Application of New Seismic Attributes to Collapse Chimneys in the Fort Worth Basin

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ABSTRACT

3-D seismic volumes from the central Fort Worth Basin display collapse chimneys that extend vertically some 800 m from the Ordovician Ellenburger Formation to the Atokan (middle Pennsylvanian) Caddo Limestone. Collapse chimneys in carbonates may be caused by subaerial karst, hydrothermal, or tectonic extensional processes. We have used 3-D geometric attributes including coherence, volumetric curvature, and coherent energy gradients to investigate the origin of these collapse chimneys.

Time slices through the Ellenburger contain features that could be interpreted as subaerially formed cockpit karst, dolines and frying pan valleys. However several lines of evidence show that within the study area, these features are not karst: 1) many of these features coincide with deep basement faults and with Pennsylvanian and younger lineaments; 2) the relatively thin carbonates in the Mississippian to Pennsylvanian interval do not appear to be candidates for subaerial karst; 3) no regional unconformity is associated with the observed collapse features in the lower Atokan Marble Falls limestone; 4) horizon slices on the Upper Atokan Caddo Limestone lack exposure features of significant magnitude to produce top-down karst through 800m of mostly siliciclastic section; and 5) The geometries of the collapse features indicate that they are small tectonic pull-apart basins associated with wrench faults.

By incorporating the timing constraints provided by better imaging of subtle

lineaments in the seismic volume, we hypothesize that many of the sinkhole-like features may represent subaerial karst enhanced by the regional lower Mississippian unconformity, but that first order control on the formation of the vertically extensive collapse chimneys is “bottoms up” tectonic-induced collapse, probably related to Mesozoic or Cenozoic regional extensional tectonics. We speculate that although these collapse chimneys have been affected by burial fluid diagenesis, the main consequence of burial fluid flow may be the documented cementation of macrofractures. The presence of tectonically controlled collapse, coupled with burial fluid flow and subaerial karst has basin-wide implications for distribution of fractures, late-stage cements, and reservoir compartmentalization.