

MEGAGEOMORPHOLOGY AND NEOTECTONICS

Laurence H. Lattman
New Mexico Institute of Mining and Technology
Socorro, New Mexico

For several decades, subtle neotectonic effects involving several square kilometers have been studied in detail using remote sensing -- primarily various types of stereo-aerial photographs at scales of 1:10,000 to 1:80,000. These subtle effects, especially local uplifts associated with growing structures or differential compaction, have been detected by the effect on drainage patterns, changes in hydraulic geometry of individual channels or groups of channels, tonal halos (soil) and fracture patterns. The studies were extended with the advent of thermal IR imagery particularly in tonal analysis, and SLAR primarily in fracture pattern studies. Lately, quantitative efforts have begun attempting to link measured uplift over known structures with measured changes in hydraulic geometry and alluvial deposition. Thus, efforts are now underway attempting to quantify the relationship between neo- (micro-) tectonic changes and geomorphic parameters of drainage systems.

No published studies exist, to my knowledge, relating to regional neotectonic movement and geomorphic effects. Now, with thousands of square kilometers visible at once, and very recent stereoscopic imagery, mega-geomorphic effects of "mega-neotectonics" may be observable. For example, regional tilting or warping over an area tens or perhaps hundreds of kilometers long is known or suspected from repeated first-order level lines or cadastral surveys. No systematic studies of the large scale effects of such neotectonics exist.

Several Questions arise immediately:

1. Scale of effects: Streams are known to "slip off" or deflect around structural uplifts of small vertical extent. Such features generally cover 5 to 15 square kilometers. Do larger, fourth or higher order streams "slip off" or deflect due to subtle regional tilting or uplift? Are the many variations in lithologic resistance to stream erosion which would be encountered in a large area too great and therefore likely to mask such effects? In what large geomorphic provinces are such variations in resistance likely to be unimportant -- alluvial plains, deltas, glacial till plains?

2. Time scale: Are very large scale neotectonic effects likely to have mega-geomorphic expression as rapidly as studies have indicated local neotectonism does? It appears that small streams (second order) may show changes in hydraulic geometry due to neo-tectonism (or man-made, pseudo-neotectonic) effects within a few years. Is the same time enough for mega-geomorphic effects on drainage systems -- an intuitive, negative answer may be incorrect.

3. Non-drainage effects: Are there mega-geomorphic features other than those of large drainages to be seen resulting from large scale neotectonism? For example, subtle eolian effects, changes in features related to sheetwash, subtle changes in directions of erosional grain (smaller stream erosion seen only as a "grain" on small scale imagery), alluvial deposition changes, coastal features both erosional and deposition and far less obvious than the classical "shorelines of submergence or emergence."

In the United States and Europe, first and second order level lines have been established and resurveyed over many years. Regional neotectonism may be estimated from such data. Reasonably good repeated aerial photography now covers about 50 years in this country and systematic satellite imagery over a dozen years. Space photos, Landsat data, etc., provide a new format by which to study regional neotectonism involving uplift or tilting.

Neotectonic effects along larger faults -- those well expressed on regional imagery and particularly those on which recent movement has occurred -- are an area perhaps amenable to similar studies. An eventual aim here might be the systematic study of subtle mega-geomorphic features possibly associated with strain and incipient movement. This is again an area in which, to my knowledge, no concerted effort has been reported in the literature. A suggested approach would be first, to take the well-known geomorphic criteria for detection of local neotectonic effects which have been established by the oil explorationist (photogeologist-geomorphologist) and apply them over a much larger area to features such as the Palmdale "bulge" or the Wasatch fault system. In such a study the logical (and common) approach would be from the regional, small scale image to the detailed, large scale images of selected areas.

Several areas in the southwestern United States such as the Rio Grande Valley studied by Schumm and his associates, show measurable neotectonic uplift. These have not been studied by remote sensing, and should be.

Finally, the type of sensor or image best suited for such studies, if indeed a "best one" exists, is unknown. A review of mega-geomorphic effects related to the Palmdale "bulge" as seen by several types of remote sensor or after various types of enhancement, might shed light on this question.