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THERMOMECHANICAL MODELING OF THE COLORADO PLATEAU-BASIN AND RANGE TRANSITION ZONE; Michael D. Londe, Department of Geology and Geophysics, University of Wyoming, Laramie, WY 82071

The Colorado Plateau (CP) - Basin and Range (B & R) boundary is marked by a transition zone on the order of 75 to 150 km in width. As one moves westward across this transition from the CP interior to the B & R there is a variation in the surface topography, surface heat flow, Bouguer gravity, seismicity, and crustal structure. This transition extends eastward into the western CP from the Wasatch-Hurricane fault line and is largely coincident with the high plateaus of Utah and the Wasatch Mountains. Figure 2 shows the variation in surface heat flow, topography, and Bouguer gravity for the three profiles shown in Figure 1. It has been suggested that this transition zone marks a thermal and tectonic encroachment of the CP by the B & R [1, 3, 4].

A simple two dimensional numerical model of the thermal regime for the transition zone has been constructed to test the hypothesis that the observed geophysical signatures across the transition are due to lateral heat conduction from steady state uniform extension within the B & R lithosphere. Surface heat flow, uplift due to flexure from thermal buoyant loading, and regional Bouguer gravity are computed for various extension rates, crustal structures, and compensation depths. Figure 3 shows the dimensions of the models tested in this study. Model compensation depths of 65 and 120 km were chosen to correspond to the depth of the B & R lithosphere, as determined from surface wave studies, and the upper limit of thickness of the CP lithosphere. Two crustal structures are used in this study to examine the effect of the crustal structure on the flexural uplift and the Bouguer anomaly. For one case a thin crust is present to the mechanical boundary and in the second case a thickened block of crust extends 40 km to the west of the mechanical boundary.

Lachenbruch and Sass (1978)(2), have shown that uniform lithospheric extension can adequately explain the surface heat flow in the B & R interior. However theirs is a one dimensional model and cannot be used to examine thermal and mechanical effects near the boundary of the extending region. The use of two dimensional models allows the investigation of the effects of lateral heat conduction into a fixed block (the CP interior) bounding the extending region. Use of a state state model is justified by the fact that the thermal structure of the lithosphere should have reached a dynamic steady state if extension has been occurring for the last 20 to 40 my (2). In effect this model yields a "snapshot" of present conditions.

These models predict heat flow differences of 35 to 45 mW/m^2 across the transition zone. This is consistent with the step in heat flow shown in Figure 2 although the exact nature of the step is not clearly defined due to a lack of detailed observations.

Figures 4 and 5 show the results of uplift and regional Bouguer gravity calculations for a model with a compensation depth of 120 km, 1%/ma strain rate, and the two crustal structures discussed earlier. In Figure 4 a thin crust extends to the mechanical boundary. This structure yields relative uplifts (superposed on an average uplift of 1750 m) of 200-400 m, depending on flexural rigidity, which are confined to the thick crust fixed block and a relative subsidence of 200 to 300 m within the extending region. The Bouguer anomaly, at a datum of 1750 m elevation, shows a step of approximately 50 to 60 mgals across the transition zone with a small broad low of -15 mgal corresponding to the uplifted zone.

In Figure 5 a thickened crust extends 40 km west of the mechanical boundary. An uplift of 400 to 800 m is generated largely within this zone of thickened crust with a relative subsidence of 200 to 300 m within the extending region. The gravity shows a step of 50 to 70 mgals across this transition with a relative low of -30 mgal corresponding to the zone of uplift.

The results of this simple modeling demonstrate excellent agree with the observed signatures shown in Figure 2. This suggests that a model of uniform lithospheric extension within the B & R with lateral heat conduction into the Colorado Plateau can explain the observed geophysical signatures of the transition zone. This work suggests that the uplift and gravity across the transition zone can be explained by a simple model of elastic plate flexure. The results of the flexural model suggests that the crustal thickness within the transition zone must be at least intermediate in thickness between the observed CP and B & R thicknesses, 30-45 km.

This model is being further refined by calculation of the transfer function of the topography and Bouguer gravity to further constrain the compensation mechanism and material properties.

References

(1) Keller, G.R., L.W. Braille, and P. Morgan, 1979, Crustal Structure, Geophysical Models, and Contemporary Tectonism of the Colorado Plateau, Tectonophysics, 61, 131-147.

(2) Lachenbruch, A.H., and J.H. Sass, 1978, Models of an Extending Lithosphere and Heat Flow in the Basin and Range Provence, in Cenozoil Tectonics and Regional Geophysics of the Western Cordillera, G.S.A. Memoir 152, edited by R.B. Smith and G.P. Eaton.

(3) Thompson, G.A., and M.L. Zoback, 1979, Regional Geophysics of the Colorado Plateau, Tectonophysics, 61, 149-181.

(4) Smith, R.B., 1978, Seismicity, Crustal Structure, and Intraplate Tectonics of the Interior of the Western Cordillera, in Cenozoic Tectonics and Regional Geophysics of the Western Cordillera, G.S.A. Memoir 152, edited by R.B. Smith and G.P. Eaton.

Figure Captions

Figure 1: Base map showing location of profiles 1, 2, and 3 across the CP - B & R Boundary. Heavy dashed line shows location of seismic refraction lines. Light dashed line shows the approximate boundary of the transition zone - central Utah.

Figure 2: Variation surface heat flow, Bouguer anomaly, and elevation across the transition zone. All profiles normalized so that the Wasatch

fault line is at 200 km.

Figure 3: Dimensions, crustal structures, and reference density columns used in the thermal and mechanical models.

Figure 4: Relative uplift and Bouguer gravity anomaly (1750 m datum) for model with a compensation depth of 1120 km, and a thin crust to the mechanical boundary. 1%/ma strain rate.

Figure 5: Same as Figure 4 except how a thickened block of crust extends 40 km west of the mechanical boundary.

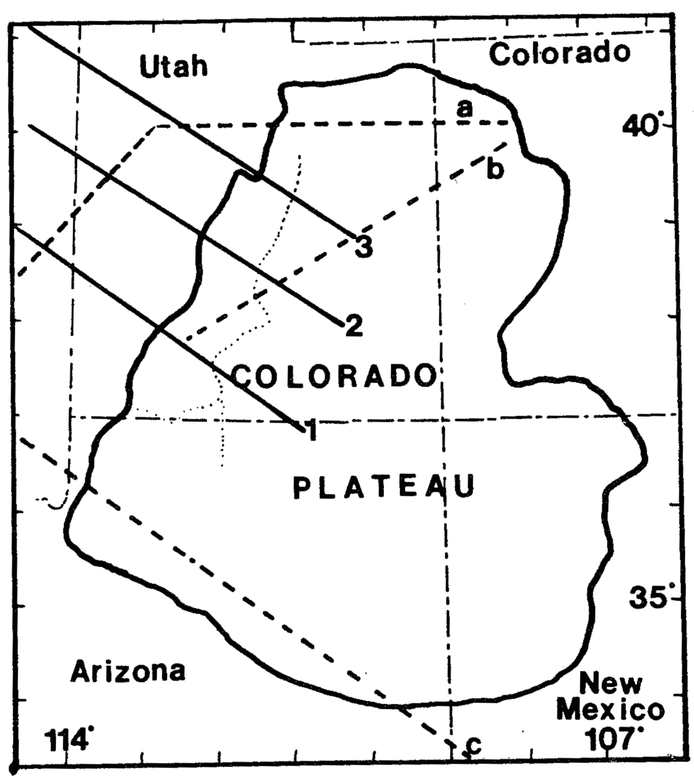

Figure 1

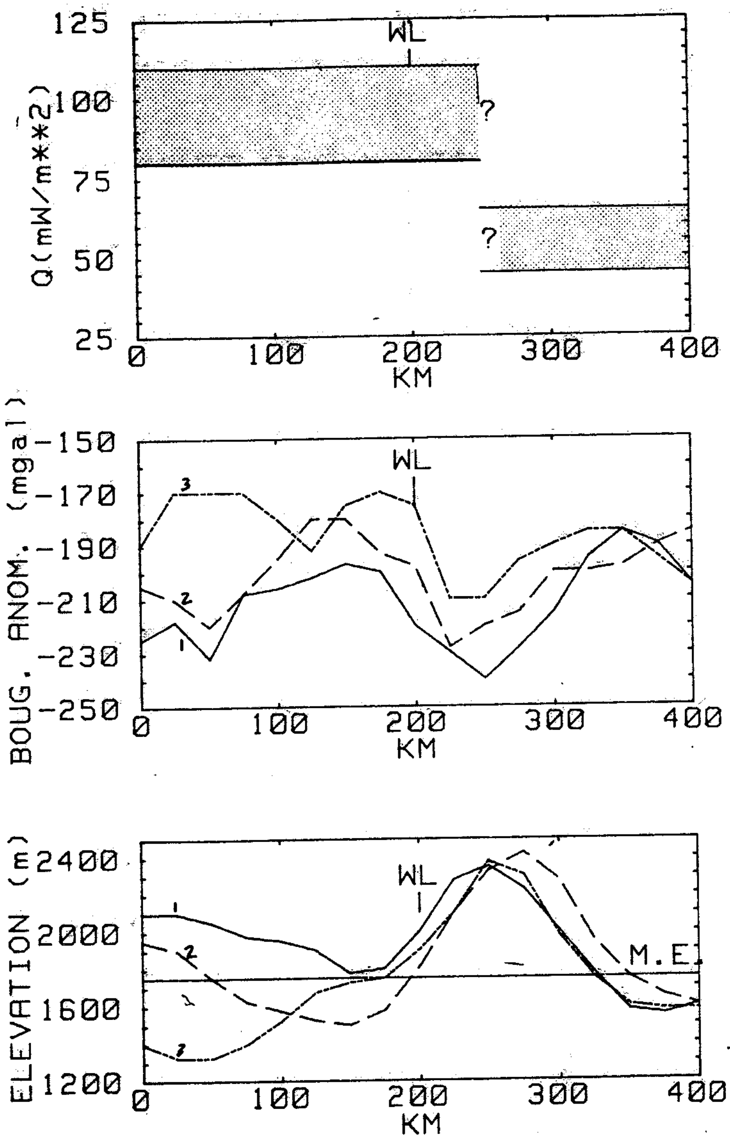

Figure 2

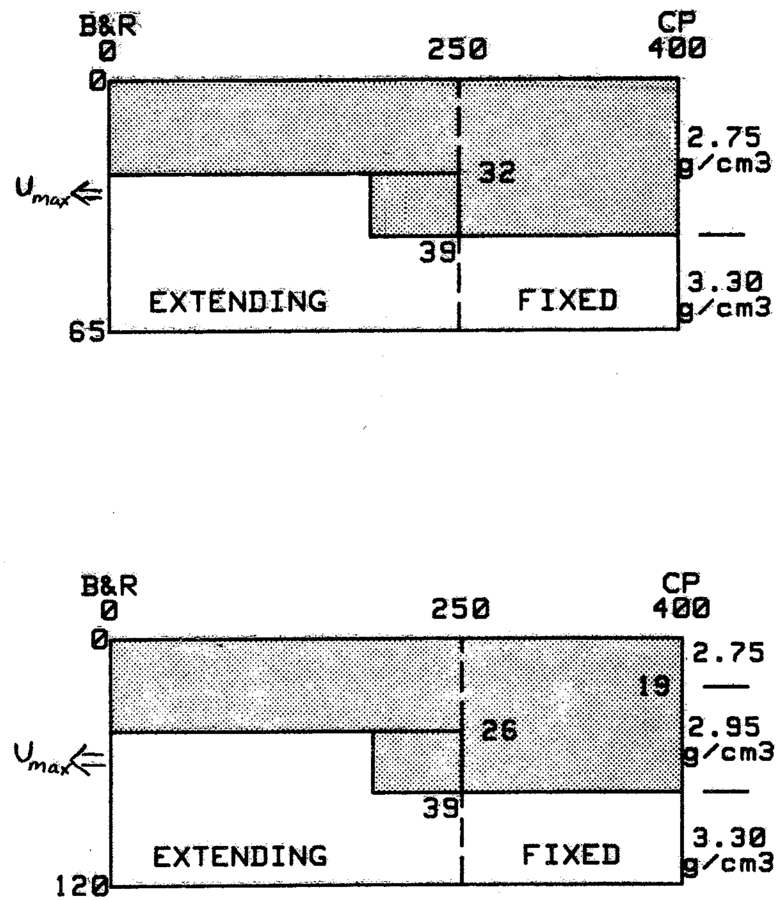

Figure 3

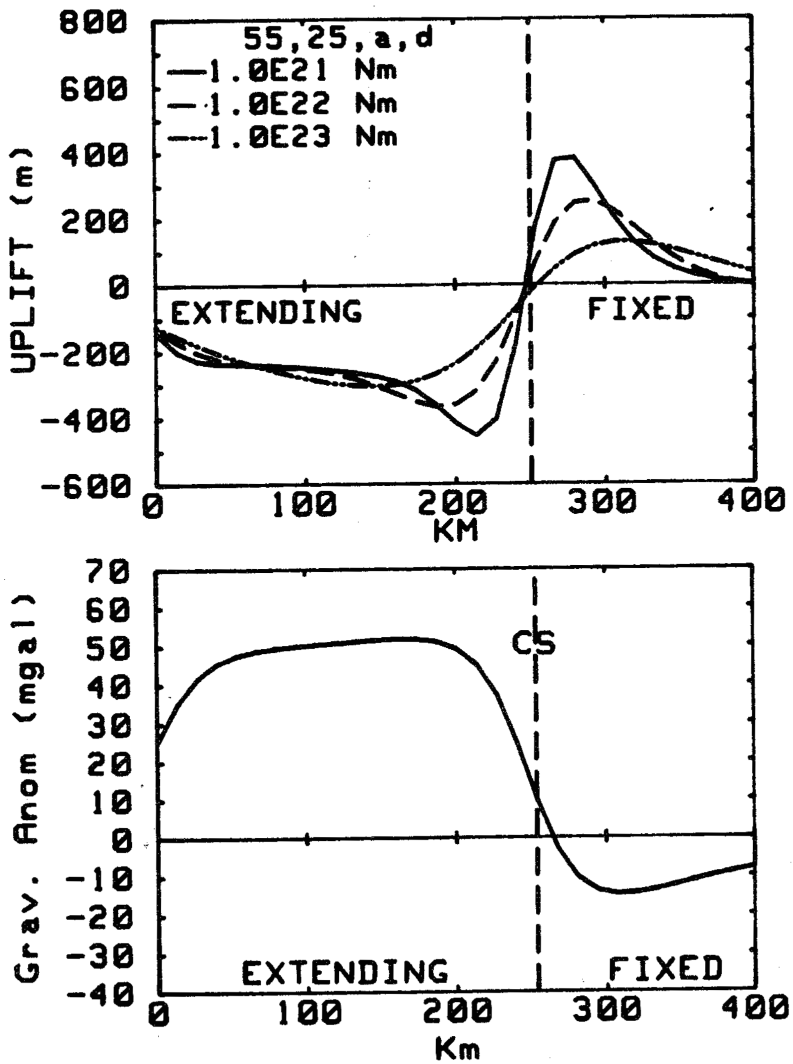

Figure 4

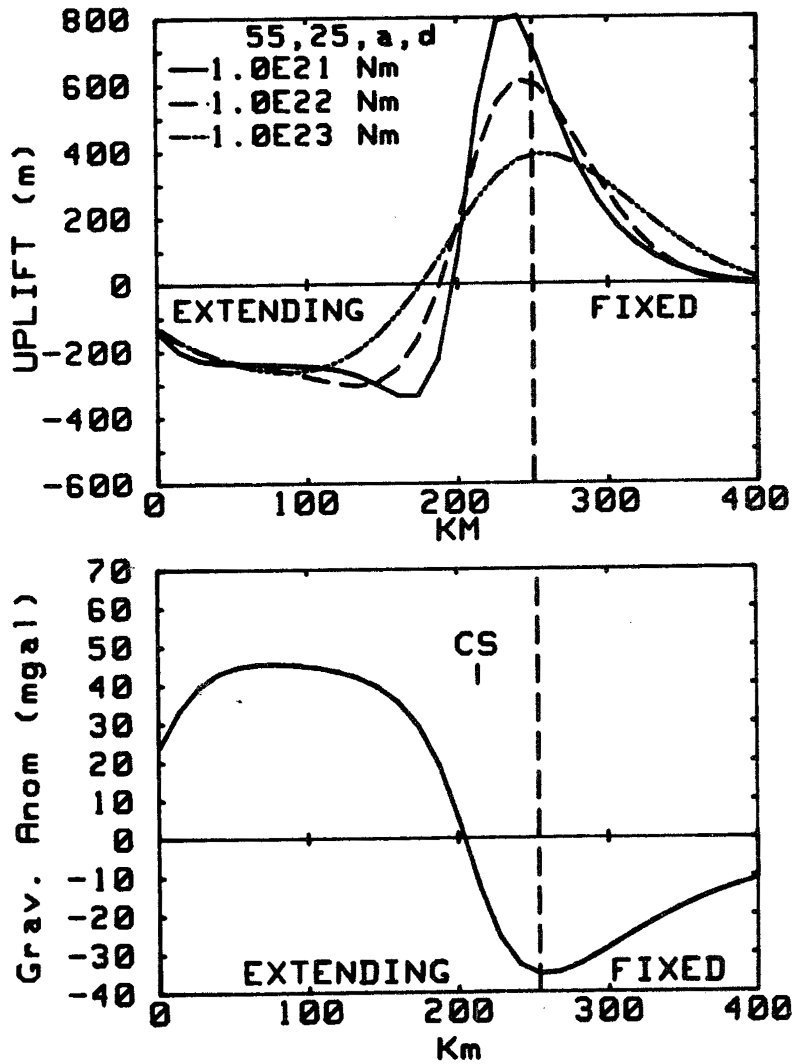

Figure 5