Cinematic modeling of local morphostructures evolution

Vadim Bronguleev

Institute of Geography RAS, Geomorphology, Moscow, Russian Federation (bronguleev@gmail.com)

With the use of a simple 3-dimensional cinematic model of slope development some characteristic features of morphostructure evolution were shown. We assume that the velocity of slope degradation along normal vector to a surface is determined by three morphological parameters: slope angle, its profile curvature and its plan curvature. This leads to the equation of parabolic type:

$$\partial h / \partial t = -A|gradh| + K_{pr} \, (1+|gradh|^2)^{1/2} - CK_{pl} \, (1+|gradh|^2)^{1/2} + f$$

where $h=h(x,y,t)$ is the altitude of slope surface, $K_{pr}(x,y,t)$ is the profile curvature of the slope, $K_{pl}(x,y,t)$ is the plan curvature, $f(x,y,t)$ is the velocity of tectonic deformation (or base level movement), A, B, and C are the coefficients which may depend on coordinates and time.

The first term in the right part of the equation describes parallel slope retreat, typical to arid environment, the second term describes slope vertical grading due to viscous flow, typical to humid conditions, and the third term is responsible for slope plan grading due to such processes as desquamation, frost weathering, etc.

This simple model describes a wide range of local morphostructures evolution: stepped slopes and piedmont benchlands, lithogenic forms – terraces and passages, flattened summits and rounded hills. Using different types of the function f (block rise, swell, tilt), we obtained interesting reformations of initial tectonic landforms during the concurrent action of denudation processes. The result of such action differs from that of the successive action of tectonic movements and denudation. The relation of rates of the endogenous and exogenous processes strongly affects the formation of local morphostructures. Preservation of initial features of slope such as steps or bends as well as their formation due to tectonics or lithology is possible if coefficients B and C are small in comparison to A.