

Hillslope Geomorphology
Spring 2008
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Mar. 4 – Mar. 18

Overview: We will examine the feedback among channel incision (or tectonics) at the base of hillslopes (external forcing), sediment generation, transport, and chemical weathering (processes), and morphology and geochemical composition of hillslopes (landscape properties). In each class, we will discuss three aspects of doing hillslope geomorphology: (1) observation, (2) theory, and (3) matching observation and theory. For observation I will use many slides, and for the theory I will introduce simple mass balance equations and their concepts. No background in differential equations is required, however. Matching observation and theory often requires tools. Among many tools in geomorphology, I will briefly introduce the techniques of cosmogenic radio nuclides and geochemical mass balances.

Mar.4 (Tuesday): Lecture 1. Gilbert's analysis of soil mantled hillslopes. (A philosophical basis for modern hillslope geomorphology)

Major text: Robert Anderson's Little Book of Geomorphology. You can download the entire text book at <http://instaar.colorado.edu/~andersrs/publications.html#littlebook>

You don't have to read the whole book! We will use p. 78-84.

Mar.6 (Thursday): Lecture 2. How do soils erode? (Soil production and transport)

Major texts (all downloadable from the university library website):

- Humphreys, G. S. and M. T. Wilkinson (2007). "The soil production function: a brief history and its rediscovery." Geoderma **139**: 73-78.
- Heimsath, A.M., Dietrich, W.E., Nishiizumi, K., and Finkel, R.C., 1997, The soil production function and landscape equilibrium: Nature, v. 388, p. 358-361.
- Heimsath, A.M., Chappell, J., Spooner, N.A., and Questiaux, D.G., 2002, Creeping soil: Geology, v. 30, p. 111-114.
- Furbish DJ, Hamner KK, Schmeeckle M, Borosund MN., Mudd SM. (2007) Rain splash of dry sand revealed by high-speed imaging and sticky paper splash targets. Journal of Geophysical Research-Earth Surface Volume: 112 Issue: F1 Article Number: F01001.

Mar.11 (Tuesday): Lecture 3. How do hillslopes and channels talk to each other?

Major texts (all downloadable from the university library website):

- Sklar LS, Dietrich WE, (2001), Sediment and rock strength controls on river incision into bedrock: Geology, Volume: 29 Issue: 12 Pages: 1087-1090
- Dietrich WE, Wilson CJ, Montgomery DR, et al (1992), Erosion thresholds and land surface-morphology, Geology, Volume: 20 Issue: 8 Pages: 675-679.

March 13 (Thursday): Lecture 4. How do physics and chemistry interplay in forming the geochemistry and morphology of soil covered hillslopes?

Major texts (all downloadable from the university library website except the Anderson et al.):

- Yoo, K., et al., (2007), Integration of geochemical mass balance with sediment transport to calculate rates of soil chemical weathering and transport on hillslopes, Journal of Geophysical Research, 112, F02013, doi:10.1029/2005JF000402. (D)
- Riebe et al., 2004, Erosional and climatic effects on long-term chemical weathering rates in granitic landscapes spanning diverse climate regimes: Earth and Planetary Science Letters. (D)
- Anderson SP, von Blanckenburg F, White AF, 2007, Physical and chemical controls on the Critical Zone, ELEMENTS Volume: 3 Issue: 5 Pages: 315-319 (will be emailed from the instructor).

March 18 (Tuesday): Lecture 5. What are the next questions? Integrating ecological, geochemical and physical processes across the scales from mineral grains to soil profiles to hillslopes

Major texts (all downloadable from the university library website except the Amundson et al.):

- Yoo K. and S.M. Mudd, 2008, The Discrepancy between Mineral Residence Time and Soil Age: Implications for the Interpretation of Chemical Weathering Rates, Geology, v.36; no 1, 35-38.
- Yoo K., R. Amundson, AM Heimsath, WE Dietrich, (2005), Process-based model linking pocket gopher (*Thomomys bottae*) activity to sediment transport and soil thickness, Geology, 33 (11): 917-920 Nov. 2005.
- Amundson R, Richter DD, Humphreys GS, et al. (2007), Coupling between biota and earth materials in the Critical Zone: Elements, Volume: 3 Issue: 5 Pages: 327-332 (will be provided from the instructor).

Requirements and Grading

1) Class participation (10%)

2) Quizzes (40%): 4 questions for 10 minutes at the classes on March 6th and 18th

2) Individual report (50%): Answer the following question based on the materials from the hillslope geomorphology classes.

“Consider a forested soil covered hillslope. The hillslope is in steady state meaning that its curvature and soil thickness are constants along the hillslope. The base of the hillslope is being down cut by a channel. Now, due to the change in tectonic uplift, the bedrock incision rate by the channel suddenly increased by a factor of 10. How will the increased incision rate (external forcing) propagate to the hilltop altering the hillslope morphology and soil geochemistry (landscape properties)?”

In answering this question, you need to *explicitly* focus on the processes (soil production, sediment transport, and chemical weathering). Compose your answer or hypotheses in a full 1 page long article (11 fonts with single spacing and 1 inch margin). *Explicitly* use the materials from the class. Be specific. Answers using the materials outside of the class won’t count well for your grading.