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Interactions between drainage pattern and growing folds (Central Otago, New Zealand)

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Although a number of previous studies have dealt with the evolution of the drainage network in folding Tertiary rocks, the behavior of rivers crossing growing anticlines is less known in basement rocks. Geomorphic transport laws for the erosion of exposed bedrock slopes are also lacking. The goal of our project is to explore the controls and consequences of interactions between rivers and actively growing folds affecting basement rocks. In this study, we address the following questions: How does the hydrographic network respond to fold growth and how far upstream those effects are felt? How do the rates of folding (or rock uplift) and the variations in rock strength affect the incision power of a river? Are the relationships between the different variables predictable?

To evaluate the impact of active Cenozoic tectonics on the behavior of rivers, we based our analysis on drainage systems associated with active reverse faults and folds in Central Otago, New Zealand. This area located within the zone of distributed deformation along the Australian Pacific plate boundary presents a flat peneplain surface corresponding to a late Cretaceous/early Tertiary erosion surface that has been locally deformed by late Cenozoic folds. Four factors make this a particularly favorable study area. The same bedrock (schist) underlies the entire study area. No glaciation has occurred in these ranges. Fold growth and fault propagation styles and rates are rather well constrained by previous studies. Low rates of erosion in the semi-arid climate permit confident reconstruction of the pre-erosion geometry of the folds.

Prior to field studies, we have performed a GIS analysis, the results of which are pre-

sented here. Using a high resolution DEM (10-m TOPSAR data), we have attempted to quantify the evolution of topography during anticlinal growth and to evaluate the river-fold interactions. Because these folds have developed over several million years, we particularly focus on spatial changes in channel slope and other basic channel characteristics as a function of time and topographic relief. We are able to interpret the drainage pattern morphometry in terms of active tectonics (knickpoints along channel), tilting of active folds (physiography of the drainage pattern, main slope of fans) and uplift (stream long-profiles, profiles of old river courses in air gaps, geometry of fans and terraces).

This high-resolution topography analysis provided us qualitative data on the structural and geomorphic evolution of the Central Otago active fold system. However, it also highlights the need to constrain our evolution model with quantitative data such as the rates of folding and uplift, spatial variations in erosion rates, controls on the magnitude of channel incision, and the role of stream capture and abandonment. Studies of high-resolution topographic data and rates of deformation serve to quantify the processes responsible for shaping surface in Central Otago and to better understand linkages between tectonics, climate and erosion.