ANDEAN EXAMPLES OF MEGA-GEOMORPHOLOGY THEMES

Arthur L. Bloom
Department of Geological Sciences
2122 Snee Hall
Cornell University
Ithaca, New York 14853

I. GEOMORPHIC PROVINCES

Geomorphic (or physiographic) provinces have been a well-known and useful method of regional landform classification for a century. Every earth scientist will recognize a phrase such as "Appalachian Plateau" or "Southern Rocky Mountains" as defining a discrete region of consistent geologic structure that has experienced a similar interval of erosion by a similar process or set of processes. The geomorphic provinces formalized in the United States by Fenneman in the 1920's continue to be highly satisfactory even though some boundaries were only vaguely drawn. Mosaics of Landsat images illustrate better than any earlier maps the validity and coherence of Fenneman's provinces (see Bloom, 1979). The concept of geomorphic provinces has been used subconsciously or intuitively, to describe the relief of the ocean floor and the topography of the moon and other planets.

A variant of the geomorphic province is the "morphotectonic region" in which relief is a direct expression of recent or ongoing tectonic and volcanic activity. The central Andes have apparently attained their present relief only in late Cenozoic time, and the landforms clearly show the regional tectonic patterns. A particularly interesting aspect of the morphotectonic subdivisions of the Andes is the repetition of "basin and range" morphologies in two tectonically different areas, the Puna and the Sierras Pampeanas. In spite of the geomorphic similarity to the extensional Basin and Range of the western United States, in both the Puna and the Sierras Pampeanas the ranges are bounded by reverse faults. This contradiction between the extensional Basin and Range of the western U.S. and the compressional "basins and ranges" of the Central Andes illustrates there is still much to be learned about the genesis of morphotectonic provinces.

Because relief elements are so easily seen and defined on TM and other space images, the central Andes is an excellent area in which to construct a complete morphotectonic classification of landforms from TM images. Suspected correlations between landforms and tectonic movements can be clarified by use of other space images such as side-looking radar and thermal images, and existing geologic maps and reports. Based on five years of previous research in the central Andes and on-going projects, including the anticipated receipt of SIR-B coverage, selected ancillary TM images and hand-held camera photographs, the Cornell Andes group will have built an extensive data base for the efficient and tectonically significant definition of that complex landscape.

II. LANDSCAPE INHERITANCE

The Sierras Pampeanas are fault-bounded mountain massifs of crystalline basement rocks that reach elevations of 6 km on the eastern flank of the Andes between 28°S and 33°S. Tectonic uplift of the mountain blocks and subsidence of intervening basins has been active in Pliocene and Pleistocene time.

The uparched and tilted surfaces of the Precambrian and Paleozoic crystalline rocks in the Sierra Pampeanas are being stripped of younger sedimentary cover strata. Most of the covering rocks are of Cenozoic age, but some are of late Paleozoic and Cretaceous age. All are continental sediments except for a small area of Miocene marine sediments in the Valle de Santa Maria. Cemented to the basement gneisses and schists along some mountain fronts are red arkosic conglomerates of possible Mesozoic age. If so, then the basement surface under them is an exhumed Gondwana landscape.

The western flank of the Sierra Quilmes is a typical basement exposure with remnants of cemented conglomerate cover. The exhumed Gondwana surface, probably a pediment, dips westward at 11° to 16°, an angle that could be primary. LANDSAT and shuttle radar images of the Sierra Pampeanas show extensive areas of mountain fronts with similar rhombohedral fracture patterns and gentle slopes on crystalline rocks. Many or most of these surfaces are probably exhumed Gondwana pediments.

III. PROCESS THRESHOLDS

Astronaut photographs taken during the STS-8 mission in September 1983 showed great plumes of red and white dust being blown out of dry lake beds in the southern Puna and transported southeastward across the Argentine Pampas, which were covered by low clouds at the time. This was the first demonstration that the Pampean loess is still actively accummulating, and provides a direct and obvious answer to the long-standing question of the origin of the Pampas and their soils. With an indication of the source of the wind-blown sediments, pedogenesis can now be studied in a much more direct and quantitative manner.