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**Geology of the Northern Alto Relex
Area, Sierra del Carmen, Big Bend
National Park, Brewster County, Texas**

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Detailed mapping around Alto Relex in the western Sierra del Carmen Mountains in Big Bend reveals Cretaceous rocks that have been folded, sheared and thrust by Laramide compression, cut by Tertiary sills and overprinted by high-angle normal faults from Basin and Range extension. Alto Relex is a prominent, near vertical, ~1,000 foot-high fault line scarp. The general geology of this area was delineated by Moustafa (1988) and was partly mapped by Cooper et al. (2011); this study focuses on the Alto Relex area in more detail. Cretaceous units in the area include the Santa Elena Limestone, Del Rio Clay, Buda Limestone, Boquillas Formation and the Pen Formation. In some areas the thin-bedded, flaggy Boquillas contains folds that have an average axial plane of ~N30°W, 86° SW, low plunge axes, an average inter-limb angle of ~95° and wavelengths of ~6 feet. Minor thrust faults were found in the multiple formations striking ~N18°W, and dipping ~42° SW on average. A large sinistral strike-slip fault on the east side of Alto Relex has been traced for over 2,200 feet striking N40°W. Distinctive reddish-brown fault breccia on the west side of Alto Relex appear to have been silicified, possibly by hydrothermal fluids. Some locations in the study area have slickensides and chatter marks with different orientations within a short distance, suggesting a complex structural history.

