Impact of Angiosperms and Gymnosperms on chemical weathering and element mobility

M.Y. ANDREWS*, J.J. AGUE AND R.A. BERNER

Dept. of Geology & Geophysics, Yale Univ., New Haven, CT 06520 (*correspondence: megan.andrews@yale.edu)

Forest trees, both Gymnosperms (Paleozoic origin) and Angiosperms (Mesozoic origin), form an important biological link coupling climate to weathering and erosion over time scales ranging from geological to modern. Differences in tree nutritional requirements, seasonal shedding of biomass, rooting depth and distribution, foliar chemistry, exudation of organic acids, litter decomposition and acidity all contribute to differences in chemical weathering, element mobility and soil profile characteristics beneath each type of tree. This study observed modern trees in both field (Cascade and Olympic Mountains, Washington State) and laboratory settings to quantify these differences.

Over tens of millions of years, differences in Gymnosperm and Angiosperm weathering rates of Ca- and Mg-bearing minerals may have a significant impact on atmospheric CO_2 concentrations via the mechanisms of the long-term carbon cycle. In this study, 20-40% more Ca was leached from soils beneath Angiosperms than from beneath Gymnosperms. However, Angiosperms retained net Mg in the system, while Gymnosperms released net Mg from the soil. Thus the overall impact of the rise of Angiosperms on the chemical weathering portion of the carbon cycle depends greatly on the relative Ca and Mg present in the affected lithologies.

On shorter time scales, trees can still have profound impacts on rates of chemical and physical weathering, nutrient cycling, and element mobility, in addition to strongly influencing soil textures and profiles. Here, Angiosperms concentrated metals in the upper organic layers, correlating well to the mass of metals present in the leaf litter. Their deeper roots created a more uniform soil texture and weathering profile, and allowed clay to form throughout the soil. These deeper roots also help to slow erosion. The shallower roots of the Gymnosperms created a highly weathered upper 10 cm of the soil column, with very little clay formation. These trees are both better able to weather freshly eroded surfaces, and less able to prevent erosion. Higher concentrations of chelating organic acids observed with gymnosperms in the laboratory experiments may explain the greater mobility of most elements, including metals, from field site soils.

From intrusions to magma chambers: Conditions for the accumulation of magma in the upper crust

C. ANNEN*

Section des Sciences de la Terre, Université de Genève, Geneva, Switzerland (*correspondence: catherine.annen@terre.unige.ch)

An increasing amount of field and geochronological data indicates that intrusive bodies are products of the amalgamation of multiple magma pulses. Unless the time intervals between magma pulses are very short, each successive magma pulse injected in the cold upper crust cools down and crystallizes before the injection of the next one. At this stage, the size of any magma chamber associated with the pluton emplacement does not exceed the size of a single pulse. However, each magma injection transfers heat to the crust. Eventually, when the system is thermally mature, larger volumes of magma can accumulate. The incubation time needed to grow a large magma chamber depends on the intrusion depth and on the magma emplacement rate.

Numerical simulations show that at 2 kbar a minimum emplacement rate of a few cm/yr and incubation times of tens thousands years are needed for a magma chamber larger than one pulse to grow. At lower emplacement rates, unrealistic thicknesses of intrusions need to be emplaced before magma starts to accumulate. For realistic emplacement rates and emplacement durations, the mobile magma only forms a small portion of the intrusive body.

According to geochronological data, some intrusions that are several kilometers in thickness were emplaced over millions years [1, 2], which corresponds to an average emplacement rate of a few mm/yr. Heat transfer calculations indicate that the growth of a large magma chamber associated to these bodies is only possible if their emplacement is punctuated by rapid and dramatic increases in emplacement rate.

Thus, observations on plutons and modeling results suggest that large magma chambers may be rare and short-lived. This is supported by the difficulty to seismically image magma chambers and by the absence of deformation associated with some eruptions [3].

[1] Coleman *et al.* (2004) *Geology* **32**, 433-436. [2] Matzel *et al.* (2006) *GSA Bull.* **118**, 1412-1430. [3] Pritchard & Simons (2004) G^3 **5,** 1-42.