GSA DATA REPOSITORY 2011232

Why is the North America Cordillera High? Hot Backarcs, Thermal Isostasy, and Mountain Belts

Supporting Online Material

R.D. Hyndman and C.A. Currie

AREA OF NORTH AMERICA BACKARC

The area of the North America Cordillera backarc with inferred uniformly hot and thin lithosphere is shown in Figure DR1. Excluded are the current Cascadia forearc and the recent forearcs of western California and western British Columbia north of Cascadia because they have thermal regimes influenced by cooling subduction effects, and the eastern Cordillera foreland belt where Cordilleran crust overthrusts cold craton lithosphere. The deep Cordillera-Craton thermal boundary is precisely defined only in a few places. Bensen et al. (2009) provide estimates of this boundary based on seismic velocity and crustal thickness data.

Figure DR1. The North America Cordillera showing the hot backarc mobile belt.

HISTOGRAMS OF NORTH AMERICAN CORDILLERA BACKARC AND STABLE AREAS

Figure DR2 shows histograms of the elevation points of Hasterok and Chapman (2007) for North America Cordillera backarc compared to the craton and other stable areas. The elevations have been corrected for the isostasy effects of crustal thickness and of crustal density (from average seismic velocity) as described by Hasterok and Chapman (2007). There are two distinct populations with no overlap. The average difference in elevation is 1,600m. Although there may be other effects on isostasy, the scatter of points around the two means is approximately that expected for the uncertainties in crustal thicknesses and crustal densities.

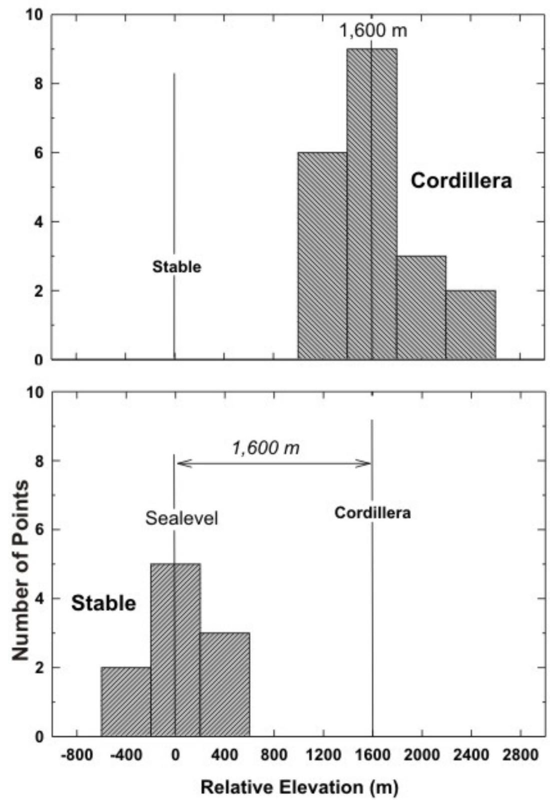

Figure DR2. Histograms of elevations in Cordillera backarc compared to the craton and other stable areas of North America. Elevations are corrected for average crustal density and thickness**.**

CORRECTIONS TO ELEVATIONS FOR AVERAGE CRUSTAL DENSITY

Figure DR3 shows the corrections to give equivalent elevations for variations in average crustal density estimated from average seismic velocity. This correction reduces the scatter significantly and removes the bias resulting from the systematic variations in crustal density with crustal thickness illustrated in Figure DR4.

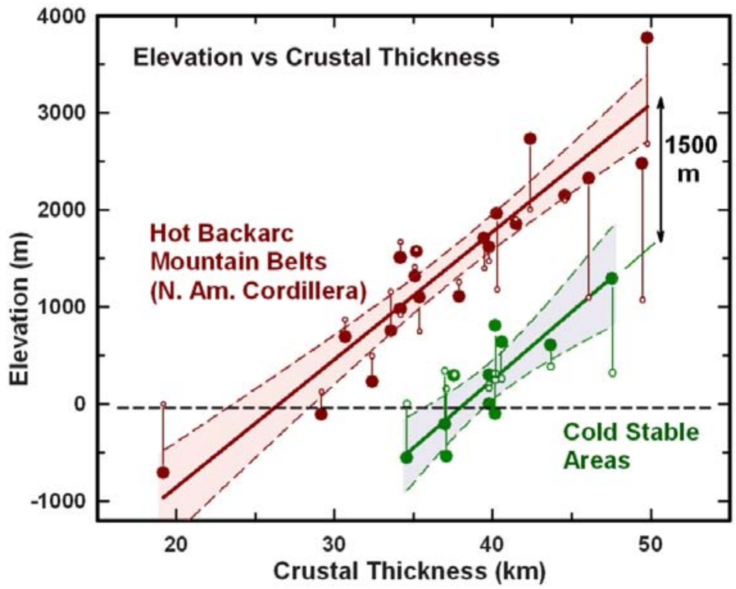

Figure DR3. Elevation versus crustal thickness data for North America, showing the elevation corrections for average crustal density based on average crustal seismic velocity. Solid points are corrected, open points are uncorrected (data from Hasterok and Chapman, 2007).

AVERAGE CRUSTAL DENSITY VERSUS CRUSTAL THICKNESS

Figure DR4 illustrates the average crustal density estimated from average seismic velocity showing the trend of higher average density for thicker crust as noted by Hasterok and Chapman (2007). The result is that thick crust areas are at slightly lower elevation compared to thin crust areas than expected for simple isostasy.

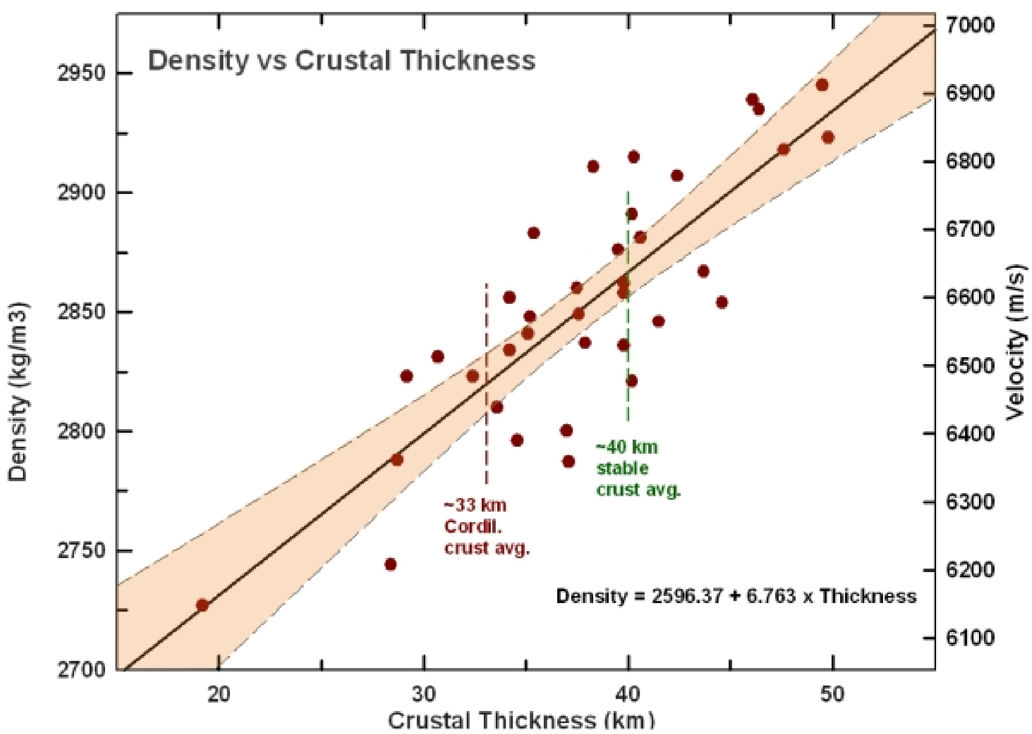

Figure DR4. Average crustal density versus crustal thickness, based on density from average seismic velocity. Although there is considerable scatter, average crustal density appears to increase with crustal thickness (data from Hasterok and Chapman, 2007).

SENSITIVITY OF THERMAL ELEVATION TO BACKARC LITHOSPHERE THICKNESS

Figure DR5 shows the sensitivity of backarc thermal elevation to lithosphere thermal regime as illustrated by lithosphere thickness. A simple linear thermal gradient approximation and no lateral variations in radioactive heat generation are assumed. For lithosphere less than about 80 km thick, there is low sensitivity of elevation to lithosphere thickness, less than about 15% smaller predicted thermal elevation for 80 km vs 60 km, because in backarcs the deeper part of the thermal regime has everywhere inferred approximately the same convective adiabat to the reference depth of about 200 km. The estimated thermal elevation anomaly relative to the craton reference decreases rapidly for lithosphere thicknesses greater than about 100 km, reaching zero at the reference depth of about 200 km for craton lithosphere.

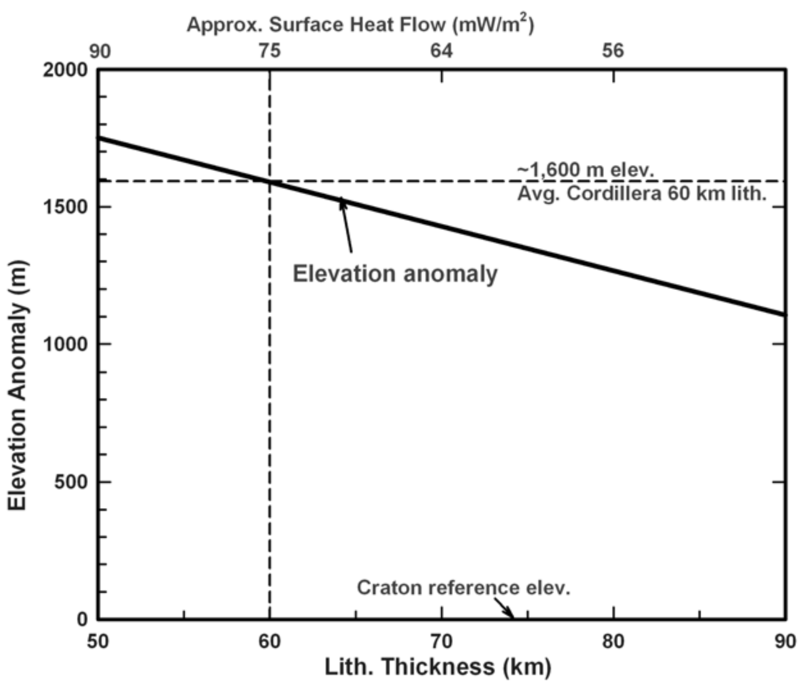

Figure DR5. Sensitivity of thermal elevation to lithosphere thickness and surface heat flow.

References

Bensen, G.D., Ritzwoller, M.H., and Yang, Y., 2009, A 3-d shear velocity model of the crust and uppermost mantle beneath the United States from ambient noise: Geophysical Journal International, v. 177, p. 1177-1196.

Hasterok, D., and Chapman, D.S., 2007, Continental thermal isostasy: 2. Application to North America: Journal of Geophysical Research, v. 112, B06415, doi: 10.1029/2006JB004664.