Geophysical Research Abstracts
Vol. 12, EGU2010-7141-1, 2010
EGU General Assembly 2010

Global CO2-consumption by chemical weathering: What is the contribution of highly active weathering regions?

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CO_2-consumption by chemical weathering of silicates and resulting silicate/carbonate weathering ratios influences the terrestrial lateral inorganic carbon flux to the ocean and long-term climate changes. However, little is known of the spatial extension of highly active weathering regions and their proportion of global CO_2-consumption. As those regions may be of significant importance for global climate change, global CO_2-consumption is calculated here at high resolution, to adequately represent them.

In previous studies global CO_2-consumption is estimated using two different approaches: i) a reverse approach based on hydrochemical fluxes from large rivers and ii) a forward approach applying spatially explicit a function for CO_2-consumption. The first approach results in an estimate without providing a spatial resolution for highly active regions and the second approach applied six lithological classes while including three sediment classes (shale, sandstone and carbonate rock) based at a 1° or 2° grid resolution. It remained uncertain, if the applied lithological classification schemes represent adequately CO_2-consumption from sediments on a global scale (as well as liberation of other elements like phosphorus or silicon by chemical weatheirng). This is due to the large variability of sediment properties, their diagenetic history and the contribution from carbonates apparent in silicate dominated lithological classes.

To address these issues, a CO_2-consumption model, trained at high-resolution data, is applied here to a global vector based lithological map with 15 lithological classes. The calibration data were obtained from areas representing a wide range of weathering rates. Resulting global CO_2-consumption by chemical weathering is similar to earlier estimates (237 Mt C a^{-1}) but the proportion of silicate weathering is 63%, and thus larger than previous estimates (49 to 60%). The application of the enhanced lithological classification scheme reveals that it is important to distinguish among the various types of sedimentary rocks and their diagenetic history to evaluate the spatial distribution of rock weathering and thus lateral inorganic carbon fluxes. Results highlight the role of hotspots (>10 times global average weathering rates) and hyperactive areas (5 to 10 times global average rates). Only 9% of the global exorheic area is responsible for about 50% of CO_2- consumption by chemical weathering (or if hotspots and hyperactive areas are considered: 3.4% of exorheic surface area corresponds to 28% of global CO_2-consumption). The contribution of endorheic areas to the global CO_2-consumption is with 3.7 Mt C a^{-1} only minor.

A significant impact on the global CO_2-consumption rate can be expected if identified highly active areas are affected by changes in the overall spatial patterns of the hydrological cycle due to ongoing global climate change. Specifically if comparing the Last Glacial Maximum with present conditions it is probable that also the global carbon cycle has been affected by those changes. It is expected that results will contribute to improve global carbon and global circulation models.

In addition, recognizing chemical weathering rates and geochemical composition of certain lithological classes may be of value for studies focusing on biological aspects of the carbon cycles (e.g. studies needing information on the abundance of phosphorus or silica in the soil or aquatic system).

Reference:

Hartmann, J., Kempe, S, Dürr, H.H., Jansen, N. (2009) Global CO_2-consumption by chemical weathering: What is the contribution of highly active weathering regions?. Global and Planetary Change, 69, 185-194. doi:10.1016/j.gloplacha.2009.07.007