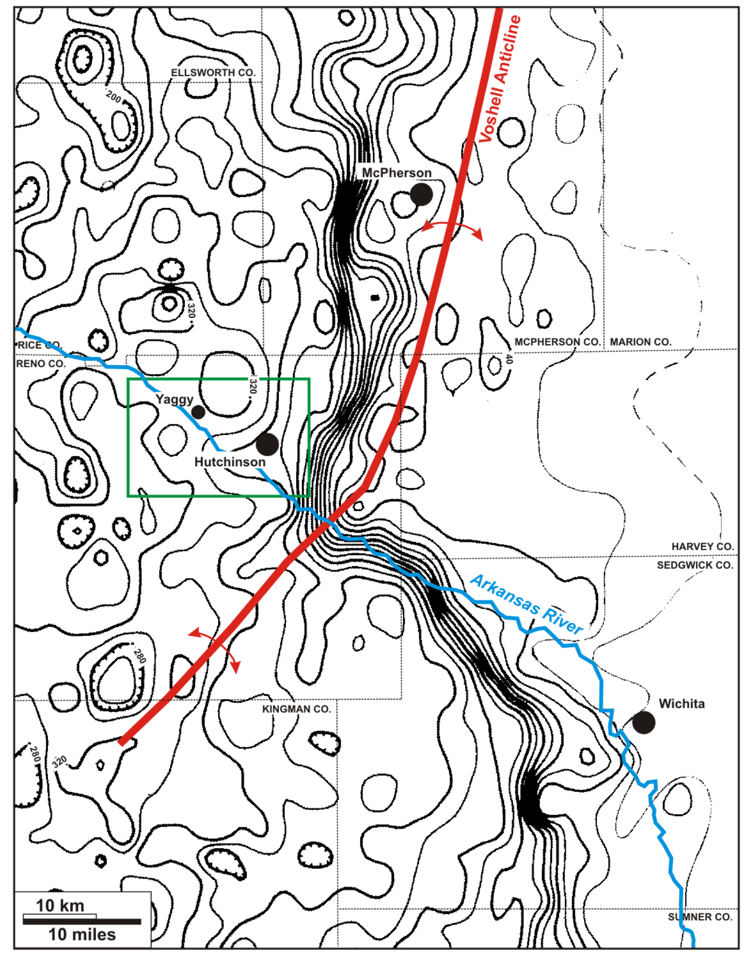
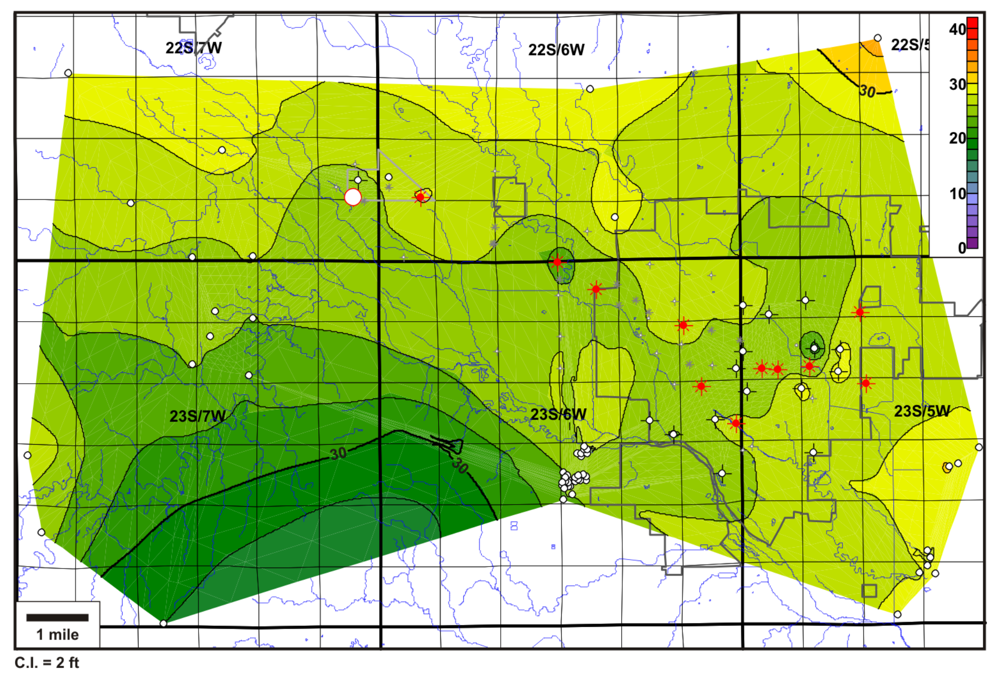
THE ROLE OF EVAPORITE DISSOLUTION

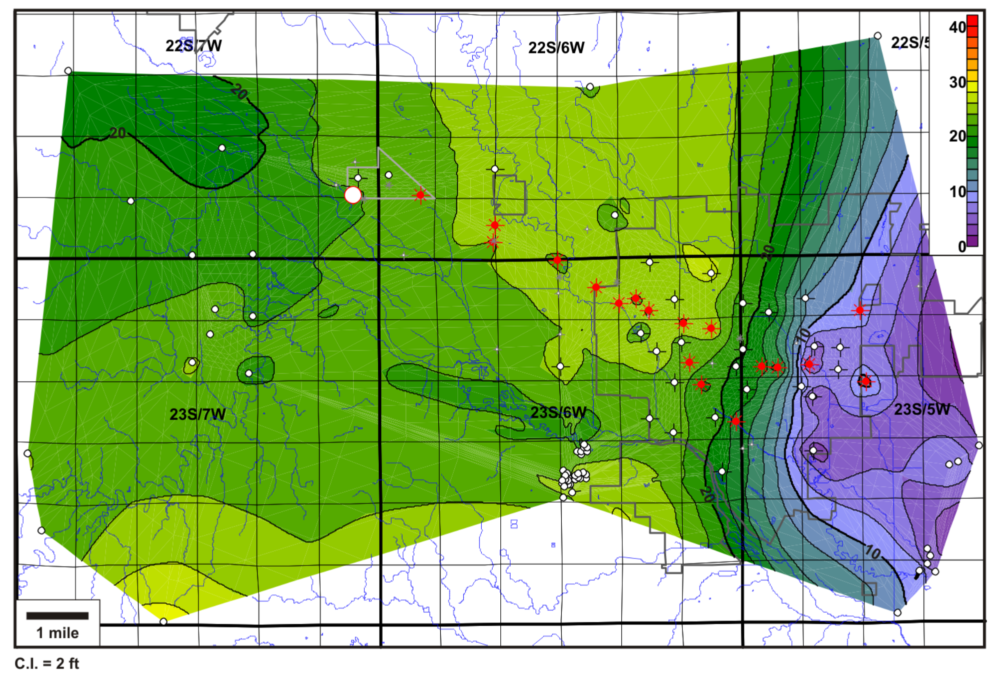


A net-salt isopach map of the Hutchinson Salt Member (Watney and Paul, 1980) shows that the Hutchinson-Yaggy study area (green box) lies within 10 miles of the main salt-dissolution front (closely spaced contours). The axis of the Voshell Anticline, a prominent faulted anticline affecting Paleozoic strata and believed to be related to north-northeast-trending salt dissolution, is shown. A local, northwest trend in the salt-dissolution front between Hutchinson and Wichita coincides with the course of the Arkansas River, which continues along this linear trend for 50 miles to the northwest.

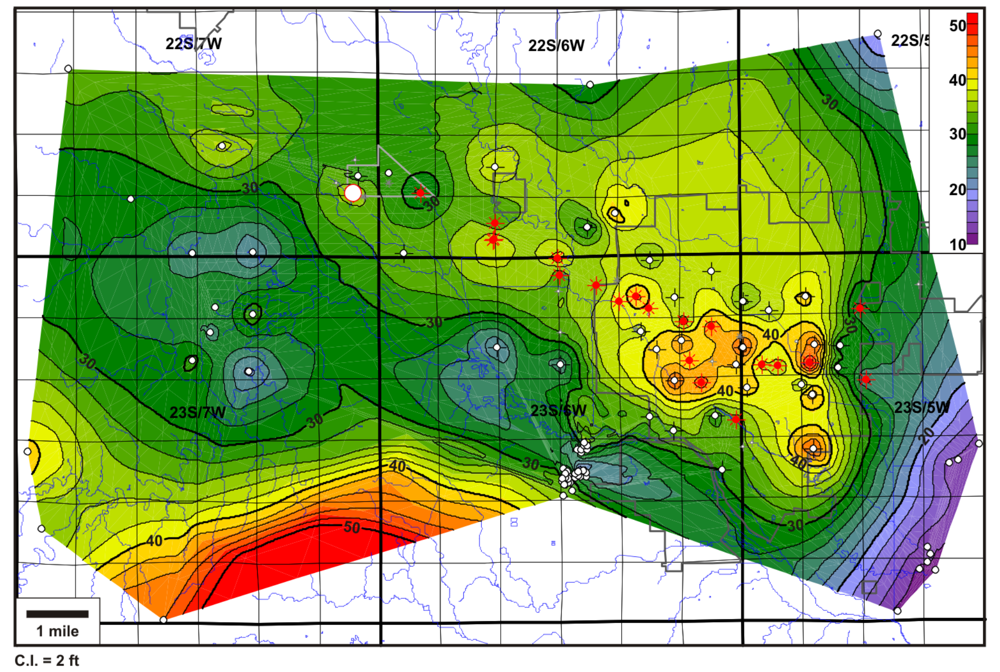
S4 - S3 Isopach



S3 - S2 Isopach

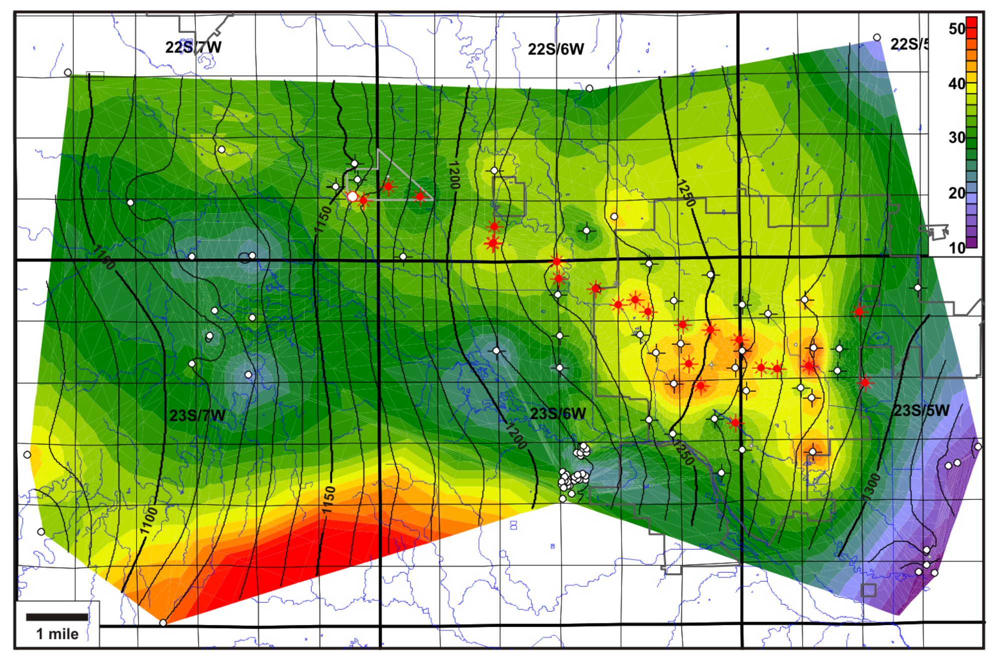


S2 - S1 Isopach



A series of isopach maps of the upper Hutchinson Salt Member shows significant thinning in the upper two salt intervals (S3-S2 and S2-S1) at the eastern edge of the study area. This thinning parallels the northeast-trending main salt-dissolution front. In addition, the S2-S1 interval (and to a lesser degree, the S3-S2 interval) exhibits a 1-2-mile-wide zone of northwest-trending thinning, which follows the Arkansas River to the south and west of Hutchinson. This feature appears to be an extension of the northwest trend in the main salt-dissolution front.

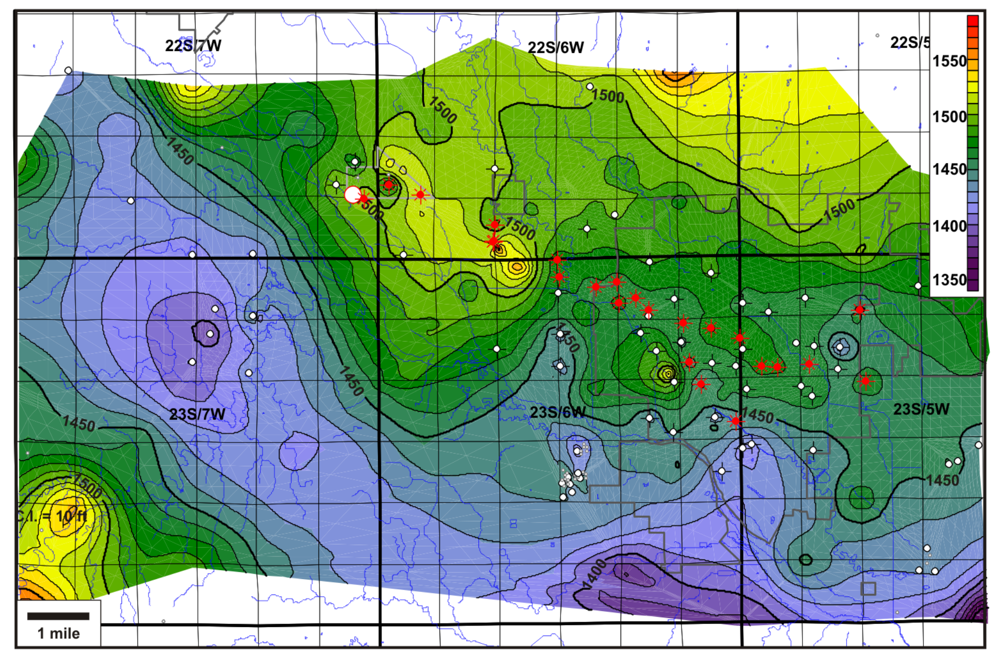
S1 - S2 Isopach with Top 3-Finger Dolomite Contours Superimposed



When structural contours of the top 3-finger dolomite interval are superimposed on the S2-S1 isopach map, it can be seen that the Yaggy-Hutchinson anticline overlies a west-northwest-trending zone of thicker salt and that regions of flexure in the top 3-finger dolomite structure correspond to areas of salt thinning. The flexure is hypothesized to be related in part to subsidence due to salt dissolution. Increased tensional forces in the strata overlying the Hutchinson Salt Member adjacent to areas of salt dissolution most likely created preferred zones of weakness, which may have been exploited as gas pathways.

Thin evaporite layers within the stratigraphic column are also susceptible to focused dissolution. This may be the cause of the localized thinning seen in the M1A to M2 isopach at the location of DDV #64. Collapse and natural fracturing associated with this dissolution may cause sufficient disruption of the stratigraphic column to carry pressured gas from one dolomite-rich interval to another.

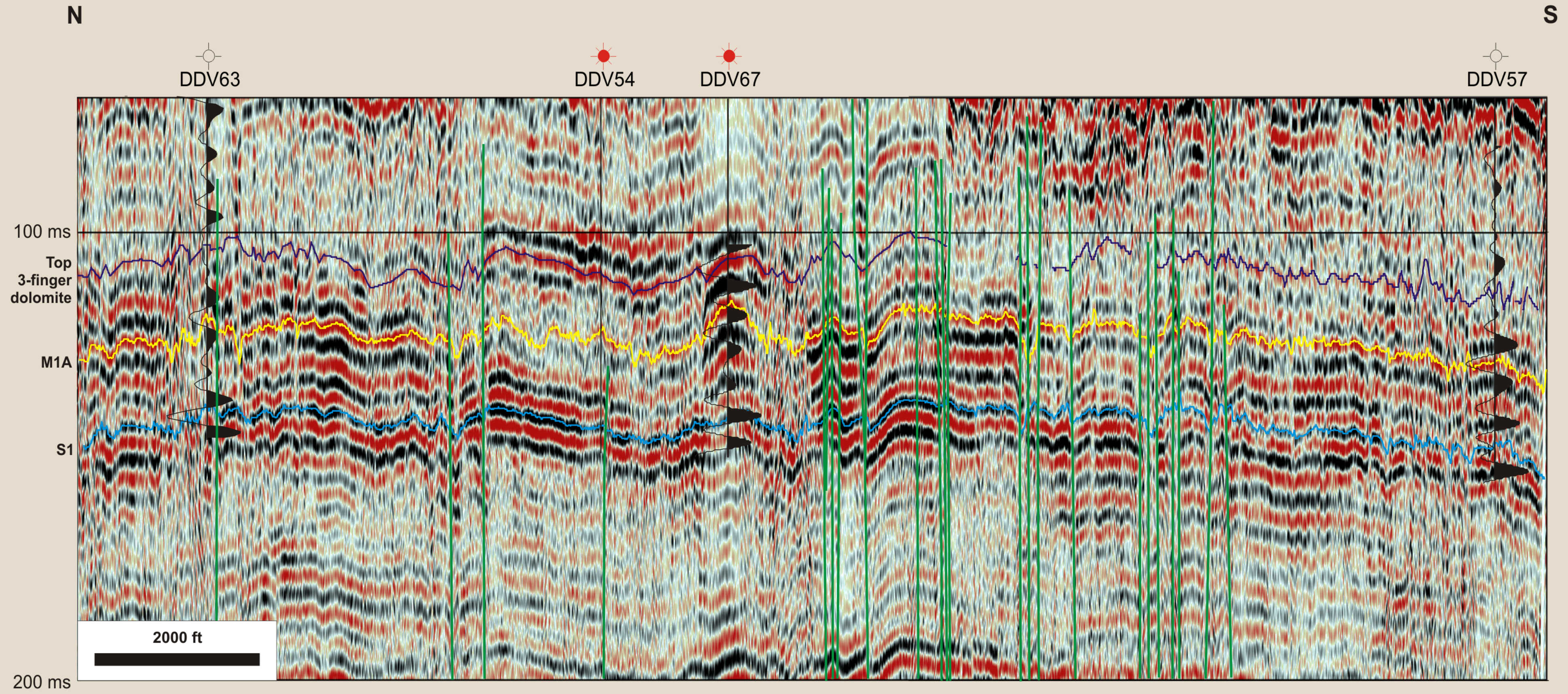
Base Equus Beds Configuration



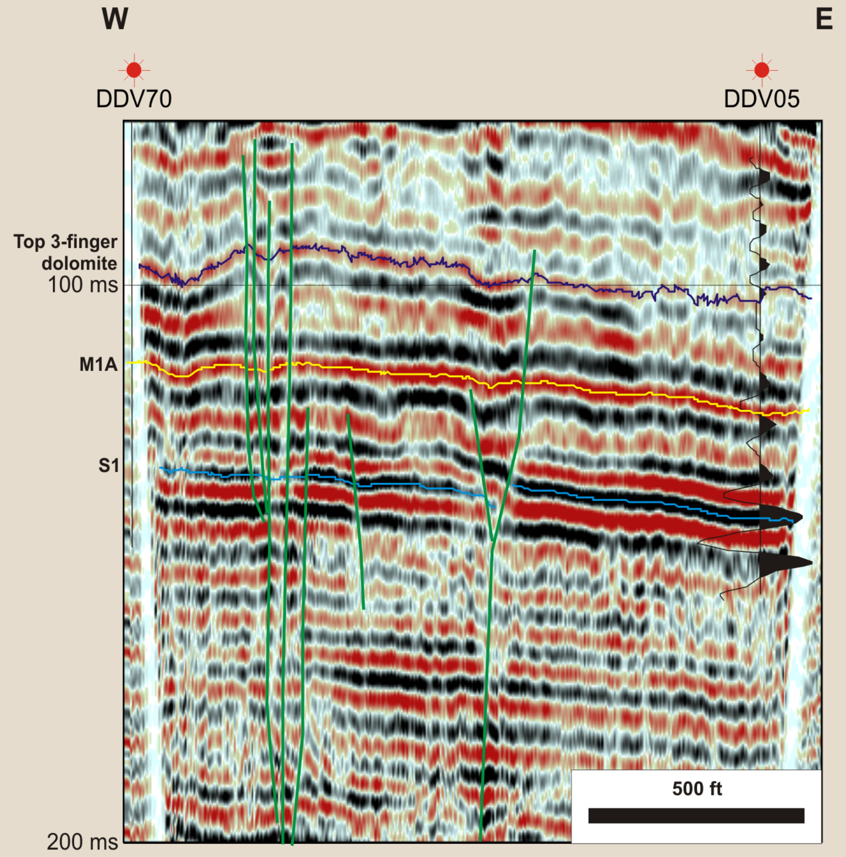
The configuration of the base of the Quaternary Equus beds, an extensive unconfined freshwater aquifer that unconformably overlies the Permian strata in the vicinity of Hutchinson, shows a paleo-valley which follows the same northwest trend as the present Arkansas River valley, as well as closely paralleling the zone of S1-S2 salt dissolution. The coincidence of these patterns suggests a common control, possibly related to episodic structural activation along a zone of basement weakness.

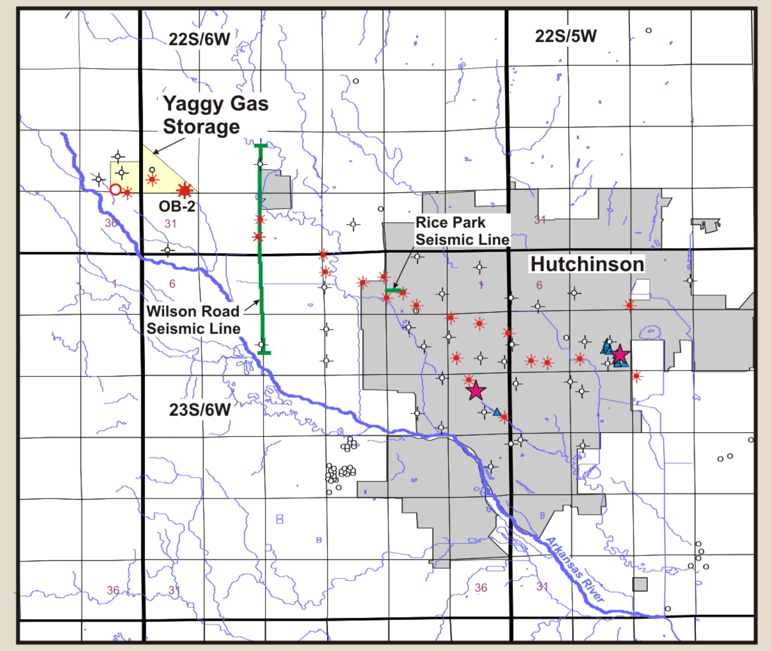
DEEP-SEATED FAULTING AND FRACTURING

Wilson Road Seismic Line

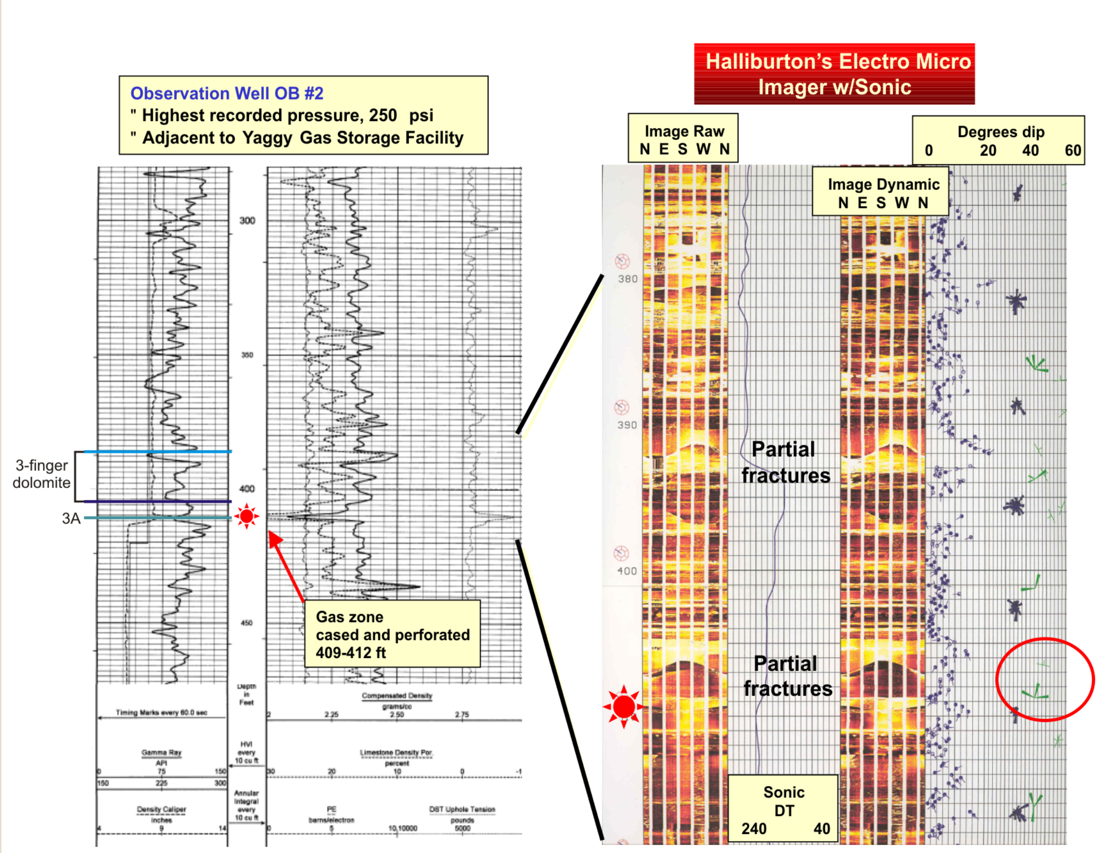


Rice Park Seismic Line



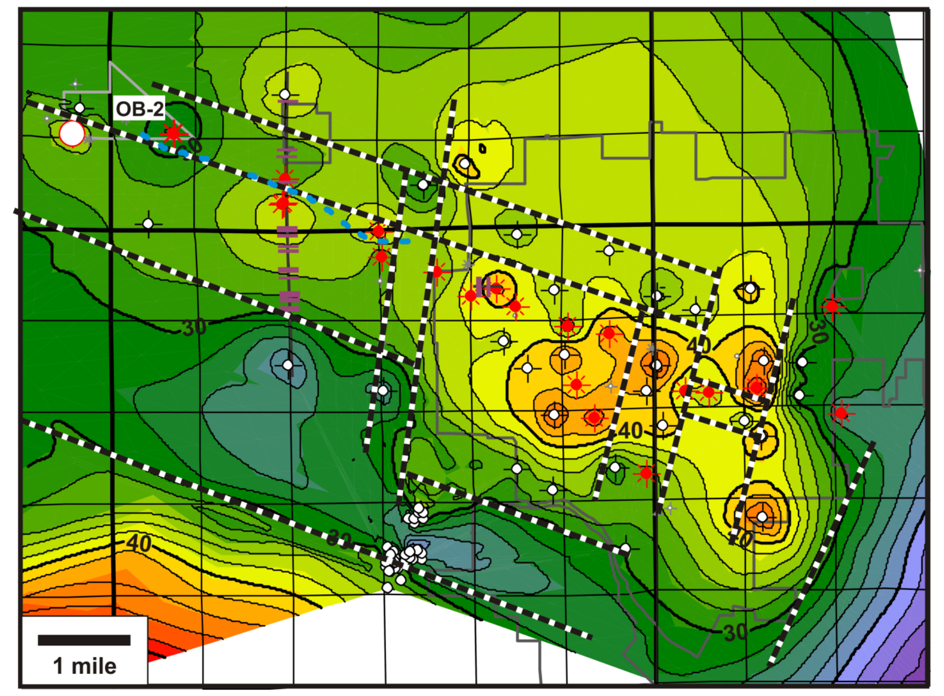


Two high-resolution seismic-reflection surveys were acquired in the Hutchinson area in February 2001. Seismic reflectors were correlated to stratigraphic markers using synthetic seismograms created from sonic and density logs in nearby wells. The seismic amplitude of the gas-bearing 3-finger dolomite interval varies across the study area, for the most part due to lithology changes in the encasing strata. A small volume of gas, such as at DDV #05, creates an amplitude anomaly which is indistinguishable from amplitude variations due to lithology change. The bright spot on the Wilson Road seismic line at DDV #67, however, is diagnostic of a thick zone of gas (Nissen et al., 2004). The seismic lines show a number of apparent faults, which extend below the Hutchinson Salt Member (base of salt is estimated to be 40-50 ms below S1). Most of these faults are also apparent in the sedimentary section above the 3-finger dolomite. The pervasive nature of these faults indicates that they are related to deep-seated structural activity, including movement that followed deposition of the 3-finger dolomite. These faults may have influenced salt dissolution and provided possible gas pathways. Evidence for salt dissolution associated with deep-seated faults can be seen at the center of the Rice Park seismic line. Here, two conjugate faults are visible which offset the S1 reflector and form a depression in the overlying strata. These faults appear to converge 8-9 ms below the S1 reflector. A faulted zone continues deeper into the section, but without significant vertical offset. This suggests that the shallow faults resulted from salt dissolution near the top of the salt, focused along a deeper structural element.



Formation micro-imaging log (right) alongside conventional gamma ray-caliper-neutron-density-photoelectric log (left) for observation well OB #2. The 3A zone is a gas-bearing dolomite interval in this well, exhibiting washout and gas show on drilling.

Scalloped patterns on the formation micro-imaging log in the interval encompassing the 3-finger dolomite and 3A are partial fractures with dips of approximately 50 degrees. The partial fractures are oriented west-northwest, while healed fractures occur along a north-south axis. These fractures parallel the two major lineaments observed in mapping.



S2-S1 isopach map with a preliminary interpretation of structural lineaments superimposed (heavy dashed lines). Locations of faults intersecting the S1 horizon, as interpreted from the Wilson Road and Rice Park seismic lines, are shown as short purple lines. The dashed blue line indicates the boundary between gas in the 3A zone (to the north) and in the 3-finger dolomite (to the south). This boundary is nearly coincident with a northwest-trending lineament interpreted as the edge of a narrow salt-dissolution trough to the north of the Yaggy-Hutchinson anticline. The lineament may represent a zone of weakness that allowed vertical migration of high-pressure gas from 3A to the 3-finger dolomite. OB-2, which exhibits west-northwest fractures, lies adjacent to this lineament. The orientations of the fractures on the seismic lines are unknown; however, fractures on the Wilson Road seismic line appear to preferentially occur on the flanks of the Yaggy-Hutchinson anticline, suggesting that they may have contributed to the salt dissolution that enhanced relief of this anticline.