlikely to be the primary source of ocean water. Together with orbital modeling, these measurements suggested instead that asteroids with composition similar to that of CI meteoroids were the main water source. As part of our solar system observation programme [1], using the HIFI instrument [2] on the Herschel Space Observatory [3], we have obtained the first measurement of the D/H ratio in a Jupiter-Family comet (103P/Hartley 2) [4]. It turned out that 103P's D/H-ratio is consistent with VSMOW. This result substantially expands the reservoir of Earth ocean-like water to include some comets, and is consistent with the emerging picture of a complex dynamical evolution of the early Solar System. We discuss the implications of these observations for the origin of water and the evolution of its distribution in the solar system.

[1] Hartogh *et al.* (2009) *Planet. Space Sci.* **57**, 1596-1606. [2] de Graauw *et al.* (2010) *Astron. Astrophys.* **518**, L4. [3] Pilbratt *et al.* (2010) *Astron. Astrophys.* **518**, L1. [4] Hartogh *et al.* (2011) *Nature* **478**, 218-220.