CURRY III, WILLIAM H.

A Postulated two-sided mantle convection sink under the U.S. Cordillera

It is suggested that the deformation of the U.S. Cordillera was caused by BOTH eastward- and westward-directed mantle convection currents which flowed near the base of the lithosphere from the Atlantic and East Pacific Rises to the Farallon subduction complex where both convection currents sank into the mantle along the upper and lower sides of the subduction complex.

Recent studies of seismic tomography (Anderson, Dziewonski, 1984) have been interpreted in terms of a somewhat similar, but deeper, system of mantle convection currents under the western Atlantic, Eastern Pacific, and North American craton; but the interaction of the several converging mantle convection currents remains an enigma. Three-dimensional studies of earthquakes in the subduction complexes of the Pacific margin (Benioff, 1954) indicate that the subduction complexes form a physical boundary to horizontal convection currents to a depth of over 200 km in Central America and to over 600 km in many other subduction complexes.

If the postulated two-sided mantle convection sink were present under the U.S. Cordillera, deformation may have been caused by a combination of: 1) compression between the converging Farallon and North American plates in a belt along the western margin of the Cordillera, AND 2) where the top of the subduction complex was more than 100 km deep, and hence below the base of the North American lithosphere, westward-directed mantle convection currents could have exerted deforming stresses on the base of the lithosphere and on the Farallon subduction complex itself.

Several possible implications of the proposed mantle convection sink are:

1. The Cordilleran Bouguer gravity low appears to reflect massive intrusion of less-dense magmatic fractions into the upper mantle and lithosphere that reached the surface, except in the Laramide Igneous Gap (Armstrong, 1974). Bouguer gravity data indicate a maximum amount of low-density rock which probably intruded during the Laramide in the Cordilleran gravity low in western Colorado. Partial melting of sinking mantle rock, magmatic differentiation of less-dense fractions and vertical rise of the less-dense intrusives are thought to have been caused by the sinking mantle convection currents.

2. It is also suggested that Laramide deformation of the Rocky Mountain Foreland was influenced by a relatively small lithospheric plate centered around the mildly deformed Colorado Plateau and bounded by the western thrust belt and other peripheral mountain ranges (Rocky Mountain small plate).

3. Two forces are thought to have influenced deformation of the Rocky Mountain small plate: 1) slight isostatic rise caused by deep intrusions during the middle Maestrichtian which, in turn, caused regional marine regression and crustal faults along the margin of the small plate and 2) continued strong horizontal compression which caused rotation of large crustal blocks into basement-cored mountains and basins along the faulted margin of the small plate.

4. Compressive deformation of the Cordillera ended from Alaska to southern Mexico about 40 m.y.B.P. yet convergent plate movements continued until 20 m.y.B.P. and continues to the present in some areas (Coney, 1978). In the last 20 million years, large portions of the western Cordillera have undergone large-scale extension (Coney, 1978). The end of compression in the face of continued plate convergence and large-scale extension may have been caused by stresses exerted on the Farallon subduction complex by westward-directed mantle convection currents.

Earth Science Bulletin, 1985