MINERALOGY MAKES MOUNTAINS

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Hills are made of resistant rocks, valleys lie in soft ones. This is so obvious and well-known that it would hardly seem to be worth stating. But in what sense are the rocks resistant or soft? What factors contribute to these properties? This paper will first put limits on the kinds of landscape to be discussed, and then seek to show that the major factor dictating the shape of the landscape is mineral solubility.

LIMITS

1) Tectonics and vulcanism are inactive;
2) The landscape is undergoing erosion, deposition occupies a small part of the landscape (~10-20%);
3) Individual areas being assessed do not embrace more than one physiographic domain; and,
4) There is some reason to believe that the terrain being assessed is of uniform exposure age.

In essence, these limits mean that the hypothesis is tested for areas that are geologically and geographically reasonably homogeneous. For example a study area would not cross the Great Escarpment, for whatever its origin, it separates coastal lowlands from the inland highland or plateau. However the coastal lowlands and the inland plateau would each be within the defined limits. A study area would not, for example include Paleozoic granites and Tertiary basalts.

STUDY AREAS TO BE DISCUSSED

- The Mt Dromedary Complex. These rocks are coeval, 90 million years old.
- The Bega Valley. The dominant rocks are granitic. They have possibly been exposed to weathering since the Devonian sediments were eroded from them, though their present landscape may only date from break-up (Late Cretaceous).
- The Canberra region. Rocks here are varied, Paleozoic sediments and volcanics. Area assessed is confined to within the Canberra Graben.
- Petford Batholith, Qld. Carboniferous volcanics and intrusives.

MINERAL SOLUBILITY

There are two approaches used here to establish numerical values for mineral solubility. The first is to compare mineral survival in a weathering profile as Reiche (1943) did nearly 60 years ago (Table 1), and rank minerals in order of apparent dissolution rate from field evidence,

Table 1: Order of mineral susceptibility to weathering from various sources.

Reiche	granite	granite	till	monzo	gabbro	basalt	basalt
quartz	quartz	quartz	quartz	quartz	quartz	ilmenite	Ti-mag
K-spar	K-spar	Kspar	Kspar	K-spar			K-spar
albite							
biotite		h'blende	h'blende		h'blende		
anorthite	plag	biotite	plag	augite	plag		
neph	h'blende	plag		h'blende	pyrox		
h'lende	biotite		biotite	biotite	biotite		
augite				plag		pyroxene	pyroxene
				nepheline		plag	plag
olivine						olivine	olivine
						glass	glass
Reiche (1943)	Aspandiar (1998)	Markovics (1977)	Law *et al.* (1991)	Wang (1988)	Creasey *et al.* (1986)	Eggleton *et al.* (1987)	Coleman (1982)

From data such as these, an order of mineral susceptibility to weathering can be developed: resistates>quartz>K-spar>albite>hornblende>pyroxene>biotite>anorthite>olivine>glass.

In: Roach I.C. ed. 2002 *Regolith and Landscapes in Eastern Australia*, pp. 21-23. CRC LEME.

The second approach is to use laboratory data of mineral solubility at a pH fairly typical of near surface regolith moisture (pH=6 used here) (Table 2).

Table 2. Mineral solubility (moles/m^2/s) at pH 6 from laboratory data.

Mineral	log rate	source
muscovite	-12.80	Nagy (1995)
kaolinite	-13.20	Nagy (1995)
gibbsite	-13.60	Nagy (1995)
biotite	-12.00	Nagy (1995)
smc	-11.89	Nagy (1995)
qtz	-13.30	Dove 1995
diopside	-10.80	Brantley & Chen (1995)
h'blende	-11.00	Brantley & Chen (1995)
augite	-12.00	Brantley & Chen (1995)
microcline	-12.80	Blum & Stillings (1995)
sanidine	-12.20	Blum & Stillings (1995)
anorthite	-9.00	Blum & Stillings (1995)
albite	-12.60	Blum & Stillings (1995)
bytownite	-11.60	Blum & Stillings (1995)
andesine	-12.20	Blum & Stillings (1995)
oligoclase	-12.80	Blum & Stillings (1995)
forsterite	-10.00	Casey & Ludwig (1995)

Using these values, a rock dissolution rate D can be calculated from a rock's modal analysis by simple addition:

$D = (\Sigma \log D_i \times W_i)/100$, where W_i the weight % for the i^{th} mineral.

The hypothesis now presented is that the mean elevation of a rock mass, for example a pluton or a sandstone unit, is in some way proportional to its Rock Weathering Index (RWI). To assess this, the mean elevation of a rock body is determined from a topographic map, either integrated over two profiles drawn at right angles or estimated by inspection, and compared to its RWI (Figure 1).

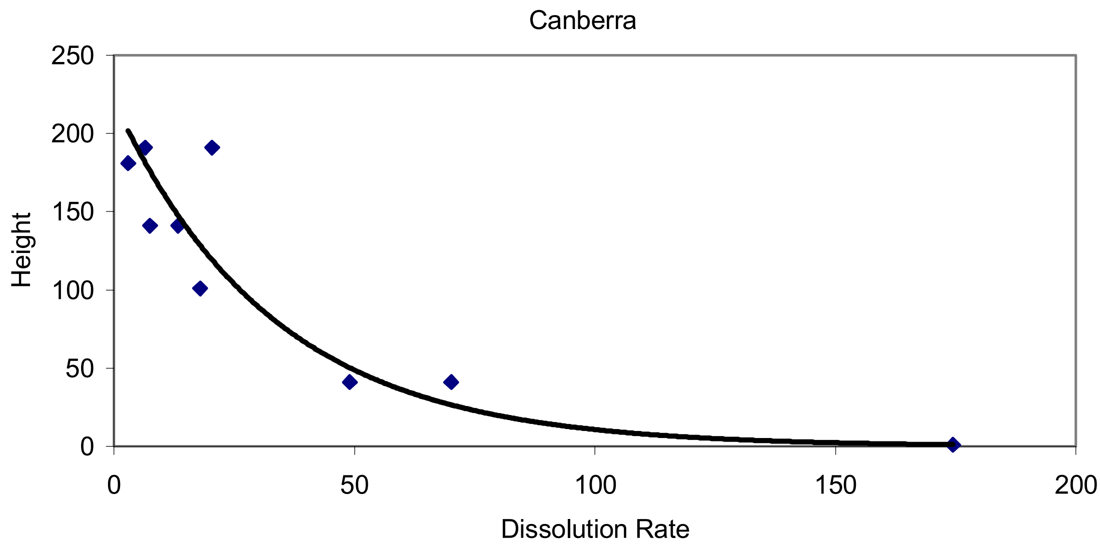

Figure 1: Plot of Dissolution Rate (moles/m^2/mA) versus height for rocks of the Canberra region.

A smooth curve is seen to relate height to the mean dissolution rate of the rock. Certainly there are deviations on a small scale, and these will be discussed; for example a small, relatively soluble pluton surrounded by more resistant ones will be supported by its tough neighbours above the elevation suggested by its mean dissolution rate.

CONCLUSION

From these and other results, it would appear that in the landscapes selected, relief is directly related to the solubility of the minerals constituting the rocks.

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