



Are turtleback fault surfaces common structural elements of highly extended terranes?

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Abstract

The Death Valley region of the U.S.A. contains three topographic surfaces resembling the carapace of a turtle. These three surfaces are well exposed along the Black Mountain front and are named the Badwater, Copper Canyon, and Mormon Point Turtlebacks. It is widely accepted that the turtlebacks are also detachment surfaces that separate brittlely deformed Cenozoic volcanic and sedimentary rocks of the hanging wall from the strongly mylonitic, ductilely deformed pre-Cenozoic rocks of the footwall.

We have found a turtleback-like detachment surface along the southern margin of the Alasehir (Gediz) Graben in western Anatolia, Turkey. This surface qualifies as a turtleback fault surface because it (a) is overall convex-upward and (b) separates brittlely deformed hanging wall Cenozoic sedimentary rocks from the ductilely to brittlely deformed, strongly mylonitic pre-Cenozoic footwall rocks. The surface, named here Horzum Turtleback, contains striations that overprint mylonitic stretching lineations indicating top to the NE sense of shear. This suggests that the northeasterly directed Cenozoic extension in the region resulted in a ductile deformation at depth and as the crust isostatically adjusted to the removal of the rocks in the hanging wall of the detachment fault, the ductilely deformed mylonitic rocks of the footwall were brought to shallower depths where they were brittlely deformed.

The turtleback surfaces have been considered unique to the Death Valley region, although detachment surfaces, rollover folds, and other extensional structures have been well observed in other extended terranes of the world. The presence of a turtleback fault surface in western Anatolia, Turkey, suggests that the turtleback faults may be common structural features of highly extended terranes.

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1. Introduction

One of the most spectacular features of Death Valley National Park in eastern California, is the high relief of the Black Mountains front. This topo-

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graphic feature contains three topographic surfaces strikingly similar to the carapace of a turtle because of their overall convex-upward shapes (Fig. 1). Curry (1938, 1954) named them the Badwater, Copper Canyon, and Mormon Point Turtlebacks (Fig. 1). The American Geological Institute, *Glossary of Geology* (fourth edition) defines the term turtleback as “An extensive, smooth, and curved topographic surface, apparently unique to the Death Valley (Calif.) region, that resembles the carapace of a turtle or the nose of a large, elongate dome with an amplitude up to a few thousand meters.”

During the 1990s, the term Turtleback fault emerged as a special type of tectono-morphologic surface distinguished by its unique topographic expression and structural setting (Miller, 1991, 1992; Davis and Reynolds, 1992). Another turtle-

back structure was mapped by Cichanski (1993) in the southwestern Panamint Mountains of the Death Valley region. However, turtleback structures were still considered unique to the Death Valley region. We question, however, that such features are unique to the Death Valley region because we have mapped a turtleback-like fault surface along the southern margin of the Alasehir (Gediz) graben in western Anatolia. This surface, which we name Horzum Turtleback, qualifies as turtleback fault surface because it resembles to the carapace of a turtle with its overall convex-upward geometry. It also has a metamorphic core separated from an overlying body of highly faulted upper crustal rocks by a brittle fault zone.

In this paper, we describe the similarities between the turtleback surfaces in the Death Valley region,

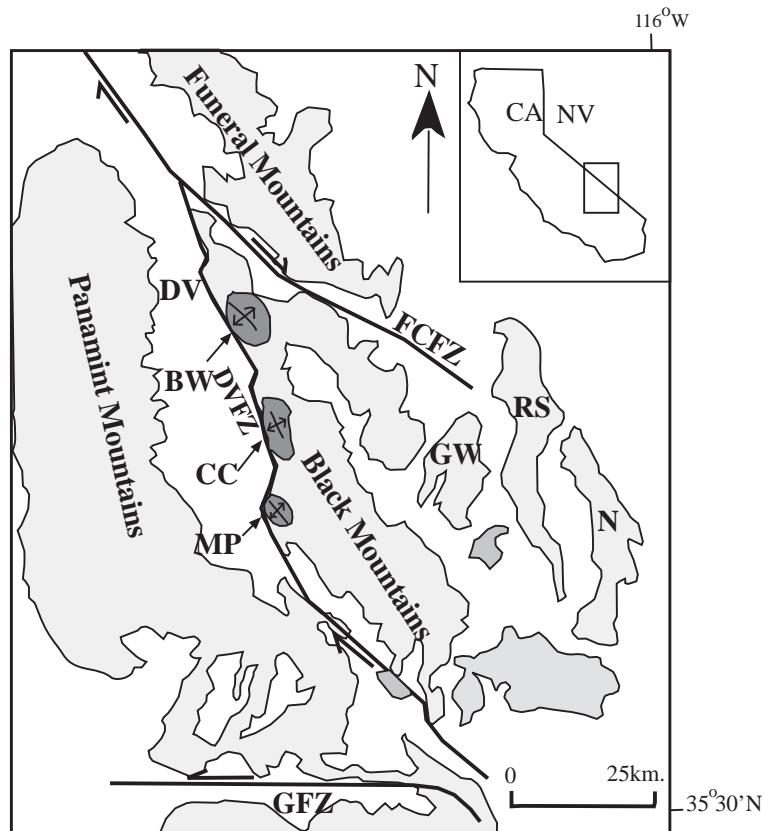


Fig. 1. Map of the Death Valley region showing location of the three turtlebacks. Abbreviations: BW=Badwater Turtleback; CC=Copper Canyon Turtleback and MP=Mormon Point Turtleback; FCFZ=Furnace Creek fault zone; DVFZ=Death Valley fault zone; GFZ=Garlock fault zone; RS=Resting Spring Range; N=Nopah Range. Insert shows the location of the Death Valley region.

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