Impact of grain size and rock composition on simulated rock weathering

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1. Introduction

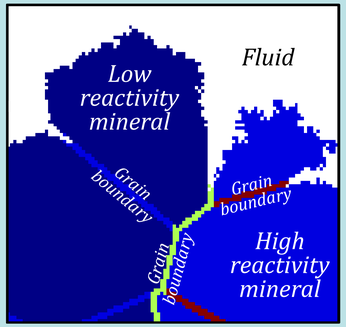
- Both chemical and mechanical processes act together to control the weathering rate of rocks.

- In micrometer grained rocks, enhanced dissolution at grain boundaries cause mechanical detachment of particles.
- However, it remains unclear how important this effect is in rocks with larger grains, and in what way the overall weathering rate is influenced by the proportion of high and low reactivity mineral phases.

2. Modeling rock weathering

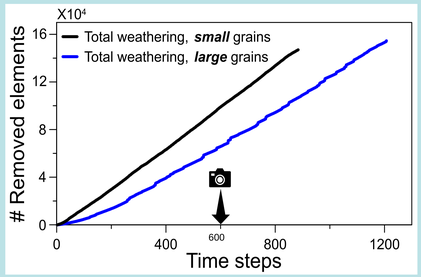
We use a numerical model to assess grain size and mineral composition impact on chemical weathering and chemo-mechanical grain detachment.

The rock is represented by a 2D cross section of mineral grains and grain boundaries.



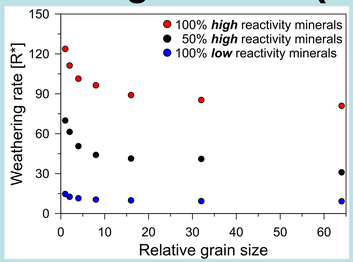
3. Impact of grain size

As grain size increases, weathering rate decreases.



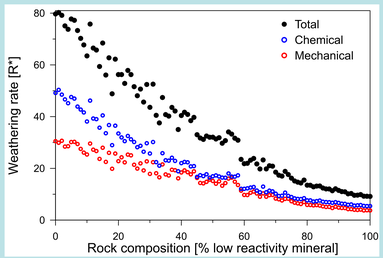
3. Impact of grain size (cont'd)

However, beyond a critical size there is no significant decrease in the rate.

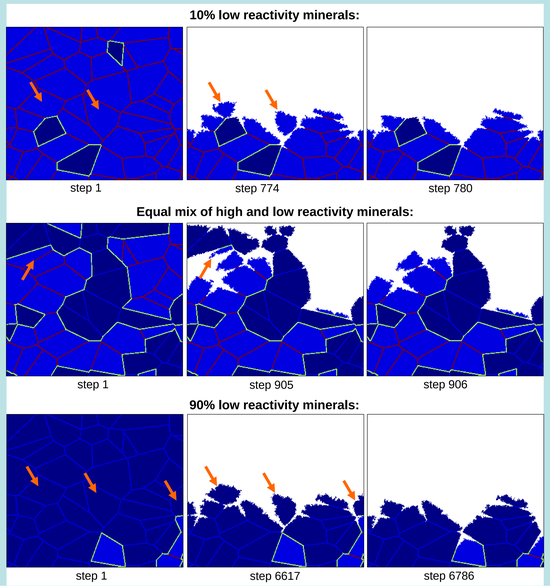


4. Impact of rock composition

The weathering rate decreases non-linearly as the proportion of low reactivity minerals increases.



This occurs because selective dissolution of the high reactivity minerals creates large clusters of low reactivity minerals which then become detached.



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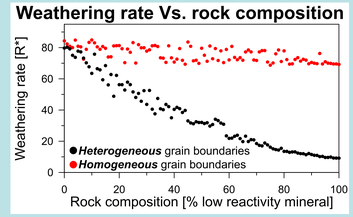
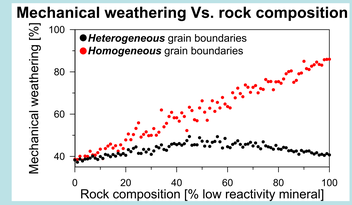
5. Impact of grain boundary reactivity

We compared a heterogeneous model (in which the reactivity of each grain boundary is dependent on the mineral type) with a homogeneous model (in which all boundaries have the same reactivity).

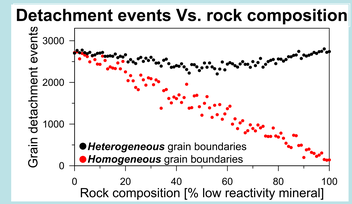
Weathering rate of rocks with homogeneous grain boundaries is almost constant, regardless of the mineral composition.



The grain boundary reactivity determines whether mechanical detachment is the dominant mode of weathering.



The number of detachment events in the different models reflects the transition from the detachment of tiny sub-grains to the detachment of large complete grains.



6. Conclusions

- The contribution of mechanical weathering is determined by the rate of dissolution along grain boundaries. This could explain the variability of rock weathering in nature.
- The balance between chemical and mechanical processes can create complex and non-linear relationships between the weathering rate and lithology.
- Our model could provide a way to simulate the mobilization of particles and contaminants in a way that cannot be achieved using existing geochemical models.

The article

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