RIMS: A real-time, interactive mapping system for neotectonic/geologic investigations of digital terrain data.

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The current flood of terrain and multispectral satellite data with regional to planetary coverage is both overwhelming our analytical capabilities and producing fertile opportunities for discovery. As a result, we need new analytical tools that can handle this flood. Although automated approaches such as feature extraction are very useful, they presume users can specify formal rules by which their data may be filtered. An alternative approach is to visualize the data and allow geologists to directly observe, measure, and record geometric patterns present within them via geomorphic/geologic mapping. An important advantage of this latter process is that it allows users to adapt or evolve their selection criteria as the analysis proceeds, and thereby discover previously unrecognized features or patterns. Unfortunately, this approach is generally limited by hardware capabilities because it requires that the data be displayed. Earth and planetary geologists have struggled with this limitation for some time and in particular with the difficult task of mapping their detailed observations across large areas (1000 x 1000 km) directly on high resolution (1-10 m) remotely-sensed data. In response, we have developed a real-time, interactive, mapping system (RIMS). RIMS uses a quadtree-based multiresolution method to circumvent hardware limitations and permit real-time rendering of high-resolution data over large spatial areas. The resulting visualization environment is analogous to Google-Earth in the way that it allows users to manipulate terrain models comprised of texture data draped over a digital elevation model (DEM). More importantly, RIMS also allows users to map inside this interactive environment by generating vector-based polylines directly on the terrain visualization and by providing a “virtual geologic compass" for measuring orientations of geological surfaces. RIMS also provides sculpting tools for 3D reconstruction of deformed and partially eroded surfaces such as folded bedding. The georeferenced maps made using RIMS can be exported to standard GIS software. Using RIMS, we are currently mapping several zones of active intracontinental deformation, including the northern edge of the Arabia-Eurasia collision zone between the Black and Caspian Seas. This area lies along the politically volatile northern foothills of the Greater Caucasus Mountains in Chechnya. Using SRTM 90 and Landsat ETM+ data, we are characterizing potential seismic sources to determine if total shortening across the range increases systematically from west to east, as observed by GPS measurements of the instantaneous deformation field (McClusky and Reilinger, 2004; Reilinger et al., 2004). Our RIMS-based mapping has revealed evidence of recent folding along two ridged that trend east-west within the foreland basin, sub-parallel to the Greater Caucasus range to the south. A fluvial terrace along on the northern edge of the northernmost ridge is both elevated relative to the active floodplain within the foreland basin and locally bowed into east-west trending linear ridges. Terrace incision and secondary ridge formation most likely resulted from recent folding. At both the western and eastern tips of the northern ridge this fluvial terrace grades upslope into a pediment surface that is locally breached by gullies draining the ridge, but is preserved as a set of triangular facets along the interfluves between the gullies. Local preservation of this relict surface attests to recent lateral propagation of the fold tips. Our Caucasus research demonstrates that the strength of RIMS is that it combines interactive rendering with interactive mapping and measurement of features observed in topographic and texture data.